980 APPLICATION NOTE – HDBaseT® INTEROPERABILITY TESTING IN THE DEVELOPMENT LAB

HDBaseT is a connectivity standard that consolidates high throughput, HDCP protected, uncompressed HD digital multimedia with bidirectional data networking over standard CAT5e/6 structured cabling up to 100 meters in length. Although HDBaseT has five key functions, extending HDMI video and audio over CAT cables is the focus of this application note.

HDBaseT extenders are engineered to be transparent within a network. From the HDMI input of the HDBaseT extender's transmit side to the HDMI output of its receiver side the bits should be exact—"bit exactness." For manufacturers of HDBaseT distribution products, ensuring that their devices are truly transparent is critical. The diagram below depicts a typical HDBaseT distribution network for HDMI video and audio.

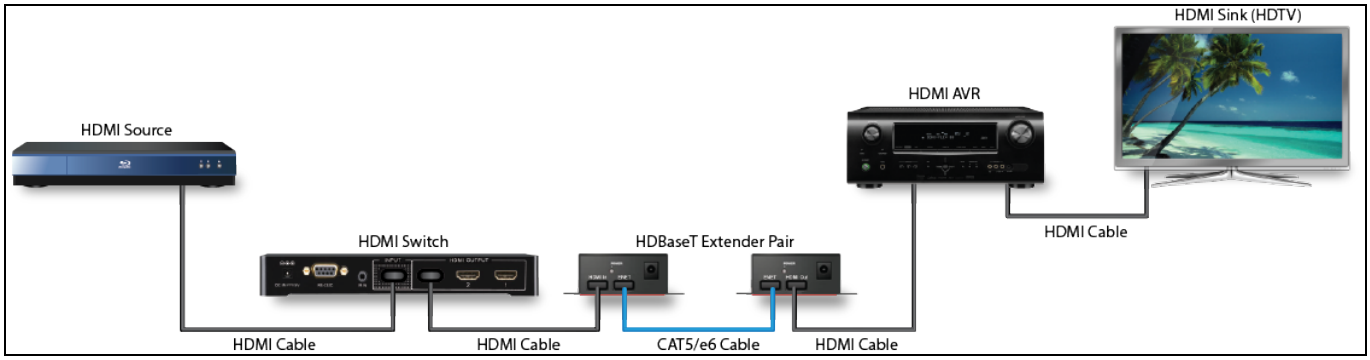


Figure 1: Typical HDMI distribution network with HDBaseT extender

In order for developers to diagnose HDBaseT distribution related interoperability problems in the most efficient manner, they require proper diagnostic equipment. This Application Note offers the Quantum Data 980 HDMI Protocol Analyzer module as a solution to engineers developing HDBaseT distribution devices. The 980 module can be equipped either in the 980 or 980B Advanced Test Platform. (The 980B is shown in Figure 2 below.)

The 980 HDMI Protocol Analyzer module is equipped with an HDMI Rx port and an HDMI Tx port. The HDMI Rx analyzer port provides full visibility into the HDMI protocol, metadata, timing, control and auxiliary data at HDMI 1.4b speeds of up to 297MHz for analyzing 4K-capable source devices and network components. By providing full visibility into all data types, the module enables developers to: 1) verify transparency—bit exactness—through the HDBaseT extender or switch and 2) identify and diagnose interoperability problems early in the product life cycle. These benefits enable manufacturers to get their HDBaseT products to market more quickly and with reduced expense.

Figure 2: Quantum Data 980B with Protocol Analyzer Module

Supports 4K capable HDMI devices at pixel rates up to 297MHz!

Test Applications

There are three (3) primary test applications supported by the 980 HDMI Protocol Analyzer module suitable for verifying the fidelity of HDBaseT extender and switch devices: 1) *Capture and Compare*. In this application an HDMI stream is first captured directly from a known-compliant source and then compared with a second capture of an HDMI stream through the HDBaseT extender using the same source; 2) *Pseudo Random Noise loop*. In this application test the 980 module's HDMI output transmits a known test pattern through the HDMI cables and HDBaseT distribution device and analyzes the received stream on the 980 module's HDMI analyzer Rx port. 3) *HDMI source compliance test*. In this case an HDMI source compliance test is run on a known-compliant source transmitting through the HDBaseT device under test.

Test Application #1: Capture and Compare

This test involves capturing an HDMI data stream directly from a known-compliant source and comparing that data with a capture from the same compliant source transmitted through the HDBaseT extender. The configurations are depicted in the Figures 3 and 4.

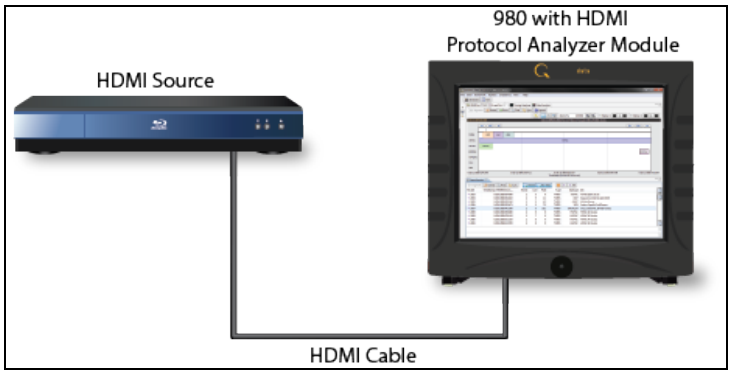


Figure 3: Configuration #1: 980 Direct Capture

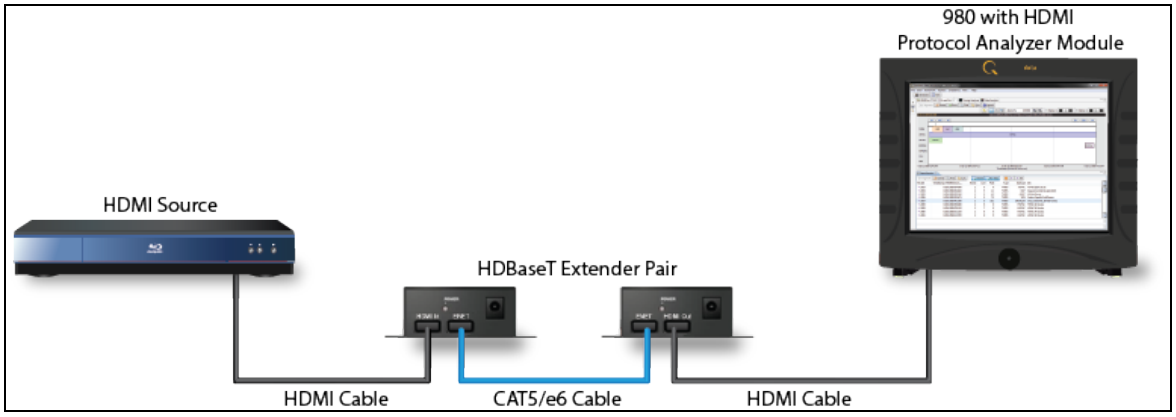


Figure 4: Configuration #2: 980 Capture through HDBaseT Extender

When running a Capture and Compare test it is important to use the same trigger settings, buffer size and ensure that the data to be captured in each configuration is the same. The 980 HDMI Protocol Analyzer module can be configured to capture protocol data, timing and control data, metadata, video data and auxiliary data. Note that the protocol data (such as guard band and preamble data) requires a separate capture and analysis. Figures 5 and 6 show sample test screens of captured data. The 980 HDMI Protocol Analyzer's GUI application enables developers to examine the data—protocol, metadata, auxiliary data, timing and control—either in graphical form or table form. The details of each packet are shown including the values of each parameter within each packet.

A variety of source video and audio outputs can be tested in each configuration. For example, various video resolutions, colorimetry, sampling and bit depths should be tested with and without HDCP content protection. Similarly, a variety of audio formats can be used including uncompressed LPCM and compressed formats as well as lossless compressed formats. An HDMI video pattern generator such as the Quantum Data 780 may make it easier to produce HDMI streams with these various video and audio settings.

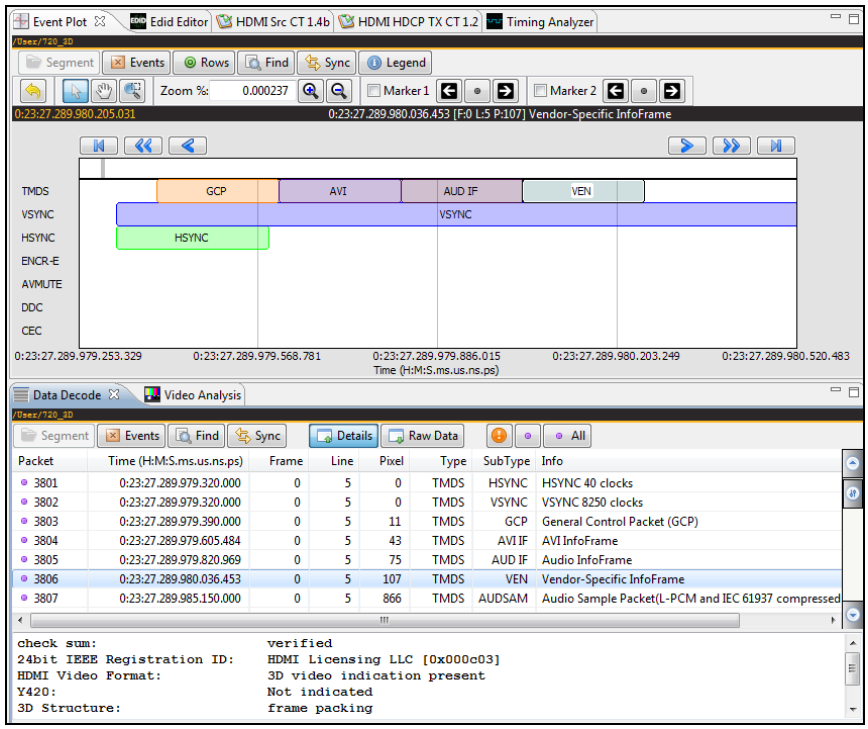


Figure 5: Screen shot of captured metadata

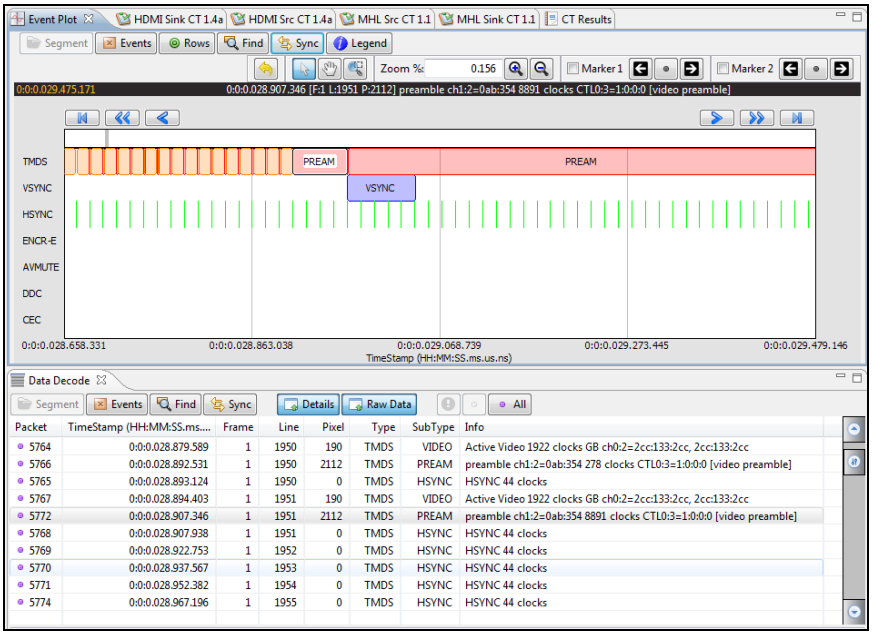


Figure 6: Screen shot of captured protocol data

Once a set of captures have been made in each configuration and each output setting, the data can be compared. Simple comparisons can quickly be made through human inspection to assess the quality of the extender. For example a comparison can be made on the number of each packet type (AVI infoframe, Audio Clock Regeneration, Audio Sample packets, etc) received in each capture configuration—with and without the HDBaseT extender in place. These packet counts should be the same in each configuration. Figure 7 shows a view of various metadata packets from a capture with arrows indicating the packet counts for a category of packets and for a specific packet type, e.g. ACR packets. The numbers in parentheses show the quantity of each packet type received in the capture.

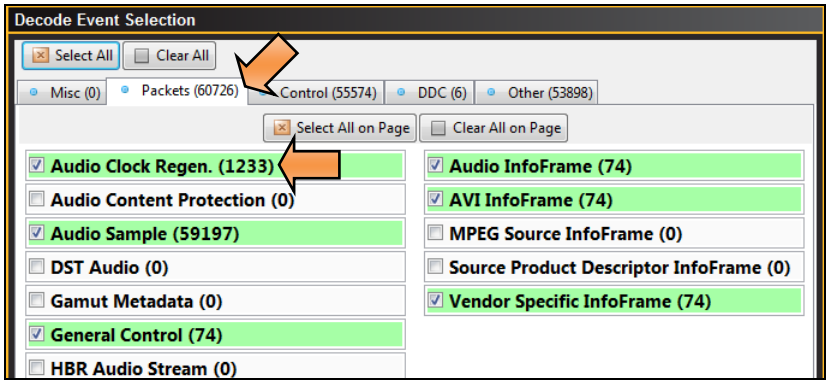


Figure 7: Screen shot of captured metadata packet counts

Checking for errors such as BCH errors in each capture provides further insight into the integrity and fidelity of the HDMI BaseT extender (Figure 8).

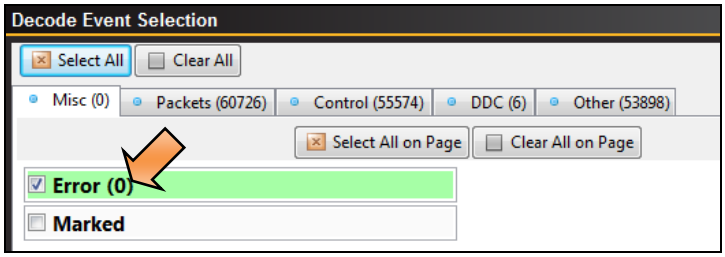


Figure 8: Screen shot of captured (BCH) error counts

The stability of the timing for each configuration can be assessed as well by comparing all vertical and horizontal timing parameters over thousands of frames between the two captures—direct from a source and through the HDBaseT device. The Timing Analysis panel will show errors when the horizontal or vertical timing values deviate from a standard timing. Refer to Figure 9 for a sample screen shot of the 980 HDMI Protocol Analyzer's Timing Analyzer application.

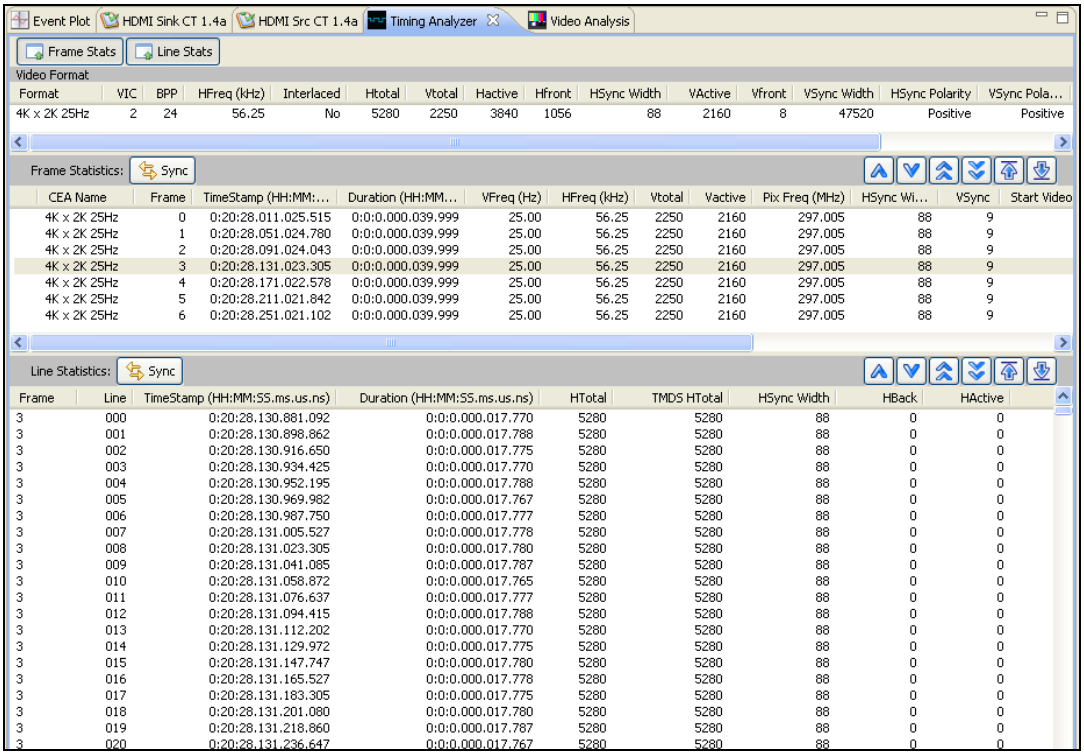


Figure 9: Screen shot of timing data

It is important to test the HDBaseT extender device for as long a period of time as is reasonably possible. By capturing only the protocol data, metadata, control data, timing data, auxiliary data and not capturing the actual video pixel data, many more frames can be captured to verify the metadata contents of the video blanking periods within an HDMI stream.

When and if a problem arises, the nature and extent of the failure can be determined by examining the details of the captured data (reference Figures 5 and 6).

There are many comparisons that can be made between the two configurations—direct capture from the source and capture from the source through the HDBaseT extender. Many of these can be automated through the 980 HDMI Protocol Analyzer module's command line using common linux shell commands and scripts.

Test Application #2: Pseudo-Random Noise Loop test

The Pseudo-Random Noise (PRN) loop test is complementary to the Capture and Compare test application previously discussed in that if focuses on the video pixels rather than the metadata and timing. Because the 980 HDMI Protocol Analyzer module is equipped with an HDMI output port that can transmit a known test pattern, it can conduct a loop test with the HDBaseT extender pair installed in the loop. This test involves sending a pseudo-random noise test pattern from the module's HDMI output port and analyzing the video at the instrument's HDMI input port (Figure 10).

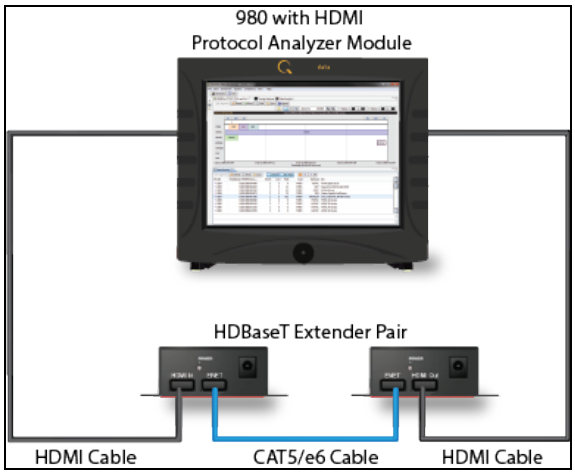


Figure 10: 980 Pseudo-Random Noise Loop test

The PRN loop test continuously compares the received video in real time—pixel by pixel—with the video it has transmitted through a cable or distribution network (Figure 11).

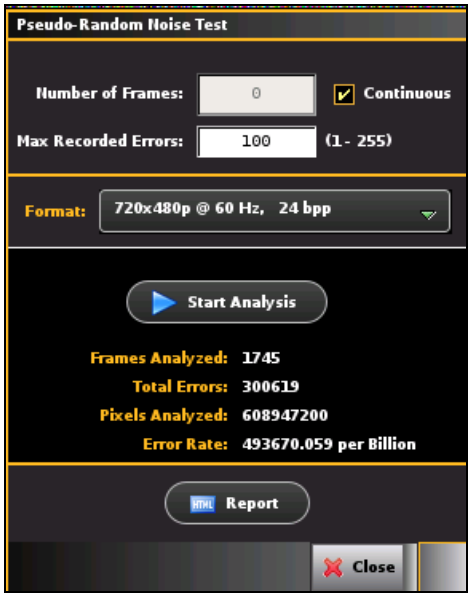
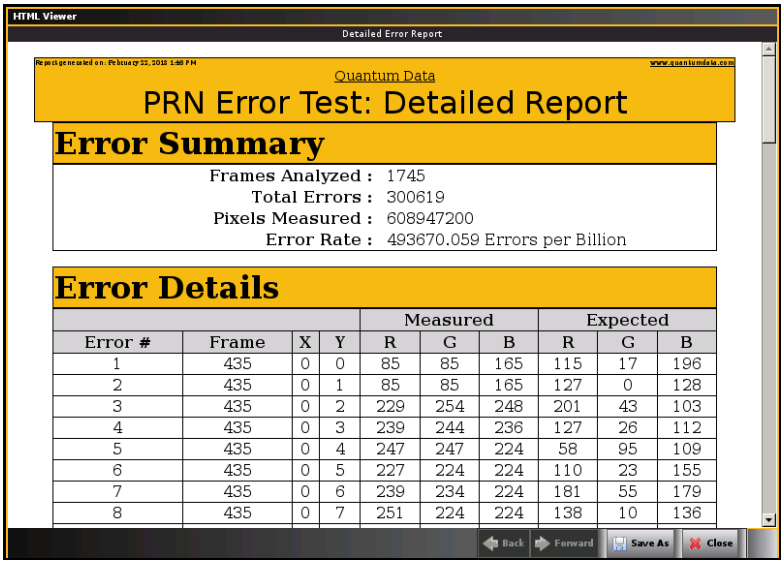


Figure 11: Screen shot of real time pixel error counts on PRN test

The Pseudo-Random Noise loop test is run at multiple resolutions (including 4K x 2K) and at color depths up to 36 bit deep color. Testing with deep color is especially useful as it causes the TMDS bit rate to increase significantly thereby further stressing the physical capabilities of the cables and HDBaseT distribution devices.

An HTML report is produced when the PRN test is complete (Figure 12). The report provides information about the test such as the number of frames tested, pixels measured, errors discovered and errors per billion pixels. Any errors are listed with details as to which frame, which pixel in a frame and what the pixel values should have been.


HTML Viewer

Detailed Error Report

Quantum Data

PRN Error Test: Detailed Report

Error Summary

Frames Analyzed : 1745
Total Errors : 300619
Pixels Measured : 608947200
Error Rate : 493670.059 Errors per Billion

Error Details

				Measured			Expected		
Error #	Frame	X	Y	R	G	B	R	G	B
1	435	0	0	85	85	165	115	17	196
2	435	0	1	85	85	165	127	0	128
3	435	0	2	229	254	248	201	43	103
4	435	0	3	239	244	236	127	26	112
5	435	0	4	247	247	224	58	95	109
6	435	0	5	227	224	224	110	23	155
7	435	0	6	239	234	224	181	55	179
8	435	0	7	251	224	224	138	10	136

Back Forward Save As Close

Figure 12: Screen shot of report of pixel error counts on PRN test

Test Application #3: HDMI Source Compliance test

Although the HDBaseT consortium has a specific compliance test specification (which uses the Quantum Data 882EA), running the HDMI source compliance test on a source stream through an HDBaseT extender is an excellent way of pre-testing an extender pair in preparation for submission to an Authorized Test Center for compliance.

The 980 HDMI Protocol Analyzer module supports compliance testing on HDMI sources. This test application involves running an HDMI source compliance test on an HDMI data stream directly from a known-compliant source and comparing these test results with the results from the same compliant source transmitted through the HDBaseT extender. The configurations are depicted in Figures 3 and 4. A sample test results screen is shown as Figure 13.

If there are any compliance failures, the underlying raw capture data can be viewed to verify the failure and determine its nature. The results of the compliance test as well as the captured data can be disseminated to colleagues and other subject matter experts for further analysis. These colleagues and subject matter experts are not required to have the 980 test instrument. The results and captured data can be viewed using the 980 GUI Manager application which is available from the Quantum Data website at no cost.

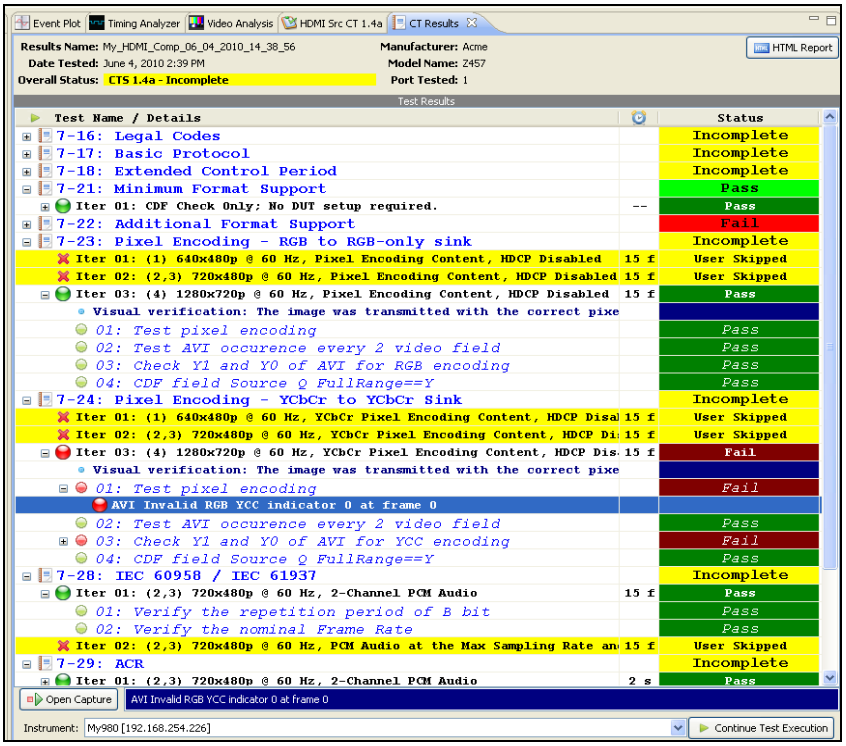


Figure 13: Screen shot of HDMI Source Compliance Test results

The Quantum Data 980 HDMI Protocol Analyzer module…an ideal solution for developers to verify signal integrity, pre-test for compliance and diagnose interoperability problems for HDBaseT devices at pixel rates up to 297MHz.

About Quantum Data

This application note was authored by Neal Kendall Marketing Manager at Quantum Data. Quantum Data invents test instruments that help manufacturers bring next-generation audio, video and control products to market – faster and without interoperability problems.