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Pass Labs XA100.5 Class A
Monoblock Power Amplifiers



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Robert Harley

There aren't many amplifier designers who have pursued innovative and original circuits with as much passion over as long a time span as Nelson Pass. Not only has Pass developed genuine advances in amplifier design, he's spent most of his career refining and improving on those designs.

All of Pass' amplifiers, going back to the first Threshold products of 1975, are built on several fundamental principles. The first is that a simple signal path and fewer gain stages translate to better sound. The ultimate realization of this concept is Pass' Zen amplifier, which, astonishingly, is based on just a single gain stage.

The second guiding principle is that output stages operating in Class A are intrinsically superior to output stages operating

in Class A/B. Eliminating the "hand-off" of the signal from one transistor to another in the middle of the musical waveform makes sense intuitively and technically, and has a basis in the physics of how sound travels through air (see the sidebar).

A third foundation of Pass' amplifiers is that the products will weigh, cost, and produce the amount of heat required to make the design perform optimally. Compromising performance to make the product cheaper and lighter and run cooler just isn't a consideration. Of course, you can buy smaller, lower-powered versions of Pass' designs, but they share the common thread of being built to a high standard.

All of Pass' circuit innovations, design philosophy, and construction approach are on full display in the new XA ".5" Series of power amplifiers. These products are the culmination of everything Pass knows about amplifier design; examining these new amplifiers is like tracing the last 30 years of his thinking.

DESCRIPTION

I requested for review the XA100.5, the middle amplifier in the new five-product XA ".5" Series line. The XA ".5" Series ranges from the XA30.5 (30Wpc stereo at \$5000) to the XA200.5 (200W monoblock at \$34,100 per pair). All the amplifiers in the series produce their rated power in Class A, and all can double that rated power into 4 ohms without leaving Class A operation. With 100W into 8 ohms, I thought the XA100.5 would be plenty of power for the Wilson Alexandria X-2 Series 2 loudspeaker with

its whopping 95dB sensitivity.

The XA100.5 gives the impression of being hewn from a solid block of metal. This amplifier is built like a tank, with a ¾"-thick front panel augmented by 1"-thick sculpted sidepieces that frame the front panel's large round meter. The heatsinks are unusual in that the fins run in parallel with the side panels, resulting in a somewhat different "dreadnought" power-amplifier aesthetic.

The front panel is dominated by a large, round meter. Unlike most amplifier meters that indicate output power, the XA100.5's meter reads the amount of bias current. If the meter moves during a musical transient, you know that the amplifier has briefly left Class A operation for Class A/B (more on this later).

The rear panel offers both balanced and unbalanced inputs, as well as two pairs of loudspeaker binding posts for bi-wiring. The amplifier has two power switches, one on the front panel and one on the rear. With the rear-panel switch in the "On" position, the supply's filter capacitors are kept charged to extend their lives. This condition, which is the amplifier's normal state when not playing music, is indicated by the illumination of a small blue LED above the round meter. Pressing the front switch then fully powers up the unit and bathes the meters in a blue glow. When the rear-panel switch is set to "Off," the amplifier is completely turned off and draws no power. A 12V rear-panel trigger-input overrides the front power switch, turning the amplifier on when 5–12V is detected at the trigger input.

The ".5" in the XA100.5's model number denotes a number of design improvements over the previous XA Series. The ".5" Series amplifiers have lower noise, can deliver more current into low-impedance loads, and have an improved power supply with greater filter capacitance, more output devices (for a given output power), an improved circuit-board layout, lower distortion, a shorter warm-up time, and greater efficiency. (See the sidebar for a complete technical description.)

LISTENING

Having lived with pure Class A amplifiers many years ago (the Mark Levinson No.20.5 monoblocks), I was expecting the XA100.5s to be room heaters. I also expected the amplifiers to reach their full sonic potential only after many hours of being powered up—not a good combination. In fact, I had to return the Levinson amplifiers despite how great they sounded; they ran unbelievably hot and sounded mediocre unless they'd been turned on for many hours. I was therefore pleasantly surprised that the XA100.5s produced a fraction of the heat I was expecting and sounded great after just half an hour of warm-up. The sound kept improving after half an hour, but most of the gains were realized in the first hour. The XA100.5 is a high-powered, pure Class A amplifier that one can easily live with.

My first thought on hearing music through the XA100.5 was that there was something extraordinarily beautiful about the sound. It was like slipping into a hot tub on a cold night; the music seemed warm, inviting, and enveloping. I had a hard time at first identifying the specific aspects of the presentation that fostered this impression—the XA100.5 was that different from other solid-state amplifiers I've heard. In fact, the XA100.5 reminded me of the best power amplifier I've ever had in my system, the Audio Research Reference 600 MkII (the forerunner of the 610T, our 2007 Product of the Year). The \$36k, 34-tube-per-side, 600-

watt monoblock Reference 600 possessed a stunning rendering of instrumental timbre, had an unparalleled sense of ease, and coupled a sense of delicacy with unfettered dynamics.

The more I listened to the Pass, the more I understood why this amplifier sounded so luscious (and so much like the ARC Reference 600); the XA100.5 had a freedom from grain and a suave liquidity in the midrange that rendered instrumental timbres with stunning realism. The best tubed amplifiers avoid the sins of solid-state—a slightly gray and grainy patina overlaying instrumental textures that is akin to a metallic aftertaste. This coloration imparts a "sameness" to midrange timbres, as well as overlaying the treble with a sterile hardness. The XA100.5 was utterly devoid of this character, the musical significance of which cannot be overstated. In fact, it was this lack of electronic "haze" that fostered my first impression of the XA100.5 sounding so beautiful. I was responding to the purity of timbre, the depth and saturation of tone color, and the utterly natural rendition of instruments and voices that is this amplifier's defining achievement.

Listen, for example, to the rich and colorful orchestration of the Lento Assai in Rachmaninoff's *Symphonic Dances* [Reference Recordings]. The XA100.5 allowed the full palette of tone colors to emerge with a lifelike palpability, unhindered by electronic artifacts. The presentation had a pristine cleanliness, particularly in the midrange, that allowed the vividness of timbres to shine through. This cleanliness wasn't a dry, analytical character, but a true transparency to the source. Music is so much more involving when one doesn't have to listen through a synthetic veil that dilutes timbral realism. In this regard, the XA100.5 sounds like a handful of the very best tubed amplifiers, with the grace, ease, and involvement that come so naturally to tubes.

The XA100.5 also had an overall "warm" character, particularly in the bass, mid-bass, and lower midrange, again much like a tubed amplifier. But unlike most tubed units, the XA100.5 had no trace of thickness or bloat that often accompanies a sense of bass warmth. Rather, the bass was tightly controlled and articulate, lacking the dryness and absence of body prevalent in many solid-state amplifiers. In addition, the XA100.5's bass swings with a great sense of rhythmic propulsion. There's no better example of this than Ray Brown's bass on the appropriately titled *Soular Energy* by the Ray Brown Trio. The Pass amp had an agility and articulation that belied the accompanying sense of weight and warmth. Brown's instrument sounded like the big, round, wooden, resonating cavity it is, not a miniaturized facsimile. (The 192kHz/24-bit DVD-A release of *Soular Energy*, mastered on a Pacific Microsonics Model 2 converter from the original analog tapes on the Hi-Res Music label, is spectacular.)

This description might lead one to think of the XA100.5 as sweet and a bit romantic, favoring ease over resolution, but that's not the case. The XA100.5 achieves its tube-like purity not by glossing over flaws with a "forgiving" character, but by reducing audible artifacts to the point where the amplifier becomes a transparent window on the source. Moreover, the XA100.5 was highly resolving of musical detail, but in a relaxed and natural way, rather than in a "hi-fi" sense.

Symphonic Dances also revealed another great strength of the XA100.5—the portrayal of dynamic contrasts. The Pass amplifier was capable of reproducing transient information and musical climaxes with sudden, explosive power. There was a sense of complete ease and of unlimited power reserve during demanding passages.²

UNDER THE HOOD

Removing the XA100.5's hefty top cover reveals a starkly minimalist design. The entire amplifier, save the power supply and output stages, is contained on a circuit board about two-thirds the size of a CD jewel case. This compact low-level stage stands in stark contrast to the XA100.5's massive power supply and overkill output stage. The toroidal power transformer is huge—larger than some I've seen in stereo power amplifiers rated at 250Wpc.

The forty matched MOSFET output devices are arrayed in two rows of ten transistors each running along each heat-sinked side panel. Forty output devices for 100W of rated output is more than generous; each transistor is specified to dissipate 125W, yet is run at a maximum dissipation of 20W. (For comparison, the output stage of a typical 100W Class A/B amplifier consists of four transistors.) This output stage can deliver 200W of Class A power into 8 ohms, and 400W of Class A power into 4 ohms. This is a staggering amount of pure Class A output power, which explains the 40 output transistors, huge heat sinks, and massive power transformer.

Let's first look at the overall circuit topology. The XA Series is essentially a combination of Pass' famous Aleph single-ended Class A circuit and Pass' "Super-Symmetry" technique (also called the "X" circuit). The Aleph amplifiers are known for their pure and highly seductive sound, which one could attribute to the Class A operation and very simple, two-gain-stage signal path. The Aleph amplifiers' strengths are in the midrange and treble, rather than in bottom-end dynamics and sheer output power. The Super-Symmetry design uses a balanced circuit so that noise and distortion cancel at the output. The two halves of the balanced circuit operate on identical signals, but one of them is inverted with respect to the other. When these two out-of-phase signals are combined, only the difference between the two signals remains. Noise and distortion that weren't part of the original musical signal will appear in both halves of the circuit and have the same polarity. Because the noise and distortion are identical in both halves of the balanced circuit, they are not passed when the two out-of-phase audio signals are combined. This phenomenon is called "common-mode rejection."

Exploiting common-mode rejection to reduce noise and distortion is an old and common technique. It typically produces a ten-fold reduction in noise in a single-ended Class A circuit. Pass' Super Symmetry innovation, for which he was awarded a patent, is to magnify this effect by using feedback to make the distortion and noise nearly identical in the two halves of the balanced signal. Because the noise and distortion are now more alike, the rejection is greater. Super Symmetry reportedly results in a one-hundred-fold reduction in noise and distortion, an order of magnitude greater distortion attenuation than in a traditional balanced circuit. Moreover, this technique of reducing distortion by common-mode rejection means the circuit needs less of the traditional form of feedback. As Pass puts it, "It is simply much easier to tweak the two halves of the circuit into identical symmetry than to eliminate all the distortion in each half of the circuit."

The XA100.5 is two balanced Aleph amplifiers that share a differential input stage. There are just two gain stages—the differential input stage just mentioned and the output stage. This circuit topology is shared throughout the XA-5 Series; the larger amplifiers are simply scaled up in the number of output transistors, power supply capacity, and heat-sinking.

The output stage is biased so that it puts out the amplifier's rated power in Class A operation. To understand Class A, it helps to first consider Class B operation. Also called "push-pull," Class B employs pairs of transistors that work together. One transistor of the pair handles the positive half of the waveform and the other transistor handles the negative half. One transistor "pulls" current

through the load (the loudspeaker) and the other "pushes" current. Each transistor is conducting current half the time, turning completely off when its partner takes over amplifying the signal.

This method is highly efficient, but introduces some problems. Transistors are not very linear at very low signal levels where the "handoff" to the partner transistor takes place. It's also impossible to match the characteristics of a pair of transistors so that this "handoff" occurs seamlessly. The result is distortion at the zero-crossing point where one transistor turns off and the other turns on.

The solution is to turn the transistors partially on all the time with a small amount of current, called "bias." This bias current keeps the transistor from turning completely off, and forces it to operate well away from its non-linear zero-crossing point. With enough bias, the transistor can be made to amplify the entire waveform rather than just half of it. The application of bias current has just turned our Class B amplifier into a Class A amplifier.¹

This amplifier will operate in Class A up to a certain amount of output power, and then switch to Class B (push-pull) mode. This transition from Class A to Class B is uneventful; the transistors just operate a little differently above a certain power level. Most amplifiers operate this way, thus the common "Class A/B" designation.

The amount of power the amplifier can deliver in Class A before switching to Class B is purely a function of the amount of bias current. Increase the bias current and you'll get more Class A watts before the amplifier switches to Class B. But if Class A is so desirable, why don't designers simply crank up the bias? The answer is that bias increases the demands on nearly every aspect of the power amplifier—particularly the expensive parts. Because current flows through the transistors at all times, and not just when they are conducting audio signals, the amplifier runs hot. This means bigger heat sinks, more output transistors to dissipate the heat, and a beefier power supply that can deliver a continuous source of current. Class A amplifiers are big, heavy, expensive, highly inefficient, and run hot. In fact, a pure Class A amplifier runs just as hot, and pulls just as much power from the wall, when at idle as at full output power. The amplifier is simply running flat-out all the time, whether it's amplifying a musical signal or not.

Most amplifiers produce a tiny fraction of their rated power in Class A, and then switch to Class B. For example, a 200W amplifier might produce 3W in Class A, and the remaining 197W in Class B. Some amplifiers are more heavily biased so that they deliver more Class A power before switching to Class B.

Pure Class A operation is common in low-level signal applications, such as in preamplifiers and CD-player output stages where the power requirements are low. Pure Class A output stages in power amplifiers are, however, a rarity, and those that can deliver 400W of Class A power into 4 ohms are rarer still. This is why the XA100.5 has the size, weight, and cost of a much more powerful Class A/B amplifier. If you want the most "watts per dollar," Class A isn't the way to go. **RH**

¹In a white paper on Class A operation, Pass has the interesting insight that sound in air is essentially a "Class A" phenomenon. A vibrating object such as a musical instrument produces compressions and rarefactions (areas of higher and lower pressure than atmospheric pressure of 14.7psi) that move our ear drums back and forth, which we perceive as sound. These pressure variations are referenced to the prevailing atmospheric pressure of 14.7psi; the rarefactions are areas of pressure lower than atmospheric pressure, but still represent positive pressure compared with a vacuum.

The atmospheric pressure of 14.7psi is analogous to the bias flowing through an amplifier's transistors. Just as the atmospheric pressure creates an elevated "zero reference level" around which the compressions and rarefactions vary, bias elevates the transistor's operating point so that when the audio signal swings "negative," it is really just "less positive."

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Some amplifiers that sound dynamic and lively tend to add a bit of etch to the leading edges of transients, creating an initial impression of dynamics and detail resolution. They don't have any real weight behind the transient impacts; it's "all show and no go." One quickly tires of such a presentation. The XA100.5 is devoid of this hyped sound, instead deriving its dynamic portrayal from sheer speed coupled with weight and power behind that speed, exploding like a crack of thunder directly overhead. The sense of unlimited dynamics, the muscular control over the bottom end, the suddenness of transient impacts, and the way that dynamics jumped from a jet-black background produced a sense of vibrancy and excitement. The combination of ease and relaxation, fostered by the midrange and treble liquidity on one hand and the vivid immediacy and drama that resulted from the highly dynamic rendering on the other, made for an immensely involving musical experience.

The XA100.5 didn't just excel at large-scale dynamics; it also emphasized (or perhaps more accurately, didn't obscure) small dynamic shadings such as accented notes. I had a new appreciation for the dynamic expression in music after living with the XA100.5.

SPECS & PRICING

Output power: 100W @ 8 ohms, 200W @ 4 ohms	Dimensions: 19" x 7" x 19"
Input impedance: 30k ohms balanced, 15k ohms unbalanced	Weight: 110 lbs. each (net)
Distortion: 0.01% @10W, 0.1% at 100W (1kHz)	Price: \$16,500 per pair
Inputs: Balanced on XLR jacks, unbalanced on RCA jacks	PASS LABORATORIES 24449 Forresthill Road Forresthill, CA 95631 (530) 367-3690
Power consumption: 270W	

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² The XA100.5's front-panel bias meters didn't budge during the entire review period, indicating that the amplifier never left Class A operation. This is partly due to the Wilson X-2's 95dB sensitivity. The wide range of output powers in the XA series allows you to precisely scale the amplifier power to the loudspeaker's requirements. I got the impression, however, that the 30Wpc XA30.5 would have capably driven the X-2.

I've long been a fan of drummer Jack DeJohnette. He has an amazingly wide range of expression, from the most delicate and empathetic cymbal work (notably in the trio with Keith Jarrett and Gary Peacock) to raw, visceral power. He also brings out the best in soloists by spurring them to greater heights with his energy and vitality. Check out the track "Tumbleweed" from Michael Brecker's *Pilgrimage* CD, particularly the way DeJohnette's take-no-prisoners playing (especially during Brecker's solo) elevates this track into a thrill ride. The XA100.5's dynamic ability better resolved the steep attacks of sticks hitting drum heads, and consequently, revealed the full extent and power of DeJohnette's expression. Another example is the Latin percussion work on the outstanding new Mobile Fidelity LP reissue of Santana's great *Abraxas*. The congas, timbales, and güiro had a vividness that made them sound as though they were recorded yesterday.

The XA100.5's spatial presentation was similarly outstanding. Instrumental images were presented against a dead-silent background, seemingly hanging in black space. The soundstage was wide and deep, with great dimensionality. The overall perspective was a bit more forward than that of many amplifiers, and the sense of depth and hearing into the far recesses of the hall wasn't as pronounced as from the Spectral DMA-360 which I also had on hand.

CONCLUSION

If I had to count on one hand the best power amplifiers I've ever had in my system, the Pass Labs XA100.5 would make the cut. This amplifier had a remarkable sense of ease, relaxation and involvement that are no doubt the result of its tube-like liquidity, midbass warmth, and freedom from electronic artifacts. Although gorgeous in its reproduction of instrumental timbres, it would be a mistake to characterize the XA100.5 as romantic or forgiving. Rather, the XA100.5's beauty comes not from what it adds to the signal, but what it doesn't.

Couple this warm and inviting quality with a high-resolution rendering that is capable of explosive and lightning fast dynamic swings and you have the makings of one very special amplifier.

Finally, it's important to note that the XA100.5 is beautifully built, designed for long-term reliability, and is backed by one of the most venerable names in high-end audio. It all adds up to one of the greatest values in solid-state amplification. **TAS**