780A APPLICATION NOTE – HDBaseT® FUNCTIONAL TESTING IN THE FIELD

One of the most vexing problems facing A/V professionals is distributing high quality HD video throughout a residence, corporate enterprise, hospitality facility, or institution. The advent of HDBaseT greatly simplifies this endeavor. 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 – and does this up to 100 meters. Although HDBaseT has five key functions, extending HDMI 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 transmitter to the HDMI output of its receiver the bits should be exact—"bit exactness." The diagram below depicts a typical HDBaseT distribution network for HDMI HD video.

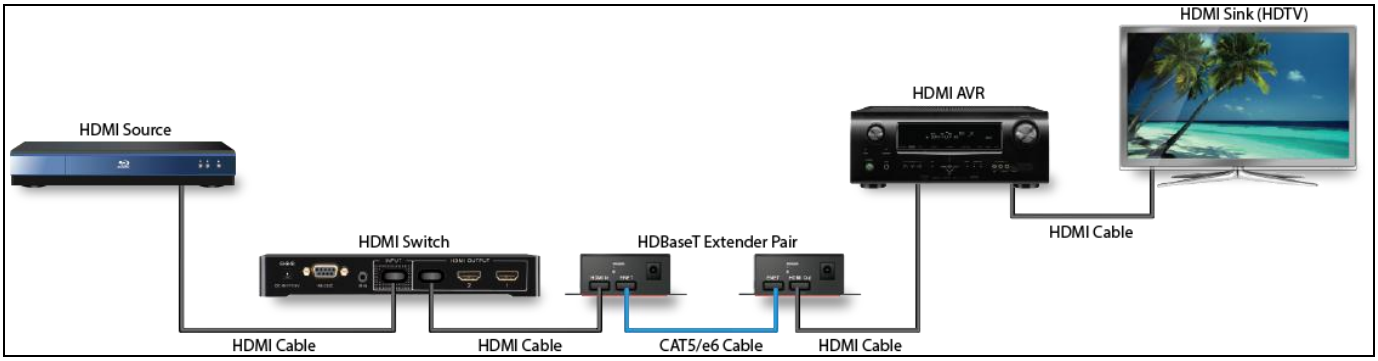

Figure 1: Typical HDMI Distribution Network with HDBaseT Extender

In order to install HDBaseT distribution solutions in the most efficient manner, A/V professionals should have the proper test equipment for verification and troubleshooting. This Application Note offers the Quantum Data 780A Test Instrument as a solution to A/V professionals who distribute HD video over HDBaseT networks. The 780A Test Instrument is a battery-powered, portable HDMI video (and audio) generator and analyzer that enables A/V professionals to conduct quick, on-site verification testing and troubleshooting of HDBaseT A/V systems. The 780A instrument is a successor to the 780 instrument and supports HDMI 1.4 speeds of 297MHz pixel clock for testing 4K resolution devices.

Figure 2: Quantum Data 780A Test Instrument

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

The 780A is equipped with both an HDMI transmitter port and an HDMI receiver port enabling A/V installers and integrators to test audio, video and HDMI protocols—HDCP, EDID, CEC & infoframes—on all types of HDMI devices: sources, sinks, repeaters, switches as well as HDBaseT distribution devices.

Test Applications

There are two general applications for A/V installation professionals: 1) pre-installation checkout, and 2) commissioning and turn up. Pre-installation involves verifying that the components in the design of an AV distribution solution work properly in principle. Often pre-installation check-out is done in a staging area prior to installation on-site. Commissioning and turn up is the final task in the overall job. It involves an end-to-end test of the A/V distribution network with all the AV players, HDTVs and distribution devices in place and the cables routed through the walls.

Test Application #1: Pre-Installation Check-Out

Pre-installation check-out is often conducted in the equipment staging area of an A/V professional's facility. In the case of an HDBaseT distribution network, the devices are connected in accordance with the design and tested. Pre-testing enables pro A/V installers to verify that the components in the design all work together. They can substitute A/V components and cables (HDMI or Cat5e/6) in cases where they do not work properly.

Pseudo-random noise pattern testing

The 780A's ability to simultaneously act as ("emulate") both a known-good HDMI transmitter (source) and a known-good HDMI receiver (sink), enables it to conduct loop test on the entire distribution network. A loop test involves sending a known pseudo-random noise test pattern out the 780A's HDMI transmit port through the network components in the design and analyzing the A/V stream at the instrument's HDMI receive port. The 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 distribution devices.

The test setup and a sample screen shot of the "Cable" loop test are depicted below as Figures 3 and 4.

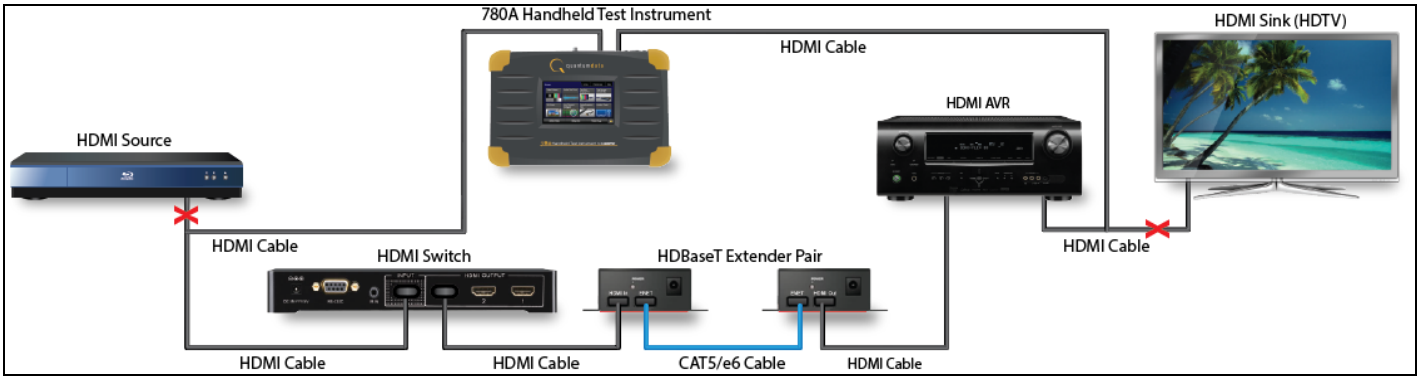

Figure 3: 780A Pseudo-Random Noise Loop Test

Figure 4: Cable and Repeater Loop Test Results Screen

Emulation and functional testing

In addition to the pseudo-noise pattern test for video quality, the 780A's Cable and Repeater test also checks for continuity on the DDC channel and the hot plug voltage. The DDC channel carries the HDCP authentication transactions and EDID exchange. In addition to a simple continuity check, the 780A can also run HDCP and EDID functional tests on the DDC channel. The HDCP functional tests screen is shown in Figure 5.

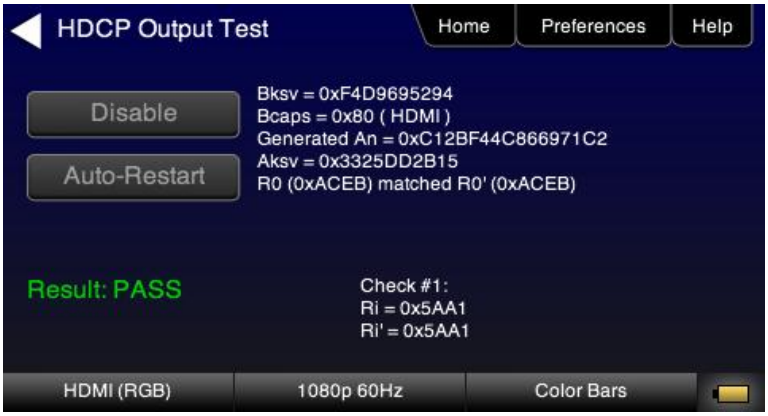

Figure 5: 780A HDCP Functional Test

Once the pre-installation check-out is completed, design engineers can be assured that their design works in principle. Verifying that the design will work in practice is the subject of the second test application: Commissioning and turn-up.

Test Application #2: Commissioning and Turn-Up

Commissioning and turn-up is conducted when the job is near completion. It involves a final end-to-end test of all A/V components as installed. Because the cables are run through the walls, a loop test is typically not possible. The 780A has a similar test to the Cable/Repeater tests that enables installers to test the video quality through the installed HDBaseT distribution network at the far end, i.e. at the sink (HDTV). A typical HDBaseT distribution network is shown below as Figure 7. This figure shows the 780A replacing the HDTV and verifying the integrity of the HDMI stream at the far end (sink end). The 780A's Frame Compare test can be run in this configuration to verify that there are no errors through the network. A sample screen shot of the Frame Compare test results is shown as Figure 8. The source can be configured to output any resolution and any color depth. It is recommended to test the highest clock rate possible which in most cases would be 1080p60 at 36 bit deep color unless the network was 4K capable.

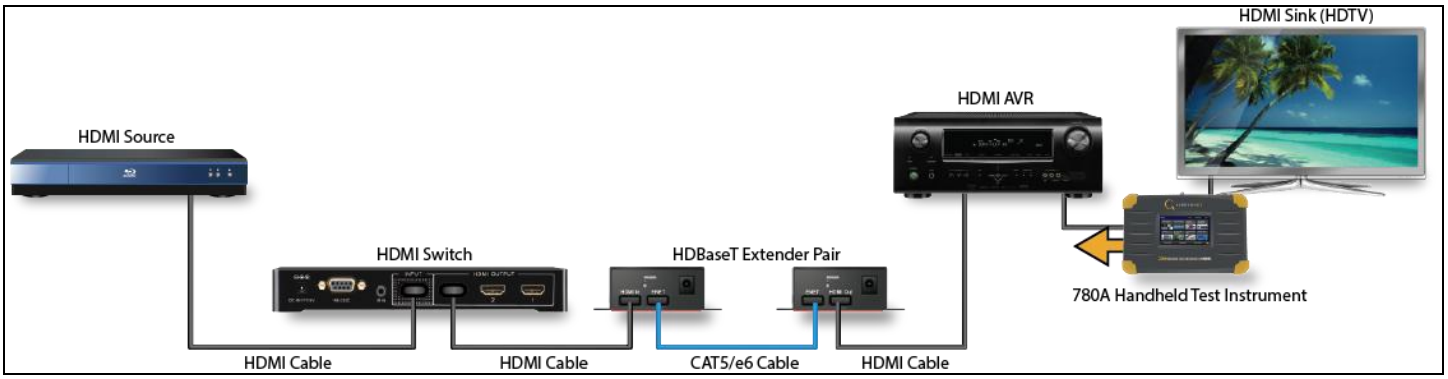

Figure 7: 780A End to End Frame Compare Test Configuration

Figure 8: Screen Shot of Frame Compare (Cable Test)

The Frame Compare test is designed to test the signal quality through the A/V network. Signal quality errors manifest themselves as pixel sparkles or a no picture condition if the physical layer is extremely poor and the video drops out due to the "cliff effect." However, in addition to testing the signal quality at the sink end, it is best to also run a set of functional end-to-end tests with the 780A test

instrument emulating a source (Figure 9). These tests enable A/V installers to identify protocol problems with EDID and especially HDCP which occur over the DDC channel. A screen shot of the HDCP functional test is shown as Figure 5.

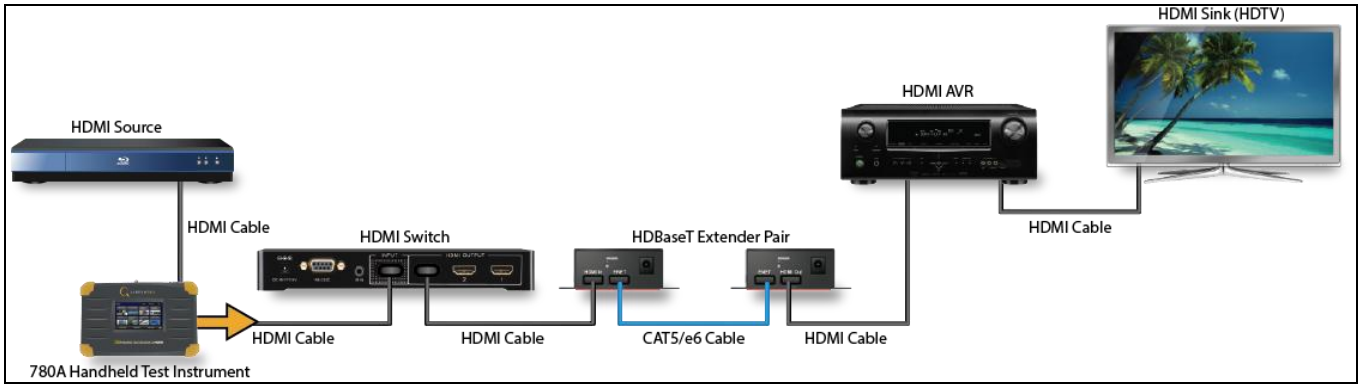

Figure 9: 780A End to End Protocol Functional Test Configuration

Regardless of whether the root cause of an A/V network problem results from a physical layer impairment or a protocol layer problem, the resolution typically involves replacing a component or cable. The diagnostic techniques are similar in both cases.

Determining the root cause of an interoperability problem

The best approach for diagnosing an A/V problem is to use the 780A's emulation capabilities and segment the network. The 780A's ability to emulate both a known-good HDMI source and a known-good HDMI sink enables it to easily isolate a problem in the HDBaseT distribution network. 780A emulation and segmentation is depicted in Figure 10 below. In this example, the 780A is emulating an HDMI source device at two locations on the upstream side of the HDBaseT extender and emulating an HDMI sink device at one location downstream from the extender pair. To isolate problems with emulation and segmentation, a set of functional tests are performed.

When the 780A is emulating an HDMI source, it is testing the downstream components in the distribution network. In this case a Video Pattern test, Audio test, EDID test and HDCP test are performed. The HDCP test screen is shown in Figure 5 above. The Video Pattern and Audio Tone tests use standard resolutions, test patterns and test tones. The EDID test verifies that the EDID is being forwarded properly through the network. The HDMI rendering sink device (e.g. HDTV or A/V receiver) and the 780A built-in screen are monitored for any anomalies during these functional tests.

When the 780A is emulating an HDMI sink, it is testing the upstream components in the distribution network. In addition to the Frame Compare test, the Video Display, Format Analyzer and Audio Analyzer tests are also performed. The Format Analyzer test screen is shown below in Figure 11 and the Video Display test screen is shown as Figure 12. These functional tests of the source side identify basic problems on the upstream side of the network.

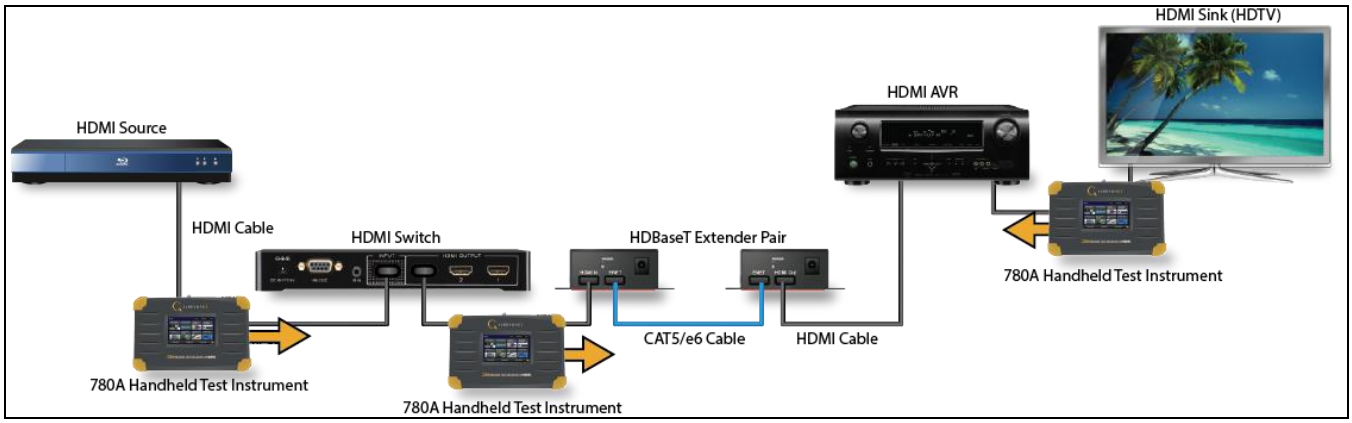

Figure 10: 780A Diagnostics using Emulation and Segmentation on HDMI HDBaseT Distribution Network

Figure 11: 780A Format Analyzer Test Screen

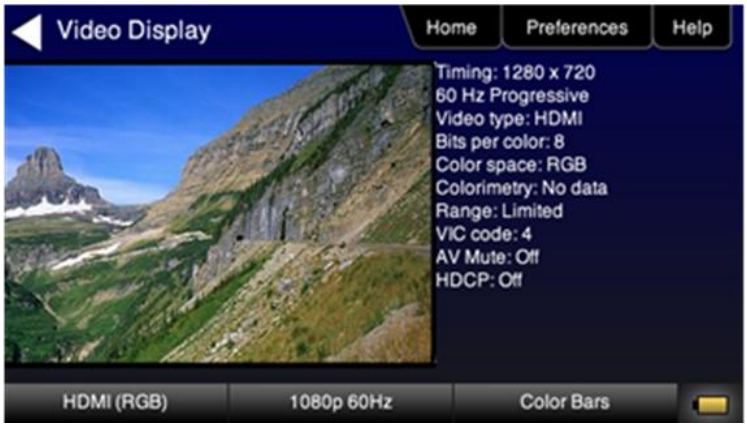

Figure 12: 780A Video Display Test Screen

Passive monitoring of the HDCP and EDID transactions

Emulation and segmentation does not enable you to diagnose all problem types because with emulation the 780A test instrument is playing an active part in the network—either as an HDMI source or an HDMI sink device. Often HDCP problems can only be diagnosed if you can view the authentication transactions between the components in the actual A/V network. This requires passive monitoring. A unique and powerful feature of the 780A is its ability to passively monitoring the DDC channel—HDCP transactions and EDID exchange--between three components and devices. Figure 13 shows an illustration of the HDBaseT network with the 780A passively monitoring the transactions from an HDMI source through an HDBaseT extender to an HDMI display device. Two monitoring locations are shown in the illustration; one on the upstream side of the HDBaseT extender pair and a second location on the downstream side of the extender pair.

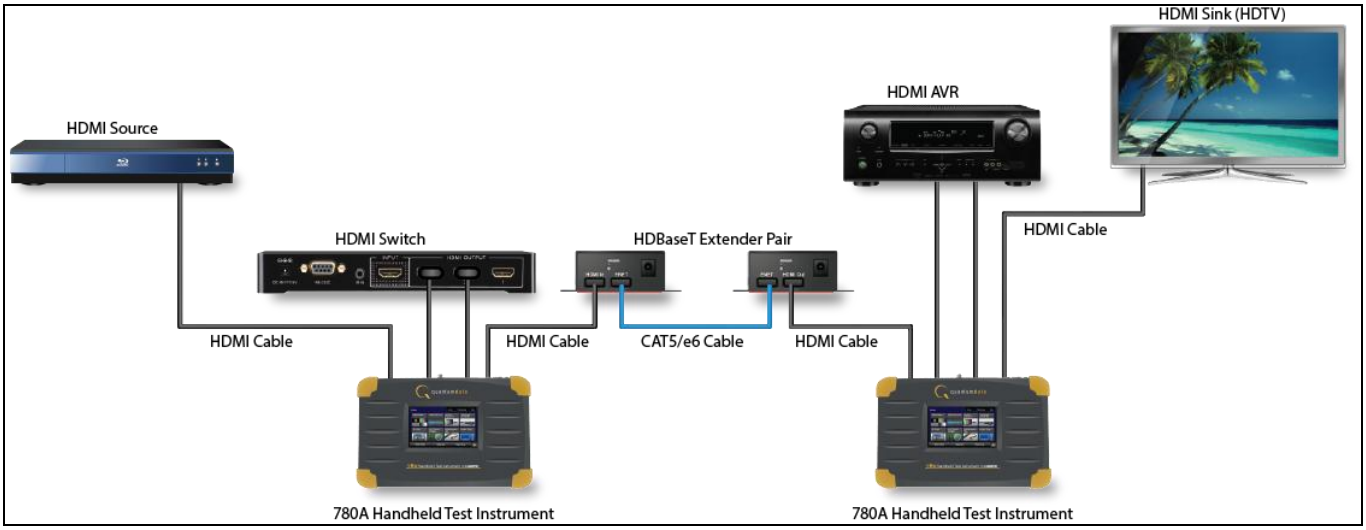

Figure 13: 780A Passive Monitoring of DDC traffic

Passive monitoring enables A/V professionals to view the HDCP transactions, EDID exchange as well as the connection events (+5V and hot plug [not shown in the screen shot below]) between the actual devices in the network. Figure 14 depicts a screen shot example showing EDID and HDCP transactions while passive monitoring both the upstream and downstream sides in a network. You can view the details of each transaction to gain further insight into each transaction (details are not shown in screen example below). The HDCP authentication transactions, EDID exchange and connection events can be logged and saved for later analysis. They can be disseminated to colleagues and subject matter experts at other locations.

Figure 14: 780A Screen showing DDC transactions logged

The 780A is a flexible and feature-rich test instrument enabling A/V professional to pre-qualify their network design, verify their installed network and diagnose problems on-site when they arise.

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.

Quantum Data played a key role in creating the CEDIA course for HDMI Troubleshooting which was based on their 780 Test Instrument. More recently Quantum Data contributed in the CEA R10WG3 Working Group in the creation of: "*R10WG3 Home Theater Video Design Working Group - Parameters of Verification for Installation of HDMI Distribution Networks Utilizing Existing Cat5/6 or Coax Cables*" also based on the 780.

Quantum Data Coming Events

Visit Quantum Data at the 2013 Infocomm show in Orlando and attend the 780-based HDMI Troubleshooting course.