HDBaseT INSTALLER EXPERT PROGRAM

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HDBaseT Alliance
HDBaseT Installer Expert Program

Agenda

• Inside HDBaseT Technology
• 5Play Elements
• Installation Practices
• Troubleshooting
• Installer Zone
• HDBaseT Demonstration
• Use-Cases
Course Accreditation

Participants in this Installer Expert Program receive the following accreditations

- InfoComm – 3 CTS RUs, 3 CTS-D RUs and 3 CTS-I Rus

- CEDIA – 1.5 CEU credits
HDBaseT Alliance

Inside HDBaseT Technology

• Why HDBaseT?
• HDBaseT Link Characteristics
• Classes and Media
• HDBaseT 5Play Elements
  – Audio/Video
  – Power
  – Controls
  – Ethernet
  – USB
HDBaseT Technology

Inside HDBaseT
The Ultimate Standard of Digital Connectivity Over a Single Cable
Maximum Cable Lengths

How Long Can They Go?

HDBaseT is not just about reducing the number of cables – it’s also about extending their range

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>Maximum Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDMI</td>
<td>15m (in practice)</td>
</tr>
<tr>
<td>USB 2.0</td>
<td>5m (by spec)</td>
</tr>
<tr>
<td>RS-232</td>
<td>15m (by spec)</td>
</tr>
<tr>
<td>I²C</td>
<td>1m @100Kbps (in practice)</td>
</tr>
<tr>
<td>IR</td>
<td>&gt;30m (in practice)</td>
</tr>
</tbody>
</table>
Structured Link/Full Duplex Asymmetric System

Asymmetric Full-Duplex Operation - HDBaseT 1.0

Main Link transmits at 250M/500M from Source to Sink over the 4-pairs while at the same time the Aux Return Channel transmits at 12.5M from Sink to Source.

Less sensitive to errors caused by electrical wire effects → optimal bandwidth
Structured Link/Full Duplex Asymmetric System

Asymmetric Full-Duplex Operation - HDBaseT 2.0

Main Link transmits at 250M/500M from Source to Sink over the 4-pairs while at the same time the Aux Return Channel transmits at 25M from Sink to Source

**UTP Cables Up to 100m**

- **Main Link**: 4 x 250M/500M PAM16 Symbols/Sec
- **Aux Return Channel**: 4x25M PAM8 Symbols/Sec

**Improved** error correction mechanism
Pulse Amplitude Modulation

HDBaseT uses PAM16 symbols. Each symbol is transmitted using 1 of 16 discrete, differential voltage levels, each representing 4 bits of data.
## HDBaseT 2.0/1.0 Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>HDBaseT spec</th>
<th>Media</th>
<th>Max Resolution</th>
<th>Supported max Cable length</th>
<th>Cable category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>1.0</td>
<td>Copper</td>
<td>1080p 4K</td>
<td>100m 70m</td>
<td>Cat5e Cat5e</td>
</tr>
<tr>
<td>Class B</td>
<td>1.0</td>
<td>Copper</td>
<td>1080p 4K</td>
<td>70m 35m</td>
<td>Cat6a Cat5e</td>
</tr>
<tr>
<td>Class C</td>
<td>2.0</td>
<td>Copper</td>
<td>1080p 4K 4K</td>
<td>100m 90m 100m</td>
<td>Cat5e Cat5e Cat6a</td>
</tr>
<tr>
<td>Class D</td>
<td>2.0</td>
<td>Copper</td>
<td>1080p</td>
<td>30m</td>
<td>Cat6a</td>
</tr>
<tr>
<td>Class E</td>
<td>2.0</td>
<td>Fiber</td>
<td>4K</td>
<td>SM: 10s of Km MM: &gt;800m</td>
<td></td>
</tr>
</tbody>
</table>

- HDBaseT is driven by pixel clock rate and not by resolution
- HDBaseT 2.0/1.0 support up to 340MHz Pixel clock
HDBaseT Functional Description

HDBaseT 2.0

HDBaseT Transmitter System

HDBaseT Transmitter

HDBaseT Fiber Interface

HDBaseT over Category cable Fiber

SFP+ Optical Transceiver

SFP+ Optical Transceiver

HDBaseT Receiver System

HDBaseT Receiver

HDBaseT Fiber Interface

HDMI
SGMII / RMII
SPDIF
UART
CIR
USB

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HDBaseT 5Play
HDBaseT: 5Play Convergence on a Single Cable

- Uncompressed ultra-HD video & audio
- 100BaseT Ethernet
- USB 2.0

- Control signals (IR, CEC, RS232)
- Power over HDBaseT (up to 100W)
Audio/Video

- A/V over HDBaseT
- What A/V can HDBaseT support?
- Can my resolution fit HDBaseT?
- HDBaseT 2.0 enhanced audio channels
Audio/Video

HDBaseT is:

• A bit exact pass-through channel for the video and audio

• Does not interfere with the DDC line

  • Does not terminate the HDCP (High-Bandwidth Digital Content Protection)

• Transparent for EDID, no manipulation over the HDBaseT
**Audio/Video**

**Video**
- Full HD/3D and 2K/4K uncompressed video
- HDMI 1.4 (HDMI 2.0 compatible)
- Multi-streaming capability
- CEC, EDID, HDCP supported
- Highest video quality with zero latency

**Audio**
- Digital Audio is passed-through directly from the HDMI chipset
- All standard formats supported, e.g. Dolby Digital, DTS, Dolby TrueHD, DTS HD-Master Audio, Dolby Pro Logic IIz 7.1 & 9.1 and more
Audio/Video - Pixel Clock Calculation

Can my resolution fit HDBaseT 2.0?

- HDBaseT is driven by pixel clock rate and not by resolution
- The table shows commonly used video formats and their attributes
  - Some of the data was taken from the CEA-861-E standard
- How to calculate pixel clock rate:
  
  $$BW = (H_{\text{active}} + H_{\text{Blank}}) \times (V_{\text{Active}} + V_{\text{Blank}}) \times \text{Color Depth} \times 3 \times f_{\text{refresh-rate}} \times \frac{10}{8}$$

  $$f_{\text{pixel clock}} = f_{\text{refresh-rate}} \times (H_{\text{active}} + H_{\text{Blank}}) \times (V_{\text{Active}} + V_{\text{Blank}})$$

- Example: 1080p/60Hz/8bit
  
  BW = (1920+280)x (1080+45)x8x3x60x10/8 = 4.455Gbps

  f = 60x(1920+280)x(1080+45) = 148.5MHz
HDMI 2.0 – Video Support

- Current versions of the HDBaseT specification support pixel clock speeds up to 340MHz
- This translates to maximum uncompressed HDMI video format of 4K/30Hz/4:4:4 or 4K/60Hz/4:2:0
- HDMI 2.0 defines video formats with pixel clock speeds up to 594MHz including 4K/60Hz/4:4:4
- These exceed the available HDBaseT bandwidth
Beyond 4K/30/4:4:4 – Visually-Lossless Compression

- Future versions of the HDBaseT specification will increase the bandwidth of the link
- Until then, interim solutions based on visually-lossless compression (VLC) are proposed
- Uses algorithm from DSC – Display Stream Compression
  - VESA standard for visually-lossless compression
  - Video is compressed line by line, meaning very low latency (few μs)
  - Very light compression ratio of 2:1 or 3:1
Visually-Lossless Compression

Mathematical difference between every pixel in original and compressed images
Visually-Lossless Compression

Comparison of worst-case pixel with largest difference
Visually-Lossless Compression - System Solution

- Visually-Lossless Compression IC
- HDBaseT TX
- HDBaseT RX
- Decompression IC

Connections:
- HDMI 2.0
- HDBaseT 8Gbps
- 4K/60/4:4:4
- HDMI 2.0
Audio - Supported Formats

HDBaseT 2.0 Native Audio

- HDBaseT 2.0 introduced support for 2 native audio interfaces
  - S/PDIF - Sony/Philips Digital Interface Format
  - I²S
- These are in addition to the audio embedded in the HDMI stream
- Supports the use of the HDMI Audio Return Channel (ARC)
Audio/Video - SPDIF

HDBaseT 2.0 supports S/PDIF

- S/PDIF is a digital audio format used in consumer audio equipment
- S/PDIF implementation can transfer audio with sample rates up to 192KHz (vendor dependent)
- Commonly two channels are contained in a data stream, but the protocol does not define a specific number of audio channels within the data stream

<table>
<thead>
<tr>
<th>S/PDIF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabling</td>
<td>75-ohm coaxial or fiber</td>
</tr>
<tr>
<td>Connector</td>
<td>RCA or TOSLINK</td>
</tr>
<tr>
<td>Output level</td>
<td>0.5–0.6 V peak to peak</td>
</tr>
<tr>
<td>Min. input level</td>
<td>0.2 V</td>
</tr>
<tr>
<td>Max. distance</td>
<td>10 m</td>
</tr>
<tr>
<td>Modulation</td>
<td>Biphase mark code</td>
</tr>
<tr>
<td>Subcode information</td>
<td>SCMS copy protection info.</td>
</tr>
<tr>
<td>Max. resolution</td>
<td>20 bits (24 bits optional)</td>
</tr>
</tbody>
</table>
Audio/Video – I²S

HDBaseT 2.0 supports I²S

- Inter-IC Sound (I²S) is another serial bus interface used for digital audio connectivity, serving mainly headsets and microphones.
- The specification was first released by Philips in 1986, and revised 10 years later.
- The I²S bus has 3 serial lines:
  - Serial data (DIN/DOUT)
  - Word select (WCLK): 0 = left channel, 1 = right channel
  - A continuous serial clock (BCLK)
- HDBaseT 2.0 limits the maximum BCLK rate to 5MHz.
Summary – Key Points to Remember About A/V Over HDBaseT

• HDBaseT 1.0 + HDBaseT 2.0
  • TMDS data over HDBaseT is bit exact, no manipulation, no compression
  • When we think of HDBaseT as resolutions → we need to calculate pixel clock rate

• HDBaseT 2.0 offers enhanced audio channels
  • S/PDIF is capable of transferring audio with sample rates up to 192KHz
  • I²S can support a maximum BCLK rate of 5MHz
  • Support for ARC
PoH – Power Over HDBaseT

- HDBaseT Power Definition – PoH
- Terminology
- Certification and Interoperability
PoH – Power Over HDBaseT

HDBaseT Power Definition

- Compatible with IEEE 802.3at and standard IEEE 802.3af
  - Input power 44-57v DC
  - Max current per 2 pairs – 1A
- Delivery of up to 100 watts
- Uses all 4 pairs in the HDBaseT cable
- PoH is fully interoperable with POE
  - Power will be driven on the twisted pair only after negotiation
  - Power level is based on the highest mutually supported
- Meets electrical power safety regulation
Power Sourcing Equipment (PSE)

- Any device that wishes to be stated as an HDBaseT PoH PSE should be classified according to the types shown in the table below.

- An HDBaseT PSE will have to declare its type and will have to meet the max power requirements of the spec.

<table>
<thead>
<tr>
<th>PSE Type</th>
<th>Max power supplied</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>15.4W</td>
<td>based on IEEE 802.3af / 802.3at-type1</td>
</tr>
<tr>
<td>Type 2</td>
<td>30W</td>
<td>based on IEEE 802.3at-type2</td>
</tr>
<tr>
<td>TWIN MP PSE (Type2-Twin)</td>
<td>30W x2</td>
<td>based on IEEE 802.3at-type2 (two power interfaces) but only defined in HDBaseT specification</td>
</tr>
<tr>
<td>Type 3</td>
<td>47.5W</td>
<td>Defined in HDBaseT specification</td>
</tr>
<tr>
<td>TWIN HP PSE (Type 3 Twin)</td>
<td>47.5W x2</td>
<td></td>
</tr>
</tbody>
</table>
PoH – Power Over HDBaseT Terminology

**Powered Device (PD)**

- A PD device has to confirm the PSE type it requires to work with, while keeping the HDBaseT link performance and conforming to the defined protocol (# of events, etc)

<table>
<thead>
<tr>
<th>PD Type</th>
<th>Max power consumed</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>13W</td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td>25.5W</td>
<td></td>
</tr>
<tr>
<td>TWIN MP PSE (Type2-Twin)</td>
<td>25.5Wx2</td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>36.2W</td>
<td>When Cable Power loss info <strong>is not</strong> known or fixed</td>
</tr>
<tr>
<td>TWIN HP PSE (Type 3 Twin)</td>
<td>36.2W x2</td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>47.5W-Cable loss</td>
<td>When Cable Power loss info <strong>is known and fixed</strong></td>
</tr>
<tr>
<td>TWIN HP PSE (Type 3 Twin)</td>
<td>(47.5W-Cable loss) x2</td>
<td></td>
</tr>
</tbody>
</table>
PoH – Power Over HDBaseT

Certification and Interoperability

• Power driven on the category cable which does not comply with the IEEE PoE or HDBaseT PoH requirements is a violation of the HDBaseT spec, and products using such techniques will not pass compliance testing.

• It is the users responsibility to verify the HDBaseT certified features.

• The HDBaseT Alliance mobile App for Android and iOS provides this information, as does the listing of certified products on the Alliance web-site.

• Products supporting PoH are listed as PSE or PD.

• User MUST cross-check the product certification spec with the manufacturer product spec in order to determine which Type is supported.
Controls

• RS232
• Consumer Infrared (CIR) – Type A/B
• Consumer Electronic Controls (CEC)
HDBaseT Control

RS232
RS-232 is a standard for serial communication transmission of data.

The maximum cable length for RS-232 is 15m/50ft.

In practice, it depends on baud rate, cable-specific capacitance, and ambient noise.
HDBaseT Control – RS232

RS232 over HDBaseT

HDBaseT supports a cable with only three pins connected (TD, RD and GND)

- Pin 2, Received Data (RD)
- Pin 3, Transmit Data (TD)
- Pin 5, Ground (GND)

HDBaseT RS232 Interoperability

- HDBaseT does not support Flow control
  - Flow control must be set to 'none' in the COM port setup on both ends (Windows Control Panel)
- The HDBaseT specification does not refer to RS232 physical layer (12v) but as TTL level (5V)
- RS232 can be terminated internally (within the unit) using a microprocessor
HDBaseT Control – RS232

HDBaseT 1.0 vs. 2.0

**HDBaseT 1.0 RS232**
- RS232 is a passthrough over-sampled channel
- All baud rates up to 115Kbps are supported
- Limited in HDBaseT low-power modes to a maximum baud rate of 9.6Kbps

**HDBaseT 2.0 RS232**
- RS232 support 2 modes of operations
  - Passthrough over-sampled channel
  - Pre-configured mode
    - Allows pre-configuration of the UART baud rate – up to 115Kbps – for optimal data transfer
    - Pre-configured baud-rate is available also in HDBaseT low power modes (up to 115Kbps)
HDBaseT Control – RS232

HDBaseT 2.0

Over-Sampled

Pre-Configured

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HDBaseT Control
Consumer Infra Red - CIR
**Consumer IR (CIR)**

What is Infra Red (IR) Signal?

- Carrier – clock frequency in the range of ~38KHz and higher
- Data – low frequency signal up to ~10KHz
  - “1” – represented by carrier clock
  - “0” – represented by no signal
**Consumer IR (CIR)**

**IR Terminology**

**CIR “over the air”**
- Infra Red Transmission between IR emitter to IR receiver
- This signal must be modulated
- Carrier frequency range is mostly in the range of 38KHz

**CIR “over HDBaseT”**
- Infrared transmission from the IR receiver to the IR emitter over the HDBaseT protocol
- The signal can be either modulated or unmodulated
**Control**

CIR Type A

**Type A – IR data is passed over the HDBaseT (carrier is filtered)**

- Supports 38KHz CIR
- IR receiver demodulates the signal (removes the 38 KHz carrier signal)
- Signal is passed unmodulated over HDBaseT (IR receiver → IR emitter)
- IR emitter must add 38KHz carrier modulation to the CIR signal before transmitting out of blaster emitter diode (“over the air”)
Control

CIR Type B

Type B – Carrier + Data are passed over the HDBaseT link

- Supports up to 60KHz IR signal carrier
- IR receiver delivers the signal to the HDBaseT link including the modulation
- IR light emitter gets the signal from the HDBaseT link including the modulation
CIR Receiver

CIR Receivers - Both Internal and External

- Type A External CIR Receiver
- Type B External CIR Receiver
- 3.5mm stereo jack
- LPF
- Extender
- HDBaseT Transmitter
- HDBaseT

**Diagram:**
- Light flow from Type B External CIR Receiver to 3.5mm stereo jack, then to HDBaseT Transmitter.
- Light flow from Type A External CIR Receiver to LPF, then to Extender.
CIR Transmitter

Internal / External / Modulation / Passthrough

- Control=0: LPF is bypassed and modulation is enabled, suits baseband input signal (Type A)
- Control=1: LPF is enabled, and modulation is bypassed, suits modulated signal (Type B)
HDBaseT Control

Consumer Electronics Control
Control - CEC

• HDMI CEC (Consumer Electronic Control) is a one-wire bidirectional serial communication used by the industry-standard AV

• It can be considered the HDMI control protocol

• Allows the user to command and control up to ten CEC-enabled devices

• For example, HDMI-CEC commands
  • System On/Standby: switches all connected devices to on/standby with single press
  • OSD Display: use the OSD of the TV set to display text
  • System Information: checks all components for bus addresses and configuration

• HDBaseT treats CEC data as passthrough
Ethernet

- Standard 100BaseT Ethernet
- Fallback
**HDBaseT Ethernet Configuration**

- RMII
- Full Duplex
- 100Mbit
- FB (Fallback) = connecting LAN to the HDBaseT RJ45 connector

**HDBaseT Definition of Ethernet**

**Transmitter HDBaseT Mode**
- PAM-16
- 100M Ethernet
- Video
- Audio
- Controls

**Receiver**
- Ethernet Switch (LAN)
- HDBaseT Module
  - RMII-3.16
  - 100M Ethernet
  - Video
  - Audio
  - Controls

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USB 2.0
USB over HDBaseT

• Compliant with USB 2.0 specification
• Supports all types of USB transfers
  • Isochronous – e.g. web cameras, audio devices
  • Bulk – e.g. disk drives
  • Interrupt – e.g. keyboard, mouse
  • Control (all devices)
• Supports maximum 7 devices
• Bandwidth up to 190Mb/s (for Isochronous transfers)
HDBaseT Installation Practices
Interoperability

• Cabling
  • Cable terminations
  • Power and cable shielding
  • Bundling
• CIR – Consumer Infra Red
• HDMI and HDBaseT Transmitter – Stretching
• Control Capabilities – UART Extension
Interoperability - Cabling
HDBaseT Cable Termination

HDBaseT Cable Diagram

• Supports different cable topologies
  • “Crossover”
  • “Semi-Crossover”
  • “Straight”

• HDBaseT automatically resolves all cross types in the cable
HDBaseT Category Cable

Cable Recommendations

- HDBaseT defines the link as
  - 90 meter infrastructure cable
  - 2 x 5m (max) patch cable, one on each side
- Infrastructure cable should be 24 AWG or better
- The minimum requirement for the cable is Cat5e or better
- Any of the following cables will fit
  - UTP
  - STP - individual shields for each twisted-pair
  - S/UTP - an overall cable shield
  - S/STP - both an overall cable shield as well as individual shields for each twisted-pair
HDBaseT Cable Termination

Category Cable Shield Termination

3 common use-cases to deal with when connecting HDBaseT transmitter and receiver

• Floating power supplies
  • Connect the cable shield on one end of the cable (due to high differential voltage developed between the Tx and Rx)

• PoH implementation
  • Connect the shield on both ends of the cable

• Chassis grounded system
  • If both sides are chassis grounded, terminate the shield on both ends
  • If one side is chassis grounded and the other is floating, connect the shield on the chassis terminated side
HDBaseT Cable Bundling – Recommendations

• The installation practices can positively impact alien crosstalk headroom when using Cat5e/6 cables
• For the first 20 meters
  • Do not “comb” or “pinstripe” cables
  • Separate path and equipment cords
  • Avoid tie-wraps
  • Use horizontal wire management techniques (e.g. route odd ports to upper management and even ports to lower management)
  • Loosely place cables in vertical wire management
  • Reduce maximum conduit fill density to 40% (but never exceed local regulations)
• Implementation of these practices is not required for any augmented Cat6a F/UTP (sometimes referred to as ScTp) or Cat7 S/FTP (fully shielded) cabling systems.
HDBaseT Cable Bundling – Recommendations (cont.)

<table>
<thead>
<tr>
<th>Media</th>
<th>Augmented Category 6 UTP</th>
<th>Augmented Category 6A F/UTP</th>
<th>Category 7/Class F S/FTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Construction</td>
<td>![Cable Construction Image]</td>
<td>![Cable Construction Image]</td>
<td>![Cable Construction Image]</td>
</tr>
<tr>
<td>Alien crosstalk</td>
<td>Exhibits compliant alien crosstalk due to core separation design</td>
<td>Exhibits virtually zero alien crosstalk due to overall foil construction</td>
<td>Exhibits virtually zero alien crosstalk due to fully shielded construction</td>
</tr>
<tr>
<td>Installation Notes</td>
<td>Larger overall diameter must be taken into consideration when calculating conduit and pathway fill</td>
<td>Grounding of the foil in one location from the patch panel in the telecommunications closet to the TGB is required</td>
<td>Grounding of the shield in one location from the patch panel in the telecommunications closet to the TGB is required</td>
</tr>
<tr>
<td>Work Area Interface</td>
<td>Standard 8-position Modular (RJ-45 style)</td>
<td>Standard 8-position Modular (RJ-45 style)</td>
<td>Quadrant-Pair Isolated Connector (non RJ-45 style)</td>
</tr>
<tr>
<td>Maximum Recommended Conduit Fill (never exceed local regulations)</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
</tr>
</tbody>
</table>

The above cable types are recommended to support the bundling of HDBaseT over several cables.
Introducing the UL Program for PoH Cable Certification

- UL has worked with the HDBaseT Alliance to develop a dedicated certification program for PoH cables.
- The requirements are based on the HDBaseT compliance test specification for the HDBaseT Alliance Recommended Cables program, and a safety and performance test under heating conditions developed by UL.
- The cables are tested in a specified bundle at 100 Watts and the HDBaseT parameters are verified at the temperature measured during operation.
Introducing the UL Program for PoH Cable Certification

- Cables are distinguished with an industry recognized UL certification Mark and a holographic sticker
- UL’s Follow-up Program covers factory inspection and market surveillance to ensure ongoing compliance
- PoH certified cables are listed separately on the HDBaseT Alliance website
- UL are also a Recognized Test Facility for the HDBaseT Recommended Cables program
Interoperability - CIR
Infra Red (IR) Extension

Things To Pay Attention To

- IR Type B interface
  - 3.5mm stereo jack is common also for audio
  - You should not connect audio to the IR interface as it might damage your equipment

- IR Diodes in the market
  - There are several types of IR blasters in the market
  - 12v and 5v are the most common
  - For each system use the IR equipment provided by the manufacturer

<table>
<thead>
<tr>
<th>Type</th>
<th>Tip</th>
<th>Ring</th>
<th>Sleeve</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR Transmitter</td>
<td>Mono</td>
<td>GND</td>
<td>-</td>
</tr>
<tr>
<td>IR Transmitter</td>
<td>Stereo</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>IR Receiver 12V</td>
<td>Stereo</td>
<td>GND</td>
<td>12V</td>
</tr>
<tr>
<td>IR Receiver 5V</td>
<td>Stereo</td>
<td>5V</td>
<td>Signal Output</td>
</tr>
</tbody>
</table>
Interoperability – RS232
RS232 Control Interoperability

- HDBaseT 1.0
  - Single operating mode: over-sampled channel
  - During low-power modes supports maximum 9.6Kbps data rate

- HDBaseT 2.0
  - Supports two operating modes: over-sampled and preconfigured
  - Over-sampled mode works identically to HDBaseT 1.0 definitions and limitations
  - Preconfigured mode works as a native interface – only data is passing on HDBaseT data is extracted on one side, reconstruct and transmitted again at the remote side

<table>
<thead>
<tr>
<th>Chipsets Interoperability</th>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDBaseT 1.0(over-sampled) + HDBaseT 2.0 (pre-configured)</td>
<td>Over-Sampled</td>
</tr>
<tr>
<td>HDBaseT 2.0 (over-sampled) + HDBaseT 2.0 (pre-configured)</td>
<td>Preconfigured</td>
</tr>
<tr>
<td>HDBaseT 2.0 (Pre-configured) + HDBaseT 2.0 (pre-configured)</td>
<td>Preconfigured *</td>
</tr>
</tbody>
</table>

* If there is a difference in baud rate settings then there will not be a communication channel
HDMI and HDBaseT Interoperability – DDC Clock Stretching
HDMI and HDBaseT Interoperability

What is stretching?

- HDMI DDC (Display Data Channel) is an I²C serial communication channel used for EDID and HDCP
- In I²C serial communications, the Master device determines the clock speed
- There are situations where an I²C Slave is not able to co-operate with the clock speed set by the Master and needs to slow things down a little
- The Slave is allowed to hold down the clock in order to reduce the bus speed
- This mechanism is known as clock stretching, and was defined in HDMI 1.3
**HDMI and HDBaseT Interoperability**

- The HDBaseT Transmitter (HDMI Receiver) act as slave on the DDC lines — the video source is the Master
- The HDBaseT Receiver (HDMI Transmitter) act as a Master on the DDC lines — the display (sink) is the Slave
- When HDBaseT is connected between source and sink, there is a propagation delay over 100m
  - HDBaseT defines maximum latency of 10μs from source → sink, and 10 μs from sink → source, resulting in a 20μsec roundtrip
  - 20μs == 50Khz clock
- Theoretically, if the source device DDC clock is above 50KHz, there is a probability that the HDBaseT TX can not fetch the sink data, and it will need to “request” the source device (DDC Master) to stop toggling the DDC clock by performing stretching as per the HDMI standard
HDMI and HDBaseT Interoperability

How to Test & How to Solve

**Test setup**
- Cut the DDC clock line and insert 10Ω serial resistor
- Checking the clock signal on the source side

**How to recognize it in the field?**
- You see colored snow
- Intermittent video drop

**Solution**
- Common solution is to use an HDMI splitter 1:2 between the source and the HDBaseT TX
Troubleshooting
What To Do When Things Go Wrong

• HDBaseT has become the de-facto standard in AV interconnectivity
• Installers tell us that they enjoy using HDBaseT because of its reliability and ease of use
  • “It just works”
  • “True plug-and-play”
• Despite this, issues may still arise that need to be debugged
• We shall explore methods for troubleshooting HDBaseT installations
Source/Sink Equipment Compatibility

- Before dismantling any installed equipment, it is worth double-checking compatibility of the Source and Sink equipment.
- Read the product documentation to make sure of interop compatibility.
  - For example, do not expect an HDR TV to work if the video Source does not support it.
- Try to eliminate HDBaseT as the cause of the issue.
  - Directly connect the Source to the Sink to be sure they work together.
  - Not all HDMI ports support all features (e.g. HDMI 2.0 may only be on certain ports).

![Diagram of Source, HDBaseT Transmitter, HDBaseT Receiver, and Display](image)
HDBaseT Equipment Interoperability

- As discussed, not all HDBaseT products include the full 5Play functionality
- And as we know, “common” HDBaseT functions may differ from one product to another
  - CIR
  - UART
  - Cable reach (different classes)
- Refer to the list of approved products on the HDBaseT website to make sure the HDBaseT TX and RX equipment is compatible
- Use the HDBaseT App to check compatibility of the different products
Check HDBaseT Installer Zone

- The HDBaseT Alliance Installer Zone contains a wealth of information related to HDBaseT products
- Check the Installer Forum to see if any of your peers have experienced similar issues and may have the solution already
- Start a new thread on the Forum explaining the issues to see if anyone can help you
Check Cabling

- The HDBaseT cable is an essential part in the system
- How is the shield connected?
- Are the connectors correctly wired and properly crimped?
- How are the cables routed?
  - What other cables run nearby?
  - Are there any “noise” sources close to the cable (e.g. aircon units, fluorescent lights)?
- Try replacing the cable
  - Try using a shorter cable length to see if the issues are related to link performance
- Make sure the HDMI cable is suitable for its intended use
  - For example, HDMI Premium High-Speed Cable for 4K/60/4:4:4 and HDR setups
Checking the HDMI Interface

- Replace the Source and Sink products with HDMI generators and analyzers (if available)
- Check to see if the issue is related to specific formats
  - Could the HDBaseT link bandwidth be exceeded?
  - Try running with lower video formats
- Check that 5V and HPD signals are reaching their destinations
  - Without them, EDID and HDCP transactions can not be completed
  - Use simple HDMI breakout boards
- Some products have manual EDID settings
  - Make sure they are compatible with the HDMI Source and Sink
Checking the HDMI Interface

- As discussed, IR can be complicated due to different configurations of receivers and blasters
  - Some remove the modulation – other pass it through (Type A or Type B)
  - Any IR over-the-air must be modulated
- Always use the IR receivers/blasters provided by the equipment vendor
- Again, refer to the list of approved products on the HDBaseT website to confirm the IR type of the equipment
General Issues

- Status Indicators
  - LEDs can provide an indication as to the operating mode and status of the link
  - Are we in HDBaseT mode, Low Power Mode or Fallback mode? Check the Link LED
  - Is there video, and is it HDCP encrypted? Check the Video LED

- Power
  - If using PoE, make sure that there is 1 PSE and 1 PD per link
  - Check vendor documentation for the PoE class and compatibility
  - Ensure that the cable shield is grounded correctly according to the power scheme

- UART
  - If the equipment runs in pre-configured mode on both sides of the link, double-check that the configurations are identical
Expanding HDBaseT Capabilities

- Since the release of the first chipset, HDBaseT has become the de-facto standard for high-definition wired connectivity in different AV Markets
- The technology provides a convergence of multiple interfaces over a single cable, and significantly extends their reach (up to and above 100m/328ft)
- As a result, HDBaseT has become the ultimate solution for replacing multiple cables and protocols with a single category cable
- HDBaseT is ideally suited for installations up to 100m radius – for example, in-room and cross-floor systems
- However, existing HDBaseT is less well suited for cross-campus topologies
Typical HDBaseT Scope

In-Room

Cross-Floor

100m
Going Cross-Campus?

In-Room

Cross-Floor

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Limitations of Today’s IP Solutions

- Existing HDBaseT is not well suited for cross-campus topologies
- While other IP solutions are currently available for such topologies, they have a number of limitations

<table>
<thead>
<tr>
<th>Issue</th>
<th>Problems</th>
</tr>
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</table>
| No interoperability in eco-system | • Each vendor implements proprietary solution  
                                  • No interoperability across vendors                                  |
| Not standardized               | • Not standard at Application layer  
                                  • Creates interoperability issues                                       |
| Incompatible with non-IP install base | • Non-compliant with existing non-IP equipment  
                                  • Need to replace install base                                        |
| Not Pro-AV grade               | • Not up to the demands of Pro-AV grade  
                                  • HDCP does not meet DCP LLC requirements                                 |
HDBaseT-IP - Motivation

- Leverage the in-room solution to a cross-campus/cross-organization solution, with Application level interoperability
- Flexible configuration of the number of sources and sinks
- Support for ultra-large scale installations
HDBaseT-IP – Key Benefits

- Building upon a **proven standard technology** with a thriving eco-system
- Integration and scalability with existing HDBaseT products - **expanding the scope of HDBaseT**
- Unified management - **end-to-end HDBaseT**
- HDBaseT 5Play **convergence** – full **interoperability** up to the Application level
- Utilization of both **copper and fiber** interfaces
- Use of standard **10G switches and future support for lower speed rates**
  - Cost-effective quality – use the best infrastructure that meets the cost restrictions
- A true ProAV-grade solution
  - **Time-sensitive**: Zero Frame Latency, Low Latency Variation
HDBaseT-IP – Use-Cases

HDBaseT-IP 10 Gigabit Switching

- HDBaseT-IP TX
- HDBaseT-IP RX

- HDMI 4K
- 10GE

- P2P
- Multicast
- P2P + HDBaseT Extension (Hybrid)
The HDBaseT Alliance
HDBaseT Alliance Goal

To promote and standardize HDBaseT™ technology for whole-home distribution of uncompressed HD multimedia content.

All uses of the HDBaseT name and logo are trademarked by the HDBaseT Alliance.
HDBaseT Alliance Reaches 190 Members Milestone

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HDBaseT Certification Program
The Path To HDBaseT Interoperability in an Imperfect World

- Not all HDBaseT products support the full 5Play feature set
- Some features may be supported but not HDBaseT certified, so interoperability may not be achieved
- Only HDBaseT interoperability, not full product interoperability, is being tested, so check the fine print for proprietary features that may make the product interoperable in general!
HDBaseT Certification Program

Formal framework to ensure compliance & interoperability in the HDBaseT ecosystem

HDBaseT Compliance Test Specification
Logo Guidelines
HDBaseT Recognized Test Facility
Your Guide to HDBaseT Interoperability

Logo
• Only certified products may carry the HDBaseT logo
• Increased enforcement by the Alliance

The Certified Product List
• The list is constantly updated as more and more products receive certification
• You can check by manufacturer, product category, resolution, class, and specific HDBaseT features

Manufacturers’ Collaterals
• Check for the ‘fine print’ or contact manufacturer to verify any specific features that may cause the product not to be interoperable
HDBaseT Alliance Website – Installer Zone
HDBaseT Alliance Installer Zone

- Who are the Alliance members? Learn about the companies advancing HDBaseT solutions for your benefit
- HDBaseT certified products: Learn which products have received the HDBaseT certification seal
- Become an HDBaseT Expert with the Installer Zone’s specially designed training modules
- What’s on your mind? Get together with your fellow installers to discuss the latest trends in the industry on the Installers Forum

Meet the Members
Product List
Expert Program
Installers Forum
HDBaseT Certified Product List

- Over 1700 Certified Products
- Rapid annual growth
- Enforcement program - every HDBaseT product MUST be certified
Online Installer Expert Program

- Comprises nine lessons
- Users that pass the training receive
  - HDBaseT expert certification, email and printed
  - HDBaseT T-shirt
  - Submit the certificate to InfoComm to receive 1 RU (Renewal Unit) accreditation
Installer Zone Forum

- Registration is required (free of charge)
- Users can submit HDBaseT queries to be answered by the Alliance or other forum participants
- Users can open discussions and share their experience
HDBaseT
Installers Zone Registration

How to ...?

3 simple steps to join the HDBaseT installer forum

• On the main page select the “Installers Forum”
• Press the Sign-Up button
• Fill in your details and click “Sign Up”
HDBaseT App

Check for product certification on-the-go

• Make informed decisions
• Compare different vendors and products
• Research product interoperability
• Check for mix & match
HDBaseT 2.0 – Demo
HDBaseT 2.0 Demo

Complete configuration

TX Side

IR Blaster
4K HDMI & SPDIF Source Streamer
Cellular Phone

SPDIF Audio

HDBaseT - CAT6 - Up to 100m

RX Side

IR Receiver
IR Remote Control
HDMI Display
USB Portable Media
USB Mouse

USB
HDMI
HDBaseT - CAT6 - Up to 100m
SPDIF
Audio
HDBaseT 2.0 Demo
HDBaseT 2.0 Demo

USB 2.0

TX Side

IR Blaster

IR Data

4K HDMI & SPDIF Source Streamer

Cellular Phone

IR Data

I²S Audio

SPDIF Audio

L.S. + Amp

HDBaseT - CAT6 - Up to 100m

RX Side

IR Receiver

IR Data

IR Remote Control

HDMI Display

USB Portable Media

USB Mouse

HDBaseT - CAT6 - Up to 100m

I²S Audio

USB

HDMI

SPDIF

Audio
HDBaseT 2.0 Demo

I2S Audio channel

TX Side

IR Blaster

IR Data

4K HDMI & SPDIF Source Streamer

IR Data

Cellular Phone

I²S Audio

L.S. + Amp

HDBaseT - CAT6 - Up to 100m

RX Side

IR Receiver

IR Data

IR Remote Control

HDMI Display

IR Data

USB Portable Media

USB Mouse

L.S. + Amp

I²S Audio

SPDIF Audio

SPDIF

HDBaseT - CAT6 - Up to 100m

USB

HDMI

SPDIF

Audio

HDBaseT - CAT6 - Up to 100m

SPDIF

Audio

Cellular Phone

4K HDMI & SPDIF Source Streamer

IR Blaster

IR Receiver

HDMI Display

USB Portable Media

USB Mouse

L.S. + Amp

IR Remote Control

I²S Audio
HDBaseT 2.0 Demo

IR Type B

TX Side

IR Blaster

IR Data

4K HDMI & SPDIF Source Streamer

SPDIF Audio

Cellular Phone

L.S. + Amp

HDBaseT - CAT6 - Up to 100m

RX Side

IR Receiver

IR Data

IR Remote Control

HDMI Display

USB Portable Media

USB Mouse

L.S. + Amp

I²S Audio

USB

HDBaseT - CAT6 - Up to 100m

HDMI

SPDIF

Audio

IR Data

IR Remote Control

HDMI Display

USB Portable Media

USB Mouse

L.S. + Amp

I²S Audio

USB

HDBaseT - CAT6 - Up to 100m

HDMI

SPDIF

Audio
HDBaseT Use-Cases
HDBaseT Major Applications

Home | Custom Installations | Digital Signage | Projection
Whole Home Networking Application

HDBaseT Switch for Complete Home Networking

Legacy In

HDBaseT Out

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Whole Home Networking Application

All AV Devices are Placed in a Central Location

**HDBaseT Switch Terminates the Sources**

Legacy Connectivity is Supported
Whole Home Networking Application

Standard LAN Cable – Existing Infrastructure Can Be Used
Whole Home Networking Application

Tablet or Smartphone for Remote Control over HDBaseT™ Switch
HDBaseT™ Connected Home Topology

The HDBaseT™ Switch connected using standard CAT5e/6 cabling and various Wall-Mount Adapter plates.

HDBaseT™ wall plates supports legacy connectivity, e.g. HDMI, Ethernet ports and various controls.
Whole Home Networking Application

Central Equipment Cabinet

Gaming Console

Blu-ray Player

PC

Set-Top Box

HBaseT™ Switch

HBaseT™ Display

Bedroom

Living Room

Home Office

Tablet or Smartphone for Remote Control over HBaseT™ Switch
You’re in Control
Select Set-Top Box Source
Whole Home Networking Application

- **Central Equipment Cabinet**
  - Gaming Console
  - Blu-ray Player
  - PC
  - Set-Top Box
- **HDBaseT™ Switch**
- **HDBaseT™ Display**
  - Bedroom
  - Living Room
  - Home Office
- **Tablet or Smartphone for Remote Control over HDBaseT™ Switch**
Whole Home Networking Application

[Diagram of a whole home networking application with various devices connected via HDBaseT technology.]
You’re in Control
Select Set-Top Box Source
You’re in Control
Select Set-Top Box Source
Whole Home Networking Application

Central Equipment Cabinet

HDMI HDBaseT HDMI HDMIUSB

Living Room

HDBaseT™ Display

Gaming Console

Blu-ray Player

PC

Set-Top Box

HDBaseT™ Switch

Bedroom

HDBaseT™ Display

Living Room

HDBaseT™ Display

Home Office

Keyboard & Mouse

Tablet or Smartphone for Remote Control over HDBaseT™ Switch
Whole Home Networking Application

Diagram showing a central equipment cabinet connected to various rooms through an HDBaseT™ Switch. The rooms include the Living Room, Bedroom, Home Office, and a central Hub for Blu-ray Player, PC, and Set-Top Box. Devices such as Gaming Console and Blu-ray Player are also integrated via HDMI and USB connections. A tablet or smartphone is shown for remote control over the HDBaseT™ Switch.
You’re in Control
Select Blu-Ray
Whole Home Networking Application

Central Equipment Cabinet

HDBaseT™ Switch

HDBaseT™ Display

HDBaseT™ Display

HDBaseT™ Display

Living Room

Bedroom

Home Office

Gaming Console

Blu-ray Player

PC

Set-Top Box

HDMI

HDMI HDBaseT HDMI HDMI USB

Tablet or Smartphone for Remote Control over HDBaseT™ Switch
Whole Home Networking Application

- Central Equipment Cabinet
- HDBaseT™ Switch
- HDBaseT™ Display
- Gaming Console
- Blu-ray Player
- PC
- Set-Top Box
- Bedroom
- Living Room
- Home Office
- Tablet or Smartphone for Remote Control over HDBaseT™ Switch
Surfing from Bed
By Choosing PC Source
Whole Home Networking Application

Central Equipment Cabinet

Gaming Console
Blu-ray Player
PC
Set-Top Box

HDBaseT™ Switch

HDMI
USB
HDMI
HDMI

HDBaseT™ Display

Bedroom
Living Room
Home Office

Tablet or Smartphone for Remote Control over HDBaseT™ Switch
Whole Home Networking Application
Surfing from Bed
By Choosing PC Source
Or Playing a Game
By Choosing Console Source
Whole Home Networking Application
Whole Home Networking Application

Central Equipment Cabinet

- Gaming Console
- Blu-ray Player
- PC
- Set-Top Box

HDBaseT™ Switch

- Bedroom HDBaseT™ Display
- Living Room HDBaseT™ Display
- Home Office HDBaseT™ Display

Keyboard & Mouse

Tablet or Smartphone for Remote Control over HDBaseT™ Switch
Or Playing a Game
By Choosing Console Source
Whole Home Networking Application
Whole Home Networking Application

- Central Equipment Cabinet
- HDMI
- HDBaseT™
- Display
- Gaming Console
- Blu-ray Player
- PC
- Set-Top Box
- HDBaseT™ Switch
- Bedroom
- Living Room
- Home Office
- Tablet or Smartphone for Remote Control over HDBaseT™ Switch
- Keyboard & Mouse

Devices connected via HDBaseT™ technology allow for seamless integration and control across multiple rooms in the home.
Work on Your PC
By Choosing PC Source
Or Monitor CCTV
By Choosing CCTV Source
HDBaseT™ Home Network Benefits

- **Total Control**: Connect any Video or Data source to any display
  Control sources using tablet or smartphone app

- **Elegance**: True single cable solution eliminating cable clutter

- **Distance**: Connect display devices up to 100m away from the switch

- **Simplicity**: Plug and Play
  Rely on existing Cat5e/6/7 Cabling infrastructure

- **Quality**: Support all resolutions up to 4K UltraHD / 3D video
Custom Install
All Professional Needs On a Single Cable

• Unmatched solution for professional integrators
• Eliminates current transmission distance limitations
• Simple, reliable and low-cost installation without compromising on quality
• Popular applications: AV switching matrix adaptors
Popular Pro-AV HDBaseT Applications

Switching Matrix

HDBaseT Adaptor

Up to 100m (Single Hop) of **Point-to-Point/Multi-Point** HD Connectivity
HDBaseT Switching Matrix

HD sources are placed in a central location. **Legacy cabling** can be used.

HDBaseT switching matrix **terminates sources** and **delivers 5Play feature set** to remote devices.

HD Devices can be placed up to ~**1Km** (8 hops) from Switching Matrix.
**HDBaseT Adaptor**

**HDBaseT transmitter** is used to deliver legacy input up to **100m away**

Bidirectional **RS232** and **USB** supported

**HDBaseT receiver** terminates cable and connects to remote displays
Corporate Enterprise

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Corporate Enterprise Application

HDBaseT Switching Matrix Facilitates Full Multimedia Capabilities
Hospitality

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Hospitality Application

HDBaseT Facilitates In-Room Entertainment System & Signage
Projectors
In Projection,
Distance
is Always a Challenge
HDBaseT Projector
HDBaseT Projector

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2-Box Projector

Elegance and Practicality
PC KVM Extension

Industrial PCs
Internet Cafés
HDBaseT Industrial

The Ultimate Cable that Carries All Your Industrial Computing

- Video, USB, Control and Power over standard Cat6 cable
- Powers up remote displays
- Up to 100m IPC-to-monitor
- Plug-and-play installation
HDBaseT IPC Installation

Native HDBaseT Deployments
HDBaseT IPC Installation

Daisy-Chain Support for IPC to Multi-Display Implementation

Legacy IPC

HDBaseT Adaptor

Up to 100m/328ft Cat6 Cable

Remote Displays in Control Room or Manufacturing Floor

HDBaseT IPC

Manufacturing Floor

HDBaseT IPC

Up to 100m/328ft Cat6 Cable

Remote Displays in Control Room or Manufacturing Floor

Manufacturing Floor

Remote Displays in Control Room or Manufacturing Floor

Daisy Chain
HDBaseT IPC Installation

- Legacy IPC
- HDBaseT Adaptor
- HDBaseT IPC
- Manufacturing Floor

Up to 100m/328ft Cat6 Cable

Remote Displays in Control Room or Manufacturing Floor

Bi-directional USB channel for keyboard, mouse, touchscreen, USB drive and more
Standard Internet Café
HDBaseT Internet Café – Server Rooms
HDBaseT Internet Café – “Zero-Client”
Digital Signage
HDBaseT – Digital Signage Made Simple

- Supports daisy-chaining and multi-streaming
- Simple, low-cost and standard implementation
- 4K ultra-high-definition video
- Popular applications: HDBaseT digital signage displays, AV switching matrix, adaptors
HDBaseT Building Blocks for Digital Signage

- HDBaseT Server
- HDBaseT Digital Signage Display
- HDBaseT Adaptor

Up to 100m (single hop) of **point-to-point/multi-point** ultra-HD connectivity
HDBaseT Daisy Chaining

HDBaseT supports Daisy-chain architecture

Perfectly suits digital signage installations
Video Wall Application
Point to Multi-Point HDBaseT

Simultaneous transmission over up to 100m per display
HDBaseT Video Wall Installations
We live in an HDBaseT world
Installation in a private home in Oslo

Maintaining historical integrity while upgrading connectivity over 3,000 meters of Cat7 cables in 18 rooms, for a sleek and elegant residential solution
Engaging thousands of spectators with distribution of live video system, PTZ cameras and digital signage over long distances in the 21,000m² sport arena in Sweden.
Streamlining conferencing and meeting facilities across Microsoft Redmond headquarters

Installation at

Microsoft

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Educating the next-generation through an interactive, 48-multi-touch video wall across two floors, connected over 8km of Cat6 cables
Connecting 65 TV displays and 40 projectors for distribution of high-definition content at the iconic NYC store.
Real Life Installations - BMW Showroom (USA)

The Solution

- HDBaseT switching matrix was used to transmit video to the screens over existing CAT5e cables (from original installation/infrastructure) and newly installed CAT6a cables.

- Daisy-chain over HDBaseT was used – it was the only way to cover the large building under the design limitation.

- HDBaseT was the only solution that was able to cope with the high electric emissions caused by challenging environment (all other technologies were tested and failed).
Real Life Installations - Empire Cinema Complex in London

- Empire Cinemas are operating 17 modern multiplex cinemas throughout the U.K.

- Replacing all 35mm projectors with digital projectors, which provide a much sharper picture and supports 7.1 surround sound.

- Using HDBaseT-enabled Wyrestorm extender sets to future-proof the new equipment. The extenders are capable of transmitting full 4k resolution, 48bit color HD video and high quality HD audio with bidirectional control of source and display from either location to multiple screens throughout theatres distances up to 100m/328ft

“I chose Wyrestorm HDBaseT equipment due to the speed and ease of installation we enjoy, combined with an excellent compatibility with our audio and projection equipment”

Andre Mort, Technical Director for Empire Cinemas.
Real Life Installations – Vertex Pharmaceuticals HQ (NY)

• Vertex is a large pharmaceuticals company

• Chose HDBaseT for 2x8 video wall made up of 55-inch Prime view Ultra Narrow Bezel HDBaseT displays

• The displays are daisy chained with HDBaseT

“From an installation perspective, HDBaseT just made wiring these displays that much easier. We only needed to run four category cables, one to each of the 2x2 arrays from our AV closet that’s about 100 feet away. The category cable terminated at the Prime view monitor with the embedded HDBaseT receiver. The other monitors in each of the 2x2 arrays were then simply daisy-chained with DVI-D cables. The installation process was simple and we did not have to waste time troubleshooting multiple cables to find areas for potential failure.”

Peter Thompson, a principal at ACT Associates.
Contact Us

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Thank you