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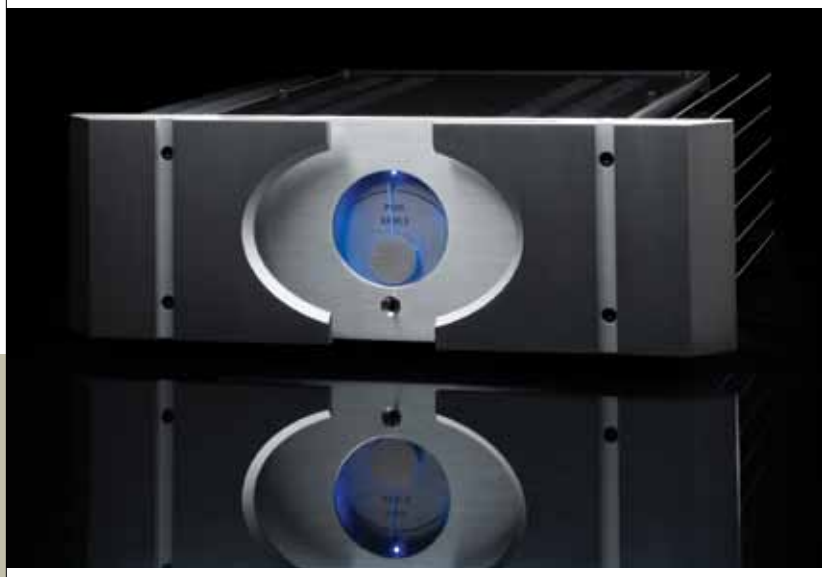
EQUIPMENT REPORT

Pass Labs
XA30.5

POWER AMPLIFIER

BRIAN DAMKROGER



Pass Labs XA30.5 power amplifier

DESCRIPTION Solid-state stereo power amplifier. Inputs: 1 pair unbalanced (RCA), 1 pair balanced (XLR). Outputs: 2 pairs binding posts. Rated power output: 30W into 8 ohms, 60W into 4 ohms (both 14.8dBW). Maximum output voltage: ±35V. Maximum output current: ±20A. Voltage gain: 26dB. Input sensitivity: 0.77V at 26dB gain. Frequency response: 1.5Hz–100kHz, –3dB at 1.5Hz, –2dB at 100kHz. Signal/noise: 150dB at full power. Distortion: 0.01% at 3W, 0.1% at 30W. Input impedance: 30k ohms balanced, 15k ohms unbalanced. Damping factor: 150 at 8 ohms. Slew rate: ±50V/µs. Power consumption: 238W.
DIMENSIONS 19" (485mm) W by 7" (180mm) H by 19" (485mm) D. Shipping weight: 75 lbs (34kg).
SERIAL NUMBER OF UNIT REVIEWED 18723.
PRICE $5500. Approximate number of dealers: 20. Warranty: 3 years, transferable.
MANUFACTURER Pass Laboratories, PO Box 219, 24449 Foresthill Road, Foresthill, CA 95631.
Tel: (530) 367-3690.
Fax: (530) 357-2193.
Web: www.passlabs.com.

Over the course of his 30-plus years in high-end audio, Nelson Pass's designs have never been far from the leading edge. In his first Threshold amplifiers he pioneered the use of dynamically adjusting bias and cascode circuitry; then, in the later Stasis models, he switched gears to the simpler approach of pure class-A. All were innovative designs, and among the very best-sounding amps of their time, but were just warmups for what was to come. In 1991, Pass Labs introduced the Aleph 0, a class-A amplifier that was a startling departure from conventional solid-state designs and combined design elements generally thought mutually exclusive: transistors, single-ended operation, and the ability to output 75Wpc into an 8-ohm load. Not surprisingly, the Aleph 0 sounded like nothing else, and became the basis for the widely acclaimed series of Pass Labs amplifiers that evolved over the next decade.

Pass's designs have varied widely, but all reflect his quest for simplicity. It's considered a self-reinforcing design philosophy: simple circuits and a minimum number of gain stages result in less distortion being generated, ergo less need for feedback and the additional gain needed to offset it. This approach leads to low-distortion, typically smaller devices that operate under optimal class-A conditions. The challenge has always been to accomplish these goals in an amplifier with enough power and current capacity to drive insensitive audiophile loudspeakers. Dynamically adjusting bias, cascoding, Stasis, Supersymmetry, and the hybrid configuration in Pass's XA.5 series are different ways to enable the simplest possible gain circuit to do the job.

The X.5 and XA.5 series of amplifiers are the second respective generations of the original X and XA series. The X models, beginning with the X1000 in 1998, were the

first implementation of Nelson Pass's patented Supersymmetric topology (see sidebar, "Pass on the Patents of Pass"). The XA series, which debuted four years later, combined Supersymmetry with the single-ended class-A operation of the Aleph series. The XA and XA.5 models run substantially hotter and produce about half the power of their X and X.5 counterparts, which operate in class-A at low levels but switch to class-AB for most of their dynamic range. Though the .5 designs aren't entirely "new," they incorporate enough small changes to merit the designation.

The XA30.5

Nelson's amplifiers, whether they were his earlier designs for Threshold or his later ones for Pass Labs, have always been on my wish list, so I was delighted when the opportunity arose to review one of the latest Pass amps. I was a little surprised, however, at Nelson Pass's suggestion that I audition the XA30.5. I'd expected a pair of X1000.5 monoblocks perhaps, or maybe XA200.5s, if he thought they'd do the job . . . but a nominally 30Wpc stereo amp? I double-checked, and yes, he did know what speakers and other amplifiers I was using, and yes, he was aware of the sort of gear I usually reviewed. Despite all that—actually, *because* of all that—he reiterated his preference that I audition the little guy.

The smallest amplifier in the Pass Labs line, the XA30.5 retails for $5500. It's hardly a featherweight, though, because producing 30Wpc of pure class-A power requires a lot of hardware. The XA30.5 shares the handsome industrial design Desmond Harrington created for the larger Pass Lab amps: a mix of strong, simple shapes and textures surrounding a glowing blue power meter. The overall impression is one of strength and elegance. Were the XA30.5 a car, it would be something beautiful yet purposeful, like a Ferrari 599GTB—midway between the soft curves of a Jaguar XKR and the angular menace of a Lamborghini Gallardo LP560-4.

The XA30.5's inner workings are similarly well executed. The boards are nicely laid out and well labeled, the wiring routes simple, the parts all of top quality. The mechanical assembly is similarly well thought out, and the workmanship is excellent throughout. There are relatively few boards, reflecting the simple, symmetric nature of the design. One board just behind the front panel holds the meter and Standby/Operate switch. There are two more boards at the rear of the chassis: The lower one contains the

MEASUREMENTS

I examined the Pass Labs XA30.5's measured behavior with *Stereophile*'s loaner sample of the top-of-the-line Audio Precision SYS2722 system (see the January 2008 "As We See It" and www.ap.com); for some tests, I also used my vintage Audio Precision System One Dual Domain.

Before performing any tests on an amplifier, I run it for 60 minutes at one-third its specified power into 8 ohms, which is thermally the worst case for an amplifier with a class-B or -AB output stage. Superficially, the XA30.5 appears to be a 30Wpc class-A design. But this is not the *maximum* output power. The specifications list the amplifier's maximum output voltage as ±35V, which, assuming this is the RMS voltage, is equivalent to 153W into 8 ohms. The XA30.5 thus transitions into class-B for the top 6dB of its dynamic-range capability. I therefore preconditioned the Pass amplifier by running it at 40Wpc into 8 ohms for an hour. The heatsinks were just over 60°C (140°F) at the end of that period; the distortion had dropped slightly, from 0.0192% to 0.0176%.

The XA30.5's voltage gain into 8 ohms was 26.65dB from both balanced and unbalanced inputs, and both sets of inputs reserved absolute polarity; *ie*, were non-inverting. (The XLR jacks are wired with pin 2 hot.) The input impedance of the balanced XLR jacks was 29k ohms, close to the specified 30k ohms; the input impedance of the single-ended RCA jacks was higher than specified, at 20k ohms. Both figures were constant across the audioband.

The output impedance was low, at 0.08 ohm at low and middle frequencies, rising inconsequentially to 0.1 ohm at 20kHz. As a result, the modification of the amplifier's frequency response by the usual Ohm's Law interaction between its source impedance and the modulus of the loudspeaker's impedance remained within ±0.01dB limits (fig.1, gray trace). This graph also reveals excellent channel matching, as well as a wide small-signal bandwidth—the –3dB point lies at around 125kHz. The XA30.5's reproduction of a 10kHz squarewave was consequently superbly square (fig.2), with short risetimes and no hint of overshoot or ringing. The 1kHz squarewave (not shown) was similarly well formed.

Channel separation was superb, at better than 110dB below 5kHz, and still 98dB (R–L) and 104dB (L–R) at 20kHz. The audioband unweighted signal/noise ratio, ref. 1W into 8 ohms, was an excellent 83.6dB, increasing to 87.2dB when A-weighted.

Fig.3 shows how the THD+noise percentage in the

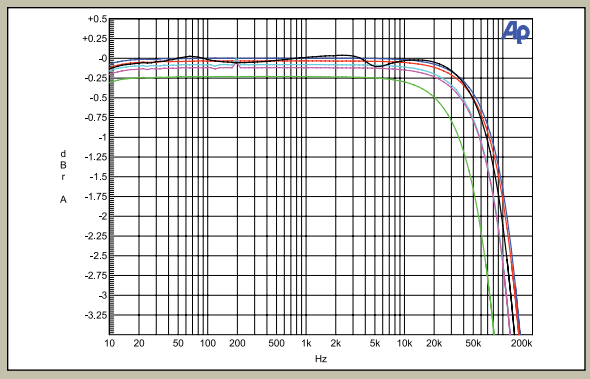


Fig.1 Pass Labs XA30.5, frequency response at 2.83V into: simulated loudspeaker load (gray), 8 ohms (left channel blue, right red), 4 ohms (left cyan, right magenta), 2 ohms (green). (1dB/vertical div.)

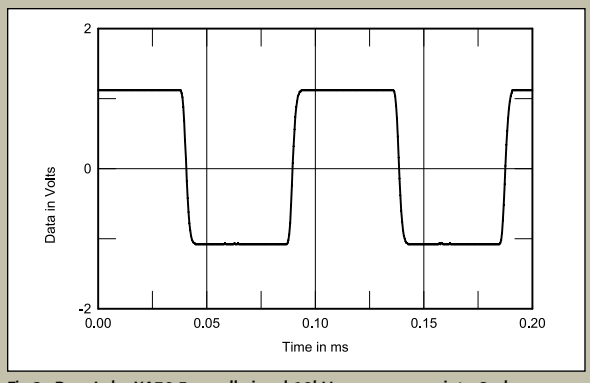


Fig.2 Pass Labs XA30.5, small-signal 10kHz squarewave into 8 ohms.

power-supply electronics, the upper one the bias circuitry. The upper board also acts as a mother supporting two daughter boards. Each of these is what Pass calls a Universal Gain Stage (UGS), which consists of a cascoded input and a voltage gain stage. Two more boards run the full length of the chassis, one along each side. These are the output stages, each comprising 10 pairs of power MOSFETs. Because the XA30.5 is a fully balanced design, this translates to five complementary pairs each for the plus and minus legs. The front half of the chassis is filled, nearly top to bottom, with a huge Plitron toroidal transformer that no doubt accounts for most of the amp's 75 lbs.

This simple, three-stage topology is common throughout the Pass line, the major differences being in the power supplies and biasing. In the XA.5 amps the bias is set quite high, so that the output stage operates in class-A up to the rated output and emulates a single-ended amplifier at low levels. Pass described this to me as "a push-pull output stage in parallel with a constant current source. The *n* channel, which handles the push, or plus, side of the push-pull, is biased at a higher level than the *p*, or negative channel. At very low power levels, the *p* channel doesn't see the current source and the output is effectively that of the *n* channel functioning in single-ended mode. At higher levels, both *n* and *p* devices contribute to the output as a push-pull pair, operating in class-A mode up to the amp's rated output and class-AB beyond that point."

Beauty, brains . . . how about personality?

The XA30.5 was very simple to set up and operate. On the rear panel are balanced and unbalanced inputs, a single set of hefty binding posts for speaker cables—the user is warned not to connect either terminal to ground—another set of lugs to bring in a 12V trigger signal if desired, a removable power cord, and an on-off switch. The amp is intended to be left on at all times, and switched between its Standby and Operate modes via a toggle switch just below the meter. I let the XA30.5 burn in for two weeks before doing any listening, then left it on throughout the review period. At least an hour before each listening session, I switched the amp to Operate to let it warm up.

My system was pretty stable during the XA30.5's tenure here. I used two turntable-tonearm combos: the VPI HR-X, and a Spiral Groove SG-2 with a Triplanar arm, each fitted with either a Grado State-

amplifier's output varies with output power into 8, 4, and 2 ohms. While the XA30.5 may give 30Wpc into 8 ohms in class-A (14.8dBW), the distortion at this power level is low, at 0.015%. The amplifier doesn't actually clip (defined as the THD reaching 1%) until a much higher power level: 130Wpc into 8 ohms (21.14dBW). Even higher powers were available into lower impedances before clipping: 195Wpc into 4 ohms with both channels driven (19.9dBW), and 332W into 2 ohms with one channel driven (19.2dBW). The shapes of the traces in fig.3 indicate that the distortion starts to rise out of the noise floor at output powers above a few watts, with then a gentle increase until the waveform starts to square off. I therefore examined how the THD+N percentage changed with frequency at a level of 10.5V, equivalent to 13.8W into 8 ohms. The results are shown in fig.4. While the distortion is very low in the low and middle frequencies, it does start to rise with increasing frequency above 500Hz, and is worse into 2 ohms (green trace) than into higher impedances.

What matters more than the absolute level of an amplifier's distortion is its spectral composition. Fig.5 reveals that the XA30.5's THD is almost pure third harmonic, even at a level where the amplifier's output stage is no longer running in pure class-A. And as you'd expect from the rich bias level, there is no hint of crossover distortion. FFT analysis indicates that while there is some second

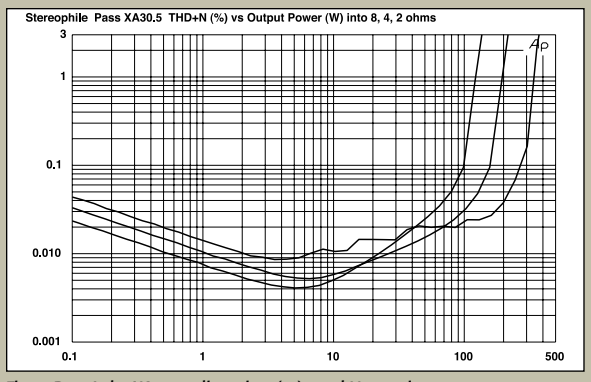


Fig.3 Pass Labs XA30.5, distortion (%) *vs* 1kHz continuous output power into (from bottom to top at 10W): 8, 4, 2 ohms.

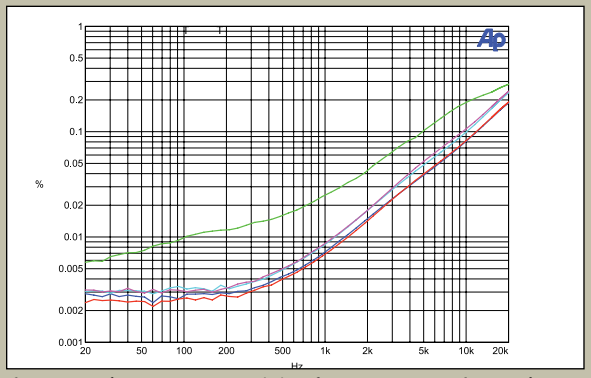


Fig.4 Pass Labs XA30.5, THD+N (%) *vs* frequency at 10.5V into: 8 ohms (left channel blue, right red), 4 ohms (left cyan, right magenta), 2 ohms (green).

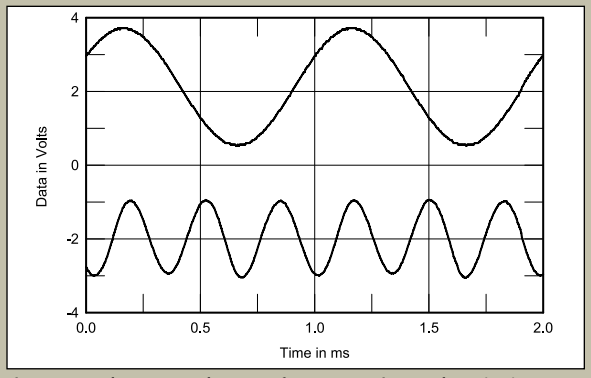


Fig.5 Pass Labs XA30.5, 1kHz waveform at 50W into 8 ohms (top), 0.023% THD+N; distortion and noise waveform with fundamental notched out (bottom, not to scale).

ment Reference or Lyra Titan *i* cartridge. Digital signals were supplied by a Primare CD31 CD player, and the electronics consisted of a Sutherland PhD phono stage feeding either a Sutherland Direct or Placette Active line stage. The Pass drove two sets of speakers, the Sonics by Joachim Gerhard Allegras and my Wilson Audio Sophia 2s. After experimenting a bit, I settled on Nordost Valhalla interconnects and speaker cables as the best match for an XA30.5-powered system. The amp was plugged directly into the wall; everything else was fed juice from the new Audience AdeptResponse T power conditioner via Audience PowerChord e AC cords.

All of the true class-A amplifiers I've had in my system have shared a few characteristics that I can now tick off on my fingers: a smooth, distortion-free purity to the sound that is most obvious across a gorgeous midrange; tonal balances that are often a bit dark, due to a softened and truncated high end; bass reproduction that typically lacks a bit of punch and extension; slightly softened dynamics; and soundstages that are deep but recessed, particularly at the center. The mix and extent of these characteristics have varied from amp to amp, but all have always been present to some degree.

The XA30.5 had the lifelike smoothness and purity in spades. It's easy, on a steady diet of recorded music, to "listen around" too-common distortions. We turn the volume down a bit to tame a bit of harshness in closely miked trumpets or a steeliness in crescendos of massed violins, and learn to accept a forceful but indistinct impact when a bass drum is first struck. The absence of these insidious distortions is one reason that live music is so immediately and obviously different from recordings. But within the first few seconds of listening with the XA30.5 in the system, it was clear that these distortions had been dramatically reduced. There was a natural ease to the sound, and a level of inner detail that hadn't been distinguishable before.

IT WAS AS IF THE BAND MEMBERS HAD RELAXED, LOWERED THEIR SHOULDERS, AND **TAKEN A DEEP BREATH.**

One evening, Dave Grusin's album of Glenn Miller classics, *In the Digital Mood* (CD, GRP Digital Master, GRP-A-1002), provided a few great examples of these differences. Before installing the XA30.5 in my system, the sound of this album had been dynamic, with a bright, sunny feel. The orchestra had sounded tight and well paced, with a foot-tapping kind of drive. Installing the Pass changed this feel to one of effortlessly smooth swing. It was as if the band members had relaxed, lowered their shoulders, and taken a deep breath. The trumpet crescendos in the halting, expanded runs midway through "In the Mood" sounded less forced through the Pass, and a slight glare was now gone, leaving the images of individual instruments more distinct and harmonically more rich. The musicians gained body and depth, and there was a sense of the spaces between them. I could picture the individual musicians and imagine the air moving through each instrument. Whenever I replaced the Pass with a different amplifier, the images flattened and the slight glare returned. Although these differences were subtle, I was surprised at how badly the glare smeared or obscured inner detail during the loudest passages.

The XA30.5 extended this effortless purity and portrayal of inner detail from the midrange out to the frequency ex-

measurements, *continued*

harmonic present as well as the third, it lies about 100dB down from the fundamental level (fig.6), and all higher-order harmonics are very low in level. The presence of sidebands at ±120Hz around the fundamental and third harmonic, however, suggests that the amplifier is working hard. Still, all power-supply–related spectral components are at or below –108dB, which is negligible.

Finally, the XA30.5's decreasing linearity in the top octaves led to a somewhat disappointing result on the high-power, high-frequency intermodulation test, particularly with the right channel (fig.7, red trace). (The power level chosen for this test was just below visible waveform clipping on the oscilloscope screen.) While the second-order difference component from the 19+20kHz test signal was respectably low, at –103dB left channel (0.0007%) and –94dB right (0.002%), higher-order products also made an appearance, with the 18 and 21kHz tones reaching –60dB (0.1%). This is very much a worst-case test, however.

Pass Labs' XA30.5 is a Jekyll-and-Hyde amplifier. Ostensibly a 30Wpc class-A design, its measured performance reveals that it can actually deliver clipping-free peaks 6dB higher in power, while the fact that its distortion under those conditions is predominantly the subjectively innocuous third harmonic is commendable. **–John Atkinson**

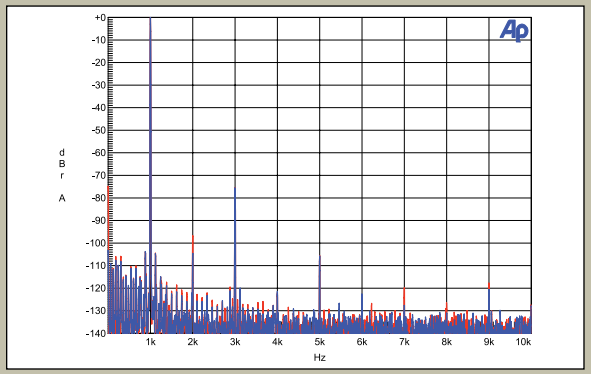


Fig.6 Pass Labs XA30.5, spectrum of 1kHz sinewave, DC–1kHz, at 37W into 8 ohms (left channel blue, right red; linear frequency scale).

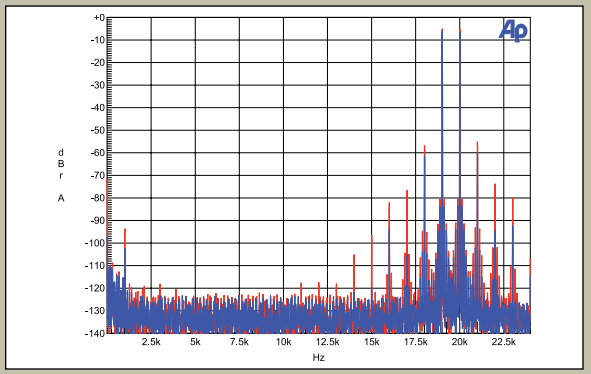


Fig.7 Pass Labs XA30.5, HF intermodulation spectrum, DC–24kHz, 19+20kHz at 75W peak into 8 ohms (linear frequency scale).

tremes. The cymbals on the Grusin disc had a sweet timbre and long, delicate decays. Their crashes seemed a little attenuated, though, so I wondered if the Pass might be softening transients or rolling off the highest frequencies. The drum set on *Test CD 2* (Stereophile STPH004-2) is a more natural recording, and showed that the Pass didn't lack extension. It was just removing a splashy overemphasis from the leading edges of hard transients—such as those cymbal crashes. In fact, the XA30.5 reproduced the initial cymbal stroke well enough that I could easily hear both the initial impact of the drumstick and the bell-like ringing within the transient.

I heard less of this ringing in the cymbals when I switched to other amps, though the differences weren't huge. With my VTL Ichibans, for example, the cymbals still sounded like cymbals, though with a bit less ring and a bit more dense, metallic hiss. They had a complex timbre and structure, just not as sweet or as focused as they'd been with the Pass, or quite as three-dimensional. Switching from the Pass to other amps also seemed to truncate the cymbals' decay, preventing me from hearing the last, faintest traces of the shimmer dissolving into the background. Again, however, the differences were subtle.

The Pass did a great job of reproducing harmonic and inner detail on the bottom end as well, although here the XA30.5 did lack a bit of weight and extension in comparison to more powerful amps. Returning to Russ Henry's drum kit on *Test CD 2*, the Pass beautifully captured the round, booming nature of the bass drum, but didn't really convey the sense of a moving pressure wave. In a run down succeedingly larger toms, the Pass gave each drum a distinct location, size, and shape, each described by a clear and unique blend of elastic skin sound and trailing body resonances. The toms had more punch through other amps, and increasingly so as they dropped in pitch, but with neither the precision nor the tonal and textural detail they had through the XA30.5.

The Pass's effortless, almost lazy feel did lack some of the snap and energy I heard with other amps. Instead of turning the volume down a bit to tame the crescendos, with the Pass I was constantly turning the volume *up*—partially because there was no glare to tone down, but also in a quest for more impact and drive. Parsing it into audiophile terms, the XA30.5's macrodynamics—the big swings and huge crescendos—weren't as large as with my other, far more powerful amps. Where my VTL Ichibans would transition from, say, *ppp* to *fff*, the Pass would go only from *ppp* to perhaps *ff*. Don't get me wrong—the XA30.5 had dynamic range, just not as much as my larger, pricier, class-AB goliaths.

To be fair, I was running the XA30.5 well out of its comfort zone. Nelson Pass explained to me that the front-panel meter, which indicates the amount of current being drawn from the wall, "should sit somewhere in the middle" and "won't move if you're running in class-A." During most of my listening sessions, the meter would bounce between the middle and, say, the three-quarters point of its range. When I was listening to and for large dynamic swings, the meter would frequently be pegged. This didn't seem to bother Pass when we discussed it, though he did say, "Hmmm . . . so you're pulling a lot of juice." Well, maybe if I'd gotten those XA200.5 monoblocks . . .

On the other hand, the XA30.5 beautifully rendered the subtle, microdynamic nuances in more intimate material. With the volume set at a level that seemed correct for the material, my megaton class-AB amps would quickly and cleanly *step* between *ppp* and *pp*, but lost focus and detail at the lowest, *pppp*, levels. They sounded perfectly fine—until I compared them to the Pass. With the XA30.5 again set to a level appropriate for the material, the difference between *ppp* and *pp* was, instead of a step, a continuous spectrum of subtly different levels—even the faintest, barely audible sounds were detailed. The unearthly voices of "Yulunga," from Dead Can Dance's *Into the Labyrinth* (CD, 4AD 45384-2), were exactly that through the Pass: *voices* rather than *sounds*. There were now different layers of microdynamic nuance within these voices' tonal components, which gave them a more natural complexity than I was used to hearing from this track. The balance of these layers would shift as the voice changed pitch or level, thus giving it a slightly different character. It's difficult to describe what the XA30.5 did in audiophile terms, but the way it reproduced these nuances flipped some internal switch of mine: instead of *synthesizer*, I was now thinking *vocal cords*.

Pure class-A amplifiers are often thought of as having a slightly dark tonal balance, but that wasn't the case with the Pass. Though it definitely wasn't bright, the XA30.5's tonality sounded pretty neutral to me. Male and female voices sounded correct, as did orchestral instruments from the cello up to the violin and piccolo. One of the most compelling aspects of the Pass's performance was how well it re-created both voice and instrument in a solo acoustic performance. One of my favorite examples was Townes Van Zandt's performance of his "Pancho and Lefty," on *Together at the Bluebird Café*, a benefit concert album by Van Zandt, Steve Earle, and Guy Clark (CD, American Originals SDPCD161). Not only were the tonal bal-

THE XA30.5 **BEAUTIFULLY RENDERED** THE SUBTLE, MICRODYNAMIC NUANCES IN MORE INTIMATE MATERIAL.

ASSOCIATED EQUIPMENT

ANALOG SOURCES VPI TNT HR-X turntable & tonearm; Spiral Groove SG-2 turntable, Triplanar tonearm; Lyra Titan *i*, Grado Statement Reference cartridges.
DIGITAL SOURCE Primare CD31 CD player.
PREAMPLIFICATION Sutherland PhD phono stage; Sutherland Direct, Placette Active line stages.
POWER AMPLIFIERS Mark Levinson No.20.6, VTL Ichiban (both monoblocks).
LOUDSPEAKERS NHT SuperZero, Sonics by Joachim Gerhard Allegra & Anima, Wilson Audio Specialties Sophia 2.
CABLES Nordost Valhalla, Stereovox, Audience Au24, Nirvana S-X Ltd. interconnects and speaker cables. AC: Audience PowerChord e.
ACCESSORIES Audience Adept-Response T power-conditioning & distribution system, FIM 880 AC outlets; Finite Elemente Reference equipment stand, Ceraball & Cerapuck component footers; Wally Tools phono alignment system; VPI HW-16.5 record-cleaning machine; VPI, Disk Dr. record-cleaning fluids; Immedia SPT stylus-cleaning fluid; Zerostat, Nordost ECO3, Audience Aural Illuminator CD cleaners/treatments; Audio Tools CD storage racks.
—Brian Damkroger

ances of his voice and guitar spot on, I left my listening room absolutely convinced that I would recognize his guitar—that specific instrument—if I heard it somewhere else. Another, similar combination that the Pass handled uncannily well was Diana Krall's voice and piano on her debut album, *Stepping Out* (CD, Justin Time 50). Both seemed exactly right, alone and mixed in a common acoustic space, and sounded consistently so across very wide ranges in pitch and level.

One characteristic that I *have* observed in a lot of class-A amps is a distinctive spatial presentation that can be grossly described as being deeper and wider, slightly more recessed in the center, and filled with smaller-than-normal images. This definitely did *not* describe the XA30.5's soundstage—it was both wide and deep, with excellent resolution to the outer edges in both dimensions. If anything, there was an occasional tendency for soloists at center stage to be a bit more forward than with other amps, though in all cases, images were correctly sized.

With simple recordings made in real acoustic spaces, the distances and perspectives all seemed correct. While listening to one of my favorite opera recordings, soprano Mady Mesplé's performance in Delibes' *Lakmé*, with conductor Alain Lombard and the Paris Opéra Comique (LP, Seraphim SIC-6082), I noted how well all the pieces were tied together. I could place myself in the audience, in the hall; the characters were the right size, and moving around on a stage that was consistent with both their size and my vantage point. Even the orchestra pit was sized and placed correctly, without any spotlighting or segregation of soloists. The Pass's spatial performance was just as impressive with studio tricks. The barking dog at

PASS ON THE PATENTS OF PASS

If high-end audio were to carve its own Mt. Rushmore, whose faces would appear there—besides that of *Stereophile* founder J. Gordon Holt, of course? It's likely that no two audiophiles would ever come up with identical lists of subjects, but I wouldn't be surprised if they could agree on at least one name: Nelson Pass.

Pass's influence has now spanned three decades and shows no signs of stopping. Card-carrying audio junkies and the more-power-is-always-better crowd have long lusted after his megawatt beauties. The flea-power amp and open-baffle types drool over the Zen models of his First Watt line, and the true hard core, the DIY crowd, refer to him as "Papa" as they eagerly absorb his donated designs, wisdom, and general good humor.

Nelson Pass is many things, but most of all he's an engineer. He views the world as a puzzle to be solved, and immediately after figuring out how something works, he begins thinking about how to make it work better. He's approached audio design with this combination of curiosity and pragmatism, and the result has been a string of innovative, often brilliant designs, many of which have been based on technologies that Pass has patented. I tried to follow the evolution of his designs through these patents but was quickly buried in legalese, so I asked Pass to walk me through them chronologically. The result turned out to be a mini-history of his career as an audio designer. —Brian Damkroger

1976—US Patent 3995228: Active bias circuit for operating push-pull amplifiers in class-A mode: [*Pass's first patent describes what's often referred to as "sliding bias," where the bias on the output devices varies with the signal to prevent them from shutting off, ergo avoiding crossover distortion.*]

There was a lot of interest in class-A operation, but there were practical issues, mainly their size and inefficiency. The maximum power output was theoretically limited to twice the bias current, and really more like half that. I modulated the bias to stretch the bend in the operating curve. Technically, this kept it operating in class-A, but at a lower bias level.

The design was successful; the amps sold like gangbusters and were copied immediately. Unfortunately, the approach ended up getting a bad reputation. Our first amplifier, the Threshold 800A, used about a 1:1 ratio, so that it idled at 150W for 150W output instead of 300W. That seemed reasonable and worked well, but some people took it to an extreme. Instead of idling at 150W, there were 200Wpc amps that idled at 10W, ran cool, and didn't have any heatsinks—all claiming to be class-A. In retrospect, we could have sued the copycats, but we were young and foolish, and besides, I had another design waiting in the wings.

1978—US Patent 4107619: Constant-voltage/constant-current high-fidelity amplifier: The patent application actually shows the circuit of the [Threshold] Stasis 1 as the example circuit. This is a kissing cousin to the Quad 405, injecting current into the output for error correction, but with way more current. We had a massive power supply and a huge bank of power devices that we used to support a smaller output-voltage source.

All distortions are variations in a device's characteristic with changes in voltage and current. Ideally, you want to lock the operating point of your gain device, the voltage and current, at a constant value, thereby eliminating distortion. Cascoding covers locking the voltage, so for the current, I devised a "current bootstrap," an external current source in parallel with the gain stage. It responded to the current going out and sourced current to the load, outside of the loop gain path. The result was to keep the output current very nearly constant, which dramatically lowered distortion, so we could operate without feedback. These were great amps. They sold for years and years. We licensed it to Nakamichi. They're still great amps.

1988—US Patent 4752745: Opto-isolated bias circuit for operating push-pull amplifiers in class-A and class-AB modes: This one was optically coupling current sensing to the bias circuitry, which locked it nicely. Typically, bias drifts over time, and with changes in temperature. Even if it's perfect, the amp heats up and things shift. This was a way to look at the current and couple it back to the bias circuit for a constant bias. Nowadays, we just let the amp warm up and settle in. One hour is pretty good, two hours is better.

1990—US Patent 4899387: Active low-frequency acoustic resonance suppressor: [*This patent isn't for an amplifier circuit, but for a floorstanding device that canceled out problematic room resonances. You'd set it where a peak was occurring, usually in a corner. It would*

the beginning of "The Ballad of Bill Hubbard," from Roger Waters' *Amused to Death* (CD, Columbia 468761), wasn't next door, it was in the next county—and the infamous breaking glass in "Private Investigations," from Dire Straits' *Love Over Gold* (CD, Warner Bros. 47772-2), was not just across the street but at the far end of the alley.

Summing up

The Pass Labs XA30.5 is the latest in a long line of brilliant designs from Nelson Pass. Its innovative circuit combines the best attributes of single-ended and push-pull architectures while sidestepping their respective weaknesses. It's a pure class-A amplifier with the power to drive insensitive loudspeakers while avoiding most of the stereotypical weaknesses associated with class-A operation. The design is a simple, three-stage configuration, but the elements that permit that simplicity to be practically realized are the subjects of multiple patents (see sidebar).

Most of all, the XA30.5 is a superb-sounding amplifier. I absolutely loved listening to music through it, album after album and night after night. It's simple to operate, nice to look at, and extremely well built. It will almost certainly extend the bulletproof reliability I experienced over the short term to a lifetime of use, and add to the stellar reputation that previous Threshold and Pass Labs components have established. Plus, in today's high-end audio world, the XA30.5 is a steal. Compared to what else is out there, a price of $5500 is low for an amplifier of this quality. No, I probably wouldn't buy one, but only because I think that a *larger*, more expensive Pass Labs model would work better in my system. Absolutely, positively, and enthusiastically recommended!

PASS ON THE PATENTS OF PASS, *continued*

measure the sound, amplify it, and play it back out of phase, canceling out the resonance—kind of like Bose noise-canceling headphones for your room.]

Oh! The [Phantom Acoustics] Shadow.[1] You probably never heard of it—it was an active acoustic absorber. It worked, but dealers didn't really know what to do with it. Plus, it cost a fortune. By the time they got done with the manufacturing [*by this time Pass had left Threshold*], I think it cost something like $2000 just to build it. I think to be successful, it would have had to retail for less than $1000.

1994—US Patent 5343166: Efficient high-fidelity audio power amplifier: One of my favorite tricks is to look at what other people do and think creatively. For example, see what happens if you just swap the words *voltage* and *current*. There's a Panasonic patent, by Sano, Hirota, *et al*, where a little class-A amp has its power-supply ground driven by the output of a bigger amp that can swing a lot of voltage. If you switch voltage for current, you have an altogether different beast.

With this circuit, you can run a cascoded gain stage at low voltage, but at high current through a separate power supply. Then, you can bias the gain stages at enormous currents. Bipolar outputs usually have a sweet spot around 100mA or so, but MOSFETs just keep getting more linear with higher-bias currents. MOSFETs love current. For example, a 100W class-A amp would need a 5A peak output into 8 ohms, so you'd normally bias it at 2.5A. Here, you could bias it at 10 or 15A. The distortion is inversely proportional to bias, so 10 times the bias gives roughly 1/10 the distortion. There's no need for feedback—you get great performance without any. It's a cute idea. Technics made a few [of their version] but it didn't seem to go very far. This is one that I've got, still waiting to be turned into product.

1994—US Patent 5376899: Amplifier with gain stages coupled for differential error correction: This is Supersymmetry, which was the basis for the X series of amplifiers. It's a way of connecting two matched, balanced amplifiers to more effectively cancel out noise and distortion. One of the advantages of balanced circuits is that when the two halves are summed, noise and distortion that are in phase cancel out. This only works to the extent that the noise and distortion are identical in both halves. Rather than trying to totally eliminate noise and distortion, Supersymmetry works to make the noise and distortion in the two legs identical, which is comparatively easy. The two inputs of the balanced circuit are cross-coupled; the noise and distortion created in each half is fed through the other, so that they're more closely matched at the output, and effectively canceled. It's another way of making a very simple circuit work well enough to operate with less feedback—although it's a kind of feedback itself. You may notice that this amplifier was invented before the Aleph 1998 patent, but came out years later.

1998—US Patent 5710522: Amplifier having an active current source: The is the Aleph circuit, where the output device is biased to run in single-ended class-A mode. It draws current from the negative rail to the output. One of the reasons I started Pass Labs was because I wanted to go a new direction. When a company is successful, as Threshold was, it limits what you can do, how far you can diverge from successful products. If you do something different every year, no one will buy your products. Pass Labs was a clean slate for me.

There was a lot going on with single-ended designs, but it was mostly in the 1–2W region. I discovered that, with the Aleph circuit, I could get a reasonable amount of power before it transitioned into push-pull. The Aleph 0, which actually preceded this patent, was biased to produce 75W in single-ended class-A mode. It was a simple circuit with only three stages. The Aleph 3 was different. It had only two gain stages and was purely a single-ended design, with no transition to push-pull. There were no adjustments of any kind and it was impossible to break. Now, in the X series, we're again using a push-pull output stage that's biased by a single-ended constant-current source, similar to the Aleph 0.

Today—which is your favorite? It changes, depending on what I'm doing at a particular time, what else is in the system, what I'm listening to, how I'm feeling. Each one is a different experience. Plus, there are different situations where one type of amp is better suited than another. Yeah, I get asked that question pretty often. You know, I can't answer it. [*laughs*] They're like children . . . it's like asking which is your favorite child. **—Nelson Pass**

1 See *Stereophile*'s December 1989 review at www.stereophile.com/roomtreatments/1289phantom.—*Ed.*