Dynamic Power Compression and Modulation Noise. 12/21/2022

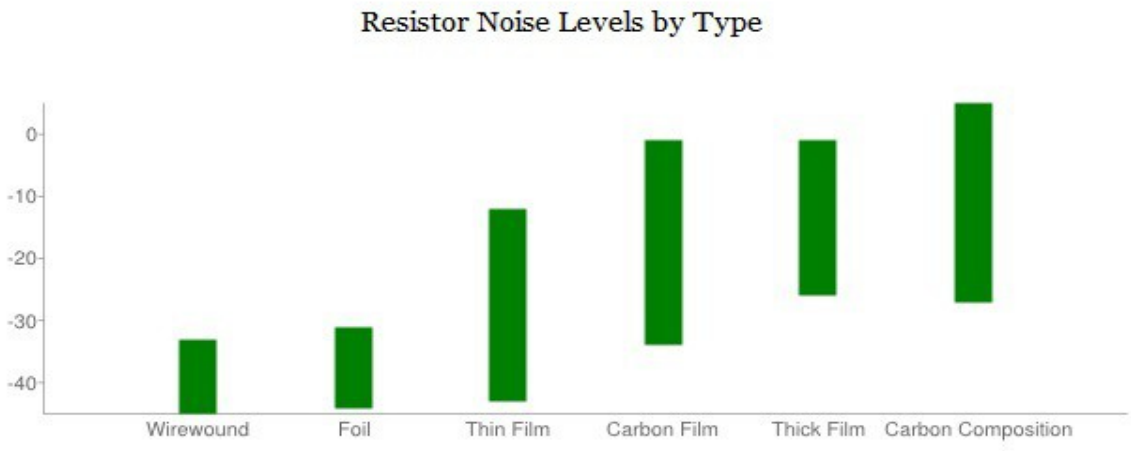
On the surface Dynamic Power Compression, and Modulation Noise may seem like two different things, but they are really simply two ways of looking at the same thing, but there are two effects that happen at the same time by the same cause. By way of understanding all this lets first consider the history and definition of what this is.

The History:
This type of noise was discovered and first measured by John B. Johnson at Bell Labs. He described his findings to Harry Nyquist, also at Bell Labs, who was able to explain the results.

In 1926, experimental physicist John Johnson working in the physics division at Bell Labs was researching noise in electronic circuits. He discovered that there was an irreducible low level of noise in resistors whose power was proportional to temperature. Harry Nyquist, a theorist in that division, got interested in the phenomenon and developed an elegant explanation based on fundamental physics.

The Definition:
Johnson–Nyquist noise is the electronic noise generated by the thermal agitation of the charge carriers (usually the electrons) inside an electrical conductor at equilibrium, which happens regardless of any applied voltage. Thermal noise is present in all electrical circuits, and in sensitive electronic equipment (such as radio receivers) can drown out weak signals, and can be the limiting factor on sensitivity of electrical measuring instruments. Thermal noise increases with temperature. Some sensitive electronic equipment such as radio telescope receivers are cooled to cryogenic temperatures to reduce thermal noise in their circuits. The generic, statistical physical derivation of this noise is called the fluctuation-dissipation theorem, where generalized impedance or generalized susceptibility is used to characterize the medium.

Thermal noise in an ideal resistor is approximately white, meaning that the power spectral density is nearly constant throughout the frequency spectrum, but does decay to zero at extremely high frequencies (terahertz for room temperature). When limited to a finite bandwidth, thermal noise has a nearly Gaussian amplitude distribution. - Wikipedia



So what does all this mean to us as vacuum tube audio enthusiasts?

Well tubes produce heat, and their elements inside them have this same thermal noise, but beyond that they can heat up connecting and surrounding components which then produce more noise. Therefore it is wise for the designer of a vaccum tube amplifier take this into consideration. Myself I have found that lowering this form of noise, which is different that the noise floor of an amplifier.

The noise floor is produced by the operation of the power supply and the current is providing for the amplifier in an idle state or without any signal going through its circuits. This is measure and then compared to its maximum signal level to give a signal to noise ratio in decibels. This is often thought of as the usable dynamic range of the amplifier. But this is different than the Johnson/Nyquist noise(JNn) we are talking about here. Although some JNn is found in the circuit that does contribute to this noise floor, this thermal noise is more dynamic, it tracts the signal, more voltage and current applied to anything with resistance and the more noise it will produce. So as current and voltage increase in conductors, capacitors, and resistors so does their noise, and since audio signals are not constantly the same amplitude so the noise tracts the signal. This is often referred to as modulation noise.

But there is also something that goes with this in voice coils of loudspeakers, and other parts of an amplifier whether it be conductors, resistors, capacitors or anything else conducting the signal. That is as everythings thermal heat increases their resistance increases. How much depends on how much heat and how quickly they are able to dissipate that heat, and quickly they can cool down, at least in theory. So we have a double whammy against signals, one say a drum hit happens, if there is a lot of resistance in the circuit then you will have a lot of noise following it, and all those resistors can heat up for a short period of time as well increasing their resistance and diminishing its dynamic potential. Both effect precieved micro dynamics, of course one of these factors can be greater than the other, but both are happening by the same cause JNn.

How a designer can lower JNn is only limited by creativity of the design and component selection. Not all resistors or wire is created equal in this regard. Now another type of noise is probably less agrengious in vacuum tube amplifiers but should be given some attention as well, flicker noise. This noise is closely realated and contrubutes to all this. But where JNn noise effects mostly higher frequencies, Flicker noise effect lower frequencies more. Now I know some will argue on the level of currents and voltages and the combination of them in an audio circuit these types of noise are not effecting what we here. I propose they are, and if we consider them on at least a minimal level we can design better sounding circuits without a lot of extra cost.

When you look at some of these very expensive DACs with descrete ladder arrays, and power supplies with lots of capacitors in a storage back and very low impedance reflected to those ladders. Then people hearing a difference with those DACs so much so they get better reviews and person after person notes they hear a difference, then there is more to this that the skeptics realize. Perhaps our own ears are more sensitive of instruments than the machines we are using or create to tell us how a circuit or component is behaving. If it sounds good, but measures poorly wouldn't it make sense that your simply measuring the wrong things, or attributing what sounds good to the wrong measurements. It should be very obvious to scientists, and listeners, that you can not judge how something will sound by its measurements. Those being “objective” sound quality is an oxymoron, sound quality can not be objective but can only be subjective. And although there is some variance into what sounds better from person to person, in general what sounds good a majority will agree upon.

Johnson-Nyquist noise, shott noise, flicker noise, all of them exist, how much they effect the sonic

performance of an amplifier is what is debatable. Personally although I admitt these noise levels effect the sonic performance very little in audio components, they do have an effect. Likewise when it comes to average audio components and very high end, electronically the difference in "objective" measurable performance is very small, less than 10%, and I would say most of the time less than 2%. So since many things in a SYSTEM sum to an end product, why not give attention to as much as you can to achieve a greater sonic quality. Personally I think these things are worth more per dollar than expensive cables and interconnects, and no many have any issue in spending that kind of money on those products. So why not spend a far smaller amount to simply use better quality resistors with lower noise in a product, since they will be making as much if not more electrical difference?

So how does this relate to what La Dolce Audio is doing with single ended pentode amplifiers, and other things. Well this lowering any noise even in the slightest level is one thing we want to do. There is no such thing as too low of noise factors. For example we LOVE Schottky diodes, why because they lower shot noise levels, and sound similar to us to some of the best tube rectifiers. So why not marry them with tube audio circuits to get a more consistent sounding amplifier.

Also at La Dolce Audio we advocate highly sensitive speakers because they do not dynamically compress the signal or music as much. Here is a quote found in a JBL specificaiton sheet:
"To increase power handling while reducing power compression, JBL engineers have created a unique, direct voice coil-to-air heat dissipation methode called Vented Gap Cooling. This process pumps air through the magetic gap and directly over and around the voice coile to provide immediate heat transfer and reduction in operating temperature – a direct improvement in power compression."

The more we can reduce ANY dynamic compression the better. So our circuits are all about minimizing dynamic power compression. We also use distortion to enhance dynamics. We deliberately use distortion to create greater micro dynamics giving a greater sense of space and detail to the music. There are a lot of naysayers and folks that feel that is a gimmic we are spouting to make ourselves sound different, but the proof is in the pudding. And we have always said and will continue to say, "If it sounds good, it is good." That is no matter what specifications or measurements say. If it sounds good but measures bad they your measuring the wong thing.

Although the effects of our amplifiers are very delicate, so the more sensitive your speakers the more what we design around is heard. We/I have always said the single best upgrade you can make to any home stereo system is speakers with greater sensitivity, real sensitivity specifications, not false inflated sensitivity specifications that some manufactures are know to portray. So we are telling the secret sauce of our amplifiers, we aren't telling you how to make it, but simply the ingredients that we feel we put into them to help them sound the way we do.

Terry Gesualdo
La Dolce Audio (The Good Sound)

If it sounds good it is good, welcome along in our journey!