FRIED REIM

HEADPHONE AMPLIFIER COOKBOOK

FRIED REIM

Sound pioneer and author of this book

With his innovative developments and his in-depth expertise, Fried Reim has left a lasting mark on the world of professional audio technology and in particular on headphone amplifier technology, setting standards in sound quality and precision.

As the founder of Lake People, he has worked with passion and technical finesse since 1986 to fulfill the highest demands for sound fidelity and reliability, which he brought to the market with the first dedicated headphone amplifier Phone-Amp V6.

His vision then as now: to develop audio devices that are not only technically convincing, but also create an emotional connection to the music. Thanks to his dedication, vision and innovation, the company has continued to develop, introducing new technologies and expanding its portfolio with the Violectric and Niimbus brands.

Today, Lake People products are highly regarded by sound engineers, producers and audiophiles around the world. The philosophy of Fried Reim and Lake People is based on authenticity, purity and precision of sound—values that are reflected in every single product.

In this book, he provides insights into his decades of experience in audio technology, describes technical developments with passion for music and sound design and explains the subtle nuances of perfect sound.

The second, revised edition of the Headphone Amplifier Cookbook is not only a technical treatise, but also a source of inspiration for sound enthusiasts who are interested in the art of perfect audio reproduction.

FRIED REIM

THE HEADPHONE AMPLIFIER COOKBOOK

Or: Why headphone amplifiers at all?

LAKE PEOPLE AUDIO


PREMIUM
BALANCED
HEADPHONE
AMPLIFIER
VOLUME
BALANCE
1 - XLR
2 - RCA
3 - RCA
PHONES
OUT
LINE
OUT
STATUS

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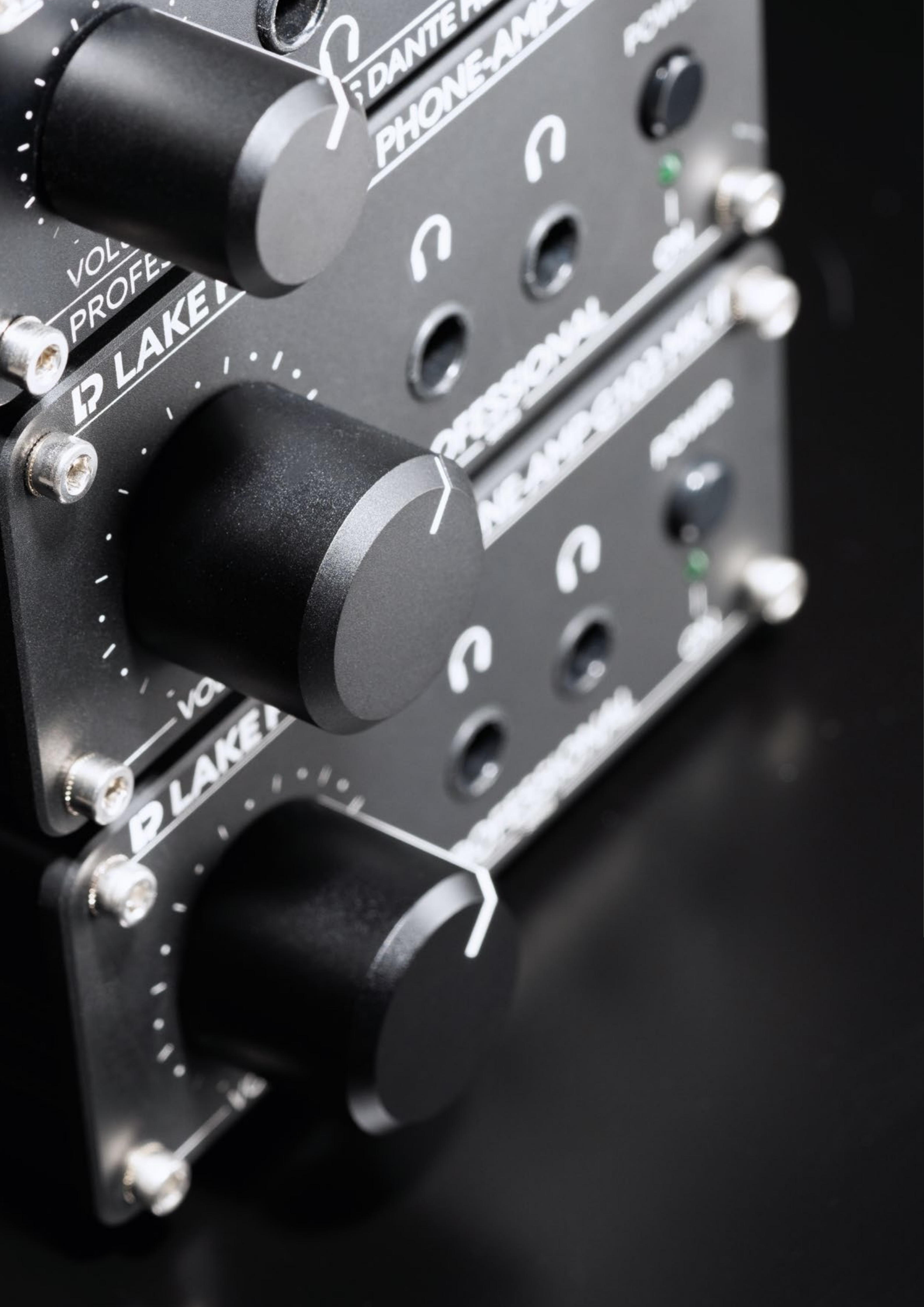
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#01
WHY HEADPHONE AMPLIFIERS AT ALL?

Headphones place entirely different demands on an amplifier and cover a significantly wider impedance range than speakers.

To meet the critical parameters of impedance and sensitivity, a powerful headphone amplifier is required.

INTRODUCTION

Isn't it true that headphones are just small speakers and therefore only need—if anything—small amplifiers?

While a speaker amplifier typically deals with just two impedances, namely 4 and 8 ohms, the range for headphones is significantly wider, from 8 to 600 ohms, with some outliers above and below. Additionally, both speaker and headphone amplifiers must deliver considerable power to accommodate the varying efficiencies of transducers.

A headphone amplifier is a device designed to condition an audio signal to match the specific characteristics of a headphone. At first glance, this doesn't sound particularly groundbreaking and can often be achieved with minimal effort. However, as with most things, the devil is in the details, and a certain level of effort is required to create **an amplifier suitable for all headphones**.

Conditioning also means that the headphone amplifier doesn't necessarily have to amplify the signal; in some cases, it even attenuates it. In such cases, its role is that of an impedance converter: it must provide the signal with as low an impedance as possible.

It's true that many headphones require only a few milliwatts for "satisfactory" operation. However, headphones themselves are highly variable. Two key parameters come into play here: impedance and sensitivity/efficiency.

Generally, headphones with high impedance are less sensitive than those with low impedance, which are typically more sensitive. This isn't always the case, but it holds true most of the time.

Headphone sensitivity is usually specified in decibel [dB] (sound pressure level) per milliwatt [mW]. The extremes are, for example, the AKG K1000 at 74 dB/mW on one end and the Sennheiser HD 25 at 108 dB/mW on the other. This means it takes over 250 times more power to bring the K1000 to the same sound pressure level as the HD 25. Additionally, since $P = U^2/R$, high-impedance headphones often require a lot of voltage to get truly loud—meaning you need an amplifier that operates with a high internal voltage.

For high-impedance headphones in particular, a "small" amplifier simply won't suffice. But the power requirements for low-impedance headphones shouldn't be underestimated either. Furthermore, other technical details must be considered, which will be discussed in more detail later.

The G108: precision headphone amplifier for professional studio work

FUNDAMENTAL QUALITIES

When designing a headphone amplifier, several fundamental considerations have proven essential. One of these is variable gain, referred to as "PRE-GAIN" at Lake People and Violectric. This "pre-amplification" allows different headphones—from sensitive in-ears to high-impedance over-ears—to be connected to the same amplifier without compromising sound quality.

Other critical factors include voltage, power, and the damping factor. A high operating voltage optimizes the reproduction of fast transients, especially with high-impedance headphones. It also enhances the dynamics and headroom (the reserves for distortion-free signal peaks) of the amplifier, resulting in more precise and detailed playback.

Adequate reserves in voltage and power extend the lifespan of the headphones by preventing distortion and overload. The damping factor significantly contributes to the linearity of the reproduction.

#01.1 WHY VARIABLE GAIN MAKES SENSE: PRE-GAIN

Variable gain, known as PRE-GAIN at Lake People and Violectric, serves to reduce amplifier noise and minimize unavoidable inaccuracies between the left and right channels in mechanical volume controls.

Since headphone transducers are very close to the ear, the amplifier's inherent noise is often audible, and with so-called IEMs (In-Ear Monitors), it can even be extremely disruptive. The same applies to speakers, though this is usually only noticeable when standing close to the tweeters.

The static noise of an amplifier is always present due to physical reasons, and its level depends directly on the base gain of the (output) amplifier—and, of course, on the care taken in circuit design. Unfortunately, high gain—and thus avoidably high noise—promotes stable amplifier operation. Lower gain increases the tendency to oscillate (the system's inclination to wobble or tremble uncontrollably) and requires greater technical effort to prevent.

Because they are easier to produce, many headphone amplifiers on the market have unnecessarily high gain of around 10–20 decibels (a factor of 3–10). High gain isn't necessary for sensitive headphones, but a high-impedance (somewhat less sensitive) headphone may require it. To achieve the lowest noise on one hand and the possibility of high gain on the other, a variable gain adjustment before an output stage with the lowest possible gain factor is desirable—this feature is what we call **PRE-GAIN**. At our company, PRE-GAIN is typically adjustable in at least five steps, covering a range of -18 to +24 decibels.

Here are two extreme examples, with the fixed factor being a headphone amplifier with 6 decibels (2x) gain in the output stage:

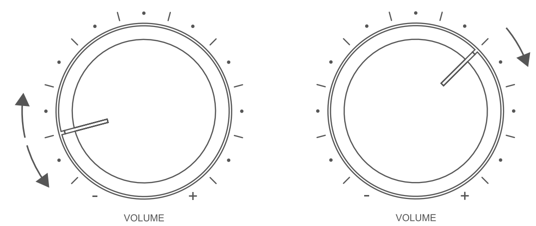
1st Example

The (pre-)amplifier delivers 4 volts, but the headphone only needs 2 volts to produce 100 decibels of sound pressure. With the volume control fully open, the headphone amplifier at 6 decibels gain would deliver 8 volts, meaning the volume control must be used cautiously to avoid hearing damage. Additionally, loud input noise should be avoided, as it would be amplified mercilessly. With PRE-GAIN, the input level can be reduced by 12 decibels (1/4), turning 4 volts into 1 volt. This 1 volt is then amplified 2x, resulting in 2 volts—allowing the volume control to be turned up safely.

2nd Example

The (pre-)amplifier delivers 1 volt, but the headphone needs 10 volts to produce 100 decibels of sound pressure. With the volume control fully open, the headphone amplifier at 6 decibels gain would deliver 2 volts—far too little for the headphone.

With PRE-GAIN, the input level can be increased by 12 decibels (4x), turning 1 volt into 4 volts. This is then amplified 2x, resulting in 10 volts—exactly right for the headphone.



Another reason for PRE-GAIN is the ever-present level mismatch between left and right channels, which EVERY mechanical volume control exhibits due to its design. A potentiometer always has a deviation between the left and right channels, which is smaller the higher the quality of the potentiometer.

Unfortunately, this level mismatch increases toward the left stop—meaning when adjusting to very low volumes, the left and right channels tend to diverge more. With PRE-GAIN, the control range can be shifted to the more precise middle range of the potentiometer, minimizing channel deviation.

While in the middle position (12 o'clock), the level mismatch in Violectric devices must not exceed an imperceptible 0.3 decibel, with lower-quality potentiometers in the 8 o'clock position, it can already exceed a clearly noticeable 3 decibels.

With PRE-GAIN, the headphone amplifier's gain can be adjusted so that the volume control for "normal" listening is always to the right of 12 o'clock, thereby minimizing the natural level mismatch.

#01.2 WHY A HIGH INTERNAL OPERATING VOLTAGE IS IMPORTANT

The higher the impedance of a headphone, the more voltage it requires to accurately reproduce fast transients. Additionally, a high internal operating voltage helps protect the headphones.

While a headphone doesn't require much power, the formula $P = U^2/R$ shows that, for a given (load) resistance of the transducer, voltage contributes quadratically to power. Thus, the higher the impedance of a headphone, the more voltage it needs. This is only partially related to the absolute achievable volume: music relies on fast transients[1], which place high demands on transmission technology.

A fast impulse can easily push a standard amplifier with ±15 volts or less operating voltage to its limit. Lake People and Violectric devices typically have an internal operating voltage of ±25 to ±30 volts. This significantly increases headroom and ensures that the headphone operates in the linear, distortion-free range even at high volumes. This benefits the lifespan of expensive headphones.

However, high operating voltages can lead to high currents in the event of a short circuit or other anomalies, which could damage the amplifier or power supply. This must be taken into account and can be mitigated through current-limiting circuits in various parts of the amplifier.

A good design will ensure that the low output impedance of the amplifier is not compromised (see below on the damping factor).

Why high power is important

Adequately sized power reserves in the amplifier protect the headphone and extend its lifespan.

Admittedly, the power output of a headphone amplifier doesn't need to be exceptionally high compared to a speaker amplifier. However, for low-impedance and/or low-efficiency headphones, at least 1,000 milliwatts at 50 to 100 ohms load impedance should be available.

As with high operating voltages for high-impedance headphones, the goal is to provide a clean and distortion-free signal under all operating conditions. This benefits the lifespan of expensive headphones.

[1] "Transients" refer to the very fast, impulsive attack phases that form the onset of a musical signal. They are crucial for the recognizability of instruments.

#01.3 WHY A HIGH DAMPING FACTOR IS IMPORTANT

The damping factor suppresses the unwanted current inevitably generated by the movement of a driver. A damping factor that is too low negatively affects the frequency response of a headphone.

Every electrodynamic system produces a reaction following an action, known as counter-EMF (electromotive force). When the voice coil of a headphone is deflected by the amplifier, an (unwanted) current is generated as it returns to its initial position. This current must be suppressed as effectively as possible, which is best achieved when the output impedance of the amplifier is as low as possible. This maximizes the amplifier's ability to absorb current.

The **damping factor** describes the ratio of the amplifier's output resistance (= output impedance) to a given load. Since there are no standardized technical regulations, we at Lake People and Violectric define the load (voice coil impedance) as 50 ohms. This results in damping factors exceeding 250 for Lake People and Violectric devices, based on output impedances of <0.2 ohms.

If the amplifier's output impedance is too high, it adversely affects the linearity of the headphone's frequency response, often "distorting" it, particularly in the lower frequency range. This effect is more pronounced the higher the amplifier's output impedance and the lower the headphone's impedance. Typically, this leads to an elevation of low frequencies, which is often perceived as pleasant. However, this "great" bass is merely a resonance, resulting in a "spongy" and less precise sound rather than a "crisp" one.

This resonance behavior also explains why a headphone may "sound good" with one specific amplifier but not with another.

The Violectric HPA V550 is a headphone amplifier with a PRE-GAIN function that can be adjusted for input signals from -18 dB to +18 decibels, enabling optimal adaptation to various sources and headphones.

QUICK SUMMARY

- Variable gain (PRE-GAIN) can minimize noise and optimize level balance between left and right channels.
- A high internal operating voltage ensures flawless reproduction of fast transients, especially with high-impedance headphones.
- High power and voltage reserves reduce distortion and protect headphones and hearing from overload.
- A high damping factor preserves the headphone's frequency response and prevents sonic coloration.

CIRCUIT DESIGN CONSIDERATIONS

It is important to understand some fundamental properties of the overall circuit before highlighting the central elements in detail.

The power-on and power-off processes of a standard amplifier can cause damage to headphones. Therefore, relays should be incorporated to delay connecting the headphones to the electronics, protecting the transducers from dangerous current spikes.

Frequencies beyond human hearing can also cause damage. For this reason, the frequency response should not be fully open but rather limited at the extremes. This leaves the audible spectrum unaffected, ensuring no information is lost.

Additionally, it is critical that the volume control is implemented with high quality. More detailed information on volume control follows in the next chapter.


1 MK II
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AL
ON

#01.4 WHY A RELAY FOR POWER ON/OFF IS USEFUL

A relay prevents harmful current spikes from reaching the headphone during power-on and power-off.

Every amplifier generates disturbances during the power-on and power-off processes, which can damage connected headphones. Through a relay and associated electronics, the headphone can be connected to the amplifier with a delay and disconnected immediately after power-off. This protects the headphone during the power-on phase while the operating voltages are ramping up, as stable conditions cannot be guaranteed during this time.

After the amplifier is powered off, the headphone is immediately disconnected from the electronics, safeguarding it from distortions caused by the collapse of operating voltages.

#01.5 WHY LIMITING THE FREQUENCY RESPONSE IS USEFUL

The spectrum of frequencies audible to humans is limited. Frequencies outside this spectrum contain no useful information but can impair playback or even cause damage.

Sound is an alternating electrical voltage. Young people can hear frequencies from approximately 20 Hertz to 20,000 Hertz. As people age, their ability to hear high frequencies diminishes. To transmit these frequencies effectively, an amplifier's frequency response must be as wide and smooth as possible.

The lower limit is set by direct current (0 Hertz), as it cannot go lower. DC voltages are always present in the signal, either originating from the source or unintentionally generated within the amplifier. These voltages silently deflect the transducer's membrane in one direction, depending on whether the voltage is positive or negative. They strain the amplifier and voice coil, can limit amplitude, and even destroy the transducer!

The upper frequency limit can theoretically be almost arbitrarily high, but this makes the device susceptible to electromagnetic interference. While such interference may not be immediately audible, it can mix with useful frequencies and become audible. Additionally, it can cause oscillations, potentially destroying the amplifier, its power supply, and the transducer.

An arbitrarily open frequency response is not necessarily a sign of remarkable engineering but rather of irresponsibility. Therefore, the frequency response in Lake People and Violectric devices is limited to a sensible range.

#01.6 WHY A GOOD VOLUME CONTROL IS IMPORTANT

The better the volume control, the more precisely it fulfills its purpose without introducing unwanted changes to the signal.

A volume control is a mechanical component available at very low cost on the global market. While it is increasingly being replaced by electronic circuits, these have clear disadvantages in terms of dynamics, noise, and distortion.

For high-quality applications, resistive tracks made of conductive plastic, precise "multitap" sliders, and separate chambers for individual sections are ideal. High mechanical quality is essential to ensure long-term reliable operation.

The best available option for high-quality potentiometers, as we have determined over many years, is the RK27 potentiometer from Alps.

In fact, volume control is so complex and significant that the following chapter is entirely dedicated to this topic.

The RK27 potentiometer from Alps—the best available option for precise volume control.

QUICK SUMMARY

- Relays prevent current spikes during power-on and power-off, protecting headphones.
- A deliberately limited frequency response optimizes playback and protects transducers.
- High-quality volume controls are crucial for excellent sound quality.


256-step PROCONTROL
VOLUME

#02 VOLUME CONTROL

Theoretically, there are a number of ways to implement volume control electronically; in practice, however, only a few of these methods are actually suitable. Rotary switches, electronic switches, VCAs, and ICs are, for various reasons, only partially or not at all effective as volume controllers.

Probably the most widely used and practical solution is the potentiometer, or simply "pot". A pot works by having a contact slide along a circular resistive track to adjust resistance. The quality of a potentiometer varies depending on the materials used and how well it is manufactured; accordingly, pots in different price ranges can sound quite different. The higher the quality of the pot, the more precise and interference-free the volume adjustment will be. That makes the quality of this component crucial.

The best way to achieve top-notch volume control is the RCA, which stands for Relay Controlled Attenuator. This method uses a series of relays to switch between fixed resistors. The result is an extremely precise, channel-consistent, and interference-resistant volume control system—but it comes at the cost of significant technical complexity and material expense.

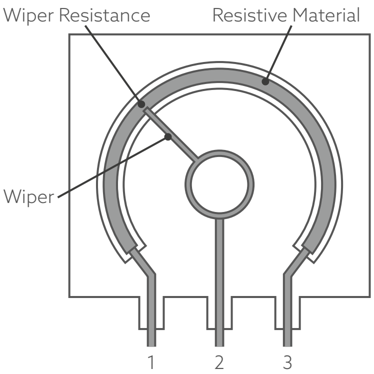
ABOUT DIFFERENT TYPES OF VOLUME CONTROL

To control volume, a variable voltage divider is needed—one that only allows a specific portion of the signal level from the preamp to pass to the power amp of a device. The simplest form of such a variable voltage divider is a mechanical actuator known as a potentiometer, or simply "pot".

#02.1 THE POT

Potentiometers are mechanical components, so their quality is heavily dependent on the materials used and the quality of workmanship. These components are also subject to aging, which can increasingly affect their functionality. Purely passive pots often introduce additional issues due to impedance. Therefore, the quality of a pot is crucial for flawless operation; the Alps RK27 has established itself as a high-quality standard.

A volume control pot can be imagined as a bare resistor. One end (3) is connected to the input signal, the other end (1) to ground. A mechanical wiper (2) moves across the surface of this resistor. The closer the wiper is to the input side, the louder the signal; the closer it is to ground, the quieter. If the wiper sits directly on ground, the signal is muted.



It's easy to imagine that such a mechanical part can be manufactured with varying degrees of quality. The resistive tracks might be made from low- or high-grade carbon, ceramic, or conductive plastic; the wipers from simple or premium materials, with basic or specialized designs.

The resistive tracks in audio pots are typically logarithmic, to better match the ear's perception of loudness. The resistance changes more steeply from low to medium volume and then more gradually toward the high end.

Stereo applications introduce further complications: the resistance tracks must match very closely for left and right channels (which is difficult), and ideally should be housed in separate chambers.

To ensure reliable operation over many years, the surfaces of the resistive tracks should be as hard and smooth as possible, and the wipers should be made of premium materials such as silver or gold—at least at the contact points.

Alps RK14
stereo potentiometer

Alps RK 27
stereo potentiometer

Pots are filled with special grease. Over time, aging and material wear will inevitably cause a pot to scratch or crackle, as the wiper no longer makes clean contact with the track due to debris and dust. Using contact cleaner is a big mistake: while it might temporarily stop the scratching by washing away debris, it also removes the grease, which leads to even worse wear in a short time.

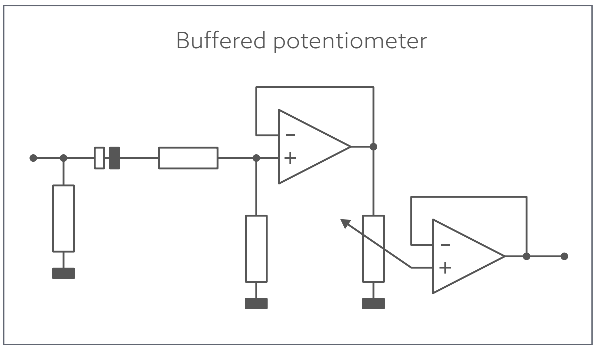
Mechanical requirements are also high. The shaft should not wobble; a solid, smooth turning feel is desirable, and multiple pots should have uniform rotational resistance.

Mechanical detents (click stops) can be built into pots to help with repositioning:

- For volume control, a 31- or 41-step detent is popular.
- A balance control often has a center detent.
- For tone controls, a 13-step detent is useful.

These detents are not the same as the discrete steps of a stepped switch! They are just meant to improve usability and give a sense of precision.

By design, a pot presents a fairly constant and high impedance to the source, but a highly variable impedance to the next amplifier stage. To minimize interference, this output impedance should also be low—which typically requires additional circuitry, such as a buffer amplifier.



This is one reason why passive volume controls often cause more problems than they solve!

Pots can be relatively easy to automate by adding a motor via a gear mechanism. A slip clutch allows manual control from the front while the motor turns it from the back.

Pots are available on the global market in virtually unlimited price ranges, from just a few cents to several hundred euros—like the Alps RK50. The market for truly high-end pots is small, which is why manufacturers have stopped producing them. The Alps RK27 remains the go-to choice when it comes to good quality at a reasonable price.

Because pots are expensive and inevitably wear out, alternatives have been under discussion for quite some time.

#02.2 THE STEPPED ATTENUATOR

Stepped attenuators (also called stepped switches) generally offer more precision and durability than potentiometers. However, they are limited in the number of volume steps and cannot be automated.

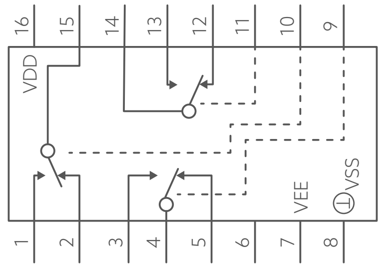
A stepped switch can serve well as a replacement for a pot. Instead of a continuous resistive track, it uses a voltage divider formed by two resistors per step.

Advantages include excellent channel matching; with high-quality contacts and solid construction, these switches last significantly longer than pots.

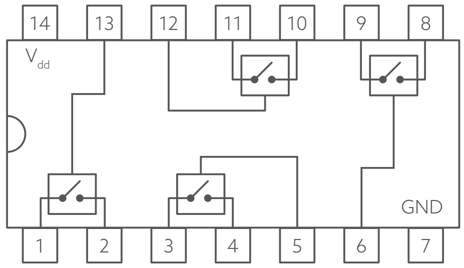
However, there are also significant disadvantages. The limited number of steps (usually 12 or 24) makes stepped attenuators less suitable for fine volume adjustment. They are also expensive, especially the 24-step versions, complex to build, and not automatable.

#02.3 THE ELECTRONIC SWITCH

Electronic switches are inexpensive, but they do not meet the sound quality requirements of a high-end volume control.



CD4051 Operating principle



CD4066 Operating principle

While electronic switches are suitable for various functions, they are not ideal for controlling volume. They tend to introduce distortion and are not sonically convincing.

An electronic switch is a component that can toggle between a high-resistance state (high resistance, low current flow) and a low-resistance state (low resistance, higher current flow). This method does not allow for continuous volume control, as it simply switches between two resistance states—unlike a potentiometer, which allows smooth adjustment.

Early versions of these switches had issues with the "low-resistance" state. It wasn't truly low-resistance—the resistance was higher than desired and unstable, leading to unreliable current flow and signal loss, which is a problem in precision audio applications.

These switches are typically based on field-effect transistors (FETs), which can introduce notable distortion and require specific placement within the circuit for optimal results.

Under certain circuit conditions, electronic switches can be used as relay substitutes, such as for input switching. Modern electronic switches have tighter tolerances and lower ON-resistance, which improves current flow, reduces signal loss and distortion, and makes them more efficient and reliable.

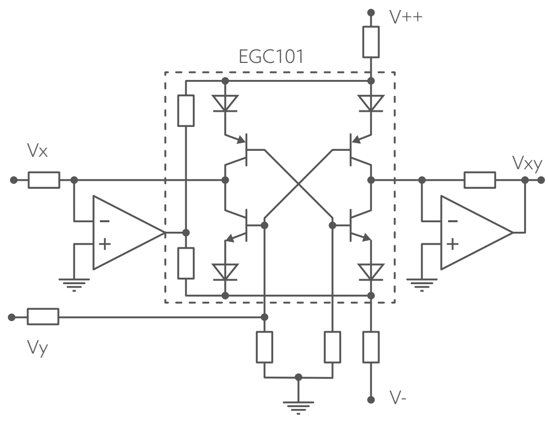
However, despite this progress, electronic switches are still not a viable replacement for a potentiometer in volume control applications.

Aside from the fact that such switches don't typically produce scratchy noise, their sound quality is generally lacking. That said, due to their low cost, electronic switches do present a budget-friendly alternative, and a major advantage is their ease of automation.

#02.4 THE VCA

Voltage Controlled Attenuators introduce distortion and are therefore unsuitable for high-fidelity audio applications.

VCA stands for Voltage Controlled Attenuator. Originally used in early analog computers—where it was also known as a four-quadrant multiplier—it was further developed for audio technology in the early 1980s.



Internal circuitry of a VCA

VCAs found applications in studio equipment such as limiters and noise gates, and were also used in early mixing console automation systems.

However, in its attenuating (dampening) state, the VCA introduces noticeable distortion that is no longer acceptable by modern standards. This makes it unsuitable for sound-critical applications.

The VCA is controlled by a relatively low control voltage (typically around 6 milivolts per 1 decibel of attenuation), which leads to limited channel matching accuracy. In addition, automating a VCA requires significant effort, making it less practical compared to other solutions.

#02.5 MONOLITHIC INTEGRATED CIRCUITS

ICs are inexpensive and versatile, but suffer from significant sonic drawbacks due to high distortion and noise.

An early approach came from Philips in the early 1980s with chips like the TCA730 and TCA740. These integrated circuits were designed to control volume, balance, treble, and bass for two audio channels using simple, low-cost linear pots and minimal wiring. The concept aimed to reduce production costs by allowing the use of very cheap potentiometers and simplifying the circuitry. However, even back in the 1980s, these ICs earned a reputation as "noise and distortion generators."

As a result, they are completely unsuitable for high-quality audio.

#02.6 THE DCA

Digitally Controlled Attenuators operate in the analog domain but are controlled digitally. They offer good sound quality and are commonly used.

Advancements in chip technology since the late 1990s brought the development of the DCA—short for Digitally Controlled Attenuator. In this design, the attenuator itself is fully analog, but the internal "switches" are controlled digitally using data words.

Internally, a DCA is a smart combination of many electronic switches, precision resistors, and buffer amplifiers. One of the first usable examples was the CS3310 from Cirrus Logic. This and similar chips are typically two-channel devices with 256 steps, each in 0.5 decibels increments. These switches often occur at zero-crossings of the audio signal, contributing to excellent performance in terms of linearity, low noise, and minimal distortion. Automation is very easy to implement.

One limitation of the CS3310 is that it operates only at 5 volts, which limits headroom. Some newer chips from other manufacturers have improved on this. While widely used and well-regarded, DCAs still fall short of true high-end performance.

#02.7 THE RCA

The Relay Controlled Attenuator combines the advantages of all other methods while avoiding their drawbacks. It achieves maximum precision, channel matching, and crosstalk rejection by switching between fixed resistors using relays.

The Niimbus US 5 uses a virtually inaudible reed relay with 256 steps in 0.4 decibel increments as a volume control.

Like a stepped attenuator, it uses combinations of resistors, but with more steps and automation capability (e.g., via remote control).

At Lake People and Violectric, there is a current implementation offering 256 steps with 0.4 decibel resolution, enabling a total control range of over 100 decibels. Of course, this doesn't mean 256 relays per channel—only eight relays per channel are needed, using binary switching combinations (2^8 = 256 steps).

Advantages of Relay-Controlled Attenuators

- No scratch noise, as there's no resistive track
- Excellent channel matching using 1 % or 0.1 % resistors[2]
- Superior crosstalk rejection due to physical channel separation
- Wider control range than traditional potentiometers
- Easily scalable to multi-channel applications
- No additional distortion or noise, since only fixed resistors are in the signal path

Conclusion:
Relay-controlled attenuators are by far the best way to regulate volume.

Of course, there are some downsides

- Most technically complex and thus the most expensive solution
- Mechanical noise is generated during adjustment
- Clicking sounds or brief signal interruptions may occur while switching

A relay-controlled volume control can produce clearly audible switching noises during operation. This can be avoided by using reed relays. In a reed relay, the conductors are hermetically sealed and contactless. Potentiometers used for volume control often have a logarithmic taper to match the characteristics of human hearing. The resistance changes exponentially with the rotation angle.

QUICK SUMMARY

- Among all circuit options for precise volume control, only potentiometers, DCAs, and relay-based attenuators are truly practical.
- Potentiometers exist in all price ranges, with higher quality strongly reflecting the price.
- DCAs already offer good results, but don't quite reach top-tier performance.
- Relay-switched resistors are technically complex, but provide the best possible characteristics for high-end volume control.
- Stepped attenuators, electronic switches, VCAs, and ICs are only partially or not at all suitable for volume control.

[2] The percentages describe the tolerances of the components. Such low tolerances enable particularly accurate sound reproduction.


HE-560
HPA V281 LIMITED EDITION
XLR
RCA1
RCA2
HEAD
MUTE
LINE
POWER

#03 SYMMETRY: THEORY

Symmetry in signal transmission means that a signal is transmitted simultaneously over two separate conductors and then recombined in the receiving device. By inverting the phase, the effect of interference along the signal path is significantly reduced—or even completely eliminated—compared to unbalanced transmission.

Balanced transmission also improves channel separation between the left and right channels, as residual energy no longer returns via a common ground connection and therefore cannot cause crosstalk into the signal paths.

There are two ways to achieve balanced transmission:

Transformer balancing offers the highest level of noise immunity and precision, but it is relatively expensive and presents challenges in terms of frequency response and signal bandwidth.

An electronic balancing solution is more cost-effective, but it does not achieve the same level of signal integrity.

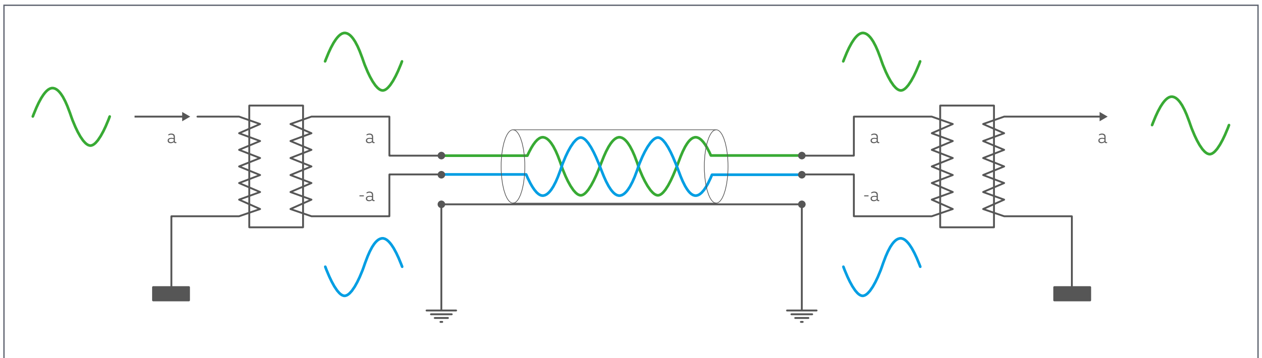
#03.1 WHY BALANCED SIGNAL TRANSMISSION BETWEEN DEVICES IS BENEFICIAL

Balanced signal transmission effectively cancels out interference on the audio signal.

In unbalanced signal transmission, the equalization of potentials[3] occurs via the cable shield, which also connects the ground potentials of the devices. If the devices have metallic housings, these are usually also connected to protective earth. These unavoidable connections between ground, shield, and protective earth can easily lead to hum interference.

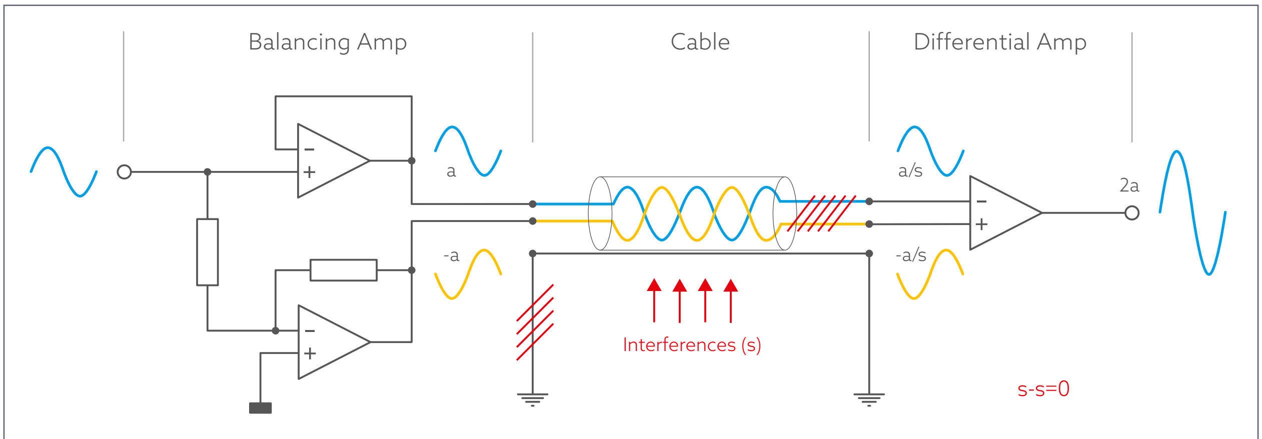
In contrast, balanced signals are carried over two wires. A ground connection is not strictly necessary, although most balanced cables are shielded. Since the signal is carried on two separate conductors, no potential equalization is needed between the devices. This allows for a clear separation between signal ground, chassis, and protective earth, effectively avoiding ground loops and hum.

A balanced signal is created by generating a version of the original (unbalanced) signal that is phase-inverted by 180 degrees. This inversion can be done electronically or via a transformer.



One wire carries the signal (a), the other carries its inverted counterpart (-a). In the receiving device, this balanced signal is passed through a transformer or differential amplifier, which calculates the difference: (a) − (−a) = 2a.

Any interference picked up on the signal lines will affect both conductors in the same phase, and is thus canceled at the receiver: (s) − (s) = 0.

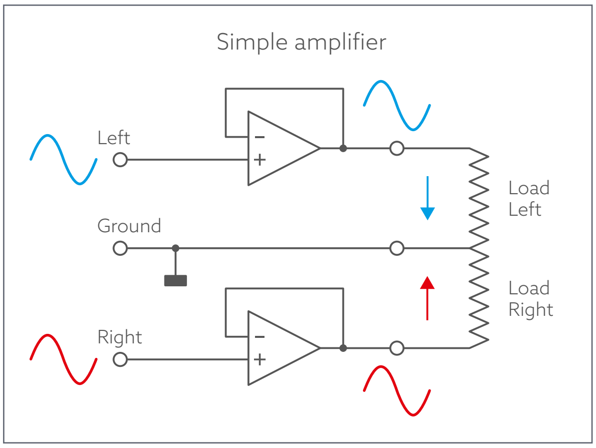


#03.2 WHY AMPLIFIERS WITH BALANCED OUTPUTS ARE ADVANTAGEOUS

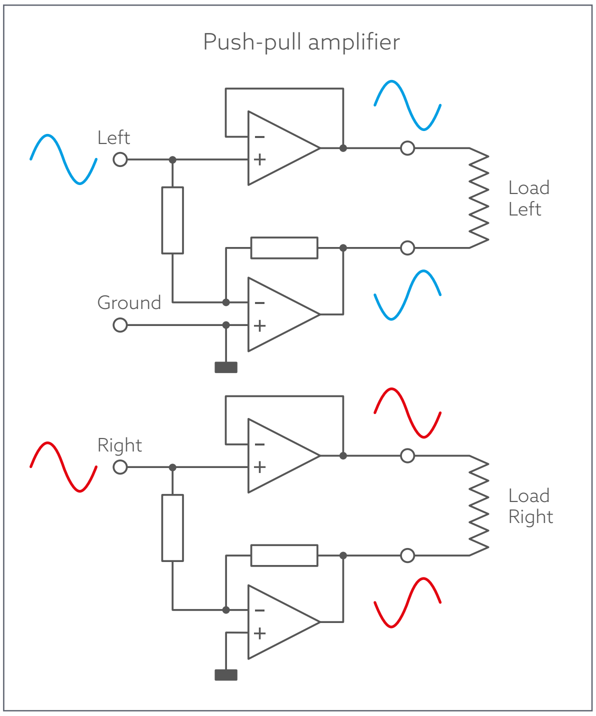
Balanced signal transmission significantly improves channel separation between left and right. The output amplifiers can operate in push-pull mode.

In the common unbalanced headphone connection (e.g., with standard TRS jacks), the return current flows through the shared ground wire to the device's ground. But that ground path has resistance—just like the signal path—so voltage drops occur across it.

This means the ground, which should be the stable reference point, becomes "contaminated" with residual signals from both left and right channels. This cross-talk creates intermodulation, which is measurable and audible.



In balanced operation, each headphone voice coil is driven by two amplifiers working 180° out of phase in push-pull mode. While one pushes, the other pulls. This not only doubles the output voltage (resulting in significantly higher volume), but it also keeps the ground path entirely free of interference.



[3] Equalization of potentials: When transmitting audio signals, electrical charges move from one device to another. To balance the resulting potential difference, these charges must return via the shield conductor.

#03.3 DIFFERENT TYPES OF BALANCED TRANSMISSION

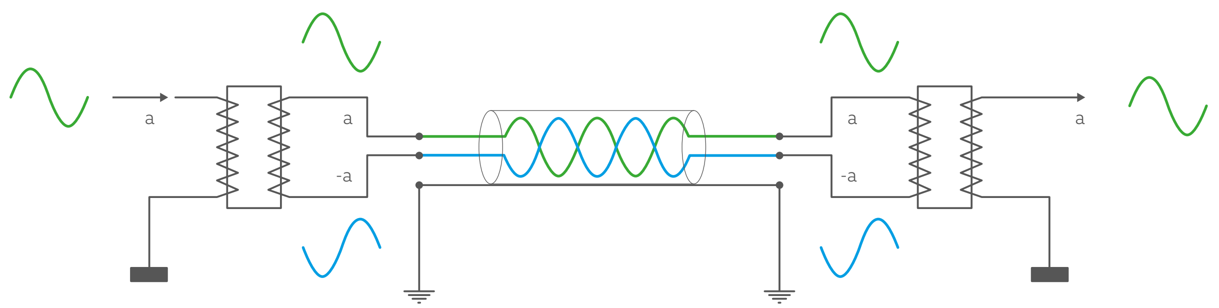
There are two main ways to balance a signal. **Transformer balancin***g is reliable and precise, but expensive and less ideal at very high or low frequencies.* **Electronic balancing** *uses operational amplifiers (op-amps) that are more cost-effective and flexible, and can amplify weak signals precisely, but are more sensitive to interference and thermal noise, which may compromise signal integrity.*

Transformer-balanced transmission

This method is used to achieve maximum noise immunity on a signal line. Anyone who served in the military might remember the field telephone and the "bongos" (cable drums worn on the back). A field telephone is a very basic phone without any electronics or power supply. It connects to another field phone using a simple twisted-pair cable, which can be several kilometers long, and yet communication remains clear. That's real-world balanced line transmission in action!

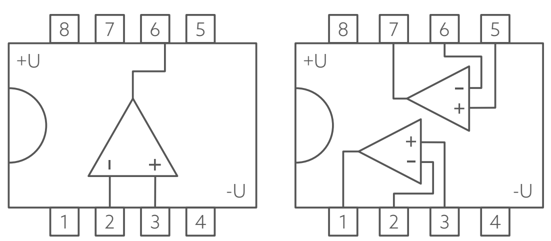
The simplest, most reliable, and highly precise method of balancing uses transformers — but these are expensive and can struggle with linear frequency response.

Balanced cable routing with transformers



Electronically balanced transmission

This approach uses universal amplifier elements to achieve affordable balancing.



The OpAmp—the component of choice

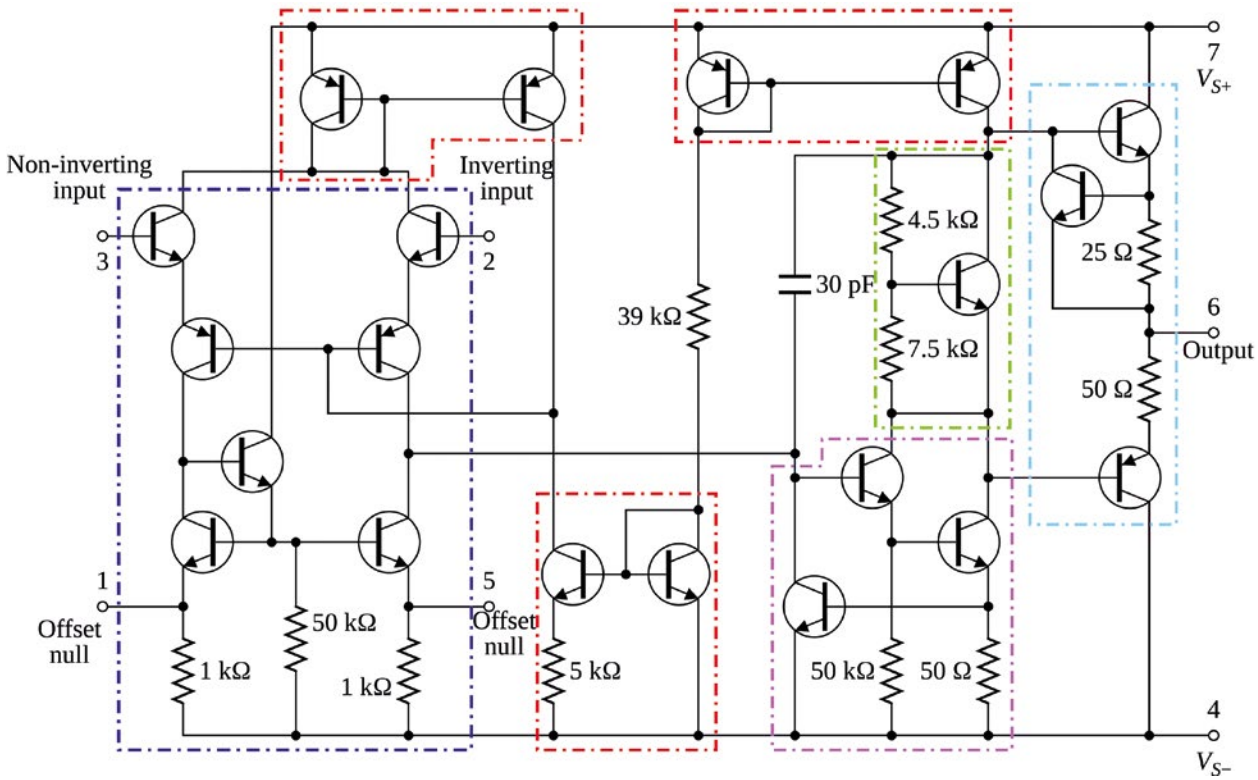
The operational amplifier (OpAmp) is the universal analog building block of practically all analog electronics.

Today, an OpAmp typically comes in an 8-pin chip package, usually containing one or two amplifier circuits inside.

Since the first OpAmps were developed in the late 1960s, industry leaders like Texas Instruments, Motorola, Fairchild, and STMicroelectronics have developed thousands of OpAmp types, optimized for a wide range of applications:

- Low Noise: generate minimal internal noise
- Low Offset: minimize unwanted DC voltage components at the output
- Low Current: extremely power-efficient—ideal for battery-powered devices or sensors
- High Output Power: provide strong output currents for driving demanding loads
- Single/Symmetric Supply: some OpAmps operate on a single power supply, others use a dual supply (+/–V)
- High Frequency: designed for fast switching and high bandwidth applications

To illustrate the complexity of an OpAmp, one can look at a basic LM741 from 1969.



Red: Current mirror
Blue: Differential amplifier
Purple: Class A amplifier
Green: Voltage amplifier
Light blue: Output amplifier

In fact, when examining the schematics of analog power amplifiers, you'll find many similarities to the internal structure of an OpAmp.

QUICK SUMMARY

- With balanced transmission, interference and interference are eliminated.
- Intermodulation between the left and right channels is prevented, so that channel separation is improved.
- Balanced output amplifiers can be set up as push-pull systems. They thus achieve higher output voltages and free the ground from interference.
- Transformer balancing is very precise, but also expensive. Therefore, balancing is often realized via OpAmps, which are more cost-effective and more compact, but have lower output power and higher susceptibility to interference.

The Violectric HPA V324 offers transformer-balanced inputs, a true balanced headphone connection with four power amplifiers and PRE-GAIN on the front.


PREMIUM TRUE BALANCED HEADPHONE AMPLIFIER
LAKE PEOPLE
VU METER
MUTE
XLR
INPUT
RCA
OUTPUT
PROTECT
HEAD
ALL
LINE
VOLUME
-6
0
-12
+6
-18
+12
PRE-GAIN (dB)
POWER
VIOLECTRIC
HPA
V324


LL
STEREO
RR
STEREO
ON
PHASE
PROFESSIONAL
SERIES
PHONE-AMP G108
POWER
NEUTRIK
MONO
STEREO
PHASE
PROFESSIONAL
SERIES

#04 SYMMETRY: PRACTICE

In a direct comparison of unbalanced and balanced amplifier design, the superiority of the balanced signal routing becomes particularly clear. The decisive advantage of the balanced amplifier lies in its better channel separation: since there is no common ground line feeding the voltage residues back to the device as a mono signal, no crosstalk is generated—left and right remain completely separate.

The situation becomes more complex when the impedances that occur are also taken into account. The number of these problem areas increases due to the greater design complexity of the balanced amplifier; however, the sonic advantages of the superior channel separation more than compensate for this disadvantage with a correspondingly high-quality design.

The most common connection types for balanced headphones are the four-pin XLR plug and the 4.4 milimeters Pentaconn connection. Many headphones can be converted for balanced operation by simply removing the jack plug and soldering on a corresponding connection.

#04.1 THE PRACTICE

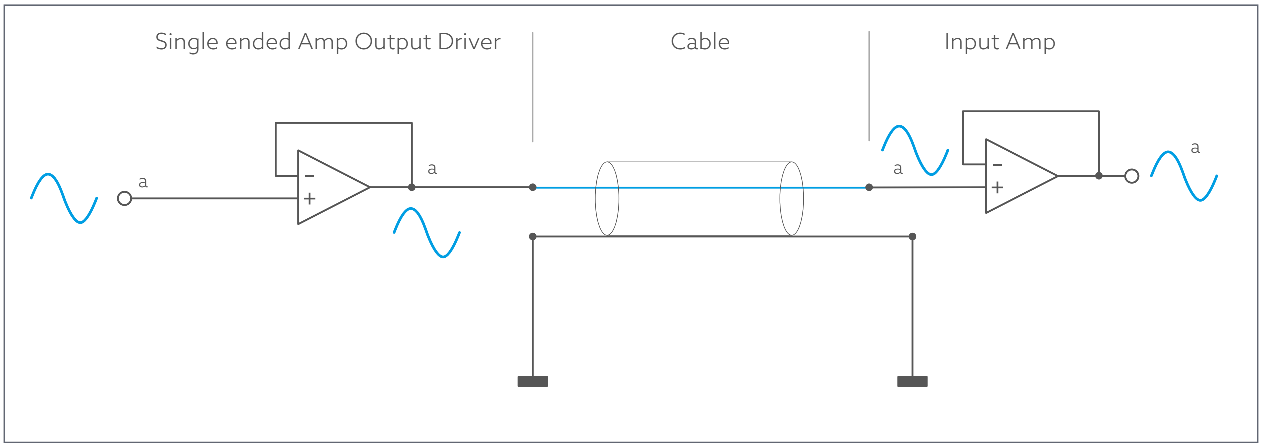
A direct comparison of an unbalanced and a balanced amplifier underlines the advantages of the balanced design. How well these advantages translate into practice depends largely on the design effort involved.

UNBALANCED

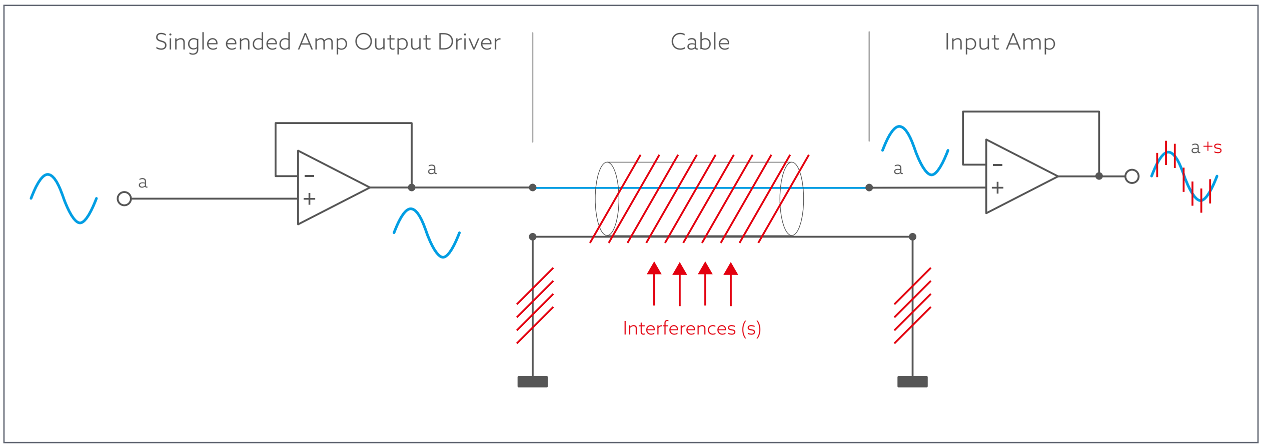
The starting point is an unbalanced amplifier.

The unbalanced amplifier drives an unbalanced cable.

The unbalanced signal reaches the input of the following device.



Any interference is also processed with unbalanced signal routing.

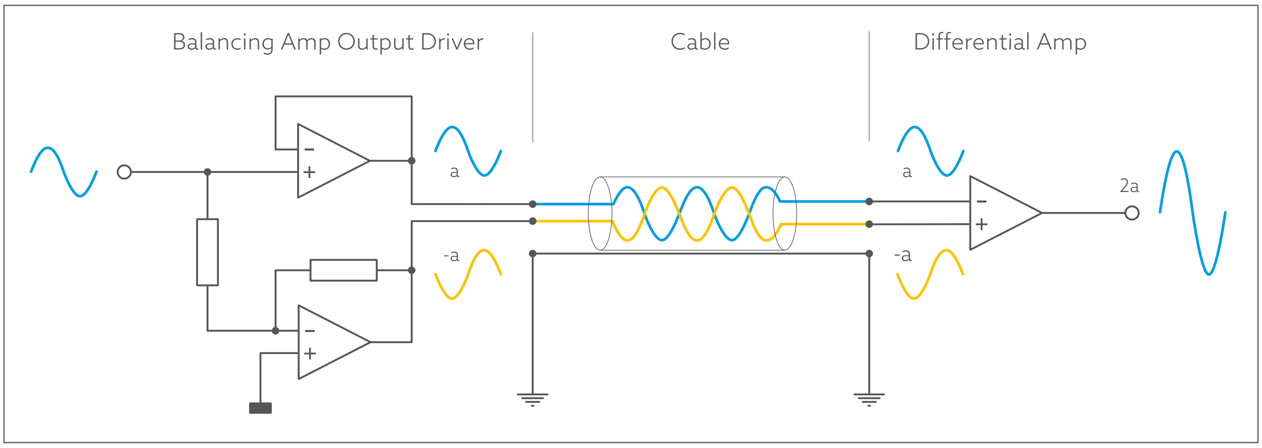


BALANCED

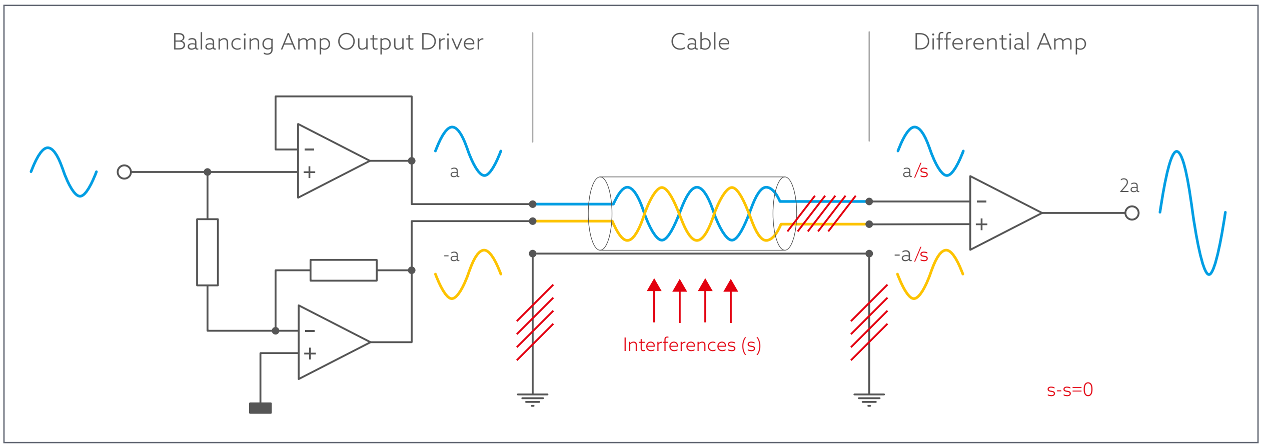
In an electronic balancer, an inverted, 180° rotated signal (-a) is formed for an existing unbalanced signal (a).

In the balanced amplifier, the signals are sent via a two-wire twisted cable, which does not even have to be shielded.

The balanced signal is sent to the differential input of the following device.



Any interference is suppressed with balanced signal routing.



In the receiver, the signal reaches a differential amplifier. As the name suggests, such a component forms a difference, i.e. subtracts one signal from the other. And this works like this:

$a - (-a) = 2a$

The differentiator does exactly the same with the interference influences that act in phase on the cable:

$s - s = 0$

The idealized result is that the receiver gets twice the signal strength without interference. In reality this does not work 100 percent. Here, voltage and impedance ratios must be taken into account, which in practice can be measured as common mode rejection. The more constructive effort is made, the better the result.

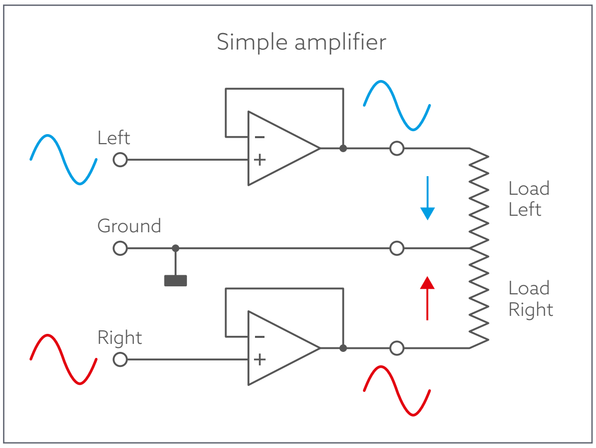
The unbalanced signal routing has the further disadvantage that the signal return between the devices takes place via the shield of the cable, because it connects the housings and the masses of the devices with each other. In addition to the significantly higher freedom from interference in comparison to unbalanced signal routing, balanced signal transmission offers the further advantage, due to its design, that the shield of the cable is not used for signal return, but exclusively as protection for the signals and for potential equalization between the connected devices—it therefore has a purely static function. In contrast to the unbalanced connection type, the shield and/or the earth is not used for signal return. Because devices with balanced inputs and outputs usually also have mains connections with protective earth, these devices often have a clear separation between the internal earth and the housing.

#04.2 SYMMETRY FOR SPEAKERS AND HEADPHONES

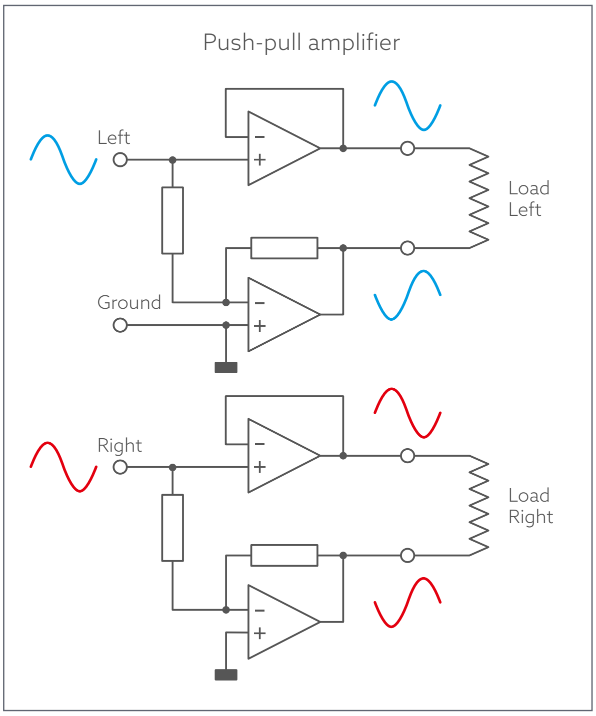
The decisive advantage of symmetry is the stationary mass. In practical implementation, the impedances at various points of the signal path must be taken into account in addition to the basic principles described.

So while a balanced line between devices primarily serves to ensure a largely interference-free signal transmission, a balanced amplifier employs a different principle. However, both should guarantee a static ground.

Let's first take a look at the principle of a simple amplifier: The left and right input signals are amplified and fed to the left and right loads.



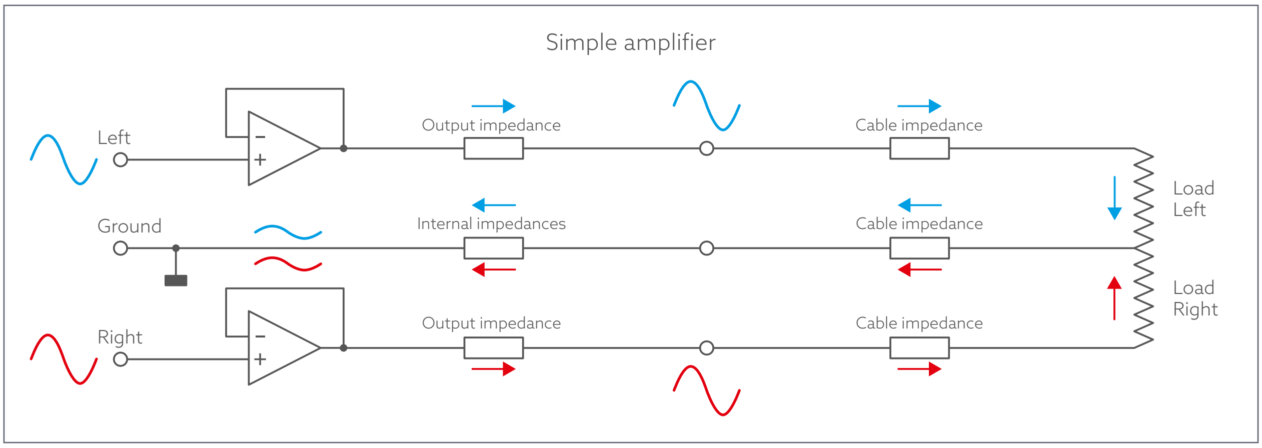
Balanced amplifiers are nothing new, but have been around for a long time. For example, this technology is used in car radios to generate four times the power at limited voltage (12 Volts). This circuit technology is also known as a full bridge amplifier, push-pull amplifier or BTL (**B**ridge-**T**ied **L**oad/**B**ridge **T**ransformer**l**ess). This is what it looks like:



The input signals are fed to the load via two amplifiers. The trick is that one of the amplifiers works "normally", while the other is inverted, i.e. phase-shifted by 180°. While one amplifier pushes the voice coil, the other amplifier pulls it. With the same operating voltage, this results in twice the voltage swing of the single amplifier or four times the power. A further advantage is the completely unloaded ground, because it has nothing to do with the load.

One of the disadvantages of the above circuit is also immediately apparent : duplication of the components.

Unfortunately, real life is not as simple as the circuit diagrams above. Here is the "simple" amplifier with "problem areas":



In addition to the load that needs to be driven, there are also plenty of parasitic impedances that need to be taken into account. They can impair the result of the cleanest possible drive of the voice coil. Impedances are a complex mix of ohmic, capacitive and inductive parameters that can lead to instability in the amplifier, for example if a cable has a high capacitive component.

For the sake of simplicity, only the ohmic component will be considered below. A voltage drops across every ohmic load, which is responsible for non-linearities in the system.

Some problems can be seen immediately from this circuit diagram:

- The higher the ohmic load, the lower the influence of the parasitic impedances.
- The lower the ohmic load, the higher the influence of the parasitic impedances.
- The lower the output impedance of the amplifier, the lower its influence on the quality of the transmission.
- The lower the ohmic load, the greater the influence of the cable and the output impedance.
- In headphones with jack plugs, major errors are caused by the common ground cable for both channels and the suboptimal connection of the jack plug to the jack socket with its much too large contact points.
- The ground does not rest, but is loaded with the voltages from the left and right via the cable and the internal impedances. It is therefore modulated with the mono signal, which can be measured and heard as crosstalk or intermodulation.

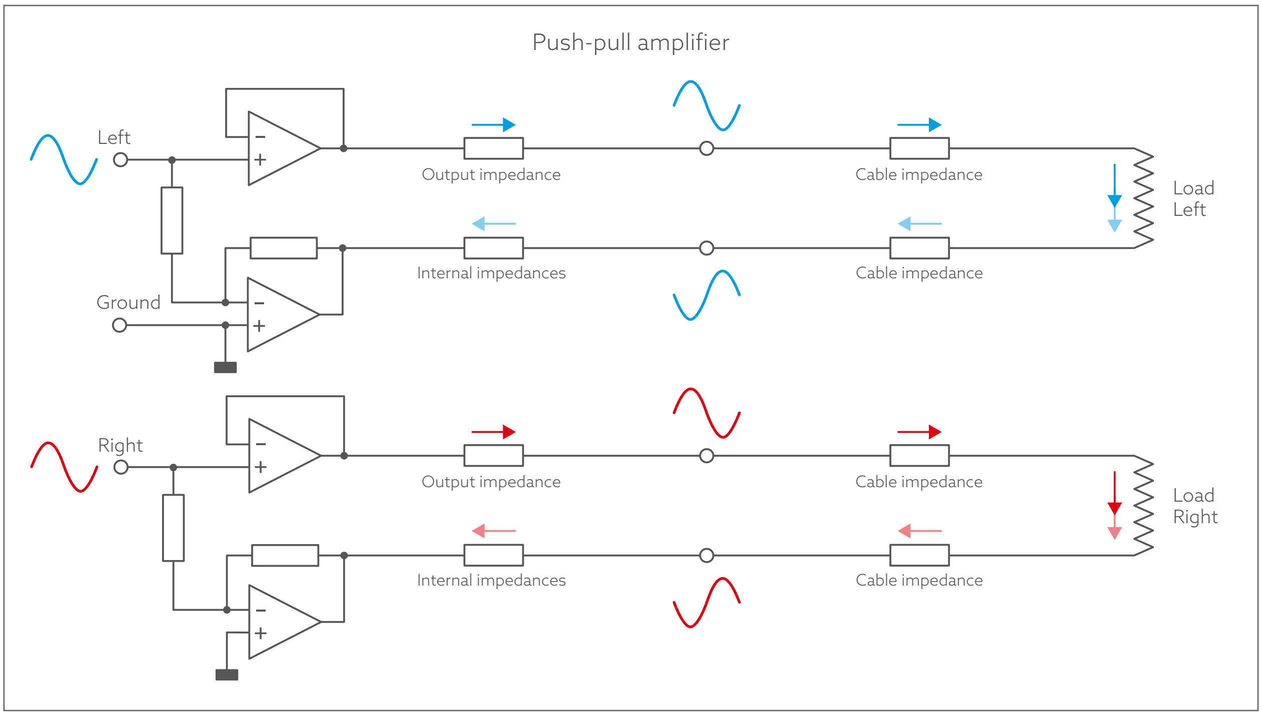
For a balanced amplifier, it looks like this: instead of six problem points as with a simple amplifier, you now fortunately don't have twelve, but only eight. So at least there is no doubling of the difficulties.

The transmission quality increases because there is no common ground line to consider, just as there is no load on the ground. However, not all is gold with push-pull amplifiers. In addition to the increased cost of a specific product due to the duplication of components, the following points must be taken into account:

- Doubling of the output impedance due to two impedances per channel
- Higher static noise due to double amplification;
- Doubled output amplitude
- Risk of additional intermodulation due to double amplifier

When using a balanced or push-pull amplifier as a headphone amplifier, the main aim is not to maximize the output amplitude. Especially not if low-impedance headphones are to be driven.

There are devices in the Lake People and Violectric range that provide more than enough amplitude—even with high-impedance headphones.




PHONES
X-FEED
MUTE
USB INS
DIGITAL
DIM
Ø REV
MONO
IN4
MASTER VOLUME

So what makes a balanced headphone amplifier useful and desirable?

The voltage of the useful signal is fed back into the device through the common ground line in the unbalanced amplifier. This causes voltages to drop across the resistors of the components involved, which generate crosstalk as a mono signal. A balanced amplifier avoids this problem and therefore offers a particularly high channel separation.

Via the load (the voice coils of the headphones), this voltage is fed back into the device via a common line to the earth connection of the headphone socket and from there to the base of the mains transformer, the actual reference point or earth point. Neither the wires from the headphones to the device nor those in the device itself or the ground plane in the device are infinitely low impedance. They themselves also have a resistance—and are therefore a load across which voltage drops.

In this way, the reference point "ground", which should actually be at rest, is "contaminated" with the residues from the left and right. This is a summed mono signal! This can be measured and heard, namely as intermodulation or crosstalk!

As shown above, the circuit itself (output impedance), the circuit layout, the cable of the headphones and the ratio between the sum of ground and the return resistance to the load resistance (voice coil) play a major role.

As mentioned above, a "simple" amplifier has the ground as its reference point. To be more precise, not just any ground line or surface in the device, but the base of the transformer.

The amplitude of the signal oscillates as closely as possible around this reference point (otherwise we are talking about DC offset) and is only limited by the positive and negative operating voltage. The theoretical maximum effective amplitude (Vrms) is calculated in simplified form as follows:

$$\frac{\text{Amount of the operating voltages}}{2 \times \sqrt{2}} \approx \frac{\text{Amount of the operating voltages}}{2{,}83}$$

A balanced amplifier (or full-bridge or push-pull or BTL amplifier) therefore consists of two amplifiers per channel, one of which supplies the normal, the other the 180-degree rotated (inverted) input signal to the voice coils of the headphones. The terms full-bridge amplifier, push-pull amplifier and BTL amplifier (Bridge-Tied Load / Bridge Transformer-Less) describe different, but related amplifier circuits, which are all based on the same basic bridge technology. Since the load (the voice coil) is now pulled back and forth between the modulated positive and negative operating voltage, the ground is completely out of play. It is no longer loaded and therefore has no influence on the crosstalk. The cables of the headphones also no longer enter into the effective balance, partly together and partly separately, but are clearly assigned resistive loads (namely two cables per voice coil) with very low complex impedance components.

The particular advantage of a balanced (headphone) amplifier is therefore the high channel separation. The channel separation is usually so high even with unbalanced amplifiers that nobody complains—but many people don't know how to improve it.

The particularly high channel separation when listening to with headphones is sometimes perceived as "unnatural" (ICL = in head localization) and is artificially reduced by "crossfeed" functions, for example. However, the optimized crosstalk attenuation and the lower intermodulation—the purer channel separation—are the reason for the "aha" experience that many people have with balanced headphones (amplifiers). The spatiality increases, the imaging sharpness improves, the location of individual instruments in the room becomes clearer.

To put it bluntly:
When listening with **loudspeakers**,
you are sitting in the **auditorium**.
When listening with **unbalanced headphones**,
you switch to the **conductor's seat**.
When listening with **balanced headphones**,
you are part of the **orchestra**.

One technical advantage of the balanced output is that you finally have to/can get away from the unfortunate jack plug with its sometimes dramatic transition resistances. However, the use of two 3-pin XLRs, which can be seen from time to time, also lacks purpose. The variant with two stereo jack plugs is also available.

Lake People and Violectric have opted for a four-pin XLR connection as the output socket, with a pin assignment that has been common since the days of the AKG K1000. Deviating from the usual standard, however, neither the socket (female) on the device nor the plug (male) on the headphone cable feature a latch. As a rule, however, balanced headphone amplifiers are wired in such a way that the socket on the device is female and the plug on the headphones is male. Although this configuration contradicts the "usual" XLR configuration, it has established itself specifically for this application. In addition, the 4.4 millimeters Pentaconn connection is also increasingly available as an alternative.

The question remains as to whether and how existing headphones can be converted to balanced operation if they are not available in balanced form. Generally speaking, if the cable has four poles, there is no problem. This is usually the case if the cable is inserted into the left AND right earcup. Then you can simply cut off the jack and solder on a 4-pin XLR.

QUICK SUMMARY

- Balanced amplifiers offer superior channel separation because the ground does not carry a common residual signal back to the amplifier.
- The greater design effort of the balanced amplifier also leads to a greater number of problematic impedances. Nevertheless, with careful design, the advantage of better channel separation clearly outweighs the disadvantages.
- Many unbalanced headphones can be converted for balanced operation, provided the cabling allows separate signal routing for left and right.
- Established connection types for balanced headphones are the four-pin XLR connection and the 4.4 mm Pentaconn connector.


LAKE PEOPLE
PHONE-AMP G103-D-4
Dante
MUTE
VOLUME
Dante
PROFESSIONAL SERIES DANTE HEADPHONE AMP
LAKE PEOPLE
PHONE-AMP G103 MK II
POWER
VOLUME
PROFESSIONAL
SERIES
ON
LAKE PEOPLE
PHONE-AMP G103 MK II
POWER
VOLUME
PROFESSIONAL
SERIES
ON

#05
THE HEADPHONE AMPLIFIERS FROM LAKE PEOPLE

OUR MANUFACTORY: PRECISION AND CRAFTSMANSHIP "MADE IN GAUTING"

Lake People is more than just a manufacturer of high-quality audio equipment—we are an owner-managed company, dedicated to the development and manufacture of audio components with passion, precision and a clear focus on quality. Our products are created in our own factory in Gauting near Munich, Bavaria. Here, with our team of excellently trained and experienced specialists, we rely on careful craftsmanship, which is characterized by the highest precision and reliability.

Craftsmanship and Innovation

Each of our products is developed from the ground up with meticulous attention to detail and deep technical expertise. From the first prototype to the final testing of production units, every device undergoes a precise manufacturing process that combines cutting-edge technology with traditional craftsmanship. Our engineers rely not only on innovative circuit designs that have proven themselves in practice for decades, but also continuously develop new solutions to further enhance the performance, design, and user-friendliness of our products. This not only ensures outstanding sound quality, but also guarantees the long-term usability of our devices.

In-House Manufacturing

The entire manufacturing process at Lake People takes place in our own workshop—a deliberate decision to ensure the highest quality and full control over every stage of production. This allows us to guarantee that every unit meets the most demanding standards. All components are carefully assembled by hand, with rigorous quality checks carried out before any device leaves our facility to ensure it meets the desired specifications.

Built to Last

At our facility, we place special emphasis on the durability of our products. They are made from robust materials designed for years of reliable use. Each device is crafted to meet the high expectations of users—not just today, but for many years to come. And if a repair is ever needed, we ensure that maintenance is simple and cost-effective.

Made in Germany—A Mark of Quality

For us, "Made in Germany" is more than just a label—it's a commitment to exceptional craftsmanship and reliability. We take pride in manufacturing in a region known for its rich tradition of skilled workmanship.

Our local production secures jobs and allows us to maintain the highest standards throughout the entire process. The resulting quality is recognized worldwide, satisfying both professional users and audiophiles who rely on the longevity and superior sound of our products.

Long-Term Vision and Sustainable Development

Lake People is guided by a long-term perspective. Our products are designed to deliver outstanding performance today while retaining their value for years to come. We focus on sustainability—through carefully selected materials, long-lasting construction, and easy repairability. Continuous product development is an integral part of our process, allowing us to meet the ever-evolving needs of the audiophile community.


BALANCED HEADPHONE AMP
RCA 1
RCA 2
USB
STATUS
HEAD
OFF
LINE
ON
PCM + DSD DAC
INPUT
OUTPUT
POWER
VOLUME
VIOLECTRIC
DHA V226
XLR
INPUT
RCA
PREMIUM BALANCED HEADPHONE AMPLIFIER
ON
POWER
VOLUME
VIOLECTRIC
HPA V222
XLR
INPUT
RCA
PREMIUM HEADPHONE AMPLIFIER
ON
POWER
VIOLECTRIC
HPA V202

THE FUTURE NEEDS HERITAGE

Since 1986, we've been your partner for professional audio electronics.
It all began under the roof of Rosgartenstraße 13 in Konstanz, where three young enthusiasts started out developing and manufacturing limiters and noise gates—without much commercial success. It was the production of headphone amplifiers that ultimately kept the business afloat, albeit on a modest level.

Our first significant development was sparked by a suggestion from Lupo Greil, then head of the Music Shop in Munich. He needed a headphone distribution amplifier, preferably an active one. He liked our ideas, and in Lake People's founding year, we developed the Phone-Amp V6, which was offered for the equivalent of €270. The unit quickly found satisfied users, though some noted the insufficient volume with the high-impedance headphones common at the time. Indeed, the V6's internal design was fairly basic, and the ±15 volts operating voltage didn't provide enough headroom for the volume-hungry clientele.

1988

To address this, we introduced the **Phone-Amp V6 HP** (High Power), capable of delivering a full 20 volts RMS into high-impedance loads (>200 ohms) thanks to its ±30 Volts (60 Volts total) supply. The challenge was to keep the compact unit short-circuit-proof, which we solved using a specially designed, temperature-monitored transformer. The **V6 HP** was priced around €320.

1989

By 1989, the **Phone-Amp V6 HP** was available under the **AKG** brand. That same year, we created our first custom unit for SDR (Süddeutscher Rundfunk) in Stuttgart: the **V6 HPS**.

1990

Starting in 1990, the headphone amplifiers were offered with balanced inputs under the names **V6 Pro** and **V6 HP Pro**, priced at approximately €350 and €400, respectively.

A standout innovation from 1990 was the **G1 HP**, arguably the world's smallest headphone amplifier at the time, measuring just 110 x 56 x 80 mm and including a built-in power supply—retailing for about €175. A DIY version without housing was available as the **G2**.

Another notable development for SDR was the **G7 Satellite**, a headphone amplifier with an integrated 8-channel mixer, powered via a 36-pin system cable using Centronics connectors. The G7 quickly became a go-to solution for virtually all German-speaking broadcasters.

In the early 1990s, the development of Germany's first **20-bit A/D and D/A converters** catapulted Lake People into the spotlight, earning the company a reputation for cutting-edge high-tech solutions.

Over the years, our steadily increasing know-how led to significant growth in both our analog and digital product ranges.

1991
In 1991, the previously re-acquired **V6** and **V6 HP** models were renamed **G5** and **G6**, and were also made available in professional ("Pro") versions.

1992
By 1992, only the "HP" headphone amplifiers remained in production—simplifying the naming and phasing out earlier versions without replacement. The **G7 Satellite** evolved into the **G7 Mk II**, and later into another version called the **G14**.

1995
A complete redesign of our headphone amplifiers took place in 1995. This resulted in three new models:

- **Phone-Amp G3** with unbalanced inputs (~€200)
- **G3 Pro** with balanced inputs (~€250)
- **G8 Deluxe** (~€300)

1999
In 1999, the next generation of amplifiers was introduced, featuring a focus not only on high volume but also on superior audio fidelity. The newly developed amplifier circuit, later used in the **G109** and **V100**, debuted in the models: **G92**, **G94**, and **G96**, priced between €220–320.

2000
The **G92** was replaced by the more affordable **G91 Std** and **G91 Pro**, starting at €170.

2001
A new **satellite** amplifier, the **G98**, was released as a successor to the **G7**, priced around €900.

2004
Further development of the **G94** and **G96** led to the **G95** and **G97**. The **G91** was reworked into the **G93** in 2005.

2005
As our products gained popularity beyond studios and into home use, we launched a high-end version of the **G97** in 2005. Outfitted with a premium Alps RK27 potentiometer, the **G99** was tailored for audiophiles.

It was so well-received that by 2008, an enhanced version—the **G100**—was introduced, featuring a toroidal transformer, optimized circuitry, and the RK27. This became the foundation for what would become Violectric.

2009
The Violectric brand was born in 2009. Its first products were:

- **HPA V90** – entry-level model
- **HPA V100** – based on the G100
- **HPA V200** – flagship amplifier with a unique amplification design that remains unmatched.

2010
The **HPA V181** launched in 2010, becoming the first German-made headphone amplifier with a balanced output.

2012
In 2012, Lake People introduced a visually and technically refined lineup: **G103**, **G105**, **G107**, and **G109**.

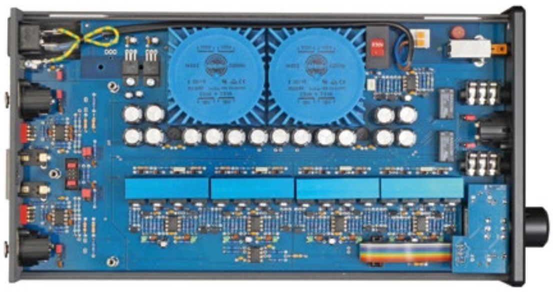
2014
By 2014, Violectric unveiled its most advanced and luxurious models to date: the **HPA V220** and **HPA V281**—the culmination of three decades of engineering expertise and dedication.

2015

Violectric streamlined its product line: the **V90** and **V100** amplifiers were discontinued. From this point on, two distinct amplifier technologies were officially defined:

- "**V100 Technology**" (4 transistors per channel) used in models like **G105**, **G107**, **G109**, **RS 02**, **RS 08**
- "**V200 Technology**" (8 transistors per channel), exclusive to Violectric's top-tier models like **V200**, **V280**, and **V281**

The **HPA V280** was introduced as a new, "simpler" balanced amplifier in the Violectric line.



At the end of 2015, in celebration of 30 years of Lake People, the **G109-A** "30 Years of Excellence Special Anniversary Edition 1986–2016" was released.

2016

Lake People expanded its RS Series (Reference Standard) with the addition of two high-end headphone amplifiers: **RS 02** (unbalanced) and **RS 08** (balanced).

2018

In May, the **Niimbus** brand was launched with the debut of the **US 4** and **US 4+** headphone amplifiers—refined successors of the V281. These models featured a bold new design language and extraordinarily complex internal circuitry, combining more than 30 years of Lake People expertise.

2019

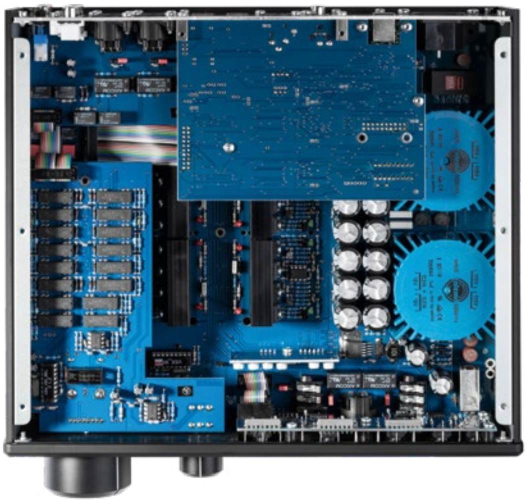
Lake People expanded production capacity in Konstanz and began custom assembly of **Mogami cables**.

The **G100** had already opened the door to the Hi-Fi market, and in 2019, its legacy was continued with the **G111**—a compact headphone amplifier delivering exceptional sound.

2020

In January, Lake People electronic and cma audio GmbH officially joined forces. Shortly thereafter, the new **Violectric V-Series** launched, marking another milestone in audio engineering.

The **DHA V590PRO**, a multi-award-winning DSD/DAC headphone amplifier with cutting-edge conversion technology, became one of the most powerful devices on the market.



Its analog counterpart, the **HPA V550**, followed as the high-performance successor to the legendary **HPA V281**.

2021

The Lake People **G111 MKII** was introduced as a reference-class headphone amplifier for professional studio applications.

2022

Violectric launched the **DHA V226**, a compact headphone amplifier with built-in DAC and USB-C connectivity.

2023

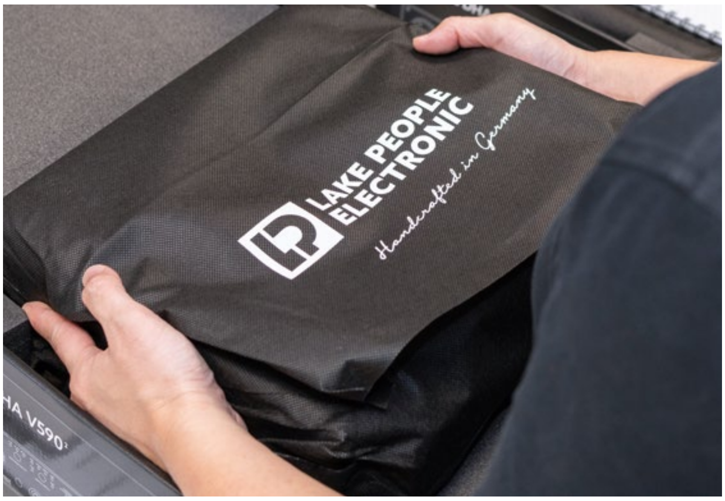
The **PPA V790**, a phono preamplifier from Violectric featuring extensive configuration options, entered the market.

2024

Violectric introduced the **HPA V324**, a balanced premium headphone amplifier with four power stages, preamp functionality, and calibrated VU meters.

2025

Lake People unveiled the **Phone-Amp G118**, a balanced studio headphone amplifier in a 19-inch rackmount chassis. It features mono/stereo/phase-reverse switching, a PREGAIN control, and VU meters—tailored for professional studio environments.



RELIABILITY AND LONGEVITY

Products from Lake People and Violectric are not mass-produced commodities—and for good reason. Our customers make a conscious investment in quality that pays off over time. Reliability, exceptional craftsmanship, and long service life are not just our promise—they are our standard.

The production costs of our devices primarily stem from manufacturing in Germany. Here, employees benefit from high ethical standards, solid social security, and fair wages that allow for a decent life with just one job.

Since we already invest heavily in production, we also make no compromises when it comes to component selection! Our products are designed not only to deliver technically, but also to meet the highest standards in terms of appearance and feel.

That's why we use rugged aluminum enclosures with a minimum wall thickness of 3 millimeters. Our front panels vary between 3 and 10 millimeters thick.

The surfaces are glass bead blasted, a process that densifies the aluminum and improves the durability of the anodized coating. In many cases, the panels are also brushed. All labeling is laser-engraved, not printed—so it won't wear off over time.

Another mark of quality: Most of our devices use traditional transformers for power conversion, not switching power supplies. This might be less convenient for users needing to switch mains voltages, but it significantly benefits sound quality—even if it's more expensive.

Like nearly everywhere today, many of the electronic components come from China—this is virtually unavoidable. However, component placement, soldering, and final assembly are mostly carried out in Germany. Throughout the entire production process, every device undergoes continuous quality checks.

Heat—The Silent Enemy of Electronics

Heat is a major factor in the aging and failure of electronic components. It can dry out capacitors, increase tolerances, and damage semiconductors. Our specialized circuit designs reduce heat where possible, and we distribute internal heat evenly to avoid hotspots. We also take steps to keep internal temperatures below 122°F (50°C) whenever possible.

Mechanical Components—Built to Last

Switches and rotary controls endure the most wear and tear—which is exactly where many manufacturers cut corners. The result: poorly coated contacts and cheap potentiometers that crackle and fail.

At Lake People, we focus especially on these mechanical components. Wherever possible, we avoid mechanical switches in the signal path and instead use sealed relays or electronic switches. For volume controls—the most frequently used component—we rely on Alps potentiometers from Japan, which have proven to be extremely reliable over nearly 40 years of use. Scratchy knobs are virtually nonexistent.

Protection from Misuse and Overload

Protecting your headphones is a top priority for us. Many of our devices feature delayed startup, so headphones are only powered once operating voltage is fully established—eliminating harmful pop noises at startup. Additional protection circuits monitor DC offset, prevent overloading, and manage high temperatures.

Our amplifiers also include current limiters, protecting both the amplifier and your headphones from damage. You don't have to worry when plugging or unplugging your headphones—our systems have you covered.

The Bottom Line: Lake People and Violectric products are built to deliver exceptional sound, outstanding reliability, and long-term performance—for people who listen seriously, and for the long haul.


High Definition Driver 300 Ω
XLR
INPUT
RCA
PREMIUM
BALANCED
HEADPHONE
AMPLIFIER
VIOLECTRIC

LAKE PEOPLE AUDIO

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