

UCD-5XX



User Manual

UCD Console SW Version 2



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1. ABOUT THIS MANUAL

Purpose

This guide is User Manual of UCD-500 Series, that are USB-connected video interface test units for use with a PC with Windows® 11, Windows® 10 or Windows® 8 operating system.

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 UCD-500 units.
- Provide instructions for the user on how to use UCD Console software.

Product and Software Version

This manual explains features found in UCD Console Software Bundle **2.4**. 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

Note: This version of the User Manual describes features in UCD Console version 2 based on the functionality in Microsoft Windows operating system.
UCD Console version 2 is available also for macOS operating system to be used in iMac and MacBook computers and for Linux operating system. Detailed description of the macOS and Linux versions will be added later.

2. INTRODUCTION

Product Description

UCD-500 family are high speed, USB 3.0 connected video interface test units.

UCD Console is common graphical user interface (GUI) for Unigraf's UCD-500 series, UCD-400 and UCD-300 series units. The outlook and details of UCD Console will vary depending on the capabilities of the connected unit and will reflect the features enabled.

The software package for UCD-500 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.

Product Features

- **UCD-500:** DP 2.0 / DP 2.1 capable Reference Sink and Reference Source for verifying DP and USB-C connected devices with link rates up to 20 Gbps (UHBR20) using USB-C interface and 10 Gbps (UHBR10) using DP interface.
- **UCD-500 Gen2:** DP 2.1 capable Reference Sink and Reference Source for verifying DP and USB-C connected devices with link rates up to 20 Gbps (UHBR20)
- High resolution video and audio capture up to 8K @60Hz, 16K @60Hz with DSC
- Generate HDR formats such as Dolby Vision™, HDR 10 and HDR 10+
- 16 GB capture memory
- High speed USB 3.0 host PC interface

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

Available Interface Roles

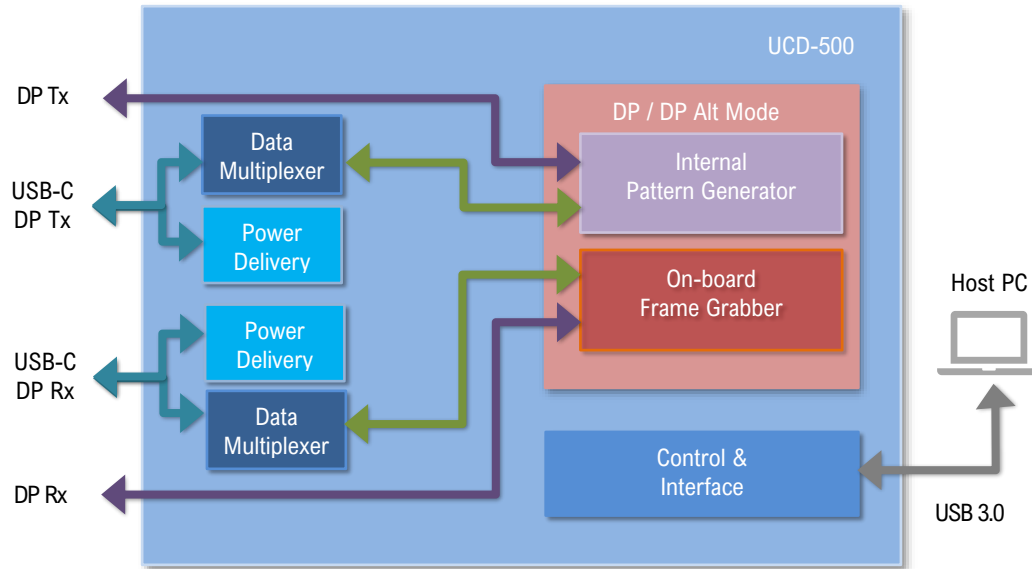
UCD-500 products are able to operate in various interface role combinations. The used role is selected when UCD Console is launched.

Selection	UCD-500	UCD-500 Gen2
DisplayPort Sink and Source	•	•
USB-C DP Alt-Mode Sink and Source	•	•
DisplayPort Source and USB-C DP Alt-Mode Sink	•	•
USB-C DP Alt-Mode Source and DisplayPort Sink	•	•

Functional Description

UCD-500 units consist of a multimedia signal input stage, an internal pattern generator, a control stage with on-board frame buffer 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.

UCD-500 Functional Diagram



Delivery Content

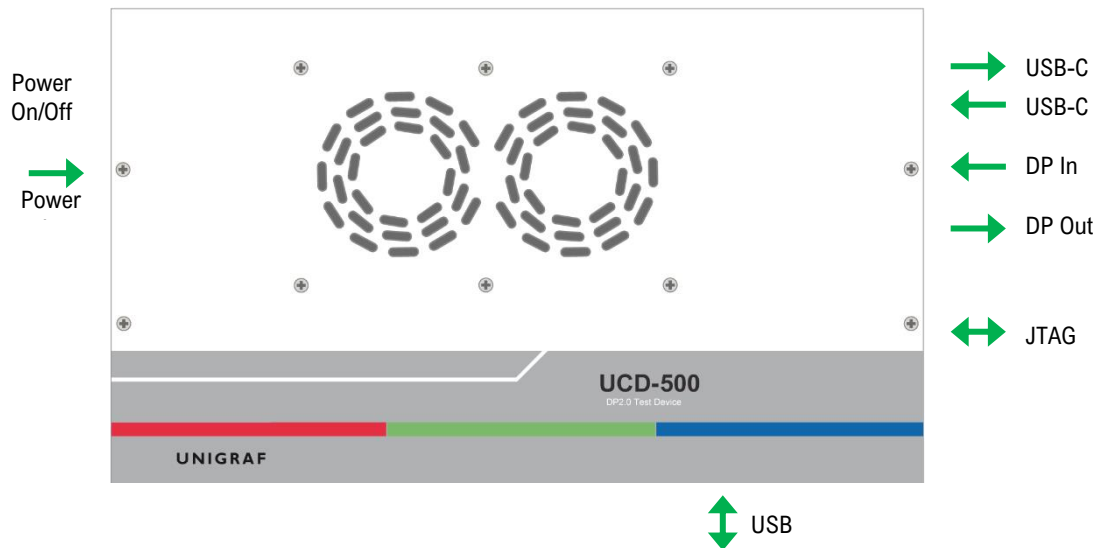
Please find below an image of the items included in UCD-500 delivery



1. UCD-500 Unit
2. AC/DC Power Supply (100 to 240 Vac 50/60Hz input, +12 Vdc output)
3. DisplayPort cable 0.5 meters length
4. Micro USB cable for FW update
5. Passive TBT4 cables, 0.5 and 1.0 meters length
6. USB 3.0 compliant cable for host PC connection

Connections

The image below indicates the connections in **UCD-500** and **UCD-500 Gen2** unit and their description.



Name	Description
DP in	DisplayPort™ 2.1 capable input (*)
DP out	DisplayPort™ 2.1 capable output (*)
USB-C in	USB-C PD 3.0 DP Alt-Mode input (20 Gbps)
USB-C out	USB-C PD 3.0 DP Alt-mode output (20 Gbps)
Power in	+12 Vdc Power Supply Input
Power On/Off	Rocker power switch
USB	USB 3.0 connection to the host PC
JTAG	JTAG interface for maintenance purposes

* In UCD-500 10 Gbps link rate maximum, in UCD-500 Gen2 20 Gbps link rate maximum

Note Capturing and sourcing high resolution video modes and high frame rates set stringent requirements on the video cables and connectors. If in doubt, please contact Unigraf Support.

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.

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 a 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/>

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

- Windows drivers (installed during set up)
- UCD Console software (installed during set up)
- License Manager (installed during set up)
- Device configuration utility (installed during set up)
- DSC compression tools (installed during set up)
- DSC Content library (optionally 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.

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

Note: System administrator's privileges are required for performing the installation.

Software Installation

- Start the installation by running application **SoftwareBundle_X.X.XXXX**

Once the installer has started, a welcome page is displayed. The welcome page shows the software package release version.

The user is also asked to confirm

- Creating a desktop shortcut
- Installation of Visual C++ redistributable (needs to be present in Windows)
- Installation of Unigraf USB drivers
- Installation of DSC Content library

Note: The size of the DSC Content Library Generator with supporting files is 2.6 Gbytes

Next dialog confirms the selections made. If you are ready, click **Install** to start the installation.

Click **Finish** to exit the installation dialog.

Firmware Installation

Along with the change to UCD Console version 2, Unigraf is restructuring the SW builds and releases. For the time being we are releasing FW packages separately from SW for UCD product families. This means that SW installation **does not** automatically install the new FW package.

After SW installation is completed, please download the **FirmwarePackage_X.X.XXXX** also available on Unigraf download page <https://www.unigraf.fi/downloads/> and run the included application.

New firmware files will automatically be copied to the correct location in the PC. Please follow instructions in *Firmware Update Procedure* below to update firmware in the UCD device.

Firmware Update Procedure

UCD Configuration Utility is used to load an updated firmware to the device. As an option, UCD Configuration Utility can be used to select possible operation roles present in the UCD unit. A firmware set for the selected operation roles is created and the firmware set is programmed to the device. Please contact Unigraf for details.

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-500 device, please perform the following steps:

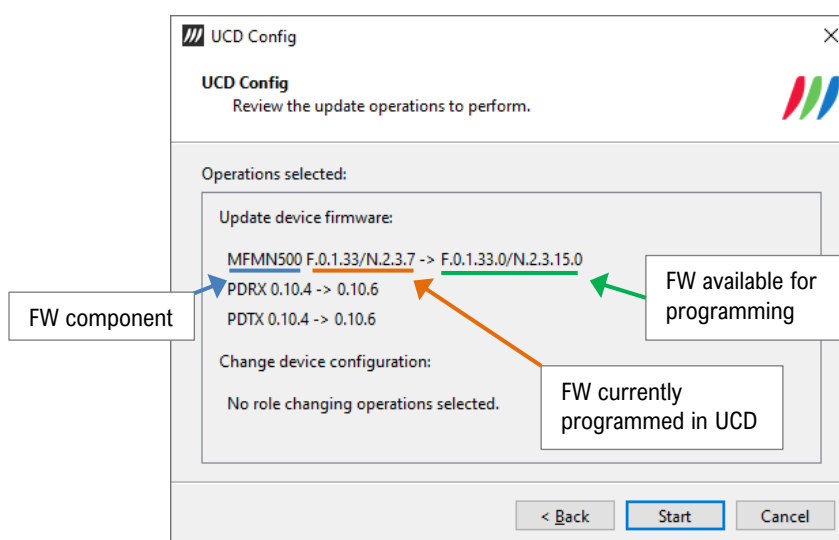
- ▶ Connect the UCD unit to a power supply and connect the USB cable.
- ▶ Open UCD Console. Select Tools > Firmware Update.

The first page of the utility indicates the firmware component versions present in the package. Please click Next.

From the list of connected UCD devices please select the one that you want to update. Click Next.

Updated Modules

The tool lists the FW components available in the UCD device, the currently programmed FW version, and the FW installed in the PC for programming.



- ▶ Click Start to start programming.

Power Cycle

When re-initiating the firmware of a UCD device the whole process cannot be done during one session. Therefore, on certain point, user needs to power cycle the device (switch off power from UCD device > wait for 10 seconds > re-apply power to UCD device).

- ▶ Click OK button on the dialog.

Note: The procedure may take several minutes depending on the speed of the USB connection of the host PC.

License Manager

Licensing

The features of UCD Console GUI 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**. License manager can be found in the **Tools** menu of UCD Console.

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.

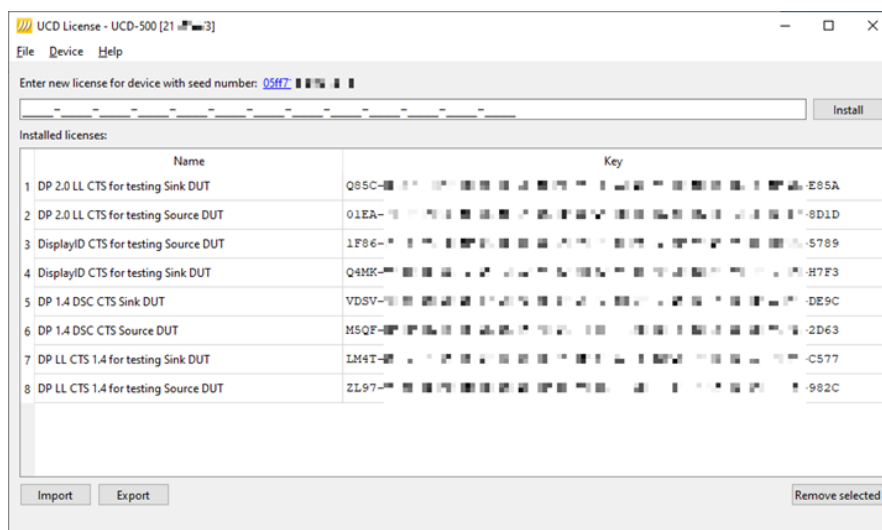
The **Rescan...** button will re-scan the system for installed hardware.

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 the **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.

Please 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 notice, 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. 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 Version 2 is the 2nd generation 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 the problem detection.

In UCD Console 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.

Note:

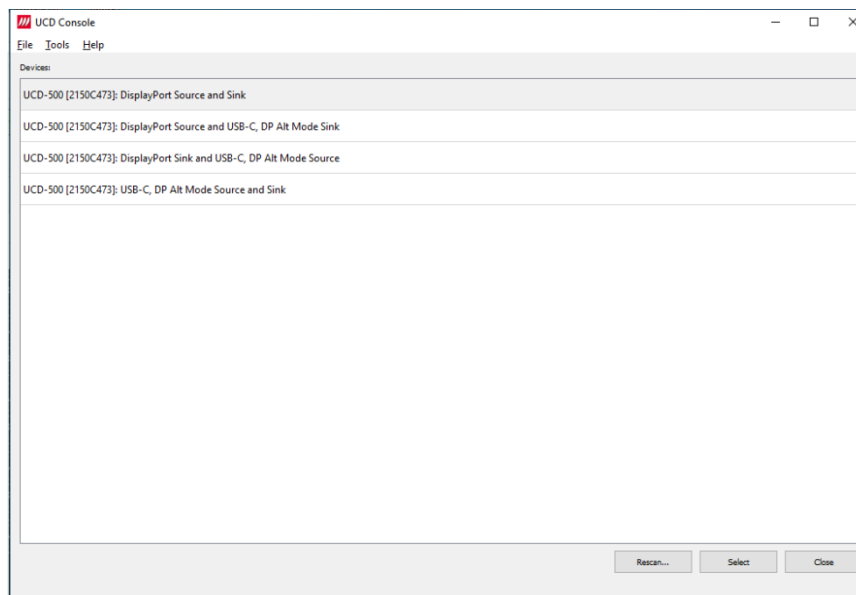
This version of the User Manual describes features in UCD Console version 2 based on the functionality in Microsoft Windows operating system.

UCD Console version 2 is available also for macOS operating system to be used in iMac and MacBook computers and for Linux operating system. Detailed description of the macOS and Linux versions will be added later.

Device Selection

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

Once UCD Console GUI 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.

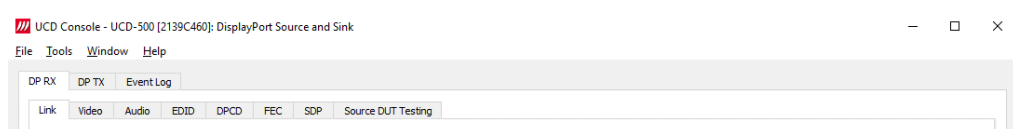


Role Selection

UCD-500 features two alternative Sink interfaces (DP and USB-C), and in a similar way two alternative Source Interfaces. One Sink role and one Source role can be active at one time. Sink / Source role selection is done by selecting one of the four combinations during launch of UCD Console.

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**.

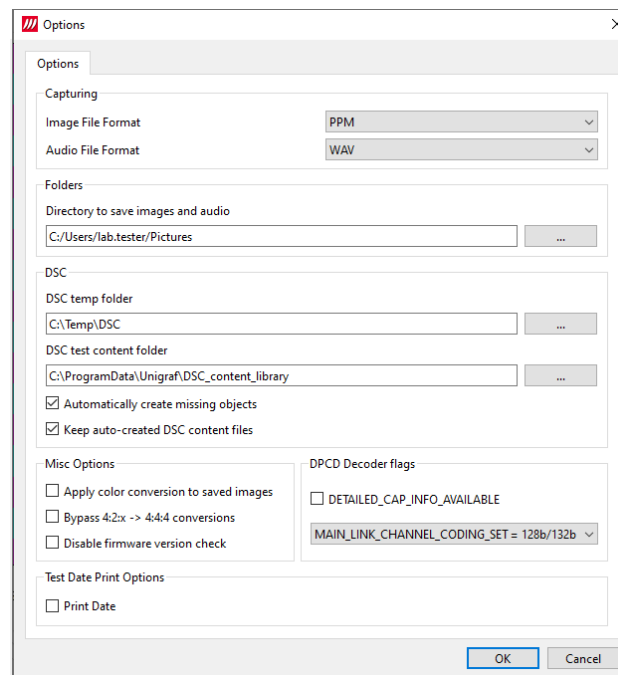


Image File Format

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

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>Automatically create missing content</i>	When selected, compliance test tool During execution of DSC Compliance Tests, the tool automatically creates the DSC compressed content used for testing the DUT.
<i>Keep auto-created</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.

Misc. Options

<i>Apply color conversions to saved images:</i>	When saving captured frames, the Color Mode selected in <i>Video</i> tab will be applied also to saved images.
<i>Bypass 4:2:x -> 4:4:4 conversions:</i>	4:2:2 and 4:2:0 images are previewed and stored as received, without pixel doubling.
<i>Disable firmware version check:</i>	UCD Console lets the user operate a non-matching Software / Firmware combination. NOT RECOMMENDED.

DPCD Decoder flags

Parameters for DPCD decoder in parsing AUX Channel transaction is DPCD Editor and Event Log.

<i>DETAILED_CAP_INFO_AVAILABLE:</i>	Information about DFP capability field in Sink DPCD register.
<i>MAIN_LINK_CHANNEL_CODING_SET</i>	Selection of used main link coding 8b/10b or 128b/132b

Test Date Print Options

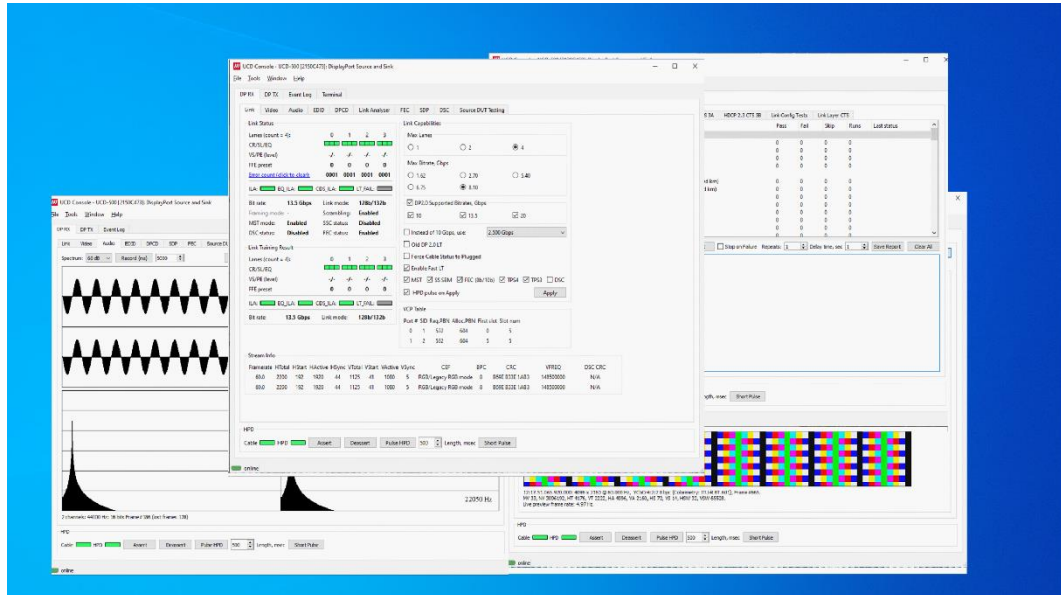
Configure DUT Testing reports.

<i>Print Date:</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-500 device acts as DisplayPort or USB-C DisplayPort Alt Mode Sink or Receiver device.

Analyzer functionality related controls and dialogs can be used by selecting *DP RX* tab.

Please note that in UCD-500, *Generator* functionality is available simultaneously with Analyzer. Please find description of Generator functionality later in this manual.

Functionality Tabs

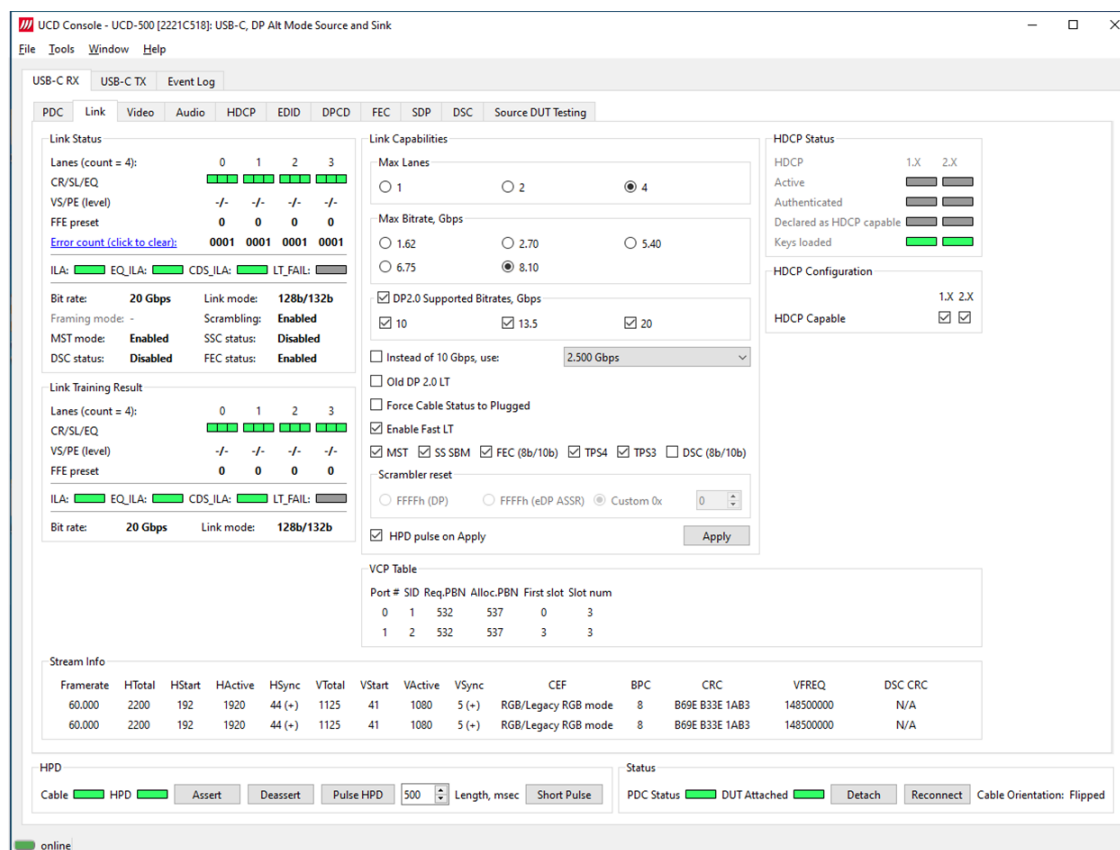
UCD Console features are presented in tabs. Some of the tabs are enabled by default, some only when an applicable license is included.

Note:

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









Link Tab

Link tab contains the following panels: Link Status, Link Training Result, Link Capabilities, VCP Table, Stream Info and HPD.



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.









Link Status							
Lanes (count = 4):	0	1	2	3			
CR/SL/EQ							
VS/PE (level)	-/-	-/-	-/-	-/-			
FFE preset	0	0	0	0			
Error count (click to clear):	0001	0001	0001	0001			
ILA:		EQ_ILA:		CDS_ILA:		LT_FAIL:	
Bit rate:	20 Gbps		Link mode:	128b/132b			
Framing mode:	-		Scrambling:	Enabled			
MST mode:	Enabled		SSC status:	Disabled			
DSC status:	Disabled		FEC status:	Enabled			

<i>Lanes:</i>	Indicates the number of lanes used for DisplayPort or DisplayPort Alt Mode.
<i>CR/SL/EQ:</i>	LED indicators for status of Clock Recovery / Symbol Lock / Channel Equalization for each of the four lanes
<i>VS/PE (level):</i>	Voltage Swing / Pre-emphasis level
<i>FFE Preset:</i>	TX Feed Forward Equalization (FFE) preset value (only with 128b/132b channel coding)
<i>Error count:</i>	Content of DPCD Error Count registers
<i>ILA:</i>	Status LED for Inter-Lane Alignment
<i>EQ_ILA</i>	Status LED for Inter-Lane Alignment on Equalization stage
<i>CDS_ILA</i>	Status LED for Inter-Lane Alignment on Clock and Data Switch stage
<i>LT_FAIL</i>	Status LED for Link Training failure
<i>Bit rate:</i>	Currently enabled link bit rate
<i>Link mode:</i>	Currently enabled channel coding (128b/132b or 8b/10b)
<i>Framing mode:</i>	Currently enabled Framing Mode (Normal or Enhanced) (only with 8b/10b channel coding)
<i>Scrambling:</i>	Status of link data scrambling (Enabled or Disabled)
<i>MST mode:</i>	Status of Multi-stream transport (Enabled or Disabled)
<i>SSC Status:</i>	Status of Spread-Spectrum Clock (Enabled or Disabled)
<i>DSC Status:</i>	Status of Display Stream Compression (Enabled or Disabled)
<i>FEC status:</i>	Status of Forward Error Correction function (Enabled or Disabled)

Note: Spread-Spectrum Clock feature will be supported in later versions of UCD-500

Link Training Result

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

Link Training Result				
Lanes (count = 4):	0	1	2	3
CR/SL/EQ				
VS/PE (level)	-/-	-/-	-/-	-/-
FFE preset	0	0	0	0
ILA:  EQ_ILA:  CDS_ILA:  LT_FAIL: 				
Bit rate:	20 Gbps		Link mode:	128b/132b

<i>Lanes:</i>	Indicates the number of lanes used for DisplayPort or DisplayPort Alt Mode.
<i>CR/SL/EQ:</i>	LED indicators for status of Clock Recovery / Symbol Lock / Channel Equalization for each of the four lanes
<i>VS/PE (level):</i>	Voltage Swing / Pre-emphasis level
<i>FFE preset:</i>	TX Feed Forward Equalization (FFE) preset value (only with 128b/132b channel coding)
<i>ILA:</i>	Status LED for Inter-Lane Alignment
<i>EQ_ILA</i>	Status LED for Inter-Lane Alignment on Equalization stage
<i>CDS_ILA</i>	Status LED for Inter-Lane Alignment on Clock and Data Switch stage
<i>LT_FAIL</i>	Status LED for Link Training failure
<i>Bit rate:</i>	Currently enabled link bit rate
<i>Link mode:</i>	Currently enabled channel coding (128b/132b or 8b/10b)

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.

<i>Max Lanes:</i>	Maximum lane count used
<i>Max Bitrate, Gbps:</i>	Maximum link rate used when 8b/10b link coding is selected in LT.
<i>DP2.0 Supported Bitrates, Gbps:</i>	When selected 128b/132b link coding is supported. Link rates used when 128b/132b link coding is selected in LT. Please observe the Note below.
<i>Instead of 10 Gbps, use:</i>	For supporting low link rate Source devices, the user can make UCD-500 sink PHY use a selectable lower link rate when performing “10 Gbps” link training in protocol level. Link rates are: 2.5 Gbps, 2.7 Gbps, 5.0 Gbps and 5.4 Gbps
<i>Old DP 2.0 LT:</i>	When checked LT will follow initial DP 2.0 spec description. Otherwise, LT as per DP2.0 SCR LT (DP 2.0 Errata)
<i>Force cable status to plugged:</i>	When checked, sink functionality is active regardless of a failure of upstream device detection e.g., due to incorrect AUX Channel electrical termination.
<i>Enable Fast LT:</i>	Indicates support for link training without AUX transactions.
<i>MST:</i>	When 8b/10b link coding enabled, indicate support for MST mode and Sideband MSG handling. When 128b/132b link coding enabled, indicate support for multi-stream transport and Sideband MSG.
<i>SS SBM:</i>	When selected, indicate support Sideband MSG while not supporting multi-stream transport. Valid only when “MST” is unchecked.
<i>FEC (8b/10b):</i>	Indicated support for Forward Error Correction feature when 8b/10b link coding is enabled
<i>TPS4, TPS3:</i>	Indicate support for Link Training Pattern Sequence 4 and 3 correspondingly.
<i>DSC (8b/10b):</i>	Select to enable Display Stream Compression (DSC) feature when 8b/10b link coding is enabled
<i>Scrambler Reset:</i>	Selection of the value to which the Linear Feedback Shift Register (LFSR) is reset during scrambler reset
<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.

To update the new status to the DPCD registers click **Apply**.

Note: Please note that deviating from the rules set in DP 2.1 Specification, UCD-500 allows selection of maximum link rate for 8b/10b coding also when support for 128b/132b link coding is enabled.

Note: When changing link coding capability of the Sink device (8b/10b vs 128b/132b), please make sure to issue a Long HPD Pulse after applying new setting or make sure that "HPD pulse on Apply" is selected before applying the change

Stream Info

Stream Info is achieved from the Main-Stream Attributes (MSA) of the monitored stream. Frame rate is measured by UCD Local Sink

Stream Info													
Framerate	HTotal	HStart	HActive	HSync	VTotat	VStart	VActive	VSynC	CEF	BPC	CRC	VFREQ	DSC CRC
60.0	2200	192	1920	44	1125	41	1080	5	RGB/Legacy RGB mode	8	0000 01C1 0000	148500000	N/A
60.0	2200	192	1920	44	1125	41	1080	5	RGB/Legacy RGB mode	8	B69E B33E 1AB3	148500000	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.
<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.
<i>CEF</i>	Used color mode: Color format + subsampling / colorimetry
<i>BPC</i>	Color depth in bits per color (BPC)
<i>CRC</i>	16-bit Cyclic redundancy check (CRC) value per color component calculated from active pixels
<i>VFREQ</i>	Video Frequency (128b/132b channel coding only)
<i>DSC CRC</i>	16-bit Cyclic redundancy check (CRC) calculated from compressed pixel stream

VCP Table

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

VCP Table					
Port #	SID	Req.PBN	Alloc.PBN	First slot	Slot num
0	1	532	604	0	5
1	2	532	604	5	5

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

<i>Port#:</i>	Port number where the virtual channel is directed.
<i>SID:</i>	Stream identification number of the virtual channel
<i>Req.PBN:</i>	Requested PBN (payload bandwidth number) 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.

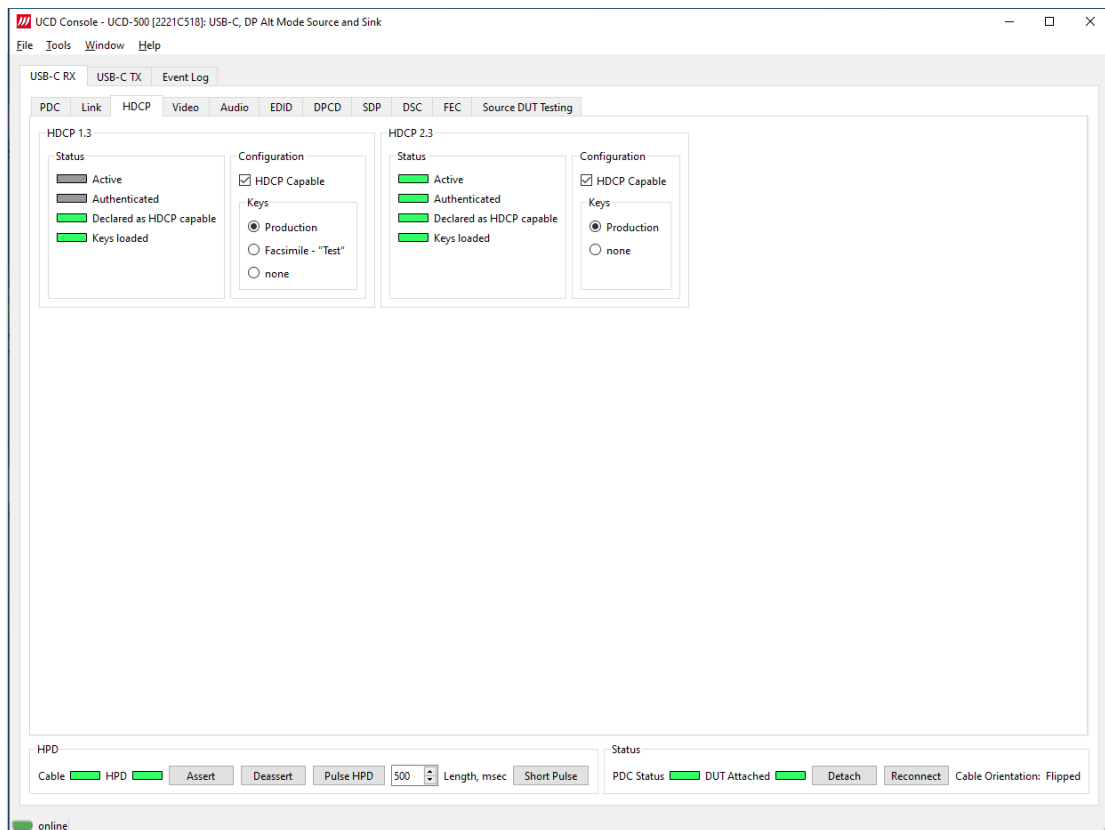
HPD

The HPD control interface includes two green LEDs labeled 'Cable' and 'HPD'. To the right are four buttons: 'Assert', 'Deassert', 'Pulse HPD', and 'Short Pulse'. The 'Pulse HPD' button is followed by a numeric input field containing '500' and a unit label 'Length, msec'.

<i>Cable:</i>	LED indicates that the hardware has detected an upstream cable.
<i>HPD:</i>	LED indicates that the HPD signal is Asserted (logical “high”).
<i>Assert:</i>	Click to re-activate the HPD line (set to logical “high”).
<i>Deassert:</i>	Click button to set HPD line to logical “low” (de-asserted) and hence no HPD pulse can be generated.
<i>Pulse HPD:</i>	Click to apply an HPD Pulse with programmable duration. Duration will be defined in the provided field.
<i>Short Pulse:</i>	Click to apply a short pulse. Pulse duration is 1 ms.

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

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.

Configuration

HDCP Capable: To disable HDCP, uncheck the box.

Keys

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

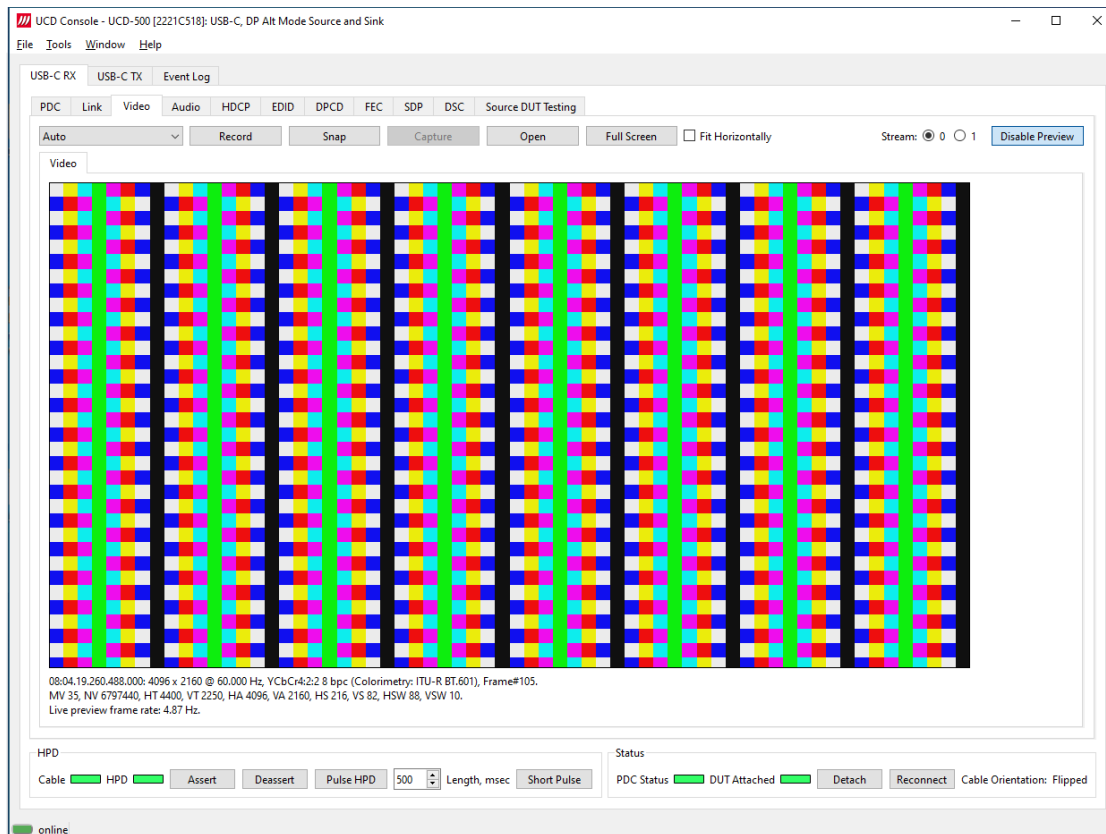
HDCP 1.3 vs. HDCP 2.3

UCD-500 devices support by default both HDCP 1.3 and HDCP 2.3 standard.

Note: With current SW release UCD-500 supports HDCP only when 8b/10b link coding is enabled.

Video Tab

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



Disable / Enable Preview

Click here the button to start or stop capturing video frames.

Stream

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

Stream: ☒ 0 ☐ 1

Video Status

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

16:04.33.906.884.000: 5120 x 2160 @ 60.000 Hz, YCbCr4:2:2 8 bpc (Colorimetry: ITU-R BT.601), Frame#3211.
MV 44, NV 4302496, HT 5500, VT 2250, HA 5120, VA 2160, HS 216, VS 82, HSW 88, VSW 10.
Live preview frame rate: 4.65 Hz.

First row:	Counter, frame size, frame rate, color mode, color depth, frame counter.
Second row:	Mvid, Nvid, Horiz Total, Vert Total, Horiz Active, Vert Active, Horiz Start, Vert Start, Hor Sync Width, Vert Sync Width.
Third row:	Live preview frame rate.

Note:

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. Live preview frame rate is limited e.g., by the USB communication between UCD test equipment and the PC.

Color Mode for preview

YCbCr ITU-601 -> RGB

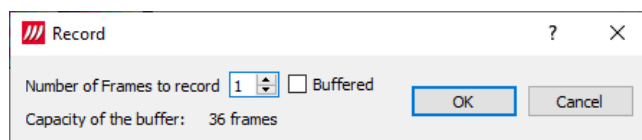
<i>No Conversion:</i>	The captured color components are interpreted as R, G and B respectively. No color conversion will be done.
<i>Auto:</i>	The color mode is selected based on the information in the MSA. If there is no color information available, "No Conversion" is used.
<i>YCbCr (ITU-709) -> RGB:</i>	The captured data components are interpreted as Y, Cb, and Cr respectively. Color conversion to RGB is done based on ITU-709 standard.
<i>SMPTE 170M -> RGB:</i>	The captured data components are interpreted as Y, U, and V respectively. Color conversion to RGB is done based on SMPTE 170M standard.
<i>SMPTE ITU-601 -> RGB:</i>	The captured data components are interpreted as Y, U, and V respectively. Color conversion to RGB is done based on ITU-601 standard.

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

Record

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. 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 mode.

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

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



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 RGB and YCbCr components of the pixel on the cursor location in hexadecimal 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:

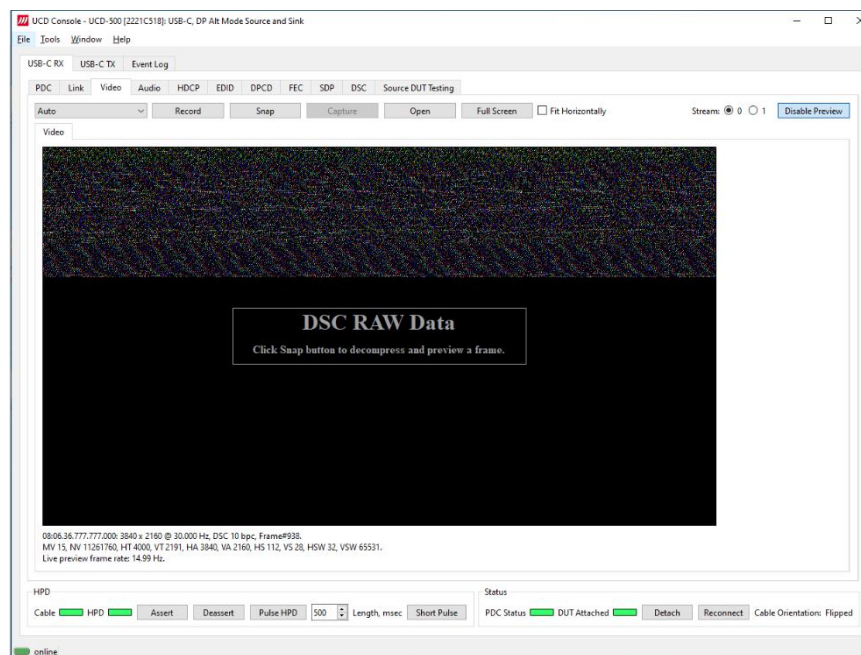
In PPM format the files are stored with the captured color depth, with other formats the color depth is truncated to 8 bits per color.

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.

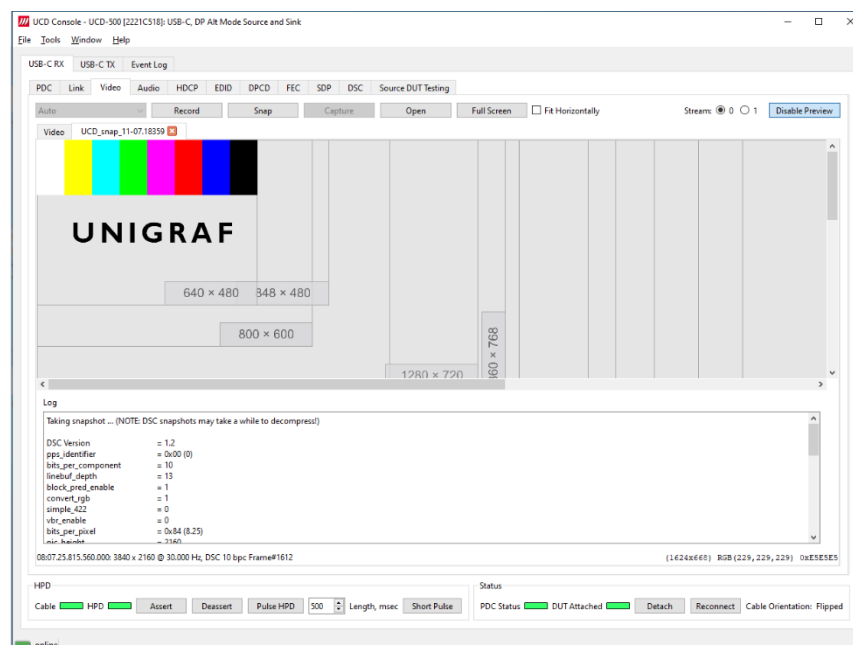
Preview DSC Decompressed Stream

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.

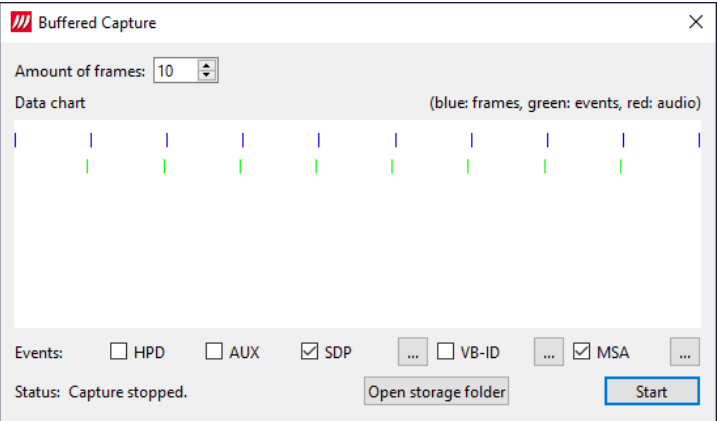


Click Snap button to capture one frame and start the decompressor (offline in the PC). Once the decompression is ready, the frame is shown, and Log lists the details of the compressed image



Buffered Capture (video, audio)

Capture of video, audio, and metadata in a file for later analysis. Video can be stored as RGB or RAW data.



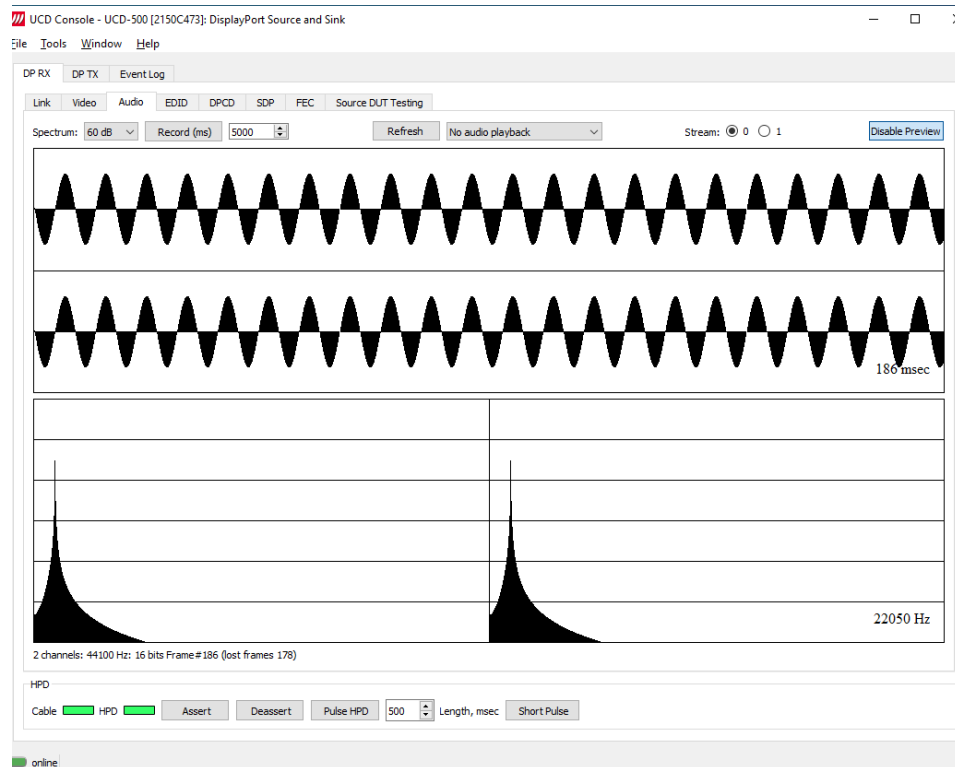
Data Chart indicates the approximate order of captured items with colored stripes (blue: video frames, green: events, red: audio data).

<i>Amount of frames:</i>	Number of video frames captured.
<i>Events:</i>	Please refer to chapter Event Log for details of the captured events
<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).

Note: Video Preview needs to be disabled to use Data Capture functionality.

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.

Enable Preview / Disable Preview

This button controls capturing the audio data.

Select Monitored Stream

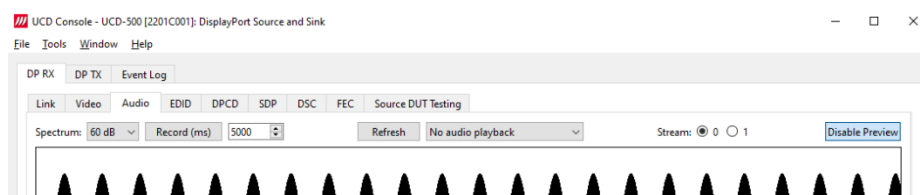
When Multistreaming (MST) is enabled, the monitored stream can be selected from **Current Stream** selection in the bottom of the dialog.

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

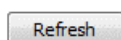
The captured audio can be played back in the PC. The combo-box defines the audio device in the host PC through which the captured audio is played. By default, *No audio playback* is selected.



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-500 EDID. Since UCD-500 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

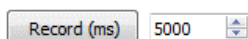


Click here to re-read the list of audio devices after making changes to the host PC configuration.

Audio Buffer Size

The amount of buffering used in the data transfer between the UCD-500 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

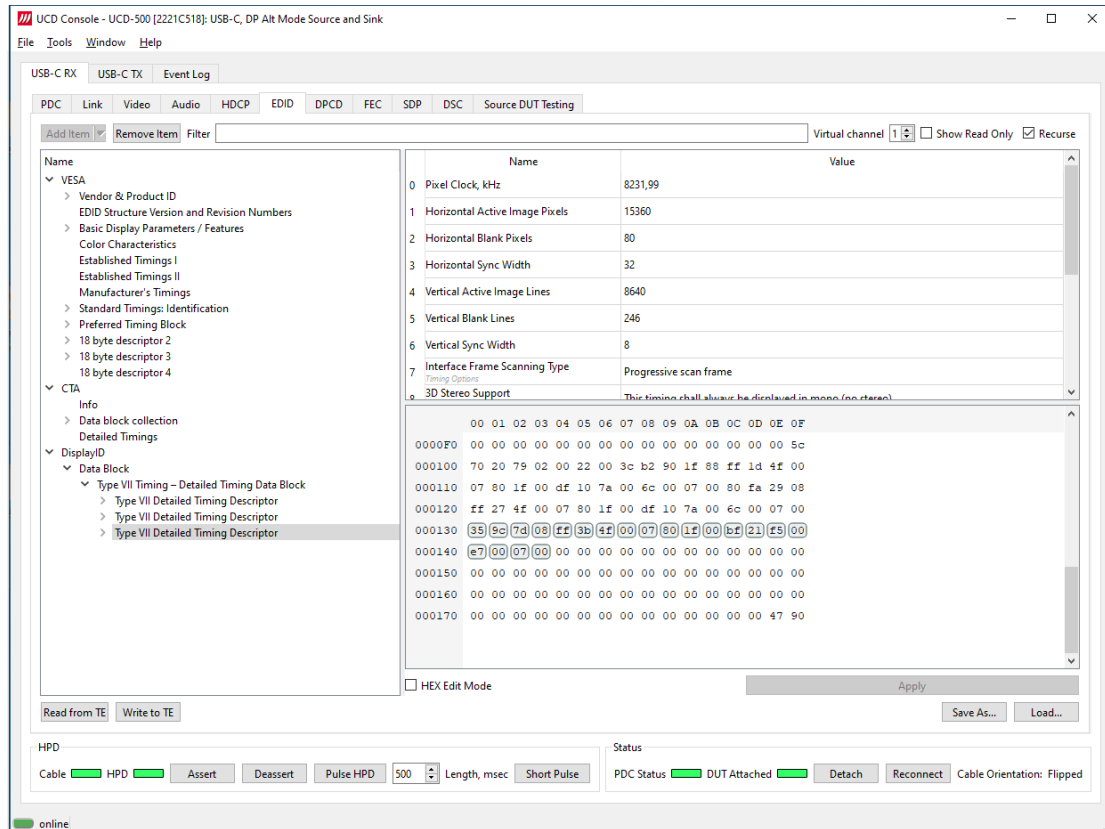
2 channels: 44100 Hz: 16 bits Frame #413 (lost frames 0)

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

EDID Tab

EDID Tab provides tools for accessing the EDID and Display ID of the UCD Sink presented to the Upstream Source Device. There are three basic functions:

- Load and save EDID data files in the host PC
- Edit the EDID contents either in EDID Editor or in hex format
- Program and read the contents of the EDID memory for all virtual channels



EDID Files

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

Note: Four blocks (512 bytes) of EDID code are read. If the device is not supporting all four blocks, the non-supported area is replaced with blanks.

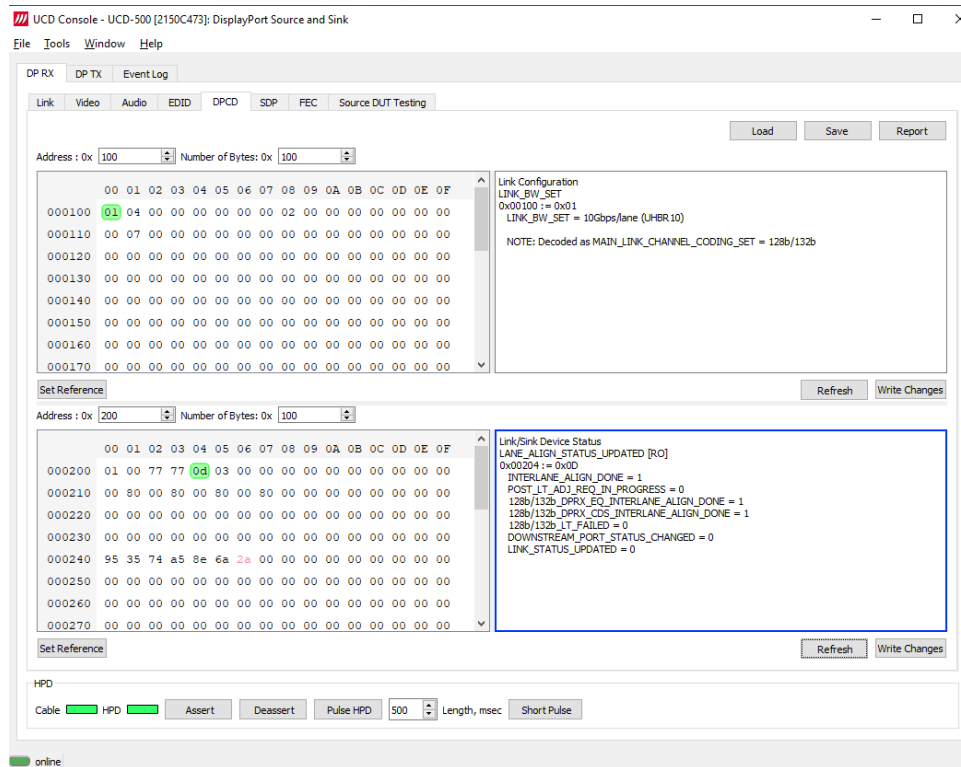
Note: All virtual ports have their individual EDID – Display ID content. Currently only EDID of virtual port 0 can be accessed

EDID Editor

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

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.

DPCD Decoder flags in Tools > Options contain control of DETAILED_CAP_INFO_AVAILABLE flag and MAIN_LINK_CHANNEL_CODING_SET flag.

<i>Refresh:</i>	Re-read the data from the DPCD registers to the window in question
<i>Write Changes</i>	Write the portion of data shown in the window in question to the DPCD registers.
<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 two alternative formats listed below. Please add 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.
- *HEX Dump* (*.HEX) in a human readable text format.

Click Save to select the location and the format of the file.

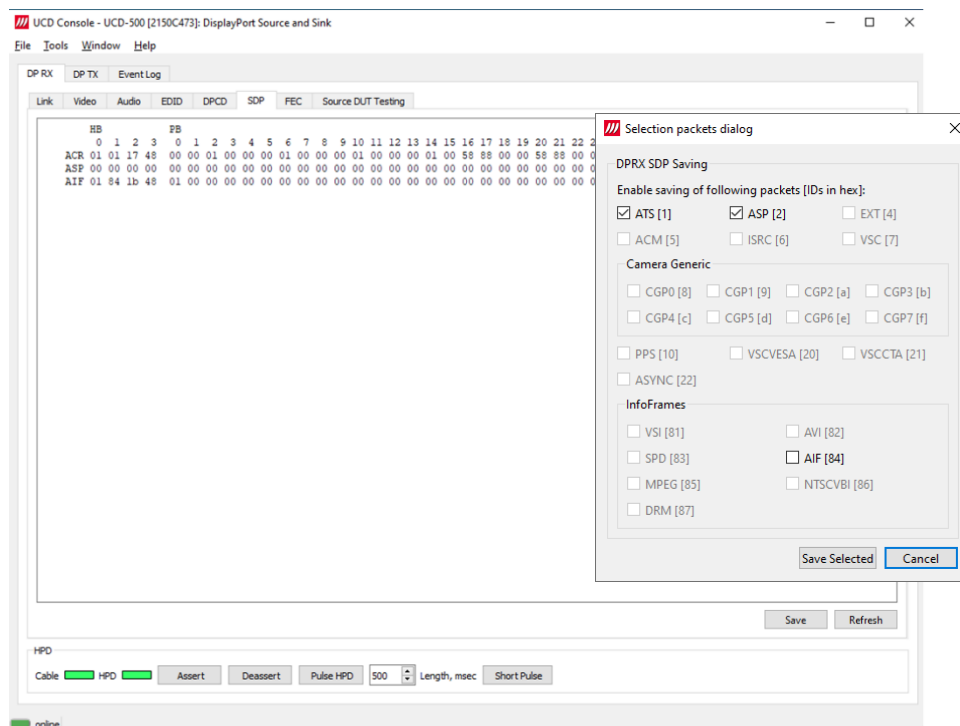
Click Load to load DPCD data saved in DPCD Data File (*.DPD) format to the editor.

To program the data into the DPCD registers of UCD Local Sink click Write **Changes**.

Note:	- User control like Link Training or mode changes will modify the content of the DPCD registers
	- During a reboot of UCD-500 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.



The following packets are recognized:

- Audio_TimeStamp
- Audio_Stream
- Extension
- Audio_CopyManagement
- ISRC (International Standard Recording Code)
- Video Stream Configuration (VSC)
- Camera Generic 0
- Camera Generic 1
- Camera Generic 2
- Camera Generic 3
- Camera Generic 4
- Camera Generic 5
- Camera Generic 6
- Camera Generic 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)

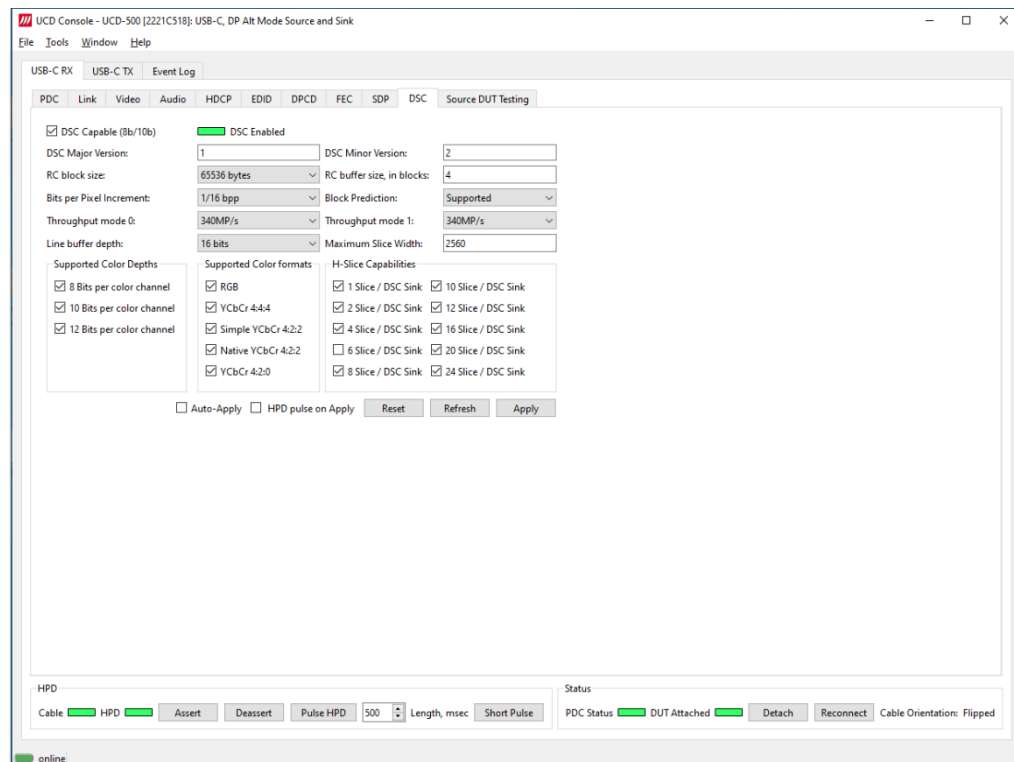
Saving SDP Packets

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-500 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-500 sink to find out if DSC capability is declared.

<i>DSC Capable</i>	UCD-500 is declared as DSC capable. Control is only in use with 8b/10b link coding.
<i>DSC Enabled</i>	Connected source has enabled DSC

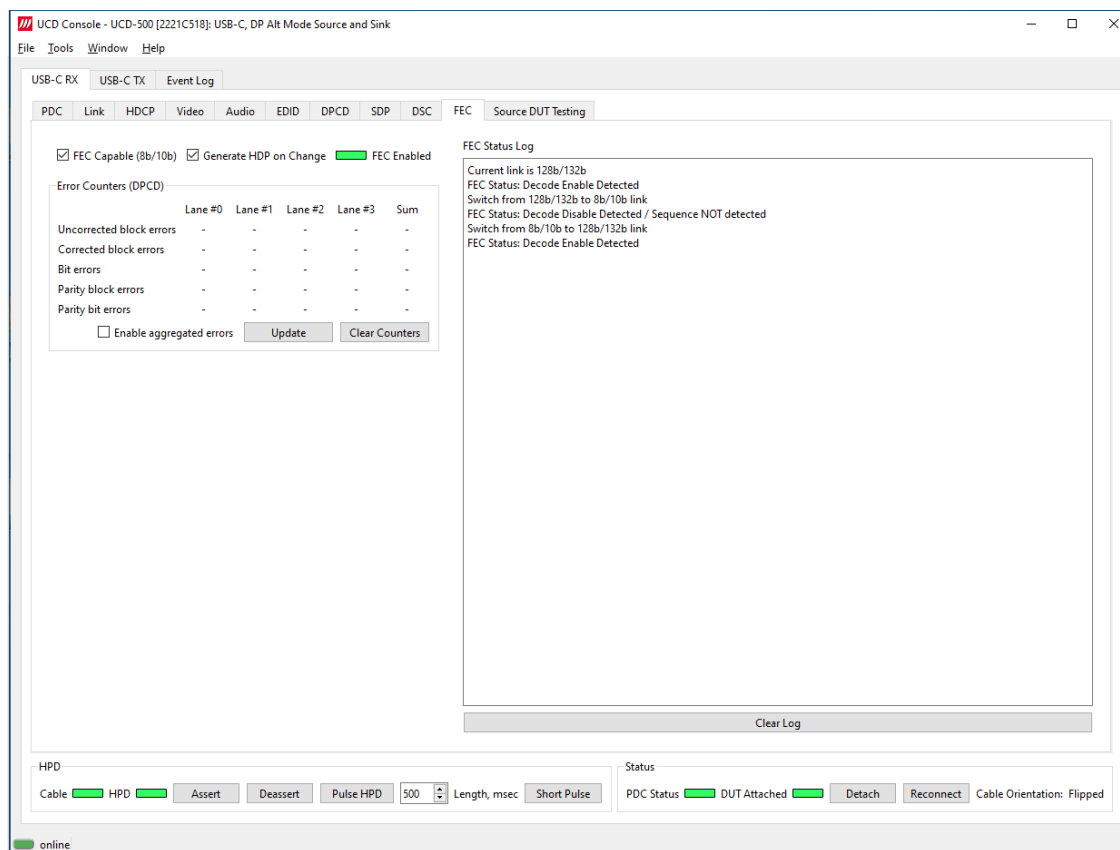
DSC Support Capabilities

The various controls in this tab change the content of UCD-500 sink DPCD register address range (0x00061 through 0x0006F) related to DSC. Please click **Apply** to enable the change.

<i>Apply:</i>	Write changes to UCD-500 sink DPCD registers
<i>Refresh:</i>	Re-read the content of UCD-500 sink DPCD and update the control status.
<i>Reset:</i>	Reset the content of UCD-500 DSC related DPCD registers (0x00060 through 0x0006F) to the default values as defined in UCD-500 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.

FEC Capable: UCD-500 is declared as FEC capable. Control is only in use with 8b/10b link coding.

Generate HPD on change: When selected, UCD-500 generates a HPD to establish a new connection after the change to make sure that the Source re-reads the FEC capability status

FEC Enabled: LED to indicate if the source has enabled FEC

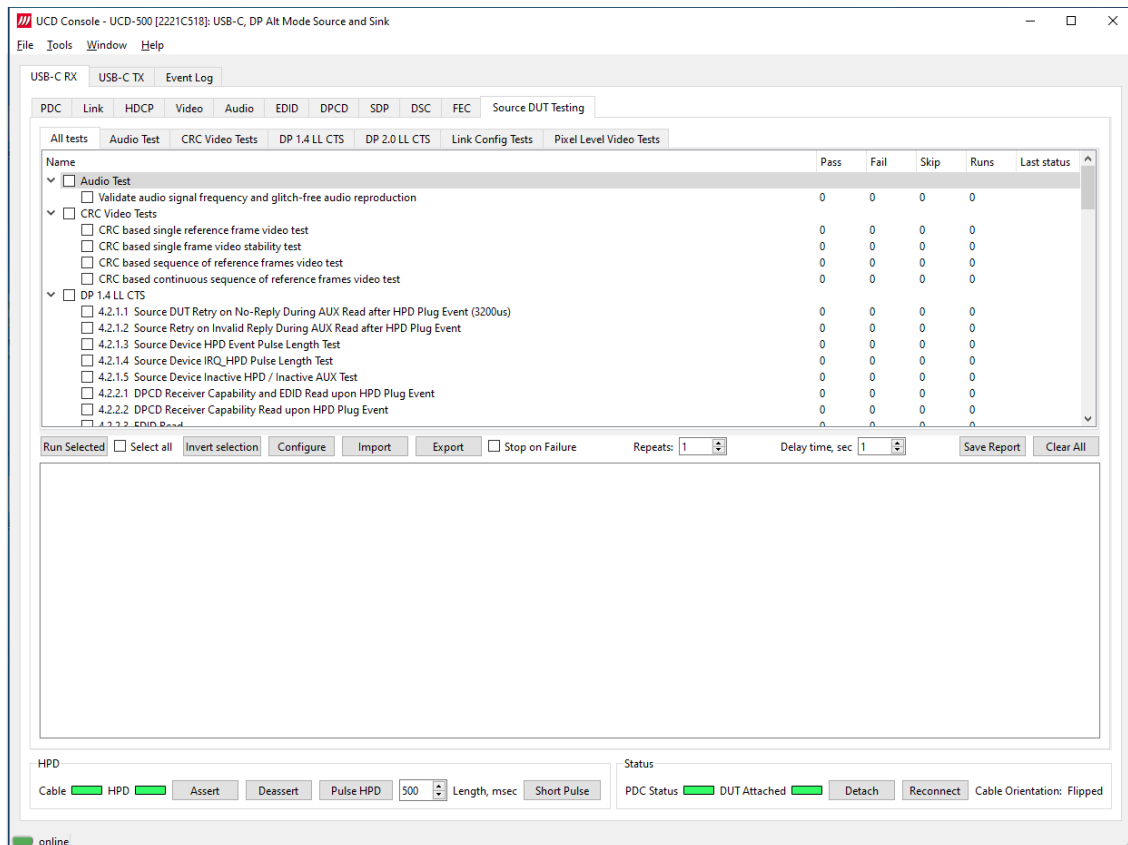
Update: Read FEC Error Counters from DPCD

Clear Counters: Clear FEC Error Counters in DPCD.

FEC Status Log lists FEC events.

Source DUT Testing Tab

Please refer to **Appendix E** later in this document for description of the tests available.



Select the tests for execution by clicking the corresponding row.

Run Selected:	Click to start selected tests. By clicking <i>Abort</i> the sequence is stopped.
Select all:	Select all tests in the selected tab.
Invert selection:	Invert selection of tests selected. Hint: To clear all selections, click <i>Select all</i> and then <i>Invert selection</i> .
Configure:	Clicking opens a dialog for defining the test parameters for the selected test set. Please refer to <i>Test Parameters</i> below for details.
Import:	Load saved test parameter files (*.td or *.json).
Export:	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.
Stop on Failure:	Stops execution of the selected tests if one of the tests fail
Repeats:	Repeat the selected test several times
Delay time:	Delay in seconds between individual tests.

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.

Save Report:	Click to generate a report file in HTML format for sharing the results with other parties for viewing without UCD Console.
Clear All:	Clear the test log and the results matrix

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.

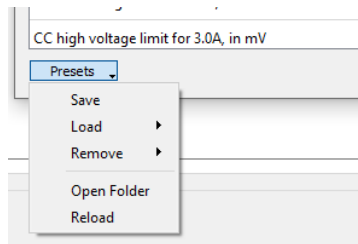
Saving Test Parameters

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 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 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.

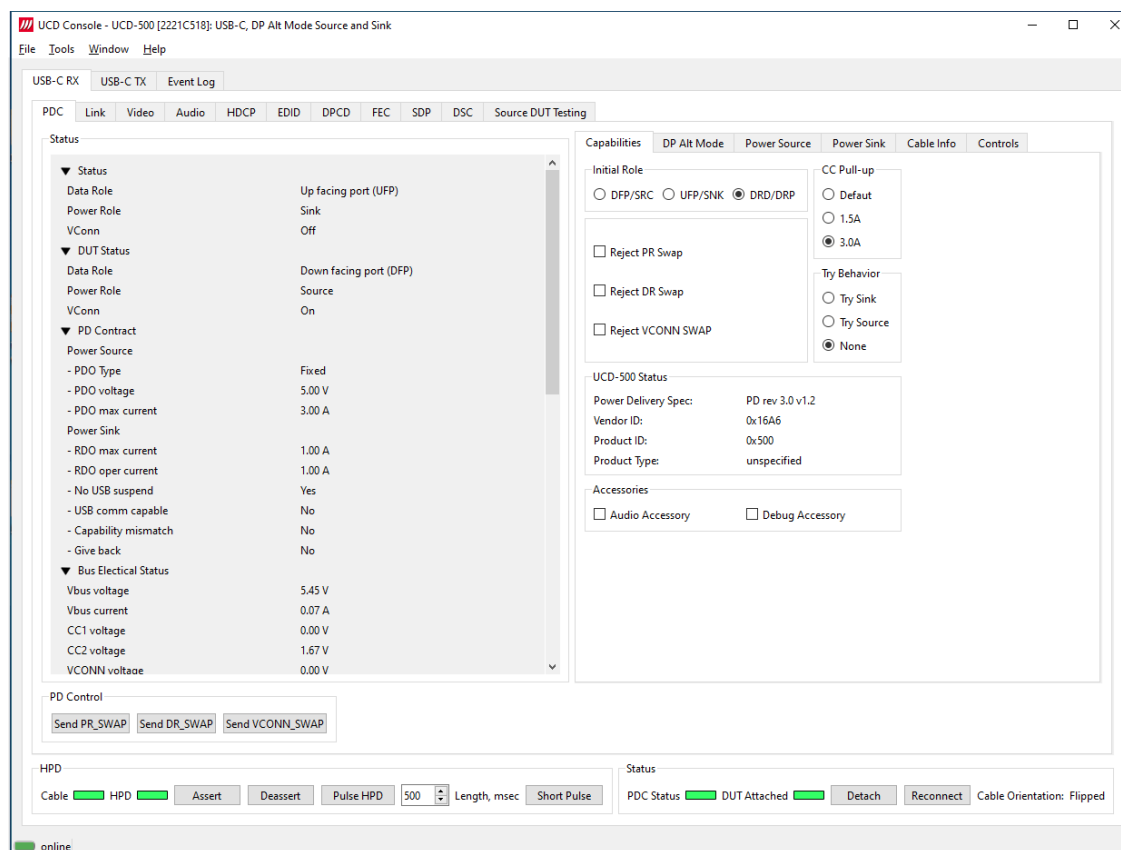


USB-C Monitoring

In UCD-500 with USB-C DP Alt-Mode Sink or Source in selected device role, 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-500 test equipment and the optional capabilities for UCD-500 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-500 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

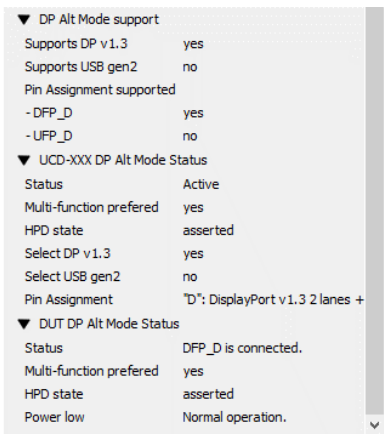
In Status List the information is presented in foldable sections. Each section contains information related to one feature of USB-C interface or PD protocol. The user can fold out the sections needed for the task in question.

▼ Status	
Data Role	Down facing port (DFP)
Power Role	Source
VConn	On
▼ DUT Status	
Data Role	Up facing port (UFP)
Power Role	Sink
VConn	Off
▼ PD Contract	
Power Source	
- PDO Type	Fixed
- PDO voltage	5.00 V
- PDO max current	3.00 A
Power Sink	
- RDO max current	3.00 A
- RDO oper current	3.00 A
- No USB suspend	Yes
- USB comm capable	No
- Capability mismatch	Yes
- Give back	No

Status:	UCD-500 internal status (Data role, Power Role, VConn status)
DUT Status:	Status of the connected USB-C port partner gained from status messages (Data role, Power Role, VConn 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)

▼ Bus Electrical Status	
Vbus voltage	5.24 V
Vbus current	0.01 A
CC1 voltage	1.71 V
CC2 voltage	0.00 V
VCONN voltage	5.25 V
VCONN current	0.00 A
▼ DUT Discovery	
Data Capable as Host	yes
Data Capable as Device	yes
Product Type	N/A
USB Vendor ID	0x16A6
USB Product ID	0x300
BCD Device	0x00
SVID0	0x00
SVID1	0xFF01

Bus Electrical Status:	Vbus voltage and current, CCI and CC2 voltage, VCONN voltage and current)
DUT Discovery:	Status of the connected USB-C port partner gained from discovery messages (Data Capabilities, Product Type, Vendor and Product ID, device version number, supported SVIDs)



<i>DP Alt Mode support:</i>	Supported DisplayPort Alt Mode features (Supports DP v 1.3, Supports USB gen2, Pin Assignments supported as DFP_D and UFP_D)
<i>UCD-XXX DP Alt Mode Status:</i>	UCD-500 internal DP Alternate mode status (DP Alt Mode Status, Multi-function preferred, HPD status, Select DP v1.3, Select USB gen2, Pin Assignment selected)
<i>DUT Alt Mode Status:</i>	Status of the connected USB-C port partner gained from status update messages (DP Alt Mode Status, Multi-function preferred, HPD State, Power low)

Capabilities

Capabilities DP Alt Mode Power Source Power Sink Cable Info Controls

Initial Role

☐ DFP

☐ UFP

☒ DRP

☐ Reject PR Swap

☐ Reject DR Swap

☐ Reject VCONN SWAP

CC Pull-up

☐ Default

☐ 1.5A

☒ 3.0A

Try Behavior

☐ Try Sink

☐ Try Source

☒ None

UCD-500 Status

Power Delivery Spec:

PD rev 3.0 v1.2

Vendor ID:

0x16A6

Product ID:

0x500

Product Type:

unspecified

Accessories

☐ Audio Accessory

☐ Debug Accessory

<i>Initial Role:</i>	Defines the role which UCD-500 presents itself in the start of PD communication (both power and data role).
<i>Reject Swaps:</i>	Allow or reject role swap requests from the connected port partner.
<i>CC Pull-up:</i>	Control of Rp that Source uses to advertise the current source capability in initial USB Type-C operation and in PD Rev 2.0 operation.
<i>Try Behavior:</i>	Control the USB-C PD role that UCD-500 initially takes in the connection handshake.
<i>UCD-500 Status:</i>	Status information provided by UCD-500.

Accessories

Accessories

☐ Audio Accessory

☐ Debug Accessory

<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-500 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.

CapabilitiesDP Alt ModePower SourcePower SinkCable InfoControls

Enter 2 lane mode (D)

Enter 4 lane mode (C,E)

Exit DP Alt Mode

Disable DP Alt Mode

☒ Auto enter on connect

☒ Multi-function preferred

DP Alt Mode Capabilities

UFP_D

☒ C: 4 DP lanes

☐ D: 2 DP lanes + USB SS

☐ E: 4 DP lanes

<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>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-500 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.

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-500 when acting as *Power Source Port*.

CapabilitiesDP Alt ModePower SourcePower SinkCable InfoControls

	PDO1	PDO2	PDO3	PDO4
PDO Type	Mandatory	Fixed	Disabled	Disabled
Max Current, mA	3000	3000	0	0
Voltage, mV	5000	9000	0	0
Peak Current, %	100	100	100	100
Max Power, mW		0	0	0
Max Voltage, mV		0	0	0
Min Voltage, mV		99999	0	3150

Refresh

Apply

Send PDO

Load PDO

Save PDO

PDO Type: 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

Note: Please note that UCD-500 is not able to simulate as Source the electrical behavior of Variable and Battery source types.

<i>Refresh</i>	Re-read status from UCD-500
<i>Apply</i>	Program new values to UCD-500
<i>Load PDO</i>	Load a stored Power Source PDO configuration from file.
<i>Send PDO</i>	Send a Source Capabilities message
<i>Save PDO</i>	Store current Power Source PDO configuration to a file

Power Sink

Definition of Power Data Objects (PDO) for UCD-500 when acting as *Power Sink Port*.

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

Capabilities

DP Alt Mode

Power Source

Power Sink

Cable Info

Controls

Sink PDOs

PDO1

PDO2

PDO3

PDO4

Mandatory

Variable

Disabled

Disabled

Oper Current, mA

900

900

0

0

Voltage, mV

5000

0

0

0

Max Power, mW

0

0

0

0

Max Voltage, mV

10000

0

0

0

Min Voltage, mV

5000

0

0

0

PDO type priority

Prefer higher power

Refresh

Apply

Load PDO

Save PDO

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

<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>Refresh</i>	Re-read status from UCD-500
<i>Apply</i>	Program new values to UCD-500
<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	Power Source	Power Sink	DP Alt Mode	Cable Info	Controls
95 20 00 18 74 09 00 00 10 03 05 00 D2 27 08 11 00 00 00 00 00 00 00				Refresh	
USB Vendor ID		2095		XID Assigned by USB-IF 0x00000974	
Modal operation supported		no			
Product Type		Passive Cable			
USB Communications Capable as USB Device		no		bcdDevice 0x0310	
USB Communications Capable as USB Host		no		USB product ID 0x0005	
USB SuperSpeed Signalling Support		USB 3.1 Gen1 and Gen2			
VBUS through cable		Yes			
VBUS Current Handling Capability		5A			
SSRX2 Directionality Support		Configurable			
SSRX1 Directionality Support		Configurable			
SSTX2 Directionality Support		Configurable			
SSTX1 Directionality Support		Configurable			
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		1			
Hardware Version		1			

Note:

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

Controls

Control tab includes miscellaneous controls related to UCD-500 behavior as a USB-C PD Port Partner.

The screenshot shows the 'Controls' tab selected in a software interface. The tab bar at the top includes 'Capabilities', 'DP Alt Mode', 'Power Source', 'Power Sink', 'Cable Info', and 'Controls'. The 'Controls' panel contains three sections: 'PD Contract settings' with a checked checkbox 'Automatically negotiate power contract'; 'RDO Flags' with unchecked checkboxes 'Give back flag' and 'No USB suspend'; and 'USB Communication Capable' with checked checkboxes 'As PD Source' and 'As PD Sink'. An 'Apply' button is located at the bottom of the panel.

PD Contract Settings

Automatically negotiate power contract: When selected UCD-500 will start power contract negotiation if suitable configuration is found.

RDO Flags

Give back flag: When selected, UCD-500 sets *GiveBack* flag in its *Request Data Object*

No USB suspend: When selected, UCD-500 sets No USB Suspend flag in its Request Data Object

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

Status

PDC Status DUT Attached (E-Marked) Detach Reconnect Cable Orientation: Flipped

<i>PDC Status</i>	Status of USB-C PD Controller
<i>DUT Attached:</i>	Indication that <i>Attach</i> is detected by the Source port in one of its CC lines. Type of USB-C cable detected.
<i>Attach / Detach:</i>	Manually Attach or <i>Detach</i> USB-C port partners.
<i>Reconnect:</i>	Restart USB-C Source-to-Sink attach procedure.
<i>Cable Orientation:</i>	Cable orientation status: <i>Straight</i> or <i>Flipped</i> .

Note: Please note that UCD-500 is not automatically Attached to the connected port partner even if the cable is connected physically. The user needs to to click the Attach button manually to make the connection.

PD Control

PD Control

Send PR_SWAP Send DR_SWAP Send VCONN_SWAP

<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.

5. GENERATOR OPERATION

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

Please note that in most UCD-500 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.

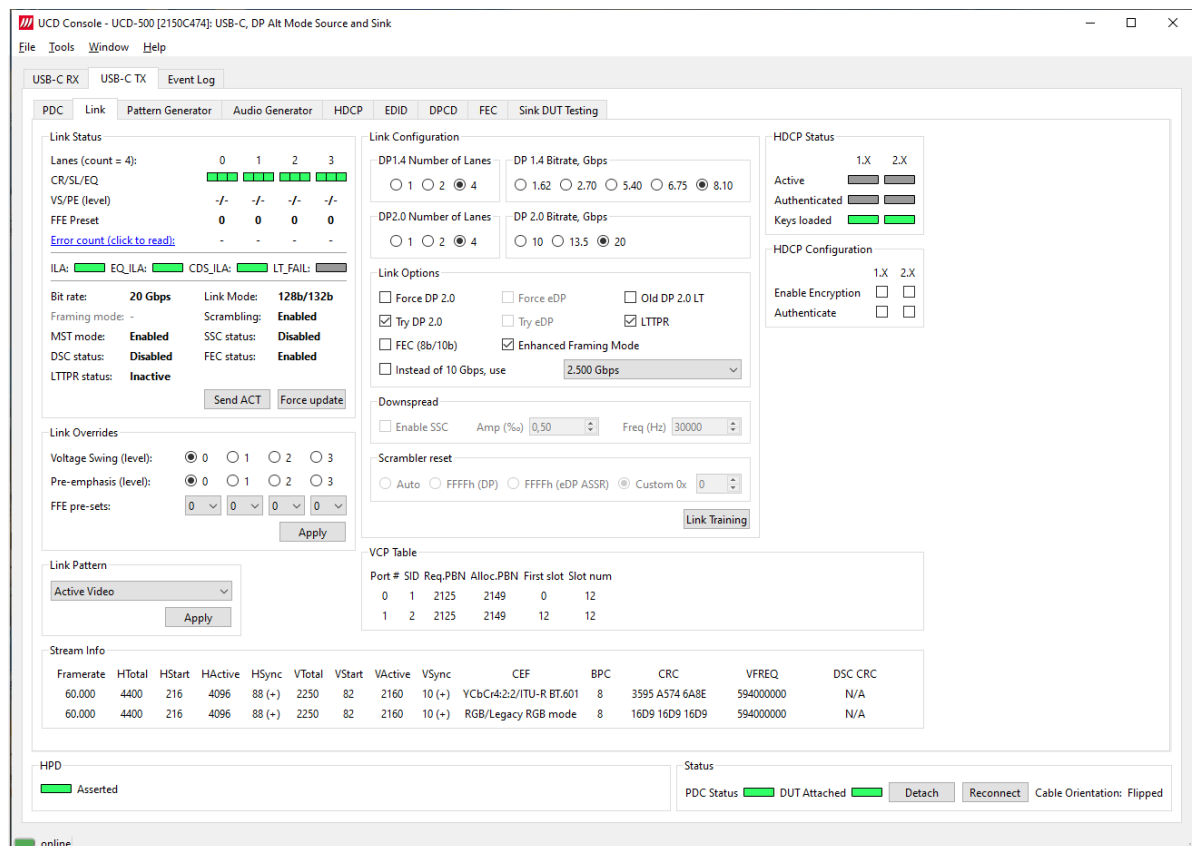
Some of the tabs are enabled by default, some only when an applicable license is included.

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

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, but in case it seems that the update is delayed, please click on *Force update* button.

Link Status					
Lanes (count = 4):	0	1	2	3	
CR/SL/EQ					
VS/PE (level)	-/-	-/-	-/-	-/-	
FFE Preset	0	0	0	0	
Error count (click to read):	-	-	-	-	
ILA:		EQ_ILA:		CDS_ILA:	
LT_FAIL:					
Bit rate:	20 Gbps		Link Mode:	128b/132b	
Framing mode:	-		Scrambling:	Enabled	
MST mode:	Enabled		SSC status:	Disabled	
DSC status:	Disabled		FEC status:	Enabled	
LTPR status:	Inactive				
<input type="button" value="Send ACT"/> <input type="button" value="Force update"/>					

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

FFE preset: TX Feed Forward Equalization (FFE) preset value (only with 128b/132b channel coding)

Error count: Content of DPCD Error Count registers

ILA: Status LED for Inter-Lane Alignment

EQ_ILA Status LED for Inter-Lane Alignment on Equalization stage

CDS_ILA Status LED for Inter-Lane Alignment on Clock and Data Switch stage

LT_FAIL Status LED for Link Training failure

Bit rate: Currently enabled link bit rate

Link mode: Currently enabled channel coding (128b/132b or 8b/10b)

Framing mode: Status of Enhanced Framing symbol sequence (only with 8b/10b)

Scrambling: Status of link Data Scrambling (Enabled or Disabled)

MST mode: Status of the Multistreaming (MST) mode

SSC status: Status of Spread-Spectrum Clock (SSC) function

DSC Status: Status of Display Stream Compression (DSC) function

FEC status: Status of Forward Error Correction (FEC) function.

LTPR Status: Status of Link Training-tunable PHY Repeater (LTPR) function

Send ACT: Force sending an Allocation Change Trigger (ACT) sequence over the Main-Link

Force update: Re-read statuses to update the panel

Note: Spread-Spectrum Clock feature will be supported in later versions of UCD-500

Link Configuration

Link Configuration

DP1.4 Number of Lanes
☐ 1 ☐ 2 ☒ 4

DP 1.4 Bitrate, Gbps
☐ 1.62 ☐ 2.70 ☐ 5.40 ☐ 6.75 ☒ 8.10

DP2.0 Number of Lanes
☐ 1 ☐ 2 ☒ 4

DP 2.0 Bitrate, Gbps
☐ 10 ☐ 13.5 ☒ 20

Link Options

☐ Force DP 2.0
☐ Force eDP
☐ Old DP 2.0 LT

☒ Try DP 2.0
☐ Try eDP
☒ LTTTPR

☐ FEC (8b/10b)
☒ Enhanced Framing Mode

☐ Instead of 10 Gbps, use

2.500 Gbps

Downspread
☐ Enable SSC

Amp (‰)

0,50

Freq (Hz)

30000

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

0

Link Training

Set target capabilities for the link training. Click **Link Training** to with changed features.

<i>DP1.4 Number of Lanes</i>	Lane count used when 8b/10b link coding is selected in LT
<i>DP1.4 Bitrate, Gbps</i>	Link rate used when 8b/10b link coding is selected in LT
<i>DP2.0 Number of Lanes</i>	Lane count used when 128b/132b link coding is selected in LT
<i>DP2.0 Bitrate, Gbps</i>	Link rate used when 128b/132b link coding is selected in LT
<i>Force DP 2.0</i>	UCD-500 Source uses only 128b/132b link layer protocol, no fall back to 8b/10b link layer.
<i>Try DP 2.0</i>	UCD-500 Source checks capabilities of the connected Sink and, if it supports 128b/132b link layer protocol, it starts Link Training with 128b/132b link layer. If LT fails it falls back to 8b/10b link layer protocol
<i>Old DP 2.0 LT</i>	When checked LT will follow initial DP 2.0 spec description. Otherwise, LT as per DP2.0 SCR LT (DP 2.0 Errata)
<i>LTTTPR</i>	Select to enable Link Training Tunable PHY Repeater (LTTTPR) protocol support
<i>FEC (8b/10b)</i>	Enable Forward Error Correction feature (only in 8b/10b coding)
<i>Enhanced Framing Mode</i>	Enable Enhanced Framing Mode
<i>Instead of 10 Gbps, use:</i>	For supporting low link rate Sink devices, the user can make UCD-500 source PHY to use a selectable lower link rate when performing '10 Gbps' link training in protocol level. Link rates are: 2.5 Gbps, 2.7 Gbps, 5.0 Gbps and 5.4 Gbps
<i>Enable SSC</i>	Enable down spreading of link frequency (SSC).
<i>Amp (‰)</i>	SSC Spreading Amplitude. Allowed amplitude range is 1 to 10‰ (per mil, 0.1%) (It is mandatory for a DP Rx to support up to 0.5% down spread).
<i>Freq (Hz)</i>	SSC Modulation frequency. Allowed Frequency range is 30 to 35 kHz.
<i>Scrambler Reset:</i>	Selection of the value to which the Linear Feedback Shift Register (LFSR) is reset during scrambler reset. In <i>Auto</i> mode UCD verifies that connected DP Sink supports eDP and Alternate Scrambler Seed, and then applies FFFEh. If not, FFFFh will be used.

Note: Spread-Spectrum Clock feature will be supported in later versions of UCD-500

Link Overrides

Link Overrides

Voltage Swing (level): ☒ 0 ☐ 1 ☐ 2 ☐ 3
Pre-emphasis (level): ☒ 0 ☐ 1 ☐ 2 ☐ 3
FFE pre-sets:

Voltage Swing (level): Override Voltage Swing level selected during link training

Pre-emphasis (level): Override Pre-emphasis levels selected during link training

FFE pre-sets: TX Feed Forward Equalization (FFE) preset value (only with 128b/132b channel coding)

Apply to validate changes. VS/PPE or FFE 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 Pattern

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

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_HPDPulse due to link loss.

<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 Compliance EYE pattern</i>	Send HBR2 Compliance EYE pattern
<i>SER (Symbol Error Rate)</i>	Send Symbol Error Rate Measurement pattern
<i>Force Video</i>	Reference Source will continue Video pattern transmission on the previously established link configuration regardless of the link status.
<i>Force Idle</i>	Reference Source will continue Idle pattern transmission on the previously established link configuration regardless of the link status.
<i>PRBS9</i>	Send PRBS9 Link Quality Test Pattern
<i>PRBS11</i>	Send PRBS11 Link Quality Test Pattern
<i>PRBS15</i>	Send PRBS17 Link Quality Test Pattern
<i>PRBS23</i>	Send PRBS23 Link Quality Test Pattern
<i>PRBS31</i>	Send PRBS31 Link Quality Test Pattern
<i>Link square pattern</i>	Send Square Sequence Pattern. The number of continuous 1s followed by continuous 0s is given as a parameter. 0x00 represents one set of 1s and 0s, 0xFF represents 256 1s and 0s.

Click **Apply** to validate the selection.

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_HPDPulse 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 monitored stream. Frame rate is measured by UCD Local Sink

Stream Info														
Framerate	HTotal	HStart	HActive	HSync	VTotol	VStart	VActive	VSynC	CEF	BPC	CRC	VFREQ	DSC CRC	
60.000	4400	216	4096	88 (+)	2250	82	2160	10 (+)	YCbCr4:2:2/ITU-R BT.601	8	3595 A574 6A8E	594000000	N/A	
60.000	4400	216	4096	88 (+)	2250	82	2160	10 (+)	RGB/Legacy RGB mode	8	16D9 16D9 16D9	594000000	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.
<i>VTotol</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.
<i>CEF</i>	Used color mode: Color format + subsampling / colorimetry
<i>BPC</i>	Color depth in bits per color (BPC)
<i>CRC</i>	16-bit Cyclic redundancy check (CRC) value per color component calculated from active pixels
<i>VFREQ</i>	Video Frequency (128b/132b channel coding only)
<i>DSC CRC</i>	16-bit Cyclic redundancy check (CRC) calculated from compressed pixel stream

VCP Table

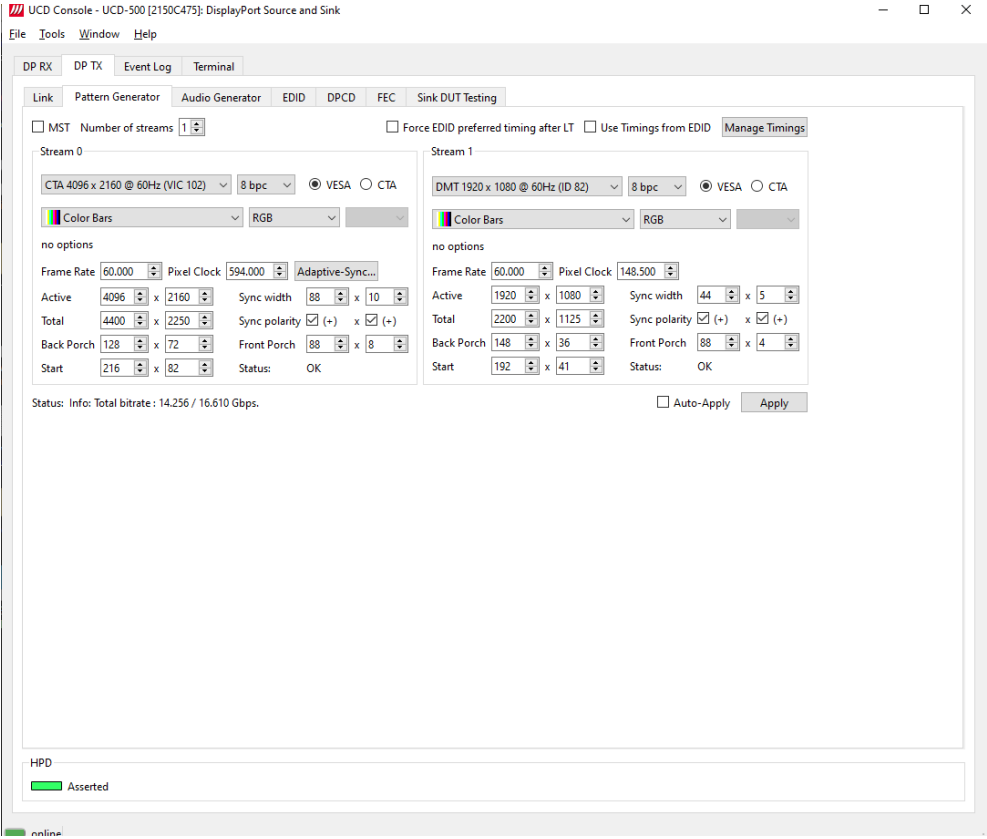
VCP table shows allocation of Virtual Channel Payload for active virtual channels.

VCP Table					
Port #	SID	Req.PBN	Alloc.PBN	First slot	Slot num
0	1	2125	2149	0	12
1	2	2125	2149	12	12

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

<i>Port#:</i>	Port number where the virtual channel is directed.
<i>SID:</i>	Stream identification number of the virtual channel
<i>Req.PBN:</i>	Requested PBN (payload bandwidth number) 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.

Pattern Generator Tab



<i>MST:</i>	When 8b/10b link coding enabled, enable MST mode. When 128b/132b link coding enabled, enable multi-stream transport.
<i>Number of streams:</i>	When MST mode or multi-stream transport enabled, select number of streams

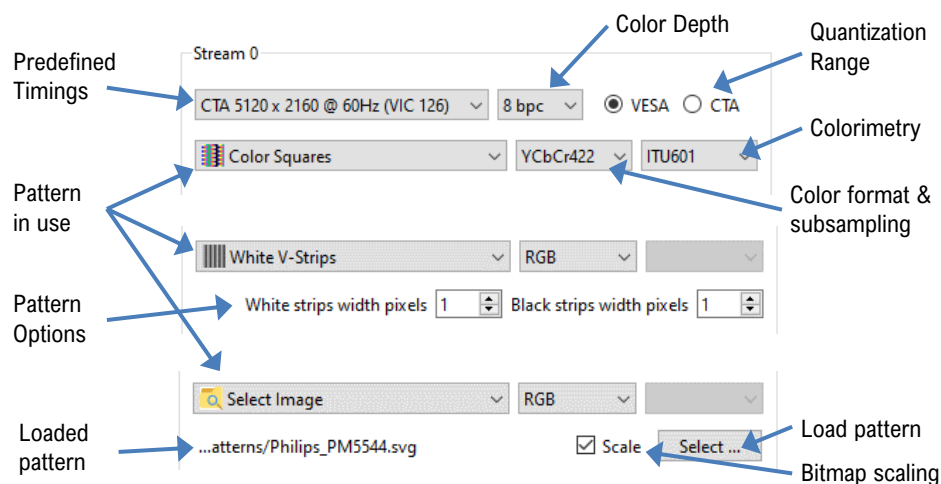
Note: Please note that the actual number of streams sent will be negotiated between the source and the sink during link training.

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>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 <i>Manage Timings</i> later in this manual
<i>Info:</i>	Used link payload / Total link capability in Gbps
<i>Auto-Apply:</i>	In order to avoid sourcing invalid video mode combinations, new settings are being validated when the user is clicking Apply. Automatic validation will be applied when <i>Auto-Apply</i> is checked.
<i>Apply:</i>	Apply recent changes

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.

Quantization Range

VESA: Patterns are sent with Full Range color values (0 to 255 with 8 bpc)

CTA: Patterns are sent with Limited Range color values (16 to 235 with 8 bpc)

Quantization range selection is enabled based on the type of pattern selected.

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 virtual channel 0

Custom Image Patterns

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

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*).

Please refer to *Link Pattern* in description of Generator role *Link tab* earlier in this manual for sending special binary patterns in the link instead of video.

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.

Info

Info row indicates how much link capacity is being used by the streams and what is the total available link capacity.

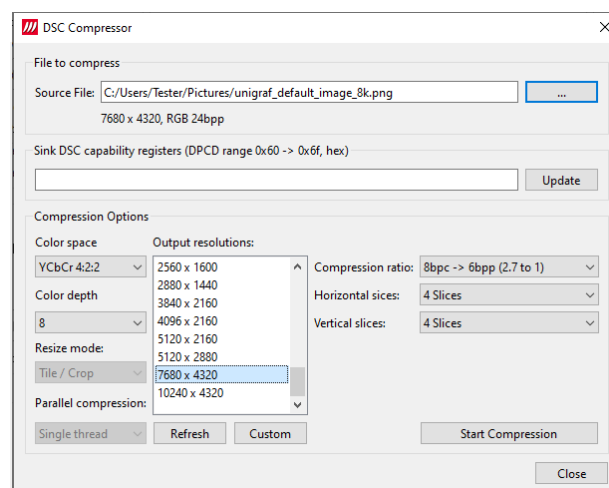
Status: Info: Total bitrate : 20.246 / 54.000 Gbps.

Sourcing DSC Compressed Patterns

UCD Pattern Generator function is able to 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.

Please find description of *DSC Compressor* tool below. *Appendix H* of this document describes an alternative method of generating DSC compressed files.

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>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 depth of the output compressed file (8, 10, 12, 16)
<i>Output resolution:</i>	Resolution of the output compressed file
<i>Compression ratio:</i>	Used compression ratio
<i>Horizontal slices:</i>	Nr. of slices horizontally
<i>Vertical slices:</i>	Nr. of slices vertically
<i>Refresh:</i>	Refresh the list after adding a custom resolution
<i>Custom:</i>	Create a custom output resolution
<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:

Default_bitmap_pattern_8K.png >> Default_bitmap_pattern_8K_7680_4320_RGB888_bpc8.dsc.

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

Stream 0

CVT 3840 x 2160 @ 30Hz [RB1] 8 bpc ☐ VESA ☒ CTA

Select DSC Image RGB

...x2160_RGB444_BPY_bpc8_bpp162_4slice_8slice_13lb.dsc Select ...

Frame Rate: 30.000 Pixel Clock: 262.920 Adaptive-Sync...

Active: 3840 x 2160 Sync width: 32 x 5

Total: 4000 x 2191 Sync polarity: ☒ (+) ☐ (-)

Back Porch: 80 x 23 Front Porch: 48 x 3

Start: 112 x 28 Status: OK

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.

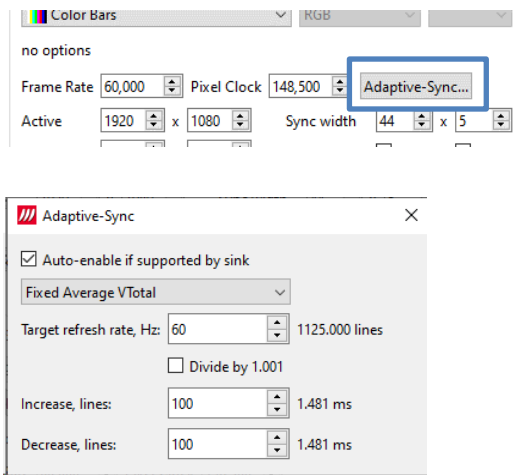
Note:

Please note that the selected video mode has to match the used compressed DSC file.

Adaptive-Sync Control

Adaptive-Sync feature is available for Stream 0. Adaptive-Sync control dialog opens by clicking button *Adaptive-Sync....*

Note: Adaptive-Sync is currently limited to 8b/10b link coding and SST mode.

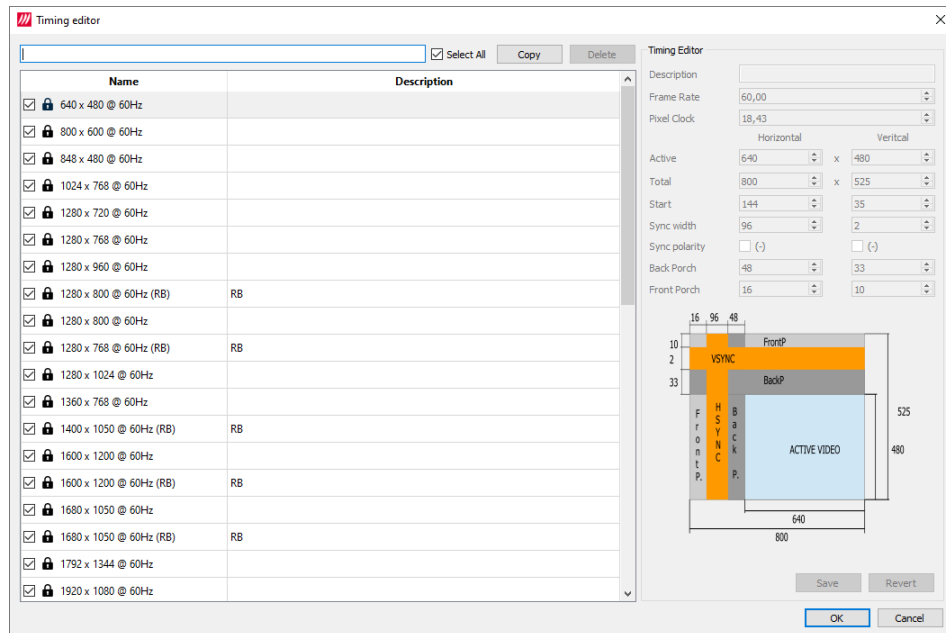


<i>Auto enabled if supported by Sink:</i>	The feature is enabled based on connected Sink status
<i>Disabled:</i>	Feature is disabled unless <i>Auto Enabled ... box is checked. Please see the note below.</i>
<i>Adaptive Total, constant refresh rate:</i>	Added blank lines
<i>Adaptive Total, Square pattern:</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.

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 check-box 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 .

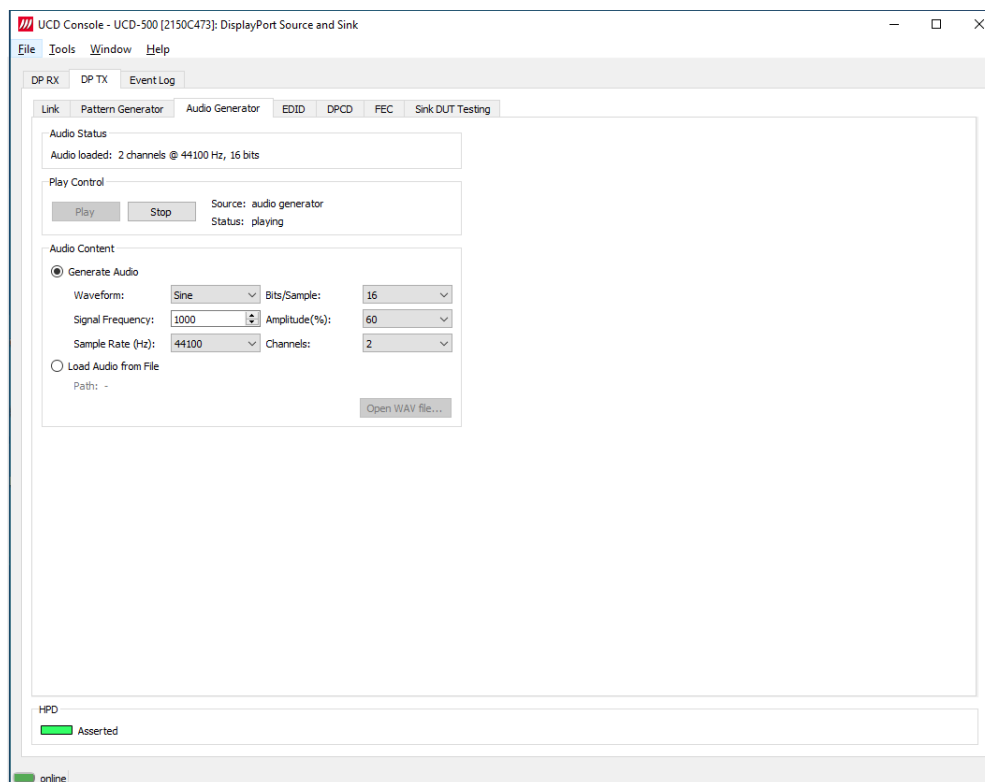
Copy: Create a new custom timing based on the selected fixed timing.

Save: Save changes in the selected custom timing.

The dialog will make a sanity check for the values entered and will warn the user for any combinations that cannot be used.

Audio Generator Tab

Audio generator allows the user to play LPCM audio generated internally or from files in WAV format. 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 click **Open**

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

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

Audio Status in the top of the tab indicates the type of the currently played audio content.

Audio Content

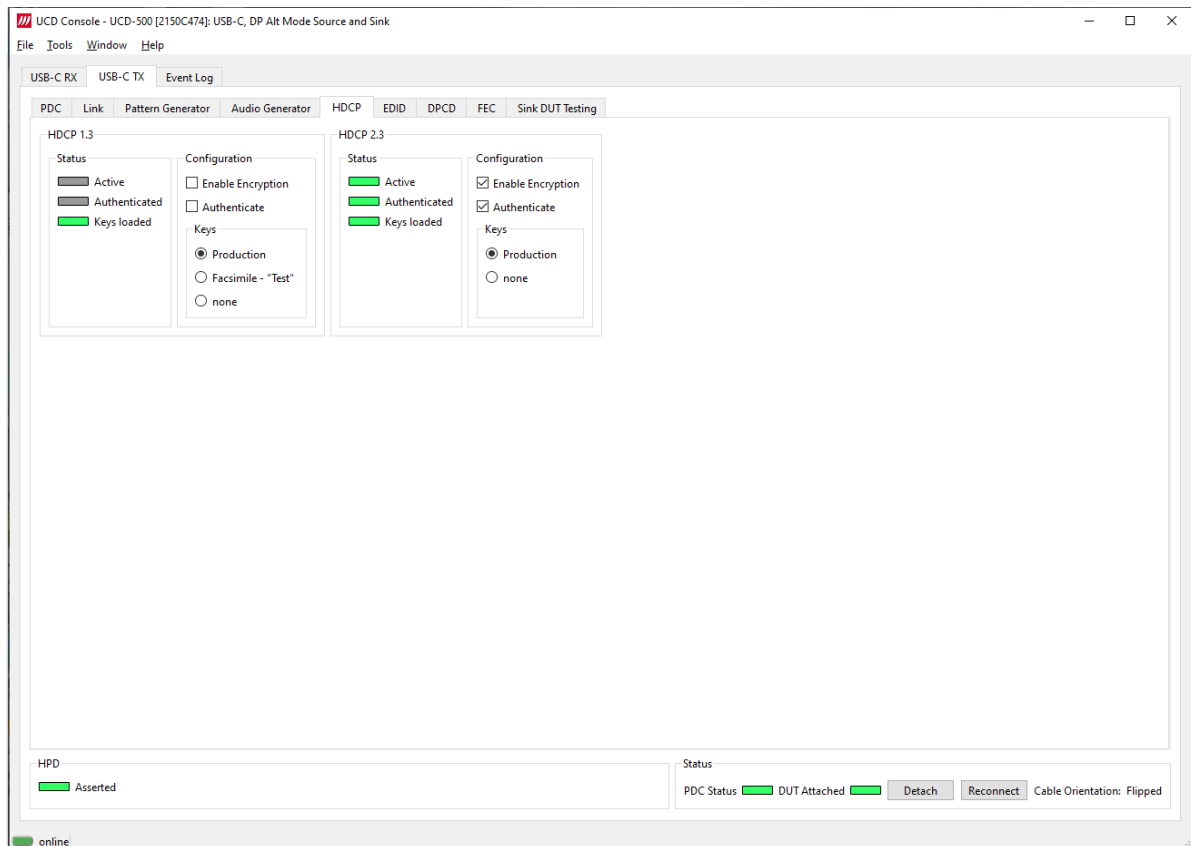
Sent audio can be generated internally or used a WAV file loaded from the PC.

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, 24
<i>Amplitude(%)</i>	Selection of audio amplitude: 10%, 20%, ..., 90%, 100%
<i>Channels</i>	Selection of sent audio channels: 1, 2, ..., 7, 8. When selecting 1 or 2 audio channels '1 and 2 channel LPCM Audio mode' is used and when 3 and more channels '3- to 8-channel LPCM Audio mode' is used.

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 fields indicate the HDCC status of the UCD device.

<i>Active:</i>	The stream between UCD and the downstream sink has been encrypted.
<i>Authenticated:</i>	HDCC handshake between the UCD and the sink unit has been completed successfully.
<i>Keys loaded</i>	HDCC keys are loaded to the UCD unit.

Configuration

<i>Enable encryption</i>	Check to enable the encryption of the stream between UCD and the downstream sink.
<i>Authenticate:</i>	Perform the HDCC initiation handshake between the UCD and the sink unit.

Keys

Select between *Production* and *Facsimile* HDCC keys. To remove the keys, select *None*.

HDCC 1.3 vs. HDCC 2.3

UCD devices support by default HDCC 1.3 and HDCC 2.3.

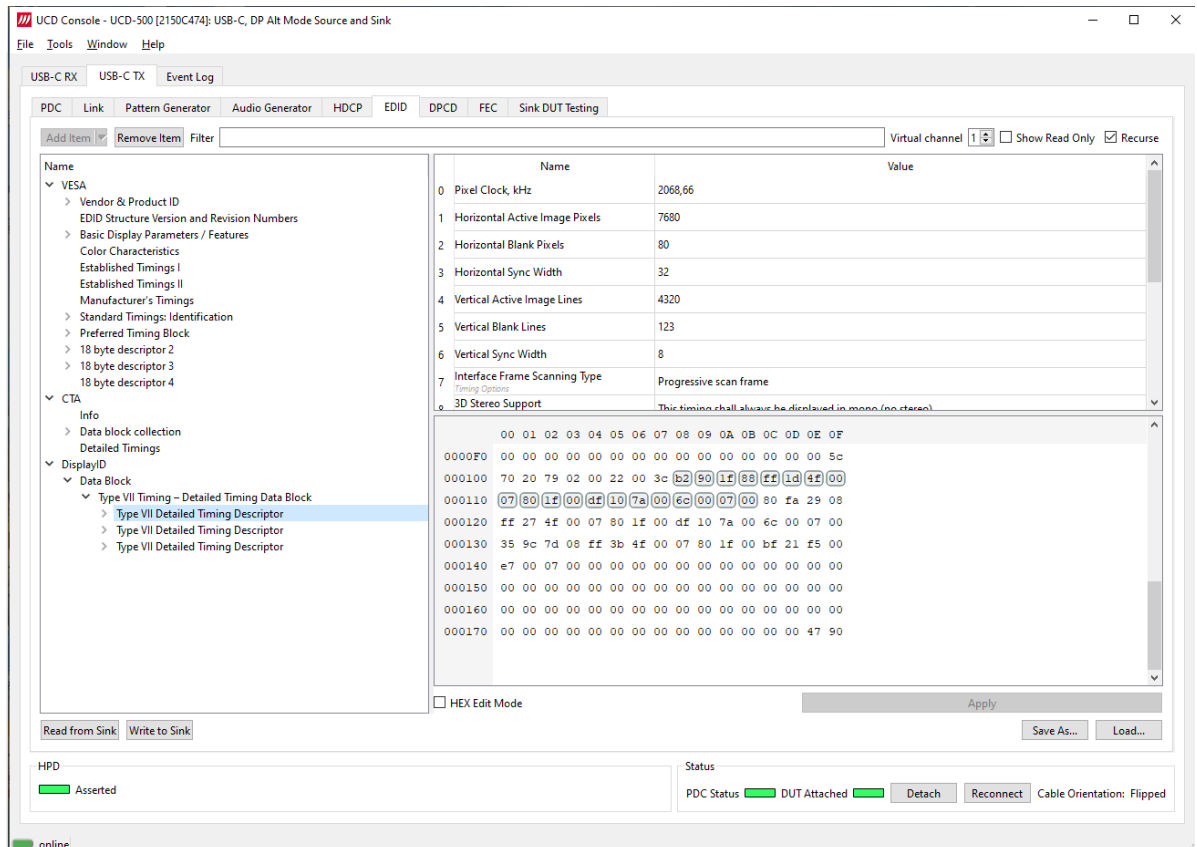
Note: With current SW release UCD-500 supports HDCC only when 8b/10b link coding is enabled.

EDID Tab

EDID Tab provides tools for accessing the EDID and Display ID of the connected sink device.

There are three basic functions:

- Load and save EDID data files in the host PC
- Edit the EDID contents either in EDID Editor or in hex format
- Program and read the contents of the EDID of the sink devices connected



EDID Files

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

Note:

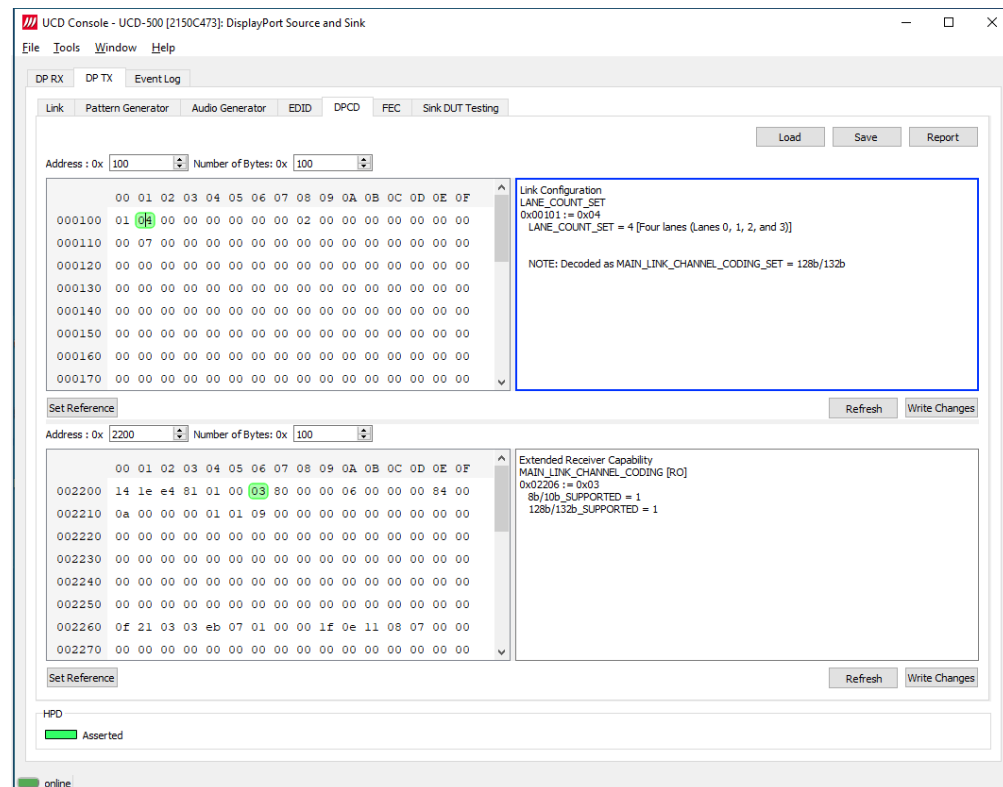
Four blocks (512 bytes) of EDID code are read. If the device is not supporting all four blocks, the non-supported area is replaced with blanks.

EDID Editor

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

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.

DPCD Decoder flags in Tools > Options contain control of DETAILED_CAP_INFO_AVAILABLE flag and MAIN_LINK_CHANNEL_CODING_SET flag.

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

Write Changes Write the portion of data shown in the window in question to the DPCD registers.

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 two alternative formats listed below. Please add the intended format when saving:

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

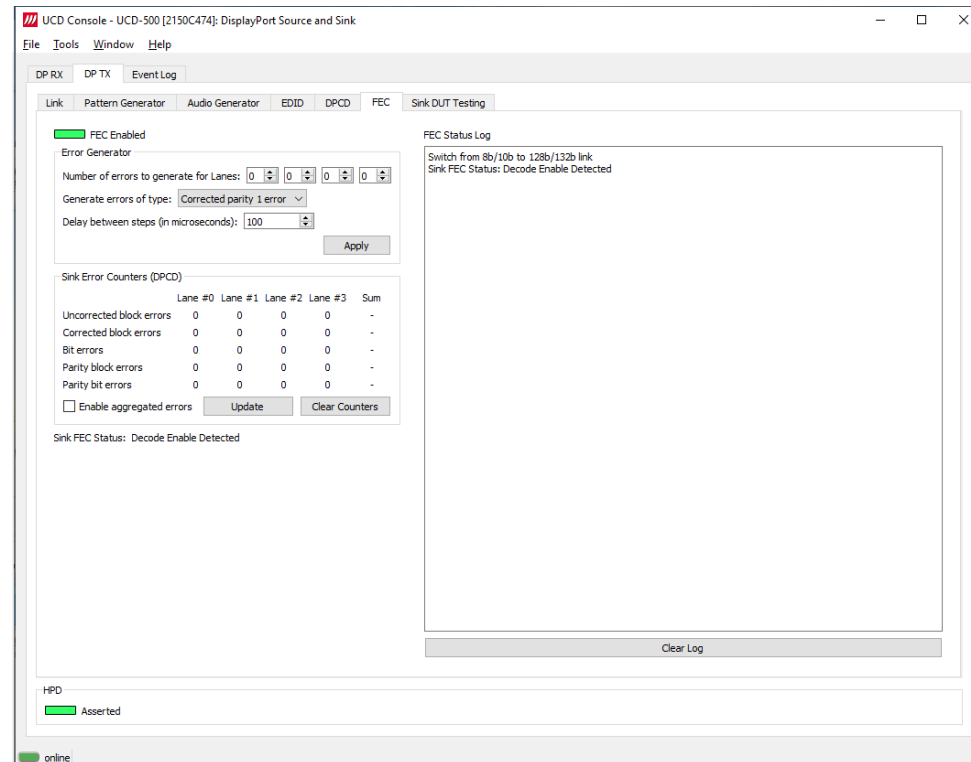
Click **Save** to select the location and the format of the file.

Click **Load** to load DPCD data saved in *DPCD Data File (*.DPD)* format to the editor.

To program the data into the DPCD registers of the connected sink click **Write Changes**.

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.



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	
Corrected parity 1 error	

Note:

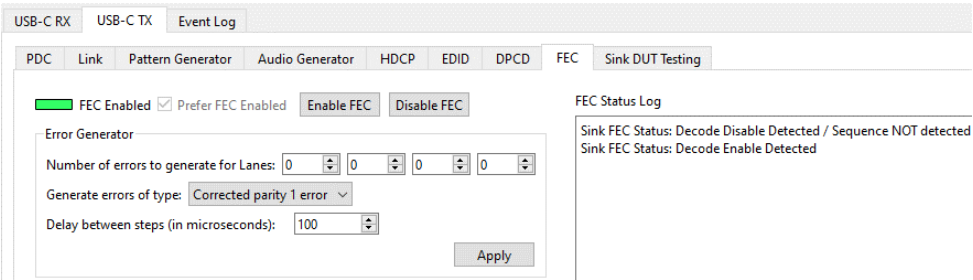
FEC must be enabled and running before errors can be added.
Link training will reset sink FEC error counters.

Each lane can have its individual error amount. Errors can be injected to even and odd decoders by using **lane #0** and **lane #1** counters when link is configured to one lane.

<i>Apply</i>	Start error injection
<i>Update</i>	Read sink DPCD FEC error counter registers
<i>Clear counters</i>	Clear sink DPCD FEC error counter registers

Debug FEC Sequencing with 8b/10b Link Coding

When 8b/10b link coding is enabled, FEC is an optional features. For FEC debugging in 8b/10b link mode UCD Console provides some additional functionalities.



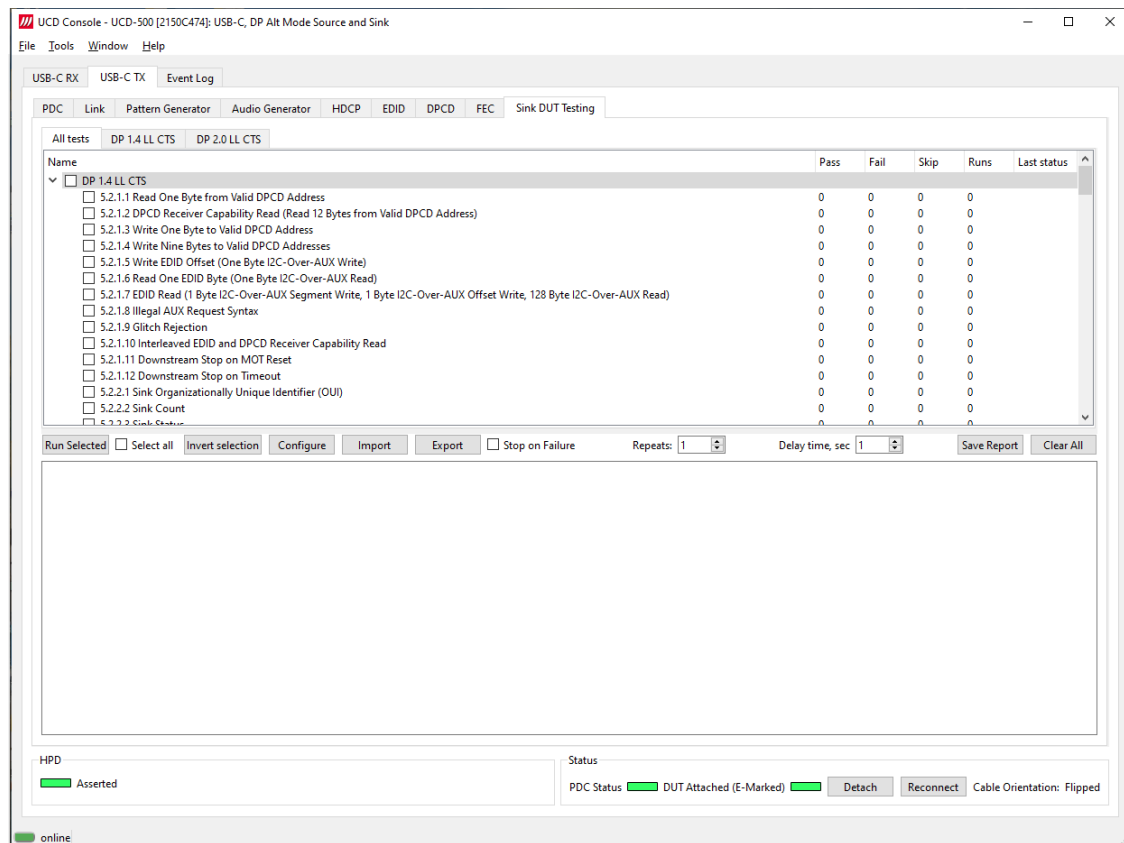
Send FEC Enable Sequence: When clicked UCD-500 will start adding FEC Enable Sequence in its main link data.

Send FEC Disable Sequence: When clicked UCD-500 will start adding FEC Disable Sequence in its main link data.

Sink DUT Testing Tab

Please refer to **Appendix E** later in this document for description of the tests available.

Select the tests for execution by clicking the corresponding row.



Run Selected:	Click to start selected tests. By clicking <i>Abort</i> the sequence is stopped.
Select all:	Select all tests in the selected tab.
Invert selection:	Invert selection of tests selected. Hint: To clear all selections, click <i>Select all</i> and then <i>Invert selection</i> .
Configure:	Clicking opens a dialog for defining the test parameters for the selected test set. Please refer to <i>Test Parameters</i> below for details.
Import:	Load saved test parameter files (*.td or *.json).
Export:	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.
Stop on Failure:	Stops execution of the selected tests if one of the tests fail
Repeats:	Repeat the selected test several times
Delay time:	Delay in seconds between individual tests.

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.

Save Report:	Click to generate a report file in HTML format for sharing the results with other parties for viewing without UCD Console.
Clear Log:	Clear the test log and the results matrix

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.

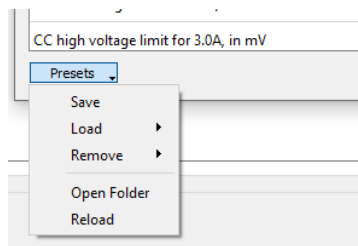
Saving Test Parameters

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 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 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.



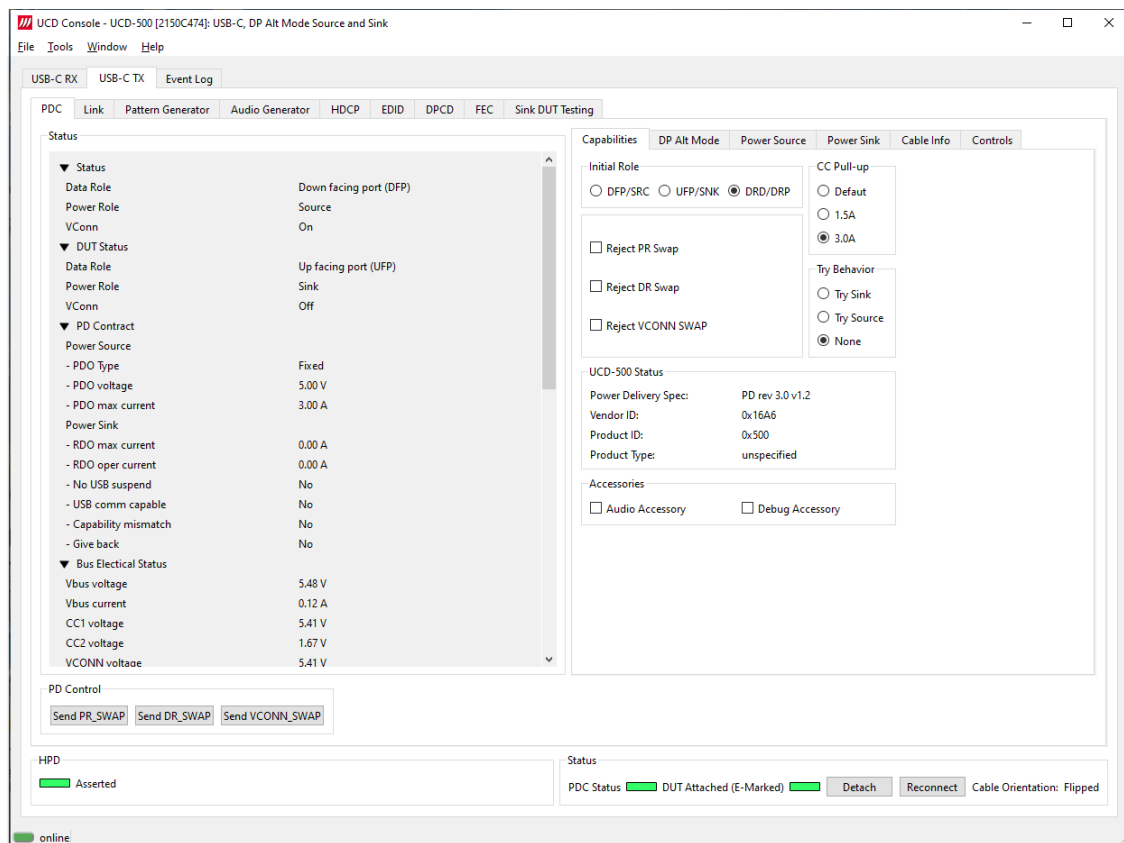
USB-C Monitoring

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

- USB-C Power Delivery (PDC)

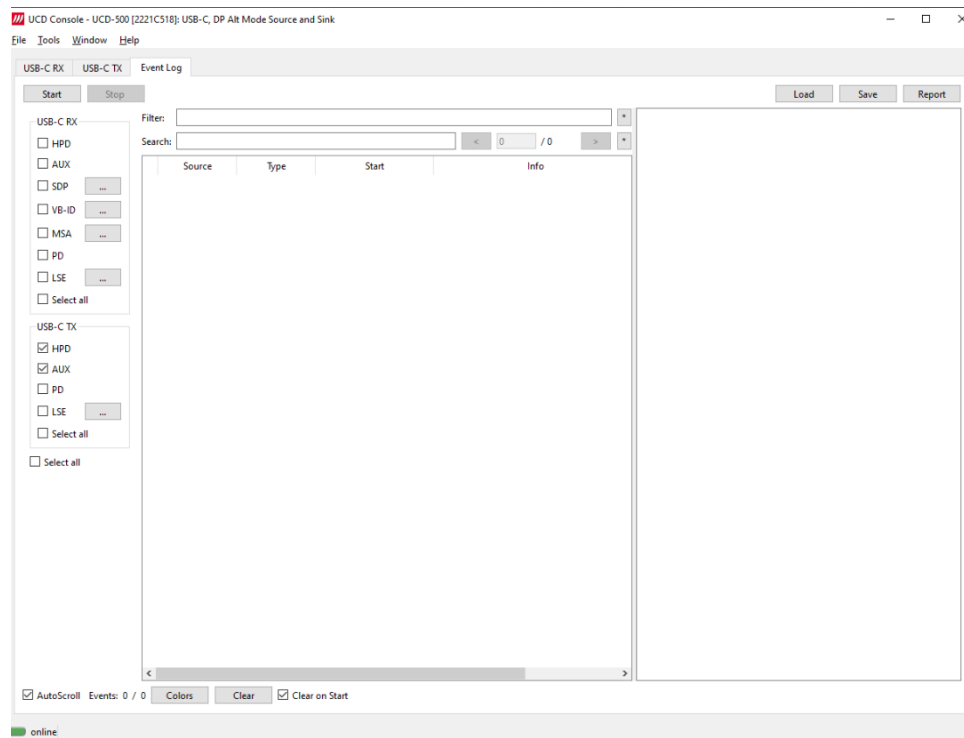
When UCD-500 is used in *DP Alt Mode Reference Source* role, *USB-C Power Delivery* (PDC) tab is available. The content of *USB-C Power Delivery* tab is similar to the tab available when in UCD-500 is used in *DP Alt Mode Reference Sink* role.

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



6. 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 DP Alt Mode Sink	HPD, AUX, SDP, VB-ID, MSA
DP Source DP Alt Mode Source	HPD, AUX
DP Alt Mode Sink DP Alt Mode Source	PD, LSE

Start:	Starts event logging and stop it by clicking <i>Stop</i> .
Save:	Save transactions as Event Log data as binary or as CSV
Load:	Load saved Event Log data
Report:	Store event logs as reports in HTML format to be shared and viewed with any web browser.
AutoScroll:	When selected, transaction list is scrolled vertically, and the latest transaction is shown as the last item of the list. When not selected, the items shown before clicking Start will be shown.
Events:	Number of events detected
Colors:	Open configure colors dialog
Clear:	Click to clear transaction list. When <i>Clear on Start</i> is selected, the list is cleared when clicking Start.

Selecting Logged Events


HPD

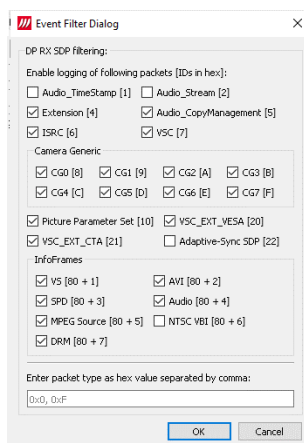
Status and status changes of Hot Plug Detect (HPD) signal, power detection status and cable connection status.

AUX


Log DP AUX Channel transactions and Sideband Messaging.

SDP

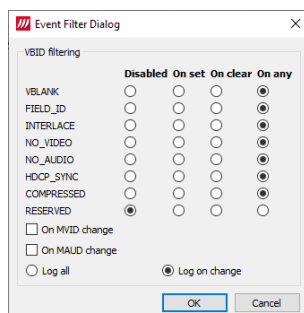
Log DP Secondary-data Packets. Click the  button to open the *Event Filter Dialog*. The dialog enables filtering of SDP packets. In the dialog, the reference to Packet Type Value is indicated in square brackets “[]”.




VB-ID

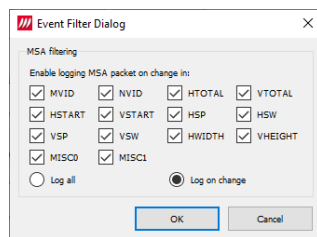
Log Vertical Blanking ID packets sent in DP stream. Click the  button to open the *Event Filter Dialog*. The dialog enables definition of which events will be logged.

Logging VB-ID packets will only work when established link is in 8b/10b coding mode. Support for logging VB-ID packets in 128b/132b link coding will be added in the future.



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 packets and the changes on the selected parameter.

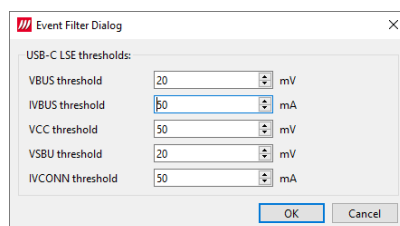


Logging MSA packets will only work when established link is in 8b/10b coding mode. Support for logging MSA packets in 128b/132b link coding will be added in the future.

PD

Log USB-C PD communication messages

LSE

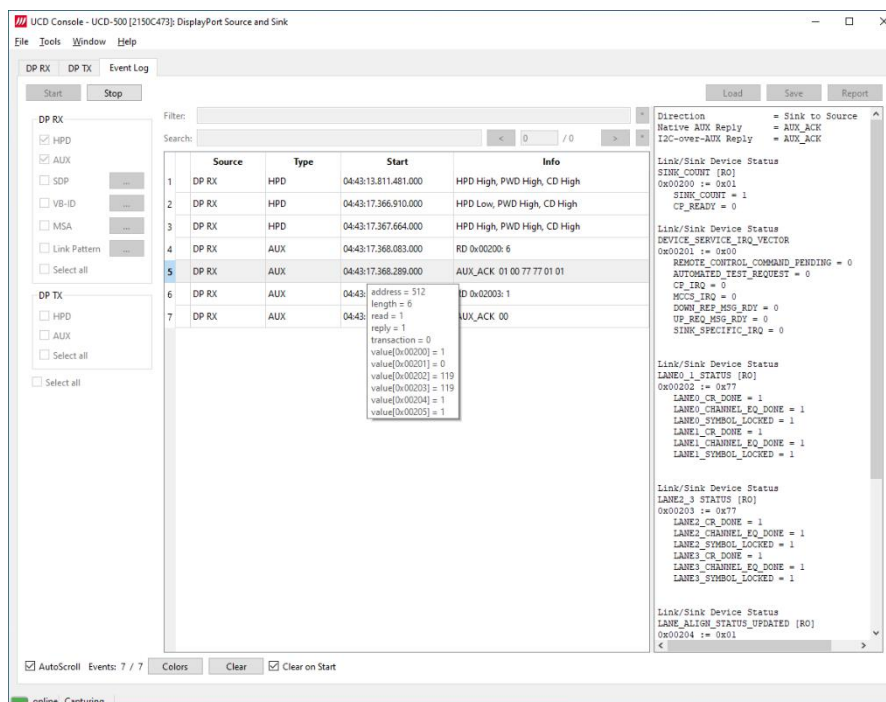


Low Speed Electrical logger captures the Voltage and Current on the low speed lanes of the USB-C connector including CC, VBUS, VCONN, and SBU.

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.



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.

Source and Type

The communication port: DP RX to DP TX

Type

The logged item: HPD, SDP, AUX, MSA Change or VB-ID change

Info

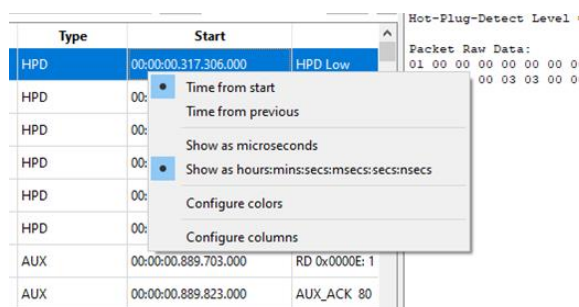
This column provides a short description of the message content

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:

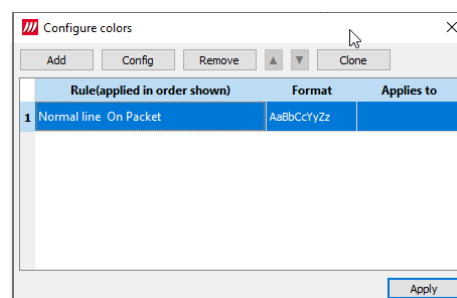
- Time from start of the capture
- Time from previous event

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.



Add: Add a new color highlight rule

Config: Modify the selected rule

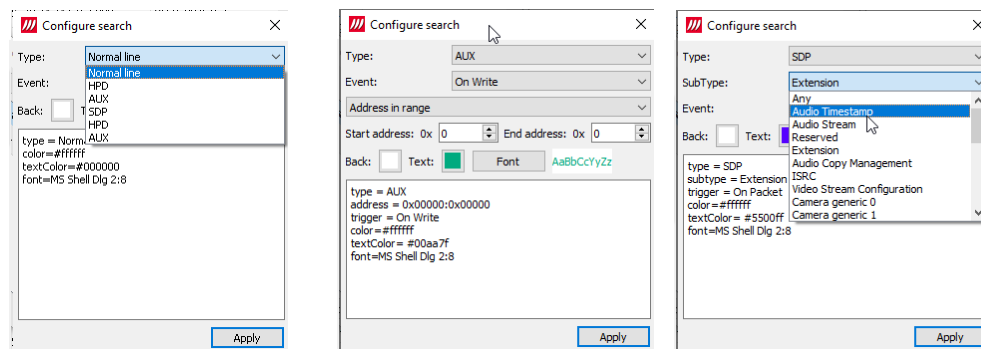
Remove: Delete the selected rule

Clone: Duplicate the selected rule

▲ ▼: Change order where rules are applied.
The rules are applied from the bottom to the top of the list.

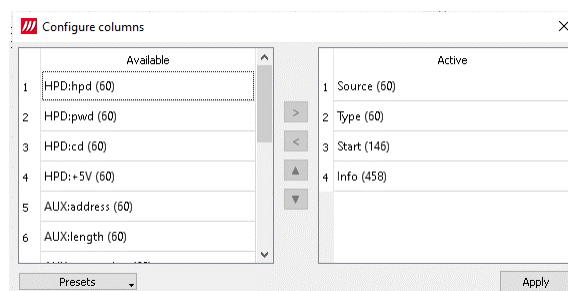
Adding Rules

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

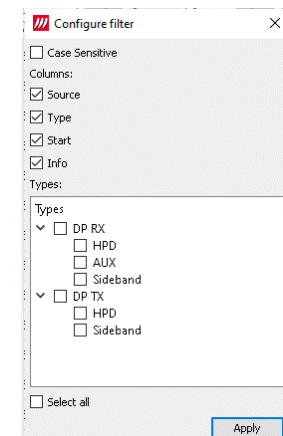
In the dialog there are two columns: *Available* and *Active*. An item from Available list can be included in Active columns by selecting it and clicking on the right arrow [>] in the middle of the two columns.



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>HPD Level:</i>	Status of HPD signal: HIGH (Asserted), LOW (De-asserted)
<i>Power Level: (in DP RX)</i>	Status of source device detection: High (DP Tx detected), LOW (DP Tx not detected)
<i>Cable Detect Level: (in DP RX):</i>	Status of cable detection HIGH (Cable connection detected) LOW (Cable connection not detected)

```
Device ID      = 01 [DP RX]
HPD Level      = HIGH
Power Level    = LOW (DP Tx is connected to Rx and has power applied to AUX pull-up resist
Cable Detect Level = HIGH
```

AUX

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> HDCP Trace 1.X or 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_REP_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_Number_Available 7737
Payload_Bandwidth_Number  7737

```

HDCEP 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

```

DP Secondary-data Packets.

Vertical Blanking ID packets sent in DP stream.

Main Stream Attributes sent in DP stream.

79.

Link Pattern

Details of the link data

```
Device ID = 01
Lane 0 [ACTIVE VIDEO; Detected; ]
Lane 1 [ACTIVE VIDEO; Detected; ]
Lane 2 [ACTIVE VIDEO; Detected; ]
Lane 3 [ACTIVE VIDEO; Detected; ]
```

PD

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

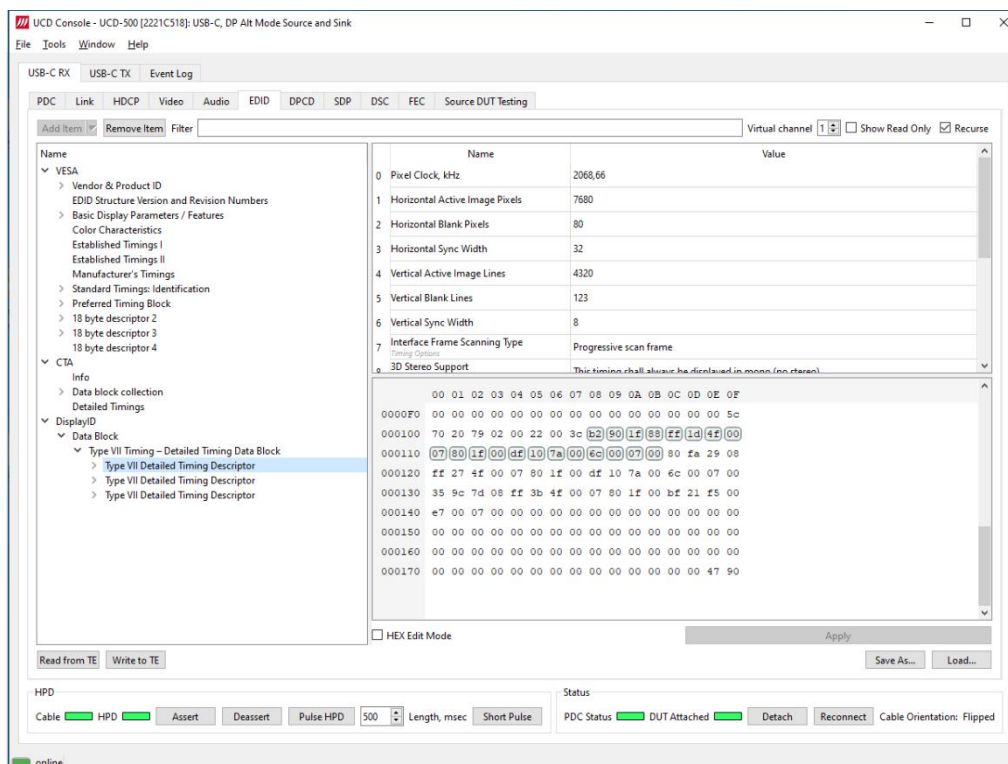
Status of USB-C Low Speed Electrical signals

```
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]
```


7. EDID EDITOR

The *EDID Editor* main window is divided into three logical areas. The bottom part additionally contains the command buttons. The top-left portion shows the currently edited E-EDID blocks in a tree-form, and the top-right portion shows an edit control for the currently selected item, possibly a list of sub-keys and their names (The list is not shown for all values) and the HEX-view of the block collection.



Controls

<i>Add Item:</i>	Add a new EDID or DisplayID block
<i>Remove Item:</i>	Delete the selected EDID or DisplayID block.
<i>Filter:</i>	Show only items having indicated the string in the field name
<i>Virtual channel:</i>	Select virtual channel where EDID is accessed
<i>Show Read Only:</i>	When selected, also automatically created fields are shown
<i>Recurse:</i>	When selected, the whole logical tree of the selected item is parsed on the right hand side list.

The buttons in the bottom of the dialog differ based on the role selected, i.e., is the subject the local EDID or EDID of a connected device.

<i>Read from TE (Analyzer):</i>	Read UCD-500 local EDID.
<i>Write to TE (Analyzer):</i>	Program UCD-500 local EDID.
<i>Download from Sink (Generator):</i>	Read EDID of a connected sink device
<i>Upload to Sink (Generator):</i>	Program EDID of a connected sink device
<i>Load:</i>	Load an EDID block collection file from disk.
<i>Save As...:</i>	Save the current block collection to a disk file.

EDID Editor Features

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 blocks contain a structure that is very similar to a tree-structure. The EDID Editor decodes each block into a tree-view of the block. The tree-view then contains all values contained within the EDID block. The contents can then be easily browsed, using only a few mouse clicks. The EDID Editor has a support for automatic variables, such as the block checksum. When the user changes a value in an EDID block, the tool will update the checksum accordingly. The automatic variables appear as read only values for the user. A log print will be made when an automatic variable is updated by the editor.

Editing Tips

Editing an EDID block is very straightforward, but there are some special cases where the user must know how to accomplish certain types of tasks.

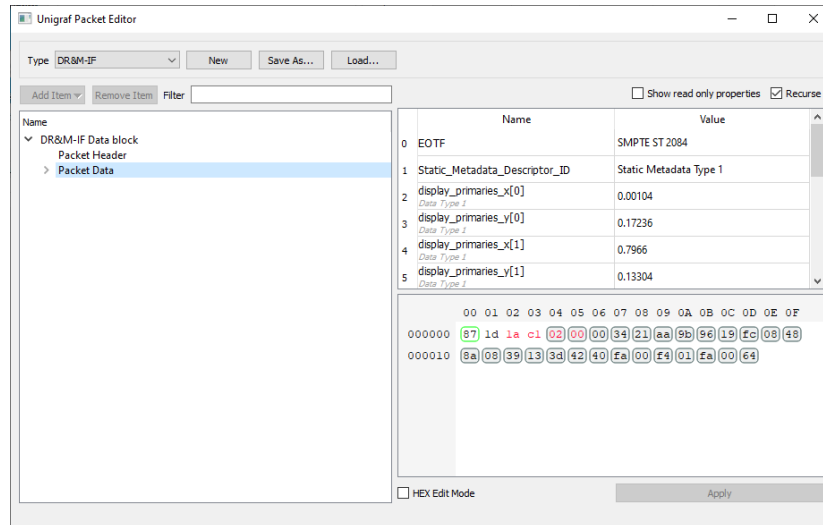
- Double-click the property field to edit
- Red values in the HEX view indicate a changed value.
- **Enter** key will apply text-edit values and combo-box selection.
- In CTA-861 blocks, you can add and remove 18-byte descriptors and CEA data blocks by setting the values "18-byte Descriptors in this block" and "CEA Data block count".
- Enter hex values with prefix "0x" or "\$", no prefix means a decimal value.
- You can always enter HEX or DEC, even if the value is presented as HEX, and/or value range is given in HEX.
- Floating point values must be given with period "." as decimal separator, even if your localization setting defines decimal separator as comma (or other).
- Remember to click **Set** after changing a bit-value presented as a single check-box 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.

8. PACKET EDITOR

Packet Editor enables creation and editing metadata packets to be included Scenarios played with Playback function.



The types of packets are:

- Audio InfoFrames (Audio-IF)
- Auxiliary Video Information InfoFrames (AVI-IF)
- Custom packets (Custom)
- Dynamic Range and Mastering InfoFrames (DR&M-IF)
- Video timing Extended metadata (EMP-VRR)
- General Control Packet (GCP)
- Source Product Description InfoFrames (SDP-IF)
- Vendor-Specific InfoFrames (VSIF)

9. PATTERN EDITOR

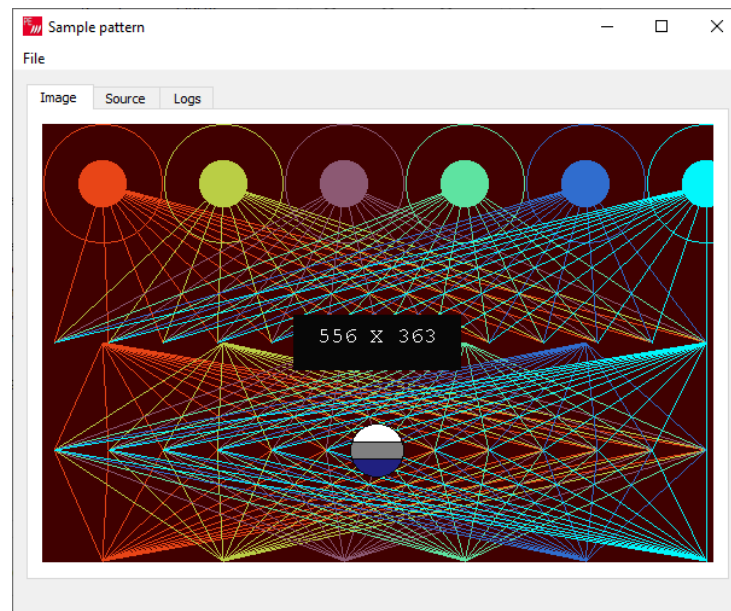
Pattern Editor is a tool for editing and debugging Unigraf Custom VTP Pattern scripts.

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:

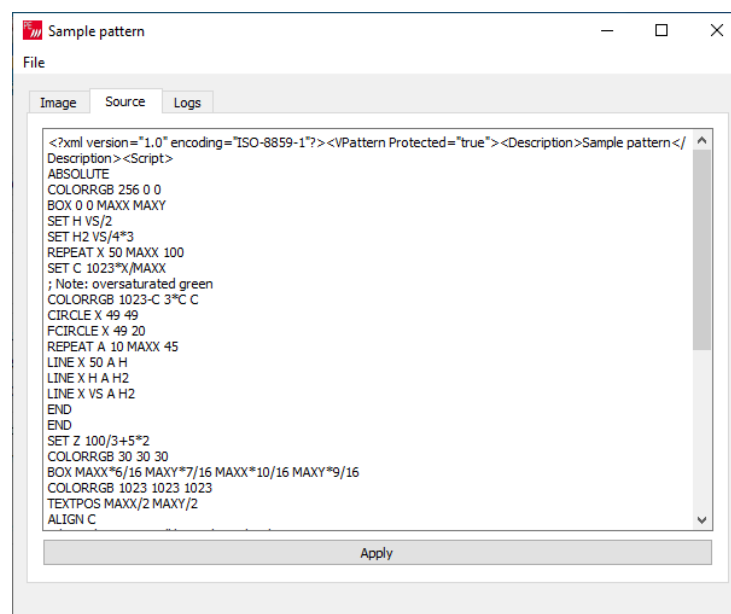
Image Tab

Monitoring the rendering of the VTP pattern script.



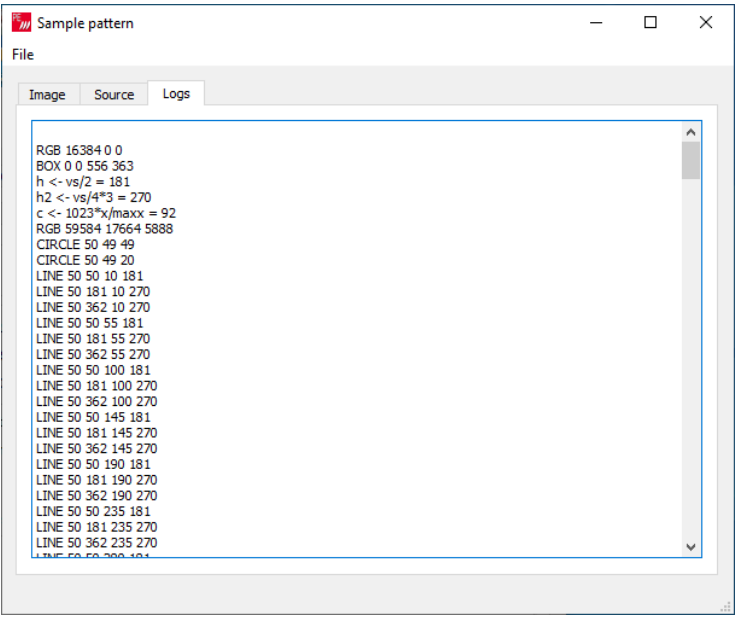
Source Tab

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.

<i>Open:</i>	Open a VTP language script from PC
<i>Save Script:</i>	Save the script currently in Source tab to PC
<i>Save Image:</i>	Save a rendered pattern in PNG, BMP, JPG or PPM format
<i>Select Save Resolution:</i>	Select from six common resolutions the size in which the pattern script will be rendered when saved.

10. 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.

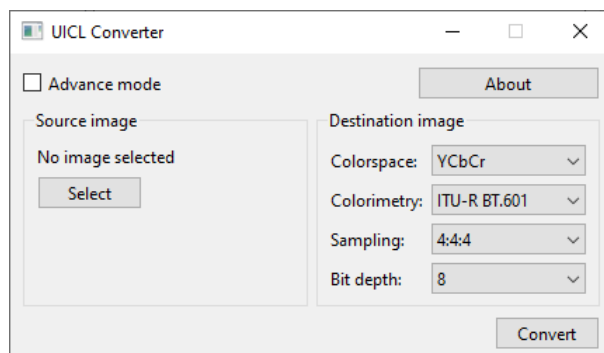
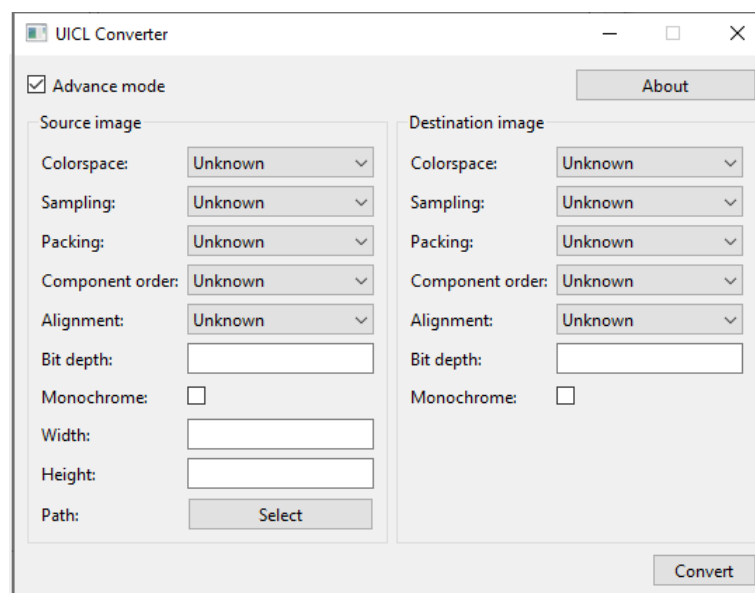


Image Converter has two operating modes: Standard mode and Advanced mode. In Standard mode typical Windows image file formats are used as Source image and the user sets basic color formats for the Destination image. In Advanced mode, the user is able to define the Source and Destination image parameters 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-500

Input	DisplayPort: DP 2.0/2.1 capable (DP In) (10 Gbps link rate maximum) USB-C: PD 3.0 compliant (USB-C In) (20 Gbps link rate maximum)
Output	DisplayPort: DP 2.1 compliant (DP Out) (10 Gbps link rate maximum) USB-C: PD 3.0 compliant (USB-C Out) (20 Gbps link rate maximum)
Max video mode	7680 × 4320 p60 input and output 15360 × 8640 p60 input and output with DSC
Audio	LPCM, 2 – 8 channels, 44.1 to 192 kHz
Content Protection	HDCP is supported when 8b/10b link coding is enabled
DSC Capability	DSC sink, with off-line decompression DSC source using pre-compressed content
Additional features	FEC, LTTPR, DSC
Computer interface	USB 3.0
Software	Windows, MacOS, Linux UCD Console application, TSI SDK.
Power supply	AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +24 Vdc output)
Environmental	Operating temperature: 15 to 35 deg C Storage temperature: 0 to 50 deg C Humidity 30% to 70% RH, non-condensing
Mechanical Size	331mm x 197mm x 66mm
Weight	1.9kg

UCD-500 Gen2

Input	DisplayPort: DP 2.1 compliant (DP In) (20 Gbps link rate) USB-C: PD 3.0 compliant (USB-C In) (20 Gbps link rate)
Output	DisplayPort: DP 2.1 compliant (DP Out) (20 Gbps link rate) USB-C: PD 3.0 compliant (USB-C Out) (20 Gbps link rate)
Max video mode	7680 × 4320 p60 input and output 15360 × 8640 p60 input and output with DSC
Audio	LPCM, 2 – 8 channels, 44.1 to 192 kHz
Content Protection	HDCP is supported when 8b/10b link coding is enabled
DSC Capability	DSC sink, with off-line decompression DSC source using pre-compressed content
Additional features	FEC, LTTPR, DSC
Computer interface	USB 3.0
Software	Windows, MacOS, Linux UCD Console application, TSI SDK.
Power supply	AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +24 Vdc output)
Environmental	Operating temperature: 15 to 35 deg C Storage temperature: 0 to 50 deg C Humidity 30% to 70% RH, non-condensing
Mechanical Size	331mm x 197mm x 66mm
Weight	1.9kg

APPENDIX B: PRODUCT FEATURES

Input / Output Role	UCD-500 Default	DP 1.4 LL CTS	DP 2.1 LL CTS	DP 1.4 DSC CTS	DP 2.x DisplayID-EDID CTS	DP 2.x Adaptive-Sync CTS	DP HDCP 2.3 CTS Source DUT	DP HDCP 2.3 CTS Sink, Source & Repeater DUT	LTTTPR CTS for Source DUT	TSI Basic
DP Reference Sink										
Video status, preview and saving	•									▲
Buffered capture	•									▲
Audio monitoring, graphical preview and saving	•									▲
Link status	•									▲
Link control	•									▲
HPD status and control	•									▲
MST Feature (up to 2 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)	•									▲
DP 1.4 LL, Audio, FEC CTS for testing Source DUT		•								
DP 2.1 LL CTS for testing Source DUT			•							
DP 1.4 DSC CTS for testing Source DUT				•						
DP 2.x DisplayID-EDID CTS for testing Source DUT					•					
DP 2.x 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*								•		
DP LTTTPR CTS for testing Source DUT									•	

*) HDCP is supported only when 8b/10b link coding is enabled

**) Adaptive-Sync is currently limited to 8b/10b link coding and SST mode.

Input /Output Role	UCD-500 Default	DP 1.4 LL CTS	DP 2.1 LL CTS	DP 1.4 DSC CTS	DisplayID / EDID CTS	Adaptive-Sync CTS	DP HDCP 2.3 CTS Sink DUT	DP HDCP 2.3 CTS Sink, Source & Repeater DUT	LTTTPR CTS for Sink DUT	TS/ Basic
DP Reference Source										
Video pattern generator (fixed patterns and timings)	•									▲
Custom video patterns and timings	•									▲
Audio generator	•									▲
Link status	•									▲
Link control	•									▲
HPD status	•									▲
EDID read and write	•									▲
EDID / DisplayID Editor	•									
MST Feature (up to 2 streams)	•									▲
FEC Feature	•									▲
DSC Encoder	•									▲
Adaptive-Sync Feature**	•									▲
DPCD editor	•									
LTTTPR Feature	•									▲
HDCP 1.3 status and control*	•									▲
HDCP 2.3 status and control*	•									▲
Event Log, AUX Analyzer	•									
Sink DUT Testing	•									
DP 1.4 LL, Audio and FEC CTS for testing Sink DUT		•								
DP 2.1 LL CTS for testing Sink DUT			•							
DP 1.4 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*								•		
DP LTTTPR CTS for testing Sink DUT									•	

*) HDCP is supported only when 8b/10b link coding is enabled

**) Adaptive-Sync is currently limited to 8b/10b link coding and SST mode.

UCD-500 Product Options

Product	P/N
UCD-500	066700
UCD-500 Gen2	066710
DP 2.1 LL CTS for testing Sink DUT	MT6660
DP 2.1 LL CTS for testing Source DUT	MT6662
DP 1.4 LL CTS for testing Sink DUT	MT6635
DP 1.4 LL CTS for testing Source DUT	MT6637
DP 1.4 DSC CTS for testing Sink DUT	MT6643
DP 1.4 DSC CTS for testing Source DUT	MT6642
DP DisplayID / EDID CTS for testing Source DUT	MT6646
DP DisplayID / EDID CTS for testing Sink DUT	MT6647
Adaptive-Sync CTS for testing Source DUT	MT6648
Adaptive-Sync CTS for testing Sink DUT	MT6649
DP HDCP 2.3 CTS for testing Source DUT	MT6634
DP HDCP 2.3 CTS for testing Sink DUT	MT6636
DP HDCP 2.3 CTS for testing Sink, Source and Repeater DUT	MT6638
DP LTTPR CTS for testing Source DUT	MT6680
DP LTTPR CTS for testing Sink DUT	MT6679

APPENDIX C: PREDEFINED TIMINGS

Description*	HA	VA	HT	VT	HST	VST	HSYN	VSYN	FR	Pixel Clock (MHz)
VESA 640x480 @ 60Hz (DMT 04h)	640	480	800	525	144	35	96	2	60	25,20
CTA 720x480 @ 60Hz (VIC 2)	720	480	858	525	122	36	62	6	60	27,03
CTA 720x480 @ 120Hz (VIC 48)	720	480	858	525	122	36	62	6	120	54,05
VESA 800x600 @ 60Hz (DMT 09h)	800	600	1056	628	216	27	128	4	60	39,79
VESA 848x480 @ 60Hz (DMT 0Eh)	848	480	1088	517	224	31	112	8	60	33,75
VESA 1024x768 @ 60Hz (DMT 10h)	1024	768	1344	806	296	35	136	6	60	65,00
CTA 1280x720 @ 60Hz (VIC 4)	1280	720	1650	750	260	25	40	5	60	74,25
CTA 1280x720 @ 120Hz (VIC 47)	1280	720	1650	750	260	25	40	5	120	148,50
VESA 1280x768 @ 60Hz (DMT 17h)	1280	768	1664	798	320	27	128	7	60	79,67
VESA 1280x768 @ 60Hz RBv1	1280	768	1440	790	112	19	32	7	60	68,26
VESA 1280x800 @ 60Hz (DMT 1Ch)	1280	800	1680	831	328	28	128	6	60	83,76
VESA 1280x800 @ 60Hz RBv1	1280	800	1440	823	112	20	32	6	60	71,11
VESA 1280x960 @ 60Hz (DMT 20h)	1280	960	1800	1000	424	39	112	3	60	108,00
VESA 1280x1024 @ 60Hz (DMT 23h)	1280	1024	1688	1066	360	41	112	3	60	107,96
VESA 1360x768 @ 60Hz (DMT 27h)	1360	768	1792	795	368	24	112	6	60	85,48
VESA 1400x1050 @ 60Hz (DMT 2Ah)	1400	1050	1864	1089	376	36	144	4	60	121,79
VESA 1400x1050 @ 60Hz RBv1	1400	1050	1560	1080	112	27	32	4	60	101,09
CTA 1440x480 @ 59.94Hz (VIC 14)	1440	480	1716	525	244	36	124	6	60	54,00
CTA 1440x576 @ 50Hz (VIC 29)	1440	576	1728	625	264	44	128	5	50	54,00
VESA 1600x1200 @ 60Hz (DMT 33h)	1600	1200	2160	1250	496	49	192	3	60	162,00
VESA 1600x1200 @ 60Hz RBv1	1600	1200	1760	1235	112	32	32	4	60	130,42
CTA 1680x720 @ 60Hz (VIC 83)	1680	720	2200	750	260	25	40	5	60	99,00
CTA 1680x720 @ 120Hz (VIC 85)	1680	720	2000	825	260	100	40	5	120	198,00
VESA 1680x1050 @ 60Hz (DMT 3Ah)	1680	1050	2240	1089	456	36	176	6	60	146,36
VESA 1680x1050 @ 60Hz RBv1	1680	1050	1840	1080	112	27	32	6	60	119,23
VESA 1792x1344 @ 60Hz (DMT 3Eh)	1792	1344	2448	1394	528	49	200	3	60	204,75
VESA 1856x1392 @ 60Hz (DMT 41h)	1856	1392	2528	1439	576	46	224	3	60	218,27
VESA 1920x1080 @ 30Hz RBv1	1920	1080	2080	1096	112	13	32	5	30	68,39
VESA 1920x1080 @ 30Hz RBv2	1920	1080	2000	1096	72	14	32	8	30	65,76
CTA 1920x1080 @ 30Hz (VIC 34)	1920	1080	2200	1125	192	41	44	5	30	74,25
VESA 1920x1080 @ 60Hz (DMT 52h)	1920	1080	2200	1125	192	41	44	5	60	148,50
VESA 1920x1080 @ 60Hz RBv1	1920	1080	2080	1111	112	28	32	5	60	138,65
VESA 1920x1080 @ 60Hz RBv2	1920	1080	2000	1111	72	14	32	8	60	133,32
CTA 1920x1080 @ 60Hz (VIC 16)	1920	1080	2200	1125	192	41	44	5	60	148,50

*) CVT: Coordinated Video Timings (CVT; VESA-2013-3 v1. 2)

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)

Other: Unigraf proprietary timing

Description*	HA	VA	HT	VT	HST	VST	HSYN	VSYN	FR	Pixel Clock (MHz)
VESA 1920x1080 @ 120Hz RBv1	1920	1080	2080	1144	112	61	32	5	120	285,54
VESA 1920x1080 @ 120Hz RBv2	1920	1080	2000	1144	72	14	32	8	120	274,56
CTA 1920x1080 @ 120Hz (VIC 63)	1920	1080	2200	1125	192	41	44	5	120	297,00
VESA 1920x1440 @ 60Hz (DMT 45h)	1920	1200	2592	1245	536	42	200	6	60	193,62
VESA 1920x1440 @ 60Hz (DMT 49h)	1920	1440	2600	1500	552	59	208	3	60	234,00
VESA 2048x1536 @ 60Hz RBv1	2048	1536	2208	1580	112	41	32	4	60	209,32
VESA 2560x1080 @ 60Hz CVT	2560	1080	3424	1120	704	37	272	10	60	230,09
VESA 2560x1080 @ 60Hz RBv1	2560	1080	2720	1111	112	28	32	10	60	181,32
CTA 2560x1080 @ 60Hz (VIC 90)	2560	1080	3000	1100	192	16	44	5	60	198,00
CTA 2560x1080 @ 120Hz (VIC 92)	2560	1080	3300	1250	192	166	44	5	120	495,00
VESA 2560x1440 @ 60Hz RBv1	2560	1440	2720	1481	112	38	32	5	60	241,70
VESA 2560x1440 @ 60Hz RBv2	2560	1440	2640	1481	72	14	32	8	60	234,59
VESA 2560x1600 @ 60Hz (DMT 4Ch)	2560	1600	3504	1658	752	55	280	6	60	348,58
VESA 2560x1600 @ 60Hz RBv1	2560	1600	2720	1646	112	43	32	6	60	268,63
Other 2880x1440 @ 60Hz	2880	1440	2976	1456	48	8	8	1	60	259,98
VESA 3840x2160 @ 30Hz RBv1	3840	2160	4000	2191	112	28	32	5	30	262,92
VESA 3840x2160 @ 30Hz RBv2	3840	2160	3920	2191	72	14	32	8	30	257,66
CTA 3840x2160 @ 30Hz (VIC 95)	3840	2160	4400	2250	384	82	88	10	30	297,00
CTA 3840x2160 @ 50Hz (VIC 96)	3840	2160	5280	2250	384	82	88	10	50	594,00
VESA 3840x2160 @ 60Hz RBv1	3840	2160	4000	2222	112	59	32	5	60	533,28
VESA 3840x2160 @ 60Hz RBv2	3840	2160	3920	2222	72	14	32	8	60	522,61
VESA 3840x2160 @ 60Hz RBv3	3840	2160	4000	2222	152	14	32	8	60	533,47
CTA 3840x2160 @ 60Hz (VIC 97)	3840	2160	4400	2250	384	82	88	10	60	594,00
CTA 4096x2160 @ 50Hz (VIC 101)	4096	2160	5280	2250	216	82	88	10	50	594,00
VESA 4096x2160 @ 60Hz RBv1	4096	2160	4256	2222	112	59	32	10	60	567,41
VESA 4096x2160 @ 60Hz RBv2	4096	2160	4176	2222	72	14	32	8	60	556,74
VESA 4096x2160 @ 60Hz RBv3	4096	2160	4256	2222	152	14	32	8	60	567,61
CTA 4096x2160 @ 60Hz (VIC 102)	4096	2160	4400	2250	216	82	88	10	60	594,00
VESA 3840x2160 @ 120Hz RBv1	3840	2160	4000	2287	112	124	32	5	120	1097,76
VESA 3840x2160 @ 120Hz RBv2	3840	2160	3920	2287	72	14	32	8	120	1075,80
CTA 3840x2160 @ 120Hz (VIC 118)	3840	2160	4400	2250	384	82	88	10	120	1188,00
VESA 5120x2160 @ 30Hz RBv1	5120	2160	5280	2191	112	28	32	10	30	347,05
VESA 5120x2160 @ 30Hz RBv2	5120	2160	5200	2191	72	14	32	8	30	341,80
CTA 5120x2160 @ 30Hz (VIC 123)	5120	2160	6000	2200	216	32	88	10	30	396,00
VESA 5120x2160 @ 60Hz RBv1	5120	2160	5280	2222	112	59	32	10	60	703,93
VESA 5120x2160 @ 60Hz RBv2	5120	2160	5200	2222	72	14	32	6	60	693,26
CTA 5120x2160 @ 60Hz (VIC 126)	5120	2160	5500	2250	216	82	88	10	60	742,50

*) CVT: Coordinated Video Timings (CVT; VESA-2013-3 v1. 2)

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)

Other: Unigraf proprietary timing

Description*	HA	VA	HT	VT	HST	VST	HSYN	VSYN	FR	Pixel Clock (MHz)
VESA 5120x2160 @ 120Hz RBv1	5120	2160	5280	2287	112	124	32	10	120	1449,04
VESA 5120x2160 @ 120Hz RBv2	5120	2160	5200	2287	72	14	32	8	120	1427,09
CTA 5120x2160 @ 120Hz (VIC 193)	5120	2160	5500	2250	216	82	88	10	120	1485,00
VESA 5120x2880 @ 60Hz RBv1	5120	2880	5280	2962	112	79	32	5	60	938,36
VESA 5120x2880 @ 60Hz RBv2	5120	2880	5200	2962	72	14	32	8	60	924,14
VESA 5120x2880 @ 60Hz RBv3	5120	2880	5280	2962	152	14	32	8	60	938,69
CTA 7680x4320 @ 24Hz (VIC 194)	7680	4320	11000	4500	768	164	176	20	24	1188,00
VESA 7680x4320 @ 30Hz RBv1	7680	4320	7840	4381	112	58	32	5	30	1030,41
VESA 7680x4320 @ 30Hz RBv2	7680	4320	7760	4381	72	14	32	8	30	1019,90
CTA 7680x4320 @ 30Hz (VIC 196)	7680	4320	9000	4400	768	64	176	20	30	1188,00
VESA 7680x4320 @ 60Hz RBv1**	7680	4320	7840	4443	112	120	32	5	60	2089,99
VESA 7680x4320 @ 60Hz RBv2**	7680	4320	7760	4443	72	14	32	8	60	2068,66
CTA 7680x4320 @ 60Hz (VIC 199)**	7680	4320	9000	4400	768	64	176	20	60	2376,00
VESA 7680x4320 @ 100Hz RBv1**	7680	4320	7840	4529	112	206	32	5	100	3550,74
VESA 7680x4320 @ 100Hz RBv2**	7680	4320	7760	4529	72	14	32	8	100	3514,50
CTA 7680x4320 @ 100Hz (VIC 200)**	7680	4320	10560	4500	768	164	176	20	100	4752,00

*) CVT: Coordinated Video Timings (CVT; VESA-2013-3 v1. 2)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings










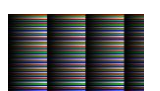
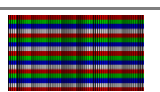
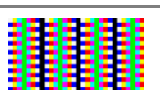


CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)

Other: Unigraf proprietary timing






















**) Currently timings with pixel clock higher than 1520 MHz are not supported

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%). 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. Intensity is increased from 0 to 100% with steps defined by the given parameter (Color Step = cs) and selected color. (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. 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/downloads/testpatterns.html.

APPENDIX E: SINK, SOURCE AND REPEATER TESTS

Source DUT Testing		Default	DP 1.4a LL CTS*	DP 1.4a DSC CTS*	DP 2.1 LL CTS*	DP DisplayID & EDID CTS*	Adaptive-Sync CTS DUT*	DP LTTPR CTS	DP HDCP 2.3 CTS*
Audio Test	Validate audio signal frequency and glitch-free audio reproduction	●							
CRC Video Tests	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	●							
DP 1.4a Link Layer CTS	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, 4.4.4.2 – 4.4.4.6, 4.5.1.1 – 4.5.1.2		●						
DP 1.4a DSC CTS	4.6.1.1 – 4.6.1.9			●					
DP 2.1 Link Layer CTS	4.2.2.11 – 4.2.2.12; 4.3.1.1 – 4.3.1.5; 4.3.1.14 – 4.3.1.23				●				
DP 2.x DisplayID-EDID LL CTS***	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					●			
DP 2.x Adaptive-Sync LL CTS****	4.8.1.1 – 4.8.1.2, 4.8.2.1 – 4.8.2.2						●		
DP LTTPR CTS	4.9.1.1 – 4.9.1.23							●	
DP HDCP 2.3 CTS 1A Test Set**	HDCP2.3 CTS 1A-01 – HDCP2.3 CTS 1A-12								●
DP HDCP 2.3 CTS 1B Test Set**	HDCP2.3 CTS 1B-01 – HDCP2.3 CTS 1B-10								●
Link Config Tests	Link Training at All Supported Lane Counts and Link Rates	●							
Pixel Level Video Tests	Compare video frame sequence with a single reference	●							

*) Separate licenses for testing Sink, Source, Branch (LL CTS, DSC) DUT

**) HDCP is supported only when 8b/10b link coding is enabled

***) Unigraf UCD-400 was used by VESA for TE correlation of the tests

****) Adaptive-Sync is currently limited to 8b/10b link coding and SST mode. Unigraf UCD-400 was used by VESA for TE correlation of the tests

Sink DUT Testing		Default	DP 1.4a LL CTS*	DP DSC Encoder CTS*	DP 2.1 LL CTS*	DP DisplayID & EDID CTS*	Adaptive-Sync CTS DUT*	DP LTTTPR CTS	DP HDCP 2.3 CTS*
DP 1.4a Link Layer CTS	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	5.6.1.1 – 5.6.1.26, 5.6.2.1 – 5.6.2.14			●					
DP 2.1 Link Layer CTS	5.2.1.8 – 5.2.1.12, 5.2.2.1 – 5.2.2.3, 5.2.2.5 – 5.2.2.9, 5.3.1.1 – 5.3.1.15, 5.3.2.1 – 5.3.2.2, 5.5.1.1 – 5.5.1.12				●				
DP 2.x DisplayID-EDID LL CTS***	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, 5.7.2.1 – 5.7.2.3.5, 5.7.4.1 – 5.7.4.2, 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, 5.7.12.1 – 5.7.12.3					●			
DP 2.x Adaptive-Sync LL CTS****	5.8.1.1 – 5.8.1.3 (Tests are in VESA correlation)						●		
DP LTTTPR CTS	5.9.1.1 – 5.9.1.15							●	
DP HDCP 2.3 CTS 2C Test Set**	HDCP2.3 CTS 2C-01 – HDCP2.3 CTS 2C-06								●

*) Separate licenses for testing Sink, Source, Branch (LL CTS, DSC) DUT

**) HDCP is supported only when 8b/10b link coding is enabled

***) Unigraf UCD-400 was used by VESA for TE correlation of the tests

****) Adaptive-Sync is currently limited to 8b/10b link coding and SST mode. Unigraf UCD-400 was used by VESA for TE correlation of the tests

Repeater DUT Testing		Default	DP HDCP 2.3 CTS*
DP HDCP 2.3 CTS 3A Test Set**	HDCP2.3 CTS 3A-01 – HDCP2.3 CTS 3A-06		●
DP HDCP 2.3 CTS 3B Test Set**	HDCP2.3 CTS 3B-01 – HDCP2.3 CTS 3B-07		●
DP HDCP 2.3 CTS 3C Test Set**	HDCP2.3 CTS 3C-01 – HDCP2.3 CTS 3C-25		●

*) Separate licenses for testing Sink, Source, Branch (LL CTS) and Repeater (HDCP) DUT

**) HDCP is supported only when 8b/10b link coding is enabled

Compliance Tests

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-500.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.

For a detailed description of capabilities listed on the tab please refer to Chapter 3 Compliance Test Operation of document VESA DisplayPort Link Layer Compliance Test Specification.

DP 2.0 Link Layer Source DUT CTS

General | Audio | DSC | DisplayID | Adaptive-Sync

Test Timeouts
 Test Timeout (ms): 5000
 Long HPD pulse duration (ms): 1000

DUT Capabilities
 Max lanes supported: 4
 Max Bitrate supported: HBR3 (8.10 Gbps)
 DP 2.0 Settings:
☒ 10 Gbps ☒ 13.5 Gbps ☒ 20 Gbps
 LTTPR device count: 0
 Minimum Link rate: RBR (1.62 Gbps)
 Minimum Lane Count: 1
☒ 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
☐ Max Link Bandwidth Policy supported

Colorimetry
 RGB ☒ YCbCr 4:2:2 ☐ YCbCr 4:4:4
☒ 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

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

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. The content needed by the test will be created from the source bitmap files downloaded during installation (optional).

Creation of the test content will take time and considerably slow down the execution of the test. In order to avoid this user is able to create the DSC content in advance by using a batch file stored during installation. The batch file can be found by default here: _

C:\ProgramData\Unigraf\DSC_content_library\generate_all_dsc_files.bat

The batch file will additionally need a tool called ImageMagick

- ▶ Download and install ImageMagick from the authoritative website
<https://imagemagick.org/script/download.php>

Please download for example the following version for Windows use:

ImageMagick-7.1.0-28-Q16-x64-static.exe *Win64 static at 16 bits-per-pixel component*

- ▶ From the install folder of ImageMagick please copy *magick.exe* and *ffmpeg.exe* to
C:\ProgramData\Unigraf\DSC_content_library
- ▶ Run the batch file

Warning

Please note, that the space needed for storing the full library **can be very large** (appr. 100 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>Automatically create missing content</i>	When selected, compliance test tool During execution of DSC Compliance Tests, the tool automatically creates the DSC compressed content used for testing the DUT.
<i>Keep auto-created</i>	By default, the DSC compressed content is deleted after use. If selected, the content is not deleted

Warning

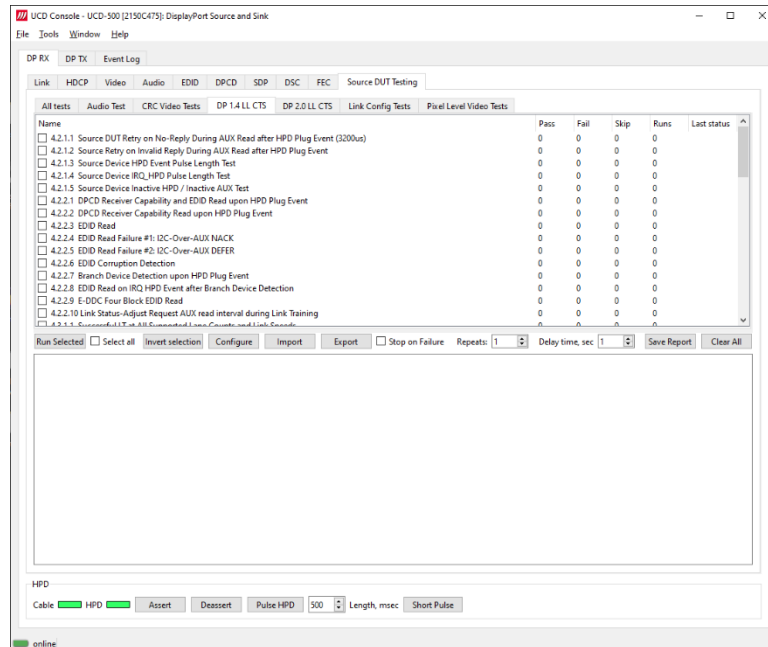
Keeping the automatically created DSC compressed content will shorten the time needed for running the DSC compliance tests.

Please note, that the space needed for storing the full library **can be very large** (appr. 100 GBytes). Please make sure that the content will be stored in a medium that has the required space available.

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-500 firmware implements the test according to the test specification.

Test flow parameters like **Test timeout** and **Test cycle delay** can be defined in *Test Parameter* dialog launched by clicking **Configure**.



Select the tests for execution by clicking the corresponding row. 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.

Run Selected	Click to start selected tests. By clicking <i>Abort</i> the sequence is stopped.
Select all:	Select all tests in the selected tab.
Invert selection	Invert selection of tests selected. Hint: To clear all selections, click <i>Select all</i> and then <i>Invert selection</i> .
Configure	Clicking opens a dialog for defining the test parameters for that set. Please refer to <i>Test Parameters</i> below for description.
Import:	Load saved test parameter files (*.td or *.json).
Export:	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.
Stop on Failure:	Stops execution of the selected tests if one of the tests fail
Repeats:	Repeat the selected test several times. 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.
Delay time	Delay in seconds between individual tests.
Save Report:	Click to generate a report file in HTML format for sharing the results with other parties for <i>viewing</i> without UCD Console.
Clear Log	Clear the test log and the results matrix

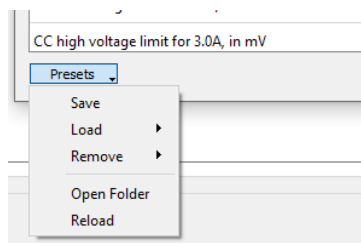
Saving Test Parameters

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 Console. Please find a description below.

Presets

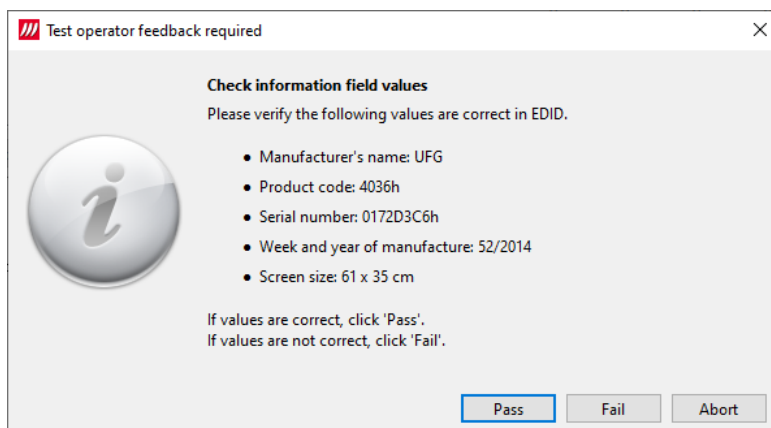
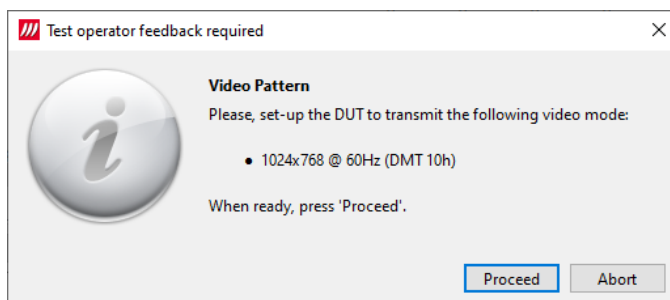
In all *Configure* dialogs the selected parameters can be saved as Presets. Please click **Presets...** to save or recall a configuration



Operator Feedback

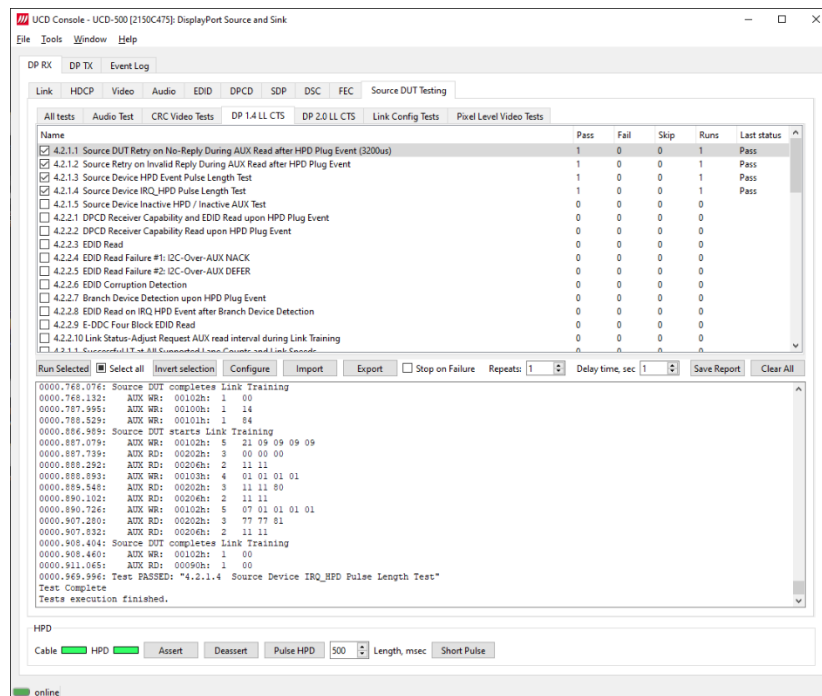
In some compliance tests operator action or feedback is required for items that the test itself cannot perform or confirm. In these cases test opens a pop-up dialog. In the dialog the operator is instructed about items to do or to be verified and buttons for providing the “Proceed” instruction or “Pass” 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.



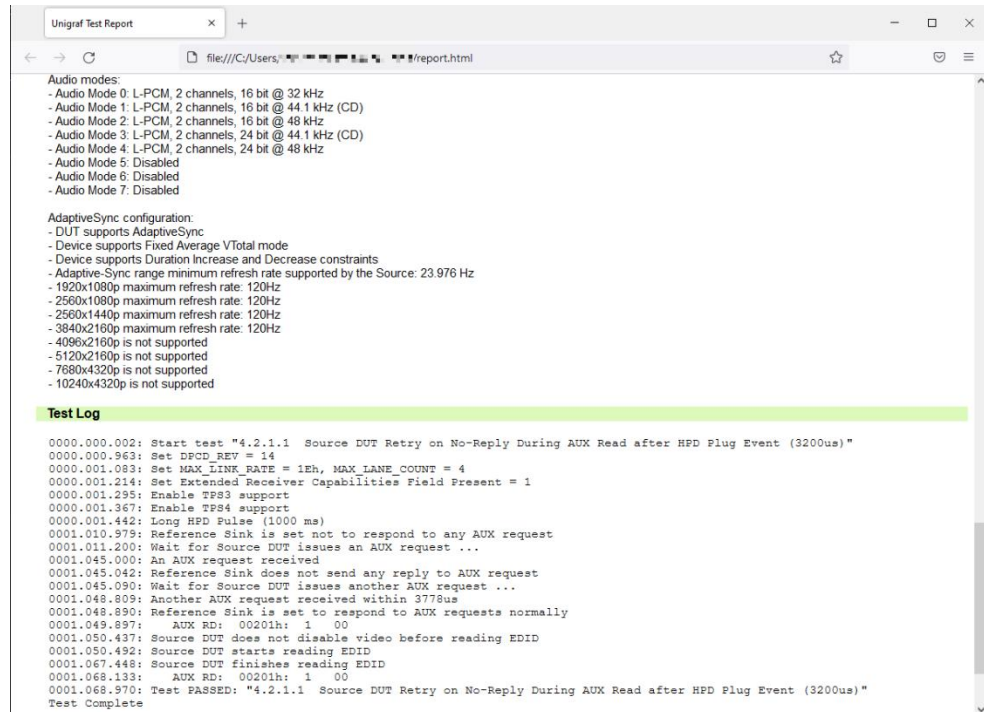
At the completion of each test the result of the test is indicated in the matrix on the right hand side of the test panel. For each test the matrix lists the number of occurrences of each result and the number of tries performed.

Test Report

Results of the test can be saved as a report in HTML format.

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 and individual tests.



Audio Test Set

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 ± 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	C:/Users/Tester/Documents/Test Reports

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)
- Tested audio save conditions (Save none / Save failed / Save all)

Click **Location where the captured audio is to be saved** to browse for the folder to store tests

CRC Based Video Test Set

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*.

The screenshot shows the 'CRC based Video Test Set' dialog box with the following settings:

- Base parameters:**
 - Test timeout (milliseconds): 10000
 - ☐ Run until timeout
 - Test length (# frames): 200
 - Errors allowed (# frames): 20
 - ☐ Repeat "Continuous motion picture test" until timeout
 - Test iterations (# of repeats): 1
- Expected Video Signal:**
 - Width (# pixels): 1920
 - Height (# pixels): 1080
 - Reference BPP: 24
- Frame rate checking:**
 - ☒ Enable frame rate check
 - Expected frame rate (mHz): 60000
 - Frame rate tolerance (±mHz): 100
- Reference CRC's:**
 - 0xB69E, 0xB33E, 0x1AB3,
- CRC Capture length (# frames):**
 - 1
 - Capture now** (button)
- Buttons:** Presets (dropdown), OK, Cancel

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 100 000 ms)
- Total number of frames (default 2 000 ms)
- Number of bad frames allowed (default 2)
- Reference width (default 1920)
- Reference height (default 1080)
- Reference BPP (default 24)
- Expected frame rate (mHz, Hz/1000)
- Frame rate tolerance (mHz, Hz/1000))
- 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 100 000 ms)
- Total number of frames (default 2 000 ms)
- Number of bad frames allowed (default 2)

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 100 000 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, Hz/1000)
- Frame rate tolerance (mHz, Hz/1000)
- 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 100 000 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, Hz/1000)
- Frame rate tolerance (mHz, Hz/1000)
- 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.

Link Config Tests

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)

Pixel Level Video Tests

Compare video frame sequence with a single reference

The test compares captured frames to the provided reference image on pixel level by buffering the indicated number of captured frames first in UCD-500 and after that downloads them to the PC for evaluation.

The test compares the captured frames to a provided reference image on pixel level.

- 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>Load image:</i>	Load the reference image
<i>Image resolution:</i>	Video resolution expected
<i>Image format:</i>	Image format expected
<i>Bits per component:</i>	Bits per component expected
<i>Data format:</i>	Video data format 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>Maximum number of exported frames:</i>	Maximum number of failed frames stored to PC
<i>Folder to save failed frames:</i>	PC folder where failed frames are stored.
<i>Presets:</i>	Store and recall settings

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 at the right of a semicolon (;) is treated as comment.
- All strings are delimited by quotation marks (“a string”). Quote and backslash characters must be prefixed by the backslash symbols (“ a quote \” and a backslash \”).
- 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

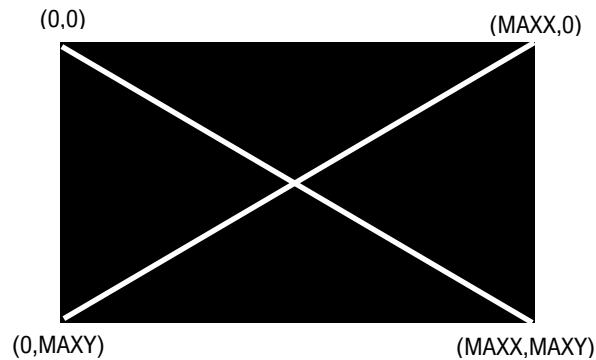
LINE 0 MAXY MAXX 0 ; Draw a line from lower left to upper right corner

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

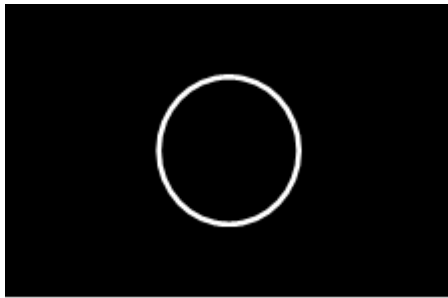
Syntax: CIRCLE x y r

Draws a circle with center point at (x,y) and radius r. Please, note that when using SCALED coordinates radius r is expressed as a vertical measure.

Example:

```
SCALED
COLORDEPTH 8
COLORRGB 255 255 255
CIRCLE 5000 5000 50
```

The pattern will look like this:

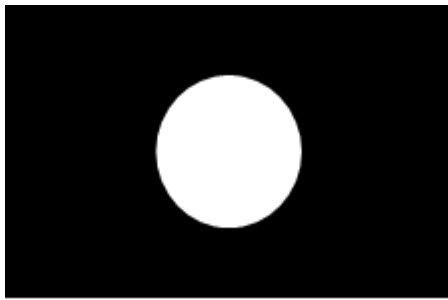


FCIRCLE

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 as a vertical measure.

The pattern will look like this:



ELLIPSE

Syntax: ELLIPSE x y hr vr

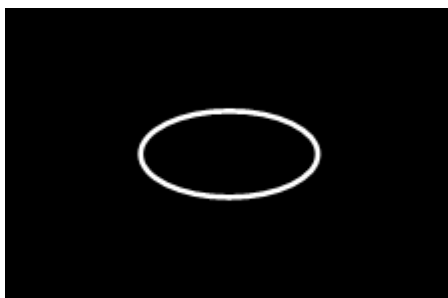
Draws an ellipse with center point at (x,y), horizontal radius hr and vertical radius vr.

You can use ELLIPSE instead of CIRCLE for example when the displayed pixel is not square for compensating the stretching.

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.

Note:

Please note that when using the timing parameters in a pattern the display will be redrawn every time the timing is changed. Normally the VTG does not have to redraw the picture when only e.g., the horizontal sync is changed, but if the HS variable is used in the pattern it needs to be updated to display the new value.

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 variable HR value 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

Coordinate system: ABSOLUTE

Foreground color: 1023 1023 1023

Background color: 0 0 0

Output image is cleared (all black)

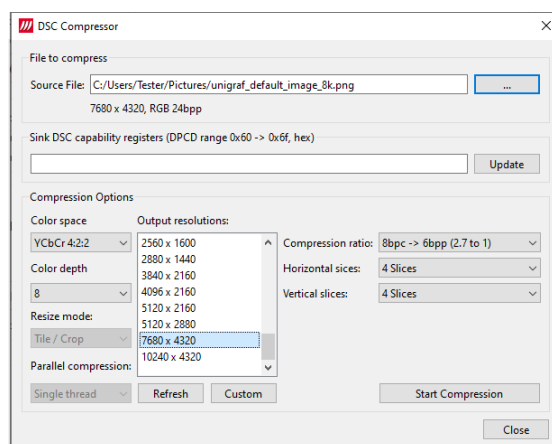
All variables are initialized to zero

COLORDEPTH 10

APPENDIX H: CREATING DSC CONTENT

UCD-500 Pattern Generator function is able to source DSC content originating from pre-created DSC compressed files.

Please find description of *DSC Compressor* tool under *Pattern Generator* earlier in this document.

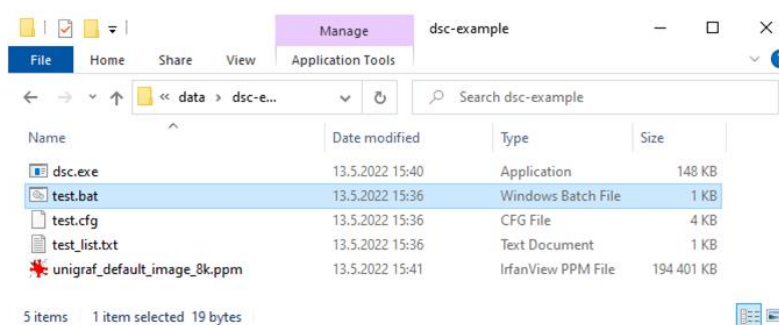


Please find below two alternative methods of creating DSC files. This description is divided in two parts. First part explains DSC conversion of a sample .ppm image and second part preparation and DSC conversion custom bitmap images.

DSC Conversion Example

Installation of UCD Console includes an option for installing also “DSC Content library” that is required e.g. for running DSC Compliance Test using UCD-500. Along with this library the installer includes an example for easily creating a DSC compressed sample bitstream file.

The example can be found by default in folder
C:\ProgramData\Unigraf\DSC_content_library\data\dsc-example



In the example, the DSC conversion is done using batch file *test.bat*. It is creating DSC content from *unigraf_default_image_8k.ppm* using VESA created tool *dsc.exe* and its parameter file *test.cfg*. A detailed explanation of the process can be found later in this appendix in chapter *DSC Conversion*.

In the example DSC conversion is done with the following main parameters:

- Input file in test list.txt: unigraf_default_image_8k.ppm
- Resolution: 7680 x 4320 pixels
- One slice per line, slice height 108 lines
- Pixel format RGB 4:4:4
- Using predefined configuration file *rc_16bpc_8bpp.cfg*

► To run the conversion double click *test.bat*

Creating Custom DSC Content

Please find below instructions for creating DSC bitstream content from user selected bitmap files.

Installation of the Tools

- ▶ Download and install Unigraf Console.
- ▶ Download and install ImageMagick from the authoritative web site <https://imagemagick.org/script/download.php>

Please download for example the following version for Windows use:

ImageMagick-7.1.0-28-Q16-x64-static.exe *Win64 static at 16 bits-per-pixel component*

- ▶ Create a temporary folder in your PC and copy there the following items.
 - Files *ffmpeg.exe* and *magick.exe* in the folder where ImageMagick was installed.
 - *Dsc.exe* is installed with Unigraf Console. By default, the location is C:\Program Files\Unigraf\Unigraf UCD Tools
 - Batch file *test.bat* is installed with Unigraf Console. By default, the location is C:\Program Files\Unigraf\Unigraf UCD Tools\data\dsc-example
 - File *test_list.txt* is installed with Unigraf Console. By default, the location is C:\Program Files\Unigraf\Unigraf UCD Tools\data\dsc-example
 - File *test.cfg* is installed with Unigraf Console. By default, the location is C:\Program Files\Unigraf\Unigraf UCD Tools\data\dsc-example
 - Sample content can be found by default in self extracting compressed file C:\Program Files\Unigraf\Unigraf UCD Tools\data\dsc-images\dsc_sample_images_v2.exe
Please extract the content in a folder in the temporary folder
 - Configuration files can be found by default in folder C:\Program Files\Unigraf\Unigraf UCD Tools\data\dsc
Create a folder ConfigurationFiles in the temporary folder and copy there the needed files

Preparation of RGB 4:4:4 Images

Please use the following command line instructions for preparing any bitmap file for DSC conversion. This chapter describes the tool for creating images with RGB 4:4:4 format.

When using Linux:

```
convert ./input_image -crop resolution+0+0 +repage -size resolution -
depth bpc -sampling-factor 4:4:4 ./output_image.ppm
```

When using Windows:

```
magick.exe convert ./input_image -crop resolution+0+0 +repage -size
resolution -depth bpc -sampling-factor 4:4:4 ./output_image.ppm
```

Parameters:

input_image = image to prepare; *bpc* = 8, 10, 12; *resolution* = e.g. 3840x2160;

output_image = prepared image

Examples

The following examples will use *unigraf_default_image_16k.ppm* as the test bitmap

```
convert ./unigraf_default_image_16k.ppm -crop 3840x2160+0+0 +repage -size
3840x2160 -depth 8 -sampling-factor 4:4:4 ./image-8bpc-RGB444.ppm
convert ./unigraf_default_image_16k.ppm -crop 3840x2160+0+0 +repage -size
3840x2160 -depth 10 -sampling-factor 4:4:4 ./image-10bpc-RGB444.ppm
convert ./unigraf_default_image_16k.ppm -crop 3840x2160+0+0 +repage -size
3840x2160 -depth 12 -sampling-factor 4:4:4 ./image-12bpc-RGB444.ppm
```

Preparation of YUV Images

```
ffmpeg -loglevel panic -i ./input_image -vf crop=resolution:0:0 -pix_fmt
pixel_format ./output_image.yuv
```

Parameters:

-pix_fmt for 8bpc = yuv444p, yuv422p or yuv420p;
 -pix_fmt for 10bpc = yuv444p10le, yuv422p10le or yuv420p10le;
 -pix_fmt for 12bpc = yuv444p12le, yuv422p12le or yuv420p12le

Examples

```
ffmpeg -loglevel panic -i ./unigraf_default_image_16k.ppm -vf
crop=3840:2160:0:0 -pix_fmt yuv422p ./image-8bpc-RGB422.yuv

ffmpeg -loglevel panic -i ./unigraf_default_image_16k.ppm -vf
crop=3840:2160:0:0 -pix_fmt yuv422p10le ./image-10bpc-RGB422.yuv

ffmpeg -loglevel panic -i ./unigraf_default_image_16k.ppm -vf
crop=3840:2160:0:0 -pix_fmt yuv422p12le ./image-12bpc-RGB422.yuv
```

DSC Conversion

The tool *Dsc.exe* will be used for creating the actual DSC compressed data.

Dsc.exe is using configuration file *test.cfg* and *test_list.txt* as the list of images to process.

Command syntax is

```
dsc.exe -F test.cfg
```

Test.cfg is a configuration file template. It should be edited to match the task.

Example

As an example of the conversion, please find below conversion a single file, *image-12bpc-yuv420.yuv*.

- First step is the preparation of the image as explained above

```
ffmpeg -loglevel panic -i ./unigraf_default_image_16k.ppm -vf
crop=3840:2160:0:0 -pix_fmt yuv420p12le ./image-12bpc-RGB420.yuv
```

- In the temporary folder, please create a file called *test_list.txt* and insert a line containing the name of the output file *image-12bpc-RGB420.yuv*.
- After that we have to set appropriate parameters in the *test.cfg* configuration file.

Set image resolution:

```
PIC_WIDTH 3840
PIC_HEIGHT 2160
```

For selecting 4:2:0:

```
USE_YUV_INPUT 1 // Enables YCbCr mode. Required to be =1 for 4:2:2
// and 4:2:0 modes.
NATIVE_420 1 // Enables DSC 1.2 native 4:2:0 mode
```

Indicate the corresponding configuration file file:

```
INCLUDE ./ConfigurationFiles/rc_12bpc_6bpp_420.cfg
```

- Run the command

APPENDIX I: FIRMWARE RECOVERY

The chapter below describes a procedure for recovering UCD-500 Series Firmware in a case when e.g., the normal FW Update procedure failed because a critical error.

Downloading Tools

The Recovery patch is programmed to UCD Device with a separate tool called **Intel® Quartus® Prime Pro Edition Programmer and Tools**. The tool can be downloaded from **Intel® FPGA** website:

<https://www.intel.com/content/www/us/en/software-kit/746667/intel-quartus-prime-pro-edition-design-software-version-22-3-for-windows.html>

1. On the download page, please select section “**Additional Software**”. Please download the software under “**Intel® Quartus® Prime Pro Edition Programmer and Tools**”.
2. Please download and install the tool using default option in the PC.

The screenshot shows the Intel FPGA Software Download Center page for Intel® Quartus® Prime Pro Edition Design Software Version 22.3 for Windows. The page includes a navigation bar with links to PRODUCTS, SUPPORT, SOLUTIONS, DEVELOPERS, and PARTNERS. The main content area displays the software version and a table of download options. The 'Additional Software' tab is selected, and a red box highlights the 'Intel® Quartus® Prime Pro Edition Programmer and Tools' section.

Download	Size	SHA1
ptc-22.3.0.104-windows.exe	0.39 GB	b8adb559957633e99d3b147af7a509f173606b3b
Intel® Quartus® Prime Pro Edition Programmer and Tools Download QuartusProProgrammerSetup-22.3.0.104-windows.exe	1.2 GB	46fa1732c9aac991e85bdebb3cdac94298c0954d
Ashling RiscFree IDE for Intel® FPGAs	541.5 MB	

Step 1

3. Connect the UCD device to the power supply and switch on power.
4. 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)
5. Please locate the *UCD-500_recovery.zip* file. Extract the content of the ZIP file in a folder in your PC, e.g., c:\Temp
6. Open Windows **Command Prompt** application
7. Change current directory to where the ZIP file was extracted (e.g. *cd \Temp*)
8. Run batch file *USB_backend_update.bat*
9. When instructed cycle power on the UCD device (switch off power > wait for 10 seconds > turn on power).

Step 2

1. Please make sure that power of the UCD device is switched on
2. Connect a micro-USB cable to **JTAG** connector in the UCD device (Please refer to chapter **Product Description > Connections** earlier in this document).
3. In the directory where the ZIP file was extracted (e.g. c:\Temp) edit file **prog_sof.bat**
4. On line three (3) parameter "QUARTUS_DIR" is set to point to the folder where the Quartus Programmer was installed (by default **C:\intelFPGA_pro\21.2**). If needed, edit line three to match. Please save the file.
5. In the same folder please note the name of the SOF file (e.g. **s10_dptrx_F0.1.33_N2.3.15.sof**)
6. In Windows **Command Prompt** application please make sure that current directory is still the same (e.g. C:\temp)
7. Launch batch **prog_sof.bat <sof_file>** where <sof_file> is the name of the SOF file noted earlier.
8. Please wait until the batch file is completed (may take up to several minutes)

Step 3

Perform FW update procedure as described in section **Installation > Firmware Update Procedure** earlier in this manual.

After Recovery procedure has been completed, you can delete the files stored in e.g., C:/Temp.