

Testing HDMI Quantization Range on Quantum Data 882

The Quantum Data 882 Video Test Generator has a variety of settings to provide you with a high degree of flexibility in testing HDMI sink devices. If you are concerned with digital video quantization ranges, you should be aware of how the various settings affect the digital signal as well as the AVI infoframe. This application note describes these commands and explains how to make sure you have the proper settings for your application.

The 882 has two quantization-related commands:

1. DVQM sets the actual quantization range as well as the AVI Infoframe RGB quantization range bits. The DVQM command should be followed by the FMTU command to activate the new setting.
2. XAVI:RGB sets the AVI Infoframe RGB quantization range indicator bits without changing the actual quantization range of the digital video. The XAVI:RGB command should be followed by the IFGU command to activate the new setting.

The current quantization range is controlled by the DVQM (Digital Video Quantization Mode) variable, which can be set and queried from the command line. DVQM has three allowable values which set the range of digital component values as well as the AVI Infoframe Q1:Q0 bits in data byte 3. DVQM can also be set from the front panel menus via the SOURCE → OPTIONS → OPTIONS key sequence, which presents a menu with three selections: FullRange, ShootRange, and LimitedRange. (Note: these names are new for firmware release 2.20.0. The former names were MaxRange, MaxRangeTV, and NomRangeTV, respectively.)

Table 1 shows the possible settings for DVQM/Range, the actual resulting digital quantization range at the three supported color depths for RGB, and the resulting range indicators in the AVI Infoframe.

DVQM Cmd Args	Menu Range Setting	Digital Range			AVI Q1:Q0	CEA-861-D Range Name
		8 bits	10 bits	12 bits		
0	FullRange	0 - 255	0 - 1023	0 - 4095	1:0	Full
1	ShootRange	1 - 254	4 - 1019	16 - 4079	0:0	Default
2	LimitedRange	16 - 235	64 - 940	256 - 3760	0:1	Limited

Table 1: RGB Quantization Settings

Note that changes made to the front panel range menu settings will be immediately reflected in command line DVQM queries; however, DVQM settings from the command line are not shown on the front panel menu unless you refresh the menu by leaving the menu level and entering again.

To completely exercise a receiver's quantization range performance, you will need to set the AVI Infoframe quantization bits independently of the actual quantization range of the digital video signal. For example, when testing a CEA-861-D defined consumer video

format, the normal quantization range is the CEA Limited range as shown in table 1. When such a format is selected on the 882, the quantization range and infocode bits will be set as the DVQM=2 line of table 1, with limited quantization range and the AVI quantization indicator bits set to 0:1 (Limited.) However, CEA-861-D indicates that the quantization range indicator bits may be set to 0:0, indicating the CEA default for a CE video format. To test this setting, you will need to use the XAVI:RGB command to change the Q1:Q0 bits. Table 2 shows the allowable XAVI:RGB arguments and the resulting Q1:Q0 bits in the AVI infocode.

Cmd Line XAVI:RGB	AVI Q1:Q0	CEA-861-D Range Name
0	0:0	Default
1	0:1	Limited
2	1:0	Full
3	1:1	(Reserved)

Table 2: AVI Q1:Q0 Settings

Examples:

Set digital quantization range to LimitedRange, AVI Infocode Q1:Q0 bits to 0:1, indicating limited range:

```
DVQM 2
```

```
FMTU
```

or

press SOURCE → OPTIONS → OPTIONS, select LimitedRange

Query the current DVQM setting:

```
DVQM?
```

Set AVI Infocode Q1:Q0 bits to 0:0, indicating CEA default range:

```
XAVI:RGB 1
```

```
IFGU
```

Query the current XAVI:RGB setting:

```
XAVI:RGB?
```

You may also want to test illegal combinations to verify that your receiver responds in an acceptable way when receiving invalid combinations of settings.

Verifying the outputs

If you want to be sure that your settings are producing the correct HDMI video signal and infocode, you can connect the 882EA or 882CA OUT1 connector to the IN1 connector and use the analyzer to verify the output. You can also connect a display to OUT2 to see the image at the same time.

In this example we verify the 882EA's output when testing an 8-bit HDTV for correct handling of RGB quantization range and related AVI infocode bits.

1. Press INTERFACE key so that you see the list of video interfaces.
2. Select HDMI-H.
3. Press INTERFACE again and select HDMI IN 1.
4. Press SOURCE key so that you see the list of video formats.
5. Scroll the list if necessary, and select 720P60 format (or the CE format of your choice.)
6. Press OPTIONS key; verify that RGB and 8-bits are selected.
7. Press OPTIONS again; verify that LimitedRange is selected.
8. Press CONTENT key so that you see the list of images.
9. Scroll the list if necessary, and select CheckBy6 image. This is a checkerboard pattern of alternating white and black rectangles; 6 horizontal by 6 vertical.
10. Enter the pixel analyzer by pressing TOOLS → Analyzer → ViewPix.
11. Press the upper-left soft key to Capture the current image.
12. The ViewPix screen shows the current X-Y pixel coordinate as well as the R, G, and B component values for that pixel. You can select whether to move in the X (horizontal) or Y (vertical) direction by pressing the 2nd or 3rd softkey on the left, respectively. The asterisk indicates which axis is active. With the bottom left soft key you can select the pixel increment of 1, 10, or 100. The +/- arrows at the right side of the keypad move the pixel by the selected increment.
13. Note the RGB values for the current pixel. They should be 235 for a white pixel in LimitedRange.
14. Change the pixel increment (EXP) to 100, then repeatedly press the up-arrow until the pixel is in the black square. The RGB values should all be 16.
15. Now we have verified that the actual quantization range is 16 – 235. The next step is to verify the RGB Quantization bits (Q1:Q0) of the AVI Infoframe. Press the upper right soft key (Exit) to leave the pixel analyzer.
16. To view a report of transmitted or received infoframes, press TOOLS → Reports → Packets. Then choose TX Packet for transmitted packets or RX Packet for received packets. In this example, the HDMI Tx is looped back to HDMI Rx, so both packet reports should show the same information. Press the soft key for RX Packet.
17. From the 882EA Web Interface home page, select the Generated Reports link.
18. On the Generated Reports page, select RX Packets to view the report.
19. In the AVI Infoframe section, find the line for RGB Quantization Range. Verify that it indicates Limited Range (see table 2.)
20. You can change the value of the AVI Infoframe Q1:Q0 bits by executing the XAVI:RGB command from an 882EA command prompt. Launch a serial terminal, telnet session, or the 882EA CMD Terminal. Issue the commands
XAVI:RGB 0
IFGU
to set the AVI Infoframe Q1:Q0 bits to 0:0, indicating Default range.
21. Repeat steps 16 – 19 to verify the new setting of the Q1:Q0 bits.

Verifying Legal Range

The HDMI specification states that for CE formats, black is represented by all components of a pixel being set to 16, and white by all components being set to 235 (for

8-bits/component.) However, the legal range of component values is 1 – 253, to accommodate for overshoot when digitizing an analog signal. You can use the following procedure to test your receiver’s behavior when receiving pixels in the 1 – 15 range (blacker-than-black) and the 236 – 253 range (whiter-than-white.)

1. Press INTERFACE key so that you see the list of video interfaces.
2. Select HDMI-H.
3. Press INTERFACE again and select HDMI IN 1.
4. Press SOURCE key so that you see the list of video formats.
5. Scroll the list if necessary, and select 720P60 format (or the CE format of your choice.)
6. Set digital quantization range to ShootRange, AVI Infoframe Q1:Q0 bits to 0:0, indicating default range:
DVQM 1
FMTU
or
press SOURCE → OPTIONS → OPTIONS, select ShootRange (Referring to table 1, note that with this setting, the 882’s quantization range includes the entire legal range for HDMI, including the blacker-than-black and whiter-than-white ranges. However, the AVI Infoframe Q1:Q0 bits indicate the Default quantization range, which for a CE format is the same as Limited.)
7. Press CONTENT key so that you see the list of images.
8. Scroll the list if necessary, and select HiLoTrk image. This test image includes regions with pixel values near the top and bottom of the quantization range.
9. Verify that your receiver correctly handles these settings.

Plug-In functions enable front-panel setting of infoframe quantization bits

The XAVI:RGB command sets the AVI Infoframe RGB quantization range indicator bits without changing the actual quantization range of the digital video. This command is executed from the 882 command prompt, which can be inconvenient when the user is operating the instrument from the front panel. Using Quantum Data’s ScriptSDK functionality, we have developed plug-in scripts that allow the user to set the quantization bits from the front panel. These plug-ins can be downloaded from our website at this URL: <http://www.quantumdata.com/apps/files/avirgb.zip>

The plug-ins are for the Quantum Data 882E, 882EA, 882C, 882CA, and 882D video generators, and allow the user to set the Quantization Range bits in the transmitted AVI Infoframe. Three scripts are provided to allow easy front-panel setting of the Q bits to indicate Default, Limited, or Full range.

Important Note: These scripts do not affect the actual digital video RGB Quantization Range. They only set the AVI Infoframe bits that are used to indicate the quantization range of the video stream. The 882 is a flexible test instrument, and it is easy to choose combinations of settings that are illegal, so the user should be aware of the proper settings for specific testing needs.

Installation:

1. Unzip the avirgb.zip file to your PC.
2. Launch the 882 Web Interface and select FTP Browser.
3. In the left pane of FTP Browser, browse to tffs0:/Library.
4. If folder tffs0:/Library/Scripts does not already exist, create this folder.
5. In the right pane of FTP Browser, browse to the unzipped *.o files.
6. Highlight and download the 3 files to the tffs0:/Library/Scripts folder of the 882.

Usage:

1. Press the TOOLS key so that you see the Tools menu (with System and Reports at the top.)
2. Press the down arrow to scroll the menu down so that you see ScriptSDK.
3. Press the soft key for ScriptSDK.
4. Press the soft key for the desired script, then watch the front-panel display to verify the proper function.

Note: These settings will be overridden when you select a different video format, and possibly when you make other settings on the 882. Therefore, it is recommended that you re-select your desired script after making other format-related changes.

ZIP File Contents:

avirgb0.o Sets Tx AVI RGB Q bits to 0:0 to indicate Default range
avirgb1.o Sets Tx AVI RGB Q bits to 0:1 to indicate Limited range
avirgb2.o Sets Tx AVI RGB Q bits to 1:0 to indicate Full range
AVIRGB.txt Instructions

References

1. High-Definition Multimedia Interface Specification Version 1.3a, HDMI Licensing, LLC, <http://www.hdmi.org>
2. CEA-861-D, A DTV Profile for Uncompressed High Speed Digital Interfaces, Consumer Electronics Association, <http://www.ce.org>
3. 881/882 Series User Guide, Quantum Data, Inc., <http://www.quantumdata.com/downloads/index.asp>