Ensuring Interoperability in EDID implementations

A White Paper by Quantum Data, inc.

Overview

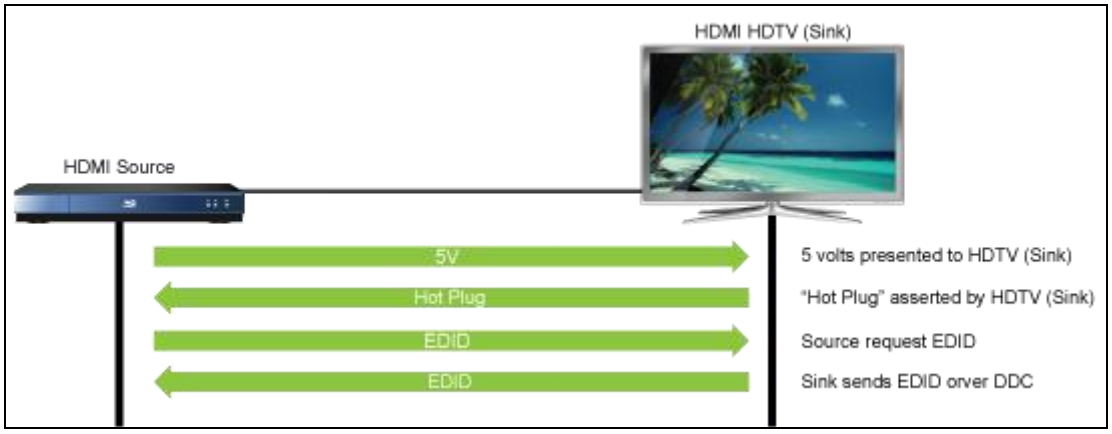
Extended Display Identification Data (EDIDs) were created by Video Electronics Standards Association (VESA) to support “plug and play” on PCs when VGA monitors supported multiple video resolutions. The Consumer Electronics Association (CEA) adopted EDIDs for use in consumer electronics HDMI devices and added an additional 128 byte block. The original VESA EDIDs in computer monitors were relatively simple compared to the EDIDs that now reside in HDMI consumer electronics devices which is the focus of this white paper.

EDIDs are compact data structures that reside in a display device—commonly referred to as “sinks” in HDMI standards documents. Sink devices include video rendering components such as HDTVs, computer monitors, projectors, etc. However, the input sides of “repeater” devices also have EDIDs. Repeater devices include video scalers, audio receivers, and HDMI distribution devices such as switches, splitters and extenders.

How EDIDs Work

When implemented properly, EDIDs serve a very useful purpose. Source devices (players, set top boxes, PC, etc.) read the audio and video capabilities of sink devices and configure their output such that the optimal audio and video are rendered. Without the information provided in EDIDs and the ability to interpret the information, a user would either have to examine the specifications of the source and sink devices and set the optimal video and audio output accordingly; or they would have to configure the source output by trial and error.

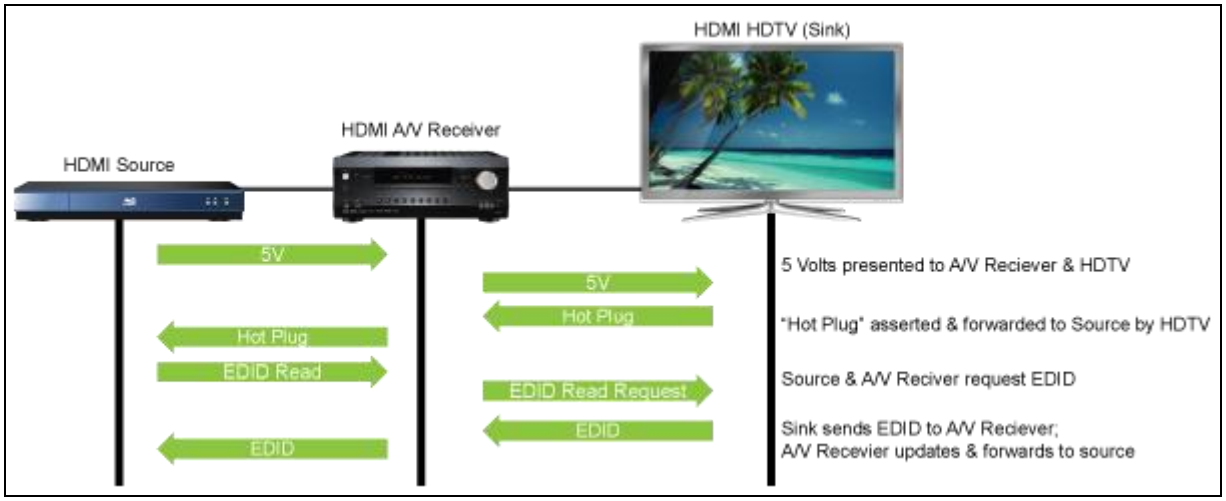
In the simple case of an HDMI source device connected directly to an HDMI sink device in the same room, the exchange and configuration associated with EDIDs is usually straightforward. The EDID has a preferred timing (resolution) and the source puts that resolution out if it is capable of doing so. If not, the source will browse through the EDID and select the next best resolution taking into account the native resolution of the video content and its ability to scale video.



The process for the audio is similar. Typically HDTVs support only 2 channel audio and indicate this in their EDIDs. In this case, with an HDMI source connected to an HDMI sink (e.g. HDTV) the source player device sets the audio format on the HDMI stream to “Basic Audio” – two (2) channel LPCM.

There are a variety of other important things that an EDID exchange has to accomplish in addition to selecting the proper video resolution and audio format. Many of these pertain to advanced features. These include whether a sink video rendering device supports YCbCr colorimetry with 4:2:2 sampling, lip sync handling, “deep color” and 3D format structures. For those using Consumer Electronics Control (CEC), the EDID provides essential addressing information. If the physical address for a device is not established by the EDID then very few functions related to CEC will work.

As HDMI installations have become more complex with the addition of various intermediate devices such as video scalers, audio receiver systems, and distribution devices, interoperability problems related to EDIDs have become more common.



What Can Go Wrong?

While properly formed EDIDs can provide all sorts of useful information to make the installation of HDMI-based A/V devices easier, they are not without problems. Were you to sift through the professional forums you would find many threads citing problems whose root causes are traceable to EDID issues. (A few examples are discussed in this section below.) The classic symptom of an EDID interoperability problem is that the video or audio will be rendered but rendered in an anomalous or non-optimal way. In some cases, an EDID interoperability problem could result in no audio or video being rendered at all, but this is less common.

Some EDID related interoperability issues are caused by protocol failures such as improperly formed EDIDs, EDIDs claiming capabilities the sink device itself does not have, or the inability of a source to parse a properly formed EDID. Some are related to configuration issues, i.e. failing to properly configure EDID settings of intermediate devices that have this capability.

Other EDID interoperability problems are caused by the underlying physical channel. This is more common when HDMI distribution network components are used. The EDID is transmitted over the DDC channel which is comprised of a clock and data wire. Excessive electrical impairments on the DDC channel can cause corrupt bits by “smearing” the digital signal. Smearing can result in bit errors when binary zeros (0) are interpreted as binary ones (1) or vice versa. Corrupt bits during the exchange of EDID information will almost certainly result in at least a transient interoperability problem due to a checksum error. If checksum errors are common over the channel, the correct EDID may seldom be

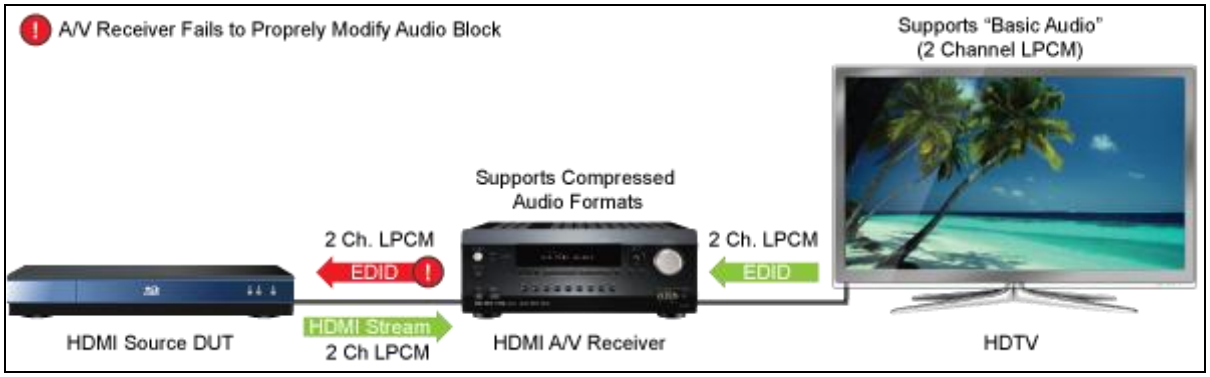
received. In most cases when the checksum is bad, a source will re-read the EDID. If the source cannot successfully read an EDID it should send video at the minimal resolution and transmit basic audio rather than 1080p60 with 7.1 high bit rate audio for example. A corrupted EDID header could be interpreted as a DVI device by the HDMI source in which case the source would not transmit any audio.

It is not easy to distinguish between EDID protocol handling problems on the one hand and corrupt bits in the underlying physical channel on the other without specialized test instruments. Test instruments that enable viewing of the EDID content can reveal the true cause by identifying checksum and header errors in the EDID and also by ruling out protocol handling problems as a possible root cause.

"No audio or low quality audio out of A/V receiver connected to a projector"

A/V receivers have to ensure that the EDID passed upstream to the source includes the proper video resolutions and the correct set of supported audio formats. Consider a common and uncomplicated HDMI installation involving a Blu-Ray player connected to an A/V receiver which in turn is connected to an HDTV.

There is an EDID stored both in the Input side of the A/V receiver and also in the HDTV input. The EDID that gets passed to the source device (Blu-Ray player) is essentially a composite EDID that must contain the proper video resolutions and audio formats such that the best possible audio capabilities are rendered on the A/V receiver and the best possible video resolution is rendered on the HDTV through the A/V receiver. To accomplish this, the A/V receiver has to substitute its audio block for the audio block of the downstream video rendering device before forwarding it upstream to the source device. If it fails to substitute its audio block, or does so improperly, the source will send audio based on what is in the EDID it is presented with, which could be basic audio, i.e. 2-Channel LPCM. This is depicted in the illustration below. In the case of a projector, there may not be an audio block in the EDID at all and in the case of the scenario above, there may not be any audio in the HDMI stream at all.

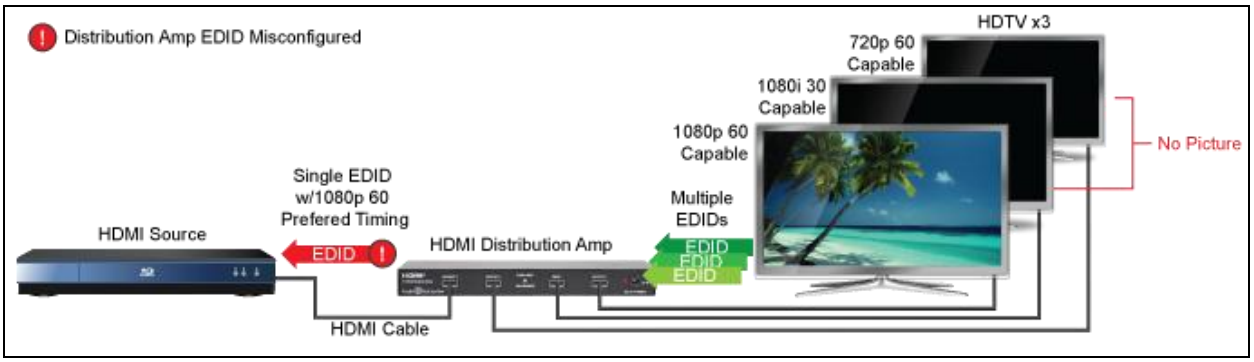


"Not getting 1080p on HDTV through A/V receiver"

Typically an A/V receiver will present the source with the "preferred timing" of the downstream HDTV even when its own preferred timing is different as long as the A/V receiver supports the HDTVs preferred timing. The A/V receiver also has to remove any video resolutions that it does not support from the EDID received from the downstream HDTV before forwarding it to the source device. For example, if the A/V receiver does not support the HDTV's preferred timing, typically 1080p60, it presents its own preferred timing (resolution) to the source device which will almost certainly be—and needs to be—supported by a newer HDTV. In this case the viewer might be puzzled as to why they are not getting full 1080p video on their nice new HDTV.

"Not getting video out of one output on distribution amp"

When distribution amps (splitters) are involved, there is only one EDID presented to the source, but two or more HDTVs connected to the splitter's outputs. If the video capabilities of the HDTVs connected to the outputs of the distribution amp differ in their A/V capabilities, then either some of the HDTVs will not render video at their highest capable resolution or some will not have any video at all (depicted in the illustration below). EDID interoperability problems involving distribution amps are more often related to improper configuration of the distribution amp's EDID settings than an error in protocol handling. In these cases, understanding how EDIDs are exchanged, what information they contain and especially how they are configured in a distribution or switching device are critically important in getting the A/V installation commissioned.



"Video image looks purplish"

A purplish image (or a green image) can be the result from an EDID problem but it can also be caused by the video metadata in the HDMI metadata (AVI InfoFrame) being inconsistent with the video transmitted in the stream. If a sink's EDID claims to support YCbCr and 4:2:2 sampling but in fact does not, the video color will be incorrect if the source sends out video with this color space and sampling mode.

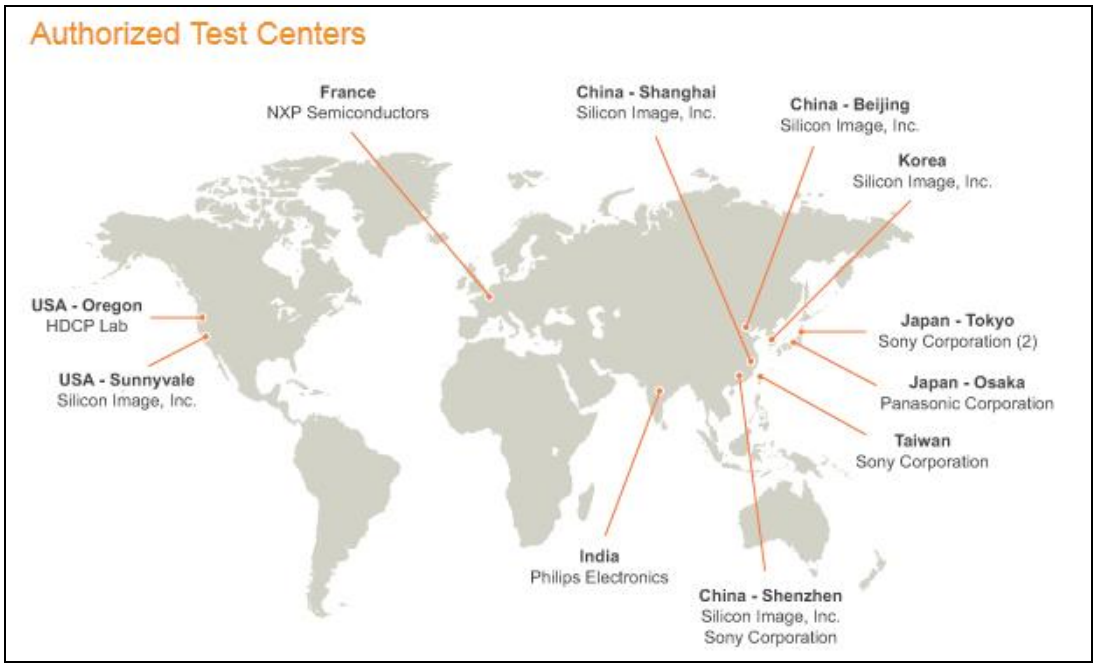
Verifying EDIDs

Given the importance and complexity of EDIDs, a mechanism for verifying that they work properly is essential. There are several mechanisms established by the industry for testing EDIDs.

Compliance Testing

The primary mechanism within the Consumer Electronics A/V industry for ensuring EDIDs do what they are supposed to do is through compliance testing. HDMI, LLC publishes both a general Specification and a Compliance Test Specification (CTS) associated with the general specification for each release. There are several "Test IDs" associated with EDID verification in the HDMI CTS. Each is designed to test a particular aspect of EDID compliance.

Compliance testing is conducted at any of the HDMI Authorized Test Centers (ATCs) throughout the globe (see map below). These ATCs are equipped with the "approved test tools" along with a team of highly technical test engineers who know the ins and outs of the HDMI CTS and how to operate the various approved test tools. The approved test tools are provided by test instrument manufacturers that serve this market. Typically the manufacturers of HDMI devices procure these approved test tools to conduct pre-testing or even self-testing where the HDMI testing policies and procedures allow this.



However, *compliance testing is no guarantor of interoperability*. Because of the complexity of EDIDs, it is quite possible to be approved as a compliant EDID device, yet encounter EDIDs constructed in ways that, although compliant, were unanticipated. Compliant EDID structures that are atypical in form can result in interoperability problems when exchanged.

"Plug Fests"

Plug Fests offer added assurance of EDID interoperability. Plug Fests are sponsored by the Consumer Electronics Association (CEA) and are held once or twice a year at various locations. Their focus is to ensure that the new generation of HDMI products interoperate with one another. Manufacturers from all over the world are invited to bring their latest HDMI source, sink, and repeater devices for testing. All participating suppliers of HDMI devices test their products under NDA; source manufacturers test their devices with those of sink and repeater manufacturers; repeater manufacturers test their devices with both source and sink devices.

Ensuring EDID Interoperability in the Real World

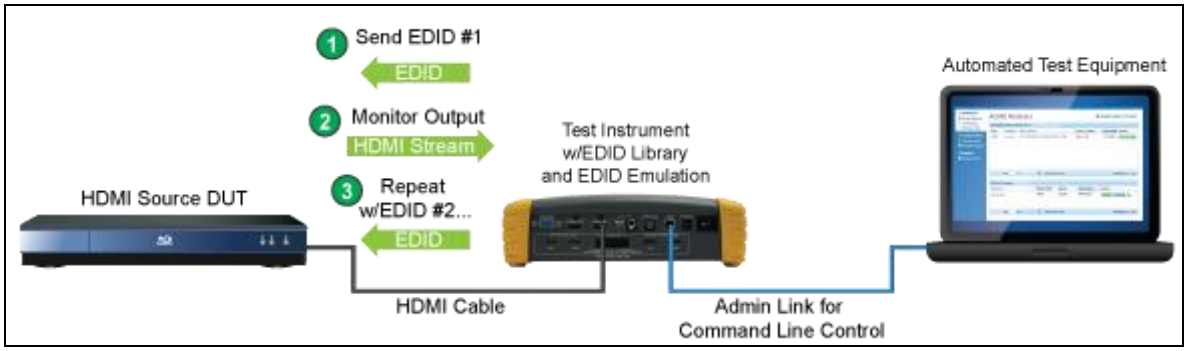
Plug Fests, although a marvelous invention, are aimed only at ensuring that new products interoperate with one another. *Plug Fests do not ensure that products of differing vintages interoperate*. There is no provision to test products released in 2010 with products released in 2012 for example which is common in the millions of residences and businesses throughout the world. Manufacturers of HDMI products construct validation labs to achieve an additional measure of assurance for interoperability. However assembling enough of a variety of devices to represent a sufficient sample of EDIDs for thorough testing is arduous and prohibitively expensive. A better solution is needed.

EDID Library – For Product Manufacturers

The ideal solution for a manufacturer of HDMI source and repeater devices to ensure that their product

interoperates with a wide variety of EDIDs, is to procure test instrumentation with the capability of emulating any EDID. An EDID emulator is an important feature of test instrumentation which should also be capable of conducting many other useful tests on HDMI devices. The ability to emulate an EDID is essential, but the real value of EDID emulation insofar as ensuring interoperability is concerned, is to provide an entire library of EDIDs with a variety of capabilities and, importantly, whose structures are at the boundaries of compliance and even intentionally flawed in ways that mimic what is likely to exist in the real world. Source devices should be able to output video and audio even when confronted with a bad EDID or an EDID that is formed in an uncommon way.

Automated testing using test instruments equipped with a library of EDIDs would allow test engineers to conduct true robustness testing on their source or repeater devices to ensure that they will interoperate with the EDIDs of virtually any product in any installation. Although human operation during testing is useful, automation is an essential feature of test instruments for efficiently testing source and repeater devices for EDID interoperability. Automated testing employs command line tools for sequentially loading and assigning EDIDs for emulation and then verifying that the proper audio and video output is achieved.



EDID Library – For ProAV Integrators

EDID emulation along with an EDID library is not only useful for manufacturers when readying their devices at the end of the product release cycle. These EDID capabilities, tools and library are also an important tool for professional A/V installers and integrators. More often than not, an integrator will have to ensure that the HDMI products he/she is procuring for the job interoperate with existing products on site, which in many cases will be older devices—sometimes quite a bit older.

Imagine a scenario where an A/V professional is installing a complex HDMI network within a home or small business. The network may consist of an HDMI switch, extender, A/V receiver and several HDTVs. Often there are source devices already on premises; perhaps an older set top box, DVD player, PC or media server. It is certainly in the best interest of an A/V integrator to remove any older devices that will not play well with newer, known-good EDIDs. Some integrators bring a small HDTV with a known-good EDID to their sites to conduct tests on existing source devices. But it is much more efficient and far more effective to bring a portable test instrument that can emulate a large number of EDIDs to a site.

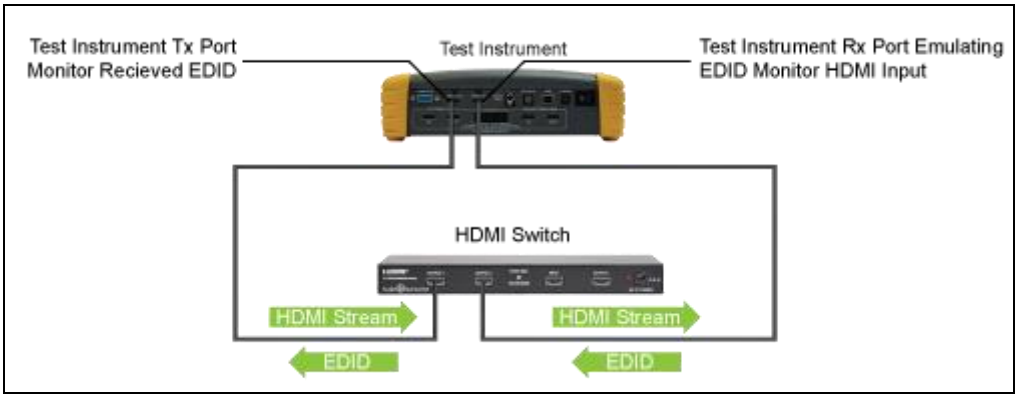
Using test instruments equipped with an EDID emulator and an EDID library (as well as other important tools), an installer can quickly conduct a suite of tests on the existing source devices to ensure that they can properly handle the EDIDs of the new devices that the integrator is installing. Further testing can ensure that existing source devices will interoperate with virtually any EDID. And this can all be done prior to shipping or transferring the new A/V components to the installation site.

Building up the EDID Library

Updates to an EDID Library with new commercial HDMI devices should be posted by the EDID library provider. However, both manufacturers and A/V integrators can collect new EDIDs—beyond what the EDID Library supplier provides—using the tools provided by some test instruments. EDIDs can be captured from HDTVs, projectors, PC monitors, repeaters and various other displays and stored in the library, simply by connecting the test instrument to one of these devices. Over time, test engineers and A/V integrators can accumulate a large collection of all varieties of EDIDs. Owners of test instrumentation can also take advantage of the tools for creating new EDIDs themselves and adding these to their EDID library for testing as well.

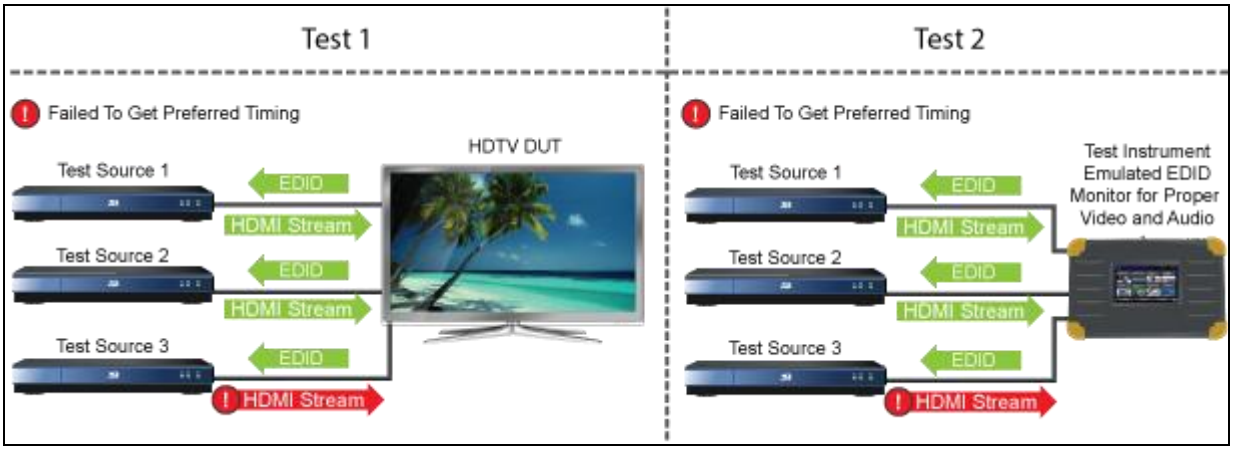
Repeater Devices – A Special Case

Repeater devices such as video scalers, A/V receivers, extenders, and switches have both a sink and a source side. A repeater's sink side presents an EDID to a connected source device. A repeater's source side receives an EDID from a connected sink device (test configuration is depicted in the illustration below). Whether verifying a repeater device's handling of EDIDs in the development lab or on site during an installation or in preparation for an installation, testing with a variety of EDIDs is necessary. Test EDIDs are applied on the repeater's output with the test instrument emulating a sink device. The resulting EDID received from the repeater's input is monitored at the test instrument's output. Testing in this way is essential for two reasons: 1) ensuring that the repeater device will operate properly when the A/V system is installed and 2) providing a significant measure of assurance that whatever new devices are installed in subsequent years the repeater will interoperate with them.



EDID Emulation – Not Just for Testing Source and Repeater Devices

Although it may not seem obvious, the value of EDID emulation is not limited to testing source and repeater devices. EDID emulation with an EDID library can be important when testing HDMI sink devices as well. Why? Consider a scenario testing an HDTV or projector in a manufacturer's validation lab with a few source devices that are available. When an EDID related failure occurs on one source device but not another, test instruments with EDID emulation capabilities and an EDID library can corroborate a suspicion that the source device is not handling the EDID properly. If the suspect source device fails to properly parse most or any EDID from the test instrument—judged by the audio and video it outputs or fails to output—it is fair to say that the EDID failure is not attributable to the HDTV or whatever sink device is being evaluated.



Beyond the value of EDID emulation with an EDID library related to testing HDMI sink devices, test instruments that can emulate an HDMI source device provide obvious value by enabling a test engineer to test the EDIDs of their sink against a known-good source device with a rich set of tools for testing EDIDs as well as other HDMI features.

In Summary

EDID are complex but essential data structures. When implemented properly, they greatly simplify HDMI interoperability. However, implementing EDIDs correctly is difficult; verifying that the components, within which they reside, will interoperate with other HDMI components once installed, is also difficult. Test instruments with a versatile EDID emulation function, a large library of EDIDs and EDID editing and testing tools are essential for efficiently and effectively ensuring EDID interoperability.

About the author: The paper was authored by Quantum Data Inc. Quantum Data specializes in the manufacturing of compliance and interoperability test equipment for digital video interfaces. Recently Quantum Data has offered an EDID library to the industry. This EDID library can be used with Quantum Data's test instruments such as the 980 HDMI Protocol Analyzer, 780 Handheld Test Instrument and the 882EA Video Test Instrument. Quantum Data also offers a variety of EDID related test tools such as EDID Editors and DDC monitoring.