

Extending HDMI and other Digital Display Signals

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While the advantages of HDMI and other digital display signals are well documented, the challenges of distributing those signals remain. The limited transmission distances, the lack of field termination and the limited reliability of the extenders on the market have hampered the adoption of this technology. In 2008, several new technologies will become available to further enable the adoption of HDMI™, DVI™ and other digital display signals including DisplayPort™.

The Advantages and Disadvantages of HDMI

There are essential advantages to HDMI and other digital display signals:

- **Content protection for copyrighted material.** The highest quality output from High Definition sources will only be available with some form of copy protection, and only available with digital signals.
- **Digital signal integrity.** The next advantage to digital signals is that they can be stored, transmitted and viewed without changes from the original, unlike analog signals where degradation is subtle and always occurs.
- **Effective source and display relationship.** Digital signals allow a one-to-one pixel relationship between the source and the display, eliminating scaling devices that degrade the image.
- **Appearance and efficiency.** A single cable is used to connect source and display, reducing the “rat’s nest” behind the equipment rack.

Scalers are the enemy of great images. Many installers negate the advantage of HDMI signals by using source resolutions different from the native resolution of the display. Pixeled displays (LCD, DLP, Plasma and ILA) will look their best when the source resolution matches the display, and there is no advantage to using an HDMI source with an analog (CRT) display.

The disadvantages of HDMI technology include:

- **Unfamiliarity with the quirks of HDMI by the installer.** Early adopters faced equipment and cables that did not meet the standard of performance for today’s mainstream products.
- **Mixed format systems.** For example, legacy computers, DVD players, set-top cable and satellite boxes are often combined with state of the art HD tuners, Blu-Ray™ and HD-DVD™ sources. Switchers and other devices are not designed to combine analog and digital formats and then transmit them to a single digital output. HDCP© (High-Bandwidth Digital Content Protection) handshakes between devices complicate the issues quickly.
- **Distance limitations.** The distance limitations of digital display signals are a fear factor, discouraging adoption by all but the bravest installer!

Perhaps it can be said that the greatest impediment to adoption has been the changing HDMI standard itself.

HDMI Categories: Home Theatre vs. Commercial Applications

HDMI 1.3 standard was released about a year ago. It divides HDMI performance into two categories, 1 and 2. Nominally, Category 1 is designed for home theater applications (2.23 Gbps), and Category 2 is designed for higher-resolution commercial applications such as 3D flight simulators and electronic cinema (10.2 Gbps). Devices that advertise HDMI 1.3 compliance are normally compliant to Category 1.



The exception to this is the requirement to display 1080p with a 60 Hz refresh rate (3.73 Gbps), which approximately doubles the data

rate from 1080i, 720p and 1080p/24. The rate of 1080p/60 is a more difficult standard than HDMI 1.3 Category 1 (Liberty Wire and Cable references 1080p/60 as the normal performance level).

The techniques to support 1080p/60 are completely different than those required to support 10.2 Gbps). In addition, the costs are much lower. According to HDMI, LLC, "Consumers should not look for a particular version of HDMI, but rather for the functionality that they want the device to support (Deep Color, specific audio formats, etc.). Alternatively, consumers can look for support for these features called out in the manufacturer's product information."

Standard vs. High-speed Cables

According to HDMI, LLC:

Standard cables (referred to as Category 1 cables in the HDMI specification) are those tested to perform at [pixel] speeds of 75 MHz, which is the equivalent of an uncompressed 1080i signal.

High-speed cables (referred to as Category 2 cables in the HDMI specification), are those tested to perform at [pixel] speeds of 340Mhz, which is the highest bandwidth currently available over an HDMI cable and can successfully handle 1080p signals including those at increased color depths (e.g. greater than eight bits per color) and/or increased refresh rates (e.g. 120Hz). High speed cables are also able to accommodate higher resolution displays, such as those at the latest 1440p and WQXGA resolutions (e.g. cinema monitors with a resolution of 2560 x 1600).

The changes in HDMI 1.3 Category 2 include:

- **Higher speed:** Although all previous versions of HDMI have had more than enough bandwidth to support all current HDTV formats, HDMI 1.3 increases its single-link bandwidth to 340 MHz (10.2 Gbps) to support the demands of future HD display devices, such as higher resolutions, Deep Color and high frame rates. In addition, built into the HDMI 1.3 specification is the technical foundation that will let future versions of HDMI reach significantly higher speeds.
- **Deep Color:** HDMI 1.3 supports 10-bit, 12-bit and 16-bit (RGB or YCbCr) color depths, up from the 8-bit depths in previous versions of the HDMI specification, for stunning rendering of over one billion colors in unprecedented detail.
- **Broader color space:** HDMI 1.3 adds support for "x.v.Color™" (which is the consumer name describing the IEC 61966-2-4 xvYCC color standard), which removes current color space limitations and enables the display of any color viewable by the human eye.

The Future of HDMI

The fastest format used in 99% of all home theaters, now and in the foreseeable future, is 1080p, with a 60 Hz refresh rate and 8-bit color. That requires a 3.73 Gbps data rate, well within the capability of most Liberty cables. Twelve-bit color raises that to 5.23 Gbps (used by Sony Playstation games). There is no plan within the industry to change the Blu-Ray, HD-DVD, or broadcast standards to a higher resolution or to increase color accuracy. Only digital cinema and commercial computer simulation will require that level of performance.

When manufacturers say they are 1.3 compliant, they are normally referring to Category 1, which is a very low threshold 1080i/30. That is a 1.87 Gbps data rate; 1080p/24 is even lower at 1.49 Gbps. Category 2 compliance is very difficult to prove, as there are no test devices available to do the analysis.

Since this is a digital signal without error correction, discrepancies are immediately visible and there is no value to a "better" cable provided no errors are visible. Exceptions to that statement

include resistance to outside EMI from devices such as cell phones which can create havoc with the signal and a loss of audio, which often happens on lower quality cables at shorter cable lengths than the lengths at which video fails.

No copper product to date by any manufacturer of HDMI can pass 10.2 Gbps past 10m (33 feet). Currently, the best way to stretch that length is to use electronic devices with coax cables or fiber. 10 Gbps would be required for a computer with a resolution of 2,560 x 1600, 12 bits of color per pixel, and a refresh rate of 60 Hz.

Installation Techniques: Extending the HDMI signal

Liberty Wire and Cable is a leading producer of HDMI products that transmit over long distances. Currently, we offer HDMI cables up to 35 meters (115 feet) in length. With most modern equipment they will work successfully, without additional electronics in HDMI 1.3 Category 1 applications. They will not work in Category 2 applications. In addition, the HDMI connector was not designed for field termination and that makes it difficult to pull into walls and when damaged makes it difficult to repair. Thus, installers have looked for a variety of other solutions

There are four basic techniques:

1. HDMI cables with "extenders"
2. UTP (category cable) extenders for HDMI
3. Coax extenders for HDMI
4. Fiber extenders for HDMI

Each strategy has advantages and disadvantages and should be chosen carefully. Many of the devices are excellent as video extenders, but lose performance with the digital audio signals (DVI mode). HDCP is also a challenge for some manufactures. Confirm that the extender you chose supports both these signals at the distance you require.

HDMI Cable Extenders

Using standard HDMI cables with extenders is the most basic way to use HDMI over longer distances. These devices can be included in a system as insurance against failure due to poor performing sources and displays. The most recent versions of these devices:

1. Use a wall wart for power (due to insufficient power at the HDMI port for this application)
2. Should be used at the end of the cable, not at the source.
3. Equalize and add gain to the signal, but don't regenerate it. Thus there is a limit to "daisy-chain" applications. The lengths include total distances from the source (not a switcher) to the display.
4. Use electronics which may fail, thus should not be permanently attached to the cable or built into a wall without an access port.
5. Require quality cables on both sides of the extender.

UTP (Category cable) Extenders

UTP (Category cable) extenders for HDMI have been around for several years. Early versions were notoriously finicky, requiring shielded cables and connectors, and careful cable positioning and termination. The latest devices are considerably better, although they remain susceptible to

EMI (Electro Magnetic Interference) from cell phones are other high level emitters such as florescent lights, motors, microwave ovens and light dimmers.



Liberty UTP HDMI Extender

There performance improves dramatically with better cables. We recently compared the performance of Liberty's new devices and had 25-30% improvement in distance with CAT6 compared to a quality CAT5e cable. Shielded cables will reduce effects of EMI. These devices use 2 Category cables for each run.

UTP extenders perform acceptably for HDMI 1.3 Category 1 applications. Their performance is much more limited with 1080p/60 sources. The recent tests showed good video performance for 1080i at 80 meters with CAT6 cables, but only 30 meters with a 1080p/60 signal.

Proportionally shorter distances were achieved with a CAT5e cable. With both cables, the image was disrupted with a Blackberry about 1 meter away from the cables. When the Blackberry was actually laid on the cables, the disruption was so bad that the devices were unable to recover without disconnecting and reconnecting the devices.

These devices are very attractive since Category cable is inexpensive and readily available, easy to pull and termination systems are readily available. They have severe limitations in high EMI environments, or where there are high resolution sources with high refresh rates.

Liberty offers these devices both as stand alone devices and as wall plate mounted devices designed for a neatly finished installation. Liberty has anticipated product availability shipment in early Q2 2008; the MSRP will be \$399.



HDMI over UTP wall plates

Coax Extenders

No copper wire solution offers a more robust and reliable HDMI extension that Liberty's HDMI over coax solution. Transmitters and receivers are similar in appearance.

These devices transmit a true HDMI signal, not an analog version of the digital signal. Short, conventional HDMI cables are used to connect the transmitter and receiver to the source and the display respectively. Transmission distance is governed by the quality and size of the coax cable selected.

Liberty Cable		1080p / 60 w/ HDCP Distance in feet*
RGB5C-PVC/PLN	(26 awg Stranded)	150'
RGB5-MINI	(25 awg Stranded)	165'
RGB5C-25-CMP	(25 AWG solid)	175'
RGB5C-23-CM	(23 AWG SD)	250'
RGB5C-20-CMR	(20 AWG SD)	400'
RGB5C	(18 AWG SD)	600'

*preliminary distance, subject to change without notice.



These devices are ideal for retrofits of existing

systems. The cable you used for VGA or component signals can be used with these electronics and a HDMI capable projector to upgrade older analog systems to take advantage of the newest HDMI technology. It does require a high-quality VGA cable with at least 26 AWG construction and 4 coax cables.

These electronics are HDMI 1.3, Category 2 compliant, and for use with any HDMI system. They may be powered at either end, or at both ends, which then eliminates the need for the 5th coax.

These devices use the unmatched bandwidth of precision coax cable, combined with the magic of Gennum's ActiveConnect™ technology to successfully transmit 1080p /60 Hz refresh HDMI signals over 250' feet using Liberty RGB5C-23-CM cable and easy to install Liberty ConnecTec BNC connectors. These connectors can be installed faster and more accurately than any RJ45 connector on the market. Coax cable is designed for higher frequency applications than unshielded twisted pair (UTP or category cable). Therefore is it capable of transmitting these signals much longer distances without loss than similarly priced UTP extenders.

Liberty has anticipated availability of this product in early Q2 2008; the MSRP will be \$599.

Fiber Extenders

Using fiber optics to extend HDMI signals has a great deal of promise. To date, the consumer has only a few choices:

1. **An expensive fiber only system (\$2000).** These are excellent systems but are outside the range of most home owners
2. **A four fiber UTP system.** Works well, but most technicians don't terminate fiber. In addition the cost of terminating the cables adds up quickly.
3. **A single cable with DVI or HDMI heads already installed.** This is relatively expensive, can't be repaired and can't be pulled into a wall.

There is a new generation of devices arriving on the market that resolves many of these issues. Fiber termination systems are now simple to operate and reliable. Fiber optic drivers are becoming available that will be about the size of my finger and cost about the same as the copper extenders we've been discussing. These devices will use single mode fiber which is competitive in price with UTP cable. They will use common connectors, enabling a technician to terminate in the field, or use a commercially terminated cable from Liberty Wire and Cable.

Summary

HDMI is the display signal of the future for consumer electronics. With new devices and equipment the signals can be run similar distances compared to conventional analog signal with much better results. All installers should become familiar with the many options for these cables. They should also be familiar with the cable requirements for HDMI 1.3 category 1 compared to category 2 compared to 1080p /60. That will enable the consumer to get the right product for the project.

****Data requirements were calculated by multiplying:***

*Resolution * refresh rate * number of colors * (color depth +2) (HDMI standard adds 2 bits to each pixel) E.g. 1920 * 1080 * 60 * (8+2) *3 = 3.73 Gbps*

Variations may occur in practice due to the addition of "blanked lines" and other production requirements.

Credits:

- HDMI and the HDMI Logo are registered Trademarks of HDMI, LLC.
- DVI is a registered trademark of the Digital Display Working Group
- DisplayPort is a registered Trademark of VESA
- ActiveConnect is a registered Trademark of Gennum Corporation.
- ConnecTec is a registered trademark of Liberty Wire and Cable
- Blu-Ray is a registered trademark of Blu-Ray Disc Association

- HD-DVD is a registered trademark of the DVD Forum

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