

UCD Console for UCD-400



User Manual

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UCD-400 products meet the essential health and safety requirements, is in conformity with and the CE marking has been applied according to the relevant EU Directives using the relevant section of the corresponding standards and other normative documents.

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1. ABOUT THIS MANUAL

Purpose

This guide is User Manual of UCD-400, USB-connected video interface test unit for use with a PC with Windows® 10 Windows® 8 or Windows® 7 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 the UCD-400 units.
- Provide instructions for the user on how to use UCD Console software.

Product and Driver Version

This manual explains features found in UCD Console Software Package **1.7**. 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
------	--------------------------------

2. INTRODUCTION

Product Description

UCD-400 is a high speed, USB 3.0 connected video interface test unit. *UCD Console* is the common graphical user interface (GUI) for Unigraf's UCD-400 and UCD-300 family units. The outlook and details of UCD Console will be different depending on the capabilities of the connected unit reflecting the features enabled.

UCD-400 units feature a high-level Software Development Kit (SDK) for use in automated testing. It is called Test Software Interface (TSI). 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

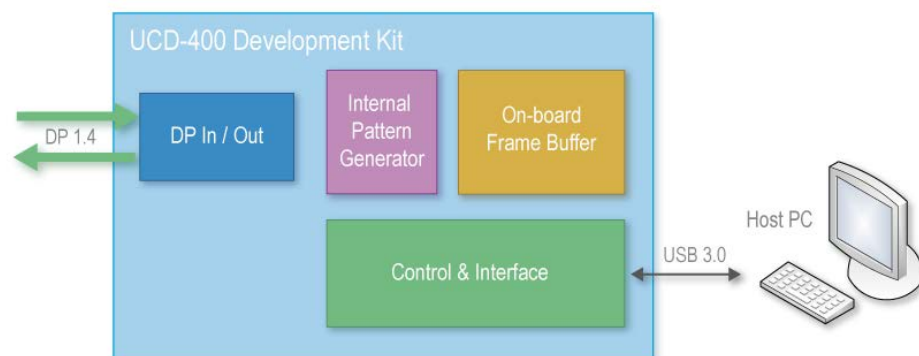
- High resolution video and audio capture up to 8K 30 Hz, 4K / UHD 120 Hz
- Supports HBR3 feature of DP 1.4
- Compatible with HDCP versions 1.3 and 2.2
- 2 GB on-board high-speed video buffer
- High speed USB 3.0 host PC interface

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

Functional Description

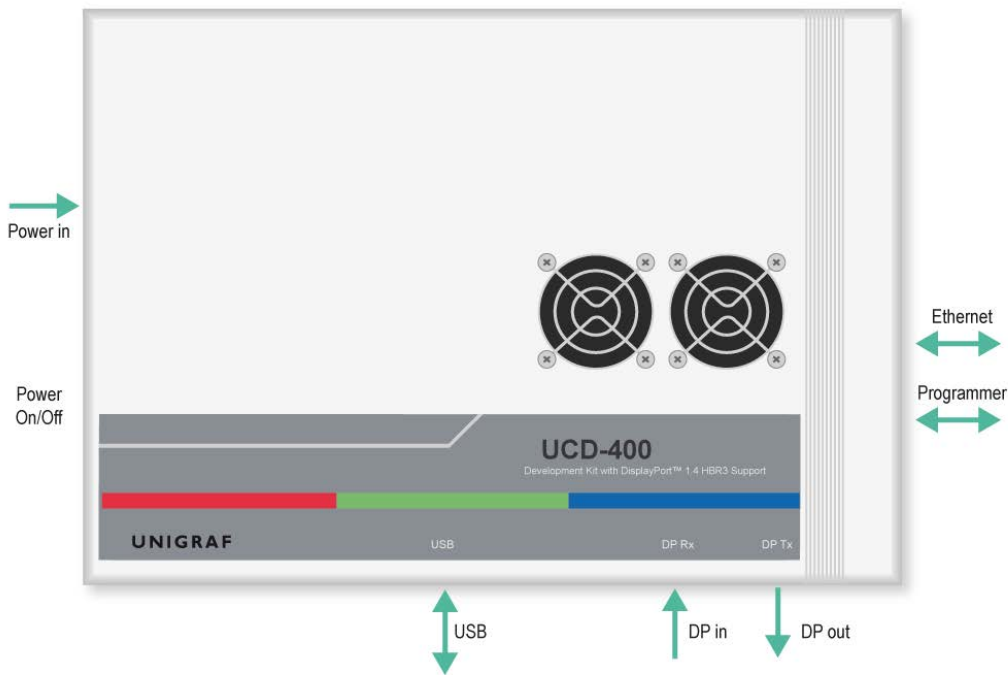
UCD-400 units consist of a multimedia signal input stage, an internal pattern generator, a control stage with on-board frame buffer and a PC interface stage. In the Input Stage the signal is conditioned and converted to desired format. The Interface and Control stages are either passing the captured 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.

Please find below logical diagram of UCD-400 unit



UCD-400

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



Name	Description
DP in	DisplayPort™ 1.4 compliant input from the upstream Source
DP out	DisplayPort™ 1.4 compliant output to the downstream Sink
Power in	+12 Vdc Power Supply Input
Power On/Off	Rocker power switch
USB	USB 3.0 connection to the host PC
Programmer	USB interface for configuring the UCD-400 device FW
Ethernet	Ethernet interface for updating the UCD-400 device FW

Note	Capturing and sourcing high resolution video modes, especially 4K video modes and the 120 Hz frame rate set stringent requirements on the video cables and connectors.
Warning	In order to avoid damage to the unit and the PC, please always attach the power cord (Power In) to the unit first , and after that connect the USB cable to your PC.

USB Type-C Interface

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

Unpacking

The UCD-400 product shipment contains:

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

Installation Package

The UCD-400 software installation package can be obtained from Unigraf download page at <https://www.unigraf.fi/support/download-links>. Please log in with the following credentials before attempting to access the download page:

Username: *unigraf*

Password: *ruukintie*

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 GUI (installed during set up)
- License Manager (installed during set up)
- TSI SDK
- User Manuals including this document.

In some cases, you will need to update also the firmware of the unit. If in doubt, please contact Unigraf.

Note: The software should be installed before connecting the UCD-400 unit in your PC.

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

Software Installation

- ▶ Start the installation by running **Unigraf Software Bundle Setup.exe**

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

- ▶ Click **Next** to continue. In the next dialogs, you will be able to define the software components installed.

The next two dialogs will allow you to define the installation folder in your PC and the Start Menu folder used.

- ▶ When you are ready with the selections, click **Install** to start the installation.
- ▶ Click **Finish** to exit the installation dialog.

3. LICENSE MANAGER

Licensing

The features of UCD Console GUI are divided into groups based on the target use of the device. Some basic features can be used without licenses. Advanced feature groups have their dedicated licenses that open the related part of the GUI or enable the related control.

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

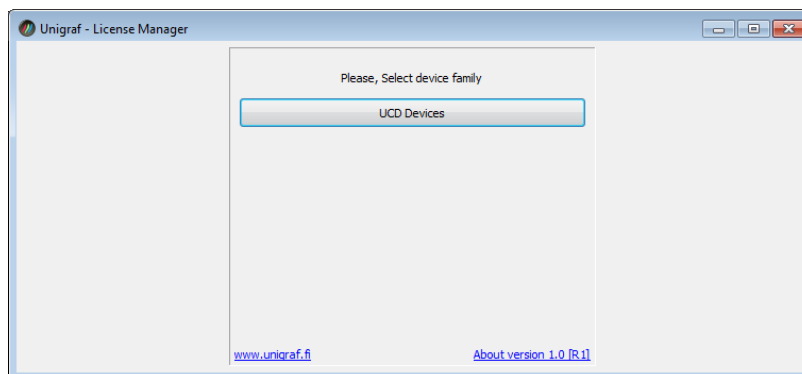
License keys are managed with Unigraf **License Manager**. By default, shortcut to Unigraf License Manager can be found in Start Menu under: **All programs/Unigraf/UCD-400**.

Please click **Yes** in the first dialog. License Manager can be run only with Administrator rights.

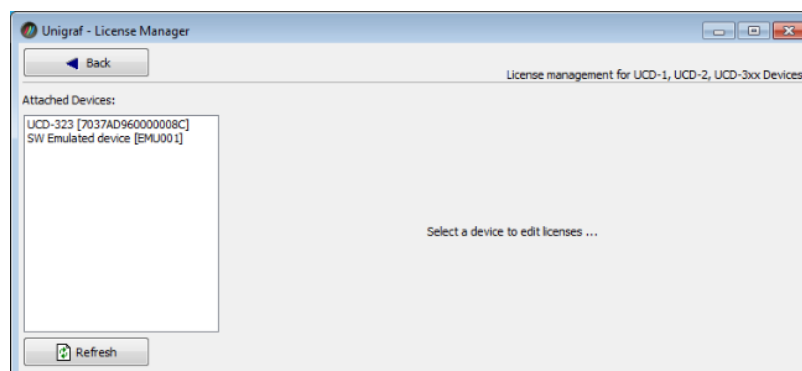
Note: System administrator's privileges are required for accessing the licenses.

License Manager GUI

When run, License Manager will list the licensing enabled Unigraf devices. If no suitable device families are detected, License Manager will exit. Please first select one of the available device families by clicking one of the device family selector buttons.

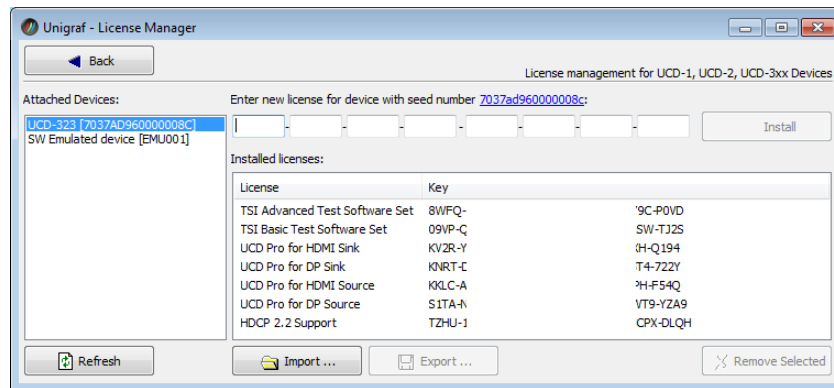


In the list of Attached Devices please select the device in question. You can find the *serial number* and the *seed number* of your device in a sticker attached to the bottom of your device.



The **Back** button will bring you back to the device family selection screen. The **Refresh** 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. You can find the Seed Number of the selected unit in the top of the dialog.

The Seed Number link in the dialog will allow you to copy & paste the Seed Number of the selected device 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 boxes provided. The License Manager will automatically move the caret across the edit boxes as you type. If you have the key 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 you have typed the key correctly and that the seed number on the license key sticker matches the seed number displayed seed number for the device.

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 can't 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 currently installed licenses for the currently selected device. The list shows the actual license key, and what that key unlocks.

Remove Selected will uninstall selected licenses. To uninstall a license, click on the license and then click the Remove Selected button.

Export will allow you to save all installed licenses for the currently selected device into an INI file for backup and distribution to other PCs. Please notice that licenses from multiple devices can be exported into the same INI file.

Import will install licenses from an INI file for the currently selected device.

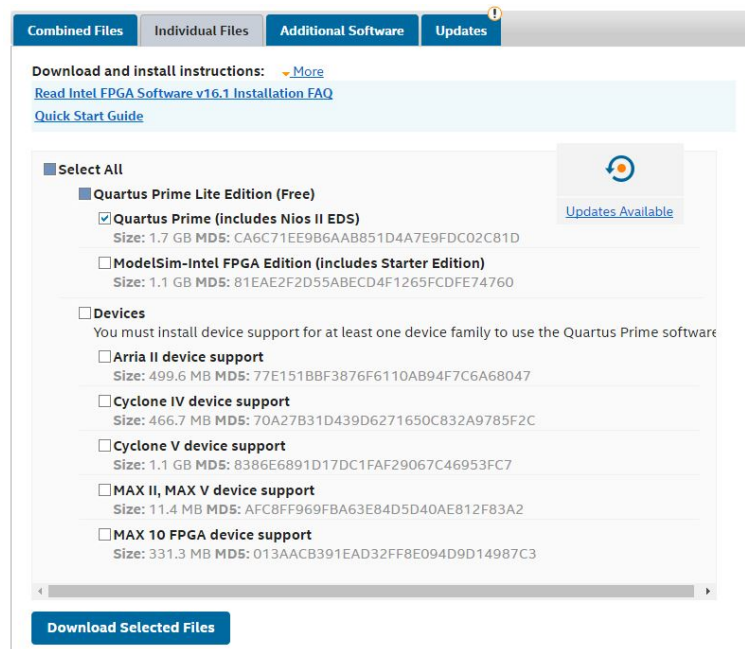
4. FIRMWARE UPDATE PROCEDURE

FW Update Tool

The firmware (FW) of UCD-400 is programmed with a separate tool called **Quartus Prime (includes Nios II EDS)**. The tool can be downloaded from **Intel® FPGA** website:

<http://dl.altera.com/?edition=lite>

On the download page, please un-check **Select All** check-box and then check **Quartus Prime (includes Nios II EDS)** check-box. Then click on **Download Selected Files** button to start the download.



Note: You need to be registered for the download.

Please download and install the tool in your PC.

Connect to the UCD-400 Unit

- ▶ Power on your UCD-400.
- ▶ Connect UCD-400 with a USB cable to your PC through **Programmer** connector.
(Pls refer to page 7)

The programming interface is the Ethernet connector in the UCD-400 unit. Your PC can be connected to the UCD-400 unit either through a network HUB or directly.

In case of direct connection, you need to configure your PC to be an Ethernet network host by enabling WIFI network share (The WIFI network itself will not be used for programming).

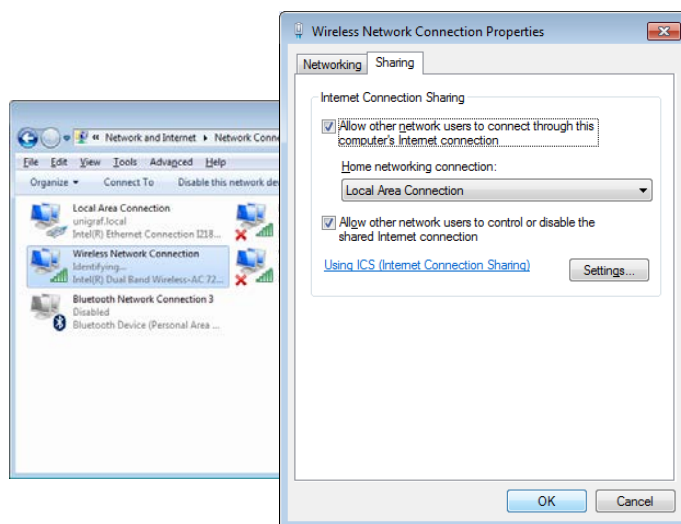
Please follow either of the two procedures below.

Connecting Through Ethernet Network

- ▶ Connect UCD-400 through **Ethernet** connector to the same network HUB where your programming PC is connected.

Connecting with Direct Ethernet Cable

- ▶ Connect UCD-400 directly to your PC through **Ethernet** connector;
- ▶ Enable **WIFI** Internet access of your PC.
- ▶ From Laptop Wireless Network Connection Status > Properties and
- ▶ Wireless Network Connection Properties > Sharing Tab



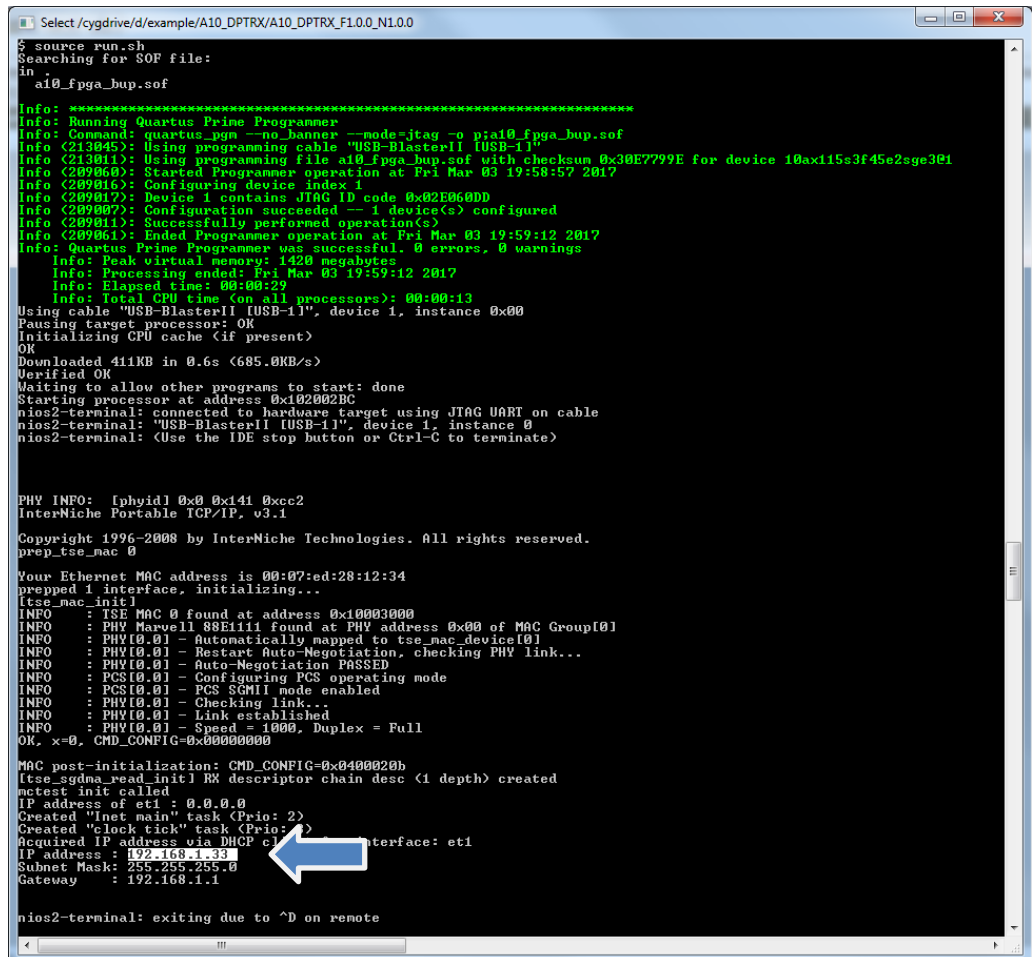
- ▶ Select **Allow other network users to connect through this computer's Internet connection**
- ▶ In **Home networking connection** combo-box select **Local Area Connection**
- ▶ Click **OK** to close the window.

Note	The network sharing is shown above for Windows 7. Similar controls can be found for other Windows versions and other operating systems.
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Programming the FW

- ▶ Run Nios II 16.1 Command Shell application
- ▶ Select FW update folder location. For example:
`cd /cygdrive/c/Program\ Files\ \(\x86\)/Unigraf/TSI/UCD-400/Firmware/`
- ▶ Run the boot loader that initiates the HTML programming interface.
`source run.sh`

Upon command completion, the **assigned IP address for UCD-400 device** is highlighted in the picture below.



```
Select /cygdrive/d/example/A10_DPTRX/A10_DPTRX_F1.0.0_N1.0.0
$ source run.sh
Searching for SOF file:
in .
a10_fpga_bup.sof

Info: *****
Info: Running Quartus Prime Programmer
Info: Command: quartus_pgm --no_banner --mode=jtag -o pia10_fpga_bup.sof
Info (213045): Using programming cable "USB-BlasterII [USB-1]"
Info (213011): Using programming file a10_fpga_bup.sof with checksum 0x30E7799E for device 10axi15s3f45e2sge30i
Info (209966): Started Programmer operation at Fri Mar 03 19:59:57 2017
Info (209916): Configuring device index 1
Info (209917): Device 1 contains JTAG ID code 0x02E060DD
Info (209907): Configuration succeeded -- 1 device(s) configured
Info (209911): Successfully performed operation(s)
Info (209961): Ended Programmer operation at Fri Mar 03 19:59:12 2017
Info: Quartus Prime Programmer was successful. 0 errors, 0 warnings
Info: Peak virtual memory: 1420 megabytes
Info: Processing ended: Fri Mar 03 19:59:12 2017
Info: Elapsed time: 00:00:29
Info: Total CPU time (on all processors): 00:00:13
Using cable "USB-BlasterII [USB-1]", device 1, instance 0x00
Pausing target processor: OK
Initializing CPU cache (if present)
OK
Downloaded 411KB in 0.6s (685.0KB/s)
Verified OK
Waiting to allow other programs to start: done
Starting processor at address 0x102002B0
nios2-terminal: connected to hardware target using JTAG UART on cable
nios2-terminal: "USB-BlasterII [USB-1]", device 1, instance 0
nios2-terminal: <Use the IDE stop button or Ctrl-C to terminate>

PHY INFO: [phyid] 0x0 0x141 0xcc2
InterNiche Portable TCP/IP, v3.1

Copyright 1996-2008 by InterNiche Technologies. All rights reserved.
prep_tse_mac 0

Your Ethernet MAC address is 00:07:ed:28:12:34
prepped i interface, initializing...
[tse_mac_init]
INFO : TSE MAC 0 found at address 0x10003000
INFO : PHY Marvell 88E1111 found at PHY address 0x00 of MAC Group[0]
INFO : PHY[0.0] - Automatically mapped to tse_mac_device[0]
INFO : PHY[0.0] - Restart Auto-Negotiation, checking PHY link...
INFO : PHY[0.0] - Auto-Negotiation PASSED
INFO : PCS[0.0] - Configuring PCS operating mode
INFO : PCS[0.0] - PCS SGMII mode enabled
INFO : PHY[0.0] - Checking link...
INFO : PHY[0.0] - Link established
INFO : PHY[0.0] - Speed = 1000, Duplex = Full
OK, x=0, CMD_CONFIG=0x00000000

MAC post-initialization: CMD_CONFIG=0x0400020b
[tse_sgdma_read_init] RX descriptor chain desc (1 depth) created
mctest init called
IP address of et1 : 0.0.0.0
Created "inet main" task (Prio: 2)
Created "clock tick" task (Prio: 2)
Acquired IP address via DHCP client interface: et1
IP address : 192.168.1.33
Subnet Mask: 255.255.255.0
Gateway : 192.168.1.1

nios2-terminal: exiting due to ^D on remote
```

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Virhe. Määritä Aloitussivulla Heading 1, jota haluat käyttää tähän kirjoitettavaan tekstiin.

- ▶ Launch web browser on your PC. If you are using Ethernet connection, please make sure that your PC is connected to the same network as your UCD-400 unit.
- ▶ Access the HTML programming interface by entering the IP address assigned for your UCD-400 unit.



- ▶ Browse **Hardware File Name** for UCD-400 update (e.g. **a10_dptrx_p1.flash**) and then press “Upload” button
- ▶ Once uploading process done – cycle power on the UCD-400.

Note	Please cycle the power on the UCD-400 unit to enable the FW update.
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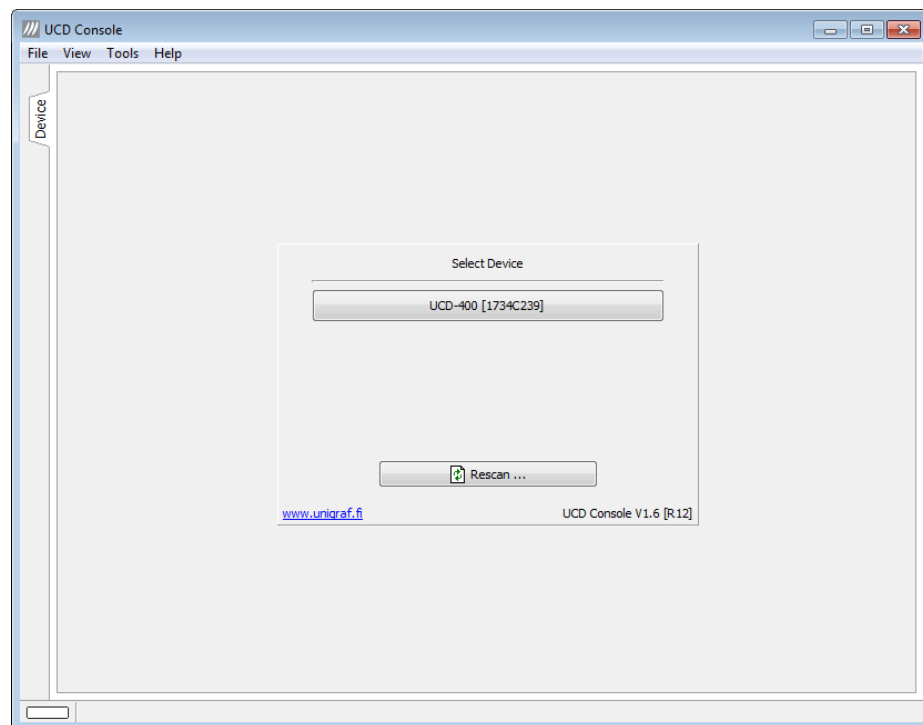
5. UCD CONSOLE

UCD Console is the graphical user interface (GUI) of UCD-400 family for desktop use. It 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.

The various features of the UCD-400 are divided into interface specific screens and tabs. Each tab contains data and controls for a specific feature.

Device Selection

You can find the shortcut of UCD Console by default under Start Menu path **All programs/Unigraf/UCD-400**. Once UCD Console GUI is launched the dialog provides a list of UCD-400 devices connected in the PC. Please select your target device by clicking on the appropriate button. If you cannot find your device in the list, please confirm the power and USB connection to the device and click the **Rescan ...** button.



Select Role

The use of UCD-400 devices with UCD Console is divided in display interface specific roles. The structure of UCD Console varies between roles by having a varying set of tabs dedicated to functionalities available in the enabled role. The table below lists the roles and tabs available in each role. Please find a detailed description of each role in the later chapters of this manual.

Each UCD-400 model features a unique set of modes available. In special occasions, Unigraf can create custom configurations. Please contact Unigraf Support for details.

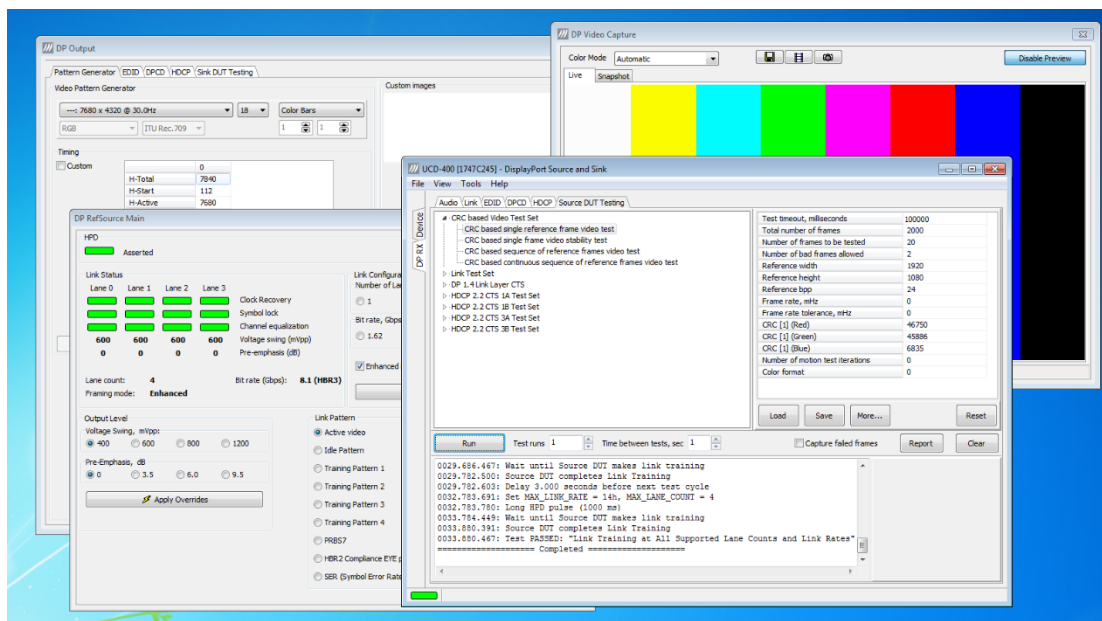
Available Mode Configurations for UCD-400

Role	DisplayPort Reference Sink	DisplayPort Reference Source
Combined Role	<p>Video preview and saving (Video). Audio monitoring and saving (Audio). Status information and control of the upstream link (Link). EDID editor (EDID). DPCD editor (DPCD). HDCP 1.3 and 2.2 status monitor and control (HDCP). Monitor Secondary-Data Packets (SDP) Event log (Event log) Executing TSI Test cases (Source DUT Testing). Executing HDCP 2.2 CTS Tests (Source DUT Testing).</p>	<p>Video preview and saving (Video). Audio monitoring and saving (Audio). Status information and control of the upstream link (Link). EDID editor (EDID). DPCD editor (DPCD). HDCP 1.3 status monitor and control (HDCP). Executing TSI Test cases (Source DUT Testing).</p>

A full description of the functions and the licensing can be found in [Appendix B. Licensing](#)

Detaching Tabs

You can detach any of the UCD Console tabs into a separate window for being able to monitor and control separate features simultaneously. To detach a tab **Right-click** on a tab and select **Detach Page**. 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 your keyboard.



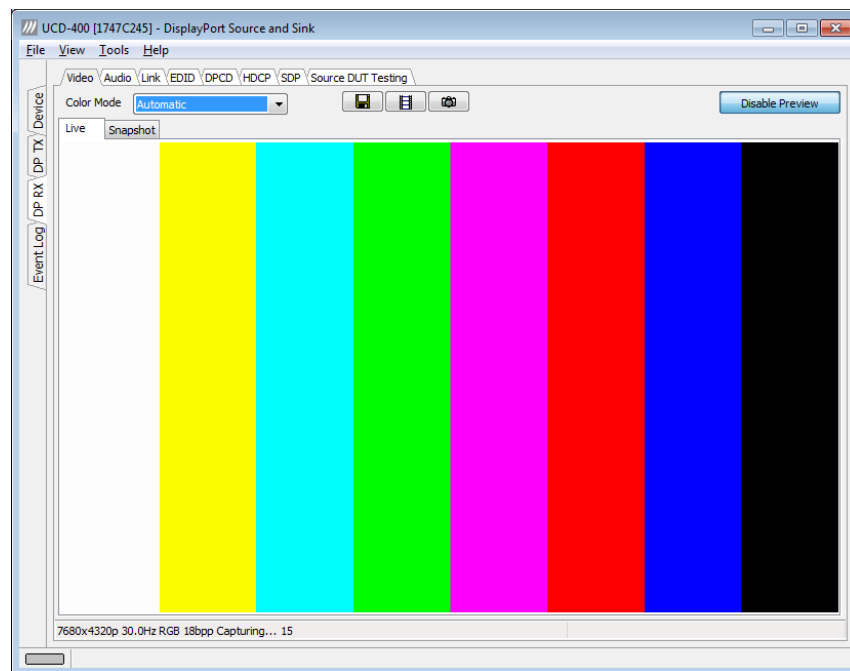
6. DISPLAYPORT REFERENCE SINK

DisplayPort Reference Sink dialog (DP RX) can be selected from the vertical tab on the left edge of the GUI. The horizontal tabs on the top of the GUI enable the various functions available for the input channel. Some of the tabs are enabled by default, some only when an applicable license is included. DPRX features the following functions.

- Video preview and saving (Video).
- Audio monitoring and saving (Audio).
- Status information and control of the upstream link (Link).
- EDID editor (EDID).
- DPCD editor (DPCD).
- HDCP status monitor and control (HDCP).
- Source DUT Testing

Video Tab

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



Input video mode

3840x2160p 60.1Hz RGB Capturing... 173

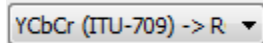
The measured input resolution, frame rate and color format is shown below the preview window. The indication of the number of frames captured to the PC shows you the pace of the image data transfer to the PC.

Disable / Enable Preview

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

The top ribbon of the tab has the following controls:

Color mode for preview



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

Save one frame



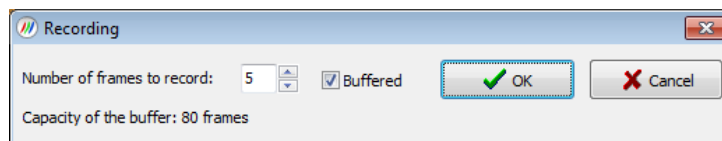
Capture and save one video frame as a bitmap file in the PC. The format and storage location can be selected in Tools > Options pull-down menu. The available bitmap formats are PPM, BMP and JPG.

In Tools > Options menu you can 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.

Sequence recording



Clicking the button opens a dialog where you can enter the amount of frames that you want to record. You can also enable the buffered mode in this dialog.



In buffered mode, all input frames are captured non-drop until the on-board frame buffer will be full. E.g. for Full HD (1920×1080) input 242 frames and for UHD 3840×2160 input 64 frames can be stored.

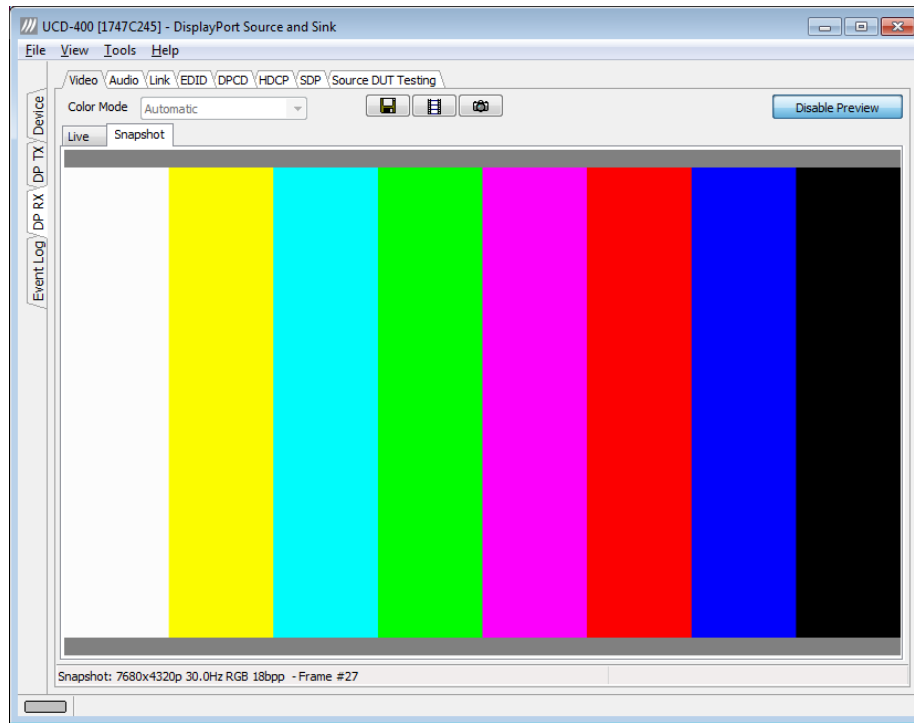
In non-buffered mode, only one input frame is buffered at a time. Frames will be skipped if the transfer of the data to the PC is slower than the input data rate.

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

Snap preview



You can snap one frame of the incoming video and view it in the GUI. To snap, click the “camera” icon. A preview of the snapped frame will be shown.



You can save the captured bitmap with the **Save one frame** function described above.

You can evaluate the **Color Information of the Captured Bitmap** by placing the mouse cursor on top of it. On the lower right-hand side ribbon of the GUI you can find

- Location of the cross cursor on the bitmap
- The intensity of the Red, Green and Blue components of the pixel on the cursor location
- The HTML color code of the pixel on cursor location

You can set the **Zoom of the Preview Image** by right clicking on top of the preview image and selecting between

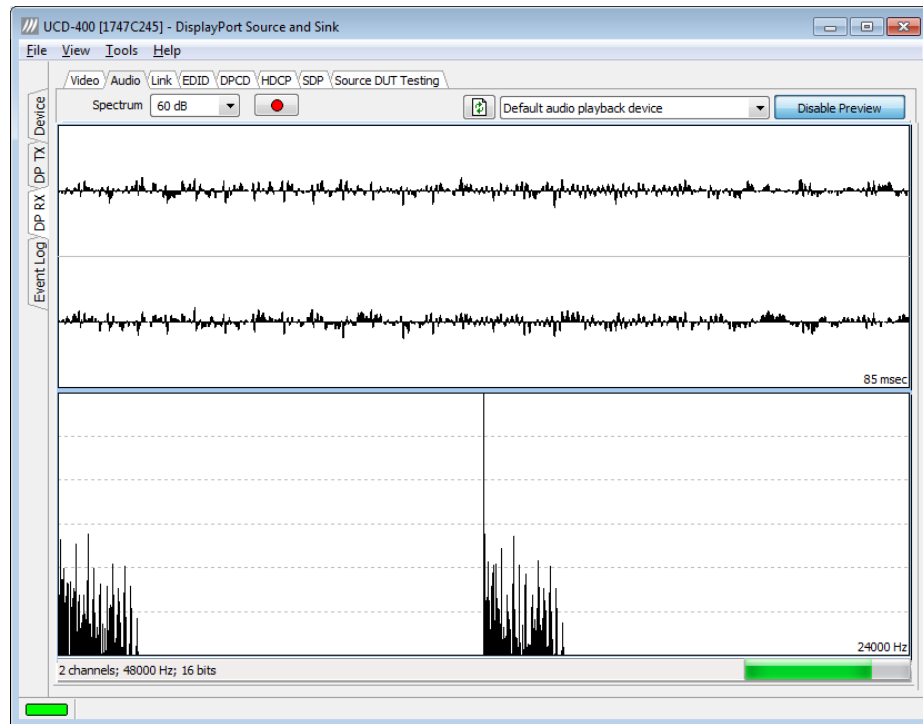
- Zoom 25%
- Zoom 50%
- Zoom 100%

While in the *Snap preview mode* click on the “Camera” icon to take additional snapshots

You can swap between the *Live Preview Mode* and *Snap Preview Mode* by choosing between the **Live** and the **Snapshot** tabs.

Audio Tab

Audio tab has a preview of the audio signal format and the controls for audio playback and recording.



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 24 000 Hz. The amplitude scale of the spectrum display can be selected between 'Linear' to 80 dB.
- The horizontal sound level indicator is in the bottom of the dialog.

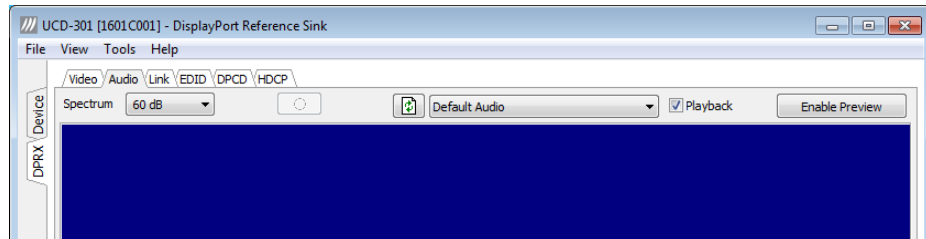
The span of the preview window is defined with **Audio preview size** found in Tools > Options dialog. The value is given in ksamples (1024 samples). The relation between the preview window span in milliseconds (msec) and the value given in *Audio preview size* depends on the sampling frequency. Please do not exceed the *Audio buffer size* set in the same dialog.

Disable / Enable Preview

Use this button to control capturing the audio data.

Playback device selection

You can enable audio playback in your PC by selecting the **Playback** check-box. Use the combo-box to select the audio device in the host PC through which the captured audio is played. By default, the *Default Audio* device of your PC is chosen. Please **Disable Preview** in order to make changes.



Note Please note that the audio capabilities of the audio playback device of your PC are not automatically reflected in the audio capabilities description in UCD-400 EDID. Since UCD-400 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.

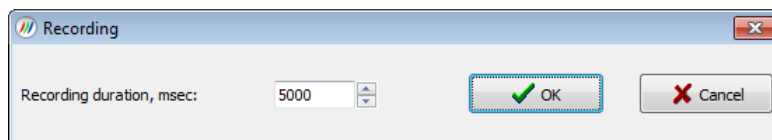
Audio Buffer Size

You can define the amount of buffering used in the data transfer between the UCD-400 unit and the PC. **Audio buffer size** can be found in Tools > Options dialog. 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



Clicking the button, you can start or stop recording the captured audio in the PC using Waveform Audio File Format, WAV (*.wav) format. In the pop-up dialog, you can define the recording duration. The folder where the audio file will be saved can be selected in File > Options.



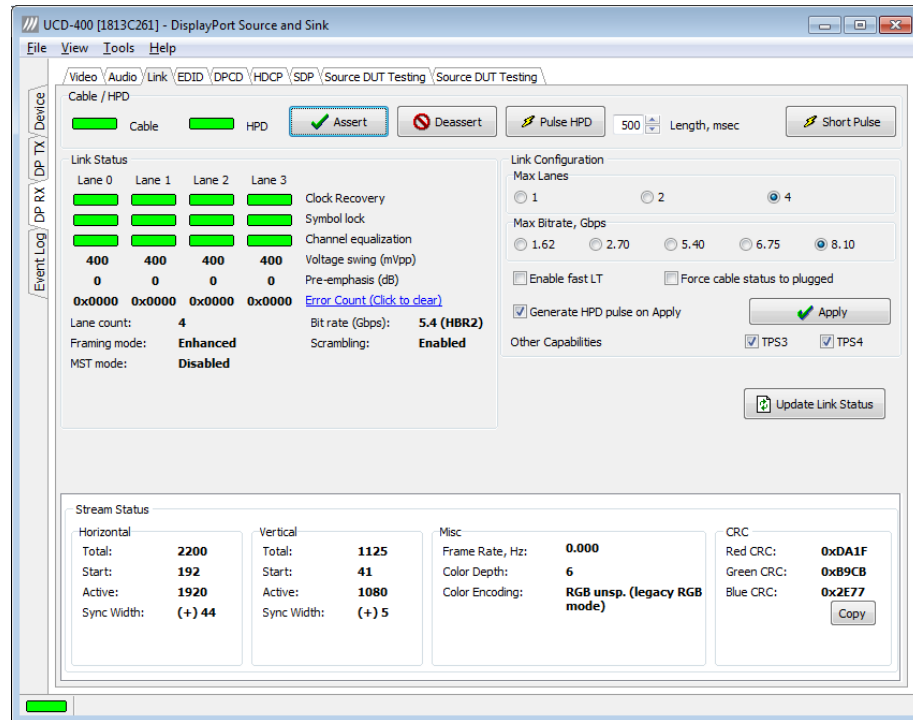
Input audio mode

2 channels; 48000 Hz; 16 bits

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

Link Tab

Link tab contains four panels: Cable / HPD, Link Status, Link Configuration and Stream Status.



Cable / HPD

Indicator lights of the state of the cable. **Cable** indicates that the hardware has detected an upstream cable. **HPD** indicates that the HPD signal is logical “high”.

Clicking the **Deassert** button will cause HPD line to be set to logical “low” (de-asserted) and hence no HPD pulse can be generated. Click the **Assert** to re-activate the HPD line (set to logical “high”).

To apply a HPD Pulse with programmable duration click **Pulse HPD**. The duration will be defined in the provided field.

For applying a short pulse click **Short Pulse**. Pulse duration is 1 ms.

Link Status

Link Status displays the status of the link training and the link parameters negotiated between UCD-400 Sink and the Upstream Source. The data is retrieved from the DPCD registers of the UCD-400 Sink. The status is updated automatically.

Link Configuration

Link Configuration allows the user to change the way the Sink capabilities are announced in the DPCD registers of the UCD-400 Sink. Maximum Lane Count and Maximum Link Rate are set with their appropriate radio buttons. To update the new status to the DPCD registers click **Apply**.

When **Force cable status to plugged** is checked, sink functionality is active regardless of a failure of upstream device detection e.g. due to incorrect AUX Channel electrical termination.

To apply a Hot-Plug Detect pulse automatically after updating the status, select **Generate HPD pulse on Apply**. HPD pulse duration will be defined in the *Pulse HPD* field.

Stream Status

Stream status is enabled with *UCD Pro for DP Sink* license.

Video Timing Details are retrieved from the Main Stream Attributes (MSA) of the monitored stream.

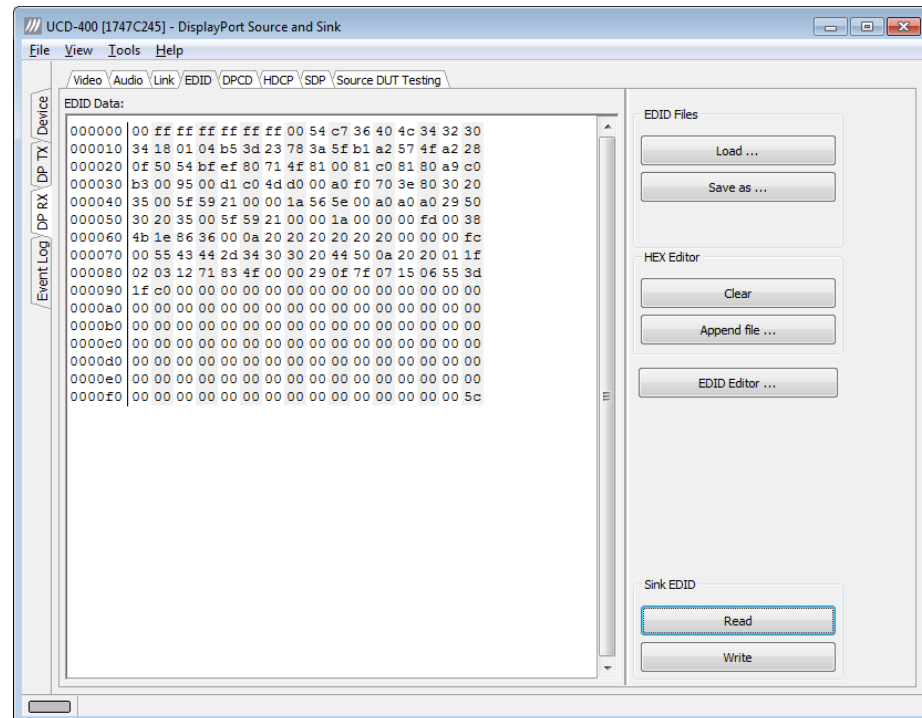
Note:	Please note that the MSA information used for Video Timing Details is provided by the Upstream Source, it is not measured by the UCD-400 Local Sink.
-------	--

The 16-bit CRC values of the three color components is calculated by the Sink hardware. To re-calculate, click **Update Link Status**.

EDID Tab

EDID Tab provides tools for accessing the EDID of the UCD-400 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
- Program and read the contents of the hardware EDID memory



EDID Files

With **Load...** and **Save as...** you can read and write a hex EDID file from your 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 is read. If the device is not supporting all four blocks, the non-supported area is replaced with zeroes.

Currently the EDID Editor does not support Display ID. You can however modify hex EDID files with the HEX Editor or load and program externally generated hex EDID files that have Display ID content.

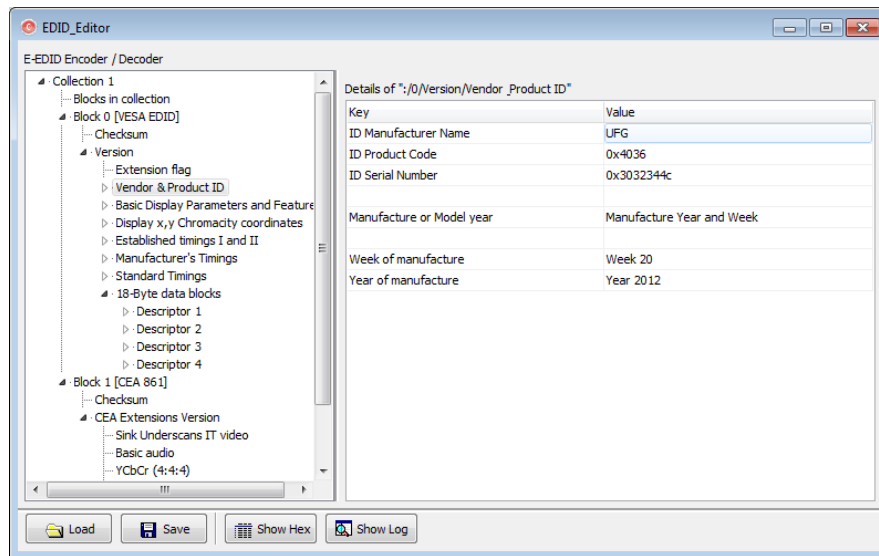
HEX Editor

When EDID content is either loaded from a file or read from the hardware EDID memory, it is shown in the *EDID Data* panel on the left hand side of the dialog. You can edit the EDID contents by typing over the existing values. The altered content is highlighted with **RED**. Please note that Hex Editor itself does not alter the contents of the EDID data or verify its integrity.

Once you are done with editing the data, you can either save it to an *.ecd file in your PC with **Save as...** or program it to the hardware EDID memory with **Write**.

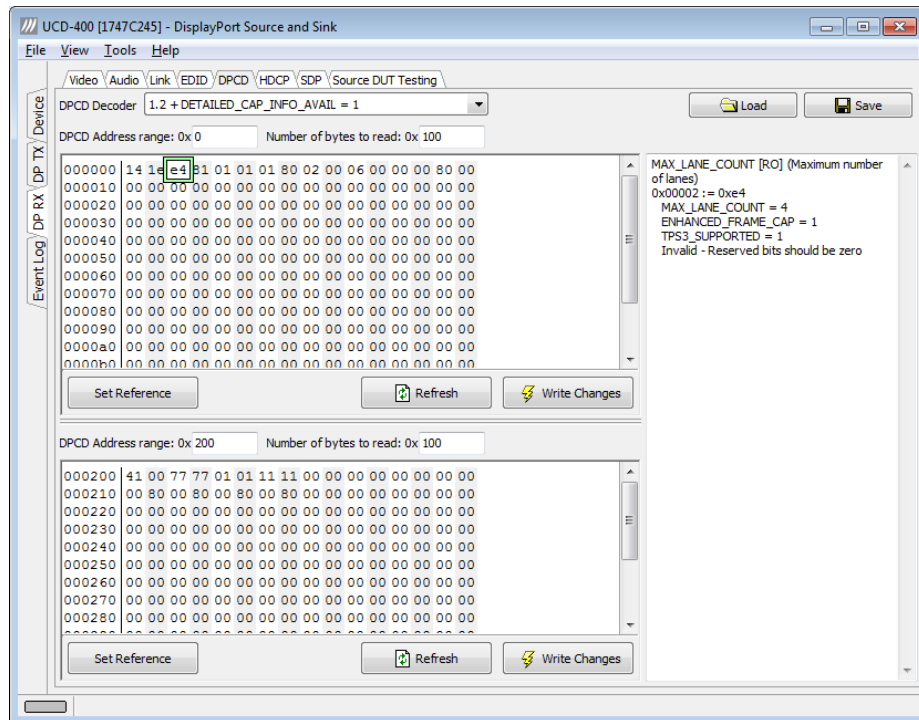
EDID Editor

You can edit the EDID structures of the data in the *HEX Editor* by clicking **EDID Editor**. EDID Editor is launched in a separate pop-up window. 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-400 Sink.



The tool consists of two independent monitoring and editing windows for the DPCD data. The user can freely select the the DPCD address areas shown on each panel.

The *DPCD Decoder* panel on the right hand side shows the interpretation of the DPCD byte selected on the monitoring windows. The selected byte is shown with a green outline.

In the combo box above the DPCD Decoder window you can select how the DPCD data is interpreted, either as *DP 1.1 DPCD*, or as *DP 1.2 DPCD* with *Detailed Capability Info* selected or not (*DETAILED_CAP_INFO_AVAIL* = 1/0).

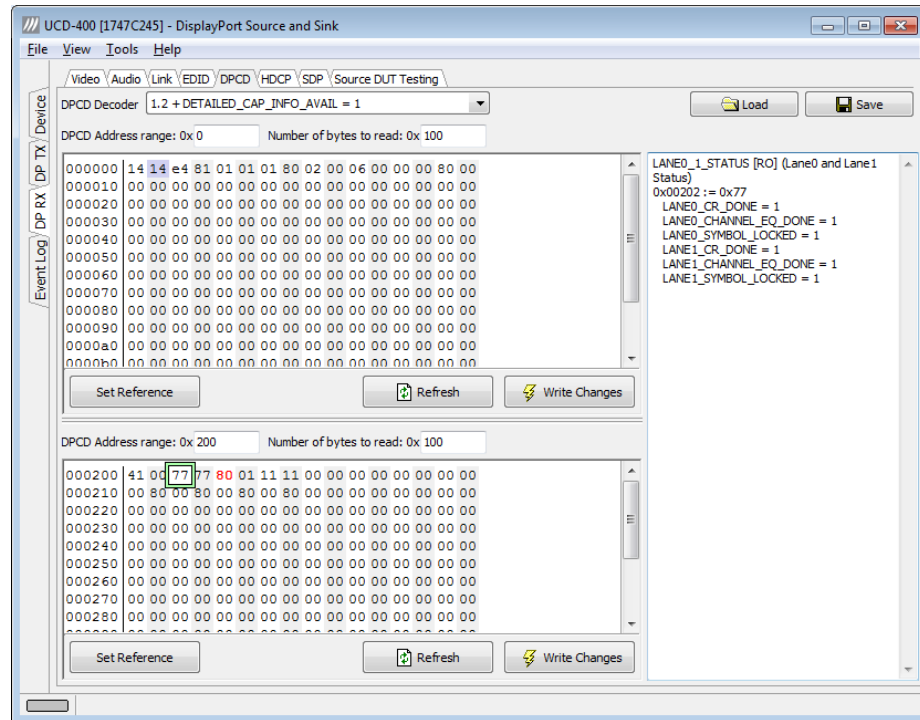
By clicking **Refresh** you can re-read the data from the DPCD registers to the window in question.

By clicking **Write Changes** you can write the portion of data shown in the window in question to the DPCD registers.

By clicking **Set Reference** you can store currently shown data as a reference for comparison.

When you refresh the data from the DPCD registers the changed bytes will be highlighted with **gray** background.

The fields edited by the user will be highlighted with **red** color.



Saving and Loading DPCD Content

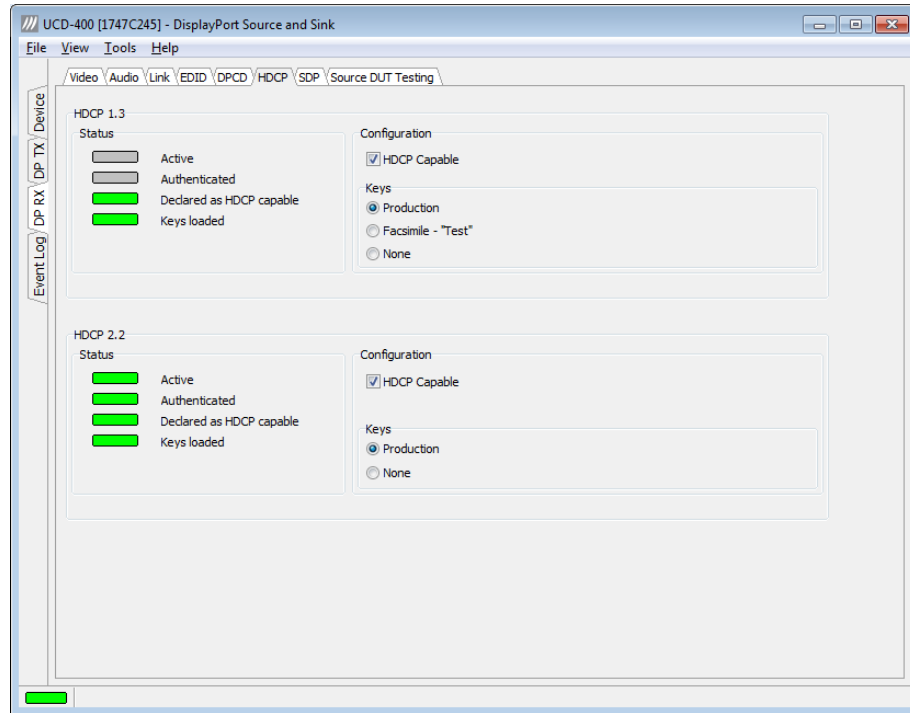
You can save the DPCD data in the address areas that you selected for the two windows as a file in your PC. You can save the content in three alternative formats:

- *Binary DPCD Data File* format (*.DPD). This is Unigraf proprietary format. You can also load the DPCD content stored in this format.
 - *Comma Separated Values* (*.CSV) for loading the data to a spreadsheet.
 - *HEX Dump* (*.HEX) in a human readable text format.
- By Clicking **Save** you will be able to select the location and the format of the file.
- By Clicking **Load** you can load DPCD data saved in *DPCD Data File* (*.DPD) format to the editor.
- To program the data into the DPCD registers of UCD-400 Local Sink click **Write Changes**.

Note	<ul style="list-style-type: none"> - Writing DPCD data to the DPCD registers of the UCD-400 Local Sink will potentially affect the status and capabilities of UCD-400 as seen by the upstream source. - User control like Link Training or mode changes will modify the content of the DPCD registers - During a reboot of UCD-400 the DPCD registers will be returned to their default values
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HDCP Tab

HDCP tab is the dialog for monitoring the HDCP (for *High-Bandwith Digital Content Protection*) status and controlling the HDCP capabilities of the UCD-400 device.



Status

The status field indicates the HDCP status of the UCD-400 device.

Active: The link between UCD-400 and the upstream source has been encrypted.

Authenticated: The HDCP handshake between the UCD-400 and the sink unit has been completed successfully.

Declared as HDCP capable: The UCD-400 unit recognizes HDCP handshake messages.

Keys loaded: The HDCP keys are loaded to the UCD-400 unit.

Configuration

HDCP Capable: To disable HDCP uncheck the box.

Keys

You can select if you are using *Production* or *Facsimile* HDCP keys. To remove the keys, select *None*.

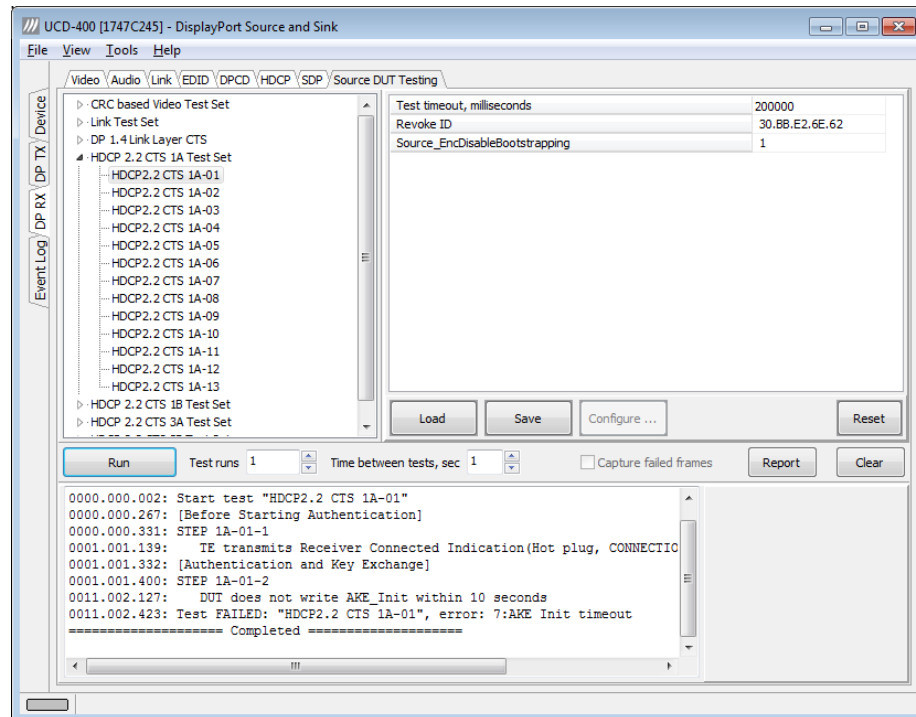
HDCP 1.3 vs. HDCP 2.2

UCD-400 devices support by default both HDCP 1.3 and HDCP 2.2 standard.

Source DUT Testing Tab

Source DUT Testing Tab is enabled with *UCD Pro for DP Sink* license.

Source DUT Testing enables the execution of selected TSI tests and other tests for a DP Source. Please refer to **Appendix E** later in this document for description of the tests available. Please refer to document **TSI_Reference.pdf** in the install package to get a full definition of the TSI Test Cases, the parameters and the reporting.



Click **Load** a saved parameter set of the selected Test Case from a text file.

Click **Save** to save the current parameter set of the selected Test Case to a text file.

Click **Configure...** to open a new dialog for providing additional test specific parameters. Please see chapter **Additional Parameters below**.

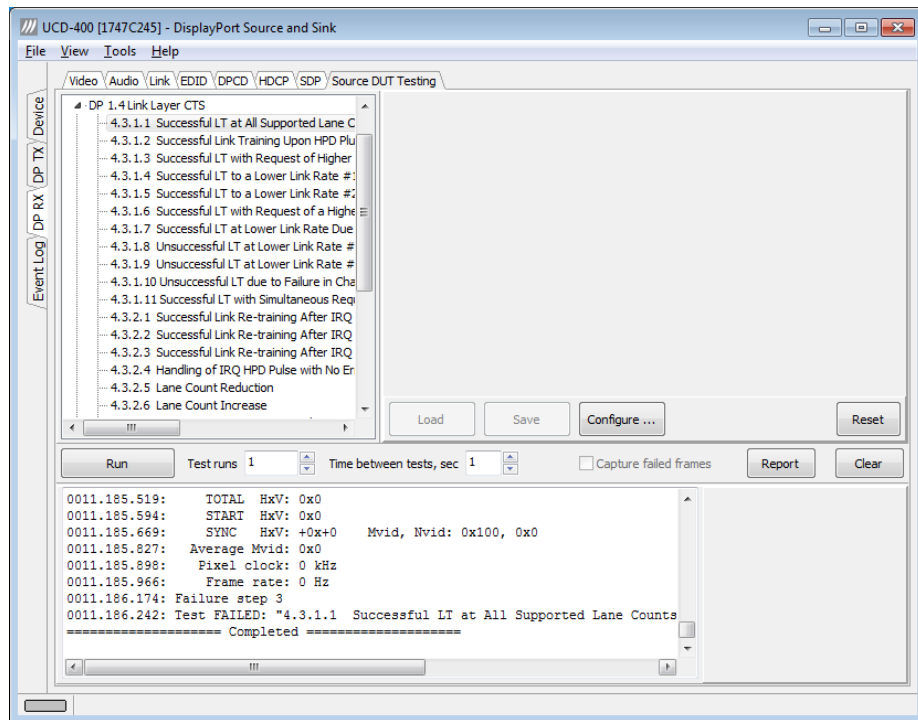
Click **Reset** to bring all parameters of the selected Test Case to their default values.

Click **Report** to generate a HTML report file for sharing the results with other parties for viewing without UCD Console.

Click **Run** to run the selected Test.

DP 1.4 Link Layer CTS

When running the DP 1.4 Link layer CTS tests, all the parameters can be accessed by clicking the **Configure...** button. Please see chapter **Additional Parameters** below.



Additional Parameters

CRC Video test and *Link Layer CTS* provide an additional dialog for entering detailed parameters for test. Please select the test group and click **Configure....**

In both dialogs you can save the selected parameters as Presets. Please click **Presets...** to save your configuration. If you have saved configuration Presets, you can load one of the saved ones, save a new Preset or delete a Preset.

CRC Video Test

CRC Video Test Parameters allows you to define the test duration, # frames captured and errors allowed. It allows you to define the frame size and capture the reference stream.

The screenshot shows the 'CRC Video test parameters' dialog box. It is divided into two main sections: 'Base parameters' and 'Reference CRC's'.
Base parameters:
 - Test timeout (milliseconds): 30000
 - Run until time-out: ☐
 - Test length (# frames): 2000
 - Errors allowed (# frames): 2
 - Expected Video Signal:
 - Width (# pixels): 1920
 - Height (# pixels): 1080
 - Reference BPP: 24 BPP
 - Frame rate checking:
 - Enable frame rate check: ☐
 - Expected frame rate (mHz): 60000
 - Frame rate tolerance (±mHz): 100
 - Presets... button
 - OK and Cancel buttons
Reference CRC's:
 - A list of 20 CRC values, each consisting of three hexadecimal strings (e.g., 0xda1f, 0xb9cb, 0x2e77).
 - CRC Capture length (# frames): 80
 - Capture now button

Link Layer CTS

Link Layer CTS allows you to set test timeouts and delays, the DUT Capabilities, Select used Test Automation features and the Fail-safe and Maximum supported video modes. Please refer to *Source Device Capability Question List* in document *DisplayPort Link Layer Compliance Test Specification*.

The screenshot shows the 'DP 1.4 LL CTS test parameters for testing Source DUT' dialog box. It is divided into several sections:
Test timeouts:
 - Test timeout (milliseconds): 5000
 - Long HPD pulse duration (milliseconds): 1000
 - LT Start timeout (milliseconds): 5000
 - Test cycle delay (milliseconds): 3000
DUT Capabilities:
 - Max lanes supported: 4 Lanes
 - Max bit rate supported: HBR2 (5.4 Gbps)
 - Voltage Swing level 3 (1.2V) supported: ☐
 - Pre-Emphasis level 3 (9.5dB) supported: ☐
 - Fixed timing DUT: ☐
 - Spread Spectrum Supported: ☐
 - Video format change without LT supported: ☐
 - Lane count reduction without LT supported: ☐
 - E-DDC supported: ☒
Test Automation:
 - TEST_LINK_TRAINING: ☐
 - TEST_EDID_READ: ☐
 - TEST_VIDEO_PATTERN: ☐
 - Event indicating DUT ready: Active Video
Video Modes:
 - Fail-safe video mode: 640x480 @ 60Hz 18 BPP
 - Maximum supported video mode: 1920x1080 @ 60Hz 24 BPP
Colorimetry:
 - RGB: ☒ 18bpp VESA, ☒ 24bpp VESA, ☐ 30bpp VESA, ☐ 24bpp CEA, ☐ 30bpp CEA
 - YCbCr 4:2:2: ☐ 24bpp CEA (ITU.601), ☐ 30bpp CEA (ITU.601), ☐ 24bpp CEA (ITU.709), ☐ 30bpp CEA (ITU.709)
 - YCbCr 4:4:4: ☐ 24bpp CEA (ITU.601), ☐ 30bpp CEA (ITU.601), ☐ 24bpp CEA (ITU.709), ☐ 30bpp CEA (ITU.709)
 - Select All: ☐
Most Packed Timings:
 - 1 Lane: 1280 x 800 @ 60Hz 18bpp
 - 2 Lanes: 1280 x 1024 @ 60Hz 24bpp
 - 4 Lanes: 2048 x 1536 @ 60Hz 24bpp
Time-stamp generation:
 - 1 Lane: RBR: 848x480@60 Hz, HBR: 1280x720@60 Hz, HBR2: 1280x960@60 Hz, HBR3: 1280x960@60 Hz
 - 2 Lanes: RBR: 1280x720@60 Hz, HBR: 1280x960@60 Hz, HBR2: 1920x1440@60 Hz, HBR3: 1920x1440@60 Hz
 - 4 Lanes: RBR: 1920x1080@60 Hz, HBR: 1920x1440@60 Hz, HBR2: 1920x1080@120 Hz, HBR3: 1920x1080@120 Hz
 - Presets... button
 - OK and Cancel buttons

7. DISPLAYPORT REFERENCE SOURCE

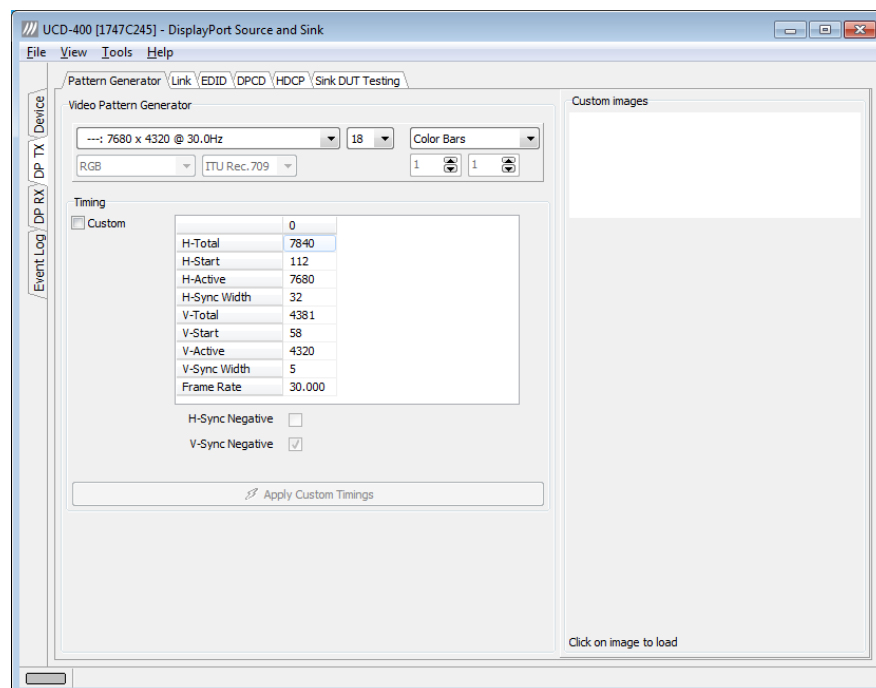
DP Reference Source function is using one output channel, DisplayPort Source (DP TX). The corresponding vertical tab can be seen on the left edge of the GUI.

The horizontal tabs on the top of the GUI enable the various functions available for the output channel. Some of the tabs are enabled by default, some only when an applicable license is included. DPTX features the following functions.

- Video pattern generator (Pattern Generator).
- Status information and control of the downstream link (Link).
- EDID editor (EDID).
- DPCD monitor (DPCD)
- HDCP status monitor and control (HDCP).

Pattern Generator Tab

You can enable the DP Reference Source role either with or without the support to Multi-streaming (MST). The names of the roles are *DisplayPort Reference Source MST2* and *DisplayPort Reference Source SST*. The two roles have a slightly different pattern generator functionality.



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

Predefined Timings

UCD-400 includes a set of common predefined video timings. Please find a list of the timings with their major details in [Appendix C](#) of this document.

Click **Select** to choose the video timing used.

Color Mode

RGB color mode with full range quantization levels will be used with all patterns except with *Color Square Pattern*. This pattern allows the user to select RGB, YCbCr 4:4:4, YCbCr 4:2:2 color mode. When YCbCr is selected, the Colorimetry dropdown box is enabled and allows selection between ITU-709 and ITU-601. Please find a description of the available test patterns in [Appendix D](#) of this document.

Color Depth

You can set the color depth used. The available color depths are: 18, 24, 30, 36 and 48 bpp.

Predefined Video Patterns

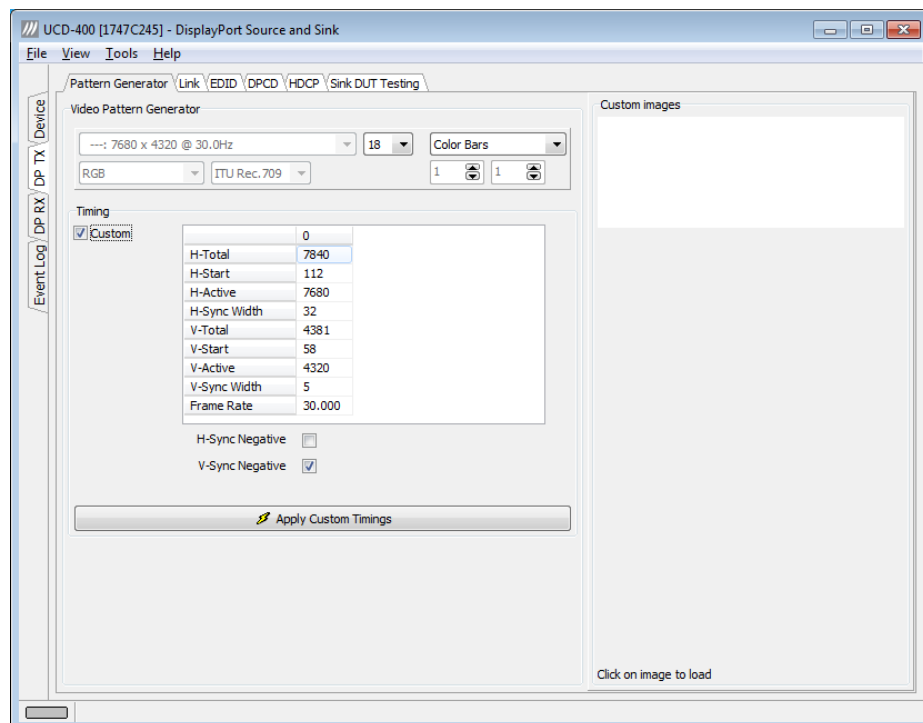
UCD-400 has a set of predefined patterns and a possibility to user defined custom pattern. You can select the pattern in the provided combo box. By selecting **Disabled** you can have the links activated but no video data transferred.

Please find a description of the available test patterns in [Appendix D](#) of this document.

You can use BMP, PNG, JPG and TIFF files in your PC as custom images. The bitmaps will be aligned to the top left hand side corner, displayed at the original resolution, no scaling, cropped to the active area.

Custom Timing

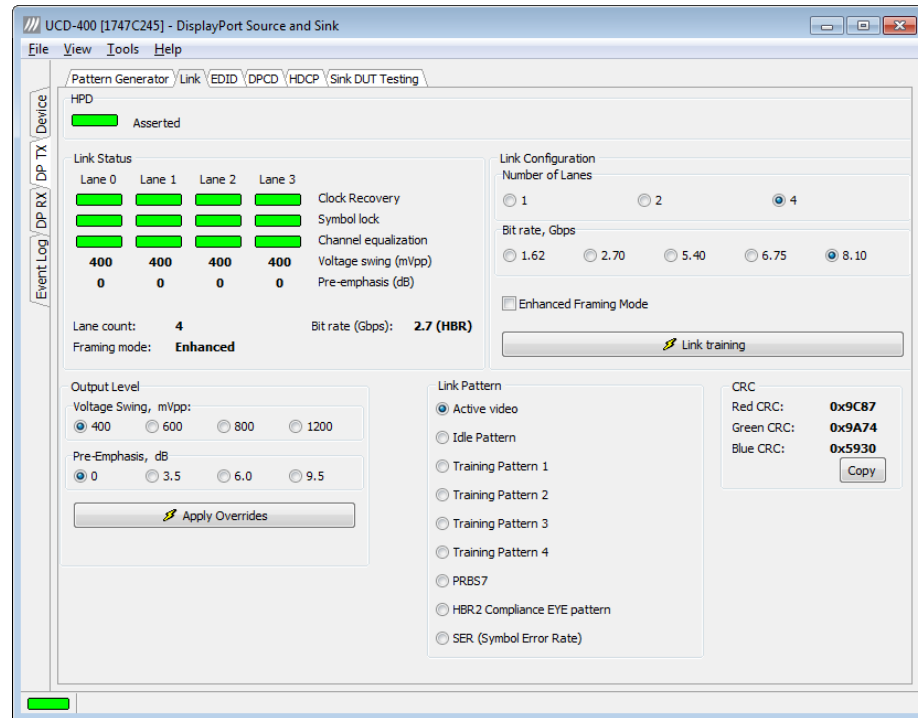
Custom Timing feature is enabled with *UCD Pro for DP Source* license.



You can modify the timing parameters of the predefined video modes by selecting the **Custom** check-box and editing the fields of the matrix. Enable the new parameters by clicking **Apply Custom Timings** button.

Link Tab

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



HPD

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

Link status

The panel shows the result of the link training with the connected downstream sink.

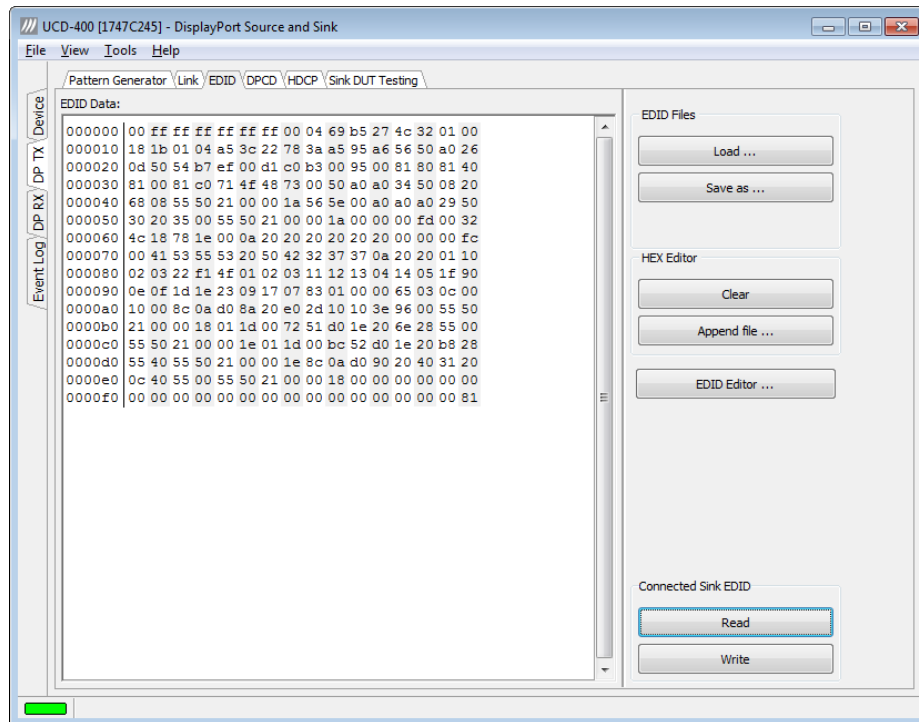
Link configuration

You can set the capabilities of the DisplayPort source in the link training:

- Set the Number of Lanes used,
- Set the maximum Link Rate,
- Enable Enhanced Framing Mode
- Enable special bit patterns.

EDID Tab

EDID tab enables analyzing and saving the EDID read from the connected Sink device.



There are three basic functions:

- Read the contents of the EDID of the downstream sink over the DisplayPort link.
- Load and save EDID data files in the host PC
- Edit the EDID contents

EDID Files

With **Load...** and **Save as...** you can read and write a hex EDID file from your 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	Currently the EDID Editor does not support Display ID. You can however modify hex EDID files with the HEX Editor or load and program externally generated hex EDID files that have Display ID content.
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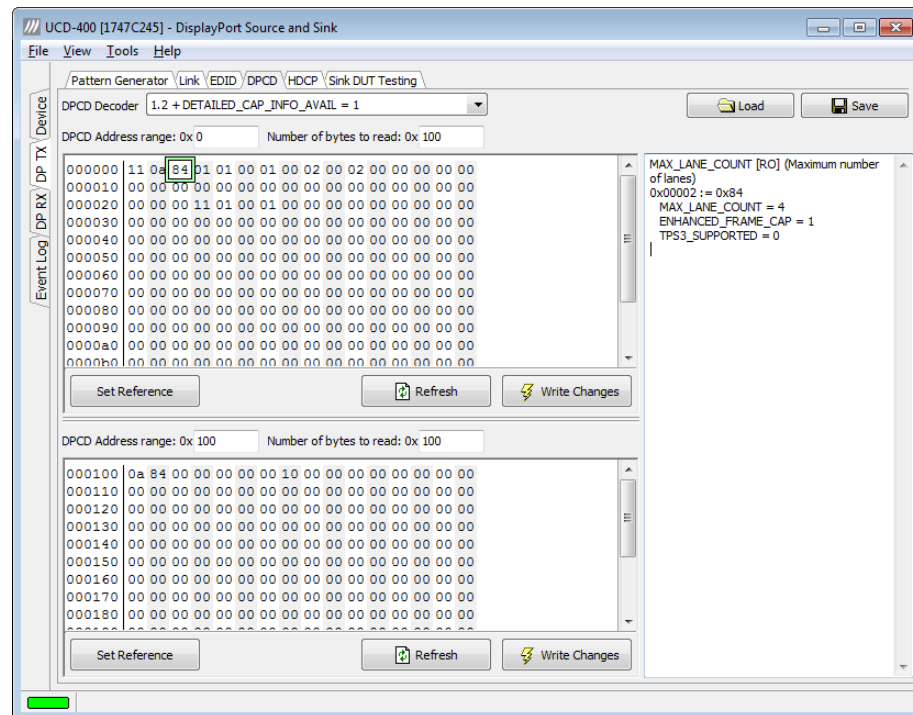
HEX Editor

When EDID content is either loaded from a file or read from the hardware EDID memory, it is shown in the *EDID Data* panel on the left-hand side of the dialog. You can edit the EDID contents by typing over the existing values. The altered content is highlighted with **RED**. Please note that Hex Editor itself does not alter the contents of the EDID data or verify its integrity.

Once you are done with editing the data, you can either save it to an *.ecd file in your PC with **Save as...** or program it to the hardware EDID memory with **Write**.

DPCD Tab

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



The tool consists of two independent monitoring and editing windows for the DPCD data. The user can freely select the the DPCD address areas shown on each panel.

The *DPCD Decoder* panel on the right hand side shows the interpretation of the DPCD byte selected on the monitoring windows. The selected byte is shown with a green outline.

In the combo box above the DPCD Decoder window you can select how the DPCD data is interpreted, either as *DP 1.1 DPCD*, or as *DP 1.2 DPCD* with *Detailed Capability Info* selected or not (*DETAILED_CAP_INFO_AVAIL* = 1/0).

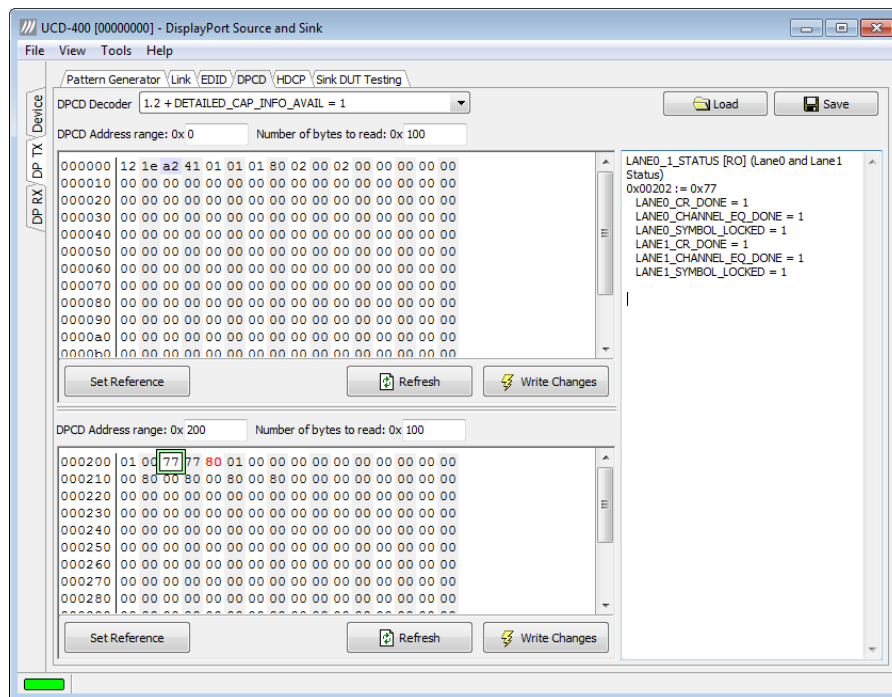
By clicking **Refresh** you can re-read the data from the DPCD registers to the window in question.

By clicking **Write Changes** you can write the portion of data shown in the window in question to the DPCD registers.

By clicking **Set Reference** you can store currently shown data as a reference for comparison.

When you refresh the data from the DPCD registers the changed bytes will be highlighted with **gray** background.

The fields edited by the user will be highlighted with **red** color.



Saving and Loading DPCD Content

You can save the DPCD data in the address areas that you selected for the two windows as a file in your PC. You can save the content in three alternative formats:

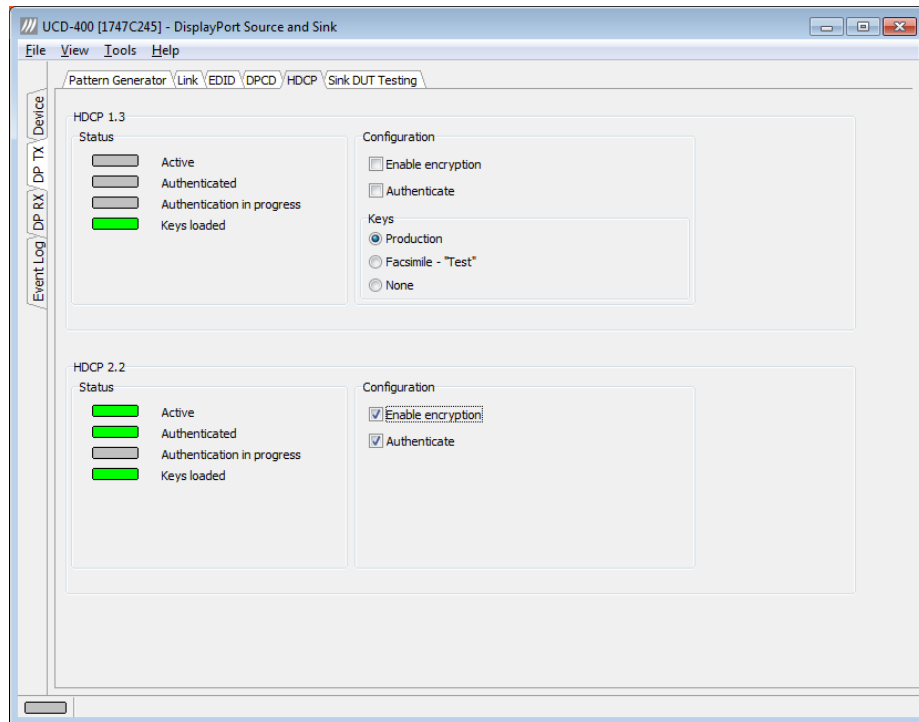
- **Binary DPCD Data File format (*.DPD)**. This is Unigraf proprietary format. You can also load the DPCD content stored in this format.
- **Comma Separated Values (*.CSV)** for loading the data to a spreadsheet.
- **HEX Dump (*.HEX)** in a human readable text format.

- ▶ By Clicking **Save** you will be able to select the location and the format of the file.
- ▶ By Clicking **Load** you can load DPCD data saved in *DPCD Data File (*.DPD)* format to the editor.
- ▶ In order to program the data into the DPCD registers of UCD-400 Local Sink click **Write Changes**.

Note	<ul style="list-style-type: none"> - Writing DPCD data to the DPCD registers of the Sink will potentially affect the status and capabilities of sink as seen by the source. - User control like Link Training or mode changes will modify the content of the DPCD registers
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HDCP Tab

HDCP tab is the dialog for monitoring the HDCP (for *High-Bandwith Digital Content Protection*) status and controlling the HDCP capabilities of the connected UCD-400 device.



Status

The status fields indicate the HDCP status of the connected UCD-400 device.

Active: The stream between UCD-400 and the downstream sink has been encrypted.

Authenticated: The HDCP handshake between the UCD-400 and the sink unit has been completed successfully.

Authentication in process: The HDCP handshake is in process between the UCD-400 and the downstream sink unit.

Keys loaded: The HDCP keys are loaded to the UCD-400 unit.

Configuration

Enable encryption: Check to enable the encryption of the stream between UCD-400 and the downstream sink.

Authenticate: Perform the HDCP initiation handshake between the UCD-400 and the sink unit.

Keys

You can select if you are using *Production* or *Facsimile* HDCP keys. To remove the keys, select *None*.

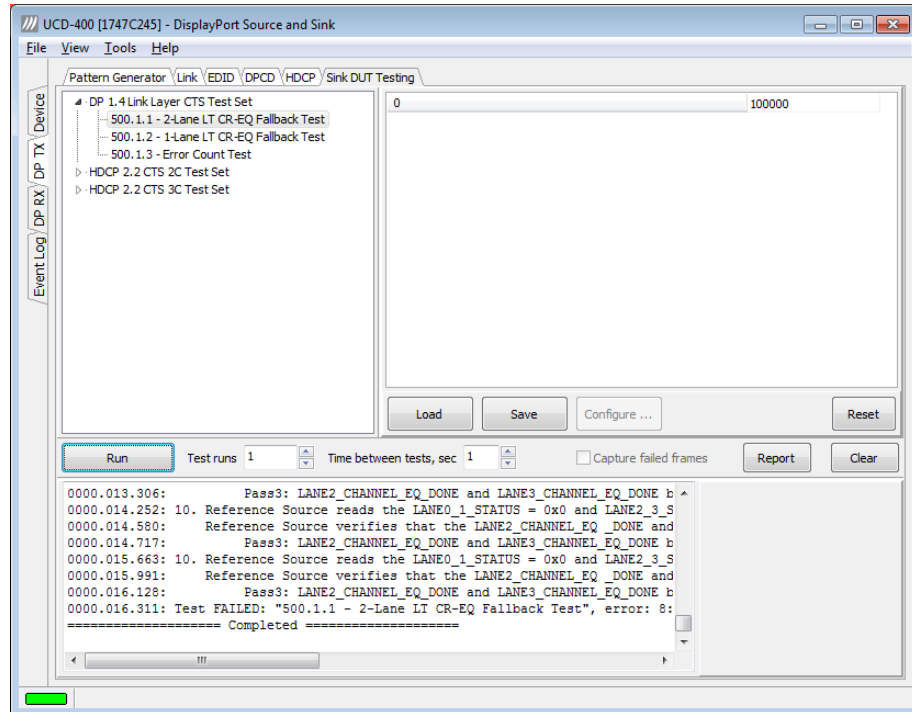
HDCP 1.3 vs. HDCP 2.2

UCD-400 devices support by default HDCP 1.3 and HDCP 2.2.

Sink DUT Testing Tab

Sink DUT Testing Tab is enabled with *UCD Pro for DP Source* license.

Please refer to **Appendix E** later in this document for description of the tests available. Please refer to document **TSI_Reference.pdf** in the install package to get a full definition of the TSI Test Cases, the parameters and the reporting. Sink DUT Testing enables the execution of TSI tests for a DP Sink.



Click **Run** to run the selected Test Case.

Click **Save** to save the current parameter set of the selected Test Case to a text file.

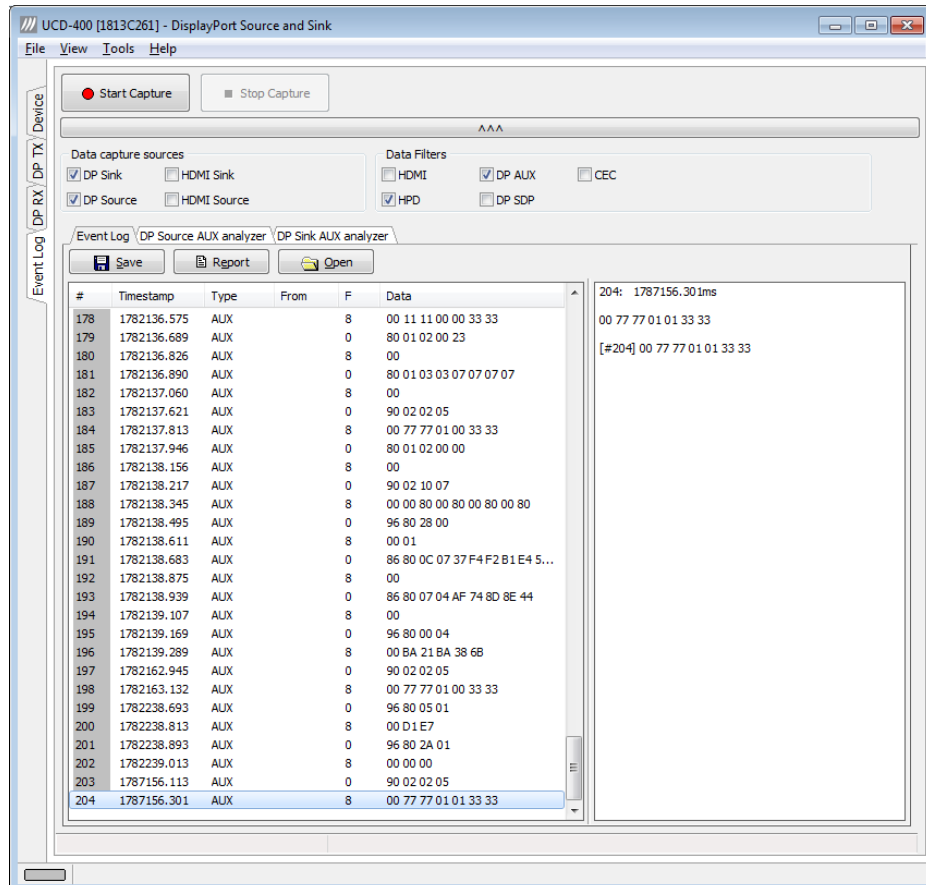
Click **Load** a saved parameter set of the selected Test Case from a text file.

Click **Reset** to bring all parameters of the selected Test Case to their default values.

8. EVENT LOG

Event Logger (Event Log) vertical tab can be seen on the left edge of the GUI. Event Log is enabled with *UCD Pro for DP Sink* or *UCD Pro for DP Source* license.

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.



With the *Event Logger* you can capture and evaluate

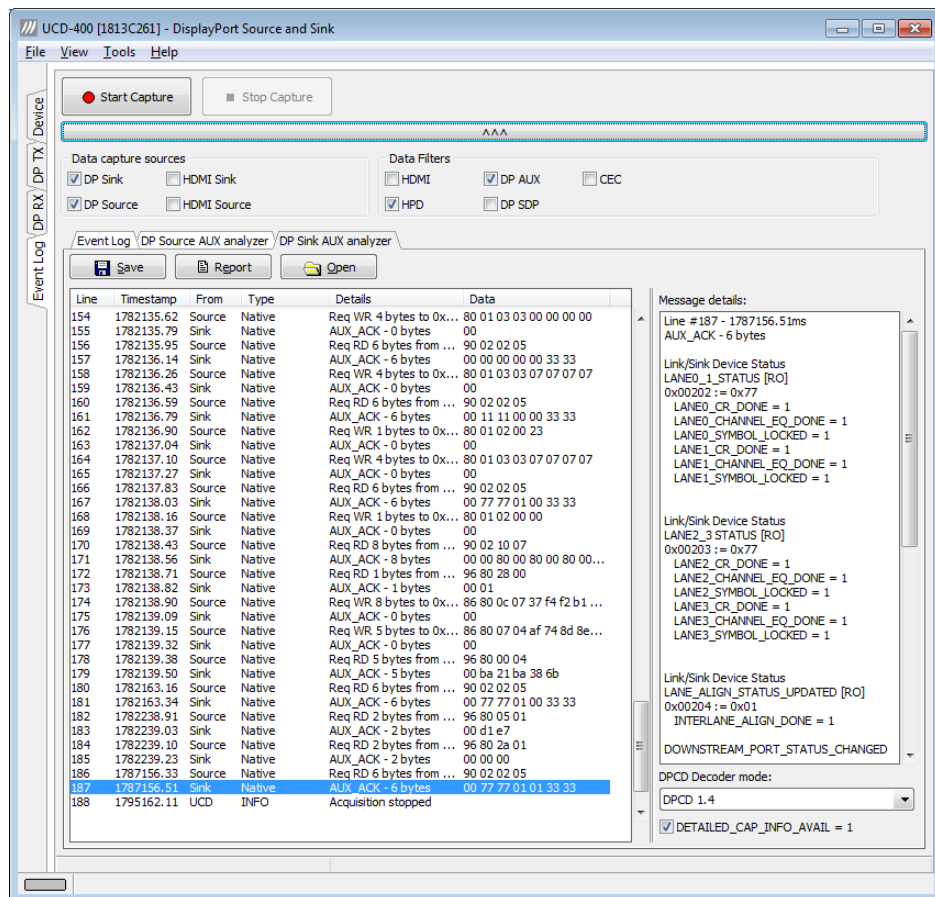
- HPD status
- DP AUX messages
- DP SDP messages

The left panel lists the transactions with Time stamps, Type indications, Message source, and raw message data. The right panel lists the content of one message. Messages belonging together with the selected one are shown in red color.

- ▶ Start event logging by clicking **Start Capture** and stop it by clicking **Stop Capture**.
- ▶ You can save transactions in binary *.evt Event Log files by clicking **Save**. You can recall saved Event Log files by clicking **Open**.
- ▶ By clicking **Report** you can store event logs as html reports to be shared and viewed with any web browser. You are first asked to indicate the file name and location, then you can add detailed information about the DUT and the test in free-text *Report information*.

DP AUX Analyzer

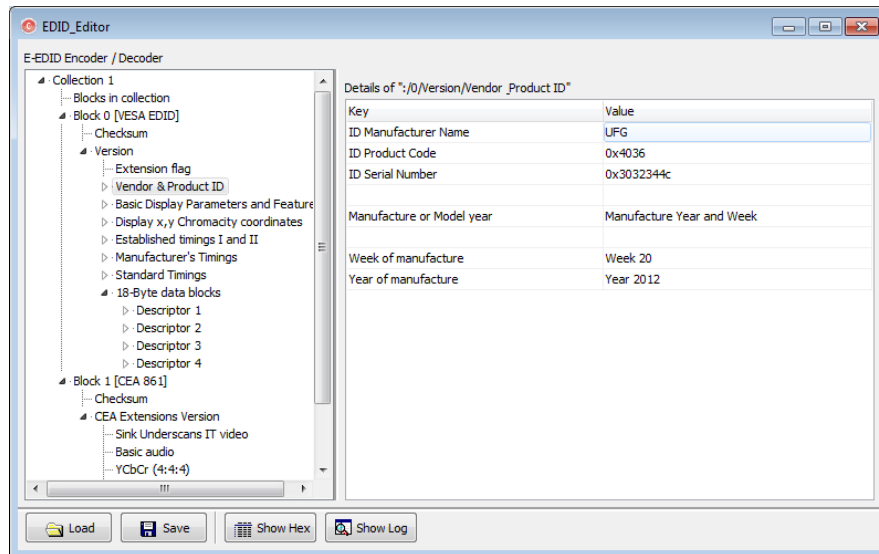
Event Log is able to parse the AUX transactions captured. In the same way as in *Event Log* panel the *DP Source AUX Analyzer* and *DP Sink AUX Analyzer* panels list the captured transactions with their time stamp.



The panel on the right shows the details of each transaction with message details and parsed DPCD register bit definitions.

9. EDID EDITOR

The Main Window



The *EDID Editor* main window is divided into three logical areas. The bottom part of the window contains the command buttons, and the log view. 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.

Command Buttons

Load: Load an EDID block collection file from disk.

Save: Save the current block collection to a disk file.

Show Hex: Show or Hide the HEX view.

Show Log: Show or Hide the Log view.

EDID Editor Features

The EDID Editor currently supports VESA E-EDID block versions 1.3 and 1.4. As the standard defines, the versions 1.0, 1.1 and 1.2 are supposed to be backward compatible, and therefore the VESA E-EDID decoder will also show their contents. However, in these cases it should be noted that the error checking is not compliant with restrictions given in these older versions of the standard. In addition to VESA E-EDID block, the CEA-861 versions 1, 2 and 3 EDID blocks are also fully supported as well as the VESA Block Map Extension blocks.

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.

HEX View: An optional HEX data display of all blocks in the collection. The view also shows the latest changes highlighted.

LOG View: An optional LOG view, which will contain log prints generated by the editor. Mostly it will list values that have been automatically updated due to edits.

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.

- **Enter** key will apply text-edit values and combo-box selection.
- To apply new setting to *binary* values (ones that show a check-box), please click the **Set** button.
- When you see a **Quick Config** button appear below an editor, you can access a configuration menu that allows you to quickly select one of multiple pre-defined setup options.
- In CEA-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”. Unfortunately re-arranging the descriptors and CEA data blocks is not supported yet, so you need to be careful when editing these.
- 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	It is recommended that you back up the un-edited EDID contents to a file before editing and writing it to the card.
------	---

Saving EDID Data

When you are done with editing you can either save the EDID contents to a file in the PC or bring it in the *HEX Editor*.

For saving the data to a file in your PC click **Save**.

For bringing the data to the HEX Editor close the EDID Editor window by clicking the **Window Close** button in the top right-hand corner of the window. You will be asked if you would like to copy and replace the EDID data in the HEX Editor. Click **Yes** to replace the data, click **No** to discard the modifications.

When you are back in the *HEX Editor*, the bytes that the *EDID Editor* changed are highlighted with **BLUE BACKGROUND**.

APPENDIX A. PRODUCT SPECIFICATION

UCD-400

Input	DisplayPort™ 1.4 compliant (DP Rx)
Output	DisplayPort™ 1.4 compliant (DP Tx)
Max video mode	7680 × 4320 p30 input and output 3840 × 2160 p120 input and output
Audio	LPCM, 2 – 8 channels, 44.1 to 192 kHz
Content Protection	HDCP 2.2, HDCP 1.3
DSC Capability*	DSC 1.2a sink support Support RGB / YCbCr up to 12 bits per component 2 slices, max width 2560 pixels Pixel clock 120 MHz max.
Additional features	FEC, LTTPR** DP 1.4 LL CTS** HDCP 2.2 CTS**
Computer interface	USB 3.0
Software	Windows 10, 8 and 7 compatible software drivers, UCD Console application for Windows. Compatible with Unigraf TSI SDK.
Power supply	AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +12 Vdc output)
Mechanical Size	280 × 200 × 80 mm
Weight	1.2 kg w/o power supply

*) Please refer to Appendix F for details

**) Please contact Unigraf for detailed availability

APPENDIX B. LICENSING

The table below lists all functions in UCD-400 devices and the licensing scheme involved.

Overview

Input / Output Port	Tab	Default	HDCP 2.2 CTS	DSC	DP 1.4 LL CTS	TSI (default)
DisplayPort Reference Sink (DPRX)	Video preview and saving (Video).	●				▲
	Audio monitoring and saving (Audio).	●				▲
	Status information of the upstream link (Link).	●				▲
	Video mode and control of the upstream link (Link).	●				▲
	FEC Feature			■		
	DSC Feature			■		
	EDID editor (EDID).	●				▲
	DPCD editor (DPCD).	●				▲
	HDCP status monitor and control (HDCP)	●				▲
	Monitor Secondary-Data Packets (SDP)	●				
	Event Logger (Event Log)	●				
	DP AUX analyzer	●				
	Source DUT Testing	●	■		■	▲
DisplayPort Reference Source (DPTX)	Video pattern generator (Pattern Generator).	●				▲
	Status information of the downstream link (Link).	●				▲
	Control of the downstream link (Link)	●				
	FEC Feature			■		
	EDID editor (EDID).	●				
	HDCP status monitor and control (HDCP)	●				
	Event Logger (Event Log)	●				
	DP AUX analyzer	●				

In the following pages, please find detailed explanation of the functions and the licensing. Please refer to TSI documentation on detailed description of TSI features.

DisplayPort Reference Sink (DPRX)

Tab	Function	Basic	DP 1.4 LL CTS	HDCP 2.2 CTS	DSC Decoder
Video					
	Preview, Snap preview	●			
	Capture	●			
	Status	●			
Audio		●			
	Monitor and graphical preview	●			
	Capture	●			
	Status	●			
Link		●			
	Link Status	●			
	Link Configuration	●			
	Stream Status (video, audio)	●			
	HPD Status, HPD Assert / De-assert	●			
	HPD Long Pulse, HPD Short Pulse	●			
	FEC Feature				■
	DSC Decoder				■
EDID					
	Read/Write, Save/Load	●			
	EDID Editor	●			
DPCD					
	Read/Write, Save/Load	●			
	DPCD Decoder	●			
HDCP					
	HDCP 1.3 Support	●			
	Authentication status, Encryption status	●			
	HDCP 2.2 Support	●			
Event Log					
	Event Log	●			
	DP AUX Analyzer	●			
Source DUT Testing					
	Execute TSI Tests	●			
	Execute DP LL CTS		■		
	HDCP 2.2 CTS for testing DP Source DUT			■	

DisplayPort Reference Source (DPTX)

Tab	Function	Basic	DP 1.4 LL CTS	HDCP 2.2 CTS	DSC
Pattern Generator					
	Fixed Video Timings	●			
	Fixed Video Patterns	●			
	Custom Timing	●			
	Custom Video Patterns	●			
Link					
	Link Status (Clock Recovery, Symbol Lock, Voltage swing, Pre-emphasis, Lane count, Link rate, Framing mode)	●			
	HPD Status: (Asserted / De-asserted)	●			
	Link Configuration: (Lane count, Link Rate, Framing mode, Clock mode)	●			
	FEC Feature				■
EDID					
	Read/Write, Save/Load, EDID Editor	●			
DPCD					
	Read / Write, Save / Load	●			
	DPCD Decoder	●			
HDCP					
	HDCP 1.3 Support	●			
	Control: (Enable / Disable, authenticate only, Encryption Enable / Disable)	●			
	Status: (Authentication status, Encryption status)	●			
	HDCP 2.2 Support	●			
Event Log					
	Event Log	●			
	DP AUX Analyzer	●			
Sink DUT Testing					
	Execute TSI Tests	●			
	Execute DP LL CTS		■		
	HDCP 2.2 CTS for testing DP Sink DUT			■	

APPENDIX C: PREDEFINED TIMINGS


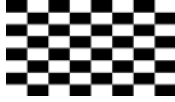







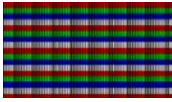
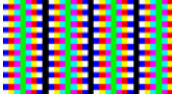


Description	H active	V active	H total	V total	Frame rate	18 bpp	24 bpp	30 bpp	36 bpp	48 bpp
VESA: 640 × 480 @ 60Hz	640	480	800	525	60	●	●	●	●	●
VESA: 1024 × 768 @ 60Hz	1024	768	1344	806	60	●	●	●	●	●
VESA: 1280 × 720 @ 60Hz (R)	1280	720	1650	750	60	●	●	●	●	●
VESA: 1920 × 1080 @ 60Hz (R)	1920	1080	2200	1125	60	●	●	●	●	●
VESA: 1920 × 1080 @ 120Hz (R)	1920	1080	2200	1125	120	●	●	●	●	●
VESA: 1920 × 1440 @ 60Hz	1920	1440	2600	1500	60	●	●	●	●	●
VESA: 2048 × 1536 @ 60Hz (R)	2048	1536	2208	1580	60	●	●	●	●	●
VESA: 2560 × 1440 @ 60Hz (R)	2560	1440	2720	1481	60	●	●	●	●	●
2880 × 1440 @ 60 Hz	2880	1440	2976	1456	60	●	●	●	●	●
VESA: 1680 × 1050 @ 60Hz	1680	1050	2240	1089	60	●	●	●	●	●
VESA: 1680 × 1050 @ 60Hz (R)	1680	1050	1840	1080	60	●	●	●	●	●
VESA: 2560 × 1080 @ 60Hz	2560	1080	3424	1120	60	●	●	●	●	●
VESA: 2560 × 1080 @ 60Hz (R)	2560	1080	2720	1111	60	●	●	●	●	●
VESA: 2560 × 1600 @ 60Hz	2560	1600	3504	1658	60	●	●	●	●	●
VESA: 2560 × 1600 @ 60Hz (R)	2560	1600	2720	1646	60	●	●	●	●	●
VESA: 4096 × 2160 @ 60Hz (R)	4096	2160	4176	2222	60	●	●	●	●	
CEA: 3840 × 2160 @ 30Hz	3840	2160	4400	2250	30	●	●	●	●	●
CEA: 3840 × 2160 @ 50Hz	3840	2160	5280	2250	50	●	●	●	●	
CEA: 4096 × 2160 @ 50Hz	4096	2160	5280	2250	50	●	●	●	●	
CEA: 3840 × 2160 @ 60Hz	3840	2160	4400	2250	60	●	●	●	●	
CEA: 4096 × 2160 @ 60Hz	4096	2160	4400	2250	60	●	●	●	●	
3840 × 2160 @ 120 Hz (R)	3840	2160	4000	2222	120	●	●			
3840 × 2160 @ 120 Hz (R)	3840	2160	3920	2287	120	●				
5120 × 2880 @ 60 Hz (R)	5120	2880	5280	2962	60	●	●			
7680 × 4320 @ 30 Hz (R)	7680	4320	7840	4381	30	●	●			

● = Supported video mode and color depth

Pixel Bandwidths for Supported Video Modes

Description	H active	V active	H total	V total	Frame rate	18 bpp	24 bpp	30 bpp	36 bpp	48 bpp
VESA: 640 × 480 @ 60Hz	640	480	800	525	60	0,45	0,60	0,76	0,91	1,21
VESA: 1024 × 768 @ 60Hz	1024	768	1344	806	60	1,17	1,56	1,95	2,34	3,12
VESA: 1280 × 720 @ 60Hz ®	1280	720	1650	750	60	1,34	1,78	2,23	2,67	3,56
VESA: 1920 × 1080 @ 60Hz ®	1920	1080	2200	1125	60	2,67	3,56	4,46	5,35	7,13
VESA: 1920 × 1080 @ 120Hz ®	1920	1080	2200	1125	120	5,35	7,13	8,91	10,69	14,26
VESA: 1920 × 1440 @ 60Hz	1920	1440	2600	1500	60	4,21	5,62	7,02	8,42	11,23
VESA: 2048 × 1536 @ 60Hz ®	2048	1536	2208	1580	60	3,77	5,02	6,28	7,54	10,05
VESA: 2560 × 1440 @ 60Hz ®	2560	1440	2720	1481	60	4,35	5,80	7,25	8,70	11,60
2880 × 1440 @ 60 Hz	2880	1440	2976	1456	60	4,68	6,24	7,80	9,36	12,48
VESA: 1680 × 1050 @ 60Hz	1680	1050	2240	1089	60	2,63	3,51	4,39	5,27	7,03
VESA: 1680 × 1050 @ 60Hz ®	1680	1050	1840	1080	60	2,15	2,86	3,58	4,29	5,72
VESA: 2560 × 1080 @ 60Hz	2560	1080	3424	1120	60	4,14	5,52	6,90	8,28	11,04
VESA: 2560 × 1080 @ 60Hz ®	2560	1080	2720	1111	60	3,26	4,35	5,44	6,53	8,70
VESA: 2560 × 1600 @ 60Hz	2560	1600	3504	1658	60	6,27	8,37	10,46	12,55	16,73
VESA: 2560 × 1600 @ 60Hz ®	2560	1600	2720	1646	60	4,84	6,45	8,06	9,67	12,89
VESA: 4096 × 2160 @ 60Hz ®	4096	2160	4176	2222	60	10,02	13,36	16,70	20,04	N/A
CEA: 3840 × 2160 @ 30Hz	3840	2160	4400	2250	30	5,35	7,13	8,91	10,69	14,26
CEA: 3840 × 2160 @ 50Hz	3840	2160	5280	2250	50	10,69	14,26	17,82	21,38	N/A
CEA: 4096 × 2160 @ 50Hz	4096	2160	5280	2250	50	10,69	14,26	17,82	21,38	N/A
CEA: 3840 × 2160 @ 60Hz	3840	2160	4400	2250	60	10,69	14,26	17,82	21,38	N/A
CEA: 4096 × 2160 @ 60Hz	4096	2160	4400	2250	60	10,69	14,26	17,82	21,38	N/A
3840 × 2160 @ 120 Hz ®	3840	2160	4000	2222	120	19,20	25,60	N/A	N/A	N/A
3840 × 2160 @ 120 Hz ®	3840	2160	3920	2287	120	19,36	N/A	N/A	N/A	N/A
5120 × 2880 @ 60 Hz ®	5120	2880	5280	2962	60	16,89	22,52	N/A	N/A	N/A
7680 × 4320 @ 30 Hz ®	7680	4320	7840	4381	30	18,55	24,73	N/A	N/A	N/A

APPENDIX D: PREDEFINED PATTERNS

Selection	Pattern	Description
Disabled	N/A	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 Black		0% luminance
Solid White		100% white
Solid Red		100% red
Solid Green		100% green
Solid Blue		100% blue
White Vertical Stripes		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 0 to 5000.
Gradient Vertical Stripes		16 pixels high horizontal red green, blue and white stripes. Intensity is increased from 0 to 100% with steps defined by the given parameter (n). (step = $n \cdot \text{color_depth} / 256$). "n" range 0 to 5000 (default 120).
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)
Custom Image		Bitmap image uploaded by the user. Click on the Custom Images panel to browse. By default, a black image with a white square in the upper left corner.

More test patterns can be downloaded e.g. from www.icdm-sid.org/downloads/testpatterns.html.

APPENDIX E: SINK, SOURCE AND REPEATER DUT TESTS

The tables below list the Unigraf TSI SDK Test Cases that you can run in *Sink DUT Testing* / *Source DUT Testing* tabs of UCD Console, their definition in *TSI Reference Manual* and the licensing needed.

Source DUT Testing		Default	DP 1.4 LL CTS*	DP HDCP 2.2 CTS*
CRC based Video Test Set				
	CRC based single frame reference video test (TSI_TEST_VIDEO_CRC_SINGLE_REF)	✓		
	CRC based single frame stability test (TSI_TEST_CRC_VIDEO_STABILITY)	✓		
	CRC based sequence of frames reference video test (TSI_TEST_CRC_VIDEO_SEQUENCE)	✓		
	CRC based continuous sequence of frames reference video test (TSI_TEST_CRC_CONT_VIDEO_SEQUENCE)	✓		
Link Test Set				
	Link Training at All Supported Lane Counts and Link Rates (TSI_TEST_DP_SIMPLE_LINK)	✓		
DP 1.4 Link Layer CTS				
	400.1.1 – 400.1.3 (will get new numbers in DP 1.4 later)		✓	
	400.2.1, 400.2.2 (will get new numbers in DP 1.4 later)		✓	
	4.2.1.1 – 4.2.1.2		✓	
	4.2.2.1 – 4.2.2.10		✓	
	4.3.1.1 – 4.3.1.11		✓	
	4.3.2.1 – 4.3.2.5		✓	
	4.3.3.1		✓	
	4.4.1.1 – 4.4.1.3		✓	
	4.4.2		✓	
HDCP 2.2 CTS 1A Test Set	HDCP2.2 CTS 1A-01 – HDCP2.2 CTS 1A-13			✓
HDCP 2.2 CTS 1B Test Set	HDCP2.2 CTS 1B-01 – HDCP2.2 CTS 1B-10			✓

Sink DUT Testing		Default	DP 1.4 LL CTS*	DP HDCP 2.2 CTS*
DP 1.4 Link Layer CTS				
	500.1.1-500.1.3 (will get new numbers in DP 1.4 later)		✓	
	5.2.1.1 – 5.2.1.12		✓	
	5.2.2.1 – 5.2.2.8		✓	
	5.3.1.1 – 5.3.1.7		✓	
HDCP 2.2 CTS 2C Test Set	HDCP2.2 CTS 2C-01 – HDCP2.2 CTS 2C-06			✓

*) Separate licenses for testing Sink, Source and Repeater DUT

Repeater DUT Testing		Default	DP HDCP 2.2 CTS*	
HDCP 2.2 CTS 3A Test Set	HCDP2.2 CTS 3A-01 – HCDP2.2 CTS 3A-06		✓	
HDCP 2.2 CTS 3B Test Set	HCDP2.2 CTS 3B-01 – HCDP2.2 CTS 3B-07		✓	
HDCP 2.2 CTS 3C Test Set	HCDP2.2 CTS 3C-01 – HCDP2.2 CTS 3C-25		✓	

*) Separate licenses for testing Sink, Source and Repeater DUT

CRC Based Video Test Set – DP Rx

CRC Based Single Reference Frame Video Test

The test compares captured frames to a provided reference.

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)
- Frame rate tolerance (mHz)
- 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)
- Frame rate tolerance (mHz)
- 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)
- Frame rate tolerance (mHz)
- 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 Test Set – DP Rx

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.

Parameters in use

- Test Timeout (default 5 000 ms)
- Max lane count supported by DUT (default 4)
- Max lane rate supported by DUT as multiple of 0.27 Gbps.
(valid settings 6, 10 and 20; default 20)
- Long HPD pulse duration (default 1 000 ms)
- Link training start timeout (default 5 000 ms)
- Delay between test cycles (default 3 000 ms)

APPENDIX F: DSC CAPABILITIES

DSC 1.2a

Support for RGB / YCbCr 4:4:4
Support for 8, 10 and 12 bits per component
Supports Block Prediction (BP)
Supports Index Color History (ICH)
Support for multiple slices per line
Supports Simple 4:2:2 mode
Support for Native 4:2:2 subsampled mode
Support for Native 4:2:0 subsampled mode

Currently compiled:

2 Slices with max. slice width of 2560 pixels
Pixel clock limited to 120 MHz
Bits per pixel increment 1/16
RC buffer block size 1 KB x 1 block
Line buffer depth 16 bits
Capture bit depth 8-bits

Version History

Rev.	Date	Author	Description
10	5.10.2017	JSa	- Updated license matrices in Appendix B
10b	12.10.2017	JSa	- Corrected typo in matrices in Appendix B (HDCP 2.2 CTS for testing DP Source DUT >> HDCP 2.2 CTS for testing DP Sink DUT)
11	19.10.2017	JSa	- Added Appendix E SINK AND SOURCE DUT TESTS - Added FEC - Added description of the additional parameter dialogs on page 29 and 30. - Updated Specs in Appendix A to match with the Data Sheet (added 8K, DSC, FEC, LTTPR) - Updated screen shots.
11a	2.11.2017	JSa	- Correction: Removed mentioning to MST and SST modes - Correction: Removed Electrical testing from matrix in Appendix B - Correction: Removed Status Log in Appendix B - Added 3A to 3C Repeater tests to Appendix E
11b	09.01.2018	JSa	- Correction: Removed asterisk from LL CTS for "Sink DUT Testing" on Appendix B page 43 - Added Appendix F - Added Color Depth support information to matrix in Appendix C
12	22.1.2018	JSa	- Updated version reference to 1.7 - Updated screen shots - Updated matrices in App B Licensing - Updated table in App E to match the release version (1.7.8) - Added description of Force cable status to plugged
13	08.03.2018	JSa	- Added new entries in "Available Mode Configurations" table - Included SDP and Event Log tabs in DP RX - Updated DP 1.4 LL CTS test parameters dialog - Updated screen captures to reflect addition of new tabs - Updated matrices in Appendix B
13a	12.03.2018	JSa	- Correction: Removed reference to USB-C in Event Log
14	04.04.2018	JSa	- Removed FEC and DSC from the text - Changed support for FEC in feature matrix from "Basic" to "DSC"
15	25.06.2018	JSa	- Added USB-C interface in Chapter 2 (p 7) - Improved description of the FW update procedure and added the direct connection method (pp 12 – 14) - Updated Event Log to match the featured release - Updated list of included tests in Appendix E (p 52) - Added detailed descriptions of tests in Sink DUT Testing tab