# UCD Console for UCD-422



# **User Manual**



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## **Company Information**

Unigraf Oy

Piispantilankuja 4 FI-02240 ESPOO Finland

Tel. +358 9 859 550

mailto:info@unigraf.fi

https://www.unigraf.fi

http://www.unigraf-china.cn

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UCD-422 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.

UNIGRAF UCD Console for UCD-422 User Manual

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## 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**

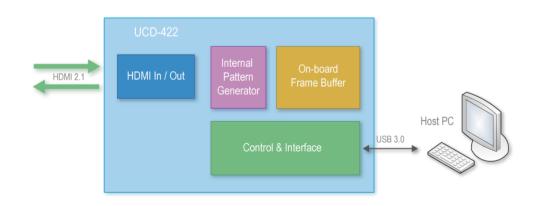
- High resolution video and audio capture up to 10k30Hz, 8k60Hz, 4K/UHD 120 Hz
- Supports FRL
- Supports Auto Low Latency Mode (ALLM) and Variable Refresh rate (VRR)
- Compatible with HDCP versions 1.4 and 2.3
- 2 GB on-board high-speed video buffer
- High speed USB 3.0 host PC interface

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.

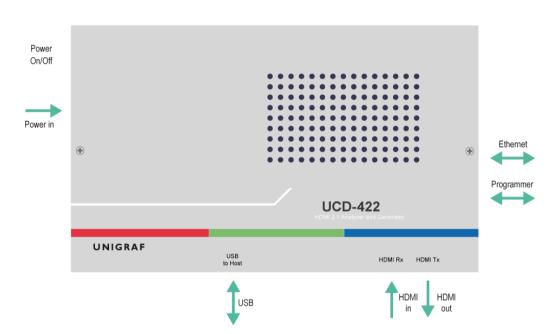
Please find below logical diagram of UCD-422 unit



Introduction

### 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.

#### Introduction

### UNIGRAF

## 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 <u>https://www.unigraf.fi/support/download-links</u>. 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.

🧶 Unigraf - License Manager				- • ×
		Please, Select device far	mily	
	<u>www.uniqraf.fi</u>		About version 1.0 [R1]	

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.

🕖 Unigraf - License Manager	
A Back	License management for UCD-1, UCD-2, UCD-3xx Devices
Attached Devices:	
UCD-323 [7037AD960000008C] SW Emulated device [EMUU01]	Select a device to edit licenses
Refresh	

The **Back** button opens the device family selection screen. The **Refresh** button will re-scan the system for installed hardware.

### Managing Licenses

d Back		License management for UCD-1, UCD-2, UCD-3xx Devic
Attached Devices:	Enter new license for device wit	h seed number <u>700399700000066</u> :
JCD-422 [1941C325] SW Emulated device [EMU001]	Installed licenses:	Install
	License	Кеу
	UCD Pro for DP Sink UCD Pro for DP Source HDCP 2.2 Support	AQR0-640 NPW6-12-442 R6EQ-C
(†) Refresh	Import	🔄 Export

#### 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**.

UCD Configuration Utility			×
			×
Pleas	e click Next to upda	te your UCD device.	
Available Firmwar	e Packages	Included components	:
Device UCD-3xx UCD-4xx DP UCD-4xx HDMI	Firmware 0.0.23 2.1.0/1.9.30	UX 2.3.0 UF 1.3.4 BF 1.1.3/1.4.3 PD 0.0.15 PX 0.0.1	
J			
	<	Back Next >	Cancel

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

UCD Configuration Utility Connected UCD Devices Please select the device		× ///
Multple UCD dev applications durin	UCD-3xx devices UCD-400 (19390-320) LCD-400 (19390-320) ices found. Make sure not to run other Unigraf g configuration.	
	< <u>B</u> ack <u>N</u> ext >	Cancel

### **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.

- UCD Mod		pdated are checked		
				///
	evice: UCD-424 [19	950C336]		
Module	New	Existing	Comment	
UX 🔽	2.2.2	2.0.1	To be updated	
UF UF	1.3.4	1.3.1	To be updated	
🗆 BF	1.1.3/1.4.3	2.0.1/1.9.27	No update needed	
PX PX	0.0.1	0.0.0	To be updated	
MC MC	0.21.45	0.0.2	To be updated	
			< Back	Cancel



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.

Attention	×
- Power OFF the device - Wait for 10 seconds. - Power ON the device	e.
OK	
	Please do the followin - Power OFF the device - Wait for 10 seconds Power ON the device - Press OK when done

ъ т		
N	oter	
ΤN	on.	

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

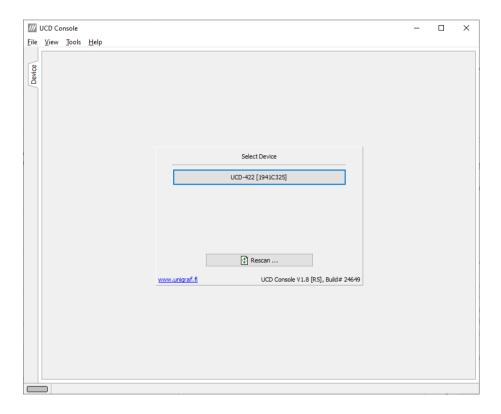
## 5. UCD CONSOLE

*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.

_		325] - HDMI Source	and Sink				- 🗆 X
<u>F</u> ile	View Tools	Help	or \Link \EDID				
Device	Video Pattern	Generator					Custom image
	CTA 1920 x 1	1080 @ 60.0Hz	∨ 8 b	x v	Color Bars	$\sim$	UNIGRAF
¥	RGB	$\sim$	$\sim$		0 • 0	A V	
IMOH			∨ 8 bj	oc 🗸 🗸		$\sim$	
KX	RGB	$\sim$	$\sim$		0 • 0	A V	
IWOH			∨ 8 bj	oc 🗸 🗸		$\sim$	
[]	RGB	$\sim$	$\sim$		0 • 0	A V	
ent L			<ul> <li>✓ 8 b)</li> </ul>	oc 🗸		$\sim$	Click op impege to load

## Options

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

tions				
ideo, Audio and Mi	sc options			
Image File Forma	t			
PPM	○ BMP	⊖ JPG		
Audio File Format				
• WAV				
Audio Buffer size				
Main buffer, Ksan	nples 16	Playback buffer, Ksa	mples	4
Folders				
Directory to save	images and audio			
C:\Users\Tester\	Pictures		- <mark>1</mark> 8:: E	Browse
Presets directory				
			- <mark>1</mark> 8:: E	Browse
DSC				
DSC Work folder				
C:\Temp\DSC			<b>1</b> 8: 6	Browse
DSC test content	directory			
E:\DSC_content_	library\		<b>1</b> 8: 6	Browse
Automatically	create missing contents			
Keep auto-	created DSC content file	s		
Misc. options				
Apply colour o	onversion to saved image	es		
Bypass 4:2:x	> 4:4:4 conversions			
The monitor is	not HDCP protected.			
TSI Integration				
Enable TSI Int	egration			
Select when to	append exported DUT t	test to 'RunTest' scrip	t	
Always apper	id when exporting to a n	ew file		$\sim$

### 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**

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

<u>Bypass 4:2:x  $\rightarrow$  4:4:4 conversions</u>: 4:2:2 and 4:2:0 images are previewed and stored as received, without pixel doubling.

<u>HDCP protected monitor</u>: 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*  $\rightarrow$  *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.

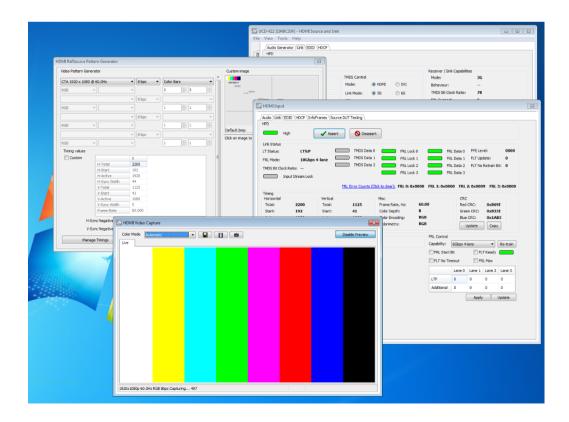
Workspace folder:		
C: \Users\Tester \Desktop \TSI	1	
Use TSI x64 (64-bit)	O Use TSI x86 (32-bit)	
Create / Update 'init.tsi' file		
Select a TE device + role to	be used as 'sourcedevice' in scripts	
Select a TE device + role to No source device		
No source device		

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.



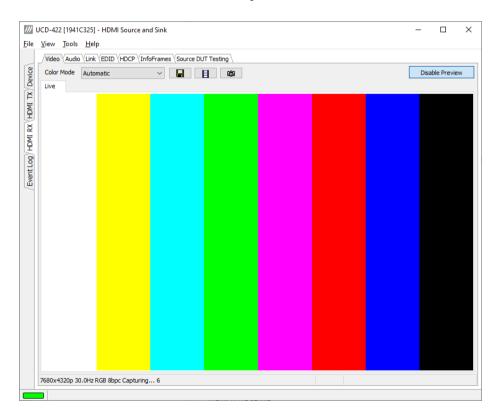
## 6. HDMI REFERENCE SINK

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

7680x4320p 30.0Hz RGB 8bpc Capturing... 19

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.



The top ribbon of the tab has the following controls:

#### **Color Mode for preview**

YCbCr (ITU-709) -> RGB ~

- 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.

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

#### Sequence recording



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

Recording			×
Number of frames to record:	5 🔺 🗹 Buffered	🗸 ок	🗶 Cancel
Capacity of the buffer: 9 fram	es		

In buffered mode, all input frames are captured non-drop until the on-board frame buffer will be full. The dialog also informs the capacity of the buffer with the selected video mode.

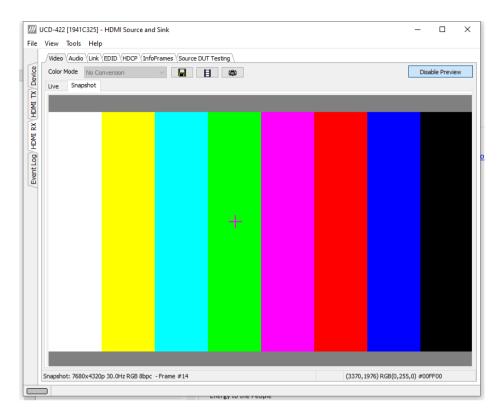
In non-buffered mode, only one input frame is buffered at a time. Frames will be skipped if the transfer of the data to the PC is slower than the input data rate.

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

#### Snap preview



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

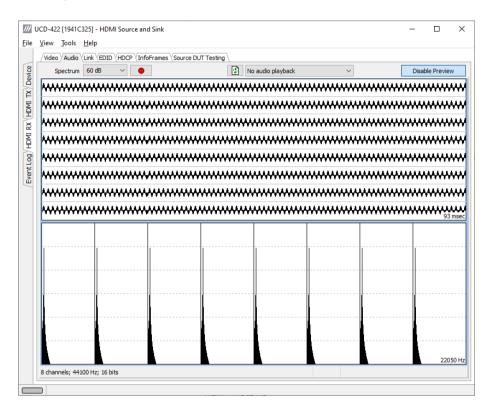
Zoom of the Preview Image can be altered by right clicking on top of the preview image and selecting between

- 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.

/// Eile	UCD-422 [1941C325] - HDMI Source and Sink View Tools Help			-		×
Device	/Video / Audio / Link \EDID \HDCP \InfoFrames \Source E Spectrum 60 dB V	DUT Testing \	~	Disa	ble Preview	1
HDMI TX/Dev						
E		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		1000000	mm	m

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.

Mecording		×
Recording duration, msec:	5000	✓ OK X Cancel

#### 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

/// UCD-422 [2040C371] - HDMI Source and Sink  $\times$ File View Tools Help Video Audio Link EDID HDCP InfoFrames Source DUT Testing HPD Device 🚫 Deassert Hiah 🖌 Assert ř Link Status IMOH TMDS Data 0 ERL Lock 0 FRL Data 0 FFE Level: 0000 TMDS Data 1 FRL Lock 1 FRL Data 1 FLT Lindate: n HDMI RX TMDS Data 2 FRL Lock 2 FRL Data 2 Ē FLT No Retrain Bit: TMDS Bit Clock Ratio: FRL Lock 3 FRL Data 3 Input Stream Lock Event Log FRL Error Counts (Click to clear): FRL 0: 0x0000 FRL 1: 0x0000 FRL 2: 0x0000 FRL 3: 0x0000 Timing Vertical CRC Horizontal Misc 2200 1125 Frame Rate, Hz: 60.00 Total: Total: Red CRC: 0xB69E Start: 192 Start: 41 Color Depth: 8 Green CRC: 0xB33E Active: 1920 Active: 1080 Color Encodina: RGB Blue CRC: 0x1AB3 Sync Width: (+) 44 Sync Width: (+)5 Colorimetry: RGB Update Сору ALLM FRL Contro Ē Ē Capability: 6Gbps 4-lane ✓ Re-train FRL Start Bit FLT Ready FLT No Timeout FRL Max Lane 0 Lane 1 Lane 2 Lane 3 0 0 0 0 LTP Additional 0 0 0 0 Apply Update

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

## 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

		i25] - HDMI Source and Sink	_	
<u>F</u> ile	<u>V</u> iew <u>T</u> ools	<u>H</u> elp		
	/Video Audio	Link / EDID \/HDCP \/InfoFrames \/Source DUT Testing \		
Device	EDID Data:		EDID Files	
D	000000 00	ff ff ff ff ff ff 00 54 c7 36 40 4c 34 32 30	LEDID THES	
	000010 34	18 01 03 80 80 48 78 0a da ff a3 58 4a a2 29	Load	
HDMI RX HDMI TX		49 4b 21 08 00 31 40 45 40 61 40 81 80 01 01		
豆		01 01 01 01 01 08 e8 00 30 f2 70 5a 80 b0 58 00 ba 88 21 00 00 1e 02 3a 80 18 71 38 2d 40	Save as	
X		2c 45 00 ba 88 21 00 00 1e 02 3a 80 18 71 38 2d 40		
1		44 2d 34 32 32 20 48 44 0a 20 20 00 00 00 fd		
Ē	000070 00	17 3d 0f 88 3c 00 0a 20 20 20 20 20 20 01 f7	HEX Editor	
8		03 58 f0 57 1f 10 14 05 20 21 22 13 04 12 03		
Event Log		07 60 61 5d 5e 5f 65 66 62 63 64 29 0f 7f 07 06 55 3d 1f c0 7e 03 0c 00 40 00 f8 3c 2f 00	Clear	
ver		01 02 03 04 81 41 01 9c 06 16 08 00 18 00 96	Append file	
		98 00 a8 00 6a d8 5d c4 01 78 80 57 62 28 78	Append file	
		00 4b e4 0f 00 60 0c 56 5e 00 a0 a0 a0 29 50		
		20 35 00 ba 88 21 00 00 1a 66 21 56 aa 51 00 30 46 8f 33 00 ba 88 21 00 00 1e 00 00 00 6f	EDID Editor	
		v	Sink EDID Read Write	

#### **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.

Collection 1     Blocks in collection	Details of ":/0/Version/Vendor Produ	ct ID"	
<ul> <li>Block 0 [VESA EDID]</li> </ul>	Key	Value	
Checksum	ID Manufacturer Name	UFG	
✓ Version	ID Product Code	0x4036	
- Extension flag	ID Serial Number	0x3032344c	
> Vendor & Product ID	Week of manufacture	Week 52	
<ul> <li>Basic Display Parameters and F</li> <li>Display x, y Chromacity coordination</li> </ul>	Year of manufacture	Year 2014	
<ul> <li>Established timings I and II</li> <li>Manufacturer's Timings</li> </ul>			
> Standard Timings			
<ul> <li>18-Byte data blocks</li> <li>Descriptor 1</li> </ul>			
> Descriptor 2			
> Descriptor 3			
> Descriptor 4			
<ul> <li>Block 1 [CEA 861]</li> </ul>			
Checksum			
✓ Checksum ✓ · CEA Extensions Version			
<ul> <li>CEA Extensions Version</li> <li>Sink Underscans IT video</li> <li>Basic audio</li> </ul>			
<ul> <li>CEA Extensions Version</li> <li>Sink Underscans IT video</li> <li>Basic audio</li> </ul>			

## 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.

:	_	×
es \Source DUT Testing \		
Configuration / HDCP Capable Keys Production Facsimile - "Test" None		
Configuration HDCP Capable Keys Production Faccimile - "Test" - R1 Faccimile - "Test" - R2		
() None		
Production     OFacsimile - "Test" - R1		

#### 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:

<u>V</u> iew	Too	s	<u>H</u> elp	0																						
/Vide	o Auc	dio (	Link	EDI	D (H	DCP	Inf	foFra	mes	So	urce	DU	T Tes	sting	7											
Info	Frames	;																								
		HB			PB																					
		0	1	2		1	2	3	4	5	6	7	8										26			
	ACR																						15			
	ASP GCP				10																		00			
	AVI				67																					
	AIF																									
																										-
																								l	Update	
																										1

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.

<i>///</i> uc	D-422 [1941C325] - HDMI Source and Sink @ Developer's PC		-	-		Х
<u>File</u> <u>V</u>	(iew <u>T</u> ools <u>H</u> elp					
	Video (Audio (Link (EDID (HDCP (InfoFrames))Source DUT Testing					
Device	CRC tests					
	Test Name	Pass	Fail	Skip	Run	
Ma	<ul> <li>CRC based single reference frame video test</li> </ul>	0	0	0	0	
핏	<ul> <li>CRC based single frame video stability test</li> </ul>	0	0	0	0	
8	<ul> <li>CRC based sequence of reference frames video test</li> </ul>	0	0	0	0	
É	<ul> <li>CRC based continuous sequence of reference frames video test</li> </ul>	0	0	0	0	
i i i						
5.						
l 2						
vent						
Ľ.						
	E Configure	Impor	t	[]	Export	
	Run Selected Stop on Failure Repeats: 1 💌 Delay time, sec: 1 🔹 Save Report			Clea	ar All	
т	est Log:					
						^
						$\sim$

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

CRC Video test parameters						×
Base parameters			Reference	e CRC's		
Test timeout (milliseconds):	10000	* *			), 0xA7BF	$\sim$
Run until timeout					), 0xA7BF ), 0xA7BF	
Test length (# frames):	2000	•				
Errors allowed (# frames):	20	-				
Repeat "Continuous motion picture to	est" until timeout					
Test iterations (# of repeats):	1	A V				
Expected Video Signal						
Width (# pixels):	4096	•				
Height (# pixels):	2160	<b>A</b>				
Reference BPP:	24 BPP	$\sim$				
Frame rate checking						
Enable frame rate check						$\sim$
Expected frame rate (mHz):	60000	* *	CRC Capt	ure length	(# frames)	
Frame rate tolerance (±mHz):	100	A V	3	- -	Capture now	
Presets			🗸 ок		🗶 Canc	el

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.

	Configure	Fi	Imp	ort	[1]	Expo	rt
<ul> <li>5.2.1.12 Downstream Stop on Timeout</li> </ul>			0	0	0	0	,
<ul> <li>5.2.1.11 Downstream Stop on MOT Reset</li> </ul>			0	0	0	0	
5.2.1.10 Interleaved EDID and DPCD Receiver Capability Read			0	0	0	0	
5.2.1.9 Glitch Rejection			1	0	0	1	

*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

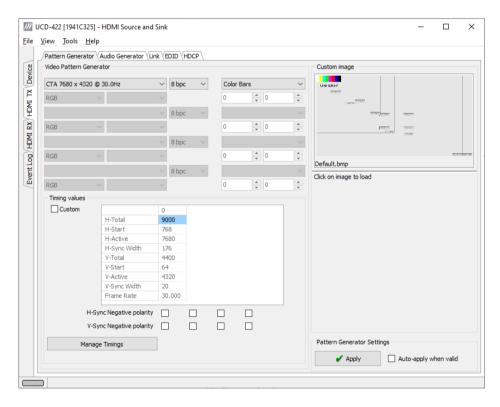
## 7. HDMI REFERENCE SOURCE

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 <u>Appendix C</u> 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 <u>Appendix D</u> 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 Appendix D 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.



Ν	ote

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.

#### **Custom Timing**

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

Ľ.	RGB 🗸 🗸		$\sim$	0	× 0	×	-
- I F	Timing values						
	Custom		0			1	
		H-Total	9000				
		H-Start	768				
		H-Active	7680				
		H-Sync Width	176				
		V-Total	4400				
		V-Start	64				
		V-Active	4320				
		V-Sync Width	20				
		Frame Rate	30.000				
	H-Syr	nc Negative polarity					
	V-Syr	nc Negative polarity					
	Manage	Timings					Pattern Generator Settings
							Apply Auto-apply when valid

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**.

/// Timing Edi	itor									-		×
Current timings:												
Show/Type	Name			Timing	values							^
<ul> <li>✓ Fixed</li> <li>✓ Custom</li> </ul>	VESA CTA VESA VESA CTA VESA	7680 x 4320 @ 30 7680 x 4320 @ 30 7680 x 4320 @ 30 7680 x 4320 @ 60 7680 x 4320 @ 60 7680 x 4320 @ 60 7680 x 4320 @ 10 7680 x 4320 @ 10 7680 x 4320 @ 10 7680 x 4320 @ 10	0Hz [R 0Hz [R 0Hz [R 0Hz [R 0Hz [R 0.0Hz [ 0.0Hz [	Active ( Active ( Active ( Active ( Active ( Active ( Active ( Active (	7680 x 4320), To 7680 x 4320), To	tal (776 tal (900 tal (784 tal (776 tal (776 tal (776 tal (776 tal (776	40, 4381), Sync ( i0, 4381), Sync ( i0, 4400), Sync ( i0, 4443), Sync ( i0, 4443), Sync ( i0, 4443), Sync ( i0, 4400), Sync ( i0, 4529), Sync ( i60, 4529), Sync ( i60, 4500), Sy	32, 8) 176, 20) 32, 5) 32, 8) 176, 20) 32, 8) 176, 20) 32, 5) 32, 8) (176, 20)				
<												>
Delete Selecte	d											
		Horizontal timing	Vertical tim	ning								
	Total	3920	2222		Frame rate	(Hz)	50					
A	ctive	3840	2160		O Pixel Clock (	MHz)	435,512				Clear	
	Start	72	14									
Svnc v	width	32	8							U	pdate timi	ng
Sync pol	larity	Negative	Negativ	/e		Name	Test-1			Ac	ld new tim	ning
									🗶 Cancel		🗸 ок	

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.

## Audio Generator Tab

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

Pattern Generator Audio Generator				
Audio Status Audio loaded: 8 channels @ 44100 Hz, 16				
	DILS			
Play control				
Audio from: Audio gene Playing	erator.			
Audio Content				
Generate audio:				
Waveform: Sine ~	Bits/Sample:	16 bits $\vee$		
Signal frequency: 1000	Amplitude:	60% ~		
Sample Rate: 44100 Hz $\vee$	Channels:	8 Channels $\sim$		
O Load audio from file:				
Open WAV file				

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.

<u>v</u> iew <u>1</u> 00	ls <u>H</u> elp	0											
/Pattern Ge	nerator	Audio Gener	ator /Lir	nk (EDI									
HPD													
	Assert	ed											
Transmitter	-							Receiver / Sink	Canabiliti	es			
HDMI Beh	aviour			- T	MDS Control			Mode:					
01.4	02	.0 (0)	2.1		Mode:	HDMI	ODVI	Behaviour:					
					Link Mode:	() 3G	() 6G	TMDS Bit Cloc	k Ratio:	78			
Status					Enable So	-	000	FRL Support:		5			
Mode:		HDMI				rampier		VRR Support:			078		
Behaviou	r:	HDMI 2	.1					ALLM Support			ported		
TMDS Bit	Clock Rat	tio: 1/10 (3	G mod	e)				Error count					
								_			Lane		
	Scramblii Video	ng							ane 1: c5B6A	Lane 2: 0x0056			
FRL		ng				test a							
	Video	ng 12Gbps 4-lar	ne		$\sim$	itatus			c5B6A	0x0056	0x1	F82	
FRL	Video	12Gbps 4-lar		100	~	FRL Mode:	10Gbps 4-lane	0x0044 0x	Lane 0	0x0056	Ox1F	F82	
FRL Link Mode:	Video 3G	12Gbps 4-lar 6G3L 6G4L	8G	10G	~ 12G		10Gbps 4-lane LTS:P/3	0x0044 0x	Lane 0	0x0056	Ox1F	F <b>82</b> Lane 3	
FRL	Video 3G	12Gbps 4-lar		10G 0	~ 12G	FRL Mode:	-	0x0044 0x	Lane 0	0x0056	Ox1F	F82	
FRL Link Mode:	Video 3G 0	12Gbps 4-lar 6G3L 6G4L	8G 0		~ 12G 0	FRL Mode: LT Status:	LTS:P/3	0x0044 02 Channel lock LTP	Lane 0 1 0	0x0056	<b>0x1</b>	Lane 3 1 0	
FRL Link Mode:	Video 3G 0	12Gbps 4-lar 6G3L 6G4L	8G 0	0	> 12G 0 ms	FRL Mode: LT Status: FLT Update: FLT Ready:	LTS:P/3 0 1	0x0044 0x Channel lock LTP Pattern	Lane 0 1 0 0	0x0056	Lane 2 1 0	Lane 3 1 0 0	
FRL Link Mode: FFE Max LT Timeout	Video 3G 0	12Gbps 4-lar 6G3L 6G4L 0 0	8G 0	0 2000	<pre>     12G     0     ms     ms </pre>	FRL Mode: LT Status: FLT Update: FLT Ready: FRL Start:	LT5:P/3 0 1 0	0x0044 0x Channel lock LTP Pattern	Lane 0 1 0 0	0x0056	Lane 2 1 0	Lane 3 1 0 0	
FRL Link Mode: FFE Max LT Timeout LT Poll Tim	Video 3G 0 t: eout:	12Gbps 4-lar 6G3L 6G4L	8G 0	0 2000	<pre>     12G     0     ms     ms </pre>	FRL Mode: LT Status: FLT Update: FLT Ready: FRL Start: FLT No Timeout:	LT5:P/3 0 1 0 0	0x0044 0x Channel lock LTP Pattern	Lane 0 1 0 0	0x0056	Lane 2 1 0	Lane 3 1 0 0	
FRL Link Mode: FFE Max LT Timeout	Video 3G 0 t: eout:	12Gbps 4-lar 6G3L 6G4L 0 0	8G 0	0 2000	<pre>     12G     0     ms     ms </pre>	FRL Mode: LT Status: FLT Update: FLT Ready: FRL Start:	LT5:P/3 0 1 0	0x0044 0x Channel lock LTP Pattern	Lane 0 1 0 0	0x0056	Lane 2 1 0	Lane 3 1 0 0	

#### HPD

The status LED indicates the state of the HPD signal Asserted (logical "high") or Deasserted (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

/Pattern Generator \LukiyEDID \HDCP\           EDID Data:           000000   00 ff ff ff ff ff ff ff ff 00 54 c7 36 40 4c 34 32 30           000010   34 18 01 03 80 80 48 78 0a da ff a 35 4a a2 29           000002   17 49 4b 21 08 00 31 40 45 40 61 40 81 80 00 101	EDID Files
2 000010 34 18 01 03 80 80 48 78 0a da ff a3 58 4a a2 29	EDID Files
2 000010 34 18 01 03 80 80 48 78 0a da ff a3 58 4a a2 29	
-  000020 17 49 4b 21 08 00 31 40 45 40 61 40 81 80 01 01	Load
000020         17         19         4b         21         08         00         31         40         45         40         61         40         81         80         01         01           0         00030         01         01         01         01         01         01         03         82         70         58         58           0         00040         88         02         00         02         38         01         71         38         2d         40	Save as
1         000050         58         2         45         00         10         00         00         0         10	
22         000050         58 2c 45 00 ba 88 21 00 00 1 a 00 00 1 50 2a 450           35         000050         58 2c 45 00 ba 88 21 00 00 1 a 00 00 1 60 55           42         000060         43 44 2d 34 32 32 20 48 44 0a 20 20 00 00 00 0f d           000070         00 17 3d 0f 88 3c 00 0a 20 20 20 20 20 20 01 f7           000080         12 03 85 f0 57 1f 10 14 05 20 21 22 13 04 12 03           000090         16 07 60 61 5d 5e 5f 65 66 2c 36 64 29 0f 7f 07           000000         15 06 55 3d 1f c0 7e 03 0c 00 40 00 f8 3c 2f 00           00000b0         90 01 02 03 04 81 41 01 9c 06 16 08 00 18 00 96	HEX Editor
9         000090         16 07 60 61 54 55 5f 65 66 62 63 64 29 0f 7f 07           5         0000a0         15 06 55 3d 1f c0 7e 03 0c 00 40 00 f8 3c 2f 00           6         0000b0         90 01 02 03 04 81 41 01 9c 06 16 08 00 18 00 96	Clear
0000000 a6 98 00 a8 00 6a d8 5d c4 01 78 80 57 62 28 78 0000c0 a6 98 00 a8 00 6a d8 5d c4 01 78 80 57 62 28 78	Append file
0000e0 30 20 35 00 ba 88 21 00 00 1a 66 21 56 aa 51 00 0000f0 1e 30 46 8f 33 00 ba 88 21 00 00 1e 00 00 00 6f	EDID Editor
	Connected Sink EDID Read Write

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.

III EDID Editor			-	×
E-EDID Encoder / Decoder	Details of ":/0/Version/Vendor _Product II	* Value		
✓ ·Block 0 [VESA EDID] … Checksum	TD Manufacturer Name	UEG		
✓ Version	ID Product Code	0x4036		
Extension flag	ID Serial Number	0x3032344c		
> Vendor & Product ID	Week of manufacture	Week 52		
Basic Display Parameters and Feat Display x,y Chromacity coordinates	Year of manufacture	Year 2014		
S - Established timings I and II     S - Manufacturer's Timings     S - Standard Timings     Chedsum     Chedsum     CEA Extensions Version     Sink Underscans IT video     Basic audio     YCbCr (4:4:4)     YCbCr (4:2:2)     Native DTD's in entire E-EDID     S - 18-Byte Descriptors in this block     S - CEA Data block count     CEA Data block count				
🔄 Load 🔚 Save 🏢 Show Hey	Show Log			

# HDCP Tab

HDCP tab is the dialog for monitoring the HDCP (for High-Bandwith Digital Content Protection) Status

<u>F</u> ile	<u>V</u> iew <u>T</u> ools	390] - HDMI Source and Sink Help rator \Audio Generator \Link \EDID	2)/HDCP		-	×
Event Log/HDMI_RX/HDMI_TX Device		Active Authenticated Authentication in progress Keys loaded	Faable encryption     Authenticate      Keys     Production     Facsimile - "Test"     None			
Eve	HDCP 2.3 Status		Configuration			
		Active Authenticated Authentication in progress Keys loaded	Configuration   Enable encryption  Authenticate  Keys	Content level		
			Production     Facsimile - "Test" - R1     Facsimile - "Test" - R2     None	Type 0   Type 1		
				1		

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.

Start Capture	. 5	top Capt	ure					
Data sources and filters:		/Event	Log					
✓ · HDMI Input			Save	Report	<u></u>	ben		
HDMI		#	Timestamp	Туре	From F	Data	^	262: 2418769, 132ms
V HDMI Output		258	2418757.106	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	2 1207031132113
- HPD		259	2418759.988	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	48 44 52 58 20 53 4
I2C		260	2418763.036	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	44 43 3A 20 52 44 2 30 78 31 30 3A 55 5
		261	2418766.084	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	44 41 54 45 5B 30 5
		262	2418769.132	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	20 30 78 30 30 0A 0
		263	2418772.014	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	00
		264	2418775.062	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	HDRX SCDC: RD
		265	2418778.111	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	0x10:UPDATE[0]
		266	2418780.994	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		0x00
	<	267	2418784.043	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		268	2418787.092	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	
		269	2418790.141	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	
		270	2418793.023	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	
		271	2418796.072	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	0	
		272	2418799.120	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	-	
		273	2418802.003	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		274	2418805.051	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		275	2418808.097	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		276	2418811.143	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		277	2418814.024	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		278	2418817.070	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		279	2418820.117	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0		
		280	2418822.997	INFO	0	HDRX SCDC: RD 0x10:UPDATE[0] 0x0	•	
Presets		<					>	

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

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Collection 1     A	Details of ":/0/Version/Vendor _Produ	ct ID"		
<ul> <li>Blocks in collection</li> <li>Block 0 [VESA EDID]</li> </ul>	Key	Value		
Checksum	ID Manufacturer Name	UFG		
<ul> <li>Version</li> </ul>	ID Product Code	0x4036		
Extension flag	ID Serial Number	0x3032344c		
> Vendor & Product ID	Week of manufacture	Week 52		
<ul> <li>Basic Display Parameters and F</li> <li>Display x, y Chromacity coordination</li> </ul>	Year of manufacture	Year 2014		
✓ · 18-Byte data blocks     S · Descriptor 1     S · Descriptor 2     S · Descriptor 3     S · Descriptor 4     V · Block 1 (EC& 86:1)     Checksum     ✓ · CEA Extensions Version     L - Snick Luderscans IT video				

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.

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### **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

\*) Please contact Unigraf for detailed availability

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# **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		0
EDID			
	Read / Write, Save / Load, EDID Editor	•	
HDCP			
	HDCP 1.4 and HDCP 2.3 Support	0	
	Authentication status, Encryption status	0	
Event Log			
	Event Log	•	
Source DUT Testing			

• Feature available

○ To be introduced later

## UNIGRAF

## HDMI Reference Source (HDMI TX)

		Basic	DSC Encoder
Tab	Function		
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		0
EDID			
	Read / Write, Save / Load, EDID Editor	•	
HDCP			
	HDCP 1.4 Support	0	
	Control: (Enable / Disable, authenticate only, Encryption Enable / Disable)	0	
	Status: (Authentication status, Encryption status)	0	
	HDCP 2.3 Support	0	
Event Log			
	Event Log	٠	
Sink DUT Testing		0	

• 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	UNIGRAF	Bitmap image uploaded by the user. Click on the <b>Custom</b> <b>Images</b> panel to browse. By default, Unigraf test image will be used.						

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

# 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.