Pass Labs technology

Oran Burns | Power Amplifiers | 27 April 2021

Pass Labs are the brain-child of one of the world's greatest amplifier designers Nelson Pass. Nelson has been designed world class state of the art amplifiers at Pass Labs since 1991 and also had a distinguished career before that at Threshold audio.

Many of Nelson's designs have reached legendary status amongst the audiophile community. Apart from being an amazing amplifier designer Nelson Pass also gives generously of his time and expertise to the amplifier DIY community through the Burning amp festival as well as contributing designs that can be built on a small budget.

Nelson also designs fantastic amplifiers under the banner of First Watt where this enterprise allows him freedom to experiment with simple linear topologies and take those learnings into Pass Labs which is a hugely beneficial R+D endeavour. The First watt amplifiers are generally lower powered designs where careful loudspeaker matching is required, however with the Pass Labs range there truly is an amplifier for every scenario.

Everything from the "baby" XA 25 amplifier all the way up to the monstrous XS 300, this outstanding product range offers industry leading musical
performance, build quality and value.

I first came across the work of Nelson Pass a few years ago when I was returning from a visit to the Munich High-end show. I was at the airport waiting for a flight home and I was researching single ended amplifier topologies on the internet and I stumbled upon a wondeful article that Nelson wrote some years ago.

The article intrigued me so much that I simply had to learn more and many chapters later I am very proud to say that Pass Labs are a staple brand of Ultimate Resolution audio. I truly believe that dollar for dollar, or pound for pound Pass labs amplifiers can go up against any other brand and come out on top for musical performance, reliability and most critically value for money.

The first Pass product that I properly listened to was the "baby" XA 25 amplifier and that experience has made a lasting positive impression. Its very difficult to describe in words how a product sounds, and of course I could use colourful, flowery language full of big impressive words, however that's not really what Ultimate Resolution is about. Instead I will just say that

Pass Labs solid state designs have redefined my understanding of what a transistor based amplifier can actually do. Solid state sound which perfectly conveys the realism and emotional impact of voice and instruments. I'm a big fan of valve amplification and when I hear the Pass house sound I do scratch my head and wonder if I will ever need to resort to those wonderful glass bottle power tubes ever again.

Nelson Pass has also written a bunch of other really interesting technical articles which are very helpful in digging deeper into the technology used in his amplifier designs.

If you would like to explore these articles they can be found here:

https://www.passlabs.com/technical-articles/

Nelson's understanding of the distortion profile of amplification devices is very complete and he demonstrates a wonderful ability to mix objective criteria with subjective considerations. That alone is a huge deal as a surprising amount of engineers major on being able to design devices which are technically "correct" and measure very well, but they havent properly considered the fact that music is fundamentally an expression of emotion, so ultimately devices need to be evaluated that way.

music/ˈmjuːzɪk/*noun*

1. 1.vocal or instrumental sounds (or both) combined in such a way as to produce beauty of form, harmony, and expression of emotion."couples were dancing to the music"

All that along with extensive use of amplification devices running in Class A result in a product range quite unlike any other. Class A is where all of the amplification devices contribute to the amplification of the signal all of the time. Lots of manufacturers design amplifiers which run in class A at some lower power level and then revert to class B at higher power levels. However in may cases it is not always clear when the transition from class A to class B actually happens. Everyone wants to run higher into class A as it is the most linear operating region and the sonic benefits are substantial however the trade off is that class A is very inefficient. For lower powered amplifiers this is not a problem however for high powered amplifiers running in class A/B it is both a smart and necessary compromise. In push pull circuits, where there are typically 2 amplification devices which are working in opposition to each other, one amplification device ceases to conduct current when the system enters into class A/B operation. The point where this happens depends on the amount of bias current applied.

An audio signal has alternating positive and negative sinusoidal cycles and as the phases are split in a push pull circuit where one transistor amplifies the positive half cycle and another amplifies the negative half cycle. When either voltage approaches the "zero" crossing point typical transistors tend to shut off producing a dead zone and a poor transition between devices. This is known as crossover distortion and is to be avoided at all costs. The solution to this is to add some bias current so that as the voltage drops towards the crossing point both transistors are already working which produces a smoother transition. When only one transistor is conducting its own positive or negative half cycle this is class B operation and once both devices are working this becomes class A operation.

Apart from being a great amplifier designer Nelson Pass has developed some great analogy's for explaining technical details. The analogy here is of 2 relays runners passing the baton. Imagine that the 2 relay runners are the transistors and the baton is the signal. In a race the baton hand over is done with both runners moving at high speed. If a runner has to stop to receive the baton this will blow their chances of a smooth hand over. Its the same thing with a pair of transistors in a push pull configuration. The higher the bias the smoother the transition.

Some amplifier designs will try to correct crossover distortion anomalies through the use of negative feedback, however this can actually introduce additional distortion artefacts. It is much better to design the circuit well in the first place rather than relying on seemingly easy fixes. Pass Labs amplifiers which are biased high into class A produce superlative audio performance with the trade off being heat and weight, as extensive metal work is required to dissipate the heat generated when amplification devices are generally switched on. The amount of bias used is a trade off between performance and efficiency. The bias is set relative to the hardware's ability to dissipate heat. Bias settings which cause the heat sinks to go 20 – 30 degrees above the ambient temperature are preferred. This means that if you really want to you can put your hand on the heat sink for around 10 seconds. Although it is not advised to try this. Its also good to avoid letting your cat sleep on a warm Pass Labs class A amplifier as this can result in cat hairs finding their way into the electronics.
The XA.8 range of amplifiers are the high current members of the family and these amplifiers are all designed to run higher into class A. This means that they will typically have lower power outputs compare to other products. Remember the XA.8 specified power figures are simply stating the available class A watts, above this level the amplifier will go into class A/B mode and produce more watts.
In practical terms, as long as we know a users preferred listening level, loudspeakers specs and listening distance from the loudspeakers we can work out which amplifier is appropriate. If you would like to listen exclusively in class A then this is possible through the XA.8 range.
The X.8 range of amplifiers are the high voltage members of the family and these amplifiers do not run high into class A operation. They typically offer the all important first few watts in class A but then switch to class A/B to offer high powered outputs. This becomes very useful in situations where the loudspeaker load is very demanding and/or the listening level or distance is significant.
An intresting comparison is to compare the XA 60.8 against the X 260.8. These 2 mono block amplifiers use the same size chassis, they look the same and weigh the same.

The basic specs are as follows:

Output wattage into 8 and 4 ohms:

XA 60.8 60/120 watts

X 260.8 260/520 watts

The XA 60.8 can deliver a peak of 122 watts in class A. The X 260.8 can deliver a peak of 34 watts in class A.

Its intresting to compare their respective output current and voltage capabilities. The XA.8 range use high ammounts of bias current for their operation. The X.8 use much lower levels of bias current and also have higher rail voltages to draw from.

Maximum output (Volts)

XA 60.8 48

X 260.8 80

Maximum current output (Amps)

XA 60.8 30

X 260.8 28

The XA.8 range has a current advantage whereas the X.8 has an output voltage advantage. With a range of amplifiers like this where all the specifications are transparent and readily

available with nothing hidden, the job of finding and specifying a suitable amplifier for a given application becomes much easier.
The other interesting part of this series is the function of the meters on the front of the amplifiers.

I often wonder if Nelson Pass was having a bit of fun with us when he came up with this great idea for how the meters should work. The needle never goes to zero as it is responding to current consumption and of course the bias means that there is always current. As long as the amplifier is still operating within its class A envelope the needle does not move. Once the amplifier leaves class A and goes into class B then the needle moves. This is a very clever way of helping us to gauge how many watts we actually use in real world use, as well as being a fun reminder that we usually don't need as many watts as we think we do.
Pass Labs .8 amplifiers also utilise a superb technology called Super symmetry which has been patented by the company and therefore can only be used on Pass Labs amplifiers.
This technology takes advantage of precision matched balanced circuitry to reject distortion and noise by making distortion and noise virtually identical on each side of a balanced amplification circuit. This gives up to 100:1 rejection of artefacts without requiring an equivalent amount of negative feedback. It is much easier to tweak the 2 halves of the circuit into symmetry rather than eliminating the distortion from each half of the circuit.
This allows the designer to utilise simple linear amplifier topologies which sound better than complex circuits which utilise large amounts of negative feedback.
Through the use of super symmetry amplification artefacts are eliminated well beyond any audibility threshold leaving more space for well recorded music to be enjoyed.
So there you have it, the Pass Labs .8 range is a superb range of amplifiers with innovative technology which is unique in our industry. The manufacturer has made every effort to share all the relevant technical details about the products so that I can help users to carefully select the right component for their application. Pound for pound watt for watt these amps can not just compete but come out on top against any other product on offer.

If you would like to listen to or chat about one of these incredible amplifiers please do get in touch using the contact details below.