Active Power Management

This abstract outlines the background and basics for the TC Electronic Active Power Management™ introduced on the RH450 Bass amp.

What watt?

When rating an amps' power handling there are number of factors that need to be included, i.e. voltage, time, crest factor of the source signal and a number of other technical parameters. However to most bass amp users the perception of power is more important than how it measures – in other words, it all comes down to sound and loudness.

In bass amps specifically, there are very obvious differences in the perceived power handling of the two most classic categories: Tube- and solid state- (transistor) amps. In order to understand why this is, we need to take a quick look at the dynamics of a typical bass signal as well as how our ears respond to sound.

Bass signals and Dynamics

The average signal of a bass has a very wide dynamics span that ranges from a short and very high peak at the stroke of the string and quickly dropping to a significantly lower level at the sustain of the note played. This is known as the 'crest factor' and describes the ratio between the highest peak and the average energy of the signal. Typically bass signals have a high crest factor of 10-15 dB depending on playing style (fig. 1).

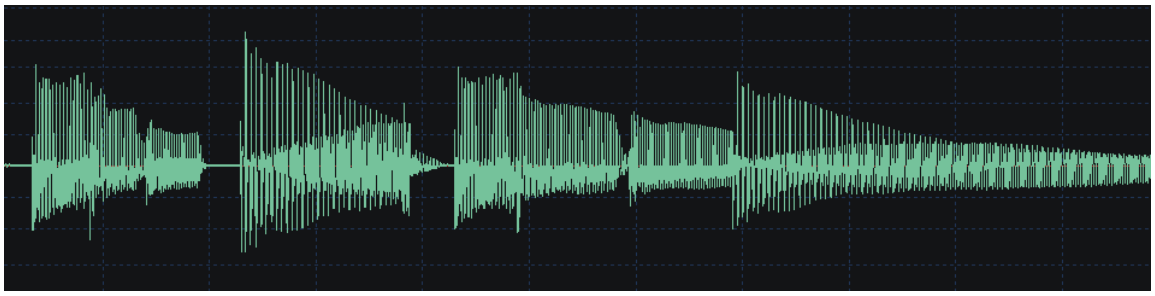

Figure 1: Bass signal sample

Human ear response

Our ears, being fairly slow in response, pick up on the average level of sound rather than short term peaks. In other words the level, or loudness, that we experience rarely has to do with the peaks, but is tied closely to the average level, or energy, of a certain signal. In the case of bass signals, this means that it is not the actual stroke of the string, but the sustain of the note that we determine the perceived loudness by (fig 2).

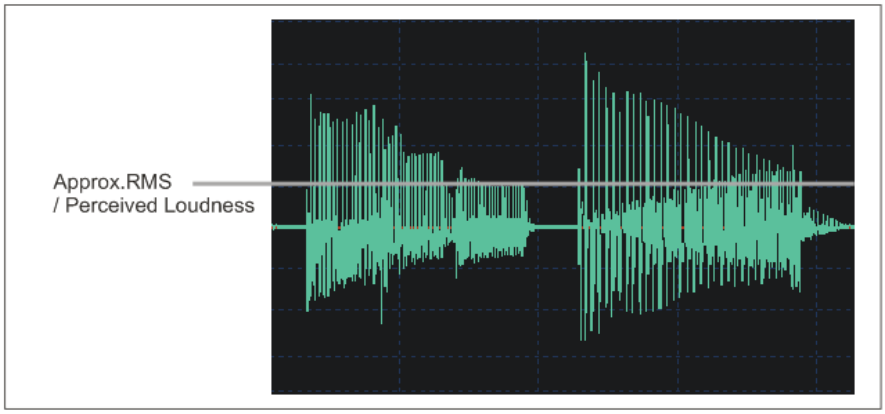

Figure 2: Bass signal with approximated RMS marking / perceived loudness

Solid State Amps
Most solid state amps have a very clean and fast response time in the amplification but also a sharp edge of going into distortion when reaching its maximum performance level. The distortion created when the amp reaches its clipping point is very rarely desirable and most users prefer to not ever experience that in their amp. Furthermore quite a few transistor designs have the unfortunate feature of 'output stage lockup' which in essence means that when the amp goes into distortion, the output circuit itself gets stuck in the distorting mode for several hundred milliseconds longer than the original audio impulse i.e. the transistor circuit adds more distortion than the audio signal itself created in the first place.
With the dynamics of bass signals in mind, this means that a transistor amp has to be able to cleanly amplify very high peaks in order to reach a decent perceived loudness or power level without distorting.
In the example below (fig.3), the 800w amp plays back the transients or peaks cleanly at its max., but because of the high crest factor of bass signals, the average level and power is more likely to be perceived as 300w by the listener.

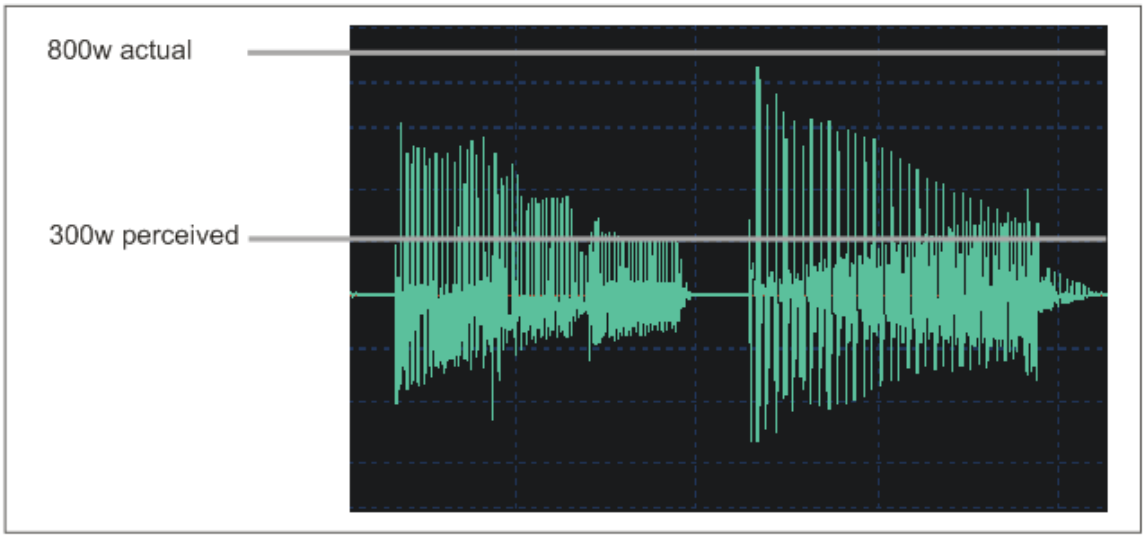

Figure 3: Transistor: Actual vs. Perceived power

Tube Amps
The nature of tube amps is very different from that of transistor amps. Rather than suddenly hitting the distortion point, tubes gradually go into saturation and tend to 'round off' signals in a very soft way when getting to its maximum performance. The overdrive created by tube amps is quite pleasant to our ears and is known by many as a central part of the highly complex 'tube sound' that have been pursued in many bass amp designs.
Again, looking at bass signals, the gradual saturation of tubes essentially 'compresses' or limits the high peaks of the bass with only little resulting overdrive thereby altering the original crest factor to become quite a bit lower than the original signal with a consequently higher perceived loudness at a lower power rating – this is a quite known effect by many users, usually referred to as the difference between 'transistor watts' and 'tube watts' (fig. 4)
In the example below the 400w tube amp has reduced the peaks, and hereby the crest factor, of the original bass signal, achieving a perceived level and power of 300w.
This means that the 400w tube amp and 800w transistor amp are perceived to have the same power even though they are vastly different in the actual power measurable.

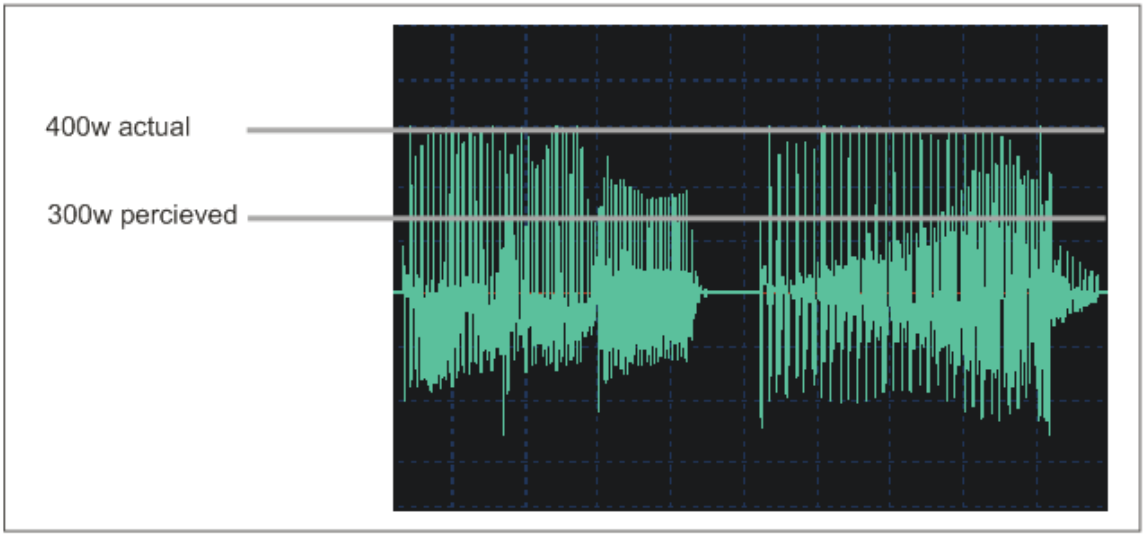

Figure 4: Tube amp: Actual vs. Perceived power

Active Power Management™

Active Power Management™ is inspired by the nature and response of tube amps and is in essence an adaptive part of the amp that actively reacts to the source signal.

Active Power Management™ is controlling an integrated circuit that kicks in when the amp gets close to its maximum performance and starts to compress and limit the peaks of the bass signal similar to the way a tube amp would do. We have spent numerous hours tweaking and tuning this circuit to optimize the performance and sound of it (fig.5).

The result is an amp that, regardless of how hard it is pushed, will not go into 'transistor' clipping and will have a higher perceived level pr. Watt similar to what is known as 'tube watt'.

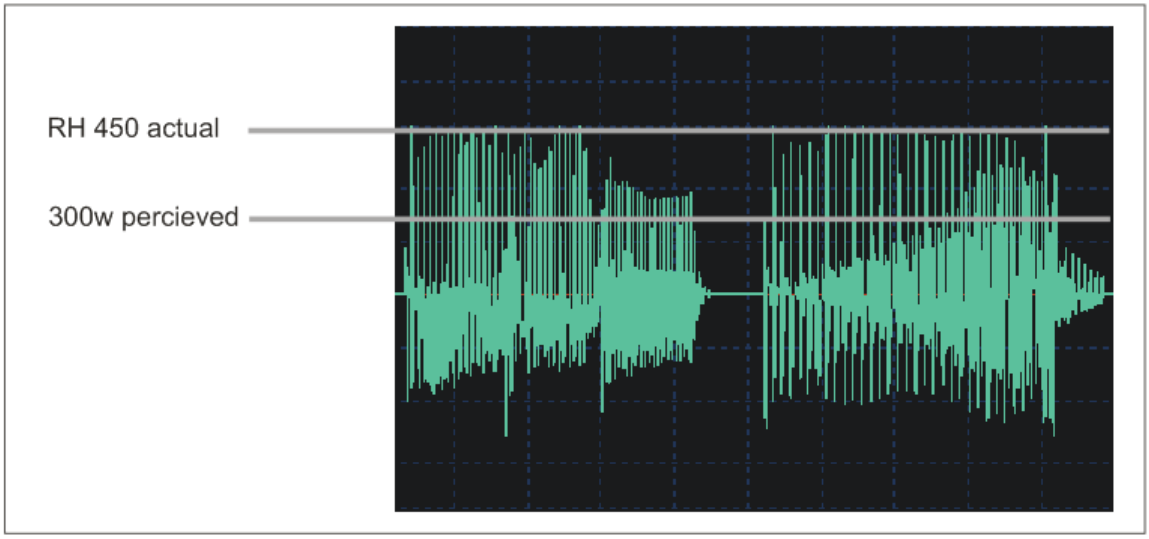

Figure 5: RH450: Actual vs. Perceived power performance