Fried Reim

The Headphone Amplifier Cookbook

Why bother with a headphone amp at all?

NIMBUS

LAKE PEOPLE

VIOLECTRIC

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WHY A HEADPHONE AMPLIFIER?

Isn't a headphone just a small speaker – and doesn't it need a small amplifier, if at all?

A headphone amplifier is a piece of equipment that processes an audio signal with the purpose of adapting it to the special characteristics of a headphone.

On the face of it, there's nothing amazing about that. In fact, it's pretty easy to accomplish. But – as with almost everything – the devil is in the detail. You have to go to some lengths to build one amplifier suitable for any headphone.

Headphones exist in many variants. There are two important characteristics: impedance and sensitivity.

Generally, we can say that headphones with higher impedance are less sensitive than headphones with lower impedance that are, as a rule, more sensitive. That's not always the case but it mostly holds true.

> Headphones with **higher impedance** are **less sensitive** than headphones with lower impedance.

The sensitivity of a given headphone can often be expressed in dB (sound pressure) per mW. Let's take a look at two models. The AKG K1000 has a sensitivity of 74 dB/mW while the Sennheiser HD25 has 108 dB/mW.

We need over 2,500 times more power to achieve the same sound pressure level on the K1000 than we do on the HD25.

Here's an additional problem: headphones with high impedance often need high voltage to playback loudly. So we'll need an amplifier with a high operating voltage. With high-impedance headphones, a "little" amplifier isn't going to cut it.

When we're powering low-impedance headphones, other technical details need to be considered. We'll have a look at those later.

WHY IT'S USEFUL TO HAVE VARIABLE AMPLIFICATION

PRE-GAIN on LAKE PEOPLE and Violectric gear

Because headphones operate very closely to the ear, they are substantially more sensitive than loudspeakers. Some in-ear monitors have an extremely high sensitivity. This can make annoying static noise of an amplifier noticeable to listeners.

The laws of physics mean that there is always static noise. Its volume depends on the fundamental gain of the amp (and its output stage). For reasons of electric stability, the gain can't be set arbitrarily low. That's why the fundamental gain is normally around 10–20 dB, i.e. a factor of between 3 and 10.

Sensitive headphones don't need lots of gain, whereas high-ohm headphones that aren't as sensitive do.

To attain the lowest levels of noise on one hand and the highest possible amount of gain on the other, it's desirable to have a variable gain setting before the output stage. We call this feature PRE-GAIN.

> **Pre-GAIN** enables the **lowest levels of noise** on one hand and the **highest possible amount of gain** on the other.

On our products, we often offer this in 5 levels: -12, -6, 0, +6, +12 dB.

Let's look at two (extreme) examples here. The common characteristic is a headphone amp with 8 dB of gain (x 2.5), with the volume set to maximum.

HPA RS02

The LAKE PEOPLE HPA RS02 provides a variable gain setting in front of the amplifier which can be adjusted in five steps.

1. Example:

The (pre)amp delivers a voltage of 4 Volts. But the headphone needs only 2 Volts to provide 100 dB sound pressure. At maximum volume setting, the headphone amp would deliver 10 Volts at 8 dB of gain. So you'd have to be very careful in adjusting the volume control to avoid damaging your hearing. Also, noise at the input should be avoided because it'll also be amplified.

Using a PRE-GAIN stage, the input level is reduced by 12 dB (1/4). A 4 Volt input signal is turned into a 1 Volt signal. That single Volt is then amplified 2.5 times, turning it into 2.5 V. You can now turn the volume up without a problem.

2. Example:

The (pre)amp delivers a voltage of 1 V, the headphone needs 10 Volts to provide a sound pressure of 100 dB.

If the volume control is set to maximum, the headphone preamp would deliver 2.5 Volts and 8 dB of gain. That's far below what a headphone needs.

We can use PRE-GAIN to increase the input level by 12 dB (x 4). 1 Volt is turned into 4 Volts. This is then amplified 2.5 times, making 10 Volts. That's exactly the right level for a headphone.

WHY HIGH INTERNAL VOLTAGE IS IMPORTANT

Headphones don't need a lot of power. But $P = \frac{U^2}{R}$ means that at a given resistance the power relies on the square of the voltage. So the more impedance (resistance) the headphone has, the more voltage is required.

This is only partially linked to the maximum attainable volume. Music is all about fast transients, and these place substantial demands on the technology used to transmit the signal.

A fast impulse can push a conventional amplifier with a maximum operating voltage of +/- 15 Volts to its limits. LAKE PEOPLE and Violectric products normally have an internal voltage of +/- 30 Volts. This gives you more control and the peace of mind that you're going to be powering the headphone linearly with no distortion. That will extend the life of this expensive piece of equipment.

WHY A HIGH DAMPING FACTOR IS IMPORTANT

After creating a force, every electrodynamic system then creates a counter-force (counter-EMF). When the voice coil in a headphone is caused to move by the amplifier, a counter voltage results when the coil returns to its initial position.

This voltage should be suppressed as much as possible. And that's easiest if the output impedance of the amplifier is as low as possible. That's because its ability to take up current is as high as possible.

The damping factor describes the relationship between the output impedance (= output resistance) of an amplifier to a given load.

Let's assume a load (impedance of the voice coil) of 50 Ohms. This results in damping factors of over 500 at output impedance below 0.1 Ohm in our amplifiers.

But the output impedance of the amplifier and the impedance of the headphone have an adverse effect on the linearity of the frequency progression; they "bend" it. This effect becomes stronger with rising amplifier output impedance and falling headphone impedance.

Headphones might sound **different on various amps** – depending on the **damping factor**.

This explains why some people "prefer" headphones hooked up to one specific amplifier over when they're connected to another.

WHY USE A RELAY TO SWITCH ON/OFF

Every amplifier produces noise or interference when it's switched on or off. This can damage any headphones that are attached.

We can use a relay connected to some additional electronics to delay connection between the headphones and the amplifier and immediately disconnect them when it's turned off.

This protects the headphones from the electronics as long as no proper operating conditions can be expected.

WHY IT'S USEFUL TO LIMIT THE FREQUENCY RANGE

Sounds are an electrical AC current. Young people can hear sounds from 20 Hz to 20,000 Hz. The older we get, the less sensitive we become to the higher frequencies.

To reproduce these frequencies well, the amplifier's frequency response should be as wide and as linear as possible. The lower limit is set by the DC voltage (0 Hz). Obviously, we can't go any lower. The upper limit can be set at (almost) any desired value. But that also makes the equipment sensitive to electromagnetic interference.

Although you can't immediately hear them, they mix with the useful frequencies and become audible. So rather than a sign of incredible engineering prowess, not restricting the frequency range is, in fact, quite irresponsible.

WHY A GOOD VOLUME CONTROL IS IMPORTANT

A volume control is a mechanical actuator. These are available on the world market in versions covering all price points. These days, they're often replaced by electronics. This circuitry, however, often has disadvantages in terms of dynamics, noise and distortion.

Resistive elements made from conductive plastic, good-quality "multi-tap" loops and physical separation for the individual sections are desirable for high-quality applications.

To guarantee problem-free use over many years, you need high-quality components.

Because the market for really good potentiometers is pretty small, manufacturers like Noble or Panasonic have stopped making them. That's why the RK27 pot by Alps is among the best available.

Read more about volume control on page 15 in this guide.

VIOLECTRIC V280

The Violectric V280 offers two unbalanced headphone sockets as well as a 4-pin XLR socket for balanced headphones.

WHY BALANCED SIGNALS ARE BETTER

In contrast to the unbalanced kind, balanced signals use two conductors (plus ground). A symmetrical signal is created when the original signal is inverted (phase shifted by 180°) on the "sending" end. One conductor is transmitting Signal (a), the other Signal (-a). In the equipment on the "receiving" end, the signal is fed into a differential amplifier. This produces the difference between (a) - (-a) = 2a.

Noise can be introduced along the path between the two devices. The noise is in phase and also reaches the differential amplifier. This produces the difference between the two noise elements (s) - (s) = 0. Ideally, this will eliminate any noise introduced along the signal path.

Find out more about balanced signals on page 23.

WHY AMPLIFIERS WITH SYMMETRICAL OUTPUTS ARE BETTER

Common (unbalanced) headphones have 3-conductor cords and are plugged to 3-pin jack sockets. While the signal is running through dedicated conductors for the left and right signal from the amp to the headphones, it is running through only one conductor back from the headphones to the amp. So, the residual left and right channel energy is transmitted along this common cable from the headphone to the phone jack of the amp and here to the device's ground. Each element, the cable, the socket and the ground wiring inside the amp have specific resistances where a voltage is dropped. This "contaminates" the ground (which should be completely neutral because it is the reference point) with the residual signals of L+R – which is a mono signal. The generated effect is crosstalk, it is measurable and audible as intermodulation between the channels.

Running a balanced configuration you need four wires from the amp to the headphone. Every headphone voice coil is powered by two amplifiers running at 180° phase in "push-pull" operation. When one "pushes", the other "pulls". This means not only double the output voltage – and significantly higher volume – but the ground is free from any crosstalk interferences.

For more on amplifiers with balanced outputs see page 28.


VIOLECTRIC
DIG
RCA
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DIFFERENT WAYS OF CONTROLLING VOLUME

To control volume, we need a voltage divider. Its job is to pass only a certain amount of the voltage from one part of the device to another. The simplest form of voltage divider is an actuator called a potentiometer, also called a "pot" for short.

POT

You can picture a pot used to control volume as a "naked" resistor. On one side, the pot is connected to the source signal, on the other to the ground. A mechanical wiper moves along the surface of the resistive element.

If the wiper is closer to the side connected to the source, the signal is louder. If it's nearer the ground, the signal is quieter. When the wiper is touching ground, the signal is "gone".

It's easy to imagine that this kind of mechanical actuator can be made with varying degrees of effort and cost.

The resistive element can be made of carbon, ceramic or conductive plastic of varying quality, the wiper can be made of simple or special material, can be formed in a simple or more special way.

For use cases in stereo configuration, things get more complex. The resistive paths for the left and right channels should be as similar as possible (which is difficult) and should ideally be physically separate.

If you want to guarantee operation over many years, the surface of the resistive element should be as hard and smooth as possible. The wiper contact should be made of a specially suited material, like silver or gold.

The pot is filled with a special lubricant. Age and friction will eventually make the pot "scratchy" because the wiper no longer sits perfectly on the resistive element. But if your bright idea now is to use some contact spray, forget it. The spray will act as a solvent to get rid of grease. To begin with, the pot will stop scratching, but after a while the problem will get worse.

Never use **contact spray** at a potentiometer!

The mechanics of the pot are also important. It shouldn't wobble around the axis. A heavy and smooth turning motion is also desirable, as is the same torque on devices with several pots.

Also, a pot can be fitted to include steps that allow the user to come back to the same setting:

- Volume pots often use 31 or 41 steps
- A balance pot often has a centre position
- Attenuating the sound is best done using a 13-step pot

These "steps", by the way, have nothing to do with those in step switches. All they do is to give the user a better idea of the position the pot is set to, and provide the feeling that the control is working at high precision.

Because of its design principles, the pot's source "sees" a constant, high impedance. The next stage "sees" a highly variable impedance.

To avoid interference, this impedance should also be small. This can only be achieved by adding more electronics, ideally by using a buffer amplifier.

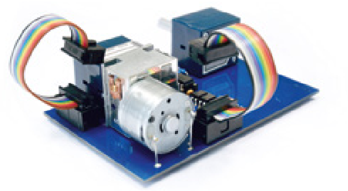
This, by the way, is a reason why passive actuators in the signal path often cause more problems than they solve!

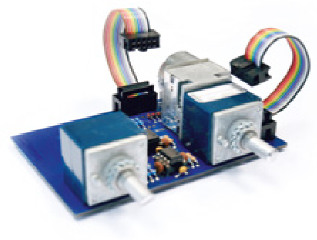
The world potentiometer market offers products priced all the way from almost nothing (a few cents) to eye-wateringly expensive. The Alps RK50, for example, costs several hundred Euros.

The market for really good potentiometers is small. That's why companies like Noble or Panasonic stopped making them. The Alps RK27 is our go-to product for good quality at an acceptable price.

Pots can easily be "automated" by fitting a motor and transmission. A slip coupling lets the user move the wiper while a motor is attached behind it.

Pots are often expensive and sooner or later will become susceptible to wear. That's why people have been trying for a long time to develop alternatives:





STEP SWITCH

A step switch is a good alternative to the potentiometer.

Instead of resistive paths it uses a voltage divider made up of two resistors per step, giving better channel balance. If the contacts and build quality are good, this kind of switch will last longer than a pot.

But there are also considerable disadvantages. The small number of steps (12 or 24) means that this type isn't well suited to controlling volume. It's expensive, especially the 24-step version. It's more difficult to make and can't be automated.

ELECTRONIC SWITCH

An electronic switch is an element that can be switched between a resistance with a high number of Ohms to a resistance with a low Ohm number.

The first electronic switches had problems with the "low" part (the on-resistance wasn't all that low and it varied considerably). This "switch" is also a Field-Effect Transistor, meaning that it can cause considerable amounts of distortion.

Under certain circumstances, electronic switches can be used to replace relays in applications such as input switching. Electronic switches have also been developed with narrower ON-resistance tolerances.

Despite all the advances made in their design, electronic switches are only partially suitable as replacements for potentiometers.

Putting to one side the advantage that these switches will never scratch or crackle, they aren't generally very "hi-fi". But they are cheap; prices have fallen off a cliff. Another advantage is that they are very easy to automate.

VCA

VCA stands for Voltage Controlled Attenuator. The VCA arose as the "four-quadrant multiplier" in early analog computers and was developed further in the early 80s for audio technology applications. It was used in studio contexts in limiters and noise gates. Early forms of mixing console automation also used VCAs.

When damping, it causes levels of distortion that aren't tolerable these days, making it useless for use in hi-fi gear.

The control voltage in a VCA is relatively small (6 mV per dB of damping), meaning that it has relatively poor channel balance. It's also more difficult to automate.

MONOLITHIC INTEGRATED CIRCUITS

Philips was among the early pioneers in this field in the 1980s when it made the TCA730 and TCA740. These chips had simple linear pots controlling volume, balance, treble and bass for two channels.

The idea was to make pots as cheap as possible while reducing the amount of wire connections needed. Unfortunately, these ICs quickly got a reputation as sources of hiss and distortion. They're totally unsuitable for premium hi-fi equipment.

DCA

The Digitally Controlled Attenutator was the result of advances in chip technology during the late 90s. While the attenuator itself is analog, the internal "switch" is set digitally.

The DCA's internal structure is a clever combination of many electronic switches, precision resistors and buffer amplifiers.

One of the first to perform well was the CS3310 by Cirrus Logic. This and later components have two channels and mostly offer 256 steps of 0.5 dB each.

It uses zero cross switching and is well suited to use in hi-fi equipment in terms of linearity, noise and distortion. It's also very easy to automate.

One disadvantage of the CS3310 is that it can only be run at 5 V, limiting its usefulness in controlling volume. This has been improved in some of its derivatives.

The CS3310 and similar units are often used in the audio field but are still far from ideal for serious hi-fi equipment.

RCA

The Relay-Controlled Attenuator combines all the advantages mentioned above and avoids the concomitant disadvantages.

The relays are switching between different combinations of resistors in a way that's reminiscent of a step switch. But it has many more steps and can be automated and remote controlled.

Some Violectric products incorporate a 128-step model. Each step represents 0.75 dB, creating a volume range of 96 dB.

A 256-step version is available in Niimbus gear with a step value of 0.4 dB, creating a volume range of over 100 dB.

Of course, we're not using 128 relays per channel. 128 = 27 or 256 = 28 combinations mean 7 or 8 relays per channel.

The advantages:

- no scratching or crackling because no resistive strips involved
- excellent channel balance using 1 % and 0.1 % resistors
- Best cross-talk damping (channels are physically separate)
- Greater (theoretical) control range than a potentiometer
- Multichannel configurations very easy to realise
- No danger of additional noise or distortion because the signal path only includes fixed resistors

There are disadvantages:

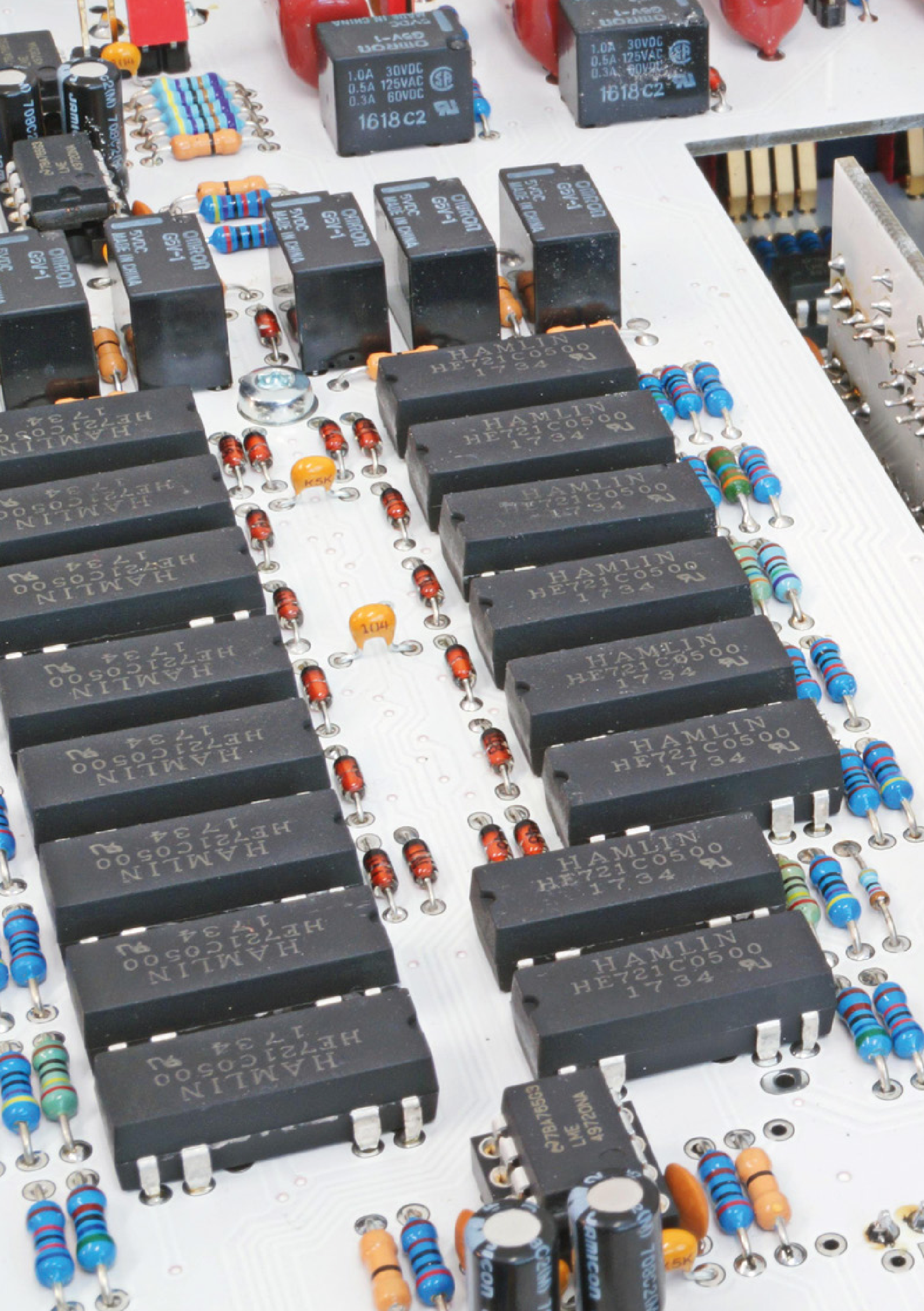
- This is the technically most elaborate and costly solution
- Mechanical noises while settings are made
- Slight sound artefacts and clicks possible while settings are made

Summary:

RCAs are the best way of controlling volume!

NIIMBUS US 4+

Niimbus US4+ uses a volume control with a nearly inaudible reed relay with 256 stages in 0.4 dB steps.


1.0A 30VDC
0.5A 125VAC
0.3A 60VDC
1618 C2
1.0A 30VDC
0.5A 125VAC
1618 C2
HAMLIN
HE721C0500
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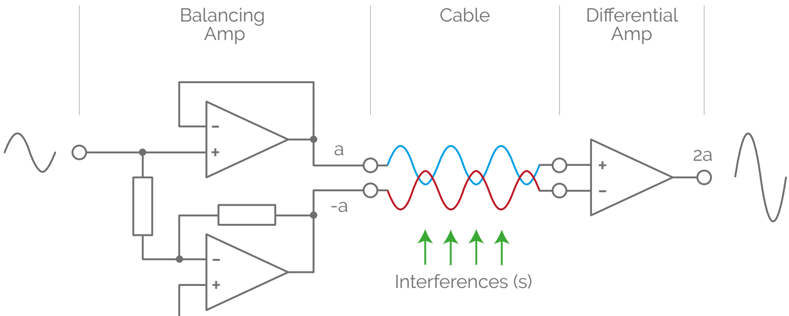
ON BALANCED HEADPHONE AMPLIFIERS

DIFFERENT FORMS AND USES OF BALANCE/SYMMETRY

Balanced Signal Paths are used to attain the lowest sensitivity to noise along a signal path. If you've served in the military, you might remember the old field telephones and the unfortunate people who had to carry the cable reels on their backs. Field telephones were a rudimentary form of telephone with no electronics or power supply. They were connected with each other using simple twisted two-core wire. But the person on the other end is still audible even if the wire is several kilometres long. That's an example of a balanced signal path in action!

The simplest, most reliable and most precise way is to use a transformer. But these are expensive and have problems handling high frequencies. In an electronic balancer, an existing unbalanced signal (a) is turned into an 180° phase-inverted signal (-a).

The two signals are then sent down a dual-core twisted cable that doesn't require any additional shielding. Any interference encountered along the way to the receiver affects both signals. In the receiver, the signal is routed to a differential amplifier.



balanced signal transmission

As the name suggests, this component generates the difference, subtracting one signal from the other: a - (-a) = 2a. The interference goes through the same procedure: (s) - (s) = 0.

In an idealised scenario, the receiver will have double the signal strength with no interference. In the real world, of course, it doesn't work 100 %.

Voltage and impedance factors have to be considered, measurable in practice as common mode rejection (CMR). The more elaborate the system, the better the results.

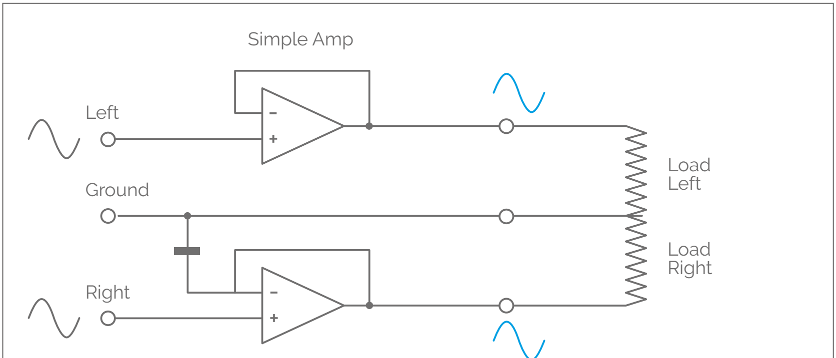
Aside from the advantage of much improved noise characteristics, balanced systems have another advantage over unbalanced signals.

The cable's ground or shield is used solely to shield the signal from interference and to balance out the potential between the connected devices, meaning that it has a purely static function. In contrast to unbalanced connections, the shield/ground is not used to carry the signal back.

The result? The ground is neutral and is not modulated.

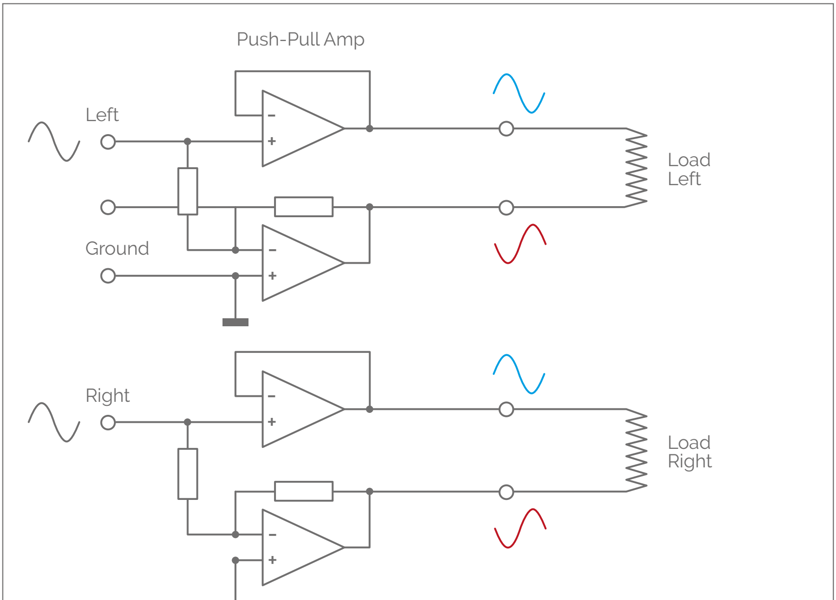
While a balanced cable is used to transmit a signal with as little interference as possible and to keep the ground static, a "balanced" amplifier has other uses.

Let's have a look at the basic principles behind a simple amplifier. The left and right input signals are amplified and sent to the left and right load.



the concept of a simple amp

Balanced amplifiers aren't new. They're used in car radios where a limited voltage (12 V) is used to multiply the power by 4. This kind of circuit is also called a BTL, which stands for Bridge Terminated Load. It looks like this:



the concept of a balanced amp

The input signals are sent to the load via two amplifiers. The trick is to use one amplifier working "normally" while the second is inverted, meaning that the phase is shifted by 180˚. When one amplifier pushes the voice coil, the other is pulling it. At the same voltage, this gives twice the voltage excursion and four times the power compared to a single amplifier system.

Another advantage is that the ground is completely neutral as it is "untouched" by the amplification process.

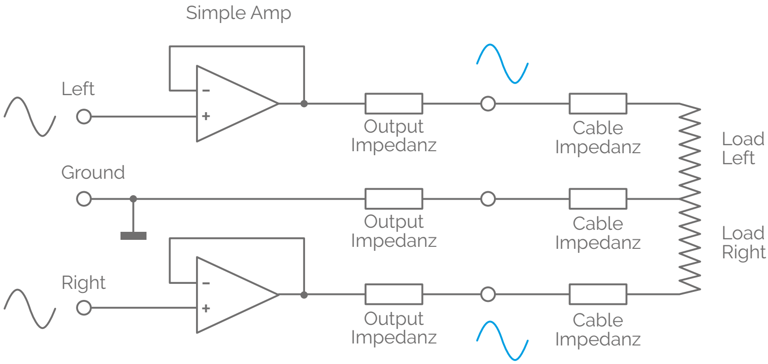
One disadvantage of the system described above immediately becomes obvious, however: We need double the number of components.

Unfortunately, the real world isn't as easy as the idealised examples above might suggest. The "simple" amplifier design has its caveats.

Apart from the load which we're trying to move here, there are myriad other "parasitic" impedances at play that we have to consider and which might impair the movement of the voice coil. We want to keep that as "clean" as possible.

Impedances are a complex mix of resistive, capacitive and inductive parameters, A high capacitive component in a cable might lead, for example, to instabilities in the amplifier's performance.

To keep things simple, we'll look at only the resistive component. Every resistive load causes a voltage drop, causing non-linearity in the system!

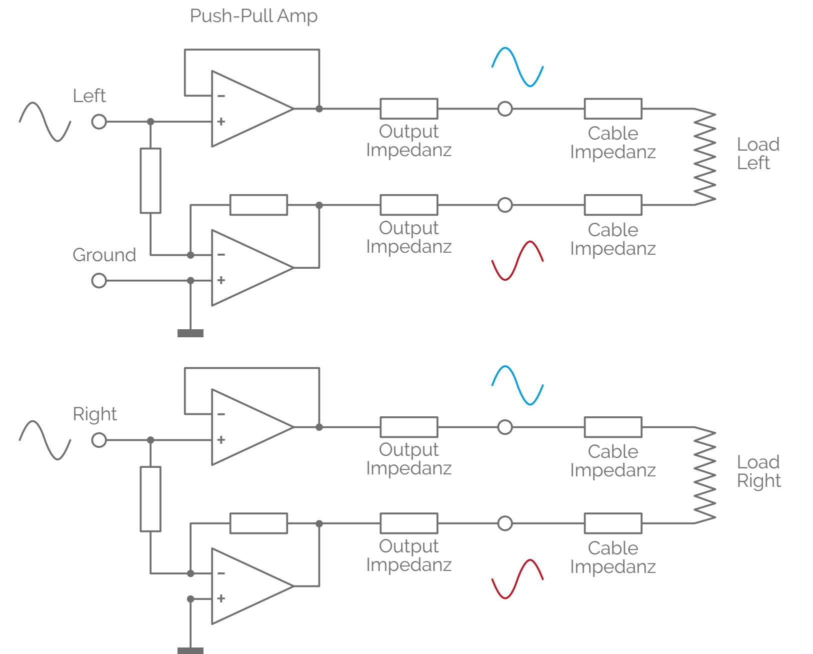


the "simple" amp with "problem areas"

A few problems in the left circuit diagram become visible straight away:

- The higher the resistive load, the weaker the influence of the parasitic impedances
- The lower the resistive load, the stronger the influence of the parasitic impedances
- The lower the output impedance of the amplifier, the lower its influence on transmission quality
- The lower the resistive load, the higher the effect of cables and the output impedance
- With headphones on a TRS connector, the jack causes major problems via the ground cable – because it's used for both channels – as well as the poor connection between jack and socket (the contact surfaces are far too large)
- The ground is not "idle" but is loaded with a voltage. This voltage is dropping because of the cable and the internal impedance. This means that it's being modulated by Left + Right signals (meaning a mono signal). This is measurable and audible as cross-talk or intermodulation.

A balanced amplifier looks like this:



the balanced amp with "problem areas"

Instead of the six problem areas we get with a "simple" amplifier, we thankfully have only eight, rather than twelve. A balanced system doesn't result in double the number of problem areas.

The transmission quality increases because there's no shared ground, and the ground has no load.

But push-pull amplifiers aren't perfect. Aside from the increase in product cost by needing twice the components, the following areas need consideration:

- Double the output impedance because two impedances per channel
- More static noise because the amplification is doubled
- More danger of distortion because of two amplifiers

When designing a balanced or push-pull amplifier to power headphones, we're not focussing on maximising the output amplitude, especially not when we're powering headphones with low resistance.

There are plenty of products in the LAKE PEOPLE / Violectric palette that provide more than enough amplitude, even when used with headphones with high resistance.

WHY IS A BALANCED HEADPHONE AMPLIFIER USEFUL AND DESIRABLE?

As we learned earlier, a "simple" amplifier is referenced to ground. Specifically, that's not some ground cable or surface in the device but the bottom of the transformer.

The amplitude of the signal oscillates as smoothly as possible around this reference point (otherwise we'd be talking about DC offsets) and is limited only by the positive and negative operating voltage. The theoretical maximum effective amplitude (V_{eff}) is calculated as follows (simplified):

$$\frac{\text{Operating voltage}}{2 \times \sqrt{2}} \approx \frac{\text{Operating voltages}}{2{,}83}$$

This voltage is passed along a shared path to the ground connector in the headphone socket of the device via the load (the headphone voice coils).

From there it's carried to the base point of the transformer, which is the real reference or ground point.

The conductive pathways in the headphone and the device, as well as the ground surface in the device do not have infinitely low resistance. They also have their own resistance, producing a load that results in a drop in voltage.

This is how the reference point "ground", which should be at "idle", is "contaminated" by residues from Left and Right. It is a summed mono signal that's measurable and audible as intermodulation, or cross-talk.

As seen above, many factors play a role, including the circuit itself (output impedance), circuit layout, headphone cabling as well as the relationship between the sum of the ground + return resistance and the load resistance (voice coil).

Advantages of a balanced amplifier

A balanced amplifier (or full-bridge or push-pull or BTL amplifier) consists of two amplifiers per channel. One delivers the normal input signal, the other the same signal phase-shifted by 180° (inverted) to the headphone's voice coils.

Because the load (the voice coil) is being pulled forth and back by the In-phase and out-of-phase amps, the ground potential remains completely untouched. That means that no cross-talk effects are caused.

The big advantage of a balanced (headphone) amplifier is the channel separation. The channel separation in "standard" amplifiers is often good enough that users won't complain. But many of those don't know how to do it "better".

> Balanced (headphone) amplifiers offer a perfect **channel separation.**

When listening to standard headphones, often the enhanced channel separation is rated to be "unnatural" because of the in-head localisation. This effect is sometimes reduced by the users by adding "crossfeed".

But the optimised cross-talk damping and the reduced intermodulation – the stringent separation of the channels – are also a reason for the aural epiphany that many people experience when listening to balanced amps and headphones.

The spatial characteristics are improved, the reproduction accuracy is enhanced and the arrangement of specific instruments on the stage is more precise.


"LISTENING ON
BALANCED
HEADPHONES
IS LIKE BEING PART OF THE
ORCHESTRA."

Put simply

Listening to speakers is like sitting in the auditorium. Listening on “normal” headphones is like listening from the conductor’s position. Listening on balanced headphones is like being part of the orchestra.

Advantages of a balanced outputs

A technical advantage of balanced outputs is that we’re freed from having to use jacks; we’re no longer forced to accept a (sometimes very high) connector resistance.

We sometimes see two 3-pole XLR connectors used, even though that’s completely pointless. There are also devices with dual stereo jacks.

At LAKE PEOPLE / Violectric / Niimbus, we decided to use a 4-pin XLR connector on the output side configured in the way that became standard during the days of the AKG K1000. Like every manufacturer we diverged from the norm by using the female connector on the device (without a latch) and the male type on the headphone side.

Balanced headphones

All we need to figure out now is how to adapt existing headphones for balanced operation if they’re not available in a balanced version.

Generally, if they use a four-conductor cable, it’s not a problem. This is often the case if the cable goes to the left and right earphone. All you need to do is cut off the jack and solder on a 4-pin XLR connector.


HPA V200
VOLUME
DAC V800
COAX
OPTO
LOCK
INPUT SELECT
MUTE ON
ERROR
MUTE

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HEADPHONE AMPLIFIERS BY LAKE PEOPLE

The initial spark for the first stage in the development of our company came from Lupo Greil, who used to run Music Shop in Munich. He needed a device to distribute signals to headphones, preferably an active device.

He liked our first ideas and in 1986, the year the company was founded, we developed the **V6 Phone Amp** which sold at € 270 in today's money.

The product soon found many satisfied customers who nevertheless sometimes complained that the volume wasn't high enough for the high-Ohm headphones that were common at the time.

Truth be told, the internal workings of the **V6** we relatively "normal". The available operating voltage of +/- 15 V wasn't enough for those clients hungry for more volume.

1988

Back in 1988, we extended our portfolio with the **V6 HP Phone Amp** (HP = High power). With its 60 V (+/- 30 V) operating voltage, the unit could effectively deliver 20 Volts to high-Ohm loads (> 200 Ohms).

The fundamental design challenge was preventing the device from shorting out given its very compact dimensions. We managed this by using a special temperature-controlled transformer. The **V6 HP** was priced at € 320.

1989

From 1989, the V6 HP was also available as an AKG-branded product. That year also saw the first custom edition, the **V6 HPS**, for the now-defunct broadcaster Süddeutscher Rundfunk based in Stuttgart.

1990

From 1990, the headphone amps were offered with “Pro” added to the name as **V6 Pro** and **V6 HP Pro** featuring balanced inputs. They retailed at € 350 and € 400 respectively.

In 1990, we came up with a new product, the **G1 HP**. It was probably the smallest headphone amp in the world with a built-in transformer, measuring 110 x 56 x 80 mm. It cost around € 175. The same design was also available in a **G2** version without a housing for DIY fans.

Another product developed for SDR was the **Satellit G7**, a headphone amp with a built-in 8-channel mixer. It used a 36-pole system cable with Centronics connectors. That product was later bought by almost every broadcaster in German-speaking Europe.

1991

In 1991, the **V6** and **V6 HP** were once again offered under the LAKE PEOPLE brand. They were renamed **G5** and **G6** and, of course, also produced in a Pro variant.

1992

From 1992, we produced only “HP” headphone amplifiers. At this point we stopped using our naming convention of having a “normal” and “HP” version.

The **Satellit G7** was reborn as the **G7 MkII** and also produced in a **G14** version.

" WE REPRESENT COMPREHENSIBLE TECHNICAL-PHYSICAL SOLUTIONS AND THEIR HIGH-QUALITY IMPLEMENTATION. "

1995

In 1995, the existing headphone amplifier line-up was completely rebuilt, reappearing as the “simple” (unbalanced input) **G3 headphone amp**. It sold for around € 200. The € 250 **G3 Pro** offered balanced inputs while the **G8 “deluxe” version** was priced at around € 300.

1999

In 1999, the headphone amplifiers were redesigned again, now employing new technology. The focus shifted from providing maximum volume to ensuring excellent signal quality at the same high volume levels.

The amplifier we developed at that point is more or less the design used in the current **G109** and **V100**. The new models were named **G92**, **G94** and **G96** and cost between € 220 and € 320.

2000

Back in 2000, the **G92** was replaced by the cheaper **G91 Std** (€ 170) version and a **Pro** model.

2001

In 2001, we announced the successor to the **G7**; the **Satellit G98** was priced at € 900.

2004

From 2004, the **G94** and **G96** were developed into the **G95** and **G97**. In 2005, the **G91** was replaced with the **G93**.

2005

By now, our equipment wasn’t just being used in studios but also in homes. So in 2005, we decided to offer the **G97** fitted with an Alps RK27 premium-class potentiometer as the **G99** for home audio.

This model was so successful that we introduced the **G100**, an even more refined version of the **G99**, in 2008. It featured a toroidal transformer, improved circuitry and the RK27. This was the common ancestor of our Violectric product range.

2009

We introduced the **Violectric** brand in 2009. Its first products were the **HPA V90 headphone amplifier**, the entry-level product; the **HPA V100**, a refined version of the **G100**; and the **HPA V200**, the premium version using an amplifier design that was and still is completely unique.

2010

In 2010 we introduced the **HPA V181**, the first headphone amplifier with balanced outputs produced in Germany.

2012

2012 saw the introduction of the visually and technically improved LAKE PEOPLE **G103**, **G105**, **G107** and **G109** headphone amps.

2014

In 2014, the **HPA V220** and **V281** models were launched under the Violectric brand.

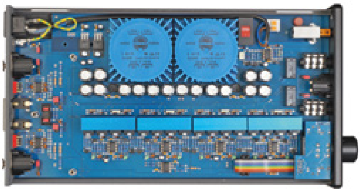
They were the most elaborate, best and expensive headphone amplifiers we had ever offered, and were the product of expertise accrued over three decades.

2015

20 We slimmed down the Violectric portfolio in 2015, deciding to discontinue the **V90**, **V100** and **V181** amplifiers.

From then on, the “V100 Technology” (4 transistors per channel, **G100**, **G105**, **G107**, **G109**, **RS 02** and **RS 08**) was differentiated from the “V200 Technology” (8 transistors per channel, **V200**, **V220**, **V280**, **V281**), which is exclusively available in our Violectric products.

In 2015 we introduced the **HPA V280**, a "simple" balanced amplifier, to the Violectric product palette.



In late 2015 and marking the 30th anniversary of LAKE PEOPLE, we launched the **PHONE-AMP G109-A** as an exclusive "30 Years of Excellence Special Anniversary Edition 1986 – 2016" model.

2016

The Premium series by LAKE PEOPLE (RS Series = Reference Standard) was extended by adding the **RS 02** (unbalanced) and **RS 08** (balanced) headphone amplifiers.

2018

In autumn 2018, we introduced our new Niimbus brand and its new **US 4** and **US 4+** headphone amplifiers. These are refined versions of the **V281** that profit from almost 10 years of additional experience gathered under the Violectric brand.

The Niimbus products follow a different aesthetic design philosophy and incorporate circuitry so lavishly extravagant in its complexity that it remains unique in our industry.

The future depends on the past!


THE FUTURE“
„DEPENDS ON THE PAST!

NIMBUS

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