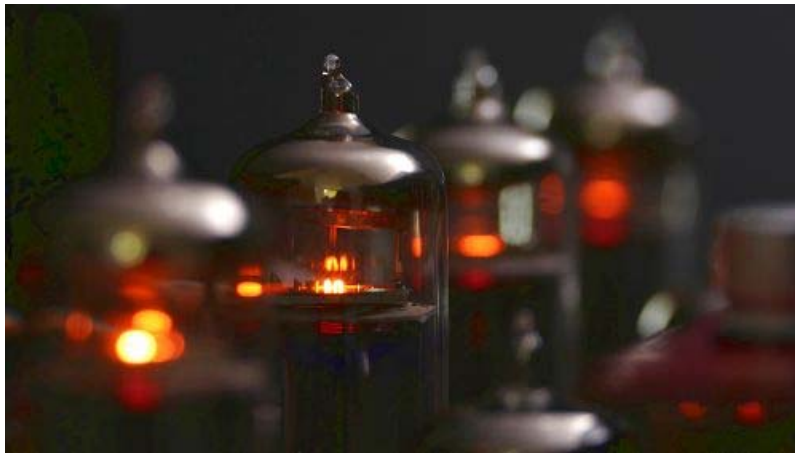


# Retro Stereo 50

## There are Watts and there are Watts



### Question: How does the Stereo 50 achieve 25W+25W?

The short answer is that the Stereo 50 is measured using a music signal into real speakers (the LS3.5 to be precise) as opposed to a sine wave test into a resistor.

This has been outlined in the technical specifications area of the Retro Stereo 50 webpage:

<http://ifi-audio.com/portfolio-view/retro-stereo-50/>

As this uses a music signal, this we feel is relevant in the real world and differences tend to be large. For the technical reason behind this, please read on.

### The technical backdrop

Modern audio testing is carried out generally using steady sine waves and test sets such as the Audio Precision System Two.



These test systems and the methodology came long after the advent of transistor amplifiers. So they are geared to testing such amplifiers and they are fair and equitable to such amplifiers.

Some fifteen years ago, Peter Van Willenswaard<sup>1</sup> investigated connected issues and found that while testing transistor amplifiers with resistive load and steady state sine waves and driving speakers with music led to results for maximum power and output from the speakers that are closely matched between the two states. Yet when testing tube amplifiers the results from the two different tests were manifestly different<sup>2</sup>.

*"I hooked up my oscilloscope to one of the speaker outputs of my 300B amp and observed the screen while Touch (a specific CD – Ed) was playing.*

*Holy Moses. I saw something like 30V peaks from an amp that, when driven with sine waves and loaded with an 8 ohm resistor, never showed more than a 14V peak—more than twice the voltage technically supposed possible. You'd need a 50W transistor amp to realize the same peaks my 9W 300B launched without wincing at my speakers."*

In the letters resulting from the publication a reader recounted a case where he replaced a 15 Watt rated Leak 'Point One' EL84 Tube amplifier (likely the Leak Stereo 20) with a Solid-State amplifier rated 75 Watt per channel and found that at levels that did not bother the Tube amplifier the least, the Solid-State Amplifier would run out of steam and shut down<sup>3</sup>!

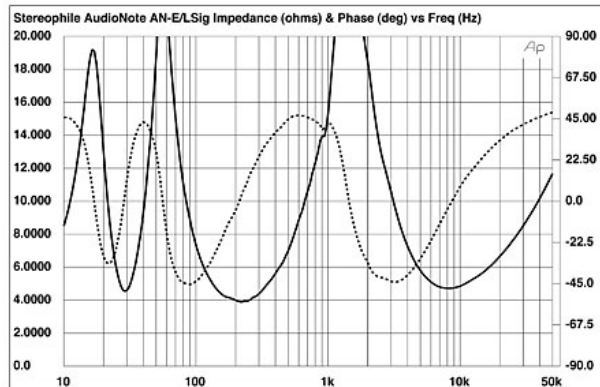
Most extreme perhaps was the finding that a tube amplifier capable of no more than four watts continuous output power in sine wave testing produced a subjectively undistorted output from the speakers used in the test equal to that of a 25 watt transistor amplifier. Yes, on the same speakers a 4W tube Amplifier matched a 25W transistor amplifier for actual playback levels<sup>4</sup>.

This seems to break all laws of physics, though in reality this is not so. There are two key underlying reasons for this behavior of Tube Amplifiers.

## 1) Speakers are not Resistors

Modern Loudspeakers are designed to be driven by low output impedances, in effect by voltage (with current being drawn by the speaker as required). A typical 2-Way speaker such as the Audio Note Model-E as used by Van Willenswaard has an impedance magnitude that is very variable with frequency and often has very high impedance in the bass region, where normally much of the power demand of music happens.

Here the impedance curve for the AN-E (from Stereophile<sup>5</sup>) as used by Van Willenswaard:



We observe that while the impedance minimum is 4 Ohm at around 220Hz, the mean impedance of the speaker is much higher. A crude analysis in excel suggests a geometric mean of 8.5 Ohm and an average of 9.5 Ohm Impedance.

A transistor amplifier usually clips (read: distorts heavily) when its output approaches the power supply voltage. It can simply no longer increase the output voltage.

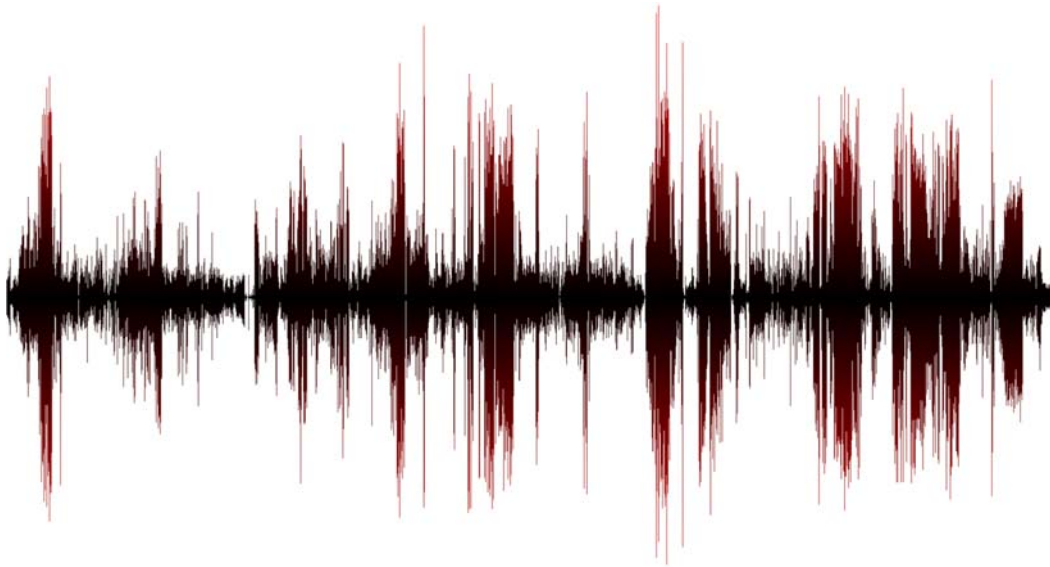
By comparison Tube Amplifiers invariably are current limited, meaning if the load impedance (speaker) is higher than the nominal match, they can drive much higher voltages into the speaker load because of the higher average impedance of the speaker.

As the speakers' sound output is actually directly proportionate to the applied VOLTAGE (and not the power drawn by the speaker) we get more sound pressure as would normally be possible using a transistor amplifier of equal output voltage limit tested using sine waves into a resistor load.

This is however only half the story and still does not account for in effect turning a 4 Watt Tube Amplifier into the equal of an over 6x more powerful transistor Amplifier. Another 'hidden' mechanism must be accounted for.

## 2) Music is not a sine wave

If one looks at the waveform of music we find that that in fact the average levels are quite low, while peaks close to the maximum occupy only a small fraction of the time:



So, whereas a sine wave has a constant demand of power, music has a low average power requirement, but a high peak requirement.

Both classic Tube Amplifiers as well as modern ones (like the Retro Stereo 50) often employ a method to control output stage quiescent current called variously self-bias or cathode bias. This method has a great advantage in that it makes the resulting amplifier self-adjusting, with no need to perform maintenance nor regularly adjust the tube bias.

For a Push-Pull Amplifier (such as the Retro Stereo 50) this means that if the Amplifier output stage is driven out of the Class A operation the bias voltage will change. In effect, the bias will increase thus turning the output tube off progressively. Another mechanism is the onset of so-called 'grid current' which creates an additional negative grid bias; again, in effect turning the output tube more off, when it should be turned more on.

There is timing linked to this. In the Retro Stereo 50 for example, the cathode circuit will delay this self-adjustment by around 0.2 seconds (the grid circuit even longer), long enough to deal with largely all musical peaks, but so short that with steady state sine waves the adjustment seems instant to the experimenter or audio test set. The result, using sine waves, the amplifier seems to 'saturate' at fairly low power, turning up the input signal produces more distortion but no more output. In effect the amplifier power with steady sine waves is self-limiting, yet the limits do not apply to short high-power events.

This particular mechanism was well known in the 'Golden years' of tube audio and widely discussed<sup>6</sup>. It was also widely known that optimising an Amplifier output stage for sine wave testing would increase distortion with music or speech signals<sup>7</sup>. Equally known and discussed was the fact that sine wave measurements were not representative of the maximum power output available from a Tube Amplifier playing music into speakers<sup>8</sup>:

*"To provide an agreed standard of measurement, all amplifiers are tested with a pure sine wave input signal. This never occurs in speech or music except, remotely, in the case of the flute. From the point of view of power handling capacity a pure sine wave is one of the most difficult waveforms for an amplifier to reproduce and invariably gives an inferior result. It can, therefore, be taken that an amplifier rated at 30 watts continuous sine wave output will give an instantaneous peak output of speech and music of at least double this figure."*

### **Real world audibility over scientific measurements**

So, there you have it. Testing Tube Amplifiers with sine waves and resistor loads will give a power reading that is artificially low and does not fairly reflect what the amplifier is capable of. This gave rise to such audiophile fairy tales that stated that Tube Watts are "Louder" or "Bigger", they are not. They simply have been measured in an inappropriate way.

Thus we specify the 'Output Power' based upon testing with music and speakers attached to the amplifier. We connect an Oscilloscope in parallel with the speaker and observe the waveform. We keep turning up the level until peaks just barely flatten out (onset of true clipping). Tested like this most Tube Amplifiers show much larger signal swings than with sine waves into resistors. Transistor Amplifiers on the other hand show no such effects.

In other words, sine wave testing does allow us to make meaningful determinations about how much signal the Amplifier will drive into the speaker for transistor amplifiers, but it severely understates what a Tube Amplifier can do. Our rating is fair insofar as in real life, a 25W solid-state amplifier will play equally loud on the same speakers as the Retro Stereo 50.

We hope we have shed more light on this and explained why we have done what we have done.

*References:*

- 1) *Tubes Do Something Special*, by Peter van Willenswaard • *Stereophile* Sep 2000
- 2) *ibid*
- 3) *Letter to the Editor*, by Bob McIntyre • *Stereophile* Nov 2000
- 4) *Tubes Do Something Special Followup* by Peter van Willenswaard • *Stereophile* June 2001
- 5) *Audio Note AN-E Lexus Signature loudspeaker Review*, by Art Dudley • *Stereophile* May 2006
- 6) *Circuits for Audio Amplifier*, Mullard Limited • *Second edition* August 1960
- 7) *ibid*
- 8) *Avantic DL7-35 Amplifier Manual*, Beam Echo Ltd.; Witham, Essex • ca. 1960

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