

Getting Into Your Head

What You Need to Know About Headphone Amplifiers

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We use headphones more than ever today, enjoying music in the easy chair, working at the computer, or working out at the gym, but for musicians, headphones have been standard studio fare for many years. Headphone listening can be as simple as plugging into a device's headphone jack, but for studio or on-stage monitoring, a dedicated headphone amplifier is usually required. There are many different devices that fall under the name "headphone amplifier." They differ in the number of inputs and outputs, offer controls beyond volume, and find use in different applications. In this article we'll look at a variety of devices that go between an audio source and one or more sets of headphones, look at their similarities and differences, and suggest appropriate applications.

The Many Breeds of Headphone Amplifier

A headphone amplifier's basic job is to drive a set of headphones to an ample listening volume. We've all plugged into the headphone jack on a mixer, recorder, or computer but for the recording studio, stage, or even for armchair listening, you often need more. This article will focus on headphone systems for the studio and its close cousin, on-stage in-ear monitoring, though we'll touch on other roles as well.

I like to think about headphone amplifiers as being in a few different families: Just a plain amplifier, a distribution amplifier, a "more me" amplifier, and a multi-channel remote mixing system.

Many integral headphone jacks can't provide sufficient volume with sufficiently low distortion, however this is easily remedied by a straightforward, no frills amplifier to boost the output level from the headphone jack. Some basic headphone amplifiers are utilitarian, some are expensive audiophile devices which, when used with high quality headphones, make for a joyous listening experience.

Headphones are really old. Early radios had no loudspeakers, only terminals to connect headphones. Broadcasters from the 1930s worked with headphones but 'pones didn't really take a role in music recording until Les Paul started overdubbing in the late 1940s. They became a necessary evil in studios of the 1970s that were build so dead that you couldn't hear other players more than a couple of feet away, and now they're expected as a matter of course to help musicians play better.

Unless you only record one person at a time, you'll want some type of headphone amplifier, which offers more flexibility than a built-in headphone jack. A headphone distribution amplifier is one which has a single (usually stereo) input and jacks for a few sets of headphones, generally with a volume control for each listener.

A "More Me" headphone amplifier has several inputs, several outputs, and offers some mixing functions. Each listener can slightly customize the headphone mix, usually with "more me." At the top of the heap, there's the multi-channel headphone mixing system which puts a mixer within reach of each player, allowing musicians to fully customize what he hears. With this quick overview in mind, let's look at what goes into and comes out of a headphone amplifier.

Gozintas and Gozoutas

Outputs are pretty obvious - conventional 1/4" headphone jacks, though some include mini jacks to accommodate ear buds. The maximum headphone volume is a function not only of the amplifier's rated power output, but of the headphone's impedance and efficiency as well. Most headphone amplifiers are rated at 50 to 200 mW power per channel and provide adequate volume over a wide range of headphone impedance ('phones run from about 15 to 600 ohms). A good headphone amplifier will do that with low distortion, and distortion is the prime contributor to listener fatigue.

Studio headphone amplifiers are usually fed from a line level source such as the stereo main or control room output of a mixer or audio interface. When musicians request a custom headphone mix, auxiliary bus outputs are the usual source. Most of today's pro audio gear interfaces at the nominal +4 dBu operating level, though the output level of a computer's built-in sound card is often lower. Most headphone amplifiers have sufficient gain to accommodate consumer sources, though the drummer may not be happy with his headphone volume when the reference track comes directly from a portable music player.

Stereo or mono headphone mix? That seems obvious – stereo of course, since you have two ears and two earphones – but a mono (the same signal in both ears) headphone mix for tracking was the standard studio setup for 30+ years. A stereo distribution amplifier will provide everyone with the same mix, however when only independent mixes will keep everyone happy, you may not have enough outputs available to feed everyone in stereo. This is a hardware limitation that you must consider when planning your studio or stage setup.

Few small format analog mixers offer stereo auxiliary buses though you can cobble up a stereo headphone mix using two (mono) auxiliary sends for left and right 'phones. By sending a channel to two buses, you can adjust the panning by juggling the left and bus send levels – possible but not convenient. On the other

hand, today's digital consoles are a different story. Since their internal signal routing and control functions are derived through software, the ability to link a pair of buses for stereo operation is a fairly common feature. For example, with Aux 1 and 2 buses "linked," for a given channel, Aux 1 Send becomes the stereo auxiliary mix level while Aux 2 Send pans the channel signal between Aux Outputs 1 and 2.

Count your chickens before you hatch a new headphone system! A mixer with six auxiliary buses, when linked in pairs, will give you only three stereo headphone feeds. A previously adequate mixer may become instantly obsolete when band members show up with their own headphones and want their own mixes. And don't forget to count outboard signal processors – they usually get their inputs from auxiliary sends as well.

DAWs are usually capable of creating as many stereo or mono mixes as you want, but how many you can use for monitor outputs is limited by the number of independent hardware outputs your interface has. An 8-output interface will allow you to have four independent stereo mixes (of which one might be for the control room) though an interface with only one stereo output means everyone must share one mix. Know, too, how your interface counts its outputs, particularly if you're still in the shopping phase. A brochure might tout separate headphone, control room, and auxiliary output jacks, perhaps with individual volume controls, but if they're all fed from the same D/A converter, they all carry the same mix.

Let's have a look at some representative types of headphone amplifiers and how they might best be used. This isn't a review or recommendation, but the models mentioned here are representative of the various configurations you might encounter in a search to meet your needs.

The Headphone Distribution Amplifier

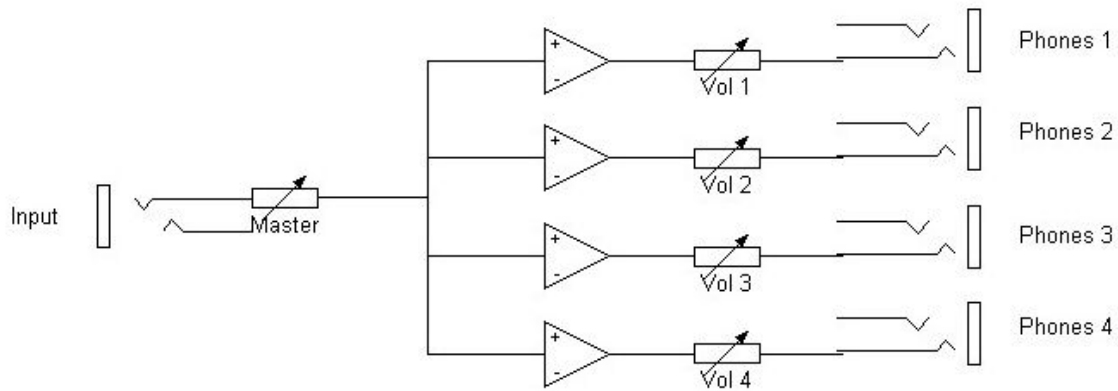


The PreSonus HP4 is typical of the basic stereo headphone distribution amplifier. Left and right input jacks branch out to four independent

amplifiers and on to individual headphone jacks, each with its own volume control. This is about as uncomplicated as headphone amplifiers get and is also the least expensive.

With a basic distribution amplifier, everyone hears the same mix, though each player can control his own headphone volume. Acoustic bands generally are comfortable playing to a well balanced mix, so a distribution amplifier would be a

good choice if that's your style of music. Of course when it comes to individual players doing overdubs, you can send the player whatever mix he wants to hear with no squabbling about "the bass is too loud." Here's a simplified block diagram of a four channel distribution amplifier:

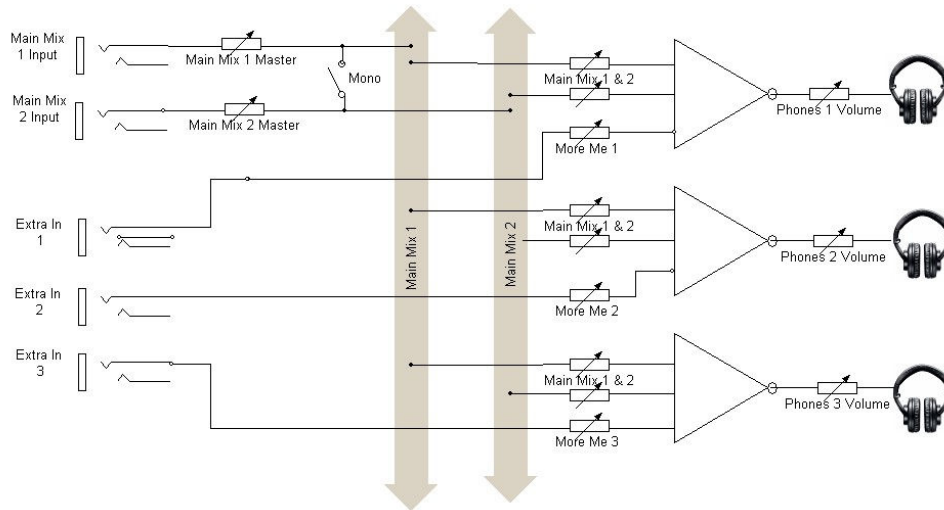


When shopping, you'll find a few variations and additions. The PreSonus HP4 pictured here has a Mono button which sends a mono input to both the left and right headphones. In addition, there's a "thru" output to send the input on to another headphone amplifier for expansion for when everyone in the choir wants a headset. Other differences are generally related to how the inputs are physically configured. For example, you might find a single stereo input jack rather than separate left and right jacks. This is convenient for distributing the headphone output of a mixer to several listeners, but requires a special cable (an "insert" cable will work) to connect it to separate left and right output jacks. You might find a second set of inputs so the musicians in the studio can listen to a custom mix while recording and, after a take, hear an evenly balanced mix. While all distribution amplifiers have analog line level inputs, some also have an S/PDIF digital input, and some have mini output jacks duplicating the standard 1/4" jacks.

The Stereo Mix Plus ("More Me") Headphone Amplifier

Here's where things get interesting, and why I thought this article needed to be written. There are a few different ways in which inputs are mixed in this type of headphone amplifier, and it's necessary to dig into the specifications and descriptions, sort out the differences and similarities, and decide which one best suits your needs. A block diagram is your best friend here, but when doing research for this article, I found that block diagrams of headphone amplifiers are scarce. Most manuals are available on line from the manufacturer's web site, but few include a block diagram, and detailed product reviews are rare. Study the manual, but often the best way to see learn a particular unit can do is with a hands-on trial.

Generally, with this type of headphone amplifier, the headphone mix begins with a stereo mix which is sent to all of the headphone jacks, just like with the simple distribution amplifier. Each output has a volume control, but wait! There's more! And that's where the differences between headphone amplifiers arise. Here's a representative block diagram of a headphone amplifier similar to the PreSonus HP60. While HP60 is a six channel amplifier (four or six outputs seem to be most common) only three channels are shown here for clarity.



The HP60 has inputs for two global (goes to all headphone outputs) stereo mixes, with either or both mixes available to each of the headphone channels. A balance ("Mix") control for each headphone channel adjusts the blend of the two global inputs or, when fully counterclockwise or clockwise, selects one input by itself. One source might be a dry mix with the other being the output of a reverb applied to that mix. With that setup, the listener can, at his option, hear some reverb in his phones. One input could be a mix without vocals and the other a vocals-only mix so the listener can adjust the vocal level in his headphones. Another possibility for the two sources is a basic mix and a click. There's a lot of flexibility here if you're creative.

In addition to those two global inputs, each headphone channel has a third input which is unique to that channel. This could be for "more me" or even a full custom mix for that player. A Mute button turns off the global mixes so they won't

get in the way of a custom mix, and a Mono button splits a mono external input source to both the left and right earphones.

Around back you'll find the input jacks.



The Left and Right jacks for each of the two global mixes are normalled; with nothing plugged into the Right jack, whatever is connected to the Left jack is automatically routed to both the left and right channels. This makes it easy to accommodate a mono source like a click track or a single instrument. A special feature of the HP60 is the Talkback mic input. When the amplifier is mounted in a rack in the control room, a front panel button connects the Talkback mic to all headphone outputs. A rear panel jack duplicates the Talkback switch for the engineer in the control room when the HP60 is located out in the studio with the musicians. The Stereo Output of each headphone channel is a line level copy of that channel's mix which can be used to feed an additional headphone amplifier to provide that mix to additional listeners.

While this article isn't intended to be a shootout, let's take a look at how a couple of other popular manufacturers approach the design of a multi-input multi-channel headphone amplifier. We don't all do the same things, so there are some differences between headphone amplifiers that may make one device more appropriate than others for your particular application or workflow.

The popular Behringer HA4700 and HA8000 share the same manual, but there are significant differences lurking between their inputs and outputs. Both begin with the "one input to all outputs" concept. The HA4700 has one main global stereo input plus a second stereo input labeled "Direct" which is mixed with the main input. This is where you might put the click when recording basic tracks. Its cousin, the HA8000, has two sets of global inputs like the PreSonus HP60, but for each headphone output, rather than a blend control between the two mixes, each channel has a switch to select Main mix 1 or 2. In addition, the HA8000 has one Direct input jack (same name, different function!) for each headphone channel which, when connected, *replaces* (rather than adds to) the selected Main input.

The HA4700 has an Auxiliary stereo input for each channel with a Mix knob which does double duty. It adjusts the left/right balance of the Main Input when there's nothing connected to the Auxiliary input. When a plug is inserted into the Auxiliary jack, the Mix knob adjusts the Main/Auxiliary balance. The HA4700 has a global Direct input (there's that "Direct" word again!) which *replaces* the global

main input for all headphone channels. The HA4700 has bass and treble controls for each headphone output. The HA8000 has a Mono button to combine left and right inputs of the channel's Direct input to both headphones. The HA4700 can do the same trick but offers a bit more flexibility in that in addition to the stereo mix, you can listen to only the left or only the right channel in both phones. Essentially this gives you a second global input if your players don't mind a mono headphone mix (and some actually prefer it).

Since each headphone channel of the HA8000 can be fed from either the Main or Direct input, you can set up a combination of global (one-to-several) and custom (one-to-one) headphone mixes. The HA4700, on the other hand, can function as a "more me" headphone amplifier by adding a channel's Auxiliary input to the Main mix. You'll need to be creative to find "me" sources – direct outputs, auxiliary outputs, or subgroup buses are usually good places to look.

Another pair of kissin' kin "more me" headphone amplifiers is the ART HeadAmp 6 and HeadAmp 6 Pro. These are more similar to the Behringer amplifiers than the PreSonus, but there are subtle differences. Both ARTs have a master Direct input jack which overrides the signal from the Main inputs. Like The HA4700, both have an Auxiliary input and Mix knob for each channel but Behringer and ART manage mono/stereo differently.

ART's approach is to provide a left, right, and stereo switch for each headphone output which puts the entire headphone mix (main + auxiliary) into mono. If you want a stereo headphone mix with the Auxiliary input centered, you'll need to either send the same signal to both the left and right Auxiliary input (it's on a single TRS jack) or jump the tip and ring terminals together at the plug going into the Auxiliary Input jack. But in trade, you can feed one mono mix to the left input, a different mono mix to the right input, and the listener can put his phones in mono and select between the two mixes.

It's worth noting that most auxiliary and direct outputs, even when balanced, are single ended. This is fine for feeding a stereo input as long as you can route the signal to both ears. But if you have a real symmetrical output (transformer or electronically balanced) you *don't* want to feed the high and low sides of the output to tip and ring of a stereo input. That will put the input source 180 degrees out of phase in the left and right ears. This sounds very weird and is undesirable. Use just one side (tip or Pin 2) of the symmetrical balanced output instead.

Are you beginning to get the idea that there's more to a headphone amplifier than the number of headphones you can connect to it? Good!

Go Mix Yourself! – Personal Monitoring Systems

The holy grail of headphone systems, at least it seems that way on first look, is one that allows each listener to create his own headphone mix without stepping away from his mic stand or bugging the engineer or other band members. While the concept of sending several channels of audio out to individual monitor mixing stations isn't new (the Oz Audio Q-Mix from the mid 1990s and resurrected for a short time by Mackie was one of the few early commercial products of this nature) digital technology has made these system more practical and less costly. When talking about personal monitoring today, Aviom and Hear Back Technologies are the names that usually come to mind first, because they were first on the scene with practical products, but several other several manufacturers have entered the game within the past couple of years.

On the surface, this seems like a fabulous concept, and in many cases, it is. While it frees you, the engineer, from dealing with seemingly endless requests for changes to various headphone mixes, the musicians need to learn the basic concepts of mixing so they don't dig themselves into a hole, ending up with a less than satisfactory mix and not wanting to show their innocence by asking for help.

There are two major components to such a system - an interface, or base station, to which the audio sources for the headphone mixes are connected, and the remote stations that have the mixing controls and headphone jack. The interface converts the incoming audio to a digital format and sends it out to the remote mix/headphone stations, usually over Cat5 Ethernet cable. The system is configured much like computer network, using an Ethernet hub or switch to distribute audio to the mix stations. Depending on the architecture of the particular system, the actual mixing can either take place in the box at the listener's position, or in the base station, with the remote box acting as a control surface.

The base station gets its inputs from a mixing console or a DAW equipped with a multichannel computer audio interface. Typical sources are direct outputs from the mic preamps, stereo subgroup mixes (stems), and dedicated sound sources such as a metronome, drum machine, or prerecorded backing tracks. Some remote mixing boxes have an input for the player's mic or instrument (or both) which serves as the "more me" source. Headphone mixes, particularly with in-ear phones, can be pretty dry, so some of these systems include a reverb processor as part of the mixing suite. Lacking that feature, you might include an ambient mic which can be added to the musicians' mix, or provide an overall reverb as one of the monitor mix channels.

Because the controls at the mix station are operated by musicians who aren't necessarily engineers or computer technicians, the user interface is usually quite straightforward. Each input source has a volume and pan control though some go beyond that and offer EQ either on the overall mix or on individual channels. The Movek myMix, perhaps the most fully featured (and, in my opinion, the geekiest) of all of the multichannel personal monitor systems, puts all of the controls in a tiny hand-held box with a big knob, a touch screen, a few buttons and the headphone jack. Mostly, though, form follows function and at the player's end, there will be at least one knob for each channel, possibly switchable between level, pan, and other channel-strip-like functions.

A personal headphone monitoring system is an elegant solution for the self-contained performing band that uses the same setup for each performance and wants to use in-ear monitors. In the studio, however, where setups can change daily (unless it's your studio and you only record your own music) setting up the headphone system for a session, patching inputs, and making labels for the control boxes so the musicians know which knob controls what can be quite time consuming. Flexibility has its price.

The iGadget Revolution

Many of today's digital mixing consoles offer as many as a dozen auxiliary outputs which can be configured as stereo buses for headphone mixes. While time consuming, it's straightforward on a console such as the PreSonus StudioLive to set up six individual stereo headphone mixes. But recently, console manufacturers have developed ways to turn a mobile device, such as Apple's iPad running a custom application, into a remote controller for the console. Take the tablet out to where the players are and you can tweak headphone mixes on the spot.

The next step, which came along pretty quickly once the "remote mixing" concept took off, was an iPhone app (every musician, it seems, has an iPhone) allowing band members to "log in" and adjust their own monitor mix. While this was first conceived for live sound applications, it's also well suited to the studio. Since many remote-controllable consoles also serve as a DAW audio interface, recorded tracks are available for playback through the console at the touch of a button, taking the same route to the headphones as when the track was recorded. In addition, nearly all digital consoles allow you to save a snapshot of all the settings, so it's easy to recall the headphone mix from the previous session when it's overdub time.

Setting up such a system requires some knowledge of computer networking as well as a thorough understanding of how to set up permissions so the drummer doesn't accidentally boost the snare in the lead singer's headphones. Typically there's an outboard computer involved which is connected to the console and

provides the remote control functions. The computer connects to a WiFi router which provides a communication link to the remote mobile devices. The mobile devices control the computer software, which in turn controls the console.

Many bands are jumping onto this concept since it became affordable. With equipment costs being spread among band members (typically they buy their own 'phones and iGizmo), the band's investment is limited to the console, computer, and router. There's a risk of obsolescence, though, since the console maker must constantly update his remote software to support the rapidly changing world of tablets, phones, computers, and operating systems, and eventually someone will get left behind. Such is the cost of progress.

The Hi Fi Headphone Amplifier

To bring us back to where we started, there are single input/output headphone amplifiers that are designed to provide plenty of volume at very low distortion to a single pair of headphones. This family includes straightforward high quality stereo amplifiers, tube amplifiers for the audiophiles, and some incorporate a D/A converter to go straight from a digital source to the 'phones. And interesting variant is the Focusrite VRM box which, in addition to being a decent headphone amplifier driven from a USB port, offers simulation of a variety of listening environments for checking a mix using headphones. The SPL Phonitor mastering amplifier goes well beyond sending the left input to the left ear and right input to the right ear, incorporating DSP modeling of the loudspeaker listening environment with adjustments for cross-blending of the two channels to simulate the placement of the speakers relative to the listener. Of course you'll need some very fine headphones to get the most value from its \$2,000 cost, not something you'd use on stage or in the studio, but perhaps in the mastering lab.

Sit Back and Listen

So there you have it, a short overview of the various things that we call a "headphone amp." You can see that there are many variations and each has its best and not so best applications. Knowing what to look for can save you from puzzling over "How the heck can I do this?" too often. Choose the right type for your job and you'll monitor happily.