NETWORK HD

Technical Reference Guide

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Overview

NetworkHD™ is a robust and highly scalable AV over IP solution designed for the distribution of audio, video, and control signals over a standard IP Network. The truly modular nature of the NetworkHD system allows an AV distribution of a hugely scalable number of sources and displays to be created over a standardized cabling infrastructure and a managed Network switch topology. To achieve this, NetworkHD consists of three compression technology options – each with its own set of advantages.

NetworkHD 100 & 200 series utilizes the highly efficient, low-bandwidth H.264/H.265 standard for AV compression supporting 1080p60 video, 2CH PCM audio and HDCP 1.4 over a 1GB network.

NetworkHD 400 series leverages JPEG 2000 compression to provide a visually lossless 4K30Hz image with very low latency with support for HDR10, HDCP2.2 and multichannel audio over a 1GB network.

NetworkHD 500 series leverages JPEG 2000 compression to provide a visually lossless 4K60Hz 4:4:4 image with very low latency with support for Dolby Vision/HDR10, HDCP2.2 and multichannel audio over a 1GB network.

NetworkHD 600 series is powered by SDVoE technology. This allows for mathematically identical audio and video to be distributed over a 10GbE network. With support for 4K60Hz 4:4:4, Dolby Vision/HDR10, HDCP2.2, multichannel audio the 600 series is a premium, lossless AVoIP solution.

System Components

NetworkHD comprises of a combination of hardware and software common to all NetworkHD Series components. This unified approach removes the need to learn different setup methods across the NetworkHD family. This helps to reduce system design times and offers a known platform from which an Integrator can specify any NetworkHD Series, focusing instead on the concerns of the deployment.

Controllers (CTL)

The NHD-000-CTL and NHD-CTL-PRO are the brains of a NetworkHD AVoIP system, they provide the interface point that act as a control bridge for the encoders and decoders, allowing for the selection of content and displaying it at the end point. They feature auto discovery NetworkHD components, a web-based user interface (UI), and the ability for 3rd party control. Only a single CTL is required per system.

Encoders

Every NetworkHD Encoder supports the direct connection of source devices using HDMI or DVI-D (via adapter), while additional connection types are available on other specific models. These source devices are then encoded over a network using the respective NetworkHD series technology.

Analog audio de-embedding is available on most encoders with the additional ability on the 600, 500 series and some 400 series models to inject analog source audio.

Decoders

NetworkHD RX Decoders receive the A/V stream from the TX Encoders over the Network and convert the signal to HDMI. This allows the content to be used via HDMI on TVs, monitors, or projectors, as well as HDMI/analog audio processors.

Through optional video resolution scaling, frame-rate conversion, and color-space conversion, NetworkHD decoders output content that can be formatted correctly for the connected display. This allows for content to be shown using optimum video requirements without affecting the source transmission.

Analog audio de-embedding is available on most decoders with the additional ability to utilize discrete audio source switching and also advanced audio matrixing on the 600 Series decoders.

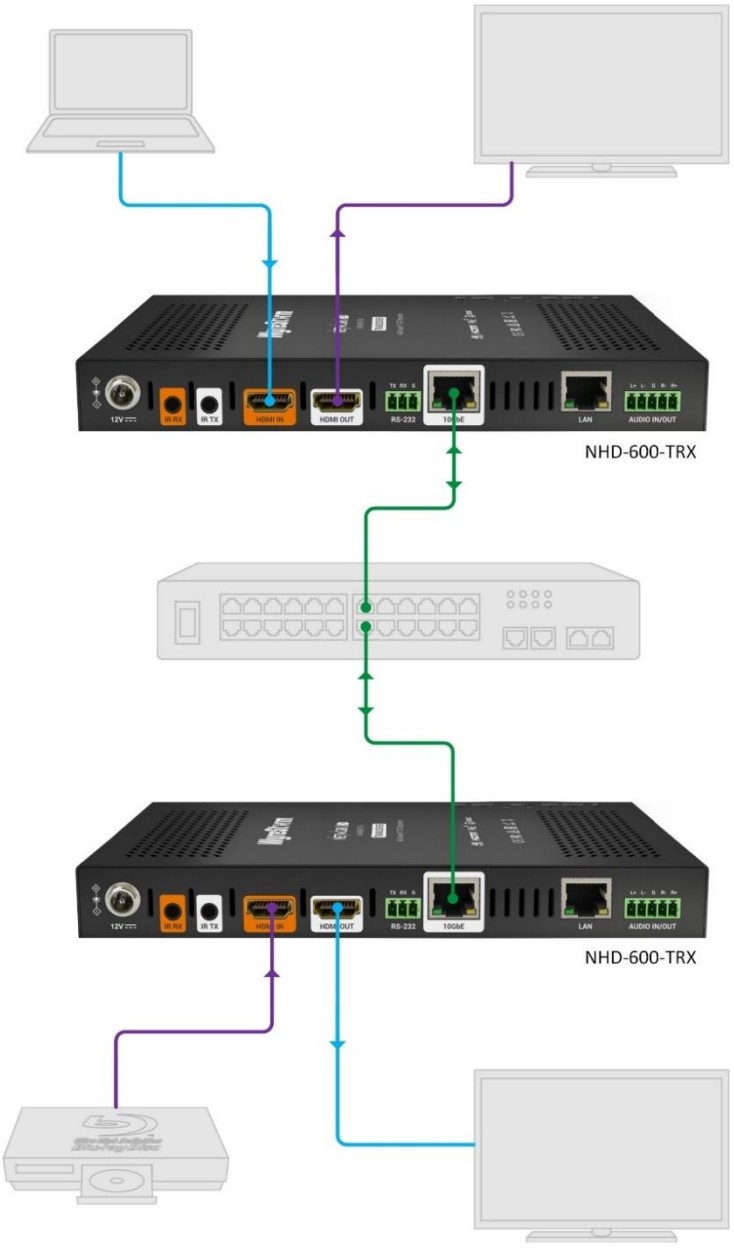
Transceivers

The NetworkHD 600 series contain two transceiver models, NHD-600-TRX & NHD-600-TRXF. Both of these models allow A/V signals to be transmitted and received simultaneously via one physical device. Transceivers have three operating modes that can be configured via PC Console software.

Transceiver (default) – the TRX can encode via the HDMI input and decode A/V streams from other NHD-600 devices via the HDMI output simultaneously.

Transmitter – the TRX will only encode via the HDMI input and will not decode A/V streams from other NHD-600 encoders. The HDMI output acts as a local loop-out.

Receiver – the TRX acts only as a decoder and will not encode A/V streams via the HDMI input connection. The HDMI input can be used as a local switched input to the HDMI output instead of decoding a network A/V stream.



NetworkHD Series Encoder/Decoder Comparison

Features	100/200 Series	400 Series	500 Series	600 Series
Maximum Input Resolution	1080p	4K UHD	4K UHD/DCI	4K UHD/DCI
Video Compression Codec	H.264/H.265	JPEG 2000	JPEG 2000	SDVoE
Maximum Timing	60Hz 8bit	60Hz 4:2:0 8bit	60Hz 4:4:4 8bit	60Hz 4:4:4 8bit
HDCP 2.2		✓	✓	✓
HDR10/HLG		✓	✓	✓
Dolby Vision			✓	✓
Multichannel Audio	N/A	Up to Dolby Atmos; DTS:X	Up to Dolby Atmos; DTS:X	Up to Dolby Atmos; DTS:X
Analog Audio Breakout	✓, unbalanced	✓, balanced/unbalanced	✓ balanced	✓ balanced
Analog Audio Input			✓ unbalanced	✓ balanced
Audio Delay Adjust	✓			
Minimum Latency	80ms	16ms	16ms	0ms
PoE	✓802.3af	✓802.3af	✓802.3af	✓802.3at*
Auto-discovery	✓	✓	✓	✓
Custom Splash Screen Image	✓	✓	✓	
Multiview	✓(NHD-250-RX)			✓
Video Wall	✓16x16	✓ 16x16	✓ 16x16	✓ 8x8
VW Bezel Correction		✓	✓	✓
Mosaic Video Wall		✓	✓	
Image Rotation		✓	✓	
Batch Firmware Upgrade	✓	✓	✓	✓
NetworkHD Touch™ Control	✓	✓	✓	
Fast Switching	✓		✓	✓
IR Routing	✓	✓	✓	✓
RS-232 Routing	✓	✓	✓	✓
CEC Routing	✓	✓	✓	✓
USB for K/M		✓	✓	✓
High Speed USB 2.0		✓	✓	✓*
Open Control API	✓	✓	✓	✓
Network Type	1GbE	1GbE	1GbE	10GbE
Peak Bandwidth per Tx	30Mbps (H.265) 5Mbps (H.265)	850Mbps	850Mbps	8.7Gbps
Bandwidth control	✓	✓	✓	
Rack Mountable	✓	✓	✓	✓
Preview Stream	✓	✓	✓	
Warranty	5yrs	5yrs	5yrs	5yrs

*The ability is only available on specific models within a NetworkHD series. Refer to specific product specification sheets for more details on limitations and functionality.

NetworkHD Touch™

The NetworkHD Touch™ app for iPad and Android tablets is available as a free download on the app store. It allows instant deployment of drag-and-drop control for NetworkHD AV switching, video walls, and multiview. By communicating with the NetworkHD configuration file stored on the CTL, NetworkHD Touch can be configured with minimal setup.

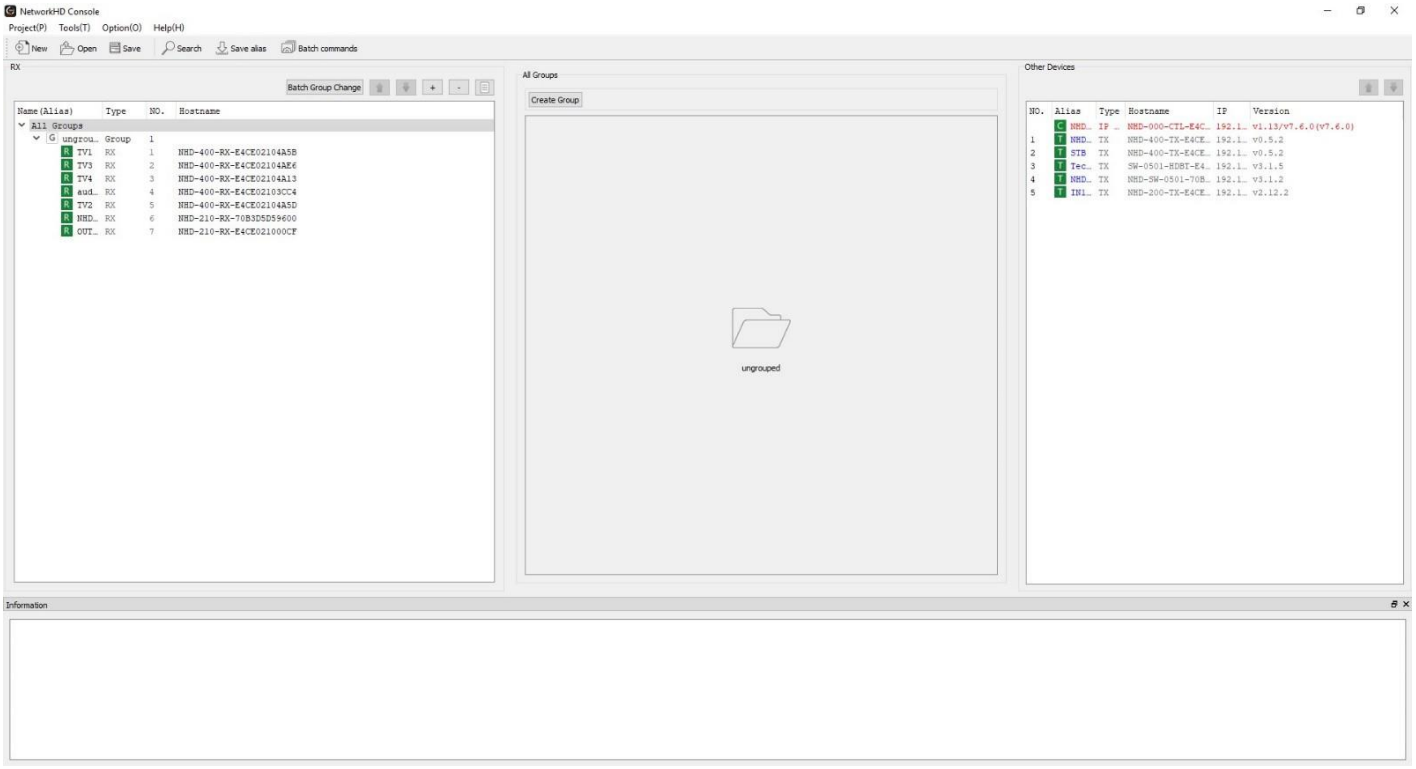
NetworkHD Touch does not require a separate control system or Driver, allowing for instant control deployment of simple display control and system verification checks. By adding integration to a 3rd-party control processor, NetworkHD Touch can utilize more advanced equipment control.

Companion Control

Companion Control is a supplementary control app that is used for controlling source devices in a NetworkHD installation such as set-top boxes, Blu-ray players or media streamers. Companion Control works in combination with NetworkHD Touch to create a comprehensive software-based control solution.

For configuration details you can refer to this video: Companion Control Setup Video

NetworkHD Console Software



NetworkHD Console is a software configuration tool for Windows PCs enabling the configuration of NetworkHD components and the construction of A/V matrix switching, video walls or Multiview displays for use in projects.

It is also ideal for configuring “set & forget” systems where a control system is not required. It offers fast, powerful configuration options and an intuitive UI for setting up all system settings while helping build a collection of video-wall and Multiview configurations for use with capable NetworkHD components.

NetworkHD Console is part of the WyreStorm Management Suite configuration tool, which contains other tools for configuring NetworkHD as well as other WyreStorm products. It is available on the website via the product pages.

Visit the Management Suite webpage for more information.

Note: NetworkHD Console is only required when using the NHD-000-CTL controller. The NHD-CTL-PRO contains all configuration options in its web interface.

Application Scenarios

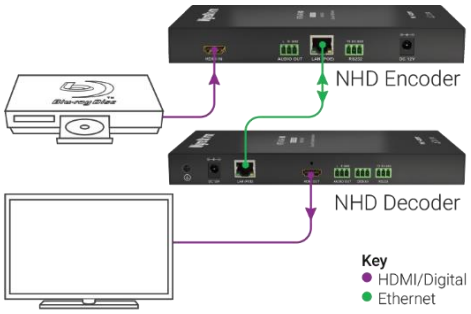
NetworkHD can be used for a variety of applications, ranging from simplistic single source to single display or complex multiple sources to multiple display scenarios. The number of end points in a deployment can be scaled after the fact by adding/removing encoders and decoders as needed.

One to One Scenario - Single Encoder and Decoder

In the simplest of installation scenarios, a single encoder and decoder can be linked directly or via the LAN, to send video from a source to a display in another location. If linked directly, the devices must each be powered with the supplied external power supply and the Ethernet cable linking them should not run more than the Ethernet standard dictates, depending on the cable type used and installation environment.

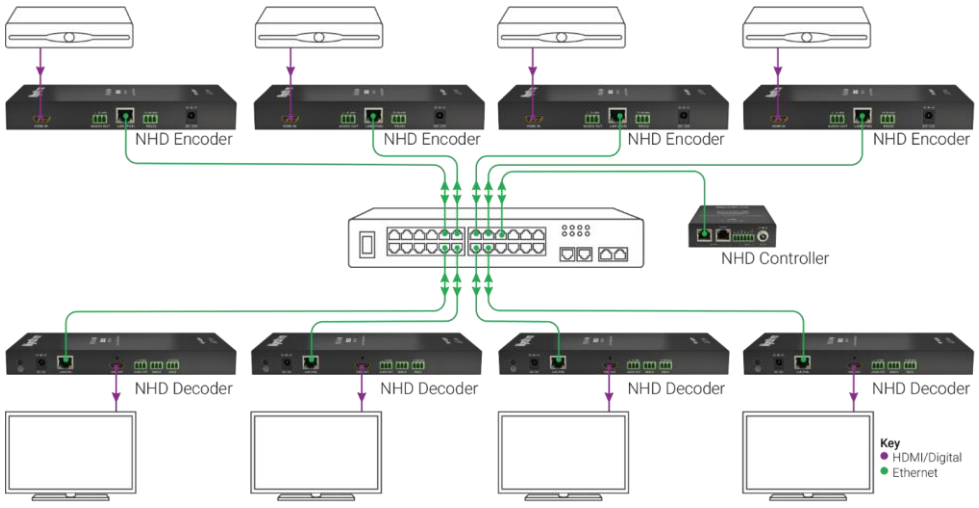
The encoder and decoder may not automatically connect and must first be connected via an NHD Controller and/or the Console software application. This will require connection to a managed Network switch, although once linked the devices can then be connected directly.

One to One Direct Connection



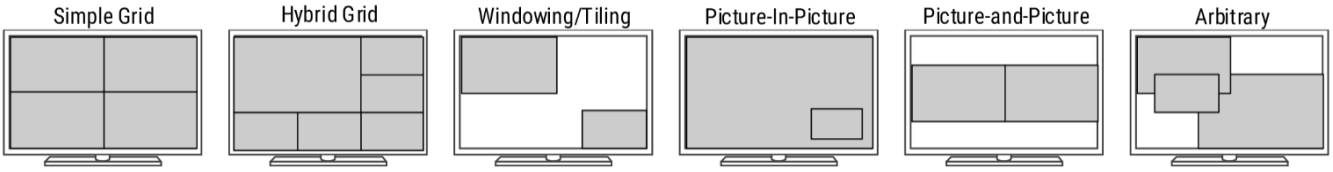
Many to Many Scenario - Multiple Encoders and Decoders

The truly modular nature of the NetworkHD system topology allows an AV distribution with a hugely scalable number of sources and displays. NetworkHD can be used to form a virtual “matrix switch” for AV and control signals to and from source and sink equipment.



Multiview

Going above single images on a display, NetworkHD can also render images from multiple encoders onto a single display, this is known commonly as Multiview. Not all decoders support this functionality and there are differences in the modes supported. Refer to the table below for products and available modes.



	NHD-250-RX	NHD-0401-MV	NHD-600-TRX*
Simple Grid Modes	✓	✓	✓
Hybrid Grid Modes	✓	✓	✓
Video Windowing/Tiling	✓		✓
PiP , PaP	✓	✓	✓
Arbitrary Layouts	✓		✓

*Also available on NHD-600-TRXF & NHD-610-RX

NHD-600 Multiview

Each NetworkHD 600 encoder has a secondary low bandwidth sub-stream that is designed for use in multiview applications. This secondary stream is required as 600 series decoders cannot decode more than one high bandwidth uncompressed stream at the same time. By using the secondary stream, multiple separate encoders can transmit to the same decoder.

Due to this, there are use-case limitations when incorporating more than one 600 decoder in the same system to process multiview. Depending on the multiview layout being displayed on a 600 decoder, the encoders will scale the secondary stream to fit in the PiP layout. For example, if using a "Simple Grid" layout (like the one shown in the graphic above) on a 4K screen, each encoder's stream would be scaled to 1080p so that they fit appropriately in the layout.

Since the secondary stream is scaled at the encoder, this means if a second 600 decoder wishes to use the same encoder stream but in a different PiP layout, there can be a scaling mismatch. This will translate to a video source either being too large or too small for one of the PiP windows.

Therefore, when sharing encoders across multiple multiview decoders, the resolution of the multiview windows must match.

Additionally, the NHD-600-TRX and TRXF cannot decode multiview and encode via its HDMI input at the same time.

NHD-250 Multiview

The NHD-250-RX multiview receiver is compatible with all NHD-100 series encoders. The NHD-250-RX supports two processing modes: tile and overlay. Tile mode supports grid-based layouts, such as simple-grid, hybrid-grid or picture-and- picture (represented in the graphic above). Overlay supports picture-in-picture and arbitrary layouts. Note that in overlay mode, the NHD-250 is limited to a 30Hz output.

NHD-0401 Multiview

The NHD-0401-MV is a 4-input HDMI multiview processor. This switcher is a versatile device which allows it to be used as a standalone multiview processor or combined within a NetworkHD 400 or 500 installation via API integration with the NHD-CTL-PRO. This switcher does not support custom multiview layouts and comes preconfigured with four multiview configurations as listed above.

Video Walls

In addition to AV and Control matrix switching, NetworkHD can also be used in video wall scenarios to display a single image across multiple displays. Each panel in the wall requires an RX decoder in order to display the image. Not all decoders support this functionality and there are differences in the number of panels that can be used. Refer to the tables below for products and available modes.

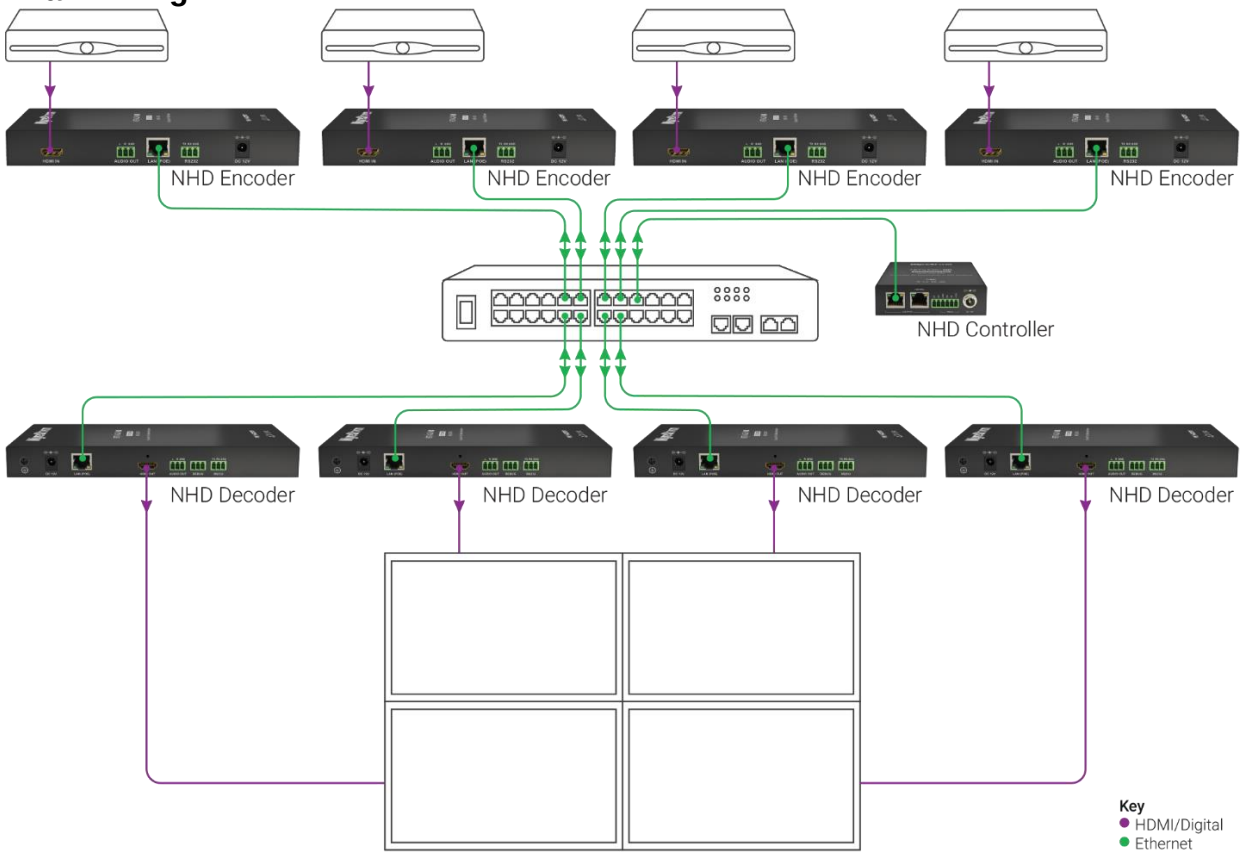
With the exception of the 500 series, NetworkHD decoders do not allow for partial screen rotation in standard video walls, all screens must be the same orientation. For example, in a 2x2 video wall the top two screens cannot be rotated 180° to compensate for ununiform bezel thickness.

Video Wall Features

	NHD-110-RX	NHD-400-RX*	NHD-500-RX	NHD-600-TRX*
Maximum Number of Displays	16x16	16x16	16x16	8X8
Image Stretch	✓	✓	✓	✓
Display Bezel Compensation	N/A	✓	✓	✓
Image Rotation	N/A	✓	✓	N/A
Genlock Synchronization	N/A	✓	✓	✓

*Also available on NHD-400-E-RX, NHD-600-TRXF & NHD-610-RX

Video Wall Wiring



System Design Guidelines and Requirements

While NetworkHD is easy to configure and install, there are some guidelines and requirements that make the system operate to their optimum level. By following this section, a NetworkHD deployment can be designed, configured, and operated at its optimum performance level.

Preparation for Design and Installation

Build the system and test all components before attending the installation site. Doing so will find any issues before moving to the less flexible and time sensitive environment of the install itself. Knowing that a unit was configured properly before installation makes it far easier to pinpoint the cause of the problem, saving time and money for your business.

WyreStorm offers several resources to improve the effectiveness of the preparation stages, we recommend that these items are downloaded and utilized before starting any system design, configuration, and/or installation.

- Latest version of NetworkHD Firmware.
- Latest version of the WyreStorm Management Suite required to configure a NetworkHD system.
- Switch Configuration Guides for a wide array of popular network switches.
- Switch Mapping Worksheets for recording IP addresses and alias names.
- 3rd Party Drivers for a wide array of popular control systems.

Powering NetworkHD Components

A majority of NetworkHD components support PoE standards which minimizes the use of external power supplies and allows for centralizing the power distribution for the components. This not only reduces the cable count at various stages, but also enhances the effectiveness of labor time on site. When utilizing PoE be sure to observe the power requirements of the quantity of NetworkHD components connected to a network switch and ensure this is within the PoE power budget and in accordance with the standards provided by a network Switch.

System Cooling and Airflow

Ineffective thermal considerations can have a detrimental effect on the lifetime of electronic products. Ensure proper passive or active cooling strategies are used to ensure heat is moved away from the components allowing them to remain within their operating temperatures. Poor positioning of components or installation of cables may attribute to creating hotspots that trap heat, whenever possible avoid placing cables in areas that will prevent air from reaching the components limiting proper cooling.

NetworkHD rack-mount kits (NHD-000-RACK4|NHD-140-RACK-1U) have been designed to allow for optimal mounting and cooling of the NetworkHD equipment within an AV rack. We recommend that these are used in order to ensure a clean installation that also allows for proper thermal performance. Should the installation not allow for the use of a rack-mount kit, the encoders and decoders should never be positioned flat against a shelf or stacked on top of each other. At least 1.5in/38.1mm of clearance should be left on the top and sides of each NetworkHD component to ensure adequate airflow is maintained.

Software/Firmware

Where possible WyreStorm ships all components with the most up to date firmware, however before starting any installation the firmware in the components should be verified to be the latest. This will allow for the components to operate properly and ensure that the latest features are available. We also recommend that the firmware version on all third-party hardware, particularly network switches and TVs, is verified to be the latest as well. Refer to the relevant manufacturers content for information on how to obtain and install any new firmware required.

Mounting/Installation

The correct mounting of devices, particularly in the unforgiving environment of an AV or IT rack is vital to any successful installation. When mounting devices using the included wall brackets, observe the orientation of the device conforms to the correct method to allow for secure mounting and proper cooling.

For AV and IT racks, WyreStorm offers rack mount kits to allow for quick and easy installation that provides a clean installation with adequate airflow. All rack mount kits provide a steel housing that can be used in a central and secure location for the components.

NHD-000-RACK4 is designed for all NetworkHD encoders including the NHD-000-CTL and NHD-CTL-PRO-V2.

NHD-140-RACK-1U is designed for the NHD-140-TX encoder.

Source & Display Settings

WyreStorm NetworkHD components use the highest quality encoding available to provide efficient distribution across a large number of video and audio endpoints. However, the video quality starts with and depends on the source content being encoded. The following guidelines apply to any and all encoding within a NetworkHD system.

- Some legacy NetworkHD 100/200 series encoders are not compatible with interlaced sources. For those devices, ensure that all source content is set to Progressive scan (e.g. 720p/1080p) and not interlaced (e.g. 1080i). Interlaced content is not supported on the NHD-100-TX or NHD-200-TX.

- Low power modes should be disabled on the displays and sources to ensure the system is always supplied with content. If a display shows no image, ensure the source device or display device has not entered a power- saving mode or is in a standby mode.

- Enabling CEC for all displays ensures that NetworkHD can power them on and off making them available to display an image when the system is accessed. This setting may be called something other than CEC and is not always enabled by default. Refer to the technical information for the display for details. By default, NetworkHD utilizes a specific subset of CEC power commands, One Touch Play and Standby that may not be supported by all third-party equipment vendors, however alternative CEC commands may be defined using the NetworkHD setup software.

- Overscan or “smart” aspect ratio settings should be disabled in any display that is part of a video wall, if it is enabled the image may not be a correct representation. This setting is almost always enabled by default and often hidden in advanced settings menus. Refer to the technical information for the display for details on how to disable it. Video wall displays should have video scan or aspect ratio processing disabled as well.

- Ensure that displays or other HDMI sinks used are fully compatible with the signal type used. The NetworkHD decoders feature a video scaler which can influence a signal presented to a display, depending on the scaler settings used. Refer to Appendix A.2 for details of the NetworkHD output signals.

AV Input Compatibility

	NetworkHD 110	NetworkHD 400	NetworkHD 500	NetworkHD 600
Compatible HDMI Version	1.4	2.0a	2.0b	2.0b
Compatible HDCP Version	1.4	1.4, 2.2	1.4, 2.2	1.4, 2.2
Maximum HDMI Bandwidth	4.46 Gb/s	8.91 Gb/s	17.82 Gb/s	17.82 Gb/s
Maximum HDMI TMDS Clock	165 MHz	300 MHz	595 MHz	595 MHz
Maximum HDMI Timing	1080p@60 8b 4:4:4	2160p@30 8b 4:4:4 2160p@60 8b 4:2:0 2160p@30 12b 4:2:2	2160p@60 8b 4:4:4 2160p@60 12b 4:2:2	2160p@60 8b 4:4:4 2160p@60 12b 4:2:2
Maximum VGA Timing	N/A	1920x1080@60 8b*	NA	NA
Interlaced Video Support	Y	Y	Y	Y
Color Space	RGB	RGB, YCbCr	RGB, YCbCr	RGB, YCbCr
YCbCr sampling	NA	4:4:4, 4:2:2, 4:2:0	4:4:4, 4:2:2, 4:2:0	4:4:4, 4:2:2, 4:2:0
HDR Support	N	HDR10 / HLG	HDR10/HLG/ Dolby Vision	HDR10/HLG/ Dolby Vision
2ch PCM Audio	Y	Y	Y	Y
Multichannel PCM Audio	N	Y	Y	Y
Dolby / DTS Audio Support	N	Y	Y	Y
2ch Analog Audio Ingest	N/A	Y*	Y	Y

*Functionality only available on certain models

AV Output Compatibility

	NetworkHD 100/200	NetworkHD 400	NetworkHD 500	NetworkHD 600
Compatible HDMI Version	1.4	2.0a	2.0b	2.0b
Compatible HDCP Version	1.4	1.4, 2.2	1.4, 2.2	1.4, 2.2
Maximum HDMI Bandwidth	4.46 Gb/s	8.91 Gb/s	17.82 Gb/s	17.82 Gb/s
Maximum HDMI TMDS Clock	165 MHz	300 MHz	595 MHz	595 MHz
Maximum HDMI Timing	1080p@60 8b 4:4:4	2160p@30 8b 4:4:4 2160p@25 8b 4:4:4	2160p@60 8b 4:4:4 2160p@60 12b 4:2:2	2160p@60 8b 4:4:4 2160p@60 12b 4:2:2
Color Space	RGB	RGB, YCbCr	RGB, YCbCr	RGB, YCbCr
YCbCr sampling	NA	4:4:4, 4:2:2, 4:2:0	4:4:4, 4:2:2, 4:2:0	4:4:4, 4:2:2, 4:2:0
HDR Support	N	HDR10 / HLG	HDR10/HLG/ Dolby Vision	HDR10/HLG/ Dolby Vision
2ch PCM Audio	Y	Y	Y	Y
Multichannel PCM Audio	N	Y	Y	Y
Dolby / DTS Audio Support	N	Y	Y	Y

Control Signal Compatibility

	NetworkHD 100/200	NetworkHD 400	NetworkHD 500	NetworkHD 600
RS-232 Pass-through				
TX > RX	NA	Routed	Routed	Routed, Broadcast
RX > TX	NA	Routed	Routed	Routed, Broadcast
RS-232 Generation (API)				
To TX	Y	Y	Y	Y
To RX	Y	Y	Y	Y
RS-232 Notification (API)				
From TX	Y	Y	Y	Y
From RX	Y	Y	Y	Y
RS-232 Serial Bit Rate				
Stepped rates between	50 – 230400 b/s	50 – 230400 b/s	50 – 230400 b/s	2400 – 115200 b/s
Data Bits				
Byte size supported	5, 6, 7, 8	5, 6, 7, 8	5, 6, 7, 8	6, 7, 8
Stop Bits				
No. of stop bits	1, 2	1, 2	1, 2	1, 2
Parity Bit				
Type supported	None, Odd, Even	None, Odd, Even	None, Odd, Even	None, Odd, Even
Infrared Pass-through				
TX > RX	Routed	Routed	Routed	Routed, Broadcast
RX > TX	Routed	Routed	Routed	Routed, Broadcast
Infrared Generation (API)				
To TX	Y	Y	Y	Y
To RX	Y	Y	Y	Y
Infrared Notification (API)				
From TX	N	N	N	Y
From RX	N	N	N	Y
CEC Generation (API)				
To RX	Y	Y	Y	Y
Discrete 1GbE Switch				
At TX	N	N	N	Y
At RX	N	N	N	Y
USB Pass-through				
Device (RX) > Client (TX)	Y	Y	Y	Y
USB Class Device Quantity per TX	HID: Unlimited	HID: Unlimited Other: 5	HID: Unlimited Other: 1	HID: 3 Other: 3
USB Max. Data rate	115200bps	64Mbs	300Mbps	480Mbps**

**480Mbps speeds only available on NHD-610 series or NHD-600-TRXF

RS-232 Compatibility

RS-232 on all NetworkHD devices with RS-232 ports is full duplex and compatible with the TIA-232-C standard. All NetworkHD devices utilize 3-wire RS-232 and thus do not support hardware flow control. Due to the nature of control signal translation in the NetworkHD system, the RS-232 data transmission cannot be guaranteed to be isochronous. Some NetworkHD devices may also include a +12V power rail on the same RS-232 connector. Be sure to observe the device port labelling to avoid connection issues.

Where RS-232 data pass-through is supported, ensure that the correct default UART settings on an encoder or decoder are set using the NetworkHD Console software application before connecting external equipment. These will remain statically assigned until modified in the Console application. This may include baud rate, number of data bits, number of stop bits and type of parity bit (if used). When utilizing the NetworkHD API to generate RS-232 data, the UART attributes in the API command and subsequently generated RS-232 data can be different from the statically assigned, default values.

Infrared Compatibility

Using WyreStorm infrared emitters and receivers is the best way to ensure that most IR coding formats are transmitted and received by the NetworkHD system. Other 3rd party emitters and receivers can be used; however, these devices must operate in the same manner as the WyreStorm devices.

On the 110/400/500 series the IR data modulation (carrier) frequency is passed through NetworkHD from the receiver to the emitter, however on the 600 series the carrier frequency is fixed at 38kHz when used in pass-through mode. When using the API, the carrier frequency can be defined for greater compatibility.

Due to differences in IR across 3rd party control systems, their IR ports should never be connected directly to a NetworkHD system as an incompatibility may exist. WyreStorm offers a cable known as the CAB-IR-LINK that allows for connection to 3rd party control systems that compensates for voltage differences, as well adjusts for differences in the pins used within the port. Use of this cable helps ensure compatibility between the control system and the NetworkHD system. Refer to the CAB-IR-LINK product page for more information.

CEC Compatibility

CEC wiring is mandatory in HDMI ports and cables, although implementation of CEC in a product is optional. It was defined in HDMI Specification 1.0 and updated in HDMI 1.2, HDMI 1.2a and HDMI 1.3a.

HDMI-CEC is often branded differently depending on the equipment vendor. Some common examples are listed below:

- Anynet+ (Samsung)
- Aquos Link (Sharp)
- BRAVIA Link, BRAVIA Sync, Control for HDMI (Sony)
- CE-Link, Regza Link (Toshiba)
- E-link (AOC)
- EasyLink (Philips)
- Fun-Link (Funai, Sylvania, Emerson, Magnavox, Philips)
- HDMI-CEC (Hitachi)
- INlink (Insignia)
- Kuro Link (Pioneer)
- NetCommand for HDMI, Realink for HDMI (Mitsubishi)
- RIHD (Remote Interactive over HDMI) (Onkyo)
- RuncoLink (Runco International)
- SimpLink (LG)
- T-Link (ITT)
- VIERA Link, HDAVI Control, EZ-Sync (Panasonic)

It is important to note that some third-party equipment may not support the commands generated by NetworkHD devices. It is imperative that compatibility is verified before assuming this feature will be compatible with any chosen third-party equipment.

CEC control command generation via the HDMI interface is supported on some NetworkHD devices. This can be useful for controlling a connected HDMI sink device that supports specific CEC commands. The default CEC commands generated by NetworkHD devices are as follows:

- **One Touch Play:** Allows NetworkHD to switch the HDMI sink to use it as the active source when playback starts. This typically turns on a display and selects the correct HDMI input on a display.

  CEC Address: NHD 400 Series: 0xF0 | NHD 100/200 Series: 0x40
  CEC Message ID : 0x0D

- **System Standby**: Allows NetworkHD to switch the HDMI sink into a standby mode.

  CEC Address: NHD 400 Series: 0xFF | NHD 100/200 Series: 0x40
  CEC Message ID: 0x36

Control Signal Limitation - NHD-110 Series

NetworkHD 110 series components support three methods of control signal pass-through/routing: USB, Infrared & RS-232. Due to hardware limitations, only 2 of these 3 protocols can operate simultaneously, meaning one of the control signals will be disabled. By default, RS-232 is disabled with IR and USB operational. This can be changed from within the NetworkHD console software.

Discrete Ethernet Compatibility (Virtual Switch)

The NetworkHD 600 series includes a "Virtual Switch" capability. This allows third-party Ethernet-capable devices to connect to an encoder or decoder and be linked to other devices connected to other NetworkHD 600 series encoders and decoders.

The IEEE 802.1ab compliant "LAN" ports on NetworkHD 600 series devices are linked together to form a "virtual" 1GbE unmanaged switch. It must be noted that the 1GbE links are encoded as part of the SDVoE connectivity used for the main 10GbE port on a 600 Series device. Thus, the Network topology of the "LAN" ports follows that of the host NetworkHD device within a Network deployment. The "LAN" ports themselves do not offer discrete Layer 2 or Layer 3 configuration options and should be treated as basic nested, unmanaged Layer 2 switch ports.

It is important that network loops are not created when using the 1GbE ports. Note that access to the 1GbE ports is typically achieved at the 10GbE switch.

The 10GbE ports and the 1GbE ports are logically connected together.

USB Compatibility

NetworkHD 110 Series

The 110 series are equipped with USB 1.1 (HID) ports and only support keyboard/mouse or similar HID devices. An unlimited number of keyboard/mouse connections can be made to a single host (TX) device.

NetworkHD 400 Series

The 400 series offers a higher data-rate USB 2.0 (up to a max. theoretical data-rate of 64Mbs) on v2 or newer hardware. See below for USB modes and supported device types on the 400 series.

Supported USB Device Types:

1. Bulk Data transfer:
    a. Devices such as Printers, Scanners, Memory Sticks, HDD/SSD and other devices that do not rely on time sensitive data transfer.
2. Control Data Devices:
    a. Devices such as Keyboard, Mouse, Touchscreen, and other user-initiated data transfers.
3. Interrupt Data Devices:
    a. Devices that generate asynchronous but not time sensitive data that generally require user attention.

Unsupported USB Device Types:

- Isochronous Data Devices:
    - Devices that require time-sensitive data transfer, such as some Webcams and audio devices. Due to the data transfer of AV over IP technology favoring the Video and Audio streams, the USB data is sent in bursts and cannot guarantee isochronous behavior. Thus, support for some time-sensitive device types cannot be guaranteed. WyreStorm recommends testing such products for compatibility in advance of system deployment.

400 Series USB Operation:

When an encoder is connected to a host machine via a USB cable, the host machine will enumerate a Standard USB Hub. If KMoIP mode is enabled on the encoder the host machine will also enumerate a HID class composite device.

USB functionality operates in the following two modes:

USBoIP Mode:

USBoIP allows up to 5 USB devices to be routed simultaneously to any encoder. It offers transparent redirection technology, allowing the encoders and decoders to appear invisible to the host machine. When a device is attached to a decoder and a decoder with attached devices is assigned to an encoder, (via a matrix assignment command) the connected devices will enumerate on the host machine as if they are connected via a standard USB Hub to a host USB port. This mode is selected automatically if the device connected at a decoder is not of the USB HID class type (Base Class 03h) or if KMoIP mode is disabled on the decoder.

A maximum of 5 USBoIP mode devices is supported on any one encoder. When an encoder is assigned a 6th USBoIP device on a decoder, the connection will be ignored and the host machine will not enumerate it. If a USBoIP device leaves an encoder (a USB device is unplugged at an RX or an RX becomes unassigned to a TX), space at a TX will allow more USB devices to be assigned. This will not happen automatically; the USB assignment will have to be established again via an API or control system command.

KMoIP Mode:

KMoIP mode (if KMoIP mode is enabled on the decoder) is automatically selected if the device connected to a decoder is of the USB HID class type (Base Class 03h). KMoIP mode offers emulation of a composite keyboard and mouse device to the host machine, enumerating at the point at which the encoder is connected, via a USB cable to the host machine.

KMoIP mode offers a few advantages over USBoIP mode:

- An unlimited number of keyboard or mouse devices can be used at the same time, connected to the same host machine
- When switching a host machine (using a matrix assignment command) to a KMoIP mode decoder, the host need not enumerate the device each time, leading to much quicker switch times and instant usage.

KMoIP mode only enumerates on the host machine as an 84/101/104 standard keyboard and up to 8-button mouse with one wheel. At this time, touch panels, gamepads and joystick devices may not be supported, depending on the USB profile they require. To use unsupported HID class (Base Class 03h) devices the decoder can be instructed to disable KMoIP mode and revert to USBoIP mode.

To enhance the user experience, devices utilizing KMoIP mode will block other KMoIP devices assigned to an encoder when they are in use. This results in only one keyboard, for example, sending data to the host at any one time. The block is in place for 100ms after a keystroke. After 100ms has elapsed any assigned KMoIP device can then send data to the host again.

KMoIP mode is enabled on both the encoder and decoder by default or after a factory reset procedure.

When changing the KMoIP mode on an encoder or decoder the setting will only be realized after a device reboot.

Please note that if KMoIP mode is disabled on the encoder but enabled on an assigned decoder, and a HID class device is used with a decoder, the device communication to the encoder will be blocked. Thus, it is recommended that KMoIP mode on the encoder is always set to “enabled” unless the host machine explicitly
requires enumeration removal of the HID class composite device.

NetworkHD 500 Series

The NHD-500-RX features two different types of USB device ports. Two ports are USB 1.1 (HID) for keyboard/mouse or similar HID devices. These two HID ports operate in KMoIP.

KMoIP mode offers:

- An unlimited number of keyboard or mouse devices can be used at the same time, connected to the same host machine
- When switching a host machine (using a matrix assignment command) to a KMoIP mode decoder, the host need not enumerate the device each time, leading to much quicker switch times and instant usage.

A third USB port is available which supports higher bandwidth USB 2.0 (up to a theoretical 300Mbps upstream). This port uses USBoIP mode and only supports a 1-to-1 link (client to host), it does not support a one-to-many configuration.

Most USB 2.0 devices are supported by the 500 series however due to the bandwidth limit of 300Mbps there is potential for incompatibility. Any USB device should be tested to function before real-world application use.

If multiple RXs are receiving the same video stream, the last matrix assigned RX will be the active client connection to the host TX. The USB link can be discretely changed using specific USB API commands via the NHD-CTL.

NetworkHD 600 Series

NHD-600-TRX:

The NHD-600-TRX is equipped with three USB 1.1 (HID) ports and only support keyboard/mouse or similar HID devices. USB assignment is a 1-to-1 link (client to host); it does not support a one-to-many configuration.

Because the NHD-600-TRX is a transceiver, the USB data flow can be manipulated. The transceivers feature both USB Type A device ports and a USB Type B host port. By default, the host connection will auto-negotiate based on the active Type B connection to a PC. The active host connection can be forced via NetworkHD software tools. This is referred to LEX and REX modes.

LEX: Local USB Extender – the NHD-600-TRX acting as the host connection to a PC
REX: Remote USB Extender – the NHD-600-TRX device connecting to peripheral HID components

If multiple TRX's are receiving the same video stream, the last matrix assigned TRX will be the active client connection to the host TRX.

NHD-600-TRXF & NHD-610-TX/RX

These models incorporate a high-speed Icron USB chipset capable of the full 480Mbps USB 2.0 specification and therefore compatible with virtually any USB 2.0 peripheral device.

The NHD-600-TRXF abides by the same USB limitations as the NHD-600-TRX including LEX and REX configurations.

The NHD-610-TX and NHD-610-RX are dedicated encode and decode units and USB data will always be RX > TX. They only support a 1-to-1 link (client to host); they do not support a one-to-many configuration.

If multiple TRX's are receiving the same video stream, the last matrix assigned TRX will be the active client connection to the host TRX.

Note: Since the 610s and TRXF series use an Icron USB chipset, the USB data is a proprietary transmission and is not compatible with USB on the NHD-600-TRX.

System Infrastructure Guidelines and Requirements

Ensuring the correct infrastructure is key to a successful NetworkHD deployment. Read through and follow the information provided in this section to allow for successful deployment and operation of a NetworkHD system.

AV Cabling Guidelines

Due to the ever-changing technologies for transmission and increases in content bandwidth, preparing for changes at the time of installation is advisable.

As signal bandwidth increases, useable AV or control cable lengths can decrease. To avoid connectivity issues due to cable length, ensure connected AV or control devices are located as close to NetworkHD components as possible.
Refer to the relevant standards for the signal type used (e.g. HDMI, RS-232 etc.)

Testing & Certifying a Network Cabling Infrastructure

While WyreStorm products are manufactured and tested to the highest standards, the installation environment can have an adverse effect on system performance. WyreStorm recommends that network each cable is not only tested for correct termination but is also certified to conform to the relevant network bandwidth, crosstalk and interference limit standards for each link type and distance required before installation of NetworkHD components.

Refer to the **Required Network Switch Features** section for information regarding the network connection to a NetworkHD device.

Choosing an Ethernet Switch

The flexibility of a WyreStorm NetworkHD solution brings AV distribution into the network domain. Many network switch vendors exist but the interoperability of any network depends on the support of various network standards. WyreStorm NetworkHD products take advantage of well-established, common network standards found built into the majority of managed switches.

The guidance that follows is intended to give various details on the network standards required of a switch selected for use with NetworkHD. Refer to the **NetworkHD Switch Configuration Guides** located on WyreStorm.com for detailed, vendor-specific switch information when choosing and configuring a network switch.

Basic Switch Parameters

The main features of a selected network switch depend on the NetworkHD devices used:

NetworkHD 100/200 Series (Multicast)	1GbE switch	Layer 2+* / Layer 3
NetworkHD 110 Series (Unicast)	1GbE switch	Any layer switch
NetworkHD 400 Series	1GbE switch	Layer 2+* / Layer 3
NetworkHD 500 Series	1GbE switch	Layer 2+* / Layer 3
NetworkHD 600 Series	10GbE switch	Layer 2+* / Layer 3

It should be noted that most 10GbE switches support backward compatibility with 1GbE devices.
*Layer 2 switches must have support for IGMP Snooping and Multicast Filtering.

Preconfiguring an Ethernet Switch

Network switches that are directly connected to NetworkHD components should always be configured prior to connecting any components. Due to the encoder's instant-on feature, a multicast stream could disrupt the expected behavior of a switch if it is not configured to accept multicast traffic in advance.

WyreStorm offers a library of **Switch Configuration Guides** specific to many tested network switches to help reduce set-up times. NetworkHD 100/200/400/500 Series components have subtle differences to the 600 Series. Although all NetworkHD multicast operation is the same, the NetworkHD 600 Series requires a 10Gb infrastructure rather than the typical 1Gb. This means that the WyreStorm recommended switches for 100/200 & 400 may not be common to the 600 Series and a separate list of recommendations exist.

As the NetworkHD solution is inherently scalable, it is recommended that a switch is purchased that will have more Ethernet ports than NetworkHD devices so that more can be quickly added in the future where required.

Required Network Switch Features (Multicast)

Switch Ports

The WyreStorm NetworkHD family devices utilize twisted pair cable Ethernet standards. The Ethernet switch port connecting directly to a NetworkHD device must therefore support the following:

NHD-000-CTL	100Mb/s Full-duplex	100Base-TX	IEEE 802.3u
NHD-CTL-PRO	1Gb/s Full-duplex	1000Base-T	IEEE 802.3ab
NHD 100, 200, 400, 500 Series	1Gb/s Full-duplex	1000Base-T	IEEE 802.3ab
NHD 600 Series	10Gb/s Full-duplex	10GBase-T	IEEE 802.3an

Core Switch Features

- Multicast forwarding or filtering
- IGMP Snooping
- IGMP v2 Querier
- IGMP Fast-leave
- Jumbo Frames (only 400/500 series require Jumbo frames, specifically with an MTU size ≥ 9000 bytes.)

Packet Routing

To enable the transmission of a source to multiple destination, NetworkHD devices make use of Multicast. The default behavior of an unmanaged Ethernet switch could be to broadcast those packets to every switch port. This means that every packet will be transmitted to all connected devices.

This is why any network switch used with NetworkHD has to support IGMP Snooping. NetworkHD devices use the IGMP protocol to request data from a specific multicast group (encoder) and the switch uses IGMP snooping to identify IGMP messages and efficiently forward multicast packets only to decoders that want to receive them.

Many switches have the IGMP Snooping feature disabled by default and manual configuration is required. Often, a simple check mark near “Enable IGMP Snooping” is the only thing needed to enable IGMP Snooping. However, the implementation of IGMP Snooping is vendor specific, and more configuration is often needed.

An Ethernet switch can be informed that a device wants to leave a multicast group by sending it an IGMP LEAVE GROUP packet. Once received, the time it takes for the switch to apply the new configuration may vary from one switch to another. Most switches implement and include a FASTLEAVE configuration option. When enabled, it takes much less time for a particular switch port to leave a multicast group and to assign the port to a different multicast group. The end result is often a noticeably shorter video switching time. However, care must be taken when using FASTLEAVE across multiple switches.

A selection of Ethernet switches exist that are pre-configured for NetworkHD packet forwarding by default. In this situation, for a pure NetworkHD system, the switch is simply plug-and-play out of the box. This only applies to single switch deployments however and further NetworkHD device setup will still be required.

Refer to the **NetworkHD Certified Switches** document located on WyreStorm.com for a list of plug-and-play switches currently supported.

Ethernet Switch Configuration (Multicast)

The following list includes all network switch configuration options that WyreStorm engineers have come across so far. NetworkHD data is typically contained in one VLAN. Look for these or similar options when configuring your switch.

Feature	Setting
IGMP Snooping	Must be enabled.
IGMP Snooping on VLAN	Must be enabled on VLAN NetworkHD resides in.
Filter/Drop Unregistered Multicast	Must be enabled if found. *If not applied, the behavior of the switch will be to broadcast multicast packets if there is no known destination for that packet*
Unregistered Multicast Flooding	Must be disabled if found
IGMP Querier	Must be enabled For VLAN – must be enabled if found Must be set to IGMP V2 *Multiple switch topologies may require this to be disabled on some switches. See Using IGMP Querier Function for more information*
Fast Leave	Should be enabled for single switch deployments if found. *Multiple switch topologies may require this to be disabled on some switches. See Using the Fast Leave Function for more information*
Green Ethernet or Energy Saving	Must be disabled if found.
Jumbo Frames	Must be enabled if found when using NHD-400s. (MTU size ≥ 9000 bytes)

Refer to the **NetworkHD Switch Configuration Guides** located on WyreStorm.com for detailed, vendor-specific Switch information.

Using the IGMP Querier Function

In order for IGMP, and thus IGMP snooping, to function, a multicast router or IGMP Querier function on a switch must exist on the network and generate IGMP queries. The tables created for snooping (holding the member ports for each a multicast group) are associated with the Querier. Without a Querier, the tables are not created, and snooping will not work. Furthermore, IGMP general queries must be unconditionally forwarded by all switches involved in IGMP snooping. Some IGMP snooping implementations found on many switches include full Querier capability.

One IGMP Querier should exist on a NetworkHD VLAN. In multiple switch deployments for example, when cascaded switch topologies exist, only one switch should enable the Querier function with it disabled (manually or automatically) on all other switches.

Using the Fast Leave Function

An Ethernet switch can be informed that a NetworkHD device wants to leave a multicast group by the device sending the switch an IGMP LEAVE packet. When a switch receives an IGMP V2 leave message from a NetworkHD device, it sends out multiple multicast group-specific queries. If no other NetworkHD device replies within the waiting period, the switch stops forwarding traffic. When FASTLEAVE is configured, and when the switch receives an IGMP leave message on a port, it immediately stops forwarding to that port. The switch then does not send multicast group- specific queries. When FASTLEAVE is configured on a switch, you must not have multiple NetworkHD devices connected on any port in the switch. This includes links between multiple switches. Thus, care must be taken in multiple switch topologies when using this function.

Using PoE

Most NetworkHD devices utilize PoE for local power as an alternative to the supplied external power supply adapter. This can offer centralized power distribution from the switch as well as reduction in component count, cable count and installation labor time.

The power options available to NetworkHD devices related to switch PSE PoE ports is as follows:

NHD-000-CTL/NHD-CTL-PRO	PoE compliant (AV Port) 15.4W - IEEE 802.1af or Local DC power supply
NHD 100/200/400/500 Series	PoE compliant 15.4W - IEEE 802.1af or Local DC power supply
NHD-140-TX	Local DC power supply
NHD-600-TRXF	Local DC power supply
NHD-600-TRX & NHD-610-TX/RX	PoE+ compliant 25.5W - IEEE 802.1at or Local DC power supply

When selecting a PoE capable switch, the total PoE budget must be considered. For example, some switches can supply PoE to only a subset of ports when running at 15.4W per port, other switches can support 15.4W on every port simultaneously. Switch PoE budget can easily be calculated by adding the number of NetworkHD devices that require PoE.

For example: 24x NHD-110-RX = 370W total switch PoE budget

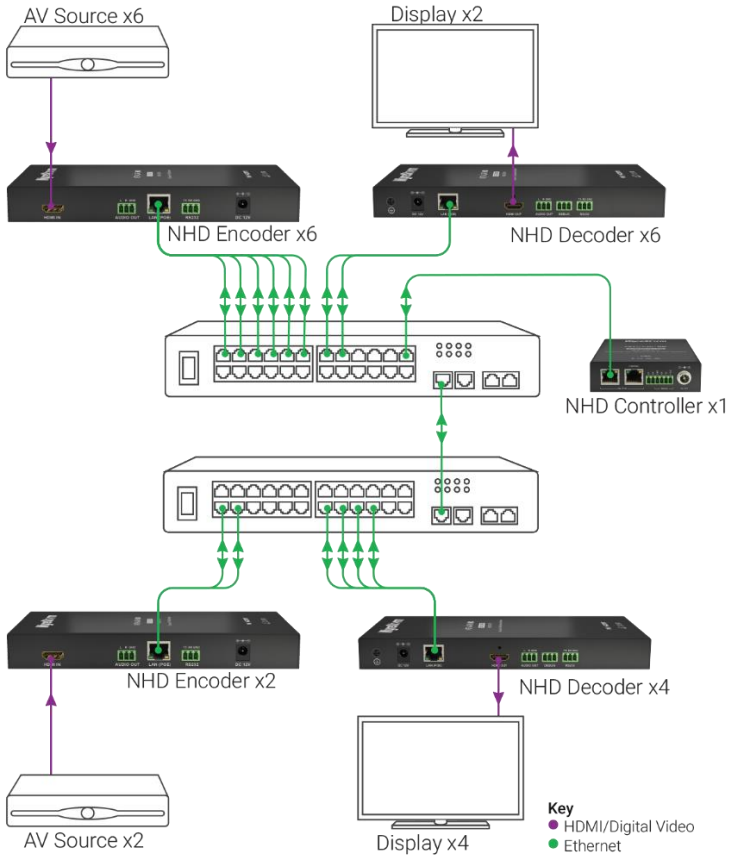
Using multiple Network switches

When using more than a single network switch with multicast, further configuration options must be considered. Multiple switch topologies usually employ 2 main methods:

Switch Stacking

A stackable switch is a network switch that is fully functional operating standalone, but which can also be set up to operate together with one or more other network switches, with this group of switches showing the characteristics of a single switch but having the port capacity of the sum of the combined switches.

- If a switch supports operating in this mode, be sure that the configuration guidance shown above applies to the entire switch stack to ensure unified stack multicast support.
- Often, switch vendors will utilize special port modes for use with stacking and some switches make use of dedicated stacking ports and cables. These will have a finite bandwidth.



Switch cascading

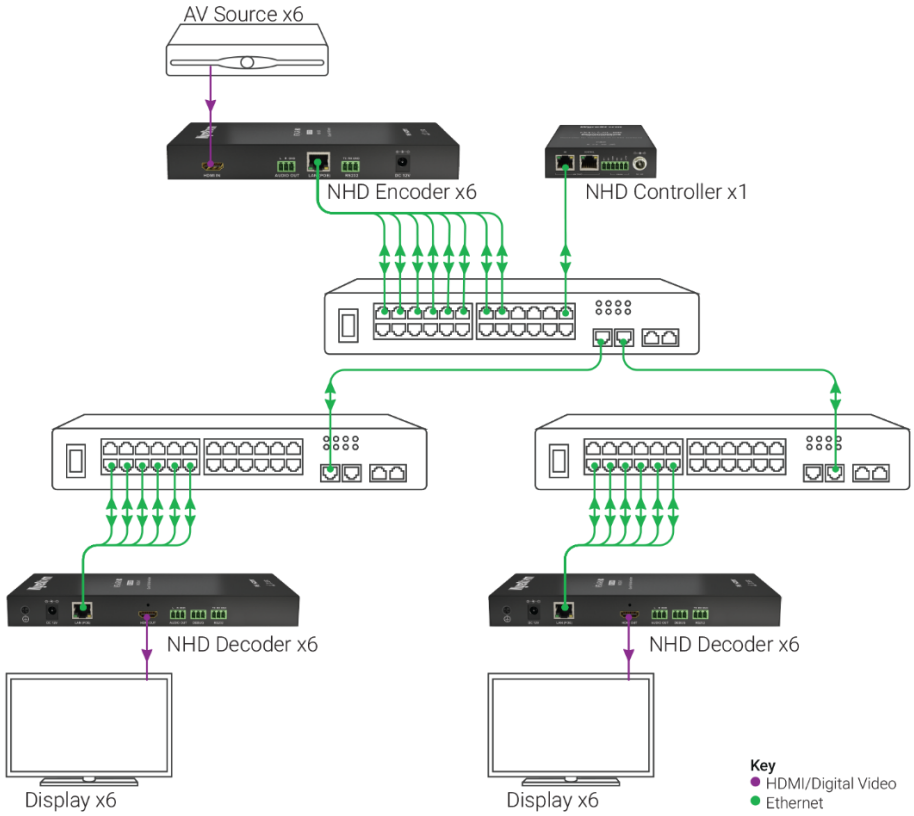
Linking switches together, often with links that support a greater bandwidth, is an alternative method by which to increase the amount of NetworkHD units connected to a system.

Either by using dedicated link ports or aggregated link ports, network switches can extend the NetworkHD VLAN across multiple locations using varying topologies. Bandwidth requirements should be considered, with the maximum peak NetworkHD stream bandwidth required being exceeded by the link segment between switches.

Further Considerations for Multiple Switch Deployments

Ethernet switches that are used for cascaded topologies must also support the following functions:

Dynamic multicast router port	Must be enabled on all switches that do not contain the IGMP Querier function
Forwarding unknown multicast to multicast router port X only	Must be enabled on all switches that do not contain the IGMP Querier function



Switch Configuration (Multicast)

Feature	Single Switch Networking	Cascading Networking	
		Core Switch	Extended Switch
Green or energy-saving feature	Disable	Disable	Disable
Multicast forwarding or filtering	Enable	Enable	Enable
IGMP Snooping	Enable	Enable	Enable
IP address of IGMP Querier	Must be assigned a valid value		Does not matter
IGMP Querier	Enable	Enable	Disable
IGMP snooping fast leave	Enable	Disable	Enable
Dynamic multicast router port	Disable	Disable	Enable
Forward All unknown multicast	Disable	Disable	Router port only*

* Port which connects the extended switch back to the switch running an IGMP Querier

Multiple VLAN NetworkHD

NetworkHD components are typically designed to reside within a single VLAN. By default, many switches will have a single VLAN (perhaps VLAN ID 1). Unless specifically noted or required, it is not necessary to create an additional VLAN.

Multicast routing using PIM or an equivalent multicast routing process is not currently supported by NetworkHD.

The NHD-000-CTL is equipped with dual Ethernet ports so that it can simultaneously connect to two separate networks or VLANs without the need for additional routing functionality configured within the switch. Both NHD-000- CTL ports are separately compliant with the NetworkHD control API or control system driver communications channel. This enables a Control network to be completely isolated from an AVoIP network, while connected to the NHD-000- CTL, without further considerations for Network administration.

Where physical network isolation utilizing the dual NHD-000-CTL interfaces is not used and a control system that needs to communicate with the NetworkHD Controller exists on a different VLAN or broadcast domain, the following information can be used to aid routing of the API or control system driver communication channel:

NHD-000-CTL: Telnet server <NHD-000-CTL IP address>, CTL ingress on TCP Ports 23 and 23000, CTL egress TCP port undefined

It must be noted that the factory default “AV” port interface IP address of the CTL uses a value that is a link-local address (default IP statically assigned as 169.254.1.1/16) and thus might not be routable unless changed to a routable IP address.

The data generated by the CTL (where the destination IP is outside the scope of the relevant network interface) is forwarded to the Gateway IP address assigned to the relevant CTL interface. It is thus important that a Router at this Gateway IP address is configured to forward the data to the correct route for the intended destination IP.

NetworkHD Stream Bandwidth

The NetworkHD encoders transmit AV content at a known bitrate. It is the encoder bandwidth that makes up almost all of the Network traffic in a VLAN. Each NetworkHD encoder sends multicast stream data at the following peak bitrates:

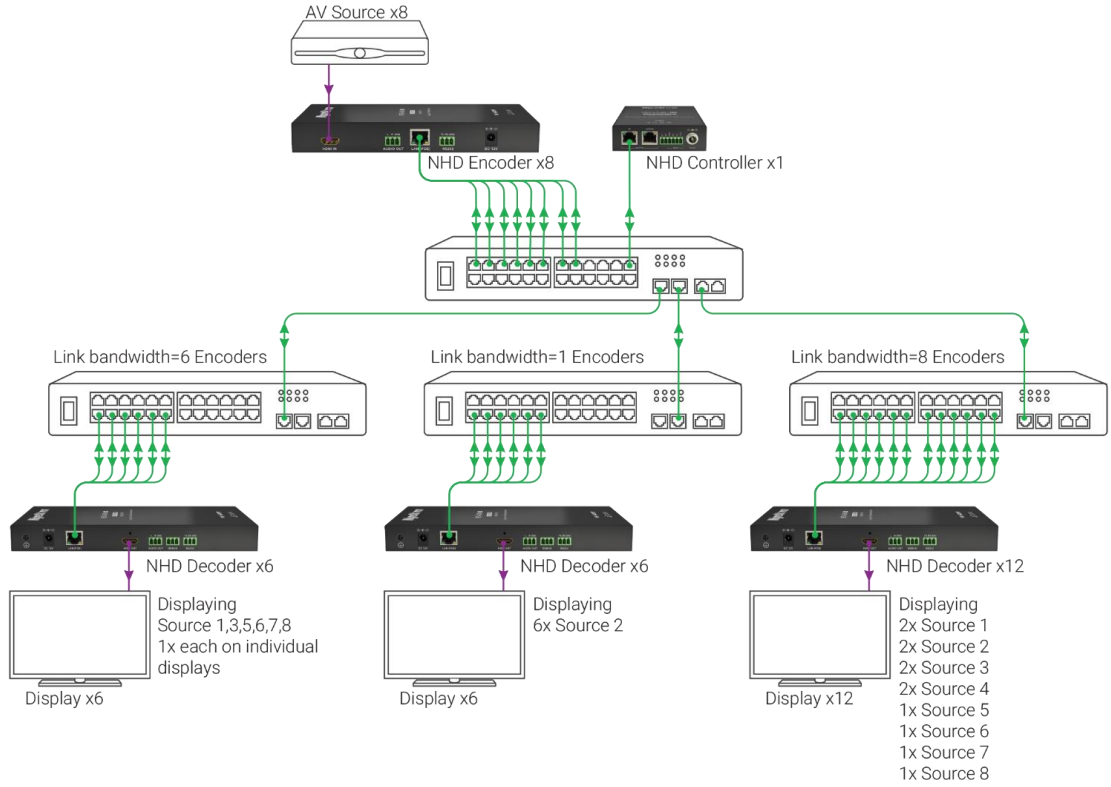
NetworkHD NHD-110-TX:	30Mb/s(H.264) 5Mbps (H.265)	1GbE switch required
NetworkHD NHD-140-TX:	120Mb/s (30Mbps per input)	1GbE switch required
NetworkHD 400 Series encoder:	850Mb/s	1GbE switch required
NetworkHD 500 series encoder	850Mb/s	1GbE switch required
NetworkHD 600 Series encoder:	8.7Gb/s peak (varies by source resolution)	10GbE switch required

When using a single switch with multiple NetworkHD encoders, the main consideration is the backplane speed of the switch which must exceed the bitrate sum of the total number of NetworkHD encoders.

For example: 10x NHD-400-TX = 10x 850Mb/s = 8.5Gb/s total bitrate

When using multiple switches, the considerations extend further, introducing the need to calculate the link bandwidth between switches. This should be considered both for switch stacks and for other topologies.

For example, when using a core/extended topology, the link speed between switches must exceed the bitrate sum of the total number of NetworkHD encoders required by decoders on a link segment.



NetworkHD 600 series bandwidth varies depending on the video timing of the source content. Below is bandwidth consumption based on resolution.

- 1080p@60Hz 8bit - 3.4Gbps
- 4K UHD@30Hz 4:4:4 8bit - 6.4Gbps
- 4K UHD@60Hz 4:4:4 8bit – 8.7Gbps (with light compression)

The remaining bandwidth out of the available 10Gbps is used for transmission of control signals, LAN and the multiview sub-stream.

Unicast Mode for 110 Series

The NetworkHD 110 series components support two operating modes, multicast and unicast. When in multicast mode, a Layer 2 or higher switch is required just like when using the 400 or 600 series devices. When the 110 series is programmed for unicast mode, this removes the need for a managed switch and IGMP Snooping. By default, NHD-110s utilize multicast. Unicast mode can be enabled from NetworkHD console software.

Unicast mode offers the benefit of universal compatibility with any network switch but does introduce some limitations. When in Unicast mode the 110 series are not compatible with any other NetworkHD 100 or 200 series component, NHD-110-TXs are only compatible with NHD-110-RXs.

Additionally, when using unicast mode, bandwidth usage changes. Unlike multicast which only sends one stream per encoder regardless on the number of decoders receiving that stream, unicast duplicates the stream for every decoder receiving it.

For example:

Multicast using H.265 - 1 TX to 50 RX = 5Mbps of bandwidth
Unicast using H.265 – 1 TX to 50 RX = 250Mbps of bandwidth

WyreStorm recommends limiting the number of RXs receiving video from the same TX to 50. This is to ensure performance and reliability.

Dante Audio Streams

Dante is an uncompressed, multi-channel digital media networking technology, based on industry standards, developed by Audinate.

To maintain maximum compatibility, Dante encoders built within WyreStorm products comply with all Audinate software tools for Dante. Thus, Audinate software should be obtained and used for configuration and switching of Dante audio.

Although not mandatory, it is recommended that Dante network data is separated from NetworkHD AV over IP data to simplify the Dante networking.

WyreStorm has designed Dante audio encoders into NetworkHD products so that they can be isolated from general AV over IP network traffic, removing any concern from Dante network administrators regarding how the Dante network data may or may not be "affected" by general NetworkHD AV over IP network traffic, despite sharing a physical network port. Due to WyreStorm's unique design, the Dante encoder elements within a NetworkHD product have a separate MAC address and IP address compared with the NetworkHD encoder elements. Considering that a managed Layer 2 or Layer 3 switch is mandatory for use with NetworkHD products, all compatible switches used for NetworkHD will include a simple function to filter Dante data ingress at the switch port and isolate this data away from NetworkHD AV over IP data. The most ubiquitous technique used for this process is the MAC-based VLAN function.

Please refer to the **Dante MAC-Based VLAN Application note** and the various **NetworkHD Switch Configuration Guides** located on WyreStorm.com for detailed, vendor-specific Switch information.

Inter-VLAN Routing

In situations where the CTL API/Control system driver communication channel or encoder preview stream data needs to be accessed from a different VLAN the data will need to be routed. When using Inter-VLAN routing to route data between VLANs there will need to be a Gateway IP defined within the CTL (API channel) IP settings or each encoder (preview stream) IP settings. This Gateway IP is required to be the interface IP address of the Router's interface that is connected to the NetworkHD VLAN. This necessitates that the Gateway IP address is within the scope of the IP subnet assigned to the NetworkHD CTL or encoder.

Likewise, equipment connected to a VLAN different to that of the NetworkHD VLAN will need to send data to a Router that can forward the data to the correct route so that the destination IP (the IP address of the target NetworkHD device) can be reached.

The router(s) used therefore may require additional routing table entries assigned to them depending on your network setup.

Switch Operation Verification

During WyreStorm's testing, we've found that different vendors and models of switches vary in performance when handling multicast data packets. Therefore, although a switch may meet the previous requirements, they may still not be suitable for use with NetworkHD. A final conclusion can be made through practical function verification and pressure testing. WyreStorm cannot offer detailed support on switches that are not documented by our library of switch configuration guides, therefore choosing to use other switch models is done so at the installer's own risk.

Refer to the **NetworkHD Switch Configuration Guides** located on WyreStorm.com for detailed, vendor-specific Switch information.

Security Protocols

Certain communication protocols can be enabled or disabled on individual NetworkHD components. By default, all series of products use Telnet and HTTP for various aspects of operation. SSH and TLS (SSL) protocols can be enabled in addition or in lieu of Telnet and HTTP to provide encrypted communication methods.

Enabling SSH/TLS on the NHD-CTL provides the following:

- Encrypted internal API communication between TX and RX devices
- Encrypted external API communication between CTL and 3rd-party control system
- Encrypted access of the web interface
- Prevents unauthorized access to root privileges by requiring authenticated credentials

Enabling SSH/TLS on encoders/decoders provides the following:

- Encrypted internal API communication to CTL
- Encrypted access to web servers (preview streams)
- Prevents unauthorized access to root privileges by requiring authenticated credentials

In addition to the above-mentioned security protocols, NetworkHD encoders and decoders utilize AES 128-bit encryption of multicast audio and video streams over the network.

Multicast IP Addresses & Ports

The following information outlines multicast addresses, protocols, and ports utilization across multiple NetworkHD series products.

NetworkHD 400 & 500s

B.CD.EF shown in the multicast addresses below should be replaced by the last 20 bits of a device's MAC address, which is then converted from hexadecimal to decimal. For example, if calculating a device's video stream MC address where the device has a MAC address of E4:CE:02:A2:34:4F, the calculated MC address would be 234.34.52.79.

Application	**Address**	**Host -> Client** **Host <- Client**
Heartbeat/ Multicast/ UDP	video 234.32+B.CD.EF	X → 59002 59002 ← X
	audio 234.48+B.CD.EF	X → 59003 59003 ← X
	ir 234.64+B.CD.EF	X → 59004 59004 ← X
	serial 234.80+B.CD.EF	X → 59005 59005 ← X
	audio return 234.96+B.CD.EF	X → 59006 59006 ← X
	usb 234.112+B.CD.EF	X → 59007 59007 ← X
node_query → node_response	225.1.0.1	X → 59101
node_response → node_query	UDP	X → 59100
VideoIP Host encode	234.32+B.CD.EF	X → 59200 59201 ← X X → 59204 59204 ← X

AudioIP Host encode	234.48+B.CD.EF	X → 59300
IRoIP Host encode	234.64+B.CD.EF	X → 59400 59400 ← X
SoIP Type 3	234.80+B.CD.EF	X → 59500 59500 ← X
Audio Return Decoder	234.96+B.CD.EF	59301 ← X
USBoIP	TCP	59700 ← X
KMoIP	234.112+B.CD.EF	X → 59702 59703 ← X
node_list → node_reply	225.1.0.0	X → 3333
node_reply → node_list	UDP	X → 3334
CTL → TX/RX	226.1.0.0 228.1.0.0	X → 1234
TX/RX → CTL	226.2.0.0	X → 10000 X → 20002
HTTP Service	TCP	80
HTTPS Service	TCP	443

NetworkHD 100 & 200s

For details on how to calculate NHD-100/200 series multicast addresses please reach out to WyreStorm Technical Support.

Application	Protocol	IP:PORT	Relevant Device
Main video stream port	UDP	F(0x1)[1]:12345	NHD-100, 200, 110, 140 & 250
Main audio stream port	UDP	F(0x1) [1]:12346	NHD-100, 200, 110, 140 & 250
Sub stream port	UDP	F(0x2) [1]:12345	NHD-100, 200, 110, 140 & 250
Pure audio stream port	UDP	F(0x3) [1]:12346	NHD-100, 200, 110, 140 & 250
RS232 TX	UDP	F(0x4) [1]:12400	NHD-110
RS232 RX	UDP	F(0x4) [1]:12401	NHD-110
IR TX	UDP	F(0x5) [1]:12410	NHD-110
IR RX	UDP	F(0x5) [1]:12411	NHD-110
USB TX	UDP	F(0x6) [1]:12420	NHD-110
USB RX	UDP	F(0x6) [1]:12421	NHD-110

Searching devices listening port	UDP	225.1.0.0[3]:3333	NHD-100, 200, 110, 140 & 250
I frame unified switch to RX information listening port	UDP	226.2.0.0[3]:4321	NHD-100, 200, 110, 140 & 250
I frame unified switch order listening port	UDP	226.2.0.1[3]:4322	NHD-100, 200, 110, 140 & 250
CTL Notify information listening port	UDP	226.2.0.0:10000	NHD-100, 200, 110, 140 & 250
Mjpeg http browser port	TCP	0.0.0.0:80	NHD-100, 200, 110, 140 & 250
Mjpeg https browser port	TCP	0.0.0.0:443	NHD-100, 200, 110, 140 & 250

NHD-CTL & Console Software

Application	Protocol	Address	Host -> Client
Search protocol used for devices searching or searched by PC software.	UDP/MC	225.1.0.0	CTL->TX/RX or PC->CTL
Batch control event channel for CTL and Console software.	UDP/MC	226.1.0.0	CTL->TX/RX
Matrix switch command to TX address via Console	UPD/MC	226.2.0.1	CTL->TX/RX
Serial report and video lost/found Notification via Console.	UPD/MC	226.2.0.0	CTL->TX/RX
Search protocol used by CTL	UDP/MC	225.1.0.0	X->3333
Search protocol reply	UDP		3334<-X
Matrix switch command to RX	UDP/MC	226.1.0.0	X->1234
Matrix switch command to TX. (Only valid for H.264 products)	UDP/MC	226.2.0.1	X->4322
Serial report and video lost/found notification.	UDP/MC	226.2.0.0	10000<-X
Telnet API channel	TCP		23 <- X
Telnet API channel for NHD Touch	TCP		23000 <- X
SSH API channel for NHD Touch	TCP		10022 <- X
Web service	TCP		80 <- X

Encoder Preview Streams

The NetworkHD encoders in the 110, 400 and 500 series all produce a low-bandwidth, low quality unicast Motion JPEG video stream of the source content intended to provide a real-time preview of the source content that can be separately accessed by a control system's UI. The NetworkHD Touch App for iPad uses these streams to present real- time video previews of each encoded source in the Touch UI. The same streams can be used for this purpose in a 3rd- party user interface or for monitoring source content in a Web browser.

The preview stream is generated by each encoder. Thus, the unicast source IP address of the preview stream is that of the encoder generating it. When using the source preview stream in a UI or for monitoring purposes the IP address of the encoder must be reachable by the device requesting it.

Example preview stream request URL syntax:
http://<encoder IP address>/stream

For more information on the source video preview function, the details can be referenced as part of the **NetworkHD Installation Guide** document or **NetworkHD API document**.

If the device, such as a control processor, PC hosting a Web browser, or iPad running NetworkHD Touch is not within the same VLAN or broadcast domain as an encoder generating a preview stream, the following information can be used to aid routing of the preview stream data:

NetworkHD Encoder (TX): Web server <TX IP address>, TX ingress on TCP Port 80, TX egress TCP port undefined

It must be noted that the factory default encoder (TX) port interface IP address uses a value in a range of potential link-local addresses (169.254.0.0/16) and thus might not be routable unless changed to a routable IP address. In addition, after factory reset the encoders utilize stateless address autoconfiguration. This means that without assigning a static IP to an encoder, the IP is subject to change after boot. This is also a concern if using DHCP client mode. Thus, it is highly recommended that if preview streams are to be used, even if no routing is required, the target encoder's IP address should be statically assigned after initial device discovery.

The data generated by the encoder (where the destination IP is outside the scope of the relevant network interface) is forwarded to the Gateway IP address assigned to the encoder's network interface. It is important that a Router at this Gateway IP address is configured to forward the data to the correct route for the intended destination IP.

NOTE: The NHD-600-TRX, TRXF & NHD-610-TX do not produce a preview stream.

Default IP Addresses

A NetworkHD device restored to factory defaults will have the following IPv4 Network details:

	Host IP	Netmask	Default Gateway
100, 200, 400, 500, 600 Series	DHCP, auto-IP	DHCP, auto-IP	DHCP, NA (undefined)
NetworkHD NHD-CTL (AV)	169.254.1.1	255.255.0.0	169.254.1.254
NetworkHD NHD-CTL (Control)	192.168.11.243	255.255.255.0	192.168.11.1

If a DHCP server is not on the network units will default to an auto-IP range of 169.254/16. It must be noted that when devices are in auto-IP mode, Routers will not forward packets with link-local (auto-IP) addresses.

NetworkHD 600 series devices require two IP addresses per device. One IP address is for the SDVoE transmission and the other is for the MCU (microcontroller). Keep this in mind when allocating an IP address range from either a DHCP server or assigning static IP addresses to ensure enough addresses are available.

In the NHD-610-TX and NHD-610-RX the high-speed Icron USB chipset also requires a unique IP address in addition to the SDVoE and MCU IP addresses.

Restoring Default IP Addresses

NHD-110-TX/RX NHD-140-TX, NHD-250-RX, NHD-400-TX/RX, NHD-500-TX/RX:
With the unit powered on, press and hold the reset button for 15 seconds

NHD-600-TX/RX:
Disconnect the DC power adapter. Press and hold the button labelled “1”. Continuing holding the button and apply power using the DC adapter. Continue to hold the button for up to 15 seconds.

NHD-600-TRX, NHD-600-TRXF, NHD-610-TX/RX:
Disconnect power. Press and hold the reset button. Continue holding the button and apply power. Continue to hold the button for up to 15 seconds.

NHD-000-CTL, NHD-CTL-PRO:
With the unit powered on, press and hold the reset button for 15 seconds

NHD-0401-MV
With the unit powered on, press and hold the reset button for 15 seconds

Document Revision History

V6.8 – December 2022	• Added Multicast IP Address & Ports Section • Updated NHD-600 factory default procedure
V6.7 – November 2022	• Added details pertaining to NHD-0401-MV • Added details pertaining to IP addresses on 600 series
V6.6 – September 2022	• Added Companion Control section • Added details regarding multiview on 600 series transceivers
V6.5 – May 2022	• Added details pertaining to NetworkHD 500s • Updated formatting • Removed details pertaining to legacy/discontinued models
V6.4 – March 2022	• Removed bezel correction and mosaic video wall features on NHD-110s to reflect version 2 capabilities • Clarified USB functionality on NHD-110s. Updated to reflect version 2 capabilities.
V6.3 – December 2021	• Added information pertaining to NHD-600-TRX, TRXF, NHD-610-TX/RX
V6.1.1 – April 2021	• Added clarification on use-case and limitations for multiview
V6.0.2 – January 2021	• Added details pertaining to NetworkHD 110 series devices
V6.0.1 – April 2020	• Corrected default IP settings for various devices
V6.0.0 – March 2020	• Added references for new products • Added Dante Audio Streams information for 400 series
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