COMMSCOPE®

White Paper

Implementation Considerations for HDBaseT Networks

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Background

The availability of high-end digital video systems for both home and commercial premises is creating the need for a video distribution application supported by generic local area networks (LANs). Homeowners want to be able to move video from a central source—such as a cable company set-top box or a Blu-Ray player—to monitors in different rooms. Commercial users are looking to improve video displays in places like transportation hubs, big-box stores, auditoriums, conference centers, and digital signage. There is also an increasing need for high-definition video in healthcare, where the ability to observe, consult, and diagnose remotely over the Internet is a rapidly growing application. A detailed and exact video image can make a big difference in diagnosing and analyzing a medical condition. University classrooms are also increasing their use of sophisticated audio/visual equipment, high-speed LANs and Internet connections. Stock traders need to keep track of current news and developing events that will impact their trading decisions. It is in this context that HDBaseT is starting to gain attention as an application that extends HDMI connectivity from a few meters to a reach of 100 meters using HDBaseT and Category 6/6A cabling with the ubiquitous universal RJ45 interface connector.

Why Category 6/6A instead of HDMI cables?

HDMI was designed as a point-to-point connection protocol serving equipment within a room. Although there is no formal specification for the length of HDMI cables, in order to be certified as compliant they have to meet various video performance specs such as maximum signal attenuation. Depending upon how the cables are constructed, this limits the length to somewhere between 12 and 15 meters. So, to send uncompressed video more than about 50 feet, the use of a powered signal booster becomes necessary. HDMI is sufficient for a single room in a home, but—for whole-house or commercial applications—it does not have the 100-meter reach that is the standard length for commercial building applications. A second issue is that the HDMI connector is a special connector that makes it bulky, incompatible with common distribution cables used in commercial LANs, and very difficult to work with. This presents a significant obstacle to the distribution of digital video in commercial buildings.

HDBaseT overview

HDBaseT features

In addition to using a standardized RJ45 connector and balanced twisted pair cabling, HDBaseT includes five different functions to support:

1. Uncompressed high-definition video
2. The same audio formats supported by HDMI
3. A variety of options for device control
4. 100BASE-TX Ethernet data channel
5. DC power over the same cable

Classes of HDBaseT

Class A HDBaseT supports all five functions as described in the section on HDBaseT features up to a distance of 100 meters (328 feet). Class B HDBaseT supports only four functions (no 100BASE-TX Ethernet) up to 70 meters (230 feet).

Both classes A and B do support HD/3D HD and 2K/4K UHD uncompressed streaming video.

HDBaseT cabling

Initial specifications indicate that HDBaseT will function over Category 5E or Category 6 cabling. These specifications are for individual channels that are typical of residential premises. Neither Category 5E or Category 6 cabling have alien crosstalk specifications, so, when multiple HDBaseT distribution cables are bundled together, or laid together into trays, as is typical of commercial buildings, additional considerations and implementation practices will be needed to ensure robust and reliable support for HDBaseT.

Category 6A cabling has alien crosstalk performance specified in the TIA and ISO standards. Therefore, it can support typical bundling and cable tray installation practices used in commercial buildings — making it recommended for new installations.

Power delivery

The PoE+ standard delivers up to 25 watts at 57 volts dc and 350 mA over 2-pairs. HDBaseT intends to have the additional ability to deliver up to 100 watts of dc power by sending power over all four pairs in the cable. Due to the higher power levels, multiple HDBaseT cables should not be bundled together when delivering power to HDBaseT devices.

Due to a higher gauge and larger surface area, Category 6A cables have a higher power delivery capacity than lower Category cables and are recommended for new installations.

Signaling schemes

HDBaseT is close to 10GBASE-T in expectations of cabling using similar data rate (10.2 Gbps) and signaling schemes (PAM 16). Hence, similar transmission requirements for cabling are applicable to HDBaseT as have been specified for 10GBASE-T for commercial buildings. This includes stringent alien crosstalk specifications when multiple cables carrying HDBaseT signals are bundled or laid together in a pathway.

CommScope GigaSPEED X10D® cabling certified by the HDBaseT Alliance

CommScope GigaSPEED X10D channels up to lengths of 100 meters are certified as compliant to HDBaseT Class A specifications defined by the HDBaseT Alliance (hdbaset.org). Both UTP and F/UTP cabling solutions were tested and passed the HDBase-T 100 meter channel requirements with substantial margins.

Based on an HDBaseT engineering evaluation of the similarity of design, all CommScope Uniprise® Ultra cables are also recommended and listed in http://hdbaset.org/cables for use in support of HDBaseT.

This certification confirms that CommScope GigaSpeed X10D and Uniprise Ultra cables will support HD/3D HD and 2K/4K UHD uncompressed streaming video up to a distance of 100 meters.

Implementation considerations for HDBaseT networks

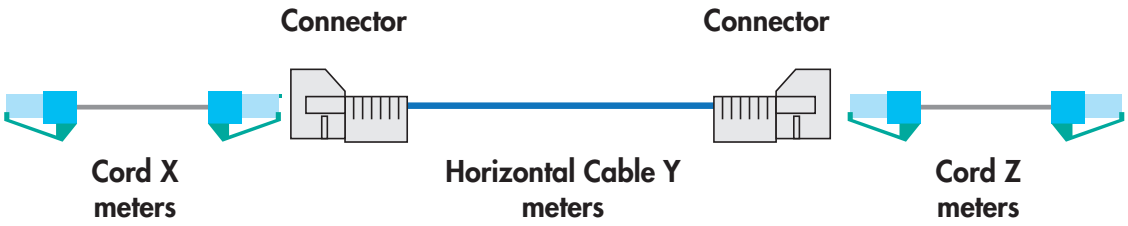
As described in the section on HDBaseT cabling, the HDBaseT specification does not currently include an alien crosstalk specification, and installation practices for bundled cables supporting HDBaseT need further investigation. The following additional common configurations were investigated using a limited set of compliant HDBaseT equipment in a laboratory environment.

1. Impact of bundling multiple HDBaseT channels using Category 6A cabling
2. Impact of bundling multiple HDBaseT channels using Category 6 cabling
3. Mixing HDBaseT channels of different length in the same bundle
4. Mixing HDBaseT with 10GBASE-T and 1000BASE-T in the same bundle

Both short and long channel configurations were investigated to ensure practical HDBaseT channels of varying lengths will function as expected. The tests were repeated with the victim channel configured in the forward and reverse directions to study the effect of both PSANEXT and PSAACRF on HDBaseT channel performance.

Figure 1 shows the configurations used to test short and long channels supporting HDBaseT.

Figures 2 through 4 show the cabling infrastructure connecting HDBaseT equipment used in the laboratory testing. Figure 5 is a typical result showing clear pictures on all channels bundled together.



4-94-1 configuration implies:

- X is 4 meter cord
- Y is 94 meter horizontal cable
- Z is 1 meter cord

Figure 1. HDBaseT short and long channel configuration illustration

Figure 2. Overview of test setup showing bundled cabling connecting HDBaseT transmitter and receiver equipment

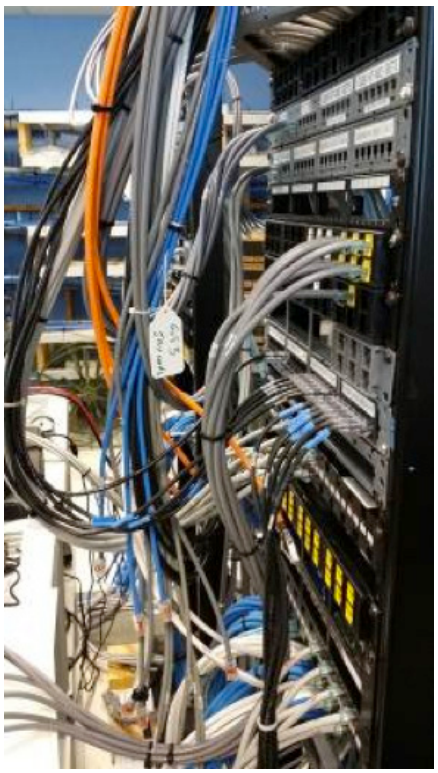


Figure 3. Detail of bundled cabling coming out of HDBaseT transmitter equipment

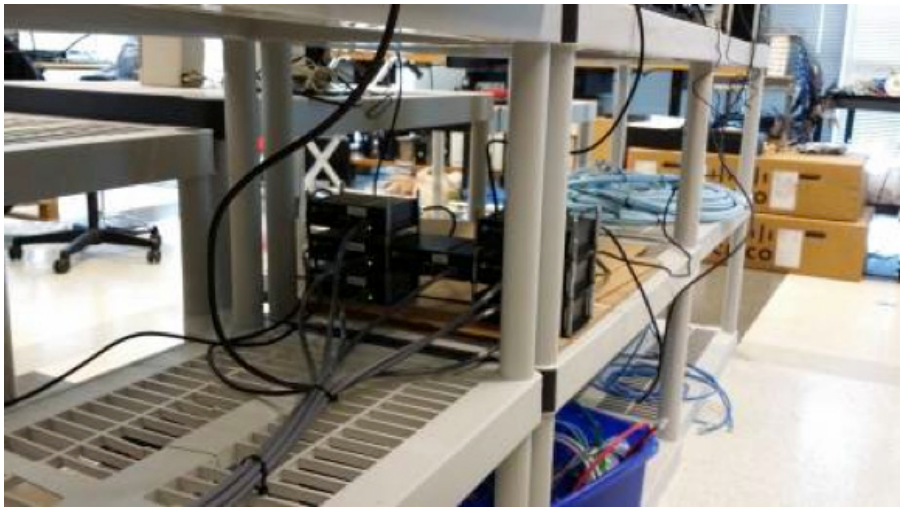


Figure 4. Detail of bundled cabling coming into the HDBaseT receiver equipment

Figure 5. Display screens connected to HDBaseT receiver equipment showing clear pictures

Impact of bundling HDBaseT channels using Category 6A cabling

Category 6A UTP and F/UTP cabling supporting HDBaseT was investigated in a 6-around-1 bundled configuration, with the results shown in the following sections.

Category 6A UTP 6A1 bundle of channel configuration 4-5-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Reverse: Test transmission with the victim channel reversed.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Category 6A UTP 6A1 bundle of channel configuration 4-5-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Reverse: Test transmission with the victim channel reversed.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Category 6A F/UTP 6A1 bundle of channel configuration 4-5-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Reverse: Test transmission with the victim channel reversed.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Category 6A F/UTP 6A1 bundle of channel configuration 2-97-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Reverse: Test transmission with the victim channel reversed.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Impact of bundling HDBaseT channels using Category 6 cabling

Category 6 UTP cabling supporting HDBaseT was investigated in a 6-around-1 bundled configuration, with the results shown in the following sections.

CAT6 UTP 6A1 bundle of 2-30-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Reverse: Test transmission with the victim channel reversed.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

Category 6 UTP bundle of 2-97-1

Forward: Test transmission with all transmitters on the near end and all receivers on the far end. If the signal is ok, the test can be considered completed; otherwise, cut 10-meter sections off of all the channels until the signal becomes stable. The results are in Figure 6 below.

—There were no observed problems (dropouts/pixilation/coloration) on any of the channels with either the Blu-Ray HDMI source or the Atlona signal generator.

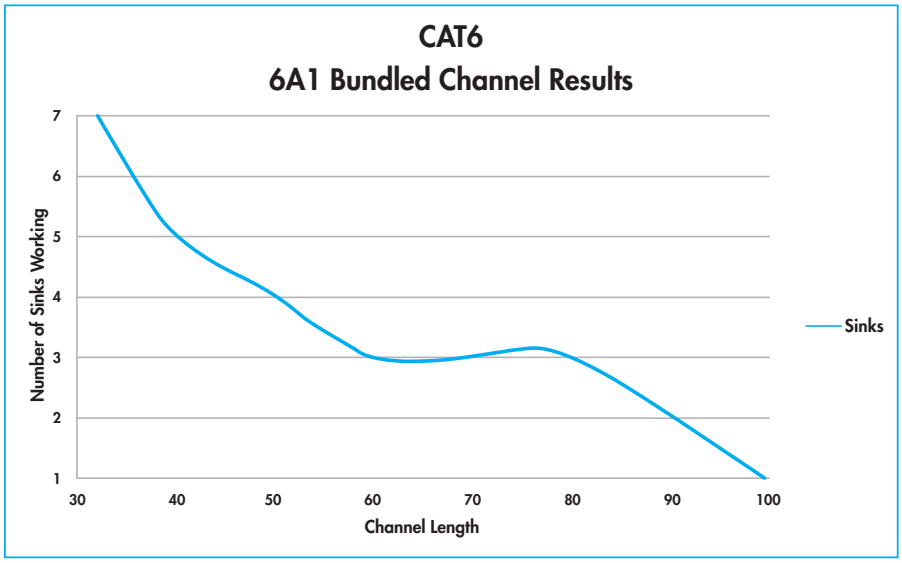


Figure 6. Length of bundling versus Signal Integrity for CAT6 Channels

Reverse: Test transmission with the victim channel reversed.

—There was significant failure with the channels at the 100-meter length. One sink at a time would come on and stay on. When the victim sink was run with no disturbers on, the channel would connect and run video without any observed problems (dropouts/pixilation/coloration). No further testing was done due to the length of the channel reaching the same as the short channel Category 6 bundle.

Mixing HDBaseT channels of different length in a bundle

The objective was to monitor a victim channel of Category 6A UTP (4-95-1) with varying lengths of disturbers. As the disturber channels are reduced in length, the signal coupling into the victim channel becomes stronger and could compromise the HDBaseT application. This test essentially uses a PSAACRF test configuration with varying lengths for the disturber channels.

Table 1 shows the lengths cut off from the disturber channels with the corresponding errors observed on the victim channel. There were no visible effects on any of the sinks—irrespective of the length of the disturbing channels.

Channel length of disturbers (m)	Errors on victim channel
100	None
90	None
80	None
70	None
60	None
50	None
40	None
30	None
20	None
10	None

Table 1: Disturber channel lengths with corresponding errors observed on victim channel

Mixing HDBaseT with 10GBASE-T and 1000BASE-T in the same bundle

The test for mixed applications was performed on Category 6A UTP long and short bundles. The test procedure consisted of using a Spirent bit error rate tester, four servers, and a switch—all to generate 10G and 1G traffic across the disturbing channels of the 6-around-1 bundle. The victim channel carried HDBaseT traffic. The performance criterion of the test was any errors on the three traffic paths (10 Gbps, 1 Gbps, and/or HDBaseT traffic). The objective of the test was to ensure the feasibility of mixed applications co-existing in the same bundle when channels are carrying HDBaseT as part of a mixed bundle.

Category 6A UTP long channel bundle 4-95-1 with mixed applications

The victim channel contained the HDBaseT traffic and the disturber channels were running the 10GBASE-T and 1000BASE-T applications. There were no errors seen on either side of the Ethernet traffic on any of the disturbers or on the HDBaseT traffic on the victim channel.

Category 6A UTP short channel bundle 4-5-1 with mixed applications

The victim channel contained the HDBaseT traffic and the disturber channels were running 10GBASE-T and 1000BASE-T applications. There were no errors seen on either side of the Ethernet traffic on any of the disturbers or on the HDBaseT traffic on the victim channel.

HDBaseT equipment

CommScope GigaSPEED X10D cabling solutions are certified to work with HDBaseT-compliant equipment (non-HDBaseT-compliant equipment is not supported).

EMC considerations

EMC is a system consideration that is the responsibility of HDBaseT system providers, including equipment, connectivity, and installation configurations tested in accordance with the IEC 61000 series of EMC standards.

CommScope is in the process of conducting some high-level sanity tests to verify the robustness of current HDBaseT equipment using both F/UTP and UTP cabling. Additional generic EMC testing is also an item under investigation for different applications. CommScope is committed to working with the HDBaseT equipment vendors to ensure EMC performance with HDBaseT-compliant cabling is maintained.

Recommendations

Category 6A cabling is recommended for HDBaseT—both from the point of view of having alien crosstalk specifications as well as better power delivery efficiency due to higher gauge conductors and greater surface area for heat dissipation. Category 6A includes UTP, F/UTP, and S/FTP constructions. When properly installed with a 360-degree shield termination around connectors and shields bonded to a ANSI/TIA-607-B/EN 50310/ISO/IEC 30129 bonding/grounding network at both ends, shielded cabling offers extra protection from EMI in noisy external environments.

Category 6 channels supporting HDBaseT are limited both in terms of bandwidth and alien crosstalk performance. Lengths above 30 meters are not recommended when the HDBaseT channels using UTP cables are bundled together or laid in a pathway system with other cables.

The following practical situations were investigated and found to not affect the performance of HDBaseT:

- Bundling multiple HDBaseT channels using Category 6A cabling
- Mixing Category 6A channels of different length supporting HDBaseT in the same bundle
- Mixing HDBaseT with 10GBASE-T and 1000BASE-T applications in the same bundle

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