AESOP network redundancy

How to setup a full redundant AESOP network

1 AESOP Basics

The AESOP standard can transport a single bidirectional ethernet 100 Mbps control data stream and two separate AES3 digital audio monodirectional streams using one Cat 5 cable. Every K Series amplifier with the optional KAESOP board installed has at least two RJ-45 connectors, these are AESOP ports capable of sending and/or receiving data and audio. If the amplifier has only two RJ-45 plugs, they will be on the front panel. If four plugs are present, the rear two will be "Primary" ports, while the two on the front panel will be "Secondary" ports. Primary ports are capable of carrying data and AES3 streams; secondary ports, on the other hand, are data-only ports, allowing ethernet connections only. Ring, daisy chain and a variety of network topologies are available using the dual port design implemented in all K Series amplifiers.

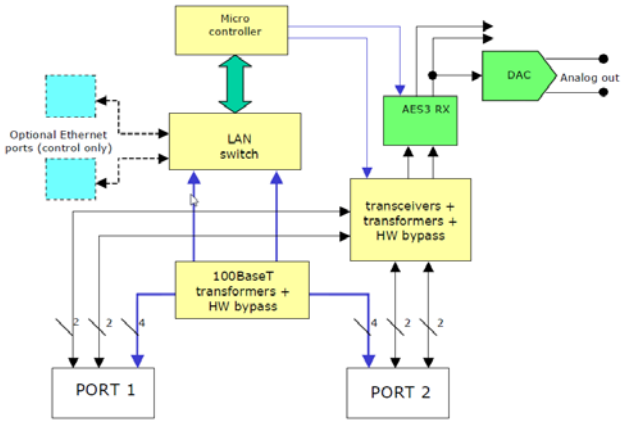

FIGURE 1: KAESOP audio/data distribution principles

1.1 Data stream

The data stream in the AESOP is implemented by an auto-sensing 100 Mbit Ethernet connectivity. A built in fault-bypass feature takes into account the possibility of losing an intermediate device or having a faulty cable link without compromising the ring integrity. Each device can use a static IP address assigned by the user, alternatively, it can be set automatically without the user intervention following the Zeroconf protocol. The KAESOP board detects bad quality connections by counting errors on the Ethernet control, faulty connections are automatically switched from 100Mbit/s to 10Mbit/s in order to keep the link active even in the worst case scenarios. Please note that even if crossed Ethernet cables would work control wise, they must NOT be used for KAESOP connections: they don't allow AES3 streams to flow correctly.

1.2 Audio

Audio is distributed to devices via the AESOP protocol by two independent and separate AES3 streams. These are carried by two CAT5 wire pairs unused in the 100 Mbit Ethernet protocol. AES3 is a license-free and well known standard that guarantees low-latency, high reliability and excellent audio quality. A single AES3 stream can carry a stereo audio signal. The AESOP protocol can therefore handle four audio channels.

When a K Series amplifier is powered off or is unavailable, a passive high frequency relay circuit allows the audio signal to pass through, preserving the network chain connection integrity. When the device is powered up, the internal circuits automatically select the most appropriate AES3 stream direction and bypass the relay, re-buffering actively the digital signal. The direction is maintained until errors are detected on the receiving circuit; when failures are detected, the direction is swapped, to build-up a new path for the audio. In a fraction of a second (no more than 50 ms), some of the devices in a ring will swap to the other direction, restoring the audio streaming.

2 Connect Audio

K Series amplifiers allow the user to choose three different input modes (if available): Analog, Digital AES3(2) and KAESOP (2). Each of these inputs can either be processed by the internal DSP or not. The up and down buttons on the "Input select" screen toggle between the available input sources. The "sel" button locks the selected option.

Possible input/signal path configurations are:

- Analog → out (analog input and direct output)
- Analog → DSP → Out (1) (analog input and internal DSP processing, output)
- AES3 → Out (1) and/or (2) (AES3 input, direct output)
- AES3 → DSP → Out (1) and/or (2) (AES3 input, internal DSP processing, output)
- KAESOP → Out (2) (AES3 input, direct output)
- KAESOP → DSP → Out (1)(2) (KAESOP input, internal DSP processing, output)

(1) *Available only with optional DSP board*
(2) *Available only with optional KAESOP board*

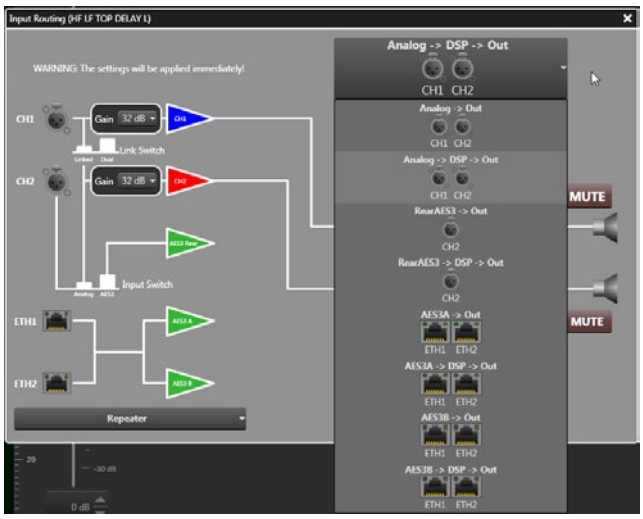

FIGURE 2: Selecting source in Armonìa

1.3 Analog Connection

Input connections are made via the 3-pin XLR-female type or 1/4" phone Jack connectors on the rear side of the amplifier.

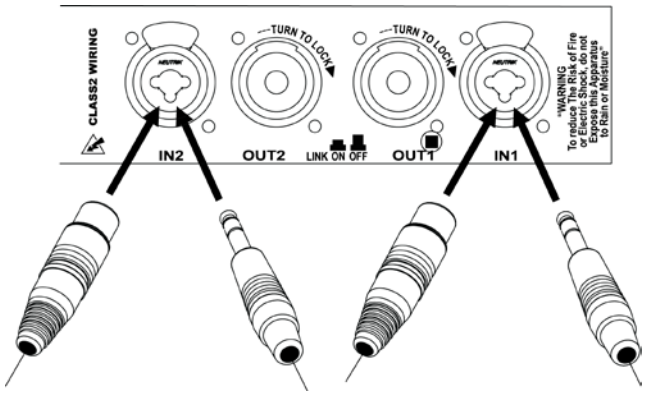

FIGURE 3: Analog input connections

You can use both a balanced or unbalanced connection for the analog inputs but you must consider that unbalanced long lines can introduce noise in the audio system.

The "Link On/Off" switch located in the rear panel is used to parallel the rear input connectors. The remaining input connector can be used to carry signal to other amps.

1.4 AES/EBU Connection

On DSP equipped amplifiers if the AES/EBU - Analog pushbutton is pressed CH 2 is used as an analog input, otherwise it's an AES/EBU input. If the pushbutton is depressed the analog CH 2 OUT will be off.

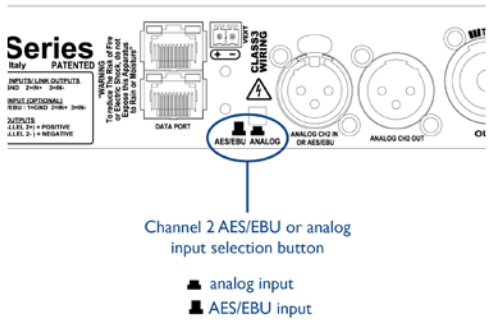

FIGURE 4: AES/EBU - Analog pushbutton detail

1.4.1 AES3 from rear XLR

The primary audio signal for this amplifier configuration is an AES3 signal, fed via the rear panel IN 2 (push button set to "AES/EBU"). The backup analog cable, with an identical analog signal, should be plugged in the IN 1 (analog) plug. The source selection of the amplifier must be set to "Input from CH 1". If the AES3 feed fails the amplifier will automatically fall back to the analog input on CH 1 plug, feeding both outputs with the same backup mono signal. The levels of both primary AES3 and backup analog signals should be carefully matched, this can be done using the "Gain trim" parameter or by adjusting the analog signal level.

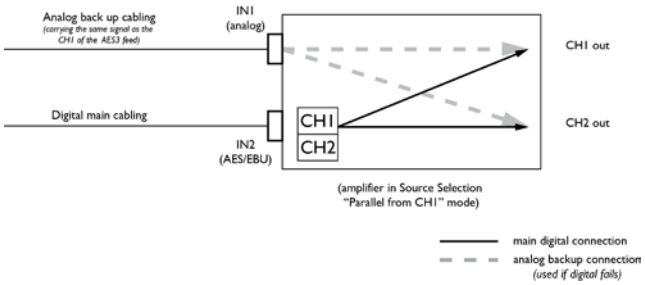

FIGURE 5: Analog back up mode connection: in this example, the amplifier is set to output the AES3 CH 1

1.4.2 AES3 from KASEOP

The primary audio signal for this amplifier configuration is an AES3 signal, feed via an ethernet port. The backup analog cable, with an analog signal identical to the one provided by AES3, must be plugged in the IN 1 and IN 2 (set to analog) plugs. If the AES3 feed fails, the amplifier will automatically fall back to the analog input on the CH1 and CH2 plugs. The signal levels of both primary AES3 and backup analog signals should be carefully matched. This can be done using the Gain trim parameter or by adjusting the analog signal level.

When the AES3 stream is lost and the analog backup kicks in, a message on the front panel is displayed and an alarms are sent to the remote client if one is connected to the amplifier.

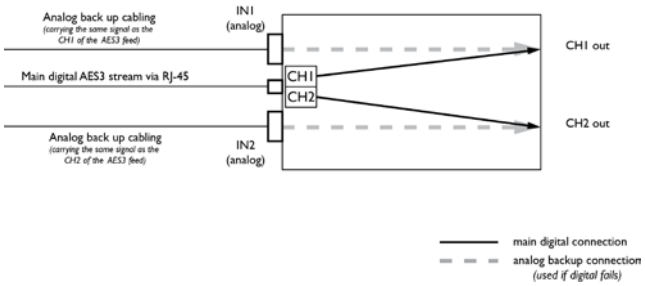

FIGURE 6: Analog back up mode connection: in this example, the amplifier is set to output the AES3 stream in stereo mode

3 Configure Analog BACKUP input

If no link

This menu, as in FIGURE 7(1), controls the behavior of the amplifier when the AES3 signal connection fails or become unreliable. The AES3 connection is considered unreliable when transmission errors are greater than 1% of total data transmitted. The possible options are:

- Mute, when the AES3 connection fails, the amplifier mutes the output.
- Analog, when the AES3 connection fails, the amplifier will rely on the analog input as a backup. This source signal switching is done in real time in order to avoid any glitches in the audio feed. If the input levels are correctly matched between analog input and AES3 input, the switch between AES3 and analog will be inaudible.

The I/O latency, with any media input, is compensated to be the same.

Gain trim (dB)

This menu, shown in FIGURE 7(2), allows the user to set the gain to be applied to the signal coming from the AES3 digital input. Setting a 0 dB gain makes the full-scale digital signal equivalent to an analog input signal of 20 dBu.

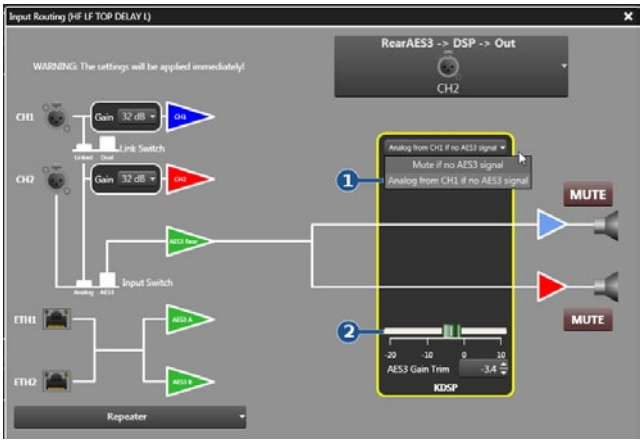

FIGURE 7: (1) Select the analog backup mode (2) Select the trim gain

4 AESOP routing

Each K Series amplifier can be configured to handle the pair of AES3 streams embedded in the AESOP protocol in one of the two basic network modes: repeater and forward. It's very important to understand these two modes thoroughly before attempting to create or modify larger and more complex amplifier networks. The following section will describe these setups in detail.

Definitions of the therms used in this section:

- AES3-A STREAM, AES3-B STREAM: streams from the AESOP CAT5 network. Each stream can carry a stereo audio signal.
- REAR AES3 STREAM: AES stream from the rear panel CH 2 XLR with when the pushbutton is not pressed.
- PORT 1, PORT 2: primary RJ-45 AES3 and control ports (on the rear panel of amplifiers with four RJ-45 ports, on the front panel for amplifiers with only two RJ-45 ports).
- PORT 3, PORT 4: secondary control data-only ports(on the front panel of amplifiers with four RJ-45 ports, not present in amplifiers with only two RJ-45 ports).

1.5 Ethernet internal switch

All control data streams in the KAESOP system are transported via ethernet protocol. Inside all the K Series amplifiers there is an ethernet switch connected to the RJ-45 plugs, this means that the bidirectional data stream can enter/exit one port and exit/enter any other port, either alongside AES3 streams or on its own. Internal routing of Ethernet networking is automatic and not user configurable. The internal switch provides packet flooding block services in order to allow networks with a ring topology.

1.6 KAESOP repeater mode

In the "Repeater" mode any AES3 stream received on port 1 will be repeated on port 2 and vice-versa. This applies to both AES stream A and AES stream B independently. If any of these two streams is present at both RJ45 ports (this can happen when a ring network topology is used), the internal AESOP repeater feeds only one of them, keeping the second stream in standby. If for some reason the first stream fails the second stream is used as a backup audio source.

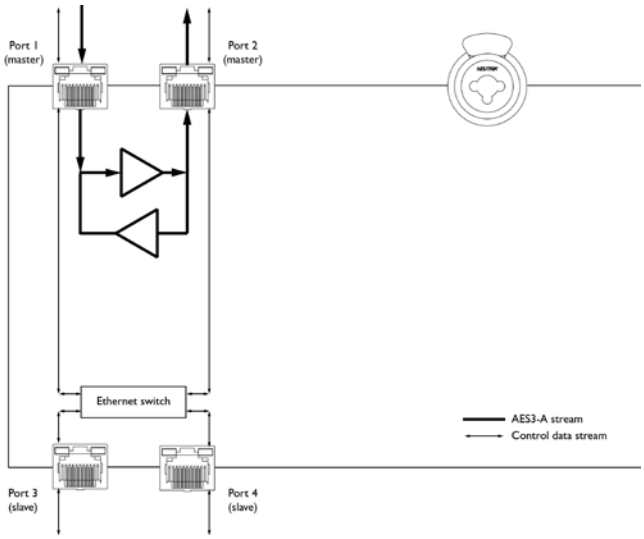

FIGURE 8: This diagram illustrates a simplified internal AES3 and an ethernet data path. The amplifier is set to repeat the AES3-A stream coming from primary port 1 to primary port 2. For consistency, primary ports are placed in the rear of the amp, while secondary ports are at the front. Notice that AES3 streams are monodirectional, while data stream is bidirectional.

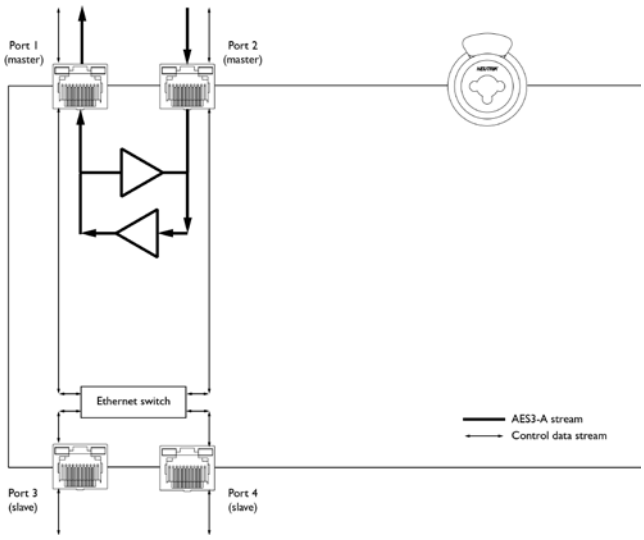

FIGURE 9: This diagram shows the amplifier set to repeat the AES3-A from primary port 2 to primary port 1

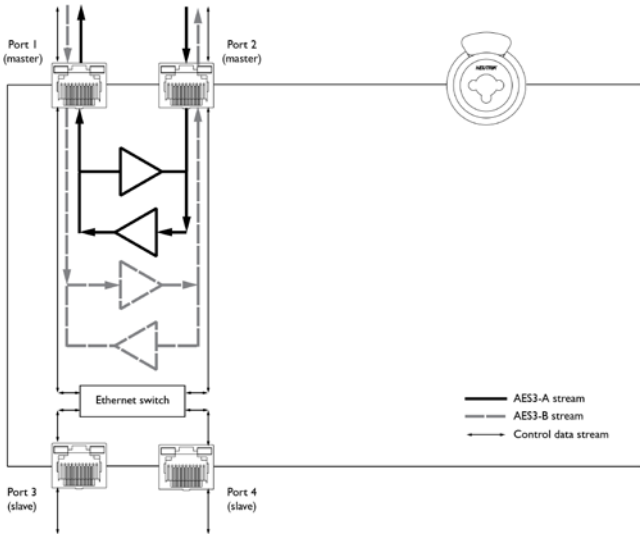

FIGURE 10: This diagram shows both AES3 datapath in repeater mode. In this example, the AES3-A streams enters port 2 and is repeated out of port 1. At the same time, the AES3-B stream is incoming in port 1 and is repeated outwardly via port 2. All possible permutations are not displayed

1.7 KEASOP forward mode

When the amplifier is set to forward mode, the AES3 signal coming in the amplifier from the rear panel XLR connector is forwarded to both primary RJ-45 ports. There are three ways of doing this:

- Forward to AES3-A: the XLR AES input of the amplifier will be routed to the AES stream A on both primary ports. If there is an AES3-B stream coming from either primary ports (1 or 2), this will be repeated on the other primary port. For example, FIGURE 11 shows the "Forward to AES3-A" function when the XLR AES3 stream is sent to the AES3-A with no AES3-B stream is present.

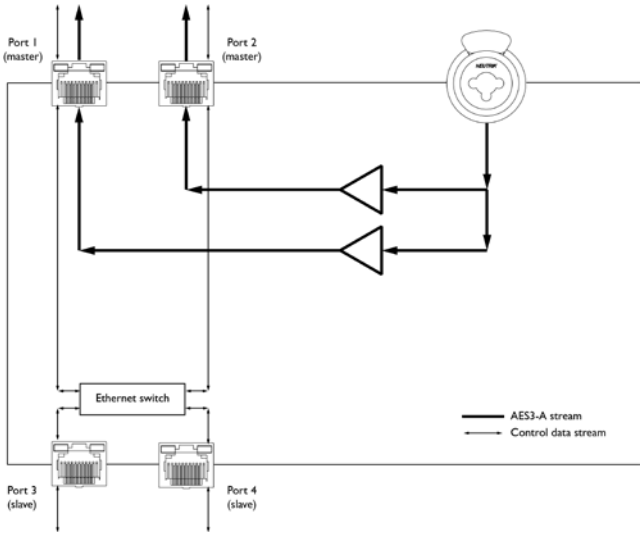

FIGURE 11: Forward to AES3-A signal path. No AES3-B stream present

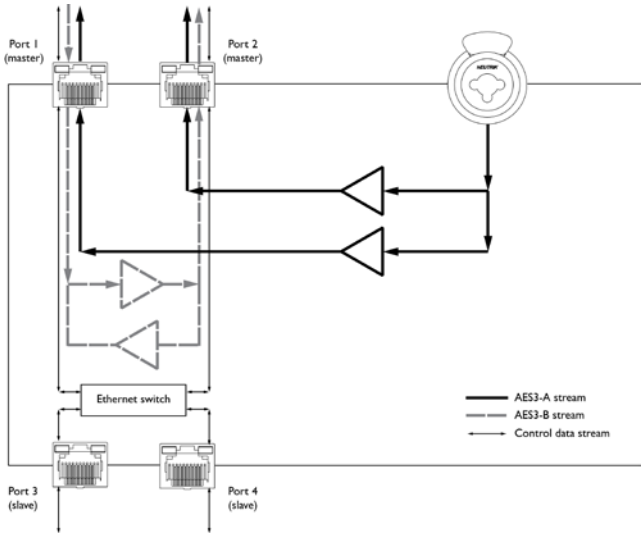

FIGURE 12: Forward to AES3-A signal path and simultaneous AES3-B stream in repeater mode

- Forward to AES3-B: the amplifier behaves just as in the "forward to AES3-A" mode but respect to the AES3-B stream. The AES3 stream coming from the rear panel XLR connector will be routed to the AES3-B stream on both RJ-45 ports 1 and 2. The AES3-A stream, if present will be repeated from/to primary RJ-45 ports 1 and 2.

- Forward to both: the amplifier's rear panel AES input via the XLR connector will be routed to both AES3 stream A and AES3 stream B on the primary ports 1 and 2. Repeater functionality will be disabled.

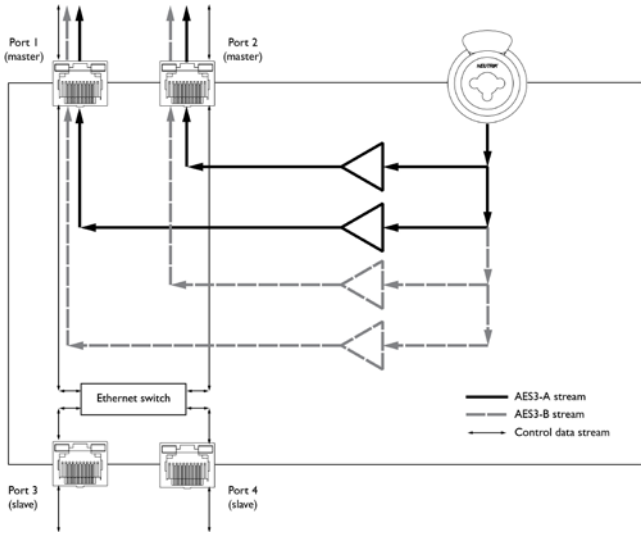

FIGURE 13: AES3 stream coming from the rear XLR stream is routed to both AES3 streams A and B via the primary RJ-45 ports.

IMPORTANT: when an amplifier is set to forward the XLR AES3 signal to either the AES3-A or AES3-B stream, the sole AES3 input signal is the one coming from the XLR connector. The RJ-45 ports cannot, when the amplifier is in forwarding mode on both streams, input an AES3 signal to the amplifier.

1.8 AESOP Routing with Armonia

To feed the AES3 signal from the rear XLR it's necessary to set at least one device in forward mode, two streams slots are available, they are called A or B. The input stream A or B must be selected as a source, the other as router.

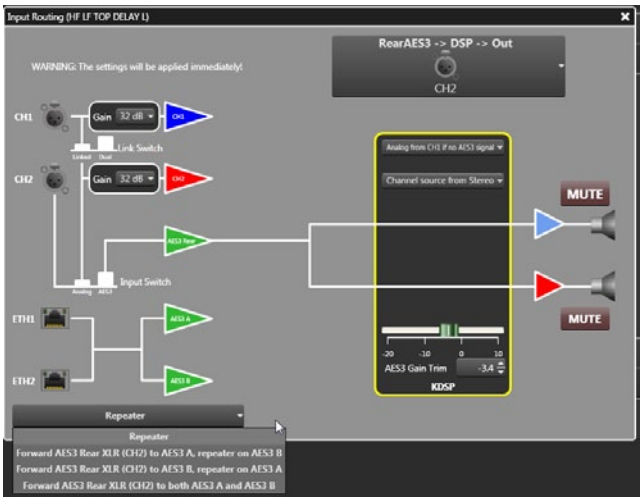

FIGURE 14: Selecting the KAESOP routing

5 Network robustness

K Series amplifiers equipped with a KAESOP board are capable of being connected to each other via a network. Using a single source each amplifier in the network can be, for example, dedicated to providing power audio signal to a given subsection of a large venue. Dealing with amplifiers networks one of the most important aspects to consider, especially if working in a critical application such as large venue sound distribution, is the robustness of the network. Data and audio connections can be made "fault proof": this means that if for some reason an audio or data connection fails, the whole system will not be compromised. The degree of redundancy expresses how many network connections can fail before the sound is interrupted in any part of the system. A "zero degree" redundant system is not robust: if a connection is lost (either from a cable failure or even from an amplifier problem) the whole system goes down. A "one degree" redundant system, on the other hand, will continue to work automatically if one (but no more than one) connection fails. This happens because K Series amplifiers can sense a connection failure and automatically (and almost instantaneously) invert the audio direction allowing the source signal to remain uninterrupted.

The following section illustrates and analyzes some common amplifier networks divided by redundancy degrees.

1.9 Daisy chain

The following diagrams are showing a daisy chain connection of 4 amplifiers.

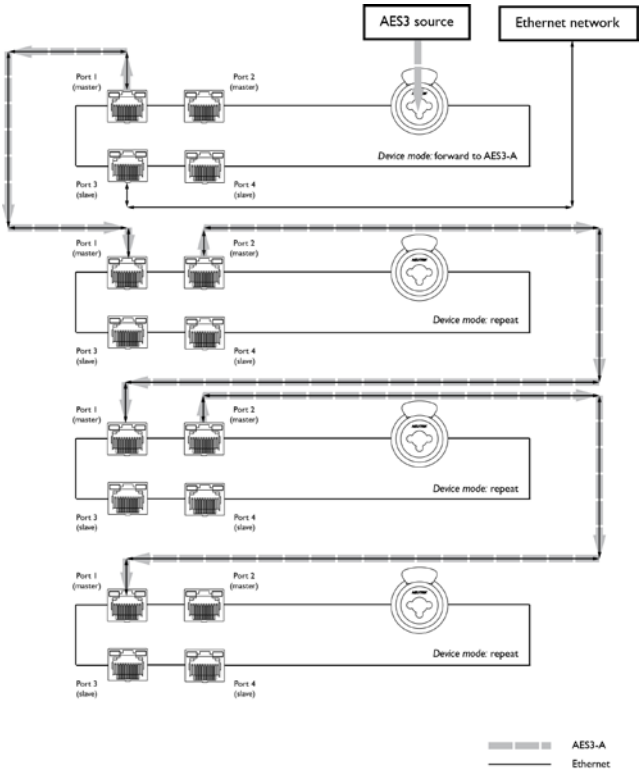

FIGURE 15: Daisy chain connection of four amplifiers with four RJ-45 ports each

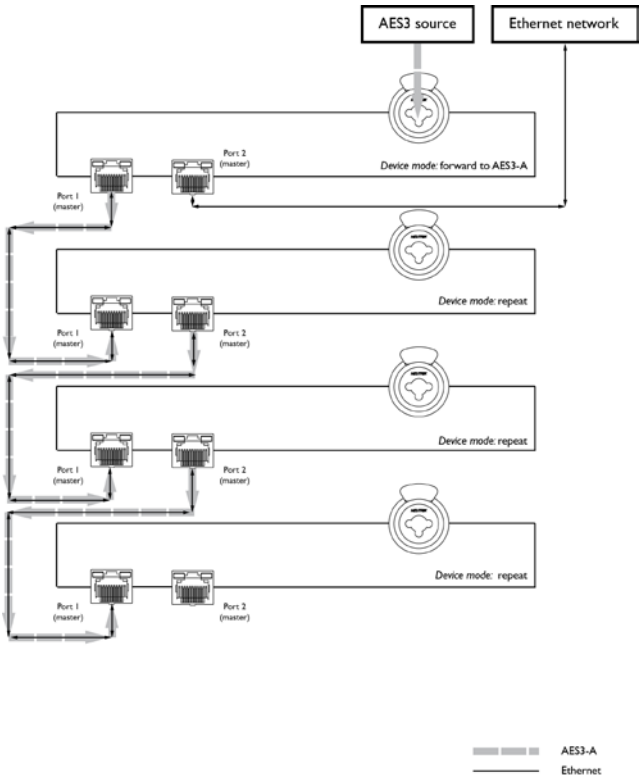

FIGURE 16: Daisy chain connection of four amplifiers with two frontal RJ-45 ports each

The first amplifier in the chain receives the AES3 input from the rear panel XLR connector and then forwards it to the AES3-A (or, alternatively, the AES3-B) stream. In order to do so, the first amplifier mode is set to "forward to AES3-A stream".

The second amplifier in the chain receives the AES3-A stream from the primary port number 1. Set in repeater mode, this amplifier relays the AES3-A signal to the third amplifier in the chain via the RJ-45 port number 2. This setup is repeated until the final amplifier in the chain receives its AES3-A signal. The first connection to the Ethernet network is done via a cat 5 cable inserted in any free RJ-45 port (FIGURE 15 shows port number 3 being used, but ports 2 or 4 could have been used instead. In FIGURE 16 the only free port is the number 2). The control data stream, travelling using the Ethernet standard, goes within the chain alongside the AES3-A stream in a bidirectional manner.

The daisy chain topology is not robust. If any single AES3 or Ethernet cable connection is interrupted, the whole system fails. In the diagram below, if the crossed out connection fails, both amplifiers 3 and 4 would not be able to receive any audio signal. Their connection to the Ethernet network will fail as well.

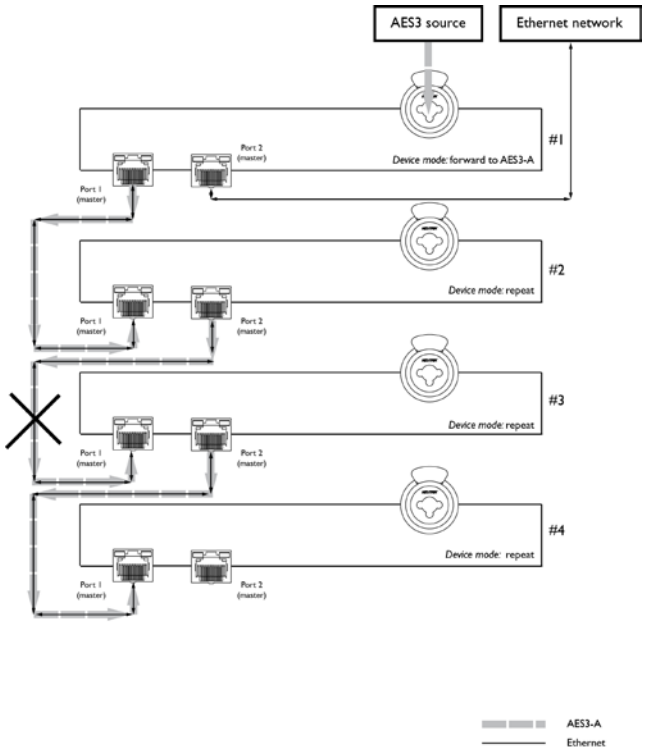

FIGURE 17: Daisy chain connection of four amplifiers with two frontal RJ-45 ports each: case of a connection failure between amps number 2 and 3

1.10 Data robust chain

The data signal robustness can be achieved using an external switch capable of managing two (and more) ethernet streams. The diagram below shows this configuration for amplifiers with two or four RJ-45 plugs.

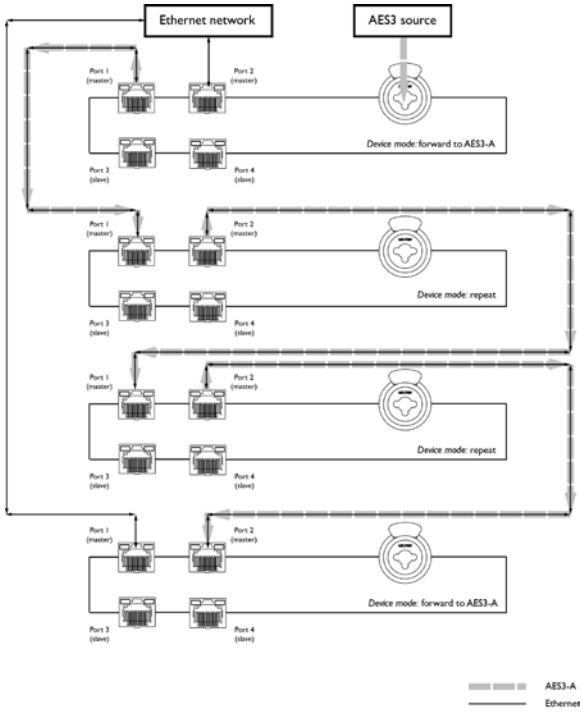

FIGURE 18: Intermediate connection, internally robust respect to the data stream. Four-port-amplifier diagram

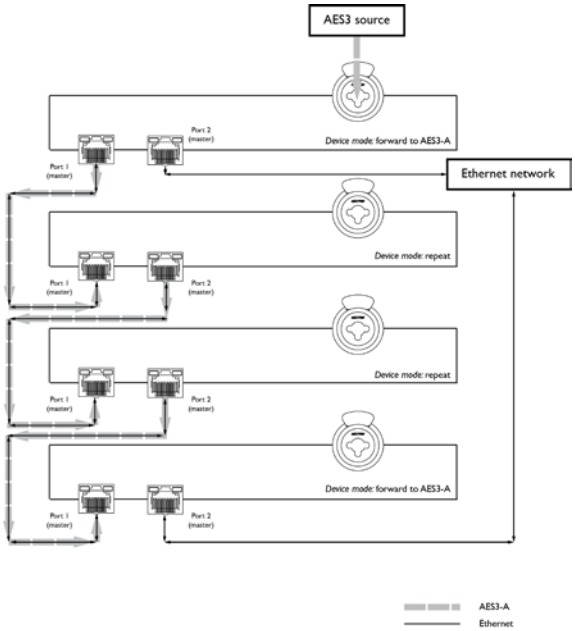

FIGURE 19: Intermediate connection, internally robust respect to the stream. Two-port-amplifier diagram

6 Audio robustness

1.11 Intermediate audio robust chain

A slightly more robust network respect to the audio system is the one illustrated in FIGURE 20. In this connection, two amplifiers, the first and the last one in the network, are set to work in forward mode. The remaining "central amplifiers" are set to work in repeater mode.

The fourth amplifier has the AES3 stream coming from the

XLR connector because it is in forward mode; the AES3-A stream coming from amplifier number 3 via primary port 1 is redundant. The reason for this connection is to improve the robustness of the audio connection of amplifiers 2 and 3.

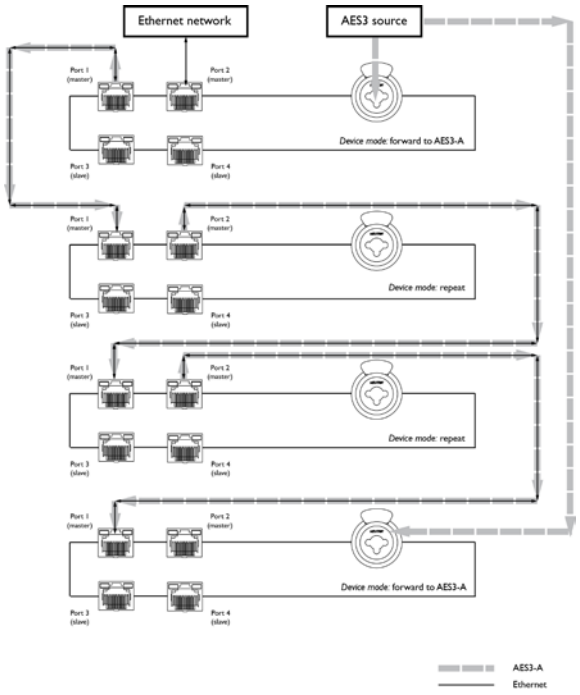

FIGURE 20: Intermediate connection, internally robust with respect to the AES3 stream. Four-port-amplifier diagram

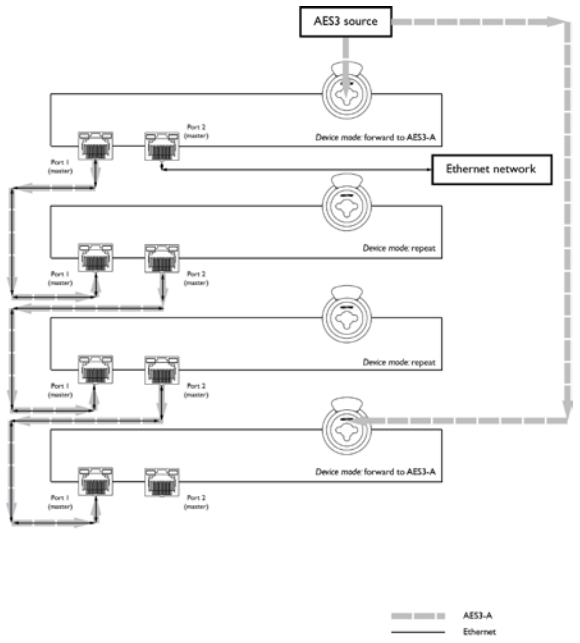

FIGURE 21: Intermediate connection, internally robust with respect to the AES3 stream. Two-port-amplifier diagram

The system's connections could be interrupted in the following ways:

- If the connection between amplifiers 2 and 3 fails, the ethernet network connection will be interrupted (but not the audio stream). As a result of the interruption of the link between amplifier 2 and 3, number 3 would stop receiving an incoming AES3 stream from amplifier number 2; the number 4, however will continue forwarding the AES3 stream to amplifier 3. This means that amplifier 3 automatically senses a backup AES3 feed coming from amplifier 4. The ethernet network, however, would still be compromised.

- If the connection between amplifier number 3 and 4 or 1 and 2 fails, no audio interruption will be heard. Amplifier number 3 receives its AES3 stream from amplifier number 2. The fourth amplifier reproduces sound coming directly from the AES3 source fed in its rear panel XLR connector.

The robustness of this network is guaranteed for AES3 signals only, and for a single cable failure at a time. If two or more connections will fail, one or more amplifiers (depending on where the interruption occurs) will be muted.

1.12 Going to full redundancy

It's finally possible to achieve full redundancy for data and audio signal using a combination of connection illustrated above and by building a physical patch to merge AES3 and 100 Mbit ethernet data into the same cat 5 cable.

The analog backup is assured on both analog inputs by toggling in the right position the AES3 rear button.

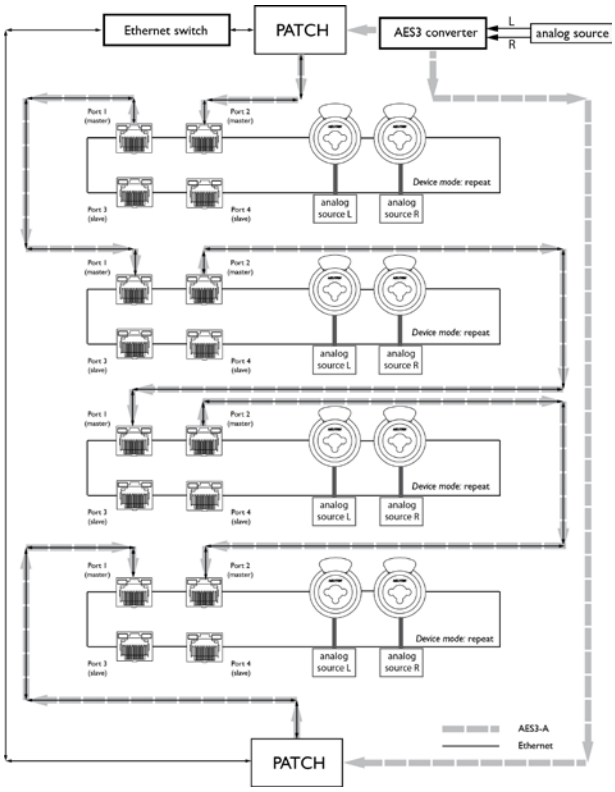

FIGURE 22: AES3 stream (here only the stream A) coming from the patch and routed to all the devices with the output port RJ-45 ports. The same happens for the control data

7 Appendix

7.1 KAESOP RJ 45 plug pinout

This is the pinout for a pair of ports:

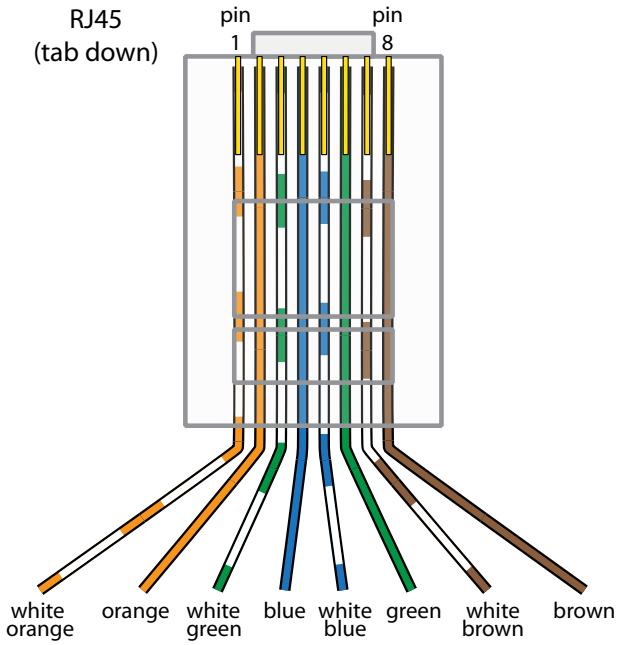

FIGURE 23: RJ-45 jack pinout for KAESOP connections

All RJ-45 jacks on the amplifier are identically wired, following the pinout summarized below:

When a node is powered off, each pin on one port is connected passively to the corresponding pin on the other port in the pair with an insertion loss of less than 2 dB.

	RJ-45		
	Color code (TIA/EIA-568-B)	**Pin**	**RJ-45 KAESOP pinout**
	ORANGE / WHITE	1	100 BaseT AutoMDI RX/TX +
	ORANGE	2	100 BaseT AutoMDI RX/TX -
	GREEN / WHITE	3	100 BaseT AutoMDI RX/TX +
	BLUE	4	AES3-A RX/TX +
	BLUE / WHITE	5	AES3-A RX/TX -
	GREEN	6	100 BaseT AutoMDI RX/TX -
	BROWN / WHITE	7	AES3-B RX/TX +
	BROWN	8	AES3-B RX/TX -

7.2 RJ 45 jack LEDS

Blinking pattern of the two (green and yellow) LEDs on each RJ-45 port can identify which kind of signal is being transmitted or received from the port. A fixed once-on-once off blinking pattern means that the signal passing-through is an AES3-A stream. A once-on-twice off blinking pattern means that the stream is AES3-B.

7.3 Custom Ethernet/AES3 combo box

It is possible to build a custom box to combine the Ethernet signal and AES3 signal/s in a single RJ45 connector. This makes possible to avoid using amplifiers in a network in forwarding mode. That increases system robustness, as an amplifier in forward mode can receive input only from the rear panel XLR; on the other hand, the repeater mode allows the amplifier to reroute its incoming signal automatically from either one of two primary ports.

Following the AESOP standard, the following diagram shows the pin-out of the adapter box.

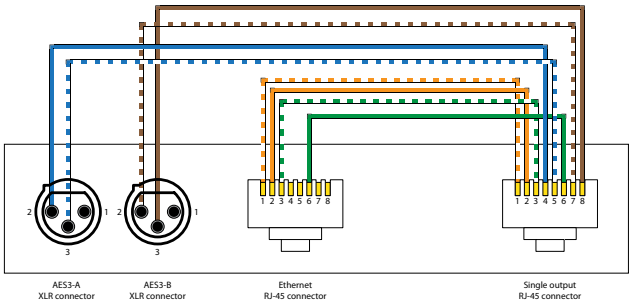

FIGURE 24: Pin out diagram for female connectors in a custom Ethernet - AES3-A/B box

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