

**TESTS: JENSEN • LEGACY • RADIO SHACK • PS AUDIO  
INFINITY • SNELL • PIONEER • SENNHEISER • MARANTZ**

# AUDIO

## CD PORTABLE SHOOT-OUT

**AIWA, FISHER & SANYO  
DO DIGITAL MEMORIES  
WORK?**

THE EQUIPMENT AUTHORITY  
APRIL 1995

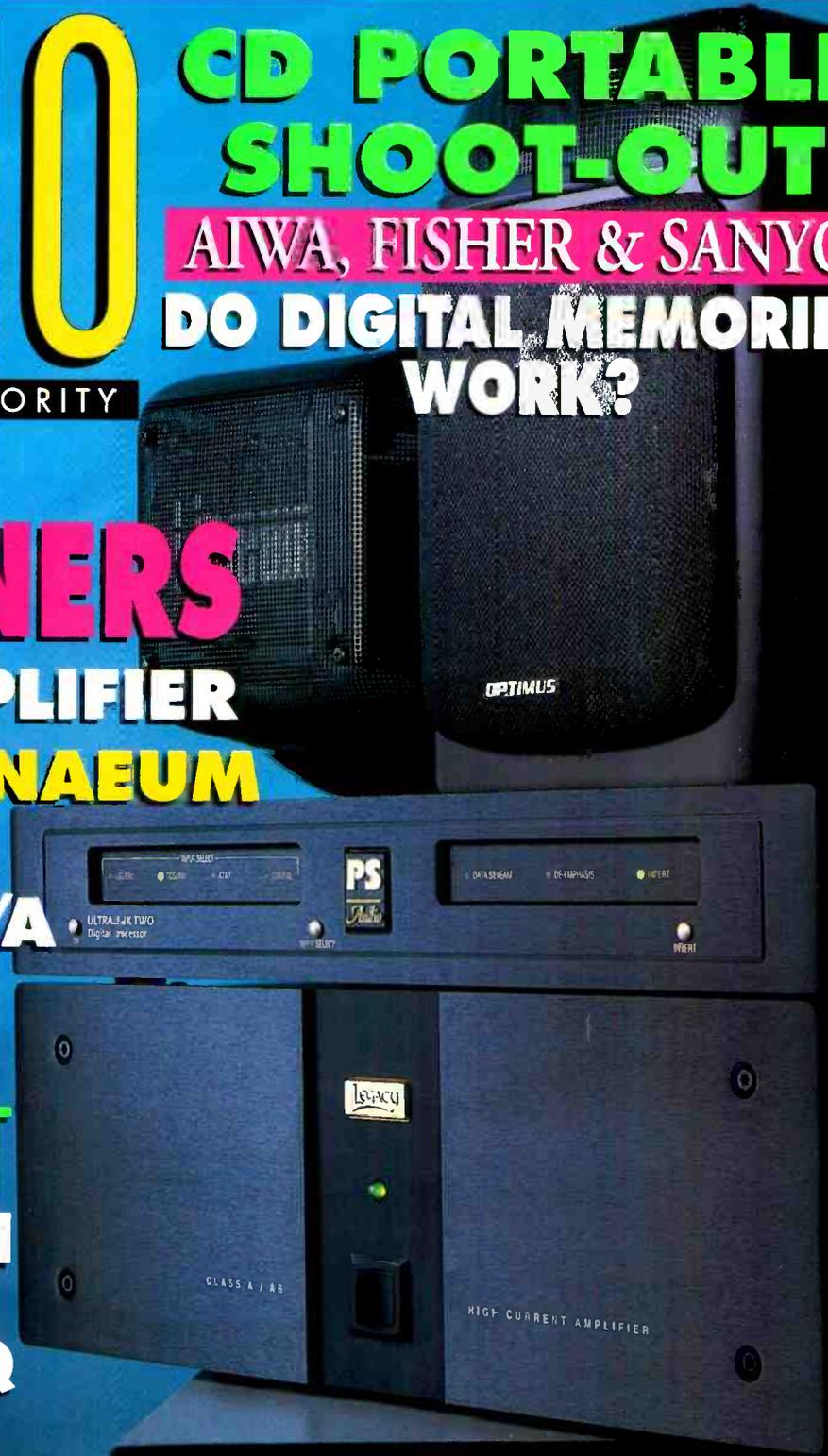
### 3 WINNERS

**LEGACY AMPLIFIER**

**OPTIMUS/LINAEUM  
SPEAKER**

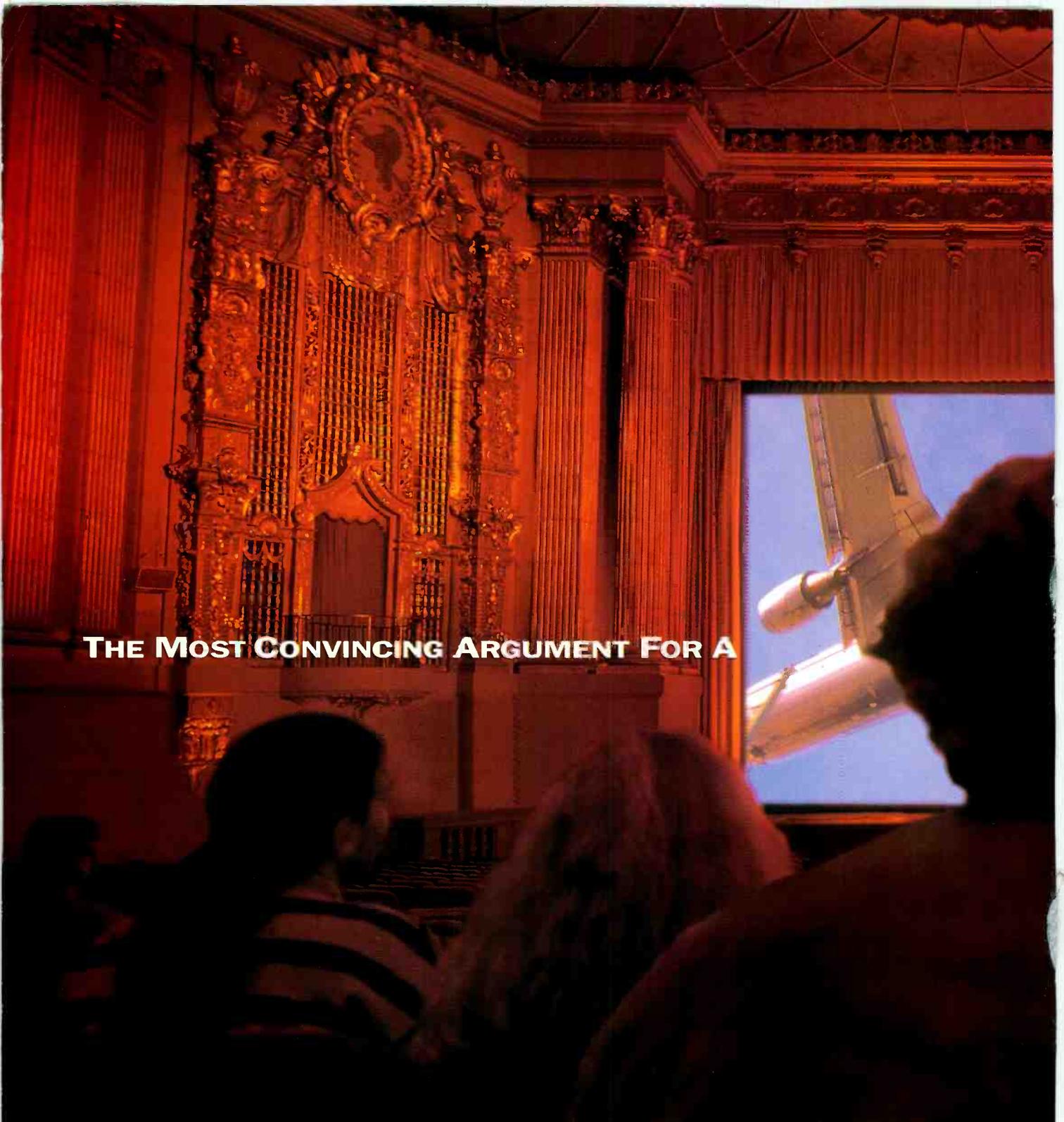
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CONVERTER**

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HOME HI-FI  
GETS  
DIGITAL EQ**



US \$3.50  
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A photograph of a grand, ornate theater interior. The room is filled with warm, golden light. The walls are covered in intricate carvings and columns. A large screen at the front of the theater displays a close-up of an airplane's wing and engine. In the foreground, the silhouettes of several people are visible, looking towards the screen.

## THE MOST CONVINCING ARGUMENT FOR A

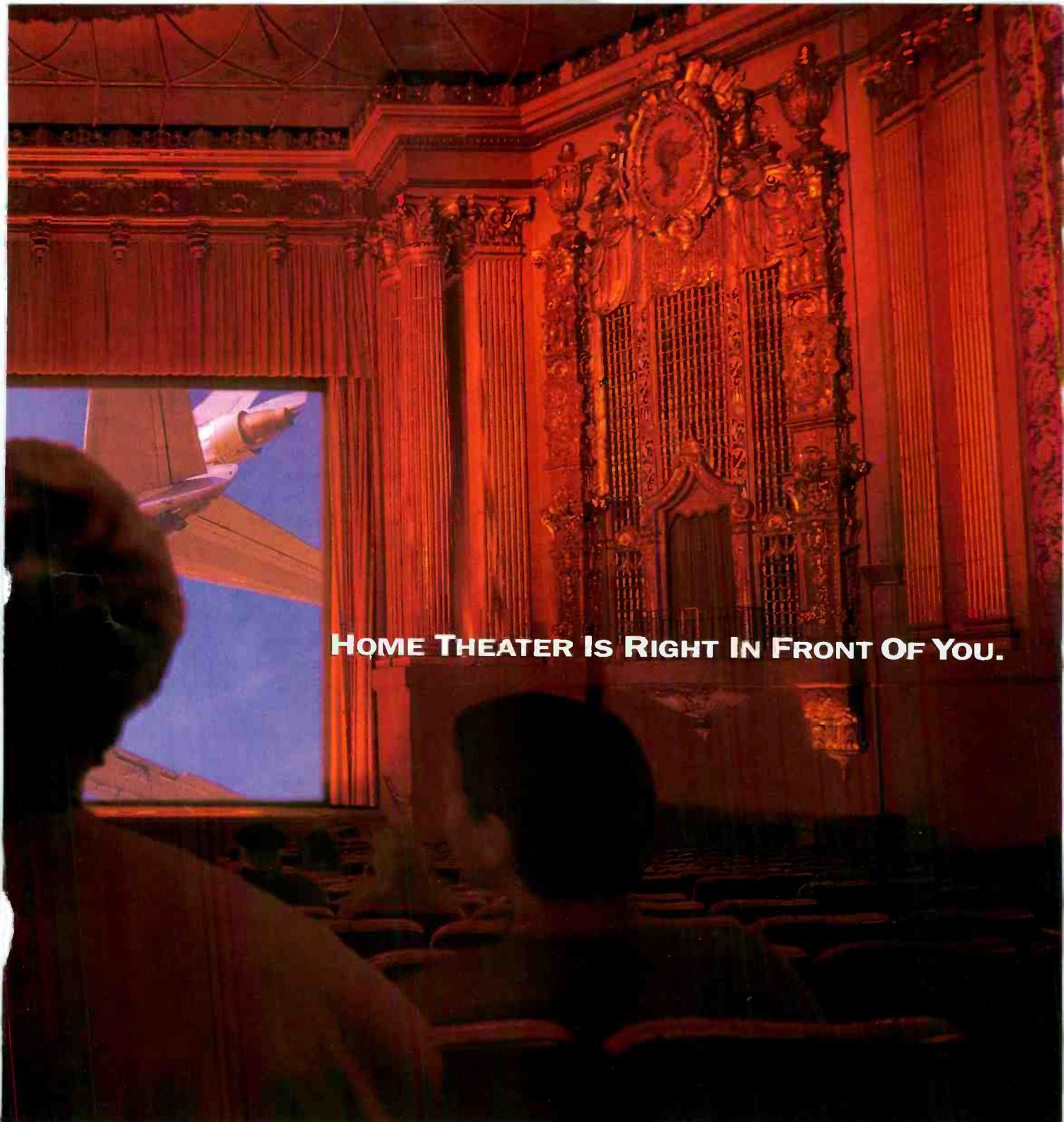
*Y*ou've waited in the rain, paid your seven bucks, bought your real buttery-flavor popcorn and snagged the best seat in the house. When somebody decides to sit in the second best seat in the house.

You know, of course, the solution is to create the ultimate theater in your home. And as anyone will tell you, a truly moving theater experience is built around sound even more than the picture. But not just any sound. Parasound.

You see, we've built our company around the notion that a



*P/SP-1000 Dolby Pro Logic Surround Processor. This is what the home theater world has been waiting for. The latest in surround technology using the very finest audio components and circuitry.*



**HOME THEATER IS RIGHT IN FRONT OF YOU.**

person shouldn't have to spend a fortune to hear the finest that technology has to offer. And now that we've applied that principle to home theater, the cinematic experience will never be the same. Just look at our remarkable new Dolby Pro Logic® Surround Processor. It combines a high-end preamplifier with all the features that even the most fervent audiophile turned movie buff could ever want. We also offer the widest variety of THX®-certified and six channel amplifiers available, as well as the most powerful and most accurate subwoofer on the planet.

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Plus, because we design every component of the Matrix 805 and make all our own drivers, voice coils, and crossover networks, you can rest assured the 805 is built to stand the test of time.

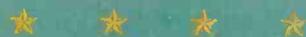
For the name of a B&W dealer near you, call 1-800-370-3740. And hear how much the compact B&W Matrix 805 has in common with the legendary 801.



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*Our commitment to flawless music reproduction is evident in every loudspeaker we make. B&W's advanced engineering is conducted at its famous Steyning Research Laboratory in Sussex, England, where scientists and acoustic engineers pursue the quest for perfection begun by founder John Bowers over 25 years ago. The B&W Matrix 805 is a product of this relentless effort.*



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LARRY GREENHILL  
*Stereophile*

[Vol. 16 No. 4, April 1993]

T H E K E V L A R D I F F E R E N C E



*Critics are continually amazed at how much technology B&W has packed into a 16"H x 10"W x 8"D enclosure.*

The space-age material used in bullet-proof vests and high-tech sails is the same material used in the Matrix 805's drivers. B&W is the first company to use Kevlar® cones. So all you hear is pure, uncolored music.

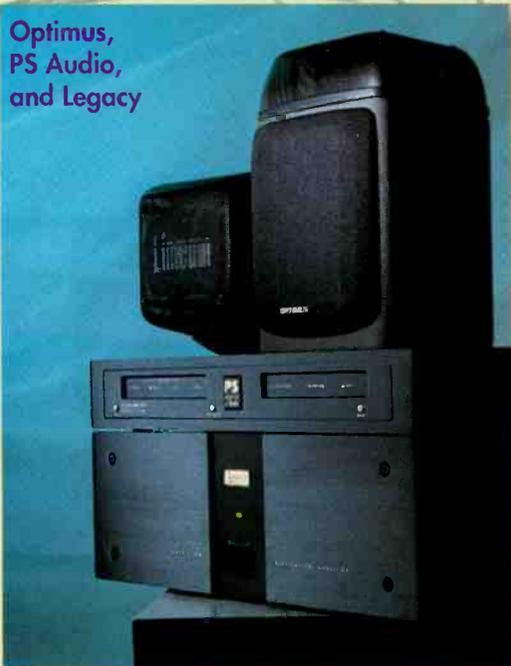
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PS Audio,  
and Legacy



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The Cover Photographer: Bill Kouirinis Studio  
The Cover Equipment: Optimus PRO LX5 speaker, PS Audio Ultralink Two D/A converter, and Legacy High-Current amplifier

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# The Experience

## **'In particular.'**

While engineering recordings for many clients, among them the Chicago and St. Louis Symphonies, I hear of Martin-Logan's special electrostatic precision and clarity from several of my colleagues. So, I installed a pair in my studio.

What happened next was amazing. Every change in the recording process became apparent. Details of space in the hall, microphone placement and even converter qualities were instantly perceived. Yet the superior dispersion of their curvilinear transducer allowed remarkably easy room placement, even in my studio.

After using Martin-Logan products for years, I am excited to introduce the new advanced SL3, shattering industry standards yet again.

## **What else can I say?**

Go to your local dealer and audit on the new SL3.

Be prepared for the experience.

**SL3**

\$3,200.00 JS/pr

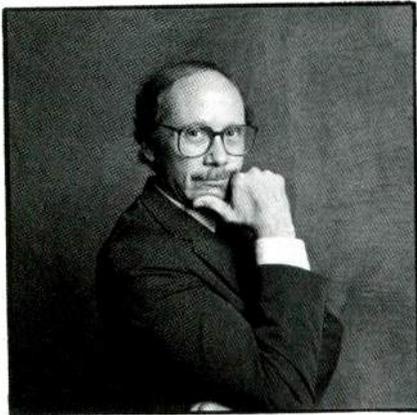
Following is a sampling of Larry's works:  
WFM Fine Arts Network weekly broadcast of the Chicago Symphony Orchestra, Erato, RCA/BMG, CBS Sony, Koss Classics, Marc Polo New World, Crystal, Peregrine, Pro APE, Semmit, Centaur, Orfeo, Musical Heritage Society.

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**A**ttendance at the Winter Consumer Electronics Show (WCES) in Las Vegas this past January was over 103,000. This was year-on-year growth of more than 13% and a 31% jump from 1993, when attendance was about 78,500.

I have discussed Summer CES politics in earlier editorials. I suspect that show's viability was questioned not because the WCES had come to be the only show we needed, but rather because there were low points in our industry's economy during the spring seasons of both 1993 and 1994. Remember, hi-fi is a seasonal industry, with most sales occurring in the fall. The result was that hi-fi oriented dealers just didn't go to the Summer CES, preferring to reduce costs and tend to what business they had.

On a related point, the usual pattern for the four-day versions of these shows has been to have them on Thursday through Sunday, not on Friday through Monday, as was the case this year. (We'll ignore the three-day version last June.) We amateur show-watchers have assumed that the show people thought traffic would be light on the last day, being a Monday. The theory was, we believed, that the showgoers were getting back to work in their stores as quickly as possible. However, this year the aisle-walkers were still there on the last day.

The most important thing from my point of view was that the whole show had a good atmosphere, as if to say that our industry was back on a more sound financial footing. Frankly, I have not

experienced that much business confidence at a show for half a dozen years or so. I only hope the enthusiasm grows.

You have probably seen reports about the two competing forms of digital videodisc (DVD)—one from Sony and Philips and the other from Toshiba and Time Warner. At the WCES I saw the Sony-Philips version; a split-screen monitor had the DVD versus videotape, then LaserDisc, and finally a D-1 digital master tape. I thought that the D-1 had the sharpest picture, and I noticed color shifts between DVD and both videotape and LaserDisc, though I couldn't say which was best. In other similar demonstrations in the past, I have noticed telephone poles jumping across the screen, but not here.

In recent days, the Sony-Philips camp seems to have given ground in the "discussions" as to which DVD format is preferable. Some in the trade press say that apparently Sony and Philips feel it is preferable to achieve an industry-wide format consensus, even if it is for the other camp's disc, than to get into a protracted battle in the marketplace.

While issues relating to manufacturing costs are involved, I feel that the main item of concern is the quality of the picture on the consumer's screen. The more data capacity each disc has, the easier it will be to achieve high quality; this mitigates in favor of the Toshiba-Time Warner system.

My Wag of the Show Award goes to Neil Terk for his comment, "Revolutionary idea—equipment that actually works!"

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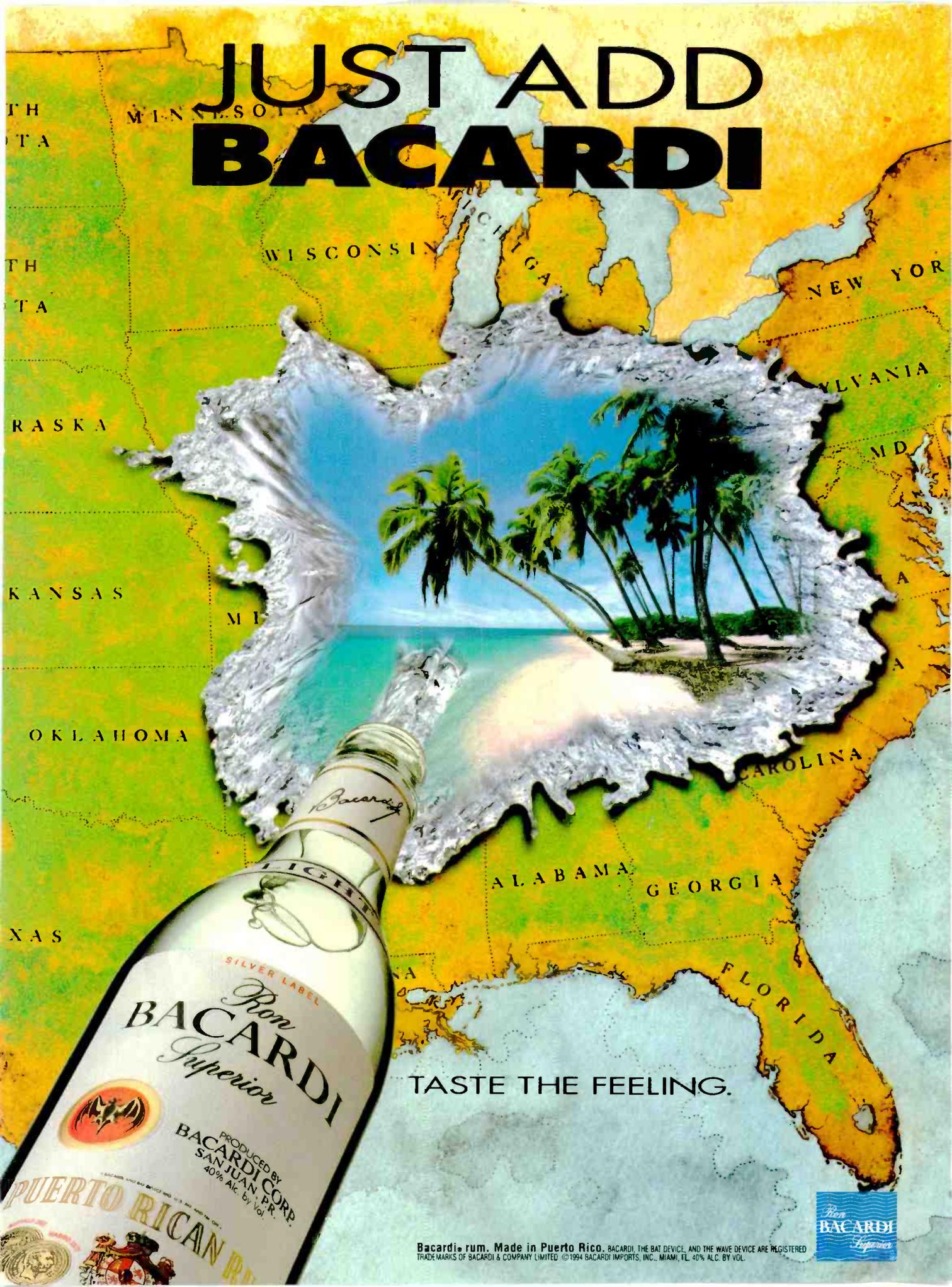
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# JUST ADD BACARDI



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# WHAT'S NEW

## PSB Speaker

A magnetically shielded version of PSB's Alpha, the Alpha SE is a compact two-way system with high sensitivity (92 dB), a 6½-inch woofer, and a ½-inch poly-flare dome tweeter. A narrow cabinet, flush tweeter mounting, and a frameless, bevelled-edge grille minimize diffraction. The SE also features five-way binding posts that can accept up to 12-gauge cable. Finish is black-ash wood grain or white; the white version includes a white terminal cup. Price: \$249 per pair. For literature, circle No. 100



## Platinum Speaker

Both the dome tweeter and the 5-inch woofer of Platinum's Solo have alloy diaphragms with butyl rubber surrounds. A die-cast aluminum back plate incorporates the speaker vent, acts as a heat-sink for the steep (30- and 36-dB/octave) crossover, and houses gold-plated bi-wire terminals. Enclosure panels are of high-density fiberboard, 1½ to 1½ inches thick. Standard finish is satin rosewood with piano black top and bottom; other finishes are optional. Price: \$2,500 per pair. For literature, circle No. 102



## M & K Subwoofer

The amplifier built into M & K Sound's V-125 delivers 125 watts rms, with an Active Headroom Maximizer circuit to prevent clipping or audible distress. In addition to the upper roll-off, which can be set anywhere from 50 to 125 Hz, the V-125 features a 36-dB/octave low-pass above 125 Hz, to minimize directional cues in the woofer output. A high-level, high-pass, 100-Hz filter for satellites uses bypass capacitors for clearer sound. The speaker weighs 52 pounds and measures 15¼ inches wide x 18½ inches high x 20¼ inches deep. Price: \$695 each. For literature, circle No. 101



## Sanus Speaker Stands

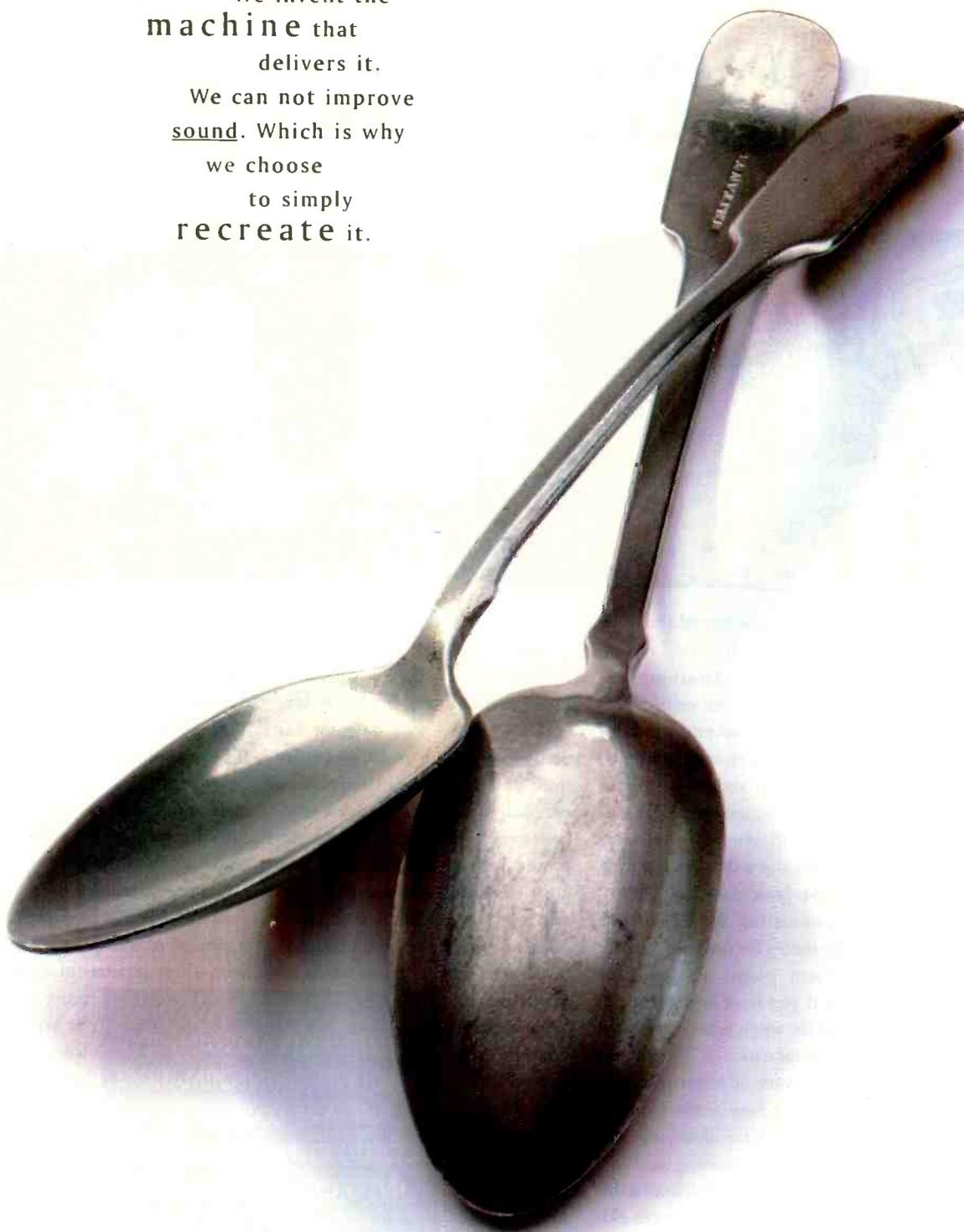
The Euro Foundation stands, from Sanus Systems, are built of steel, with adjustable steel floor spikes, rubber isolation pads,

and a concealed wire path; the bases can be filled with sand or shot to damp resonances and improve stability. The stands shown are the 16-inch-tall EF16, the 24-inch EF24, and the EF32,

which is adjustable from 28 to 40 inches high and whose angle can also be adjusted. Prices: EF16 and EF24, \$79.99 per pair; EF32, \$99.99 per pair. For literature, circle No. 103



We do not invent sound.  
We invent the  
**machine** that  
delivers it.  
We can not improve  
sound. Which is why  
we choose  
to simply  
**recreate** it.



**AR**

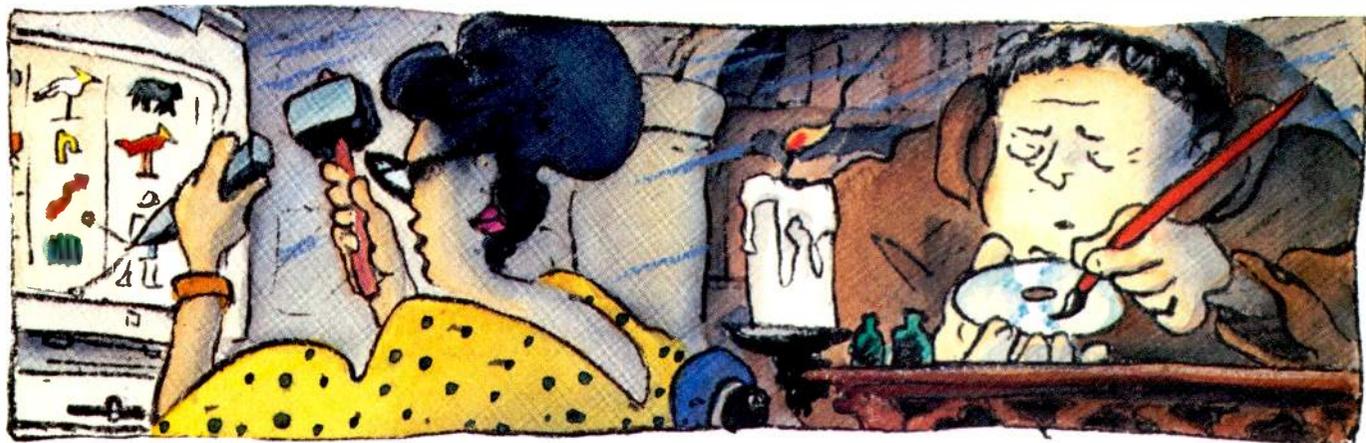
The way life sounds.

The new AR 303, 302, 338, 228, 208v & 218v loudspeakers. 1-800-969-AR4U.

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EDWARD TATNALL CANBY

## PAPYRUS VS. THE FLOPPY DISK



I am freshly concerned about the future of our historical record. A number of disturbing new evaluations, from outside audio, display several kinds of sheer shock treatment unmistakably aimed at audio (along with other areas of technology). One article in *Scientific American* (January 1995) tosses out a detailed technical study of our present media in light of the accumulating records of our time, the means for continuity in our civilization; phew, you will be stunned if you have any interest in us, all of us, some time beyond the day after tomorrow.

Another, very different piece appeared in *The New Yorker* (April 4, 1994), one of those ultra-long articles that keeps you reading until 2:30 in the morning. This one, from a different angle altogether, concerns old-fashioned library file cards. Wow, what extraordinary quantities of information we are losing now, and at an accelerating rate, simply by converting card files into computer files! And tossing the cards out by the millions and billions.

Yes, much faster, far greater capacity, and so on. You know the computer story well enough. But what utter idiocy in the process! In place of centuries of intelligent data on the cards—in pencil or 19th-century quill pen, with extra information variously added over the years (perhaps even by recent typing) and with a moderate and useful number of cross references—the computer version not only omits all annotations but gives you 58 or 129 or 1,001 supposed references, 95% of which are totally useless. What a mess. You will have to read the article to fully appreciate the ghastly stupidity of this sort of “history” in digital form, the very fabric of present civilization as the future will see it, and much of it sheer nonsense, if readable at all.

Perhaps you need to be a librarian, or a student or researcher, to appre-

ciate this. Harvard University, with one of the largest library systems in the world, is systematically getting rid of *all* its card files, and Nicholson Baker, the author of the article in *The New Yorker*, has been frantically trying to find a way to preserve them. Not much luck! There surely would be enough to fill four warehouses and 25 old New England barns, plus maybe a covered stadium or two. Even so...

Just think of the billions of hours of intelligence that went into the gradual accumulation of all that data, a record of civilization itself. Take this to heart, you library users! It's happening everywhere.

When I was at Harvard, 10 dogs' ages ago, I was most unwillingly forced to do some small music research in the huge Widener Library. You entered, looked in the acres of card files, filled out a request slip (or a number of them), and sat down to wait. Three-quarters of an hour was

**WHAT EXTRAORDINARY  
AMOUNTS OF INFORMATION  
WE ARE LOSING BY  
CONVERTING CARD FILES  
INTO COMPUTER FILES!**

more or less to be expected before you were called up and presented with a book (or books), maybe what you wanted, maybe not. I had one absurd experi-

ence there that illustrates the basic frustration, though in this case it was my fault. I was doing a term paper on “World” (i.e., European in those days) Folk Music. My topic was Germany, and I requested a whole batch

Illustration: Philippe Lechien

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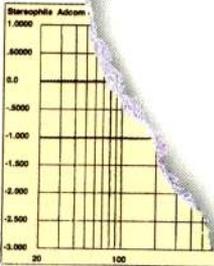


Fig. 1 Adcom GDA-600, frequency response (top); de-emphasis error channel dashed, 0.5dB/octave

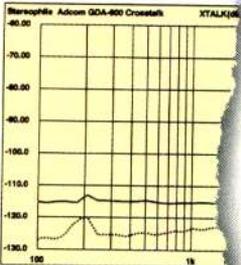


Fig. 2 Adcom GDA-600, cross-talk (top); dashed, 10dB/vertical div.

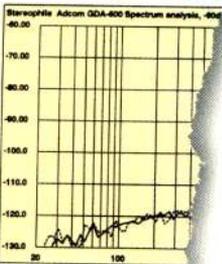


Fig. 3 Adcom GDA-600, 1kHz tone at -90dB (top); spuriae (1/5-octave dashed).

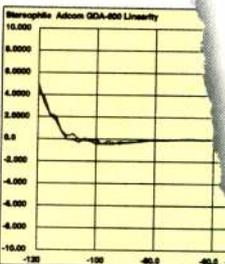


Fig. 4 Adcom GDA-600, dynamic range and linearity (right channel); dashed, 2dB/vertical div.

## “Nothing less than a steal.”

—Robert Harley, *Stereophile*

There's something in this review of our GDA-600 digital-to-analog converter that the competition doesn't want you to see. Maybe it's the fact that the GDA-600 makes digital formats sound richer and more musical. Or that it has advanced 20 bit conversion architecture and a Class "A" analog output stage. But what they really don't want you to see is that the GDA-600 costs much less than you might expect. For the full review see *Stereophile*, Volume 17, No. 3, (March '94). Or, if your copy has been stolen, give us a call.

**ADCOM**<sup>®</sup>  
*details you can hear*



of volumes appropriately carded under the heading of "Deutsche Volkslieder." Doesn't that sound reasonably accurate? After the usual lengthy wait, down came a stack of big volumes from the stacks (we weren't allowed there) under that very title. But in thousands of pages, there was not one note of music! You see, in German the term *Lied* refers mainly to the written word—the way poets in English refer to "song" in their music-free writings. ("Song of Myself" by Walt Whitman? If there's music to that, it definitely is not his!) So I dumped the big volumes into the discard boxes and walked out of there in a state of high dudgeon.

What might happen today (or tomorrow)? In three minutes, maybe, I would receive some sort of printout announcing that there are some 21,529 available references for "Volkslieder"—and asking me to please specify country, province, city, and other location with street and zone number for each example desired, and to please wait for a detailed listing. It could be 30 feet long, I'll bet.

I don't mean to pick on Harvard, and this is a purely fictitious example, of course, but the fact is that the Harvard cards *are* going away and nobody is likely to stop the mayhem. Also cards in most other big libraries. Only the little places that are too poor to convert still hang on to their card files, even if they might want to junk them like everybody else. But don't! Keep them even if you do convert.

Before this, I had not realized the nature of the info now going into computerized files. Libraries—public, academic, or private—are only a part of the picture, even if you count the accumulating spreadsheet records of, say, all the K-Mart and Wal-Mart outlets in our land as a form of library.

Don't forget that the very first known preserved records in more than one ancient civilization were exact parallels to these, that is, records of business transactions. On clay tablets instead of hard disks. What's the

diff? (Well, some of them used a numerical base of 60, not our decimal. . . .) The real difference is that one form has lasted thousands of years, and the other, with luck and all sorts of elaborate reading equipment, may be legible for a dozen years before obsolescence sets in and the restoration people have to restore "ancient" equipment be-



**TO EQUAL THE ABUNDANT  
RECORDS OF OUR PAST,  
ALL WE HAVE TO DO  
IS SOLVE THE PROBLEMS  
OF PERMANENCE.**

ceived, and whatever may remain of them today, by the eyes. The good Lord has not yet converted them to digital, let alone a.c. operation.

Almost all past "messages" are indeed codes of some sort—representations of words, numbers, dates, concepts, symbols, ideas. None of them can be appreciated by the ears, the sense of smell, or that of touch. But it is from this that we today have taken off, uniquely since history began. We have added mass duplication of many sorts for the still-pristine eye to see—millions of eyes. And we have added audio! The first really pervasive use of another sense to perceive the breadth of history—through millions of ears. Does this make you begin to feel a little better?

All we have to do, to equal the abundant records of our indispensable past, is to solve the problems of permanence. And they are huge, if we plan to, and hope to, continue our civilization for more than that dozen years, the rough median estimate of current technology. Rather, let us say, we should aim for 20 centuries or more. That's as far

ahead as we now can go behind and come up with *readable* past history. We are building further back at a dizzying pace, year by year. Can our "forwardness" keep up?

Happily, I've done a lot of other recent reading and looking back that heartens my soul a bit, if only to show what miracles of preservation have existed. Clay tablets and, of course, all sorts of stone figures and architecture, and even wood, are obvious relics; paper, remarkably, came very early and persists astonishingly with still-readable information. See *National Geographic* for January 1995 on ancient Egypt and its papyrus, extraordinarily durable in a dry climate; a legible roll, some 130 feet long, was discovered a long while back and can be read now, after more than 20 centuries.

I was surprised to find that in old Egypt the scribes first learned a "cursive" script, for business-type records, perhaps corresponding to our fast-departing longhand, and then went on to hieroglyphics, used exclusively for sacred inscriptions, century after century. All this information can be decoded now with remarkable accuracy.

Then there is a (reproduced) page of a Shakespeare sonnet, only a few hundred years old but perfectly legible, almost as new. You can read it yourself (*Sci. Am.*).

Will a floppy disk—such as these words are being written upon—be readable in the year 4050, the other direction from the Egyptian? Or a mere 400 years, like the Shakespeare? Alas, 95% of us couldn't care less. It's entirely up to the few (as it always has been, even in Egypt), the advanced and creative technicians, to burden themselves with "progress," later to become history.

As for me, left-handed non-touch-typist that I am, I will stick to papyrus (paper) as a backup for the impermanent and nonstandard word-processor disk that is now my lot. I've already been sunk into minor but typical confusions, no help at all toward future history. I painfully learned to type onto floppies for *Audio's* new desktop publishing equipment; my first effort turned out blank. Incompatible. On a new and different machine, the letters were transferred but minus spaces, paragraphs, or punctuation! Can you imagine it? Wrong conversion software. I'd hate to see my immortal words going down in history like this page after page but I'll try again and better luck next time.

A

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CES NEWS



Panasonic CQ-R535: A record button?

Nakamichi 1000td: Pure premium.



Sony MDX-C150: Third-generation MiniDisc.



CD changer, the CDX-P2000, uses a Legato Link D/A converter system like that in Pioneer and Elite home players.

I noted a trend to higher output volt-

ital Reference system last year. Kenwood's KAC-R7 remote fits on the steering wheel and changes volume, source, play mode, and station.

Panasonic has built recording capability into several CD and cassette models, but not to tape programs off the air. Designed to record brief items (such as directions to a destination or phone numbers), the system's microchip memory has only a 20-second capacity. The recorder is built into the removable faceplates of the models involved; an auxiliary power pack may someday allow you to record messages when you're not in the car.

Jensen showed two cassette players, the DF511 (reviewed this issue) and DF521, with battery voltage indicators in their displays.

Several Pioneer head units now have an enhanced version of ID Logic, the system that uses a built-in database of station frequencies and cities to identify stations and help you find the ones broadcasting the program formats you want. Earlier ID Logic radios required manual entry of the car's exact location and direction of travel, plus manual updates after each change of direction, before they could find the stations you wanted. Pioneer's requires entering only your original country and state; it then figures your exact location, tracks your path from there

by comparing the stations it's receiving to the entries in its database, and then finds stations transmitting the program format you desire.

The Radio Data System (RDS), which can be tied into ID Logic, is making progress. Denon has been pushing the system by making equipment available to FM stations and by producing home and car equipment that can receive RDS. At CES, Blaupunkt, Coustic, and Kenwood also announced RDS

Last year's Winter CES saw a freshet of new car stereo ideas, probably an outpouring of developments bottled up during several years of slow business. Although audio innovations took a back seat to car navigational equipment at this year's WCES, there were still refinements worth noting.

In changers, the main trends are toward larger capacity (12-disc players from Pioneer and Premier and, from Clarion, a 6+6-disc, dual-magazine model) or smaller size (Alpine and Sony each claimed the world's smallest six-disc models, Panasonic claimed to be "among the smallest," and Clarion claimed the smallest 10-disc model). At least one Kenwood head unit, the KDC-PS900, can control two separate 10-disc changers, with both CD and MiniDisc changers to choose from. Premier's 12-disc

ages, to overcome cars' electrical noise. Alpine's new flagship CD Max CDA-7939 has 4-V preamp outputs, Kenwood's KDC-PS900 is switchable between 2- and 4-V output, and the Eclipse ECD-415 and ECD-416 have an output of 2.7 V.

In the past, remote controls were mainly for passenger use; they're now becoming handier for drivers. Sony's RX-2XS Driver's Commander and Pioneer's Smart Remote Control have shaped-differentiated controls that can be told apart by touch, an idea that was introduced in Sony's Mobile ES system a few years back and also embraced by Pioneer in its Optical Dig-

**MOST CAR STEREO INNOVATIONS AT CES WERE AIMED MORE AT CONVENIENCE THAN AT ENHANCED SOUND.**

components. Moreover, the FCC has approved a new Emergency Broadcast System using RDS; radios equipped for it will turn themselves on when emergency messages are received.

The fanciest car stereo with RDS that I saw at CES was Blaupunkt's Berlin RCM 303A, which has a map system. It has a five-tuner setup, with one tuner dedicated to RDS and the other four working with the four parts of an Audio Directional Antenna phased array. The Berlin's RDS tuner will work when the rest of the system is shut off, so you can get traffic bulletins you might otherwise miss.

Head units with Dolby C noise reduction were announced by Sony and Kenwood at about \$450 and by Nakamichi at \$2,800. (I've seen none with Dolby S NR yet.) As you'd expect from its price, the Nakamichi 1000td is something special. It boasts such Nakamichi hallmarks as a closed-loop dual-capstan transport with azimuth fine tuning and three tone controls instead of two, plus a tuner that adjusts r.f. gain to minimize noise. The fanciest touches of all are motorized subpanels that switch between tape and CD-changer controls. But despite this example, cassette head units with built-in controls for CD changers are moving down in price; Panasonic and Blaupunkt, for example, have models costing under \$250.

Owners of Chrysler cars made since '73 and of post-'82 GM cars can now get Pioneer head units to fit them. Proton has expanded its car stereo line to include head units again, and Sansui is back in car stereo.

There wasn't the rush to MiniDisc seen at last year's WCES, but Sony did announce its third-generation MD unit, the MDX-C150. It's priced at \$550, roughly half what its predecessor cost. Kenwood showed its first MD changer, the KMD-C80.

Two new head-unit security systems made their debuts. Blaupunkt showed its KeyCard system, already on sale in Europe; it's based on a credit card whose insertion activates the stereo system and sets your preferences for favorite station, turn-on volume level, and other control settings. Two Panasonic models have alarms that shriek through the speakers if the unit is tampered with while the faceplate is off. And the Eclipse Security Network (ESN), which was introduced last year, has been expanded. The system, which allows Eclipse

owners to pick a "key CD" that must be inserted to reactivate the player after its power has been cut off, originally worked only with in-dash CD players. Now ESN will work with CD changers connected to the newest Eclipse cassette models.

The most public-spirited innovation came from the indefatigable Prof. I. Lirpa, who buttonholed me in my hotel's parking lot as I left the Show. Now living in a New York apartment, Lirpa is annoyed by car stereos so loud that he can hear them, five flights up, even with his windows closed.

"It's simple," said he. "You put speakers in the driver's headrest, and make them 12 dB louder than any other speakers in the car. Of course, not even kids would do that voluntarily, so I've proposed a New York City ordinance that such systems be mandatory in any car driven by a person under 25. While I'm at it, I've also proposed a solution to unnecessary horn-blowing: Every car should have not one, but *two* horns—the second one just inches away from the driver's ear. And this would apply to grownups, too." A

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## In Praise of Tone Controls

Dear Editor:

In his review of the Mark Levinson No. 38S preamplifier (December 1994), Anthony H. Cordesman writes, "Most U.S. high-end audiophiles have also rejected preamps with extensive equalization, signal processing, tone controls, or filters." I suspect that the public has not rejected these. Rather, manufacturers have stopped giving the public any choice in the matter.

I was very fond of preamps by Dynaco and Hafler that contained tone controls, mono buttons, external loops, etc. For the past four years, I have been using the excellent Aragon 24K preamp, which, alas, has no tone controls. (I have never seen a review of this in your or any other domestic audio magazine. Is the reason that it is so bad, or is it so good that it threatens the competition?) In checking another magazine, I find capsule reviews of 20 high-end preamps. Not one has tone controls. Today, the only control-equipped preamps that readily come to my mind are the Adcoms... or maybe the McIntoshes.

So I went out and bought an Audio-Source equalizer, which I have inserted into a tape loop. The results are amazing. Well-recorded CDs may not need tone contouring, but I have lots of open-reel and cassette tapes that now sound much better than before. Even some dull-sounding LPs come to life with a bit of treble boost. I suspect that fancy and expensive interconnects would be unnecessary if their owners had access to tone controls.

I hope that some preamp manufacturers read this because I, for one, will never buy another preamp that lacks tone controls.

David Adler  
Clark, N.J.

*Author's Reply:* There is a great deal to be said for using equalizers and special filters to correct the tonal problems in recordings. There is, however, far less of a case for conventional tone controls or loudness controls. Mr. Adler may find such controls to be useful, but most audiophiles have

found over the years that the chances that a treble or bass control actually has the frequency characteristics needed to help with a given recording problem are limited, and that their benefits are offset by the coloration such controls introduce in terms of transparency. As for loudness controls, I have never heard one that did not do more harm than good.

The alternative is a carefully chosen range of five or more controls, integrated into circuitry that preserves as much transparency as possible, and which offer many of the benefits of an equalizer. I have reviewed preamps by both Cello and McIntosh that provide such controls, and both offered the kind of benefits Mr. Adler describes. (See "Auricles" on the Cello Palette preamplifier, June 1993, and the McIntosh C40 preamp with the MC500 amp, January 1995.)

Equalizers can also help improve the sound of a given system by correcting the effect of room and speaker interaction problems. This is particularly true if such equalization is based on detailed measurements, and if careful attention is paid to measurement at a wide range of different loudness levels and points in the listening area. Such benefits can only be obtained, however, if the speaker and listening positions are properly located, if the equalizer is used with intelligence and discretion, and if great care is taken to ensure that equalization does not drive a speaker into excessive distortion or do more to increase the level of standing waves and reflected sound than to improve the quality of frequency response.—A.H.C.

## Herewith, Whyte's Stereo Tapes

Dear Editor:

I noted with considerably more than casual interest the letter from Steve Haller ("Signals & Noise," December 1994) regarding Bert Whyte's experimental stereo taping at Mercury recording sessions in late 1952 and early 1953, at which I was a producer. Yes, he did some of our Detroit recording sessions, too.

To the best of my recollection, as I noted in my original letter (September 1994), the Magnecorder on which Bert took our feed was a staggered-head affair. So if there are complete takes in existence, not only are they unedited, but they will have to be mastered from a playback head in staggered configuration.

As to the tapes themselves, to the best of my knowledge, Mercury (PolyGram) does not have them. I believe Bert retained them with the tacit understanding that they were a "private affair." At all events, Ruth Whyte, Bert's surviving spouse, and/or Wilma Cozart would be the people from whom to seek definitive verification.

David Hall  
Castine, Maine

*Ruth Whyte's Reply:* The experimental stereo tapes Mr. Hall and Mr. Haller referred to were indeed made on a Magnecorder staggered-head machine. These tapes were never edited, and these pieces are not complete. Therefore, it would be inappropriate to put them out on Compact Disc or vinyl record. Bert Whyte retained these tapes, and I agree it is too bad they could not be released.—R.W.

## King's Experimental Subwoofer

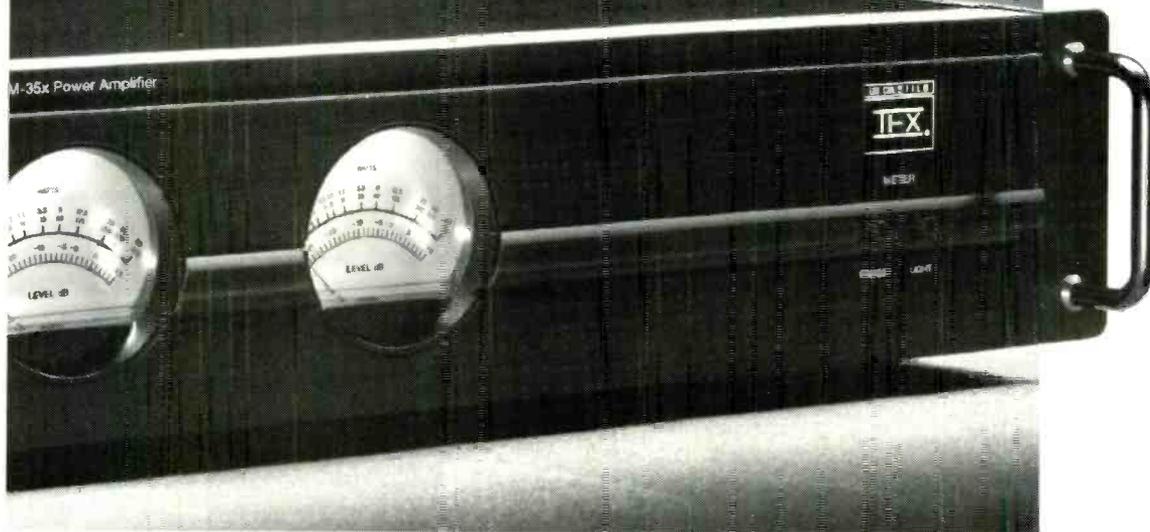
Dear Editor:

In Bascom H. King's review of the Luxman M-383 amplifier and C-383 preamplifier (January), there is the following sentence: "Loudspeakers used were B & W 801 Matrix Series 3s, augmented in the range from 20 to 50 Hz by a pair of experimental subwoofer systems, each using a JBL 1400Nd driver in a 5-cubic-foot ported enclosure."

I've been a subwoofer addict and a JBL follower for many years, because they deliver some of the best bass in the business (I own three pairs). However, I've never heard of a JBL 1400Nd driver, nor a JBL experimental subwoofer. I presume "Nd" stands for "neodymium"; recent microphone technology uses it for magnets, but this would be a new material for speakers, which are also transducers. Moreover, the last JBL subwoofer article you published ("New Lows in Home-Built Subwoofers") was in the August 1983 issue, almost 12 years ago.

Would it be possible to learn more about this experimental subwoofer system and

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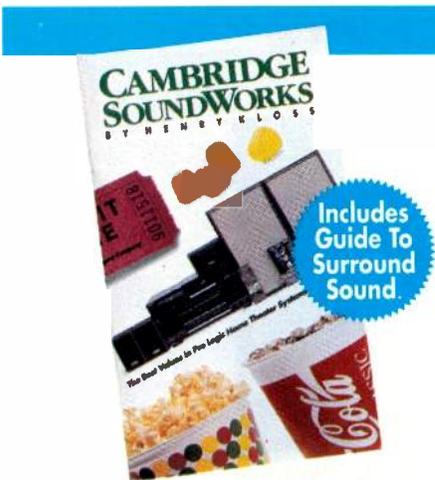
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the 1400Nd driver? JBL rarely comes up with a new driver series not worth writing about. Such an article would help satisfy your readers’ wish to see more technical texts and projects in *Audio*. And you wouldn’t have difficulty enrolling the JBL technical staff, for that matter: They’re usually quite cooperative with users and the press.

*Richard Mercier  
Laval, Quebec, Canada*

**Author’s Reply:** It would appear that there is some confusion as to whom the word “experimental” applies, JBL or me. What I meant was that it is an experimental woofer project of mine that uses the JBL 1400Nd driver in a 5-cubic-foot ported enclosure. It in no way is a JBL experiment. The 1400Nd driver is not available for sale in the U.S., as it was used in two speaker systems, the K2 and the M-9500, exclusively for export to Japan. Yes, the “Nd” does stand for “neodymium.” I got the drivers through being a consultant to Infinity Systems, which is owned by Harman International, also parent company to JBL.

How this all came about was that I heard from some very acute listener friends of mine that these were killer drivers. I was able to hear a four-way system belonging to a JBL engineer who was using these drivers in the low end of the system, which he had modified from one of JBL’s standard models. I went away most impressed and eventually got a pair of the drivers.

The way the B & W 801 Matrix Series 3 loudspeakers interface via the room modes to my listening position results in a dropoff in response below about 50 Hz. By positioning the subwoofers against the wall behind the 801s and driving the subwoofers with a suitably tailored and low-passed signal derived from the main system amplifier output (so that the subwoofers will take on the bass characteristic of the main system amplifier, handy for reviewing amplifiers), I get a nice and extended response, down to about 25 Hz, at the listening position. It is unfortunate that the 1400Nd is not available as a separate item in the U.S.—*B.H.K.*

## When Is a “Tube Engineer” Not a Tube Engineer?

Dear Editor:

Fascinating interview with Tim de Paravicini (January). As an operator (in live

theater) of effects decks, I land squarely in his camp regarding the operator-unfriendliness of digital tape decks (including DCC). The “stop, fit, fart, and think” sequence of a DAT deck makes it an unusable tool in my world. Reel-to-reel with razor-blade editing (remember that?) is still our standard—but getting more and more expensive to maintain.

Whoever wrote the cover blurb describing Mr. de Paravicini should be banished to whichever circle of hell is reserved for tabloid writers and headline writers who don’t bother to thoroughly read the articles they’re writing heads for. Mr. de Paravicini is no more a tube engineer than Bob Carver is a solid-state engineer. They are both superb *audio* engineers with the ability to make marketing decisions independently of engineering criteria. Bob Carver said, years ago, that he could duplicate the “sonic signature” of any tube component with solid-state electronics. Mr. de Paravicini said: “I don’t have to use tubes in my designs; I only do it for marketing reasons. I’ve got an exact equivalent in solid-state. I can make either type do the same job, and I have no preference.” Obviously, the people that he identifies as his customers want tube designs—and that’s what he produces. Carver’s customers want solid-state—and they get it. But Bob Carver designed one superb tube amp when he felt like it.

To cover-blurb Mr. de Paravicini as a “tube engineer” promotes the witchcraft, subjective, tweako hocus-pocus B.S. that has made it impossible for a rational man to deal with high-end audio and associated publications—i.e., *The Absolute Sound*, *Stereophile*, etc.

“What comes out must sound the same as what went in.”—*de Paravicini*

We should all try to remember that when we talk about sonic signatures et al. Try to get Mr. de Paravicini at greater length. He is no guru, but a fine light in the darkness.

*Russell Buonasera  
Missouri City, Tex.*

## Erratum: Jamo Address

In our most recent Annual Equipment Directory (October 1994), the “Company Address” shown for Jamo is incorrect. The correct address is 425 Huehl Rd., Bldg. 8, Northbrook, Ill. 60062 (phone, 708/498-4648; fax, 708/498-1948).

# How Do You Improve On "... The Best Value In The World"?

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We're pleased to introduce new versions of our *Ensemble* and *Ensemble II* systems, as well as our new, ultra-compact *Ensemble III*.

### The New Ensemble

*New Ensemble* is an improved version of our original dual-subwoofer/satellite speaker system. *New Ensemble* maintains the dual subwoofer design, which allows for maximum room placement flexibility. Placement of bass and high-frequency speakers in a room (and how those speakers interact with the room) has more influence on the sound quality of a music system than just about anything. *New Ensemble's* ultra-slim (4 1/2") subwoofers give you more placement flexibility than any system we know of.



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*New Ensemble* maintains the tonal balance, frequency range and quality of construction of the original. There are two basic differences.

1. *New Ensemble* uses a new 8" woofer with a very long "throw" for linear cone excursion and more accurate bass. An integral heat sink provides improved power handling.

2. *New Ensemble's* satellite speakers use the same speaker drivers and crossover as the original, but with new midrange and high frequency balance controls.

The midrange control lets you choose the same output in the key 800-1600 Hz octave as in the original, or you can emphasize that octave by 2 dB. *Ensemble* satellites have relatively less output in this range to avoid the "boxy" sound typical of many speakers. This results in an "open" sound on large-scale symphonic works. For small-scaled music, the higher output position proves a "warmer" sound.

A high frequency control has three positions: A) The same balance as original *Ensemble*. B) A 2 dB high frequency increase. C) A 2 dB high frequency decrease. The switch can subtly increase the system's "airiness" (Increase) or it can reduce any tendency towards "edginess" (Decrease).

In terms of "real life" performance, we believe our *New Ensemble* system competes head-on with speakers selling for hundreds more. Available with black-laminate subwoofers for \$629, or with vinyl-clad subwoofers for \$549.

### The New Ensemble II

*New Ensemble II* is an improved version of our best-selling speaker system. It's more affordable than *New Ensemble* because it uses one cabinet to house both subwoofer speakers. *New Ensemble II* maintains the tonal balance, frequency range, power handling and construction quality of the original *Ensemble II*. But its satellite speakers use the same tonal balance controls as *New Ensemble's*.

*New Ensemble II* also uses a new flared subwoofer port. The subwoofer cabinet encloses two 6 1/2" long throw woofers mounted in a sealed "acoustic suspension" chamber. They project into a second chamber fitted with the flared port, which provides smoother air flow, eliminating extraneous noise on strong bass notes.

*Stereo Review* said the original *Ensemble II* "performs so far beyond its price and size it can be compared only with much larger speakers at substantially higher prices." *New Ensemble II* carries on this tradition, outperforming other speakers in its category, including well-known models for about twice the price. Factory-direct price, \$439.

### The Ensemble III

Now you can bring the clear, balanced wide-range sound of *Ensemble* speakers to a small, crowded room. Our new *Ensemble III's* satellite



speakers are only 4 1/2" x 6 1/2" x 3" and its subwoofer is 8" x 8" x 15".

Compared to *New Ensemble II*, *Ensemble III* gives up a little in power handling, low bass range, and efficiency. Unlike the "cube" satellite speakers you'll find in most similarly priced systems, *Ensemble III's* satellites are two-way speakers. *Ensemble III's* 6 1/2" woofer uses two

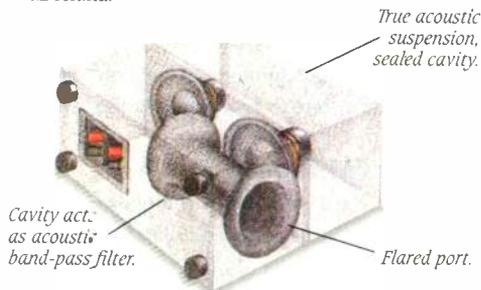
voice coils in a cabinet with a flared port for smooth air flow.

With most recordings *Ensemble III* will sound virtually identical to *New Ensemble II*. It simply won't play as loud. Its construction quality is normally found only in much more expensive speakers.

Factory-direct price, including connecting wire, cutter/stripper and Hook-Up Guide, is only \$329.

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### Car Stereo at Home

**Q** *I have an old but still quite serviceable Delco automobile stereo system that I don't need in my car. It works so well, I thought it would make a nice high-fidelity system for my small apartment. The receiver uses ungrounded output terminals, if that is important. Can I use it in the way I would like?—R. P. Culhane, Hoboken, N.J.*

**A** I see no reason why you can't use your car receiver as a home system. The fact that the output terminals are not grounded only has a bearing if you are planning to add speakers in the Hafler surround configuration, as you would have to add a 1-to-1 transformer to each channel. Attempting to wire these extra loudspeakers without the transformers would almost certainly result in damage to the output stages of the equipment.

What could be mildly challenging is the requirement for a well-regulated, 12-V power supply. When building or buying one, be sure that it is capable of handling somewhat more than the maximum current that will be drawn by the receiver. This can amount to several amperes if your car stereo is a high-wattage unit.

The lead-acid storage battery used in a car is a wonderful power source, but in the home it would require good ventilation, recharging, and suitable maintenance—not to mention care to avoid spilling the acid.

### Noisy FM Tuning

**Q** *I have noticed on many old tuners that noise and static appear, especially on the lower end of the FM band. Is there any way of permanently getting rid of this? Spraying TV tuner cleaner around sometimes helps a bit, but not for very long.—William Luginbuhl, Bluffton, Ohio*

**A** If this is noise picked up by the antenna, there is probably little you can do about it. But your mention of "tuner cleaner" makes me think that perhaps you have an older tuner with an analog dial and that you hear noise as you tune across the band. This is usually the result of oxidation on the wiper contacts of the tuner's variable

capacitor sections. These wipers are used to ground the rotor plates during tuning, and oxidized contacts make the grounding erratic, causing the noise you hear as you adjust the set.

I have successfully cured this type of noise by spraying WD40 on the wiper contacts. I have tried some other cleaners, but with less durable results. Surprising as it seems, the use of WD40 doesn't even disturb the alignment of the front-end tuned circuits! However, I have also run into some tuners whose variable capacitors were so cheaply made that their wipers just didn't exert enough pressure to make good contact even where there was virtually no oxidation on them.

### What FM Doesn't Give Us

**Q** *I know that FM signals are compressed, because, when I record from FM, the VU meters do not move very much. Why don't FM stations give us as wide a dynamic range as possible? I've also noticed that the frequency response of FM stations is not as wide as it is, for example, for CDs. Why not give us all that is coming to us?—Rick Wang, Irvine, Cal.*

**A** Many FM stations compress their signals in order to provide the largest possible area of signal coverage with a minimum of background noise. While the signal leaving an FM transmitter can be very low in noise, distance from the transmitter, interference, and the quality of your antenna and receiver can each raise the noise level you hear. Compression ensures that really soft musical passages won't be lost in the noise. If only those listeners near the transmitter could hear a station's signal properly, the station would reach fewer listeners, which would result in lower advertising revenue. In addition, pop stations sometimes use extra compression, to achieve a "punchier" sound that catches the ears of people tuning through the dial.

The frequency range of FM has to be narrower than CD's: It is limited at the top to 15 kHz, to leave room for the 19-kHz stereo pilot signal. At the low end, the rated

limit of 50 Hz is just a minimum—many stations do transmit lower audio frequencies very well.

### Adding Remote Loudspeakers

**Q** *I want to locate my receiver and primary loudspeakers on the first floor of my home and a second pair of speakers on the second floor, which will require about 40 feet of cable. This will allow me to hear my stereo system from anywhere in my home. One audio salesman told me that in order to do this I would have to buy a receiver having at least 100 watts per channel. Another salesman told me that what I really needed was a high-current power amplifier. I'm working within a total budget for this project of \$1,000. What should I do?—David E. Witt, Covington, Ky.*

**A** The amount of power required to drive all of your loudspeakers depends on your speaker's efficiency, your room sizes and acoustics, how loud you like your music, and, to a lesser extent, the resistance of your cables. You might need only 25 watts per channel, or you might need 300 watts.

First, see how well your present receiver works with two pairs of speakers, assuming that it can handle the low impedance of the combined load. (Two 8-ohm speakers paralleled present a 4-ohm load; two 4-ohm speakers in parallel yield 2 ohms.) If you're already driving your amplifier to something near its maximum output, you should get—regardless of what that maximum is—at least twice as much power to drive the added loudspeakers. (Most amplifiers will deliver more total power into your reduced load impedance, but I like an added safety margin.) Because of that 40-foot cable run to each of the upstairs loudspeakers, I suggest that you use at least 12-gauge wire or, even better, 8-gauge.

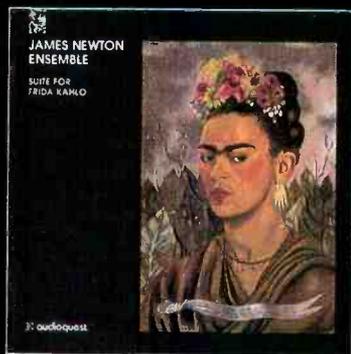
If your present receiver works out with the added speakers, you can continue using it. This will leave you more money to spend on loudspeakers, and I'm convinced that they contribute the most to an audio system's overall sound. A

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

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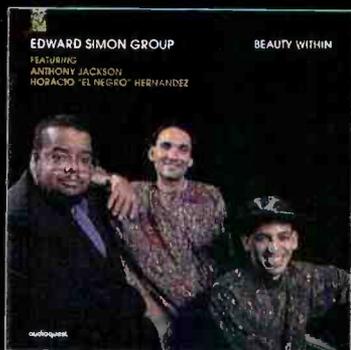
The Absolute Sound Vol. 18, Issue 92



JAMES NEWTON 1023

**SUITE FOR FRIDA KAHLO**  
The award winning flutist and composer celebrates the incredible life and work of Frida Kahlo.

“Brilliant!” -*Jazz Times*  
“My choice for jazz record of the year.” -*Stereophile*  
“\*\*\*\*A gem!” -*DownBeat*



EDWARD SIMON 1025

**BEAUTY WITHIN**  
The rave reviews have been rolling in on this stunning synthesis of Latin music and power jazz.  
“A striking statement...the alchemy is audible from the very first track.” -*CD Review*  
“\*\*\*\*An inner exploration...a relentless present day groove.” -*DownBeat*  
“Deftly straddles Afro-Cuban with hard bop.” -*Jazziz*



DOUG MACLEOD 1027

**COME TO FIND**  
AudioQuest Music is proud to add one of the brightest singing and song writing talents in blues to its roster. *Come To Find* is the remarkable sound of a consummate bluesman touching the core of his art. He is beautifully supported in an intimate setting by harmonica ace Charlie Musslewhite and the Mighty Flyers' rhythm section, Jimi Bott and Bill Stuve. Don't miss this!



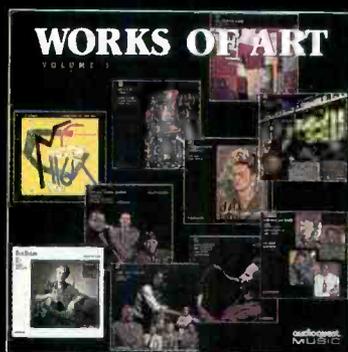
KEI AKAGI 1028

**MIRROE PUZZLE**  
Pianist and composer Kei Akagi has for many years been one of the most in-demand artists on the jazz and creative music scene. He has recorded and performed with, among others, Miles Davis, Stanley Turrentine and Freddie Hubbard. Kei's working band, featured here, includes fellow Miles Davis alum Rick Margitza on sax, bassist Charles Fambrough and drummer Willie Jones III. Pure musical magic!



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# CD Players on the go!!!

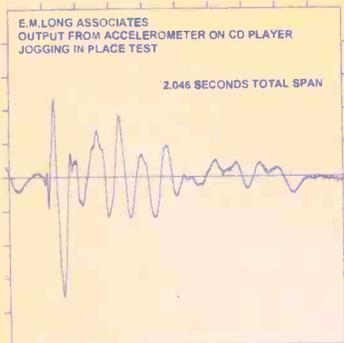
by Edward M. Long



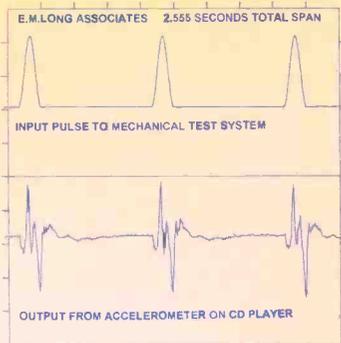
If you have ever taken portable CD players jogging or even for a drive over a rough road, you are aware that they are very sensitive to shocks: They just stop playing every time they are jarred or bumped. Unlike phono turntables, which produce some pretty terrible sounds when they skip or slide across grooves, CD players don't produce any sound at all, until the laser locks on the track again and the digital data stream is restored. It doesn't take long to do this, and unless the CD player is subjected to a continuous series of shocks, the sound returns quickly. If the shocks are spaced by a reasonable amount of time, for example, about half a second apart (as would be true for someone jogging), then digital techniques can provide a solution.



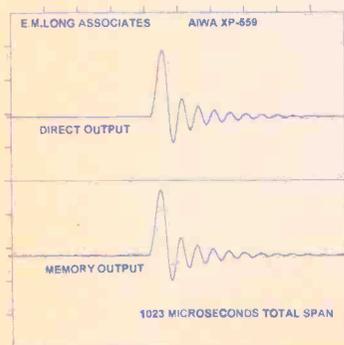
Photograph: Michael Groen



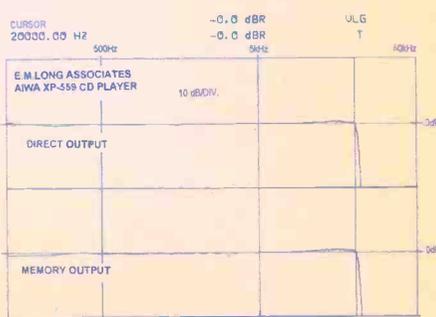
**Fig. 1**—Accelerator waveform from jogging in place.



**Fig. 2**—Comparison of pulses, 1 S apart, applied to mechanical test system (top) and resultant output from an accelerometer on a CD player (bottom).



**Fig. 3**—Direct output (top) and output via anti-shock memory (bottom) from Aiwa XP-559 subjected to test pulse from Denon Audio Technical test CD.

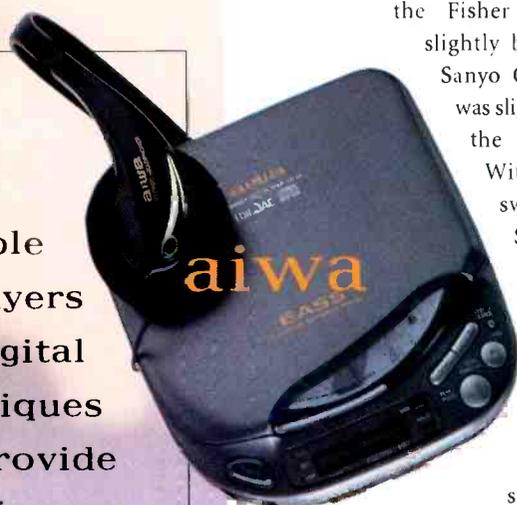


**Fig. 4**—Spectrum of output for recorded test pulse from Aiwa XP-559, direct (top) and via memory (bottom).

Among the first portable CD players to use such techniques are the Aiwa XP-559, the Fisher PCD-60, and the Sanyo CDP-55. They use digital memory to provide continuous output when they receive mechanical shocks that make the laser lose tracking. When the memory system is switched on, the information data stream is diverted to a digital memory that acts like a delay line. When the laser loses tracking due to a mechanical shock, the data stream into the memory is interrupted but the data output from the memory to the D/A converter continues, so the sound is uninterrupted. Once the laser locks again on the CD track, the data stream is fed to the memory and joined to the previous data. Internally, the time delay of the data stream varies when the player is subjected to mechanical shocks; externally, the result is a seamless stream of information with no interruption.

To test these CD portables, I set up a vibration system that would provide a series

**these three portable CD players use digital techniques to provide continuous output, even if they're jarred.**



of mechanical shocks to the players. I calibrated the system with a B & K accelerometer and set the 0-dB reference to a force of 1 G. I did a lot of experimenting before I settled on the final test procedure; I put an accelerometer on a CD player and jogged in place. To capture a transient impulse caused by the jogging, I used a digital storage oscilloscope and a Fast Fourier Transform (FFT) analyzer. The result of this test is shown in Fig. 1 as output versus time. This gave me a good insight and made it easier to decide on the final impulse that I applied to each CD player. The main difference between the impulses caused by jogging and the one I used is that my test impulse is consistent, controlled, and repeatable. The top trace of Fig. 2 shows the signal applied to the mechanical test system; the bottom trace shows the output from the accelerometer mounted on a CD player. The test pulses are spaced at 1 S; I know that this is slower than a jogger's pace, but I used this time spacing in order to allow the output to settle fully so that the FFT could capture the spectrum properly.

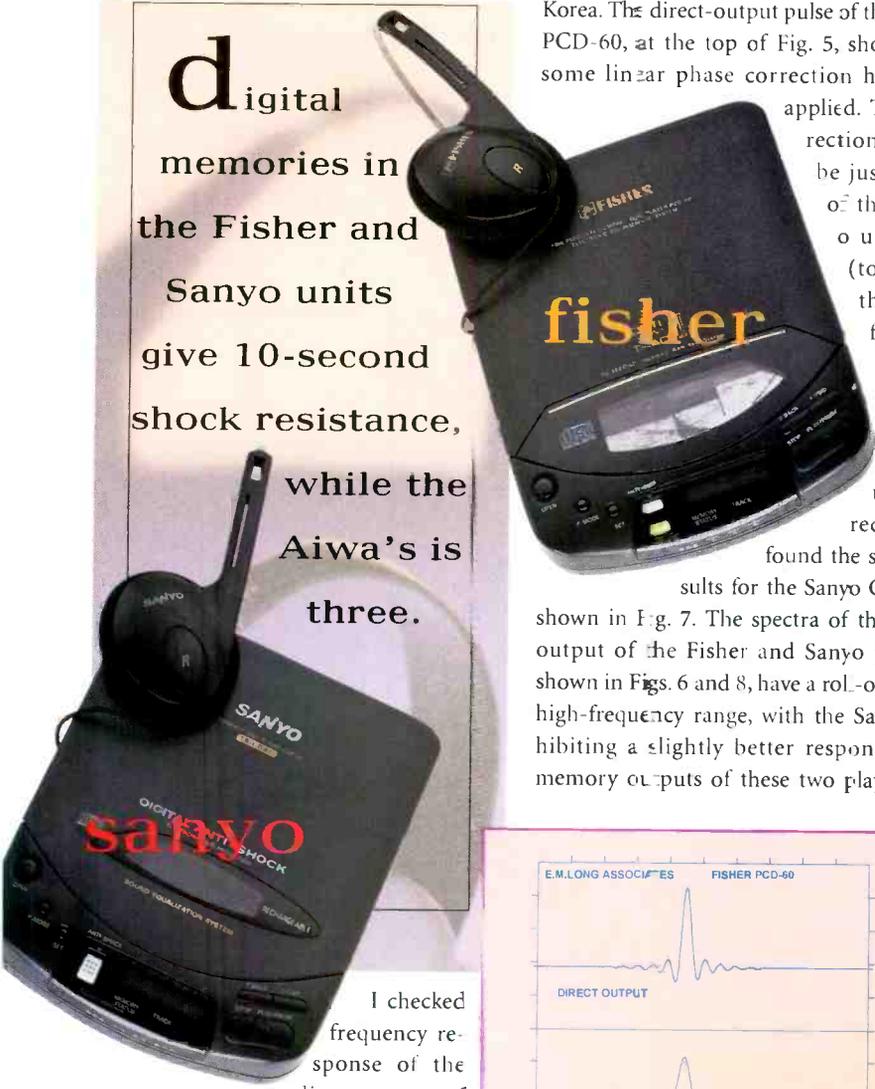
During the tests, each of the three CD players lost tracking at about the same level of mechanical vibration;

the Fisher PCD-60 was slightly better than the Sanyo CDP-55, which was slightly better than the Aiwa XP-559.

With the memory switched on, the Sanyo and Fisher units were able to maintain a constant output for ten mechanical shocks spaced 1 S

apart; the Aiwa produced a constant output for about 3 S. I jogged in place with each of the players and verified the results of my controlled tests. The results were similar, with the Fisher best, the Sanyo slightly behind the Fisher, and the Aiwa last.

**d**igital memories in the Fisher and Sanyo units give 10-second shock resistance, while the Aiwa's is three.

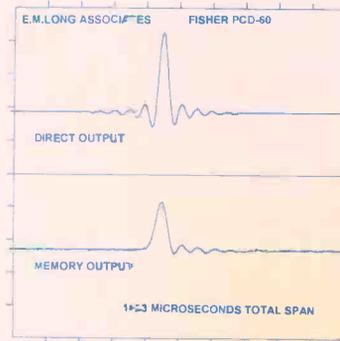


Korea. The direct-output pulse of the Fisher PCD-60, at the top of Fig. 5, shows that some linear phase correction has been applied. The correction has to be just ahead of the direct output (top), as the pulse from the memory (at bottom) is uncorrected. I found the same results for the Sanyo CDP-55, shown in Fig. 7. The spectra of the direct output of the Fisher and Sanyo players, shown in Figs. 6 and 8, have a roll-off in the high-frequency range, with the Sanyo exhibiting a slightly better response. The memory outputs of these two players are

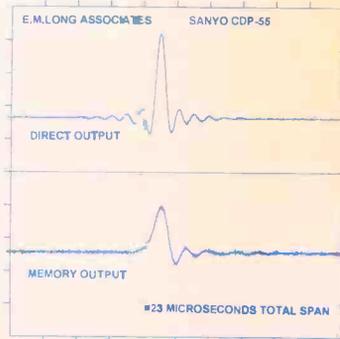
also similar. The memory output levels are on the order of 15 to 16 dB lower than the direct outputs, using the test pulse of the Denon CD. This is a strange result because, when I listened to the Fisher and Sanyo players, playback level was the same whether the memory was switched in or out. Perhaps the lower output levels, shown in the lower curves of Figs. 6 and 8, are caused by the frequency of the test pulse being a little higher than the frequency limit of the memory. This may be an acid test, but the Aiwa passed it with flying colors. These CD players are definitely intended to travel: Each comes with a car cigarette lighter power adaptor and an adaptor that allows you to play CDs through the cassette player in your car. (The Aiwa is also available without these accessories, as the Model XP-55) All three also include a.c. power adapters and earphones. The earphones are not very good compared to the ones I have been testing for *Audio*; they do little more than let you know that the player is working. If you want to hear the good sound that

I checked frequency response of the direct output of the three players with the memory switched both off and on. The test pulse was from track 76 of a Denon test CD (No. 38C39-7147). This high-frequency pulse allowed me to obtain a spectrum using an FFT. The Aiwa fared best for this test; the output versus time is shown in Fig. 3, while the spectrum is shown in Fig. 4. The output from the Aiwa's digital memory is identical to the direct output. The pulses of Fig. 3 do show that no linear phase correction has been applied. I found this interesting because I had assumed that most modern CD players, especially those with one-bit D/A converters, would have linear phase correction.

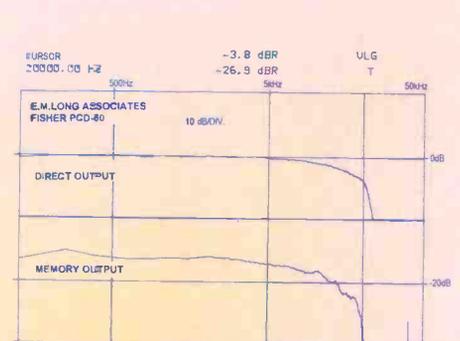
The Fisher and Sanyo CD players are very similar and have many common parts, even though the Fisher was made in China and the Sanyo was made in



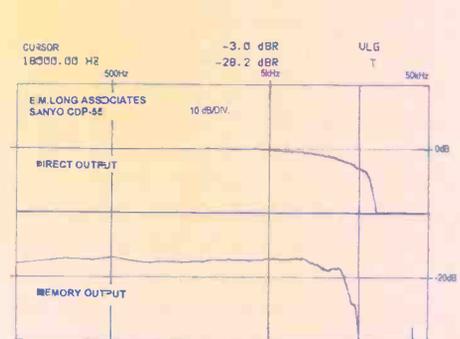
**Fig. 5**—Direct output (top) and output via memory (bottom) from Fisher PCD-60 subjected to test pulse.



**Fig. 7**—Direct output (top) and output via memory (bottom) from Sanyo CDP-55 subjected to test pulse.



**Fig. 6**—Spectrum of output for recorded test pulse from Fisher PCD-60, direct (top) and via memory (bottom).



**Fig. 8**—Spectrum of output for recorded test pulse from Sanyo CDP-55, direct (top) and via memory (bottom).

	<b>AIWA XP-559</b>	<b>FISHER PCD-60</b>	<b>SANYO CDP-55</b>
Line Output at 0-dB Reference	0.68 V rms	0.8 V rms	0.8 V rms
Earphone Output	0.7 V rms	0.8 V rms	0.8 V rms
DAC Type and Oversampling Rate	One-Bit, 8X	One-Bit, 8X	One-Bit, 8X
Linear Phase Correction?	No	Yes	Yes
LCD Indications	Memory Status/Track/ Time	Memory Status/Track (Backlit)	Memory Status/Track
Memory Storage Time Before Play	1.7 S	2.0 S	1.8 S
Full Memory Storage Time	3.0 S	10 S	9.7 S
Applied Force to Skip (Memory Off)	0.8 G	0.87 G	0.9 G
No. of Programmable Selections	22 Tracks	22 Tracks	24 Tracks
Repeat Play of Tracks	Single/All/Programmed/ Random	Single/All/Programmed	Single/All/Programmed
Earphones Rating	C+	C-	C-
50-Hz Level for Bass EQ Positions	0.0, +10.9, +16.0 dB	0.0, +10.7, +17.7 dB	0.0, +17.8, +22.1 dB
Battery Voltage and Life	6 V d.c./12 Hours (8 Hours with Memory)	3 V d.c./Not Stated	3 V d.c./Not Stated
Batteries	Four AA, Not Included	Two, Rechargeable Nickel-Cadmium	Two, Rechargeable Nickel-Cadmium
Adaptor for Car Cassette?	Yes	Yes	Yes
Adaptor for Car Cigarette Lighter?	Yes	Yes	Yes
A.C. Adaptor?	Yes	Yes	Yes
Mini-to-Phono Patch Cord?	Yes	No	Yes
Price	XP-559, \$220; XP-55 (without car accessories), \$190	\$219.95	\$180

these players can produce, you should buy better earphones.

It is a little hard to choose between these three Compact Disc players. For sound quality, I think that the Aiwa is slightly better for pop and rock, while the Sanyo and the Fisher are better on classical and other finely detailed music. I like the backlight on the Fisher LCD display and the fact that this unit is slightly better for jogging. I like the playing-time indicator on the Aiwa, something that is lacking on both the Fisher and Sanyo. The four AA batteries of the Aiwa also provide longer play than the others' rechargeable batteries. I expected that the Aiwa's 6-V power supply would also in-

crease the headroom, but it was about the same as the Fisher and Sanyo, which operate with 3-V supplies.

I hope that I have provided you with some good information about these three CD players that will assist you in making a purchasing decision, but you should still look them over and listen to them. I suggest that you take along some familiar CDs and a good pair of earphones when you do. If you are looking for a CD player for your car, each of these will work very well. If you are planning on jogging, their memory limitations may warn you to do your jogging a little more smoothly and help save your knee joints. A

### Company Addresses

#### AIWA

800 Corporate Dr., Mahwah, N.J.  
07430. For literature on Model XP-55  
or XP-559, circle No. 80.

#### FISHER

21350 Lassen St., Chatsworth, Cal.  
91311. For literature on  
Model PCD-60, circle No. 81.

#### SANYO

21350 Lassen St., Chatsworth, Cal.  
91311. For literature on  
Model CDP-55, circle No. 82.

## Movie Theatre Performance with Flexibility

### The Bryston 8B THX® Amplifier



8B THX

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20

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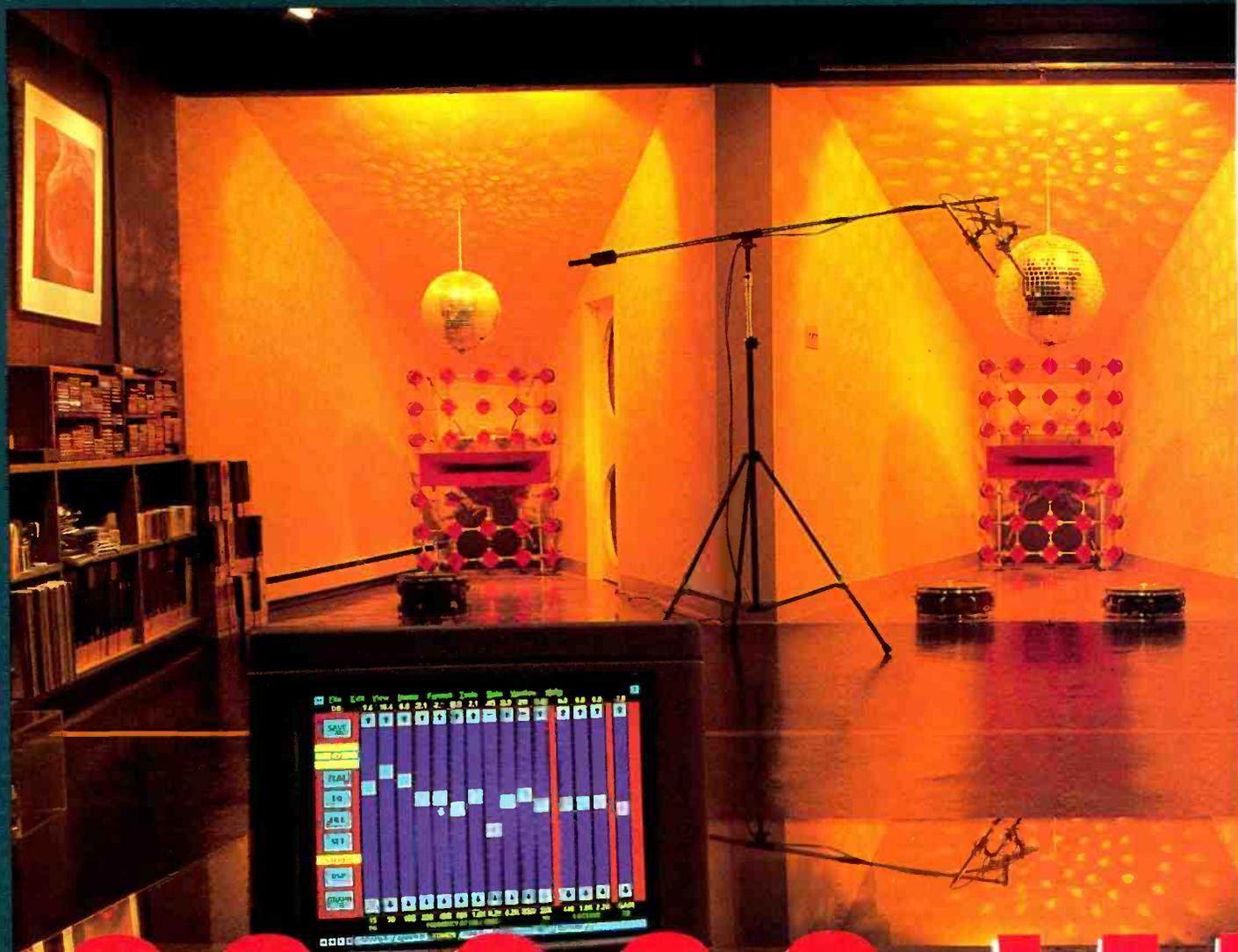
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Music

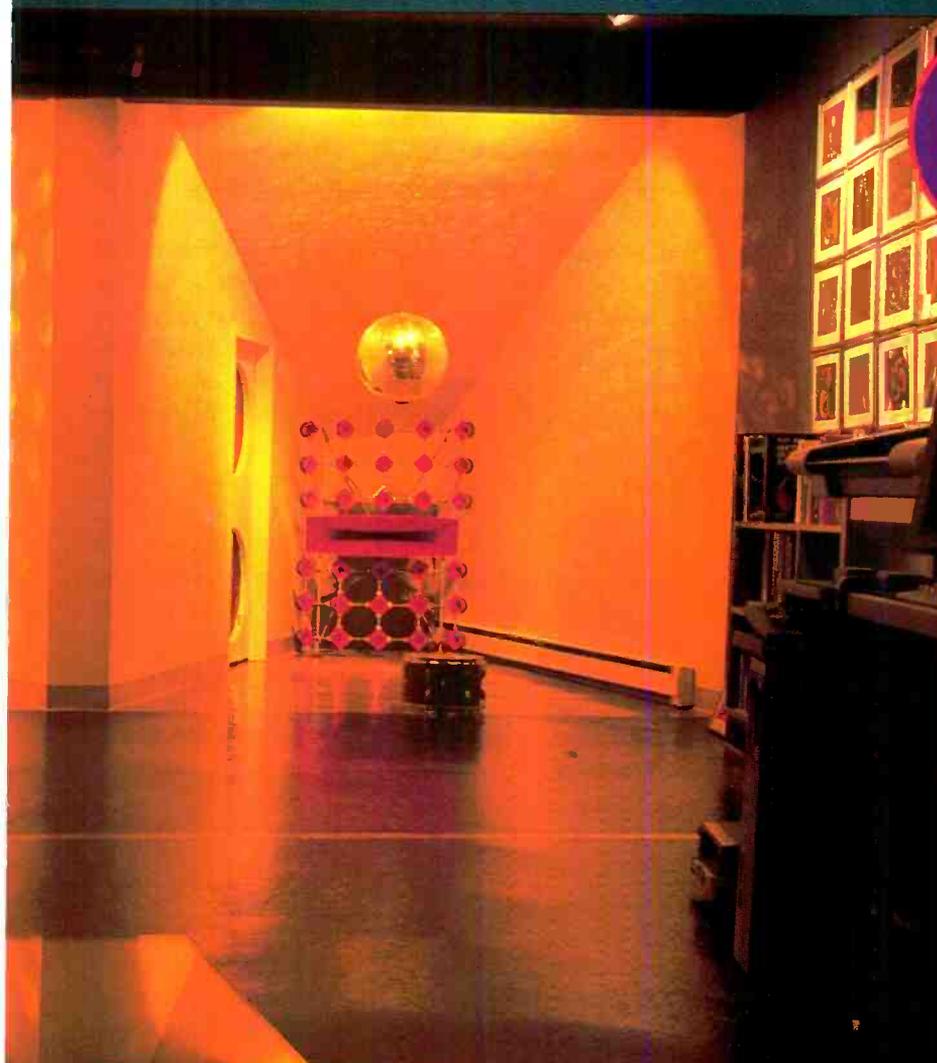
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S

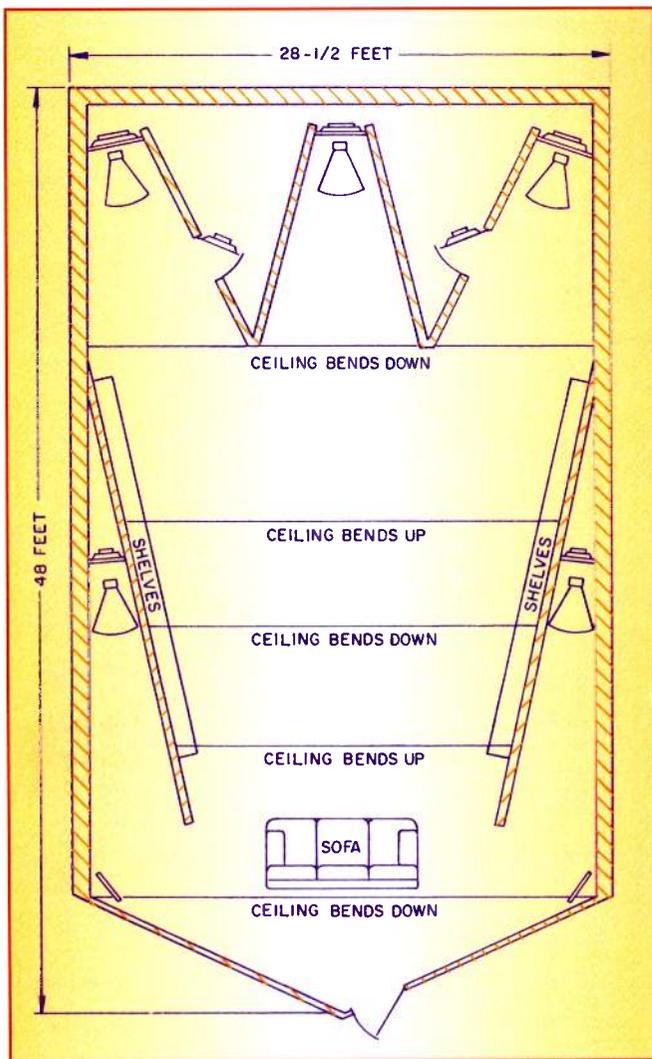
ince 1931, I have recorded classical and jazz music, both in my studio and in concert halls and clubs, using the Sony PCM-F1 digital format and, more recently, also using DAT and MiniDisc. I have never found a

piece of program material—mine or anyone else's—that could not benefit from a bit of equalization. Every decent recording I have made over the past 20 years was equalized during recording. When I play these tapes today, they sound even better with further equalization. The amount of equalization I use varies dramatically with the program material. Different musical selections recorded at the same concert may require different equalization due to orchestral imbalance or changes in seating arrangements.

My audio system has eight one-control (equalizer) panels and remote units for recording and playback; it was the subject of the cover feature article in the April 1976 issue of *Audio*. Recently I added a new two-control system using a digital signal processor board in a personal computer. I have found that adjusting tonal balance (frequency response) is the single most important system parameter in achieving good sound.

# ATTITUDE AT THE HI-FI TABLE EQ

RICHARD S. BURWEN



My standard for fine sound is *not* the original performance and environment but maximum entertainment value. To me, music is art—and art is entertainment. Anything goes, short of grossly distorting the composer's original intent. I think tonal balance is by far the most important aspect of a sound system. Of course, you also need low distortion of all types, enough power, speakers with smooth frequency response and suitable directional characteristics, and good room acoustics—preferably live acoustics rather than lots of sound absorbing materials. Purists may disagree, but I think pleasing frequency response is what really makes a system musical and, to a large degree, accounts for the audible differences among systems.

Part of entertainment, for me, is lots of bass—not boomy, but the kind that makes your clothes flap in the breeze. I hate screechy sounds and don't care about hearing such details as resin on the bow. I like

the well blended sound of a symphony orchestra in a live hall, with different notes seeming to come from different directions, but without the little noises and imperfections of the individual instruments.

Tonal balance is critical to within  $\pm 0.5$  dB in the range from 200 Hz to 5 kHz. As little as 1 dB of boost from 400 Hz downward can change the "body" of a kettle drum. Tilting the high frequencies up as little as 1 dB above 1.5 kHz can increase the apparent width of the orchestra. Regardless of your own benchmark for great sound, achieving what you perceive as perfection requires precise control of the tonal balance.

Digital signal processing provides this precise tonal balance with far greater flexibility, accuracy, and channel matching than I have ever been able to achieve in 50 years of analog tone-control designs. Instead of launching directly into how I accomplished the digital equalization, let me first provide details on the system.

### Sound Studio



My sound studio was designed first, and then the house was designed and built around it.

As shown in the floor plan, the room is 48 feet long x 28½ feet wide; it contains five speaker horns, each 13 feet deep with a 64-square-foot mouth. Three of the horns are in the front; the other two horns are along the studio's long sides, facing the rear and delivering reflected sound. Cinder block and concrete make the walls rigid, and the heavy, wavy, plaster ceiling diffuses sound. Acoustically the room is

very live. Its nonparallel surfaces produce many standing waves, closely spaced in frequency, while eliminating flutter echoes.

Altogether there are 169 woofers, midrange horns, and tweeters plus an intercom speaker. Each of the five horns contains two 16-inch Empire woofers, a midrange horn with two JBL drivers, and 30 Cerwin-Vega tweeters. In addition, the left- and right-front horns each have two 24-inch Cerwin-Vega woofers, which operate below 50 Hz, while the 16-inch woofers cover from 15 Hz to 400 Hz. The midrange horns reproduce 400 Hz to 6 kHz, avoiding crossover defects in the critical mid-frequency region.

Each woofer, each midrange, and each group of nine or 12 tweeters is driven from one channel of a modified Phase Linear 400 stereo amplifier, capable of 250 watts at the 8-ohm load impedance presented. The front-speaker enclosure room, occupying space behind and between the horns,

20,000

I've never  
recording that  
did not

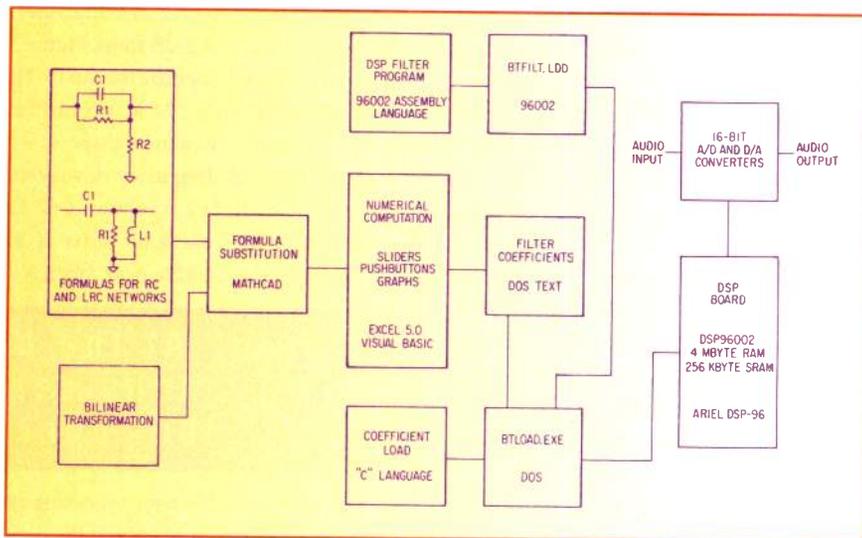
contains 11 amplifiers. Six more amps are located in the side speaker horns. Electronic crossovers ahead of the 34 amplifier channels increase the effective acoustic output to that of a single 20,000-watt amplifier.

Why all that power? Because it takes most of the power available for any one horn to reproduce drums at live levels, leaving only 3 to 6 dB of headroom for the contributions of other orchestral instruments.

The crossovers, incidentally, also equalize the frequency response. I spent a year adjusting the response, in fractions of a dB, so that a tape recording of a drum set, made while the drummer actually sat in my front-center speaker horn, sounded real.

I haven't yet mentioned the lighting power. Four channels of 2,400-watt, SCR controllers light the three front horns in different colors automatically, in response to the music.

My "preamplifier" consists of 7-foot-high relay racks. I have 3½ of these racks, which contain signal-processing and tone-control equipment, mostly of my own design. The racks' bottom sections hold playback equipment, while the top sections



**Fig. 1**—Components of the DSP software and hardware system.

hold recording equipment that can handle live mixing of 52 channels. Each of the 28 recording inputs includes a control equalizer

D/A converters—that receive analog stereo audio and deliver the processed analog stereo output. At the 48-kHz sampling rate, the Motorola DSP96002 chip can perform about 347 instructions in each 20.8- $\mu$ s sample period. In response to each instruction line, the digital signal processor (DSP) can, in 60 nS, simultaneously multiply two 32-bit floating-point numbers, add and subtract two others, and move two more numbers to new locations. Many instructions are less efficient, involving only one or two operations. The 46 filters and gain changes in this stereo tone-control system use about 80% of the processor's available instructions.

For each tone control, the DSP scales the results from the last few samples and adds them, in combinations, to the value of the current sample. (Scaling means multiplication by a coefficient.) The filters are all infinite-impulse response (IIR) types, in which a portion of the output is regeneratively added to the input, closely approximating the transient, frequency, and phase responses of simple RC and LRC circuits.

Figure 1 shows the component blocks of the DSP software and hardware system. It started with the basic filter formulas for simple RC and LRC circuits. For example, the RC filter in the upper left block is a treble-boost or bass-attenuation circuit, depending on the parts values and specified gain. By substituting a simple formula, known as the bilinear transformation, for the complex frequency variable in the design formula for an analog filter, one can create a digital filter having the same frequency characteristics. Mathcad computer

software from MathSoft made the algebraic substitution easy and accurate.

Instructing the DSP what to do requires three software programs, as can be seen in Fig. 1. First is a spreadsheet program using Microsoft Excel 5.0 for Windows; Excel's Visual Basic program section provides mouse-actuated sliders and pushbuttons on the screen. From the positions of the sliders, it calculates the coefficients for the corresponding digital filters, implementing the results of the formula substitution block. (Excel also makes graphs of frequency response.) The coefficients of the digital filters, each with a resolution of 10 digits after the decimal point, are exported to a DOS text file. Then another DOS program, BTLOAD.EXE, which is written in "C" language, scans the coefficients and sends them, one at a time, to the host port of the

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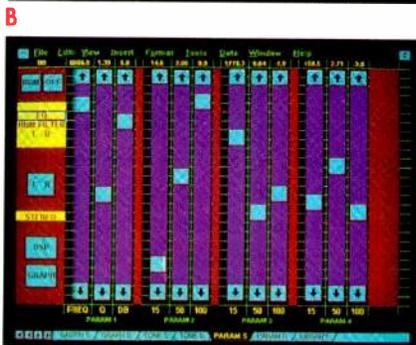
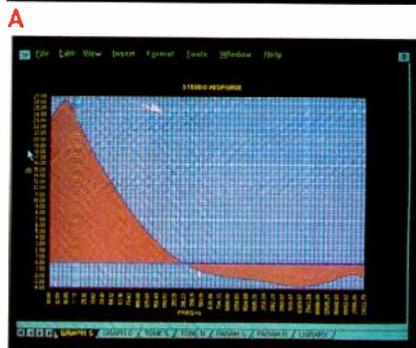
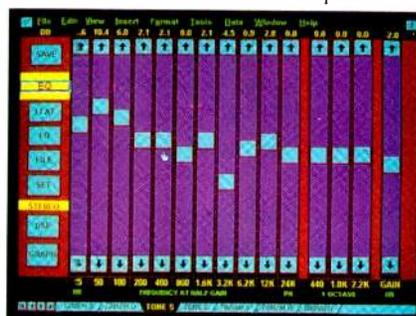
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with four shelf-type tone switches and two peaking types at the ends of the audio range. The front playback section has two different tone-control panels and two remote tone-control units. The rear playback section uses only two equalizer panels.

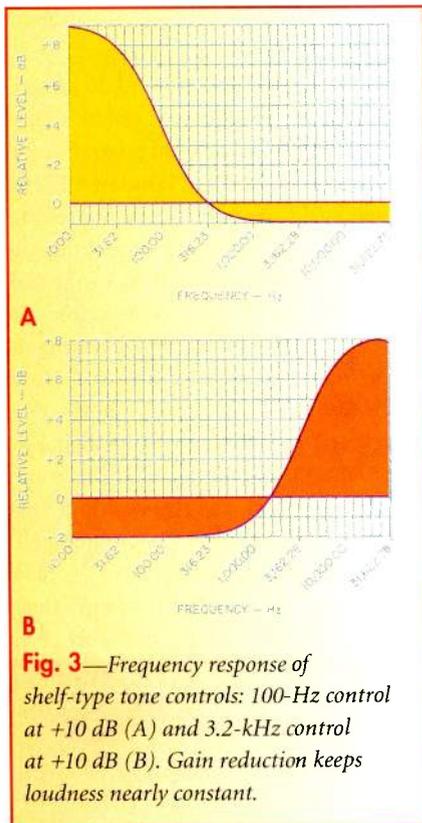
Although I started out recording and reproducing four-channel tapes through my five speaker systems, I found in recent years that I can achieve better sound from two-channel recordings. Front sound fed into the rear speakers (directly, via five delays, and via three microphones) provides a concert-hall effect while preserving stereo imaging. The center speaker horn receives a front left/right mix at -13 dB. The new digital tone controls, which I will describe, take the place of the four front tone-control units.

### How It Works

**A** ll signal processing between A/D and D/A conversion is performed digitally by an Ariel DSP-96 board in a personal computer. This board carries a daughterboard containing 16-bit A/D and



**Fig. 2**—Three of seven screens: Stereo tone controls (A), frequency response graph (B), and parametric equalizers (C).



**Fig. 3**—Frequency response of shelf-type tone controls: 100-Hz control at +10 dB (A) and 3.2-kHz control at +10 dB (B). Gain reduction keeps loudness nearly constant.

DSP board. Finally, a DSP assembly-language program, BTFILT.LDD, instructs the DSP to shuffle the numbers among various registers and perform all the required multiplications, additions, and subtractions during each sample period. The net result is that each outgoing audio sample, for either the left or the right channel, winds up being a complicated function of the original incoming sample and of about 40 preceding incoming samples and 40 intermediate calculations.

### Tone Controls and Buttons

The system has a total of 54 mouse-actuated sliders and 17 buttons on four display screens. Two more screens show graphs of the left-channel frequency response and the difference between the left and right channels. A seventh, library, screen stores certain button settings and the settings of all the sliders in dB as well as position. Figures 2A, 2B, and 2C show three of the seven screens. The first and principally used screen, shown in Fig. 2A, contains 15 sliders and seven buttons. These sliders are actually scroll bars, as used in familiar Windows programs. The controls in the first screen set the tone for both left and right

channels, with a resolution of 0.1 or 0.2 dB and perfect digital matching.

All the tone controls are completely independent and noninteracting. If I set the 15-Hz peaking control at +30 dB and each of the shelf-type bass controls (centered at 100, 200, 400, and 800 Hz) at +15 dB, I get 90 dB of bass boost at 15 Hz! A graph of these settings actually shows a range from +69.5 dB at 15 Hz to -20.5 dB at 10 kHz, because the system automatically adjusts the gain to achieve nearly the same musical loudness with different tone-control settings. At the top of each slider is the setting, in dB.

The left group of sliders in Fig. 2A provides peaking controls at 15 Hz and 24 kHz, together with shelf-type controls operating at octave intervals. A shelf-type control produces a curve that levels off at both high and low frequencies, like the curve shown in Fig. 3A for the 100-Hz control. The name of the control shows the frequency at which half the boost or cut occurs. Each control produces symmetrical boost or cut. The 50-Hz bass control has a range of  $\pm 20$  dB at d.c. ( $\pm 17.2$  dB at 15 Hz), adjustable in 0.2-dB steps; the 100-, 200-, 400-, and 800-Hz bass controls have a range of  $\pm 15$  dB, adjustable in 0.2-dB steps. The 1.6-, 3.2-, and 6.2-kHz treble controls are each adjustable over a range of  $\pm 15$  dB, in 0.2-dB steps. Figure 3B shows the response of the 3.2-kHz, shelf-type control when set for 10 dB of treble boost. Note the 2-dB reduction in gain to keep the loudness constant. All controls affect the gain in varying amounts.

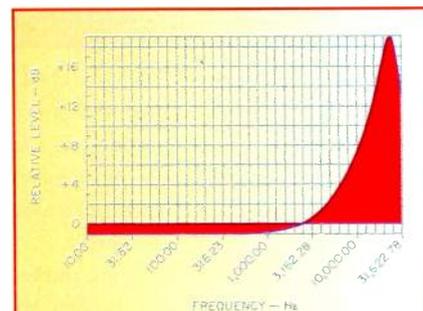
The 12-kHz control, shown in Fig. 4, has half its maximum boost at 12 kHz. Although designed as a shelf type, it looks more like a peaking type with a resonance at 24 kHz. This points out one of the important differences between the analog and digital domains. A digital system cannot accurately reproduce signals above half the sampling frequency without producing aliasing or beat notes. Transforming an analog filter to a digital filter results in squeezing the high-frequency gain curve, so half the sampling frequency corresponds to infinite frequency in the analog domain. The curve, plotted by the software, does not take into account the anti-aliasing filter built into the A/D converter that cuts off high frequencies above 20 kHz with a nearly "brick-wall" response.

The 15-Hz and 24-kHz peaking filters each cover  $\pm 30$  dB in 0.2-dB steps. Figure 5 shows the combined response for the 15-Hz control at +30 dB and the 24-kHz control at -30 dB. The low-frequency slope is -6 dB/octave. The high-frequency downward slope starts slowly but accelerates to 12 dB/octave at 12 kHz and a bit faster at 20 kHz. (Actually, the 24-kHz peak filter is a

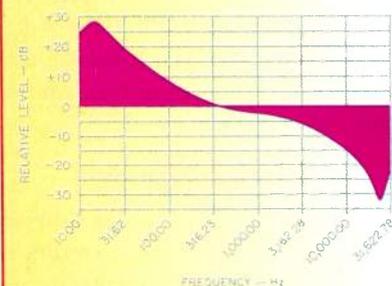
**20,000** At the heart of tone controls that operate

shelf type that benefits from squeezing its characteristics to below 24 kHz in the digital domain.)

The second group of controls shown in Fig. 2A consists of three one-octave peaking types, similar to those used in graphic equalizers. The center frequencies are 440, 1,000, and 2,000 Hz. As tonal balance is extremely critical in this middle frequency region, each control has small, 0.1-dB steps from -10 to +10 dB. Figure 6 shows the response of the 1-kHz control at +10 dB.



**Fig. 4**—The 12-kHz shelf-type control at maximum, +20 dB. High-frequency response is squeezed to below half the sampling frequency, making it look like a peak.



**Fig. 5**—Peaking controls, 15 Hz at +30 dB and 24 kHz at -30 dB.

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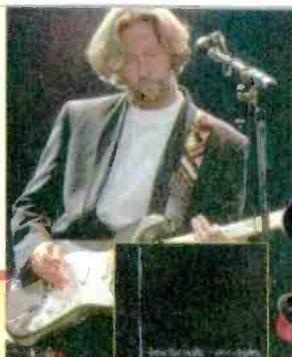
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Note the automatic, 2.5-dB volume reduction. The last control on the right is a gain control having a range of  $\pm 20$  dB in 0.2-dB steps. It presets the gain to avoid clipping; it is not my main volume control.

At the left in Fig. 2A is a vertical array of buttons. The "Save" button retains both dB and position settings of all sliders on all four screens. Using the "Flat" and "EQ"

of my digital  
is a computer  
three programs.

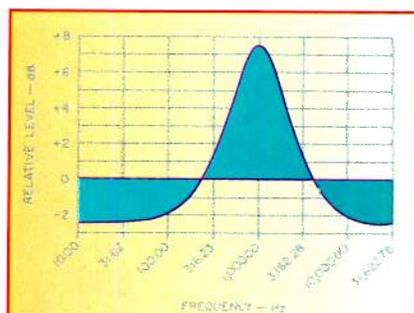
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buttons, I can compare my tone settings with flat, unity-gain response. The "File" button recalls the previously saved dB settings from an item on the library screen, allowing A/B comparison with new control settings. The "Set" button recalls the slider positions and dB settings for an item on the library screen.

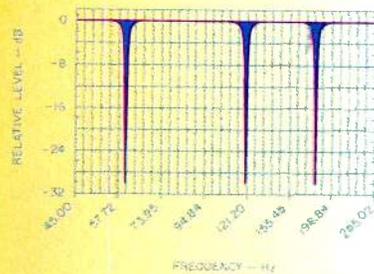
The "Graph" button creates a plot of frequency response, shown in Fig. 2B, using the dB settings from the selected button. To make the graph, the spreadsheet calculates and adds the gains, in dB, for each of 22 filters at each of 175 different frequencies; it uses formulas as long as 140 characters. (The graphs can also be printed out.)

The "DSP" button controls the one really disappointing aspect of this digital tone-control system. This button sends the computed filter coefficients to the DSP board using the "C" and assembly programs. I had hoped each movement of the sliders could automatically update the filter coefficients in real time at the DSP, but there is too much computation, and even my new computer is too slow. It took 8 seconds on my old 33-MHz 386 machine to change the tone after actuating the "DSP" button. My new 100-MHz Pentium shortened the time to less than 2 seconds. This drawback does not prevent my enjoying the improved sound due to the new digital controls. For demonstrations, I recall library settings; if I want to remix a classical digital tape, I normally rehearse the remix before I decide on final settings.

When I want a difference between the left and right channels, I use a similar set of 15 controls on the second screen. These controls have about  $\circ$  the dB range of the controls in the first screen and produce only a



**Fig. 6**—Octave control, 1 kHz at +10 dB.



**Fig. 7**—The 30-dB hum filter creates notches at 60, 120, and 180 Hz. Filter "Q" is 1,000.

difference between the left and right channels. The "DSP" and "Graph" buttons are duplicated on this screen. (The "Graph" button on any screen actually makes two different graphs. The first shows the left-channel response; the second shows only differences between the left and right channels, which may be as small as 0.2 dB.)

The third screen, Fig. 2C, provides four parametric equalizers. These controls produce curves similar to the 1-kHz peaking control's (shown in Fig. 6) but with complete adjustability. Each equalizer has three sliders—"FREQ," "Q," and "DB." I can set the center frequency logarithmically anywhere from 10 Hz to 10 kHz, in steps of 2.3%. The "Q" slider sets the curve's sharpness anywhere from 0.2 to 20. Thus, the bandwidth of each filter can vary from five times the center frequency to 5% of that frequency. The "DB" slider sets a peak or dip up to 10 dB, in steps of 0.2 dB. Deliberate interaction between the "DB" and "Q" sliders causes some broadening of the bandwidth at maximum dB settings, so the audible bandwidth effect is nearly constant.

The fourth screen is a duplicate of the third screen and affects only the right channel. Normally an "L-R" button on the third screen causes its control settings to produce

identical effects on the left and right channels. The settings on the fourth screen are ignored. By actuating the "SEP" button on the fourth screen, the third screen becomes effective only for the left channel, and the fourth screen adjusts the right channel. Each screen has duplicate "DSP" and "Graph" buttons.

A unique feature of the third screen is a hum filter. This filter, magnified in Fig. 7, notches out 60, 120, and 180 Hz and works in stereo. Each notch attenuates 30 dB, and the loss is only 1 dB at a point just  $\pm 3\%$  away from the center frequency. Bass loss is negligible. Each notch filter has a "Q" of 1,000, a value that would be impractical in analog circuits.

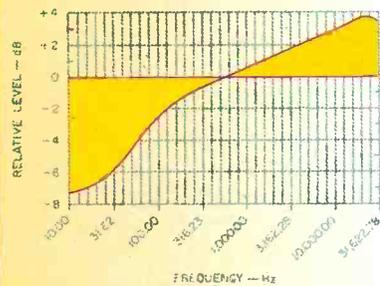
### Listening Results

**P**rogram material, especially older recordings, varies in the extreme. The improved flexibility compared with my previous tone-control systems means I can make more recordings in my CD collection sound pleasant. More important, the fine adjustment capability imparts a greater degree of perfection to my best-sounding CDs and my own live recordings. Interestingly, although the midrange peaking and the parametric controls can provide any kind of a peak or dip—however broad or narrow, at any frequency—my saved control settings show that after trying these highly adjustable controls, I used them for only six out of 87 recordings or radio programs.

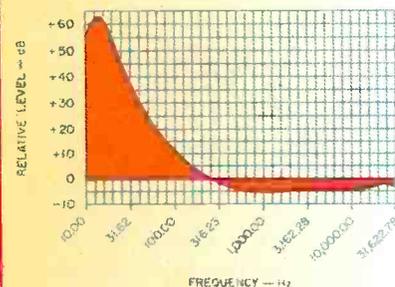
I found that once I had achieved a fairly pleasing balance on each recording, I continued to make fine adjustments, in steps of only 0.2 dB, for various controls. I do not notice the effect of moving a single tone control by 0.2 dB, but I can hear the cumulative change in balance from moving two or three mid-frequency controls by a total of 0.4 or 0.6 dB. Left/right balance is extremely critical, and I adjust the right-channel gain relative to the left in steps of only 0.1 or 0.2 dB.

It is far easier to adjust both stereo channels with a single control than with two. The gradual, completely noninteracting controls seem to produce much more desirable curves than the resonant types produced by conventional graphic equalizers. There is no problem of lack of transparency due to resistor, capacitor, or potentiometer

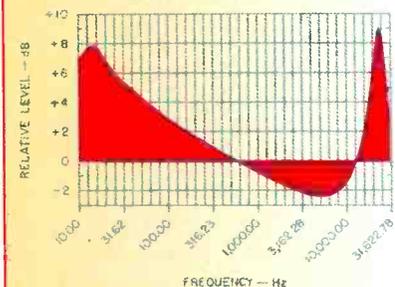
**Fig. 8**—Pleising response curves for selected program sources.



**A** CNN broadcast, with a tilt up that makes voices more intelligible.

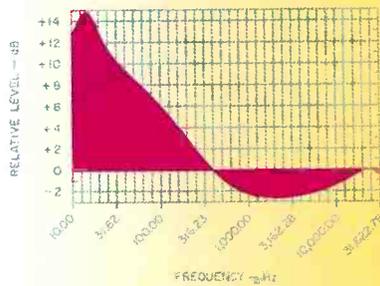


**B** *La Traviata* on LaserDisc, where lost low bass is retrieved by 68-dB boost at 15 Hz relative to 1 kHz.

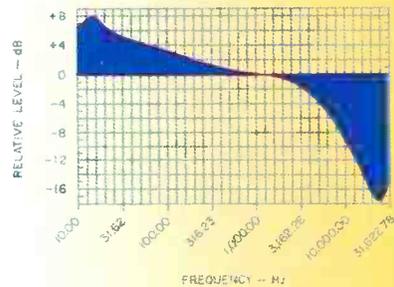


**C** November 1986 concert of Civic Symphony Orchestra of Boston, on PCM-F1 format tape, where the slope is  $-1$  dB/octave from 25 Hz to 3 kHz.

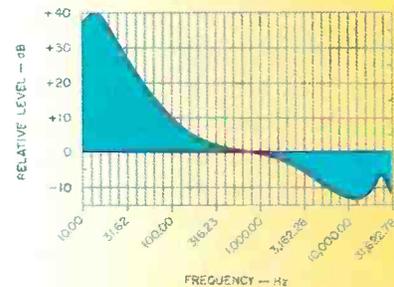
**G** CBS telecast of 1994 Tony Awards, where 22-dB bass boost and 38-dB high-frequency roll-off tame sibilant voices and gross imbalance.



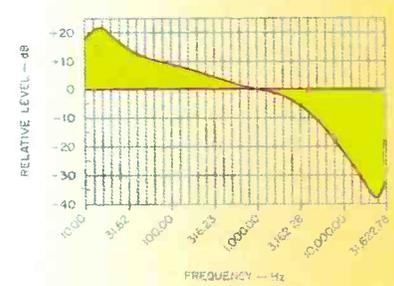
**D** A passage from Bob's Diner (*dmp CD-471*), a very high-quality CD of a band led by Bob Smith.



**E** A passage from Merle Haggard's "I'm Always on a Mountain When I Fall" (from the CD of the same name, MCA MCAD-1644), where irritating high frequencies are rolled off 17 dB.



**F** *Moonraker*, a James Bond VHS videotape, is more exciting with 40-dB boost at 15 Hz.



tolerances, as in many conventional equalizers. I can decide on the settings of the 12- and 24-kHz controls when their effect is as little as 0.5 dB at 10 kHz. Once the controls are set close to optimum, I find that small changes of 1 or 2 dB make a noticeable difference in the apparent horizontal spread of the sound. Less high-frequency gain causes the sound to come from between the left and right speakers. More gain extends the spread a little wider than the speaker placement; too much extreme high-frequency gain may make the sound come apart or become irritating. Of course, I am using all five of my speaker systems, with nearly as much sound from the rear as from the front.

Figures 8A through 8G show the frequency response curves corresponding to my saved control settings for various types of program material. They vary from an 11-dB upward slope for a CNN news broadcast (Fig. 8A) to an amazing 68-dB, low-bass boost (Fig. 8B) for the movie *La Traviata*,

**20,000** Whatever your sound requires of tonal

on LaserDisc. This Verdi opera, directed by Franco Zeffirelli in 1982, has an analog soundtrack containing a trace of low bass that can only be retrieved using that much boost. Because the 23-dB boost at 60 Hz brings up the hum level, due to the 30-foot ground path to my LaserDisc player, it is necessary to use the hum filter with this recording.

The ability to make fine settings of non-interacting, shelf-type curves allowed me to produce a very gradual downward slope of 1 dB/octave (shown in Fig. 8C) for one of my own recordings of a live concert. High frequencies above 8 kHz needed boost because the high-frequency directionality of the omnidirectional microphones, pointed at the ceiling for added reflections, caused a fall-off in the direction of the orchestra. My tone settings, however, are based entirely on what I hear.

Most curves turn up at very high frequencies, but some do not. The telecast of the 1994 Tony Awards (shown in Fig. 8G) seemed quite unbalanced, with extremely sibilant voices, causing me to roll off the

high frequencies by 38 dB. Again, I preferred a smooth downward curve to a sharp cutoff or one with peaks or dips within the audible band. Based on what I hear via this extremely flexible yet finely adjustable tone-control system, it appears that, contrary to popular opinion, flat audio systems are optimal for only a tiny fraction of available program material.

### Pure Sound

**P**urists who favor having only minimal equipment in the signal path may wonder if the sound of my system is muddied by its digital processing and the nearly 2,000 operational amplifiers in various pieces of equipment. When my system is set for unity gain and flat response, I can switch 20 or more op-amps plus the DSP system in and out of the signal path. I hear no difference when playing my cleanest recordings, and only a slight increase in noise when there is no music.

criteria, great  
precise control  
balance.

WATT

Some of the op-amps in my system have been in use for 70 hours a week for 28 years. These discrete component devices amplify audio with low noise, low distortion, and high slew rate, and they are still in a class with today's best.

Aside from the added digitization, which can be eliminated for digital sources, DSP does tend to minimize equipment in the signal path. All that is added is pure mathematics. When enough bits are used, the mathematical errors in frequency response and channel matching can be hundreds of times smaller than those of analog circuits, producing complete transparency. Too few bits, however, can produce peculiar distortion components, beat notes, and signal-related noises.

One of the surprising results of digital filtering was the amount of round-off noise. I had read that tiny random errors from rounding off the multiplication products, from 64-bit numbers to 32-bit floating-point numbers, might result in some generated noise. I was astonished to find that with low bass boost, the noise level

(peak to peak) reached 0.3 V out of 4 V full scale, only 23 dB down. It sounded like a screechy hiss that came and went at certain d.c. input levels. For a.c. input at 15 Hz, there was a fluttering effect as the signal modulated the noise. Higher frequency sine waves were cleaner, and above 50 Hz the noise was inaudible.

When I had two free hours before a scheduled demonstration, I traced the noise to the 15-Hz resonant filter. This digital filter has a denominator gain of 250,000 and tremendously amplifies the tiny round-off noise. In the remaining time before the demonstration, I was able to convert the resonant filter to a shelf type having a gain of only 500, thereby eliminating the audible noise.

Later I learned that the DSP96002 processor can compute with 64-bit accuracy instead of 32-bit simply by changing ".s" to ".x" in floating-point instructions. The complete elimination of round-off noise from all the controls (including the 15-Hz and parametric resonant types), leaving only converter noise, made a remarkable demonstration.

I would like to have a direct digital input and A/D and D/A converters whose dynamic range is 115 dB. Recently I installed three additional 40-MHz Ariel DSP96 boards. The faster DSPs allow more instructions, and they interface with two Ariel Model 656 Propport external A/D and D/A converter boxes for my front and rear channels. The Propports' differential inputs reduced hum, and the external box reduced digital noise. Still, the dynamic range is slightly less than that of the 96-dB concert recordings I have been making for the past 13 years in the PCM-F1 format.

It is inconvenient to operate the main computer from where my guests are sitting. Therefore, I have connected my laptop computer via a network coaxial cable and can use it as a remote controller from anywhere in the room.

With additional DSP96 boards, I am currently working on my second DSP project—reverberation. I want to see if I can produce an electronic "space" that sounds better than my favorite acoustic space, Jordan Hall at the New England Conservatory of Music in Boston. Now that I've seen what digital technology can do for me in other areas, I think I have a shot at it. **A**



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# JENSEN DF511 CAR STEREO

FM and two AM banks. Beneath it is the button for "Scan," which proceeds through all available stations; tap again to stop on a station. "Tune" buttons are just to the right, and the six presets are arranged along the top left of the panel. During tape playback, button "6" activates the battery monitor to show the voltage on the display.

Below the first five presets are illuminated buttons that, from left to right, toggle the



Jensen's DF511 car cassette receiver has some niceties—a detachable faceplate, line-level outputs for the rear channels, and a novel battery-voltage monitor—that you may not find on a stock radio.

But on the whole, the DF511 is best viewed as a replacement unit rather than a stock-receiver upgrade. That's not meant as a pejorative; the DF511 has a suggested retail price of only \$279 and undoubtedly can be bought for less.

What you get for your money is a quite decent tuner with 30 presets—18 FM and 12 AM, arranged in three FM and two AM banks of six—and an amp configured to drive four speakers, with 5 watts rms for each. (Jensen construes this as a "total system power" of 40 watts, obviously meaning "peak" power, not average.) The cassette deck auto-reverses but lacks Dolby noise reduction. For an extra fifty bucks, Jensen offers the DF521, which has metal/chrome tape equalization, Dolby B noise reduction, and more powerful amps: 5 watts rms per channel in front and 15 watts rms per channel in back. The DF521 also has a CD input and subwoofer line outs with internal crossovers at 125 Hz. That strikes me as worth an extra half bill. Both of these receivers are DIN/DIN E compatible.

## Control Layout

Jensen's "one knob does most" design makes the DF511 quite easy to use. In default, the knob controls volume. Tapping the "Mode" button, slightly above and to the right, accesses the other functions: Balance, bass, treble, and fader, in that order.

FOR \$279, THE DF511  
GIVES YOU A DECENT  
TUNER, CASSETTE, AND  
SEVERAL NICETIES.



The function being controlled is indicated in the display, along with a small bar graph that suggests the current setting within the range. The button for "Mute," which is total, lies directly under the "Mode" button—sensibly near the volume control.

To the right of "Mode" is a "BND" (band) button that cycles through the three

illumination between green and amber ("ILL"), change the seek/scan threshold to skip over weak stations ("LOC"), force the receiver to mono ("Mono"), activate the loudness function ("LD"), and toggle the readout between time and station frequency in the tuner mode ("DISP"). (The DF511 displays the time when it's off or playing a tape.) Pressing and holding "DISP" permits you to set the clock with the "Tune" buttons ("Up" changes the minutes, and "Down" changes the hours). Legends indicate when local scan, muting, and loudness are engaged and (except in "Mono" mode) when the receiver senses a stereo broadcast. The tuner band and bank number also appear, along with the preset number and station frequency, when the unit is in the default (non-clock) tuner mode.

Two quite differently shaped buttons near the display activate the "Seek" function (advance to and stop on the next clear station) and Jensen's Program Scan/Best Station Memory ("PS/BSM"). Tapping "PS/BSM" causes the tuner to scan through the six stations stored in the current bank, pausing on each for 5 seconds; tap again to lock a station. Holding "PS/BSM" for more than 3 seconds causes the tuner to select the next six strong stations and

store them in the current bank, replacing those already there. (Be careful.) The DF511 is also equipped with a power antenna control line.

Three mechanical buttons control the tape deck. A button to the left of the tape slot stops and ejects the tape. The two buttons to the right serve multiple purposes. Pressing either button halfway will fast-wind the tape to the point you want; pressing either all the way fast-winds to the end. (The unit reverts to broadcast reception during fast-wind.) If both buttons are depressed simultaneously, the tape reverses direction. It's a pretty standard arrangement. The "PWR" button is at the lower left

corner; a similar button at the lower right corner is used to "Release" the faceplate.

### Measurements

I made all basic measurements from the line outputs with the volume fully advanced, balance and fader set to their midpoints, and the tone controls "flat."

Figure 1 shows the FM quieting characteristics as a function of r.f. input. Like most car tuners, the DF511 partially blends the channels on weak signals to reduce noise, so in the stereo mode, I've plotted both left and right outputs (using L-only modulation) as well as left-channel noise. The difference between the curves for the left and right signals is the separation at 1 kHz; the difference between the left channel's output and the stereo noise curve is the available S/N ratio. As you can see, noise is suppressed by 45 dB or more (relative to the reference level) with r.f. inputs greater than 18 dBf.

Mono 50-dB quieting sensitivity came in at 18.7 dBf; stereo 50-dB quieting occurred at 42.1 dBf, with a quite useful channel separation of 12 dB. IHF usable sensitivity (a mono measurement for -30 dB THD + N) was 16.6 dBf. Unweighted S/N ratios at 65 dBf were 67.4 dB in mono and 64.6 dB in stereo. Channel separation at 65 dBf was 26 dB or better (worst case) across the entire frequency range, which should be fully adequate for car use.

Figure 2 shows the FM tuner's THD + N as a function of frequency for mono and stereo reception with an input level of 65 dBf. (The "holes" in the curves at 9.5 kHz are due to the 19-kHz notch filter in the measurement setup and suggest that the distortion is predominantly second harmonic.) THD + N at the three standard frequencies of 100 Hz, 1 kHz, and 6 kHz is, respectively, 0.94%, 1.15%, and 1.16% in mono and 0.78%, 1.00%, and 1.33% in stereo. I've seen better and worse figures in car tuners, many of which are designed with a narrow

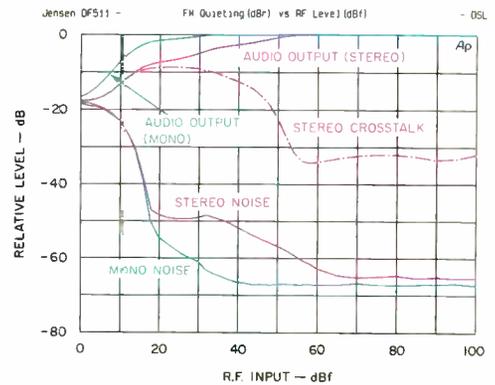


Fig. 1—FM quieting characteristics and stereo separation

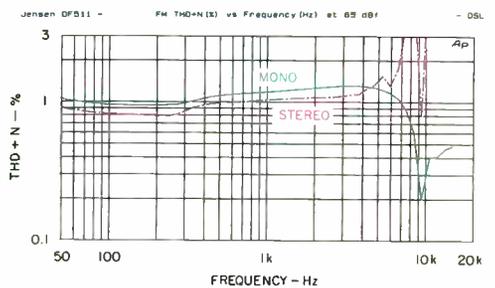


Fig. 2—THD + N vs. frequency, FM section.

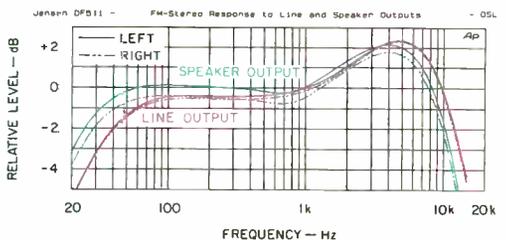


Fig. 3—FM frequency response.

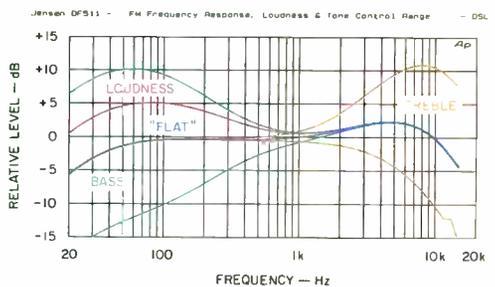


Fig. 4—Tone control range and loudness compensation.

## SPECS

### TAPE PLAYER SECTION

**Frequency Response:** 40 Hz to 17 kHz,  $\pm 3$  dB.

**Wow and Flutter, Wtd. rms:** 0.12%.

**S/N, A-Weighted:** 55 dB.

**Stereo Separation at 1 kHz:** 45 dB.

### FM TUNER SECTION

**Tuning Range:** 87.5 to 107.9 MHz.

**FM Mono Sensitivity:** 14 dBf.

**50-dB Quieting Sensitivity:** Stereo, 18 dBf.

**Frequency Response:** 50 Hz to 15 kHz,  $\pm 3$  dB.

**Capture Ratio:** 1.7 dB.

**Alternate-Channel Selectivity:** 60 dB.

**Stereo Separation at 1 kHz:** 45 dB.

**S/N: Mono,** 68 dB.

### AM TUNER SECTION

**Tuning Range:** 530 to 1,710 kHz.

**Usable Sensitivity:** 15  $\mu$ V.

### AMPLIFIER SECTION

**Power Output:** 5 watts rms x 4; total system power, 40 watts peak.

**Speaker Output Impedance:** 4 ohms.

### GENERAL SPECIFICATIONS

**Power Supply:** 11 to 16 V d.c., negative ground.

**Price:** \$279.

**Company Address:** 25 Tri-State International Office Ctr., Suite 400, Lincolnshire, Ill. 60069.

For literature, circle No. 90

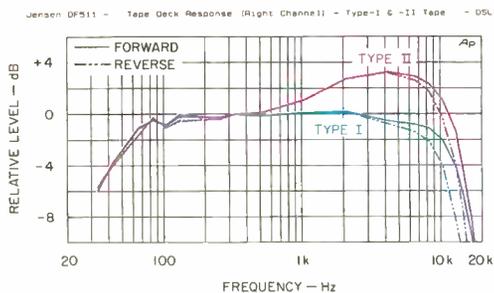


Fig. 5—Cassette frequency response.



The clock is still readable when the faceplate is off.

i.f. in order to improve selectivity. Indeed, the DF511 proved quite selective (14.8 dB) against adjacent-channel interference and exhibited an alternate-channel selectivity of 60.5 dB. Capture ratio—another item often sacrificed for better selectivity—measured a relatively modest 2.0 dB at 45 dBf. Image rejection (a measure of front-end selectivity) came in at 52.8 dB, and AM rejection was an excellent 70.5 dB.

Figure 3 shows FM tuner frequency response, measured at both the line and speaker outputs. As you can see, bass response is a little better at the speaker outputs, treble response at the line outputs. Overall, I rate the line-output response as +2.4, -3 dB from 32 Hz to 13.2 kHz and the speaker-output response as +2.1, -3 dB from 21 Hz to 11.5 kHz. I also measured maximum output power, using a 1-kHz, mono-modulated FM source and 4-ohm loads; 3% distortion occurred at 4.25 watts, 5% at 4.5 watts.

Figure 4 shows FM tuner response (measured at the line output) with the loudness on and with the bass and treble controls at maximum and minimum settings. I've also shown the "flat" response as a reference. Bass-control range is +10, -12.7 dB at 50 Hz; treble range is +10.3, -10.6 dB at 10 kHz. The loudness boosts bass response by 5 dB in the range from 75 to 100 Hz and is up 4.6 dB at 50 Hz. These figures are with

reference to the 0-dB axis, not to the "flat" control settings.

I also measured frequency response and sensitivity for the AM tuner. As usual, AM treble response was limited (-3 dB at approximately 3 kHz and -6 dB at about 3.8 kHz) but, at 12 dB/octave, rolled off somewhat more gradually than with many tuners, which might make the DF511 sound better than average. The bass was extended, with a -3 dB point at 32 Hz. The AM sensitivity measured 12.3  $\mu$ V for -20 dB THD + N with 30% modulation.

Although Jensen doesn't claim Type II (metal/chrome) tape equalization for the DF511, I measured the deck's response using both Type II and Type I test tapes because many people will use Type II tape anyway and might as well know

what the response will be like. Figure 5 shows the results taken on the right (inner) channel for each direction of travel. (The left-channel responses were essentially similar.) For Type I (standard) tape, response is within +0.25, -6 dB from 31 Hz to 14 kHz in the forward direction and to about 11.5 kHz in the reverse direction. The equalization mismatch with Type II tape shows up as a bump of 3.25 dB around 4 kHz in the upper midrange. The bump helps hold up the highs, and overall response is within +3.25, -6 dB from 31 Hz to about 15 kHz in the forward direction and to about 13.5 kHz in the reverse direction.

Without Type II equalization, you don't get the lower noise you'd expect from chrome tape either. The A-weighted noise measured -56.3 dB referenced to a 250-nWb/m recording with a virgin Type I product and was almost the same with a virgin Type II tape. Tape speed was reasonably accurate and relatively invariant over the normal range of battery voltage. With a 14.4-V source, the deck ran 0.8% fast in the forward direction, 0.4% fast in reverse. The speed increased by about another 0.1% when the battery voltage dropped to 10.8 V. Wow and flutter was quite low for a car deck: 0.10% weighted rms ( $\pm 0.14\%$  weighted peak) in the forward direction, 0.13% weighted rms ( $\pm 0.23\%$  weighted peak) in reverse. Jensen's battery-voltage indicator

was reading a bit high. A 10.8-V source showed up as 11.1 V, a 12-V source was shown as 12.3 V, a 13-V source was indicated as 13.5 V, and a 14.4-V source was displayed as 14.9 V. *Edward J. Foster*

### Behind the Wheel

My expectations for a car stereo as moderately priced as this Jensen would be moderate—but the DF511 more than easily surpassed them.

Ergonomically, the Jensen has many more good points than bad. First and foremost, the volume control is a knob instead of a rocker or, worse, a pair of up/down buttons. There is no easier type of control to set precisely in a moving vehicle. Knobs are rarely found in units with removable faceplates, but if Jensen can do it in a \$279 unit, why can't the makers of units costing a

**SELECTIVITY WAS A HIGH  
14.8 dB AGAINST  
ADJACENT CHANNELS  
AND 60.5 dB FOR  
ALTERNATE CHANNELS.**

lot more? The other controls are fairly logically grouped: The main tape controls flank the tape slot, and the main tuning controls are either clustered near the radio display or in the six-button row at the top left.

The buttons themselves, however, are too much alike and too poorly marked; you fumble about a bit until you learn them (not difficult, as there aren't many). The five brightly illuminated buttons beneath the six presets make a useful landmark for navigating the panel, especially at night—but I wonder why the five controls most people will use least are the ones that are the most brightly lit.

The display was basically a delight—large, clear, and easy to read under all available lighting conditions, though I did not get a chance to try it in direct sunlight. Everything was visible except the tops of numerals (I kept mistaking "1" and "7") and the loudness indicator.

When you detach the DF511's faceplate, the display stays behind, which makes the faceplate lighter and easier to carry, less fragile (Jensen doesn't even provide a case

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for it), and probably less expensive to replace if you lose or break it. And because the display stays behind, the car retains a functioning clock. With the faceplate off, a blinking LED says "don't bother" to prospective thieves.

The DF511 has about as nice a set of tuning features as I've seen: Seek, scan, and preset scan (it's rare to find both types of scan together) plus memories for 30 stations instead of the usual 18 to 24. Both seek and scan are subtly bidirectional, moving up or down the dial in the direction you last used for manual tuning. (The owner's manual doesn't mention this.) The "Mono" button did a much better job of clearing up noisy stations than is usual; however, the display does not tell you when you've accidentally

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John Sunier, Audio 12/94  
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invoked this mode. Switching between local and distant reception modes made hardly any difference as to which stations were picked up.

In fact, tuner performance on the road was virtually identical to that of my \$880 Alpine reference unit—quite good on FM, fairly bad on AM. Frequency response sounded similar for both units, but the Jensen had a bit more treble and less bass, slightly more noticeable on AM. The reference Alpine's FM sound seemed a bit more rounded than the Jensen's with more bass and treble extension.

The DF511's tape section is hardly as feature-rich as its tuner. You get tape reverse, eject, and fast-forward and -rewind (full logic, which is nice) but no tape EQ selection, Dolby NR, or music search. (I agree with Ed Foster that the DF521 would be a better bet.) The sound with Type I tapes made without Dolby NR was pretty good, but some Dolby-encoded tapes sounded just a bit on the hard side. I heard no wow and flutter.

All told, a good feature set (at least on tuner) and creditable performance, all at a moderate price.

Ivan Berger

would

somebody

please turn

that music

Up?



The **RE SERIES**



The **DX SERIES**



The **VS SERIES**



The **AT SERIES**

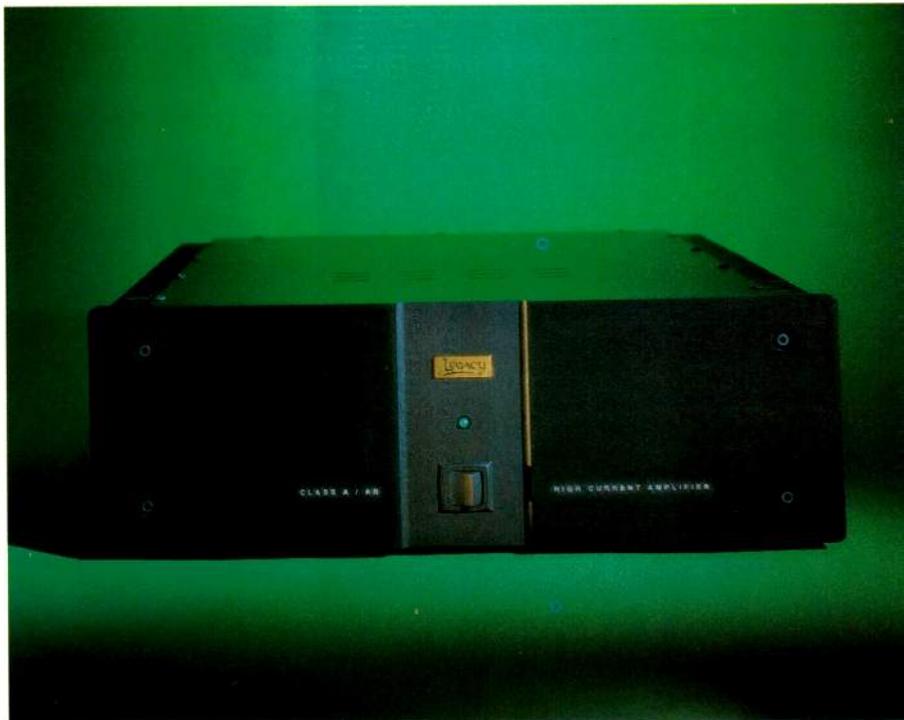
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# LEGACY HIGH-CURRENT AMPLIFIER



**T**he Legacy High-Current power amplifier is the first electronic product from Reel to Real Designs, which has manufactured loudspeakers under the Legacy name since 1983. (A matching preamplifier is now available as well.) The amp is rated at 200 watts per channel into 8-ohm loads. The design philosophy is to provide the audiophile with high-quality amplification at a reasonable price. Rather than “reinvent the wheel” with a maze of complex circuits, Legacy opted for a high-current, short signal-path design with a minimum of internal wiring.

At the center of the attractive front panel is a vertical arrangement of a rocker-type power switch, a green LED power-on indicator, and a gold Legacy logo. The rear panel sports two pairs of gold-plated, five-way binding posts for each channel; a pair of high-quality RCA jacks for unbalanced inputs; a pair of XLR connectors for balanced

inputs, and an IEC combination fuse holder/power-cord connector.

Inside the unit, a large toroidal power transformer occupies the front of the space. At the rear, a p.c. board, some 4 inches deep and running the full width of the chassis, mounts the power-supply filter capacitors, rectifiers, supply-rail fuses, and the signal input connectors. This main board connects to other boards, mounted on each side heat-sink, which contain the actual audio circuitry.

The unit I received showed signs of shipping damage, probably a result of being dropped (the manufacturer has since switched to more robust packaging). The bottom plate was bowed downward at the front-panel end a half inch or so (those big

power transformers just want to keep going when dropped!). I turned the amp over and stood on the bottom plate until I got it straight again. The amp was otherwise in good shape and functioned perfectly.

## Circuit Description

It is interesting that, although I have seen just about every amplifier circuit topology that is out there, still new permutations appear. In the case of the Legacy, while I have seen the overall front-end topology in other amplifiers, and certainly the output-stage topology, I have not seen them combined quite like this.

The circuit starts with an N-channel J-FET differential amp cascaded with a pair of NPN transistors. An NPN-transistor current source feeds the source terminals of the J-FET input pair without any degeneration resistors. Output of the first stage is directly coupled to a second-stage differential amp composed of PNP transistors. The collectors of these transistors are loaded by a current mirror (using two NPN transistors), which is referenced to the negative supply rail. A bias-spreading regulator in the second stage's uninverted phase (relative to the input signal's phase) provides appropriate drive lines to the output stage.

The output stage is a Darlington-connected complementary emitter follower with five pairs of output transistors. No output-buffering inductor is used. What about negative feedback? Separate resistors from each output-stage drive line sum into the much larger overall series feedback resistor that returns to the inverting input of

**LEGACY'S AIM  
WAS TO PROVIDE  
HIGH-QUALITY  
AMPLIFICATION  
AT A REASONABLE PRICE.**

the input differential amp. This means the whole front-end is enclosed in a feedback loop, but the output stage is not included. Thus, the source impedance driv-

ing the output stage is quite low, due to the negative feedback, which helps output stages to be fast. My experience with such an arrangement suggests that the transition from Class A to Class AB usually causes more pronounced changes in distortion level and nature than in designs where the output stage is driven from the usual,

higher impedance, source. Legacy claims that the bias regulator and the output stage's operating point are designed so that no change in output impedance or output distortion takes place in the transition from Class A to Class AB, even with different loads. No mean trick, if it is true!

The power-supply circuitry consists of a separate rectifier bridge and filter capacitors for each channel. Each channel has four 12,000- $\mu$ F, 80-V capacitors, two paralleled for each supply rail.

One little difficulty in the circuit, if I read the schematic correctly, is that the method for coupling a balanced signal into the input stage would appear to produce quite different load impedances for each phase of the input signal. I can't reconcile this arrangement with the specified balanced input impedance of 1 kilohm.

#### Measurements

Just as I had suspected, the input impedances for each leg of the balanced input

were radically different from each other. The noninverting input's resistance is about 50 kilohms; the inverting input's resistance is about 360 ohms when the noninverting input is not driven. Common-mode rejection of even-order distortion of the source signal, and of noise induced in the interconnecting balanced cable, is among the main reasons for using a balanced topology in the first place, but unequal terminating impedances for each leg of the balanced input largely negate these benefits. (My initial measurements bear this out.) With this in mind, I really don't recommend using the balanced inputs on this otherwise excellent design. Consequently, all the measurements that follow were obtained with the Legacy amplifier's unbalanced inputs.

Gain was 27.89 dB for the left channel and 27.87 dB for the right; the sensitivity figures for the two channels were 114.0 and 114.3 mV, respectively.

Figure 1 shows frequency response, at an output level of about 2.83 V (1 watt into 8 ohms) for open-circuit, 8-ohm, and 4-ohm loads. (Data is shown only for the left channel, as both channels were essentially identical.) The -3 dB point appears to be about 180 kHz. Of note is the uniform spacing between the curves, suggesting that output impedance is relatively constant with frequency. Square-wave response is shown in Fig. 2. The amount of ringing in the middle trace, where a 2- $\mu$ F capacitor is paralleled across the 8-ohm load, is admirably low. There is no tilt in the 40-Hz (bottom) trace, as the amp is truly d.c. coupled. Rise- and fall-times into 8-ohm loads were 1.8  $\mu$ s. As the amp was driven up to clipping, the rise and fall remained exponential in shape (as in the top trace of Fig. 2), a good result.

In the distortion tests, the two channels again behaved very much alike, so only left-channel results are shown. Figure 3 shows both

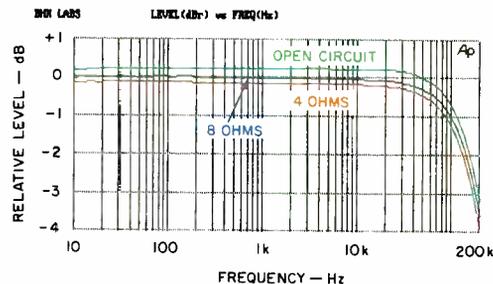


Fig. 1—Frequency response.

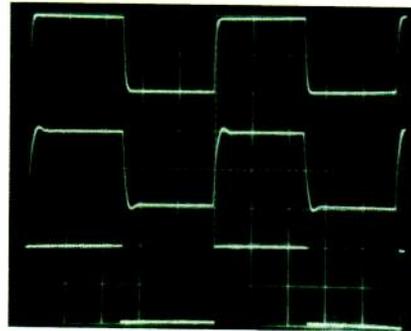


Fig. 2—Square-wave response for 10 kHz into 8 ohms (top), 10 kHz into 8 ohms paralleled by 2  $\mu$ F (middle), and 40 Hz into 8 ohms (bottom).

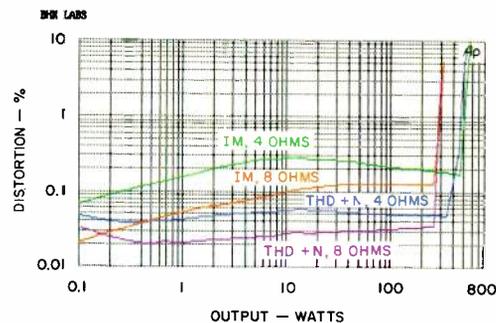


Fig. 3—THD + N at 1 kHz, and SMPTE-IM distortion, vs. power.

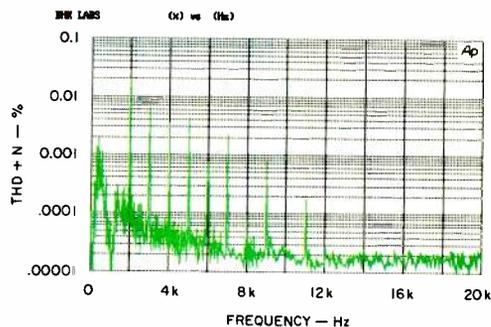


Fig. 4—Harmonic-distortion residue at an output of 10 watts.

## SPECS

**Rated Power, 20 Hz to 20 kHz, Both Channels Driven:** 200 watts/channel into 8 ohms, 380 watts/channel into 4 ohms.

**Distortion:** Less than 0.1%, 10 Hz to 20 kHz, at 200 watts/channel into 2 through 8 ohms.

**Bandwidth:** 0 to 100 kHz, +0, -3 dB.

**Gain:** 26 dB.

**Noise:** Better than 100 dB below rated output.

**Current Capability:** 50 peak amperes per channel.

**Slew Rate:** 50 V/ $\mu$ s.

**Input Impedance:** Unbalanced, 50 kilohms; balanced, 1 kilohm.

**Output Impedance:** 0.08 ohm, 20 Hz to 20 kHz.

**Dimensions:** Faceplate, 17 in. W x 5½ in. H (43.2 cm x 14 cm); chassis, 16¼ in. W x 5 in. H x 14 in. D (42.5 cm x 12.7 cm x 35.6 cm).

**Weight:** 50 lbs. (22.7 kg).

**Price:** \$1,795.

**Company Address:** Reel to Real Designs, 3021 Sangamon Ave., Springfield, Ill. 62702.

For literature, circle No. 91

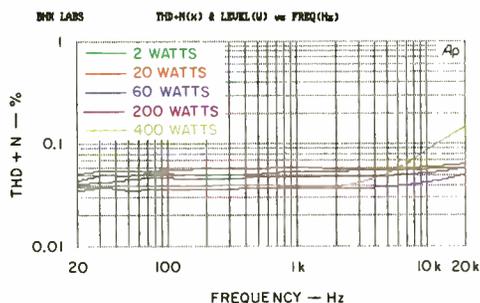


Fig. 5—THD + N vs. frequency, 4-ohm loading.

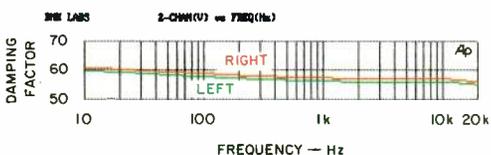


Fig. 6—Damping factor vs. frequency.



THD at 1 kHz and SMPTE-IM distortion, for 8- and 4-ohm loading, versus power. A relatively constant harmonic-distortion level that is not noise-limited, as is the case here, usually means that even-order harmonics predominate. With the Legacy amp, the distortion is mostly second harmonic up to a few watts; above this power level, it reverts to a more complex mixture of even and odd harmonics, but with the second harmonic dominant. A spectrum of the harmonic-distortion residue, at an output of 10 watts into 8 ohms, is shown in Fig. 4. Total harmonic distortion as a function of frequency for 4-ohm loading is shown in Fig. 5. Note that the amount of distortion is quite constant except at the highest power level, where it does rise with frequency. *Very few amplifiers have a constant amount of distortion*

**THE SOUND WAS  
EXCEPTIONAL, WITH  
A WONDERFUL SENSE  
OF SPACE, DELICACY,  
AND RESOLUTION.**

to 1.80 and 1.97 dB for 8- and 4-ohm loads, respectively. The large amount of filter capacitance used in the Legacy's power supply surely helps to keep the power up during the 20-mS tone burst. At the visual onset of clipping, the Legacy amp's continuous maximum power output was 272 watts for 8 ohms and 456 watts for 4 ohms. These numbers work out to clipping-headroom figures of 0.92 and 0.57 dB, respectively. With one channel operating, I was able to get  $\pm 59$  amperes at the beginning and  $\pm 51$  amperes at the end of a 20-mS tone burst into a 1-ohm load. The equivalent sine-wave power levels derived from the

versus frequency over most of their power range, but this one does. In response to the Legacy claim that they have arranged things so that the distortion is well behaved with load and power through the region from Class A to Class AB, I would say they did an excellent job.

Another measurement that shows the constancy of the Legacy amp's characteristics over the audio frequency range is the damping factor, as shown in Fig. 6. Damping factor is the ratio of the nominal load impedance (usually assumed to be 8 ohms) to the output impedance. Again, very few amps measure this flat in their output impedance or in damping factor. The Legacy's rated output impedance is 0.08 ohm from 20 Hz to 20 kHz; I got a value closer to 0.14 ohm in the middle of the audio range.

Dynamic power measurements yielded an equivalent output at the beginning and end of a 20-mS tone burst of 333 to 324 watts for 8-ohm loads and 630 to 578 watts for 4-ohm loads. With the higher power (at the beginning of the burst), IHF dynamic headroom computes out

peak voltages obtained were 1,740 watts for the beginning of the burst and 1,300 watts for the end of it. This amp can really put out the peak current!

Output noise as a function of measurement bandwidth is listed in Table I, as is the IHF signal-to-noise ratio. The Legacy's noise within the audio bandwidth consisted of pulses with a half-sinusoidal shape during the rectifier conduction times; the two channels' noise-pulse waveforms were out of phase with each other. The amount of this noise is acceptably low and is not likely to be audible (except, possibly, by sticking one's ear right into an efficient loudspeaker system).

Interchannel crosstalk (which was almost identical in both directions) measured about 84 dB down at 20 Hz. It decreased to a broad null of  $-100$  dB from 100 to 250 Hz and then climbed at a rate of 6 dB per octave (them demon capacitive couplings at work) to cross through  $-80$  dB at about 2.5 kHz. The crosstalk ended up at  $-63$  dB at 20 kHz.

The a.c. line draw was about 0.8 ampere when cold and near 1 ampere when the Legacy warmed up. After the amp was blasted with signal and its heat-sinks were hot, the current was at 0.9 ampere. These results indicate excellent output-stage bias stability.

#### Use and Listening Tests

Signal sources used in my system during the review period included an Oracle Audio turntable fitted with a Well Tempered Lab tonearm and a JVC X-1 moving-magnet phono cartridge, used with my own tube phono preamplifier or a Quicksilver Audio preamplifier. For CDs, Counterpoint DA-11A, Parasound C/DP-1000, and PS Audio Lambda CD Drive transports drove a Sonic Frontiers SFD-2, a Parasound D/AC-1000, and other (experimental) D/A converters. Additional signal sources in my system were

Table I—Output noise levels. IHF S/N ratios were 92.3 dB for the left channel and 93.2 dB for the right.

Bandwidth	Output Noise, $\mu$ V	
	LEFT	RIGHT
Wideband	244.4	210.1
22 Hz to 22 kHz	121.0	101.0
400 Hz to 22 kHz	79.7	74.0
A-Weighted	68.4	61.6

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CIRCLE NO. 22 ON READER SERVICE CARD

a Nakamichi ST-7 FM tuner and 250 cassette recorder and a Technics open-reel recorder. Preamps other than the Quicksilver Audio unit included a DGX Audio DDP-1, Forssell tube line drivers, a First Sound II passive model, and my own passive signal selector/attenuator. Other power amps on hand were a Crown Macro Reference, Quicksilver M135s, a Carver Research Lightstar, and a pair of Cary Audio Design CAD-805s. Loudspeakers used were B & W 801 Matrix Series 3s, augmented from 20 to 50 Hz by my subwoofer system (a JBL

1400Nd driver in a 5-cubic-foot ported enclosure for each channel).

My first impression of the Legacy High-Current amplifier upon initial turn-on was: "Oh, a smooth, non-irritating amp." After some warmup, I realized that it was, indeed, a very good-sounding amp. For CD listening, I used the Parasound player/transport feeding through the DGX digital preamp and an Audio Alchemy DTI•PRO jitter reducer to, finally (via ST cable), the Parasound D/A converter. This in turn was fed to the Legacy through the First Sound pas-



**I LIKED THE LEGACY  
A LOT, AND DEFINITELY  
ENJOYED HAVING IT  
IN MY SYSTEM.**

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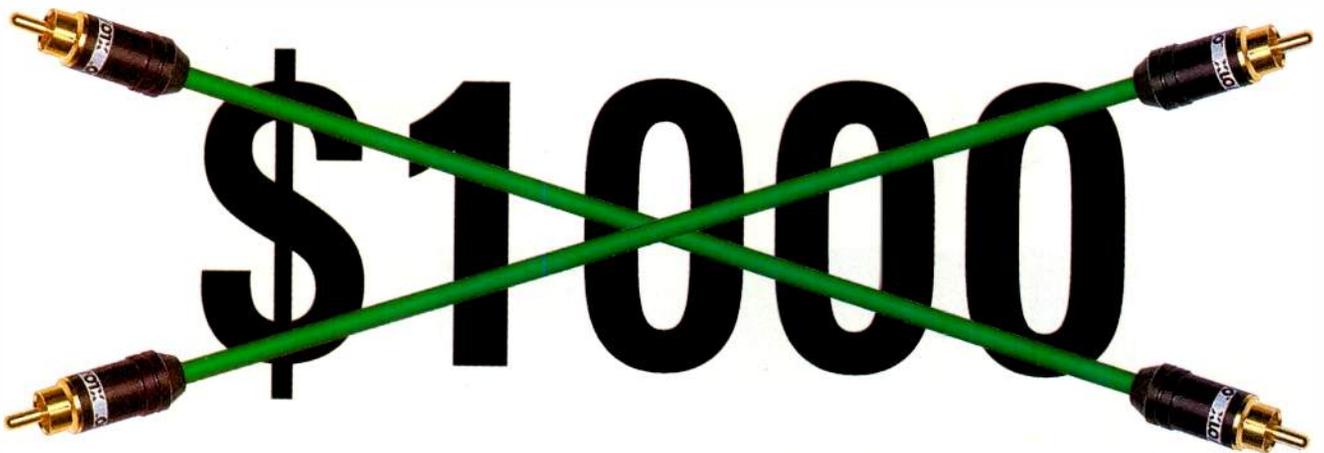
sive preamp. (The DGX Audio preamplifier was selected because it contains digital frequency equalization specifically for the B & W loudspeakers I use, as well as phase equalization to align these loudspeakers in time.) In this setup, the Legacy High-Current amp delivered exceptionally good sound, characterized by a wonderful sense of space, delicacy, and resolution. Bass, although having excellent definition and control, didn't have quite the punch and heft of the more powerful Crown Macro Reference, which excels in this area.

I then returned to my current reference digital setup, which consists of the Counterpoint or PS Audio CD transport driving the Sonic Frontiers D/A converter, in turn feeding the Forssell preamp, whose unbalanced output drove the Legacy amp. In this setup, the Legacy sounded very good too. I soon put the DGX preamp and the Audio Alchemy jitter reducer back in the chain to gain the benefits of the DGX's equalization on the B & W speakers. Again, the sound was of high caliber.

I ended up playing quite a lot of vinyl records through the Legacy High-Current amp. Here as well, the sound was very good, and I didn't have any sense that I wanted to change to another amplifier while I was listening.

In conclusion, the Legacy performed without a hitch during my lab tests and listening sessions. I liked this amp a lot and definitely enjoyed having it in my system. I would recommend auditioning one.

*Bascom H. King*



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# OPTIMUS PRO LX5 SPEAKER



**T**his review starts with the tale of two American electronics companies: One gigantic and the other quite small.

First the big guy. Radio Shack began in 1921 as a mail-order company in Boston that catered to ham radio operators and electronics buffs. It issued its first catalog in 1940 and began marketing products under the Realistic label in 1954. It is now the largest consumer supplier of electronics and related products in the United States, with more than 6,500 retail outlets, and its brands also include Archer and Optimus.

Enter the small guy. In 1984, Paul Paddock had an idea for a new type of tweeter and built it in his garage, using an old county road map as a diaphragm. He hired consultant Steve Geist to make the speaker producible and formed a company, Linaeum. In February 1990, Paddock and Geist were granted U.S. Patent No. 4,903,308, "Audio Transducer with Controlled Flexibility Diaphragm," covering "An improved audio

transducer having a pair of cylindrically shaped webs that provide greater bandwidth, reduced distortion, and greater horizontal dispersion of sound." After some preliminary sales in their local Oregon area, the new Linaeum line was presented publicly for the first time in October 1989. Later, at a Winter Consumer Electronics Show in Las Vegas, the Linaeum demo room was visited by some Radio Shack people who were scouting around for some new technology to incorporate into their speakers. They thought the new Linaeum systems sounded great. Now Linaeum has licensed its technology to Radio Shack for inclusion in a line of small speaker systems that were offered for the first time in Radio Shack's 1995 catalog. The systems are manufactured for Radio Shack in Japan, but Linaeum supplies the

voice-coils, the diaphragms, and considerable engineering expertise.

The Optimus PRO LX5, reviewed here, is at the top of Radio Shack's line of three systems incorporating Linaeum's tweeter designs. The two lower priced models contain monopole versions of the Linaeum tweeter, which radiate in the forward hemisphere only; the LX5 contains a dipole version of the tweeter, which radiates front and rear, in opposite acoustic polarities.

The PRO LX5's tweeter is attached to the top of the cabinet and is covered by an acoustically open, formed metal screen cover. The basic Linaeum tweeter driver has two pliable diaphragms, made of Mylar, which form side-by-side half cylinders about 2 inches in diameter and 1½ inches high. The outside edge of each half cylinder is clamped, and the inside edge is movable and attached to a common voice-coil. When current flows through the voice-coil, it moves in and out of the magnetic gap, thus moving the center of the diaphragms away from and toward the listener.

According to Linaeum, this front/back motion introduces a wave motion in the flexible membranes which form the two half cylinders. The waves then travel out and around the cylindrical diaphragm and are absorbed along the way by the inherent absorption characteristics of the membrane, and by added damping material inside the cylinder, before reaching the clamped edge of the diaphragm. The travelling waves on the diaphragms' surface then radiate sound into the room.

Linaeum emphasizes that the unusual travelling-wave nature of the tweeter's operation contributes to its extended high-frequency response. This is because, with wave motion, the effective diaphragm mass decreases with frequency. If the diaphragm operated as a rigid piston, its mass would remain

**THE LX5 WOULD MAKE A GOOD SATELLITE FOR USE WITH A SUBWOOFER IN A HIGH-PERFORMANCE SYSTEM.**

constant and its high-frequency response would therefore be severely limited. Linaeum states that its "technology doesn't push air; it moves air with waves."

The tweeter, as described so far, is a forward-only radiating device but with wide horizontal coverage. A front/back radiating

Photos: Michael Groen

dipole, such as the one used in the LX5, is formed by joining two of these assemblies back to back, driven by a common voice-coil. The total assemblage essentially forms a 360° radiator, but with the rear radiation out of phase with the front and with partial nulls at ±90°. Unlike a pure dipole, which has maximum radiation at 0° (front) and 180° (rear), the horizontal radiation pattern of the Linaeum device is more complicated: It includes off-axis peaks and dips at various angles, which change with frequency. Above 6 kHz, however, maximum radiation occurs at off-axis angles of approximately ±25° rather than on axis. Because of this, Radio Shack and Linaeum recommend that these speakers be aimed straight ahead instead of at the listener.

The LX5's die-cast aluminum cabinet contains one 5-inch woofer. The woofer incorporates a long-throw moving assembly with a polypropylene cone and a rubber damper in place of a normal dust cap. The damper is said to reduce voice-coil resonances and to smooth the woofer's upper frequency roll-off. Two small port tubes, approximately 0.6 inch in diameter, are on the bottom front of the cabinet. The port tubes are of different lengths, one 1¼ inches and the other 2½ inches, which is said to

offer smoother bass response. The port tubes have a 1.5-mm taper, with the smaller end inside the cabinet, and the ends are smoothed to minimize port wind noise. A removable plastic grille covers the woofer and the vents.

The drivers of the LX5 have been optimized so that a first-order, minimalist crossover design (a capacitor in series with the tweeter and an iron-core inductor feeding the woofer) can be used. The Linaeum

**FIRST LISTENING  
REVEALED OPEN SOUND,  
WITH VERY BROAD AND  
EVEN HIGH-FREQUENCY  
COVERAGE.**

tweeter has essentially a resistive, frequency-independent impedance characteristic, which means a simple crossover works quite well. The tweeter has been set back on the cabinet to provide time coherence with the woofer.

Connections are made with a single pair of heavy-duty, gold-plated, five-way binding posts on nonstandard, 1¼-inch centers (a major departure from the typical push-type Radio Shack connections!). Quite large cable, up to 0.2 inch in diameter (AWG 4), can be accepted.

#### Measurements

Figure 1 shows the anechoic frequency response of the PRO LX5 on axis and along a curve taken at 20° off-axis horizontally; both curves have been tenth-octave smoothed. At 20° off the horizontal axis, the test microphone is essentially where a centered listener would be if the speakers are aimed straight ahead, as Radio Shack recommends.

Measurements were taken with the woofer grille on, at a distance of 1 meter from the front of the cabinet and level with the tweeter (about an inch below the top of the cabinet). Other curves, taken at points slightly above and below the tweeter axis, were less flat. A voltage of 2.83 V rms, equivalent to 1 watt into the rated 8-ohm impedance, was applied. A combination of ground-plane and elevated free-field measurements was used to produce the curve.

The on-axis curve in Fig. 1 is quite flat to beyond 5 kHz, but then drops at about 6 dB/octave out to about 16 kHz, where the response suddenly rises. At 20° off axis, the response is quite close to the on-axis response to about 9 kHz but has much greater level at higher frequencies. Looked at another way, the response is quite flat over the whole range but exhibits a 6-dB dip, two-thirds of an octave wide, at 8.5 kHz. If you exclude this dip, the 20° off-axis response fits a respectable 5-dB window (±2.5 dB, referenced to 1 kHz) over the range from 90 Hz to 20 kHz. The gradual high-frequency roll-off in both curves may not be subjectively noticeable in comparison with other systems, because of the greater high-frequency energy output from the LX5's extremely wide and effectively omnidirectional high-frequency radiation. In the bass range, the response is very flat down to about 100 Hz; it then rolls off at about 12 dB/octave down to 65 Hz and at 24 dB/octave below that frequency.

Averaged from 250 Hz to 4 kHz, the LX5's 20° off-axis sensitivity was 86.6 dB SPL, about 1.5 dB below the manufacturer's 88-dB rating and within the stated tolerance. If you exclude the range between 1.8 and 3.5 kHz, the right and left systems matched within a close ±1 dB from 100 Hz to 20 kHz. In the excluded range, however, the left system's output was lower than the right system's, with a maximum difference of about 4.5 dB at 2.6 kHz. The woofer grille caused insignificant changes in the response.

Figure 2 shows a family of unsmoothed response curves, taken every 5° from 5° to 35° off the LX5's horizontal axis, and a curve that shows an average response. This range of angles approximately covers most listening positions in front of the PRO LX5s in a typical listening setup—that is, each speaker is aimed straight ahead. The average response is



**Removing the grille shows off the design of the Linaeum tweeter.**

## SPECS

**Type:** Two-way, vented bookshelf system.

**Drivers:** 5-in. polypropylene cone woofer and 2 x 4-in. Linaeum line-source dipole tweeter.

**Enclosure:** Die-cast aluminum cabinet.

**Frequency Range:** 70 Hz to 25 kHz.

**Sensitivity:** 88 dB (±2 dB) at 1 meter, 2.83 V rms applied.

**Crossover Frequency:** 2.7 kHz.

**Nominal Impedance:** 8 ohms.

**Power Handling:** 50 watts rms (per EIA-426-A).

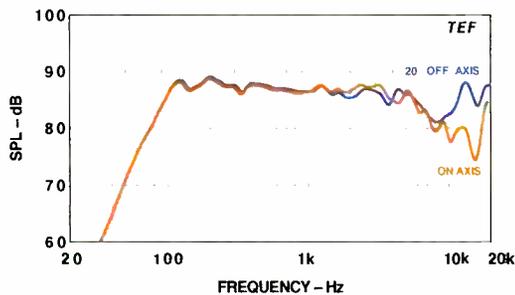
**Dimensions:** 10½ in. H x 6¼ in. W x 6½ in. D (26.7 cm x 15.9 cm x 16.5 cm).

**Weight:** 7½ lbs. (3.4 kg) each.

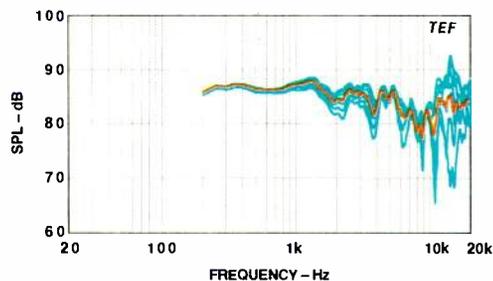
**Price:** \$149.99 each.

**Company Address:** One Tandy Center, Fort Worth, Tex. 76102.

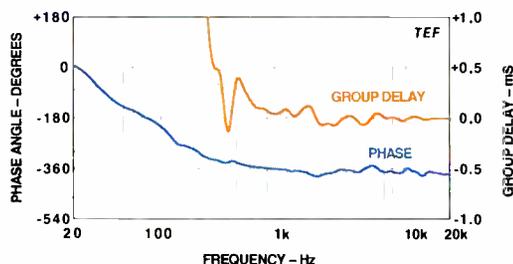
For literature, circle No. 92



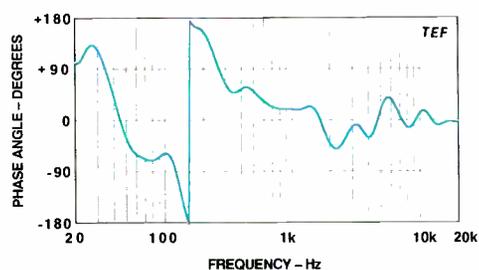
**Fig. 1—One-meter, on-axis frequency response.**



**Fig. 2—Composite horizontal frequency responses.**

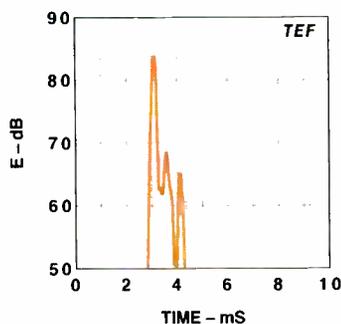


A



B

**Fig. 3—On-axis phase response and group delay (A) and waveform phase (B).**



**Fig. 4—Energy/time response.**

quite close to the 20° off-axis response in Fig. 1. However, the family of curves illustrates the wide variation in direct-field response, particularly above 9 kHz, that the LX5 provides in its primary listening window. A corresponding set of curves, taken at the rear of the system (not shown), had slightly higher high-frequency level but significantly less output (about 4 to 8 dB) in the range from 400 Hz to 3 kHz, due to directivity of the woofer.

Figure 3A shows the phase and group-delay responses of the PRO LX5, referenced to the tweeter's arrival time. The phase curve is very well behaved and, because the phase changes very little above 800 Hz, indicates that the woofer and tweeter are essentially aligned in time. The remaining phase change is due primarily to minimum-phase variations associated with variations in the amplitude frequency response. These changes would disappear if the response were equalized flat with a minimum-phase equalizer.

The group-delay curve in Fig. 3A shows essentially no time difference between the woofer and tweeter. The increase below 800 Hz is primarily due to the minimum-phase delay corresponding to the high-pass nature of the speaker's frequency response.

Figure 3B shows the results of a new measure of waveform fidelity derived from the phase and group-delay responses of a system (see sidebar). A derived phase curve, which I call "waveform phase," is plotted as a function of frequency. It directly indicates how the speaker can modify the waveforms of signals passed through it in specific frequency ranges.

For a signal's waveform to be reproduced with minimal distortion, the system's amplitude frequency response must be flat and its waveform phase must be zero throughout the effective bandwidth of the signal. If the system's amplitude response is flat but the waveform phase is  $\pm 180^\circ$ , the signal's wave-

form will be reproduced faithfully but will have its polarity reversed, i.e., the waveform will be inverted when viewed on an oscilloscope (sometimes incorrectly called an "out-of-phase" condition). For some two-way loudspeaker systems, the waveform phase will directly indicate whether the tweeter and woofer are in or out of polarity.

Waveform phase can range between  $0^\circ$  and  $\pm 180^\circ$ , and maximum waveform distortion occurs for waveform phase angles of  $\pm 90^\circ$ . Narrow-band signals, such as tone bursts, will therefore be distorted in proportion to the degree that their frequency ranges fall where the speaker's waveform phase is far from its defined endpoints of  $0^\circ$  and  $\pm 180^\circ$ .

The waveform phase curve in Fig. 3B shows performance 20° off the horizontal axis of the PRO LX5. Above 600 Hz, the waveform phase stays within a fairly narrow range of about  $\pm 40^\circ$ . This indicates that the waveforms of signals whose energy is confined to this range will suffer minimal distortion. Conversely, narrow-band signals from 130 to 200 Hz will be reproduced well but will be inverted. The rapidly changing waveform phase below 300 Hz is caused by the minimum-phase roll-off of the LX5 below 100 Hz. The waveforms of low-frequency signals, such as those from a kick drum, will be quite distorted when reproduced by this speaker.

Figure 4 shows the LX5's energy/time response, measured at 1 meter and 20° off the horizontal axis, with an input of 2.83 V rms. The test parameters accentuate the response from 1 to 10 kHz, which includes the crossover region. The main arrival, at 3 ms, is very compact but is followed by responses down only 15.4 dB (at 0.51 mS) and 18.7 dB (at 1.05 mS).

Figure 5 exhibits the horizontal off-axis responses of the PRO LX5; the bold curve at the rear of the graph is the on-axis response. The off-axis horizontal responses are quite uniform up to 8 kHz but exhibit a large amount of variability and raggedness at higher frequencies. Note that even though the high-frequency curves are quite variable, their average level stays quite high all the way around from front to rear. Only a fairly narrow dip in high frequencies is evident, at 90° off axis. Note also a reduction in high frequencies directly in front ( $0^\circ$ ) and to the rear ( $180^\circ$ ) of this system.

Observe the general reduction in level from 400 Hz to 3 kHz in the rear response due to the woofer's directivity.

The vertical off-axis curves of the LX5 are shown in Fig. 6. The bold curve in the center of the graph (front to rear) is on-axis response. In the primary ( $\pm 15^\circ$  vertical) listening window, significant changes in response are evident in the range from 1.4 to 7 kHz. Farther above axis, a depression soon appears between 1.4 and 4 kHz. Below the listening window, the response is quite well behaved up to about 4 kHz, where a dip develops in the range from 4 to 7 kHz.

As with the horizontal off-axis responses, all the high-frequency vertical responses in Fig. 6 are quite ragged. On the average, however, they exhibit high level, combined with broad vertical coverage, for the upward angles. This is despite the fact that the LX5's tweeter is claimed to act as a line source, whose vertical response should supposedly get narrower and narrower as frequency increases. The high-frequency response in the downward direction is somewhat reduced due to shadowing by the woofer enclosure.

Figure 7 shows the PRO LX5's impedance magnitude versus frequency. Below 200 Hz, the impedance curve exhibits the characteristic two-peaks-straddling-a-dip trait of the vented box. Box tuning is about 70 Hz, where the impedance dips to 4.9 ohms. The impedance reaches a local peak of 20.7 ohms at 1.8 kHz, just below crossover. Between 20 Hz and 20 kHz, a minimum impedance of 4.8 ohms occurs at 220 Hz, and a high maximum of 45 ohms occurs at 125 Hz. This is a high max/min variation of about 9.4 to 1 (45 divided by 4.8). Cable series resistance should be limited to a maximum of about 0.063 ohm to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet, 14-gauge (or heavier), low-inductance cable should be used.

Figure 8 shows the complex impedance of the LX5, plotted over the frequency range of 5 Hz to 30 kHz. The two largest loops would be nearly perfect circles had they not been squared off due to being undersampled by my measurements. The impedance changes very rapidly near the low-frequency impedance peaks at 38 and 120 Hz. The complex impedance is otherwise

pretty standard. Between 20 Hz and 20 kHz, the impedance phase (not shown) reached a maximum angle of  $+54^\circ$  (inductive) at 112 Hz and a minimum of  $-57^\circ$  (capacitive) at 138 Hz. Even with these fairly high angles in the bass range, the relatively high minimum impedance values mean that the LX5 will not be a difficult load if used by itself.

A high-level sine-wave sweep revealed a fairly rigid cabinet except for wall resonances and buzzing between 320 and 340 Hz. Below 110 Hz, much air and wind noise was generated by the ports. The 5-inch woofer has a generous linear travel capability of about 0.4 inch, peak to peak, and makes no harsh sounds when overdriven. No dynamic offset was evident. The vented enclosure works quite well and reduces the cone excursion at box resonance quite significantly.

Figure 9 shows the 3-meter room response of the PRO LX5, with both raw and sixth-octave smoothed curves. The speaker was in the right-hand stereo position, aimed straight ahead, and the test microphone was at ear height (36 inches), at the listener's position on the sofa (about  $20^\circ$  off the speaker's axis). The system was driven with a swept sine-wave signal of 2.83 V rms, corresponding to 1 watt into the rated 8-ohm impedance. The direct sound plus 13 mS of the room's reverberation are included in this measurement.

Overall, the averaged curve in Fig. 9 is quite extended and fits a reasonably tight, 11-dB window. Absent are any major room-effect dips in the range from 250 to 500 Hz. The averaged curve exhibits a downward trend of about 3 dB/octave between 1 and 10 kHz and then has a high-frequency peak at 13 kHz.

Figure 10 shows the  $B_1$  (61.7-Hz) bass harmonic distortion of the LX5 with input power ranging from 0.025 to 25 watts (14.14 V rms into the rated 8-ohm load).

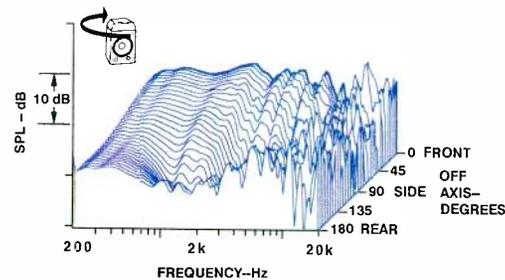


Fig. 5—Horizontal off-axis frequency responses.

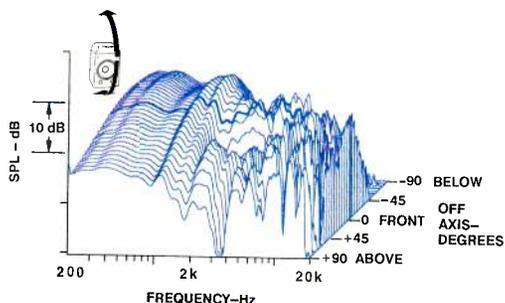


Fig. 6—Vertical off-axis frequency responses.

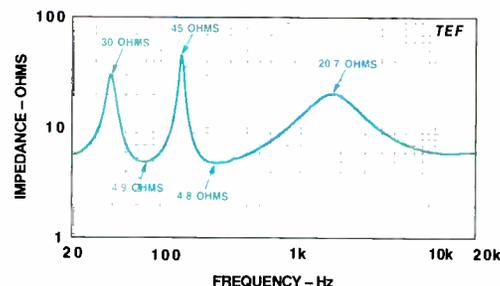


Fig. 7—Impedance.

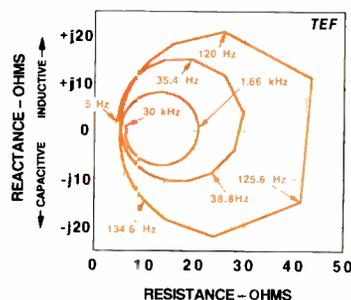


Fig. 8—Complex impedance.

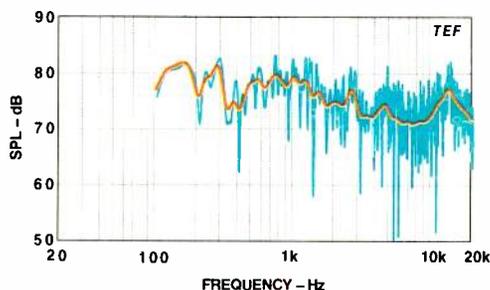


Fig. 9—Three-meter room response.

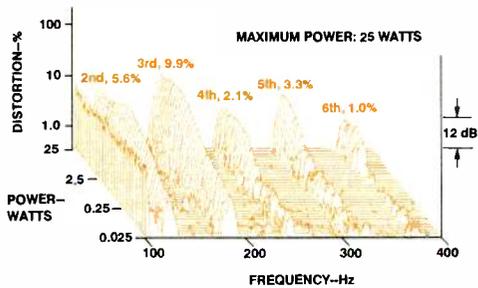


Fig. 10—Harmonic distortion for  $B_1$  (61.7 Hz).

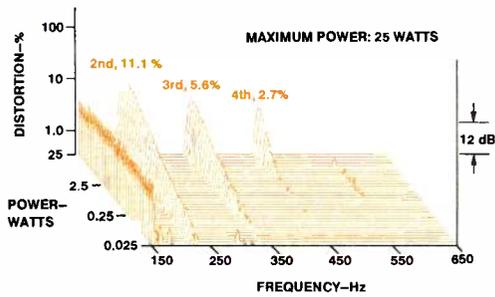


Fig. 11—Harmonic distortion for  $A_2$  (110 Hz).

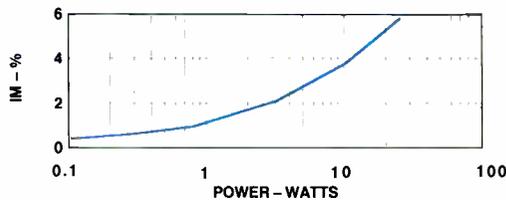


Fig. 12—IM distortion for  $A_4$  (440 Hz) and  $B_1$  (61.7 Hz).

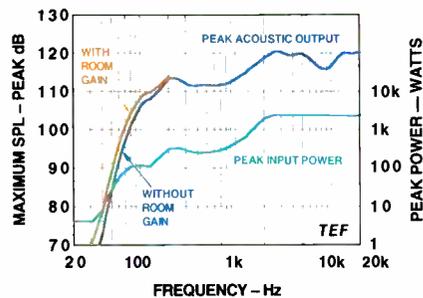


Fig. 13—Maximum peak input power and sound output.

Distortion was measured at 25 watts rather than my usual 50 or 100 watts because at higher power levels the speaker sounded stressed. The second harmonic reaches only 5.6%, while the third attains a somewhat higher 9.9%. Higher harmonics measure 2.1% (fourth), 3.3% (fifth), and 1% (sixth)

at full power. At 1 meter in free space with an input of 25 watts, the LX5 reached a marginally usable 90 dB SPL at 61.7 Hz. Much port wind noise was evident at this level.

In Fig. 11, the  $A_2$  (110-Hz) bass harmonic distortion, the predominant distortion is a moderate 11.1% second, a 5.6% third, and a lower 2.7% fourth. Higher harmonics are negligible. With a 25-watt input, the system reaches a fairly healthy 102 dB SPL at 110 Hz.

The  $A_4$  (440-Hz) distortion (not shown) rose only to the low levels of 1.05% second harmonic and 1.08% third. Higher harmonics were below the noise floor of my test gear.

Figure 12 displays IM distortion versus power, created by tones of 440 Hz ( $A_4$ ) and 61.7 Hz ( $B_1$ ) of equal power. The IM distortion rises only to the moderate level of 5.8% at 25 watts.

I measured the short-term peak-power input and output capabilities of the PRO LX5 as a function of frequency, using a 6.5-cycle tone burst with a third-octave bandwidth. The peak input power was calculated by assuming that the measured peak voltage was applied across the rated 8-ohm impedance. As can be seen in Fig. 13, the peak input power starts low, 4 watts at 20 Hz, and then begins to rise rapidly at 32 Hz. It reaches a plateau of 116 watts at 100 Hz and, after rising to a local peak of 330 watts at 250 Hz, drops slightly and then smoothly increases to 2,500 watts above 2 kHz. Between 125 and 800 Hz, the speaker's output sounded somewhat harsh and exhibited some triangularization of the acoustic output waveform, presumably due to inductor saturation in the woofer leg of the crossover.

With room gain (also shown in Fig. 13), the LX5's maximum peak output SPL starts at an unusable 70 dB at 30 Hz and then rises rapidly through a quite usable 100 dB at 68 Hz and 110 dB at 130 Hz. After reaching a maximum of 113 dB at 200 Hz, the curve drops slightly, to 111 dB at 500 Hz, and then rises into the loud range of 117 to 120 dB above 1.6 kHz. The

maximum output, although limited below 80 Hz, is very usable at all higher frequencies. Therefore, the LX5 would make a good satellite for use with a subwoofer in a high-performance system.

### Use and Listening Tests

The vast resources of Radio Shack were quite apparent when I examined the cabinet. Everything was quite tidy, fit very well, and looked good, and all parts and pieces had their proper place and function in the whole design. No money was spared on design, tooling, or manufacturing.

The instruction sheet for the PRO LX5 is a very brief, single 8½ x 11-inch page, folded to form a little four-page booklet. Two brief paragraphs on the first page describe loudspeaker placement, stating that the distance between the speakers should be the same as their distance from the listening position. It is implied that the speakers should face straight ahead rather than be canted in. No mention is made of mounting height or distance to reflecting surfaces. In earlier conversations, the people at Lineaum and Radio Shack stated that the listeners' ears should be roughly even with, or up to a foot higher than, the tops of the speakers.

The manual devotes a complete page to connecting the system, with excruciatingly detailed instructions on how to strip the wire, what directions to turn the terminal to loosen and tighten it, how to insert the wire, and so on. The rest of the manual is devoted to an introductory description of the system, specifications, and a frequency response curve.

Listening was done primarily with the PRO LX5s located in my regular positions, well away from the rear and side walls. Some listening was done with the speakers placed closer to the rear wall. This really didn't help the low bass output but did accentuate the upper bass (where no emphasis was needed) and adversely affected imaging.

Listening gear included my Onkyo and Rotel CD players, Krell's KRC preamp and KSA250 power amp, Straight Wire Maestro cabling, and B & W 801 Matrix Series 3 reference speakers. The Optimus systems were placed on stands, which raised them so that they were about level with my ears. The PRO LX5s were aimed straight ahead for

# WAVEFORM PHASE

Figure 3B of the accompanying review includes an unfamiliar curve, "waveform phase," which is a way of looking at phase response in terms of its effect on linear distortion.

Audio readers are likely familiar with such common nonlinear distortion problems as harmonic and intermodulation distortion, power compression, hysteresis effects, and directional characteristics that change with frequency. Linear distortion includes errors connected primarily with the frequency and time response of a system, such as non-flat frequency response, nonlinear phase response, time delays that change with frequency, delayed resonances, time smear, etc. Linear distortion can be corrected by equalization; nonlinear distortion can't. For a system to reproduce waveforms faithfully, both types of distortion must be low.

The characteristics a system must have for low linear distortion include flat frequency response and linear phase response (phase response that's a straight line when plotted on a linear frequency scale), both measured over the effective bandwidth of the input signal. But that's not enough.

One additional requirement is that the linear-phase portion of the phase response, when extended in a straight line to zero frequency (the phase intercept), must cross the vertical phase axis at the origin (zero phase, zero frequency point) or at a multiple of  $\pm 360^\circ$ . If this is the case, waveforms will not be distorted. If it crosses at a point  $\pm 180^\circ$  from  $360^\circ$  (or any multiple thereof), the waveform will be correct but inverted. If it crosses at any

other angle, the waveform will be distorted. Maximum distortion occurs at odd multiples of  $\pm 90^\circ$  ( $\pm 90^\circ$ ,  $\pm 270^\circ$ , etc.).

I call this phase-intercept angle "waveform phase" and plot it on a log frequency scale over a range of  $\pm 180^\circ$ . Other authors have called this phase error by different names: Phase intercept distortion [1, 2], differential phase shift distortion [3], and polarity phase [4].

Note that I have said nothing about the audibility of waveform distortion. Some errors are quite subtle, while others are quite audible [2, 5]. The interested reader is referred to the brief list of references for more information.

D.B.K.

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1. Preis, D., "Linear Distortion," *Journal of the Audio Engineering Society*, Vol. 24, June 1976 (pp. 346 to 367).
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3. Leach, W., "The Differential Time-Delay Distortion and Differential Phase-Shift Distortion As Measures of Phase Linearity," *JAES*, Vol. 37, September 1989 (pp. 709 to 715).
4. Keele, D., "Measurement of Polarity in Band-Limited Systems," presented at the 91st Convention of the Audio Engineering Society, New York, October 1991, Preprint No. 3168 (K-2).
5. Blauert, J. and P. Laws, "Group Delay Distortion in Electroacoustical Systems," *Journal of the Acoustical Society of America*, Vol. 63, May 1978 (pp. 1,478 to 1,483).

most of the listening, all of which was done with the grilles on. The upper grille can be removed, with some degree of difficulty, but I judged that the typical listener would not and, further, should not remove it, due to the possibility of damage to the membrane tweeter.

First listening revealed a quite open sound with high-frequency coverage that was very broad and even, both vertically and horizontally (even above the systems), and with essentially equal coverage to the

rear. I was particularly impressed with the coverage when I stood up and walked around, between, and to the rear of the speakers. The high-frequency output was always quite evident to me, no matter where I listened.

I did a significant amount of my listening with a recently acquired sampler disc, *24KT Premium Gold* (Clarity Recordings CCD-1010), which is going to be a permanent addition to the select few CDs I carry around for demonstration purposes. The disc, a

sampling of the broad and varied repertoire of Clarity Recordings, includes offerings from country, rock, jazz, and classical; all tracks on the sampler are minimalist two-mike recordings.

Of the 11 tracks on this disc, only two proved difficult for the PRO LX5s. These were tracks 1 and 2, which included country and rock music with heavily recorded bass. The LX5s did very well on the Schubert piano trio track, with the piano sound quite close to my reference systems'. On the Stravinsky orchestral tracks, the PRO LX5s did quite well except at higher levels, where the sound grew compressed and restricted. On track 10, Spanish guitar with female vocal, the soundstage was quite broad, with good reproduction of room sound; the vocal was quite clean and realistic although placed farther back than the B & W's soundstage.

Reproduction of high-frequency percussive sounds, such as found on another excellent disc, *Salterio* (MA Recordings GCD-1010, Spanish string music with some Mideastern influences), profited greatly from the broad high-frequency coverage of the PRO LX5s. The broad coverage encouraged me to actually get up and walk around!

I also did some listening with the LX5s hooked up as satellites for my Velodyne subwoofer. Here, their sound was significantly better because they were not called on to reproduce the bass. The additional bass from the Velodyne also helped, of course. The LX5s still do okay on their own, however.

In general, the overall sound of the PRO LX5s was more distant and diffuse than the B & W's. Most vocals were placed farther back in the soundstage. This isn't necessarily bad, but it may not appeal to some listeners. I quite liked most of the effects of the broad high-frequency coverage and can see how the LX5s might greatly appeal to the average consumer.

On pink noise, the PRO LX5s did quite well on the stand-up/sit-down test, exhibiting only a moderate midrange dip on stand-up. Even though the tweeter of the LX5 is billed as being a line source, it did not exhibit any of the vertical narrowing at high frequencies that is typical of line sources; it was actually quite broad, vertically. Horizontal coverage on pink noise

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was also very good, with only a hint of swishiness when I moved horizontally. High-frequency coverage to the rear was also quite good and essentially equal to the front coverage. The pink-noise spectral balance was fairly close to the B & W's, but with much less bass and some added spectral unevenness.

On band-limited pink noise, the PRO LX5 generated no usable bass output in the third-octave bands from 20 to 50 Hz, except for distortion and port noise. Some fundamental output was noted at 63 Hz, and much cleaner output at 80 Hz and higher. Some harshness was noted in the 80-, 100-, and 125-Hz bands, which was reduced when the ports were covered: Apparently some internal port turbulence noise was being radiated out through the ports. Unfortunately, the fundamental output of the LX5 was also reduced when the ports were covered.

The small size of these speakers encourages experimentation with their orientation and placement. One interesting experiment is to orient the LX5s so that their sides are aimed at the listener, with their fronts aimed at the side walls. This places the listener in the systems' high-frequency null and greatly attenuates the high-frequency direct sound. In this circumstance, the listener essentially hears only reverberant sound at high frequencies. The PRO LX5s actually did not sound particularly bad set up this way. The highs were not all that attenuated, but they sounded considerably more diffuse. The very broad front and rear high-frequency coverage of the LX5s greatly adds to the high-frequency reverberant level in the room.

The Optimus systems also did not sound all that bad even when placed on their backs and facing up, with the top facing me, or when they were turned around with their backs facing me.

Overall, the Optimus PRO LX5 represents quite good value for the money, with a good combination of performance, size, and looks. The very distinctive-sounding and broad high-frequency coverage makes the system stand out when demonstrated. Only the bass range is compromised, due to the woofer's small size. With a subwoofer, the PRO LX5 would make an excellent addition for use in a budget home theater.

D. B. Keele, Jr.



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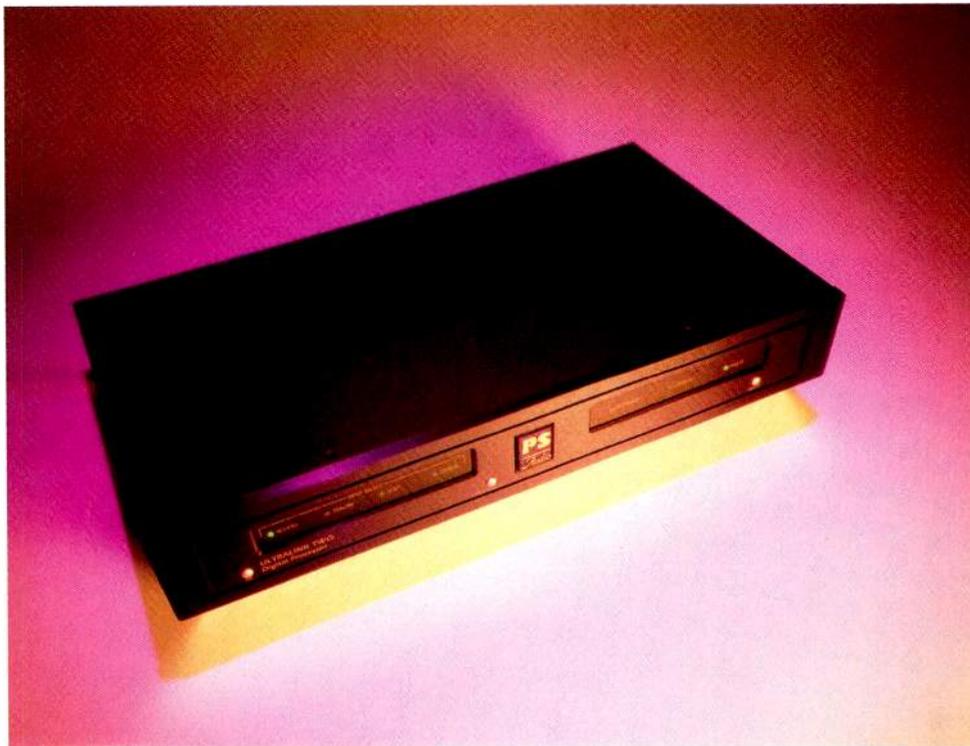
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## PS AUDIO ULTRALINK TWO D/A CONVERTER



**R**eviewing D/A converters is getting steadily harder to do. There have been some striking changes in the sound of the better converters during the last year. While the best ones scarcely sound alike, their differences in sound quality are diminishing. It is now rare to find a unit that makes the compromises in dynamics, resolution of low-level detail, and/or transparency of the upper midrange and highs that used to show up in even some of the highest priced models. It is equally rare to find a D/A converter that has anything like the "edge" or hardness in handling strings, cymbals, or massed

instruments that was all too common in the past.

This is good news for the audiophile. It also means that there is less correlation between increases in price and improvements in sound quality. Firms such as Audio Alchemy and Theta Digital make very good D/A converters at relatively low prices—and a number of jitter-reduction devices are available that can improve the sound of older converters. As digital technology matures, the benefits of once very high-priced processing are being passed down to much lower priced units.

Nevertheless, there are still important differences between D/A converters, and the better high-end firms still offer significant improvements in the finer details of sound quality in return for a higher price. The PS Audio Ultralink Two is a

good case in point. It sells for \$2,295—which is scarcely cheap, and which puts it in price competition with some of the top models in the high end. Yet you do get superior sound quality for this price. The Ultralink Two outperforms the lower priced CD players and D/A converters I have heard to date, and it competes directly with the best-sounding converters in its price bracket.

The Ultralink Two is a compact unit with simple, soft-touch switching for off/on, input selection, and polarity inversion. Pilot lights show the unit is receiving a digital data stream and whether the automatic de-emphasis circuitry is operating. The unit has automatic muting that is not in the signal path, and a choice of all the standard digital inputs—including Toslink, AT&T optical, coaxial, and AES/EBU. There is a digital tape output and both balanced and unbalanced audio outputs.

The Ultralink Two uses an Ultra-Analog 20-bit DAC and eight-times oversampling. PS Audio claims that it achieves such linearity across the entire 20-bit ladder that degradation of the incoming 16-bit signal is theoretically no longer possible. The Ultralink Two also uses a new Ultra-Analog digital receiver, the AES 21, to reduce jitter; digital oversampling and de-emphasis are done by an NPC SM5803 digital filter.

The analog reconstruction filters are a three-pole, modified Bessel, frequency-dependent, negative-resistance (FDNR) type. They are not in the signal path, and PS Audio claims that they reduce noise, signal distortion, and phase shift. Polypropylene capacitors are used in these filters. Phase shift is specified as within  $\pm 5^\circ$  at 20 kHz, and there is 85 dB of anti-image rejection to prevent the oversampled image from modulating analog signals. The analog output stage is pure Class-A complementary and is a low-impedance design which allows the use of long cable lengths and passive line preamplifiers. According to the specifications, interchannel crosstalk, power-supply

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crosstalk, and digital-to-analog crosstalk measure better than 105 dB at 1 kHz.

The Ultralink Two's power supply has an unusually large power transformer, with two secondary windings for separate digital and analog supplies. There are subsequent regulated +15 V supplies for the left channel, the right channel, and the UltraAnalog DAC. The power supply has 30,000 µF of filter capacitance, a much larger reserve than in most low-level components.

Like some digital units, the Ultralink Two does need a couple of weeks to fully break in. I would suggest you begin by using the "disc repeat" switch on your CD transport to silently play a CD for at least three days before you begin to make any judgments about sound quality. Like some other recent high-quality D/A converters, however, the Ultralink is less transport- and cable-sensitive than previous units.

In saying this, I should add several notes of caution. A low-priced CD player or transport is not going to live up to the performance of a good separate transport, such as PS Audio's Lambda. However, the practical differences between transports now normally amount to a relatively minor loss of resolution and consistency, at least with newer high-quality CDs.

I also hear less reason to invest in high-cost digital cables. You should still avoid using the low-quality Toslink connection if at all possible, and you should pay enough for a digital interconnect to ensure that you have a high-quality ST cable or a coaxial or AES/EBU cable with the proper termination and impedance. On the other hand, be very cautious about paying large amounts and expecting to hear much performance improvement in return.

Once the Ultralink Two is fully broken in, it provides a distinct improvement over previous PS Audio, and most other, D/A converters. The slightly lean or dry sound of many previous products is gone, and you get a good balance of upper bass and lower midrange warmth. Timbre is excellent, with a natural musical balance that is consistent in spite of changes in the music level and in musical dynamics. The Ultralink Two also provides midrange and treble with exceptional freedom from hardness or edge. It makes small but very real improvements in the resolution of single notes from the piano, harp, and bell. Brushed cymbals and

solo harpsichord music, scarcely one of digital sound's initial strengths, have a great deal of detail and only very faint traces of electronic character—and many of these traces may well be the fault of the A/D circuitry used to make some of my reference recordings rather than the fault of the Ultralink Two.

In addition, the unit provides more musically natural low-level detail than I have heard in virtually all of the last generation of players, and which I still hear from a number of converters in this price bracket. The low-level resolution capability of the Ultralink Two sounds very much like that of the substantially more expensive PS Audio Reference Link, which it closely resembles in many aspects of sound quality.

**YOU GET AN AWFUL LOT  
OF SOUND QUALITY  
FOR YOUR INVESTMENT  
IN THE ULTRALINK TWO.**

The Ultralink Two gives more evidence that the days of "digital bass" are over. It not only measures well in the bass but also delivers the full power and extension of the deep bass with very good dynamics and tight, well-defined bass transients and "slam." The Ultralink Two does a much better job of making the music come alive and of giving to jazz rhythm sections the power and natural character needed to really enjoy good recordings.

The soundstage was very good. I found it a bit too wide with some recordings, with a slight tendency to emphasize width and detail at the expense of coherence. At the same time, the Ultralink Two did an unusually good job of reproducing those recordings that seem to extend the soundstage to the left and right of the speakers, and it did not collapse depth at the expense of width. (Some D/A converters have more apparent depth, but it is uncertain whether this additional depth is actually on the recording.) Imaging was well defined, without being over-defined, and was very stable. Some other units provide a bit more soundstage ambience, but the Ultralink Two was still very good in this regard.

Musical dynamics were very good in all parts of the spectrum, not just in the bass. The attack was slightly more aggressive than I find entirely natural, but this aspect of musical dynamics suited the overall character of the Ultralink Two, which places the apparent listening position just slightly forward of what I normally expect from my reference recordings. I also suspect such dynamics will suit the taste of audiophiles used to more "live" halls and the dynamics of most performances of rock or jazz.

I was struck by the fact that this converter did a notably better job of reproducing what I have previously regarded as badly recorded or produced CDs and digital tapes, although it did not rival the far more expensive Mark Levinson 30.5 in this regard. I should warn you that no D/A converter is ever likely to salvage a poor CD—any more than any phono cartridge can salvage a bad LP record—but I suggest that you audition this unit with a few CDs you have previously found wanting, to hear the level of improvement involved. You might try comparing the Ultralink Two to another converter as you listen to minutes 3 through 4 on band 6 of Alfred Newman's recording of the soundtrack from *The Egyptian* (Varese Saraband VSD-5258)—but any mediocre recordings of bells, cymbals, harpsichord, or massed strings should be equally revealing.

Let me stress that you do not need to spend more than \$2,000 on a D/A converter to get high-end sound, and the Ultralink Two faces demanding competition in the price range of \$2,000 to \$3,000. I did find, however, that it provided an unusually good mix of exceptional detail and information and musical listening pleasure.

I did a lot of comparative listening with the Ultralink Two and units costing two to seven times as much. Some were indeed clearly better, but some were not. This unit came surprisingly close to even the best of the high-priced D/A converters, particularly with high-quality recordings. You get an awful lot of sound quality for your investment in the Ultralink Two. Even today, there aren't all that many converters that reduce listening fatigue to the point where you can easily immerse yourself in long performances of complex music; the Ultralink Two was made for Bach!

*Anthony H. Cordesman*

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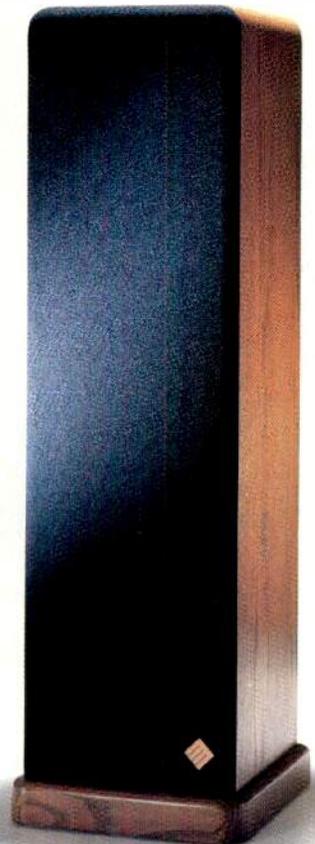
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# INFINITY IRS EPSILON SPEAKER



**M**ost of the speakers I review are variations on the same theme. They use cone or dome drivers for all or most of the frequency spectrum, and the variations in their sound, while often quite striking, have a familiar and predictable character. Infinity's IRS Epsilon is a different story. It uses three different planar drivers, which Infinity calls Electro Magnetic Induction speakers, to handle most of the frequency range and has a servo

cone woofer to handle the bass. Although the enclosure in which these drivers are mounted may look conventional, it involves a great deal of new thinking about the best way to handle dipole radiation. For these reasons, the sound of the Epsilon differs significantly from the sound of dynamic speakers and must be judged by somewhat different standards. It involves different-sounding engineering compromises in its design than dynamic speakers do. Even more than most speakers, the IRS Epsilon must be judged by the standard of how well it re-creates the illusion of a live performance and not by how well it compares to more conventional designs.

The Epsilon is a state-of-the-art design by Cary Christie, who helped create many of Infinity's classic reference speakers. To do full justice to the technical aspects of this speaker would take up most of the space in this issue, and there would be too little space to discuss how it sounds. The technically minded will be interested in Infinity's white paper on the system, "A View into Advanced Loudspeaker Design and Technology," while everyone will benefit from the instruction book, which has de-

tailed information on setup and adjustment and can teach you a great deal. This is one time a visit to a dealer can provide the technical details you need to understand the speaker as well as the opportunity to listen to it.

In brief, the \$14,000 Epsilon system consists of three parts. The first is a "black box" that contains the crossovers and the servo electronics and equalization for each channel's woofer. The other parts are the two speaker enclosures, each of which is a four-way design that uses planar drivers to cover the range above 150 Hz and a cone woofer for frequencies below that point.

The servo-control unit is inserted in the signal path between the pre-amp and the power amps. It has separate outputs for the woofer and planar drivers, and you need two stereo

**THE EPSILONS DO  
A VERY GOOD JOB  
OF MAKING MUSIC  
SOUND NATURAL.**

amplifiers or four mono amplifiers to drive the system. These amps must be capable of driving complex low-impedance loads (in the 2-ohm range), and the subwoofer amp must have considerable power. The servo system requires an additional connection between the control unit and the servo input of each woofer, but the required cables are included.

The servo-control unit is very well built and unusually flexible. It accommodates balanced and unbalanced connections, and has the control features needed to tailor the Epsilon to any given mix of amplifier gain characteristics and listening room requirements. A control on the rear panel allows the use of amps

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having different sensitivities for the woofers and upper frequencies, and separate controls on the front panel allow you to vary bass level, the contour of the bass frequencies, and the contour of the frequencies in the middle bass.

Each speaker enclosure has two planar Electro Magnetic Induction Tweeters (EMITs), covering the range from 3 to 45 kHz—with one EMIT firing forward and one firing to the rear. A planar Electro Magnetic Induction Midrange (EMIM) covers frequencies from 500 to 3,000 Hz, and a lower frequency planar midrange driver, called an L-EMIM, covers the range from 150 to 500 Hz. The drivers are mounted in a vertical array on a large, gently curved panel whose sides form an acoustic baffle. The forward-firing woofer is in a separate, sealed enclosure that acts as the base for the panel holding the planar drivers. Separate level controls for each planar driver are behind a panel on the rear of the speaker.

Infinity believes that its planar drivers offer significant advantages over electrostatic speakers because of superior dynamics, the ability to avoid high-voltage power supplies and step-up transformers, and the ability to cover the midrange without a large surface area. Infinity also feels that planars avoid

**THE EPSILONS HAVE  
A STABLE SOUNDSTAGE,  
FILLED WITH DETAIL  
AND NUANCE.**

the problems of irregular magnetic field strength, field geometry, and field linearity often found in conventional electromagnetic drivers.

The Epsilon's planars use two arrays of magnets (one on each side of the diaphragm, with like poles facing each other) to create what Infinity says is a powerful, uniform, and linear field. Its new EMIM and L-EMIM drivers also use very low-mass laminated films. These films are composed of polyamide, aluminum, and adhesives about 0.0043 inch thick, with aluminum voice-coil traces only 0.001 inch thick; new damping materials eliminate the standing waves that develop when the wavelength of reproduced sound is shorter

than the dimensions of the diaphragm's surface. For all these reasons, Infinity says, the new EMIM driver has a substantial reduction in diaphragm resonances and breakup modes and more than 12 dB greater dynamic range than previous EMIMs. The new EMIT in the Epsilon shares these technical advantages, and has good off-axis response to over 25 kHz and on-axis response to 45 kHz.

The injection-molded graphite cone of the Epsilon's servo woofer is yet another step forward in the evolution that began with the Infinity Servo-Statik 1, the speaker that established Infinity's reputation as a leading high-end firm. The circuitry in the servo-control unit compares the signal from the woofer accelerometer with the original source signal; it then sends a new signal (distortion product) to the power amplifier, in reverse polarity, to cancel the distortion. This servo drive controls cone motion in ways that reduce both linear and nonlinear distortions, including those caused by variations in the stiffness of the suspension system and the strength of the motor circuit, and it boosts and flattens the response of the system below resonance. The 12-inch woofer uses a cone that mixes graphite fibers with polypropylene; it has a large-excursion, 1½-inch voice-coil and centering spider. The magnet, a large ceramic unit, weighs more than 3 pounds. Infinity believes that servo control greatly reduces the problems caused by conventional woofer enclosures. Additionally, the servo's feedback system, which compares the woofer's output with its input signal, reduces distortion.

The Epsilon's passive crossover networks have glass-epoxy circuit boards with heavy copper traces, low-loss polypropylene capacitors, precision resistors, and high-Q inductors. Each crossover requires two 9-V batteries to electrically bias the capacitors in the high-frequency network, an unusual feature that Infinity believes produces subtle improvements in sound quality.

The Epsilon's enclosure does an exceptional job of minimizing the visual profile of a large loudspeaker. Touches of finished wood, black surfaces, and a well-sculptured shape minimize the speaker's intrusiveness while communicating a high-end look. The woofer enclosure is extremely well built, using high-density fiberboard with walls 1

**Cutaway view,  
showing driver  
and crossover  
placement,  
plus enclosure  
details of the  
IRS Epsilon.**



inch thick, and is lined with sound-absorbing material. The planar drivers are also enclosed, to absorb their back waves so as to reduce the comb-filter effects from front-to-rear phase cancellations; Infinity calls this design "radiation pattern control."

It is difficult to describe the sound of the Infinity Epsilon without exaggerating the differences between it and the sound of most dynamic speakers. In practice, such differences are matters of nuance; the non-audiophile might simply sit back and enjoy the sound without ever noticing these differences. Yet the Epsilon does have a special sound character, one much closer to that of electrostatics and far larger planar speakers than to most dynamic speakers.

The differences are particularly apparent in the bass. The current generation of flagship speakers is capable of much deeper bass than was common even a few years ago. The sound of this deep bass, however, varies from speaker to speaker in ways that affect overall timbre. The Epsilons can be easily adjusted so that their bass energy matches the timbre of the midrange and treble. They do not reach down past 20 Hz, but Infinity deliberately avoided extending the bass to frequencies that would require a massive enclosure or separate subwoofer cabinets. The Epsilons do have deep bass that sounds flat to just below 30 Hz, they have excellent power response that provides strong dynamic energy even at the bottom of the woofer's range, and they do an excellent job of reproducing the sheer power of orchestras, rock bands, and pipe organs. The bass sound is similar to what I have

heard in previous Infinity speakers using servo woofers and in models from Velodyne Acoustics.

The Epsilons also encounter the same problem as all other speakers I have heard that blend different driver technologies. There is a much smoother transition between the woofer and planar drivers than I have heard in previous Infinity speakers except the Infinity Reference. On the other hand, the woofer's crossover frequency, 150 Hz, is high enough that I hear more of a discontinuity between the woofer and lower midrange than I hear with hybrid systems that cross over below 90 Hz. You can compensate for the lack of tightness or definition in the crossover area through careful use of the contour and level controls on the servo unit and through careful placement of the speaker enclosures. Further, the flexibility of the controls on the servo unit makes it easier to position the speakers without relocating all of your furniture or overdriving your listening room when the deep bass takes over.

Once the planars take over from the servo woofer, the Epsilons combine remarkably smooth response with exceptional sweetness and detail. They have the neutral overall timbre of the better electrostatics and seem free of many of the minor response irregularities in the midrange and the upper midrange that even the best dynamic speakers exhibit. The EMIMs and EMITs also seem free of any problems from beaming or directivity.

The midrange and treble have a special character that I associate with the best planars and electrostatics. Although music was not as "dynamic" as with the best cone and ribbon drivers, in the sense that the "attack" (or leading edge) of notes seemed slightly softer, notes did seem to have less overhang and quicker decay. The Epsilons resolve the finer details of music in a way that may seem slightly soft in character—until you listen to the amount of information and musical detail that are actually present. Once you do, it is clear that the Epsilons have impressive transparency and resolving power.

The Epsilons did a very good job of making music seem natural. They may sound different from dynamic speakers, but depending on the recording, they provide transient detail very similar to that of a live

performance. This came through clearly in piano notes, harp, and harpsichord. These speakers did an exceptional job of handling the details in massed strings and string quartets without blurring the differences between older and modern instruments. They did a very good job of handling percussion detail, such as brush strokes on cymbals, and of resolving the detail in good choral recordings—although I would have liked a bit more bite in the brass and in the bowing of modern violins.

The soundstage was unusually coherent. The Epsilons did an excellent job of passing along the character of the recording and the electronics without altering depth or width. As with most full-range speakers, careful attention is needed to find the best trade-off between bass performance and soundstage depth. Place the Epsilons away from side walls, and keep them close enough together to avoid stretching the soundstage to the point where there is a hole in the middle or the sound seems to cluster around each speaker. If you pay careful attention to setup, you will get a well-focused and stable soundstage filled with detail and nuance.

The overall dynamics of the Epsilons were slightly different from those I've encountered with most dynamic and ribbon speakers—more like the dynamics you hear in the middle of a classic concert hall than what you hear closer to the performers. These dynamics suited the character of the servo woofer and the planar drivers, contributing to the Epsilons' ability to reproduce the illusion of a live performance.

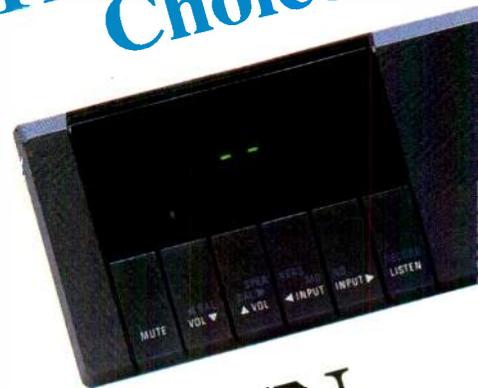
The Infinity Epsilons are an excellent illustration of why good dealers are essential to the high end. Cary Christie has created an exceptional speaker, and the Epsilons deserve the best possible demonstration. They need proper break-in time, careful setup, and compatible amplifiers, and they need to be carefully auditioned to be understood. I would suggest an extended listening session (or sessions), which, of course, is *de rigueur* for any speaker at this price. I also strongly suggest that you audition the Infinity Epsilon for its ability to get the best out of great recordings, not for whether it sounds like dynamic speakers. The Epsilon provides a new sound for the high end; it must be judged for its musicality and not its ability to follow a more familiar path.

Anthony H. Cordesman

## PART ONE – MULTIPLE CHOICE

1. The Linn Majik control amplifier is a(n) \_\_\_\_\_
  - A. Integrated Amplifier
  - C. Power Amplifier
  - B. Preamplifier
  - D. Headphone Amplifier
  - E. All of the above
2. Using special Linn "Sneaky" Modules the Majik can become a(n) \_\_\_\_\_
  - A. AM/FM Receiver
  - C. Active Electronic Crossover
  - B. Multi-Room System
  - D. Any of the above
3. The Linn Majik \_\_\_\_\_
  - A. Adapts to your ever changing life-styles.
  - B. Expands to provide music throughout your home.
  - C. Grows into an ultra high-performance multi-amp system.
  - D. Features remote control and advanced solid-state switching.
  - E. Is surprisingly affordable.
  - F. All of the above

# The Obvious Choice



# LINN MAJIK



ANSWERS: 1-E, 2-D, 3-F

See Part II of the exam on page 79  
and Part III on page 81.  
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## SNELL TYPE A MUSIC REFERENCE SPEAKER SYSTEM



Over the years, Snell has become one of the most respected names in high-end speaker manufacturing in the United States. It has survived the death of its founder and gone on to make a wide range of excellent stereo and home theater speaker systems, ranging in price from \$470 for the Type M small monitor to \$29,993 for its THX-certified Music and Reference System.

The Type A Music Reference Speaker System is Snell's top-of-the-line stereo speaker system, and it is clearly designed as an assault on the state of the art. It sells for \$18,999 and has six major components: Two subwoofers, two full-range speaker towers, and two small cabinets with the crossovers for the full-range speaker towers. You need at least four channels of amplification (full-range and subwoofer amplification for each channel), a crossover, and

four sets of speaker cables. The truly ambitious audiophile can use six channels of amplification and bi-amplify the stereo towers. While Snell will provide its \$300 EC200 electronic subwoofer crossover to any buyer of this system, there are better component solutions, such as ones from Krell, Bryston, Accuphase, or FM Acoustics.

Like all speakers that make an assault on the state of the art, the Type A Music Reference System is designed to make a statement, and it is anything but inconspicuous. The system weighs a total of 530 pounds, and the subwoofer cabinets are large vertical boxes measuring 45 inches high, 21½ inches wide, and 16½

**SNELL'S TYPE A IS  
ONE OF THE FINEST  
SPEAKER SYSTEMS  
EVER MADE.**

inches deep. The speaker columns are slender and nicely styled, measuring 63 inches high, 9 inches wide, and 12 inches deep; there are two other small towers for the outboard crossovers. For this review, Snell supplied its EC200, mentioned above, to cross the full-range speakers to the subwoofer.

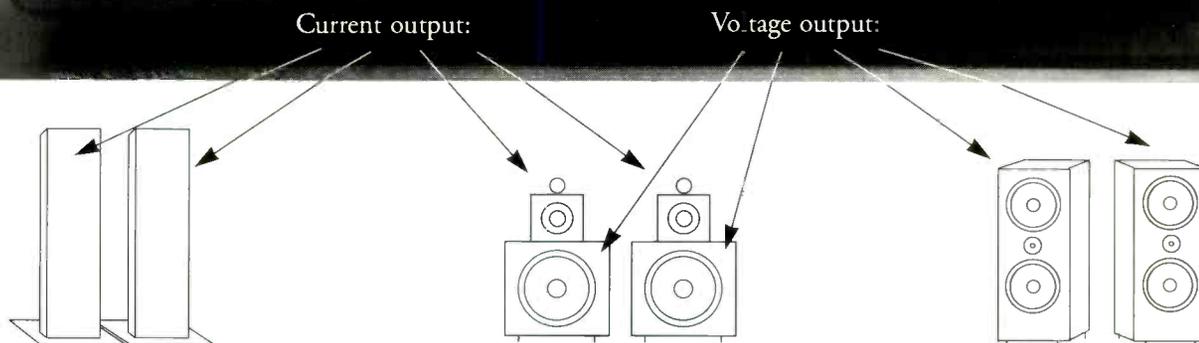
The subwoofer's cabinet size allows Snell to provide the kind of sound that makes most other subwoofers sound like a weak imitation. Each subwoofer cabinet holds a Snell SUB1800 18-inch driver that is specified to be flat ( $\pm 2$  dB, anechoic) from 17 to 80 Hz. While I cannot measure this kind of low-frequency performance, test tones and third-octave pink-noise trials indicate the subwoofers have outstanding performance. Not only can they put out

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At the same time, the new Sunfire amp, with its uncanny tracking downconverter, has the ability to raise goose bumps with its awesome power. Using 12 herculean International Rectifier Hexfets, it can drive *any* load to *any* rationally usable current or voltage level.

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Or if you're able to bi-wire, you may just arrive at the best possible interface: voltage output to woofer for incredible

bass whack, current output to midrange and treble for the subtle cues of reality. Your options even include gold RCA standard or XLR balanced inputs.

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The basis for all this is designer Bob Carver's versatility. He's worked successfully with both tube and solid state designs, as the path towards musical truth dictates.

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*.....from the mind & soul of Bob Carver*

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incredible power to below 20 Hz, they can also reach as deep a note in reproducing organ and synthesizer music as any speaker system I've heard.

The full-range towers use a computer-modelled tiered baffle, and each tower has four specially designed 6½-inch cast magnesium basket woofers with mineral-filled polypropylene cones. These drivers are mounted in pairs, with two at the top of the tower and two at the bottom to minimize the effects of room interaction. Between these sets of woofers are two similar 5-inch midrange drivers which are mounted on either side of the handmade 1-inch textile tweeter. Snell states that the tweeter is optimized for smooth response, low distortion, low compression, and high power handling. There is, as well, a rear-firing, metal-dome tweeter that flattens the power response in the room by adding ambience and that also counteracts the increasing directivity of the forward-firing tweeter at higher frequencies.

Snell calls this driver configuration Coincident Virtual Image (CVI) technology, and feels it creates a virtual image of the mid-bass and midrange that coincides with the image of the tweeter. According to Snell, this provides all of the advantages of coaxial design without the drawback of diffraction effects caused by the tweeters in true coaxial speakers.

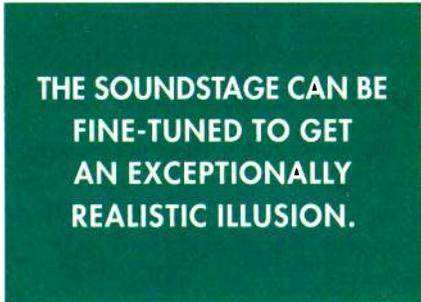
The towers are specified as having a flat frequency response from 80 Hz to 20 kHz ( $\pm 1.5$  dB), and Snell indicates they have an unusually flat off- and on-axis response in real-world listening rooms. Sensitivity is 90 dB, nominal impedance is 8 ohms, and minimum impedance is 5 ohms. Crossover frequencies are at 350 Hz and 2.8 kHz.

Construction and finish of the speaker and crossover cabinets were excellent, as you might expect at this price. I was less impressed, however, with the Snell electronic crossover, which is acceptable in sound quality but not state of the art. It imposed a slight "grunge" or electronic haze on the sound, and—with my ear near the speaker—one channel had slightly more very low-level noise than the other. Like the B & W 801 Matrix Series 3s, the sound quality of these Snells improved slightly, but significantly, with a better crossover. Snell arranged for one to be supplied by Bryston, and I would suggest that

you strongly consider the purchase of such a crossover if you decide to buy this speaker system.

Both the Snell and Bryston crossovers have variable levels to adjust to differences in the performance of power amplifiers or for room problems. While I did not need them once I had experimented extensively with placement of the Snell subwoofers, experience has taught me that 6 dB or more of adjustment in subwoofer versus main speaker level can be useful to handle both amplifier and placement problems. You may need to consult your dealer about adding some attenuation to the crossover in problem installations.

You also should be aware that the Snell Type A Music Reference System was designed to be upgradable to use the Snell RCS-1000 Digital Room Correction System now under development. The RCS-1000 is



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intended to correct the speaker's remaining irregularities in phase and frequency response and correct for listening room characteristics. There are, therefore, much more sophisticated Snell electronics to come.

Like every true reference-quality speaker system, the Snell Type A Music Reference System requires careful placement to find the best room location. (Considerable assistance is available from Snell, including a good instruction book, a computer program to help with speaker placement, and dealers who can provide support with room measurements and placement.) The towers are relatively easy to place, but getting the best out of the subwoofers requires considerable experimentation, as is true of all speaker systems with true deep bass power below 40 Hz.

The end result was superb deep bass. The Snell subwoofers could take everything I could throw at them (even using Classé Audio M1000 amplifiers), delivering incredible amounts of deep bass power. No

speaker I have ever auditioned has done quite as well in reproducing the deepest bass notes in orchestral music, and the extreme bass from the organ and synthesizer, in such a musically realistic form.

The rest of the Snell Type A-R/S performance lived up to the level of its outstanding deep bass. The Snells provided an excellent integration of the separate subwoofer with the main speaker column. I have never heard a system that did as good a job of eliminating the last traces of the colorations that come from using separate subwoofer and main speaker enclosures. The Snells also had a very smooth and controlled mid-bass and upper bass.

The upper bass and lower midrange also had a special character. It is not fair to describe the Snells as "warm," because many other top high-end speakers, systems from Vandersteen and Cello, for example, have a similar upper bass and lower midrange balance. The Snells' sound was, however, noticeably warmer than that of most systems from Apogee, Martin-Logan, and Thiel, and the overall timbre was somewhat "richer" than that of a number of other top speakers. This sound character suits the close-miked or slightly bright sound of many modern recordings, making them seem more musically natural.

The main towers provide excellent midrange and treble performance. The upper octave balance was remarkably free of the minor peaks and anomalies heard in most speakers, and they did an outstanding job of matching the midrange and treble balance. The Snells may not have the upper octave life or energy of some competing speakers, such as those with ribbon drivers, but they have an extraordinary ability to provide musically realistic air and low-level detail. The result is a deceptive musicality. You initially feel their response is slightly rolled off—until you realize that all the music is there, and you are hearing exceptional upper octave detail. What you are missing is the upper frequency coloration that is common in even very good speakers. Voice reproduction was excellent for male as well as female voices, and there were none of the occasional shifts in the sound character of lead vocals that trip up many otherwise very good loudspeakers.

As for soundstage, you get an exceptionally realistic illusion plus the ability to

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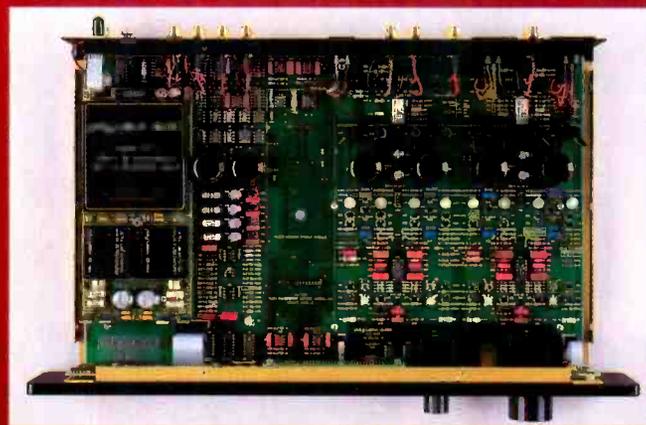
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fine-tune the soundstage to your room and taste by placing the main towers at varying distances from side and rear walls. You can also alter the apparent soundstage by adjusting the level of the rear-firing tweeter, which changes the balance of bipolar energy, and by setting different main tweeter levels. These techniques work with many speakers, but the Snells' tall, narrow enclosures and well-chosen driver array impose very little of their own character on the sound and minimize undesirable speaker/room interactions to an unusual degree.

Further, although placing the subwoofers according to the manufacturer's instructions produces good results, the crossover frequency is low enough so that you do not need to keep the subwoofers on the same plane as the towers. As a result, you can produce something very close to the soundstage you want, varying its width, depth, and directness according to your taste. Few loudspeakers, particularly large full-range monitors, offer the audiophile as much practical ability to tweak the apparent imaging and soundstage. In short, a

system of well set up Snells will provide truly lifelike imaging with those recordings that have such information.

The Snell Type A Music Reference System may not have exceptional "slam" or "life," but it does have exceptionally realistic overall dynamics. This superior performance is partly a matter of sheer power-handling capacity. Few speaker systems can really reproduce full orchestra, power rock, or grand opera in full flight without reaching their limits. Yet the Snells were able to produce the full force of the loudest music passages with remarkably little apparent distortion and without any sacrifices in performance at the frequency extremes or any changes in sonic behavior. Further, the Snell Type A-R/S was equally exceptional in its ability to reproduce the detail of low-level dynamics and to maintain consistent timbre and clarity at all levels of music. It was exceptionally free of the kind of dynamic coloration common in many expensive speaker systems, and definitely avoided the tendency of some speakers to sound sweeter or more lifelike at some listening levels than at others.

The Snell Type A Music Reference System has some limitations, as does every other speaker system. It deserves the best electronic crossover possible, something better than the EC200, which imposes something of its own character on the music (a slightly mid-hall sound). And, of course, care is needed in placing the 18-inch subwoofers. However, the Type A-R/S is one of the finest speaker systems ever made. The bass performance is stunning, matched by a superb ability to create the illusion of being in a concert hall. It reproduces the full force and dynamics of the orchestra as well as the music of smaller groups, solo instruments, and voice. It offers a wide range of adjustments to compensate for given tastes and listening rooms, and this gives you exceptional flexibility in reproducing a musically natural soundstage in different rooms and to adjust the apparent listening position in terms of width, depth, and upper octave balance, which effectively allows you to shift the apparent listening position from front to rear. If this is not a perfect speaker system, it is just one of the handful of systems that can compete for the title of the world's best.

Anthony H. Cordesman

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## PROGRAM

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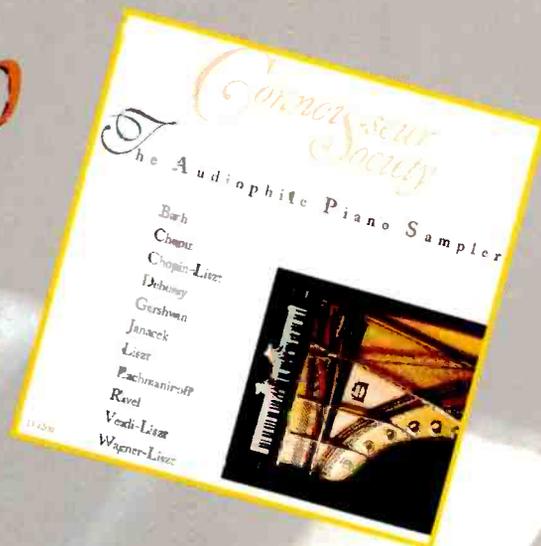
Rachmaninoff: Prelude in G-sharp minor, Op. 32, No. 12. O. Yablonskaya

Liszt: Consolation No. 3 in D-flat major. Antonio Barbosa

Debussy: pour les Arpèges composés (from Etudes, Book 2). Ilana Vered

Chopin: Mazurka in C-sharp minor, Op 50, No. 3. Karen Kushner

Chopin-Liszt: The Maiden's Wish. Mordecai Shehori



J.S. Bach: Aria da capo (from the Goldberg Variations). Samuel Bartos

J.S. Bach: Prelude (from the English Suite No. 2 in A minor). Pamela Ross

Janáček: Presto (from In the Mist). Zaiidee Parkinson

Debussy: Prelude to the Afternoon of a Faun (Trans. by Ravel). Bradshaw & Buono

Ravel: Ondine (from Gaspard de la Nuit). Sergei Babayan

Liszt: "Am stillen Herd" from Wagner's Die Meistersinger. David Allen Wehr

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# CLASSICAL RECORDINGS

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Illustration: Rick LeTulka



**Schumann: Dichterliebe; Lieder; Beethoven: An die ferne Geliebte; Lieder by Grieg, Lowe, and Franz**  
Thomas Hampson, baritone;  
Geoffrey Parsons, piano  
EMI CLASSICS CDC 5 55147 2  
CD; 74:39

What Gerhard Hüsch and Hanns Udo Müller were to the '30s, what Dietrich Fischer-Dieskau and Gerald Moore were to the '60s, Thomas Hampson and Geoffrey Parsons are to the '90s: Outstandingly beautiful baritone voices, produced so naturally that the listener hardly thinks of technique, informed by intelligence and by a flair for the dramatic, partnered with a taste that avoids both the intrusive and the obsequious, and a sensibility capable of mirroring the singer's sense of the

song. The recorded output of these six performers is, among other things, a testament to masculine sensitivity and proves that phrase to be no oxymoron, certain critics of the gender notwithstanding. (*Editor's Note:* We unhappily note the death of Parsons this past January.—D.H.)

Of the three singers, Hampson is the most mercurial, with the widest emotional and coloristic range, and the readiest to take risks—and therefore the most exciting to hear. He sounds (and I imagine he is) younger than either of the others was at the time they made the Lieder recordings by which we remember them. If Hampson must occasionally concede points for polish, he and Parsons need cede pride of place to no predecessors. They are superb.

This recital disc, far from being a grab bag of material that the singer

preens himself (or herself) on doing particularly well, is a sort of informal survey of major trends in Romantic Lieder. It begins with three songs by Robert Franz and one by Carl Loewe (both under-represented in today's concert halls) and continues with three Schumann Lieder—all these first seven based on poems of Robert Burns (in German translation, of course). Then come the cycles: Grieg's Six Lieder, Op. 48; Beethoven's *An die ferne Geliebte*, and Schumann's *Dichterliebe*. (Perhaps the Grieg and the Schumann might better be termed "collections," but why quibble?) There are no letdowns, but the recital's unexpected crown is the Grieg, in which Hampson's beautifully crafted realizations are exceptionally moving.

The recital was recorded live in 1993 before an astonishingly quiet audience in Edinburgh—so quiet, you may find the "live" designation hard to believe. Generally, the sound is excellent, keeping soloist and piano in believable relationship at some distance beyond the speakers and in a pleasantly reverberant space. Yet something is slightly amiss in the first track, muddying the piano's attacks and introducing some

**Haydn: String Quartets, Op. 76, Nos. 1, 2, and 3**  
Carmina Quartet  
DENON CO-75970, CD; 62:37

Three top-vintage Haydn quartets played expertly and with real musical commitment, captured in lively, believable sound: That's a recipe for anybody's library list. The Carmina players minimize vibrato without ever losing sight of the music, which is something of a rarity in this day of the studiously correct performance practice.

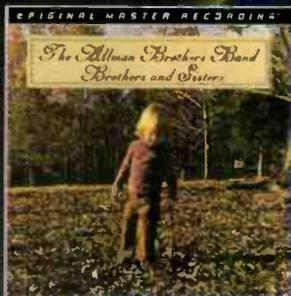
And Nos. 2 and 3 are, respectively, the "Quinten" (or "Fifths") and the "Emperor," both among the most beloved of all Haydn string quartets. How can you go wrong?

Robert Long



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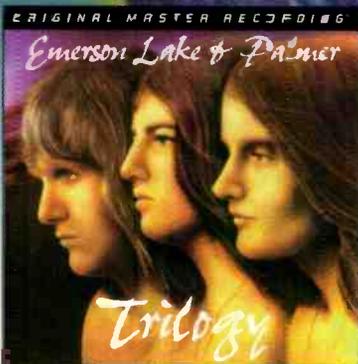
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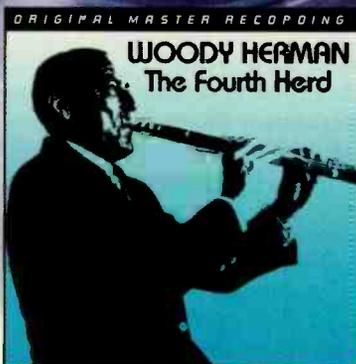
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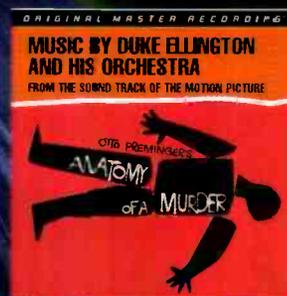
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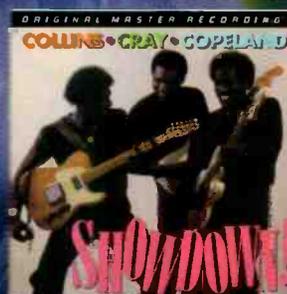
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ambiguity into its relationship to the singer. In at least one other song, artificial means appears to have been used to replace too-prompt applause with piano reverberation. But your attention is likely to be so firmly focused on the music that such minor glitches will pass unnoticed.

*Robert Long*

### **Song Without Words**

*Ray Reussner*

REUER COMPANY, CD; 60:45

Sound: A, Performance: A

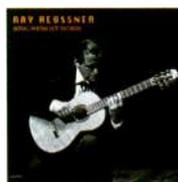
When a good friend of mine handed me this CD about six months ago and told me that it had been recorded in Santa Barbara's Mission by a guitarist he had recently met, and with a Nagra digital recorder, I was interested on many levels.

Ray Reussner has been a serious student of the guitar since age 18, when he first heard a recording of Andrés Segovia, with whom he later studied in master classes. Reussner gave numerous concerts in his career, but a number of years ago he stopped because he wasn't satisfied with the sound of his playing. After a lot of work to get his sound the way he wanted it, he resumed his playing career. This disc is one of the outcomes.

The recording portrays a realistic guitar sound. One can hear the size and reverberation of the venue, but it does not get in the way of the music. Reussner's playing here sometimes reminds me greatly of the way Segovia used to play some of these same pieces. Yet he has his own unique style—as does every player, really. The sound, the playing, and the music are all superb! I highly recommend this recording.

The CD can be obtained by writing to the Reuer Company (P.O. Box 17, Williams, Ore. 97544) or by faxing an order to 503/846-9140. The price is \$15 including shipping.

*Bascom H. King*



### **Songs by Clara Schumann, Poldowski, and Amy Beach**

*Lauralyn Kolb, soprano;*

*Don McMahon, piano*

ALBANY TROY 109, CD; 60:50

Can we talk? Frankly, I'm getting very annoyed with female ghetto recitals and recordings. If gender were the only issue here—and that certainly is the way the CD comes on at first glance—this recording would be worthless. Fortunately, it is a marvelous (if somewhat disparate) collection of songs performed to perfection by Lauralyn Kolb, whose voice, intelligence, musicality, and style qualify her

to sing almost any genre of Lied or art song. The fact that this soprano has devoted her sterling endowments to such an affirmative-action program is admirable, perhaps, but its format does not encourage one to look—or, rather, to listen—below the feminist surface.

Everybody knows about Clara Schumann. A celebrated pianist, she largely subsumed her own career to that of her husband, Robert Schumann. These songs might easily be taken for his work, indeed, though none cuts as deep as his did at their very best. They are graceful, polished, and poised—a welcome addition to the canon of, say, Schubert, Schumann, and Loewe among Lieder composers of the era. Almost the first half of the CD comprises six songs apiece from her Opus 13 and Opus 23.

Poldowski is a name that, shamefully, I must admit I never before encountered. It is an alias of Régine Wieniawska, who sought a musical identity separate from that of her father, the celebrated violinist and composer Henryk Wieniawski, whom she could not have known very deeply since he died when she was nine. Her music is far more French (Wieniawski was a Pole who taught in Belgium, where Wieniawska was born) and, for my money, more satisfying. Eight songs to texts of the imagist poet Paul Verlaine are included here, each one displaying a gift for melody and coloration.

Amy (or Mrs. H.H.A., as she preferred) Beach, on the other hand, has become almost a household name in recent years, despite her earlier disparagement as "Mrs. Ha-Ha Beach." While her chamber music is usually described as influenced by Brahms, these songs cover a wide linguistic range (French, German, English), and the English ones in particular are closer in style to those of her New England compatriots, such as MacDowell. Having toured Europe as a pianist and composer after her doctor-socialite husband died, she is no mere parlor amateur, and makes the most of her material.

Over and over in studying these songs, I've been arrested by the charm and rightness of Kolb's phrasing, by the warmth and expressiveness of her manner, and by the sheer beauty of her voice. She is a treasure, and I certainly hope to hear much more of her in the future. If her accompanist is not really in the same league, he is still more than adequate.

The recording is clear and close, with pleasant ambience surrounding it. The booklet contains full texts (except, regrettably, for Beach's English songs) plus not always reliable translations. Not to fuss: The booklet is not what you should buy this CD for.

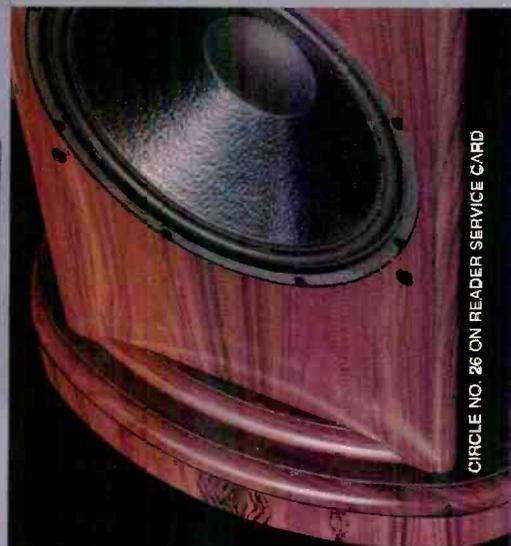
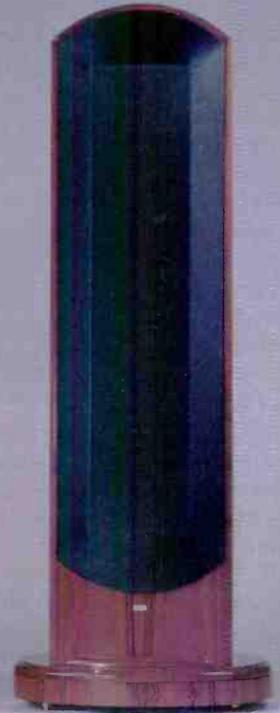
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**The Sheffield/Leinsdorf Sessions  
(Prokofiev: Excerpts from  
Romeo and Juliet;  
Debussy: Prelude to  
The Afternoon of a Faun;  
Wagner: Forest Murmurs  
from Siegfried)**

Los Angeles Philharmonic, Erich Leinsdorf  
SHEFFIELD LAB GOLD 10043-2-G  
CD; 54:05

The first of a two-volume memorial tribute to the fine "old school" conductor Erich Leinsdorf, who passed away in 1993, these recordings were originally released around 1978 as direct-to-disc LPs. (Part of *Romeo and Juliet* has been my most-used LP test material for 16 years now.) The two direct discs are still considered by many the most natural and realistic recordings ever of a full symphony. The only quibble is with a dry ambience, resulting from the MGM sound-stage recording location.

We have recently had several audible enhancements in the CD reissue of older recordings, but Sheffield Lab's Audiophile Reference Series has set itself a goal of seeming impossibility in trying to equal or better the acclaimed



direct discs, because the company is limited to the analog tapes made simultaneously at the direct-disc sessions. Sheffield calls its bit-bouncing to improve resolution and lower noise "20+→16 Ultra Matrix Processing," and it works: The CD compares very favorably with the original direct discs. On subtle material such as Debussy's *Faun* or the un-Wagnerish "Forest Murmurs" from *Siegfried*, the CD experience surpasses that of the direct disc because of complete freedom from rumble, noise, hiss, and other sonic distractions.

John Sunier

**The French Collection:  
Ravel/Debussy**

Royal Philharmonic Orchestra,  
Georges Pretre; London Promenade  
Orchestra, Eric Hammerstein  
CHESKY CD101, CD; 55:25

Now here's an example of an impeccable CD program, bringing together two older recordings, 1963 and '64, in an interesting juxtaposition illuminating both composers in new ways. On paper, at least. Moreover, the restoration by Jeremy Kipnis is highly satisfactory, at least for my musical ears. And yet the CD falls flat on its face simply by reason of near-total incompatibility between its two performing halves, Royal Philharmonic and

London Promenade. Almost nobody is going to like both.

The first segment, headed up by the 16-minute excerpt from Ravel's *Daphnis and Chloé*, then into the familiar "Nuages" and "Fêtes" from the Nocturnes of Debussy, is English playing of French music at its very best; only the fast tempos betray a 1960s feel.



The recorded sound, however, is conservative, at an uncompromising distance and with (for our ears) not enough definition. It's only when, at climax, the loud brass comes through that we understand the power of this playing, still in the grand post-Romantic manner of the early part of the century. Not much any restoration can do to change this rigorously purist orchestral sound.

The rest of the CD is utterly different—in effect, with an orchestra that could be called the London Pops. A series of tuneful, colorful, outrageous arrangements of Debussy piano works into superHollywood glory. You can almost hear the popcorn crunch. Marvelous sound, really tops—music so corny I quit when the *Sunken Cathedral* emerged from the ocean with a chorus of thousands and a full orchestra. So take your choice; they're both here!

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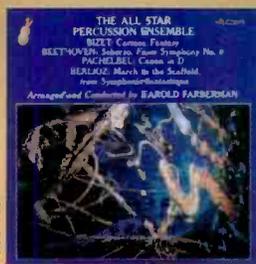
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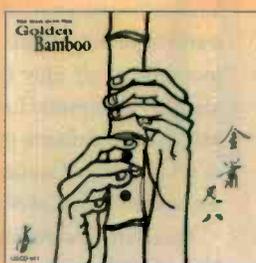
GSCD 009

*Ceremony of Angels*



GSCD 010

*Philharmonic String  
Soloists - Berlin*



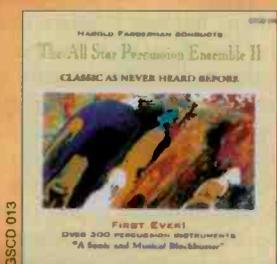
GSCD 011

*The Man with the  
Golden Bamboo*



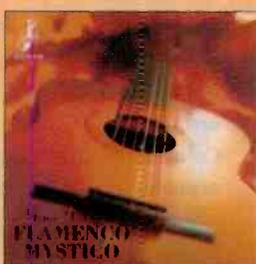
GSCD 012

*Masterworks for Viola  
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# ROCK~POP RECORDING



## The Long Black Veil

The Chieftains

RCA VICTOR 09026-62702-2, 58:56

Sound: A, Performance: A

Songs rarely dominate a Chieftains album. Instead, most of their releases comprise airs, jigs, and reels, with band member Kevin Connolly singing a song or two for variety's sake. *The Long Black Veil* reverses the balance: Eleven of 13 tracks are songs, and all feature a guest vocalist or instrumentalist. It is a glorious album of collaborations, one that overflows with joy as the visiting artists give exceptional performances that fit seamlessly with The Chieftains. Each guest seems thrilled just to be working with traditional Irish music's premier band.

The album opens with Sting singing "Mo Ghile Mear" in its original Gaelic, the timeless sounds of that ancient language mingling perfectly with the band. Other collaborations range from the riveting (Mark Knopfler performing "The Lily of the West") to the sentimental (old Chieftain friend and collabora-

tor Van Morrison with his own "Have I Told You Lately That I Love You?") to the unusual (Tom Jones doing a ham-boned, over-the-top rendition of "Tennessee Waltz," which gets expanded into a mazurka). Also unexpected is Mick Jagger's haunted reading of the title song, featuring a didgeridoo. Still, the best moment of all may be the instrumental "Dunmore Lassies," which pairs The Chieftains with Ry Cooder's fluid guitar. Cooder also sings on the tender "Coast of Malabar."

There are fine performances from Sinéad O'Connor and Marianne Faithfull and a rousing cover of "Rocky Road to Dublin" with The Rolling Stones. And it's difficult to overlook the incredible Paul Brady, who plays guitar on Knopfler's performance, or Canadian bluesman Colin James, who plays guitar and mandolin on two tracks.

Produced by Chieftain Paddy Moloney with Chris Kimsey and Cooder, *The Long Black Veil* has thoroughly excellent sound, allowing the distinct nuances and subtleties of The Chieftains to shine next to the

contributions of their guests. Within this sound, The Chieftains coax something magical and ageless from their fiddles and flutes, pipes and harps. Small wonder that the guests could bring something special, too.

Michael Tearson

## Geek the Girl

Lisa Germano

4AD/WARNER BROS. 9 45758-2

43:40

Sound: B, Performance: B

Lisa Germano and Liz Phair—twin daughters of different mothers? That's the inevitable response to *Geek the Girl*, a collection of home-made demos that tell the story of, in Germano's notes, "a girl who is confused about how to be sexual and cool in the world but finds out she isn't cool and gets constantly taken advantage of sexually." Whether you know Germano only from her violin work for John Mellencamp or whether you've worn out her previous two solo efforts, you're likely to

Photograph: David Galt

## BAD BOYS OF THE ARCTIC

Gary Lucas

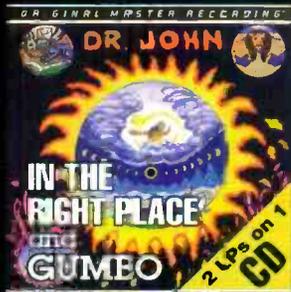
ENEMY EMY 146-2, 44:43

Sound: A, Performance: A

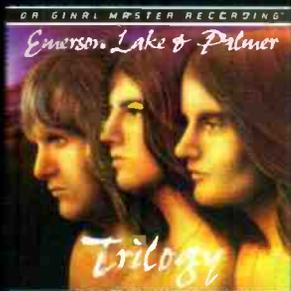
On *Bad Boys of the Arctic*, guitarist Gary Lucas has toned down the improvised Sharrack-ian psychedelia that marked his previous recordings, opting instead for a shot at accessibility with songs, hooks, lyrics (however opaque), and contributions from guest musicians. Several tracks are further sweetened by strings. But few listeners could confuse *Bad Boys* with the mainstream. Under its beguiling vocals is Lucas' nervous guitar, percolating with a rhythm that supports a bevy of influences and styles, from folksy finger-picking (reminiscent of someone like Jorma Kaukonen) to pure, caterwauling electric-guitar mayhem akin to wailing banshees. Lucas' balance of listenable art with instrumental audacity pushes the envelope without descending into cacophony.

Michael Wright

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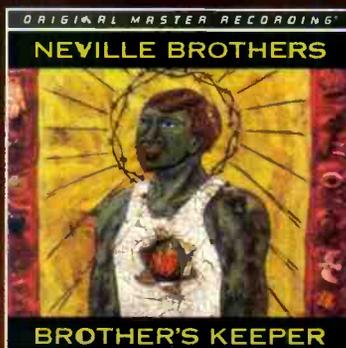
UDCD 621



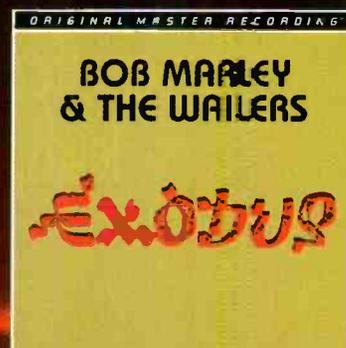
UDCD 2-625



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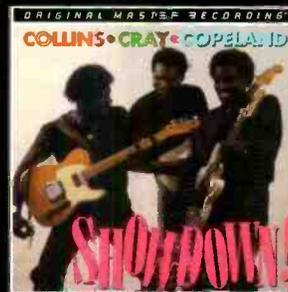
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be surprised at how elemental she allows herself to appear here. In the shadow of Phair's ever widening spotlight, Germano's simple guitar and ingenuous voice can't

help but sound familiar, even though her first solo recordings predate Phair's. Then again, this isn't the slap-in-your-face dance of Liz; hearing tracks like "... A Psychopath," "Phantom Love," and "Cancer of Everything" in the middle of the night, by the light of the stereo, places you in a convincing landscape of dread. Overall, *Geek the Girl* is a noble experiment—one whose frank tone, coupled with the eccentric production values of 1993's *Happiness*, could yield greater rewards.

Ken Richardson

#### Wanted Man

Paul Kelly

VANGUARD 79479-2, 49:24

Sound: A-, Performance: A-

When A&M released *Gossip* in 1987, hopes were high for Paul Kelly and The Messengers to make their American breakthrough. Eight years later—after two more A&M albums and the 1992 pickup of *Comedy* by California indie label Doctor Dream—the world outside of

Australia still knows as little about Paul Kelly as it does about his countryman Ned Kelly, a wanted man of the 1870s. This is a great shame, for Paul remains a deadeye songwriter. No crazy-Costello-quilt metaphors here; Kelly instead favors pure images, so that the slaking drops of "Summer Rain" conjure a vivid portrait of a longed-for woman. The Messengers



are gone, replaced by a smoother group of session musicians who apply broad chord strokes to the largely acoustic material, half of which has a countrified feel, the other half settling into trim R&B. Maybe eight years from now—after Richard Thompson, Green Day, and others have gathered for something called *Down Undercovers: A Tribute to Paul Kelly*—the man will get his due. Hear him now, so you can say you knew him when.

Ken Richardson

#### Sam Cooke's SAR Records Story

Various Artists

ABKCO 2231-2, two CDs, 2:27:36

Sound: B+, Presentation: A+

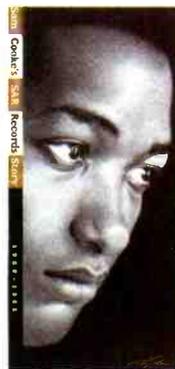
Sam Cooke's musical legacy extends beyond the recordings that bear his name. His songs have been covered by The Rolling

Stones, Rod Stewart, Otis Redding, and many others. It was Cooke's blending of pop music with gospel melodies and harmonies that proved so influential, giving birth to a thousand musical stepchildren. Once Cooke achieved great success as a secular recording artist, he had the resources to start his own label, SAR Records, where he served as the hands-on producer and songwriter.

If SAR were simply the singular expression of Cooke's musical vision—as broad as it was deep—that alone would be reason enough for owning this two-CD set. But the artists who recorded for SAR were, unto themselves, strong musical personalities: The Soul Stirrers, Johnny Taylor, and the greatest soul singer/guitarist/songwriter now walking the planet, Mr. Bobby Womack.

These seminal recordings were assembled from a fan's point of view, with chatter, outtakes, and demos included. Annotation by Peter Guralnick is completely informative, and there's hardly a dull moment. If there's more in the can, by all means let it out!

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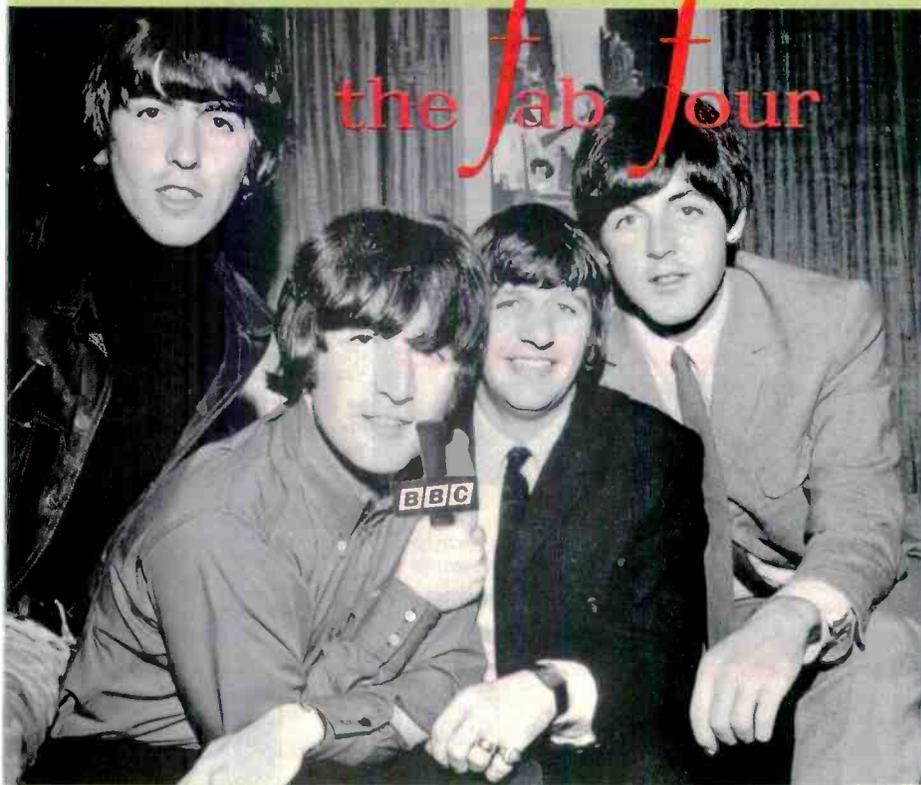


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## Live at the BBC

*The Beatles*

APPLE/CAPITOL CDP 8 31796 2

Two CDs, 1:13:40

Sound: D to B, Performance: B to A

Open the jewel box, and that familiar label art greets you: Full-frontal green Apple on disc 1, cross-section white Apple on disc 2. Peruse the 48-page booklet, and rare photo after rare photo mesmerizes you. Pop a disc into your player, and for the first time in almost 25 years, you hear legitimate recordings of previously unreleased performances by the four lads from Liverpool.

It's enough to make a grown Beatlemaniac cry.

In the three years from March 1962 to June 1965, The Beatles recorded 88 songs in various studios of BBC Radio. The station had no multitrack tape machines at the time; according to the liner notes here, "The Beatles were captured 'live,' in mono, with little studio trickery in sight or earshot." The performances were aired over 52 broadcasts, from a few days to a few weeks after each track was recorded.

Of the 88 songs, 56 are on *Live at the BBC*, chosen by executive producer George Martin. The liner notes state that "no quality recording" exists of the four 1962 broadcasts, so what we have are 39 recordings from 1963, 15 from '64, and two from '65 (as Beatlemania spread, the group had less time to do radio). Of these 56 songs, 25 have been previously released in other versions (12 originals, 13 covers); that means a whopping 31 songs, all covers but two, are making their debut.

Before you go all gooey, here's the bad news. The back of the box warns that "some tracks included for their historic significance do not represent the usual fidelity of studio recordings." Project engineer Peter Mew has admitted that few of the tracks are from the original BBC masters; some are actually from the AM radio transmissions. The worst of these—"Keep Your Hands Off My Baby," "That's All Right (Mama)," "I Forgot to Remember to Forget"—are primitive, and their "historic significance" is dubious, since the performances aren't especially dynamic. Other tracks suffer from dropouts or distortion.

The original production often doesn't help; BBC staffers simply couldn't approach the expertise of Martin, who in his recordings with The Beatles over the years

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See Part I of the exam on page 63 and  
Part III on page 81.

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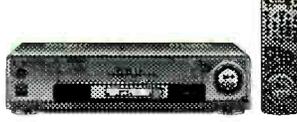
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(assisted in later days by engineer Geoff Emerick) worked harder and harder to create sonic masterpieces. Accordingly, the later the material here—"I Feel Fine," "She's a Woman," "Ticket to Ride"—the more disappointing the mix.

Now that I've said all that, you can basically forget all that I've said. *Live at the BBC* isn't meant to be a pristine listening experience but rather a journey back to a distant time and medium—as if you're listening to the actual broadcasts, complete with 13 wonderful bits of Beatle/DJ dialog, most showcasing John Lennon's trenchant humor. And many of the performances are excellent—especially those from two 1963 sessions that included "Soldier of Love," "Clarabella," "Memphis, Tennessee," and a blistering "Sweet Little Sixteen," most in good sound. (Nearly the entire CD is hiss-free, thanks to Sonic Solutions' NoNoise system.) Lennon sings a tough version of the Ringo Starr vehicle "Honey Don't." Ringo ambushes his drum kit on "I'm Gonna Sit Right Down and Cry (Over You)." George Harrison is at his early best in the guitar fills/solos for "I Got a Woman" and "Long Tall Sally." And time after time, Paul McCartney unleashes that great rock voice, howling through "Lucille" and "Ooh! My Soul."



As for the two previously unreleased Beatle originals, one is merely a radio-friendly rewrite of "From Me to You." But the other is the group's only recording of "I'll Be on My Way," a song given to Billy J. Kramer and The Dakotas that, as expected, is far better here in a performance emphasizing the song's Everly Brothers influence.

Annotation is generous, with an essay by BBC producer Kevin Howlett as well as track-by-track notes, all set up nicely by Beatle publicist Derek Taylor's thoughts. Plus the 36 photos, most from the studio. And don't fault Capitol for playing time: Disc 1 runs at 65:07, disc 2 at 68:33.

Is *Live at the BBC* worth its sound/performance trade-off? Should you ignore the naysayers who prefer the likes of nine-CD Italian bootlegs? In the end, should you buy? Indubitably, affirmative, yeah.

Ken Richardson

### High Strung Tall Tales

Adrian Legg

RELATIVITY 88561-1224-2, 69:40

Sound: A, Performance: A

After a series of acclaimed recordings that highlighted his phenomenal fingerstyle technique on acoustic guitar, Adrian Legg has finally released one that captures his wry wit as well.

We can still marvel at the British virtuoso's machine-like right-hand technique, the miraculous hammer-ons and pull-offs, the flowing eloquence, and the creative use of alternate tunings. But with *High Strung Tall Tales*, we also get to hear the between-song patter that is a staple of Legg's concert performances.



A kind of cross between Robert Fripp and Garrison Keillor, Legg spins engaging tall tales on nine tracks that were recorded live. The remaining 11 selections are studio recordings that run a stylistic gamut from lirting ("The Cool Cajun") and strangely psychedelic ("Naive II") to a tongue-in-cheek version of "Silent Night."

Guitar fanatics will drool over Legg's zen-like stamina on the "High Strung Suite" as well as his sheer mastery of reels, jigs, and breakdowns, all executed with flawless, mind-boggling technique. But the humanity of this charming troubadour is really revealed in his humorous, extended intros to the live tunes.

Bill Milkowski

### A Week or Two in the Real World

Various Artists

REAL WORLD CAROL 2346-2, 75:47

Sound: A-, Performance: A

This ambitious disc documents two separate week-long sessions where some of the world's most distinctive artists and producers converged at Real World's sprawling studio in rural Bath, England. Any preconceived notions were left at home, allowing for a spontaneity that is so often lacking in the real world.

Van Morrison and The Holmes Brothers open the set with a cover of Sam Cooke's "That's Where It's At," establishing a loose, easy feel that pervades the entire album. Fascinating collaborations spring up: Jam Nation's "She Moved Through the Fair" features truly global instrumentation atop a hypnotic dance groove, Ashkabad's "Bayaty" invites cellos and violins to dance gracefully



## PART THREE – EXTRA CREDIT

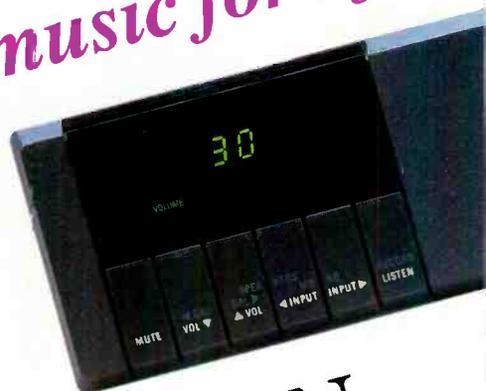
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See Part I of the exam on page 63 and Part II on page 79 .

with Islamic tar, and on "El Pescador" the group Totó La Momposina y Sus Tambores fuses African, Spanish, and Native American influences into one propulsive sound. Moments of singular inspiration are highlighted as well: Hassan Hakmoun and Zahar's "Chal-laban" is a dazzling modernist interpretation of traditional Moroccan Gnawan trance music, and Karl Wallinger (from World Party and formerly with The Waterboys) offers a sublime reading of W. B. Yeats' "Politics" alone at the piano.

Unlike most "world music" endeavors, *A Week or Two* goes far deeper than postcard images, reinforcing a McLuhan-esque ideal that music is a universal language. Still, I wish I was there. *Larry Blumenfeld*

### Hearts Gone Wild

*Katy Moffatt*

WATERMELON CD 1030, 39:22

Sound: B, Performance: B+

Katy Moffatt has the voice of a laconic angel, sweetly charming yet equally capable of full-blooded irony and sincerity. She produced *Hearts Gone Wild* with Tom Russell, a frequent collaborator; together they wrote five of the songs here. With support from Russell's ace honky-tonk band—which features the wonderful guitarist Andrew Hardin, key-

board/fiddle man Gene Hicks, and steel/slide guitarist Larry Campbell—this is a cracklin'-good album that feels poised to slip between the cracks, perhaps too tart for country radio and too country for rock radio. It also figures that the album was recorded not in Nashville but in Brooklyn in the dead of winter. Nevertheless, it has nothing but quality songs about the trials and glories of the heart, performed for all they're worth. Moffatt is a fabulous singer with great presence.

*Michael Tearson*

### Toward the Within

*Dead Can Dance*

4AD/WARNER BROS. 9 45769-2, 67:58

Sound: B, Performance: B+

For the last 14 years, Lisa Gerrard and Brendan Perry have been filtering sounds and spirits from the ancient past and bringing them into the present. Their music could have come from a crossroads of the Crusades or from an Oriental passage. Over arrangements which include bouzouki, yang ch'in, hurdy-gurdy, and ney, Gerrard intones words of her own design in an ecstatic wail that draws from myriad international sources, including



## Hiatt Comes Alive at Budokan?

*John Hiatt and The Guilty Dogs*

A&M 31454-0284-2, 76:19

Sound: B+, Performance: B+

There's no question that this is a live album, but the closest it gets to Japan's famed Budokan is San Luis Obispo, California. *Hiatt Comes Alive at Budokan?* was recorded during a coast-to-coast swing through the first half of 1994, with its entire 15-song program culled from John Hiatt's four A&M studio albums. While this isn't a full career retrospective, Hiatt's more recent work is indeed his best; thus, depth of material isn't a problem here.

Hiatt and his band, The Guilty Dogs (Michael Ward on lead guitar, Davey Faragher on bass, and Michael Urbano on drums), deliver crisp performances that avoid aping the original arrangements. Hiatt's studio albums have a real warmth, but in live performance there's an extra sparkle that's most charming, and it lights this album. Moreover, the editing of 15 songs from 11 different shows into a seamless concert continuity is outstanding. *Michael Tearson*



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open-throat singing styles, Native American chants, and Persian arabesques.

On stage, Dead Can Dance is the closest that modern music gets to rapture, and the group captures it on this live album, recorded at one stop on a 1993 North American tour. *Toward the Within* includes favorites such as "Cantara," "Yulunga (spirit dance)," and "Song of the Sibyl," but more than half the album is new material, much of it from the pen and voice of Perry. Lately, he's been moving toward a folksier modern-rock sound, evident on "American Dreaming" and "I Can See Now," which he sings in a rich tenor as if he were Frank Sinatra crooning in a monastery.

*Toward the Within* isn't the religious experience of a Dead Can Dance concert. In fact, the sound of the audience rushing in to applaud ruins the intimate nature of the music. But the possessed voice of Lisa Gerrard is one of the few pure experiences of 20th-century music.

John Diliberto

## FAST TRACKS

**The Best of 415 Records:** *Various Artists* (Columbia/415/Legacy CK 47965 74:28). San Francisco's 415 label signed some of the most interesting bands of the '80s, among them Translator, Wire Train, Romeo Void, Red Rockers, and Until December. A forerunner to what we now take for granted as "alternative rock," much of this material sadly slipped between the cracks of radio formats at the time. The tracks by Until December still sound stunningly fresh, and Translator's "Everywhere That I'm Not" is as enduring and catchy a pop song as there is. **Daniel Levitin**

**Aitara:** *Värttinä* (Xenophile/Green Linnet XENO 4026, 41:46). If ABBA had been rooted in Scandinavian folk music instead of Benny and Bjorn's Euro-pop, they might have become Värttinä. A sensation in Finland since 1991, Värttinä is a nine-member group that includes four female leads, singing with spunk and entirely in Finnish (translations are provided). The trad/mod blend is especially irresistible on *Aitara*, the band's third and best album. By comparison, those mysterious-cum-famous Bulgarian women sound like they're snoring. **K.R.**

**Somewhat Slightly Dazed:** *Jeffrey Gaines* (Chrysalis F2-29639, 56:19). This guy could be huge some day. He already has a literate pen, fat guitars, and a knowing voice, all rendered with pop-smart dashes, as if he were the down-to-earth cousin of Lenny Kravitz. A rich successor to Gaines' 1992 eponymous debut. **K.R.**

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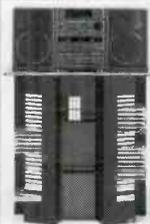
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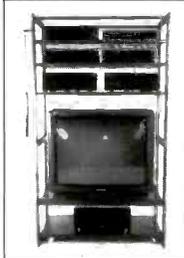
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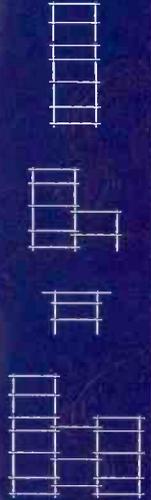
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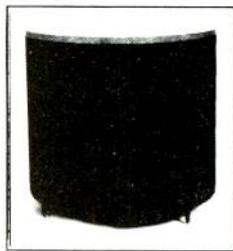
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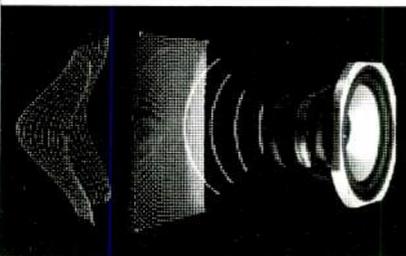
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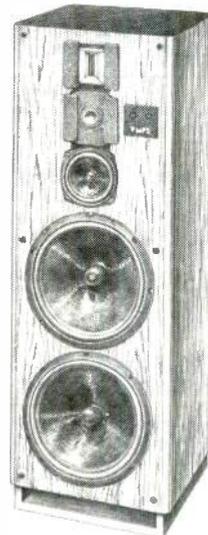
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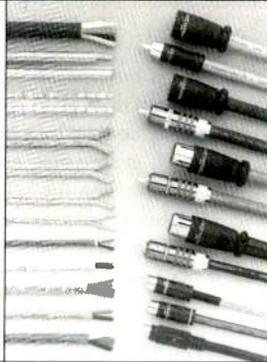
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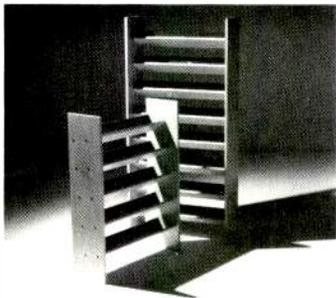
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\*Regional Ad

AUDIO, April 1995, Volume 79, Number 4. AUDIO (ISSN 0004-752X, Dewey Decimal Number 621.381 or 778.5) is published monthly by Hachette Filipacchi Magazines, Inc., a wholly owned subsidiary of Hachette Filipacchi USA, Inc., at 1633 Broadway, New York, N.Y. 10019. Printed in U.S.A. at Dyersburg, Tenn. Distributed by Warner Publisher Services Inc. Second class postage paid at New York, N.Y. 10019 and additional mailing offices. Subscriptions in the United States, \$24.00 for one year, \$42.00 for two years, \$58.00 for three years; other countries except Canada, add \$8.00 per year; in Canada, \$32.00 for one year (includes 7% GST; Canadian GST registration number 126018209).

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# PlayBack

## SENNHEISER HDC 451

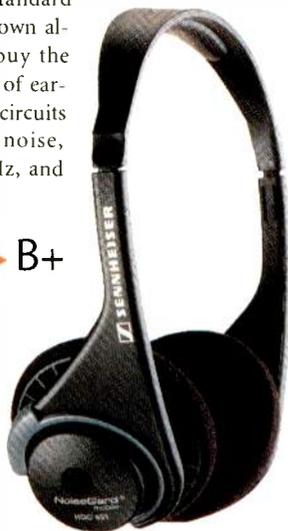
### NoiseGard Mobile Headphones

Sennheiser's HDC 451 (\$249) delivers more music with a lot less ambient noise. The headphones are a low-pressure, supra-aural design, fairly comfortable for extended wear. They're more dynamic and convey a much better sense of instrumental timbre than the standard "el cheapo" portables you may own already. But the real reason to buy the Sennheisers is the combination of ear-piece-mounted mikes and microcircuits that polarity-invert external noise, chiefly from 80 to about 800 Hz, and fold it into the audio line.

A belt-clip-sized box holds batteries, switch, and connections. The effect is uncanny. Turn the box on, and most background grunge goes away. Your music is clearer, even at reduced volume. Minor downers: There's no mini-plug to ¼-inch phone adaptor; you'll need one to use the Sennheisers with your main system. (On the other hand, a dual-mini airline adaptor is provided.) And the two AA batteries that power the system are not supplied. Still, the important things are well done. The 'phones themselves are fine: Bass is solid, mids good, highs a bit soft but eminently listenable. And the NoiseGard circuitry is truly useful and startlingly effective.

Aaron Frederick

For literature, circle No. 125



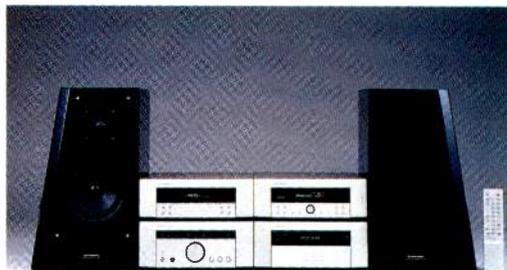
GRADE: B+

"PlayBack" mini-reviews are the result of short, sweet, and sometimes deadly testing by our all-too-experienced editors and writers. These hands-and-ears-only write-ups may look like new product announcements, but the grades and text reflect what the reviewer thought after less than an afternoon's "honeymoon." —E.P.

## Pioneer Elite MC-5 Mini System

Here's what you get when you buy the MC-5 (\$2,000): An FM/AM tuner with 36 presets, an amp rated at 40 watts per channel into 8 ohms, an auto-reverse cassette deck with Dolby B/C NR and HX Pro headroom extension (as well as auto bias, level, and EQ), a CD player with Legato Link D/A conversion for helping to restore highs, and a pair of crossoverless bass-reflex speakers, each containing a 5½-inch woofer and a 1-inch tweeter, with a frequency range of 40 Hz to 35 kHz. Unfortunately, you also get an unfriendly system remote, with an imprecise volume control, no numeric CD track buttons, no CD pause, and a bland layout that frequently had me selecting wrong controls. Back-panel cable connections seem especially tangled. And the bookshelf speakers tend toward a claustrophobic sound, whether you're in a state of Unpluggedness or kicking out the jams with the band that shares its name with this Pioneer system. Compared with the Harman Kardon Festival 500 ("PlayBack," November 1994) and the Marantz Slim Series (January 1995), the MC-5 doesn't measure up.

GRADE: C



K.R.

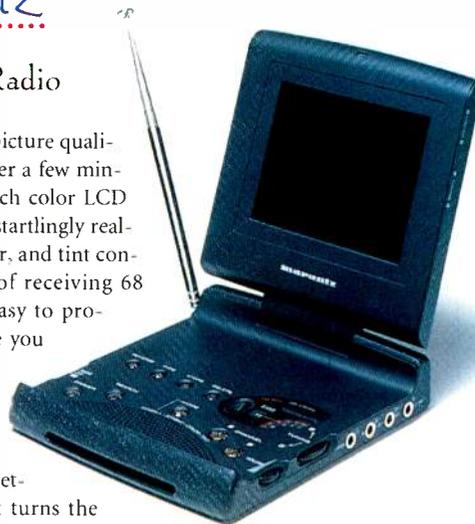
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## MARANTZ

### LCD410 Personal TV/Radio

Any doubts you may have about the picture quality of pocket TV will likely be quelled after a few minutes with the LCD410 (\$799). The 4-inch color LCD screen renders an excellent image, with startlingly realistic depth and contrast. Brightness, color, and tint controls are admirably precise. Capable of receiving 68 VHF/UHF channels, the TV tuner is easy to program. The telescopic antenna may serve you well in urban areas, but I live between New York and Philadelphia, so I needed an external antenna; an adaptor cable is supplied with the TV, as is a 9-V a.c. adaptor. Nice touches include two letterbox modes, a "Reverse" button that turns the image upside-down (to facilitate special mounting of the unit), and a "Dimmer" for economy operation if you power the TV from the battery pack (stretching the life of six AA cells to 2½ hours). The only drawback, apart from the telescopic antenna's sensitivity to shock, is the TV's audio, which is rather tinny via the speaker (the tuner of the built-in FM/AM radio sounds better). Headphones help, but the jack is wired for a single mono earphone; you'll need an adaptor to hear through both sides of stereo 'phones.

GRADE: B+



For literature, circle No. 127



As virtually every speaker manufacturer rushes to deliver "home theater" speakers to the marketplace, M&K amasses nearly twenty years of experience in the field—dating back to Hollywood screening-room installations in the 1970s.

M&K engineers have spent well over a decade studying the varied aspects of surround



sound—including encoding and decoding; soundtrack recording; and the differences between reproducing sound in theaters and in homes.

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And this is why M&K knows that any speaker that claims to be optimized for either music or film sound, one at the expense of the other, will never reproduce either one properly.

### M&K Home Theater Systems

Conventional speakers make the music and effects on film soundtracks compressed and dull. But M&K's exciting dynamics and "quick" transients give you precise 3-D imaging and a lifelike presence.

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acter when their sound moves from left to right or front to back in your room.

Even if you are just adding an M&K subwoofer, front/center, or surround



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ble timbre-match with your existing speakers—even if they are not M&Ks.

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