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White Paper

Enterprise AV: A Practical Q&A
from HDBaseT™ to 70V audio

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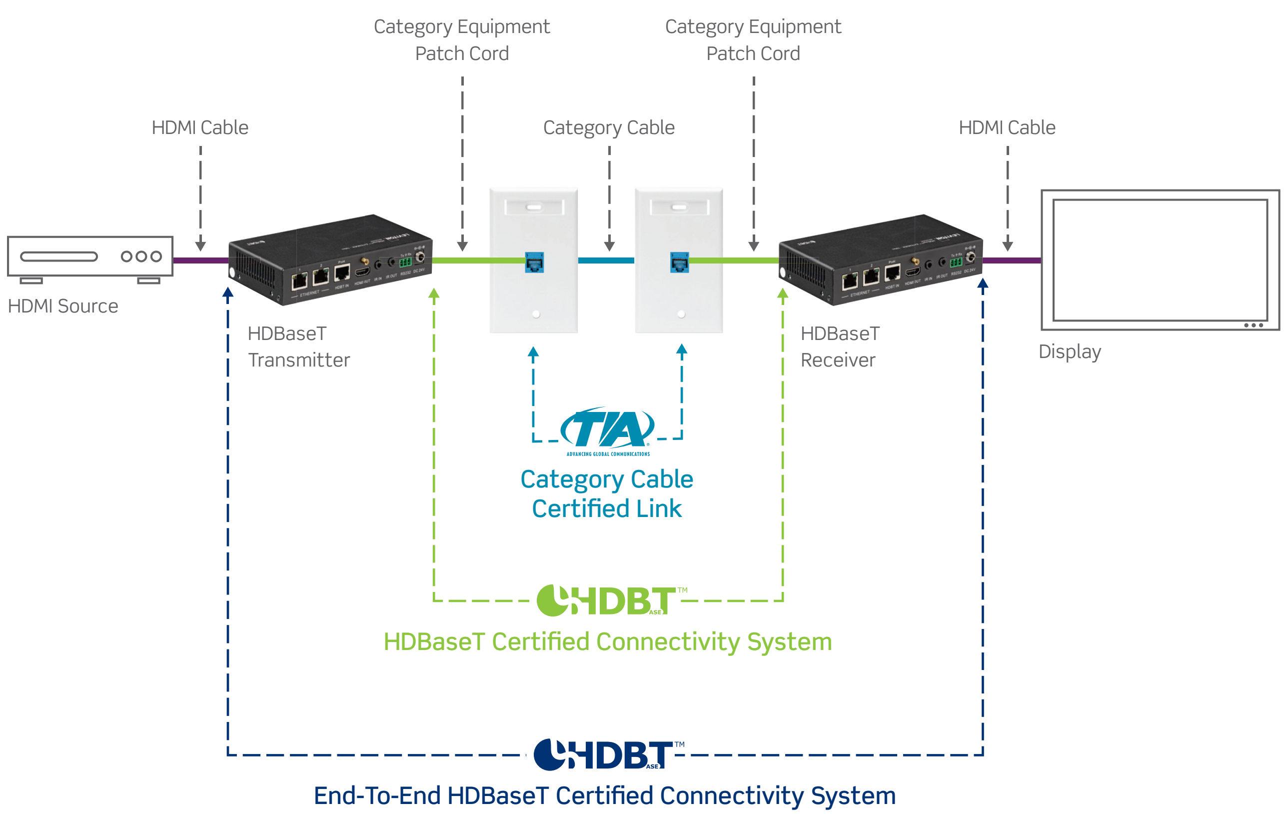
Eighty-two percent of Leviton certified contractors are deploying audiovisual technology, and that percentage is expected to grow. A key technology enabling this trend is HDBaseT which allows AV systems to be installed using the same materials and skills currently used for a LAN infrastructure, creating big opportunities and a new source of revenue for datacom installation experts. By understanding the finer points of this convergence, datacom contractors can become AV experts for their customers.

This white paper answers some common (and not so common) questions about the capability of HDBaseT technology. It also provides an overview of cabling system requirements for supporting high-density, digital audiovisual distribution for signals up to 4K and beyond.

What is HDBaseT?

HDBaseT is a technology that enables faster, simpler installations of HDMI displays and projectors. This is accomplished by using a single category-rated cable to carry the high-bandwidth signals required for high-resolution displays across distances up to 150 meters.

HDBaseT is widely adopted as a reliable, plug-and-play HDMI® extension method. With an HDBaseT AV Signal Extender you are able to turn a tested, certified datacom permanent link into an IT/AV channel that is more reliable and flexible than traditional HDMI cables or multi-conductor systems.



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Does HDBaseT Work with 4K?

HDBaseT™ is compatible with 4K video, but the distance at which the HDMI® signal is extended can vary based on the HDBaseT class, the strength of the HDMI signal, and the specific implementation of the HDBaseT technology by the manufacturer. Common video signals include 1080p and 4K (2160p).

1080p:

- 1920 pixels wide by 1080 pixels high (16:9 aspect ratio)
- Frame is progressively scanned
- Frame refreshed typically 30 or 60 times per second (fps)

4K (2160p):

- Horizontal pixel count of about 4000 pixels
- Frame is progressively scanned
- Frame refreshed typically 30 or 60 times per second (fps)
- DCI – Digital Cinema Initiatives movie projection industry standard
    - 4096 pixels wide by 2160 pixels high in a 1.9:1 aspect ratio
- UHD – Television/consumer standard
    - 3840 pixels wide by 2160 pixels high in a 16:9 or ~1.78:1 aspect ratio = 2160p

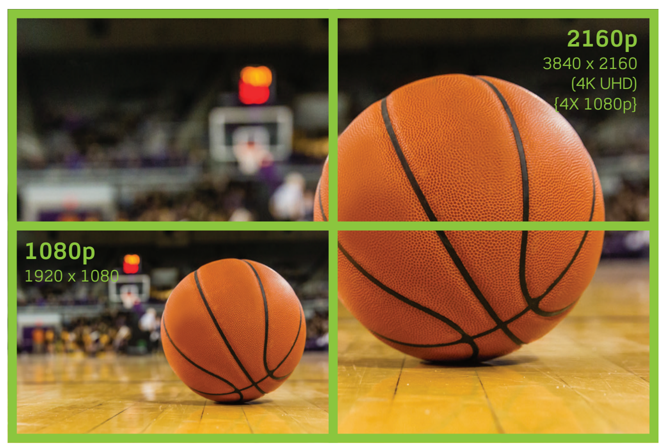
HDMI Signals

HDMI 1.4 transfers uncompressed video data and compressed or uncompressed digital audio data from an HDMI-compliant source to a compatible display. These signals support high-speed networking, audio return, 3D video formats, 4K (2160p) video resolution at 30 frames per second (fps), real-time signaling of content, and additional color spaces for enhanced digital photography and computer graphics.

Released in 2013, HDMI 2.0 transmits 4K (2160p) resolution at 60 fps for four times greater pixel count over 1080p/60 fps. In addition to being backwards compatible with earlier HDMI versions, HDMI 2.0 features:

- Transmission of High Dynamic Range (HDR) video bandwidth up to 18 Gbps
- Up to 32 audio channels for a multi-dimensional immersive audio experience
- Up to 1536kHz audio sample frequency for the highest audio fidelity
- Wide-angle theatrical 21:9 video aspect ratio
- Simultaneous delivery of dual video streams and multi-stream audio to multiple users on the same screen

The image to the right compares the 1080p and 4K (2160p) resolution.



HDBaseT

HDBaseT 1.0 was initially introduced as a point-to-point connectivity standard, and defined the 5Play™ feature set (video, audio, control, Ethernet, and power). HDBaseT 2.0 adds several new enhancements, including expanding it as a multipoint-to-multipoint technology, as well as supporting multistream and daisy chain. HDBaseT 2.0 also includes:

- USB for multi-touch and KVM applications
- Improved performance for 4K (UHD) video with enhanced error correction
- Fiber optics as a means of transmitting HDBaseT for longer distances.

For more information about HDBaseT classifications and specifications, visit: hdbaset.org

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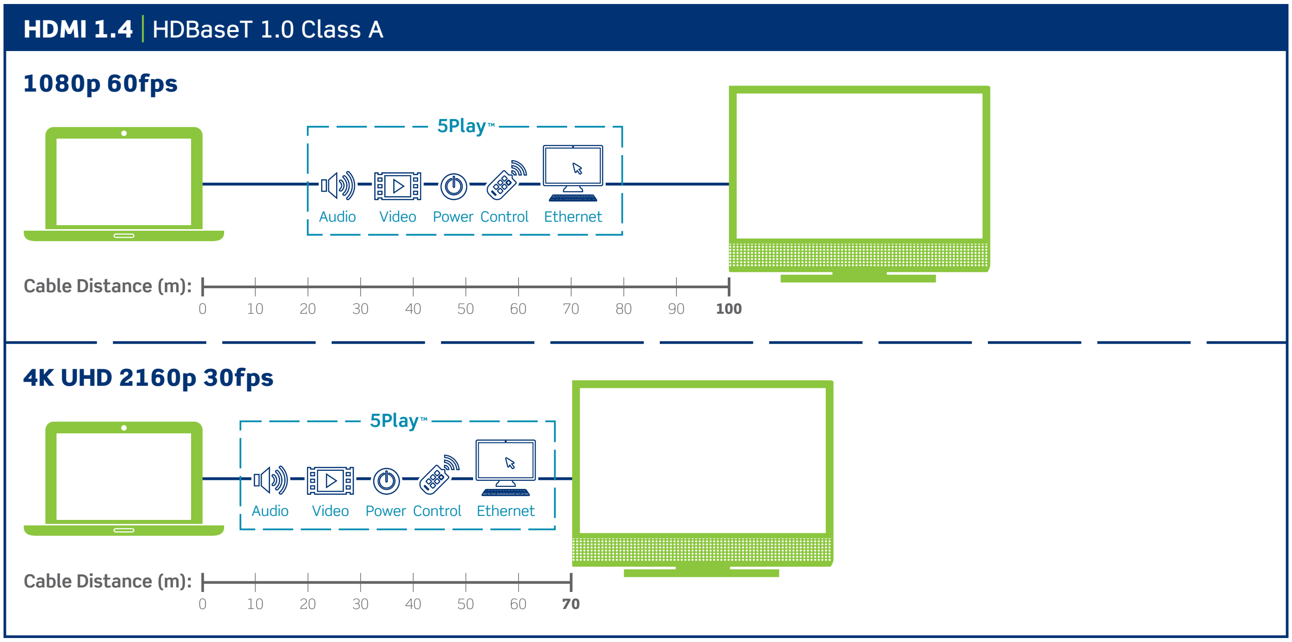
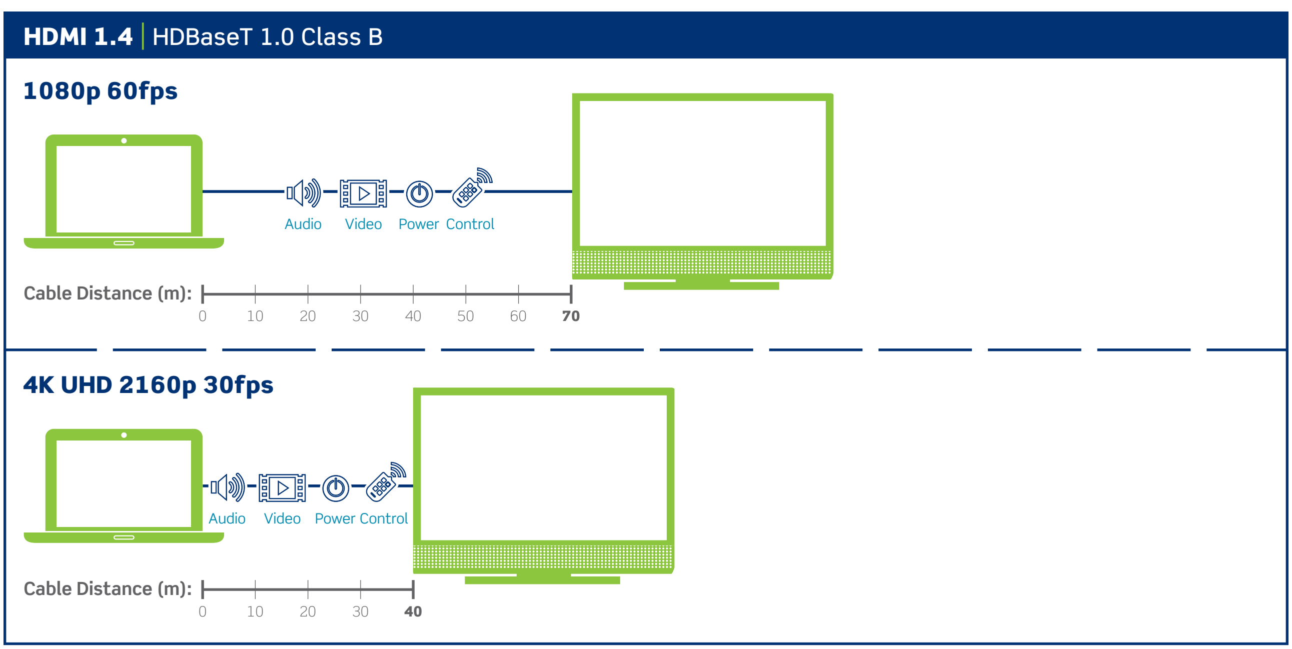
HDBaseT 1.0 Class A

HDBaseT™ 1.0 Class A extenders carry a 1080p/60 fps HDMI® 1.4 signal to a display, extending full 5Play™ audio, video, power, control, and Ethernet signals up to 100 meters. Because of the extra data received, the distance for a 4K UHD 2160p/30 fps signal is typically shorter at 70 meters (depending on manufacturer) and the refresh rate is only 30 fps. This potential limitation must be considered when designing an extender solution. The choice of extender can limit the ability to easily upgrade from 1080p to 4K resolution.



HDBaseT 1.0 Class B

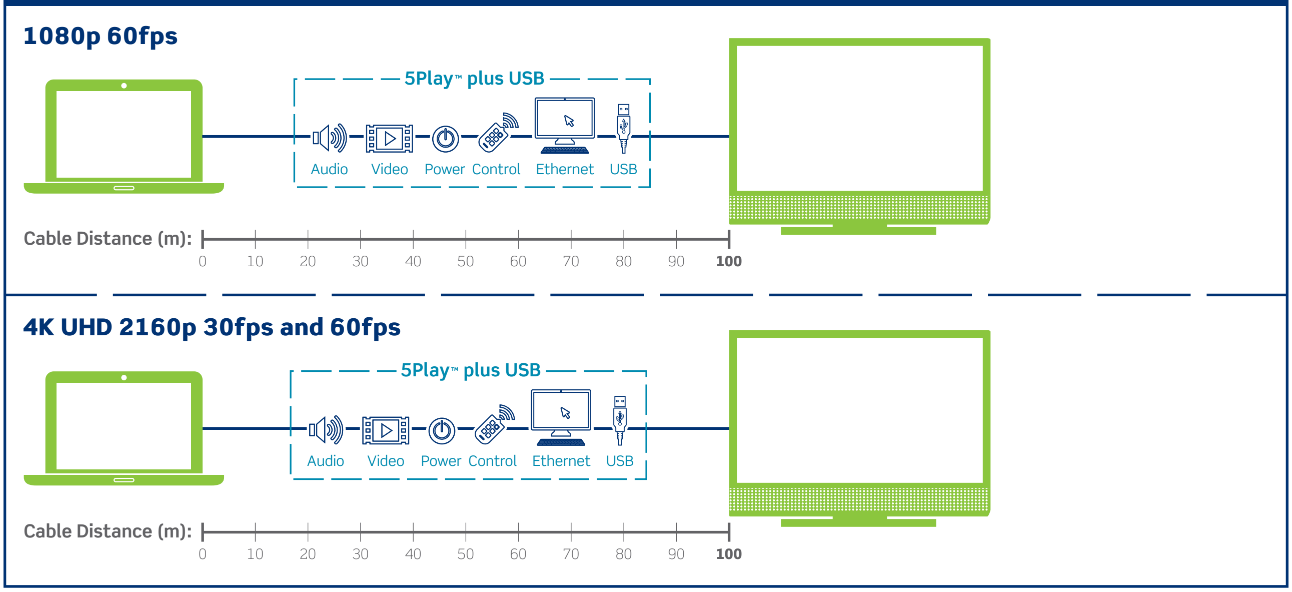
HDBaseT 1.0 Class B extenders carry a 1080p/60 fps HDMI 1.4 signal to a display, extending audio, video, power, and control signals up to 70 meters. Again, because of the extra data required, the distance for a 4K UHD 2160p/30 fps signal is typically shorter at 40 meters. Be sure to check manufacturer's specifications.



HDBaseT 2.0 Class C

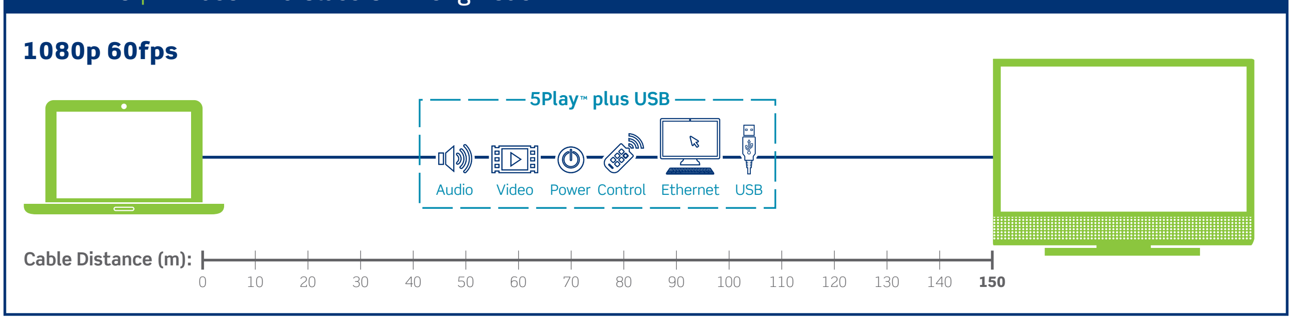
HDBaseT™ 2.0 Class C, combined with HDMI® 2.0, is able to extend higher resolution signals at greater distances. Class C can extend a 1080p/60 fps HDMI 2.0 signal or a 4K UHD 2160p 60 fps HDMI 2.0 signal to a display, extending 5Play™ audio, video, power, control, and Ethernet, plus USB 2.0 signals up to 100 meters.

HDMI 2.0 | HDBaseT 2.0 Class C



Alternatively, for longer reach, HDBaseT 2.0 Class C can be used to extend 1080p 60 fps HDMI 2.0 5Play audio, video, power, control, Ethernet, and USB signals up to 150 meters.

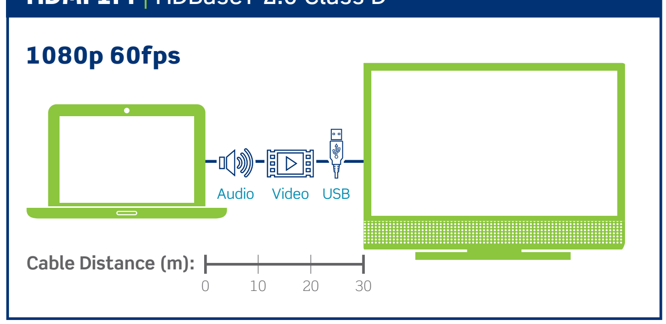
HDMI 2.0 | HDBaseT 2.0 Class C — Long Reach



HDBaseT 2.0 Class D

HDBaseT Class D is intended for short-distance transmission of 1080p/60 fps at a lower cost. Class D supports USB 2.0, making it ideal for basic conference room or classroom applications that employ an interactive (touch) flat-screen display or short-throw projector.

HDMI 1.4 | HDBaseT 2.0 Class D



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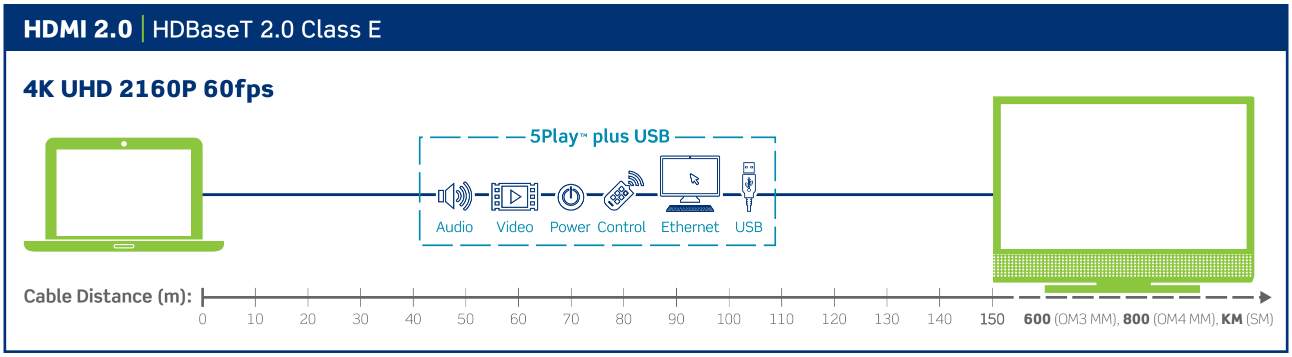
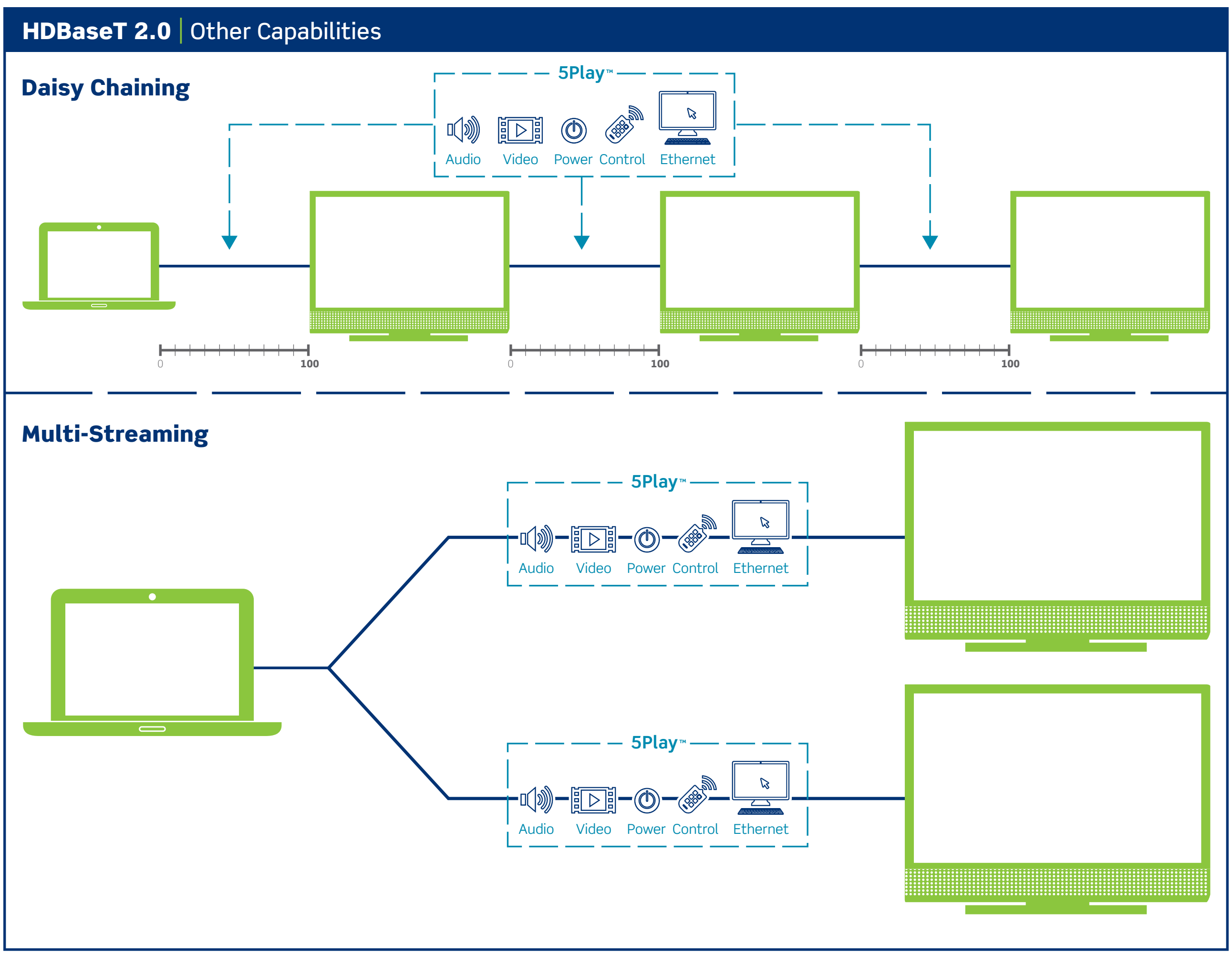
HDBaseT 2.0 Class E

HDBaseT Class E supports long-distance transmission of HD video, audio, Ethernet, and control signals using multimode or single-mode fiber. Distances up to 600 meters can be achieved with OM3 or 800 meters with OM4. For longer distances, single-mode fiber can be used.



Other capabilities of HDBaseT™ 2.0 include daisy chaining and multi-streaming. For more information on these features and to see how different manufactures implement these technologies, visit: hdbaset.org/certification.

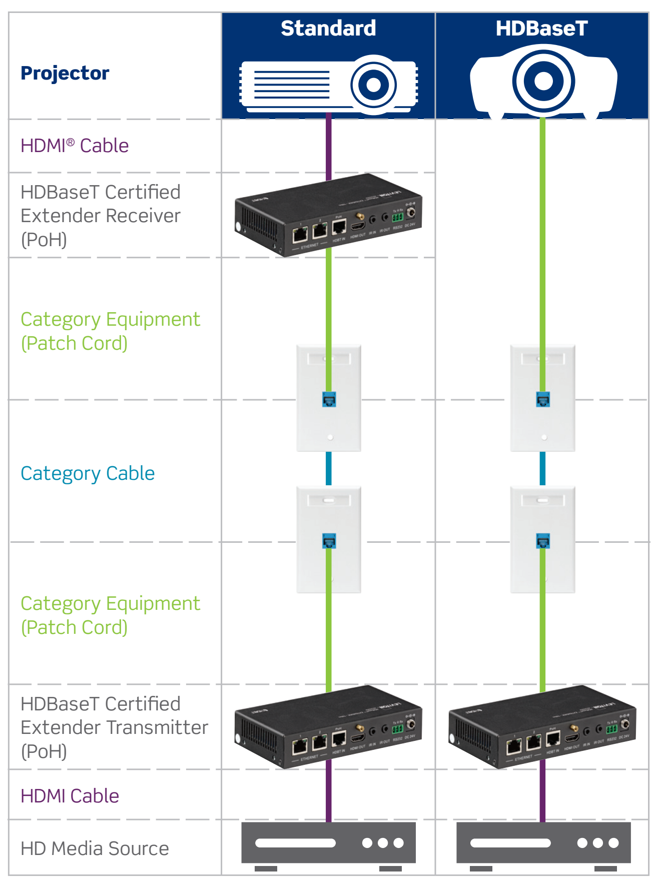


Can I Pair a Transmitter with an HDBaseT-Integrated Projector?

An HDBaseT™ transmitter can be paired with the latest HDBaseT-integrated projectors, and the technology is evolving to better accommodate IT/AV devices. Several manufacturers now offer projectors with an integrated HDBaseT receiver and HDBaseT port. This allows you to directly connect an HDBaseT transmitter to the projector, eliminating the need for an HDBaseT Extender Receiver.

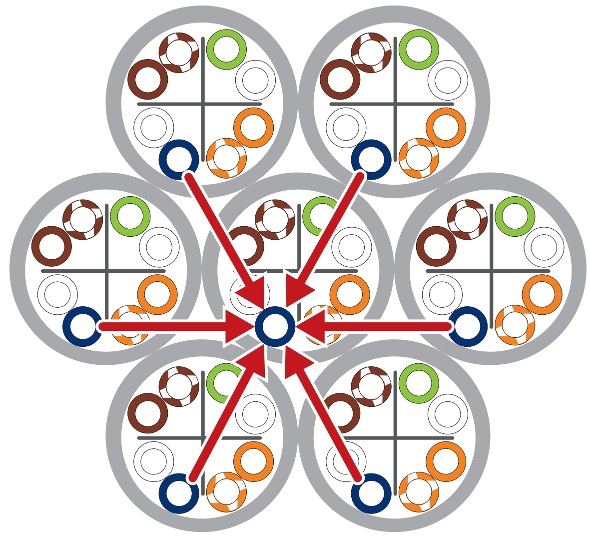
While HDBaseT-integrated devices offer additional network flexibility, there are limitations to consider. Devices, like the integrated projector, are typically not capable of supporting Power over HDBaseT (PoH). Meaning these devices cannot power the HDBaseT Transmitter from the receiver end, which could limit network layout and organization options.

Other considerations include control (IR, USB, RS232, and IP) compatibility, which should be confirmed prior to specification. For more information on device control compatibility and features, visit: hdbaset.org.



HDBaseT™

What are the Cabling Requirements?



HDBaseT™ enables the transmission of AV signals at speeds up to 18 Gbps and a frequency of 500 MHz (HDBaseT 2.0). TIA UTP cable specifications define the frequency capability for Cat 5e at 100MHz, Cat 6 at 250MHz, and Cat 6A at 500MHz. When driving a PAM-16 signal (similar to 10GBASE-T) over 100m, signal strength and complexity are greatly increased causing alien crosstalk (AXT)(signal crosstalk from one cable to another).

AXT is created in a channel by other cables and connectivity outside and in close proximity of one another. In this diagram there are six disturbers around one victim. The signals carried by the outside disturbers impact signals transported by the victim.

Unfortunately, AXT cannot be effectively predicted, and therefore cannot be reduced or eliminated through noise cancellation techniques within active equipment. AXT can only be controlled through design and installation of proper cable and connectivity.

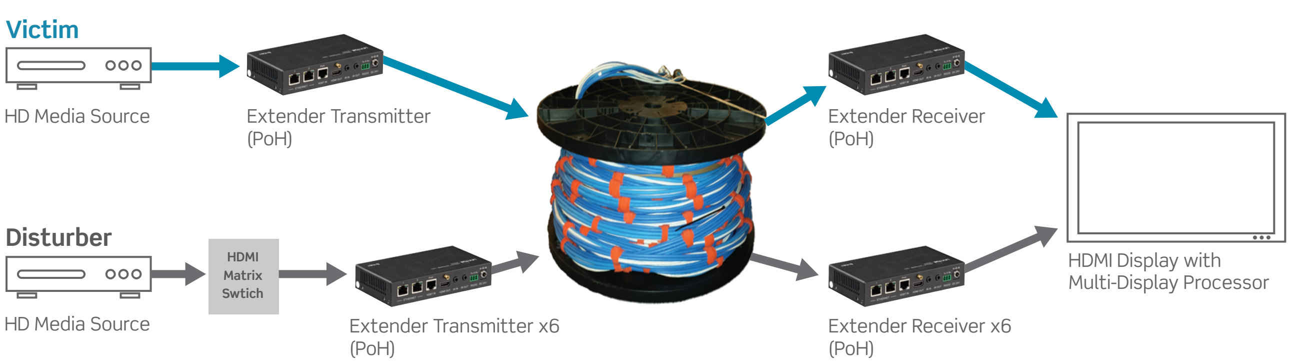
Cat 5e and the HDBaseT Signal

Leviton conducted a series of tests to verify the capability of different category channels, cable, and connector types. Testing concentrated on the effectiveness of the extenders at their maximum distance capability (shorter distances may have better performance) and was conducted using 1080p/60 fps video sources.

While Cat 5e channels can carry HDBaseT™ signals in a point-to-point link, they do not support HDBaseT in real-world high-density installations with adjacent data or HDBaseT channels. Using Cat 5e UTP cable in these applications leads to signal dropouts and total link loss, as the channels are not designed to resist alien crosstalk.

Test Configuration A - 100m Category 5e UTP Cable (6 around 1 bundle)

- Victim = HDBaseT 1.0 Extension Channel 1080p/60 fps
- Disturbers = multiple HDBaseT 1.0 Extension Channels 1080p/60 fps



Results:

- Cat 5e channels can carry HDBaseT™ 1.0 1080p signals in a single point-to-point isolated channel
- Cat 5e channels do not support HDBaseT signals in high-density installations bundled with adjacent HDBaseT channels
- When a Cat 5e UTP channel is tested with one adjacent HDBaseT disturber, the HDBaseT extender attempts to connect, but never succeeds
- Cat 5e channels are not designed for 300MHz signals and are not optimized for resistance to alien crosstalk

Effect Of Adjacent Signals On HDBaseT Victim (6 Around 1 Bundle)

Adjacent Signal Type	Cable Type	Number of Disturbers						
		0	1	2	3	4	5	6
HDBaseT	Cat 5e UTP Cable	✓	X	X	X	X	X	X

■ = PASS: Steady video signal; ■ = MARGINAL: Random, infrequent dropouts; ■ = FAIL: Frequent or total link loss

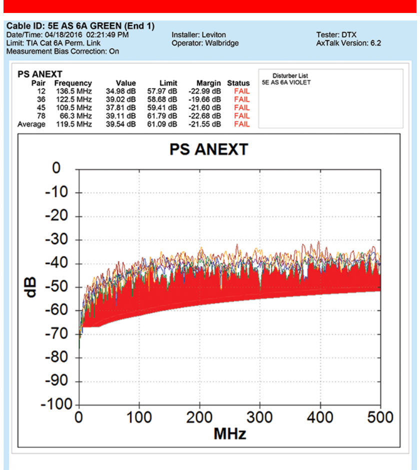
*Note: Test results were equivalent for cable bundles deployed in horizontal trays or spooled as shown in the figure.

Cat 5e cabling of all types is not designed to deal with AXT. This report shows the results of testing two Cat 5e links for AXT margin, one victim and one disturber. Adding a single disturber results in signal loss.

Comparison of Cat 5e/6/6A Cabling Testing for HDBaseT

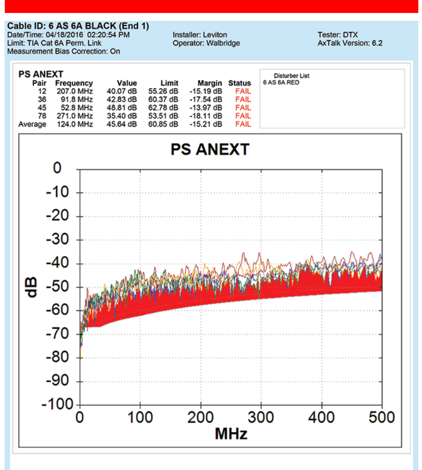
When comparing Cat 5e to Cat 6 and Cat 6A cable, both Cat 5e and Cat 6 fail to deliver the level of reliable performance needed, as shown in the figures below from an industry-standard field-test instrument. All measurements should be completely below the red limit line, which represents power sum alien near-end crosstalk (PSANEXT). The test results for Cat 5e cable (Figure 1) reveals -20dB of AXT margin—fail. This results in a dropped signal for complete video loss. Measurements of Cat 6 cable (Figure 2) are also above the red limit line, indicating the presence of significant alien crosstalk that results in signal degradation or complete video loss. In figure 3, the Cat 6A cable measurement is well below the red limit line pass indicating significant reduction of alien crosstalk and greatly improved signal reliability.

Figure 1: Cat 5e



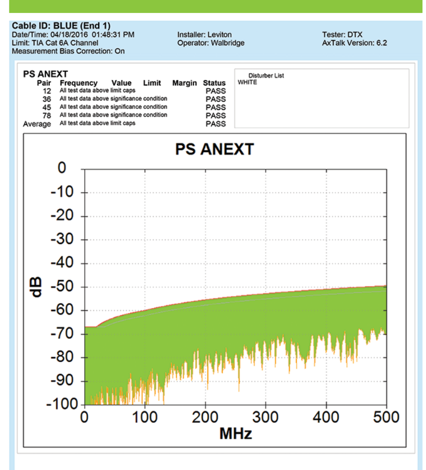
Alien Crosstalk signal over Cat 5e is about 10,000 times louder than over Cat 6A

Figure 2: Cat 6



Alien Crosstalk signal over Cat 6 is about 3,000 times louder than over Cat 6A

Figure 3: Cat 6A



Alien Crosstalk signal over Cat 6A is well within reduced limits — over +18 dB of margin

A detailed look at the test results can be found in AV Cable Recommendations for HDBaseT. This white paper can be downloaded at: leviton.com/ns/whitepapers.

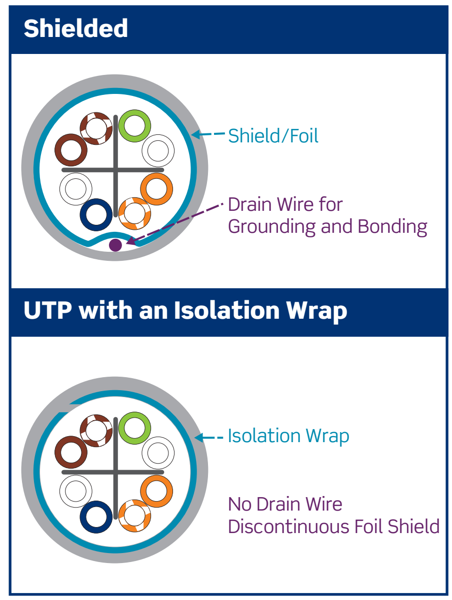
Shielded Cabling and HDBaseT

Shielded cable is ideal for high electromagnetic interference (EMI) environments, applications near high-voltage wiring, and infrastructures that require increased levels of security such as casinos or government facilities. Shielded cable works to prevent alien crosstalk in two ways:

1. Creates a barrier between pairs in adjacent cable where the inherently "open" structure of the twisted pairs allows magnetic fields to escape. The magnetic field sets up eddy currents in the shield barrier which then creates a magnetic counter field, preventing magnetic coupling from one pair to the other

2. Creates an electrostatic barrier over multiple pair twists in order to create a "zero-average" voltage potential without peaks that can also couple to an adjacent pair in an adjacent cable

At high frequencies, the important function of the shield is to perform the two aforementioned barrier tasks. When low (100s) MHz to GHz frequencies are required, like those needed for an HDBaseT™ signal, the actual grounding of the shield is not relevant. However, failing to do so creates the potential for setting up resonances that can cause alien crosstalk or other signal degradation.

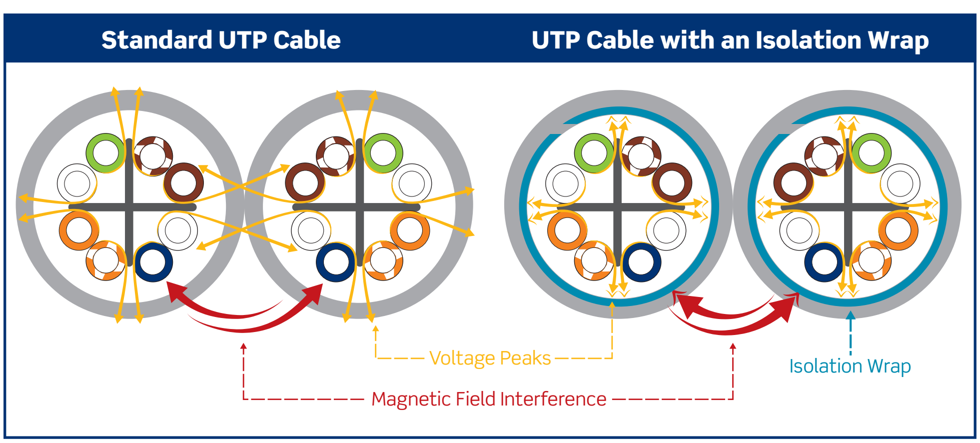


Due to the point-to-point nature of typical HDBaseT applications, it is usually not practical to follow TIA-568 or TIA-607 bonding and grounding standards. Most HDBaseT products utilize a power supply or PoE with no ground connection. Using shielded channels on a point-to-point application with no connection in a telecommunications room (TR) will result in a floating ground which can add electromagnetic interference (EMI) and should be avoided.

Additionally, there are added safety risks when using shielded channels in a point-to-point application with no ground connection. Should an energized conductor come into contact with the shield foil, the entire cable pathway may become live and dangerous. National Electrical Code (NEC) 250 sets the minimum requirements for grounding and bonding. Compliance with the NEC and local codes is essential to the proper application of the ANSI/TIA-607 standard.

UTP Cable with an Isolation Wrap and HDBaseT

UTP cable with a Leviton-patented isolation wrap takes advantage of the phenomenon that the shield can be segmented and the length of the shield can be adjusted to cover only a few twists, establishing eddy currents and the magnetic counter field, and also creating a capacitive effect sufficient to prevent alien crosstalk. This ground-breaking technology tunes the length and shape of the shielded sections to perform best in the desired frequency range for category-rated cables, and it installs just as easily as standard UTP cable. Since UTP cable with a Leviton-patented isolation wrap does not require grounding or bonding, you get the benefits of a shielded cable without any of the installation headaches or costs.



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Summary of Recommendations

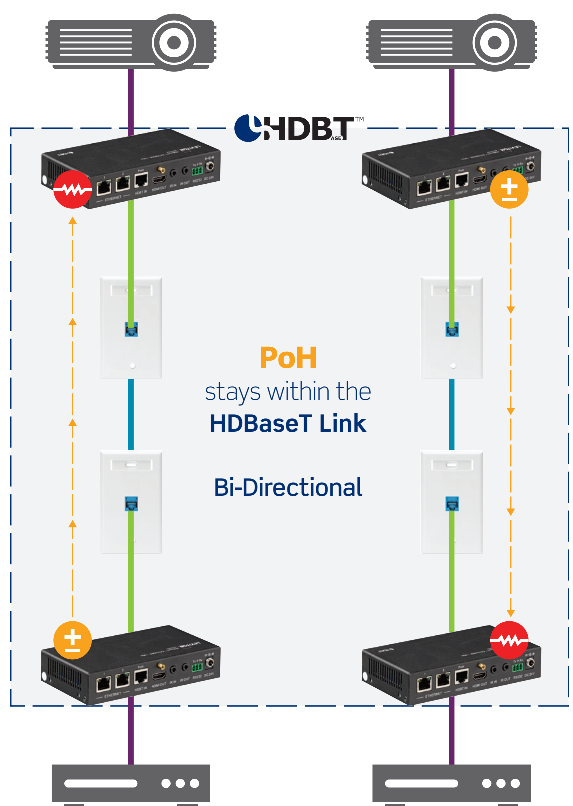
As seen in the chart below, Cat 5e and Cat 6 UTP cable is unable to provide the PSANEXT margin necessary for IT/AV signals in bundles or over long distances, and in most cases it does not support the signal at all. Standard Cat 6A UTP cable comes close to meeting signal requirements and delivers 1 dB of margin for modest performance. Across the board, Cat 6A cable delivers the level of signal required for higher resolution over long distances. A Cat 6A FTP or UTP with alien crosstalk prevention solution is capable of mitigating alien crosstalk to provide top-tier performance. The shielded solution is difficult to implement and requires additional labor and cost where a UTP cable with alien crosstalk prevention technology provides the desired performance and lower cost for an optimal HDBaseT™ system.

	CAT 5E UTP	CAT 6 UTP	CAT 6A UTP	CAT 6A FTP	CAT 6A UTP
	ANSI/TIA Standard	ANSI/TIA Standard	ANSI/TIA Standard	ANSI/TIA Standard	Alien Crosstalk Prevention Technology
Recommended	No	No	Yes for Single Links	Yes	Yes
Typical Outer Diameter	5.33mm (Typical)	5.7mm (Typical)	7.6mm	7.1mm	**6.9mm**
Typical Guaranteed PSANEXT Margin	Not Designed to Mitigate Alien Crosstalk	Not Designed to Mitigate Alien Crosstalk	1dB	16dB	**5dB**
Grounding or Bonding Required	No	No	No	Yes	**No**

What are the Practical Applications for Power over HDBaseT?

Power over HDBaseT™ (PoH) powers the HDBaseT link over category cable. This allows for integrated transmitters, in devices like matrix switches, to power remote receivers. Similar to Power over Ethernet (PoE) standards, HDBaseT transmitter and receiver pairs usually draw only 10-15 watts (typically < 300mA @ 48 VDC with PoH. Only half of that wattage is sent to the opposite end.

If implemented as a bi-directional solution, the transmitter or receiver can be powered at either end, which is ideal for environments where power-outlet locations are limited. It can also be used to power multiple auxiliary devices, such as HDBaseT control panels and autoswitching wallplates.



HDBaseT™ www.hdbaset.org For more information on PoH, visit: hdbaset.org.

How do I Test and Troubleshoot an HDBaseT Link?

The best way to ensure dependable signal performance over an IT/AV system, and avoid video signal loss, is to use category 6A cabling installed in line with BICSI practices and tested and certified with the manufacturer. However, when encountering performance issues, there are a few steps you can take to fix video signal loss. This starts by dividing and isolating the power, HDBaseT™ link, HDCP at TX (transmitter) and Rx (receiver), category cable link, and extender hardware.

Transmitter and Receiver Status

HDBaseT Extender Transmitters and Receivers typically include status indicators that can help identify any issues.

☼ Lights up red or green when powered (depending on the manufacturer)

ON Self-check blinks green when the device is working properly

LINK Lights up green when the Tx and Rx are correctly connected

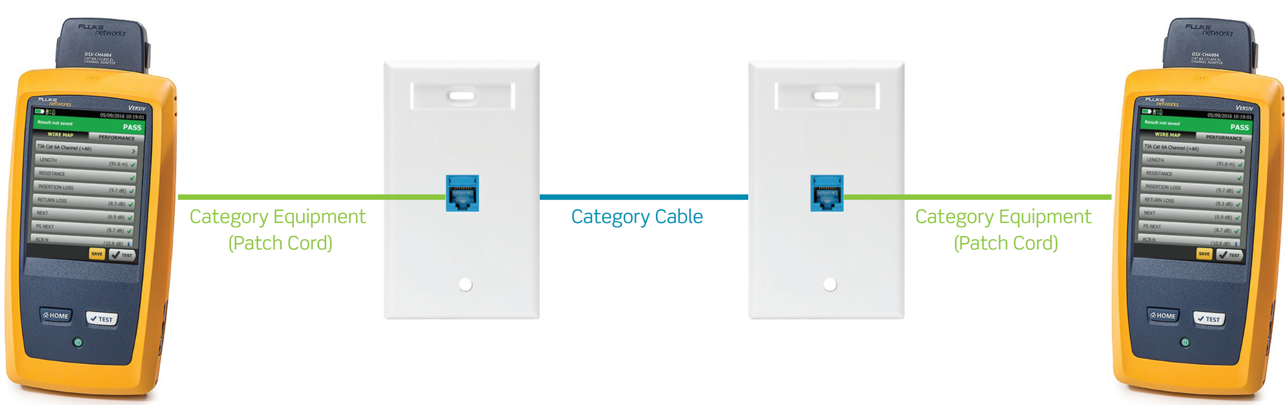
IN HDCP compliance indication lights up:

- Solid green when connected device supports HDCP
- Blinks when the device does not support HDCP

Testing

Field-testing of HDMI® signals is generally impractical, but there are a number of reliable testers available that provide a reference HDMI source and a reference sink. They are useful for monitoring HDCP key sets, EDID transactions, and hot-plug events. However, most testers are not suitable for field-testing an end-to-end link and the relative expense
of the tester often outweighs the benefits.

A standardized approach can often provide better testing results at a lower cost. Standard testing of the category cable infrastructure relies on extensive TIA, ISO, and IEC standards, and there are a number of field-proven test instruments readily available. Plus, industry-standard field testers often allow contractors to certify and warrant the cable link, providing customers added peace of mind.



A standardized field tester provides the capability to identify the following in an HDBaseT™ link:

- The actual link distance for comparison with the distance capability of the extender (Figure 1)
- The presence of an incorrectly terminated connector (Figures 2 and 3)
- Opens or shorts in the channel (Figure 4)
- Cabling and connectivity capability aligns with TIA, ISO, and IEC standards (Figure 5)

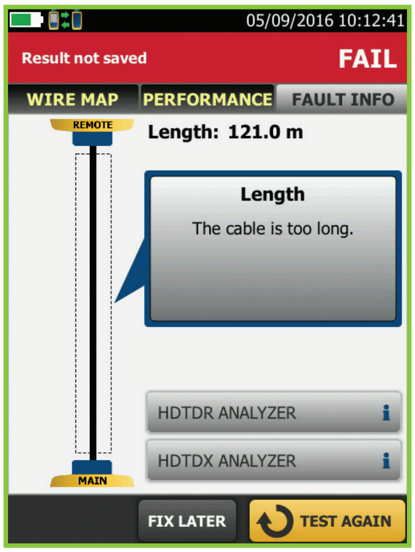


Figure 1

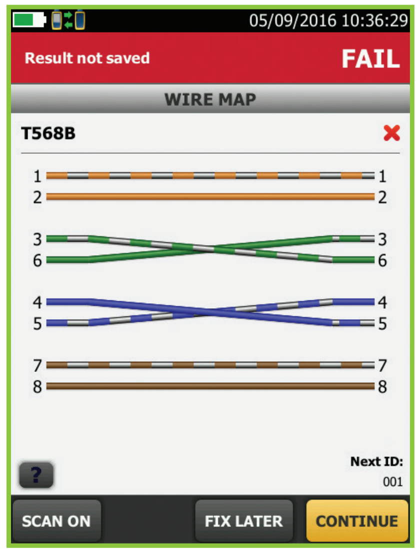


Figure 2

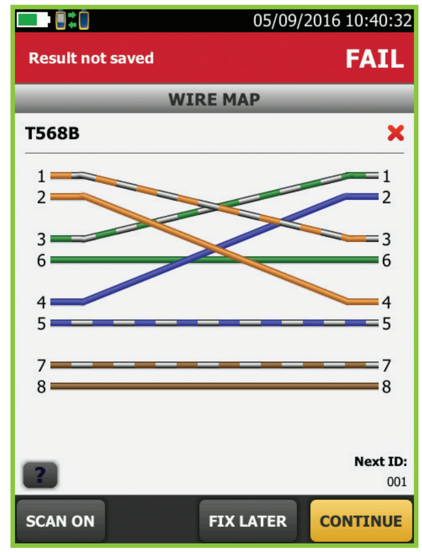


Figure 3

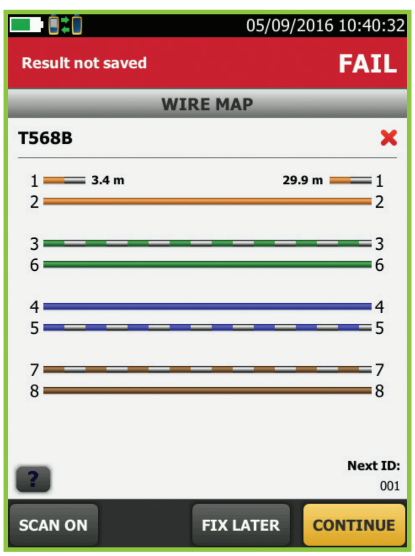


Figure 4

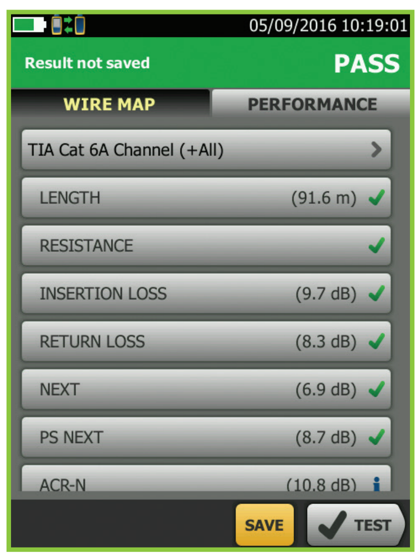


Figure 5

Some Troubleshooting Tips

Should the link test check out and signal loss is still occurring (no video), the next step is to verify the source (disc player, PC, laptop, etc.) and sink (TV, projector, flat screen display, etc.).

1. First, check that power is applied at the display or projector
2. Connect the HDMI® source directly to the display or projector using a known, good 3-foot to 10-foot long high-quality HDMI cable. Verify the display is set to the connected HDMI input. If the video is correctly displayed, then proceed to the next step. If video is not displayed, ensure the source is connected to the selected HDMI input on the display device. If video is still not displayed, substitute an alternate HDMI source or display to isolate the failing component.
3. Once video is correctly displayed when using only the HDMI cable, add the HDBaseT™ transmitter and receiver to the link substituting a Cat 6A patch cord in place of the entire category cable link. Plug the patch cord directly into the output of the HDBaseT transmitter and into the input of the HDBaseT receiver. Add the HDMI source to the transmitter using a known, good short HDMI cable and then connect the receiver to the display device using the same short HDMI cable as before. If video is correctly displayed, proceed to the next step. If video is not displayed, then one at a time, substitute a known good transmitter and receiver into the channel to isolate the failing component.
4. Now that video is correctly displayed using the short patch cable HDBaseT link, remove the Cat 6A patch cord and connect to the full category cable link.You should have video correctly displayed, but if not, you have isolated the issue back to the category cable link and should re-test using a standard field test set to verify connection, distance, and Cat 6A signal capability. Verify the link distance does not exceed the capability of the HDBaseT extender set.
5. If you are not able to identify the source of the issue, reach out to the manufacturer's technical support team for help with identifying potential problems. For Leviton product and application support call 800.824.3005.

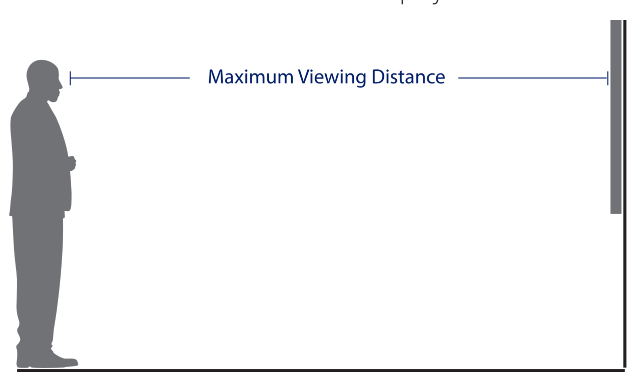
How do I Determine what Display or Projection Screen Size is Needed in a Room?

The goal of using HDBaseT is to create an optimal viewing experience for attendees, with a simple installation process. However, even when an HDBaseT setup is achieved, other considerations often arise.

One common challenge has to do with enabling an ideal display or projector screen arrangement. What size display or screen is required and how many are needed to provide adequate viewing in a classroom or conference room? Display or projector screen size for any room can be easily determined by following the 5 steps below:

1. Measure the distance from the display or screen to the farthest seat in the room
2. Select the usage model and apply the 4/6/8 rule of thumb
3. Calculate the minimum required display or screen height
4. Determine the image aspect ratio and calculate screen width
5. Calculate the required display or projector diagonal size to use for the specification

Step 1: Measure the distance from the display or screen to the farthest seat in the room.



Step 2: Select the usage model. There are generally three categories of use:

- Critical – viewing detailed presentations, spreadsheets or engineering drawings
- Reading – presentation slide content
- General – training videos or movies

The more analysis and reading that attendees must do, the larger the screen needs to be. This lends itself to the 4/6/8 rule of thumb for determining minimum screen height.

- Critical: Min screen height = Max viewing distance/4
- Reading: Min screen height = Max viewing distance /6
- General: Min screen height = Max viewing distance/8

Step 3: Calculate the minimum required display or screen height.

Example:
Maximum measured viewing distance = 20 feet / 240 inches (6.09m / 609 cm)
Usage model = Reading – rule of thumb divider is 6
Min screen height = 240/6 = 40 inches (101.6 cm)

Step 4: Determine the aspect ratio and screen width. Aspect Ratio (AR) is the ratio of width (W) to height (H). The most common aspect ratio of displays or projection screens in use today is 16 x 9.

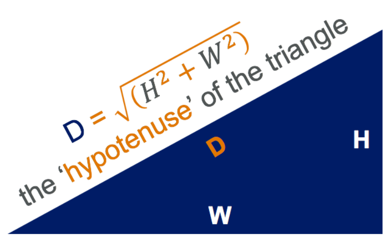
NTSC: 4 / 3 = 1.33
HDTV: 16 / 9 = 1.78 (most common)
Cinemascope: 2.35 / 1 = 2.35

For a 16 x 9 or 1.78 aspect ratio, screen width equals 1.78 X screen height. For our example:

Screen width = 1.78 X 40 = 71.2 inches (180.8 cm)

Step 5: Calculate the required display or screen diagonal size using the Pythagorean Theorem. For any right triangle the diagonal or hypotenuse is equal to the square root of the sum of the sides squared.

For our example:
H = Min screen height = 40 inches
W = Screen width = 71.2 inches
D (Diagonal) = $\sqrt{(40^2 + 71.2^2)}$ = 81.6 inches (207.2 cm)
An 85 inch class, 84.6 inch diagonal (215 cm) display would be required.



An ideal arrangement should also take into consideration the viewing angle of the display or projector screen so that depending on the room layout everyone in the audience is within view. This may require multiple displays or screens at the front of the room, or even auxiliary displays on adjacent walls. For both projectors and displays the effect of ambient lighting will also impact your selection. Most manufacturers offer services and support materials to help select the best arrangement and type of display or projector and screen.

How Should Speakers be Placed for a Classroom or Conference Room?

Another common question relates to speakers – how many speakers should there be in a room and where should they be placed? Like displays, this can be determined for ceiling mounted speakers by following a few simple steps:

1. Measure the ceiling height
2. Measure the room size
3. Determine if the room occupants will be sitting or standing most of the time – this determines the required speaker conical dispersion or coverage angle
    - Standard seated listening height is 3'6" from floor level
    - Standard standing listening height is 5'6" from floor level
4. Check the speaker specifications to determine its dispersion angle
5. Calculate the speaker coverage distance or conic section that intersects the standard height of the listener – this provides us with the coverage area for each speaker
6. Understand how listeners will be moving around the room or if they will be stationary to help direct how much overlap of speaker coverage (speaker spacing) is needed in order to create a uniform listening experience throughout the room
7. Lay out the speaker placement and determine how many speakers will be required

Let's use an example room to illustrate each step of the process.

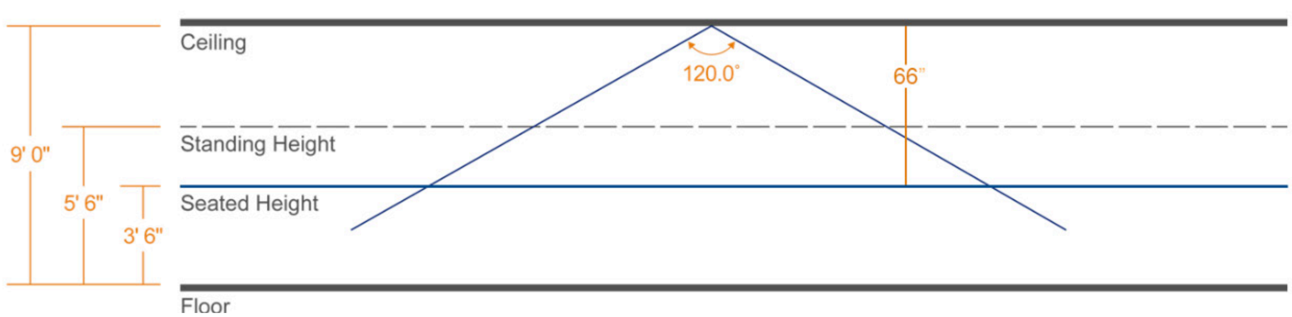
Step 1: Our example room ceiling height measures 9 feet (2.7m)

Step 2: Our room is 26 feet wide by 20 feet deep (7.9m by 6.1m)

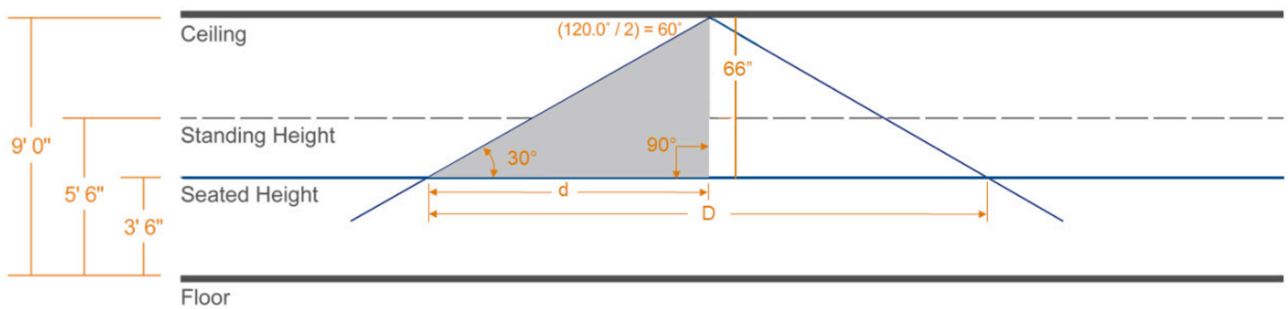
Step 3: We determine our listeners will be seated most of the time. The standard listening height is 3ft-6in (1.07m) from the floor so the distance from the seated height to the ceiling is 9 feet minus 3ft-6in, which is 66 inches (1.68m). For standing listeners, the standard listening height is 5ft-6in (1.68m) and the distance from the ceiling to the standard standing listening height would be 42"(1.07m).

Step 4: Our speakers are specified to have a 120° dispersion angle

Our room elevation layout is shown below.



Step 5: To calculate the coverage distance or conic section, we use right triangle trigonometry to first calculate one-half of the distance. First, divide the dispersion angle in half to obtain a right triangle. For our example 120°/2 = 60°.

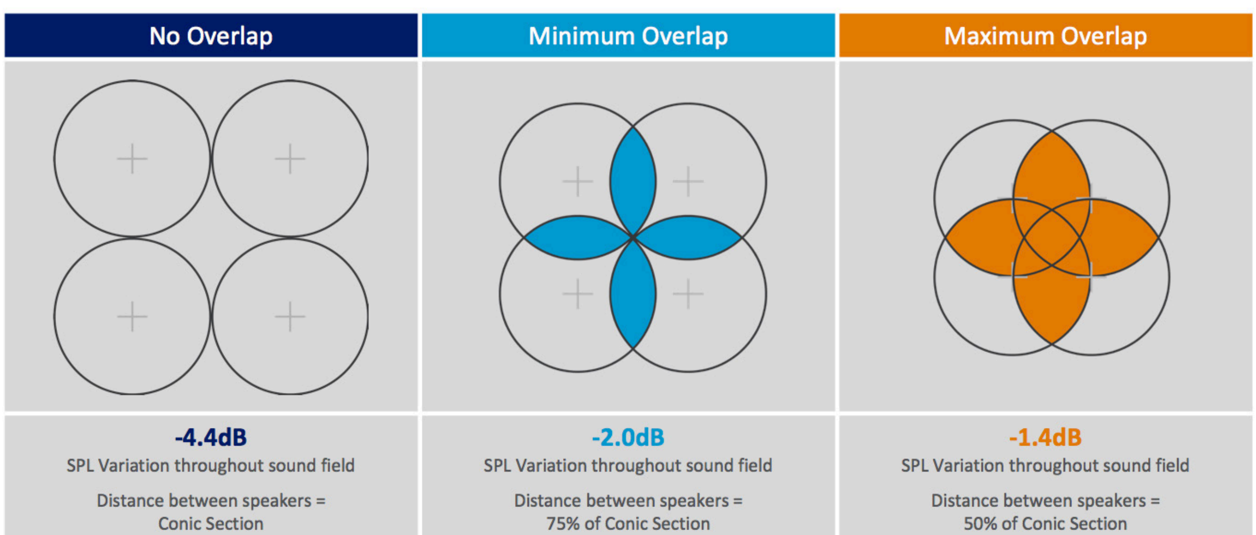


Using the properties of a right triangle where the sum of the angles is always 180°, we know the small angle at the base of the triangle is 30°. We can find the length of the "adjacent" side by multiplying the Tangent of the angle by the "opposite" side. (Trigonometry calculators can be easily found online.)

d = Tangent 60° X 66" = 1.732 X 66" = 114.3"
D = 2 X d = 2 X 114.3" = 228.6" or 19.0' (5.8m) – this is our coverage distance for each speaker at seated height

(similarly, the calculation for standing height (5'6" standard listening height – 42" from the ceiling - yields a coverage distance of 12.1' or 3.69m)

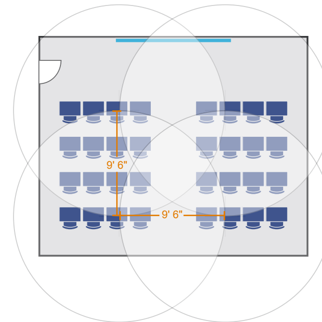
Step 6: For our example our listeners are seated and will not normally be moving around the room, so they will not be able to move slightly to be within the range of a speaker. Speaker overlap is important so there are no locations where an individual will not be within the sound field On the other hand, if our listeners were standing/mobile, we would not need overlap of sound coverage because they would naturally move slightly to improve the sound level. The more mobile our listeners are, the further apart speakers can be placed. A good rule of thumb is shown below where SPL = Sound Pressure Level.



Since in our example our listeners are normally stationary, we want to space the speakers with maximum overlap.

Step 7: Going back to our room layout, which is 26' wide by 20' deep. Our calculated speaker coverage or conic section is 19.0'. For maximum overlap the distance between speakers should be 50% of the conic section, or 9'6" (2.9").

We can place 4 speakers 9'6" center-to-center to provide maximum overlap while also covering the entire room for when the listeners are mobile or are entering or leaving the room. Notice the speaker layout is not centered on the room but is centered on the array of seated listeners.

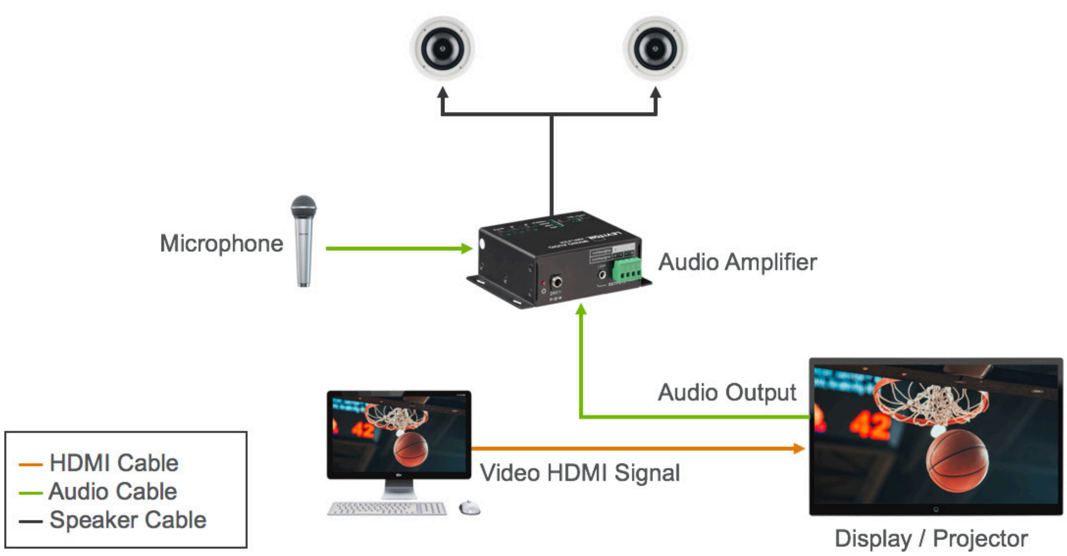


What are the Options for Speakers and Amplifiers?

There are generally two options for speakers and sound amplification. There is a low impedance option utilizing 4- or 8-ohm speakers for stereo sound typically in smaller focused spaces in the home or individual office where the effect of stereo left and right channels can be fully realized. Attempting to install stereo sound in a classroom or conference room is not recommended. Stereo sound separates the sounds signal into left and right channels. So in a classroom or conference room setting, the individuals seated at the left side of the room will only hear the left channel portion of the sound. Likewise those seated on the right will only get the right channel portion. Stereo is great for a home theater or individual space, but is not a good solution for distributing the full audio signal evenly throughout a room. This is where a high impedance system that uses 70 volt speakers for mono sound that can be used to distribute sound over large spaces is a better option.

Stereo and 70 volt amplifiers come in many variations, but a common and useful configuration is a mixing amplifier. A mixing amplifier can take in multiple inputs and mix them together to enable applications like the addition of microphone input for paging over background music or for teacher annotation while students are viewing a video or presentation. Most mixing amplifiers provide for pre-setting the various input levels, so the listening level is appropriate when the additional input is added.

The connection of an amplifier to the source audio signal should be carefully considered. For typical classrooms and conference rooms it is often best to utilize the audio output of the video display or projector. This eliminates the potential mismatch of the audio and video signal processing that takes place in the display device, which can cause delay in the processed video output resulting in mismatch of the audio and video or a "lip-synch" issue. The connection diagram for this application is shown below.



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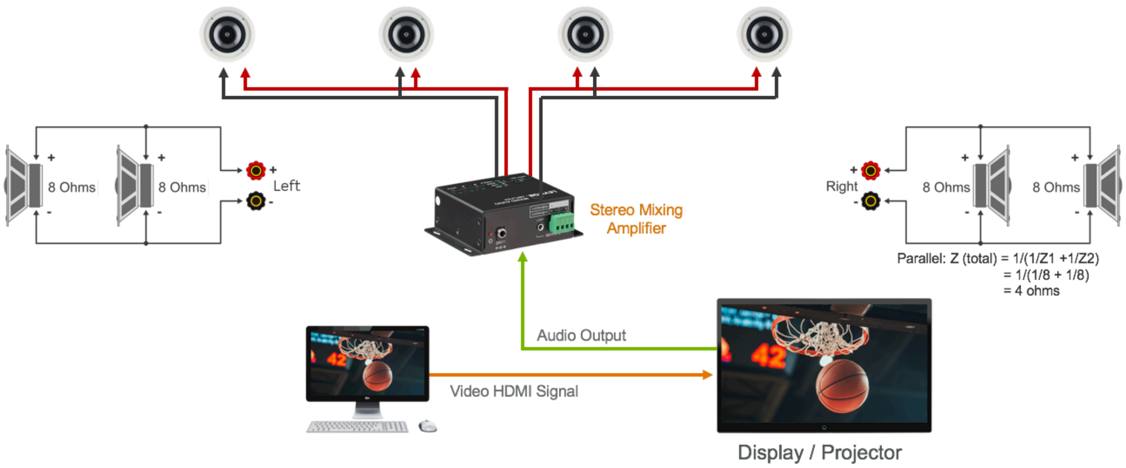
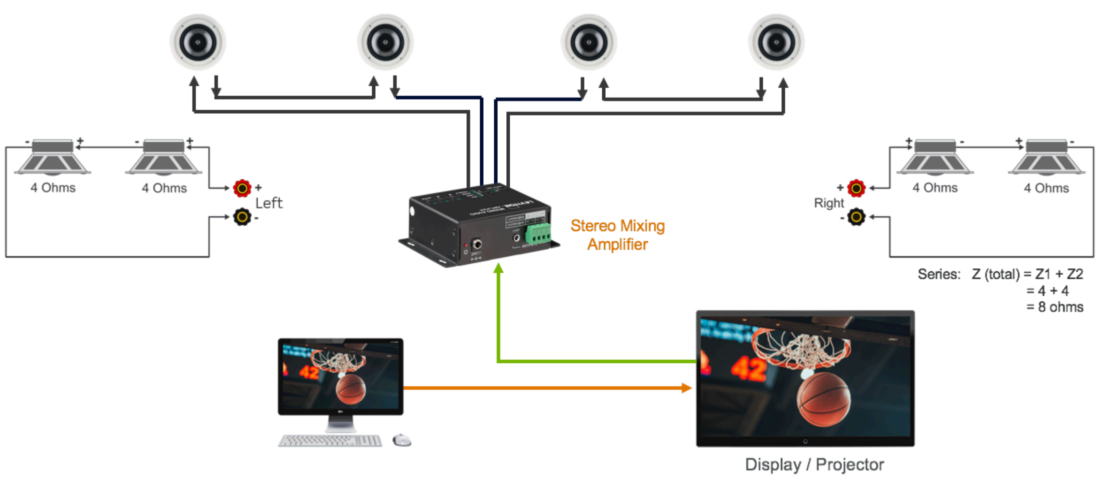
In this diagram, the mixing amplifier accepts the audio from the display or projector and the microphone input, mixing and amplifying the signals to the preset levels and powering two 8-ohm speakers - one on the left channel and one on the right channel.

Sometimes it is desirable to add additional speakers. This can be accomplished with 8-ohm speakers by wiring in parallel as shown below connecting the positive terminals together and the negative terminals together for both speakers in each channel. The result is a 4-ohm impedance presented to the amplifier. Most stereo amplifiers will perform nearly equally with either a 4 or 8-ohm load.



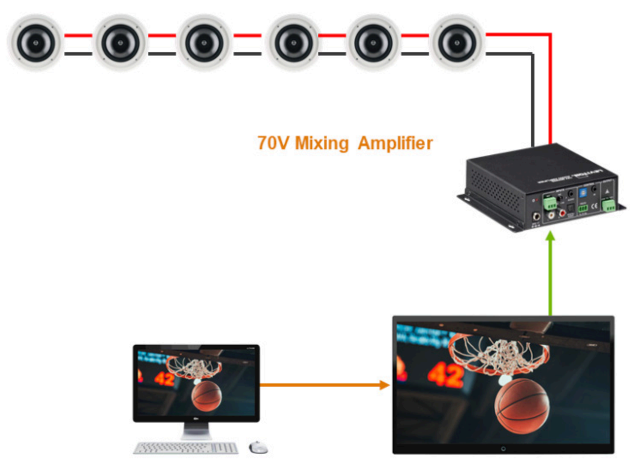
If using 4-ohm speakers, we can wire two speakers in series for each channel as shown below. In this case the impedance presented at the amplifier is 8-ohms.



For a large room or area, a 70V amplifier and speaker system can be used to provide many speakers for full and uniform sound coverage. The audio is mono, not stereo, but the high impedance system allows for the use of relatively small gauge wire (16/2) to connect many speakers to a single amplifier. 70V speakers most often have built-in transformers with multiple taps so each speaker can be set to a desired output wattage. This allows for adjustment of the sound pressure level for various areas within a room or facility such as public areas versus reception or lounge areas. The photo below shows an example speaker with an output wattage setting control typically located behind the speaker grille.

The number of speakers that can be connected to a single amplifier is determined by adding up the combined wattage of all the speakers and comparing it to the specification capability of the amplifier. For example, an amplifier with 40-watt capability can serve 16 speakers set to 2.5 watts output, 40 speakers set to 1 watt output or even 160 speakers set to 0.25 watt output.

70 volt speakers are wired in parallel making it easy to daisy chain from one speaker to the next.



Conclusion

Audiovisual systems in classrooms and conference rooms are fast becoming a part of the data network. This places datacom professionals in a unique position to become the AV experts for their customers. However, to establish complete customer confidence, it's critical to understand the variations in HDMI, HDBaseT, and video resolutions; know the practical applications for PoH; know how to set up a room for a good video and audio experience and be prepared to apply optimal troubleshooting strategies should performance issues occur. Familiarizing yourself with best practices now ensures your customers benefit from a reliable, high-quality IT/AV system for years to come. Further, beyond the data network, end users are frequently guessing as to the theory behind screen size, quantity and sizing, as well as configurations for effective sound. The business opportunity is growing, and the position of AV authority is open.

You can learn more about Leviton HDBaseT solutions at leviton.com/ITAV.

Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. Leviton can help expand your network possibilities and prepare you for the future. Our end-to-end cabling systems feature robust construction that reduces downtime, and performance that exceeds standards. We offer quick-ship make-to-order solutions from our US and UK factories. We even invent new products for customers when the product they need is not available. All of this adds up to the **highest return** on **infrastructure investment**.

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