

## Tube & Solid State Amps - What's The Tonal Difference?

Musicians say that a 'good tube amp' has:

- An overall warmer tone.
- More 'chime' to the upper frequencies.
- They're louder than a similarly rated solid state amp.

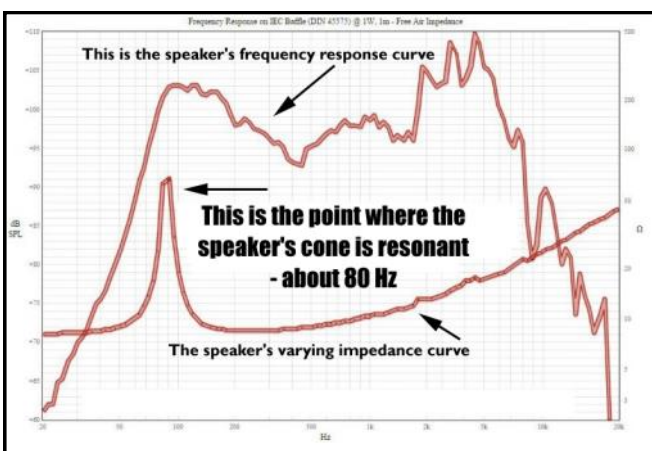
Contrary to popular belief, I do *not* dislike tube amps. I am a guitarist who grew up in the tube era, so I can hear the musical point of view behind player's comments. I spent my teen years tinkering with tube amps and built my first amp when I was eighteen. I have also had a formal education in electronics, so through my love of electric guitar and all that fiddling, I became able to develop SS guitar amp circuits that can emulate the classic sounds players like. I also worked in military electronics... so know what high reliability means!

My beef is, that solid state amps have been poorly designed and, resultantly, their true potential has not been truly seen. Simply, I would like to share my knowledge with others, so that the truth can be learned about analogue SS guitar amps and that they can truly make brilliant guitar amps... if designed using the correct background knowledge. With rising costs for tubes and their limited availability worsening at this time of world uncertainty, SS amps should become more prevalent.

### The Obvious Physical Differences

Unlike solid state (SS) amps, tube amps are bigger and have two heavy and costly transformers. They get rather hot and their tubes run down with use, so can need replacing fairly frequently depending on how often they're operate and how roughly they're used. One of the transformers is a 'power transformer' used to supply the required voltages inside the amplifier, which enables the components to work correctly. The other is an 'output transformer' (OP TX) which is used to efficiently connect a loudspeaker(s) to the amplifier's output tubes.

### Tube Amps Have A Warmer Tone



As the speaker chart shows, guitar speakers have a variable impedance with frequency. Therefore, their quoted impedance is always referred to as a 'nominal' value. And because tube amps have an output transformer (TX), which can have an average internal impedance

of around 4 Ohms, it creates what is known as a 'high output impedance' power amp. All tube amps operate with a high output impedance and means that that internal 4 ohms is effectively in series with the impedance of the speaker... 8 Ohms in this case. The TX's 4 Ohms remains constant, only the 8 Ohms rises from 8 Ohms to over 100 Ohms. The affects of Ohms Law means that the TX's output voltage will vary up and down too, governed by the speaker's actual impedance.

As the speaker's impedance rises, the current through the speaker falls causing output power to fall. But, at the same time, the voltage across the speaker rises and causes the current flowing through the speaker to rise back up again... causing the output power of the amplifier to return to it's former level at all audible frequencies. This is called 'constant current' (CC) speaker drive. As mentioned earlier, all tube amps drive their speaker this way and is what gives rise to their unique sound.

Up until fairly recently, there were very few SS amps that had this kind of speaker drive. The most well known amp brand that made SS amps exclusively with 'CC' speaker drive was HH. Wilko Johnson was a great fan of this brand and his sound was regarded as close to a tube amp sound as you could get! Marshall did introduce it into their Valvestate amplifiers during the late 1980s. Fender have had it in many of their SS amps too in recent years, but none have used it in amplifiers that were designed to sound like the classic amps of the 1950s/60s. This has probably led to the technical advantages of CC being completely overlooked by guitar players. Certainly, nothing has been said by amp makers about it's inclusion to communicate that they were

anything different from the usual 'run-of-the-mill' cold sounding SS guitar amps on the market.

Interestingly, a major advantage of CC can be heard when signals around 80Hz are being played. Here, the speaker's impedance can be well over 100 Ohms and this means, because the speaker is resonant at near that frequency (the paper cone is resonant), the speaker requires very little power to drive it to high levels of acoustic output... and it's this that gives the sound it's 'warm' plummy 'tube amp' characteristic. However, it is really nothing to do with the amp's tubes... it's just a coincidence that the amp happens to have tubes, so players give the credit to the tubes because that's what they can see! It's the OPTX that's responsible.

### **Tube Amps Have That 'Chime'**

Again, we have to look at the CC affects for an answer. A tube amp's increased 'chime' over an 'old style' SS amp is created by how the amplifier drives the speaker... the 'constant current' method produces more 'top end output' due to the fact that CC is compensating for the speaker's increasing impedance and prevents the output power from falling, like it does in a conventional 'cold sounding' SS amp that does not have CC.

So, CC is working with the speaker and output transformer to create the tube amp's tonal characteristics... which further work to enhance overdriven or distortion guitar sounds. It creates what digital modeller users call 'the amp in the room' vitality and sonic satisfaction that nearly all guitarists demand! Really, digital modeller users need an SS amp with CC, but none are specifically made at the time of writing this document. Currently, the best amplifiers for modellers are going to be tube based... except for SESSION's current SS amp range, which have all been designed to operate with modellers well.

### **Tubes Amps Are Louder Than SS amps!**

Well yes, they are louder and that's easy to explain. But players need to firstly accept that 1 Watt of power is EXACTLY THE SAME whether it's generated by a tube or transistor. It CANNOT be different, science has proven that, so there has to be something else going on.

Sadly it's not a magical 'Tube Thing'... surprise, surprise! So once again, we have to turn to CC to find the reasons why tube amps do sound louder!

As I have already discussed, tube amps drive the speakers by a method called 'constant current' (CC). CC has a 'high impedance' output, whereas a conventional SS amp has a 'low impedance' output. Unfortunately, the common SS amp's low impedance output heavily 'damps' the speaker's cone vibrations... rather like a damper/shock absorber fitted to a car's suspension. This also limits the travel of

the speaker's cone back and forth and, consequently, reduces the overall amp loudness compared to a tube amp.

Whereas, a tube amp with a high impedance output (CC) allows the speaker's cone to vibrate with far less restriction. So it can be a wild ride with a CC power amp... particularly when the amp is dealing with huge distortion signals! The speaker's cone, when under damped in this way, means you can hear harmonic 'over-tones' mechanically generated by the 'almost' out-of-control speaker cone - *not* by the tubes!

This also results in much more cone movement back and forth, so can sound significantly louder for the same rated amp power! The most delicious guitar tones of all time are, in fact, created by the 'bucking bronco' of an uninhibited speaker cone... not the tubes!

*This astounding tonal generation can all be achieved by a CC equipped SS amp!*

### **Session's RetroTone™ SS Power Amps**

When you see RetroTone™ on our products, it means it will sound and perform just like a tube amp! So are just as loud, watt for watt, as a high class tube amp. Confirmed by our customers.

The whole analogue amp is designed like it was a tube amp... except we have replaced the tubes with op-amps that do the same jobs that tubes would normally carry out! They are not used to create the distortion though, that's done another smooth way. RetroTone™ power amps do not damp the speaker's cone either.

Session is not the first to use CC in it's SS guitar power amps. HH did back in 1975! But we are the first to make 'classic toned' guitar amps that can challenge some of the most respected guitar amps of the 1950s and 1960s. CC naturally plays a very big part in this achievement.

Our BluesBaby, Rockette and 5E3-EXTRA SS amps have become bench marks in the world of SS guitar amplification... winning scores of 8/10 or 9/10 in magazine reviews along side some expensive American boutique amps.

Quite literally, all of our amplifiers have RetroTone™ Class AB power amp tone.



© Stewart Ward – 30th June 2022  
Guitar amp designer since 1967

[www.Award-Session.com](http://www.Award-Session.com)