UCD Console for UCD-422

User Manual

/// **UNIGRAF**

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Table of Contents

1. ABOUT THIS MANUAL

Purpose

This guide is User Manual of UCD-422, 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-422 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 **1.10.** 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-422 is a USB 3.0 connected video interface test unit with HDMI 2.1 Pattern Generator and Analyzer capability. *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 UCD unit reflecting the features enabled.

UCD-400 family 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 10k30Hz, 8k60Hz, 4K/UHD 120 Hz
- Supports FRL
- Supports Auto Low Latency Mode (ALLM) and Variable Refresh rate (VRR)
- Compatible with HDCP versions 1.4 and 2.3
- 2 GB on-board high-speed video buffer
- High speed USB 3.0 host PC interface

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

Functional Description

UCD-422 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-422 unit
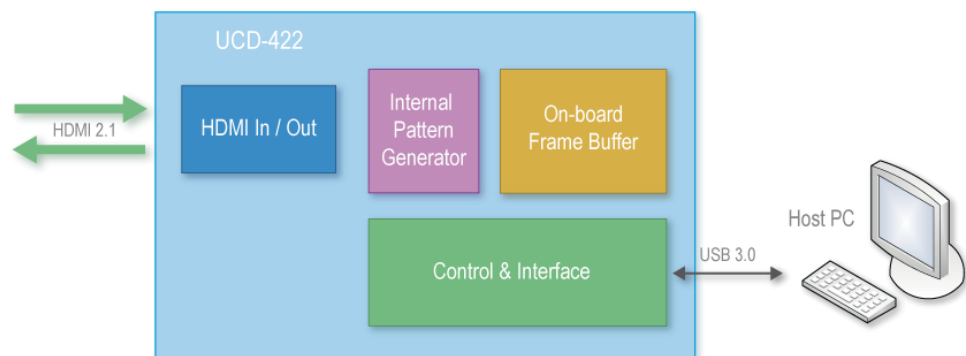
UCD-422

The image below indicates the connections in UCD-422 unit and their description.
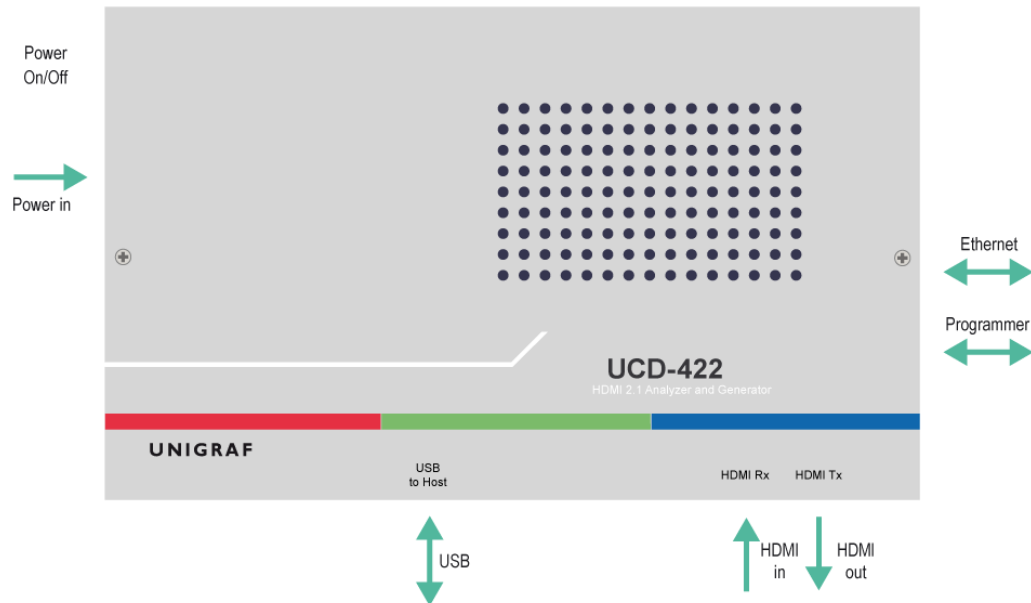
Name	Description
HDMI in	HDMI 2.1 compliant input from the upstream Source
HDMI out	HDMI 2.1 compliant output to the downstream Sink
Power in	+12 Vdc Power Supply Input
Power On/Off	Rocker power switch
USB	USB 3.0 connection to the host PC
Programmer	USB interface used in device FW update (behind a cover)
Ethernet	Ethernet interface used in device FW update (behind a cover)

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

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

Unpacking

The UCD-422 product shipment contains:

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

Installation Package

The UCD-422 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
- UCD-422 firmware (FW) matching UCD Console version (copied during set up)
- User Manuals including this document.

When launched, UCD Console verifies that the firmware (FW) version programmed to UCD-422 matches the launched version. If conflict, UCD Console informs the user. If FW update is needed please refer to *Firmware Update Procedure* later in this manual for instructions.

Note:	The software should be installed before connecting the UCD-422 unit in the 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. The next two dialogs are used to define the installation folder in your PC and the Start Menu folder used.

▶ When the selections are ready, 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.
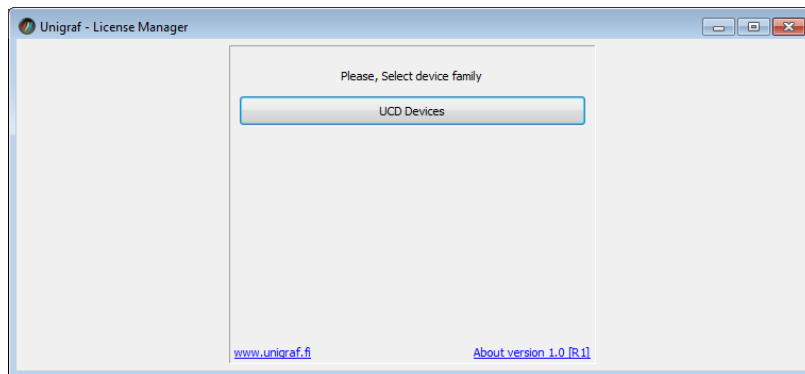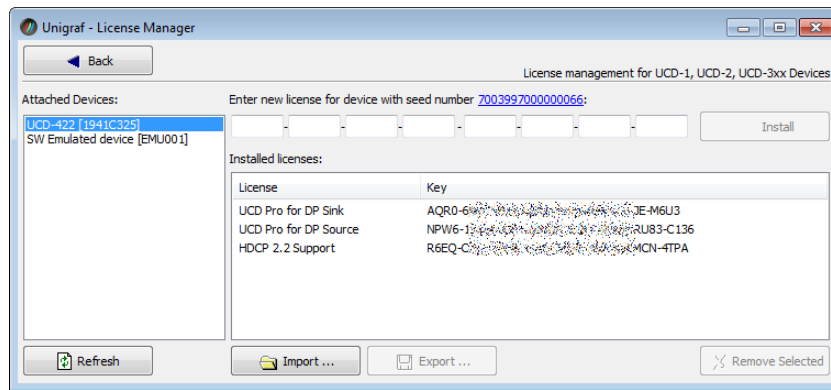

In the list of Attached Devices please select the device in question. The *serial number* and the *seed number* of your device are printed in a sticker attached to the bottom of the device.
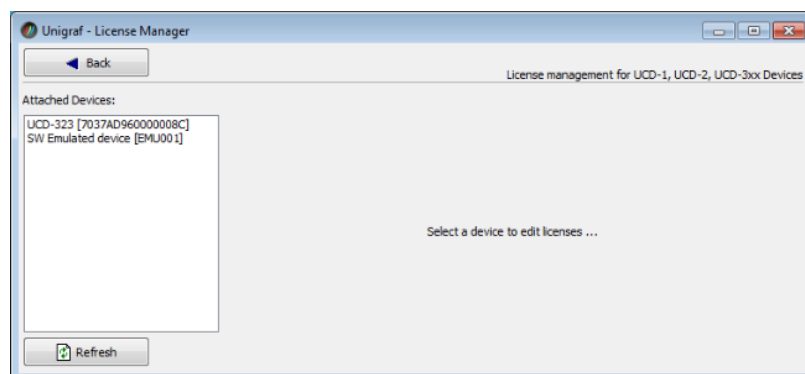
The **Back** button opens the device family selection screen. The **Refresh** button will re-scan the system for installed hardware.

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. 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 boxes provided. 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 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 all installed licenses for the currently selected device to be saved into an INI file for backup and distribution to other PCs. To export a license, click on the license and then click the Export button. 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

UCD Configuration Utility is used to load an updated firmware to the device. As an option, UCD Configuration Utility enables the user to select the operation roles present in the UCD-422 unit. The utility configures a firmware set for the selected operation roles and programs the firmware set 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-422 device, please perform the following steps:

▶ Connect the UCD-422 unit to a power supply and connect the USB cable.

▶ Open **UCD Console**. Select **Tools > Firmware update.**

UCD Firmware Configuration tool can alternatively be launched in Start Menu.

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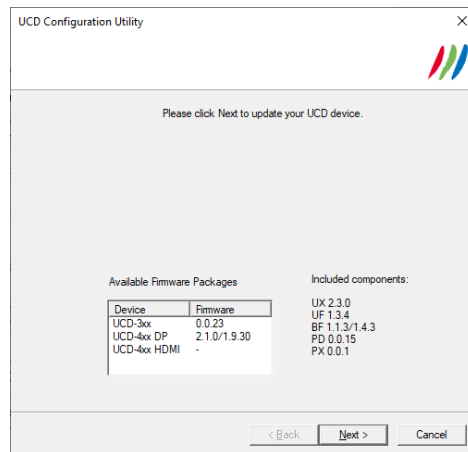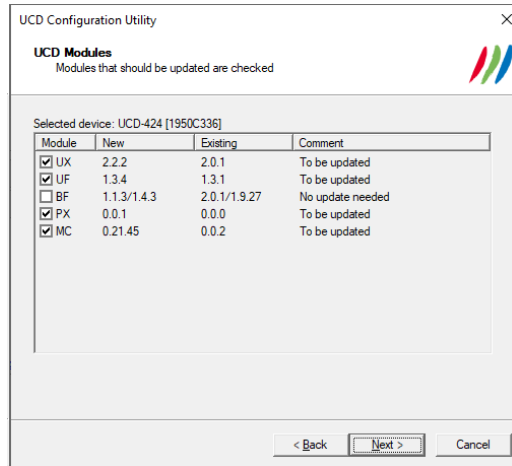

▶ If several UCD units are connected to the PC, in next dialog please select the devices to be updated. Click **Next**.
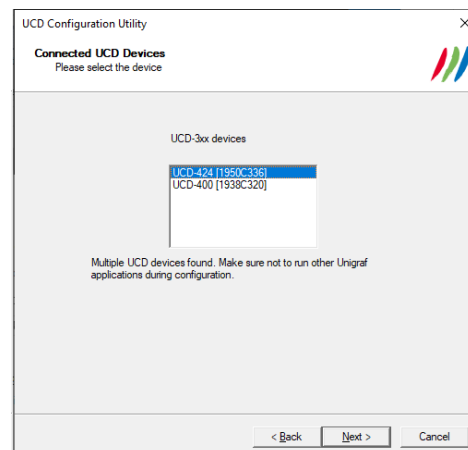
Updated Modules

The tool indicates the firmware file to be used and prompts for selection of the firmware modules to be updated. It compares the modules in the selected device and omits the ones that are the same.
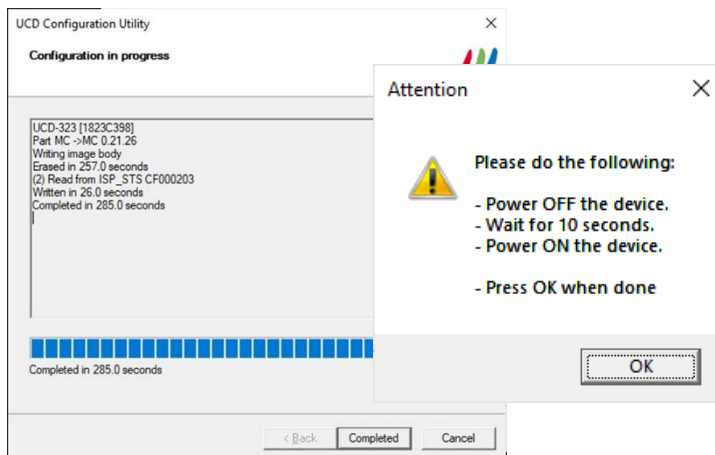

▶   When you are done, click **Next**.

Power Cycle

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

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.

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5. UCD CONSOLE

UCD Console is the graphical user interface (GUI) of UCD-422 unit for desktop use. It provides the user access to all features of the unit. UCD Console 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-422 are divided into tabs. Each tab contains data and controls for analyzing a specific feature.

Device Selection

A shortcut of UCD Console can be found by default under Start Menu path **All programs/Unigraf/UCD-400.** 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 clicking on the appropriate button. If your device cannot be found in the list, please confirm the power and USB connection to the device and click the **Rescan …** button.
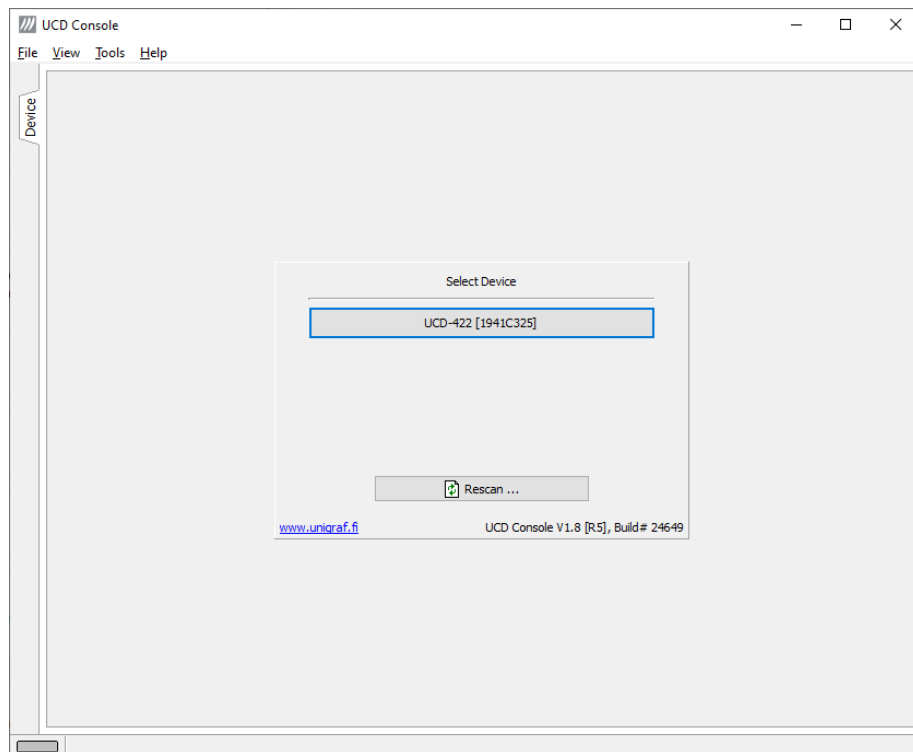

Select Role

The use of UCD-422 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. Please find a detailed description of each role in the later chapters of this manual.

Applying Changes

In various UCD Console dialogues the user needs to update several parameter or fields to make the changes needed. In order to avoid false combinations of parameters the new parameters are applied to UCD-422 test equipment hardware only after **Apply** is clicked. In UCD Console the situation that parameters have been changed but not applied is indicated by **bold values** of the parameter.
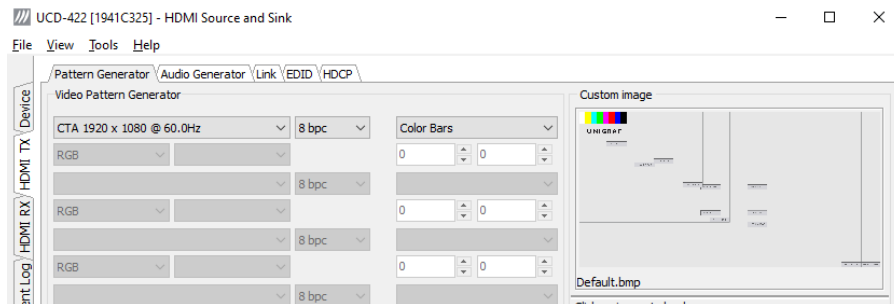
Options

Options can be found in **Tools > Options**.
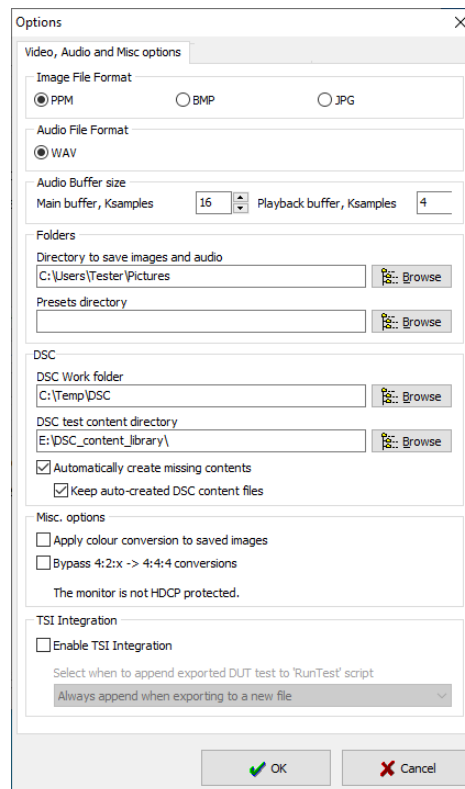
Video Audio and Misc. Options

Image File Format

You can save the captured frames either in PPM, BMP or JPG 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

Audio Buffer size

You can define how much memory is allocated in the PC for captured audio. 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.

Folders

Please select the directories in the PC for saving the captured images and audio, the saved Presets and DSC test content and DSC Work directories.

Misc. options

Apply color conversions to saved images: When saving captured frames, the Color Mode selected in *Video* tab will be applied also to saved images.

Bypass 4:2:x –> 4:4:4 conversions: 4:2:2 and 4:2:0 images are previewed and stored as received, without pixel doubling.

HDCP protected monitor: Text appearing if the monitor where UCD Console is viewed is HDCP compliant and HDCP is enabled. This feature enables preview of captured HDCP encrypted content in *Video* tab.

DSC

DSC Work folder: Folder for DSC Work files.

DSC test content directory: Folder where DSC source bitmap files, related configuration files and DSC conversion tools are stored.

Misc. options

Apply color conversions to saved images: When saving captured frames, the Color Mode selected in *Video* tab will be applied also to saved images.

Bypass 4:2:x –> 4:4:4 conversions: 4:2:2 and 4:2:0 images are previewed and stored as received, without pixel doubling.

HDCP protected monitor: Text appearing if the monitor where UCD Console is viewed is HDCP compliant and HDCP is enabled. This feature enables preview of captured HDCP encrypted content in *Video* tab.
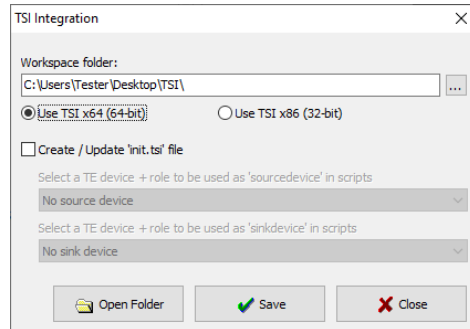
TSI Integration

Selections for generating a workspace for TSI usage.

Enable TSI Integration: When selected, TSI Integration tool (*Tools > TSI Integration*) is enabled. When exporting test parameters in Sink / Source DUT Testing, test code is also appended for execution with TSI.

Please refer to *TSI Integration* and *Exporting Tests for TSI* later in this document.

TSI Integration

**Tools > TSI Integration**. Selections for generating a workspace for TSI usage.

TSI Integration enables automatic creation of the necessary configuration files for executing tests exported from UCD Console's Sink DUT testing or Source DUT Testing.

Please refer to chapters *Source DUT Testing Tab* and *Sink DUT Testing Tab* later in this document for description about exporting tests.

Detaching 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 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 the keyboard.
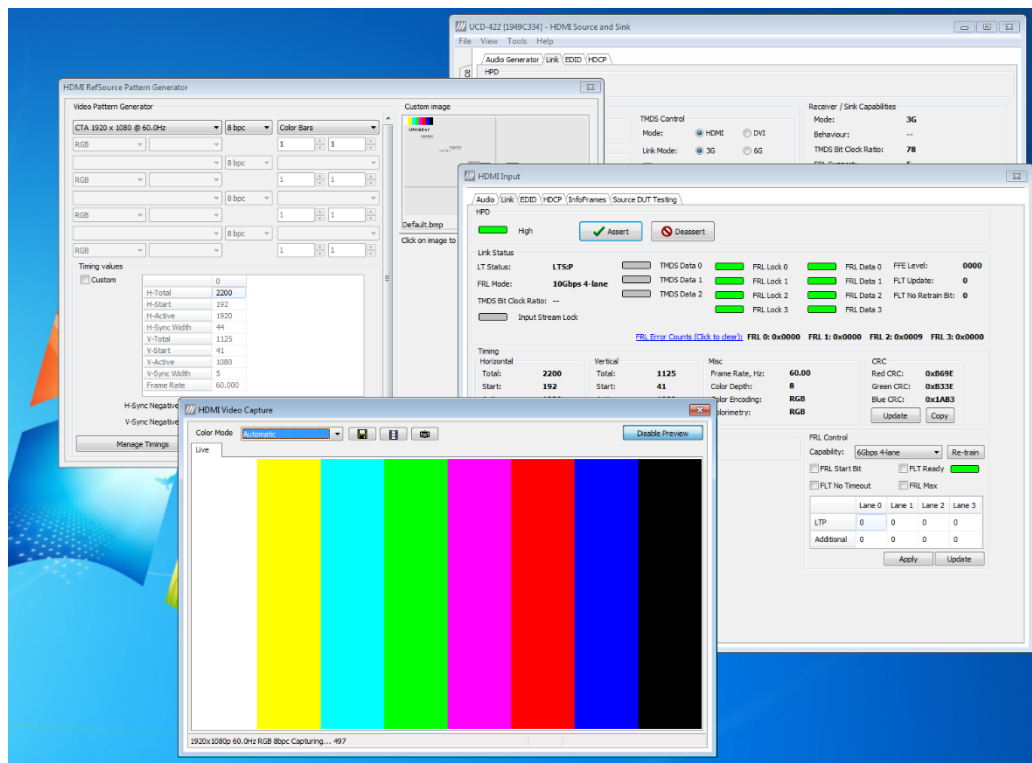
6. HDMI REFERENCE SINK

HDMI Reference Sink dialog (HDMI 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. Some of the tabs are enabled by default, some only when an applicable license is included. HDMI RX 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).
- HDCP status monitor and control (HDCP).
- InfoFrames monitoring panel (InfoFrames)
- Source DUT Testing

Video Tab

Video tab is the Preview window for the captured HDMI video.
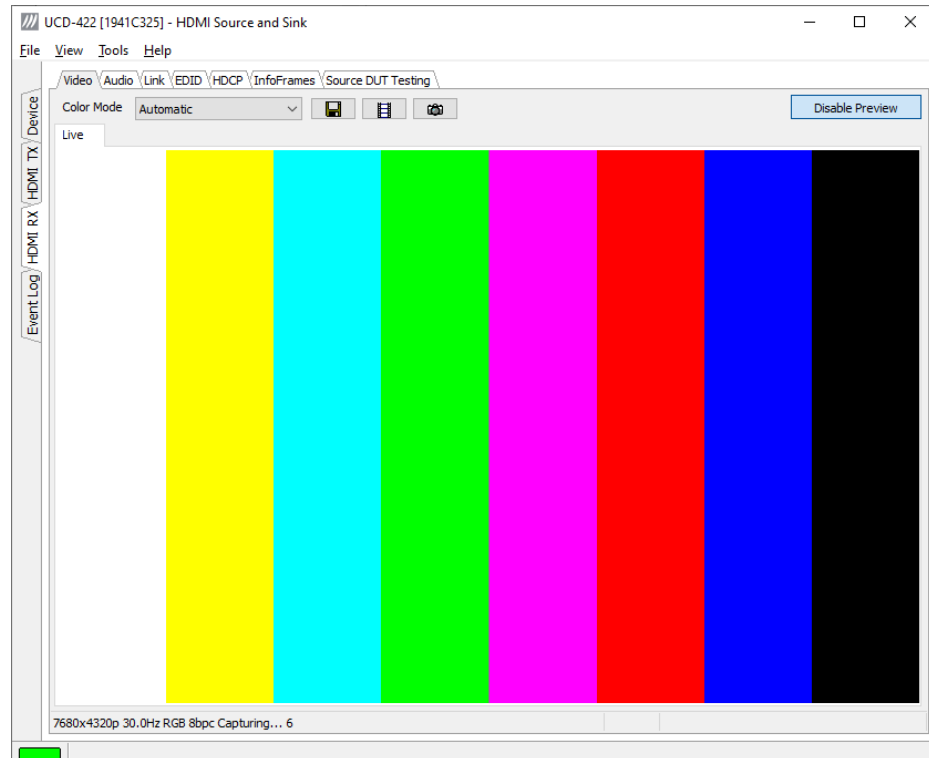
Input video mode

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

Disable / Enable Preview

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

Snap preview

When clicked, one frame of the incoming video is captured and shown in a new *Snapshot* tab. The captured bitmap can be saved with **Save one frame** function described above.

Color Information of the Captured Bitmap can be evaluated by placing the mouse cursor on top of the preview image. The lower right-hand side ribbon of the GUI lists
- 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 HEX color code of the pixel on cursor location

Zoom of the Preview Image can be altered by right clicking on top of the preview image and selecting between
- Fit Window
- Zoom 25%
- Zoom 50%
- Zoom 100%
- Zoom 200%
- Zoom 500%

While in the *Snap preview mode* clicking on the "Camera" icon will take additional snapshots

Audio Tab

Audio tab has a preview of the audio signal format and the controls for audio playback and recording.
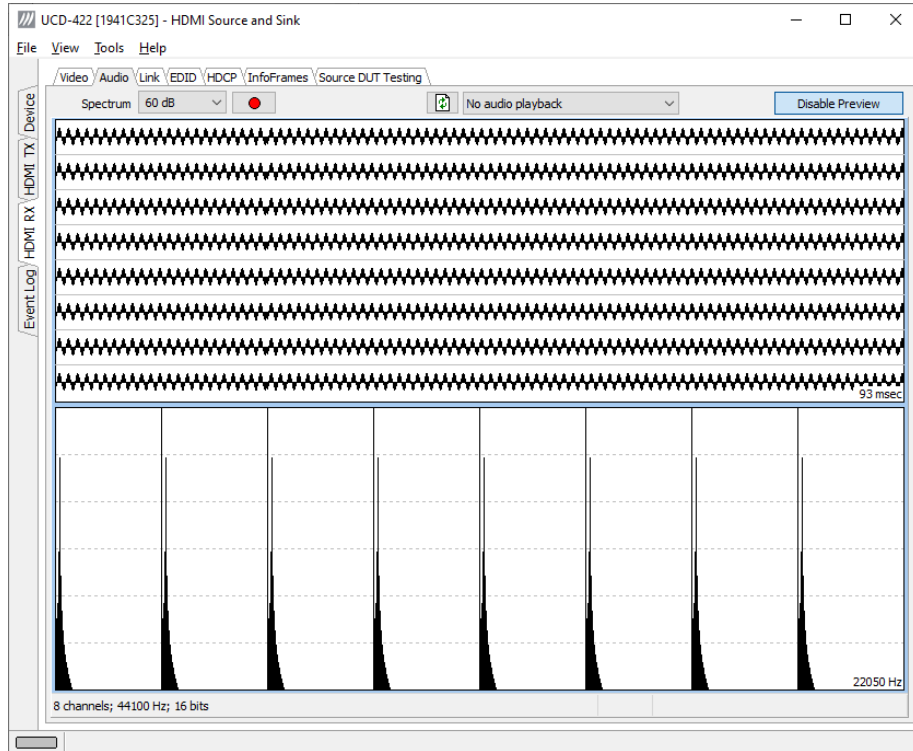
The audio signal format is shown in three ways

- 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 1/2 of the input sampling rate. 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

This button controls capturing the audio data.

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, the *No audio playback* is chosen.
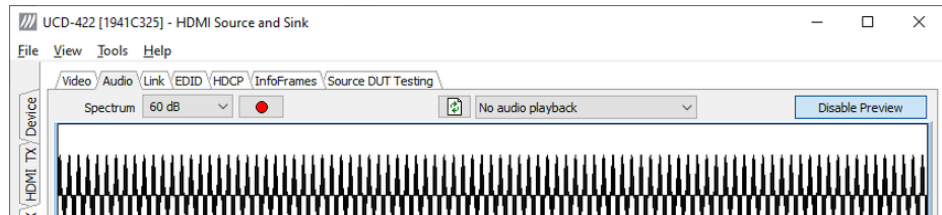
Note	Please note that the audio capabilities of the audio playback device of the PC are not automatically reflected in the audio capabilities description in UCD-422 EDID. Since UCD-422 is not performing any audio format conversion, it might occur that the source provides an audio format that the selected 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-422 unit and the PC in **Audio buffer size** 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

The captured audio can be recorded in the PC using Waveform Audio File Format, WAV (*.wav) format. The pop-up dialog defines recording duration. The folder where the audio file will be saved can be selected in File > Options.
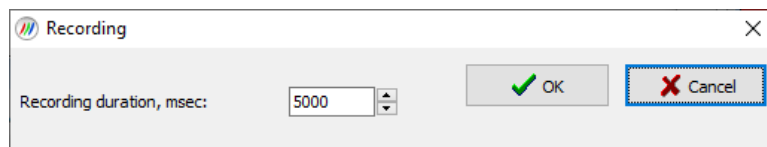
Input audio mode

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: HPD, Link Status, FRL Control and Timing.
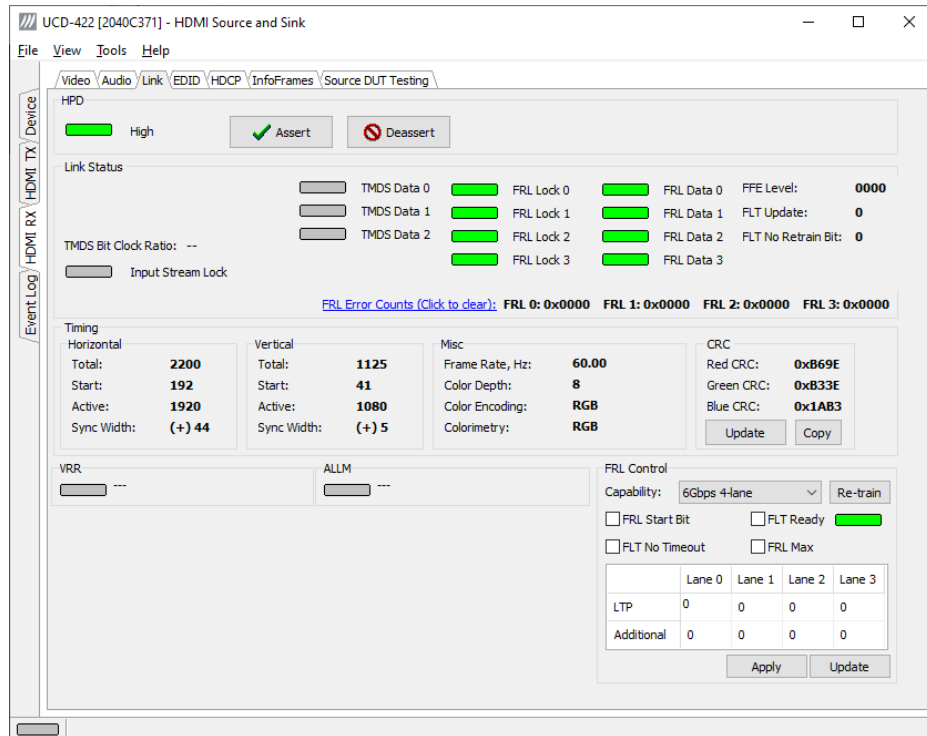
HPD

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 Asserted (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").

Link Status

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

LT Status: Status of the FRL Link Training State (only in FRL mode)

FRL Mode: Lane count and link rate configuration used in FRL mode (only in FRL mode)

TMDS Bit Clock Ratio: TMDS Bit Period / TMDS Clock Period ratio (1/10 or 1/40) (only in TMDS mode)

TMDS Data 0/1/2: Indication of data flow in TMDS links 0 to 2 (only in TMDS mode)

FRL Lock 0/1/2/3: Indication of FRL Character Lock in links 0 to 3 (only in FRL mode)

FRL Data 0/1/2/3: Indication of data flow in FRL links 0 to 3 (only in FRL mode)

FFE Level: Status of Feed Forward Equalizer Level that HDMI transmitter is using (only in FRL mode)

FLT Update: Status of the HDMI sink's FLT_update bit (1/0) (only in FRL mode)

FLT No Retrain Bit: Status of HDMI Sink's FLT_no_retrain bit (1/0) (only in FRL mode)

FLR Error Counts: Contents of the SCDSC Error counter registers.

FRL Control

Capability: Selection of the maximum link count and link rate capability of UCD-422 sink. Please **Re-train** to apply.

FRL Start Bit: Control of the HDMI sink's FRL_start bit (1/0) (only in FRL mode)

FLT Ready: Status of the HDMI sink's FLT_ready bit (1/0). Indication LED of the status. (only in FRL mode)

FLT No Timeout: Status of the HDMI sink's FLT_no_timeout bit (1/0) (only in FRL mode)

FRL Max: Status of the HDMI sink's FRL_Max bit (1/0) (only in FRL mode)

LTP: Current FRL link training pattern. Click **Update** to re-read. (only in FRL mode)

Additional: Input for user requested training pattern (1 – 8). Click **Apply** to enable request. (only in FRL mode)

Timing

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

CRC

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

VRR

Indication that Variable Refresh Rate is enabled

ALLM

Indication that Auto Low-Latency Mode is enabled

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EDID Tab

EDID Tab provides tools for accessing the EDID or DisplayID of the UCD-422 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 EDID memory of the local port

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 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. Hex EDID files can however be modified with the HEX Editor or externally generated hex EDID files that have Display ID content can be loaded and programmed into the hardware.

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. EDID contents can be edited by typing over the existing values. 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.

After editing the data can either be saved to an *.ecd file in the PC with **Save as…** or programmed it to the hardware EDID memory with **Write**.

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EDID Editor

EDID Editor is launched in a separate pop-up window. Please see the description of the EDID editor in Chapter <u>EDID Editor</u> later in this document.

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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-422 device.
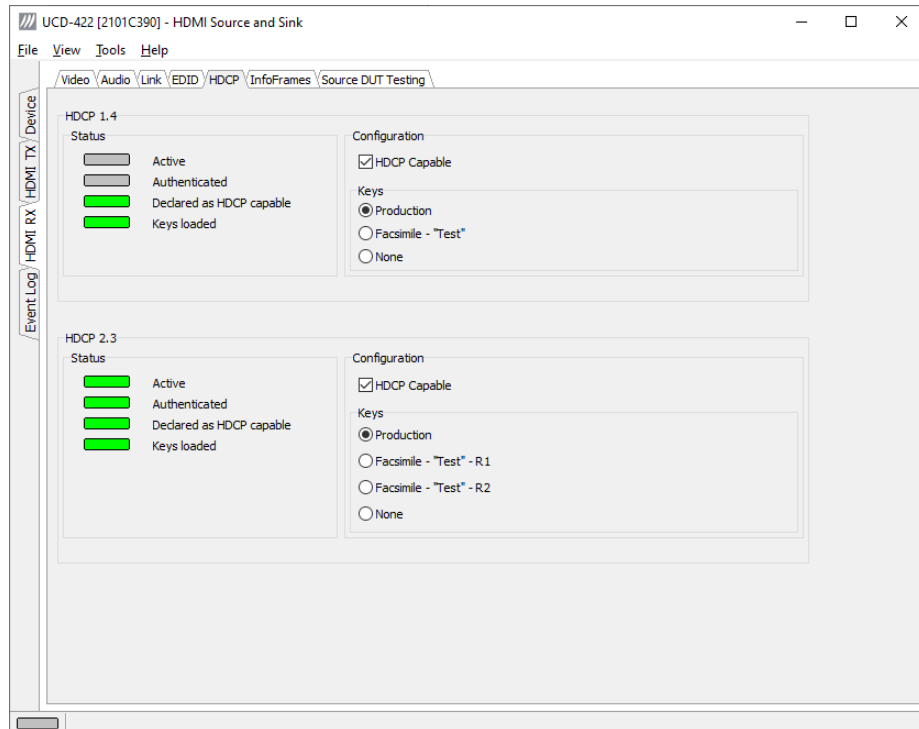
Status

The status field indicates the HDCP status of the UCD-422 device.

Active: The link between UCD-422 and the upstream source has been encrypted.

Authenticated: The HDCP handshake between the UCD-422 and the sink unit has been completed successfully.

Declared as HDCP capable: The UCD-422 unit recognizes HDCP handshake messages.

Keys loaded: The HDCP keys are loaded to the UCD-422 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 1.4 vs. HDCP 2.3

UCD-422 devices support by default both HDCP 1.4 and HDCP 2.3 standard.

| Note | Please note that when using Fixed Rate Link mode (FRL), only HDCP 2.2 / 2.3 will be used. |

InfoFrame Tab

InfoFrame Tab displays in hexadecimal format the following received infoframes:
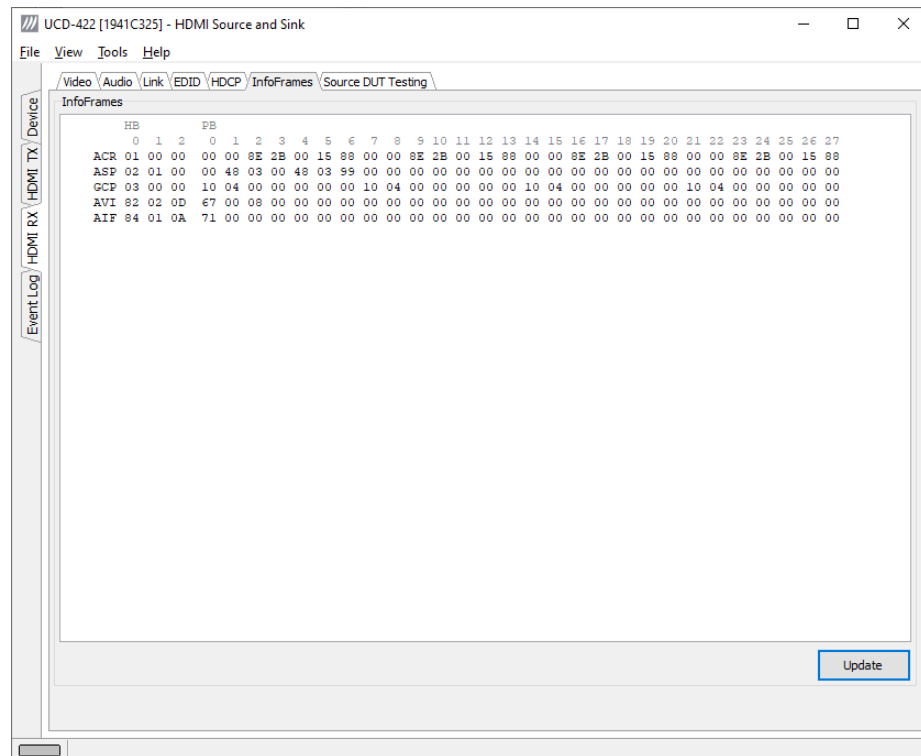
InfoFrames tab displays in hexadecimal format the following received infoframes:

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

Please click **Update** to re-read the InfoFrame data.

Source DUT Testing Tab

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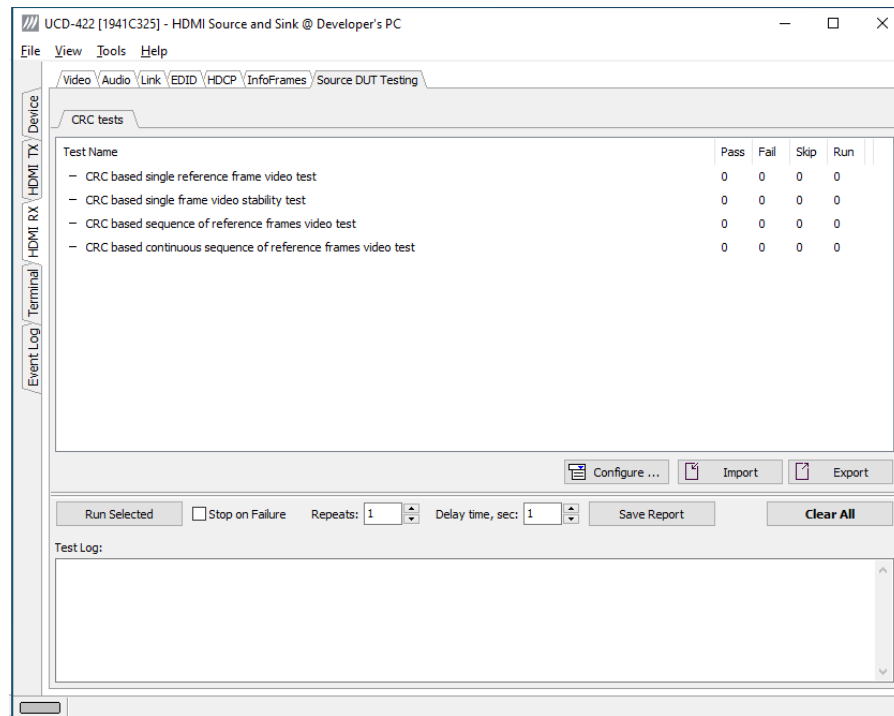
Select the tests for execution by clicking the corresponding row.

Clicking **Configure…** opens a dialog for defining the test parameters for that set. Please refer to *Test Parameters* below for description.

Parameters from *Test descriptor files* can be loaded with **Import** and stored with **Export**. Please refer to chapter *Exporting Tests for TSI* later in this document.

▶   Tests are started by clicking **Run Selected**. By clicking **Abort** the sequence is stopped.

Test flow can be controlled with **Repeats** of the test sequence, **Delay time** between individual tests or **Stop on Failure** that stops the whole sequence if one of the tests fail.

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.

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

By clicking **Clear All** the test log and the results matrix are cleared.

Test Parameters

Each test set has its dedicated set of test parameters. Open a dialog for defining the parameters by clicking **Configure…**.

Parameters of CRC Test Set

CRC Video test parameters dialog contains fields for defining the test duration, number of
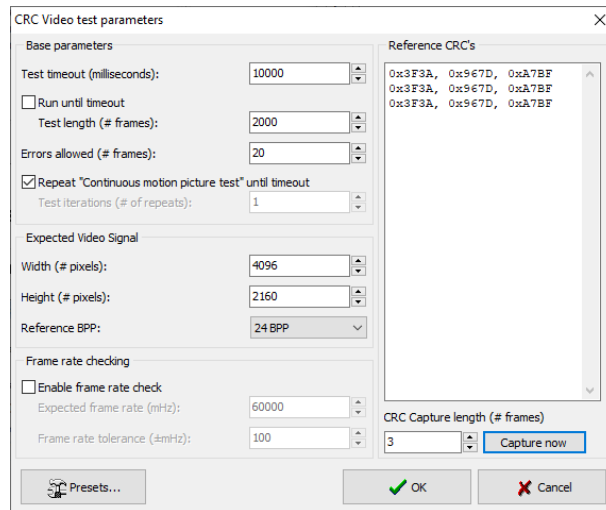
frames captured, errors allowed and expected video format.

Click **Capture now** to record *Reference CRCs.* Please define the number of frames used as reference – either one or the number of frames in the predefined test sequence.

Exporting Tests for TSI

Unigraf UCD Console includes a feature rich Software Development Kit (SDK) for use in automated testing. The SDK 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 details.

The tests included in UCD Console's Source DUT Testing tab and Sink DUT Testing tab can be executed in TSI environment. A straightforward way is to use UCD Console's *Tools > TSI Integration* dialog to create the necessary files for TSI environment and use *Export* function in *DUT Testing* tabs to include the intended tests.
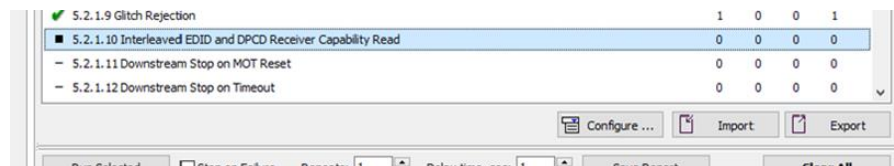
Export: Save parameters of the selected test to a file. If TSI Integration is enabled in Tools > Options, also the test is appended into 'Run Test' file in TSI workspace folder.

Import: Recall parameters from configuration file. If TSI Integration is enabled in Tools > Options, parameters are imported from a file in TSI workspace folder

7. HDMI REFERENCE SOURCE

HDMI Reference Source function (HDMI TX) can be selected from vertical tab on the left edge of the GUI.

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

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

Pattern Generator Tab
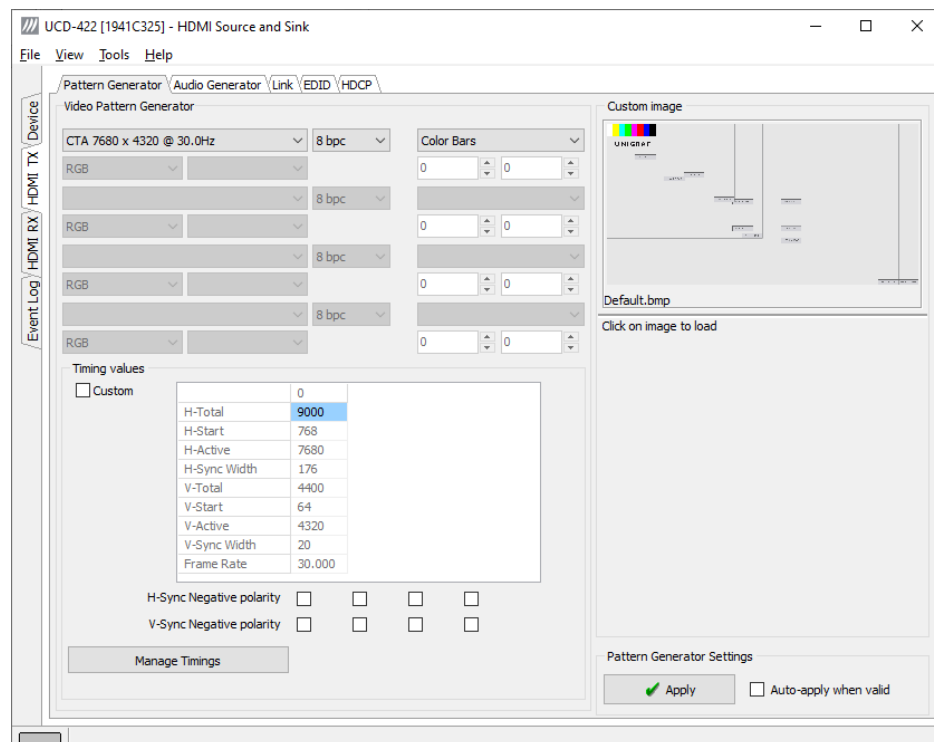
Predefined Timings

UCD-422 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.

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 and YCbCr 4:2:0 color modes. 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: 8, 10, 12 and 16 bpc. Color depth 6 bpc is only available with RGB.

Predefined Video Patterns

UCD-422 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 <u>Appendix D</u> of this document.

Custom Image Patterns

BMP, PNG, JPG and TIFF files can be loaded from the PC to be used 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.

To load a custom image, please click on the image in top right hand corner of the dialog. To enable the custom pattern, select pattern *Custom Image* in the pattern selector combo box.

Pattern Generator Settings

In order to avoid sourcing invalid video mode combinations, the new settings need to be validated by the user by clicking **Apply**. Automatic validation will be applied when **Auto-apply when valid** is checked. The situation that parameters have been changed but not applied is indicated by **bold values** of the parameter.
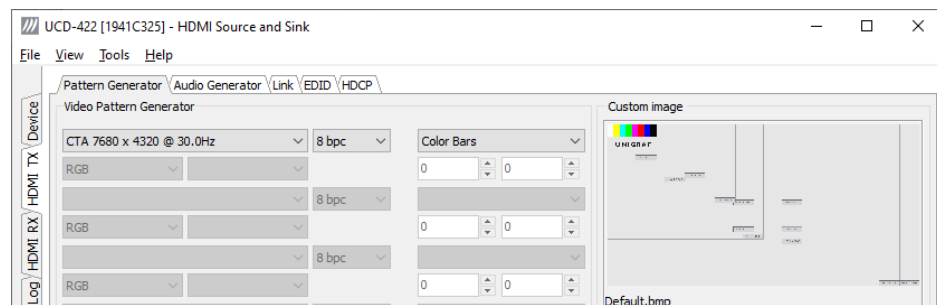
Note	Please note that the changes in Pattern Generator tab will not be applied unless the user validates them by clicking **Apply** or when **Auto-apply when valid** is checked.

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HDMI Reference Source

Custom Timing

Custom Timing feature is enabled with *UCD Pro for HDMI Source* license.
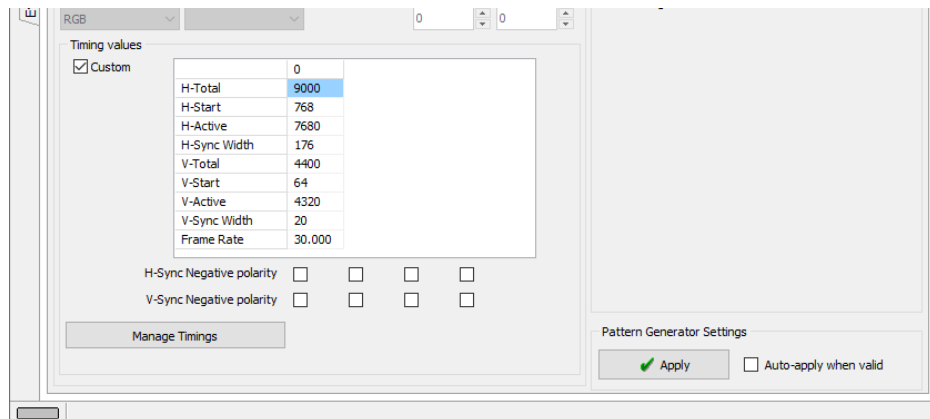
The timing parameters can be modified by selecting the **Custom** check-box and editing the fields of the matrix. Enable the new parameters by clicking **Apply** button.

Manage Timings

Custom timings can also be created and edited with pop-up *Timing Editor*. Launch the editor by clicking **Manage Timings**.
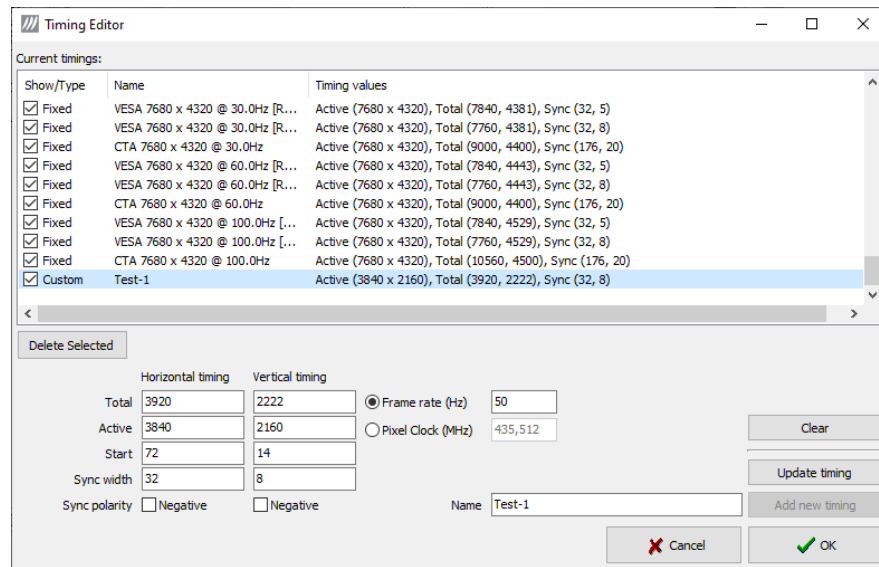
▶ In order to create a new custom timing based on one of the standard fixed, timings select the fixed timing and change its name and click **Add new timing** to store.

▶ In order to modify an existing custom timing, select it, modify and click **Update timing.**

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

Customize Timings List

The timings are shown on the pull-down menu by un-checking the **Show** box. The timings will remain in the list and can be brought back to the pull-down menu, when needed.

32.

Audio Generator Tab

Audio generator allows the user to play LPCM audio generated internally or from files in WAV format.
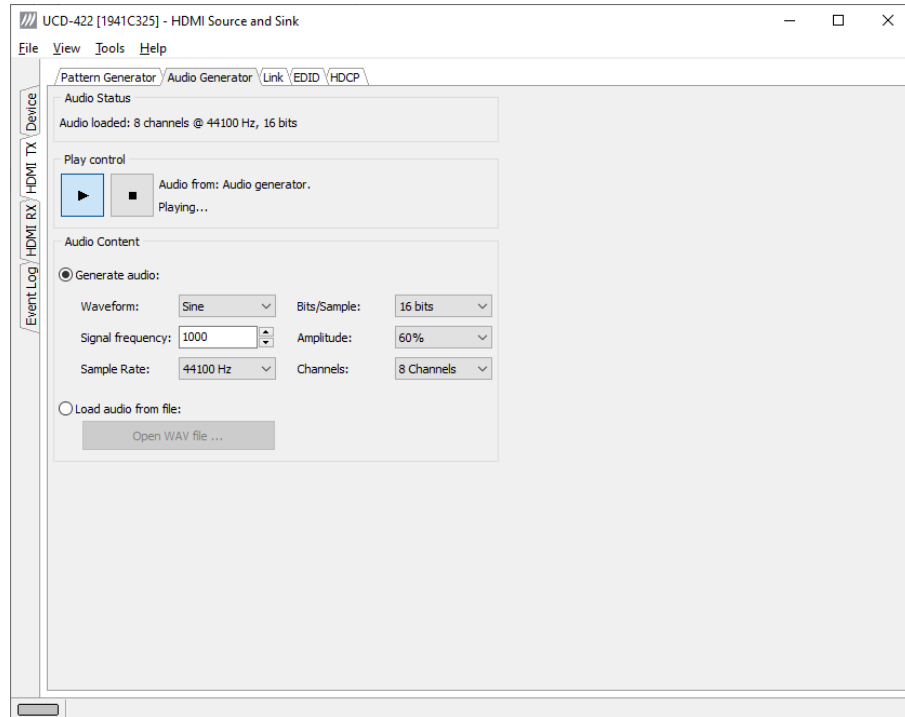
To load internally generated audio, select **Generate audio**, and adjust the controls to the desired audio format.

▶ 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.

Link Tab

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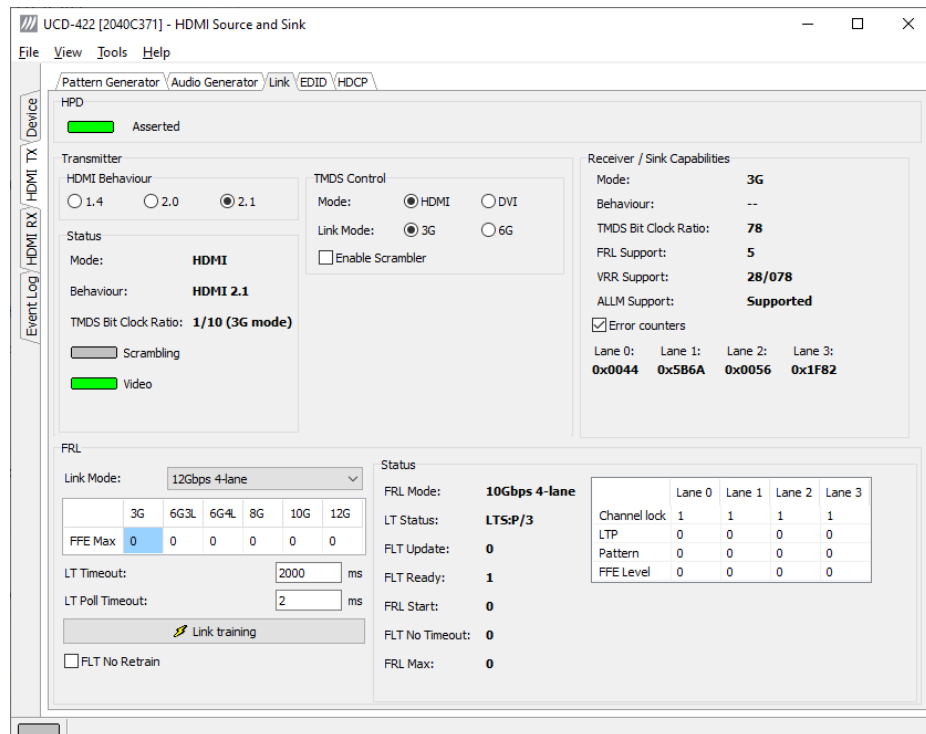
HPD

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

HDMI Behavior

Selection of the HDMI version to be used.

Status

Mode: Indication of the HDMI/TMDS mode (HDMI/DVI) (only in TMDS mode)

Behavior: Status of the HDMI Mode (HDMI 1.4 / HDMI 2.0 / HDMI 2.1).

TMDS Bit Clock Ratio: Status of (TMDS Bit Period) / (TMDS Clock Period) ratio (1/10 or 1/40) (only in TMDS mode)

Scrambling: Status of Scrambling_Enable bit (1=LED on; 0=LED off)

Receiver / Sink Capabilities

Status of connected HDMI Sink device.

Mode: Status of Max_TMDS_Character_Rate byte in the sink's VSBD

Behaviour: Used HDMI mode

TMDS Bit Clock Ratio: Status of the TMDS_Bit_Clock_Ratio (1/10 / 1/40)

FRL Support: Sink's FRL support level as indicated in sink's HF-VSDB

VRR Support: Lowest frame rate and upper limit of the frame rate that sink is able to support using Variable Refresh Rate as indicated in sink's HF-VSDB

ALLM Support: Indication of Auto Low-Latency Mode support in sink's HF-VSDB

Error counters: Check for reading sink SCDCS error counters. Results below.

FRL

Link Mode: Set the link mode used for FRL link training.

FFE Max: Set the maximum level (0 – 3) supported for each FRL rate

LT Timeout: The time used for FLT Timer (default = 2000 ms)

LT Poll Timeout: Poll interval for FLT_update flag (default = 2 ms)

Link training: Start link training with values set in this dialog.

FLT No Retrain: Set the FLT_no_retrain bit in SCDSC Sink Configuration register of the connected HDMI sink

Status

FRL Mode: FRL Mode used by UCD-422 HDMI source

LT Status: FRL link training status of UCD-422 HDMI source

FLT Update: Status of FLT_update flag in SCDSC Update Flags register of the connected HDMI sink.

FLT Ready: Status of FLT_ready flag in SCDSC Status Flags register of the connected HDMI sink.

FRL Start: Status of FLT_update flag in SCDSC Update Flags register of the connected HDMI sink.

FLT No Timeout: Status of FLT_no_timeout flag in SCDSC Source Test Configuration register of the connected HDMI sink.

FRL Max: Status of FRL_Max flag in SCDSC Source Test Configuration register of the connected HDMI sink.

Lane Status Matrix

Channel lock: Status of channel lock bits in SCDSC Status Flags register of the connected HDMI sink

LTP: Status of Lnx_LTP_req (x = 0 to 3) fields in SCDSC Status Flags register of the connected HDMI sink

Pattern: Link Training Pattern used (0 to 8)

FFE Level: FFE level used (0 to 4)

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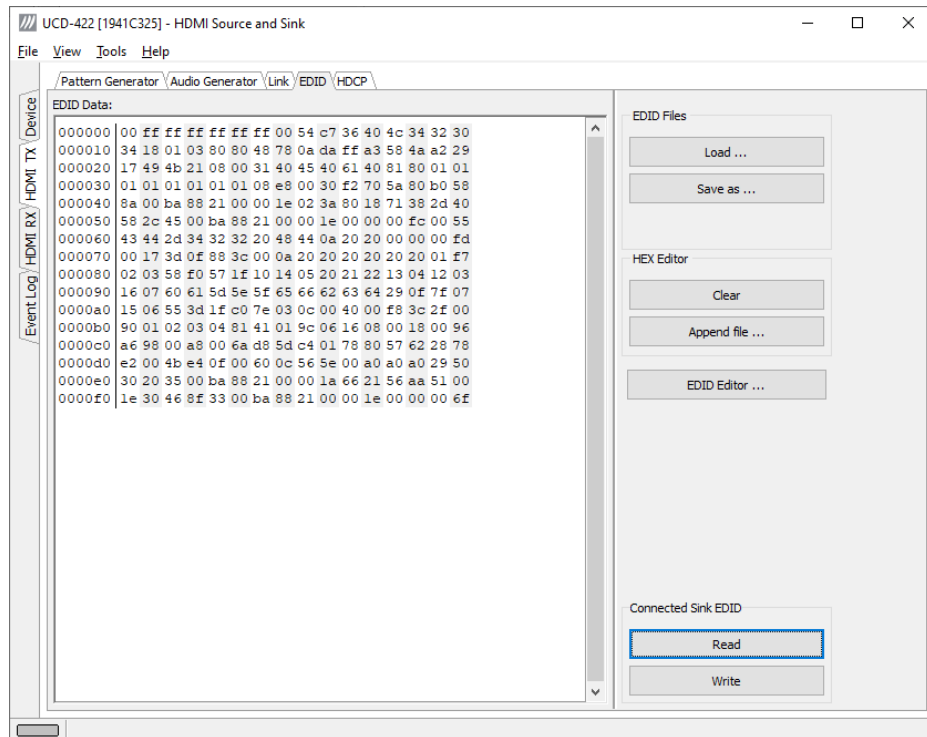
EDID tab enables analyzing and saving the EDID read from the connected Sink device.

There are three basic functions:

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

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 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. Hex EDID files can however be modified with the HEX Editor or externally generated hex EDID files that have Display ID content can be loaded and programmed into the hardware.

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. EDID contents can be edited by typing over the existing values. 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.

After editing the data can either be saved to an *.ecd file in the PC with **Save as…** or programmed it to the hardware EDID memory with **Write**.

EDID Editor

EDID Editor is launched in a separate pop-up window. Please see the description of the EDID editor in Chapter <u>EDID Editor</u> later in this document.
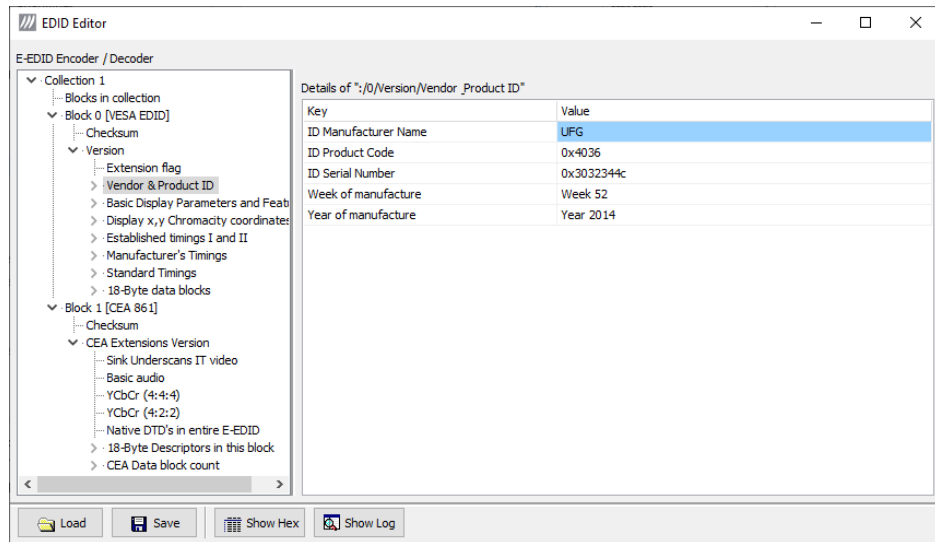
HDCP Tab

HDCP tab is the dialog for monitoring the HDCP (for High-Bandwith Digital Content Protection) Status
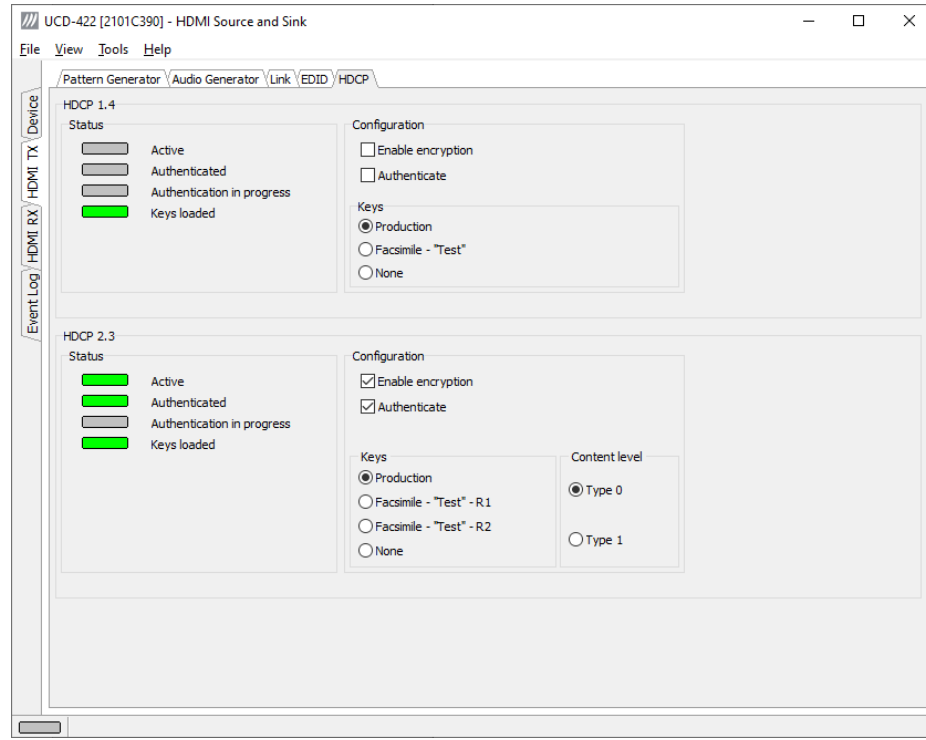
The status fields indicate the HDCP status of the connected UCD-422 device.

Active: The stream between UCD-422 and the downstream sink has been encrypted.

Authenticated: The HDCP handshake between the UCD-422 and the sink unit has been completed successfully.

Authentication in process: The HDCP handshake is in process between the UCD-422 and the downstream sink unit.

Keys loaded: The HDCP keys are loaded to the UCD-422 unit.

Configuration

Enable encryption: Check to enable the encryption of the stream between UCD-422 and the downstream sink.

Authenticate: Perform the HDCP initiation handshake between the UCD-422 and the sink unit.

Keys

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

HDCP 1.4 vs. HDCP 2.3

UCD-422 devices support by default HDCP 1.4 and HDCP 2.3.

Note	Please note that when using Fixed Rate Link mode (FRL), only HDCP 2.2 / 2.3 will be used.

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 HDMI Sink* or *UCD Pro for HDMI 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.
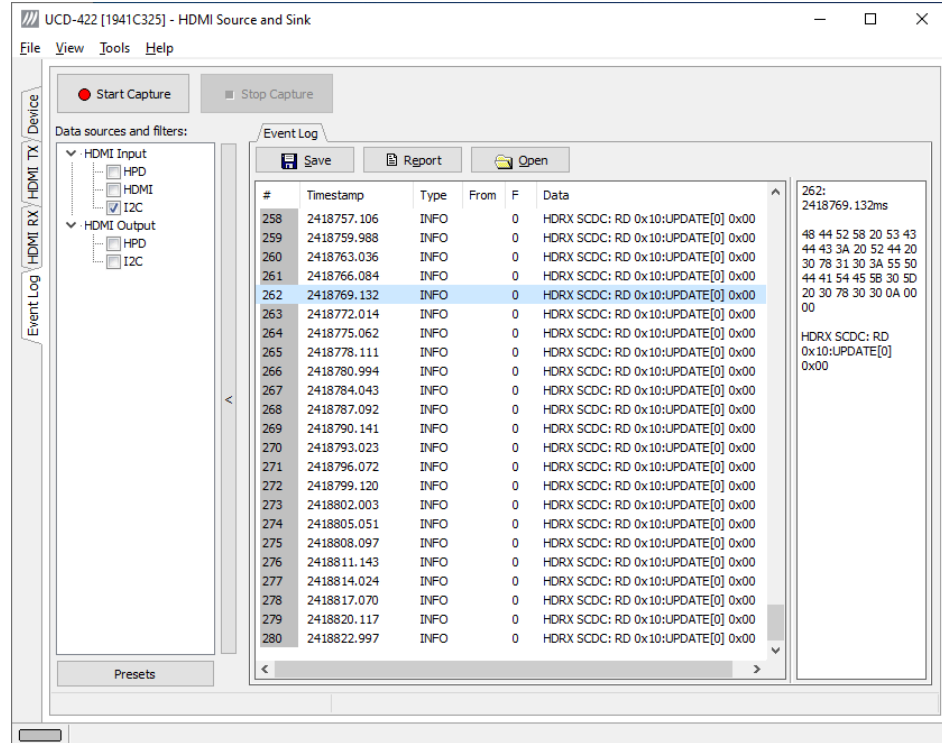
With the *Event Logger* captures the following items
- HPD status (HDMI TX and HDMI RX)
- HDMI Messages
- I2C Messages

Each item line includes Time stamp, Type indication, 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.**

▶ The transactions can be saved in binary *.evt Event Log files by clicking **Save**. Saved Event Log files can be recalled by clicking **Open**.

▶ Clicking **Report** stores event logs as html reports to be shared and viewed with any web browser. The save dialog allows inclusion of detailed information about the DUT and the test in free-text *Report information*.

9. EDID EDITOR

The *EDID Editor* main window is divided into three logical areas. The bottom part of the
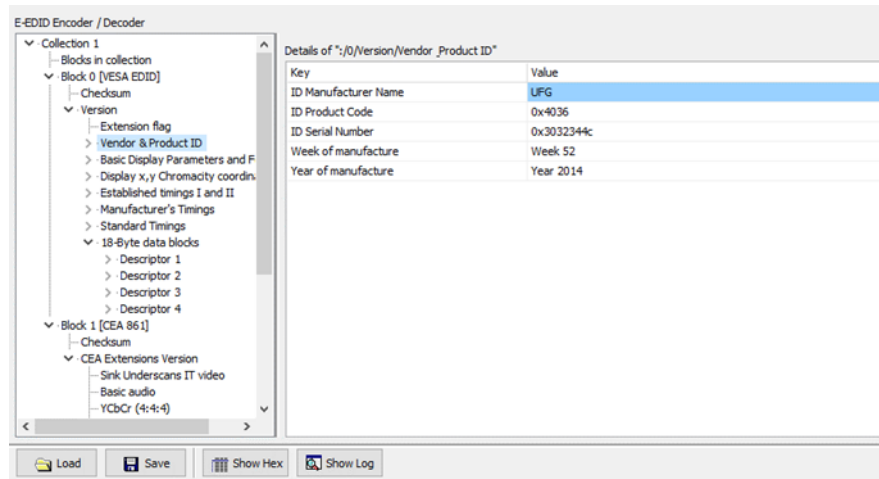
window contains the command buttons, and the log view. The top-left portion shows the currently edited E-EDID blocks in a tree-form, and the top-right portion shows an edit control for the currently selected item, possibly a list of sub-keys and their names (The list is not shown for all values) and 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-422

Input	HDMI 2.1 (10K@30Hz) (HDMI Rx)
Output	HDMI 2.1 (10K@30Hz) (HDMI Tx)
HDMI 2.1 Features	FRL, TMDS, ALLM, VRR
Content Protection	HDCP 1.4, HDCP 2.2, HDCP 2.3
Additional features	eARC*, DSC*, FEC*
Computer interface	USB 3.0
Operating System	Windows 10, 8 and 7
Software	UCD Console GUI TSI API with interface specific Test Sets
Power supply	AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +12 Vdc output)
Mechanical Size	311 × 197 × 65 mm
Weight	1.2 kg w/o power supply

*) Please contact Unigraf for detailed availability

APPENDIX B. LICENSING

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.

HDMI Reference Sink (HDMI RX)

Tab	Function	Basic	DSC Decoder
Video			
	Preview, Capture, Snap preview	●	
	Status	●	
Audio		●	
	Monitor, Capture and graphical preview	●	
	Status	●	
Link		●	
	Link Status, Link Configuration	●	
	Stream Status (video, audio)	●	
	HPD Status, HPD Assert / De-assert	●	
	DSC Decoder		○
EDID			
	Read / Write, Save / Load, EDID Editor	●	
HDCP			
	HDCP 1.4 and HDCP 2.3 Support	○	
	Authentication status, Encryption status	○	
Event Log			
	Event Log	●	
Source DUT Testing			

● Feature available

○ To be introduced later

HDMI Reference Source (HDMI TX)

Tab	Function	Basic	DSC Encoder
Pattern Generator			
	Fixed and custom Video Timings	●	
	Fixed and custom Video Patterns	●	
Audio Generator			
	Play audio files	●	
Link			
	Link Status	●	
	HPD Status: (Asserted / De-asserted)	●	
	Link Configuration	●	
	DSC Encoder		○
EDID			
	Read / Write, Save / Load, EDID Editor	●	
HDCP			
	HDCP 1.4 Support	○	
	Control: (Enable / Disable, authenticate only, Encryption Enable / Disable)	○	
	Status: (Authentication status, Encryption status)	○	
	HDCP 2.3 Support	○	
Event Log			
	Event Log	●	
Sink DUT Testing		○	

● Feature available

○ To be introduced later

APPENDIX C: PREDEFINED TIMINGS

Supported FRL Lane Combination

Description	H active	V active	H total	V total	Frame rate	8 bpc YcbCr 4:2:0	10 bpc YcbCr 4:2:0	12 bpc YcbCr 4:2:0	8 bpc 4:2:2 4:4:4	10 bpc 4:2:2 4:4:4	12 bpc 4:2:2 4:4:4
VESA 800 x 600 @ 60Hz	800	600	1056	628	60				3G	3G	3G
VESA 848 x 480 @ 60Hz	848	480	1088	517	60				3G	3G	3G
VESA 1024 x 768 @ 60Hz	1024	768	1344	806	60				3G	3G	3G
CTA 1280 x 720 @ 60Hz	1280	720	1650	750	60				3G	3G	3G
VESA 1280 x 768 @ 60Hz	1280	768	1664	798	60				3G	3G	3G
VESA 1280 x 960 @ 60Hz	1280	960	1800	1000	60				3G	3G	3G
VESA 1280 x 800 @ 60Hz [RB]	1280	800	1440	823	60				3G	3G	3G
VESA 1280 x 800 @ 60Hz	1280	800	1680	831	60				3G	3G	3G
VESA 1280 x 768 @ 60Hz	1280	768	1440	790	60				3G	3G	3G
VESA 1280 x 1024 @ 60Hz	1280	1024	1688	1066	60				3G	3G	3G
VESA 1360 x 768 @ 60Hz	1360	768	1792	795	60				3G	3G	3G
VESA 1400 x 1050 @ 60Hz	1400	1050	1560	1080	60				3G	3G	3G
VESA 1600 x 1200 @ 60Hz [RB]	1600	1200	1760	1235	60				3G	3G	3G
VESA 1600 x 1200 @ 60Hz	1600	1200	2160	1250	60				3G	3G	3G
VESA 1680 x 1050 @ 60Hz	1680	1050	2240	1089	60				3G	3G	3G
VESA 1680 x 1050 @ 60Hz [RB]	1680	1050	1840	1080	60				3G	3G	3G
VESA 1792 x 1344 @ 60Hz	1792	1344	2448	1394	60				3G	3G	3G
VESA 1920 x 1080 @ 30Hz [RB1]	1920	1080	2080	1096	30				3G	3G	3G
VESA 1920 x 1080 @ 30Hz [RB2]	1920	1080	2000	1096	30				3G	3G	3G
CTA 1920 x 1080 @ 30Hz	1920	1080	2200	1125	30				3G	3G	3G
VESA 1920 x 1080 @ 60Hz [RB1]	1920	1080	2080	1111	60				3G	3G	3G
VESA 1920 x 1080 @ 60Hz [RB2]	1920	1080	2000	1111	60				3G	3G	3G
CTA 1920 x 1080 @ 60Hz	1920	1080	2200	1125	60				3G	3G	3G
VESA 1920 x 1080 @ 120Hz [RB1]	1920	1080	2080	1144	120			3G	3G	3G	6G3L
VESA 1920 x 1080 @ 120Hz [RB2]	1920	1080	2000	1144	120			3G	3G	3G	6G3L
CTA 1920 x 1080 @ 120Hz	1920	1080	2200	1125	120			3G	3G	6G3L	6G3L
VESA 1920 x 1440 @ 60Hz	1920	1440	2600	1500	60				3G	3G	3G
VESA 2048 x 1536 @ 60Hz	2048	1536	2208	1580	60				3G	3G	3G
VESA 2560 x 1440 @ 60Hz	2560	1440	2720	1481	60				3G	3G	3G
VESA 2560 x 1080 @ 60Hz	2560	1080	3424	1120	60				3G	3G	3G
VESA 2560 x 1080 @ 60Hz [RB]	2560	1080	2720	1111	60				3G	3G	3G
VESA 2560 x 1600 @ 60Hz	2560	1600	3504	1658	60		3G	3G	6G3L	6G3L	6G3L
VESA 2560 x 1600 @ 60Hz [RB]	2560	1600	2720	1646	60			3G	3G	3G	6G3L
Other 2880 x 1440 @ 60Hz	2880	1440	2976	1456	60				3G	3G	3G
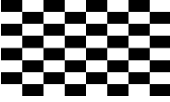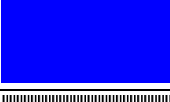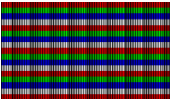
3G	3 Gbps 3 Lanes
6G3L	6 Gbps 3 Lanes

Supported FRL Lane Combination (contd.)

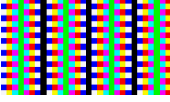| Description	H active	V active	H total	V total	Frame rate	8 bpc YcbCr 4:2:0	10 bpc YcbCr 4:2:0	12 bpc YcbCr 4:2:0	8 bpc 4:2:2 4:4:4	10 bpc 4:2:2 4:4:4	12 bpc 4:2:2 4:4:4
VESA 4096 x 2160 @ 60Hz	4096	2160	4176	2222	60	3G	6G3L	6G3L	6G3L	6G3L	6G4L
VESA 3840 x 2160 @ 30Hz [RB1]	3840	2160	4000	2191	30				3G	3G	3G
VESA 3840 x 2160 @ 30Hz [RB2]	3840	2160	3920	2191	30				3G	3G	3G
CTA 3840 x 2160 @ 30Hz	3840	2160	4400	2250	30				3G	6G3L	6G3L
CTA 3840 x 2160 @ 50Hz	3840	2160	5280	2250	50	3G	6G3L	6G3L	6G3L	6G4L	6G4L
CTA 4096 x 2160 @ 50Hz	4096	2160	5280	2250	50	3G	6G3L	6G3L	6G3L	6G4L	6G4L
VESA 3840 x 2160 @ 60Hz [RB1]	3840	2160	4000	2222	60	3G	3G	6G3L	6G3L	6G3L	6G3L
VESA 3840 x 2160 @ 60Hz [RB2]	3840	2160	3920	2222	60	3G	3G	6G3L	6G3L	6G3L	6G3L
CTA 3840 x 2160 @ 60Hz	3840	2160	4400	2250	60	3G	6G3L	6G3L	6G3L	6G4L	6G4L
CTA 4096 x 2160 @ 60Hz	4096	2160	4400	2250	60	3G	6G3L	6G3L	6G3L	6G4L	6G4L
VESA 3840 x 2160 @ 120Hz [RB1]	3840	2160	4000	2287	120	6G3L	6G4L	6G4L	8G	8G	10G
VESA 3840 x 2160 @ 120Hz [RB2]	3840	2160	3920	2287	120	6G3L	6G4L	6G4L	8G	8G	10G
CTA 3840 x 2160 @ 120Hz	3840	2160	4400	2250	120	6G3L	6G4L	6G4L	8G	10G	
VESA 5120 x 2160 @ 30Hz [RB1]	5120	2160	5280	2191	30				6G3L	6G3L	6G3L
VESA 5120 x 2160 @ 30Hz [RB2]	5120	2160	5200	2191	30				6G3L	6G3L	6G3L
CTA 5120 x 2160 @ 30Hz	5120	2160	6000	2200	30				6G3L	6G3L	6G3L
VESA 5120 x 2160 @ 60Hz [RB1]	5120	2160	5280	2222	60	6G3L	6G3L	6G3L	6G4L	6G4L	6G4L
VESA 5120 x 2160 @ 60Hz [RB2]	5120	2160	5200	2222	60	6G3L	6G3L	6G3L	6G4L	6G4L	6G4L
CTA 5120 x 2160 @ 60Hz	5120	2160	5500	2250	60	6G3L	6G3L	6G3L	6G4L	8G	8G
VESA 5120 x 2160 @ 120Hz [RB1]	5120	2160	5280	2287	120	6G4L	8G	8G			
VESA 5120 x 2160 @ 120Hz [RB2]	5120	2160	5200	2287	120	6G4L	8G	8G			
CTA 5120 x 2160 @ 120Hz	5120	2160	5500	2250	120	6G4L	8G	8G			
Other 5120 x 2880 @ 60Hz	5120	2880	5280	2962	60	6G3L	6G3L	6G4L	8G	8G	8G
VESA 7680 x 4320 @ 30Hz [RB1]	7680	4320	7840	4381	30	6G3L	6G3L	6G4L	8G	8G	10G
VESA 7680 x 4320 @ 30Hz [RB2]	7680	4320	7760	4381	30	6G3L	6G3L	6G4L	8G	8G	10G
CTA 7680 x 4320 @ 30Hz	7680	4320	9000	4400	30	6G3L	6G4L	6G4L	8G	10G	
VESA 7680 x 4320 @ 60Hz [RB1]	7680	4320	7840	4443	60	8G	10G	12G			
VESA 7680 x 4320 @ 60Hz [RB2]	7680	4320	7760	4443	60	8G	10G	12G			
CTA 7680 x 4320 @ 60Hz	7680	4320	9000	4400	60	8G	10G	12G			
VESA 7680 x 4320 @ 100Hz [RB1]	7680	4320	7840	4529	100	12G					
VESA 7680 x 4320 @ 100Hz [RB2]	7680	4320	7760	4529	100	12G					
CTA 7680 x 4320 @ 100Hz	7680	4320	10560	4500	100						

3G	3 Gbps 3 Lanes
6G3L	6 Gbps 3 Lanes
6G4L	6 Gbps 4 Lanes
8G	8 Gbps 4 Lanes
10G	10 Gbps 4 Lanes
12G	12 Gbps 4 Lanes

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*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)
White Square		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).
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, Unigraf test image will be used.

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

APPENDIX E: SOURCE DUT TESTS

CRC Based Video Test Set – HDMI 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.