White Paper

AV Cable Recommendations for HDBaseT™
Cat 6A UTP Cable with Alien Crosstalk Prevention Technology

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Large-format displays are changing the digital-media/digital-display landscape. Increasing display size for audiences in classrooms, hospitals, hotels, and the enterprise is driving the need for higher resolution, moving beyond today's high of 1080p. Ultra high-definition video with 4K and even 8K resolution is regarded as the next standard, with 4K delivering 2160p format at 3840 x 2160 pixel density. Digital AV signals driving these displays will consume more and more bandwidth as resolution increases, so installing an optimal infrastructure now can eliminate issues in the near future.

HDMI cable alone is not an ideal solution for transmitting higher resolution signals over longer distances. Long HDMI cables are heavy, inflexible, expensive, and difficult to pull. Because of the large connectors, these cables are unfeasible for retrofit or upgrade projects in conduit applications. Pre-terminated multi-conductor runners with active and passive wallplates, another method of AV connectivity, have many of the same issues when delivering high-resolution signals over long distances. Multi-conductor runners are also heavy and inflexible, making them difficult to deploy. They often require longer lead times, are limited by conduit size, and connectors are easily damaged.

Overall, HDMI and multi-conductor runner solutions, while good for shorter lengths, are more expensive and troublesome when used over longer distances, especially when plenum-rated cable is required. For higher resolution over longer distances, HDBaseT™ technology that transmits HDMI signals over category-rated cable delivers the resolution needed for the distance required while minimizing costs, maintaining reliability, and making installation fast and easy.

Why HDBaseT

HDBaseT is a technology that enables faster, simpler installations of large-format displays. 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 100 meters (328 feet).

HDBaseT is widely becoming adopted by installers 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/channel into an IT/AV link/channel that is more reliable, flexible, and scalable than traditional HDMI cables or multi-conductor systems. And HDBaseT allows displays 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.

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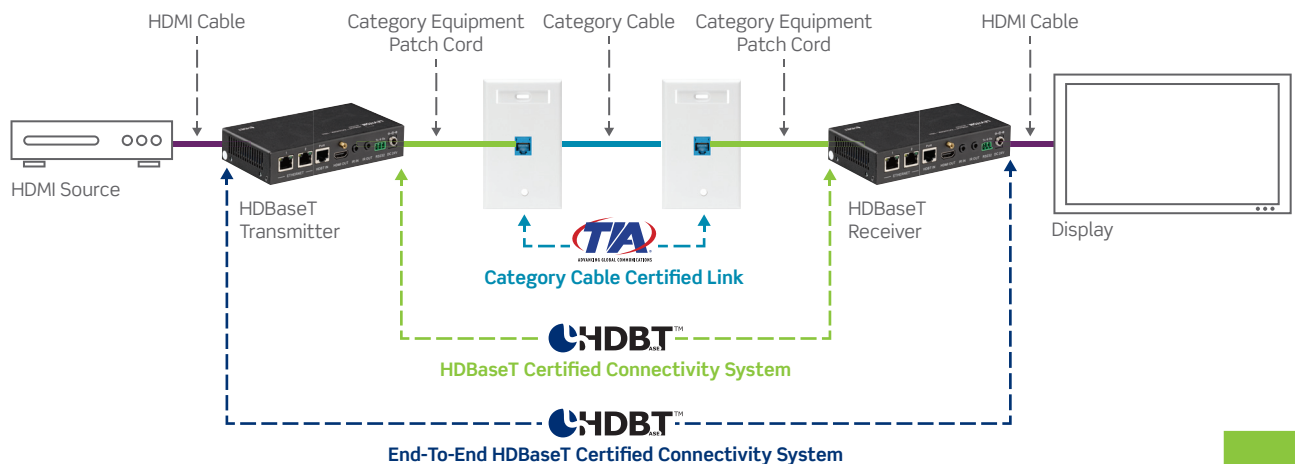
Emerging Standards

In January 2015, the Institute of Electrical and Electronics Engineers (IEEE) announced the approval and adoption of the HDBase-T™ standards. The new standards define the long-distance ultra high-definition distribution of digital media, and is expected to become IEEE 1911 once the adoption process is complete. Below are the current IEEE working standards for HDBaseT. A full list of IEEE working standards can be found at standards.ieee.org. Details about HDBaseT standards and definitions can be found at hdbaset.org.

- **P1911.1 – HDBaseT Specification Version 1.1.0:** HDBaseT is a connectivity standard which consolidates high throughput, unidirectional, HDCP protected, uncompressed high-definition digital multimedia with bidirectional data networking over standard Cat 5e/6 structured cabling. The scope of the HDBaseT specification version 1.1.0 is to specify the HDBaseT link between HDBaseT Source Port device and HDBaseT Sink Port Device. Devices complying with this standard shall interoperate in Direct Peer-to-Peer applications and shall interoperate as End-Node devices over the future HDBaseT network.

- **P1911.2 – HDBaseT Specification Version 2.0:** HDBaseT is a packet based, switched networking standard which consolidates networking of high throughput, time-sensitive data and control streams with Ethernet data networking over home span, standard Cat 5e/6 structured cabling. The scope of the HDBaseT specification version 2.0 is to specify the following:

  1. HDBaseT link between two HDBaseT ports

  2. Services provided by the HDBaseT network to protocol/ interface/ application end-point clients communicating over the network

  3. HDBaseT entities and devices

  4. Control and Management scheme

  5. End-point adaptor entities, which provide communication over HDBaseT for the following interfaces:
     - HDMI 1.4
     - USB
     - S/PDIF
     - Consumer IR
     - UART

  End-Node devices complying with this specification that do not implement an HDMI T Adaptor may interoperate with devices complying with HDBaseT specification 1.x. All other devices complying with this specification shall interoperate with devices complying with HDBaseT specification 1.x, acting both as Direct Peer-to-Peer and over the network End Nodes.

- **P1911.3 – Standard for HDBaseT 5Play™:** The HDBaseT standard defines a protocol for communicating 5Play over a single long distance Local Area Network (LAN) cable. Building on the adopted HDBaseT specifications 1 and 2, this standard further enhances HDBaseT 5Play by broadening the variety of cables that the protocol can transfer over, expanding wireless compatibility, increasing power throughput over the HDBaseT link, harmonizing with Internet Protocol (IP), and adding security features.

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# Choosing a Category-Rated Cable for an IT/AV Link

When planning to deploy category-rated cable for an IT/AV link, it's important to install the most appropriately rated cable for the performance desired. The HDBaseT™ Alliance specification lists Cat 5e and Cat 6 UTP cabling as supported media types. However, recent testing by Leviton revealed that Cat 6A UTP cabling is the most ideal solution to support an IT/AV link.

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 video sources.

HDBaseT enables the transmission of AV signals at speeds of 10.2 Gbps and a frequency of 300 MHz. TIA UTP cable specifications define the frequency capability for Cat 5e at 100MHz, Cat 6 at 250MHz, and Cat 6A at 500MHz. Prior to testing we hypothesized Cat 5e would likely fail, as its capacity is well below the 300MHz frequency requirement. Cat 6 signals would also likely struggle for the same reason.
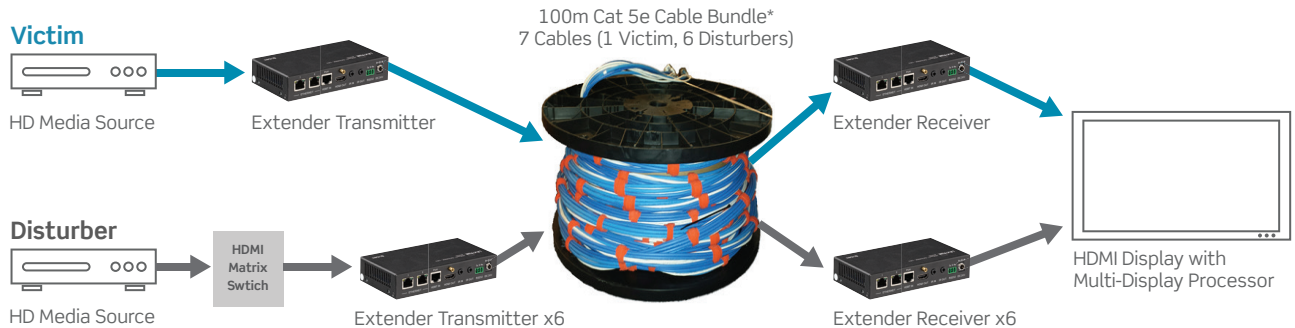
Testing with Cat 5e UTP Cable

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 led to signal dropouts and total link loss, as the channels are not designed to resist alien crosstalk (signal crosstalk from one cable to another).

6 Around 1
Cable Bundle
V = Victim, D = Distuber
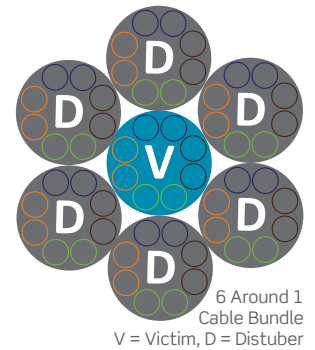
Test Configuration A - 100m Category 5e UTP Cable (6 around 1 bundle)

- Victim = HDBaseT 1.0 Extension Channel 1080p/60

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

Victim

HD Media Source   Extender Transmitter

100m Cat 5e Cable Bundle*
7 Cables (1 Victim, 6 Disturbers)

Extender Receiver

Disturber

HD Media Source   HDMI Matrix Swtich   Extender Transmitter x6   Extender Receiver x6

HDMI Display with
Multi-Display Processor

Results:

- Cat 5e channels can carry HDBaseT 1.0 1080P signals in a point-to-point isolated channel

- Category 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)							
Cable Type	**Number of Disturbers**						
	0	1	2	3	4	5	6
Cat 5e UTP Cable	✓	X	X	X	X	X	X

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

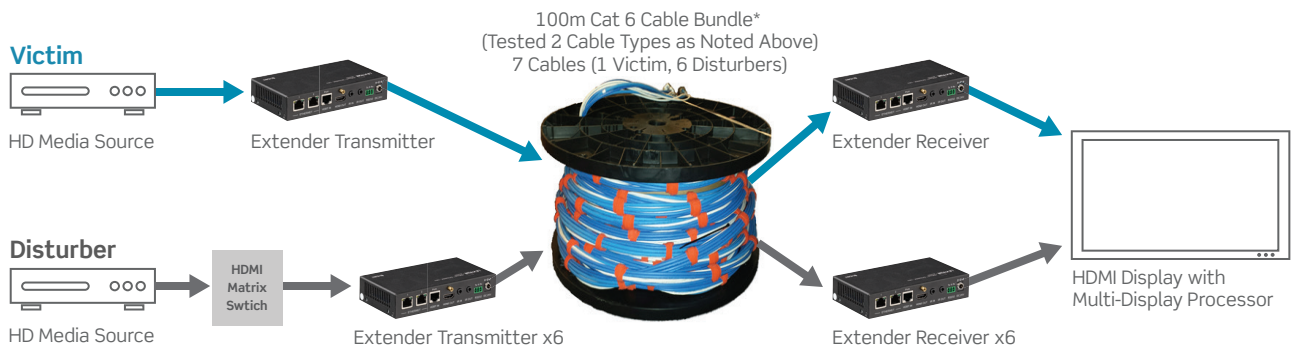*Note: Test results were equivalent for cable bundles deployed in horizontal trays or spooled as shown in the figure.

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Testing with Cat 6 UTP Cable

Leviton conducted testing with two types of Cat 6 cable (Cat 6 UTP cable to ANSI/TIA minimum standards and Cat 6 UTP cable with increased margin over ANSI/TIA standard). In both instances the Cat 6 channels demonstrated marginal success during testing, but signal failures did occur. Cat 6 UTP cables can be limited in carrying signals when adjacent to other cables carrying HDBaseT™ signals and, like Cat 5e UTP cable, Cat 6 UTP cable is not designed to support 300MHz or capable of effectively resisting alien crosstalk.

6 Around 1
Cable Bundle
V = Victim, D = Distuber
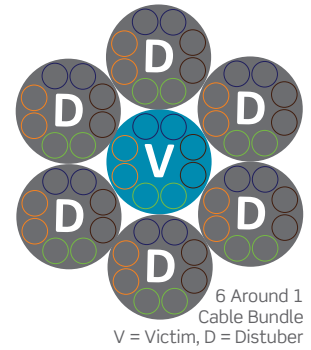
Test Configuration B - 100m Category 6 UTP Cable (6 around 1 bundle)

- Cat 6 UTP cable to ANSI/TIA standard

- Cat 6 UTP cable with increased margin over ANSI/TIA standard

- Victim = HDBaseT 1.0 Extension Channel 1080p/60

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

100m Cat 6 Cable Bundle*
(Tested 2 Cable Types as Noted Above)
7 Cables (1 Victim, 6 Disturbers)

Victim

HD Media Source   Extender Transmitter   Extender Receiver   HDMI Display with Multi-Display Processor

Disturber

HD Media Source   HDMI Matrix Swtich   Extender Transmitter x6   Extender Receiver x6

Results:

- Even Cat 6 UTP cable with increased margin over the ANSI/TIA standard is limited in carrying HDBaseT 1.0 signals when adjacent to other cables carrying HDBaseT signals

- Cat 6 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)							
Cable Type	**Number of Disturbers**						
	0	1	2	3	4	5	6
Cat 6 UTP Cable to ANSI/TIA Standard	✓	✓	—	X	X	X	X
Cat 6 UTP Cable with Increased Margin Over ANSI/TIA Standard	✓	✓	✓	✓	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.

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Testing with Cat 6A UTP and FTP Cable

Leviton conducted testing with three types of Cat 6A cable (Cat 6A UTP cable to ANSI/TIA minimum standards, Cat 6A UTP cable with alien crosstalk prevention technology, and Cat 6A FTP cable). In this phase of testing, Cat 6A cable was the only category rating to consistently support HDBaseT™ signals in the presence of multiple disturbers, including other HDBaseT signals and 10 GbE. And while errors were present when tested with an HDMI tester, no obvious video dropout occurred.

6 Around 1
Cable Bundle
V = Victim, D = Distuber
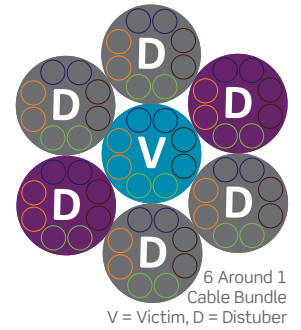
Test Configuration C - 100m Category 6A Cable (6 around 1 bundle)

- Cat 6A UTP cable to ANSI/TIA standard

- Cat 6A UTP cable with alien crosstalk prevention technology

- Cat 6A FTP cable

- Victim = HDBaseT 1.0 Extension Channel 1080p/60

- Disturbers = multiple HDBaseT 1.0 Extension Channels 1080p/60 + (2) 10GBASE-T Ethernet channels
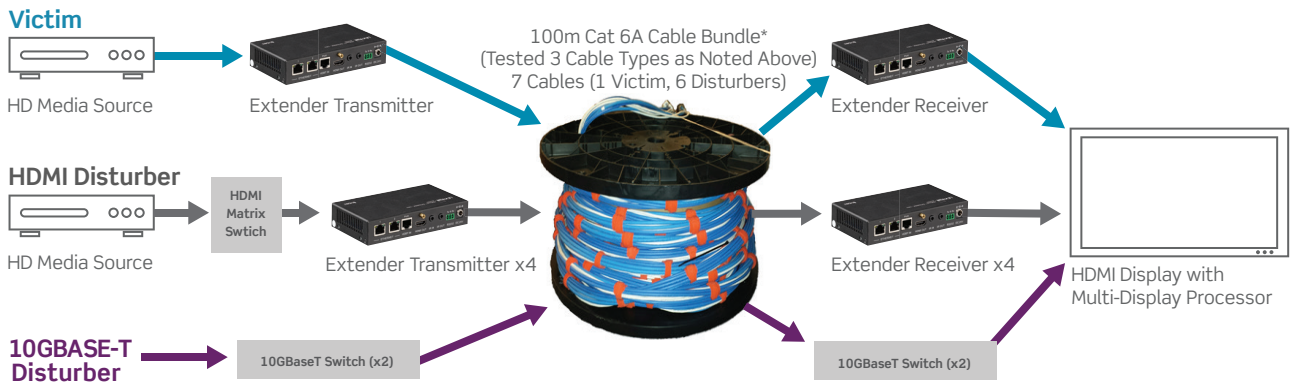
Results:

- Cat 6A UTP channels support HDBaseT 1.0 1080p signals in the presence of multiple disturbers, including other HDBaseT and 10Gb Ethernet

- Errors occur in standard Category 6A UTP channels when tested with an HDMI tester, but there is no obvious video drop-out

- Cat 6A UTP cable with alien crosstalk prevention technology exhibited 0 errors

- Cat 6A FTP cable exhibited 0 errors

Effect Of Adjacent Signals On HDBaseT Victim (6 Around 1 Bundle)							
Cable Type	**Number of Disturbers**						
	0	1	2	3	4	5	6
Cat 6A UTP Cable to ANSI/TIA Standard	✓	✓	✓	✓	✓	✓	✓
Cat 6A UTP Cable with Alien Crosstalk Prevention Technology	✓	✓	✓	✓	✓	✓	✓
Cat 6A FTP Cable	✓	✓	✓	✓	✓	✓	✓

■ = 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.

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Results Summary

Testing confirmed Cat 5e UTP cable is unable to provide the reliability desired for IT/AV signals over long distances, and in most cases it did not support the signal at all. Cat 6 UTP cable came close to meeting signal requirements and delivered modest performance, but issues with alien crosstalk raise concerns regarding reliable signal integrity. Across the board, Cat 6A cable delivered the level of signal required for higher resolution over long distances. However, cable with alien crosstalk prevention technology is recommended.

SELECT THE RIGHT MEDIA AND COMPONENTS

CABLE TYPE	CAT 5E UTP	CAT 6 UTP		CAT 6A UTP	CAT 6A FTP	CAT 6A UTP
	ANSI/TIA Standard	Increased Margin Over ANSI/TIA Standard	ANSI/TIA Standard	ANSI/TIA Standard	ANSI/TIA Standard	Alien Crosstalk Prevention Technology
Recommended	No	No	No	Yes for Single Links	Yes	Yes
Typical Outer Diameter	5.33mm (Typical)	5.8mm (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	Not Designed to Mitigate Alien Crosstalk	1dB	16dB	5dB
Grounding or Bonding Required	No	No	No	No	Yes	No

Alien Crosstalk Prevention Technology in an IT/AV Link

While Cat 6A cable was the only category rating to consistently deliver reliable signal performance over long distances, Cat 6A solutions capable of mitigating alien crosstalk provided top-tier performance throughout all phases of testing.

Alien crosstalk may not be an issue within individual classrooms, conference rooms, lecture halls, or other facilities that benefit from longer distance IT/AV signals. However, applications and pathways where multiple cables are bundled together generate enough alien crosstalk from 10GBASE-T or other HDBaseT signals to cause significant signal interference. For this reason a Cat 6A UTP solution with alien crosstalk prevention technology is ideal.

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Cat 6A UTP Cable with Alien Crosstalk Prevention Technology vs. Cat 6A FTP Cable

FTP cable works to prevent alien crosstalk in two ways:

1. By creating 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 barrier which then creates a magnetic counter field, preventing magnetic coupling from one pair to the other

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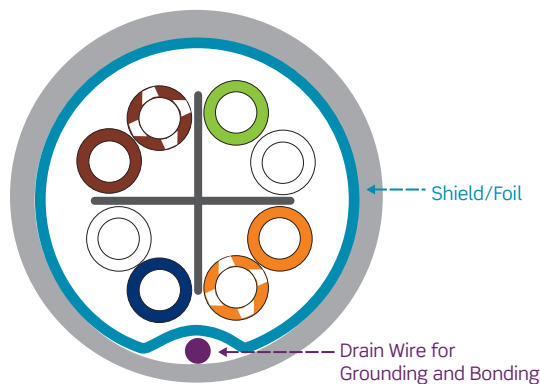
When low (100s) MHz to GHz frequencies are required, like those needed for an HDBaseT™ signal, the actual grounding of the shield is not relevant. However, failing to do so creates the potential for setting up resonances that will cause alien crosstalk or other signal degradation. At high frequencies,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

Due to the point-to-point nature of typical HDBaseT applications, it is not possible 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 in many cases. This adds electromagnetic interference (EMI) risk and should be avoided.
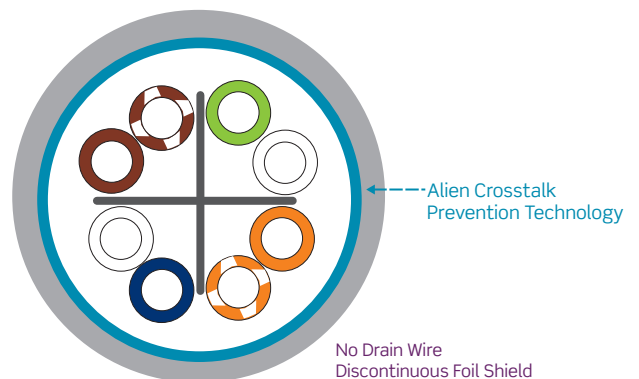
Alien crosstalk prevention technology takes advantage of the phenomenon that the shield can be discontinuous and the length of the shield segment can be adjusted to cover only a few twists, establishing eddy currents and the magnetic counter field, and also creating a capacitive effect sufficient to prevent alien crosstalk.

Leviton has developed a patented technology that tunes the length and shape of the shielded sections to perform best in the desired frequency range for category-rated cables. This innovative solution installs as easy as standard UTP cable. Since alien crosstalk prevention technology does not require grounding or bonding, you get the benefits of a shielded cable without any of the installation headaches or costs.

SHIELDED CABLE

Shield/Foil

Drain Wire for Grounding and Bonding

ALIEN CROSSTALK PREVENTION TECHNOLOGY CABLE

Alien Crosstalk Prevention Technology

No Drain Wire Discontinuous Foil Shield

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During testing, the Leviton Atlas-X1™ Cat 6A UTP system, featuring cable with alien crosstalk prevention technology, outperformed any other Cat 6A UTP solution. The Atlas-X1 Cat 6A UTP system offers the smallest outside cable diameter (O.D.), eliminates alien crosstalk without the need for grounding or bonding, supports familiar installation and termination practices, and is capable of delivering the greater signal bandwidth needed for emerging IT/AV technologies.

STANDARD UTP CABLE   **ALIEN CROSSTALK PREVENTION TECHNOLOGY CABLE**

Voltage Peaks

Magnetic Field Interference

Alien Crosstalk
Prevention Technology
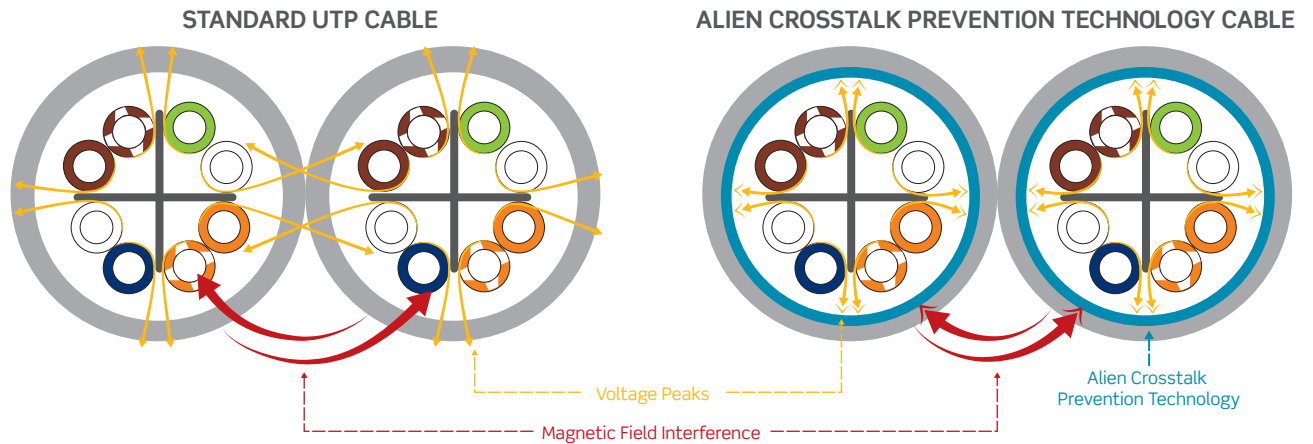
Conclusion

With the increasing demand for ultra high-definition video displays, it is important to install an optimal infrastructure now that will meet IT/AV network requirements and eliminate potential issues in the future. 4K resolution delivering 2160p format at 3840 x 2160 pixel density will be readily available by the end of 2015. To avoid dropouts or link loss at that resolution while mitigating issues caused by alien crosstalk, a Category 6A UTP channel with alien crosstalk prevention technology cable is highly recommended. No other UTP cable option reliably supports AV signal integrity over long distances while eliminating the installation headaches associated with FTP cable, making it the best solution capable of meeting future IT/AV technology demands.

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

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