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VALVE AMPLIFIERS FAQ

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"There are no stupid questions, only stupid answers"

- Unknown

"The noblest pleasure is the joy of understanding"

- Leonardo da Vinci

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VALVE AMPLIFIERS FAQ

About Amplifiers

What is an amplifier? Do I even need one?

An amplifier is an electronic device that has a very simple job: to make a tiny electrical signal bigger.

In audio, an amplifier takes the tiny electrical signals generated by whatever you're listening to (maybe a turntable, or a CD player, or whatever else… your **signal source**, in other words) and increases their power, to drive a pair of speakers.

An amplifier is a vital part of listening to music, whether through headphones or speakers (be they large house speakers or portable bluetooth ones). No matter how you're listening, the signal has gone through an amplifier.

This is because these source signals are too tiny to drive a speaker. The signal needs to have power added to it before it will be able to drive a speaker, or even a headphone.

Sometimes, the amplifier will have extra features built in, like tone controls for example, which give some control over the quality of the sound. But these are not required, just a nice-to-have option. ATRAD audio amplifiers offer tone controls as an optional extra.

So why don't we see amplifiers as separate things any more?

They're still there… just hidden.

Traditionally, stereo speakers didn't contain any electronics, you had to use wires to connect them to the "Speakers Out" terminals on your device. Those Speakers Out terminals are the output of the amplifier.

It meant you needed wires, but it also gave you freedom to position your speakers for best sound, best fit with furniture, etc.

More recently, all the electronics are frequently built in to the speaker, rather than being separate boxes.

Think of a bluetooth speaker, or a soundbar. You're playing digital media through it; maybe a streaming movie soundtrack, or Spotify, or similar. Same as a vinyl record, this is a tiny electronic signal that needs to be made bigger, to play through the speaker.

Inside the speaker box is the signal source (maybe a bluetooth receiver), and small amplifier, that does the job of adding enough power to drive the speaker.

And if you listen to bluetooth headphones, there's a tiny amplifier built right into them too.

Even in your phone, if you listen to headphones plugged right into your phone… the phone itself has a little amplifier in it just big enough to drive the headphones.

So how can you spot where the amplifier is hiding in modern gear then? The dead giveaway is the presence of a **Volume control**. If you see one of these, it's the part of the amplifier that you can see and interact with.

How do we measure amplifiers' performance?

Most people are interested in the amplifier's **power rating**, which is measured in **Watts.** More watts equals more sound power.

Because music is recorded with Left and Right channels, amplifiers are usually quoted in **watts per channel**, abbreviated to W/ch.

Sometimes, some manufacturers will try to inflate their gear's claimed power output, to make them look better. It's a bit dishonest, but in some cases, they will add both channels together and give one figure.

The power figure you should look for is "**RMS power**"* RMS is a standard, honest way of measuring amplifier power. It's how much power the amplifier can produce on a **sustained basis without distortion**.

After power, there are a few other specifications we use to measure amplifiers, the most common one is Distortion (which you'll see as "**THD**", which means Total Harmonic Distortion.) Distortion is an inescapable fact of any kind of electronics that do anything with a signal. The less the better. A theoretically perfect amplifier produces no distortion, but sadly they all do. Though a well-designed amplifier will have distortion figures so low that you can't hear them.

An interesting aside – In Guitar amplifiers, the distortion is a desired part of the sound, and the amplifiers are deliberately over-driven, so that they distort on purpose. The distortion can fit quite well with the sound and enhance it for the listener in some cases.

Similarly, an Instagram filter is a kind of distortion applied to the original picture that somehow makes it more pleasing too.

Amplifiers designed for hi-fi are designed and tested to minimise any distortions.

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* It means **Root Mean Squared**, a mathematically accurate way of measuring the average power in a varying wave form.

How much amplifier power is needed?

This is a difficult question to answer because it depends on several factors, such as:

- the size of your speakers
- the size of your room
- the type of music you're listening to
- how loud you like to listen
- whether you're using a subwoofer

A bit of background for understanding… most modern home theatre receivers (about the closest thing you can get to a separate amplifier now) are rated around **100 watts** / **channel** or more.

In the old days of valve amps, such a high power rating was practically **unheard of.** A low power amp in those days would have been less than 10 watts / channel, medium would be 10 up to about 30, and anything above 30 watts was considered a high power amplifier.

Beyond about 50 Watts was "WTF, are you deaf?!" territory.

But, things were a little different back then. For a start, speakers were a lot physically bigger. With speakers, bigger means more efficient. (Meaning they make more sound for any given input power). They needed to be big back then to handle the bass notes well, since subwoofers weren't in common usage, and amplifier power ratings were much lower than modern gear can provide.

Another factor was that the music people listened to back then was **a lot** less bassy than modern music (it takes a lot of power to produce loud bass).

With valve gear, extra watts come at a high cost. Also, valve gear drives speakers a little differently than modern gear. So if you've got one of our **15 watt amps**, you might find it to be unexpectedly powerful.

Also there's different ways you can use your amp. One popular modern configuration is to have smaller speakers handling the vocals and instruments, and a separate subwoofer hiding behind the curtain doing all the heavy lifting with the bass.

This takes a lot of power demand off the amplifier since it's the bass that takes up a lot of the power, and subwoofers usually have their own amp built in. (This is the way most Home Theatre systems work, it's why you can get such a full sound off smaller speakers… look for the hidden sub!)

What's the story with "phono" and "line" inputs?

- If you want to connect a **digital source** (such as a CD player, Chromecast, Digital Media centre, etc) you need to connect that to a **Line-level** input
- If you want to connect a **turntable**, you (probably*) need to connect that to a **Phono** input.

To understand this, we need to get a little bit technical.

The signals you feed into your amplifier, created by your source component, have to be at a specific level, which we measure in terms of **voltage.** (To over-simplify, this is how "big" the signal is)

Pretty much all source components you can think of (eg. CD, Digital media players, older sources like tapes, etc) all put out the same size signal: it has a voltage of up to **2 volts** for the loudest passages in the music. This size of signal is called "**Line level**".

A turntable on the other hand gives out a much lower signal – only **five thousandths of a volt** (we call these millivolts). So the turntable's signal is special, and needs extra amplification.

We accomplish this by having a separate input on the back of the amplifier specifically for the turntable, as below:

The signals from this input go to a separate stage inside the amplifier that amplifies it up to line-level. This is called a "**phono stage**" and it's an optional extra with our amplifiers, you only need it if you have a turntable.

Adding a phono stage adds 2 valves to the design of the amplifier.

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* Some newer turntables have the phono stage built-in, so they can be connected to an amp without a phono stage. This is useful, because a lot of modern gear (like Home Theatre receivers etc) don't have a phono input. **If you have a new-ish turntable, it may pay to check, you might not need a phono stage on your amp**

What is a Preamp?

So far we've been talking about "integrated" or all-in-one amplifiers.

Another design possibility is to have the amplifier split over two boxes. The smaller box is the part you connect all your source devices to, and it has all the controls (volume, input select, tone, etc). This part is the **pre-amp** (short for pre-amplifier) which is small and light and doesn't throw off much heat.

Then there is a larger heavier unit, called the Power Amplifier, which doesn't have any controls (except maybe a power button) that the speakers connect to.

In some totally over-the-top installations, there are TWO Power Amps, one for each speaker.

Usually, an integrated, or all-in-one design, is the most suitable.

What about a "Phono Preamp"? What is that? Do I need one?

A Phono Preamp is a single-purpose unit for use with a turntable.

If we look at the way electronic signals work, a turntable produces a different type of signal to any other source component. As a result, unless your amplifier has a separate turntable ("phono") input, you can't connect a turntable to it.

This is Bad News if you decide to buy a turntable. Suddenly you can't connect it.

The solution is to either buy a brand new amp with a phono stage, or you can buy a separate one. In this case, it sits **between** your turntable and main amplifier, and it boosts up the turntable's signal to a suitable level for the main amplifier.

ATRAD Audio amplifiers can be specified with an optional phono stage, if you want to play vinyl.

Some recently-manufactured turntables may include the phono preamp internally, so that they already put out a higher (called "line-level") signal. If you have a newer turntable and you're not sure, it may pay to check.

About Valves

What is a Valve (Vacuum Tube)?

Valves are one of the earliest electronic components. They were invented as a result of an accidental discovery in the manufacture of light bulbs. In what you could call the **defining lightbulb moment**, It was discovered that if you put another piece of metal inside the glass bulb, when the light was powered on and the filament was glowing, some electrons from that filament were attracted to the second piece of metal if it had the right kind of charge on it, but those electrons could flow in only one direction.

This exciting discovery opened up many possibilities, and led to lots of experiments being performed, and many more discoveries in regard to controlling that flow of electric current by adding other bits of metal inside the glass.

Over time, lots of different types of valves were made, each with a specific electronic purpose.

For audio amplifiers, we're most interested in the types of valve that amplify small signals, and those that can drive the speakers.

So why do we have two names for them – are they Valves, or Vacuum Tubes?

Depends whether you're using American or English terminology. UK tends to call them valves, Americans use Vacuum Tubes.

In the decades that have elapsed since they were the default technology, the distinction has become a little blurred. So these days the two are pretty much interchangeable. Older electronics engineers might show a preference for whichever term suits their culture, however.

Why do valves glow?

Valves can be considered as light bulbs with some extra bits added. Inside a light bulb (at least, an old-style one, not a curly or LED one!) there's a thin metal filament that gets hot and gives off light, and lots of heat.

In a valve, that filament is surrounded by various electrodes, but it is still essentially a lightbulb with benefits.

So, when you turn it on, it starts to glow.

That characteristic glow is one of the defining features of valve electronics.

In legacy valve equipment, they used to hide the valves away, since they weren't a particular novelty. Now, we make a feature of them.

The insides of the valve have to be hot before it will work. So they begin to glow, and then after about 15 or 20 seconds, they will start working.

Sometimes, you will also see a bluish glow. This is different, and only some valves will do it. The blue glow is caused by harmless chemical impurities in the glass envelope reacting with the electric current inside. It doesn't mean anything is wrong, unless it's a whitish-purple, which means there's some unwanted gas inside the tube. Replace it.

What happens if air gets inside the valve?

If air gets inside the valve, it is ruined.

The controlled flow of electrons inside the valve requires a vacuum. If the seal is breached and air gets inside, the valve will no longer work at all, and in fact if you power it up you may even get fireworks as the oxygen inside allows internal components to burn.

Fortunately, there's a very easy way to tell if a valve has air inside it. Take a look at the two examples below:

The valve on the right is in good condition. Note the mirrored sliver coating on the inside of the glass at the top. All valves have this, usually at the top of the tube but sometimes on the side.

In the one on the left, the insides have been exposed to air. The mirror coating has turned a powdery white.

Usually this will happen if the glass is broken or cracked, but occasionally there can be a manufacturing defect where the pins at the bottom are not sealed properly, and the repeated expansion and contraction with heating and cooling, will open up a small gap, enough for air to get in.

Once this has happened, you can't somehow suck the air out again and re-seal it.

Are valves still being made? Will we ever run out?

Valves are still being made, there are several manufacturers around the world.

In fact they never stopped being made, although now they are made in much lower quantities than the 1950s or 60s.

Also the types of valves being made is smaller. Back then, pretty much all electronics needed them, so there were all types – TV, Radio, Audio, and many others.

Now, the only equipment using them in any quantity still is audio, so those are the ones being made.

This means audio enthusiasts using valves will have a ready source of replacements for the foreseeable future.

If you have an old black-and-white TV you're restoring though, and you need a complete set of new valves for it, you may have a harder time finding them.

What are "NOS" valves? Why are they so expensive?

NOS means New Old Stock. These are valves made in the past, sometimes decades ago (most usually '50s and '60s) that were never used, and are still new-in-the-box.

This differentiates them from their currently manufactured counterparts.

There are some who hold the opinion that using NOS valves – particularly in a piece of restored vintage electronics – is somehow more authentic.

So on the one hand we have NOS valves imbued with some psychological value, and on the other, since these things are not always easy to find, the normal laws of economics and scarcity apply.

Consequently, you can pay some **serious** money for NOS valves.

Is it necessary in a hi-fi amplifier? Probably not, if sound quality and reliability are your only criteria. But if you want something unique and rare, go right ahead! The new valves are specified exactly the same as the NOS ones, so they will be truly plug-and-play. And if you have any information about the provenance of your NOS valves, that adds to the uniqueness and mystique of your amplifier.

The exception for this is for guitar amps. Since these amplifiers deliberately over-drive their valves, to get the pleasing distortion they produce, different manufacturers' valves of the same type produce different distortion. So in that case, experimentation to get the sound you want can yield results.

What is "Tube Rolling"?

Tube Rolling is the term given to plugging different manufacturers' valves into your equipment and listening for a change in the sound quality.

Guitar amplifiers can benefit from tube-rolling, since their valves are deliberately overdriven so that they distort the sound. Different valves will distort differently when overdriven, so it's a case of experimenting with different manufacturers' valves and playing with the overdrive, until you get the sound you want.

For hi-fi, it's probably more of an academic exercise, since hi-fi gear is designed to use valves in their linear area (ie without overdrive). In this region, one valve should sound identical to the next. If they don't, then there's a defect with either the valve, or the circuit.

Some audiophiles will claim to hear the difference between one valve and another of the same type costing ten times as much. These claims are hard to prove, since other factors (like Placebo effect) can affect the results.

In general, the cheapest valves are best avoided, not because of their characteristics, but because they might not be well made, and may not last very long.

But if you stick with the major mid-price valves, brands like JJ or Electro-harmonix for example, there is no need to spend silly money on "premium" valves with the hope of any improvement in sound quality… it's largely illusory.

Why do valves need high voltage? Isn't that dangerous?

High voltages can be dangerous, but with valves, there's no way around the requirement: The way valves work, high voltages are necessary. If we ran them on voltages that were too low, the sound given would become very weak and with lots of distortion.

To make it safe, we put the electronics in a robust metal chassis which is solidly grounded. This way the user is completely protected from the high voltages inside.

There is no possibility for the case, or any of the input or output terminals, to become live.

This is important, since our biggest amplifiers can have up to 600 volts inside.

It is advisable that only people specifically trained in high voltage electronics work on valve gear.

All of our designs incorporate a safe "bleed-down" facility, where once it's powered off, the remaining high-voltage charge inside drains away over about 60 seconds.

Some legacy valve gear had exposed high voltage parts. **None of our designs would ever expose anything to the user that you could get a shock from.**

About Valve Amplifiers

Why make amplifiers with valves any more?

This one needs a short history lesson…

In the early days of electronics, everything was powered by valves. There was no alternative. Then a new invention called the "transistor" took over. Transistors replaced valves quite quickly because they are smaller, lighter, cheaper, more efficient, and more reliable.

The invention of the transistor was the beginning of the revolution that made electronics more and more powerful and much smaller.

Early transistor gear had some problems though. They didn't sound as easy on the ear as the existing valve gear. They got a bad reputation in some circles.

That problem was solved quickly, and modern gear sounds excellent as a result.

But a small group of people stuck with the idea that using valves for amplifying sound resulted in a more natural, pleasing sound that was less fatiguing to listen to.

And so, decades later, we still have amplifiers made with valves. And they sound better than ever, because we now use modern electronics around the valves to give them a cleaner signal and keep them at their optimum operating conditions, far more closely than was ever possible in the original valve era.

Plus they look cool. Much more attention is given to their aesthetics now than in the past.

How long will the valves last in my amplifier?

Like lightbulbs, valves don't last forever. Eventually they need to be replaced, and this is why they sit in sockets you can easily pull them out of.

In a typical amplifier there are two types of valves: the smaller ones which take the small input signals and increase them to drive the final stage. These valves should last forever.

The output valves are a different story. If you look closely you will see that there are usually four larger valves – these do the much of the heavy lifting. Different manufacturers will specify different lifespan figures, but much of that will depend on how they're used.

The guidance we give customers is to expect between 7500 and 10000 hours of operation from a set of new output valves.

This is much longer than in guitar amps – the reason being, in hi-fi, we are not overdriving them.

How will I know when the valves need replacing?

In general, the sound from your amp will become dull, less clear and detailed, the volume might drop, and there might be a bit of fuzz or distortion behind the sound. It's a gradual loss, it won't happen overnight.

Ever been streaming audio or on a Skype call and the bandwidth drops so it adapts and uses a lower bit rate? The sound just loses some detail and presence. Same sort of thing.

It's only the output valves that will need periodic replacement, and they are best replaced as a complete set.

When you do this, the amp will immediately sound new again.

The old valves can't be recycled. Perhaps keep them as spares in case you might accidentally break one, but once they've been used up, you can't get them back to new performance.

What do replacement valves cost? Where can I get them from?

Valves come at a broad range of prices. Our recommendation is to buy in the middle of the price range. (don't buy the cheapest ones, but don't waste your money getting ones with gold pins or "signature version" or any other such brand differentiation – the insides are all the same!)

As a guide, a set of four EL84 output valves – the ones in most of our amplifiers – should cost around $70 USD.

As a side note – you'll often see the option to pay some extra to get a "balanced pair" or "balanced quad". **Don't bother with this…** our amplifiers allow you to adjust the operating conditions of each valve individually, so getting balanced sets is completely un-necessary.

There are many sources of valves available. And, there is no such thing as a valve that's been made for guitar or hi-fi usage. So if you want, buy your valves from a guitar amp supplier with complete peace of mind.

As at Jun 2018, these are the prices available from thetubestore.com which is the online supplier we recommend for good prices and fast turnaround.

EL84-type: $USD 13 – 20 ea.
EL34-type: $USD 20 – 40 ea.
KT88-type: $USD 40 – 60 ea

You can pay a lot more for valves, don't let us stop you, but it's really not necessary.

Are there different types of valve amp? Which one is best?

[This answer is a little long – but I kept it as non-technical as I could!]

There are different types of amplifier, with different operating philosophy.

The main one you'll find is "SE" (or "Single-Ended") versus "Push-pull"

Single-Ended

A Single-Ended amplifier uses only one output valve for each channel, or sometimes they can be paired up but still used in single-ended mode.

The idea is that in a Single-Ended design, each output valve carries the whole signal. This makes the design of the amp much simpler, but SE amps have a significant penalty in terms of power and efficiency. Typically you need huge speakers to get the best from a SE amplifier because they're usually very low-powered.

Some people feel quite passionately that the sound from amplifiers using the SE topology is much better. In fact it is not… SE amplifiers have their own quite pronounced distortion characteristics, but these are somehow pleasing to the ear.

Think of the SE sound as being like an Instagram filter for your sound. Some Instagram filters are quite pleasing, but each one is still a distortion in some way of the original picture.

The Audiophile community is very interested in Single-Ended amps, and as a strange irony, these are the ones that command the very highest prices, even though the SE design was invented as a cost-saving compromise back in the early days of valves.

Push-Pull

A Push-Pull amplifier takes the input signal, splits it in half, and amplifies each half separately, combining them again right at the end.

This way, each valve is able to be used much more efficiently, and the amplifier can be much more powerful as a result.

Power is usually a good thing, because these days we're listening to music which has a lot more bass than in the old days, through speakers that are a lot smaller.

Push-pull amps do need to be set up a bit carefully though, because they can add a specific type of distortion to the sound if not adjusted properly which you'll hear at high volumes.

All of the amplifiers we offer at ATRAD Audio are of the push-pull design, and we offer instructions on how to adjust these properly.

Hybrid vs. all-tube

Another design you may hear about is "hybrid".

A Hybrid amp is one that gives the best of both worlds… part of it is valve-based, and other parts are using more modern electronics (called "Solid-state", as opposed to vacuum-state).

There are many different possibilities in designing a hybrid amplifier.

Hybrid amps are usually smaller and cheaper than full valve amps. Sometimes, something might be advertised as a tube amp but in fact the tubes are only there for decoration. This is a fairly dishonest and unscrupulous practice, but at the cheaper end of the market it can happen.

ATRAD Audio amps are strictly all-tube, apart from some non-tube electronics in non-signal areas, such as the remote control or power supply circuits.

Why are there so many large heavy lumps of metal behind the valves?

If you look at the top of a valve amp, you'll usually see three large heavy metal things sitting on the top of it:

These things are a vital part of the design. They are called transformers; their job is a bit like the transmission in a car. They convert electricity from one voltage to another.

The biggest one, in the middle, is for the power supply.

The two smaller ones take the high voltage signal the valves use and turn it into a lower voltage to drive the speakers.

These transformers need to be large because they work by using a magnetic field. The solid core is made of a highly magnetic material. Vintage transformers just used iron for this, but modern materials are better as they are more strongly magnetic.

Each one has many thousands of turns of very thin wire wrapped around this heavy metal core. As you pass an electric current into one side, it comes out transformed into the shape you need it on the other side.

These transformers need to be the size they are so that they can pass through the required amount of current without adding distortion or overheating.

Because they're so large, we put them on top of the case rather than inside.

They're quite safe to touch, though they may get a bit warm.

What maintenance does my amp need?

Valve amps generally require very little maintenance.

Sometimes, if it's been turned off for a long time, and dust has fallen on the valves, when you power it up and the valves heat up, you can smell the dust cooking off the glass envelopes. This is harmless, but if you're worried about it, you can give it a light touch with a feather duster from time to time when things are switched off and cool.

Every few months you will need to give the output valves a little tune-up. Each valve has a recessed adjuster and test point and it's a simple process to adjust it until the right number shows on a meter.

We provide full instructions and a demonstration of this when we supply your amplifier.

Also after around 8000 to 10000 hours' operation, the output valves will need replacing. This is a simple procedure and full instructions are provided for this also.

Other than that, there are no specific maintenance requirements.

Nothing ever needs to be done that would require you to open up the case.

What are some precautions about using valve amplifiers?

There are three precautions you need to be aware of with valve amplifiers.

The first one relates to **heat**. Valves generate and use a lot of heat. It is important to allow sufficient ventilation and airflow around your amplifier. If placing it on a shelf, be aware of the effect of the rising heat on anything on the shelf above.

It is a bad idea to store your chocolate Easter eggs on the shelf above the amplifier, for example. Chocolate soup is a devil to clean out of the insides of an amp.

There are ventilation holes cut into the bottom of the case to allow air to flow up through the insides. It's important not to block these by placing the amp directly on carpet, for instance.

The second one is a specific caution. **It is dangerous to operate a valve amp with the speakers disconnected**. The speakers form a vital part of the circuit and you can overload the output valves and transformers if it's powered on without them connected. So always make sure the speakers are connected, whether or not you're actually playing any music through it.

If you need to disconnect the speakers to re-route wires, for example, then turn the amp off first.

The final one is just to **turn the amp off when you're not using it**. This will prolong the life of your output valves and save on power – valve amps are quite inefficient and can not be considered "green" electronics by any measure.