stereophile

EQUIPMENT REPORT

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Audio Research
Reference 110
POWER AMPLIFIER

Robert J. Reina

Audio Research Reference 110

DESCRIPTION Stereo tubed power amplifier with balanced inputs and 4, 8, and 16 ohm output transformer taps. Tube complement: 4 matched pairs of 6550C output tubes, 4 6H30 driver tubes. Maximum output power: 110Wpc continuous, 20Hz–20kHz at 1kHz with THD typically 0.3% at 110W, <0.03% at 1W; 120W at clipping (20.8dBW). Frequency response: 0.6Hz–90kHz, –3dB. Input sensitivity: 1.8V RMS balanced for rated output (24dB balanced gain into 8 ohms). Input impedance: 300k ohms balanced. Output polarity: non-inverting. Damping factor: approximately 12. Hum & noise: <0.2mV RMS, 106dB below rated output (IHF weighted, input shorted). Power requirements: 105–125VAC, 60Hz (210–250VAC, 50Hz), 630W at rated output, 800W maximum, 410W at "idle."
DIMENSIONS 19" (483mm) W by 8.75" (222mm) H by 19.5" (495mm) D. Handles extend 1.5" (38mm) forward. Weight: 67.4 lbs (30.7kg) net, 83 lbs (37.8kg) shipping.
SERIAL NUMBER OF UNIT REVIEWED 46403808.
PRICE $9,995. Approximate number of dealers: 50.
MANUFACTURER Audio Research Corporation, 3900 Annapolis Lane North, Plymouth, MN 55447-5447. Tel: (763) 577-9700. Fax: (763) 577-0323. Web: www.audioresearch.com.

When I attend *Stereophile*'s annual Home Entertainment show, I rarely sit and listen to music for very long. Instead, I try to hit every room, press the flesh, find out about new products, and play a little jazz.

But HE2006, in Los Angeles, was different. I must have spent three hours listening critically to the wonderful music and sound I heard in the three rooms occupied by the Audio Research Corporation, who'd hooked up their Reference line of electronics to speakers from Thiel, Vandersteen, and Wilson. The ARC gear included the Reference CD7 CD player, the Reference 3 line-stage preamp, and the Reference 610T and Reference 210 power amplifiers. In each of these rooms the delicacy, detail, air, and sense of ease were such that I returned again and again to listen to a wide range of music.[1]

After my fifth listening session in the room containing Vandersteen speakers, ARC's Dave

1 I also returned many times to Continuum Audio Labs' room, to hear their Caliburn turntable and Cobra tonearm. Mikey is right—these products *are* extraordinary.

Gordon cornered me. "As you're a VT100 Mk.II owner, you should be aware we will be shipping shortly a half-power stereo version of the Reference 210, the Reference 110, which replaces the VT100 Mk.III, which we discontinued a few months ago."

Naturally, I had to get a review sample of this new Reference component, to see how it would compare with the amp I've used as a main reference for over a decade now, in its Mk.I and Mk.II versions.

Design

I've been a fan of Audio Research products for many years, having owned several of their preamps and amplifiers. ARC doesn't hesitate to frequently update designs or experiment with new circuit topologies and tube types, to the point where some audiophiles have become frustrated with the company. Two things that don't change are the classic, conservative look of ARC products, and the company's commitment to customer service. ARC boasts that they will continue to service any product they've ever manufactured; their website currently promotes a new update for their SP3 preamplifier, which they stopped making in 1976.

As they sat next to each other in my listening room, the family resemblance between the Reference 110 ($9,995) and my VT100 Mk.II was strong. Aside from the 110's slightly deeper chassis and thicker faceplate, they were tough to tell apart. But a look inside at the circuit design showed the Ref 110 to be a completely different animal. This 110Wpc amplifier is based on a push-pull, fully balanced circuit using two matched pairs of 6550C output tubes per channel. The input stage, trickled down from ARC's flagship amp, the Reference 610T, uses direct-coupled JFETs with a driver stage based on 6H30 tubes, one for voltage gain and one used as a cathode-follower. Output tube biasing is accomplished using trim pots and insulated test points on the left and right circuit boards. The output-stage coupling is a combination of ultralinear and ARC's "partially cathode-coupled" topology, which the company claims yields better sound than conventional triode or pentode operation.

ARC pays more attention than most firms to circuit-board layout and wire routing. The Ref 110's right- and left-channel boards are mounted horizontally and flank the transformers, which are mounted on a raised central channel running from front to back. A small LCD display indicating the number of hours

MEASUREMENTS

Before performing any measurements on the Audio Research Reference 110 amplifier, I checked the bias of each pair of tubes, something made easy by the convenient probe sockets adjacent to the tubes on each of the circuit boards. All bias readings were within 1mV of the target 63mV, and the "Check" readings were all in the center of the specified range.

The specified input impedance is very high, at 300k ohms, and my estimate was in this region. (Measuring high input impedances is not very precise with our usual voltage-drop method, because of the very small voltage changes involved.) The balanced inputs, each wired with pin 2 hot, preserve absolute polarity; *ie*, are non-inverting. The voltage gain from all transformer taps was lower than average; in addition, the channels didn't match very well, the left channel consistently offering a higher level than the right. With a 1kHz tone, the 4 ohm tap offered 21.2dB gain into 8 ohms, left, and 20.7dB, right; the 8 ohm tap, 23.9dB and 23.3dB, respectively; the 16 ohm tap, 26.4dB and 25.7dB, respectively.

As expected, the Reference 110's output impedance was significantly higher than that of a typical solid-state amplifier, and increased both at very high frequencies and with the nominal value of the output-transformer tap. The 4 ohm tap offered the lowest impedance, at 0.5 ohm at low and midrange frequencies, rising to 0.8 ohm at 20kHz. The 8 ohm tap's impedance was 0.87 ohm at low frequencies, 1.45 ohms at 20kHz;

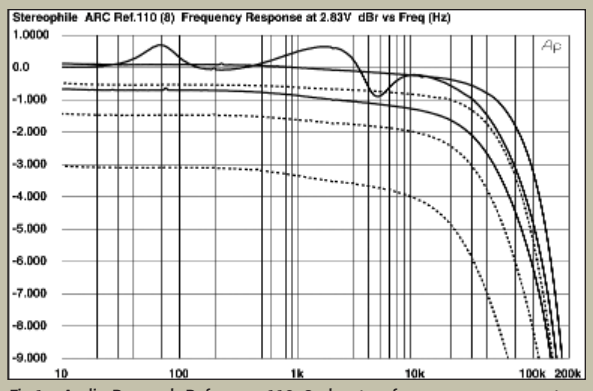

Fig.1 Audio Research Reference 110, 8 ohm tap, frequency response at 2.83V into (from top to bottom at 2kHz): simulated loudspeaker load, 8, 4, 2 ohms (1dB/vertical div., right channel dashed).

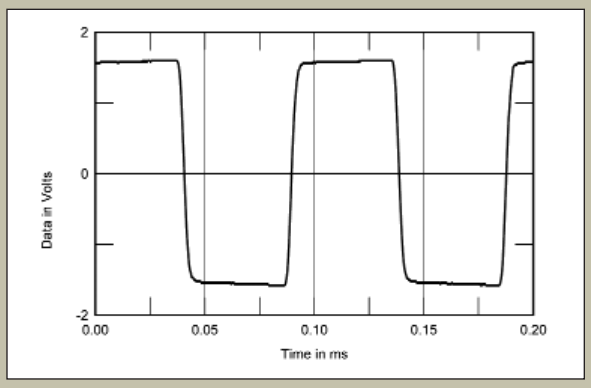

Fig.2 Audio Research Reference 110, 8 ohm tap, small-signal 10kHz squarewave into 8 ohms.

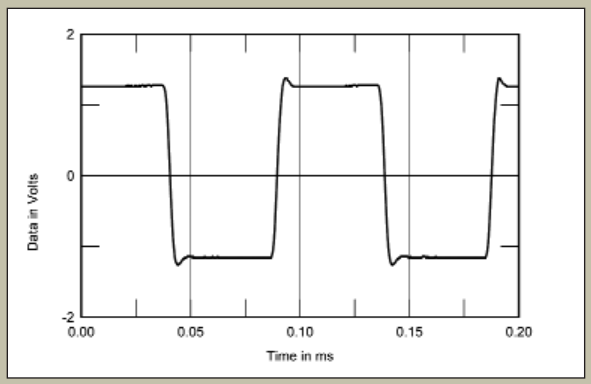

Fig.3 Audio Research Reference 110, 4 ohm tap, small-signal 10kHz squarewave into 8 ohms.

the tubes have been run is mounted on the front of one board and is visible though the top panel. *Every* tube amp should have such a display. The speed of the two small fans mounted on the rear panel is controlled with a three-way switch. The input is balanced XLR only, and there are pairs of ARC's rugged, proprietary speaker binding posts for the 4, 8, and 16 ohm taps. Two 12V triggers (input and output) allow remote turn-on. The Reference 110 is the first power amplifier I've had in house with a 20A IEC power cord.

I installed the Reference 110 in my primary reference system, using my Audio Valve Eklipse and ARC's own Reference 3 line stages. However, as the Ref 110 provides only balanced inputs, I bought an MIT Magnum M3 interconnect to replace my single-ended MIT CVT-350 Twin Terminator, then spent quite a bit of time getting used to the sound of my new wire before doing any critical listening. In all four combinations of preamp and power amp I tried, I found the Magnum M3 more detailed, dynamic, and transparent than the older CVT-350, with more extended frequency extremes. Of course, I don't know how much of the improvement was due to the wire, and how much to running the electronics in balanced mode.

Listening

Over my many weeks of listening to the Reference 110, two things made it extremely special with all recordings.

First, the 110 could unravel layers of inner detail. This, combined with its extraordinary ability to convey hall ambience and low-level dynamic inflections on a wide, deep soundstage, rendered all good recordings with startlingly lifelike realism. With every one of my very familiar reference discs, I noticed many subtle nuances for the first time. Listening to Timothy Seelig and the Turtle Creek Chorale's recording of John Rutter's *Requiem* (CD, Reference RR-57CD), it was easy to tell where the choirs were standing within the recording space. The wall reflections of the church were easily discernible, and the blend of voices and pipe organ had an incredible sense of bloom. I'm used to the male choir on Brian Wilson's *SMiLE* (CD, Nonesuch 82946-2) sounding like a mass of identically replicated voices, but through the Reference 110 I could hear each singer's individual vocal signature so distinctly that I almost felt I could write out each vocal line on a sheet of music paper. The 110's dead-neutral midrange certainly helped. On Antal

the 16 ohm tap, 1.43 ohms at low frequencies, 1.85 ohms at 20kHz. As a result, there will be a significant modification of the amplifier's frequency response due to the Ohm's Law interaction between its source impedance and the impedance modulus of the loudspeaker. With our standard simulated loudspeaker (see www.stereophile.com/reference/60), the response variations from the 8 ohm tap, for example, reached ±0.9dB (fig.1, top trace at 2kHz), which will be audible. These variations were a little greater from the 16 ohm tap, a little smaller from the 4 ohm tap.

The channel mismatch can also be seen in this graph, with the right-channel response into 8 ohms (top dotted trace) almost overlying that of the left channel into 4 ohms (bottom solid trace). But note that though the response does droop a little in the treble, presumably due to the increasing source impedance, the amplifier's small-signal bandwidth is actually quite wide, with the left channel's output not reaching –3dB until 95kHz. As a result, a 10kHz squarewave was reproduced with short risetimes and a good square shape (fig.2). This graph was taken with the output-transformer tap nominally matched to the load; in this case, the 8 ohm tap driving 8 ohms. An overshoot develops when the load impedance is higher than the nominal tap value (fig.3), but this is both slight in degree and free from ringing.

Given the Reference 110's dual-mono construction, with each channel's audio circuitry carried on its own board, I was surprised to find that the channel separation at 1kHz was 85dB (L–R) and 96dB (R–L),

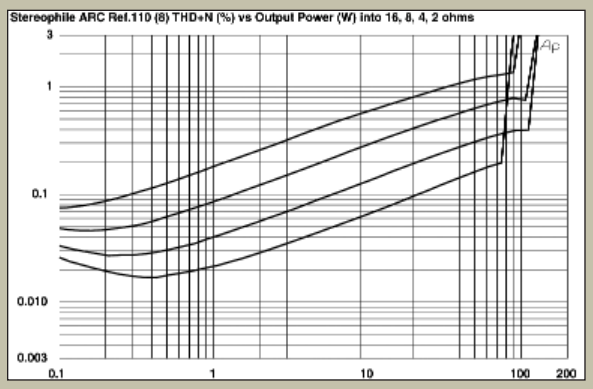

Fig.5 Audio Research Reference 110, 8 ohm tap, distortion (%) *vs* 1kHz continuous output power into (from bottom to top at 10W): 16, 8, 4, 2 ohms.

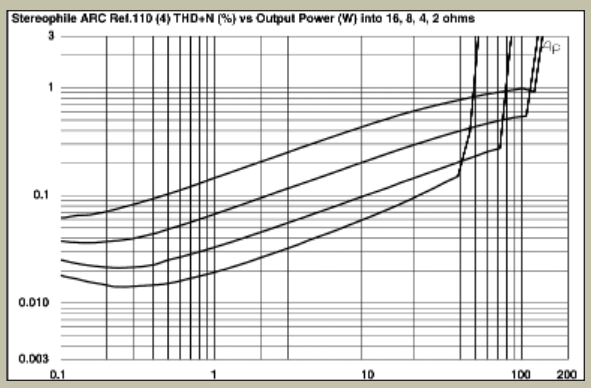

Fig.4 Audio Research Reference 110, 4 ohm tap, distortion (%) *vs* 1kHz continuous output power into (from bottom to top at 10W): 16, 8, 4, 2 ohms.

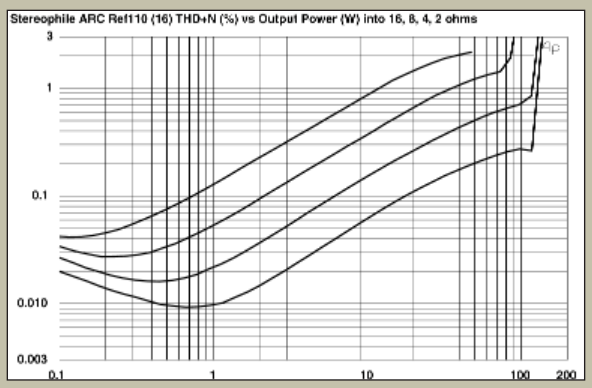

Fig.6 Audio Research Reference 110, 16 ohm tap, distortion (%) *vs* 1kHz continuous output power into (from bottom to top at 10W): 16, 8, 4, 2 ohms.

Dorati and the London Symphony's recording of Stravinsky's *The Firebird* (CD, Mercury Living Presence SR 90226), I noticed, buried way down in the mix toward the rear of the soundstage, delicate flute lines that were easy to follow no matter how complex or loud the surrounding orchestral passages.

The second of the 110's remarkable strengths was its ability to render high frequencies with a clean, pristine, extended presentation totally devoid of electronic artifacts. This was also my reaction to the high frequencies of ARC's Reference 3 line-stage preamplifier (see my "Follow-Up" in the June issue, p.139); in this region, clearly, these two designs were cut from the same sonic cloth. I tested the Reference 110 with both the Reference 3 and Audio Valve EKipse's line stage, and the amp's high-frequency strengths shone through both (although the effect was notably greater with the ARC preamp). Soloist Tom Chiu's violin in David Chesky's Violin Concerto, on *Area 31* (SACD/CD, CD layer, Chesky SACD288), revealed natural but biting extended partials, and the instrument's vibrancy seemed to pop out of thin air. Similarly, Carol Wincenc's flute, in Tomiko Kohjiba's *Transmigration of the Soul*, from *Festival* (CD, Stereophile STPH007-2), was appropriately metallic, extended, and airy, with all subtle low-level dynamic inflections intact.

The Reference 110's organic presentation of dynamics made it superb for jazz recordings. On "House Party Starting," from Herbie Nichols' *The Complete Blue Note Recordings* (CD, Blue Note CDP 8 50352 2), I fixated on the interplay of Max Roach's snare and bass drum

THE ARC'S **ABILITY** TO RENDER WIDE DYNAMIC BLASTS ON ELECTRONIC RECORDINGS DIDN'T HAMPER IN ANY WAY ITS ABILITY TO **RENDER** SUBTLE DETAILS WITHIN THESE **RECORDINGS**.

measurements, *continued*

decreasing by another 10dB at 50kHz. This is still very good, however. The wideband, unweighted signal/noise ratio (ref. 2.83V into 8 ohms, 8 ohm tap) was good rather than great at 79.5dB. Switching an A-weighting filter into circuit improved the figure to 97.8dB, suggesting that it is noise at the frequency extremes that is affecting the unweighted result.

Figs. 4, 5, and 6 plot how the THD+noise percentage in the left channel changes with increasing power into loads ranging from 4 to 16 ohms, from the 4, 8, and 16 ohm output-transformer taps, respectively. General points to note are: 1) the distortion is very low from all taps at levels of 1W or below; 2) the distortion doubles with each halving of the load impedance (*ie*, with each doubling of the output current); 3) the distortion rises linearly with increasing output power, suggesting a low overall level of loop negative feedback; 4) the amplifier gives its maximum power when the load impedance ranges from equal to half the nominal transformer tap value; and 5) under those conditions the amplifier meets its rated power of 120Wpc. The highest clipping powers measured (1% THD) were 130W, 16 ohm tap into 16 ohms (24.15dBW); 120W, 8 ohm tap into 8 ohms (20.8dBW); and 125W, 4 ohm tap into 2 ohms (15dBW).

These graphs indicate that the distortion products start to rise out of the noise floor at a level of 2.83V, so I plotted how the THD+N percentage changes with frequency at that level. The results for the 4, 8, and 16 ohm taps are shown in figs. 7, 8, and 9, respectively. General points to note are: 1) again, increases in output current from each tap result in

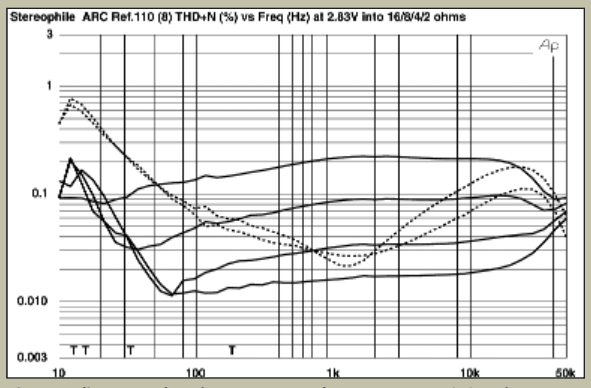

Fig.8 Audio Research Reference 110, 8 ohm tap, THD+N (%) *vs* frequency at 2.83V into (from bottom to top): 16, 8, 4, 2 ohms (right channel dashed).

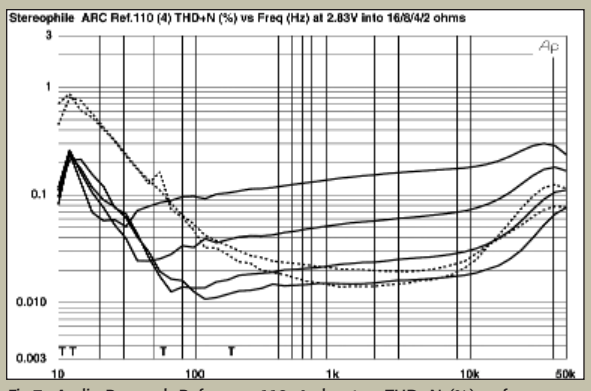

Fig.7 Audio Research Reference 110, 4 ohm tap, THD+N (%) *vs* frequency at 2.83V into (from bottom to top): 16, 8, 4, 2 ohms (right channel dashed).

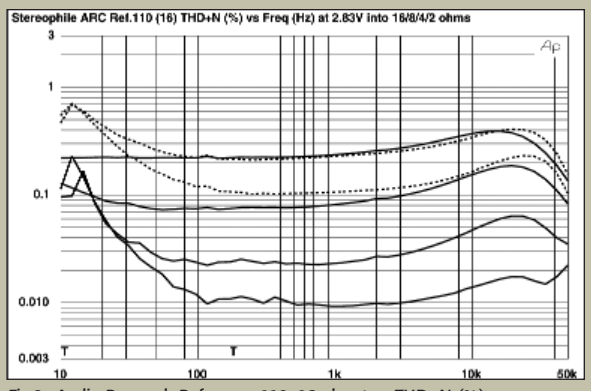

Fig.9 Audio Research Reference 110, 16 ohm tap, THD+N (%) *vs* frequency at 2.83V into (from bottom to top): 16, 8, 4, 2 ohms (right channel dashed).

with Al McKibbon's woody, warm, and vibrant walking bass line. I'd hoped that, during bombastic dynamic blasts, the Ref 110's over-engineered power supply (520 joules of storage is unusually large for a 110W amp) would make it sound more powerful than it actually is, and the ARC did not disappoint. On John Atkinson's recording of Robert Silverman's performance of Beethoven's 32 piano sonatas (CD, OrpheumMasters KSP830), I listened to the *Largo* of Sonata 2 in A, Op.2 No.2 (which is one of my favorite pieces to play as well). This delicate work from Beethoven's early twenties has a surprise near the end, when a sudden *ff* passage bursts forth without warning, using the piano's entire ranges of frequency and dynamics. My listening notes read "thunder, drama, and no strain."

"Mansour's Gift," from my jazz quartet Attention Screen's *Live at Merkin Hall* (CD, Stereophile STPH018-2) includes huge dynamic swings. Drummer Mark Flynn coaxes a broad range of bombastic colors with soft mallets from his Korean *puk* drum, and near the end there's a *tutti* crescendo that tested the dynamic limits of the recording process. The Reference 110 rendered these dynamic swells as we'd created them on the Merkin's stage.

The ARC's ability to render wide dynamic blasts on electronic recordings didn't hamper in any way its ability to render subtle details within these recordings. In Kraftwerk's *Minimum/Maximum* (CD, EMI ASW 60611), the low- and high-frequency transients were startling, detailed, and lightning-fast without being harsh, even at extreme volume levels, while preserving subtle programming details that I hadn't noticed with other amplifiers. Similarly, Chris Jones' original electronic works, on Snowflake's *Tea Lounge 6-04-06* (CD, private recording), blend powerful dynamic bass blasts with delicate kalimba samples—through the ARC 110, all were clear and pristine with no trace of mud or strain.

I had to look really hard to find any shortcomings in the Reference 110, and found only one very small one. With certain recordings, there was a touch of warmth or roundedness in the midbass region. This genuinely split hair—the music still sounded incredibly lifelike—was audible only when I compared the 110 with amplifiers that have an ultrafast, overdamped quality in this region. Ray Brown's bass solo on "I'm an Old Cowhand," on Sonny Rollins' *Way Out West* (CD, JVC VICJ 60088), was extremely natural, but a touch warm only near the bottom of the instrument's register. Simi-

measurements, *continued*

corresponding increases in THD; 2) the distortion is very low in level when the load impedance is equal to or twice the output tap; 3) the distortion rises both at infrasonic and ultrasonic frequencies; and 4) the right channel is as good as the left at midrange frequencies from both the 4 and 8 ohm taps, but worse at high and low frequencies, and is also worse overall from the 16 ohm tap.

The spectral content of the distortion was predominantly the subjectively innocuous second harmonic at low output currents and at midrange frequencies (fig.10), joined by the third harmonic at higher currents and lower frequencies (fig.11). The decrease in circuit linearity at high frequencies seen in figs. 7–9 and at high powers seen in figs. 4–6 results in somewhat disappointing performance on the demanding high-frequency intermodulation test, when the amplifier under test is asked to drive an equal mix of 19 and 20kHz tones at a level close to visible clipping on an oscilloscope screen. With the 4 ohm tap driving 8 ohms, the 1kHz difference component lay at 0.2% (–54dB), which will probably be okay subjectively (fig.12).

As I have come to expect from Audio Research products, the Reference 110's measured performance is respectable, especially considering the low level of loop negative feedback, though I was bothered by the level mismatch between the channels and the differences in linearity.—*John Atkinson*

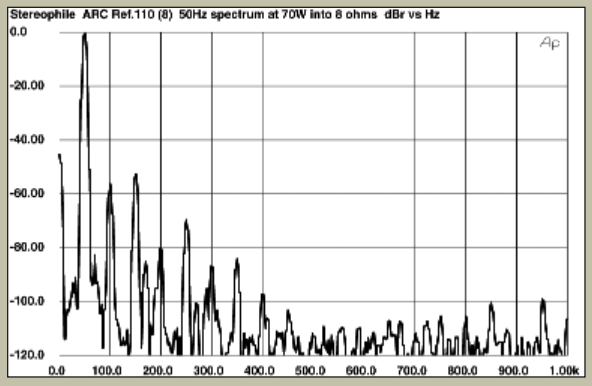

Fig.11 Audio Research Reference 110, 8 ohm tap, spectrum of 50Hz sinewave, DC–1kHz, at 70W into 8 ohms (linear frequency scale).

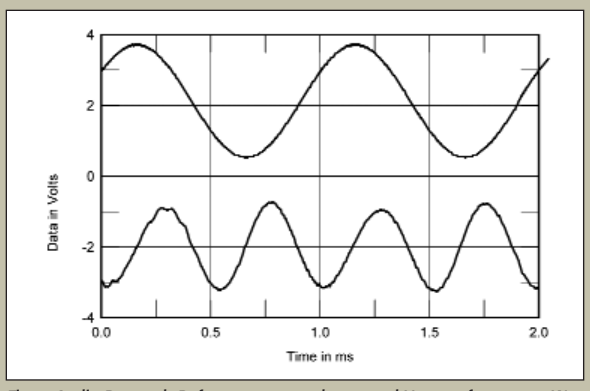

Fig.10 Audio Research Reference 110, 4 ohm tap, 1kHz waveform at 1.5W into 8 ohms (top), 0.039% THD+N; distortion and noise waveform with fundamental notched out (bottom, not to scale).

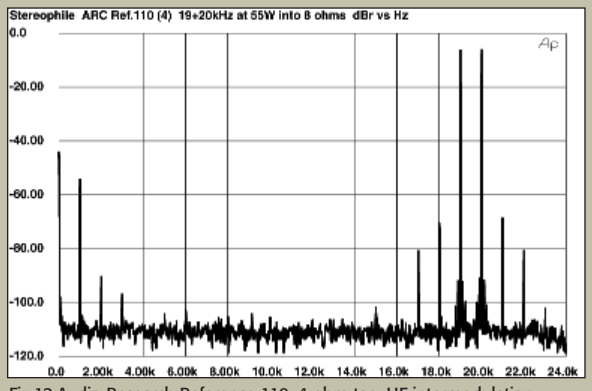

Fig.12 Audio Research Reference 110, 4 ohm tap, HF intermodulation spectrum, DC–24kHz, 19+20kHz at 55W peak into 8 ohms (linear frequency scale).

larly, the midbass synth lines on Sade's *Love Deluxe* (CD, Epic EK 53178) were natural but just a touch rounded.

Jerome Harris' arrangement of Duke Ellington's "The Mooche," on *Editor's Choice* (CD, Stereophile STPH016-2), put all of the 110's strengths together. The blend of alto sax and trombone was the silkiest I've ever heard from this track, and the musicians sounded as if they were in my room (or, more appropriately, as if I were in the recording venue, the recycled church sanctuary of Chad Kassem's Blue Heaven Studios). My notes: "this amp blooms like nothing I have ever heard; I want to listen longer and longer." I've never heard a male voice sound more natural than Hugh Masekela's through the Reference 110, in his rendition of "Stimela (The Coal Train)," on *Hope* (CD, Triloka KAT 2020-2). Moreover, the natural dynamics of the percussion on this live pop recording, and the bite and burnished brass of Masekela's trumpet, were startling.

Comparisons

I spent many days comparing the Reference 110 with ARC's own VT100 Mk.II. Both amps drove my Alón Circe speakers, and I listened to both with my Audio Valve EKlipse and ARC's Reference 3 line stages. I gave very favorable reviews in *Stereophile* to both the VT100 Mk.I (March 1997, Vol.20 No.3) and Mk.II (December 1998, Vol.21 No.12), and I still cherish this amplifier. It does everything I want an amp to do: a detailed, natural, dynamic performer with a broad range of recordings, it has exhibited no shortcomings, no colorations, and no flaws in the many years it's resided in my reference system. To exceed such performance would be a tall order.

The Reference 110 filled that order, and by a wide margin. It revealed far more inner detail than the VT100 Mk.II, and with more air, ambience, dimensionality, and a greater sense of organic drama and ease. The Ref 110 seemed to turn up the VT100 Mk.II's greatest strengths a notch or two. In the greatest difference between the two ARC amps, the Ref 110 highlighted a flaw in the VT100 that I'd never noticed before. The 110's high frequencies were so pure, so extended, and so detailed that, by comparison, the VT100's highs seemed surrounded by a slight electronic haze. In vocal recordings, sibilants were not as detailed or as pure through the VT100; and in well-recorded classical works, the balance of bow rosin and wood in violin passages seemed more skewed toward the rosin. The low- and high-level dynamic performances of both amps were exceptional. They sounded much more powerful than their ratings of 100W and 110W would indicate.

Only in one area did I feel that the VT100 Mk.II exceeded the performance of the Reference 110: The VT100 lacked that very slightly warm and rounded quality I heard in the Ref 110. By comparison, the VT100 had a tight, dynamic, kick-slam quality in the midbass that reminded me of a high-quality solid-state amp. But I'm splitting hairs again—both amps were exceptionally realistic in the bottom three octaves.

Summing up

The Audio Research Corporation's Reference 110 amplifier replicated, over many weeks of listening, the magic I'd experienced in those few hours of listening at Home Entertainment 2006. In certain areas the amplifier produced a level of realism startling enough to make me reluctant to turn the stereo off. I had this experience with all types of music, as well as with movies. Although the 110 was an excellent match for ARC's Reference 3 preamp, I didn't need an ARC preamp to hear its magic.

Those who've read my reviews for a while know that I rarely change reference components. In fact, at one point about 10 years ago, every piece of gear in my reference system had been discontinued. For me to even consider buying it, a new product must constitute a significant improvement over what I already own, as well as provide value for money. At the end of my listening sessions for the Reference 110, I put down my notebook and picked up my checkbook. This amplifier is not going back to ARC.

ASSOCIATED EQUIPMENT

ANALOG SOURCES VPI TNT IV turntable, Immedia RPM tonearm, Koetsu Urushi cartridge; Rega Planar 3 turntable, Syrinx PU-3 tonearm, Clearaudio Virtuoso Wood, Aurum Beta S cartridges.
DIGITAL SOURCES Lector CDP-7T, California Audio Labs Icon Mk.II Power Boss, Creek Destiny & CD53 Mk.II CD players; Pioneer DV-333 DVD player.
PREAMPLIFICATION Vendetta Research SCP-2D phono stage; Audio Valve Eklipse, Audio Research Reference 3 line stages.
POWER AMPLIFIER Audio Research VT100 Mk.II.
INTEGRATED AMPLIFIERS Creek Destiny & 5350SE.
LOUDSPEAKERS Alón Circe.
CABLES Interconnect: MIT Magnum M3, MI-350 CVTwin Terminator, MI-330SG, Terminator. Speaker: Acarian Systems Black Orpheus.

—Robert J. Reina

MANUFACTURERS' COMMENTS

Audio Research Reference 110

Editor:

On behalf of the Audio Research design team, I would like to thank Bob Reina for his glowing review of our Reference 110 power amplifier. We are gratified that Bob considers it a real value and will be purchasing it for his own reference system.

The only assertion with which we take issue is "ARC doesn't hesitate to frequently update designs or experiment with new circuit technologies and tube types," simply because these are practices we abandoned years ago. Tenured audiophiles will remember the many iterations of the SP6 series, for example, back in the late 1970s and early '80s. Intervals between model changes have increased dramatically over the years, with current preamplifiers having replaced predecessors that were in production from four-plus to five-plus years, which we now expect to be the norm. As Bob wrote, he acquired his own VT100 over a decade ago, and the last version, the Mk.III, was discontinued after six years! Our circuit technologies do not change often because our products are meticulously designed at their inception to advance sonic benchmarks and provide reliable performance. As for tubes, we design with types in current production, so there is no need to worry about finding high-quality replacements down the road. After all, we expect our products to remain in use for decades, being passed down to successive generations of music lovers.

We cycle every product on and off during burn-in (amplifiers for 48 hours, everything else for 24 hours), then thoroughly bench-test each component twice to make sure it meets all published specifications. It is then evaluated in a reference system to make sure it passes sonic muster and fits within a very small sonic "window" to ensure uniformity. If a small difference between channels was measured after hundreds of hours (or more) of use, our engineers surmise that a tube has drifted slightly.

We hope that Bob will enjoy the Reference 110 in his system for many years, and we encourage others to audition this amplifier for themselves. After all of Bob's keen observations, many will appreciate its great ability to bring music to life even more when they hear it for themselves.

Dave Gordon
Audio Research Corporation