

The Aleph Null, or 0, represents Nelson Pass's maiden product under the Pass Laboratories banner. When he left Threshold several years ago, Pass had the luxury of starting over with a clean slate, and decided immediately that he wanted to design a single-ended MOSFET amp. The result is aptly named after Georg Cantor's first transfinite number: Aleph Null, the gateway to higher-order infinities. Just as Cantor's transfinite mathematics stretched minds with its novel conceptual view of the infinite, the Pass Aleph 0 tantalizes the imagination with a new dimension in the future of solid-state amplification: a single-ended output stage.

THE SOUND OF ONE TRANSISTOR CLAPPING

If only objective measurements are used to assess the performance of a power amp, then complex circuit topologies will be seen to excel compared with much simpler designs. The problem with measurements, of course, is that they describe performance not in the perceptual but in the physical domain. What something sounds like does not always correlate with how it measures. I'm not advocating or excusing poor measurements—decent measurements serve to validate a given design's veracity and, by implication, the designer's competence. Rarely will an amp that has gross test bench measurements sound good. Conversely, I've heard many test-bench wonders sound downright ugly. There's a point beyond which measurements fail to convey the musical potential of a device. If it were true—as some mainline reviewers and magazines maintain—that the story begins and ends with measurements, then a Japanese receiver ought to sound superior to almost every expensive high-end tube design.

As Nelson Pass is fond of saying, audiophiles have voted with their pocketbooks: on the used-equipment market, a Marantz 9 is highly coveted, while the early solid-state Dynaco 120 is largely unwanted. Looking at the last 50 years of audio history, I've found that simple designs (tube and transistor) have come closest to capturing the textural purity and intimacy of live music.

SE designs aren't exactly new to Pass, who published a 20W single-ended DIY design in 1977 in the pages of *Audio* magazine. To paraphrase his words, the Aleph's design rests upon the philosophical tripod of simple circuitry, transconductance gain devices, and maximally linear operation.

The Aleph uses only three gain stages. The differential input stage accepts both balanced (XLR) and unbalanced (RCA) inputs, the former tied directly into the feedback loop without additional active circuitry. A cascoded voltage gain stage drives an e-channel MOSFET output stage, which is biased at 2.5 amps quiescent current. Out to about 40W into 8 ohms—that is, almost up to 2.5 amps output current—this stage operates single-ended: both the negative and the positive signal swings are accommodated by paralleled e-channel devices. Beyond this point, p-channel power MOSFETs kick in to handle the positive signal swings. The amplifier therefore operates in class-A push-pull out to its rated power-delivery limit. Pass believes that defaulting to class-A push-pull is sonically superior to simply clipping the SE stage at a lower power level.

The MOSFET, Pass's current gain device of choice, is a transconductance device, like a vacuum tube. However, it doesn't require transformer-coupling to the low-impedance load—the Achilles' heel of tubed SE amplifiers. Also, like a triode tube, a MOSFET's transconductance, or gain, tends to increase with current. Pass believes that the bad rap many MOSFET-based designs have received is attributable to two factors: most designers simply dropped MOSFETs into the same (read: complex) topologies optimized for bipolar transistors, thus failing to capitalize on the MOSFET's full potential. And MOSFETs perform poorly at low bias currents, exhibiting low-level non-linearities in traditional class-AB designs. Nelson's bottom line is that a MOSFET must be operated in class-A—where maximum intrinsic linearity is achievable—to fully realize its benefits.

US-made, International Rectifier, HexFET power MOSFETs are used exclusively for all of the Aleph 0's gain stages. Input devices are matched to within 0.2%, output devices to within 2%. Each output MOSFET is capable of handling peaks of 25 amps; two banks of eight MOSFETs are run in parallel. Since no current-limiting circuitry of any sort is used, peak currents of 50 amps can be delivered before the fuses blow. The circuit's inherent linearity means that only some 20dB of global negative feedback need be used to tailor the overall voltage gain and increase the damping factor to about 800—equivalent to an output impedance of 0.01 ohms.

Is THAT YOU, MOTHER?

So runs the punch line of the joke that begins: What does the baby porcupine say after he backs into a cactus? The Aleph 0, with heat sink fins on all four sides, reminds me of a porcupine. So it doesn't look very French or German—an American original, indeed! The machined-aluminum chassis is grained and anodized for a cool metallic look.

In 1974, Nelson Pass ushered in a new era of "cool-running" class-A amps with his patented, dynamically biased "Stasis" output stage. Pass now admits that he hasn't used this technique for the past 15 years, because he's found that operation at reduced bias levels degrades sound quality—primarily sound stage depth and textural liquidity.

So, no surprise, the Aleph 0 runs hot, its heatsinks warming up to 120-130 F after one hour of operation. When the Aleph's internal temperatures exceed 160 F, a thermal protection system in the unit shuts the amp off until the thermal sensor has cooled. With adequate ventilation (at least 6a of clearance is recommended on the sides and top), and ambient temperatures of up to even 90 F, chassis temperature is supposed to remain below the trigger level of the protection circuit. Of course, the chassis' rate of warm-up is also a function of the type of signal used, test signals being harder on the amp than music.

So when one channel went mute one hot summer evening, it took me a while to realize what had happened. I checked all cable connections and scratched my head; and when the amp came back to life some ten minutes later, it dawned on me: thermal protection! This prophylaxis is aimed at protecting the output transistors, but I found it inconvenient at the time. A few minutes after the first channel came back to life, the other channel played dead. The final solution was to shut the amps off for a while. Although it was a hot New Mexico day and the amps had been running for several hours, they were well-ventilated, and ambient conditions were within the envelope specified in the owner's manual. The thermal-protection system needs fine tuning.

The Aleph 0 is DC-coupled from input to output—there are no capacitors in the signal path. It takes an hour for the chassis temperature to stabilize, during which offset levels are a bit higher than 50mV. After the first hour, DC offset at the Aleph's output drops to around 50mV. Such DC offsets do not interfere with loudspeaker performance DC offset levels could, however, be exacerbated by the preamp—when the preamp's own output stage is DC-coupled. Another demand the Aleph places on the partnering preamp is its ability to drive a rather low input impedance, which means that, in general, the preamp's output impedance should not exceed several hundred ohms.

The Aleph is extremely well-built, and, unlike a tube amp, requires no periodic maintenance—it's apparently geared for a long life. As Pass explains in the owner's manual: "In fifteen years, the electrolytic power-supply capacitors will get old. Depending on usage, you will begin to have semiconductor and other failures between 10 and 50 years after date of manufacture. Later, the sun will cool to a white dwarf, and after that, the universe will experience heat death."

SOUND

During its lengthy stay in my listening room, the Aleph drove both Sound-Lab A-1 and Audiostatic ES-100/SW-100 electrostatics, as well as several dynamic speakers, including my own Poly Natalia design. But the Aleph spent most of its time driving Magneplanar MG-20s (reviewed in the February 1995 *Stereophile*). While the Aleph wasn't embarrassed by any load I threw at it, it seemed to prefer 4 ohm nominal loads, and speakers with a reasonably neutral tonal balance.

Since the Aleph operates SE-fashion over a significant range of its output, my initial expectation was that it would somehow emulate the sound of an SE triode amp. It did chat in a couple of crucial areas, but the overall impression was drastically different. The Aleph was undoubtedly smooth and texturally liquid, but lacked the velvety touch and vivid midrange of classic SE triode designs. The perceived disparity probably has much to do with the respective frequency responses and power bandwidths of these amps.

Because of the limitations imposed by their output transformers, SE tube designs rarely offer a power bandwidth, or even a low-power frequency response, extending much above 10kHz. In fact, it's a minor miracle any time such an amplifier breaks the 20kHz barrier. More often than not, they're already down one or two decibels at 15kHz. The subjective results of this bandwidth compression, however, are enhanced textural liquidity and a tonal balance that showcases the midrange. With the treble information subdued, the mids stand out in greater relief—often with thicker, more syrupy harmonic textures.

In contrast, the Aleph sports a bandwidth almost flat to 100kHz. It consistently sounded faster than any tube amp I've ever heard, with a top end as open and airy as New Mexico's preternaturally blue skies. Treble nuances—and low-level information in general—were retrieved with remarkable articulation.

Resolution of detail is often confused with a bright, etched presentation that artificially emphasizes delicate transient detail. Such amps advertise transients on giant billboards. For me, the concept revolves around the ability to hear into the music and follow the attack and decay of various instrumental phrases and nuances organically woven into the music's fabric. Proper reproduction demands that detail remain discreetly in the background until I choose to focus my attention on a particular instrument in a complex passage. The Aleph was outstanding in this regard, offering me high-power magnification when I wanted it while preserving the textural delicacy and natural sweetness of the upper octaves.

The Aleph's tonal character could best be described as neutral—it didn't tend to soften treble transients, as does the Coda 2.5. Hence, speakers with an emphasized treble had no place to hide. Neither did it inject a sense of warmth into the orchestral power range. The Aleph in no way beefed up speakers with lean tonal balances: their lower mids remained anemic.

In concert with its SE triode cousins, the Aleph brought to bear upon the core of the music two dramatic attributes. Harmonic purity, from cello to soprano voice, was startlingly more convincing than that afforded by any other solid-state amplifier I've heard, with reproduction of violin overtones especially noteworthy. This is a hard enough task for any amp; solid-state designs typically come up short, managing to sound like so many sewing machines whining in unison. Not so the Aleph 0. While refusing to romanticize textures, it infused harmonic overtones with a natural dose of liquid gold. The overall perception was of raw speed tempered by a fistful of harmonic tonic.

The Aleph's other SE triode-like sonic aspect had to do with its reproduction of music's microdynamics. Breathing a spark of harmonic life into instrumental outlines is part of the magic of an SE design, and derives from that first watt of power—it propels the harmonic envelope to full bloom. The dynamic microcosm lives or dies by that first watt, and SE amplifiers possess the purest initial burst of power that anyone has yet to hear. Not surprisingly, the Aleph successfully negotiated the ebb and flow of instrumental outlines, routinely communicating the music's inherent dramatic tension.

Soundstage transparency was such that I was easily able to mentally step into the spatial illusion—image outlines were tightly focused in tidy parcels of listening-room real estate. A large chorus stretched convincingly from right to left of the stage, with a strong sense of image palpability but without smearing individual voices.

**THE PASS ALEPH 0 IS TRULY
A BREAKTHROUGH PRODUCT.
I HEREBY NOMINATE IT AS
SOLID-STATE AMPLIFIER
OF THE DECADE.**

Hall ambient information was readily discernible, but the depth perspective of the hall acoustic wasn't as finely layered or fleshed out as chat conjured up by the finest tube amplifiers— e.g., the Cary Audio Design 805 or the Fourier Components Sans Pareil OTL, both of whose re-creations of an acoustic and a three-dimensional perspective are so convincing that I often feel as if I've been transported to the original venue. The Aleph, in comparison to these amps, only garnered a 2.5-D spatial rating.

When it came to dynamic headroom, the Aleph was head and shoulders above that of a conventional SE design—even the 85dB/W/m Magnepan MG-20s were adequately catered to most of the time. Only with the insensitive Sound-Lab A1s was there an obvious lack of muscle. The Aleph, which could be driven hard with little change in its perceived distortion spectrum, gracefully gave its all before finally clipping.

With an apparently huge damping factor and upward of 50 amps of peak current waiting in reserve, the Aleph dished out bass lines with an iron fist. With every speaker I threw at it, the amp squeezed out every last LF hertz and every bit of bass punch, with rhythmic nuances its specialty. Even when there was a ton of overlaying information, I was easily able to make out the inner workings of a drum kit. In terms of bass control and overall character, the Aleph struck me as a lower-powered, gourmet version of the juggernaut Classe M-700 monoblocks.

MEASUREMENTS FROM TJN

A full set of measurements of the Pass Aleph 0 was made in the unbalanced mode—the mode used by DO for most of his listening. Selected measurements were also made in the balanced mode. Unless otherwise noted, the measurements shown are for the unbalanced configuration.

Following the 1/3-power, one-hour preconditioning test, the Aleph 0's heatsinks were hot, though not too hot to touch comfortably. The Aleph 0 is non inverting in its unbalanced mode; in the balanced, pin 2 is configured as the positive leg, pin 3 the negative.

The Aleph 0's input impedance measured just under 6.5k ohms (unbalanced) and just over 7k ohms (balanced). These are low figures. While they should cause no difficulty with preamplifiers having a low output impedance (preferably 600 ohms or below), the Aleph 0 may be less than a perfect match to those few preamplifiers having output impedances over 1k ohm (some tube preamplifiers fall into this category, as do most passive "preamps"). [The subjective result of such a mismatch will be to roll off the lows prematurely the result being too lean a tonal balance. Some preamplifiers will also clip prematurely into such a load.—Ed.]



Fig.1 Pass Aleph 0, frequency response into 8 ohms (0.5dB/octave).

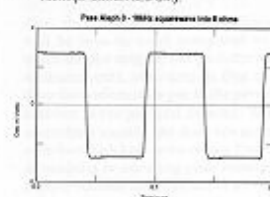


Fig.2 Pass Aleph 0, 10kHz squarewave.

The output impedance of the Aleph 0 was under 0.02 ohms at either 1kHz or 20Hz, increasing to a maximum of 0.025 ohms at 20kHz. Voltage gain into an 8 ohm load measured 25.8dB, balanced or unbalanced. DC offset was a rather high 180mV two minutes after turn-on, but decreased gradually to 60mV after 20 minutes, 38mV after 1 hour. The signal/ noise ratio (unweighted, 22Hz-22kHz, ref. 1W into 8 ohms) measured 111dB unbalanced, 109dB balanced.

Fig.1 shows the frequency response of the Aleph 0 at 1W into 8 ohms, unbalanced. The balanced response, as well as the response at 2W into 4 ohms, is virtually identical, and isn't shown. The small blip at about 180Hz is a measurement artifact, and in any case is no more than 0.1dB. The Aleph 0's 10kHz squarewave response (fig.2) indicates an excellent risetime and only the slightest rounding of the leading edge. The 1kHz squarewave was close to perfect, and is not shown.

The THD+noise vs. frequency curves are shown in fig3. The result is astonishingly low for a single-ended amplifier, and any increase in THD into lower impedance loads is minimal. The result for a balanced input, not shown, was marginally better—about 0.0001% lower at high frequencies. The 1kHz distortion waveform at 10W output into 4 ohms (fig.4) indicates primarily second-harmonic content overlaid with noise. The waveforms into 8 ohms and 2 ohms are virtually identical (second harmonic plus noise), and are not shown.

The spectrum of the Aleph 0's output reproducing 50Hz at a 107W output level into 4 ohms (2/3 the rated power of 160W) is shown in fig.5. All of the distortion artifacts are extremely low here. Only the second harmonic—at -68.6dB, or just under 0.04%—is greater than -90dB (0.003%). Fig.6 shows a similar spectrum, with the amplifier reproducing an equal combination of 19kHz and 20kHz sinewaves at 80W into 4 ohms (visible clipping was evident with this signal just above this power level). The spectrum shows the products resulting from intermodulation between these two frequencies. The largest artifacts here are at 18kHz and 21kHz (at approximately -56dB, or 0.15%), with the next largest at 1kHz (-65dB, or 0.06%). The spectrum at 43W into 8 ohms was very similar, and isn't shown.

The 1kHz, THD+N as output power curves (at 1kHz) are shown in fig.7. The distortion characteristics are typical of a solid-state amplifier, remaining very low up to the knee of the curves, and increasing rapidly above that; there was nothing unexpected due to the single-ended design. The apparent drop in measured THD up to the 4W level is due to the true distortion lying below the amplifier's noise floor below that power level. The discrete clipping levels (at 1% THD+N) are shown in Table 1, and are well above specification.

Based on my previous experience with single-ended amplifiers (all of them tube designs), I expected mundane test-bench results at best from the Aleph Q. This was certainly not the case. Its measured performance was excellent across the board.

—Thomas J. Norton

In the final analysis, the Pass Aleph 0 can be seen as a hybrid, combining the purity of low-power SE drive with the brawn of push-pull class-A operation. It will be much easier to find a partnering speaker for the Aleph than for a tubed SE design.

I think the Aleph 0 should be renamed—or at least subtitled—Shiva the Destroyer: it's bound to destroy the present benchmarks for solid-state amplification, and stretch the boundaries of the state of the art.

The Pass Aleph 0 is truly a breakthrough product. I hereby nominate it as Solid-State Amplifier of the Decade.

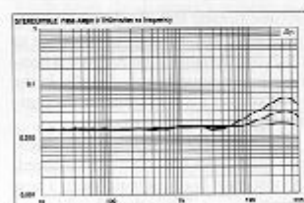


Fig.3 Pass Aleph 0, THD+noise (%) vs frequency at (from bottom to top at 20kHz): 1W into 8 ohms, 2W into 4 ohms, 4W into 2 ohms.

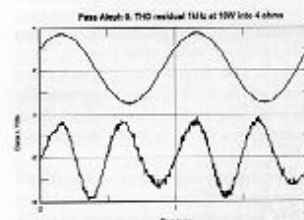


Fig.4 Pass Aleph 0, 1kHz waveform at 10W into 4 ohms (top); distortion and noise waveform with fundamental notched out (bottom, not to scale).

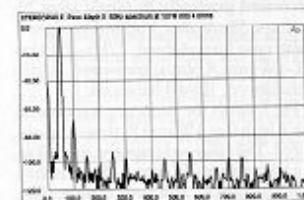


Fig.5 Pass Aleph 0, spectrum of 50Hz sinewave, DC-1kHz, at 107W into 4 ohms (linear frequency scale). Note that the second harmonic at 100Hz is the highest in level at -68.6dB (0.04%).

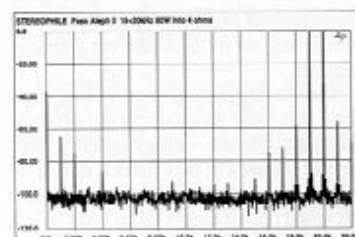


Fig.6 Pass Aleph 0, HF intermodulation spectrum, DC-22kHz, 19+20kHz at 80W into 4 ohms (linear frequency scale).

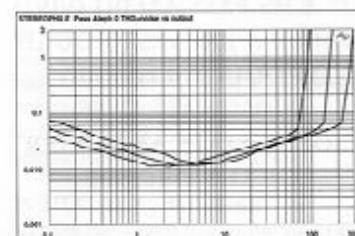


Fig.7 Pass Aleph 0, distortion (%) vs output power into (from bottom to top at 10W): 2 ohms, 4 ohms, and 8 ohms.