

CHOOSING A DIGITAL RECORDER

AUDIO

THE EQUIPMENT AUTHORITY

FEBRUARY 1999

**AMPLIFIER ACE
BOB CARVER
TELLS ALL!**

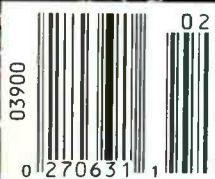
TESTED

**KENWOOD'S
NEW CONCEPT IN
A/V RECEIVERS**

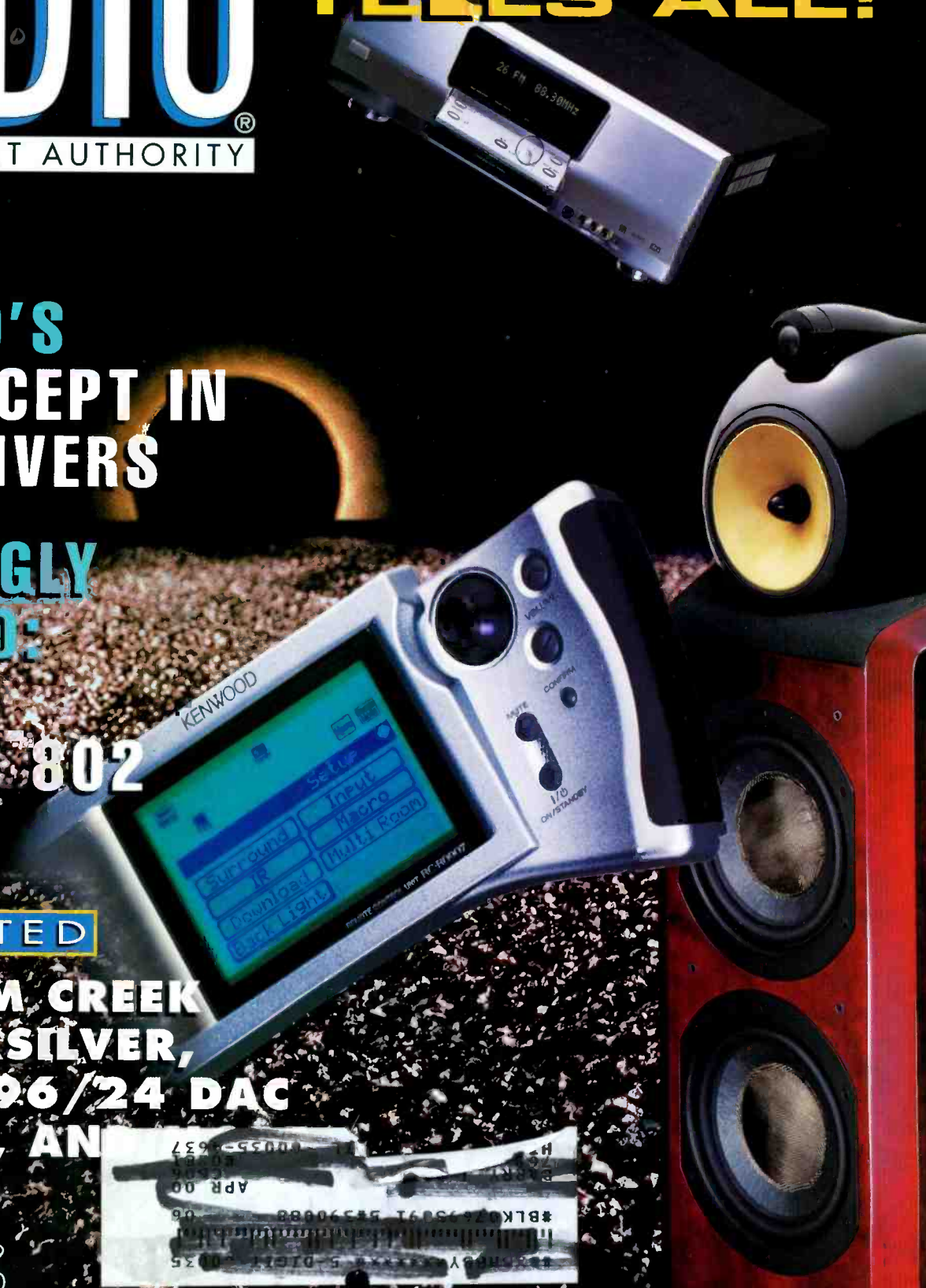
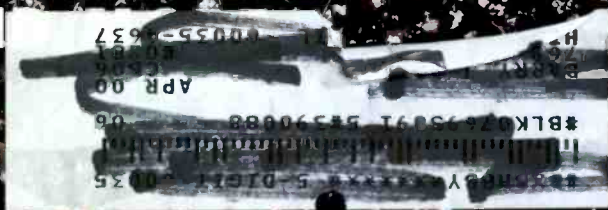
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ADVANCED:
B&W'S
NAUTILUS 802
SPEAKER**

ALSO TESTED

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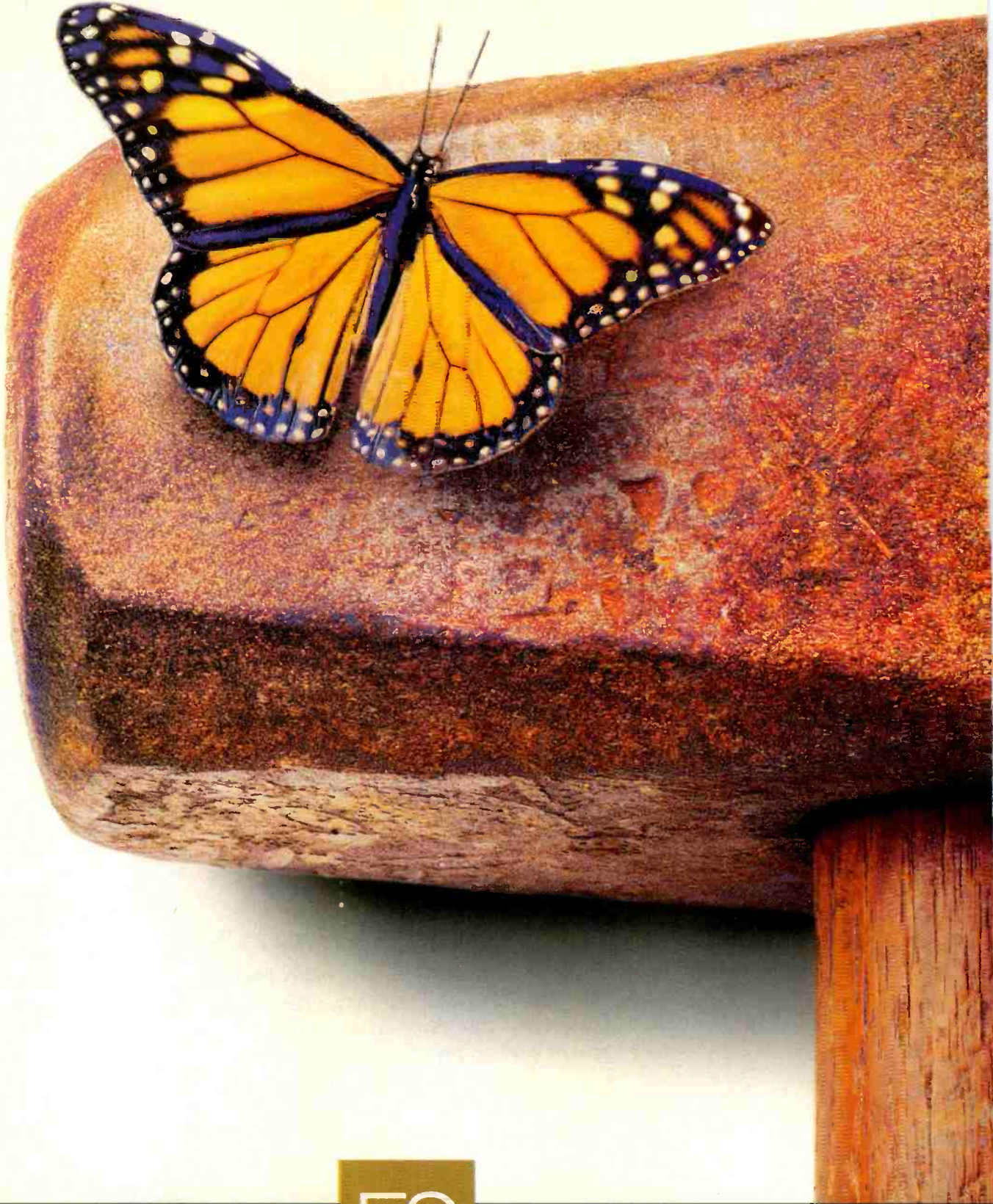
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MUSICAL FIDELITY X-RAY CD PLAYER,
AND NEUTRIK MINIRATOR MR1
PORTABLE AUDIO GENERATOR 96



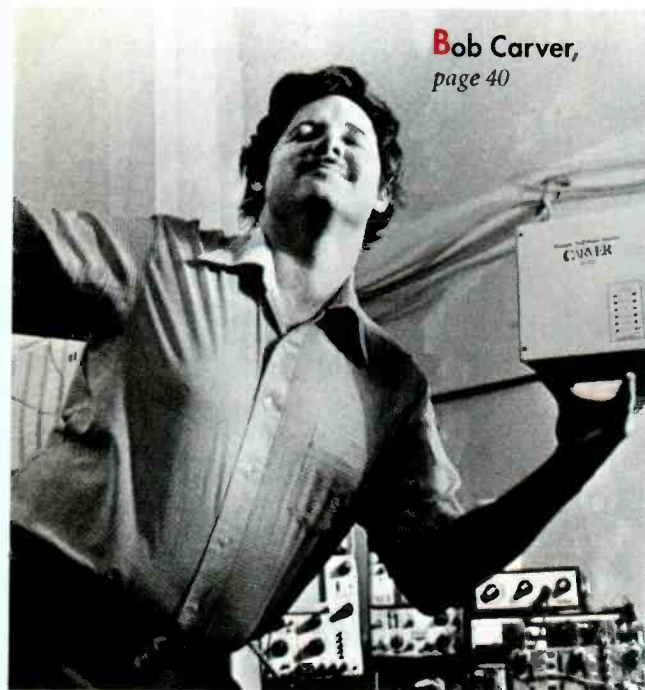
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Last week I was poking around in my basement when I came across a box of old open-reel recordings I made years ago. I no longer have the deck—a Pioneer RT-701 that I bought in the late 1970s. It was an unusual, low-profile machine that took 7-inch reels and had nice, peak-reading meters. The recordings themselves were made on quarter-track tape with no noise reduction, mostly at 7½ inches per second but some at 3¾ ips. There was a little bit of background hiss in quiet passages, but the recordings were generally very smooth and clean.

In the mid-1980s, realizing that I never played these tapes anymore, I surrendered and transferred them all to cassette. This took a long time and involved some painful decisions regarding side transitions for certain very long recordings. But I did play the cassettes more often than I had been playing the reels.

Whereas open-reel tape was clunky, cassettes were fiddly. If you wanted really good results, you had to have a deck that enabled either automatic bias and sensitivity calibration for individual tapes or metered manual adjustment of these parameters. Even then, the tapes might sound their best only on the machine that made them, especially if you used Dolby C noise reduction. Cassettes are convenient, and they *can* sound really good—you just can't rely on it.

The advent of affordable, easy-to-use digital recorders has made it possible for audiophiles to have it all: convenience, exemplary sound quality, and consistency. So what is it about digital recording that makes it so much better than analog recording (particularly analog recording on cassettes)? I think that the answer is, primarily, frequency response. Getting flat frequency response on open-reel tape required that the deck be adjusted properly for the brand and formulation of tape being used, and even then you had to be concerned about treble losses from tape saturation. Pretty much the same story for cassette, except there the dimensions, tape

speed, and necessity for noise reduction required almost maniacal precision in setup to achieve comparable results. Digital does away with all that finagling. You put the tape or disc in the recorder, and if the deck is designed and functioning properly, you get amplifier-like frequency response, all the way from the bottom to a little beyond 20 kHz.

When digital recording and the Compact Disc were introduced, the biggest fuss was about the much wider dynamic range that could be captured. No question this is a real benefit, but I think the ease with which truly flat frequency response can be achieved is more significant most of the time. Absent obvious noise and distortion, frequency response has by far the greatest influence on perceived sound quality. So as the responses of more and more links in the production and reproduction chains have been flattened, overall sound quality has improved. Today it is possible to get essentially perfect frequency response all the way from mixing console to loudspeaker input.

Yet frequency response remains one of the biggest challenges in audio. Now, however, it is primarily an issue for transducers: microphones and speakers. Of course, two transducers have been lost along the way: the record-cutting stylus and the phono cartridge. It was digital recording and playback techniques that made this possible. We have hit the wall with respect to eliminating transducers, however. It seems very, very unlikely that we will ever say goodbye to microphones and speakers. But even there, digital techniques can help by giving engineers the electronic processing power to compensate for mechanical errors. We see a little bit of that already; in the future, I think such processing will explode in both the breadth and depth of its application.



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Bennett Nails It... Almost

Rad Bennett's review of the DVD version of *Evita* (July 1998) closely parallels my view of the movie "in theater." I thought that Madonna did a very good job indeed, particularly since her reading was quite different from Patti Lupone's live theater performance. My only criticism is that I do not think Madonna's voice is quite brassy enough for "Stand Back, Buenos Aires."

I had also heard Antonio Banderas on the CD before I saw the movie. He was not impressive, but his on-screen presence is much better.

R. L. Promboin
Westlake Village, Cal.

Bit of a Discrepancy

I picked up the November 1998 issue of *Audio* for the first time at my favorite newsstand and loved it! Thanks for this generous dose of anesthesia; it made my New York rush-hour subway ride pass seamlessly.

I do have a comment. In his "Equipment Profile" of EAD's TheaterMaster Encore and Ovation A/V preamps, Edward J. Foster wrote: "And instead of Encore's multichannel, 1-bit Crystal Semiconductor DACs, the Ovation has six Burr-Brown PCM1702 20-bit ladder DACs." There are several other instances in this review where Foster mentions 1-bit Crystal DACs and their role in the Encore's performance. It seems very odd to me because, according to EAD's own specs (at www.eadcorp.com), the Encore is equipped with Crystal CS4226 20-bit delta-sigma multi-DACs instead of 1-bits. Moreover, Crystal's specs (at www.cirrus.com/products/overviews/cs4226.htm) clearly state 20-bit D/A capability of the CS4226.

Although I realize that such a discrepancy has no effect on the Encore's performance, I do not feel comfortable about this fact. Foster seems to infer a conclusion based on technical data (which dominates his review) that Encore's several slightly inferior test results are due to the 1-bit nature of its DACs.

This might appear to be just another rhetorical question about the plausibility of the review, your magazine, and, for that

matter, other A/V industry publications. Or perhaps the manufacturers have misinformed the public. I am not ready to infer a conclusion (yet).

Alex Bord
via e-mail

Editor's Reply: The term "1-bit" is a common, if not necessarily always exact, synonym for "delta-sigma," which is technically accurate for a somewhat wider range of converters that include truly 1-bit designs. What's confusing is that the 1-bit designation refers to how the converter handles data internally rather than to its resolution. (A delta-sigma D/A converter, for example, takes a multibit PCM input, converts it to some form of delta-modulated signal, and then uses that signal to drive a pulse-width or pulse-density output modulator to produce the analog output.) That is, a 1-bit converter can have 20-bit resolution, and its performance may be worse than, equivalent to, or better than that of a conventional 20-bit ladder converter. It depends on the individual designs of the converters more than on whether they are delta-sigma or multibit.

Thanks for your interest; glad you enjoyed the mag.—M.R.

Protect Yourself

I'm writing with the hope that your readers may benefit from my recent experience with a power surge. I returned home after a weekend away to find that a severe storm had caused a power surge in my neighborhood. It knocked out a telephone answering device, the receiver of a garage-door opener, and three items in my complex stereo system. This system actually contains a dozen interconnected items (not counting speakers); of these, nine were on a surge protector and three were not.

As you can guess, the protected items were fine, but I had to repair or replace the other three. One power amp (a Sanyo P-55) could not be repaired, as the parts were no longer available. It took a month to get things back in order, and the cost of repair and replacement was close to \$1,000. That's a lot more than the cost of surge protectors!

I now have surge protectors all over the house, especially for the stereo system.

The moral here is that anyone who owns an audio system or any other valued electronic component should have surge protectors to guard these items. It's a very inexpensive form of insurance and will save much aggravation and money. *David Adler*
Clark, N.J.

Copyright Concern

I'm deeply concerned by new copyright legislation being considered by Congress, legislation that the president is expected to rubber-stamp. The proposed law would give two notoriously greedy and untrustworthy industries, movie and music, carte blanche to totally stomp on the consumer's interests and gradually abolish all forms of consumer audio and video recording as well as our ability to buy infinitely playable audio and video discs.

According to an article in *The Miami Herald*, the proposed legislation would permit a new type of audio disc to be introduced, one that would be playable only in the first player it is inserted into. The disc would then be electronically "registered" to play solely on that one machine. The music industry's goal would be to force us to buy additional discs for car or portable use, thwarting us from playing the discs at friends' homes and totally wiping out the used-CD market. Such a law could also devastate hi-fi equipment makers, because consumers could never upgrade to better playback equipment without having their entire disc collections become unplayable.

The day when such a scheme becomes the only way to buy recorded music or video is the day I stop collecting it and kick back and enjoy the substantial collection I already have. There *have* to be reasonable limits to entertainment industry greed, before that industry totally alienates the consumer. We don't *have* to buy, you know.

Phil Cohen
Bay Harbor, Fla.

The Best Medicine

It is always a pleasure to see the Lirpa Labs products listed in the Annual Equipment Directory (October 1998). It never hurts to have a little humor among all the numbers.

Mike Mihelich
Coeur d'Alene, Idaho



"The Lexicon DC-1 clearly competes with the finest and most costly processors available, despite its comparatively modest price...It has the best ergonomics and real-world features of any A/V preamp/processor I have encountered."

Anthony H. Cordesman,
Audio, June 1998



"...the DC-1's sound quality was little short of stunning. No component I've heard can provide the depth of DSP ambience processing (and extraction), user-customization, and flexibility of the DC-1."

Daniel Kumin, *Video*,
January 1998



"The best digital surround processor to date at any price."

David Frangioni,
EQ, May 1998



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Alan Sircom,
Home Entertainment Awards, November, 1998

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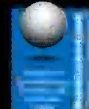
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—Cory Greenberg, Audio, on the Mini Monitor

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AUDIO CLINIC

JOSEPH GIOVANELLI

Does Channel Surfing Hurt a TV?

Q *With my entire family running our 32-inch TV, we must change channels hundreds of times a day! I'm not worried about the remote, because I think it can take it, but I am concerned about the set itself. Can rapid channel surfing damage the picture tube or anything inside the TV? If that's the case, I'll have to lock up the remote from my four sons or get physical!—Ron Hutchinson, Earlville, Ill.*

A I recommend that you spare the rod; channel surfing will *not* harm your TV set. This would not have been true in the days of the mechanical tuner (remember the ones that clicked at each channel stop?). Modern TVs are fully electronic, not mechanical; hence they never get worn or dirty contacts, which in the old sets always meant replacing the tuner. But you might want to keep a spare remote on hand. I have seen remotes fail even when they were used less frequently than yours. Fortunately, replacements are readily available and reasonably priced.

Inadequate Building Wiring

Q *I live in a pre-World War I apartment building that has the original wiring and "upgraded," 100-ampere service. That's 100 amperes (total) for all five apartments in the building. Some of my appliances simply struggle with the inadequate power, but my amplifier frequently goes into protection mode and quits. The rest of the time, the red/green status LED stays red, indicating a problem. Would a voltage regulator help in this situation? I've heard of the Variac, a device that I believe keeps line voltage from sagging when powerful amplifiers are tested. Would that solve my problem?—Mike Finocchio, via e-mail*

A It appears that your voltage runs rather low most of the time. You are on the right track when you talk about a voltage regulator, but a Variac isn't the device to use. Although a Variac enables you to vary the voltage to a load over a significant range and you can monitor the voltage with a voltmeter, thereby letting you adjust

it as required, this is *not* advisable. You may inadvertently set the voltage too high; when the line voltage recovers, your gear may then get too much voltage.

The regulator you need is a constant voltage transformer, connected between the AC power line and the load. It must be rated to handle the total wattage of all the equipment connected to it plus a margin of 25% to 50% as a safety precaution. To obtain one of these transformers, check the listings in the Yellow Pages under "Electrical Distributors" or even "Transformers."

Messed-Up Radio Reception

Q *My new tape deck sits on top of my receiver. When I turn it on to record a program off the air, it messes up the reception. Is there any way I can fix this without relocating the recorder? Would grounding it to the receiver help?—Mark Stoddard, Seadrift, Texas*

A I can't tell from your letter what you mean by "messed-up" reception. What changes when you turn the tape deck on? Is your problem on AM, FM, or both? Does it occur whenever the tape deck is on, just when its motor is running, or only when you're recording?

Because FM is usually not subject to interference from tape recorders, I assume it's your AM band that's troublesome. In a tape deck, the bias oscillator is always on during recording, and it can be considered as a sort of radio transmitter. The frequency of the oscillator may be 100 kHz, but its harmonics can extend throughout the broadcast band and somewhat beyond it. Because the AM antenna used on most receivers, a ferrite loop, is typically at the rear, it's likely that yours is close to the tape deck. It's not surprising, therefore, that this antenna may

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019, or via e-mail at joegio@cstone.net. All letters are answered. In the event that your letter is chosen by Mr. Giovanelli to appear in Audioclinic, please indicate if your name or address should be withheld. Please enclose a stamped, self-addressed envelope.

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- Corey Greenberg, Audio, on the Paradigm Mini Monitor

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pick up spurious signals from the bias oscillator. The problem can be solved by moving the recorder—something you don't want to do. (And, no, grounding it to the receiver won't help.) In the long run I think you should move your tape deck. Not only will the reception problem disappear, but better ventilation of the receiver will result. That, in turn, will help prolong its life.

If you can't or won't move the tape deck, disconnect the receiver's ferrite loop and use an AM antenna located far from the recorder. Ideally, it should be roof-mounted and fed to the receiver via a coaxial line. Alternatively, consider a separate indoor AM loop antenna, positioned well away from the tape deck and connected by cable to the receiver.

Enhancing Home Theater Sound

Q I realize that we're not supposed to use sound processors—such as equalizers, treble sharpeners, and bass-impact enhancers—in the tape or processor loops of A/V receivers and integrated amps. This makes sense, as the phase changes created by these processors play havoc with the phase-actuated steering circuits of Dolby Pro Logic processing. But it's also a shame. What film wouldn't benefit from a little sonic improvement? How can I use a processor with home A/V gear, and where should the connections be made?—Kevin A. Barrett, Plainfield, N.J.

A First off, I'd try using the processors of your choice and Dolby Pro Logic together. The results might not be bad in some cases. But if they are, you can then decide whether a film benefits more from surround sound than it does from other types of processing.

If your A/V receiver or integrated amp has preamp outputs and amp inputs, you could connect processors to those for the main channels, as those connections follow the surround decoder. This may, however, cause an audible mismatch between your main and center channels and another mismatch (which may matter less) between the main and surround channels. You can avoid the center-channel mismatch by setting the Pro Logic decoder for phantom-center operation, and you can cure the surround mismatch by using identical processors for each channel and setting them identically. (Multichannel equalizers for A/V systems are available from several companies, in-

cluding AudioControl and Rane.) You might be able to put a bass-impact enhancer in the subwoofer line output, as long as the crossover is not below the region where the enhancer searches for harmonics of "missing" fundamentals.

If you already own the processors in question, you have nothing to lose by trying. If not, try to borrow them and try them out before buying.

Too Much Voltage?

Q Will audio components (especially CD or DVD players) built to operate on Japan's 100-volt AC power lines be harmed by running them on the 110- or 120-volt AC power lines that are the norm in the United States?—Tao Gu, via e-mail

A I do not recommend using 100-volt gear on American 120-volt power lines. At best, the equipment will run hot; at worst, electrolytic capacitors may fail prematurely. If any voltage regulators are on the marginal side, they may short, placing dangerously high voltages on micro-processor chips and other sensitive parts. I once borrowed a DAT recorder, made in Japan, that was not designed for export to the U.S. Though it was made to operate at 100 volts, it came with a small transformer that stepped the 120-volt AC supply down to the required 100 volts. You may be able to find such a transformer. However, it must have sufficient capacity to handle the power, in watts, drawn by the devices connected to it.

Erasing Audio Cassettes

Q I have 5¼-inch speakers in the rear deck of my Honda Accord. If I open the trunk, I have access to their magnets. Could I effectively erase cassette tapes by rubbing their shells back and forth across the face of the magnets, as opposed to using a bulk eraser?—Name withheld, Houston, Texas

A Though you might be able to erase cassettes in the manner you describe, the results will not be good. If the speakers are magnetically shielded, there might not be enough magnetic flux to do the job. Chances are that remnants of the previous recording will remain on the tape, or noise will be added and may persist even if a new recording is made.

If you do use the approach you suggest to erase tapes and you then use one to make a

new recording, let it continue to record after the program has finished. This will prevent noise from being heard at the end of the tape. It would be particularly jarring during a listening session to have the program end, immediately followed by background noise and traces of the previous recording.

Listening Fatigue

Q *I have a pair of planar-magnetic panel speakers that I can listen to for hours without a break. But when I listen to my conventional dynamic speakers, I need regular intermissions to give my ears a rest. What causes this fatigue or lack thereof?—Dennis Wren, via e-mail*

A For me, listening fatigue becomes a problem when there are treble peaks in a speaker's frequency response, especially in the region of 2.5 to 3 kHz. The fatigue becomes even more acute when similar equalization peaks have been introduced in a recording by its producer to make the sound more "punchy."

Some drivers, even dome tweeters, exhibit peaks in the range of 2 to 6 kHz that are

quite annoying. If these peaks were higher or lower in frequency, their effects would be less audible; indeed, some listeners might even perceive the sound as enhanced on some recordings.

Along these lines, I have experienced an odd phenomenon in my own listening room. It's something that I can't explain, nor can I offer any objective data to back it up, though it seems logical enough. One of my speaker systems has a very slight tendency toward peaky treble response. When it is driven by a really good power amplifier, I don't sense any listening fatigue. But when I switch amplifiers, using one whose characteristics are good but not in the league of the other amp's, I suddenly find the response peaks unacceptable. It gets even more interesting if I switch to slightly better speakers. All of a sudden, the differences between the two power amplifiers are no longer noticeable. I'm not sure how to account for this; it may be that we still don't know all of the ways to measure amplifier performance—or that we don't fully know how to correlate what we do measure with what we hear.

Cable Runs in Biamped Systems

Q *In a biamped setup, should the separate cables to the woofer and tweeter sections of the speakers be run parallel to each other or twisted together? Does this matter at all?—George O'Sullivan, via e-mail*

A It doesn't matter how you route your speaker wires in a biamped setup. If you use a separate wire for the hot lead and another for the common, you can twist them together or strap them together with tie wraps to keep things tidy.

Although it's okay to run speaker cables parallel to low-level cables that feed the input of preamps or power amps, it's not a good idea to bundle them together, as this might cause feedback, which, in turn, might trigger system oscillation. The greater the amount of treble boost, the greater the chance of such oscillation. That may seem surprising, but it has happened in at least one instance that I recall. The frequency of the oscillation may be very high—well above the range of your hearing—but it can have such a high amplitude that the tweeters and power amp can be damaged in an instant! A

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Constructed of high-density hardboard, the Titan has a ¾-inch ceramic/metal dome tweeter and a 6½-inch polypropylene woofer. Frequency response of this bass reflex system is rated at 60 Hz to 20 kHz, ±2 dB, and the crossover is a phase-corrected quasi-Butterworth design. The company says that despite its compact size of 13 x 7¼ x 10¼ inches, the Titan is capable of full-bandwidth, natural reproduction. Price: \$219 per pair. (Paradigm, c/o AudioStream, 905/632-0180)

WHAT'S NEW



ONKYO A/V RECEIVER

Using an upgraded Motorola 24-bit chip to decode Dolby Digital (AC-3) sources and run DSP functions, the TX-DS656 has discrete 5.1-channel analog inputs to connect an external decoder for DTS or other multichannel formats. Each of the five internal amplifiers is rated at 85 watts

continuous into 8 ohms, from 20 Hz to 20 kHz, at 0.08% THD. There are four A/V inputs (each with S-video jacks), four audio inputs, three digital inputs (two coaxial, one optical), and a phono input. The tuner has 30 AM/FM station presets. Price: \$799. (Onkyo, 201/825-7950)

harman kardon system remote

You can operate your entire home entertainment system through the backlit, touchscreen LCD of Harman Kardon's Take Control System Controller. Developed by Harman and Microsoft, the Take Control may be customized to your A/V system by connecting it to a Windows 95/98 or NT-compatible PC and using the supplied Editor software and serial connection cable. Instead of the usual rows of buttons, Take Control has various "activity screens" that you select with a scroll wheel. Applicable function buttons appear directly on the touchscreen display. Price: \$349. (Harman Kardon, 800/645-7484)



PHILIPS DVD PLAYER

The DVD855AT offers 5.1-channel Dolby Digital decoding, 10-bit video processing, and 96-kHz/24-bit audio D/A conversion and can detect and pass a DTS bit stream from DTS-encoded DVDs. Component video outputs enable horizontal video resolution as great as

540 lines on similarly capable TVs. The Philips player has coaxial and optical (Toslink) digital outputs, S-video jacks, and six discrete analog RCA outputs. Features include a bit-rate display, a remote locator, and digital zoom. Price: \$599. (Philips, 888/239-6948)

TDK Recordable CDs



Designed for consumer audio CD recorders, TDK's CD-Twin-R recordable CDs (74 minutes in length) are said to achieve higher reflectivity than previous CD-Rs. The company adds that its new "HardHat" dual-layer coating is 50% more resistant to damage and can better withstand the rigors of portable use than previous CD-R media. Price: \$8.99 each. (TDK, 800/835-8273)

WHAT'S NEW



PIE CD CHANGER ADAPTOR

The VW/98-PAN CD changer adaptor is intended for 1998 and 1999 Volkswagens (including the new Beetle) that are equipped with factory-installed Clarion or Panasonic head units. It integrates aftermarket Panasonic or Clarion CD changers with the head units in the newer

vehicles while retaining full control of CD operation. Similar units are made for 1997 to 1999 VWs supplied with the Bose Audio System and for 1994 to 1997 VWs equipped with Clarion head units. Price: \$39.95. (Precision Interface Electronics, 800/526-8590)



ATI FIVE-CHANNEL AMPLIFIER

ATI says its AT2505 is the most powerful multichannel amp for home theater that doesn't require cooling fans. It is rated to deliver 250 watts per channel into 8 ohms or 375 watts per channel into 4 ohms, with no more than 0.03% THD/SMPTE IM from 20 Hz to 20 kHz and with all five channels driven simultaneously. Each of the AT2505's five amp modules has its own fault indicator; if a module fails, you can easily unplug and replace it. Other features include remote power-on and large heat sinks. Price: \$2,695. (ATI, 818/343-4777)



INFINITY POWERED SUB

Flagship of Infinity's HPS series, the HPS-1000 has two side-firing, 15-inch passive radiators coupled to a downward-firing, 15-inch driver powered by a 1,000-watt internal amp. Infinity says that the amp, which uses a digital power supply and transformerless design, yields high output from a compact chassis. The passive radiators' cones are made of a co-injection polypropylene with an optimized center of gravity. Low-frequency response is claimed to extend to below 20 Hz. Price: \$1,299. (Infinity, 516/496-3400)



SENNHEISER SURROUND PROCESSOR

Using digital signal processing, the DSP360 is said to convert the output from any stereo or Dolby Surround-encoded source into Virtual Dolby Surround when played back through stereo headphones or speakers. The device uses Toltec 3D processing to simulate a five-channel speaker setup through two channels. Controls include a bypass switch, an output selector (headphones or speakers), "3D Boost," automatic volume, and a switch for test mode. Price: \$149.95. (Sennheiser, 860/434-9190)

Tivoli Design A/V Furniture

Tivoli Design's wooden component stands are available in three- and five-shelf versions. These unassembled units have a black lacquer, black matte, or cherry-wood finish; the TV stand comes in a black lacquer or a black satin finish. Prices (depending on finish): Three-shelf stand, \$199 to \$279; five-shelf stand, \$249 to \$349; TV stand, \$249 in black satin, \$349 in black lacquer. (Tivoli Design, 877/297-9479)



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TEST TOPICS: AMPLIFIER POWER

Graphs and measurements can tell you a lot about how a component performs, but only if you know what they signify. So with this column, we begin an occasional series, "Test Topics," as a guide for novice audiophiles and a refresher for the more experienced. Feel free to send us a note or e-mail message to tell us what topics you'd like us to cover.

through the load. The lower the load's impedance, the greater the potential voltage drop and current flow. But the amplifier's output impedance also regulates the voltage drop, and its output voltage affects current flow.

If the amplifier's output impedance is low enough relative to the load impedance, its output voltage won't change much over the normal

saturation of its output devices, often keep the power from precisely doubling when the load is halved.)

Most tube amplifier circuits, however, deliver too high a voltage and too low a current to drive normal speaker loads directly. For this and other reasons, they drive speakers through output transformers, which lower the amplifier's output impedance by stepping the voltage down and the current up. For maximum efficiency, these transformers have separate output taps with the proper impedances to drive 4- and 8-ohm loads (and, occasionally, for 1, 2, or 16 ohms). Such a transformer's 4-ohm tap will normally deliver 70.7% of the voltage and 1.414X the current available from the 8-ohm tap, which means each tap delivers equal power into its designed load (0.707×1.414 essentially equals 1). That's why a tube amp's power rating usually does not change when you switch to a speaker of higher or lower impedance—as long as you use the proper output transformer tap for each load.

DISTORTION AND FREQUENCY RANGE:

The relationship between power and distortion is a bit more complicated. As you near an amplifier's power limit, its distortion goes up. So you could say that the amp tested for Fig. 1 is a 60-watt, a 50-watt, or an 80-watt model, depending on how much distortion you consider acceptable. Its manufacturer says it should deliver 60 watts at 0.1% total harmonic distortion plus noise (THD + N) from 20 Hz to 20 kHz into the 8-ohm load used here, and it obviously does. But had the company wanted to cite a lower distortion spec, the amp could have been rated as delivering 50 watts at 0.002% THD + N.

Makers of inexpensive car stereos and boomboxes—and single-ended tube amps—sometimes rate their products' power only at 1 kHz; with the amp used for Fig. 1, that could have produced power ratings of about 75 watts at 0.0005%, 77 watts at 0.1%, or 80 watts at 1% THD + N.

Strictly speaking, there's no such thing as a "50-watt amplifier." Your amplifier may deliver 50 watts per channel into a specific load at some specific distortion level, over a specific range of frequencies. But change any of those parameters, and the amp's power output will change. Therefore, you won't find a single graph of power output in our amplifier reviews. Instead, you'll find a set of graphs illustrating how the amp's behavior changes as each of these parameters is changed.

LOAD IMPEDANCE: When you put a load across an amplifier's output, the voltage across the output terminals drops and current flows

range of load impedances. Amplifiers with very low output impedances (including most solid-state amps) are, therefore, called "constant-voltage" devices.

Power is the product of voltage and current, and lowering the load impedance makes more current flow. So a constant-voltage amp will commonly deliver twice as much current into a 4-ohm load as into an 8-ohm load, but it will deliver about the same voltage into either. That's why a solid-state amp's power rating into 4-ohm loads is roughly twice its rating into 8 ohms. (Factors such as the amplifier's power-supply filter capacitance and regulation, and the





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However, when we quote measured power at 1 kHz and 1% distortion, we call it “output power at clipping,” the maximum power the amp can deliver before it reaches the point where it has almost totally run out of steam. Increasing the input voltage above that point will make distortion shoot up but won’t appreciably increase output power, as seen in the sharply rising portions of the curves in Fig. 1.

It’s called “clipping” for a reason: If you watch an amplifier’s output on an oscilloscope as you feed it a sine wave of increasing voltage, you’ll eventually see the waveform flatten a little as the amp clips off the tops and bottoms of the wave. If you raise the input sine wave’s voltage high enough, the amp’s output will resemble a square wave.

Distortion curves like those in Fig. 1, which mostly stay low but then turn an abrupt corner and zoom upward, signify that the circuit being measured has a lot of

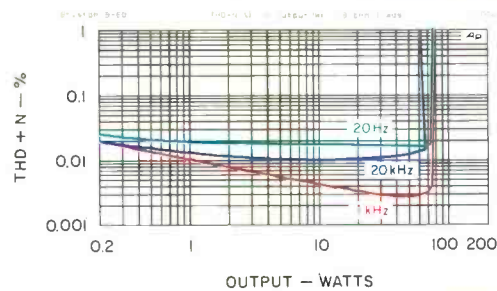


Fig. 1—THD + N vs. output for a constant-voltage, solid-state amp into an 8-ohm load. Note the rapid rise in distortion at clipping and the changes at different frequencies; see text.

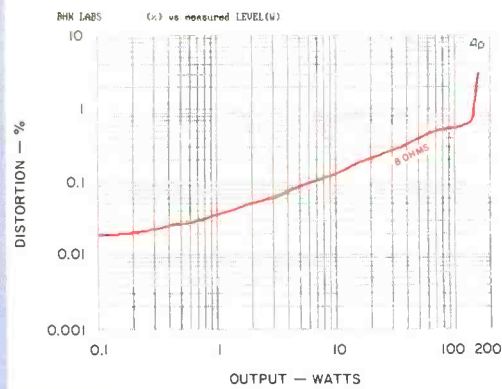


Fig. 2—THD + N vs. output for a tube amp, measured at 1 kHz.

negative feedback. The feedback keeps the distortion low as long as possible but can’t keep it low forever. (The feedback also keeps output impedance low.) Circuits that use less feedback have gradually rising distortion curves that turn gentler corners as clipping is approached. You mostly see such curves for tube amps (Fig. 2), because few of them use much feedback. (Tube amps use little feedback because their output transformers can cause instabilities if

they’re within a high-feedback loop and because negative feedback reduces gain, which tube amps usually have less of to spare.) Here, too, a choice of power ratings is possible: about 150 watts at 0.7% distortion or 70 watts at 0.5%; the manufacturer rated this amp at 120 watts, at which level its distortion is about 0.6%.

FUDGE, AND OTHER, FACTORS: There are ways, all illegal, to unobtrusively increase a stereo or multichannel amplifi-

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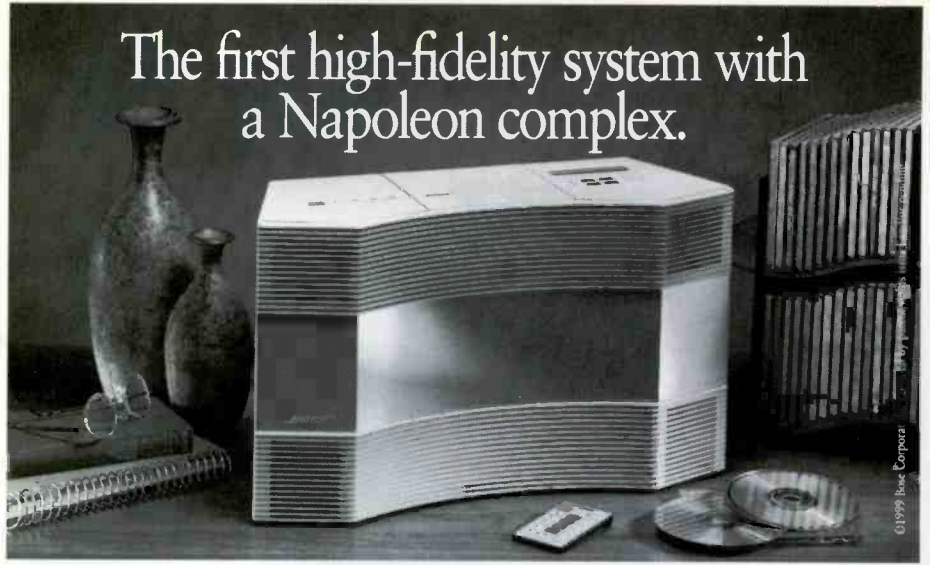
er's power rating without increasing its actual power output. One is to feed test signals only to one channel and cite that channel's measured power as the amplifier's power per channel. In most amplifiers, all the channels share a common power supply, so a single-channel measurement lets the tested channel use power that would not be available if the other channels also needed it. That's why amplifiers are normally measured with all channels driven at once.

Another way to fudge the power spec is to lump all the channels' power together, which would make a 50-watt/channel stereo amp a "100-watter." That's seldom done these days, but it's often subliminally suggested by lumping total power into the model number (calling it, say, the "Acme 100").

In the '60s and '70s, when stereo first became big business, some manufacturers used every trick in the book to inflate their power specs. Eventually, the Federal Trade Commission (FTC) clamped down and instituted disclosure rules for rating the power of home amplifiers. Although those rules mandated some specific test procedures, their main effect was to require that every amp power spec be for power per channel, with all channels driven, and that it include—you guessed it—the load, distortion level, and frequency range to which that spec applied. A lot of companies have forgotten this, but it's still the law.

LEGITIMATE DYNAMIC FUDGE: So far, we've been discussing the power an amp can deliver continuously, for long periods of time. But music's power demands fluctuate, and its peaks are usually short. On short peaks, amplifiers can usually deliver more than their rated power. To see how much more, we use the IHF tone burst, a standardized test sequence consisting of a signal that runs at a high level for 20 milliseconds, followed by 480 milliseconds at a level 20 dB lower before repeating. The amp's output, at its rated distortion, for the 20-millisecond high-level burst is its "dynamic power"—the power it can deliver briefly. "Dynamic headroom," which sounds confusingly like dynamic power, is the ratio between the amp's dynamic and continuous rated power, expressed in decibels (dB). "Clipping headroom" is the ratio between continuous power at the onset of clipping and rated power. **A**

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LISTEN AND YOU'LL SEE

BROKEN CHINA

Most Americans will likely admit—deep down inside—to not caring a jot about the rest of the planet. Indeed, there's a long tradition of isolationism that nearly kept the United States out of World War II. This tendency rears its ugly little head in between those glorious moments when the country does do a fabulous job of policing

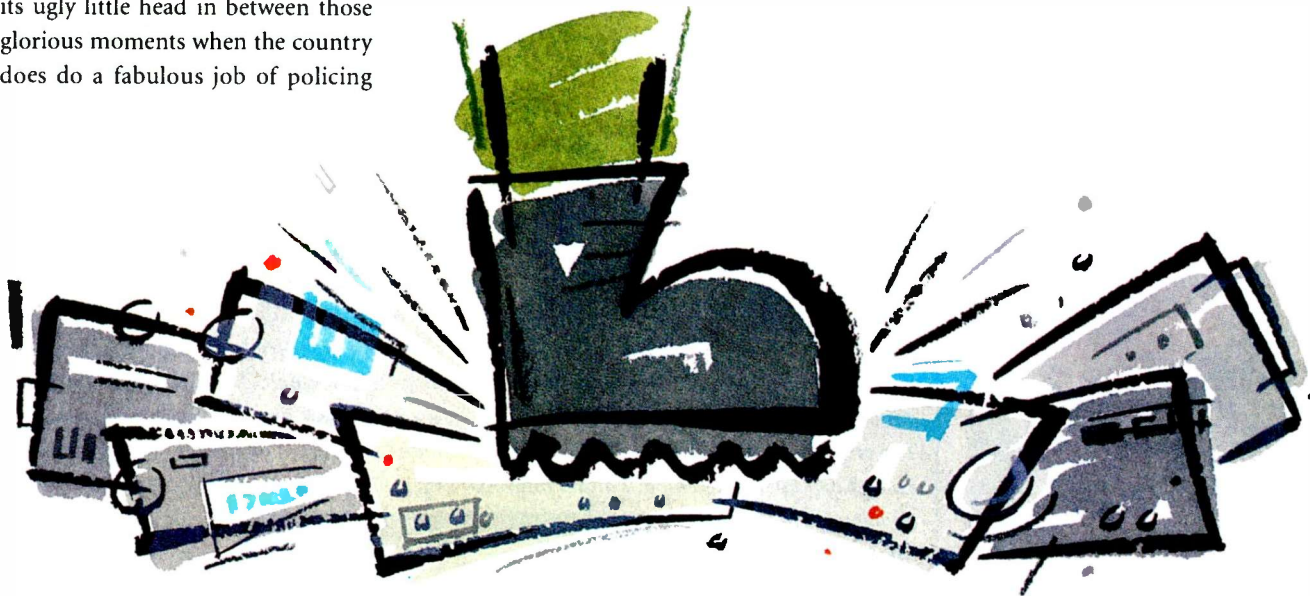


Illustration: ©Nishan Akgulian

the world's trouble spots. (Living in the United Kingdom, I find no greater joy than arguing with Brits who insist that the U.K. could have won the war with Hitler unaided; they're also the ones still furious with '60s TV shows that suggested American soldiers defeated Rommel in North Africa.)

The reason for this preamble is that most Americans usually think about global issues only when they involve military threats and solutions; it's so easy to overlook—or ignore—issues that merely affect the world economy. And in 1999, there is *only* a global economy. Though I am no expert on the details of

CHINA, THE ONE SEEMINGLY HEALTHY, UNTAPPED A/V MARKET, HAS BEEN CLOSED OFF TO THE WEST.

the GATT agreement, I firmly believe in two ultracapitalist tenets: Free, unrestricted trade is a *good thing*, and isolating one's nation/culture from the rest of the global community is a *bad thing*.

American isolationism in economic matters is understandable, regardless of the above tenets, because the U.S. is as close as any country gets to being self-sustaining. But the U.S.-based high-end audio industry, a matter closer to our hearts, is far from able to prosper solely on domestic sales; export to foreign territories is a matter of survival. And while the health of high-end audio is nowhere near as important as, say, peace in Sarajevo or the Middle East, this is *Audio* and not *Newsweek*, so

allow me to present what follows with equal gravity.

A British hi-fi manufacturer sent me a copy of a fax from his Hong Kong distributor. Because of the way the Chinese government deals with criticism, I will not disclose names. The importer, one of Hong Kong's best, deals primarily with American brands and has a reputation without peer. So eloquent is

his report that I believe it should be read in the West. True, it deals only with A/V products, but its implications go beyond hi-fi and video.

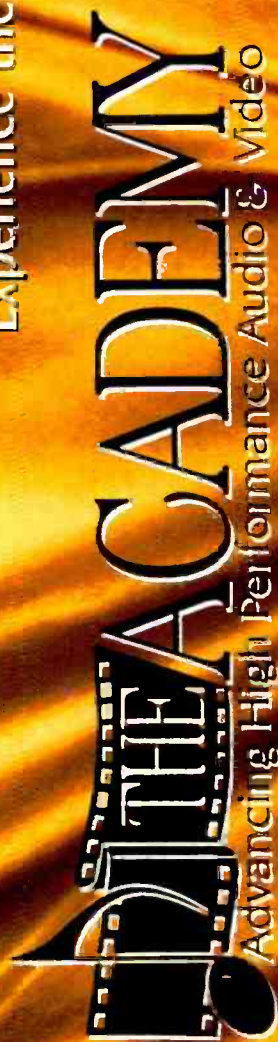
Some will read it and wonder why he's complaining, because—by selling Western goods in China and dealing with unofficial currency exchange—he's breaking the law. But that's the whole point: No importer should have to endure the trade practices common in China. What follows is the complete text, redacted to protect the privacy of individuals:

I returned yesterday from a two-day trip to Guangzhou, China, and wish to file the following market report to keep you posted on the latest developments in China:

It was warm for a November day in Guangzhou yesterday, but the chill of winter could be felt in the electronic shopping arcades in the Guangdong region. As XXX, XXXXX, and I walked into one of them to visit our dealer, we were met by store workers busily packing up and wheeling away all the imported audio and video equipment that was on display on the shop floor.

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As we looked on, store owners who had cleared their shelves began to pull down the roller shutters to close up shop, and in some cases, we saw people pulling down their own company marquees to remove all traces of their having been operating at that location.

Further down the road, the usually bustling sales activity in the small narrow corridors of the crowded arcades has been replaced by bored-looking sales staff sitting around TV sets eating lunch or playing cards.

Gossip spread that tax and customs officers had just raided several shops and arrested some people, along with confiscating their entire inventory. The word of mouth is that this sweep of illegally imported A/V equipment has reached a new level of intensity and will likely persist for the foreseeable future.

A newspaper reports that staff controlled directly from Beijing has replaced the entire customs leadership in the Guangdong region. The result is a total blackout of imports from Hong Kong for the last month and a half. As of today, there is no indication as to when shipments can resume.

Later that afternoon, we drove to a nearby city called Pan Yu. This city is in the suburbs of Guangzhou and had been the key wholesale area for imported audio and video products for the China market. What we saw was something akin to a ghost town; the shopping malls where loudspeakers used to be stacked to the ceiling and blaring away at full volume have been replaced with a ghostly silence, dimmed lights, and shuttered doorways.

Word on the street is that the key city leaders responsible for turning Pan Yu from a sleepy agricultural village to a trading boomtown have been arrested. Pan Yu has been taken over by the Guangzhou city administration, and the freestyle importing and horse-trading of A/V equipment has been eradicated. The fortunes of Pan Yu have an analogy in the mining towns of the American West: Once the supply of gold was exhausted, the thriving activity came to an abrupt halt. And on that particular day, we bore witness to the fall of the Pan Yu gold-rush boomtown.

Besides closing the smuggling loopholes and chasing down imported products at the retail level, the Central Government has tak-

en on the illegal money exchange that has drained Chinese coffers of foreign exchange. We read reports of illegal money dealers being executed, and from our own experience we are now charged a much higher rate to exchange RMB to Hong Kong dollars to reflect the added risk to the money-changers.

All this has darkened considerably the outlook for business in China during the usually busy fall and winter selling season. The situation is totally fluid, but there can be no reason for an optimistic outlook at this juncture.

By closing down the illegal import trade, Beijing is trying to foster a respect for China's import laws and tax codes. The problem we face is that even if we wished to abide by the law and pay the necessary taxes, there is no avenue open to traders in Hong Kong to undertake a legal trade to import A/V equipment into China! This is a typical Catch-22 situation and one that will prove fatal to many companies in Hong Kong that lived off the China trade during the boom years.

All that is left is to hope that China will soon revamp its laws to allow importation of A/V equipment. While we wait, we can only count on selling into the Hong Kong market to sustain our business. Bearing in

mind that Hong Kong is undergoing an economic downturn of historic proportions, this is no easy task!

With the above situation in mind, your sympathy and understanding of our predicament will be greatly appreciated.

Before the more self-righteous among you get all sniffy and start bellowing about how Hong Kong-based A/V vendors are just getting what they deserve because they're breaking the law, let me repeat one statement: "...there is no avenue open to traders in Hong Kong to undertake a legal trade to import A/V equipment into China." This should strike a chord with every one of you who indulges in the current warped fashion for cigar smoking: Hi-fi equipment has become to the Chinese what Cuban cigars are to American tobaccophiles. We're not talking about prostitution, narcotics, arms sales, or even cancer-inducing weeds.

We're talking about hi-fi equipment.

"GOSSIP SPREAD THAT OFFICERS HAD RAIDED SEVERAL SHOPS AND ARRESTED SOME PEOPLE."

In July 1995's "Mondo Audio," I wrote glowingly of a Chinese hi-fi show, of the Pan Yu district, and of the enthusiasm of China's music lovers. I observed that the country was filled with "½ billion possession-hungry citizens, more than adequate cash from who knows where, a lust for Things Western: Levis, mobile phones, Swatches, and, yes, even hi-fi. Drab is out, and China is going to be a market like no

**NO IMPORTER
SHOULD HAVE TO ENDURE
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COMMON IN CHINA.**

other." I went on to say that "The Chinese people, having been isolated from the rest of the world for decades, really did appreciate the effort made by those who visited the show, and the brands involved will benefit directly from the personal appearances by their principal players." But I also found the country to be rife with fakes, undeniably a result of the Chinese government preventing the clean, official importation of genuine articles while turning a blind eye to forgeries made in China. So I asked, "How can these obvious surrogates be marketed so freely? Alas, intellectual property still seems too abstract a concept for many in the Far East."

I had been informed that Pan Yu's 350 shops moved in excess of \$75,000,000 yearly on two streets alone. Apparently, this has now ceased. There are numerous brands, including American makes, that so depended on the Asian market that some weren't even selling equipment at home because they couldn't keep up with demand in Japan, Singapore, Hong Kong, Malaysia, and Korea.

Those markets virtually disappeared last year, and many high-end companies saw sales drop by as much as 40%. And now the one seemingly healthy, untapped market, the territory many looked to as their salvation, has been pretty much closed off to the West. And not for economic but for political reasons.

So here's a hearty welcome to the new, enlightened China. A

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GAIN 2: ELECTRIC BOOGALOO

One of the things I find fascinating about audiophile reissue labels is that they all seem to be shooting at different targets when they go back and remaster old recordings. It's a philosophical question every remastering engineer faces: Should you let the original sound speak for itself, or is it better to change its sound so it appeals to certain tastes? If every label in the reissue game has its own "house sound"—and each one definitely does—it's because each approaches the art of remastering with a different agenda.

There's the "Smoke Gets in Your Cutting Lathe" school, typified by Classic Records' Michael Hobson, which goes for a more-vintage-than-vintage sound by arbitrarily warming up the tonal balance with an equalizer and then running the signal through enough tubes to heat a high school gym. At the other end of the spectrum, Rhino's Bill Inglot loves to jack up the highs; the label's got impeccable taste when it comes to choosing its titles, but Inglot's EQ seems permanently set for stun, the end result being CDs that usually sound better on Fatburger CD jukeboxes than on a typical high-end audio system.

Shooting straight down the middle is the approach I think makes the most sense, the "sonic archeology" of DCC's Steve Hoffman. His stated aim is to recover the sound of the original session so exactly that he confers with the engineers who had been there in the first place. He hunts down all the same

**THE MOST PLEASURABLE
CD REISSUES
ON THE MARKET
ARE COMING FROM DCC
AND MOBILE FIDELITY.**

mastering gear that was used for each particular recording and painstakingly strips away decades of accumulated crud till you can practically hear King Tut scratching himself between takes.

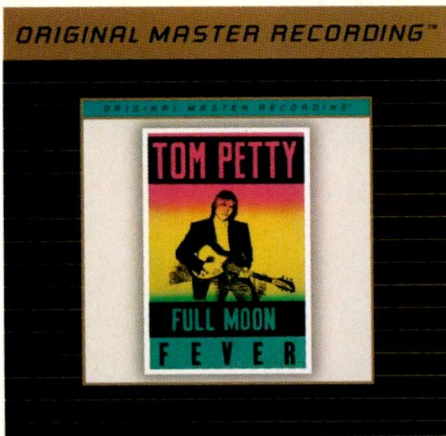


But who's to say what's "right"? The East Coast vinyl rats who shell out 30 bucks a pop for the Classic discs throw 'em on a single-ended triode rig and rasp, "Oh, yeah, dat's da stuff. Jeez, ya know, I remember back in sixty-tree I used to see dese

guys play da Vanguard every Tuesday night. Man, dose were da days. Hey, Benny, pass me dat nail clipper, I wanna shell some pistachios. . . ." Meanwhile, the nonaudiophile civilians who buy Rhino's Otis Redding

reissues marvel at how "crisp" they sound on their boomboxes and car CD players, while obsessive audio creeps like me, who are interested in hearing what Elvis's and Dylan's master tapes really sounded like before the engineers had to dumb them down to fit into a vinyl groove playable by the dime-store changers of the day, sit in front of our modern-day tweaked setups and hear the music much more clearly than they ever did.

There's certainly room for all three approaches, but that doesn't mean anyone's getting rich off them thar gold. The market for audiophile remastered CDs is a small one, and it's been a tough few years for these



small labels. Though companies like DCC and Mobile Fidelity have always had to work just that much harder to sell their gold-plated super-discs, these overachieving guppies now face a world where fewer and fewer hi-fi huts are really moving their merchandise like they used to. That leaves the mainstreet shops like Tower, megastores that certainly move a lot of Madonna and Wu Tang but can't and don't wanna 'splain to their customers why they should drop \$25 on a gold joint when you can skeez the same ya-ya in aluminum for half the price.

In times like these, you find small, high-end audio companies playing it safe, quietly shedding staff, substituting cheap Chinese parts for boutique caps and tubes, and generally paring things down to the nub. So what does Mobile Fidelity founder Herb Belkin do? He pops big money for a whole new CD mastering chain because, "It sounds better, so we've got to have it." And it was reason enough to visit Mobile Fidelity's Sebastopol, California, operation, so I flew in recently for a tour of the facilities and some quality time with both Belkin and mastering engineer Shawn Britton.

Now, Mobile Fidelity hasn't exactly been getting by with a Radio Shack karaoke machine to mint its gold discs. MoFi's original GAIN (Greater Ambient Information Network) System, designed in 1994 by Mike Moffat of MML Labs and Nelson Pass of Pass Labs, brought a startling improvement to the sound of MoFi's CD reissues that was immediately audible to anyone who heard

EVERY LABEL HAS A "HOUSE SOUND," BECAUSE EACH APPROACHES REMASTERING DIFFERENTLY.

the first GAIN-mastered reissue, Muddy Waters' *Folk Singer* (UDCD 593). This state-of-the-art A/D conversion system, using high-precision digital circuitry adapted from military satellite targeting systems, gave MoFi's Britton the ability to transfer every detail of the original analog master tape to the final gold CD, preserving the original recording's sound to a much greater degree than major-label CDs do.

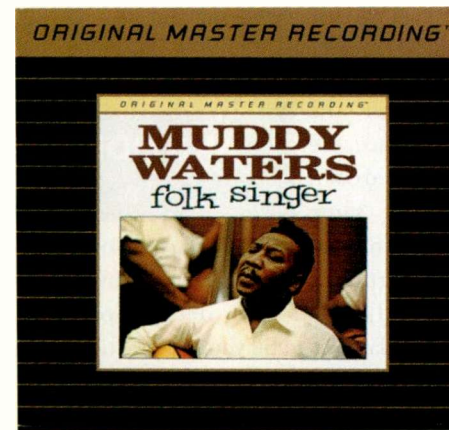
When I heard the Muddy Waters reissue, I said that's it—as far as I was concerned, CD sound could stop right there and I'd never complain again. Whether it was the addition of the GAIN System or just a general refocusing of its operation, MoFi's new CDs towered over its previous efforts, bringing the company back to the forefront of audiophile reissues. But despite the high end's general slowdown, despite MoFi's forced shift from the friendly neighborhood hi-fi huts to the mean streets of Tower Records, despite the fact that everybody was happy as clams with the sound of the GAIN discs, and despite the fact that Belkin recently took a very large and painful bath on a white elephant of an LP cutting facility he bought at the urging of a vinyl-obsessed writer better known for his blind analog zealotry than his grasp of market realities, Belkin feels it's important to MoFi's future to stay one sonic step ahead of its competitors. And if that step costs many thousands of dollars, he says it's a small price to pay for being able to press the best-sounding CDs on the market.

The GAIN 2 system was a collaborative effort between tube circuit designer Tim de Paravicini of E.A.R. and Ed Meitner of Museatex. Given the task of gutting and rebuilding MoFi's Studer A-80 analog mastering deck, de Paravicini went in and built custom electronics, wiring, and even special low-inductance tape heads whose frequency response goes out flat to 60 kHz, ± 2 dB, at a tape speed of 30 inches per second. This particular Studer deck has been modified over the years more times than Cher, but Britton says the current iteration is much more faithful to the original master tape's signal.



Once de Paravicini rebuilt the A-80, he passed the baton to Meitner, who designed a custom A/D converter inserted between the Studer and the Sony DSD (Direct Stream Digital) recording system, which Meitner feels is the most analog-sounding of current pro digital formats. (I'm guessing that when Sony's digital engineers hear stuff like this, they nod their heads politely while their eyes go into the tiniest, most imperceptible roll.) Meitner's A/D converter features an analog input stage made up of Class-A discrete complementary FET cascode buffers, run open loop with no negative feedback. He claims this beefy intermediary stage is necessary to drive the reactive inputs of the delta slope converter, which happens to be a double differential fifth-order modulator. Meitner says the delta slope converter has less of a propensity for emitting idle tones than the more commonly used delta-sigma type. (And if you think I understand a word of this, you're very kind.)

As Britton showed me around the GAIN 2 rig in MoFi's main studio, he shared his philosophy about remastering classic recordings. Unlike DCC's Hoffman, who researches the original sessions and tries to find all the tape machines, mixing boards,



and EQs that were used in the original playback system in order to re-create it, Britton uses the same playback chain for all MoFi remastering projects because he feels it's the most accurate setup in existence in terms of getting the audio signal off the analog master tapes he receives from record labels.

Britton's aim, as he described it to me, is to "make the music sound the way it should." In addition to the master tape, he listens to the original LPs and CDs for a reference point, but ultimately it's his own sense of what sounds right and what does not that guides Britton's remastering decisions. As an example, he played me the regular CD of Tom Petty's *Full Moon Fever* (MCA MCAD-6253) and then MoFi's new GAIN 2 remastered gold CD version (UDCD 735). This is definitely one of the most night-and-day differences between the original and the label's remastered disc: The gold *Fever* had a significantly richer, more natural sound than the regular CD, which sounded cold and constricted by comparison. But how does Britton know what the original sounds in the studio actually were? Maybe the instruments and vocals *did* sound synthetic in the studio—I mean, we *are* talking Tom Petty here. Britton's response was that as a musician, he knows what drums sound like, what an amplified electric bass sounds like, what guitars sound like. And what he's trying to do is make the master tape sound that way, even if it doesn't sound that way out of the box. It's a very different philosophy from Hoffman's at DCC, but as both guys are turning out some of the most monstrously pleasurable CD reissues on the market, I'll leave the debate to rec.audio.nose.pickers while I enjoy each company's discs on their own merits.

The high point of my visit, however, had nothing to do at all with matters of remastering philosophy. To demonstrate GAIN 2's transparency versus MoFi's original GAIN A/D, Britton had set up a three-way switcheroo so I could compare the sound of an original master tape to the sound of it fed through an A/D/A chain comprising first the former GAIN system and then the

**MOBILE FIDELITY
HAS A STUDER DECK
THAT'S BEEN MODIFIED
MORE TIMES THAN CHER.**

new GAIN 2, both converted back to analog audio with a custom-built D/A from Theta.

The master tape? Oh, nothing special—just *John Coltrane and Johnny Hartman!*

In critical listening comparisons, GAIN 2 did sound closer to the sound of the master tape than plain-Jane GAIN. It wasn't a night-and-day difference, but I heard more treble air and detail as well as a more see-through midrange. To my ears, the master tape had the most sparkle on top, followed closely by GAIN 2 and then the original GAIN. I'll also add that, to my great surprise, I heard differences between the direct feed and each of the two different flavors of GAIN. I've sat through careful listening tests where I couldn't reliably tell the difference between an A/D/A and a master tape or a live mike feed, so I was surprised that I could in MoFi's studio.

But really, who cares about A/D converters when you're sitting there in the same room with the original two-track master tapes of *Coltrane and Hartman*, listening to the very source tape itself on a high-end playback rig in an audiophile-approved studio?! I'm here to tell you, it just doesn't get a whole lot better than this. I kept asking Britton to roll the tape back so I could hear it again, and again, and again. "So I can be sure of what I'm hearing," I told him. Man, oh man, you should've heard it. I even rubbed my hand on the tape box, hoping to score some vintage Coltrane fingerprint oil. Definitely one of my all-time audio-geek highs.

By the time you read this, Mobile Fidelity should have its gold GAIN 2 disc of this gorgeous-sounding recording on record store shelves (UDCD 740). If you think you've heard this session, whether on the original vinyl or on the recent Impulse! 20-bit remastered CD, you won't believe your ears when you spin the new MoFi. Even with so many killer jazz reissues coming out of the woodwork lately, Mobile Fidelity's remastered *John Coltrane and Johnny Hartman* stands out from the pack as something truly special. For once, thank God, someone threw megabucks worth of audio overkill at real music. Thanks, Unkie Herb. **A**



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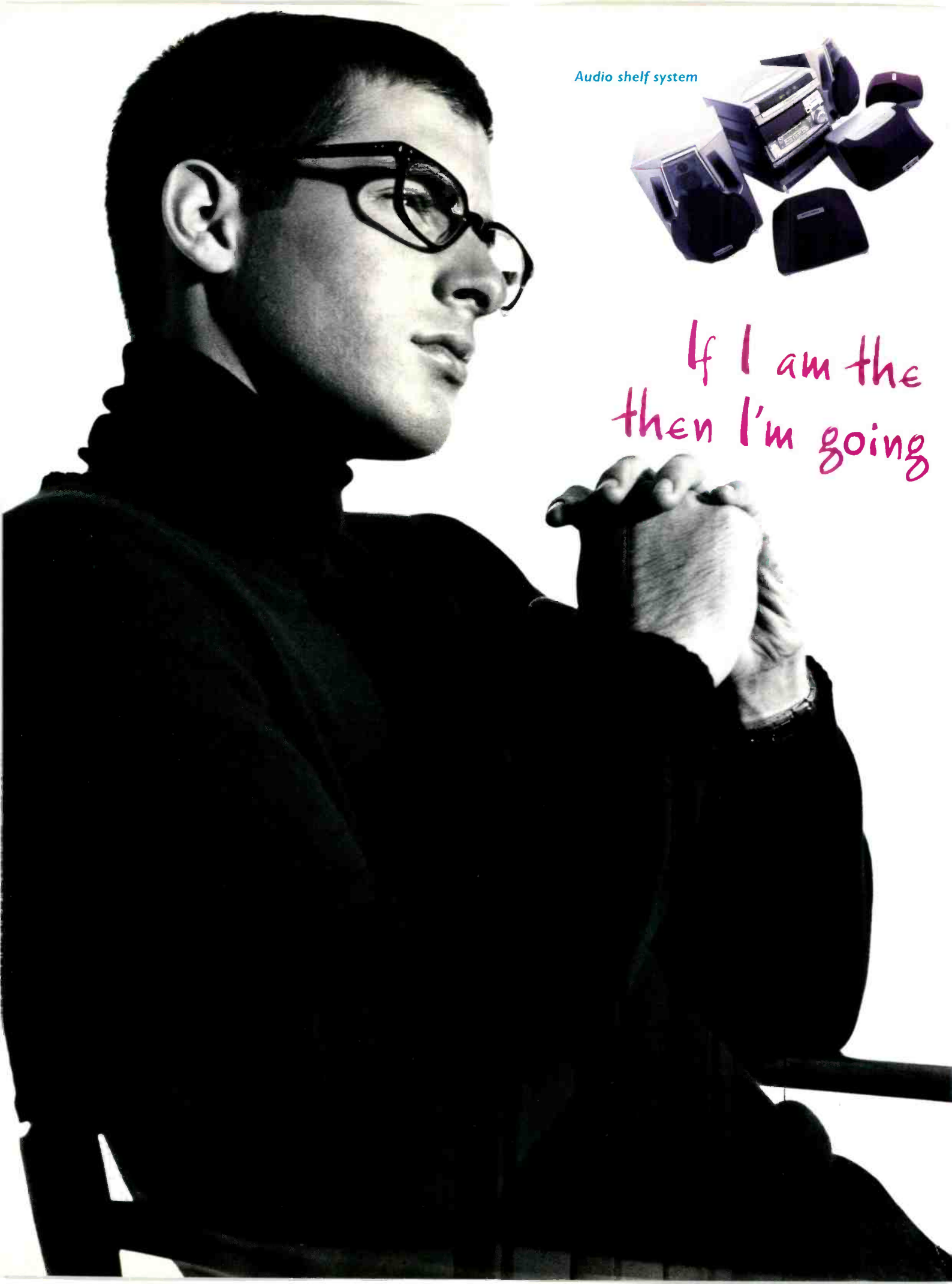
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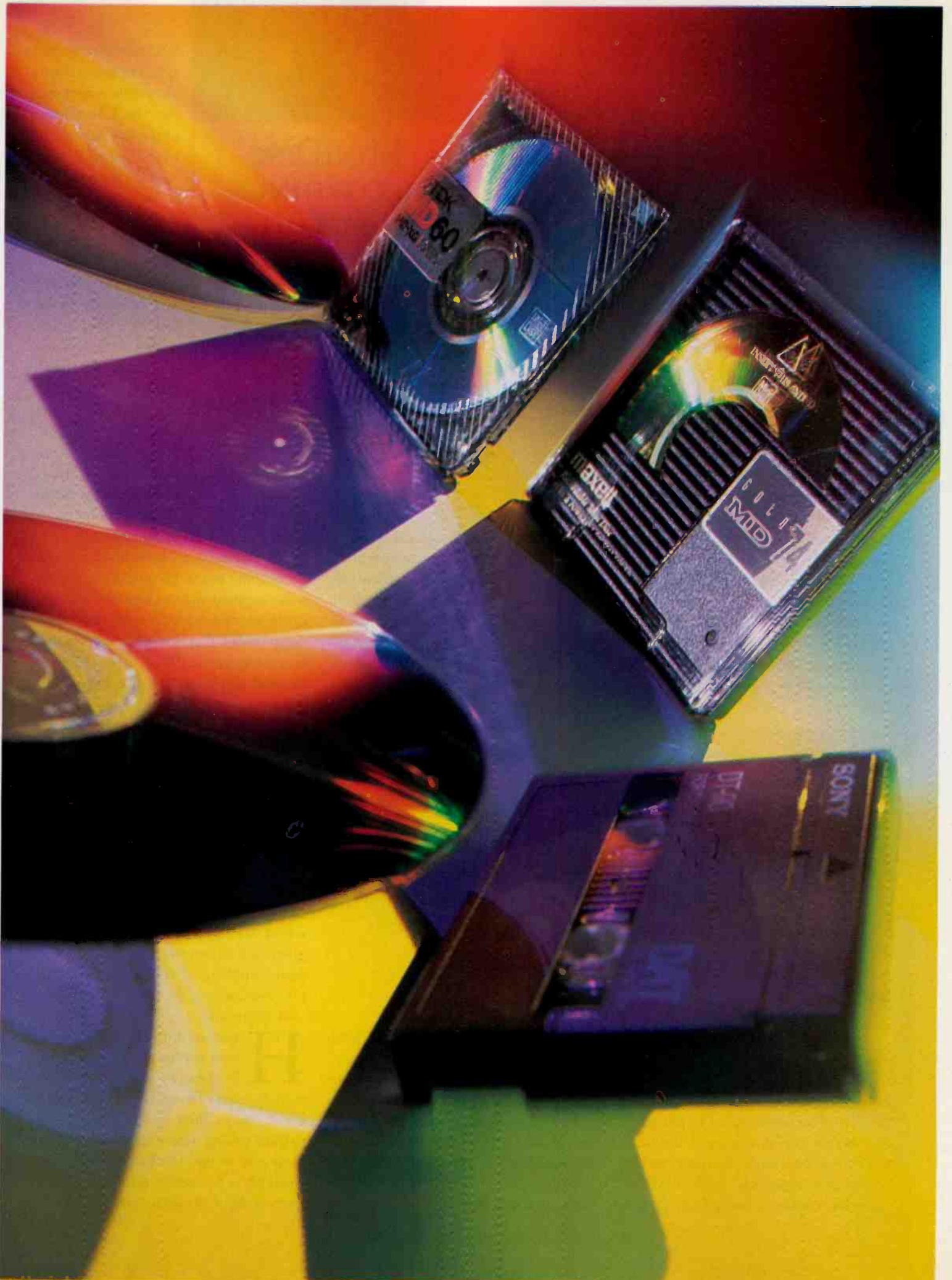
BEFORE BIDDING THE CASSETTE ADIEU, HOWEVER, A TIP OF THE CAP: IT IS NOTHING SHORT OF ASTONISHING JUST HOW ADVANCED CASSETTE MUSIC RECORDING BECAME IN ITS 25-YEAR LIFE. THE MEDIUM INHERENTLY SUFFERS SOME POTENTIALLY CRIPPLING FLAWS, INCLUDING EXCESSIVE BROADBAND NOISE, LIMITED HIGH-FREQUENCY DYNAMIC RANGE, TROUBLE-SOME FLUTTER, A TENDENCY TO AVOID FLAT FREQUENCY RESPONSE, AND SUBSTANTIAL NOISE MODULATION. AND YET, WITH THE APPLICATION OF BAND-AID UPON BAND-AID, THE CASSETTE EVENTUALLY REACHED REMARKABLE COMPETENCE, THANKS TO THE TIRELESS EFFORTS OF DECK MAKERS (MOST NOTABLY ADVENT, NAKAMICHI, TEAC, AND SONY), TAPE FORMULATORS, AND DOLBY LABS.

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by DANIEL KUMIN

H O M E R E C O R D I N G F O R T H E D I G I T A L M I L L E N N I U M

PHOTOGRAPH: ©1998, JOHN WILKES



MINIDISC

Sony introduced its MiniDisc concurrently with Philips's launch of DCC, but it would be unfair to attribute the latter's rapid demise to the former's success. The truth is, consumers worldwide (particularly those in the United States) greeted both formats with more or less deafening silence. In the long run, however, MD's random-access, optical-disc format proved to have the edge. Sony stayed the course, "repositioning" its subcompact magneto-optical system and abandoning its prerecorded MD push in favor of promoting MiniDisc as a recordist-oriented medium, specifically targeting it to cassette users.

A quick MD recap: A MiniDisc is about 2¾ inches square, with a shuttered case housing a 2½-inch disc. The mechanical arrangement resembles a 3½-inch computer disk (another Sony development). Magneto-optical recording exploits laser heat to modify the polarity of a very-high-coercivity magnetic layer; on playback the recorded polarity changes deflect reflected laser light just enough to permit the interpretation of data bits. Recorded MiniDiscs are nearly impervious to everyday magnetic fields, though some anecdotal evidence suggests partial erasure is possible by very strong fields.




A 74-minute audio MiniDisc stores approximately 160 megabytes of data, which reflects its reduction of stereo audio data from CD's 16-bit, pulse-code-modulated (PCM) 1.4 megabits/second to just under 300 kilobits/second, a compression factor just short of 5:1. Sony's proprietary perceptual-coding algorithm, dubbed ATRAC (Adaptive Transform Audio Coding), is in

principle similar to Dolby Digital (AC-3) and MPEG-Audio codecs, though different (particularly from MPEG) in its details. In playback, MiniDisc hardware funnels all data through a large memory buffer, from which it is reconstructed and relocked out as CD-standard 16-bit PCM. Since the disc can thus be read ahead by a comfy margin, MD decks can be made substantially jolt-proof, an attribute that is particularly exploited in the design of

portable MD players. This same margin enables MD players and recorders to use random-access data reading and writing to disc. In other words, data is "burnt," or recorded, onto a MiniDisc noncontiguously, as disc space and multisession recording/editing needs dictate. This means that recordings can be extensively edited, divid-

ed into multiple tracks, rejoined, deleted, and moved about with terrific freedom.

From the start, Sony has carefully avoided characterizing MD sound as "CD-transparent." The ATRAC encoder has been through four generations (all fully compatible with all ATRAC decoders) since the format's debut in early 1993, and each has delivered audible refinement. First-generation



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With its internal sampling-rate converter, the Denon DMD-1000 MiniDisc deck can record from various digital and analog sources.

flag copy-protection scheme that limits digital dubbing to a single generation. (SCMS is also required on consumer DAT and CD-R/RW machines.) Unfortunately, SCMS doesn't care if that first generation is a dub of a copyrighted CD or of your home-recorded bagpipe concert; you still get only one subsequent pure digital copy. What's more, even digitally dubbing MD does not yield bit-replica copies; an MD deck's S/P DIF digital output delivers reconstructed PCM, not raw ATRAC-encoded data. Copying from MD to MD thus involves ATRAC decoding followed by another round of ATRAC encoding. Consequently, the impact of copying more than a few generations (as you can via the analog inputs) is reported to be substantial. Note that many recent MD machines incorporate sampling-rate converters that enable direct digital dubbing of 48-kHz and even 32-kHz sources, even though the MD format is 44.1 kHz only.

Hardware for MD, both component and portable, is currently produced by at least eight major manufacturers (Sony, Denon, JVC, Kenwood, Onkyo, Pioneer, Sharp, and Yamaha), and pricing is quite aggressive. It's relatively easy to find blank discs at prices of about \$5 to \$6 each at retail and a minimum of about \$3 each in bulk.

machines were widely agreed to be less-than-sumptuous-sounding, but the latest top-of-the-line MD hardware, which uses ATRAC version 4.5, is another sonic landscape altogether. Even experienced listeners find the newest flagship MD players and recorders to be very, very close to CD quality on virtually all programs, and audiophiles who dismissed MiniDisc five years ago owe the format another serious listen.

All MD recorders implement the Serial Copy Management System (SCMS), a bit-

Bits may be bits, but where and how they are recorded and played can make a big difference. CD-R and CD-RW technology are living parallel lives: one in the personal computer world and one in consumer electronics. The underlying technologies are identical, but their applications are anything but.

IS BITS BITS?

drive to the office PC. But there's another equally powerful and far less ethical pull: money.

This Pandora's box opens because CD-R and CD-RW blank discs are sold in two versions: as data discs and as audio discs. There are only two important differences, both of

CD-R/RW combo drives, both internal and external, for personal computers are available from Hewlett-Packard, Ricoh, Yamaha, and others. The combo drives cost about \$450; CD-R-only variants come at half, or less than half, the price and from many more sources. Various models capable of writing CD-R/RWs at twice or four-times normal speed and reading any CD-ROM at 4X, 6X, or even 8X are on the street. All are marketed toward those who need to create CD-ROMs for archiving, distributing, or backing up computer data. But, combined with very affordable CD-mastering PC applications (several are available for Windows and Macintosh), any can also be used for CD-R or CD-RW audio recording, free from the SCMS impediment. In practical terms this requires only a reasonably current PC with a gigabyte or so of free hard-disk space. Many CD-R/RW drives for PCs can, in fact, dub audio CDs in real time via "pass-through" from a second CD-ROM drive. Doing so, however, risks wasting an entire CD-R if, for instance, the process is interrupted by any sort of glitch in the data flow, which might be as seemingly innocuous as a screen-saver or calendar-reminder. So most CD burners recommend "premastering" to the hard disk.

The obvious attraction of burning your tunes at your desk instead of in the listening room is the addition of a flexible data

which stem from the Audio Home Recording Act of 1992. First, "audio" discs contain a permanent, pressed-in data header identifying them as such; this must be present for any consumer-model audio CD-R/RW recorder to arm its record mode. Second, audio blanks also carry a royalty tariff, amounting to 3% of their wholesale cost. This is distributed among artists and publishers (based on record sales and airplay), under administration by the Library of Congress, as compensation for losses induced by digital copying.

Quick-thinking readers have doubtless surmised the inverse—that data CD-R/RW recorders can dub audio CDs onto cheaper "data" blanks—and have posed the obvious question: Once finalized, would these recordings (CD-R for now) play on all audio CD players (home, car, and portable)? The answer is yes. But doing so would be a clear violation of copyright and, therefore, just plain illegal.

At this writing, audio CD-R blanks cost from \$6 to \$10 each (depending on the brand, source, and quantity), whereas blank data CD-Rs are routinely available for less than \$3 each in any quantity (or, if bought in bulk with manufacturers' rebate coupons, as little as \$1 per platter or less). CD-RWs, by comparison, cost about \$30 for audio-coded blanks and bottom out at \$13 for blank data discs. I will observe without comment that these price discrepancies are far, far, greater than the difference the 3%-of-wholesale Home Recording Act tariff should be expected to exact. *D.K.*

MINIDISC STRENGTHS

•Low cost: Recorders are available for less than \$300 in both component and portable versions.

•Unmatched ergonomics and random access: Track-access speed matches Compact Disc, with similar options for fast search, random play, and programming.

•Highly editable: With a MiniDisc recorder, you can delete, insert, and join or break tracks, in the process recovering any unused disc space. Start and end points are easily trimmed, and you can reorder

tracks at no penalty in access speed or smoothness.

•Unparalleled portability: A playback buffer gives MD superb jolt-proofing (joggers and sky divers, take note). The combination of digital quality and vest-pocket size have made portable MD recorders a popular choice among the live-concert recording/trading set.

MINIDISC WEAKNESSES

•Uses data reduction: MD's reliance on ATRAC data reduction means that full

transparency is never guaranteed (late-generation models come very close). Data reduction makes generational losses unavoidable, even when you're making digital copies, which in turn makes MD less attractive for serious archiving.

•SCMS copy protection can limit dubbing options, even of originals.

•Blank discs are considerably more expensive than analog cassettes.

Overall, MiniDisc is best suited for dubbing commercial recordings for personal use at home, in portables, and in the car

and for making casual live recordings. It is least suited to pro-quality live recording.

DIGITAL AUDIO TAPE

Digital Audio Tape is the finished evolution, circa 1986, of the rotary-head "R-DAT" concept developed by an 81-firm conference spearheaded by CD creators Sony and Philips. In 1981, even as the CD itself debuted, the format was regarded as a recordable companion to the optical digital disc, but nearly a full decade of legal wrangling over copyright and digital dubbing issues ensued. As a result, DAT was largely relegated to pro audio, where it remains an accepted standard for digital mastering and referencing. Although the DAT medium has not changed substantially since its inception, it has benefited from the advances in digital audio technology engendered by CD's great success.

A DAT machine is essentially a marriage between a VCR and a CD player. Its miniaturized, protected cassette, roughly 2 x 3 inches, encases a videotape-like formulation that is 4 millimeters wide. DAT employs a rotating helical-scan head, identical in principle to a VCR's, to achieve sufficient writing density. On the playback side, a DAT recorder is very similar to a CD player. Though data is necessarily formatted differ-

ting, and analog-to-digital conversion for their input ends, all of which intensely influence ultimate quality.

There are three official DAT modes. "Standard" handles 16-bit PCM, just like CD but with a 48-kHz sampling frequency; all DAT decks include this setting. Next, nearly all DAT decks can be set to record (or play) at the CD-standard 44.1-kHz sampling rate instead, permitting digital dubbing of CDs without requiring sampling-rate conversion. (Pro DAT decks include 44.1 kHz so that studio projects destined for CD can be mastered at the final production sampling rate.) Last, the original DAT specification incorporates an optional, long-play (LP) mode combining 12-bit adaptive PCM (nonlinear coding) with 32-kHz sampling in order to double record time; in this mode,



DAT HAS BEEN RELEGATED TO THE WORLD OF PRO AUDIO, WHERE IT REMAINS AN ACCEPTED STANDARD FOR DIGITAL MASTERING AND REFERENCING.

cam/Teac, and Sony) produce relatively affordable recorders. All of the consumer models include SCMS copy protection (as noted above in the "MiniDisc" section). However, tips on disabling SCMS on a number of DAT models (by simple key sequences or turn-on/key combos) are easily found on the Web, and several semipro models make it easily defeatable.

Blank DAT cassettes have become somewhat more affordable. Available lengths range from 16 to 180 minutes, but pros tend to stick with R-90s or shorter

for important work. Bought right, 90-minute DATs will run less than \$6 per tape; so-called data-grade DATs can be considerably cheaper but are not legal for home recording of copyrighted material; that is, you don't pay the home recording royalty when you buy them (see "Is Bits Bits?").

DAT ADVANTAGES

•Sound: DAT is CD-transparent or better (at the 48-kHz sampling rate). There is no generational loss; DAT recordings can theoretically be duped (SCMS aside) indefinitely without sonic penalty.

•Standardization: DAT is the pro standard, so virtually any studio, broadcaster, or other audio facility will be able to play and record it.

•Live recording: DAT is the standard for most live stereo recording, with archival quality available in a number of portable (and even some pocket) models. A number have perfectly usable internal mike preamps (though serious recordists usually bring external mike preamps). Sony makes an external, battery-operated Super Bit Mapping (SBM) add-on for use with its portables, which can deliver near-20-bit resolution at middle frequencies.



Sony's professional PCM-M1 DAT portable has defeatable SCMS copy protection and records at sampling rates of 48, 44.1, or 32 kHz.

there's a 15-kHz high-frequency limit and a rather modest penalty in dynamic range. A small minority of today's DAT machines offer the LP mode.

Currently, only Sony offers consumer-targeted DAT hardware, with a solid handful of models that includes several nifty, Walkman-sized portables. On the pro side, however, several manufacturers (Fostex, Panasonic, Tas-

ently, DAT's standard-mode digital audio is essentially identical to CD's: 16-bit linear PCM. (At least one manufacturer, Tascam [Teac], now makes a semipro DAT deck able to record 24-bit PCM.) Of course, DAT decks also require record electronics, me-

TALES FROM THE PRO SIDE

Despite its current fascination with retro signal processing gizmos and vacuum-tube microphones, the pro audio world is also increasingly digital. A great deal of production mastering takes place on DAT. True, this work is usually done on professional decks, but aside from their four-digit price tags, confidence heads (an extra set that enables off-the-tape monitoring), and time-code capabilities, not all that much distinguishes these machines from far less costly consumer and semipro models.

Several other pro-oriented digital recording formats are worth noting, however.

Multitrack digital tape recorders have become all but universal, in two basic flavors: Alesis's ADAT format, which uses familiar S-VHS videocassettes, and Tascam's DA-88 family, based on 8-millimeter videotape. Both record eight tracks of 16-bit linear PCM onto affordable, widely available videocassettes, each with CD-standard quality. Of course, eight tracks are six too many for most home recordists interested merely in archiving commercial recordings or in creating casual live-event tapes. But for serious live recordists who routinely use multiple microphones, these machines are a powerful tool, as each feed can be tracked individually for subsequent mixdown, after the heat of the moment. (And if that's not enough, multiple units of either system may be



synched via a simple cable, effectively forming 16-track, 24-track, etc. recorders.) Alesis's second-generation ADAT-XT20 machines even offer 20-bit recording/playback. Equally interesting to leading-edge recordists is Rane's RC24A, a device that permits

up to 24-bit digital audio recording to any ADAT deck, using two tape tracks per channel; on playback it can redither down to 16-bit PCM for digital mastering destined for CD.

The Fostex FD-4 marries an analog mixer to a four-track digital-to-hard-disk recorder. It will perform cut-and-paste editing digitally.

The Fostex DMT8vl is an eight-track hard-disk recorder combined with an eight-track mixer in one console.



An increasingly popular alternative is a stand-alone, multitrack hard-disk recorder, offered in various types and capacities by Akai, Fostex, Roland, and others. Now available for well under \$1,000 and yielding very respectable CD-grade quality, these computer-based disk recorders have a dedicated computer built into a tabletop, mixer-like console. All permit flexible multitracking and overdubbing, with copy-paste editing, and many include (some as an option) DSP mixing, signal routing, and such effects as reverb, delay, and chorus. These machines are intended more for the multitracking musician/producer of rock/pop music than for real-time recording of live music. All record CD-standard, 16-bit linear PCM except for Roland's HD line of multitrackers, which use a proprietary data-reduction system. Of course, in all cases recording time is dictated by free hard-disk space and how many tracks "wide" the recording is; all (save the Rolands) run at about 5 megabytes per track per minute.

Sony, Tascam, and Yamaha now all offer briefcase-sized, four-track "porta-studio"-type multitrack recorders that store data on data-grade MDs, using late-generation ATRAC data reduction. All require more costly blank MD-Data discs (as opposed to ordinary audio MDs) and feature overdub multitracking and mixing. Again, all such models are more appropriate for the project musician/recordist than for live location recording.

D.K.

•Many semipro models permit disabling of SCMS copy protection for original recordings.

DAT DISADVANTAGES

•Compatibility: DAT tapes won't play at your friends' homes (unless they are fellow audio nuts) or on the road (unless you have a DAT portable).

•Convenience: Track access and start/end marking can be laborious and are also far

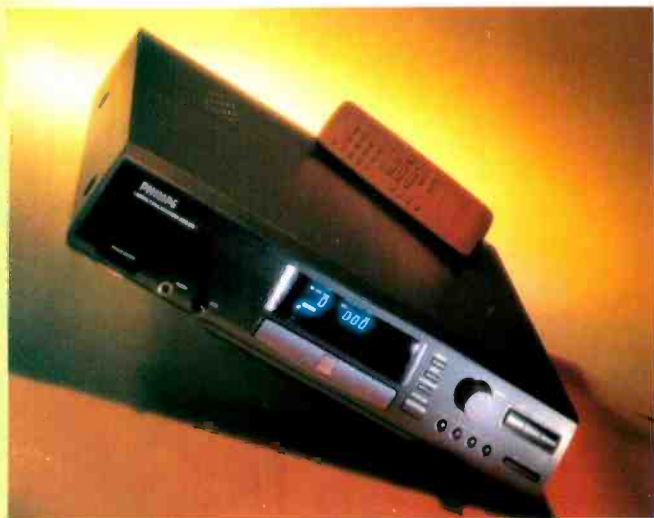
what you wish for: Both write-once CD-R and erasable CD-RW have various quirks and limitations that keep them from suiting everybody.

CD-R was developed in the early 1990s for write-once, read-many (WORM) computer CD-ROMs, as codified by the Orange Book II standards. The technology uses one of two organic dyes in place of a manufactured CD's aluminized layer; a very powerful recording laser permanently burns the

CD-R is, to reiterate, a write-once medium: You can record but not erase. Audio CD-R recording, however, is a two-step process, the first being the actual burning of audio data and the second being finalization, the permanent marking of table of contents (TOC) directory data. Audio can be written in multiple sessions, and recorded tracks can subsequently be "deleted" during any session before finalization, at which point their addresses are simply replaced by a permanent auto-skip code (but you do not recover the disc space of such deletions).

CD-RW—Compact Disc-Rewritable—was initially called CD-E (CD-Erasable). An elaboration of CD-R technology, CD-RW uses an erasable, phase-change material in place of CD-R's unidirectional dye layer. The magic layer comprises a crystalline mix of silver, indium, antimony, and tellurium (Merlin would have been proud) with some very particular behavior. When laser-heated to a predetermined temperature (about 900°), it changes to a less reflective, amorphous structure. Applying a somewhat cooler thermal cycle to the same spot changes the material in that region back to crystalline; another high-temp cycle reverts it to amorphous, and so on.

CD-RW discs can be recorded, erased, and overwritten freely, with essentially no limit (a thousand or more cycles). However, in its CD-audio mode the medium does not permit random access, so in practical terms erasure and rerecording are limited to the last track or to the entire disc. (This is not true, of



Philips's CDR 870 records CD-Rs, which play on ordinary CD players, and rerecordable CD-RWs, which currently play only on CD-RW machines.

slower than on disc-based media such as MD and CD-R/RW.

•Longevity: As a magnetic medium, DAT is subject to accidental erasure by stray magnetic fields or damage from exposure to excess heat. (DAT's high-coercivity tape formula is considerably more robust than analog audio tape, however.) The archival life of DAT tapes is unknown, though its powerful error-correction system augurs well. In DAT's 10 years of existence, there have been some reports of block-error-rate (BLER) increases, but the same thing happens with manufactured audio CDs, too. Under sensible storage conditions in the home, a DAT recording's life span is likely to be somewhere between 25 and 100 years.

•Blank DATs are relatively costly.

•SCMS copy protection can limit dubbing options, even of originals (but see the discussion of pro DATs, above).

Clearly, DAT is great for live recording and least suitable for compilation tapes for car and portable use.

CD-R/CD-RW

Recordable Compact Discs have long seemed the Holy Grail of home recordists. But be careful

dye, inducing a color change that affects reflectivity enough to mimic a pressed CD's pits and lands. CD-R reflectivity characteristics are different from those of manufactured CDs, but CD-Rs retain readability and acceptable error rates on virtually all consumer audio (and CD-ROM) players, with the possible exception of a few very early models. Note, however, that few DVD decks (except dual-pickup machines, available primarily from Sony and Pioneer) can

Pioneer's PDR-555RW will record, play, and erase CD-RWs and record and play CD-Rs.

read CD-Rs because of wavelength incompatibilities. What's more, the documentation accompanying many DVD players warns against playing CD-R/RWs because of unspecified possible damage, but I am unaware of any specific episodes.



course, of CD-RW data drives.) There's another catch: CD-RW discs are significantly less reflective than even CD-Rs and thus are unreadable by virtually all preexisting audio CD players. CD-RWs do play on their native recorders as well as on (projected)

new-generation audio CD and CD-ROM players employing multiread pickups. (These pickups, designed to comply with the Universal Disc Format standard, are intended to ensure interoperability between all future CD-R/RW/DVD-ROM players and drives. So far, only Philips and its associated brands have committed to using multiread pickups in their future consumer audio models.) CD-RWs *do* play on certain, seemingly randomly selected, models of DVD players—but not, paradoxically, the very dual-pickup designs that *can* play CD-Rs! Confusing, ain't it?

Beyond their individual optical-disc specifics and their 16-bit linear PCM, CD-format audio coding, both CD-R and CD-RW recorder/players are functionally identical to DAT recorders. They have the same virtues and liabilities of various A/D, D/A, and analog audio circuits and topologies.

So far, only three manufacturers have offered consumer recordable-CD hardware (and none of them is Tandy, for all you long-memored readers). Pioneer offers a selection of CD-R recorder/players in its regular and Elite lines and at least one CD-R/RW machine. Philips makes several CD-R/RW decks—including a dual-well CD player/CD-R/RW recorder that's tailor-made (and actively marketed) for creating "mix" discs (compilations) from prerecorded CDs; it even has a double-speed dubbing mode. Marantz makes one CD-R/RW deck, the DR700 [reviewed last issue], which is a tweaked-up version of parent Philips's top model. All of the above include the SCMS copy-protection system.

CD-R ASSETS

- Finished recordings are playable on virtually any standard CD player—home, car, or portable.

- All stand-alone audio CD-R recorders also function as conventional CD players with any commercial CDs.

- Longevity: Despite some recent debate, it appears that with reasonable storage precautions, CD-R recordings should outlast similarly archived magnetic media by a significant margin.

CD-R LIABILITIES

- CD-R recordings cannot be edited: Any edits made before finalization reduce CD-R



**BOTH
WRITE-ONCE
CD-R AND
ERASABLE
CD-RW HAVE
QUIRKS AND
LIMITATIONS
THAT KEEP THEM
FROM SUITING
EVERY USER.**



capacity, and once a disc is finalized, none are possible.

- Before finalization, discs are playable only on CD-R decks.

- CD-Rs won't play on most DVD machines, except for dual-pickup models.

- The presence of SCMS copy protection prevents second-generation (digital) dubbing, even of original material.

- Blank discs are still relatively expensive (see "Is Bits Bits?") and are not reusable; hence they're not very ecological.

- Because no CD-R portable recorders are yet on the market, the format is not convenient for live recording. (Additionally, no

current models include internal microphone preamps.)

MORE CD-RW ASSETS

- Blank rewritable discs permit deleting the last track or erasure of a complete disc for rerecording. The discs are reusable.

- CD-RWs may play on some DVD decks and should play on DVD-ROM systems.

MORE CD-RW LIABILITIES

- CD-RWs typically will not play on current CD players, only on forthcoming (from Philips) multiread CD players and on CD/DVD-ROM drives that adhere to the new UDF (Universal Disc Format) pickup requirements. Of course, CD-RWs play on all CD-RW recorders.

- Disc erasure is slow; reformatting (required to rerecord a complete disc) can take as long as 30 minutes.

- Blank CD-RWs are quite expensive.

CD-R/RWs are appropriate for archiving LP and analog tape collections, archiving and backing up DAT recordings, and compiling "mix" discs of CD tracks. They're least suited to live location recording.

If these three formats don't seem like enough options, just wait a few years.

Solid-state recording is already upon us, in the form of Diamond Multimedia's no-moving-parts MP3 (MPEG-1/Layer-3) player. As the cost of silicon memory becomes ever more like an asymptote to zero, higher-performance options are sure to arise. In the meantime, will traditional home recording survive? Copying LPs to cassettes to preserve them or play them in a car is no longer necessary, and dubbing commercial CDs for these applications makes little sense given that affordable CD players are available for every context. And the cost of the blank tapes or discs is often not far off the price of a second original. More serious recordists, however, are finding that our wealth of digital options makes for exciting opportunities. It seems probable that anyone with a serious recording bug will eventually end up with at least one machine of each format: a DAT deck for serious live sessions, a MiniDisc portable for casual use and travel (and business dictation), and—sooner or later—a CD-R recorder to make universally playable copies of original recordings. **A**

BOB CARVER

the boy wonder.

T H E A U D I O
I N T E R V I E W

by Ivan Berger

ARGUABLY THE MOST CREATIVE AUDIO DESIGN ENGINEER OF HIS GENERATION, BOB CARVER IS KNOWN THROUGHOUT THE INDUSTRY FOR HIS PLAYFUL ATTITUDE AND THE FANCIFUL NAMES HE'S GIVEN HIS INVENTIONS. OVER THE YEARS, HE'S BUILT THREE COMPANIES, LOST TWO (WHICH FADED RAPIDLY AFTER HIS DEPARTURE), AND REGAINED ONE, CARVER CORPORATION, JUST WEEKS AFTER THIS INTERVIEW. CARVER CORPORATION'S REMNANTS HAVE NOW BEEN MOVED IN WITH HIS LATEST COMPANY, SUNFIRE, IN SNOHOMISH, WASHINGTON.

TWO COMMON THREADS RUN THROUGH MOST OF BOB'S INNOVATIONS: THE URGE TO DO MORE WITH LESS (AS IN THE SMALL BUT MIGHTY SUNFIRE TRUE SUBWOOFERS AND THE CARVER MAGNETIC FIELD AMP) AND HIS COMPULSION TO DO IT IN THE MOST INTERESTING WAYS POSSIBLE. TWO UNCOMMON COMPANIES NOW OCCUPY HIM, CARVER AND SUNFIRE. HE INTENDS TO MAINTAIN THEM AS SEPARATE BRANDS WITH SEPARATE MARKET POSITIONS. "WE'RE DESIGNING SOME NEAT STUFF FOR CARVER," HE ADDS.

BOB'S WIFE, DIANA, WHO HELPED HIM BUILD CARVER CORPORATION, CHIMED IN FROM TIME TO TIME DURING THIS INTERVIEW. I.B.

Which came first, your interest in electronics or your interest in music?

They were simultaneous. My mother was a pianist, and my father was an engineer. One day, when I was very small, my dad came home and said, "Bob, we're going to see our voices today." And so you saw an oscilloscope.

That must have been it, because I remember being absolutely astonished that we could see a voice. On the way over, I said, "How can we see our voices? That's not possible, Dad." And I re-

member yelling into the microphone to make the wiggles go bigger. I think that was the beginning of it all.

When did you actually start doing electronics?

When I was a Cub Scout, I built a crystal radio. But my first real interest in electronics was for model airplanes, radio control, so I built a system from a magazine. Then, when stereo records came out, I saw an article in a magazine, "How To Build a Stereo Amplifier," and I built one. It didn't work right; I must have built it

Photograph: © Jil Sabella

...all grown up

I had no money, so I used a coffee can as the chassis for my first high-powered amp.

wrong. The instructions weren't very good. So I tried to build my own without a set of instructions, and ultimately I got it to work. From then on, I loved building amplifiers.

How powerful was it?

It probably wasn't even 3 watts, but I thought it was a hundred. I mean, it sounded great. I had a single-ended 6AQ5 output stage. Today, a single-ended 6AQ5 stage goes for about \$15,000. Back then, it could be built for less than \$2.

But my first products were all solid-state. When I finally built a commercial tube amp, at Carver—the Silver Seven—I did it as a work of love.

Tube amps are fun to watch. Didn't you once put a tube behind a little window for that reason?

That's my Sunfire tube preamp. It has three tubes behind a little window. But the three tubes didn't look good enough, so I put a mirror behind them so it looks like six. Then I put mirrors on the sides. From a certain angle, it looks like an infinite number of tubes.

And I'll bet it looks great in the dark.

Well, it didn't quite, because the tube filaments didn't light up enough. I put little incandescent light bulbs behind each tube and

Back then, McIntosh had a guy named Davie O'Brien who went around the country running "Amplifier



SONIC HOLOGRAPHY, INTRODUCED IN THE CARVER C-4000 PREAMP, WAS CARVER'S MOST LUCRATIVE INVENTION.

Clinics" at hi-fi stores. They'd advertise it in the papers, and everybody would take in their amplifiers. It was exciting to go to a Mac Clinic and watch the amplifiers be tested. Dealer events were big things. Once, I got all dressed up in my suit and took my date.

D.C.: The quintessential nerd "I-love-you." Wonderful!

B.C.: Anyway, I took my amplifier to the Mac Clinic. I knew exactly what it would do, but I needed the credibility that the McIntosh Clinic would give me. Amplifier after amplifier would go through there, and Davie O'Brien and the rep would make a graph and give it back to the owner. The graph always looked terrible; it had tons of distortion at the low end and tons at the high end. But McIntosh amplifiers always were ruler-flat, and their distortion stayed pretty much at the bottom of the graph. The Clinic was a very impressive thing for McIntosh to do. It showed that you got what you paid for. If you could afford McIntosh, you would get low distortion over the whole band at full rated power; you couldn't do that with anybody else's amp.

What people took to the McIntosh Clinic in those days was mostly tube amplifiers. Someone would plunk his amp down to be tested and say, "30 watts." Or he'd pick up one, struggle, strain, and grunt, "60 watts per channel." Those were big amps. I took my coffee can amp and went, *boop-de-do*. Remember, it had no transformer, no output transformer—just transistors mounted around the coffee can. With one hand, I put it down and said, "700 watts." It was a Frankenbox, with wires everywhere.

They ran it up, and Davie asked, "How much?" And I repeated, "700 watts." It went 200 watts, 300 watts, 350, 400, and everybody is really quiet in the room now, looking at the 'scope and listening to Davie calling out the numbers: 200, 250, 300, 350, 400. . . "Where does it clip?" he asked me. Before I could answer, the whole building went dark; my amp blew the fuses.



THE PHASE LINEAR 700 AMP WAS BOB CARVER'S FIRST COMMERCIAL PRODUCT.

ran them at a low voltage so they'd have a warm glow. Now, in the dark, it looks like there are a lot of tubes, a beautiful glow.

You once built an amplifier in a coffee can?

That circuit was the basis of my very first commercial amplifier, the Phase Linear 700. But when I was designing it, I didn't have any money so I used a coffee can as a chassis. Since I couldn't afford a power transformer, I built it line-connected, which made it immensely powerful and very light in weight. It put out so much power it was silly, and I managed to get it to the point where it didn't blow up.

By and by, they got the lights back on and finished the test, though we dropped the power back to 350 watts to keep the room lit. I said to myself, "I don't know if it's going to make 350 at 20 kHz; it might not here." So I blurted out, "I want it tested at 300 watts per channel." And they gave me this beautiful curve, just flat response down at the bottom. And Davie O'Brien, his face was sort of going white.

As soon as I got my graph, I knew I had something very valuable. I intended to reprint it and use it in a brochure, with the McIntosh Clinic's credibility behind me. Nobody believed that

my amp would really do it. I reprinted that graph, spending every dime I had making copies of it. Then I went to a banker and told him I needed money to start up a company. He said, "Okay. I'm a high-roller; I'll lend you \$5,000. You're going to buy parts with this stuff, right?" I said, "Yes." But I lied. As soon as I got the money, I went out and bought advertising. We took out a very small ad in *Audio*. It announced that I had these new-generation amplifiers, 700 watts rms, and told readers they should write us for more information. A lot of letters came in.

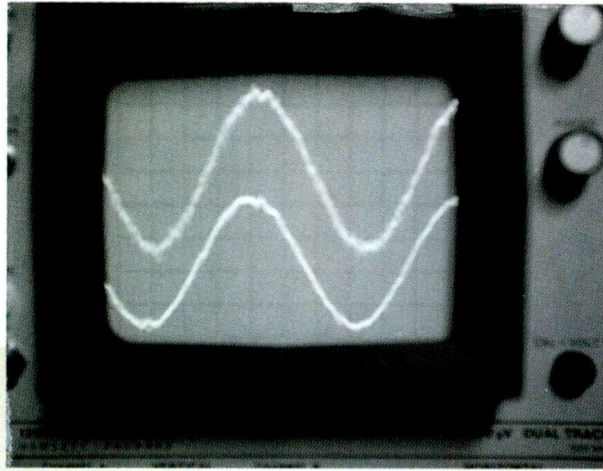
Was yours the most powerful amp on the market then?

There wasn't anything even close. The biggest solid-state amp was the Crown DC-300, at 150 a side, and mine clipped at 450, if you recall. I was chicken to rate it at 450, so I rated it at 350. McIntosh had a 350-watt mono *tube* amplifier, the MCT-3500, but it was a monster. It was half the size of a refrigerator and had who-knows-how-many output tubes in it, a big bank of them.

It was partially because of the McIntosh's 350 watts that I chose 350 watts and partially because I had done some research to find out how much power was needed to play music the way I wanted to listen to it. I had four University 315C coaxial three-way loudspeakers in a huge box. They were moderately efficient—like 86 or 87 dB, which is not all that efficient by today's standards. I remember watching an oscilloscope while I played music and deciding that I needed 52 volts of output swing to not clip the amp. That was pretty loud, but it wasn't crazy loud. It turns out that 52 volts into 8 ohms is about 350 watts rms, so there was a serendipitous convergence there.

How many amps did you sell from your ad?

It got me started. When I sent out the brochures, I included a copy of the Mac Clinic graph with each brochure—that gave it the credibility I needed. I still didn't have any money, so when dealers wrote in, I said, "You have to buy two of them to be a dealer, and you have to pay for one in advance." The money for one would buy enough parts to build about two, two-and-a-half amplifiers. I'd send the dealer one amp, back-order the other, and send the second amp to somebody else who had sent me money. So I bootstrapped it; as soon as I got some more money, I'd finish the dealer's order.



AUDIO'S TESTS SHOWED THAT THE AUTOCORRELATOR DID CLEAN UP NOISY SIGNALS.

And then that *Audio* ad got reps' attention—which is when I learned about reps, or factory representatives. Some local dealers came over and told me about how the industry worked.

I picked the name Phase Linear for my company because it sounded familiar to everybody even though it didn't exist. Everybody said, "Oh, yeah, I've heard that name," when, in fact, they hadn't.

Where did Phase Linear go from that first amp?

A smaller amp, 200 watts per channel instead of 350, and then a preamp, a speaker, and a tuner to round out the line.

Did any of those products have anything special about them?

Yes. When I was little, one of the things I loved was show and tell at school, because when I took something, everybody would sit around and watch. I couldn't act, I couldn't play a piano, but eventually I could design amplifiers. So I said to myself, if I come out with something, it has to be really very special. I would rather die than come out with a me-too product. I wanted my products to have some real meaning.

CARVER'S AMAZING LOUDSPEAKER HAD A RIBBON DRIVER THAT WENT DOWN TO 100 HZ.

When I designed the Phase Linear preamplifier, I felt the biggest unsolved problems were noise and dynamic range. So I developed a noise-reduction system, the Autocorrelator. It was a single-ended noise reducer that cut noise about 10 dB. And I developed a dynamic range enhancer, which I called the Peak Unlimiter and Downward Expander. The Autocorrelator was unique. The Peak Unlimiter and Downward Expander wasn't unique, but it didn't pump or swish the way all other dynamic range enhancement circuits do.



THE LIGHT BUT POWERFUL
MAGNETIC FIELD AMP MADE
CARVER FAMOUS.



How did you accomplish that?

Most dynamic range enhancers would try for 10 or 20 dB of compression or expansion; no matter how artfully that's done, you'll hear it working. But if it's a small change of just a few dB, done artfully, you won't. The artful part was building mine to affect only the top and bottom of the dynamic range. If the Peak Unlimiter added, say, 2 dB of boost at the top of the dynamic range, the Downward Expander cut the bottom by 4 dB, and I had a great, big, do-nothing middle band between, I'd get 6 dB more dynamic range without pumping.

How did the Autocorrelator work?

It reduced noise and hiss, record hiss. It was a four-band voltage-controlled gating system that looked at the signal coming along in each band to see whether it was highly correlated, like the ringing of a tuning fork, or more noiselike—the sibilants in speech, for instance. The gate's threshold would vary with the signal correlation in each band.

When you're creating something, do you say, "I see a problem, let me come up with a solution," do you just tinker until something hits you, or do you say, "Hey, that's a great idea. How can I use it?"

It's "there's a problem here," and I say, "I know there is a way around it. I know how this can be solved." For example, the intractable problem of surface noise on vinyl records. Double-ended solutions—encode/decode—were well known. They were really no big deal.

Like Dolby noise reduction, dbx noise reduction, and the CBS CX system for LPs.



LEN FELDMAN, WHO REVIEWED MANY OF BOB CARVER'S PRODUCTS FOR THIS MAGAZINE, WITH THE INVENTOR IN THE EARLY '80S.

Right, but doing it single-endedly, where you take a signal that hasn't been specially encoded and somehow figure out which components are noise and which are signal, and then toss out the noise without tossing the signal out—that was a trick.

Why did you finally leave Phase Linear?

As time went on, I sold some of the stock in the company to some investment bankers, and they wanted a return on their money. Fair enough. One day they came to me with visions of sugarplums dancing in their heads and told me that it

was time to make a public stock offering. I replied, "We're not quite ready. I'm not ready to sell out yet." (In my mind, that's what "going public" meant—somehow selling out and losing

I chose the name Phase Linear because it sounded familiar, even if you hadn't heard it before.

your soul. It's not true, of course, but that's what I believed back then.) The bankers kept persisting, but I refused.

One day, I bopped into the board meeting, and I knew something *very* special was up: There were all these guys with suits who I had never seen before, and there was a tape recorder in the middle of the table. Before I knew it, somebody said, "We make this motion. All in favor, say aye. . . . We make another motion. All in favor, say aye." I was going, "What? What? What?" And after about three or four motions, I was out. They bought me out, and that gave me enough money to start Carver.

How long after that did you start Carver?

About a year.

You made up names for two of your companies, Phase Linear and Sunfire, so why did it take a contest to come up with the name Carver Corporation?

I had read a book by the advertising genius David Ogilvy, who said, "Never name your company after yourself." (He has since rescinded that.) So I thought that I needed a good name and ran a contest. A lot of readers from *Stereo Review* and *Audio* wrote in, and 75% of them said that I should name it Carver.

If 75% suggested the same thing, how did you pick a winner?

D.C.: We had a lottery. A guy named Tony something (Redfern?) in Arizona won an amplifier and a free trip—a trip to the factory, not someplace like Paris; we didn't have enough money.

The products that people think of you for are the Carver products, and not just because your name was on them. At Phase Linear, you made your name with a humongous amp, but then other people made humongous amps. And the Downward Expander and the Autocorrelator didn't make that big a splash. Then, at Carver Corporation, you came up with a whole bunch of ideas, like Sonic Holography and the Magnetic Field Amplifier. Was that amp's name legitimately descriptive or just a name you hung on it?

Mostly it was a name I hung on it. My names always hark back to something scientific that you can grab onto, but mostly they're names that I just pull out of the air.

How did the Mag Amp work?

Any audio designer worth his salt is searching for a Holy Grail. That Holy Grail in amplifier design is an amp that is very efficient, so it doesn't get hot and can be very small yet have immense power output. To do that requires a tracking power supply, which can give the designer that all-but-impossible achievement of high—almost infinite—output, zero heat, utter reliability, and minuscule size. Because if the power supply tracks the audio, there can be little or no voltage drop across the output transistors; it's that voltage drop and simultaneous current that make the transistors get hot, because power is volts times amperes. If the voltage is low and current is high, there is still no heat and the efficiency is high. All amplifier

designers at one time or another have tried to make a tracking power supply; I was no exception.

Tom Holman and I sat in a coffee shop years ago talking about tracking power supplies. We both went home to try and make one, and we both failed miserably. At one CES, Tom showed an amplifier with a tracking power supply. It was very low-powered but always blew up. I was at home trying to make mine. I spent almost a year working on it, and I was often almost in tears. It was always, *poof!* I'd get it to work for 10 minutes and then *zzzip, poof!* it would blow up for no apparent



THE PHASE LINEAR 4000 PREAMP UNLEASHED THE AUTOCORRELATOR, PEAK UNLIMITER, AND DOWNWARD EXPANDER.

reason. After a year of this, both Tom and I threw in the towel. And I built the Mag Amp.

The Mag Amp has a tracking power supply of sorts, but its tracking is a stepwise approximation, a 12-step approximation to a sine wave. There were three positive and three negative power supplies, and the sine wave would step through the different power-supply rail voltages—12 steps, if it cycled up and down through all of them. The amplifier would switch rails as the signal amplitude went up and down.

It was crude and wasn't that efficient. The Mag Amp got hot and couldn't drive super-low-impedance loads. It had its flaws, but it was okay. And it was efficient enough to shrink the size and didn't have to have heat sinks. It couldn't drive 1.5 ohms, but it could drive 3 ohms or so successfully. That was what really put Carver Corporation on the map.

I think the Mag Amp was one of the things that got the high end to look kind of askance at you. The name was funny, and it was not a high-current design, which, if memory serves, was already a buzzword back then.

The figure of merit for an amplifier changes over time. For a while,

I would rather die than come out with a me-too product.

it was high slew rate. Before that, it was high damping factor. Then it became high current. It's as if the concept of limits doesn't exist. How much current do you need? If you need 10 amperes, is 100 amperes better? Of course not.

As I understand it, the art of engineering is largely a matter of setting proper limits—saying, “Okay, I want more, but there’s a certain point beyond which I don’t.”

That is the art of engineering. When I look around me at the audio landscape, I see immensely talented men and women spending an immense amount of intellectual time, effort, and energy searching for something that is a sort of silliness. If they spent the same amount of energy designing something that was real, we would advance audio much faster.

I remember back when distortion of 1% and 5% was fairly common, and 0.1% was a big deal. But then we got lower and lower distortion specs, largely the result of more and more feedback. The high end turned around and said, “Wait a minute. We’re using all this feedback to get this meaningless improvement, and feedback is not a good thing.”

I was so proud of the high-end guys who said that; that was great. Exactly. The concept of limits applies. What's the lower limit that's audible? To find out, you have to do some research. You have to at least listen.

Getting back to the beginnings at Carver Corporation, your first two products were the Sonic Holography preamp and the Magnetic Field Amplifier. What did Sonic Holography do?

With a two-channel system, when you play a stereo program you hear a flat curtain of sound strung between two speakers. It's neither particularly convincing nor real-sounding. So I wanted to present sound waves to our ear/brain system in a way that would fool us into believing we were in the presence of a real live sound source, like an orchestra. I was trying to add depth and width and a palpable three-dimensionality.

The reason stereo turns out to be, at best, a flat curtain of sound between two speakers is that, in real life, we hear two arrivals for each single sonic event, one at each ear. When we listen to stereo, however, we hear four arrivals for each sonic event, one per speaker per ear. That's confusing. The time relationship between the two signals in real life, between the single sound's arrivals at

each ear, is one of the things that tells us how far away its source is; it also tells us whether it's coming from the right or the left and gives us the sense of three-dimensionality. That's why we have two ears. If your ears are about 8 inches apart, the interaural delay is approximately three-quarters of a millisecond—or about 700 microseconds.

The Sonic Holography circuit made a cancellation signal, so that the sound the right ear heard from the left speaker was canceled by an inverted sound, 700 microseconds later, from the right speaker. So there were two arrivals per sonic event, which is what we're used to. And when you cancel the two extra arrivals, the soundstage—rather than being a flat curtain of sound—becomes something that has width and depth and even height.

I hear depth, even without Sonic Holography. Where's it coming from?

Depth arises because, by sheer chance in the recording process, there are out-of-phase signal components that cancel many of the signal components flowing into our ears from the speakers, reducing much of the signal to two arrivals instead of four. To the extent

that those components cancel by chance, we get a palpable, believable image and soundstage. We hear depth when we hear two dominant arrivals during the interaural delay; the more and louder the other arrivals, the less depth we hear.

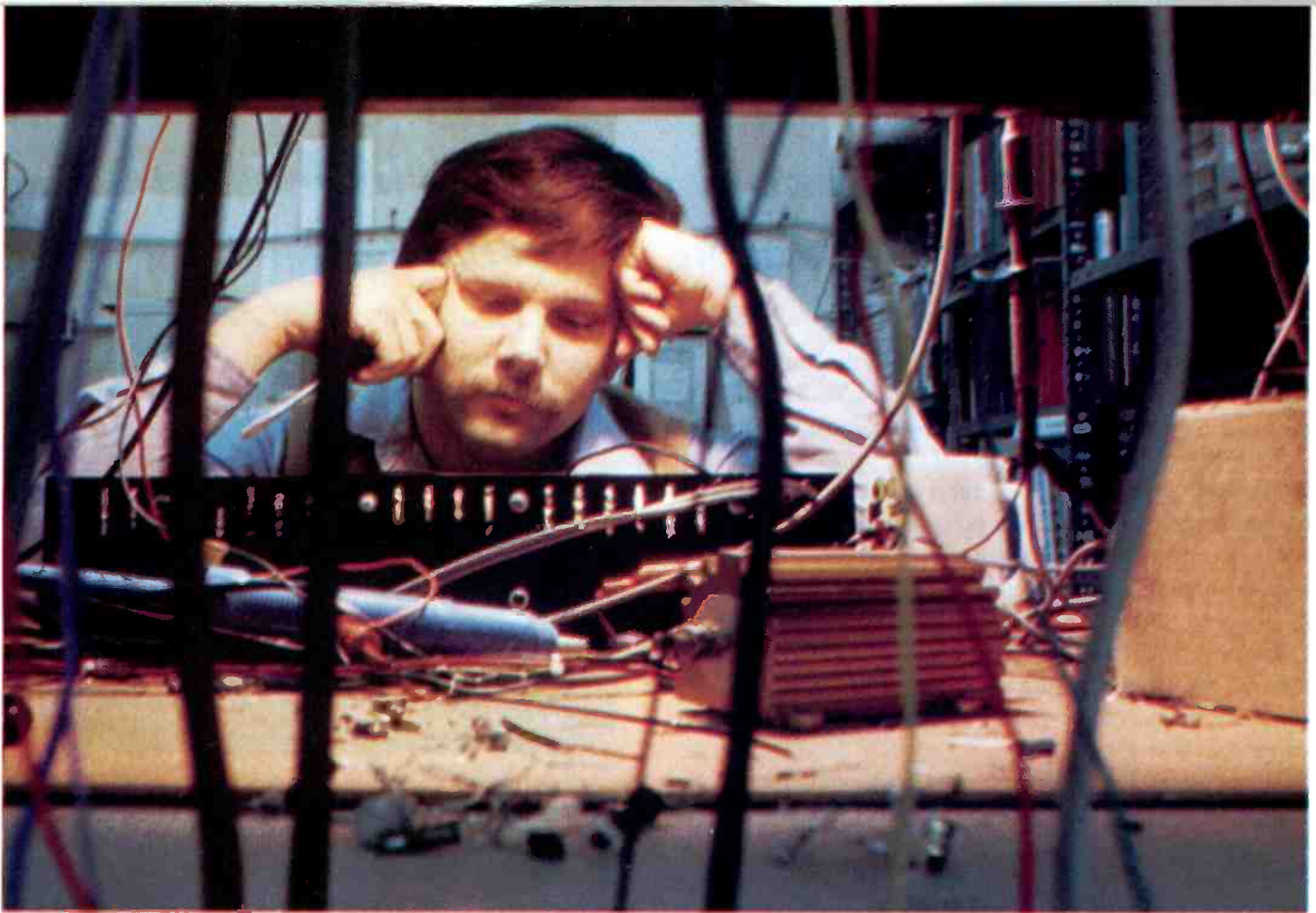
The speakers are important, too, because a speaker can launch more than one sound wave for every electrical sound impulse put into it. For example, a speaker may have hard, diffracting edges. Or it may have multiple drivers that are not arrayed vertically, and their arrivals overlap; they make their own different arrival times. Speakers like that pretty much make a flat curtain of sound. If a speaker has good imaging qualities, it's because attention has been paid to the wave launch and the wave-launch geometry of the sound source.

The best depth I've had in my house has been with electrostatic speakers.

Panel speakers do give a great sense of depth. They're pretty coherent, so they really don't make a lot of wave launches. And they send a sound wave backward, which bounces off the wall behind the speakers and then returns. Sound travels 1 foot per millisecond, so if the speakers are 3 feet away from the wall, that's a 6-millisecond delay. That delay, in



**AT THE CARVER PLANT,
BOB SHOWS OFF ONE OF
HIS TUNERS.**



and of itself, makes a significant contribution to ambience. Simply because the signal is delayed, it helps create the illusion of a big soundstage.

With the Carver C-4000 preamp, I got tired of using Sonic Holography after a while. It was this great new toy when I first got it, so why do you think I used it less and less?

I don't know. It might be that your tastes changed. It might be that the speakers you were using really did make too many launches. Remember, Sonic Holography cancels two unwanted signals by generating two others that cancel. But suppose they don't cancel? Then you've made more. You start with four signals, your two canceling signals don't cancel, and suddenly you have six or eight. That would probably make your ear/brain work very, very hard to make sense of the sound field.

For Sonic Holography to work right, you had to be exactly on the acoustic center line between the speakers. If you were half an inch off, you'd begin to dilute the effect, because the cancellation signals would no longer cancel. They would mostly cancel, but they would add as well, making more arrivals. If you didn't have the speakers just so, and the room just so, and your position just so, Sonic Holography would probably make the situation worse. These factors were far more critical in the early Sonic Holography than the later version. I worked on it a lot to make it so that if you moved around in your seat, the images would stay locked. That took some doing. With the early version, you really had to stay right dead on the center line for it to work.

Of all my inventions, Sonic Holography was the one that brought in the most money. I'd thought it would be the Magnetic Field Amplifier, the little cube, because I sold more units. But I was wrong.

What was "amazing" about the Amazing Loudspeaker you did at Carver?

First of all, it was the world's first wide-area, full-range ribbon. At that time, the lowest any ribbon loudspeakers went was 800 Hz. This one went down to 100. It went from 100 Hz all the way up to 20 kHz, with no crossover. So it was smooth and seamless. And in the voice region, that's a nice thing to have.

How did you accomplish that?

By making it wide-area. I had two thin metallic ribbons going down between the magnets, but they were glued to a big, wide sheet of Kapton. The glue was Pliobond, a model airplane cement, which is compliant. At low frequencies, the ribbon would move the whole piece of Kapton back and forth. That piece had greater area than a 12-inch driver; it was about 5 inches wide and 5 feet long.

Did it have the excursion of a 12-inch driver?

No. It had, I would say, almost an eighth-inch excursion. But because it had a lot of area, it could play loudly.

And a speaker doesn't need to move so much air if it goes down only to 100 Hz.

Right. At high frequencies, the Pliobond would decouple the ribbon from the Kapton, so the Kapton wouldn't move. Having only the ribbon element move reduced the mass, so it would act like a very-high-frequency driver.

It couldn't decouple very much.

Think of a tweeter. Along the diaphragm's edge is what seems to be a very inflexible coupling. If you push the diaphragm, it doesn't move very much. But a tweeter doesn't have to move much.

Anyway, it worked: I was able to get a lot of SPL out at 100 Hz—from a ribbon. That was the first thing that was new and unusual about it.

The concept of limits applies; you have to know what's audible and what isn't.

The second was that I was able, for the first time, to get a lot of high-SPL, low-frequency bass out of a *panel* speaker. The drivers in the Amazing Loudspeaker, a mix of ribbons and 12-inch cones, were mounted in dipole fashion, so that they radiated out the front and the back of the panel. Now, a panel speaker, with no box containing its back wave, will at some point start rolling off the bass; at low frequencies, when the wavelengths get big enough, the waves from the back will come around and cancel the waves from the front. As you go down in frequency from the point where this begins, the bass rolls off at 6 dB per octave. The bigger the panel, the lower the rolloff begins. With a panel whose dimensions are, say, 2 x 5 feet (a common size for panel speakers), the bass will normally start to roll off at 100 Hz.

So panel speakers were known for not having much bass. To improve it, I made the Amazing's woofer magnets very, very tiny and the cones very, very light (just the opposite of my Sunfire subwoofers today). Because the magnets were very tiny, the speaker was underdamped, creating a peak in the response—a giant peak, at about 28 or 30 Hz. The cones operated only below 100 Hz, so their response would rise at about 6 dB per octave below 100 Hz until it reached that peak and then go down. But the panel is an acoustic short circuit, so it rolls off response at 6 dB per octave below 100 Hz. The sum of this underdamped woofer response and the panel's

with the audio business. Audio companies are sort of weird, because we're all weird, us guys in audio. We sit around until the wee hours of the morning listening to music. We engineer at night. One of the board members said, "Bob, the fact that you can't get your



IT TOOK CARVER 20 YEARS TO MAKE THE IDEA BEHIND THIS SUNFIRE AMP WORK.

job done in eight hours means you're not good. You can't do your job properly."

But it's in the evening when nobody is around to hand you all this business-related stuff that you can do research.

I didn't want to do the business part; I wanted to do research. I wanted to sit at my lab bench and invent. So, not wanting to take full responsibility for the company, I handed it over to people who weren't in audio. And when they tried to do what seemed to me crazy things, I would object. So they voted me out.

What the board of directors didn't understand was how much our industry is based on positioning—all industries are. When you think of Black & Decker, you think power tools, and you'd no more buy Black & Decker milk than a Borden power drill. But the directors wanted to grow the company indefinitely. They wanted it to enter different fields and be everything to everybody—simultaneously to be what Carver is, to be super-high-end, and to sell \$29 and \$39 radios to every garage and Costco. Our industry won't put up with that. When our dealers objected because that didn't go with our position, the board of directors had the CEO tell them, "If you don't buy all the Carver stuff, we're not going to let you sell any of it. We're going to cut you off." And the dealers went bananas! So Carver lost its position and lost its way.

Did you start Sunfire as soon as you left Carver?

When I was kicked out of Carver, Diana and I decided to travel and to smell the flowers along the way, to be the most loving couple we could be. We decided to share life every day, all day long, together. And to hell with business.

How long did that last?

B.C.: Not long. It was wonderful. But we decided, you know, we had to be in there. And then one day, Diana evicted me from the living room.



THERE'S MORE TO THE SUNFIRE CLASSIC VACUUM TUBE PREAMP'S PRETTY GLOW THAN MEETS THE EYE.

rolloff was flat system response down to about 30 Hz. That had never been done before.

Carver was publicly financed?

After the Phase Linear experience, I decided not to have any partners, so we financed it ourselves. Then, in 1985, we did decide to go public. That seemed to be a good idea except, again, the control left me and it was a repeat. It's my karma; I do it to myself.

Why were you kicked out of Carver? It couldn't have been for refusing to go public.

I did a very dumb thing. I chose directors who had nothing to do

D.C.: He was working on some kind of system that had woofers and a big-screen television, and he had six or seven pair of Amazing Loudspeakers in various stages of tweaking in the dining room, the other parlor, and the hall.

B.C.: I had them all in the living room! The rest of the house was beautiful! I didn't let it leak out of the living room!

D.C.: And then he would work all night. And I never heard a finished piece of music. He would never listen to *music*; he would listen to *parts* of music. It was "musicus interruptus," passage after passage. He would listen to a few pieces that had certain kinds of energy content over and over again, trying it this way and that way to get it right. And then he would do sweeps—*whooeep*, *whooeeeeep*. And he played one movie so loud. . .

B.C.: *Total Recall*.

D.C.: . . . and there was so much vibration, the ceiling came down because the plumbing broke. Water landed in the piano. And the ceiling was plaster, real plaster!

My solution was a place where he could work on his projects, just outside the door. I even had an architect in mind. And then Bob started Sunfire.

What's the difference between the Sunfire and Carver Lightstar amps?

They're exactly the same. I had just finished designing the Lightstar when I left Carver. And I took that design over to Sunfire.

The reason I could do that goes back to the time, 20 years earlier, when Tom Holman and I first tried to make tracking power supplies and both of us gave up. I came back to it during the Lightstar days, and I got it to work this time—I got it to work in spades! It had everything that a tracking power supply should have. It had immense efficiency. It didn't get hot. It didn't need heat sinks. It could drive 1 ohm. It was an ideal amplifier. And it was really my old patent that I went back to and got to work the second time around.

How did you make it work?

Oh, it was so simple! It was just a dumb oversight 20 years ago. It was not because of devices or technology; it was because we didn't think of controlling transition speed. We made the amp switch very fast to maximize efficiency, but when it switched very fast, it created an electromagnetic pulse that radiated from the wires right to the switching transistors and the control circuitry. And the control circuitry would go bananas. Two transistors would turn on simultaneously, creating a short from B+ to ground, and both would blow up. This wouldn't happen all the time; the amp would be running for a while and then, for no reason we could detect, it would blow up.

Why did this happen only some of the time?

To this day, I don't know. It was one of those things that was just on the hairy edge, but it would make the control circuitry hiccup. Whenever the control circuitry would hiccup, both transistors would turn on. And since it's a straight path from B+ to ground and both transistors are on, poof city. When I finally, by intuition, realized that, I slowed the transition down.

The pulse of a signal is equal to $\frac{d_i}{d_t}$; that is, it's proportional to the rate of change of the current flowing through the wires. A straight-up pulse's $\frac{d_i}{d_t}$ is almost infinite; I bend the pulse ever so slightly, and $\frac{d_i}{d_t}$ drops by orders of magnitude. Once I turned the pulse into a slope, the control circuitry was happy and the amp

stopped blowing up. It was so simple, yet it took me 20 years to figure it out!

And it's still 12-step?

No. That's the beauty of the Tracking Downconverter. It's infinite steps, smoothly varying.

What's in the future?

By the time this interview hits print, I'll have shown my Cinema Ribbon speakers at CES. They're an extrapolation of the high-pressure, high back-EMF driver system I use in my Sunfire True Subwoofers. High-pressure, because it's all in a little box and the drivers are still moving violently, so the pressures are high. And the combination of high back-EMF and high pressure yields high performance from a relatively small box. I've just moved that idea up into the midrange and high frequencies.

It's a ribbon driver, in a little box that's only about 6 inches tall, 3 inches wide, and 4 inches deep. But it can play as loud as a much bigger speaker with two 8-inch drivers and a tweeter. It can play 105 dB SPL from 100 Hz up—actually, from 85 Hz up. So it can play really loud.

It's also the first fly-by-wire speaker on the market. I call it "fly-by-wire," because it's all electronically controlled, like a modern jet. Every speaker has to have some kind of excursion limiter—usually, the spider—to keep it from bottoming out with a loud clang. But mechanical excursion limiters throw away a lot of performance; they're crude, limiting maximum SPL and keeping the speaker from achieving minimum distortion. That's a terrible compromise to make. A better way is to throw away the spider and have the limiting done by a sensitive electronic circuit.

With a normal speaker, especially a little one, if you turn the volume up too much, it starts to sound harsh because it's being overloaded. So you back off until it sounds clean, throwing away 10 dB of useful SPL just so the peaks don't overload the speaker. But if you have the drivers under electronic control, rather than mechanical control by spiders and all sorts of nonlinear stuff, you can conform the electronic protection circuitry to the speaker's mechanical dynamics like a beautifully fitted glove. And you can get 10 dB more out of it.

In the Cinema Ribbon, electronics control the damping, the excursion, the dynamics, the details of the frequency response, and the spectral response.

What's that little amp on the desk? It's about the size of a pack of cigarettes!

I can't really talk about it much yet. It's a 300-watt subwoofer amp for cars. It goes up only to 200 Hz; then it's got to cross over.

That sounds like Class D.

Class D wouldn't be this small. I'll be showing it at CES along with a car subwoofer, a high-pressure sub. The combination will be small and high-powered, and it will have lots of bass. But unlike the Sunfire True Subwoofers' amp, which runs directly off 120 volts, this one works off 12 volts. I won't tell you how it works, but it's cool!

In nearly 30 years, you've gone from a coffee-can amp to a cigarette-pack model. Care to sum it all up?

To be successful in this industry, you have to have a passion, a real passion for it and a lot of common sense. And some creativity. That helps.

A

Critical Acclaim



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—Steven Stone, *Stereophile Guide to Home Theater*, December 1998



"We reviewed lots of great pre-pros this year—ADA's Cinema Reference, Proceed's AVP, and Lexicon's DC-1 come immediately to mind—but the \$2,995 TheaterMaster Encore provides a unique combination of outstanding ergonomics, outstanding sound, and a dirt-cheap price. Plus, it is just about the coolest-looking thing we've ever reviewed."

—Brent Butterworth, *Home Theater*, December 1998



"This is one terrific sounding processor! I don't think I have ever heard better sound in my home theater: marvelous detail, superb imaging, wide-range, and quiet—the EAD Ovation is fantastic! . . . In test after test, the Encore proved excellent, the Ovation superb."

—Edward J. Foster, *Audio*, November 1998



"The performance astounded me . . . I found stereo music reproduction even cleaner and more refined than with one of my recent favorites, the Proceed AVP . . . The sound in both DTS and Dolby Digital was exquisite: I honestly didn't want to turn the thing off." [Encore]

—Jeff Cherun, *Home Theater*, December 1998

"Reviewing this unit was sheer listening pleasure. The TheaterMaster exhibited such a smooth and natural response without a hint of harshness anywhere in the spectrum. I could play everything as loud as I pleased. It never was fatiguing. Sonic performance just doesn't get much better than this . . . If a state-of-the art processor is in your immediate future, the TheaterMaster [Ovation] belongs on your short, short list."

—Kim Wilson, *Audio Revolution*, www.audiorevolution.com, December 1998

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D. B. KEELE, JR.

B&W NAUTILUS 802 SPEAKER

The English speaker manufacturer B&W has the unusual distinction of enjoying high regard in both the audiophile and professional sound communities—something many companies aspire to but very few achieve. B&W's professional reputation is based on wide use of its products as studio monitoring speakers for classical music recording. The accuracy of these speakers, their smooth response, excellent imaging, even coverage, and reliability suit home users as well as pros, however.

The largest and most expensive system in B&W's previous line, the 801 Matrix Series 3, was also the most highly revered (I reviewed the Series 2 for the November 1990 issue of *Audio*). Several of this magazine's reviewers (including me) use the 801 Series 3 as a reference loudspeaker.

The Nautilus 800 Series, which had been brewing for more than five years, is a major update of B&W's 800 line. The new line is based on technology developed in the design of the company's avant-garde Nautilus loudspeaker in the mid-1990s (not quite reasonably priced, at \$40,000 per pair!). The Nautilus, whose appearance resembles that of an extremely large spiral conch or snail shell with three rearward-pointing, racy-looking tapered structures on its top, is B&W's attempt at making the world's most accurate loudspeaker.

The new 800 Series consists of seven models, designed for both stereo and home



Rated Frequency Response: 39 Hz to 20 kHz, ± 2 dB; -3 dB at 34 Hz and 22 kHz, -6 dB at 27 Hz and 30 kHz.

Rated Sensitivity: 91 dB at 1 meter, 2.83 V rms applied.

Rated Impedance: 8 ohms, nominal; 3 ohms, minimum.

Recommended Amplifier Power: 50 to 500 watts.

Dimensions: 43.5 in. H x 15.2 in. W x 21.6 in. D (110.6 cm x 38.5 cm x 54.8 cm).

Weight: 154 lbs. (70 kg) each.

Price: \$8,000 per pair; available in black ash, natural cherry, and red-stained cherry real-wood veneers.

Company Address: 54 Concord St., North Reading, Mass. 01864-2699; 978/664-2870; www.bwsspeakers.com.

theater use, ranging in price from \$11,000 per pair for the Nautilus 801 down to \$1,000 each for the Nautilus HTM2 center-channel speaker. The new systems are deliberately designed to appeal to both professional and home users. Whereas the original 800 Series speakers were primarily pro systems and had a typically no-nonsense, utilitarian look, the styling and industrial design of the new Nautilus 800 models are top-notch by any standard. Technically, a primary goal of the new series was greater dynamic capability: higher sensitivity, more headroom, and the ability to

play louder than the equivalent models in the preceding line.

The Nautilus 802 is one step down from the top, at \$8,000 per pair (about twice the price of the 802 Series 3 it replaces). The Nautilus 801 and 802 are both three-way designs and use exactly the same midrange and tweeter assembly. The squat, imposing Nautilus 801 is superficially similar to earlier 801 models but has a 15-inch woofer in place of the 12-inch driver used previously. The Nautilus 802 also maintains the basic traditions of its model designation, with a columnar woofer enclosure that is sig-

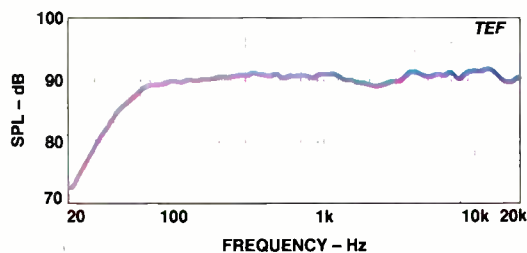


Fig. 1—One-meter, on-axis frequency response.

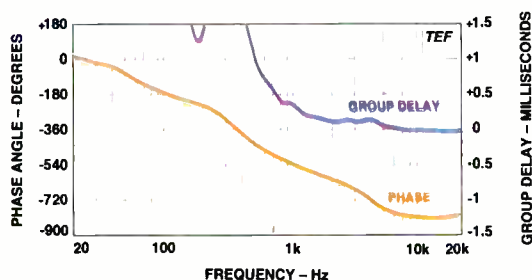


Fig. 2—On-axis phase response and group delay.

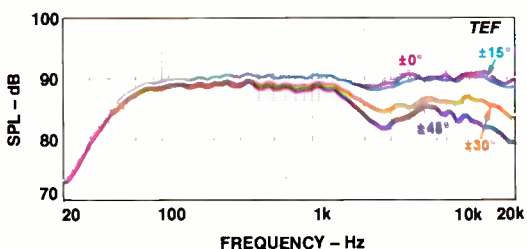


Fig. 3—Horizontal off-axis frequency responses.

nificantly narrower and shallower than the 801's. And in place of the 801's single large woofer is a vertical array of two 8-inch drivers. B&W says the crossovers are at 350 Hz between the woofers and midrange and at 4 kHz between midrange and tweeter.

Despite the similarities to earlier 802s, the Nautilus 802 has a very distinctive look that stems from its Nautilus pedigree. Some of the differences are not obvious, however. For example, the bottom portion of the cabinet, which forms the enclosure for the dual woofers, appears to be fairly conventional. Yet its curved sides and back and its massive internal matrix stiffening are anything but ordinary. The curved panels reduce diffraction and are inherently stiffer than flat panels of the same thickness. The 802's long-throw woofers have die-cast aluminum chassis and rigid cones made of a Kevlar and paper pulp composite. The dustcap is formed of carbon fiber.

The woofers face forward in the usual way, but the enclosure has a somewhat unconventional port on its bottom that radiates through tapered slots on three sides of the cabinet. The port itself is strongly flared both inside and out and has dimples on its surface, which is said to smooth airflow and reduce bass chuffing sounds.

The base of the cabinet is a heavy-duty cast-aluminum assembly that stabilizes the enclosure and houses the crossover. On its bottom are four ball-bearing roller glides that assist in maneuvering the system (handy, given that the speaker weighs a very heavy 154 pounds). Spikes, for use when you've determined the 802's final operating location, are also provided. These are not the usual pointed, headless bolts but 1¾-inch diameter x 1½-inch high cones composed of machined-aluminum, flanged bases with removable, stainless-steel points. Each spike assembly attaches to the bottom of the base with four bolts.

The Nautilus 802's most strikingly distinctive feature is its midrange/tweeter assembly. The 6-inch midrange driver is housed in a shiny, very rigid, sphere-shaped enclosure with a tapered tail that extends to the rear. The tweeter is housed in its own tapered assembly, attached to the top of the midrange enclosure.

The midrange driver, which B&W calls a Fixed Suspension Transducer (F.S.T.), has a woven Kevlar diaphragm with a "surroundless" suspension and a die-cast aluminum basket. Eliminating the traditional surround is said to remove the single major cause of midrange anomalies, "the surround resonance," in which the surround vibrates opposite to the cone, causing peaks and dips in the frequency response. The midrange's surround is actually a ⅛-inch-thick ring of foam that is said to optimally match the traveling-wave impedance of bending waves in the cone and thus minimize reflections from the cone's outside edge. The resultant driver has less excursion capability than one with a normal surround,

but B&W says that the driver's operating range makes greater excursion unnecessary. The diaphragm has no dustcap, instead vibrating around a central, stationary, bullet-shaped cone that is said to improve off-axis response.

B&W calls the midrange enclosure's long tail a reverse horn. It, together with the housing's shape, is said to greatly reduce internal reflections and to provide a smooth, diffraction-free outside surface that improves off-axis response. The enclosure is made of a synthetic resin material called Marlan and is filled with wadding.

The 1-inch aluminum-dome tweeter has a small, high-efficiency, neodymium-iron-boron magnet and an edge-wound, copper-coated aluminum ribbon voice coil cooled with magnetic fluid. The rear of the diaphragm faces through its backplate to a long, wadding-filled, tapered aluminum tube that is said to completely absorb the driver's back energy and also to act as a heat sink. The tweeter and tube are housed in a hard, cylindrical, die-cast shell that minimizes diffraction. The tweeter assembly attaches to a shaped depression in the top of the midrange enclosure.

The tweeter and midrange assemblies are acoustically decoupled both from each other and from the bass enclosure. This vibration isolation minimizes cabinet resonances and driver interactions. The vibration isolation is accomplished with gaskets made of a

**THE NEW NAUTILUS 800
SERIES IS A MAJOR
UPDATE OF B&W'S
HIGHLY RESPECTED
800 LINE.**

special gel-based, thermoplastic rubber material called IsoPath.

The Nautilus 802's crossover is on three separate printed-circuit boards, which is said to reduce electromagnetic interactions between the filters. Very-high-quality parts are used throughout, including heat-sunk thin-film resistors, polypropylene capacitor bypasses for the electrolytics, and all air-core inductors.

The woofers are driven through a third-order (18-dB/octave) low-pass filter, the

midrange driver through a second-order (12-dB/octave) high-pass in cascade with a first-order (6-dB/octave) low-pass filter, with a resistor-capacitor impedance compensation circuit in parallel. The tweeter is fed by a third-order high-pass filter.

Connections to the Nautilus 802 are through bi-wirable terminal posts (five-way WBTs) on the bottom rear of the speaker. The posts are made of gold-plated brass and accept banana plugs, spade lugs, bare wires, and WBT's side-entry copper pins. B&W supplies short jumper cables to enable single wiring.

Separate grilles cover the woofers, midrange, and tweeter. The system can be operated without the woofer and midrange grilles, but B&W suggests leaving the tweeter

**EVERY DETAIL
OF THE NAUTILUS 802'S
CONSTRUCTION
AND CABINETY
IS ABSOLUTELY THE BEST.**

grille on to protect the tweeter's diaphragm. B&W supplies a decorative midrange cone for use when its grille is removed.

Measurements

The Nautilus 802's on-axis anechoic frequency response is shown in Fig. 1 with the woofer grille off and the midrange grille on. Removal or replacement of these grilles made essentially no difference in the response, so no curves are shown for the alternative conditions. I made no tests with the tweeter grille off, in deference to the manufacturer's recommendation. Measurements were taken 2 meters away from the front of the cabinet, at a point halfway between the midrange and tweeter. I made ground-plane measurements below 250 Hz and used a large anechoic chamber for higher frequencies.

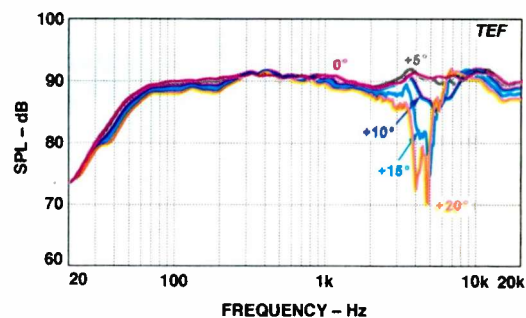
The curve in Fig. 1 is very flat overall and fits a very tight, 2.6-dB, window from 62 Hz to 20 kHz. The response irregularities above 1 kHz are only very minor, with a slight depression at 2.2 kHz and slight peaks at 3.8 and 12 kHz. Relative to the level at 100 Hz, bass response is down 3 dB at 50 Hz, 6 dB at 39 Hz, and 9 dB at 32 Hz.

Above 20 kHz (not shown), there was a sharp, high-Q response peak of about 10 dB at 24.7 kHz. (This corresponds to the first resonance of the tweeter's dome.) At higher frequencies, the response fell rapidly, passing through -3 dB at 30 kHz.

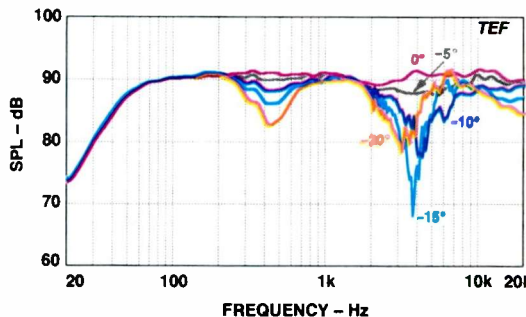
I measured the individual responses of the speaker's low- and upper-frequency outputs via its bi-wire connections. The individual driver responses rolled off at 18 dB/octave above and below the 350-Hz crossover. With both sections reconnected and in reverse polarity, the response did not exhibit much change as compared to the correct polarity connection—only a slight depression of about 2 dB at crossover. This indicates that the driver's acoustic outputs are neither in phase nor completely out of phase but are closer to 90° out of phase through the crossover region, a condition that maximizes lobing error. Ideally, the driver's acoustic outputs should be solidly in phase when connected normally and out of phase when connected in reverse (resulting in a deep null at crossover), to ensure that the speaker's directional lobe faces straight ahead through the crossover frequency range.

Figure 2 reveals no surprises in the phase and group-delay responses. The Nautilus 802 is not time-corrected, but the midrange's acoustic output lags the tweeter's by only about 0.15 millisecond (as judged by the average group delay between 1.5 and 4.5 kHz). The phase, referenced to the tweeter's arrival time, exhibits no irregularities and is typical of most other direct-radiator systems. The waveform phase (not shown) indicated that waveshapes would not be preserved in any frequency range of operation, which is typical of loudspeakers not designed specifically to maintain them.

Figures 3 and 4 show the Nautilus 802's off-axis horizontal and vertical frequency responses. You might be wondering where my usual "3D" off-axis curves are. Because

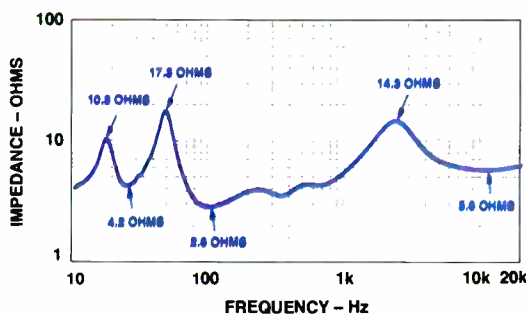


A

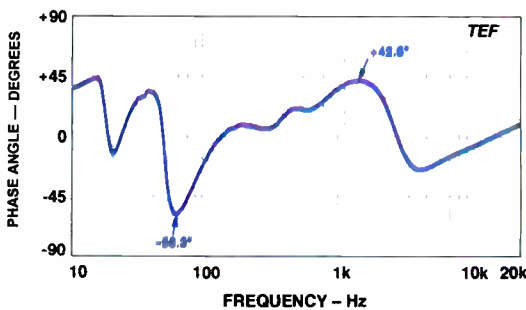


B

Fig. 4—Vertical off-axis responses, above axis (A) and below axis (B).



A



B

Fig. 5—Impedance magnitude (A) and phase (B).

of the Nautilus 802's irregular shape and its heaviness, I was not able to run my usual vertical off-axis curves, which would have required rotating the speaker around its head. The limited vertical off-axis curves presented here were taken by physically raising and lowering the microphone rather

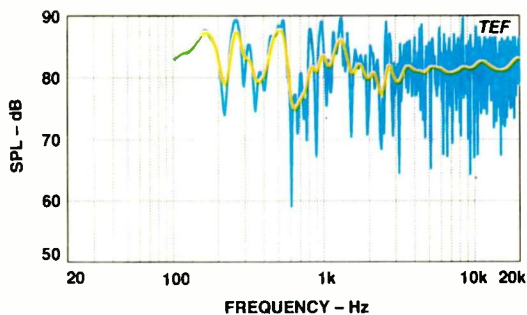


Fig. 6—Three-meter room response.

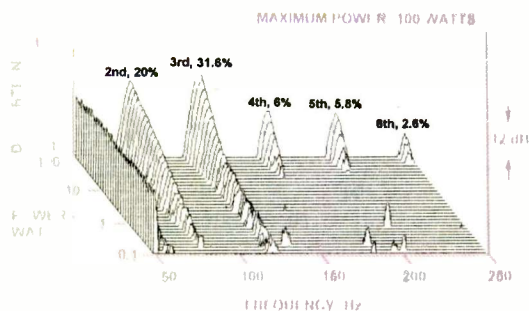


Fig. 7—Harmonic distortion for E_1 (41.2 Hz).

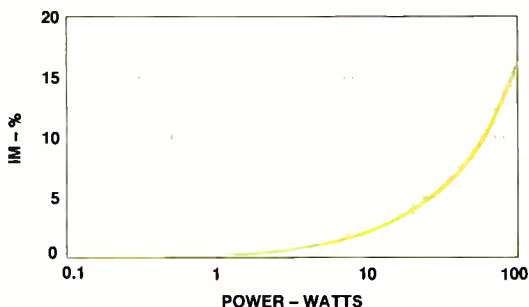


Fig. 8—IM distortion for A_1 (440 Hz) and E_1 (41.2 Hz).

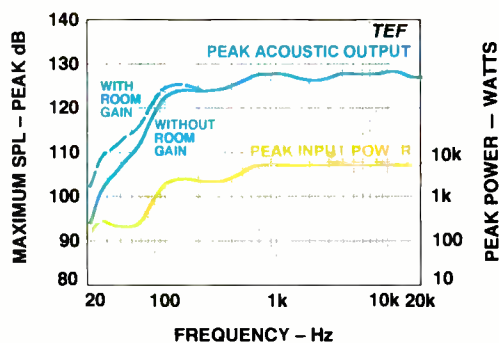


Fig. 9—Maximum peak input power and sound output.

than moving the speaker. I chose to present the horizontal off-axis curves in the same manner.

The horizontal off-axis responses, in 15° intervals from 0° to 45° , are shown in Fig. 3. In the main ($\pm 15^\circ$) listening window, the response is very uniform, essentially the same as the on-axis response. Farther off axis, output starts dropping above 1 kHz, with a sharper reduction between 2 and 4 kHz and a rolloff above 10 kHz.

Figures 4A and 4B show the vertical off-axis curves in increments of 5° from 0° to 20° . The above-axis curves on the forward axis are shown in Fig. 4A, the below-axis curves in Fig. 4B. The curves in Fig. 4A reveal major irregularities in the midrange-to-tweeter crossover region between 2 and 7 kHz. Although the 5° curve is quite similar to the on-axis response, the response gets progressively more irregular as the angle increases. Similar effects can be seen in the below-axis curves (Fig. 4B), although in this direction even the 5° response is significantly different from the on-axis response. Here, however, the maximum deviation occurs at 15° off axis, with the response improving at 20° down. For the most part, the above- and below-axis curves are quite symmetrical through the upper crossover range, which indicates minimal lobing error.

Response from 300 to 600 Hz, in the region of the crossover between woofers and midrange, is a somewhat different story. There is a dip in the below-axis curves that becomes deeper as the angle decreases. Because this dip is not much evident in the above-axis curves, strong lobing error is indicated. Fortunately, the response in this range is much more uniform for positions above the axis than below it.

Averaged from 250 Hz to 4 kHz (giving equal emphasis to each third-octave frequency band), the Nautilus 802's sensitivity measured 90.4 dB, very close to B&W's rating

of 91 dB. The speaker's impedance magnitude, seen in Fig. 5A, exhibits a very low minimum of 2.8 ohms at 100 Hz. Maximum impedance is 17.3 ohms at 48 Hz. The dip at 25 Hz between the two low-frequency peaks, characteristic of a vented enclosure, indicates the tuning frequency. Above 1 kHz, the impedance rises to a broad peak of 14.3 ohms.

Figure 5B shows the impedance phase versus frequency, with a maximum of about $+43^\circ$ (inductive) at 1.3 kHz and minimum of about -58° (capacitive) at 59 Hz. At infrasonic frequencies, the impedance phase rises to $+45^\circ$ at 15 Hz.

The low impedance in the upper bass and lower midrange between 70 and 435 Hz, where it stays below 4 ohms, makes the Nautilus 802 a fairly demanding load for an amplifier. The impedance stays below 5 ohms over a wider range of 65 to 900 Hz. B&W probably should have given this speaker a 4-ohm rating. Amplifiers used



with the Nautilus 802 should have high current capability to elicit optimum performance from it.

The Nautilus 802's minimum impedance of 2.8 ohms, coupled with the high (6.2) ratio of the maximum to the minimum, make its response relatively sensitive to cable resistance. To keep cable-drop effects from causing response variations greater than 0.1 dB, cable series resistance should be limited to a maximum of about 39 milliohms. Use of 12-gauge or larger cable typically would fulfill this requirement.

When I drove the Nautilus 802 with a high-level sine-wave sweep, its cabinet was essentially inert, and there were no significant resonances. The only vibration of the woofers' enclosure was a slightly noticeable activity of the side walls at 365 Hz. I was unable to detect any vibrations of the midrange/tweeter assembly.

The Nautilus 802's woofers exhibited a generous excursion capability of about

¾ inch, peak to peak. A sharp reduction in cone excursion occurred at 25 Hz, the vented-box tuning frequency. Port noise was very low when I drove the speaker to high levels at this frequency. Above the tuning frequency, the woofer reached maximum excursion at about 40 Hz, with an accompanying rise in distortion. (This happens to coincide with the 41.2-Hz, E_1 , tone that I use to check low-frequency harmonic distortion.) The woofers exhibited no dynamic offset.

Figure 6 shows the Nautilus 802's 3-meter room response, with both raw and sixth-octave smoothed curves. The speaker was in the right-hand stereo position, aimed laterally at the test microphone, which was placed at ear height (36 inches) at the listener's position on the sofa. I drove the system with a 2.83-volt swept sine wave. The direct sound plus 13 milliseconds of the room's reverberation are included. From 750 Hz and up, the smoothed curve fits a tight, 8.75-dB, window. Above 2.5 kHz, it fits an even tighter window of 3.5 dB. Below this frequency, the deviation increases somewhat, with peaks at 160, 260, and 500 Hz and only one significant, but not-too-deep, dip at 640 Hz. Overall, the curve fits a fairly tight, 12.6-dB, window, including all peaks and dips.

Figure 7 shows the Nautilus 802's harmonic distortion for an E_1 (41.2-Hz) input at power levels ranging from 0.1 to 100 watts (28.3 volts rms into 8 ohms), where

**THE SOUNDSTAGE
WAS WIDE AND
ROCK-STEADY,
WITH WELL-CENTERED
MONO IMAGES.**

the speaker generated a loud 104 dB SPL at 1 meter. Although the distortion rose to significantly high values of 20% second, 31.6% third, and 6% fourth and fifth, the Nautilus 802 sounded fairly clean because higher harmonics were quite low. The high second- and third-harmonic distortion was clearly audible, however. Why is the distortion so high? One reason is that the E_1 tone approximately coincides with the frequency of the woofers' maximum excursion within

the passband—a consequence of the tuning of the vented enclosure.

The harmonic distortion for an A_2 (110-Hz) input was quite low, less than 1.1% at all frequencies at full power. Distortion for an A_4 (440-Hz) input was also very low, consisting only of 1.35% second and third and with higher harmonics below 0.4%.

Figure 8 shows the 802's intermodulation distortion versus power for equal-amplitude tones of 440 Hz (A_4) and 41.2 Hz (E_1). The distortion rose smoothly, to a clearly audible 16.2% at full power. Most of the distortion was generated by the woofers, which were undergoing quite large excursions. Because the higher test tone (440 Hz) is just barely above the crossover between the woofers and midrange, the woofers contribute significantly to its reproduction. A lower crossover between them would have greatly reduced the IM distortion for this set of tones.

Figure 9 shows the Nautilus 802's short-term peak-power input and output capabilities as a function of frequency, measured using a 6.5-cycle, third-octave-bandwidth tone burst. I calculated the peak input power by assuming that the measured peak voltage was applied across the speaker's rated 8-ohm impedance.

The peak input power starts high, at 140 watts at 20 Hz; after reaching a peak of 280 watts at 26 Hz, it falls somewhat, to 205 watts at 45 Hz. The maximum input power then rises rapidly to 2.4 kilowatts at 125 Hz, falls slightly to 2.1 kilowatts at 300 Hz, and then rises to 5 kilowatts above 800 Hz. Note that if the system had been rated at 4 ohms, the upper-frequency power limit would have been 10 kilowatts! Between 125 and 630 Hz, the Nautilus 802's low impedance was a real challenge for my Crown Macro Reference amplifier, which ran out of current capability before the speaker reached its limit!

With room gain, the peak acoustic output starts fairly high, at 102 dB SPL at 20 Hz, then rises quickly, passing through 110 dB at 30 Hz, 115 dB at 52 Hz, and 120 dB at 70 Hz. Above 100 Hz, the peak output varies in the *very* loud range of 124 to 128 dB SPL all the way up to 20 kHz.

Use and Listening Tests

What's the first thing I noticed about the B&W Nautilus 802s? In a word, weight.

The Nautilus 802's curved back and sides lessen diffraction and increase cabinet rigidity.



From the four people it took to get them off the back of the truck to trying to get them down to my basement listening room, these babies were heavy! B&W suggests unpacking them in the same room where they will be used. Unfortunately, I couldn't do that. The speakers had to be unpacked, then transported to the anechoic chamber for testing, and then loaded in my camper van and taken home to be set up in my listening room. I normally do most of my listening before doing any of the lab tests. In this case, I chose to do the chamber tests (frequency and polar responses) first because I knew it would be extremely difficult to get the 802s back upstairs once they were down in my basement for listening.

What's the second thing I noticed about the Nautilus 802s? Their appearance—very different and quite distinctive. The 802's styling elicited a very broad range of comments, not all of them good. The positive comments included "stunning," "wow," "cool," and "spectacular." Most of the negative comments came from those with no interest in high-end audio (including my wife) and ranged from "weird" to "ugly" to "what's that motorcycle helmet doing on top of the speaker?"

The Nautilus 802s came with a raft of first-rate dealer support material that included a very well done installation/service video, a comprehensive service tool kit, and an excellent service manual with a complete set of detailed engineering drawings of all parts of this speaker. The service video

turned out to be a godsend after I inadvertently burned out a tweeter during my tests and had to install a replacement. Because of the speaker's design, the procedure for driver replacement is not as straightforward as with most other systems.

Everything associated with the Nautilus 802s is top-drawer. Even the promotional literature is stunning! I also received a very comprehensive, half-inch-thick, 106-page document titled "Development of the Nautilus 801 Loudspeaker" (available from B&W). This piece provided enough back-

ground material and illustrations on the design and development of the Nautilus 800 Series to fill several reviews! And every detail of the construction and cabinetry of the Nautilus 802 itself is absolutely the best.

Everything right down to the smallest particular is well thought out and extensively researched. B&W took no shortcuts.

Setup of the Nautilus 802s is a bit more involved than with more pedestrian loudspeakers. At this price, buyers often have their dealers assist in or do the setups for them. The size and weight of these speakers does require at least two adults to facilitate unpacking and proper installation. The roller-glides on the bottom very much helped with positioning. The speakers are provided with a "transit fixing assembly" (B&W's words), in the form of a tube on the back, that secures the midrange/tweeter housing to the bass enclosure. This must be removed from the speaker before it is operated. Once the final locations of the speakers are determined, the optional spike assemblies can be attached. The owner's manual covers both the Nautilus 801 and 802. It goes into considerable detail about unpacking, connecting the speakers, placement, and other topics.

Now to the main point: How do these speakers sound? In a word, marvelous. They sound uncannily like the 801 Matrix Series 3s (well, maybe that's not too surprising) but with significantly greater maximum output and dynamic range capability, a smooth, noticeably brighter high end, and a tighter, cleaner low end. The port of the older 801s produces significant bass chuffing

noises when driven hard by spectrally pure and concentrated bass tones. The Nautilus 802s did not have this problem. The 801s, however, could play slightly louder on material with content below 20 Hz.

I set up the 802s about 7 feet apart and canted in toward my listening position on the couch, about 8 feet away. Auxiliary review equipment included an Onkyo DX-7711 CD player, a Krell KRC preamp, a Krell KSA-250 power amplifier, and Straight Wire cabling. I reduced the signal level fed to the Nautilus 802s by about 4 to 5 dB

to match the lower sensitivity of the older 801s. (Such an increase in sensitivity is effectively equivalent to doubling or tripling the power of your amplifier.)

For this review, I dug out some CDs I hadn't listened to in a while. One special favorite is *By Way of the World* by Spies (Telarc CD-83305). This jazz CD, encoded in the now-defunct Shure HTS surround format (actually pretty much the same as Dolby Surround), is particularly dynamic and is a superb demo piece. The 802s performed spectacularly on it, particularly on my favorite cuts, tracks 6 and 7. Kick drum was loud and tight and did not exhibit any of the bass heaviness sometimes apparent from the old 801s. High percussion was especially effective and profited greatly from the 802's flatter high end; the laid-back character of the Matrix 801's treble came off second best. The beyond-the-speaker sound effects were fully evident, a testament to the Nautilus 802's imaging. Its soundstage was wide and rock-steady, with well-centered mono images.

On my favorite CD of my favorite symphony, Beethoven's Symphony No. 9 with Otmar Suitner conducting (Denon 38C37-7021; now available as Denon COZ 17001), the Nautilus 802s performed flawlessly in the difficult choral fourth movement. The voices were commendably open and smooth, were free from any apparent midrange problems such as honking or straining, and could be distinctly separated from the accompanying orchestral sections. Room sound and reverberation were reproduced in proper perspective.

I very much liked the Nautilus 802's performance on male speaking voice, especially since the older 801s have a tendency to add a bit of chestiness. Reproduction of female solo passages was quite smooth and unstrained.

On the stand-up/sit-down pink noise test, the 802s did not perform as well as the Matrix 801 Series 3s (which are nearly perfect in this test). Some upper-midrange tonal changes were evident when I stood up. The Nautilus 802's lateral listening window competed with those of the best speakers I have tested.

On low-frequency, third-octave, band-limited pink noise, the Nautilus 802s performed extremely well. At 20 Hz, the Nautilus 802 had slightly less clean fundamental output than the Matrix 801, but with essentially no port wind noise. At 25 Hz, however, performance favored the Nautilus 802s, again with very low port noise. At higher frequencies, the Nautilus 802's clean output equaled or exceeded the Matrix 801's. On all types of bass material, the Nautilus 802s excelled, delivering prodigious quantities of smooth, clean, extended output. They worked equally well on loud rock or pipe organ pedal notes.

The Nautilus 802's sensitivity is 4 or 5 dB higher than the older 801's, which really paid off on pop/rock, sound effects, and demo material with wide dynamic range. This was particularly evident with the Krell amplifier (a mere 200 watts per channel into 8 ohms!), the amp that I did most of my listening with. The Nautilus 802s could play significantly louder and cleaner than the Matrix 801s. At the highest playback levels, the Matrix 801s were somewhat congested (presumably because of amplifier clipping) while the Nautilus 802s were quite clean. Lower-sensitivity systems, such as the Matrix 801s, profit greatly from higher-power amplifiers, such as the Crown Macro Reference (760 watts into 8 ohms) that I often listen with.

On a wide range of different types of program material, the B&W Nautilus 802s rose to the occasion and performed almost flawlessly. The Nautilus 802s are truly spectacular speaker systems, with world-class performance and appearance to match. If their \$8,000 price is within your reach, and their somewhat out-of-the-ordinary look is to your liking, go for it!

THE NAUTILUS 802s
DELIVERED
PRODIGIOUS QUANTITIES
OF SMOOTH, CLEAN,
EXTENDED BASS.

Higher I.Q.

IRIQ.

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For universal remote controls, higher intelligence should mean higher performance. With Madrigal's IRQ, the intelligence of the remote is used to organize and simplify its operation. It is so simple to use that every member of your family—whether you like it or not—can master the complexities of a complete home theater system.

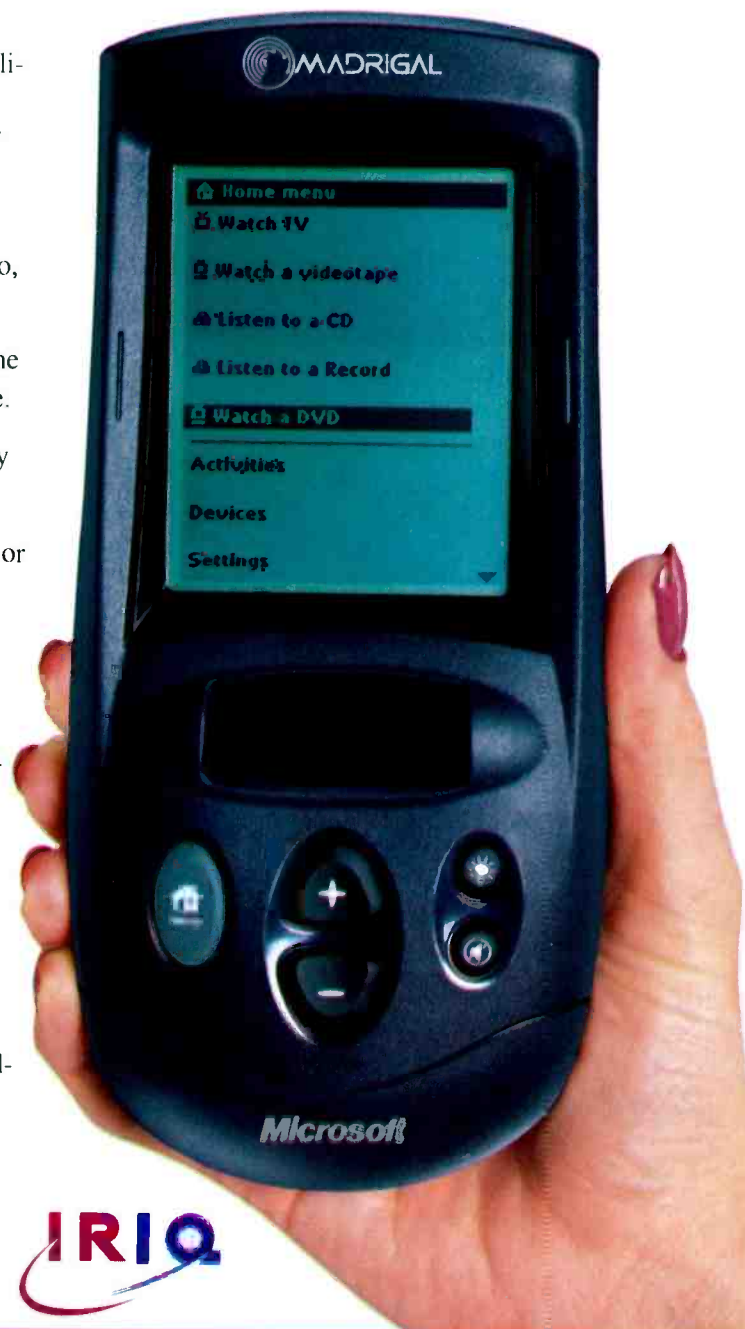
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- ◆ The **programmable, backlit touchscreen** shows only the buttons you need, and you can name them what you like.
- ◆ **Macros** can be used to send a sequence of commands by touching one button.
- ◆ Choose from **thousands of preprogrammed IR codes**, or **teach IR commands** for new components through the learning port.
- ◆ The innovative new **selector wheel** makes IRQ the ultimate surfing tool: rolling the wheel changes channels, selects menu commands, scrolls through text, and more..

IRQ is the result of a joint development project between Madrigal, Harman International and Microsoft. IRQ is available exclusively through Madrigal dealers who are audio/video specialists. They can provide programming services to help you get the most from your purchase.

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The IRQ logo, featuring the letters 'I', 'R', and 'Q' in a stylized font with a blue and red gradient, and a small circular icon to the right.



MADRIGAL

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LOOK NO FURTHER.



The new Sunfire Theater Grand tuner/preamp/processor is the latest innovation from Bob Carver. It is easy to set up, simple to operate, and delivers superb performance. Features include Dolby Digital® and DTS® decoding, Holographic Imaging, automatic signal sensing, and a versatile LCD remote. The Sunfire Theater Grand is state-of-the-art now and fully upgradable, so it is poised for the future.

It is no wonder that Home Theater magazine concluded: "If you're in the market for a full-featured controller for your system, look no further than the amazing value you get with the Theater Grand." — Jeff Cherun, Home Theater, February, 1999

Bob Carver's
Sunfire
...from his mind & soul

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KENWOOD VR-2090 A/V RECEIVER

The centerpiece of Kenwood's current audio line is the VR-2090, a 100-watt/channel A/V receiver that offers Dolby Digital and DTS decoding, lots of inputs, a really nifty remote control, and good features for custom installation and dual-room/dual-source operation.

But what grabs your attention first about the VR-2090 is its styling, which is so striking that you'd be hard pressed to miss it in a dealer's showroom. The front is brushed aluminum, with a tastefully sculpted central panel that is blessedly blank when the unit is off and, when on, displays legends that are large enough to see from across the room without binoculars. Because the characters are so big, only 15 of them can fit on the screen, so you may have to dodge down through submenus to get to what you want, but at least you can get everything from the front-panel display instead of from on-screen menus. (What a blessing! I hate having to turn on a TV to listen to a CD!)

Small legends at the left of the sculpted panel and three LEDs at its bottom augment the 15-character main display. The legends illuminate when the VR-2090 is muted, when its tuner is locked to a station, and when a station is being received in stereo. The LEDs indicate the onset of clipping and the presence of Dolby Digital or DTS bit streams. The Kenwood uses separate 24-bit Motorola 56009 DSP chips to decode those surround formats. A third Motorola chip, a 56007, handles bass management and such other DSP functions as generating ambience enhancement modes ("Arena," "Jazz Club," "Stadium," "Church," and "Theater").

The VR-2090 is operated best from its remote control, but you can work it in a rudi-

Rated Output, 6-Ohm Loads: Stereo mode, 100 watts/channel, 20 Hz to 20 kHz, with 0.03% THD; surround modes, 100 watts/channel, at 1 kHz, with 0.07% THD.

Dimensions: 17 $\frac{3}{8}$ in. W x 6 $\frac{1}{2}$ in. H x 15 $\frac{3}{8}$ in. D (44 cm x 16.2 cm x 39.1 cm).

Weight: 26.4 lbs. (12 kg).

Price: \$999.

Company Address: P.O. Box 22745, Long Beach, Cal. 90801; 800/536-9663; www.kenwoodusa.com.



mentary fashion from the panel, using a volume control and five ellipsoidal buttons clustered below the display. The buttons are for speaker selection, muting, and round-robin selection of inputs and display modes. An LED near each speaker switch lights when that set of speakers is selected. At the far left are the power button and a tiny LED standby indicator. Arrayed along the bottom of the panel are a headphone

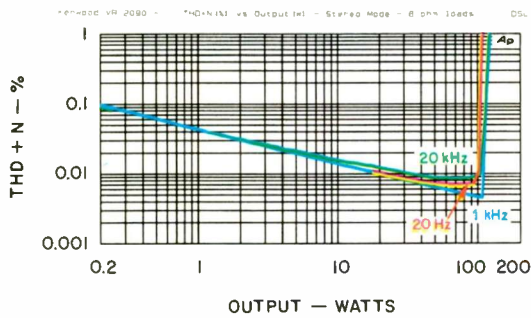
the right of the "AV AUX" cluster lights when the "CD 2/Tape 2 Monitor" input is selected.

Inputs abound. On the analog side, there are RCA jacks for a moving-magnet phono cartridge (along with a binding post for the turntable's ground wire), a CD player, and two tape decks (both with accompanying record outputs). The second tape input is also designated as an input

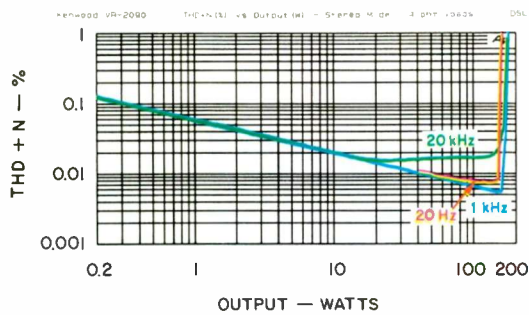
**THE KENWOOD VR-2090
IS ONE OF THE
BEST-CONCEIVED—MAYBE
THE BEST-CONCEIVED—
A/V RECEIVERS I'VE USED.**

jack and a group of connectors (S-video, composite video, and a pair of audio RCA jacks) for the "AV AUX" input. All front-panel jacks are gold-flashed. A small LED to

for a second CD player (or perhaps a CD recorder), which explains the nomenclature of the front-panel LED. The antenna inputs, next to the analog audio inputs, in-

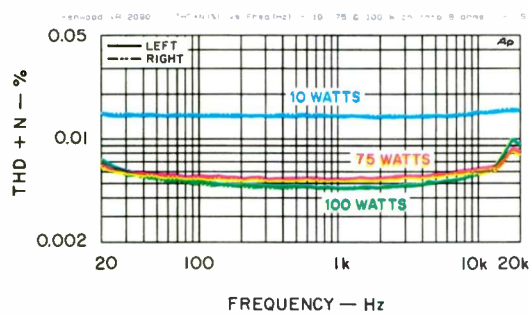


A

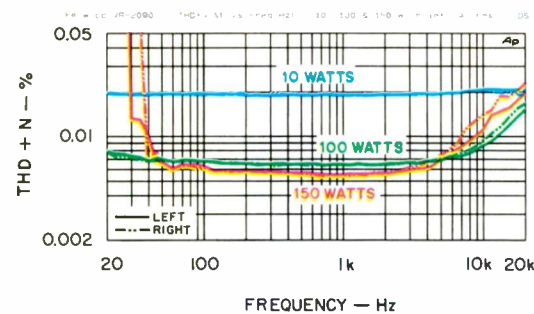


B

Fig. 1—THD + N vs. output in stereo mode for 8 ohms (A) and 4 ohms (B).



A



B

Fig. 2—THD + N vs. frequency in stereo mode for 8 ohms (A) and 4 ohms (B).

clude a 75-ohm Motorola jack for FM and wire clips for AM.

In addition to these audio sources, the VR-2090 handles five A/V sources via the front-panel “A/V AUX” jacks and four “Video” inputs on the rear. Every video input and output accommodates composite- and S-video signals, and all but the monitor output to the TV are accompanied by RCA jacks for analog audio. “Video 1” is the obvious choice for a VCR since it’s the only one with a recording output; the other three video inputs are equipped to handle digital as well as analog audio, via a coaxial jack for “Video 2” and Toslink optical connectors on the remaining pair. The “CD 1” input is also accompanied by a coaxial jack for PCM bit streams. You switch between the analog and digital CD or A/V connections with the remote.

The VR-2090’s outputs include an optical digital jack to pass the bit stream to another device and analog preamp jacks for the center and surround channels. The main front channels are hardwired to the built-in amplifier section, but there are left/right audio outputs and a composite-video jack for feeding an independently chosen program to a second room (dual-room/dual-source operation). The speaker outputs are closely spaced binding posts for two sets of main speakers, one pair of surrounds, and one center speaker, all of which accept wires and single (but not double) banana plugs. The rear-panel connectors are all base metal.

The second-room outputs are accompanied by other features that make the Kenwood VR-2090 very well equipped for multiroom operation and for custom installations. It has both an input and an output for an infrared transceiver in another room, enabling two-way communication between the receiver and its remote controls. There are also two outputs that relay commands to remote infrared

repeaters, a “TV On/Off Sensor” link that can be used to tell the VR-2090 when a monitor is on (ensuring proper operation of macros), and a relay-control output to operate projection-screen controllers or other external devices. Kenwood’s connectors and control-signal levels are compatible with a number of third-party accessories, including those from Xantech and Niles. Two AC convenience outlets are also built in; their combined power rating is 90 watts.

THERE ARE A/V OUTPUTS FOR FEEDING AN INDEPENDENTLY CHOSEN PROGRAM TO A SECOND ROOM.

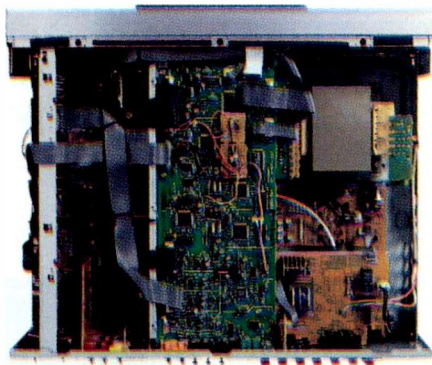
The Kenwood RC-R0907 PowerPad remote control that’s packed with the VR-2090 is a multipurpose device, preprogrammed to operate many manufacturers’ TVs, satellite receivers, cable boxes, VCRs, laserdisc and DVD players, CD players, and audio recorders. It even knows how to communicate with many home automation devices (such as X-10, Lutron, and Makita) for opening and closing drapes, lighting control, and so on. If the PowerPad doesn’t have the codes for a particular product, they can be downloaded into it via an ordinary telephone.

If you’re using an all-Kenwood system, matters are even simpler. Kenwood’s remote-controlled products use one of two control modes (XS8 or SL16), both of which the VR-2090 accommodates. Set a rear-panel slider to the proper position, daisy-chain the control lines of the Kenwood equipment together, plug the cable into the rear of this receiver, and you’re off to the races.

Kenwood’s PowerPad remote is one of the best I’ve seen included with a receiver. It’s a two-way system that issues commands to the RC-2090 and receives confirmation that they’re being followed. The legend for whatever setting you’re trying to modify doesn’t change until the PowerPad gets word that the receiver has followed the instruction. This can be a little frustrating at first (who wouldn’t get annoyed at a re-

mote that sometimes seems to ignore commands?), but it's a great idea!

I also like the fact that Kenwood makes proper use of LCD technology in the PowerPad, using the screen's ability to remap the display with alternative information while not succumbing to the temptation to make the screen touch-sensitive. Instead of pressing virtual buttons on the screen, you operate the PowerPad with five pushbuttons and a stubby, near-hemispheric joystick that I call a joyball. The joyball falls naturally under your right thumb, assuming you grasp the remote in the right hand



CROSSOVER FREQUENCY AND FILTER SLOPE ARE FIXED BUT VERY WELL CHOSEN FOR MOST APPLICATIONS.

and rest it in the left, as right-handed people would do automatically. (Lefties may have problems with this remote and should check it out before buying.) Two of the pushbuttons adjust volume, a third mutes and unmutes the receiver, another turns the system on and off ("On/Standby"), and the last ("Confirm") displays the receiver's current settings.

The PowerPad requires four AA cells. Considering all the processing that goes on, I'd expect power consumption to be rather high, especially when the backlight is activated, but Kenwood says the PowerPad is certified for 40 hours of continuous use with alkaline batteries ("continuous" defined as with the screen constantly illuminated and the remote constantly performing some activity). The screen is reasonably legible under decent lighting, so you'll

probably need the backlight only when you've darkened the room. The screen turns off after a few seconds of inactivity, presumably to conserve battery life, but goes on if you touch any button; touching "Confirm" turns it on without changing anything.

The remote uses a hierarchical structure similar to the nested menus of on-screen displays. But with this system, you can check and change settings without overlaying stuff on the picture or, for that matter, even needing a TV at all. I like that! The upper two lines in the PowerPad's screen always display icons for each of the ten program sources, two more to select the analog or digital audio input for sources that support both, and three to return to the main menu and to pull up the "Macro" and "Remote Mode" menus. Three of the PowerPad's macros, or control sequences, are programmable; the other four ("Video On," "Video Off," "Audio On," and "Audio Off") are preset.

The main menu has submenus for listening mode, sound, function, and setup. Listening mode choices include, for example, DTS, Dolby Digital, Dolby Pro Logic, Dolby 3 Stereo, DSP, and stereo. The sound submenu is used for switching loudness compensation on and off, setting bass and treble control levels, and controlling the two-step "Midnight Mode" dynamic range compression when playing Dolby Digital sources. The function submenu enables you to adjust the front-panel brightness and display mode and to control accessories and home automation modules. And the setup submenu is used for everything from programming macros to adjusting surround-sound speaker configurations, balancing levels, and so on. All in all, the PowerPad is an unusually competent remote, but, needless to say, it takes some time to learn to use it to full advantage.

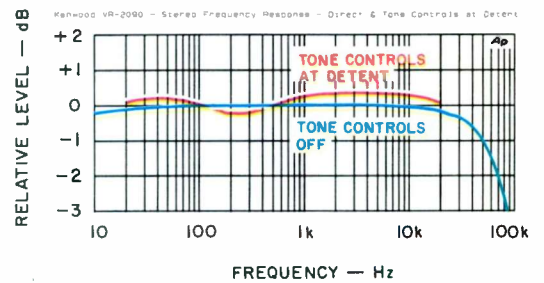


Fig. 3—Frequency response, stereo mode.

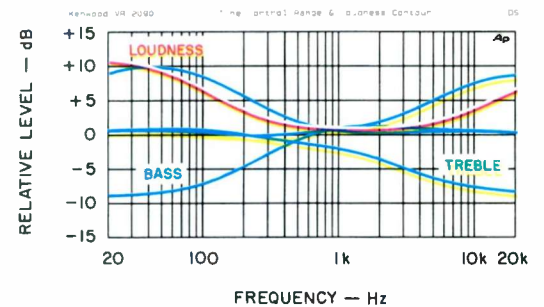


Fig. 4—Tone-control and loudness-compensation characteristics.

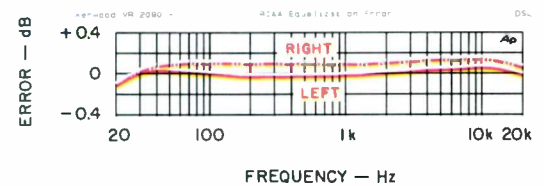


Fig. 5—RIAA equalization error.

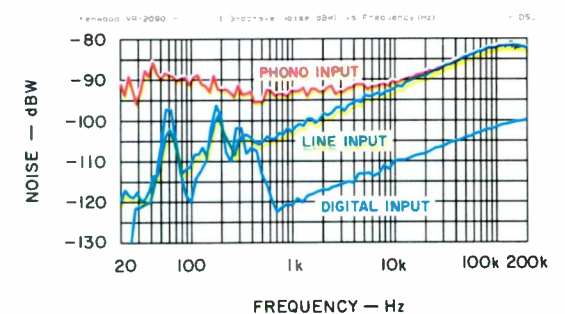


Fig. 6—Noise analysis, stereo mode.

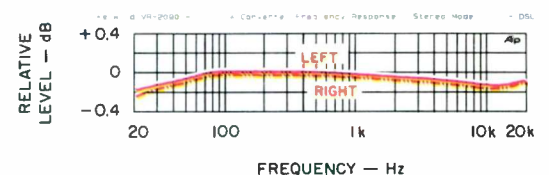


Fig. 7—Frequency response, D/A section.

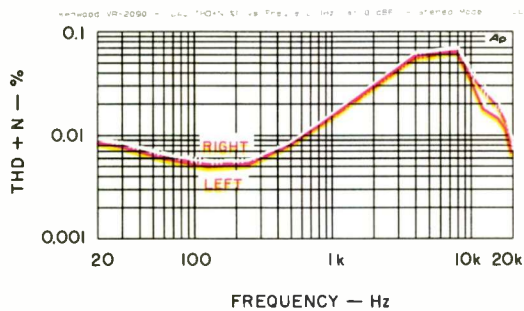


Fig. 8—THD + N vs. frequency at 0 dBFS, D/A section.

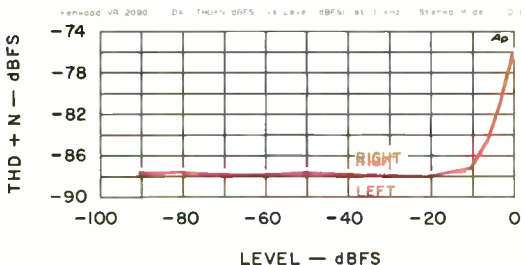


Fig. 9—THD + N vs. level, D/A section.

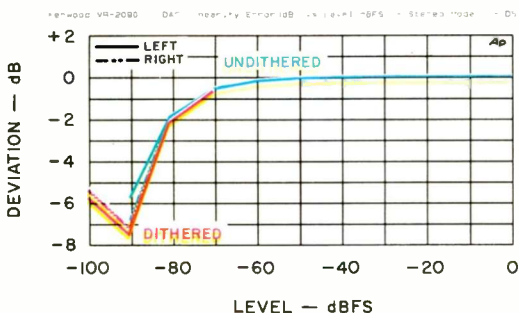


Fig. 10—Linearity error, D/A section.

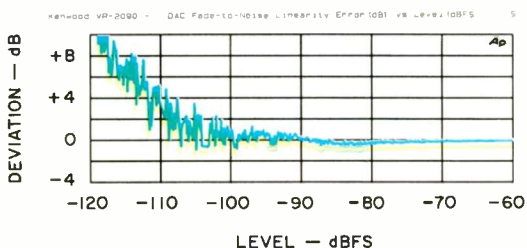


Fig. 11—Fade-to-noise test.

As usual, several setup menus relate to speaker size and bass management. Kenwood offers a quick setup procedure (in which you simply tell the VR-2090 whether or not you are using a subwoofer, center speaker, and surround speakers, and it does

the best job it can based on that information) and a custom setup procedure that offers far more choices (such as choosing the size of the front, center, and surround speakers separately). If you use a subwoofer, bass energy is normally redirected from those channels with speakers designated as “Small” to the sub, but there’s also an “SW Re-Mix” option that routes bass to the subwoofer without removing it from the channels designated as having “Large” speakers. Kenwood does digital bass management the way I think it should be done.

The VR-2090’s RDS-equipped FM/AM tuner provides 40 station presets, automatic and manual tuning, and direct station access from the PowerPad remote. The receiver’s power amplifiers use “Kenwood-developed K-STAT output transistors that are the first ever to incorporate the temperature sensor in the transistor itself.” K-STAT is said to “instantaneously correct for transistor temperature changes, maintaining ideal performance characteristics in all operating conditions.” That said, the VR-2090 as a whole is cooled by a thermostatically controlled fan.

Measurements

Following what has become common practice with A/V receivers, Kenwood restricts the VR-2090’s FTC power rating (100 watts per channel, 20 Hz to 20 kHz, at 0.03% THD) to the main front channels, operated in stereo mode with 6-ohm loads. In surround operation, each channel is rated only at 1 kHz (100 watts at 0.7% THD), again into 6 ohms. In point of fact, my sample beat those specs by a wide margin even when driving loads other than 6 ohms.

I tested the VR-2090 in stereo mode with both 8- and 4-ohm terminations (and made a dynamic-power measurement using 2-ohm loads). I didn’t experience any problems, despite a statement on the back panel that warns against using speakers rated at

less than 6 ohms. When driving a load impedance greater than that on which the power rating is based, an amplifier’s output is usually limited by its power-supply voltage. For example, the output voltage that produces 100 watts into 6 ohms produces only 75 watts into 8 ohms. When the amp is driving load impedances below the rated value, the output power is usually limited by the current-handling ability of the output devices or by the devices that drive them. This limit is usually far less well defined, so one must experiment to find a suitable rating.



**KENWOOD'S
POWERPAD REMOTE
IS ONE OF THE BEST
I HAVE SEEN INCLUDED
WITH A RECEIVER.**

To do this, I tested total harmonic distortion plus noise (THD + N) versus output at 20 Hz, 1 kHz, and 20 kHz using both 8- and 4-ohm loads (Figs. 1A and 1B). As you can see, the VR-2090’s main-channel amplifiers can deliver just over 100 watts per channel into 8 ohms and somewhat more than 150 watts per channel into 4 ohms. (Clipping at 1 kHz occurs at 120 watts with 8-ohm loads and 175 watts with 4-ohm loads.) Next, I tested THD + N versus frequency, full-range, using 4- and 8-ohm loads and three output levels (Fig. 2). In Fig. 2A, the 10-watt curves are dominated by noise and are the least interesting. The other 8-ohm curves were made at constant output levels of 75 watts per channel (the predicted “voltage-constrained” condition) and at 100 watts per channel (Kenwood’s 6-ohm rating). Noise and distortion total less than 0.0089% across the board at 75 watts and barely more than 0.01% (one-third the 6-ohm spec!) at 100 watts. Over most of the

frequency range, the noise and distortion amount to less than 0.006% at either output level.

With 4-ohm loads (Fig. 2B), at output levels of 100 and 150 watts, noise and distortion total less than 0.007% over most of the frequency range, though the distortion rises gradually above 5 kHz in both cases. At 20 kHz, the distortion measures 0.0175% at 100 watts per channel and 0.0248% at 150 watts. Below 40 Hz, the power supply has difficulty supplying the current needed to pump out 150 watts into 4 ohms, and distortion rises sharply.

Using the IHF tone burst, I measured dynamic output power of 175 watts per channel (22.4 dBW) with 8-ohm loads, 210 watts per channel (23.2 dBW) with 4-ohm loads, and 250 watts per channel (24 dBW) with 2-ohm loads. Not bad for an amplifier that's not supposed to be connected to less than 6-ohm loads!

Dynamic headroom figures aren't included in "Measured Data" because Kenwood didn't specify continuous power into any of the loads I used. Damping factor was very high (550 at 50 Hz), and output impedance was not only low but remarkably uniform; the output impedance at 20 kHz was less than twice that at 50 Hz.

Figure 3 depicts the left front channel's frequency response measured with the tone controls set to "Off" and with them "On" but with both the bass and treble at "0." The ranges of the bass and treble controls

**KENWOOD DOES
DIGITAL
BASS MANAGEMENT
THE WAY I THINK
IT SHOULD BE DONE.**

are shown in Fig. 4, along with the effect of the loudness contour. (These measurements were all made in stereo mode.) It appears that Kenwood uses analog tone-control circuitry, because with the controls on but set flat, treble response extends well beyond the 24-kHz barrier that usually applies to digital audio signals. Furthermore, the boost and cut curves are somewhat asymmetrical, and there's a modest response error with the controls in the circuit.

Although this doesn't bother me particularly, it is unusual in this day of digitally generated everything. The tone-control range is limited to less than ± 10 dB, which is just fine with me.

The loudness-compensation effect depends upon the volume setting; therefore, the curve in Fig. 4 was taken at a volume-control setting of -40 dB and rescaled to hit 0 dB at 1 kHz with the loudness compensation switched off. Switching it on shifts the entire curve upward a tad and ultimately produces a bass boost of 9.2 dB at 50 Hz and a treble boost of 5.6 dB at 15 kHz.

Compared with the phono preamps of many other A/V receivers, Kenwood's is quite remarkable. The equalization is unusually accurate (Fig. 5 shows the error plotted on a very sensitive scale), and the input impedance was well chosen for moving-magnet cartridges. Overload point was a relatively generous 145 millivolts, and the noise was quite low too. In Fig. 6 are third-octave spectrum analyses of the VR-2090's noise output through the phono, analog CD, and digital CD inputs. The absence of hum components in the phono noise spectrum is quite unusual considering the extra gain and bass boost provided by the preamp and RIAA equalizer. Although some hum pickup can be seen in the CD input noise spectra, there's no power-supply component at 120 Hz, and the absolute levels of the 60- and 180-Hz components (-102.2 and -98.5 dBW, respectively) are way, way down. Overall, A-weighted noise measured from the analog CD input was admirably low, especially in view of the unusually high impedance that Kenwood uses for the line-level analog inputs.

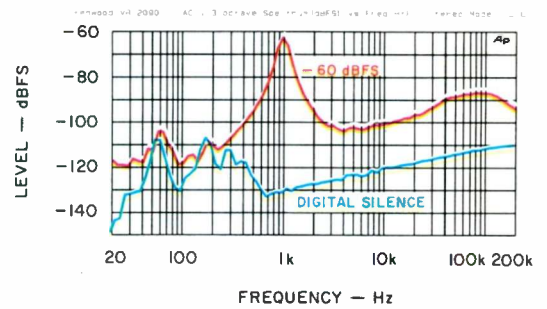


Fig. 12—Noise analysis, D/A section.

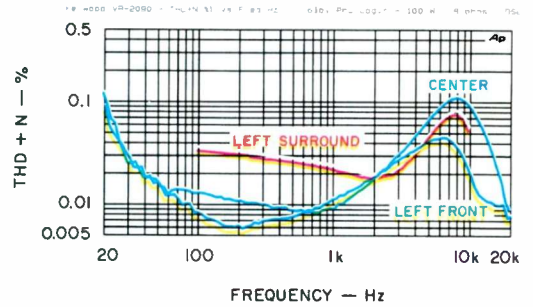


Fig. 13—THD + N vs. frequency, Dolby Pro Logic mode.

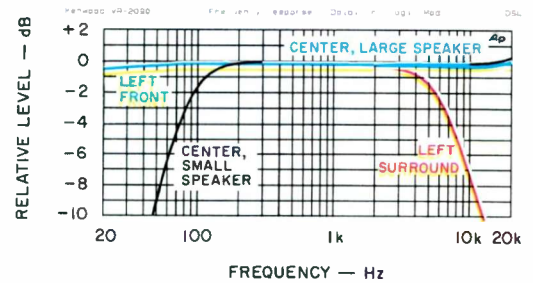


Fig. 14—Frequency response, Dolby Pro Logic mode.

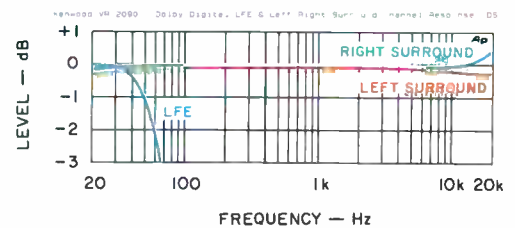


Fig. 15—Frequency response of LFE and two worst-case channels, Dolby Digital mode.

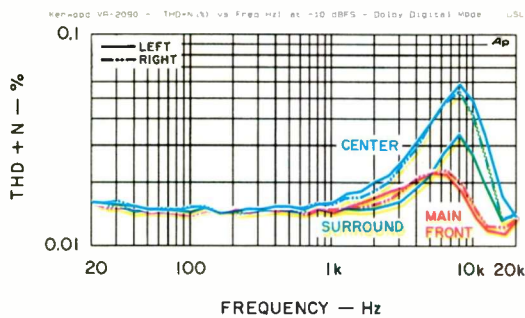


Fig. 16—THD + N vs. frequency, Dolby Digital mode.

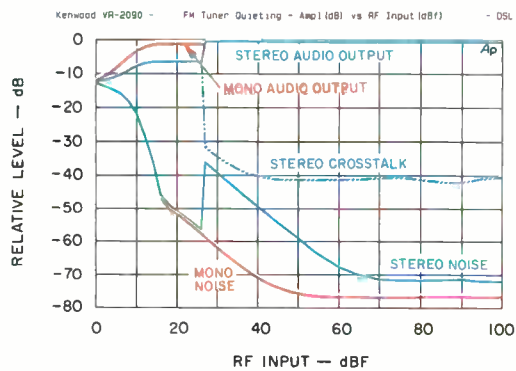


Fig. 17—FM tuner quieting.

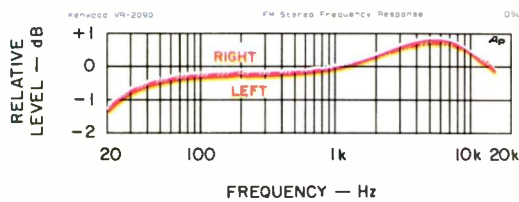


Fig. 18—Frequency response, FM tuner section.

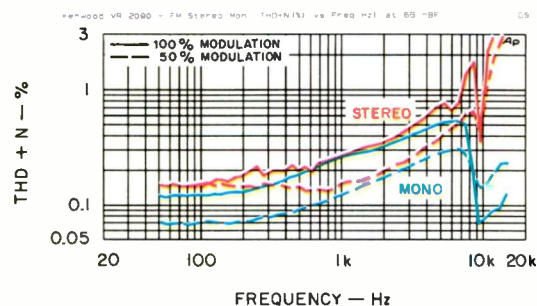


Fig. 19—THD + N vs. frequency, FM tuner section.

All results reported in “Measured Data” were taken using the “0” input-level setting in the setup menu. Kenwood provides two alternative choices, “-3” and “-6.” The first

of these drops overall gain by 2.1 dB and the second by 6 dB, but neither affects the input overload points in stereo mode: These remain 11.1 volts at the line-level inputs and 145 millivolts (at 1 kHz) at the phono input. The input-level setting does affect the overload point of the analog-to-digital (A/D) converter that is used for analog input in all modes other than stereo. For example, the line-level analog input overload point in Dolby Pro Logic mode shifts from 2.22 volts at the “0” input-level setting to 2.83 volts at the “-3” setting and to 4.42 volts at the “-6” setting.

All digitally processed signals must be converted back to analog before hitting the power amplifiers. In the Kenwood VR-2090, this is achieved with Crystal Semiconductor 20-bit D/A chips. I evaluated the DACs independently of the DSP by coupling a PCM bit stream to the digital CD input and using the stereo operating mode. Unfortunately, the DACs proved to be the weak link in this receiver.

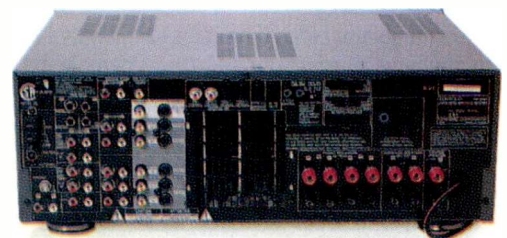
Frequency response (Fig. 7) is fine. There’s a slight error at each end of the audio band, but it’s less than 0.2 dB and probably is in the power amps rather than the DACs anyway. There’s no high-frequency response ripple, and that’s good. But as you can see in Fig. 8, full-scale (0-dBFS) distortion begins climbing at frequencies above a few hundred hertz, peaking at approximately 0.07% in the 8-kHz region. The number itself wouldn’t be all that bad, but the distortion is predominantly third-order and the curve would have continued to rise had the 22-kHz filter in the analyzer not removed the offending harmonics at test frequencies higher than 8 kHz.

Figure 9 shows THD + N as a function of level with a 1-kHz digital input. The results are worse than I would hope for, and I was forced to shift the vertical scale upward to accommodate the data. There was a time when a linearity error of 7 dB at -90 dBFS (as seen in

Fig. 10) might have been considered par for the course, but it sure isn’t today. Kenwood would be well advised to upgrade these DACs. Figure 11 shows linearity in the fade-to-noise test. Although worse than usual, it isn’t as bad as might have been expected from Fig. 10. The fade curve is taken at a lower frequency than the regular linearity curve, which might explain the seemingly better performance.

The lower curve of Fig. 12 is a third-octave analysis of the output noise from a “digital silence” input. (The same curve appears as the lowest one in Fig. 6, but there it’s plotted as a power curve in dBW whereas here it’s referenced to 0 dBFS.) It’s clear from the lie of this curve and from the weighted signal-to-noise ratios in “Measured Data” that the DACs mute when they recognize the silence code. The only noise remaining is that of the analog output amplifier, and that’s very low indeed in the Kenwood VR-2090.

The upper curve of Fig. 12 is a third-octave analysis of the -60 dBFS, 1-kHz signal used to evaluate dynamic range. The DACs remain active with this input, and the noise floor is 20 dB higher. The shape of the curve



OUTPUTS INCLUDE AN OPTICAL DIGITAL JACK TO PASS THE BIT STREAM TO ANOTHER DEVICE.

suggests that the converters are multibit types and don’t use noise shaping; linearity is not their strong suit. Dynamic range and quantization noise measurements for the VR-2090 D/A converters were also poorer than average.

Crosstalk between the left and right channels in stereo mode rose gradually with frequency. For the analog inputs, the range was from about -95 dB at 35 Hz to

MEASURED DATA

AMP SECTION, STEREO MODE

Output Power at Clipping (1% THD at 1 kHz): 8-ohm loads, 120 watts/channel (20.8 dBW); 4-ohm loads, 175 watts/channel (22.4 dBW).

Dynamic Output Power: 8-ohm loads, 175 watts/channel (22.4 dBW); 4-ohm loads, 210 watts/channel (23.2 dBW); 2-ohm loads, 250 watts/channel (24 dBW).

THD + N, 20 Hz to 20 kHz: 8-ohm loads, less than 0.0103% at 100 watts, less than 0.0089% at 75 watts, and less than 0.016% at 10 watts; 4-ohm loads, less than 0.0248% at 150 watts (to 40 Hz), less than 0.0175% at 100 watts, and less than 0.0219% at 10 watts.

Damping Factor re 8-Ohm Loads: 550 at 50 Hz.

Output Impedance: 14.9 milliohms at 1 kHz, 17.2 milliohms at 5 kHz, 21.6 milliohms at 10 kHz, and 27.3 milliohms at 20 kHz.

Frequency Response: With tone controls defeated, 20 Hz to 20 kHz, +0, -0.21 dB (-3 dB below 10 Hz and at 85.2 kHz); with tone controls at "0," 20 Hz to 20 kHz, +0.45, -0 dB (-3 dB below 10 Hz and at 65.2 kHz).

Tone-Control Range: Bass, +8.1, -7.6 dB at 100 Hz; treble, +7.4, -7.7 dB at 10 kHz.

Loudness Contour: +9.2 dB at 50 Hz and +5.6 dB at 15 kHz, with volume set at -40 dB.

Subwoofer Crossover: High-pass, -3 dB at 80 Hz and -6 dB at 61 Hz, 12-dB/octave slope; low-pass, -3 dB at 67 Hz and -6 dB at 82 Hz, 24-dB/octave slope.

RIAA Equalization Error, 20 Hz to 20 kHz: +0.06, -0.24 dB.

Sensitivity for 0-dBW (1-Watt) Output: Line input, 22.2 mV; MM phono input, 0.29 mV.

Muting: Total.

A-Weighted Noise: Line input, -84 dBW; MM phono input, -79.8 dBW.

Input Impedance: Line input, 86.7 kilohms; MM phono input, 48.6 kilohms in parallel with 165 pF.

Input Overload (1% THD at 1 kHz): Line input, 11.1 V; MM phono input, 145 mV.

Channel Separation: Greater than 68.8 dB, 100 Hz to 10 kHz.

Channel Balance: ± 0.015 dB.

Recording Output Level: Line (0.5-V input), 491 mV; MM phono (5-mV input at 1 kHz), 382 mV; FM tuner (100% modulation at 1 kHz), 670 mV.

Recording Output Impedance: 290 ohms.

AMP SECTION, DOLBY PRO LOGIC MODE

Output Power at Clipping (1 kHz), 8-Ohm Loads: Main channels, 122 watts/channel (20.9 dBW); center channel, 145 watts (21.6 dBW); surround channels, 120 watts/channel (20.8 dBW).

THD + N at 100 Watts/Channel Output, 8-Ohm Loads: Main channels, less than 0.0511%, 100 Hz to 20 kHz; center channel, less than 0.1137%, 100 Hz to 20 kHz; surround channels, less than 0.0795%, 100 Hz to 7 kHz.

Frequency Response: Main channels, 20 Hz to 20 kHz, +0, -0.36 dB (-3 dB below 10 Hz and at 23.4 kHz); center channel, "Large" speaker mode, 20 Hz to 20 kHz, +0.31, -0.38 dB (-3 dB below 10 Hz and at 23.6 kHz); center, "Small" speaker mode, 80 Hz to 23.6 kHz, +0.31, -3 dB; surround channels, below 10 Hz to 7 kHz, +0, -3 dB.

A-Weighted Noise: Main channels, -79.1 dBW; center channel, -79.4 dBW; surround channels, -80.4 dBW.

Channel Separation at 1 kHz: 39.1 dB or greater (84 dB maximum).

DOLBY DIGITAL (AC-3) MODE

Channel Balance: 0.2 dB or better.

Frequency Response: Left front, 22 Hz to 20 kHz, +0.08, -0.19 dB; right front, 21 Hz to 20 kHz, +0.12, -0.21 dB; center, 21 Hz to 20 kHz, +0.35, -0.21 dB; left surround, 21 Hz to 20 kHz, +0, -0.2 dB; right surround, 22 Hz to 20 kHz, +0.46, -0.16 dB; LFE channel, 20 Hz to 66 Hz, +0, -3 dB.

THD + N at 1 kHz for 0-dBFS Signal: Left front, 0.0113%; right front, 0.0118%; center, 0.0181%; left surround, 0.0674%; right surround, 0.0148%; LFE (at 30 Hz), 0.0066%.

THD + N, 20 Hz to 20 kHz, for -10-dBFS Signal: Left front, less than 0.0228%; right front, less than 0.0236%; center, less than 0.0584%; left surround, less than 0.0337%; right surround 0.0539%.

Channel Separation: 62 dB or greater, 100 Hz to 10 kHz.

D/A CONVERTER SECTION

Frequency Response: 20 Hz to 20 kHz, +0.03, -0.19 dB.

THD + N at 0 dBFS: Less than 0.0697%, 20 Hz to 20 kHz.

THD + N at 1 kHz: Below -75.5 dBFS from 0 to -90 dBFS and below -87.3 dBFS from -30 to -90 dBFS.

Maximum Linearity Error: Undithered signal, 6.75 dB from 0 to -90 dBFS; dithered signal, 7.39 dB from -70 to -100 dBFS.

S/N Ratio: A-weighted, 109.6 dB; CCIR-weighted, 102.6 dB.

Quantization Noise: -87.5 dBFS.

Dynamic Range: Unweighted, 87.2 dB; A-weighted, 90.3 dB; CCIR-weighted, 80.8 dB.

Channel Separation: Greater than 68.8 dB, 125 Hz to 16 kHz.

FM TUNER SECTION

50-dB Quieting Sensitivity: Mono, 19 dBf; stereo, 41.2 dBf.

S/N Ratio at 65 dBf: Mono, 75.6 dB; stereo, 69.4 dB.

Frequency Response, Stereo: 20 Hz to 15 kHz, +0.86, -1.27 dB.

Channel Balance: ± 0.03 dB.

Channel Separation: Greater than 30.3 dB, 100 Hz to 10 kHz.

THD + N at 65 dBf, 100% Modulation: Mono, 0.127% at 100 Hz, 0.269% at 1 kHz, and 0.568% at 6 kHz; stereo, 0.158% at 100 Hz, 0.275% at 1 kHz, and 0.723% at 6 kHz.

THD + N at 65 dBf, 50% Modulation: Mono, 0.07% at 100 Hz, 0.127% at 1 kHz, and 0.306% at 6 kHz; stereo, 0.15% at 100 Hz, 0.156% at 1 kHz, and 0.482% at 6 kHz.

Capture Ratio at 45 dBf: 1.3 dB.

Selectivity: Adjacent-channel, 9.6 dB; alternate-channel, 70.9 dB.

Image Rejection: 48 dB.

AM Rejection: 64.9 dB.

Stereo Pilot Rejection: At 100% modulation, 66.9 dB; at 0% modulation, 67.7 dB.

Stereo Subcarrier Rejection: At 100% modulation, 60.9 dB; at 0% modulation, 93.1 dB.

about -68 dB at 20 kHz in the worse (left-to-right) direction. Crosstalk via the digital inputs was a few decibels lower but followed roughly the same slope, which suggests that most of the crosstalk occurs in the analog output stages.

Figure 13 depicts THD + N plotted as a function of frequency in Dolby Pro Logic mode. For these curves, each channel was terminated with 8 ohms and the input was regulated to produce a constant output of 100 watts. Since there was little difference in the data taken on the left and right front channels (or on the left and right surround channels), only the left-channel curves are included here. Distortion rises at frequencies above a kilohertz or so and peaks around 8 kHz before it diminishes again. This is really the distortion of the D/A converters that follow the DSP-based Dolby Pro Logic decoder,

not distortion in the power amplifiers. When I measured THD + N as a function of output power in Pro Logic mode, the main front and the surround channels had essentially the same output power capability as the front channels in stereo operation. The center channel seemed more powerful than the others, but only because a center signal does not exercise the other channels and the center channel has the power supply all to itself during the test.

Figure 14 shows the frequency response of each channel in Dolby Pro Logic mode. The curves for the three front channels extend smoothly to 20 kHz, whereas the surround channel rolls off above 7 kHz, in accordance with the Dolby Pro Logic standard. The bandwidth of the three front channels is limited to 23.5 kHz (give or take a few hertz) by the anti-aliasing filter that precedes the A/D converter. When making these response curves, I used both "Large" and "Small" center-speaker settings. These

correspond to the old Pro Logic center-channel terminology of "Wide" and "Normal," respectively. The "Small" center-channel curve actually depicts the response of the high-pass filter in the VR-2090's bass management system. The crossover frequency and filter slope are fixed rather than selectable, but they are very well chosen for most applications, fully meeting Dolby

Labs' requirements and following Lucasfilm's Home THX recommendations.

A-weighted output noise in Dolby Pro Logic operation was around -80 dBW, which is typical for an integrated amplifier or receiver in this mode. Steady-state separation at 1 kHz ranged from 39 to 84 dB. Overall, the separation averaged more than 60 dB, which should be adequate. The worst crosstalk occurred between the surround and right front channels—better that way than the opposite!

I used the Lucasfilm THX test DVD for most measurements of the Dolby Digital decoder, although I did use the Dolby Labs test disc to measure THD + N at 0 dBFS (1 kHz). There was a bit more variation in the responses of the five channels than usual, so the two "worst" curves are plotted in Fig. 15 along with the LFE response. By "worst," I mean the curves with the greatest deviation at 20 kHz. These happened to be for the two surround channels, which are arguably least important. But we're really splitting hairs here, since even the worst-case deviation is less than a half decibel.

Output levels were well matched, all within a total spread of ± 0.14 dB. In general, THD + N at 1 kHz with the full-scale recording on the Dolby Labs DVD was about 0.015%. The left surround channel proved to be the exception; for some reason, the distortion in that channel was substantially higher (0.0674%). These measurements were made at a 10-watt output.

I also made THD + N versus frequency plots using the -10 -dBFS recordings on the THX disc. The curves, which correspond to a 1-watt output, are shown in Fig. 16. Again we see that the distortion rises above 1 kHz and peaks at 8 kHz before seeming to diminish. Clearly this is the same distortion discussed earlier, originating in the D/A converters.

Crosstalk in Dolby Digital mode averaged around 70 dB at 10 kHz, the worst-case frequency. In the worst direction, it rose linearly from -90 dB at 50 Hz to about -58 dB at 20 kHz; in the best direction, the range was from about -92 to -75 dB. No problems here.

The VR-2090's tuner is surprisingly good. It's sensitive (19 dBf for 50-dB quieting in mono) and quiet and has reasonably low distortion, a great capture ratio (1.3 dB), and excellent selectivity (almost 10 dB, adjacent channel, and 71 dB, alternate channel). Couple this performance with adequate AM rejection (nearly 65 dB), and you have a tuner that should do well under multipath-reception conditions. Image-rejection ratio (48 dB) was nothing to write home about, but that's seldom anything to fret about except near airports. Both pilot and subcarrier signals are well rejected, so recording on a cassette deck using Dolby noise reduction shouldn't be a problem.

Figure 17 shows the mono and stereo quieting curves. The tuner receives weak stereo broadcasts in mono and switches to stereo when the RF input reaches 27 dBf. At that point, 1-kHz separation already exceeds 30 dB. By the time the tuner has achieved 50-dB quieting in stereo—with a 41.2-dBf signal—separation exceeds 40 dB at 1 kHz. With a 65-dBf signal, separation is remarkably uniform across the entire audible range. With a standard 65-dBf RF input, signal-to-noise ratio exceeds 75 dB in mono and is almost 70 dB in stereo. With signal strengths greater than 70 dBf, stereo quieting reaches 71 dB, which is remarkably good.

The FM tuner section's frequency response (Fig. 18) is within ± 0.9 dB from 25 Hz to 15 kHz, with a mild bass rolloff and an even milder mid-treble peak. The left and right channels are exceedingly well matched in level, too. Figure 19 shows THD + N versus frequency with a 65-dBf input in mono and stereo at 50% and 100% mod-



**THE VR-2090 RECEIVER
HAS GREAT
ANALOG ELECTRONICS
AND AN UNUSUALLY
GOOD TUNER.**

ulation. As tuners go these days, the curves for the VR-2090 aren't bad at all.

Use and Listening Tests

Boy, do I feel like I'm on the horns of a dilemma. The Kenwood VR-2090 is one of the best-conceived—maybe *the* best conceived—A/V receivers I've played with. It's got lots of inputs, and every composite-video connection is doubled with an S-video counterpart. It doesn't handle component video, but no receiver I know of does. It doesn't have a digital audio connection for every input, but it offers either a wired or optical input on four (CD and three A/V sources), which should take care of most situations. It also has an optical digital output.

The VR-2090 can feed a separate program to a second room; with the right accessories, you can even control it from there. It has a really appealing and extraordinarily competent remote that controls

**THIS RECEIVER HAS GOT
SO MUCH GOING FOR IT,
IT'S ALMOST IN
A CLASS BY ITSELF.**

not only the VR-2090 but also a host of other components and home automation products. Raise and lower the room lights, the window shades, the projection screen; I'm sure you can turn on your coffee maker with the right accessory. The only thing I'd change about the PowerPad remote is to have its display stay on a little longer than it does when quiescent.

The VR-2090 has great analog electronics, power amps that will be comfortable in any circle, an unusually competent RDS FM tuner. It decodes just about anything you'd be likely to toss at it (Dolby Pro Logic, Dolby Digital, DTS), has the normal complement of simulated-ambience doods, and does bass management correctly. On the other hand, it's got some really punk DACs and a noisy fan that comes on far too readily!

This receiver has got so much going for it, it's almost in a class by itself. But when I play good program material and use reveal-

ing speakers, I can hear the imperfections in the DACs. Detail gets lost, the natural ambience of the recording is truncated, and listening fatigue sets in sooner than I think it would with cleaner converters.

Will you hear this? I don't know. I think it will depend upon your speakers, the type of music you listen to, and how well that music is recorded. I doubt that the DACs will be particularly bothersome in the average home theater, especially on boom-bang-shoot-'em-up movies. You're most likely to object to the DACs when listening

to classical music. And, maybe not then. Nor can I predict whether the fan will do its thing regularly in your system. That, too, will depend on the speakers, how loud you play them, and how well ventilated you keep the VR-2090.

This is a receiver that you're going to have to judge for yourself and decide whether its very real positives outweigh the potential negatives. I'll say this for it: The Kenwood VR-2090 deserves a chance. It has too much going for it to be dismissed because of a few foibles. **A**

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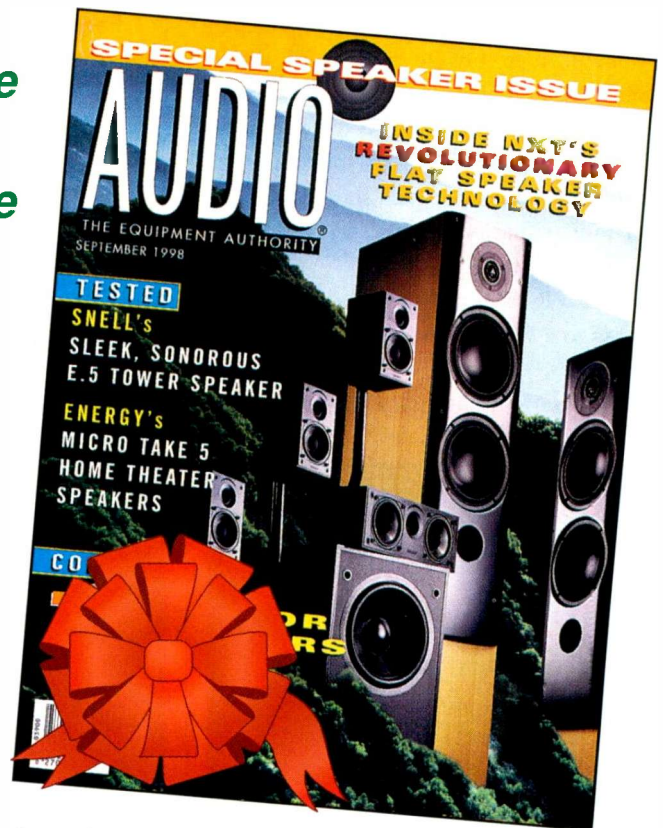
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QUICKSILVER AUDIO SILVER 60 MONO AMP

At first glance, the Quicksilver Audio Silver 60 looks a lot like the Quicksilver V4 amplifier I tested a year ago (February 1998). Internally, however, it's a rather different beast. The Silver 60 is Quicksilver's response to a speaker manufacturer's request for a tube amp that could drive difficult loads and still sound good. But this push-pull design also incorporates lessons that Mike Sanders, Quicksilver's chief designer, learned from low-power, single-ended (SE) triode amplifiers.

Initially, Sanders was skeptical about SE amps because of their generally poor measured performance. Ultimately, he realized that the best models' virtues—amazingly good dynamics and clarity and bass with equally good impact, extension, and definition—justified further research. Much of the improved low bass, he found, came from using oversized output transformers, whose primary windings had high enough inductance for efficient low-frequency coupling to the power tubes. (Low-inductance primary windings cause poor low-frequency performance with demanding speaker loads.)

According to Sanders, further experimentation with tube operating points, circuit topology, component values, and other parameters yielded a more dynamic sound and powerful bass, much like the best SE amplifiers. These changes sacrificed certain measured parameters in order to improve load-driving ability and duplicate some of

**QUICKSILVER AUDIO'S
SILVER 60 COMBINES
PUSH-PULL POWER
WITH SOME SONIC VIRTUES
OF SINGLE-ENDED AMPS.**

SE designs' desirable sonic attributes in an amp that retained the higher power of push-pull.

Visually, the Silver 60 has a simple elegance, its black rear cover (which houses the power and output transformers and two filter capacitors) making a pleasing contrast to the chrome chassis. Four output tubes and a small input tube rise from the chassis' projecting apron. The only control



features are a large on/off rocker switch and a green LED pilot light on the front of the apron; the output circuit is self-biasing, so no bias adjustment is provided. The rear panel holds a screw-terminal barrier strip for speaker connections (with taps for 1, 4, and 8 ohms), an RCA input jack, an AC line fuse, and an IEC power-cord socket.

The Silver 60's construction is simple, elegant, and traditional. The wiring is point-to-point, with Quicksilver's typical neatness, using the chassis as the ground bus. Parts are of a high quality. All in all, a very nicely made amp.

Measurements

Unless otherwise noted, all reported results are for the Silver 60 amplifier I used in

the left channel (which was distinguished from the other amp by a white band on its input jack); results for both amps were very similar.

Frequency response at the 8-ohm tap is shown in Fig. 1A, response at the 4-ohm tap in Fig. 1B. In each case, I used the NHT dummy speaker load, an open circuit, a

Rated Output: 60 watts.

Dimensions: 15 in. W x 6½ in. H x 9¾ in. D (38.1 cm x 16.5 cm x 24.8 cm).

Weight: 36 lbs. (16.3 kg).

Price: \$2,350 per pair.

Company Address: 5635 Riggins Court, #15, Reno, Nev. 89502; 702/825-1514; www.quicksilveraudio.com.

ASSOCIATED EQUIPMENT USED

Equipment used during the listening test sessions for this review consisted of:

CD Equipment: Classé Audio DAC-1 and Sonic Frontiers Processor 3 D/A converters, PS Audio Lambda Two Special and Sonic Frontiers Transport 3 CD transports, Sony CDP-707ESD CD player, Panasonic DVD-A310 DVD player, and Genesis Technologies Digital Lens anti-jitter device

Phono Equipment: Kenwood KD-500 turntable, Infinity Black Widow arm, Win Research SMC-10 moving-coil cartridge, and Vendetta Research SCP2-C phono preamplifier

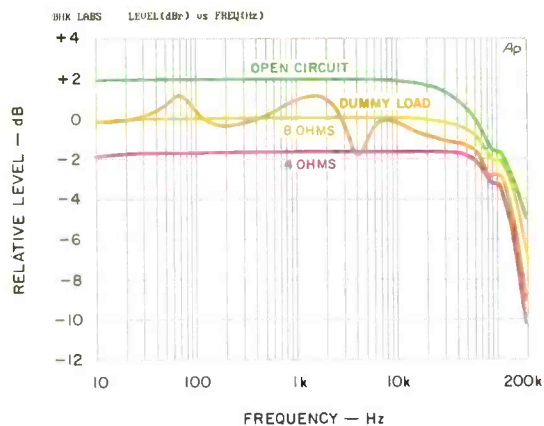
Additional Signal Sources: Nakamichi ST-7 FM tuner, Nakamichi 1000 cassette deck, and Technics 1500 open-reel recorder

Preamplifiers: Sonic Frontiers Line-3 and First Sound Reference II passive, modified Quicksilver Audio LS, and Dynaco PAS-2

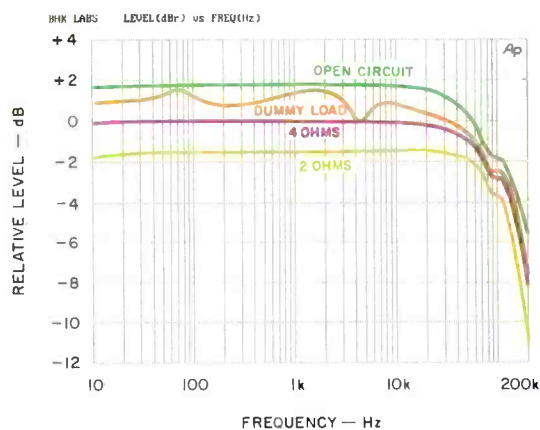
Amplifiers: Arnoux Seven-B stereo switching amp, Quicksilver Audio M135 mono tube amps, Manley Labs Stingray stereo tube amp, deHavilland Electric Company Aries single-ended mono tube amps, E.A.R. V20 integrated tube amp, and Sumo Polaris solid-state stereo amp

Loudspeakers: Dunlavy Audio Labs SC-IIIs and Tannoy Churchills

Cables: Digital interconnects, Illuminati DX-50 (AES/EBU balanced); analog interconnects, Vampire Wire CCC/II and Tice Audio IC-1A; speaker cables, Kimber Kable BiFocal-XL and Madrigal Audio Laboratories HF2.5C



A



B

Fig. 1—Frequency response as a function of loading on the 8-ohm tap (A) and 4-ohm tap (B).

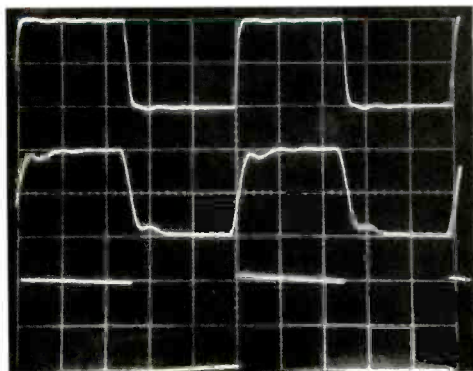


Fig. 2—Square-wave response for 10 kHz into 8-ohm load (top), 10 kHz into 8 ohms paralleled by 2 µF (middle), and 40 Hz into 8 ohms (bottom); all tests made at 8-ohm tap.

matching load (8 ohms on the 8-ohm tap, 4 ohms on the 4-ohm), and a resistance of half that load (4 and 2 ohms, respectively). The curves for the 4-ohm tap are a bit closer together, signifying slightly better output

regulation with load and a slightly higher damping factor at that tap. (This is because the turns ratios of many output transformers, including the Silver 60's, yield 9- and 4-ohm taps rather than 8- and 4-ohm.)

The Quicksilver's square-wave response (Fig. 2) is fairly good at 10 kHz into an 8-ohm resistive load on the 8-ohm tap, and the absence of the usual overshoot, ringing, and increased rise time when a 2-microfarad capacitor is paralleled across the load is commendable. (Thus, the Silver 60s would be a good choice for driving electrostatic speakers.) The amp's excellent low-frequency response can be gleaned from the small amount of tilt in the 40-Hz trace. Rise and fall times for a ± 5 -volt output into an 8-ohm load on the 8-ohm tap were 2.8 microseconds; with a 4-ohm load on the 4-ohm tap and the

same input drive level, the results were 3.1 microseconds.

Figures 3, 4, 5, and 6 show several aspects of distortion, all measured at the 8-ohm tap. Figure 3 plots two types of distortion

versus power, total harmonic distortion plus noise (THD + N) at 1 kHz for various loads and SMPTE IM distortion for an 8-ohm load. In Fig. 4, THD + N versus frequency at several power levels, there's a commendably small increase in distortion



THE SILVER 60'S CIRCUIT IS AS MINIMAL AS IT CAN GET AND STILL BE PRACTICAL.

at each end of the audio spectrum. Figure 5 reveals that the second and third harmonics are dominant through most of the output range and that the fourth and fifth harmonics are essentially out of the picture until

TECHNICAL HIGHLIGHTS

The circuit of the Quicksilver Audio Silver 60 is as close to minimal as it can get and still be practical. Signal input is applied to the common-cathode first stage, using half of a 12AT7 twin triode. That stage's plate output is directly coupled to the grid of the second stage, a split-load phase inverter, which uses the other half. The phase inverter's outputs are capacitor-coupled to the control grids of the output tubes.

Two paralleled push-pull pairs of output tubes are used, in an Ultra-Linear circuit configuration. These tubes should have a long useful life, as four of them are used even though power output is relatively low. A common cathode resistor, bypassed with a capacitor, provides self-bias-

ing (cathode bias). The Silver 60 comes with EL34 output tubes, though other types (such as KT88s, 6550s, or 6L6s) can be used. The plate-to-cathode voltage is somewhat lower than is the norm nowadays, on the order of +385 volts. Current draw, while not terribly high, is higher than Quicksilver's norm: With EL34s, it's around 55 milliamperes per tube, for output stage dissipation of some 84 watts at idle. Setting the output circuit's operating points for lower voltage and higher current than customary was part of the amplifier's voicing. Overall feedback is taken from the 8-ohm connection on the output transformer back to the cathode circuit of the first stage. *B.H.K.*

about 20 watts. Except for the sixth harmonic, which attains almost the same level as the fourth at 10 watts out (Fig. 6), the higher harmonics drop fairly rapidly to very low levels. The Silver 60's overall measured distortion was not as low as that of

tor was a bit higher, about 4, because of the improved output regulation at that tap.

Dynamic power at the start of the 20-millisecond IHF tone burst was 68 watts, yielding dynamic headroom of 1.1 dB, but dropped to 64 watts by the end of the burst. With a 1-kHz tone, the amps started to clip at about 58 watts, yielding clipping headroom of -0.3 dB. Voltage gain into 8-ohm loads on the 8-ohm tap was 24.79 dB for the amp I used for the left channel and 24.88 dB for the amp I used for the right; corresponding IHF sensitivity for 1 watt into 8 ohms was 163 and 161.3 millivolts, respectively.

Output noise for the left-channel amp was 537.2 microvolts wideband and 99.8 microvolts A-weighted; for the other amp, the results were 873.9 and 126.6 microvolts. The IHF signal-to-noise ratio was 89 dB for the left channel and 87 dB for the right. The AC line current was 1.44 amperes at idle, increasing to 1.7 amperes at 58 watts into 8 ohms on the 8-ohm tap.

SQUARE-WAVE TRACES AND DAMPING FACTOR REFLECT THIS AMP'S EXCELLENT BASS PERFORMANCE.

some past Quicksilver amps. This is primarily because of the newer circuit's simplicity, the small amount of global feedback, and the designer's optimization of circuit operating points for best sonic performance rather than lowest measured distortion.

As you can see in Fig. 7, the Silver 60's damping factor is relatively constant over the frequency range, even in the low bass, at the 8-ohm tap. Although the 4-ohm curve's shape was very similar, overall damping fac-

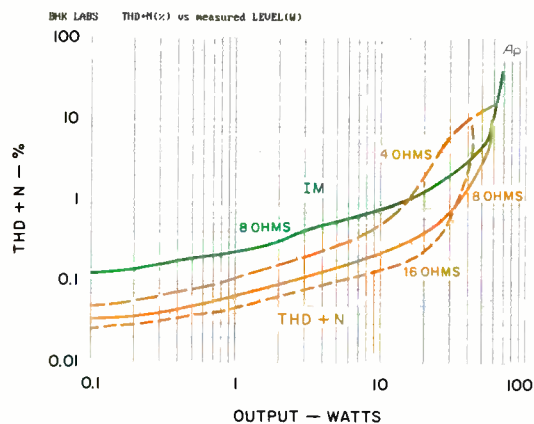


Fig. 3—Distortion vs. power output, at 8-ohm tap.

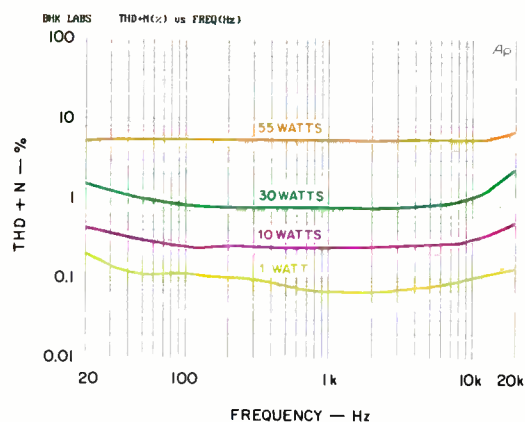


Fig. 4—THD + N vs. frequency, 8-ohm load on 8-ohm tap.

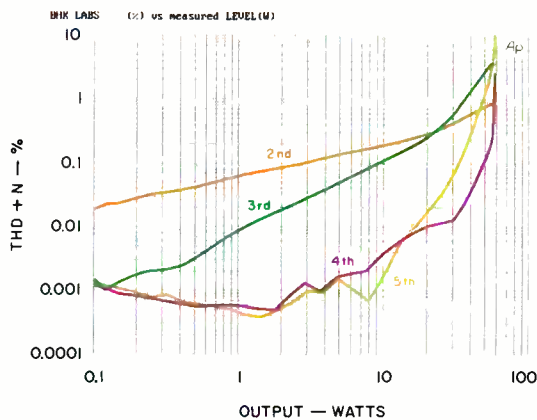


Fig. 5—Second through fifth harmonics vs. output at 1 kHz, 8-ohm load on 8-ohm tap.

Use and Listening Tests

For my initial listening, I used the Quicksilver Silver 60 amplifiers to drive a pair of Dunlavy Audio Labs SC-III loudspeakers

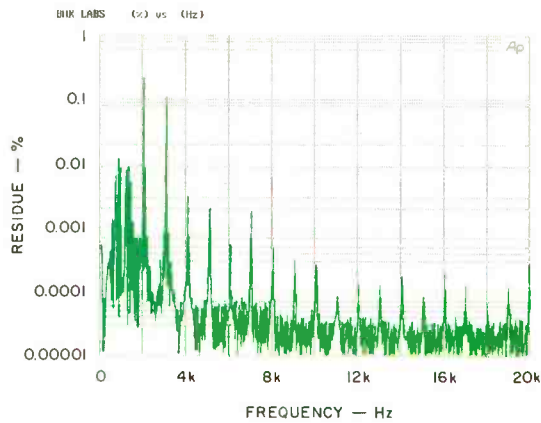


Fig. 6—Spectrum of harmonic-distortion residue for a 1-kHz signal at 10 watts out into 8 ohms on 8-ohm tap.

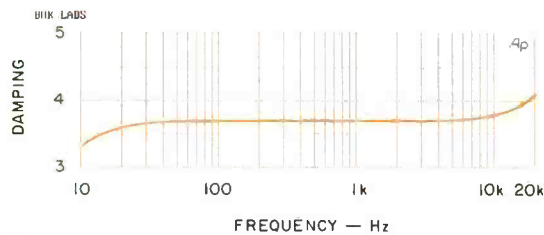


Fig. 7—Damping factor at 8-ohm tap.

(which I reviewed in the July 1998 issue), augmented by a pair of Tannoy Churchill speakers used as subwoofers; the Churchills were driven by a Sumo Polaris stereo power amp via a custom low-pass filter whose input was the output from the Quicksilvers. My preamp for this setup was the First Sound Reference II.

When I received the Silver 60s, they were quite new, with virtually no playing time on them. They sounded good right out of the box, but I knew they would sound a bit better with more hours on them. And indeed, when I set them up for further listening after I'd made my measurements, they sounded even better.

I was quite impressed with the Silver 60s. Their transparency, space, air, and dimension were right up there with the best. Bass quality, impact, definition, and extension were also quite impressive. The Quicksilvers drove the Dun-

lavy SC-IIIs with enough power to play most of my favorite music at considerably higher volume levels than those I use for normal listening. And when I replaced the SC-IIIs with the Churchills, which are 4 dB more sensitive, the Silver 60s made these Tannoy speakers really stand up and shout!

**I WAS IMPRESSED
BY THE QUICKSILVERS'
TRANSPARENCY, SPACE,
AND BASS IMPACT
AND EXTENSION.**

Whether I used the Dunlavy/Tannoy setup or the pair of Tannoys alone, the Quicksilvers sounded amazingly natural and convincing.

The Quicksilver Silver 60s did their thing most competently and without problems. My only surprise was at how good these little amps were. I liked them a lot, enjoyed a lot of music with them, and most definitely recommend your giving them a listen. A

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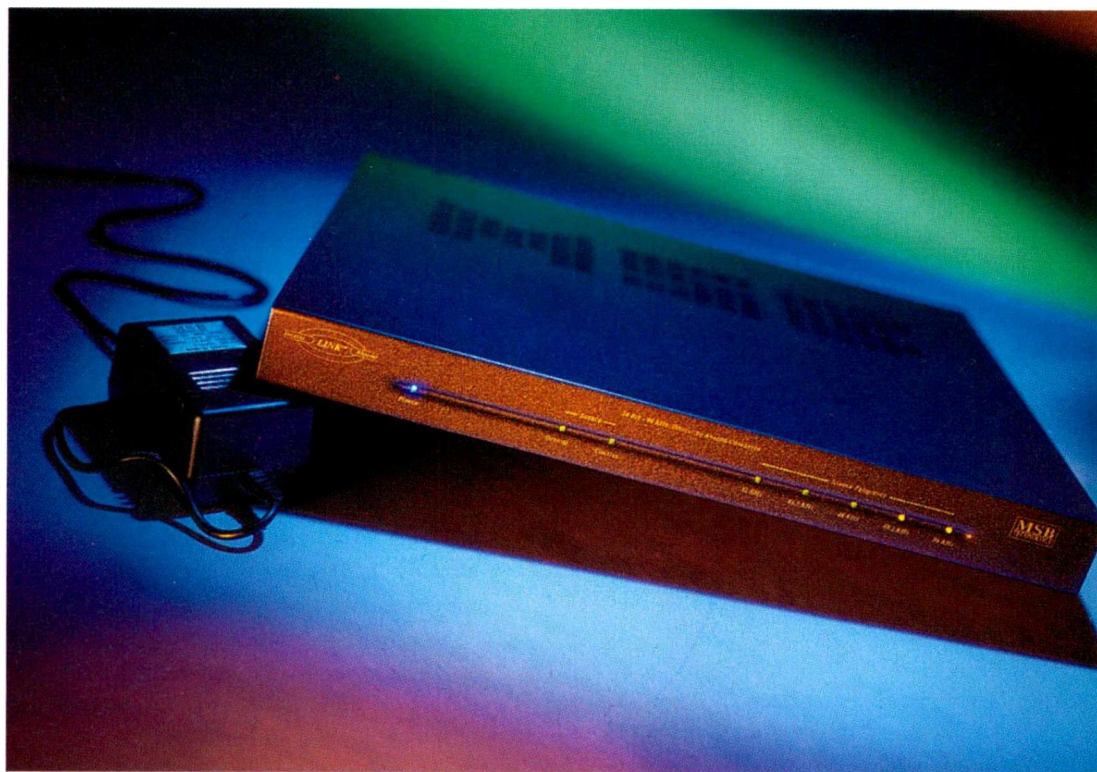
MSB TECHNOLOGY LINK D/A CONVERTER

Good things can come in inexpensive packages. At \$349, the Link won't be considered an assault on the state of the art, yet this MSB Technology D/A converter is one of the first 24-bit models available and one of the first to handle sampling rates as high as 96 kHz. Since it also accommodates standard sampling rates from 32 to 88.2 kHz, it can convert satellite broadcasts, CDs, and the 24-bit/96-kHz DVDs that are just starting to appear.

The Link is even upgradable, to an extent. Although it did not arrive in time for me to try, a plug-in virtual-surround card is available, at \$149, to provide more spacious imaging from Dolby Surround and some stereo recordings. And MSB promises that it will offer a reasonably priced decryption upgrade if a copy-protection system now sought by some software producers is adopted. (These companies want to limit the digital output from DVD players and transports to 48-kHz sampling, even on 96-kHz recordings.)

As might be expected at the Link's relatively low price, its front panel is not crammed with controls. There are none, in fact—just LEDs to tell you when the converter is on, which of its digital inputs is active, and what the signal's sampling rate is. Despite the absence of a selector switch, the Link has three inputs: coaxial and Toslink digital and a pair of analog RCA jacks. The Link automatically selects whichever digital input is active (if both are active, it chooses the coaxial); if neither is active, analog input signals are passed straight through to the output jacks. The MSB's analog input enables you to add two digital sources to your system without giving up one of your preamp's analog inputs.

The Link's digital circuitry seems very well engineered for the price. The DAC chips are Burr-Brown PCM1716s, with what that company calls Enhanced Multilevel Delta-Sigma modulator architecture. The Crystal CS8414 digital receiver chip



supports just about every professional and consumer digital signal format. And a phase-locked-loop anti-jitter circuit is said to provide 27 dB of jitter rejection.

The Link's analog circuitry is direct-coupled, to ensure good bass quality, and rated response extends down to 0 Hz. To keep these circuits entirely free of capacitors, MSB uses a servo loop to eliminate DC offset in the output signal.

The power supply is external, to keep AC out of the unit. Four voltage regulators keep the power clean.

A D/A converter with true 24-bit resolution would have an S/N ratio of 144 dB; even a 20-bit DAC should theoretically achieve about 120 dB. Yet no D/A converter I know of can lay claim to such S/N, so I'm not per-

turbed that the Link's rated dynamic range and S/N are 106 dB (about 10 dB better than a perfect 16-bit DAC). The *real* advantages of a 24-bit DAC are its ability to handle 24-bit inputs without truncation and its potential to minimize crossover distortion.

Sonically, the Link is not a world beater, but it does deliver very clean sound from conventional CDs and DATs, with less digital haze and hardness than most D/A converters in its price range. However, it is a bit lean in the lower midrange. And its

Continued on page 79

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How Do Your Speakers Measure Up?



Take a look at any speaker manufacturer's lineup. Chances are their "top of the line" offers a lot more piston area than their "starter" models. Why?

With speakers, bigger is better. Unless, of course, you don't care about visceral impact. Or distortion. Or efficiency. Or dynamic contrast.

Now some folks will try to convince you that an 8" woofer is faster than a pair of 12". But moving air is a volume velocity issue.

Relying on an 8" driver to pump up your 2500 cubic foot listening space is like fanning yourself with a guitar pick. Distortion will rise and transient response will be compromised (unless you've recently devised a scheme for miniaturizing a 30-foot wavelength).

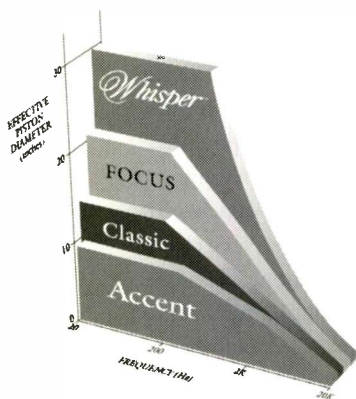
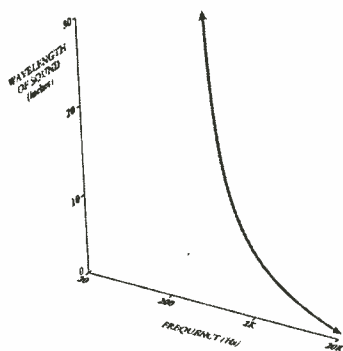
The laws of physics dictate that a loudspeaker's effective radiating diameter should increase proportionally with the wavelength of sound to provide consistently low distortion, broad dynamic range and uniform power distribution.

Study the chart to the side. Note how closely Whisper's effective radiating diameter tracks the wavelength of sound. This provides stable imaging, low distortion and extraordinary dynamic capabilities. This type of chart is very useful in approximating the potential performance level of any loudspeaker design. You may find it helpful to chart the loudspeakers you are currently using on this graph. (We think you'll be in for a surprise!)

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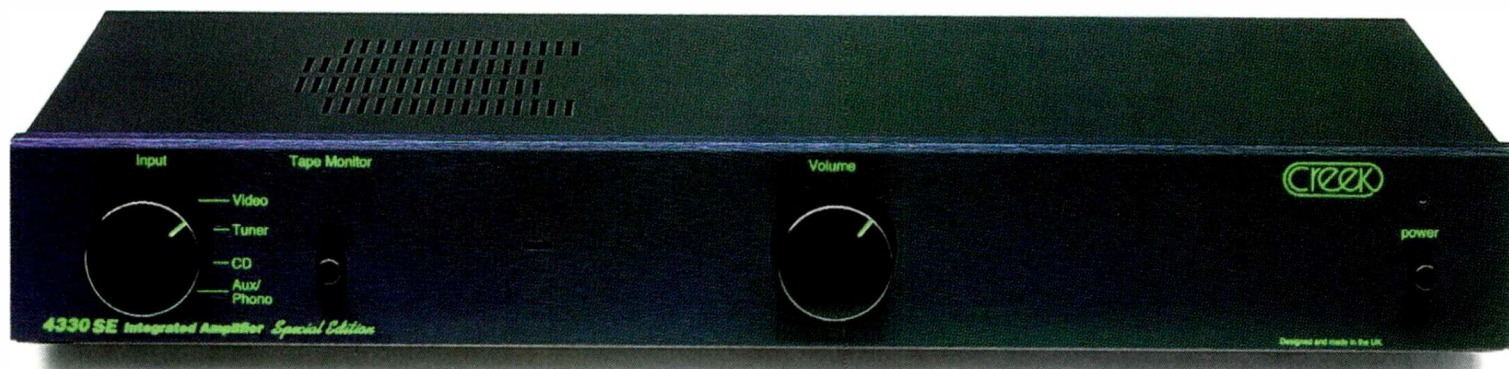
CREEK 4330SE INTEGRATED AMP

If I had to define the “Britishness” of hi-fi equipment built in the United Kingdom, all I would need to cite is two product types: small, two-way speakers and minimalist integrated amplifiers. Sure, there are other U.K. specialties—cable fetishism, belt-drive turntables, and mandatory ugliness or user-unfriendliness—but compact two-ways and integrated amps are universally identified as two-thirds of what constitutes a typically British system. The supremacy of U.K. brands in these market segments has yet to be challenged, just as American companies remain the leaders in the manufacture of huge speaker systems and powerhouse amplifiers.

styling, added features, remote or programmable functions, and nods to multiroom capability. This has resulted either in attempts at matching the commercial skills of Denon, Marantz, Pioneer, et al. or in the creation of a breed of weird integrated *überamps* that are generally too

respectable niche in a market swamped with competent 40-watters sans tone controls. The 4240 was supplanted by the \$495 4330, and now it, too, has an SE version, priced at \$900.

Creek amplifiers are deceptive because they're so understated. The



But lately, the British seem to have lost faith in the Old Ways, abandoning the classic simplicity of clutter-free amps, some of which sold in the tens of thousands. (Arcam, for instance, is said to have moved 60,000 units of the A60.) Whereas small two-ways continue to flourish, helped by the fact that they can be used in home theaters, purist amps have suffered.

Because the British have yet to recognize that the world has gone multichannel, they've decided to tackle consumer needs in the '90s with slick

iconoclastic, too poorly made, or too ugly to challenge the likes of Krell's KAV300i or other high-end integrat-eds. The British company Creek, on the other hand, knows what it does best and what still appeals to that solid, dependable market of aspiring high-enders.

Along with too few others, Creek remains willing to produce integrated amplifiers for impoverished music lovers prepared to swap novelty value for sonic worth. It has always eschewed high-priced wares in favor of good, honest fare; the 4240, launched in 1993, and its deluxe sibling, the 4240SE, carved a

first thing you notice is that they're tiny. True, the company knows the world is full of components whose front panels are 16 to 17 inches wide, so the 4330SE is a diplomatic 16½

CREEK KNOWS WHAT IT DOES BEST AND WHAT STILL APPEALS TO THAT DEPENDABLE MARKET OF ASPIRING HIGH-ENDERS.

inches across. But it's only 2¼ inches tall and is a mere 9 inches deep (not counting the knobs and connectors), so you might not take it se-

riously. Yet when you heft it and discover that it weighs a decent 13 pounds, you know that the enclosure houses more than air.

Following what is pretty much standard practice for quality amplifiers of an affordable nature, the

Company Address: c/o Music Hall, 108 Station Rd., Great Neck, N.Y. 11023; 516/487-3663; www.musichallaudio.com.

4330SE contains a large toroidal transformer occupying one-third of the chassis. The remainder is filled with a large, nicely made motherboard holding the active circuitry, large heat sinks, and directly connected controls and jacks. Internal wiring is limited to the ground, the power-supply connections, and the on/off switch.

On the back panel are multiway binding posts that address the odious European CE requirements by having the jacks for banana plugs blocked. (Ironically, the hole in the pillar that accepts bare wire just happens to be large enough to take a banana plug sideways.) There are RCA jacks for four line-level inputs, tape in and out, and preamp outputs, plus a grounding post for a turntable.

A phono stage is optional (\$60 for the CMM moving-magnet board, \$95 for the CMC moving-coil), as is an active gain stage for the preamp section (the \$60 CGAIN plug-in board). I mentioned several sub-fetishes that have taken hold in the U.K.; another is a continued flirtation with passive preamps. (Full marks must go, however, to the late, lamented Mod Squad for popularizing passive preamps in the United States and for lifting them out of the low-end, price-driven U.K. mire.) The 4330SE has a passive preamp section, whose advantages and disadvantages can easily be summed up in a single mantra: less noise and distortion but less oomph and gain.

The limitations of passive operation are more obvious in stand-alone passive preamps than in integrated amps, where preamp-to-power-amp impedance mismatches can be prevented and no interconnects are required. But you still notice an overall sense of restraint, so I wouldn't be surprised if a large number of 4330SE owners eventually opt for the turbo boost provided by the optional preamp module's extra 3, 6, or 9 dB of gain. If, on occasion, the 4330SE

will be used as a stand-alone preamp, then the module is a must if you're to avoid the constraints of passive operation.

A British integrated amplifier's street cachet is based on paucity of controls. Why? Because the British believe, to a man, that anything superfluous, such as styling fillips, means money spent on some aspect other

than sound; it's a wonder that no enterprising flat-earther has yet produced an integrated amplifier without a case, which he could argue does little more than clothe the circuitry. Anyway, the Creek 4330SE makes all the right moves, sporting only a rotary source selector, a tape monitor button, a centrally positioned rotary volume control, and an on/off button. Anything less, and it would be inoperable.

(Brickbats for the

schnorrer in the back who said, "Bring back the combination power switch/volume control!")

But Creek is wise enough to know that, although its heart is firmly with the minimalists, it must sell its wares to real people. So the 4330SE comes with a remote for volume and muting. Add to this the choice of passive or active preamplification and the luxurious touch of a three-color (red/green/yellow) LED to indicate power on, muting, and volume adjustment, and you can see that minimalism needn't be an exercise in masochism.

What you find under the hood, though, is what counts most, and Creek has made sure that the 4330 will drive tough loads (allegedly down to 1 ohm). High-current MOS-FETs are the active devices of choice, and high sensitivity in the output section enables Creek to use passive preamplification without kneecapping performance. An overkill power supply, DC coupling from input to output, and sophisticated servo circuitry to monitor the amp's behavior: This is classic "BritAmp" technology. But the SE adds more spice.

Where the standard 4330 uses zinc-plated RCA jacks, the SE's are gilded. The steel and alloy enclosure of the 4330 is, in the SE version, an all-aluminum substitute, and the 120-volt-ampere toroidal transformer of the 4330 is replaced by a 160-volt-ampere unit. Power-supply capacitance has been increased from 20,000 microfarads in six devices to 28,000 microfarads with 12 devices. The standard 4330's 16-millimeter Soundwell volume control has been replaced with a sexier, 27-millimeter Alps Blue Velvet. And, most important, the 4330's quartet of 25-ampere output transistors have been replaced with 40-ampere devices. All this, plus supplied remote control, for a mere \$405 premium over the price of the basic 4330. (Editor's Note: An intermediate model, the 4330R, is \$595 and includes a remote control.—A.L.)

Number crunchers will note only one key specification change, but it's crucial: Instead of a power output rating of 40 watts per channel into 8 ohms, the SE version is rated to deliver 50 watts per channel. But, as defenders of gutless wonders have always been at pains to point out, wattage isn't always the key to an amp's usability—even though the 4330SE can boast of 400 watts of peak power into 1 ohm. What was evident throughout my listening sessions was that the Creek didn't care what kind of load it had to feed. Thus liberated, I played with speakers ranging from a sane, nominally 8-ohm speaker with a rated sensitivity of 90 dB at 1 watt/1 meter, to a particularly nasty 4-ohm load of the less-than-85-dB type, to both old and current Quad electrostatics, 15-ohm LS3/5As, and even the quirky Optimus LX5 Pros.

Experiencing a British amp for the first time must be a shock to those weaned on behemoth designs with wattage in triple figures. What one learns *not* to use as an arbiter (of quality) is playback level—real, imagined, maximum, what-have-you. At no point did I ever crave the active preamp module, but neither did it seem as if the Creek would do justice to the weight and majesty of, say, Deep Purple in full cry. After carefully measuring sound pressure levels and settling on a selection of like-priced rivals from Roksan, Musical Fidelity, and others, I felt time and again that Creek had consciously chosen finesse over grandeur, detail over scale, transparency over rich-



**THROUGHOUT
MY LISTENING SESSIONS,
THE CREEK DIDN'T CARE
WHAT KIND OF LOAD
IT HAD TO FEED.**

ness. It was as if the 4330SE were designed with the sole purpose of optimizing the performance of, say, top-quality, two-way mini-speakers.

Confusing though it may seem, the trade-offs work, provided they're assessed in that context. However unfussed the Creek 4330SE may be about ornery loads, however loud it goes in practice, it, like the NAD 3020, must be carefully matched to speakers that favor this sort of presentation. And if you remember the way the original NAD 3020 was sold, it was always driving small two-ways. What the Creek does for that recipe depends on the caliber of speakers to be addressed.

Because it is so smooth and detailed, and so coherent and transparent as to suggest

**CREEK HAS CHOSEN
FINESSE OVER
GRANDEUR, DETAIL OVER
SCALE, TRANSPARENCY
OVER RICHNESS.**

a much higher price tag, the 4330SE is a dream companion for refined designs like the small Sonus Fabers, any of the BBC LS3/5As, and the Quad 77-10Ls. What seems to upset the Creek—or, if your glass is half empty, upstage it—are shouty speakers or those voiced to exaggerate the treble. Alas, this includes numerous bargain-basement American-made speakers, so a full appreciation of the Creek encounter is most likely with British or, at least, European speakers.

Those of you with horrible memories of the NAD 3020 should discount my likening of the Creek to that rather overrated anomaly. Instead, you should consider its precursor that sublime, if equally restrained, integrated amp from Dynaco, the SCA-35. That I'm prepared to liken, in print, the Creek 4330SE to a tubed classic (and I do mean *classic*) should be enough to alert all of you who can't spend more than \$900 to a little treasure that just might have passed you by in its relative obscurity. I mean, are Creek dealers as plentiful as those of Denon, Pioneer, and the like? More to the point: How many of you have even heard of Creek?

Now you have no excuses.

A

MSB, continued from page 75

dynamics and transients, though good to very good, are not quite excellent. Imaging is very natural, but the soundstage could stand more depth. The bass is very good to excellent, especially considering the Link's price, and there's plenty of power and definition. You can find D/A converters that equal the Link in warmth and other nuances, but you would probably have to spend at least three to four times as much to get anything cleaner or decidedly better.

The Link does enable you to clearly hear the differences between conventional 16-bit sources and the new 24-bit/96-kHz DVDs. Although its sound is not at the level of the dCS Elgar or Theta Digital's converters, its dynamics, transients, transparency, low-level detail, and natural musical overtones and harmonics are noteworthy.

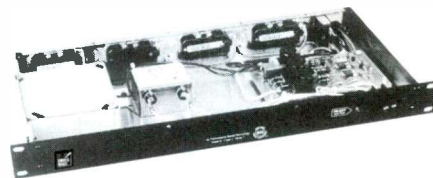
Only a few DVD decks provide the 96-kHz output you need to hear the Link at its best. Check any DVD player before buying it to make sure its output is actually 96 kHz and that it will light up the proper sampling-rate indicator on a D/A converter with 96-kHz capability. Most DVD players downsample 96-kHz signals (from those few discs that carry them) to 48 kHz before feeding them to their digital outputs. The only exceptions I know of are Pioneer's DVD decks, including the new DV-414D (which costs around \$400). Other inexpensive DVD players with 96-kHz output capability may be available soon, however, and for \$385 MSB will upgrade any DVD player for 96-kHz output.

The new Classic Records and Chesky 24-bit/96-kHz DVDs make a powerful argument for the world beyond CD. Classic has outstanding new Terry Evans, John Lee Hooker, and Jimmy Rushing remasterings, while Chesky has a variety of vocals, jazz, and classics. I was particularly struck by Evans' *Blues for Thought* (Classic DAD-1014) and by Kelly Flint's vocals and the instrumental passages on Dave's *True Stories' Sex Without Bodies* (Chesky CHDVD-174). Track 4, "I'll Never Read Trollope Again," is truly witty (possibly a first for a female vocal on a high-end recording).

Yes, such recordings present a powerful argument for the next leap in audio. But it takes an excellent, affordable D/A converter like MSB Technology's Link to make that argument compelling.

A

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25 Years is more than a survey of Kronos's career; it's a survey of the most important musical developments of the last half of the century as seen through the eyes of violinists David Harrington and John Sherba, violist Hank Dutt, and cellist Joan Jeanrenaud. Although they've performed thousands of compositions together, *25 Years* isn't a Whitman's Sampler of obscure works, outtakes, or discarded recordings. Instead, the focus is on music that has most clearly defined the group's sound and aesthetic. Kronos's takes on James Brown and Jimi Hendrix, its two albums of Thelonious Monk and Bill Evans compositions, and even its popular

albums (such as *Pieces of Africa*, a personal favorite) were ignored, because in the end, they were side trips, even for these erstwhile experimenters. The 10 CDs of *25 Years* immerse you in a world of sound. Full discs are dedicated to Philip Glass, Terry Riley, Morton Feldman, Henryk Górecki, and Alfred Schnittke, while composers John Adams, Steve Reich, and Arvo Pärt get healthy portions of other discs.

The musicians of Kronos are virtuosos, but they've never selected music solely as a showcase for their talent. An 80-minute piece of slowly shifting sustained notes, as on Feldman's Piano and String Quartet with pianist Aki Takahashi, is not the stuff of classical competitions. Yet this is a piece of extreme control and subtle manipulation, in an environment where ego is lost. In other words, it ain't Béla Bartók, though Kronos could play him as well.

Kronos has been closely associated with the maturation of minimalism. The group literally dragged the father of that movement, Riley, into notating music for the first time since 1965. This led to some of his most epic and complex pieces, represented here by "Salome Dances for Peace" and "Cadenza on the Night Plain." Note that this is decidedly not the Riley of "In C" or "A Rainbow in Curved Air"; composing for Kronos drew out expansive, dynamic works full of emotional shadings and elongated, rather than cyclical, routes.

For Glass, on the other hand, Kronos illuminates the elegant simplicity of his lines. And the group calls forth the self-plagiarism that has afflicted his music in the last decade.

25 Years is also a collection of connections. In Kronos's mind, the lighthearted dance pieces of Adams's "John's Book of Alleged Dances" and a suite of Pärt's works are points on a continuum. Adams's dances are robust works. Full of melodic whimsy and elliptical, frequently motoric, rhythms, they are played on a pre-



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Anonymous 4

A Lammas Ladymass

HARMONIA MUNDI

HMU 907222, 64:08

Sound: B+, Performance: A

While Anonymous 4 is a justly acclaimed quartet of early-music singers, something in their harmonies always struck me as too smooth, too restrained.

From the first notes of *A Lammas Ladymass*, it's clear that's changed. There's a resonant texture and quiet ecstasy to the group's performances of these English 13th- and 14th-century chants that is wonderfully seductive.

Lammas is a Celtic harvest festival, and a Ladymass celebrates the Virgin Mary. Anonymous 4 combines the two in this suite of chants, hymns, and antiphons. It's a gripping, uplifting sound that echoes

throughout Le Feuillet Paroissial de Saint Augustin, where this album was recorded.

The voices are beautifully captured in this naturally resonant space.

However, a low-end rumble of street noise or ventilation hangs like a bass pedal tone throughout.

John Diliberto



pared piano that sometimes sounds like a broken grandfather clock. Pärt, by contrast, is a composer who marked the beginning of a new spirituality in music. Often referred to in the British press as a "Holy Minimalist," Pärt's solemn refrains are in sharp contrast to Adams's spritely works. They show the range of Kronos and, on Pärt's "Fratres," the way it can wrench every nuance out of notes that are sustained till nearly breaking.

Another pairing finds George Crumb next to Reich. David Harrington has said that Crumb's "Black Angels for Electric String Quartet" inspired the formation of Kronos. Although Crumb himself called it an "impractical" piece to perform, with percussion instruments, amplification, and water-tuned crystal goblets that are bowed by the players, Kronos digs into "Black Angels" with all the theatrical verve the composer could desire. The group dives through its shards of melody, electric distortion, and glassine ambiances. Crumb's "Black Angels," a lament for Vietnam, follows Reich's "Different Trains," a tape collage of World War II remembrances from Holocaust survivors and others. These two pieces link musical generations that at one time were in opposition.

There are gaps in this collection. Little of Kronos's most experimental and dissonant repertoire—including commissions by Bob Ostertag, Cecil Taylor, and John Zorn—is represented. Kronos has commissioned a wide range of composers, many of whom wrote their only legitimate string quartets for the ensemble. Ken Benshoof, a classmate of Harrington's and the first composer commissioned by Kronos, stands in for all the relative unknowns who've written for the group. Benshoof's essentially Romantic style is tempered by a minimalist sense of austerity, but he's one of the few questionable entries here.

Kronos casts a wide net for its music, going outside the world of Western classical and

avant-garde music, soliciting and unearthing works from Africa, Asia, and Latin America. From Argentinean-born Osvaldo Golijov's klezmer-inflected "The Dreams and Prayers of Isaac the Blind" to Azerbaijan-born Franghiz Ali-Zadeh's tamboura drone on "Mugam Sayagi," *25 Years* captures a group that has fought against Western hegemony in classical music. Kronos inhabits each of the worlds on *25 Years*—whether it's Górecki's restrained spiritualism or Astor Piazzolla's sensual tangos—as if its members have lived in them all their lives. In many cases, Kronos was the midwife to their birth.

John Diliberto

Cage: Sonatas and Interludes

Aleck Karis, prepared piano;

John Cage, lecturer

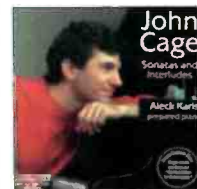
BRIDGE RECORDINGS 9081A/B

Two CDs, 1:27:53

Sound: A, Performance: A

John Cage's name is well known, but his compositions often are not. Although many people know only of his innovative, controversial, and sometimes outrageous ideas, few have taken the time to appreciate the music itself. This new Bridge recording of Cage's fascinating sonatas and interludes for prepared piano makes a good introduction to this consummate musician.

These 16 "sonatas" are, of course, light-years away from the classic sonata form. The pieces are grouped in fours, occasionally interrupted by the interludes, and are all through-composed. It is not the form of the works that captivates, but the huge spectrum of sounds. For in these pieces for prepared piano, we at times hear a piano, at other times a percussion ensemble, and sometimes even an Indonesian gamelan. There is none of Cage's notorious



randomness; everything is precisely notated. Indeed, each of the various nuts, bolts, screws, and erasers that are to be placed on the strings inside the piano must be carefully set according to explicit directions.

Some pianists might be hesitant to take on Cage's work; at best, they may see it as an interesting curiosity. Yet Aleck Karis performs these pieces with enthusiasm and musicality. As you listen to his interpretation, you sense that he is looking for beauty rather than novelty. After preparing the Steinway himself, Karis plays it with a wide variety of touch, from delicate to percussive. Yet it is always played *musically*, with the emphasis on line rather than effect.

Lest any thrill-seeking listener be disappointed in buying this package and finding "only" lovely, credible music, Bridge has included a second CD, of Cage reading a lecture entitled "Composition in Retrospect." It is vintage Cage philosophy, guaranteed to leave you pondering.

Patrick Kavanaugh

Elgar: The Sketches for Symphony No. 3, Elaborated by Anthony Payne

BBC Symphony Orchestra, Andrew Davis
NMC D053, ADD, 56:10
Sound: A, Performance: A

Elgar: Commentary for The Sketches for Symphony No. 3

Anthony Payne, commentator; Robert Gibbs, violin; David Owen Norris, piano;
BBC Symphony Orchestra, Andrew Davis
NMC D052, ADD, 69:30
Sound: A-, Performance: A

The story has been much featured lately in periodicals, especially British music magazines. Just before his death from cancer in 1934, Edward Elgar discussed with his violinist friend, W. H. Reed, the status of some 130 pages of sketches he had for a BBC-commissioned Third Symphony that was to be his Opus 88. While in a depressed mood, he implored Reed, "...the symphony [is] all bits and pieces. ...don't let anyone tinker with it. ...no one could understand. ...[I] think you had better burn it." Yet Elgar had also told his doctor, "If I can't complete the Third Symphony, somebody will complete it. ..."

One can sympathize with the legal and ethical considerations of a composer's spoken thoughts, his heirs' desires not to publish any sketches or have anyone attempt a completion using the actual publication of over 40 facsimile pages (in Reed's biography of Elgar), and, not least, the overriding question of whether a jigsaw of isolated and in many cases unmarked fragments could actually be made into a viable work. Finally, in summer 1995, with the cooperation of Elgar's heirs and the BBC, the brilliant 62-year-old British compos-

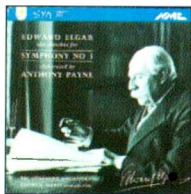
er, broadcaster, and lecturer Anthony Payne began to flesh out what previously had been mainly illustrative lecture material. The result is a magnificent symphony, even though, as Colin Matthews points out in the extensive annotations, "Although there can be no pretence that this is the Symphony as Elgar would have completed it, what we are given is the unmissable opportunity to hear the final thoughts of a great composer."

It is a powerful, haunting work and one of many moods: from the heroic drama and lyric sweep of the outer movements, through a wistful and questioning scherzo-light second movement, to the Adagio, which Elgar himself had described to the critic Ernest Newman as "stately sorrow." It is the last, in part introverted but often emotionally charged, that should be considered the crowning movement, though it is also difficult not to respond to the finale, vigorously confident at the start and resignedly up in the air at the very end, a kind of unanswered question and a far cry from the composer of the popular "Pomp and Circumstance, March No. 1." But without a doubt, all of this grand symphony has the sound of Elgar.

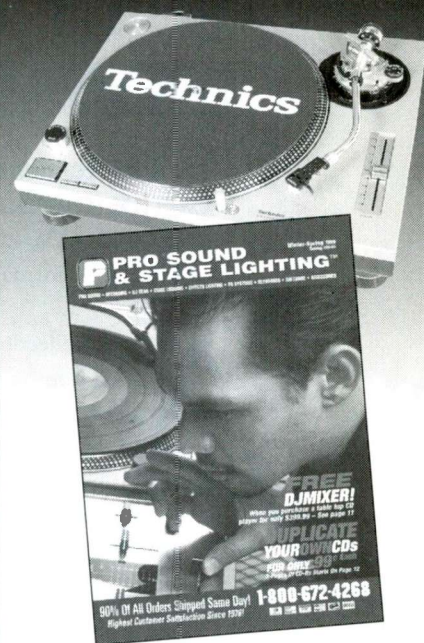
The performance of the "elaboration" (as Payne prefers to call his realization, rather than "completion" or "reconstruction") is entirely convincing and holds together marvelously. If the upper strings lack the ultimate mellowness, we should at least be glad to have such strong advocates for the first recording of this important piece. The orchestral sound is extremely full-bodied, with a fine sense of the soundstage and imaging that reveals second violins (as in the older disposition) to be on the right.

A nearly 70-minute-long companion CD (NMC D052) contains 50 sketches, all on separate tracks, and is linked together by Payne's spoken commentary. This fascinating, detailed document reveals the workshop procedures of both Elgar and Payne and includes some orchestral segments, but it principally consists of fragments performed on the piano with the greatest sensitivity and vitality by David Owen Norris. Norris also teams up with violinist Robert Gibbs in the same way that Elgar had run through the sketches in progress with his violinist friend Reed in the early 1930s. Perhaps a minor criticism might be voiced at the slight disparity in level between the well-recorded musical examples and the too-soft speech, but the symphony itself should be a prime candidate for a record-of-the-year citation.

Igor Kipnis



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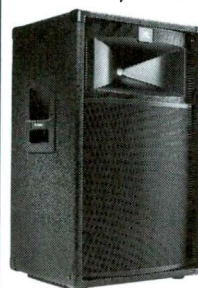


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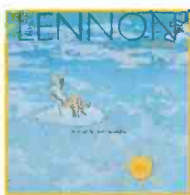
CAPITOL CDP 7243 8 30614 2 6

Four CDs, 4:27:49

Sound and Performance: Variable

A four-disc collection of previously unreleased home recordings, studio outtakes, and live tracks, *The John Lennon Anthology* effectively caps the former Beatle's career. Judging by some of the dubious choices and obvious filler (three outtakes of

these songs do not reach their apocalyptic heights; instead they seem positively humble. "Working Class Hero" is performed tentatively. Lennon still isn't sure of the phrasing, and his guitar playing lacks the droning determination of the final take. It's amazing to think that the album's spontaneous and raw sound was actually due to Lennon's unflagging sense of professionalism. You could take the boy out of The Beat-



producer Phil Spector and Lennon driving each other crazy through the studio intercom, home recordings of Lennon doing Bob Dylan impersonations, and Lennon's son Sean rambling incoherently), this anthology should be the last rummage through the archives and stand as Lennon's final word.

On the bright side, though, are the nine outtakes from Lennon's first solo album, 1970's *Plastic Ono Band*, which are among the collection's most startling discoveries. Because "Mother" and "God" are performed sans piano, with Lennon on guitar,

les, but you couldn't take The Beatles out of the boy.

The outtakes from *Imagine* are similarly uneven. The title track's first take is flawed by the presence of a droning harmonium. But "How Do You Sleep," Lennon's diatribe against Paul McCartney, is effectively blunt, without the Spectorian wash that softens the official version. The instruments bite hard, and Lennon's vocal is pure rage.

Sadly, however, Lennon couldn't keep pace. Discs two and three include an appalling number of clinkers, from the didactic politics of "Atti-

ca State," "John Sinclair," and "Luck of the Irish" to the bored professionalism of *Mind Games*, *Walls and Bridges*, and *Rock 'n' Roll*. *Walls and Bridges*' "Steel and Glass" and "Nobody Loves You When You're Down and Out" stand out as powerful portraits of Lennon's mid-'70s ennui.

By 1980, Lennon had recharged. And the fourth disc charts this, with the Cheap Trick-backed "I'm Losing You," rollicking takes of "Nobody Told Me" and "I Don't Wanna Face It," and a guitar and voice demo of "Watching the Wheels."

The *Anthology*'s sound and performances are variable, as there's everything from rough home demos to professional studio outtakes. A one-disc, 21-track sampler from the *Anthology* collection, *Wonsaponatime*, is available. But it's a mediocre overview that contains too many of the *Anthology*'s weaker cuts. *Rob O'Connor*

Photograph: © David Gahr

Dr. John

Anutha Zone

POINTBLANK/VIRGIN 13191, 56:58

Sound: B-, Performance: A-

After decades of moving toward the mainstream, Mac (Dr. John) Rebennack returns to the elements—the sun, moon, and earth—of his voodoo-rock roots. Back in '68, on the genre-busting *Gris-Gris*, Rebennack updated New Orleans gumbo with a strange and beautiful infusion of psychedelic R&B. He imprints that music's dense thematic swirl of good and evil, love and death, and desire over, under, and through *Anutha Zone*, his best recording in years.

Rebennack sounds revitalized as he rolls out thick carpets of layered horns over the supplest of rhythm sections on the title track. "I Don't Wanna Know" glistens, thanks to Paul Weller's tasty fret work and Jools Holland's succulent B-3. Rebennack is also helped out by Spiritualized on a few tracks. The best fit occurs on "Hello God," where the good doctor groans, "it's a hell of a world down here."

Even if *Anutha Zone* doesn't quite match the frenzied weirdness of the original *Gris-Gris*, it's great to have Mac back in the zone. *Steve Guttenberg*



Adam Cohen

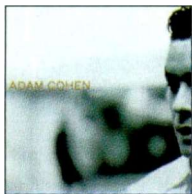
COLUMBIA CK 67657, 50:32

Sound: A, Performance: B

Leonard Cohen's 25-year-old son, Adam, shows the same talent for humor, self-exploration, and risk-taking as his father, producing songs that are at times as intricate as a novel and at other times as shallow as a comic book. Although the younger Cohen occasionally mires himself in corny melodrama, his debut is undeniably touching and memorable. A new rock voice to be reckoned with has emerged.

Recorded at 15 different Los Angeles studios, the self-titled album features a heavy-weight cast that includes Dean Parks, Larry Klein, Jim Keltner, Greg Phillinganes, David Baerwald, and Mark Isham. Cohen and producer Steve Lindsey took the Steely Dan approach here, mixing performances for utmost effect. The production is wonderfully lush, with subtle yet striking instrumental nuances throughout.

But it is Cohen's breathy singing that brings the album into focus, adding depth



to delicate songs like "This Pain," "Down She Goes," and the minor radio hit "Tell Me Everything." But with its syrupy, histrionic cries, his voice can also sink ships, as in "Quarterback" and "Opposites Attract."

Citing such records as Peter Gabriel's *So*, Roxy Music's *Avalon*, and Robbie Robertson's *Storyville*, Cohen signals that he is ambitious enough to take on the past. His own music is dreamy, melancholy, and mysterious—on a very warm, analog-sounding album in this hard-drive, digitized age.

Ken Micallef

Turnstyles & Junkpiles

Pullman

THRILL JOCKEY THRILL 055, 42:08

Sound: A, Performance: A

The Chicago alternative scene is much more than Smashing Pumpkins. Groups there have been producing guitar-based music that jumps and bumps with disjointed funk and deconstructed rock, as Sea and Cake does, or that rocks and weaves with electronically produced blips and beeps, as Tortoise and Trans Am do. Pullman, however, is a different animal.

John McEntire, the producer behind these bands, also has his hand in Pullman's *Turnstyles & Junkpiles*, but you'll hear nothing remotely danceable or electronically textured. This is an album of gentle guitar music, written and arranged by four men who've been around the Chicago music scene for some time and decided to apply a few of "their"

acoustic ideas to two-track. There are no fits and starts, no extreme highs or unexpected lows—just beautifully performed acoustic music, appropriate for a quiet night at home or a long drive at dawn.



I'm not suggesting that Pullman members Chris Brokaw, Bundy K. Brown, Curtis Harvey, and Doug McCombs don't offer some variety. ("Lyasnya," for instance, suggests a trip through a fun house, while one can definitely feel the chain gang or roadhouse blues of McCombs' solo guitar in "Fullerton" and the crawl of "Sunday Morning Traffic" is not a mystery.) Rather, what the quartet has opted for here is a consistency of feel, an evenness of execution. *Turnstyles & Junkpiles* is not an anthem for youthful joyrides but a soundtrack to real adult life.

Marie Elsie St. Léger

Step Inside This House

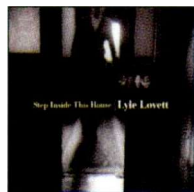
Lyle Lovett

CURB/MCA MCAD2-11831, two CDs, 1:20:27

Sound: A-, Performance: A

Lyle Lovett, one of the real, fanatical standard-bearers of original country music, moves even closer to his roots with *Step Inside This House*, a tribute to a pack of his favorite Texas songwriters. It's not that he had to do it: Lovett's recent recorded history includes two Grammy Awards (his second, Best Country Album in 1997, was for *Road to Ensenada*) as well as six diverse and extraordinary solo albums since 1986.

For Lovett—and, by extension, for us—*Step Inside This House*, a two-disc offering with 21 songs of blissful Texas-informed music, is a match made in musical heaven. In disc one, Lovett's voice dominates. He sounds as strong as ever, especially on the magical Guy Clark-penned title track, the understated but still elegant "Memphis Midnight/Memphis Morning" (composed by overlooked songwriter Eric Taylor), and David Rodriguez's gorgeous epic, "Ballad of the Snow Leopard and the Tanqueray Cowboy."



Lovett's three favorite Texas writers dominate disc two. Townes Van Zandt and Walter Hyatt, both recently deceased, and Steve Fromholz weigh in with three songs each. Though every track on each disc resonates with emotional impact and musical relevance, Fromholz's "Texas Trilogy"—divided into "Daybreak," "Train Ride," and "Bosque County Romance"—is a musical and cultural masterpiece. This triptych of skeletal acoustic simplicity paints a grand and colorful picture of the Texas landscape.

Bob Gulla

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DVD REVIEWS

Blues Brothers 2000

Blues Brothers 2000 1998; PG-13 rating; one-sided, dual-layer (1.85:1 aspect ratio); English and French Dolby Digital 5.1; English and Spanish subtitles. UNIVERSAL 20281, 124 minutes (feature), \$34.98
Picture: A, Sound: A, Content: A-

As one who was a little mystified at the popularity of the often caustic, abrasive original *Blues Brothers*, I've come out a born-again believer in the concept after seeing this sequel. *Blues Brothers 2000* takes place 18 years down the road, when Elwood Blues (Dan Aykroyd) is released from prison, only to find his brother, Jake, has died. In putting his band back together, he picks up a new partner, Mighty Mike the bartender (John Goodman), while hauling around the appealing pint-sized Buster (J. Evan Bonifant), a 10-year-old lad he's been asked to mentor.



Aykroyd, Goodman, and Bonifant make a much more immediately likable team than Aykroyd and John Belushi did in the first film. The production numbers are more masterfully choreographed and elaborate this time, including an exhilarating revival tent number. There's even an hysterical send-up of groups like the Charlie Daniels Band in which the musicians pose as the Bluegrass Brothers Band to play at an outdoor county fair.

Car chases and crashes abound, but there is even more emphasis on the music this time around, which is welcome. And what great music and musicians this movie show-



Photo: © George Kratichyk/Universal/Kobal

cases! As if it weren't enough to have veterans Aretha Franklin, James Brown, and Blues Traveler as headliners, there's a final battle of the bands that pits the Louisiana Gator Boys against the Blues Brothers Band. This made-in-heaven rhythm-and-blues band features such performers as Eric Clapton, Bo Diddley, Steve Winwood, B.B. King, Travis Tritt, Dr. John, Jimmie Vaughan, Isaac Hayes, and Lou Rawls on stage at the same time. (I've left out another dozen or so big names for lack of space.) The movie also manages to spotlight some new talent, such as the lovely Erykah Badu, who sang "A

The Replacement Killers

The Replacement Killers 1997; color; R rating; two-sided (one side 2.35:1 aspect ratio, the other full-screen pan and scan); Dolby Digital 5.1; English, French, and Spanish Dolby Digital two-channel matrix surround; English/Spanish/French subtitles; closed-captioned; includes trailer and featurette. COLUMBIA TRISTAR 21629, 88 minutes, \$29.98

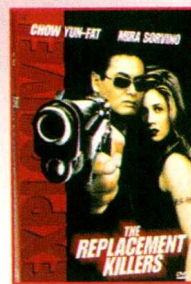
Picture: A, Sound: A, Content: B+

A hit man (Chow Yun-Fat) reneges on a contract when he discovers the target is a child. Then *he* becomes a target—along with the child—of professional “replacement killers.” Teaming with a feisty young passport counterfeiter (Mia Sorvino), he battles the mob in an effort to save the boy and his father.

John Woo was an executive producer of *The Replacement Killers*, so there's liberal in-

dulgence in the adrenaline rush of Hong Kong-style shootouts. Unlike in the movies Woo himself directs, these action scenes are not exceedingly bloody yet are exciting.

The video transfer is first-rate. The opening shot of a game arcade that spans the complete width of the Panavision frame, a gunfight in a car wash (replete with gleaming water, steam, and chrome), and an assassination attempt in a theater showing a *Mr. Magoo* cartoon are a few of the scenes that exhibit extraordinary video detail.



Soundwise, the surround mix is imaginative and the pulsing music has ample bass. All in all, *The Replacement Killers* is an exciting action adventure—not deep, but nevertheless totally engaging. R.B.

Child with the Blues” on the soundtrack of 1997’s *Eve’s Bayou*.

This Collector’s Edition DVD features a short “making of” documentary, still-frame galleries, and cast biographies. Video and audio production values are tops, as good as any out there.

Blues Brothers 2000 is worth buying just for the final combined-band version of “New Orleans,” though it provides joyous R&B entertainment right from the beginning. Perhaps if the original movie had concentrated on music and dance—as this sequel does—rather than on comic deadpan mugging and car crashes, I would have climbed on board the bluesmobile a lot sooner. But if you liked the first movie, you might not like this one; they’re that different. *Rad Bennett*

The Unknown Marx Brothers 1993; no rating; color and black-and-white; one-sided; Dolby Digital two-channel mono; closed-captioned; includes outtakes. WINSTAR WHE73004, 126 minutes, \$24.98

Picture: A–, Sound: B+, Content: A

This always-entertaining PBS-style documentary chronicles the meteoric rise of the Marx Brothers and how each member of the comedy team fared after the act broke up. Groucho was the most successful, going on to host the popular TV quiz show *You Bet Your Life*, which was shot some 15 minutes longer than needed so censors could snip out risqué passages. An enjoyable supplemental section on this DVD contains many of these outtakes.

Another unusual feature of the DVD release is Zoom Link, a cross-reference icon that appears from time to time. If you click “Enter” on your remote when you see this icon, a related, though somewhat unpredictable, topic from the supplemental footage will be called up. For example, the icon appears during a scene in which Zeppo is pouring liquor; selecting the icon brings up a scene from Groucho’s *You Bet Your Life* containing a discussion about booze.

The picture quality is very good, especially considering the wide range of source material that was used. *R.B.*

Capricorn One 1978; PG rating; one-sided (2.35:1 letterboxed); Dolby Digital 5.1; Spanish subtitles; closed-captioned; includes trailers. ARTISAN 60475, 123 minutes, \$29.95
Picture: A–, Sound: A–, Content: B+

To stack the deck in favor of an underfunded space program, a NASA director (Hal Holbrook) secretly snatches three astronauts

(James Brolin, O. J. Simpson, and Sam Waterston) from a flight seconds before launch and blackmails them into participating in a cover-up that involves an elaborately staged “Mars landing.” When the rocket disintegrates on reentry, the men know their lives are in danger. Director Peter Hyams stages all of this potentially preposterous fiction in such an exciting and breathless manner that one doesn’t mind suspending belief and being manipulated.

Artisan has acquired the original ITC masters and brought them to DVD with great attention to detail. The video image is clear and clean, and the spatially opened audio remix, with specifically located instruments spread widely around the sound field, brings unquestionable clarity to Jerry Goldsmith’s effective, masterfully orchestrated score. The remixed stereo surround is also very effective in providing atmosphere and sonic spatial cues that match the locations on screen.

An interesting bit of trivia: O. J. Simpson’s DVD bio mentions his recent trials, but Waterston’s rundown fails to mention his continuing long-running role on TV’s *Law and Order*, a show that surely has helped make him an instantly recognizable personality to many viewers. *R.B.*

Matinee 1993, PG rating; one-sided (1.66:1 aspect ratio); Dolby Digital two-channel matrix surround. IMAGE/UNIVERSAL ID4288USDVD, 99 minutes, \$24.98

Picture: A–, Sound: A–, Content: A–

John Goodman is ideally cast here as Lawrence Woolsey, a producer of low-budget horror films who sets up a screening in Key West, Florida, of his newest feature, *Mant*, just as the Cuban Missile Crisis reaches a climax a mere 90 miles away. An affectionate satire on all of the atomic mutant monster movies of the ’50s and ’60s, *Matinee* contains all sorts of inside jokes. Universal’s own Sensurround sound, for example, is called “Rumble-Rama,” while 3-D is parodied as “AtomoVision.” *Mant*, the movie that Woolsey has made, itself satirizes the black-and-white features of the day—such as *Them!*, *Tarantula*, and *The Preying Mantis*—and is presented earnestly. A previously issued laserdisc of *Matinee* contained a supplement with a complete version of *Mant*. Would that this DVD had done the same, as the black-and-white movie within the movie is one of the best things I’ve seen on DVD so far, rivaling or perhaps even surpassing my benchmarks, *A Hard Day’s Night* and *To Kill a Mockingbird*.

The main feature is in opulent color. It’s razor-sharp and well-defined, an almost picture-perfect image that is marred at times only slightly by a little shimmer from aliasing, an inability of the NTSC system itself to reproduce the sharp image being fed through it.



These effects can be tweaked out, as they were in TriStar’s recent *Oliver!*, but it could come at the expense of some of the astonishing detail here. The interior scenes of the old theater showing *Mant* are prime examples, for you can easily read the cards and posters in the lobby. Such visuals are so realistic that you can almost smell the popcorn.

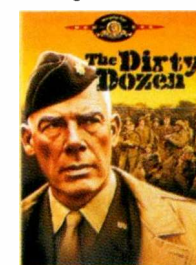
The Dolby matrix surround sound is quite good. The dialog is easily understood, and the surround effects are appropriate. Though the “Rumble-Rama” sequences seemed to have more bass in the theater, Jerry Goldsmith’s varied score—which at times imitates the sci-fi movie music of the period and at other times contains such ’60s hits as “The Locomotion” and “The Lion Sleeps Tonight”—comes across well.

If you’re looking for an entertaining family film that will also demonstrate the capabilities of your new DVD player, you should consider *Matinee*. And be sure to watch all the way to the end of the credits, or you’ll miss the final punch line. *R.B.*

The Dirty Dozen 1967; no rating; one-sided, dual-layer (1.85:1 letterboxed); English and French Dolby Digital two-channel matrix surround; English, French, and Spanish subtitles; includes theatrical trailer and behind-the-scenes short. MGM/UA 906563, 150 minutes, \$24.98

Picture: A, Sound: A–, Content: A–

This gripping war film, in which Lee Marvin leads a motley band of convicted criminals against the Nazis, is this month’s example of an old film made new again by the still-new DVD format. Video quality is very film-like, with good color and fine detail; one has only




to compare the digital transfer of the complete 1967 movie to the original period trailer to realize how much work has been done on this feature. The soundtrack, which contains some exciting surround in the final shoot-out sequence, strikes me as one of the best transfers to Dolby Digital of material originally carried on magnetic tracks. *The Dirty Dozen* is a class entertainment act, at a near-bargain price. What a deal! *R.B.*

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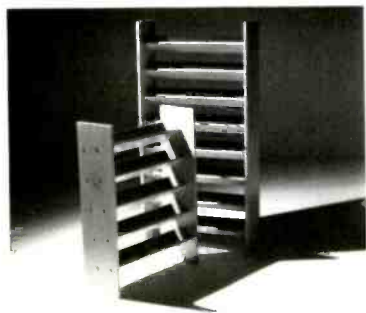
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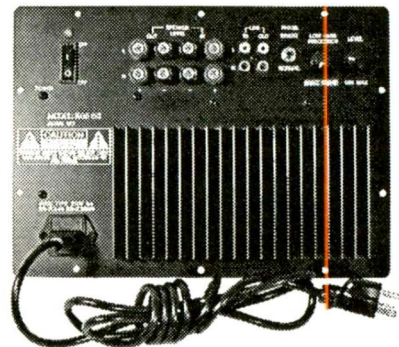
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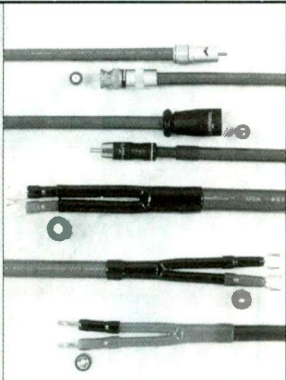
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PlayBack

PASS LABORATORIES D1 D/A CONVERTER

Nelson Pass and company have come up with a great-performing, high-end D/A converter that can also (thanks to a level control and input selector) double as a minimalist digital preamp. A 20-bit D/A converter, the Pass Laboratories D1 (\$5,000) should soon be upgradable for 96-kHz operation and for 24-bit operation down the road.

The exquisite front panel of brushed gray metal sports a stepped output level control, switches for polarity reversal and input selection, and LEDs that indicate the input signal's sampling rate. Around back are AT&T, AES/EBU, Toslink, and coaxial digital input jacks and balanced XLR and unbalanced RCA analog outputs. In keeping with the D1's high-end design, its MOS-FET analog output stage operates in single-ended Class A, with no negative feedback or polarity inversion; its output level control uses discrete precision resistors, and its analog and digital sections have their own toroidal power transformers.

I listened to the D1 via a direct connection to my amplifiers and through various tube and solid-state



GRADE: A

preamps (including Pass Labs' Aleph P MOS-FET preamp).

The amps were Pass

Labs Aleph 2s and a Legacy Audio High Current; the speakers were Legacy Audio Classics.

I found the D1 to be one of the best-sounding D/A converters I have ever auditioned. Music, especially, from good live recordings, was rendered with greater detail and a more open stereo image than it was by my CD player's internal DACs or by the other stand-alone D/A converters I had on hand. The D1 was exceptionally quiet. And because its level control is analog, the D1's resolution did not decrease when I turned down the level.

Yes, the Pass Labs D1 is expensive—but it sounds so good that audiophiles who can afford it needn't feel guilty about the cost. (Pass Laboratories: 24449 Foresthill Rd., Foresthill, Cal. 95631; 530/367-3690; www.pass-labs.com.)

John Gatski

preamps (including Pass Labs' Aleph P MOS-FET preamp). The amps were Pass Labs Aleph 2s and a Legacy Audio High Current; the speakers were Legacy Audio Classics. I found the D1 to be one of the best-sounding D/A converters I have ever auditioned. Music, especially, from good live recordings, was rendered with greater detail and a more open stereo image than it was by my CD player's internal DACs or by the other stand-alone D/A converters I had on hand. The D1 was exceptionally quiet. And because its level control is analog, the D1's resolution did not decrease when I turned down the level. Yes, the Pass Labs D1 is expensive—but it sounds so good that audiophiles who can afford it needn't feel guilty about the cost. (Pass Laboratories: 24449 Foresthill Rd., Foresthill, Cal. 95631; 530/367-3690; www.pass-labs.com.)

The MR1 Minirator is an affordable source for test signals that once were available only in sophisticated test gear or from test CDs. And test discs are often cumbersome to use, because you need a CD player and must memorize track numbers or keep the liner notes handy for consultation. Neutrik has nicely summarized the instructions on a label affixed to the Minirator, and its display lets you know what it's doing at all times. Further, the MR1's adjustable levels are far more useful than the fixed, full-scale (0-dBFS) levels found on some CDs, which can overload audio gear. (Neutrik: 1195 Lehigh Ave., Lakewood, N.J. 08701; 732/901-9488; www.neutrikusa.com.)

John Gatski

Musical Fidelity X-Ray CD Player

Leave it to the Brits to create a niche market for quirky high-performance products. (Remember the MG, Triumph, and Morgan?) Musical Fidelity's ever-expanding line of "X" components in extruded, aluminum-tube chassis is the audio embodiment of that breed. X-philes have been clamoring for Musical Fidelity to introduce an "X" CD player for a long time, but the original chassis tubes were too skinny to accommodate a disc drawer; the new X-tended oval shape has the room.

The \$1,295 X-Ray uses the hot new Burr-Brown 24-bit/96-kHz chip set that incorporates the company's Enhanced Multilevel Delta-Sigma DAC, said to improve dynamics and reduce jitter sensitivity. A silky-smooth Sony drive mechanism gives the X-Ray an extra touch of class.

Inquiring minds might wonder what the X-Ray's 24-bit/96-



GRADE: A-

kHz processing brings to the 16-bit/44.1-kHz CD listening experience. Perhaps it's the way the

X-Ray penetrates the veneer of the sound to reveal pristine transparency, or it could be there's simply less schmutz obscuring the details. Whatever—it's a rounder sound.

The X-Ray's chiseled body looks and feels as solid as any overbuilt high-end behemoth, and its futuristic yet retro styling should complement most audio systems. (Musical Fidelity: c/o Audio Advisor, 4649 Danvers Dr. S.E., Kentwood, Mich. 49512; 800/942-0220; www.audioadvisor.com.)

Steve Guttenberg

Neutrik Minirator MRI Portable Audio Generator

Neutrik's handy Minirator MR1 (\$140) packs a whole bunch of test-signal output options into a small package. Powered by two AA batteries, the 6-ounce MR1 can generate sine waves (tones) from 20 Hz to 20 kHz, square waves from 20 Hz to 5 kHz, wideband white and pink noise, a 20-Hz polarity test tone, and a frequency sweep from 20 Hz to 20 kHz.

The MR1's functions, including output level and mode switching, are controlled by three front-panel buttons; an LCD shows mode, level, and frequency. Output is via a top-mounted RCA unbalanced jack or an XLR balanced jack that retracts into the bottom plate.

Novices can make a lot of useful measurements with an MR1 and a sound level meter for speaker and acoustic checks or with an MR1 and a multimeter for testing components. Owners of more sophisticated instruments, such as oscilloscopes and real-time analyzers, will also find the MR1 an accurate source for test tones. I used its sine waves to bias a cassette deck for more accurate recording at 15 to 20 kHz than the deck's internal test-tone generator's 1- and 10-kHz output allowed. I also used the MR1 to equalize my home theater, with pink noise from the Minirator and an RTA; then, with a sound level meter, I used those tones to match my subwoofer's level to that of my main speakers. (My Dolby Digital preamp generates setup tones for the front and surround speakers but not for the sub.)

The MR1 Minirator is an affordable source for test signals that once were available only in sophisticated test gear or from test CDs. And test discs are often cumbersome to use, because you need a CD player and must memorize track numbers or keep the liner notes handy for consultation. Neutrik has nicely summarized the instructions on a label affixed to the Minirator, and its display lets you know what it's doing at all times. Further, the MR1's adjustable levels are far more useful than the fixed, full-scale (0-dBFS) levels found on some CDs, which can overload audio gear. (Neutrik: 1195 Lehigh Ave., Lakewood, N.J. 08701; 732/901-9488; www.neutrikusa.com.)

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GRADE: A



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