

CobraNet, ACU16-C & NHB32-C Guide



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Yamaha Web Site

Information about the ACU16-C, NHB32-C, NetworkAmp Manager, and other Yamaha professional audio equipment is available on the Yamaha Professional Audio Web site at:
<http://www.yamaha.co.jp/product/proaudio/homeenglish/>

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CobraNet in a Nutshell

Developed by Peak Audio, a division of Cirrus Logic, Inc., CobraNet technology allows real-time uncompressed digital audio distribution over industry-standard 100Base-T Ethernet networks. Up to 128 channels, 64 in each direction, can be carried simultaneously over a 100Base-T network (64 channels on repeater networks). Fiber-optic cables support distances of up to two kilometers.

CobraNet currently supports a 48 kHz sampling rate with 16, 20, or 24-bit resolution. Digital audio is distributed in bundles, with one bundle per Ethernet data packet. A single bundle can carry eight channels of 20-bit/48 kHz digital audio, or seven channels of 24-bit/48 kHz digital audio.

CobraNet's Serial Bridge feature allows serial data to be transmitted over the network. Normally, the ACU16-C and NHB32-C use the Serial Bridge to transmit amp control data. However, it can be used to transmit MIDI (Program/Control Change) or AD824 head-amp control data between any two NHB32-Cs on the network.

CobraNet—the Technical Stuff

What is CobraNet?

Developed by Peak Audio, CobraNet is a network protocol for real-time uncompressed digital audio distribution over industry standard 100Base-T Ethernet networks. TCP/IP (Transmission Control Protocol/Internet Protocol), the network protocol used on the Internet, is also a network protocol. However, unlike that protocol, CobraNet technology includes a hardware interface, namely the CM-1 CobraNet interface board manufactured by Peak Audio and licensed to audio manufacturers for inclusion in their products.

CM-1 Interface

Peak Audio's CM-1 is a compact, low-power, CobraNet compliant module that manufacturers can build into their professional audio products. It has two Ethernet ports—one for a primary network connection, another for a secondary, or backup connection. It can receive and transmit up to 32 audio channels simultaneously, and supports a 48 kHz sampling rate with 16, 20, or 24-bit resolution. It can also drive Error, Conductor, and Link status LED indicators. The CM-1 firmware can be upgraded via the CM-1's Ethernet ports.



The CM-1 interface module

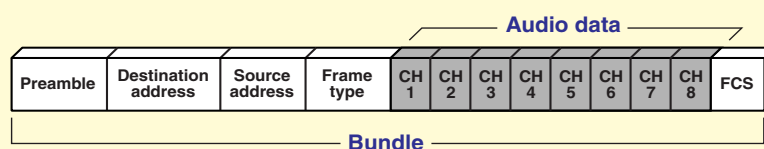
What Networks are Supported?

CobraNet runs on industry-standard 100Base-T Ethernet networks (100 Mbps). It does not support 10Base-T (10 Mbps). CobraNet can be used with standard off-the-shelf 100Base-T Ethernet networking equipment, including switches, media converters, CAT5 cables, and so on. 100Base-T Ethernet equipment is readily available and inexpensive.

Packets, Bundles & Isochronous Cycles

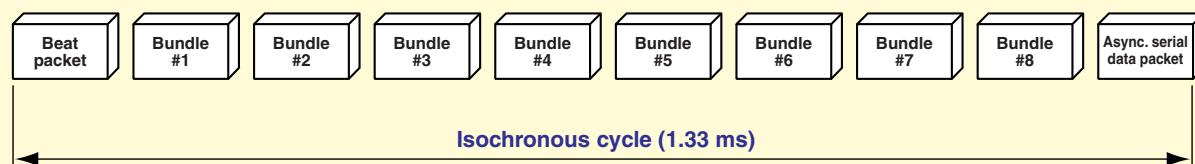
On an Ethernet network, data is transmitted in small *packets*. Digital audio data must be *packetized* before transmission, and *unpacketized* upon reception.

The CobraNet equivalent of a packet is a *bundle*. A single bundle may contain data for up to eight channels of 20-bit/48 kHz digital audio, or seven channels at 24-bit/48 kHz. Each bundle consists of a preamble, destination address, source address, frame type, audio data, and FCS (Frame Check Sequence) error checking.



A bundle

Bundles are transmitted in isochronous cycles, and the cycle duration is 1.33 ms. There are eight bundles per cycle. Each cycle starts with a beat packet, which is used for synchronization. The last packet in the cycle can be used to transmit asynchronous serial data. The ACU16-C and NHB32-C use this for power amp control, MIDI, and AD824 head-amp control.



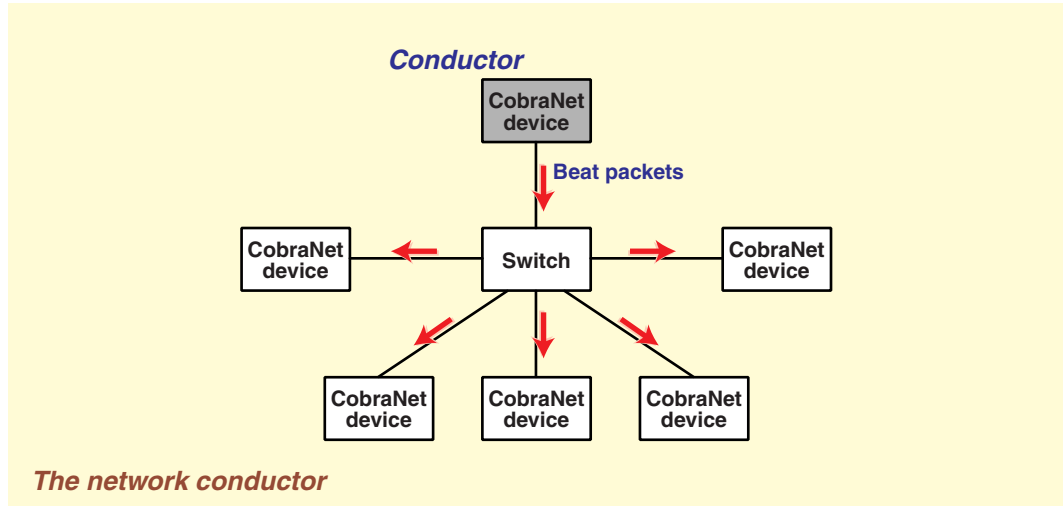
An isochronous cycle

The NHB32-C can transmit 4 bundles and receive 4 bundles simultaneously (i.e., 32 channels in, 32 channels out). The ACU16-C can receive 4 bundles (i.e., 32 channels in).

CobraNet has a fixed latency of 5.33 ms (or 256 samples). This is mostly due to digital audio *packetization* and *unpacketization*.

Conductors & Performers

One device on the CobraNet network works as the *conductor* (network sync master). All other CobraNet devices are *performers* (network sync slaves). Each device synchronizes its own internal clock to the beat packets transmitted by the conductor.



The conductor device is chosen automatically and no user intervention is required. The ACU16-C and NHB32-C have front-panel indicators to show when they are working as the conductor. If the conductor fails, another device automatically takes over.

Since the conductor transmits beat packets onto the network, each performer doesn't require an external wordclock connection, reducing cabling complexity and cost. Any non-networked digital audio equipment should derive its wordclock from a networked device.

Multicast & Unicast Bundles

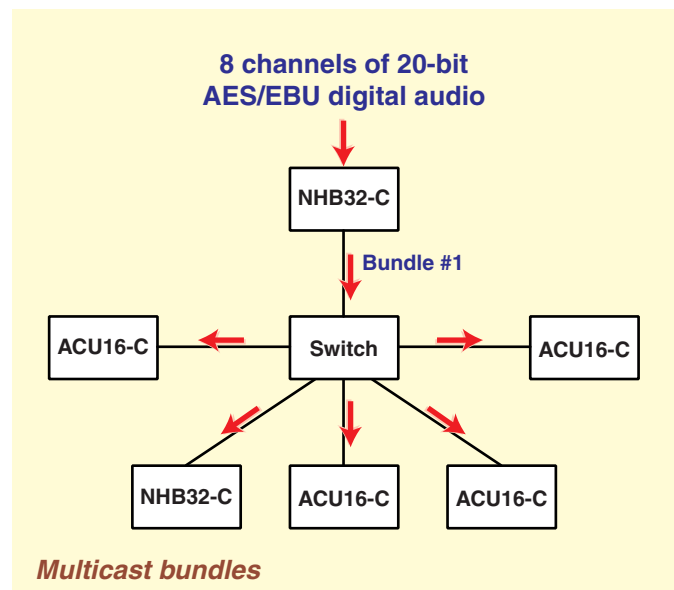
CobraNet bundles can be either *multicast* or *unicast*. Multicast bundles are transmitted from one device to all devices on the network (*one-to-many*). Unicast bundles are transmitted from one device to another (*one-to-one*). For routing around the network, bundles are assigned numbers from 0 through 65,279.

Multicast bundles are numbered 1 through 255 and are transmitted regardless of whether any devices are configured to receive them. It's recommended that no more than four multicast bundles be used on a switched network, offering up to 32 channels. Unicast bundles should be used if more channels are required. (More multicast bundles can be used in certain circumstances. See the following Web page for details.)

http://www.peakaudio.com/CobraNet/licensee/Bundle_Assignments.html

Since multicast bundles are distributed indiscriminately to all devices on the network, they wreak havoc on switched networks and it's recommended that no more than four multicast bundles be used on switched networks.

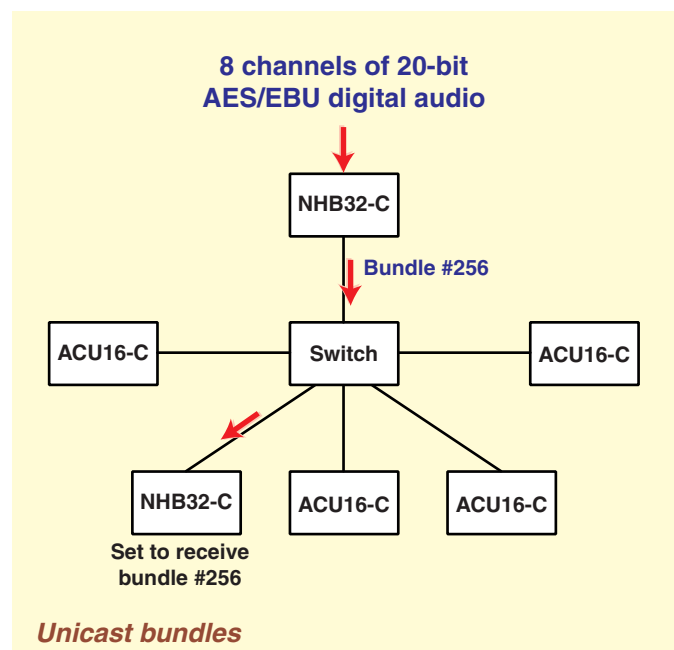
Note that although multicast bundles are received at the ports of all devices on the network, only devices that are configured to receive them will actually process them.



Unicast bundles are numbered 256 through 65,279 and are transmitted only when another device is configured to receive them, allowing destination controlled routing.

The conductor ensures that only one device transmits data in each bundle during any isochronous cycle.

The ACU16-C and NHB32-C support all multicast bundle numbers and unicast bundle numbers 256 through 16,383. Bundle numbers are assigned in NetworkAmp Manager.



Network Infrastructure

Since CobraNet is designed to work on industry-standard 100Base-T Ethernet networks, it has no special requirements and a suitable network can easily be constructed by using readily available 100Base-T Ethernet-compatible equipment, switches, cables, and so on.

The theoretical maximum cable length for 100Base-T Ethernet over CAT5 copper cables is 100 meters. However, because of cable quality and environmental considerations (i.e., interference), sometimes this cannot be realized. About 70 to 80 meters is a safe maximum. Always use high-quality shielded CAT5 cables (cables that use all 8 pins, RS-485 spec). The maximum distance for multimode fiber optic cables is 2 kilometers.

In the world of Ethernet networking, two devices can be connected directly together using what's known as a *crossover* Ethernet cable (i.e., a cable whose data transmit and receive lines are crossed at one end).

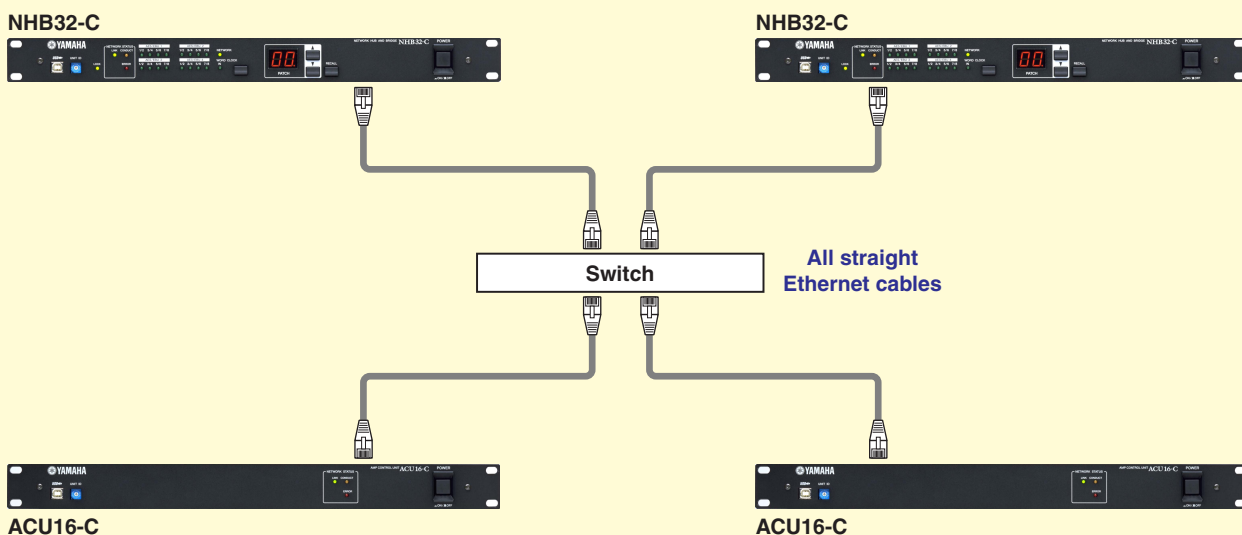


Connecting two Ethernet devices using a crossover Ethernet cable

To connect three or more devices requires a *hub*. There are two types of Ethernet hub: *repeater hub* and *switching hub*, or *switch* for short. Switches are recommended for CobraNet networks.

Networks made up of switches are called switched networks. A switch knows the network addresses of all the devices on the network. When it receives data packets, it checks the destination address and outputs the data to the port to which the correspondingly addressed device is connected. This is an efficient use of the available network bandwidth, hence switched networks support up to 128 channels per connection, as opposed to the 64 channels network-wide supported by repeater networks.

Straight cables (wired pin-to-pin) should be used to connect the ACU16-C, NHB32-C, and other network devices to a switch.



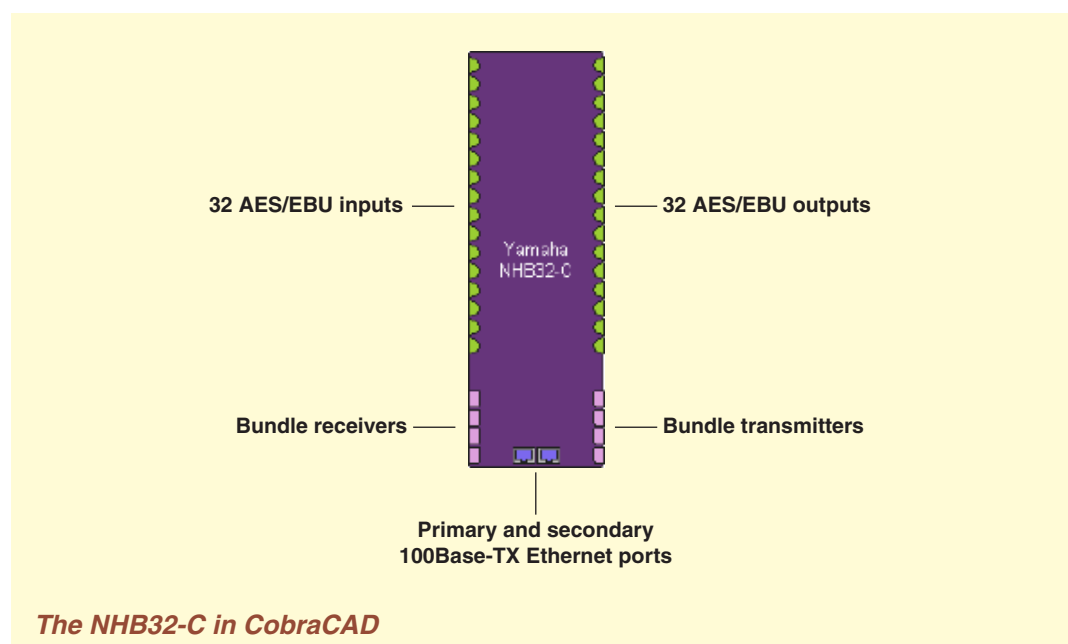
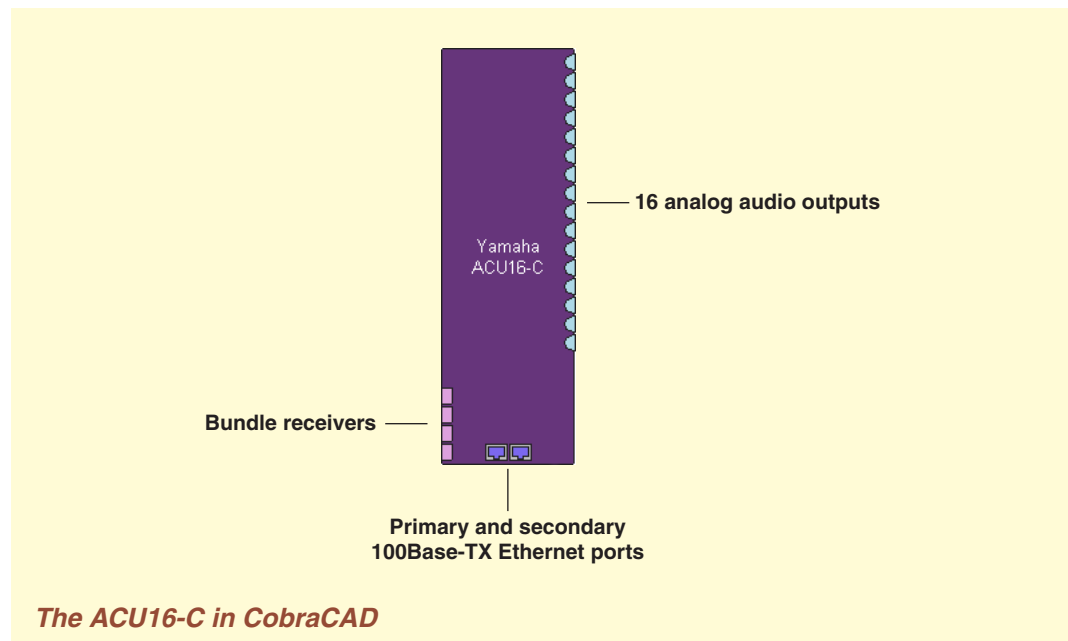
A switched network

Built-in Redundancy

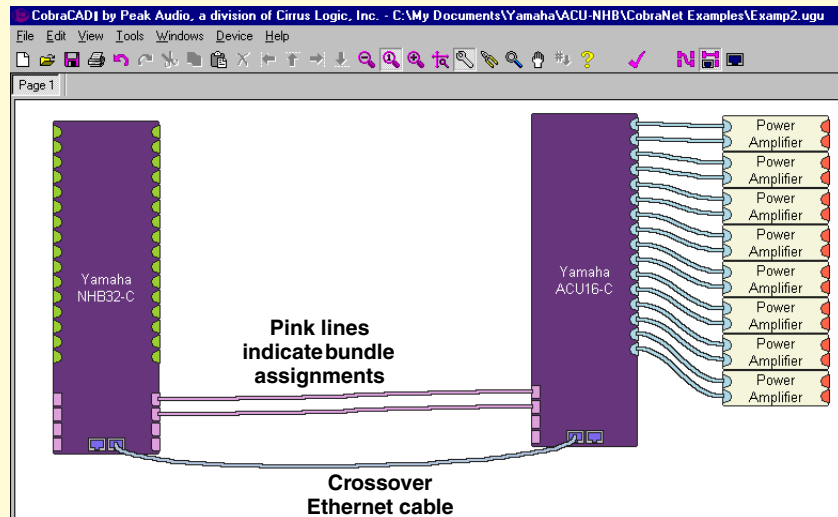
The CobraNet CM-1 interface has two Ethernet ports for built-in redundancy—one for a primary network connection, another for a secondary, or backup connection. If for some reason the primary connection fails (e.g., a cable is damaged, inadvertently disconnected, or a switch fails), the secondary connection automatically takes over.

CobraCAD Software

With Peak Audio's CobraCAD software you can design, test, and refine your CobraNet network before you buy any equipment or begin installation. You can arrange devices onscreen, wire them up, and test. CobraCAD includes most CobraNet-compatible devices, including the ACU16-C and NHB32-C. CobraCAD runs on Windows computers and can be downloaded for free at: <http://www.peakaudio.com/CobraNet/cobracad/>

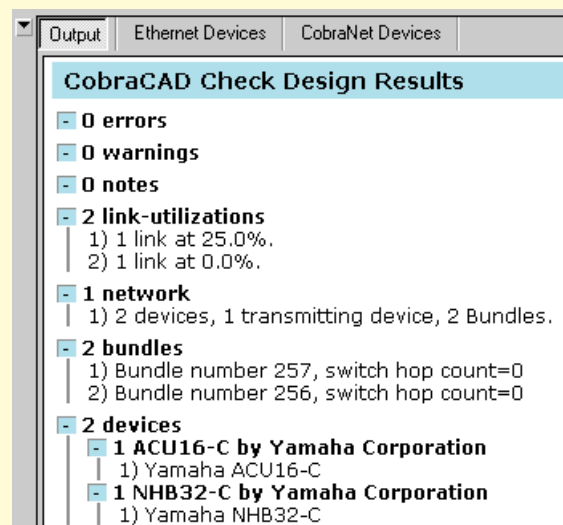


Example #1 below shows how network designs appear in CobraCAD. This particular design uses unicast bundles #256 and #257 to distribute 16 audio channels from an NHB32-C to an ACU16-C, which is feeding eight 2-channel power amps. Since there are no hubs on the network, a crossed Ethernet cable is used to connect the ACU16-C and NHB32-C.



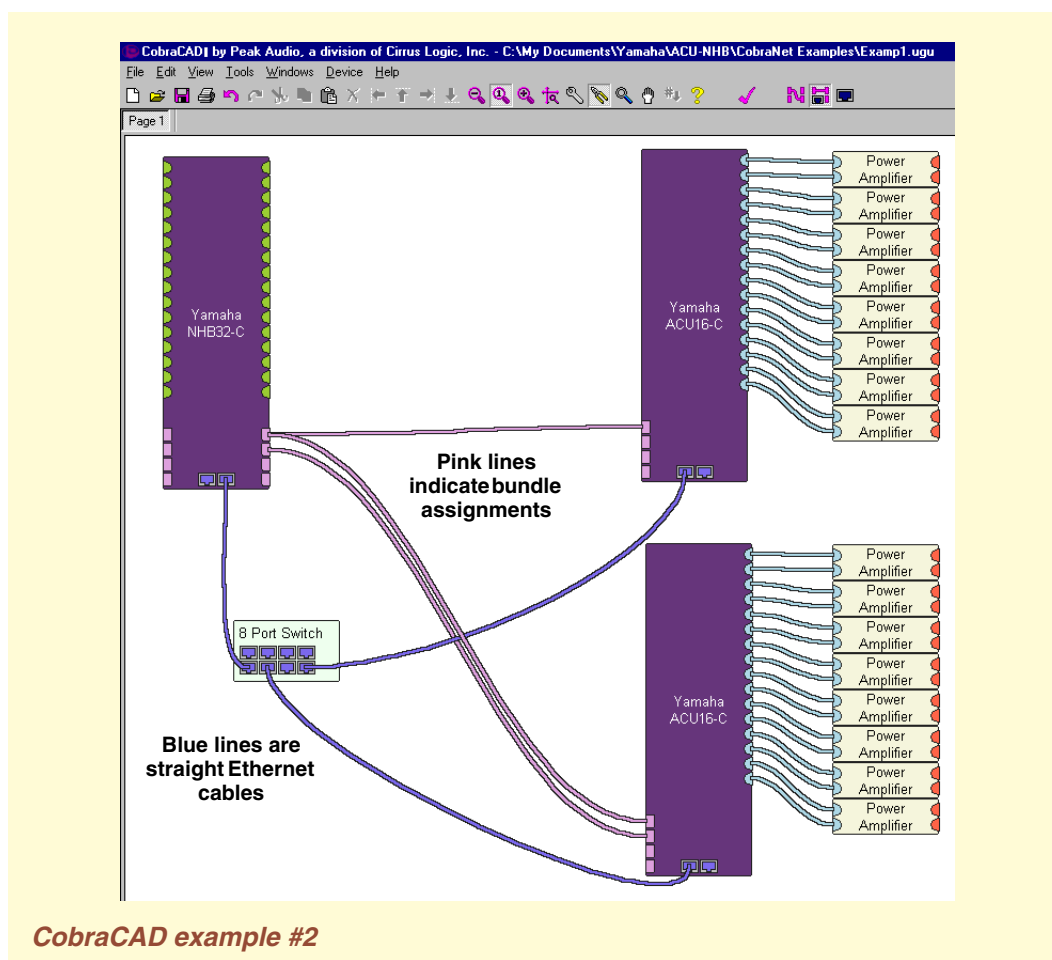
CobraCAD example #1

Network designs can easily be tested in CobraCAD by using the Check Design command. Here, for example, are the test results for example #1.

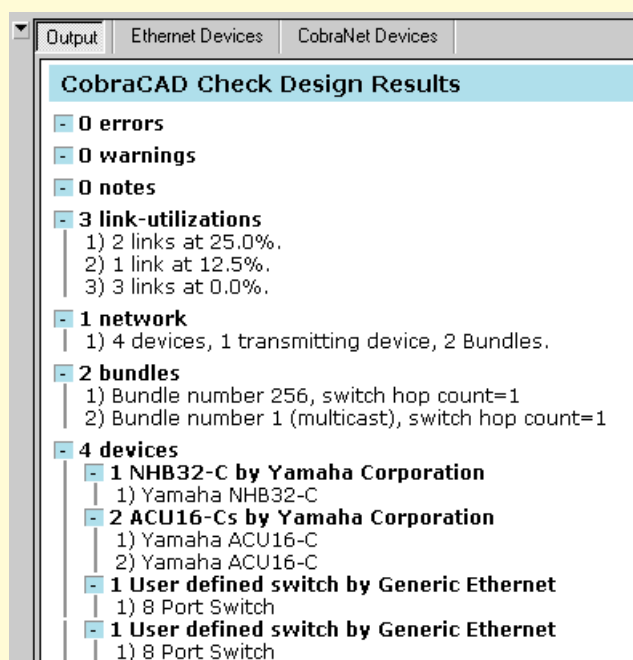


The test results for example #1

Example #2 below uses unicast bundle #256 (one-to-one) and multicast bundle #1 (one-to-many) to distribute 16 audio channels from the NHB32-C to two ACU16-Cs, which are feeding 16 2-channel power amps. Straight Ethernet cables are used to connect the devices to the switch.



Here are the test results for example #2.



The test results for example #2

Reliability & Cost Saving

A typical audio distribution system consists of many audio cables and connections. Permanent installations use conduit to hide and protect cables. If a cable or connector fails, a channel is lost, the fault must be traced and repaired, resulting in system down time and expense—unacceptable in mission-critical applications. The larger the installation, the greater the number of cables and connections, the greater the complexity and the possibility of failure. With CobraNet, a single 100Base-T Ethernet cable can carry up to 64 channels of digital audio, so one cable can do the same job as 64 traditional cables. That's 63 less things to go wrong, plus the cost saving.

Another big advantage over traditional cables is routing and patching. For example, if you need to reroute the output of a device, with traditional cables you must physically unplug and reconnect. With CobraNet you simply reassign bundle numbers. With the NHB32-C's 99 patch memories you can instantly reconfigure an entire system with a single mouse click.

By reducing the number of cables and connections required, and by using readily available Ethernet equipment, CobraNet can simplify design, reduce installation time, improve reliability, add flexible signal routing, and cut both labor and material costs.

CobraNet devices can coexist with networked computers, printers, etc., on a switched 100Base-T Ethernet network, however, a dedicated network infrastructure is strongly recommended for critical applications.

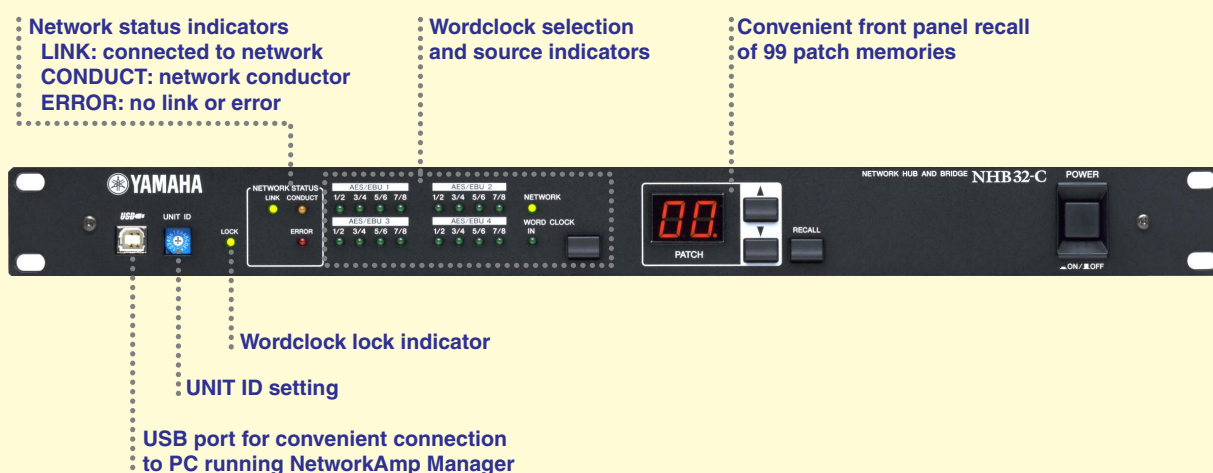
The CobraNet Advantage

- A single Ethernet cable replaces 64 traditional cables
- Fewer cables simplify design, cut costs, reduce installation time, and improve reliability
- Uses industry-standard 100Base-T Ethernet equipment
- 100Base-T Ethernet equipment is readily available and inexpensive
- Flexible signal routing
- Built-in redundancy
- CobraNet supported by professional audio manufacturers worldwide
- Serial Bridge feature allows power amp control, MIDI, and AD824 head-amp control via the network
- ACU16-C and NHB32-C can be used with CobraNet-compatible audio equipment from other manufacturers

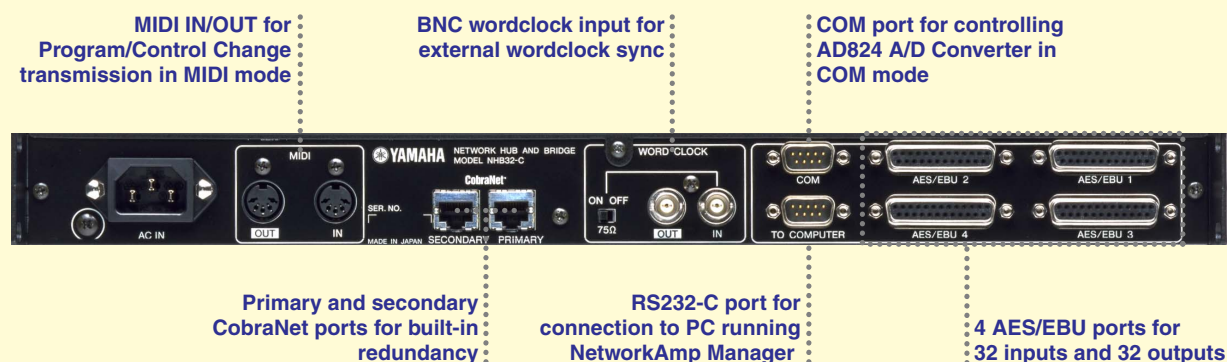
Yamaha's CobraNet Products

NHB32-C Network Hub and Bridge

The Yamaha NHB32-C Network Hub & Bridge is a bridging device for interfacing digital audio equipment with AES/EBU format I/O to a CobraNet network. It offers flexible patching of 32 AES/EBU inputs and 32 AES/EBU outputs.



NHB32-C front panel



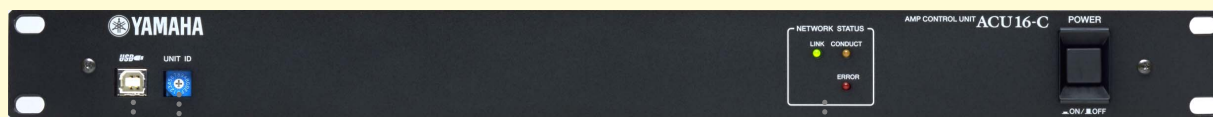
NHB32-C rear panel

NHB32-C Features

- AES/EBU–CobraNet bridging device
- Flexible patching of 32 AES/EBU inputs and 32 AES/EBU outputs
- Up to 8 NHB32-Cs can be used on the same network, bridging up to 256 channels
- Primary and secondary CobraNet ports for built-in redundancy
- Up to 99 patch setups can be created, stored, and recalled from NetworkAmp Manager
- Patches can be recalled directly from the front panel when NetworkAmp Manager is offline
- Works as an interface for Yamaha's NetworkAmp Manager software
- NetworkAmp Manager PC can be connected via USB or RS-232C
- Up to 8 NHB32-Cs can be managed from a single PC
- Serial Bridge feature allows MIDI (Program/Control Change) and AD824 head-amp control between any two NHB32-Cs on the network
 - * All other NetworkAmp Manager functions are unavailable while the Serial Bridge is being used for MIDI or AD824 head-amp control
- Selectable wordclock source from AES/EBU input, BNC WORD CLOCK IN, or the network
- Two NHB32-Cs and a single Ethernet cable are all that's required to build a self-contained 32-channel digital multicore

ACU16-C Amp Control Unit

The Yamaha ACU16-C Amp Control Unit is a CobraNet interface offering 24-bit D/A conversion of up to 16 CobraNet audio channels, which are output via Euro-block connectors. Up to 32 PC-N series power amplifiers can be connected and controlled via a single ACU16-C.



- UNIT ID setting
- USB port for convenient connection to PC running NetworkAmp Manager

- Network status indicators
- LINK: connected to network
- CONDUCT: network conductor
- ERROR: no link or error

ACU16-C front panel



- RS-485 port for daisy-chain connection and control of up to 32 PC-N series power amps

- Primary and secondary CobraNet ports for built-in redundancy

- 16 balanced analog Euro-block outputs

ACU16-C rear panel

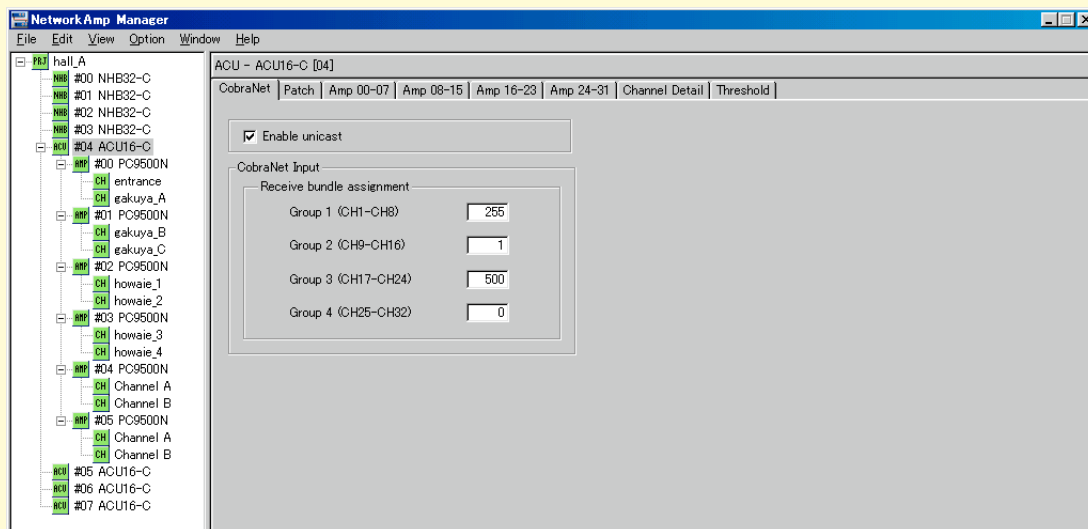
ACU16-C Features

- 16-channel, 24-bit CobraNet D/A conversion
- Euro-block connectors for 16 analog outputs
- Up to 16 ACU16-Cs can be used on the same network, providing D/A conversion of up to 256 CobraNet audio channels
- NetworkAmp Manager can control up to 32 power amplifiers via a single ACU16-C
 - * Parallel audio connections would be necessary to feed 32 amps from one ACU16-C.
- Primary and secondary CobraNet ports for built-in redundancy
- Works as an interface for Yamaha's NetworkAmp Manager software
- NetworkAmp Manager PC can be connected via USB or RS-232C

As of this writing, the Yamaha PC9500N and PC4800N power amplifiers can be networked with the ACU16-C. Please check the Yamaha Professional Audio Web site at the following URL for news and information on other Yamaha professional audio products:
<http://www.yamaha.co.jp/product/proaudio/homeenglish/>

NetworkAmp Manager

Yamaha's NetworkAmp Manager software is for controlling and monitoring PC-N series power amps and configuring ACU16-Cs and NHB32-Cs.



NetworkAmp Manager's main window

Features

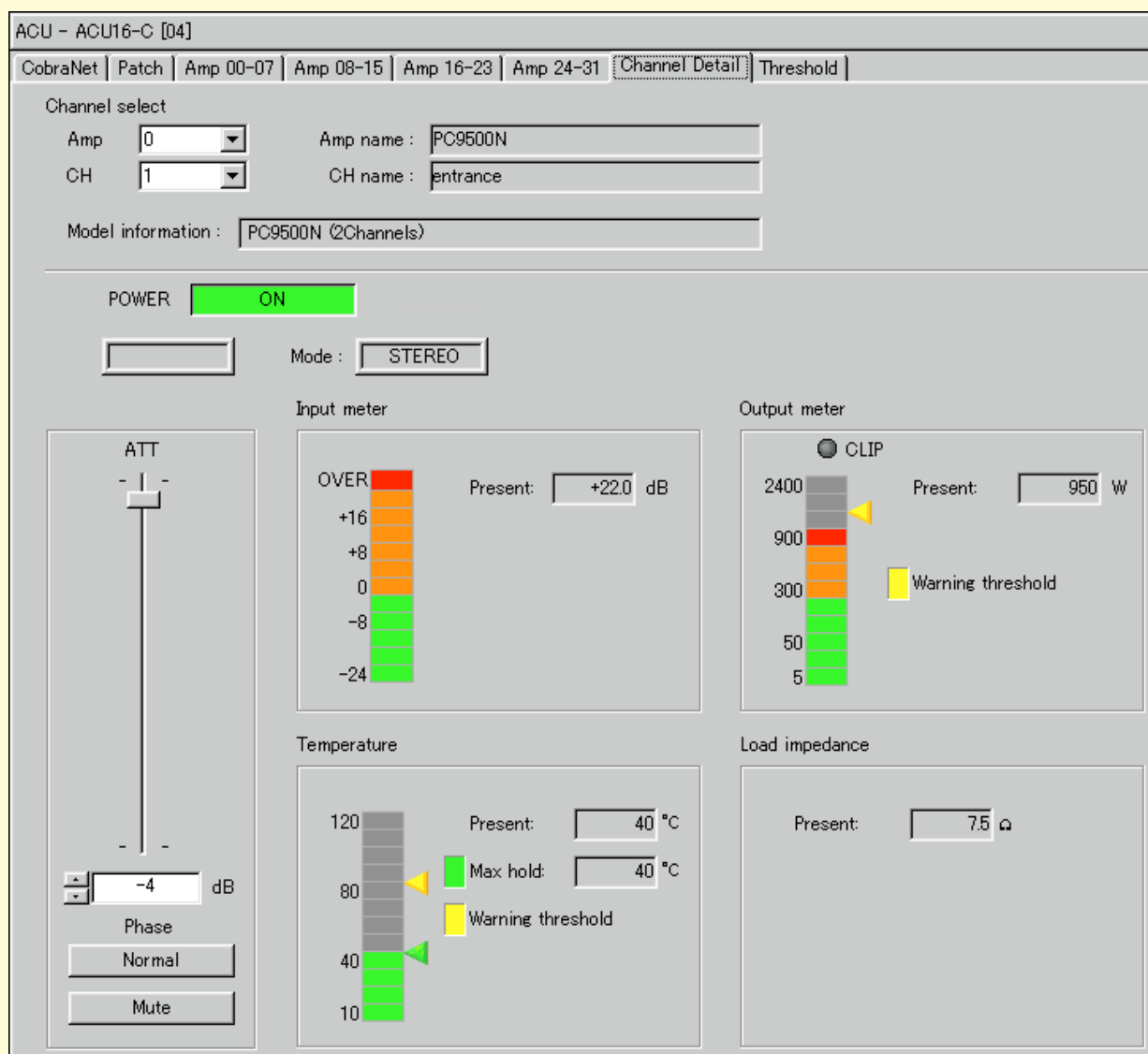
- Remote control software for PC-N series power amplifiers, ACU16-C, and NHB32-C
- Runs on standard Windows PCs
- PC can be connected to any ACU16-C or NHB32-C on the network
- USB or RS-232C connection
- Records log file of operations and warnings (e.g., output shorts, overheating) for troubleshooting analysis after a performance (see "Log File" on page 22 for details)
- Several PCs running NetworkAmp Manager can be connected to the same network, allowing control and monitoring from several locations within a venue
- NetworkAmp Manager can control and manage the following:
 - Up to 8 NHB32-Cs
 - Up to 16 ACU16-Cs
 - Up to 512 Yamaha PC-N series power amplifiers (32 amps per ACU16-C)
 - * Parallel audio connections would be necessary to feed 32 amps from one ACU16-C.
 - Up to 1,024 amplifier channels (with PC-N series power amps)

Controllable PC-N Series Amp Parameters

- Power (on/standby)
- Attenuator (63-step control)
- Input phase (normal/reverse)
- Mute (on/off)

Monitored PC-N Series Amp Parameters

- Amp mode (stereo/parallel/bridge)
- Input level (12-segment meter)
- Output level (12-segment meter, watt/volt)
- Output clip (output clipping indicator)
- Impedance (indicates current load impedance, short/open)
- Protection (protection system status)
- Temperature (heatsink temperature, 12-segment meter, centigrade/Fahrenheit)

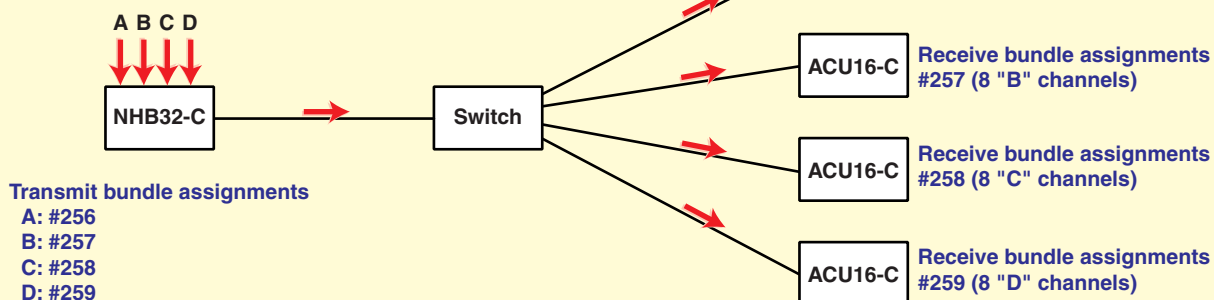


NetworkAmp Manager's power amp control page

Bundle Assignments

As explained earlier, for network routing purposes, bundles are assigned numbers from 0 through 65,279 (NetworkAmp Manager supports unicast bundle numbers 256 through 16,383). A transmitting device transmits digital audio data in a specified bundle, which can then be received by any device on the network simply by dialing in the same bundle number.

32 channels of 20-bit
AES/EBU digital audio
in four groups of 8 channels



Assigning transmit and receiver bundle numbers

NHB - NHB32-C [01]

CobraNet | Patch | WordClock

☒ Enable unicast

CobraNet Input

Receive bundle assignment

Group 1 (CH1-CH8)	<input type="text" value="7"/>
Group 2 (CH9-CH16)	<input type="text" value="255"/>
Group 3 (CH17-CH24)	<input type="text" value="500"/>
Group 4 (CH25-CH32)	<input type="text" value="32"/>

CobraNet Output

Transmit bundle assignment

Group 1 (CH1-CH8)	<input type="text" value="1"/>
Group 2 (CH9-CH16)	<input type="text" value="2"/>
Group 3 (CH17-CH24)	<input type="text" value="3"/>
Group 4 (CH25-CH32)	<input type="text" value="4"/>

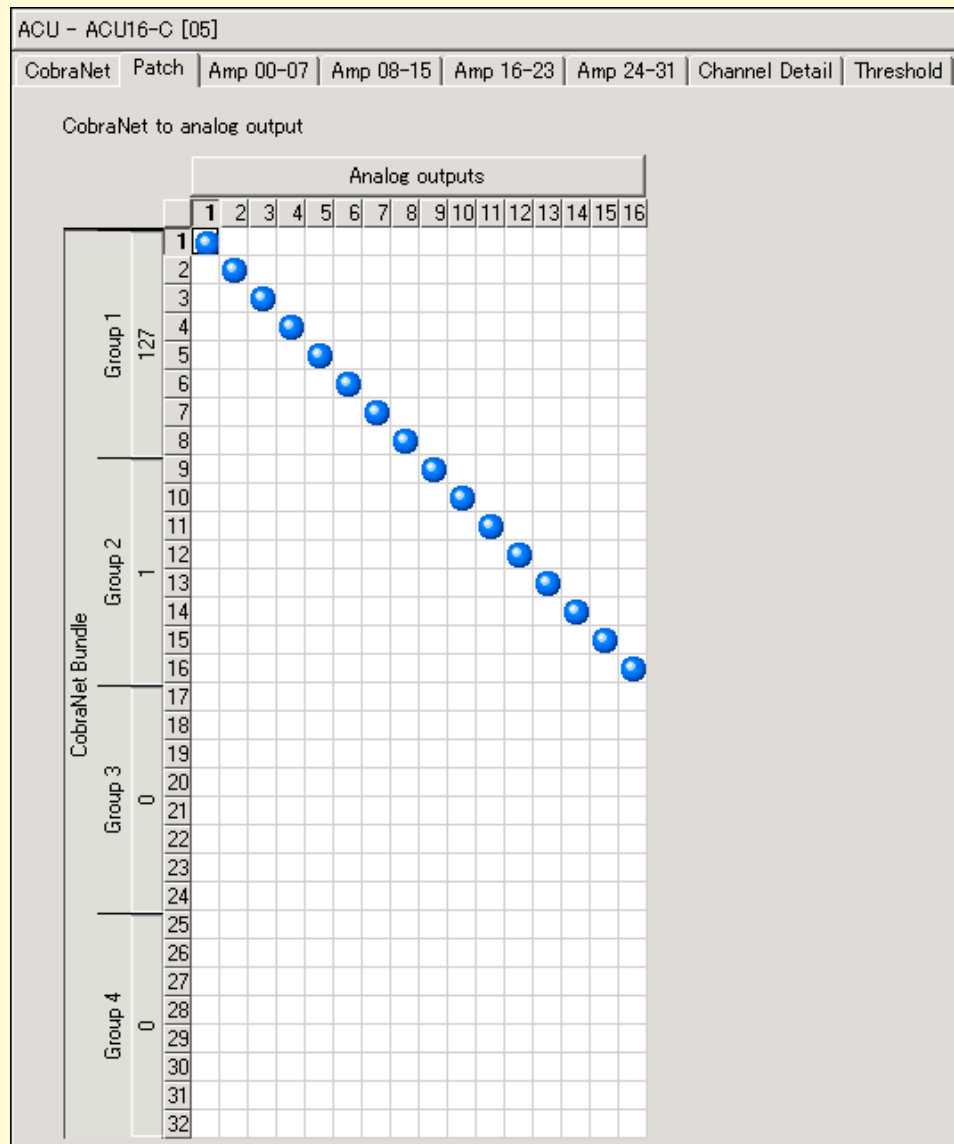
Audio resolution

☒ 20 bit
 ☐ 24 bit

NetworkAmp Manager's NHB bundle assignment page

Channel Patching

With NetworkAmp Manager you can assign up to four transmit (NHB32-C) or four receive (NHB32-C/ACU16-C) bundle numbers and use the patchbays to select individual audio channels from any of those bundles. For example, you may configure an ACU16-C to receive four bundles and then select four audio channels from each bundle, or any combination up to a total of 16 channels.

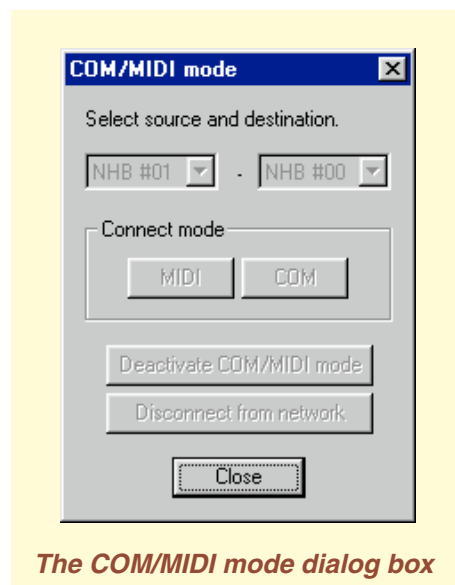


NetworkAmp Manager's ACU patch page

COM & MIDI Modes

CobraNet's Serial Bridge feature allows serial data to be transmitted over the network. Normally, the ACU16-C and NHB32-C use the Serial Bridge for power amp control. However, it can be used to transmit MIDI (Program/Control Change) or AD824 head-amp control data between any two NHB32-Cs on the network.

The Serial Bridge cannot be used for power amp control, MIDI, and AD824 head-amp control simultaneously. All other NetworkAmp Manager functions are unavailable while the Serial Bridge is being used for MIDI or AD824 head-amp control. While MIDI mode is active, only communication between the MIDI ports of the two specified NHB32-Cs takes place. Likewise, while COM mode is active, only communication between the COM ports of the two specified NHB32-Cs takes place.



The COM/MIDI mode dialog box

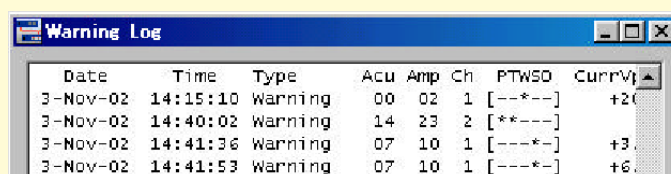
Log File

NetworkAmp Manager can record operating and warning events to a text-based log file for troubleshooting analysis after a performance. Logged events are time stamped, so you can easily determine at what point in a performance, say, a power amp exceeded a certain temperature or the load impedance dropped below a certain point.

Log files are CSV format text files that can be opened by any text editor, word processor, or spreadsheet. Events are also displayed in NetworkAmp Manager's Warning Log window.

There are five types of event that are logged: Warning, Online/Offline Status, Power Switch, Error, and Network Mode.

Warning: A Warning event occurs when a power amp's wattage, temperature, or minimum or maximum load impedance exceeds a previously specified threshold.

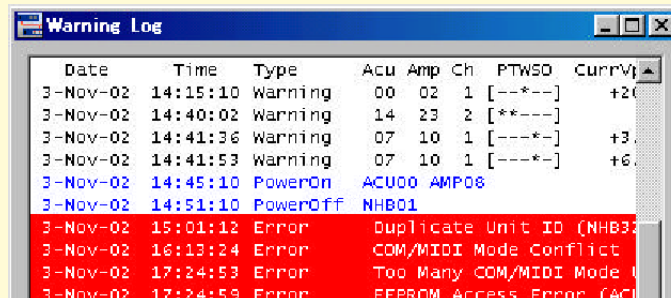


Date	Time	Type	Acu	Amp	Ch	PTWSD	CurrVt
3-Nov-02	14:15:10	Warning	00	02	1	[--*--]	+20
3-Nov-02	14:40:02	Warning	14	23	2	[**---]	
3-Nov-02	14:41:36	Warning	07	10	1	[---*-]	+3.
3-Nov-02	14:41:53	Warning	07	10	1	[---*-]	+6.

The Warning Log window showing Warning events

Online/Offline Status: This type of event occurs when a power amplifier, ACU16-C, or NHB32-C comes online (i.e., when a new device is detected on the network) or goes offline.

Power Switch: This type of event occurs when a power amp is set to On or Standby.



Date	Time	Type	Acu	Amp	Ch	PTWSD	CurrVt
3-Nov-02	14:15:10	Warning	00	02	1	[--*--]	+20
3-Nov-02	14:40:02	Warning	14	23	2	[**---]	
3-Nov-02	14:41:36	Warning	07	10	1	[---*-]	+3.
3-Nov-02	14:41:53	Warning	07	10	1	[---*-]	+6.
3-Nov-02	14:45:10	PowerOn	ACU00	AMP08			
3-Nov-02	14:51:10	PowerOff	NHB01				
3-Nov-02	15:01:12	Error				Duplicate Unit ID (NHB32	
3-Nov-02	16:13:24	Error				COM/MIDI Mode Conflict	
3-Nov-02	17:24:53	Error				Too Many COM/MIDI Mode	
3-Nov-02	17:24:59	Error				EEPROM Access Error (ACU	

The Warning Log window showing Power Switch events (in blue) and Error events (in red)

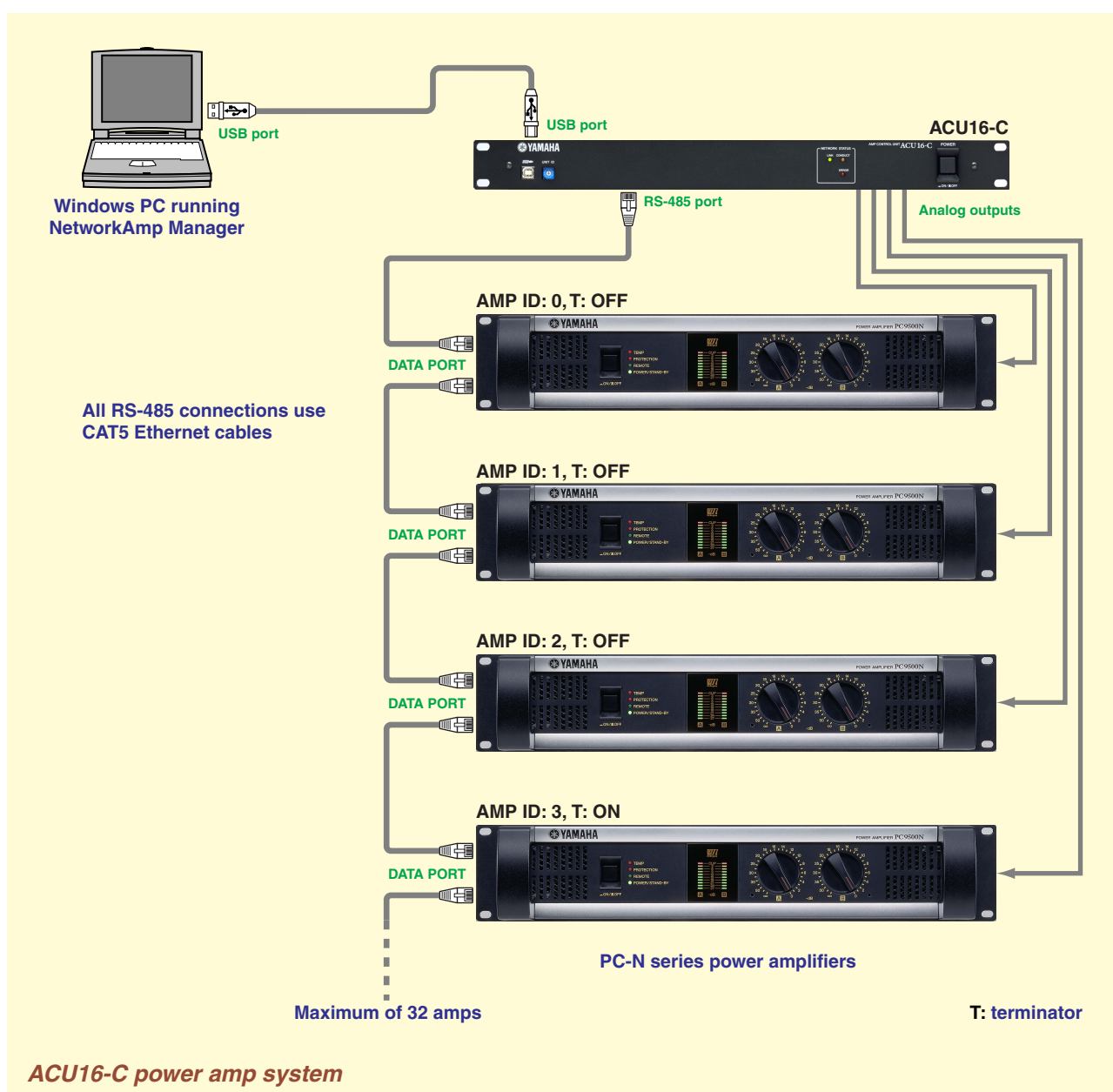
Error: This type of event occurs when either a system error or parameter error occurs.

Network Mode: This type of event occurs when COM or MIDI is activated or deactivated.

System Examples

ACU16-C Power Amp System

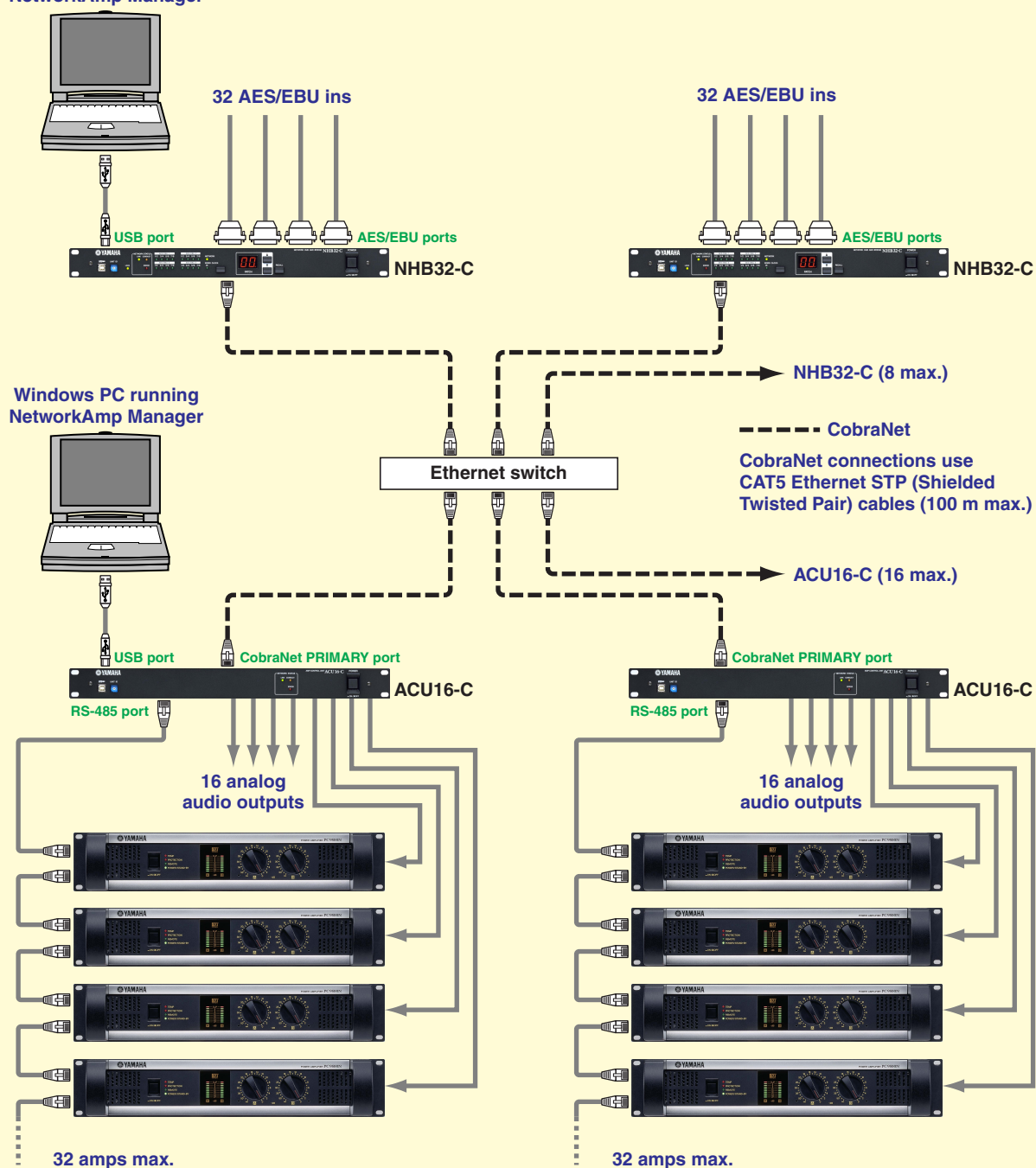
This example shows how Yamaha PC-N series power amplifiers can be connected to an ACU16-C for remote control and monitoring via NetworkAmp Manager.



ACU16-C/NHB32-C Cobra-Net Audio Distribution System

This example shows how multiple AES/EBU channels can be distributed over long distances (up to 200 meters with 100Base-TX Ethernet cabling) to multiple power amplifiers. The NHB32-Cs handle AES/EBU to CobraNet conversion, while the ACU16-Cs handle CobraNet to analog conversion. NetworkAmp Manager is running on two PCs, and power amplifier control and monitoring can be performed from either.

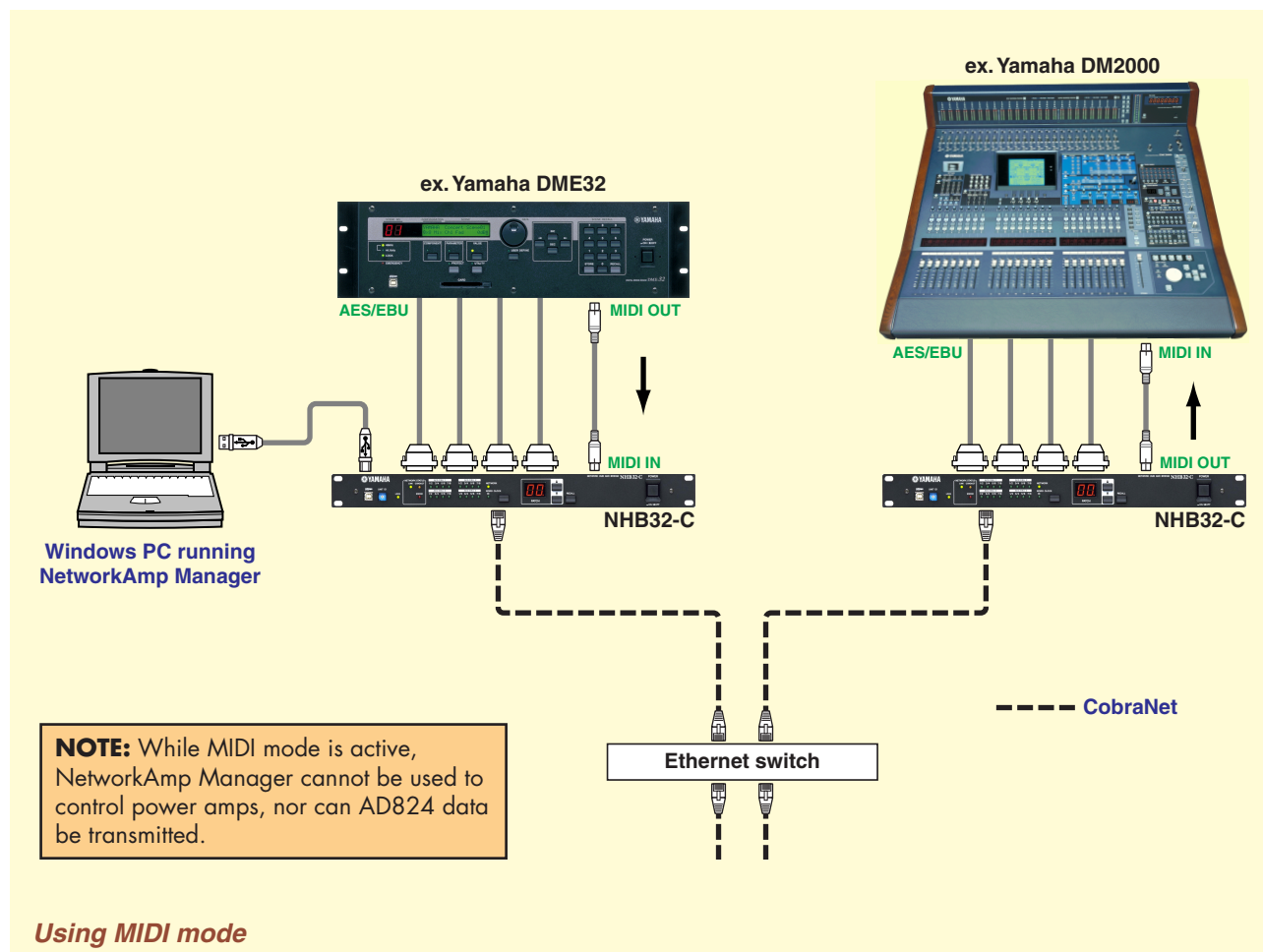
Windows PC running
NetworkAmp Manager



ACU16-C/NHB32-C distribution system

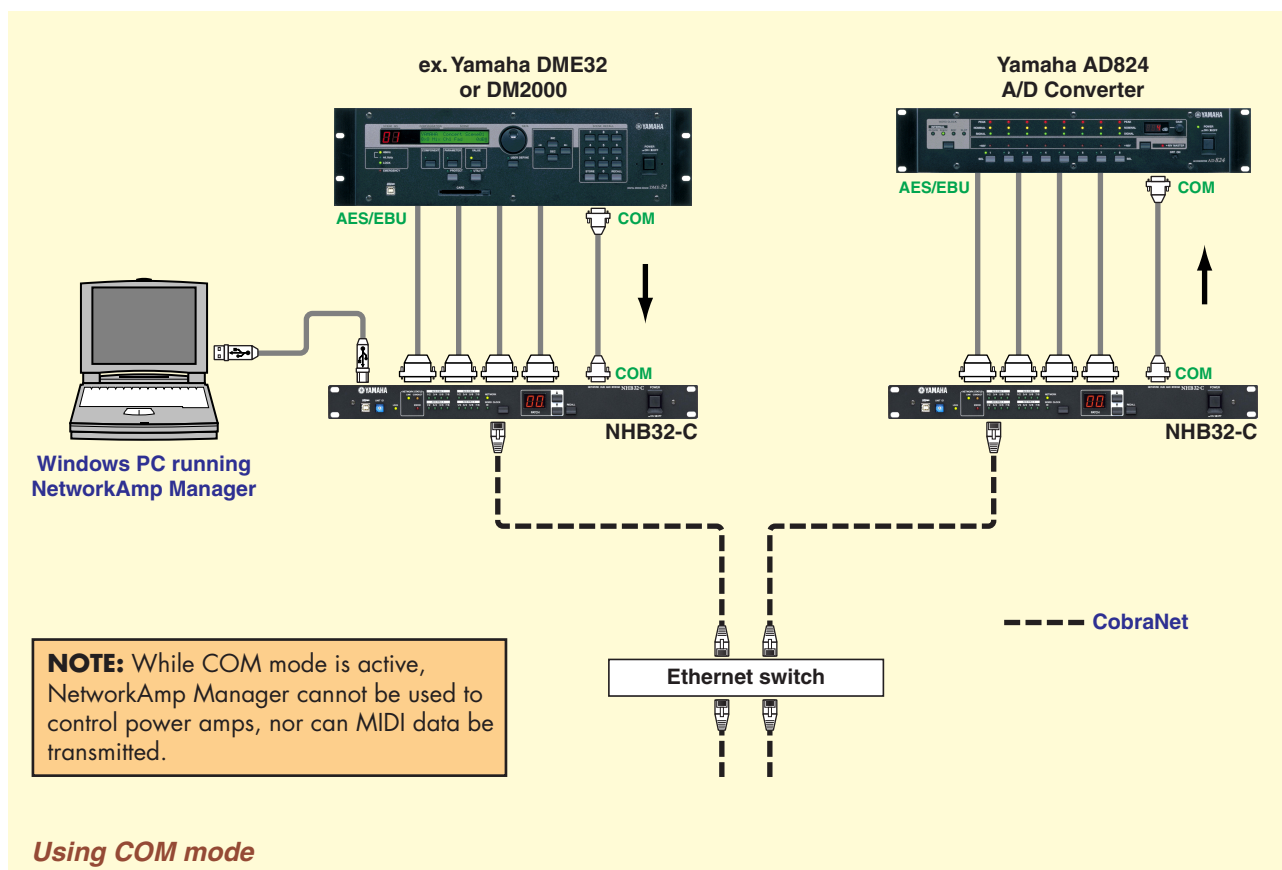
MIDI Over CobraNet

This example shows how MIDI mode, which is set in NetworkAmp Manager, can be used to transmit MIDI Program/Control Change messages from one NHB32-C to another via CobraNet's Serial Bridge feature. In this example, MIDI data from a Yamaha DME32 Digital Mixing Engine is fed through to a Yamaha DM2000 Digital Production Console. While MIDI mode is active, power amp and AD824 head-amp control are not possible.



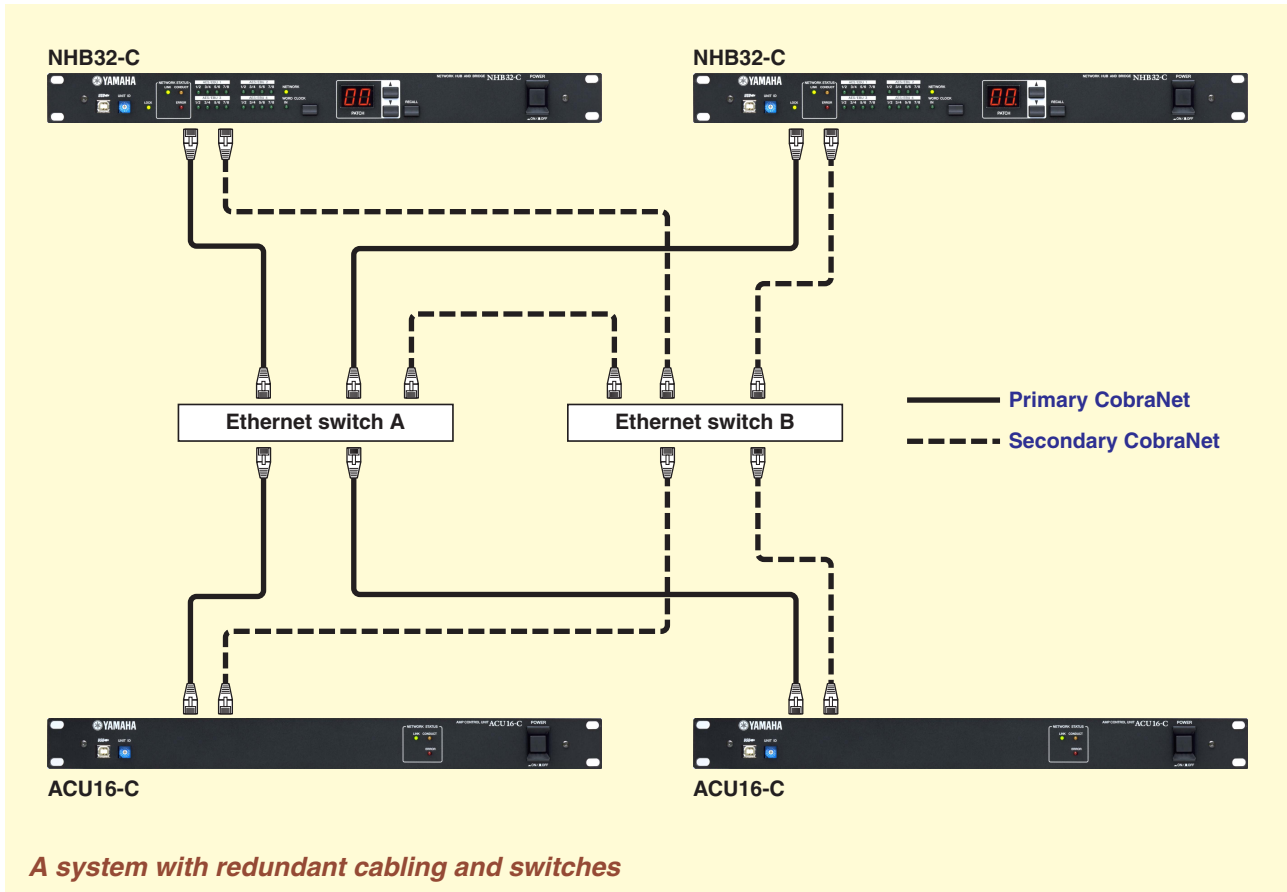
AD824 Control Over CobraNet

This example shows how COM mode, which is set in NetworkAmp Manager, can be used to transmit AD824 head-amp control information from one NHB32-C to another via CobraNet's Serial Bridge feature. In this example, head-amp control information is transmitted from a Yamaha DME32 Digital Mixing Engine, or Yamaha DM2000 Digital Production Console to a remote AD824 A/D Converter. While COM mode is active, power amp and MIDI transmission are not possible.



CobraNet Primary & Secondary

This example shows how the CobraNet PRIMARY and SECONDARY ports can be used to build redundancy into a system. Two switches are used for fully independent primary and secondary networks. If a primary cable or switch fails, the system automatically switches to the secondary network.



Further Information

A glossary of CobraNet, ACU16-C, NHB32-C, and NetworkAmp Manager related terms is provided on [page 29](#). A wealth of information about CobraNet, with sections especially for designers and installers, is available on the Peak Audio Web site at <http://www.peakaudio.com>. If you are designing a CobraNet network, we strongly recommend that you visit this Web site and study the information available in order to take full advantage of the CobraNet technology. Peak Audio also provide a list of Ethernet devices that have been tested with CobraNet, including switches and media converters.

Yamaha Web site

<http://www.yamahaproaudio.com>

Yamaha CobraNet Product Manuals (PDF)

<http://www2.yamaha.co.jp/manual/english/index.html>

Peak Audio Web site

<http://www.peakaudio.com>

CobraNet FAQ

<http://www.peakaudio.com/CobraNet/FAQ.html>

Background, Specification & Terminology

<http://www.peakaudio.com/CobraNet/Background.html>

Network Design Support

http://www.peakaudio.com/CobraNet/Network_Design.html

Installation Support

http://www.peakaudio.com/CobraNet/Support_Install.html

CobraCAD Software

<http://www.peakaudio.com/CobraNet/cobracad/>

CobraNet Glossary

<http://www.peakaudio.com/CobraNet/Terminology.html>

Glossary

100Base-T: See Fast Ethernet.

100Base-FX: Fast Ethernet utilizing multi-mode fiber optic cables, with a maximum transmission distance of two kilometers. Single mode fiber supports distances of over 100 kilometers.

100Base-TX: Fast Ethernet utilizing Category 5 (CAT5) twisted pair data grade cables and RJ-45 connectors. These cables are readily available in a range of lengths and colors. The maximum allowed cable run in an 100Base-T Ethernet network is 100 meters. If you need to make custom cables, be sure to maintain the natural twist of the conductors as close to the connector as possible. More than 25 mm of untwisted cable can affect performance. If you're using cable ties, don't tighten them so as to deform the outer insulation, and do not bend cables tightly. Doing so may affect the cable's impedance and degrade performance.

1000Base-T: See Gigabit Ethernet.

APJ: The file name extension for NetworkAmp Manager projects (e.g., My project.apj).

Asynchronous: Not synchronized. Often used to describe communications between devices that are not synchronized by a common clock, in which data is sent intermittently rather than in a steady stream. CobraNet's Serial Bridge is asynchronous. *Contrast with Isochronous.*

Auto-negotiation: The automatic negotiations that go on between two network devices in order to determine half/full-duplex operation and transfer rate (e.g., 10, 100, 1000 Mbps) before actual data transmission commences. Auto-negotiation only works on switched networks. With repeater networks, all data transfers are half-duplex and the transfer rate is determined by the slowest device on the network. All CobraNet interfaces support auto-negotiation.

Bridge: Typically a device that allows data transfer between networks using disparate protocols. The NHB32-C offers a bridge between AES/EBU and CobraNet format digital audio.

Bundle: CobraNet distributes digital audio data in bundles. Each Ethernet packet can carry one bundle. A single bundle can carry eight channels of 20-bit/48 kHz digital audio, or seven channels of 24-bit/48 kHz digital audio. Bundles are numbered from 1 through 65,279. Bundles can be transmitted one-to-one (unicast) or one-to-many (multicast). Network efficiency can be optimized by using all eight channels in each bundle instead of, for example, using four channels in two bundles or two channels in four bundles. *See also Multicast bundle and Unicast bundle.*

Bundle 0: Not really a bundle as such, more of a null setting that can be made on CobraNet devices to disable transmission and reception as necessary.

CAT3: Category 3 twisted pair cable supports a maximum data transfer rate of 10 Mbps and is used for 10Base-T Ethernet networks.

CAT5: Category 5 twisted pair cable supports a maximum data transfer rate of 100 Mbps and is used for 100base-TX Ethernet networks.

CobraCAD: Freely available software from Peak Audio for verification and performance testing of CobraNet network designs. The latest version includes the ACU16-C and NHB32-C.

CobraNet: Developed by Peak Audio, CobraNet technology allows real-time uncompressed digital audio distribution over industry standard 100Base-T Ethernet networks. Up to 128 channels, 64 in each direction, can be carried simultaneously over a switched 100Base-T network (64 channels on repeater networks). CobraNet currently supports a 48 kHz sampling rate with 16, 20, or 24-bit resolution. CobraNet devices can happily coexist with networked computers, printers, etc., on a switched 100Base-T Ethernet network, however, a dedicated network infrastructure is strongly recommended.

CobraNet audio channel: In CobraNet terminology, an audio channel is one 48 kHz digital audio signal with a 16, 20, or 24-bit resolution.

CobraNet primary/secondary

ports: CobraNet interfaces feature built-in redundancy, with primary and secondary ports for connection to primary and secondary networks. If an unrecoverable fault should occur on the primary network, CobraNet automatically switches to the secondary network, providing uninterrupted operation. Both ports are transformer isolated and fully comply with the IEEE 802.3 standard.

Conductor: The device on a CobraNet network that acts as wordclock master and network arbitrator. Only one device can be Conductor at any one time. If that device is unplugged or fails, another device automatically takes over as Conductor. The conductor ensures that only one device transmits data in each bundle at any one time. *See also* Performer.

Crossover Ethernet cable: An Ethernet cable whose data transmit and receive conductors have been swapped. Crossover cables are used to connect two Ethernet devices directly to each other. They should never be used to connect devices to a hub. *Contrast with* Straight Ethernet cable.

CSV: Abbreviation for Comma Separated Value file. CSV files, which are commonly used to exchange table-like data from spreadsheets and databases, use commas to separate the individual values on each line. NetworkAmp Manager log files use the CSV format and can easily be imported into spreadsheet programs for further analysis.

Ethernet: The most widely implemented network protocol. The first implementation 10Base-T supports data transfer rates of 10 Mbps. The next implementation, 100Base-T (or Fast Ethernet) supports 100 Mbps. The newest version, Gigabit Ethernet, supports transfer rates of 1,000 Mbps (i.e., 1 gigabit).

Fast Ethernet: Also known as 100Base-T, the Ethernet standard that supports data transfer rates of 100 Mbps. CobraNet runs on Fast Ethernet networks.

Full duplex: A communications mode that allows simultaneous transmission and reception. The telephone system is a good example of a full-duplex network. CobraNet is a full-duplex network. *Contrast with* Half-duplex.

Gigabit Ethernet: Also known as 1000Base-T, the Ethernet standard that supports data transfer rates of 1,000 Mbps. CobraNet supports Gigabit Ethernet. A Gigabit switched network can handle up to 1,028 CobraNet audio channels.

Half-duplex: A communications mode that allows data transmission in only one direction at a time. *Contrast with* Full-duplex.

Hub: *See* Repeater hub *and* Switching hub.

IEEE 802.3: The IEEE (Institute of Electrical and Electronics Engineers, Inc.) working group that develops standards for Ethernet-based local area networks).

Isochronous: Occurring at fixed intervals in time. Often used to describe real-time communications between devices in which data must be delivered at regular intervals. CobraNet transmits digital audio data isochronously. *Contrast with* Asynchronous.

LAN (Local Area Network): A network that exists in the same building or group of buildings. CobraNet is a LAN technology. *See also* WAN.

Managed hub: A type of switching hub that improves network efficiency by segregating a LAN into smaller virtual LANs.

Media converter: A device that converts from one type of distribution media to another, for example, Ethernet (100Base-TX) to fiber optic (100Base-FX).

Multicast bundle: CobraNet bundles 1 through 255 are multicast bundles, which means they are transmitted to all devices on the network regardless of whether any devices are configured to receive them. Multicast bundles allow point-to-multipoint connections and can be used with repeater hubs or switching hubs. Advantages include the ability to distribute digital audio to any number of devices simply by configuring those devices to receive the same bundle. Disadvantages are that all available network bandwidth is used, devices receive all bundles and must decide for themselves whether to receive or ignore the data, and any 10Base-T data ports (e.g., computers, printers, etc.) will be flooded with data. This can be stressful for switching hubs, which must work hard to transmit all incoming data to all output ports. *Contrast with* Unicast Bundle.

Network topology: The structure of a network. Common network topologies include *star*, *ring*, *tree*, and *bus*. Ethernet networks utilizing hubs are typically wired in a star topology, although a network may consist of various topologies.

Performer: The devices on a CobraNet network that are wordclock slaves. Performers synchronize to the conductor. *See also* Conductor.

Propagation delay: CobraNet has a fixed propagation delay of 5.33 ms. This will be acceptable for some applications, but if you're compensating for microphone placement or trying to eliminate Haas effect, you can use this fixed value to calculate compensatory delay times as necessary.

Repeater hub: A basic network hub that retransmits all incoming data to all of its output ports. *Contrast with* Switching hub.

RJ-45 connector: The type of connector used to connect 10Base-T, 100Base-T, and 1000Base-T Ethernet devices.

RS-232C: A serial interface for connecting serial devices, offering a transmission distance of approximately 15 meters, typically using 9- or 25-pin D-sub connectors.

RS-422: A balanced serial interface for connecting serial devices, offering a transmission distance of approximately 1 kilometer and higher data rates and greater immunity to interference than RS-232C.

RS-485: A balanced serial interface for connecting serial devices. Similar to RS-422 but with support for multiple receivers and transmitters, offering bidirectional half-duplex communications over a single twisted pair.

Sampling rate: CobraNet currently supports a single sampling rate of 48 kHz.

Serial Bridge: CobraNet's Serial Bridge feature allows serial data at up to 57.6 kbps to be transmitted over the network. Due to the process of packetizing and re-serializing serial data, data sent over the Serial Bridge is delayed by approximately 10 milliseconds.

Straight Ethernet cable: An Ethernet cable that is wired pin-for-pin (i.e., pin 1 connects to pin 1, pin 2 to pin 2, and so on). Straight cables are used to connect Ethernet devices to network hubs. You can easily tell whether an Ethernet cable is crossover or straight by looking at the wiring of both connectors. If the wiring is identical, it's a straight cable. If it's different, it's a crossover cable. *Contrast with* Crossover Ethernet cable.

STP (Shielded Twisted Pair): A cable consisting of two shielded conductors that are twisted together.

Switching hub: Usually called a *switch* for short, switching hubs know the network address of each device on the network and automatically route network traffic accordingly, so each device receives only data addressed to it. *Contrast with* Repeater hub.

Unicast bundle: CobraNet bundles 256 through 65,279 are unicast bundles, which means they are transmitted only when two devices are configured to transmit and receive them. Unicast bundles only allow point-to-point connections and as such are far more bandwidth efficient than multicast bundles. This efficiency means that CobraNet can happily coexist with networked computers, printers, etc., on a switched 100Base-T Ethernet network. However, the network bandwidth demands of non-CobraNet devices can be unpredictable, which may affect CobraNet performance and even cause audio dropouts, pops, or clicks. A dedicated CobraNet network is strongly recommended for mission critical applications. Unicast bundles can only be used on switched networks. *Contrast with* Multicast Bundle.

UTP (Unshielded Twisted Pair): A cable consisting of two unshielded conductors that are twisted together.

WAN (Wide Area Network): A network that covers a wide area, typically made up of two or more LANs. CobraNet is not a WAN technology. *See also* LAN.

