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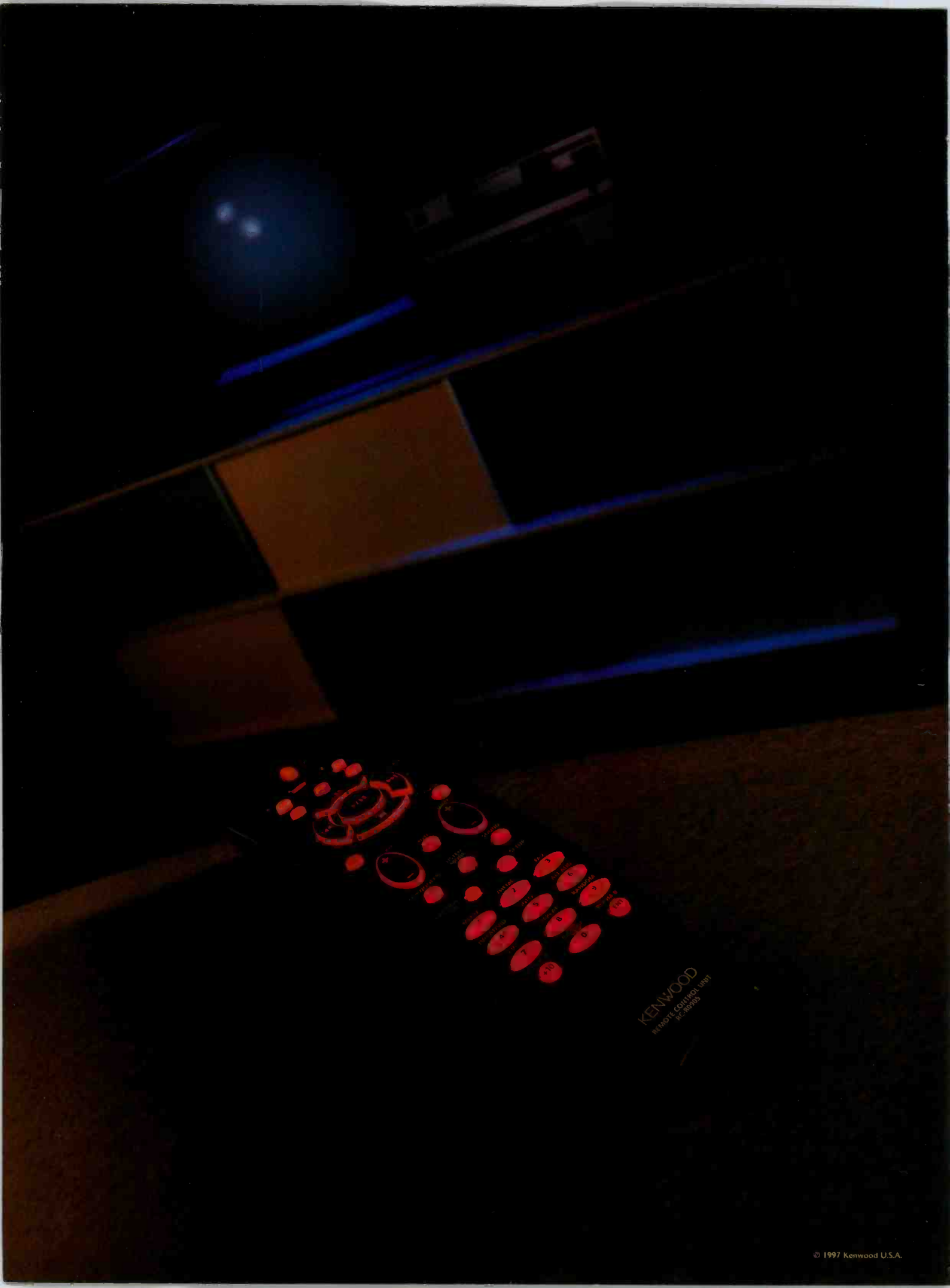

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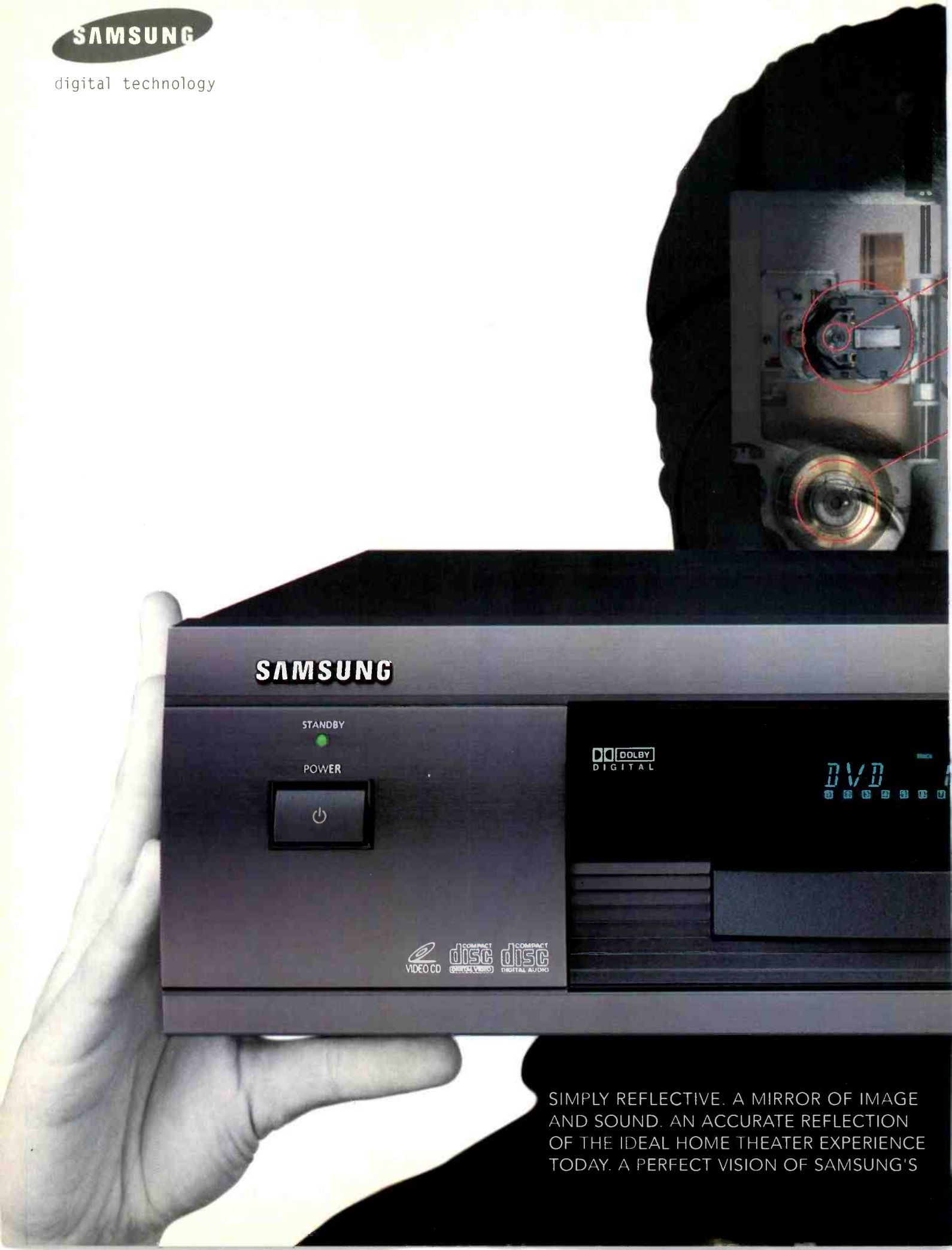

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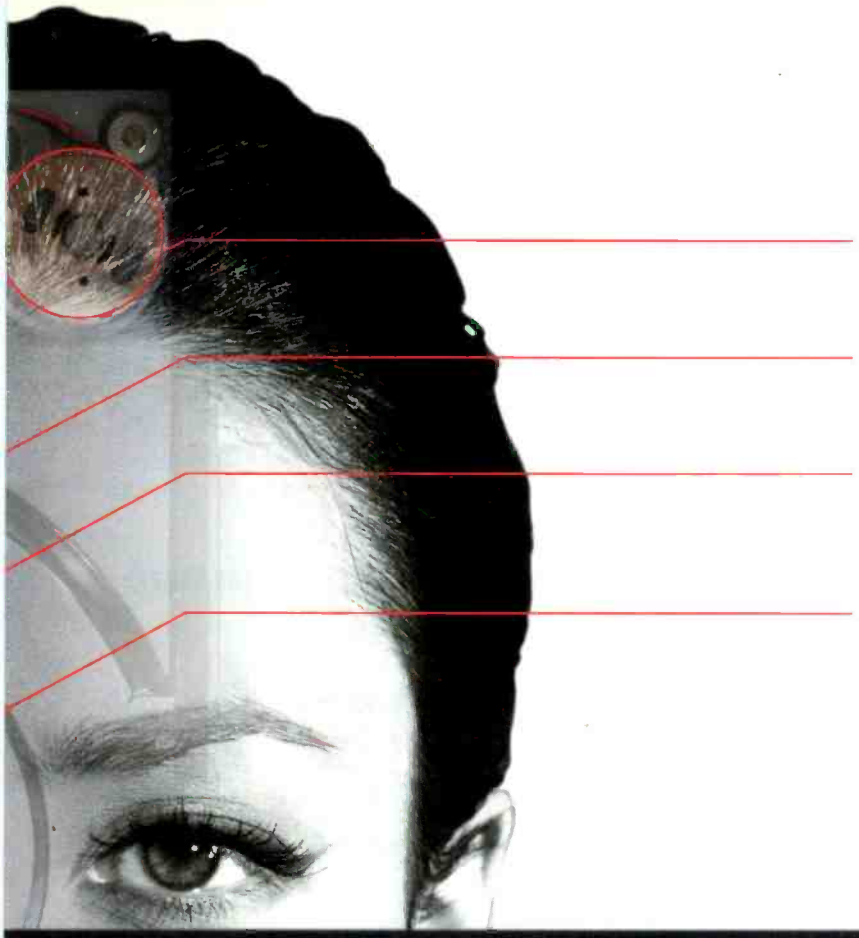

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SEPTEMBER 1997 VOL. 81, NO. 9

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THE EQUIPMENT AUTHORITY

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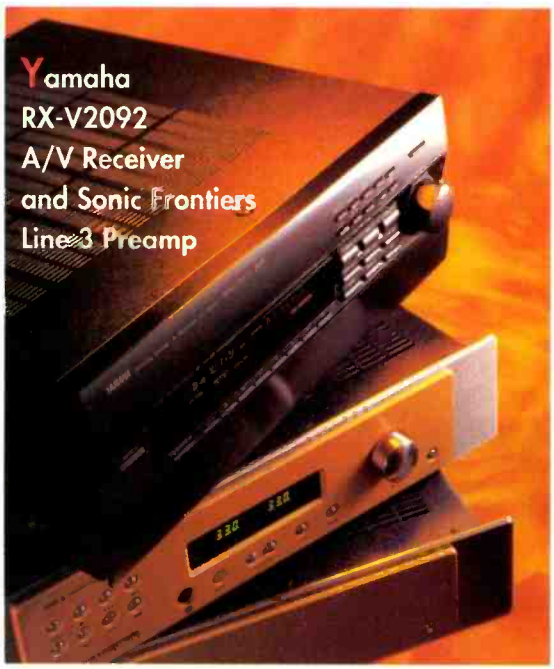

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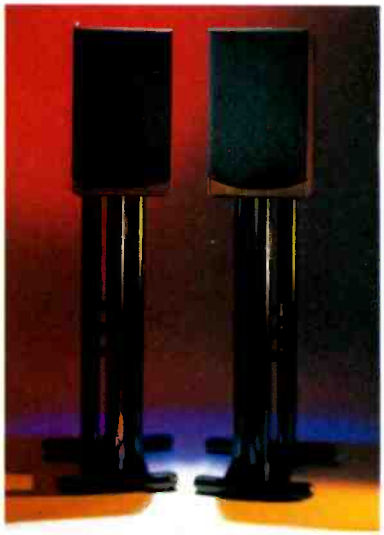

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CIRCLE NO. 1 ON READER SERVICE CARD

FAST FORE-WORD

I lived in Boston for about seven years, from 1974 through 1980. It was then, as it had been for 20 years before and remains today, a very hot hi-fi town. Although I was keenly interested in audio, I was also fairly ignorant about the real nuts and bolts of it—enough so that I was pretty much oblivious to my own cluelessness. Which is where the Boston Audio Society comes in. I don't remember how I first heard about the BAS, but I do remember the first meeting I went to, on a Sunday evening in a largish classroom at Boston University. Alvin Foster, the club's founder, spotted me as a newbie and introduced himself at the end of the meeting, asking me what I'd thought and encouraging me to join.

I did, though at first I didn't go to meetings regularly. Gradually, however, I got more involved, and, more important, I began to learn. Al was inspired to start the BAS by a weekly radio program about hi-fi produced at WBUR, one of the Boston PBS stations. Called *Shop Talk*, it was hosted by local audiophiles Peter Mitchell and Richard Goldwater. They had guests, talked about new products and developments, took phone calls, and eventually helped promote the BAS.

Probably the best thing about the BAS was its location, because if you went to meetings, you were always surrounded by a lot of very knowledgeable folks. People you might routinely encounter included Roy Allison (AR, Allison Acoustics, RA Labs), Andy Kotsatos (KLH, Advent, Boston Acoustics), Tom Holman (Advent and Apt, before he joined Lucasfilm in California), Mark Davis (then a student at MIT, later an engineer at dbx and now at Dolby), Dave Griesinger (Lexicon's genius in residence), and David Ranada (then a student at Harvard, now technical editor of *Stereo Review*), to name a few. Plus, there were plenty of engineers employed by the Route 128 companies and students from MIT. It was a sharp group that developed a reputation among visiting speakers as a tough audience.

One thing that set the BAS apart from most other audiophile clubs was that it published a wonderful, freewheeling newsletter called *The B.A.S. Speaker*, which included summaries of meeting presentations and articles submitted by members. Since the membership was a pretty interesting crew, the *Speaker* was usually packed with fascinating tidbits—well worth getting even if you had no other participation in the organization. This led to a substantial out-of-town membership, who joined just to get the newsletter (and swelled the ranks of its contributors). By the end of the '70s, the Boston Audio Society numbered well over a thousand members around the world.

The person most responsible for making the *Speaker* so strong was Jim Brinton, a professional writer and editor who was president of the BAS for a number of those years. There is no substitute for experience, and his was invaluable in establishing the *Speaker*'s quality and getting it out the door each month. Jim was also responsible for recruiting me to work on the *Speaker*, which I wound up editing for several years in the mid-'70s. And that led, not quite directly, to here.

Coincidentally, this was a period of rapid progress in audio technology, which in turn made the BAS a fascinating place to be. Among other things, BAS members, separately and together, were involved in figuring out why phono preamps of the day often sounded so surprisingly different from one another. The most popular theory starting out was slew rate, but the real answer turned out to be, in a nutshell, frequency response. Curiously, publication of this discovery drew brickbats from some quarters. It was my first inkling that audiophiles don't always want their pet problems solved!

The Boston Audio Society is 25 years old this year, so congratulations to my alma mater on its silver anniversary. The BAS is more local than it was in the late '70s, but I still look forward to getting my issues of the (now more or less bimonthly) *Speaker*. If you're interested, memberships are $35 per six-issue volume, from the Boston Audio Society, P.O. Box 211, Boston, Mass. 02126-0002.

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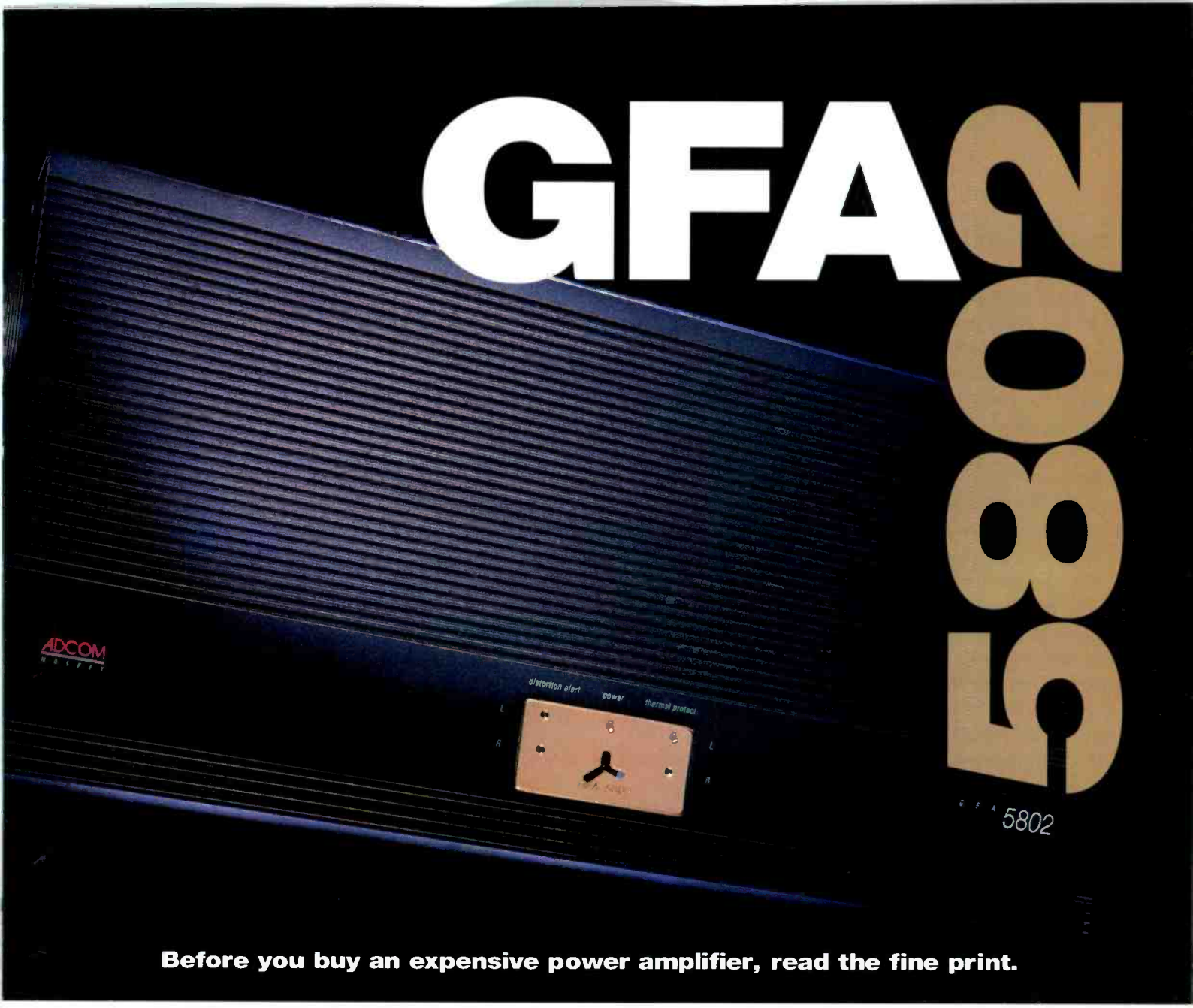

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Adcom's new GFA-5802 power amplifier also has exceptionally large capacitors to store large amounts of DC current for supply to the speakers. This large storage capacity means that the amp won't be starved for power when you're driving low impedance and/or inefficient speaker systems. Now your speakers and your music can sound the way you expect them to. All the time.

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CIRCLE NO. 16 ON READER SERVICE CARD

LETTERS

Technics and THX

Dear Editor:

This letter addresses concerns raised by Edward J. Foster in his review of the Technics SA-TX50 Home THX receiver (December 1996). Technics and THX have examined the issues in detail in the months following the review.

Ed Foster described a number of areas—subwoofer channel rolloff, noise and hum, and the like—that were inconsistent with the high level of performance offered by THX certified products.

We have confirmed that this particular review sample of the SA-TX50 did have a noticeable level of noise and hum and an inaccurate subwoofer response (see below). It is also possible that some production units of the SA-TX50 share these characteristics. We have confirmed that current production is free of these problems.

Technics has always taken customer satisfaction as its guiding principle. We feel that many SA-TX50 receiver owners are completely satisfied. If an owner wishes to have his receiver checked, Technics will verify that it meets all THX standards. Should it not meet standard, Technics will modify or replace it free of charge.

Here are comments on some key technical points identified in Ed Foster's review:

1. The subwoofer rolloff slope was found to be –6 dB at 91 Hz. As the review correctly stated, this is out of specification. In current production units, the rolloff slope is –6 dB at 80 Hz, which meets THX criteria.

2. The subwoofer output level in the review sample was found to be low, the concern being that the SA-TX50 would have "low bass response." We have confirmed that the output level of the review sample had an incorrect bass response and therefore did not meet THX specification. We have established that certified current production units have a level and output characteristic that meets the THX requirement.

3. Noise and hum at 60 Hz, and harmonics at 120 Hz and 180 Hz, were found to be excessively high. Our testing has confirmed that on Ed Foster's sample of the SA-TX50 they were indeed high and out of THX specification. This includes the peaks found at 60 Hz, 120 Hz, and 180 Hz and the hump from 150 to 700 Hz (which was of most concern). We have confirmed that the noise spectrum of current production units meets THX requirements.

Technics and THX thank Ed Foster and *Audio* for this discerning review.

Eugene B. Kelsey
General Manager
Audio Division
Panasonic Consumer Electronics Company
Secaucus, N.J.
Stephen Shenefield
Director of Product Development
and Licensing
Lucasfilm THX
San Rafael, Cal.

High-End Shop of Horrors

Dear Editor:

I live in Manhattan, and being in the market for a new CD player, I decided to stop by a nearby high-end audio store. The window was inviting enough, with components attractively arranged to beckon me in.

On entering, I was met by a salesman who asked if I needed any help. Reasonable enough, but when I said I was just browsing, he replied curtly that "browsing is not allowed." He said he would be glad to help me if I paid the $25 consultation fee, which would be refunded with any purchase of $200 or more. When I asked what brands the store carried, I was told that that information is included in the consultation fee and I was ushered out. As a consumer, I found this both horrifying and intriguing. Such treatment is by no means rare (particularly in New York), but it's not what I'd expect from a shopkeeper interested in selling me several thousands of dollars worth of equipment. What I find intriguing is exactly how such a shop remains in business, particularly with such stiff competition in this area.

He's certainly lost my business; I'll be buying my new CD player at a larger high-end shop in midtown where a salesman spent almost an hour with me last fall auditioning speakers that he knew I had no intention of buying anytime soon.

Andrew H. Conway
New York, N.Y

Good Friends Are Easy To Find

Dear Editor:

I was very pleased, and pleasantly surprised, with the 50th Anniversary issue of *Audio*. As I was scanning the pages, I spotted a familiar item on page 64 that I have wondered about for quite some time: the Grado Micro-Balance tonearm. I have one just like it and was hoping to find more information on it in Joseph Grado's article, such as the year of its manufacture, specs, etc. My arm houses a Stanton 500 stereo magnetic cartridge.

Further into the May issue, on page 122, I spotted another familiar friend, a Swiss-made Thorens TD-124 turntable from 1957. It is to this that my tonearm (now known to me as a "Grado") is mounted. I still use this trio of turntable, tonearm, and cartridge to listen to my record collection. The Thorens is mounted on a square wooden platform that looks to be original.

I have owned these components for only four years. Their previous owner had stored them in a barn, of all places! With some soapy water to remove the bird droppings and a little tweaking of the connections in the removable headshell, the cartridge is almost back to its original condition, except that the fluid in the turntable's built-in bubble level seems to have evaporated. The turntable's pitch adjustment works by a magnetic brake, which slows the speed of the belt-driven pulley that drives the platter. Speed accuracy is great, and rumble is very low. The TD-124 is truly a pleasure to use—hard to believe it's 40 years old!

Mark Young
via e-mail

Editor's Note: Joseph Grado reports that the Grado Micro-Balance tonearm was manufactured in 1958.—*S.V.C.*

Tubes: Why Bother?

Dear Editor:

I hadn't been an *Audio* reader for quite some time, but your 50th anniversary issue, with its quaint, memory-lane articles and depictions of early hi-fi equipment, roiled the storage in my brain like old, forgotten

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CIRCLE NO. 13 ON READER SERVICE CARD

pop tunes from the post-World War II era. (Anyone remember "Open The Door Richard" and "Heartaches"?) Being a former Dynakit 70 amplifier owner from way back, I was quite surprised to learn that tube amps are making a comeback. Really? You've got to be kidding! Especially humorous are the Marantz re-creations. I also owned an original Marantz Model 7 stereo preamp, which I operated with the Dynakit 70. The two were a beautiful combination and gave me great sound for a dozen years. Unfortunately, the tubes presented a problem. The EL34s (the power tubes) had to be replaced yearly, as aging caused loss of performance. Ditto for the 12AX7s in the preamp. Replacement of the EL34s would also entail a bias adjustment, so I had to buy a VTVM (vacuum-tube voltmeter) in order to accomplish precise adjustment. What a bother! During the 1960s and part of the '70s, tubes sold for a few bucks each. Now, I would imagine they cost a fortune.

It's nice to wander down memory lane and remember our youth. But it gets expensive when we try to recapture it by paying thousands of dollars for obsolete tube equipment designs. If aficionados wish to recapture the warm sound of tubes, why not buy a 10- or 20-channel graphic equalizer? Just diddle around with the levers and presto, they'll get warm tube sound. This would be much better than shopping around for replacement tubes year after trudging year.

George Nussbaum
Casselberry, Fla

Wine, Cars, and Speakers

Dear Editor:

Congratulations. I have thoroughly enjoyed *Audio* since your arrival. The products of wineries have a character that's often recognizable, and it isn't by any accident: The vintner works hard to make a wine with a certain color, smell, and taste. Much the same situation exists with audio component manufacturers and audio magazines, although the latter would argue against such a notion, claiming the higher ground of neutrality and objectivity. . .hrrmmph!

If I might add some constructive criticism: Allow your reviewers to compare and contrast similar products. I know you want to avoid the appearance of a *Consumer Reports* comparison with product rankings, but in my opinion this is a weak excuse. Car magazines can compare five convertible sports cars without sounding like know-it-alls or petty editors with an ax to grind. In fact, I can read about five driving enthusiasts' week-long road trip and their different takes on the five cars and get an accurate idea of each car's strengths and weaknesses. I can expect no absolute consensus but many similar views and acknowledgments of common ground.

Similarly, I can read about pinot noirs or champagne and expect two or more critics to compare and contrast the different flavors and do so without the usual fisticuffs of audio reviewing. Why is that?

Which leads me to the next thought: Corey Greenberg's writing in *Audio* usually involves comparisons of components, and he does so in a concise and colorful manner. He manages to mention the salient characteristics of two items in a succinct fashion. For instance, his recent comparison of the NHT SuperOne and Paradigm Mini Monitor with the Sonus Faber Concerto ("Front Row," June 1997)—great article. I'd agree with most of his statements most of the time. But wouldn't it have been instructive for him to listen to Paradigm Reference Studio/20 as well as the Mini Monitor? After all, he referred to it in the article. Readers are always interested in what the manufacturer does with twice the money. And lo and behold, in the same issue another 6½-inch two-way speaker was reviewed by Edward M. Long and guess what: Its price was close to that of the Paradigm Reference Studio/20. I wonder what Corey Greenberg and Ed Long would have thought of these basic two-way speakers.

I believe each brand of speaker has a "sound" in the same way that Mumm's champagne differs from Krug. And more important, a Krug that sells for $45 a bottle surely is different from an $85 bottle or a wonderful vintage that costs $185. So how does a B&W sound different from a Paradigm? And how does the Paradigm Mini Monitor compare to the more expensive Reference Studio/20, or B&W D- or P-series speakers differ from the Matrix series? If *Car and Driver* can describe the difference between the Porsche 911, the Carrera, and the 935, I am confident Mr. Greenberg and Mr. Long can convey the differences between two or more speakers. If not, you have a problem in your editorial staff. Again, thank you for many great articles and issues of *Audio.*

Carl V. Dais
Oklahoma City, Okla.

Editor's Reply: Reviewers are free to compare components as they see fit. As a practical matter, however, it's difficult to cover every angle that might be of interest and still get issues out the door on schedule. There are just too many products available. However, with respect to the Paradigm Reference Studio/20, Corey did compare it with the Mini Monitor; see also his review of the Active/20 on page 86 of this issue.—*M.R.*

Playing the Ratings Game

Dear Editor:

I find your Annual Equipment Directory to be a very useful tool. I talk with custom audio installers daily and use the Directory to look up the equipment the installer is using and to recommend products for their applications. The only specification that is missing from the "Amplifier" and "Receiver" sections is the minimum amplifier impedance drive capacity. For example, the Denon DRA 775RD receiver is listed at 8 ohms. However, if a 4-ohm load is on its output, will it work? Some models work only at 8 ohms and shut off, distort, or die with a 4-ohm load. I'd like to 4- and 8-ohm specifications.

John Cronk
Engineering Manager
Russound
Newmarket, N.H.

Editor's Reply: Unfortunately, we lack space to add columns for more specs in most of our Directory categories; adding anything new usually means taking something else away. And we're not confident that all amplifier companies would be able to provide us with the proper information about minimum impedance loads. You can be sure that any amp for which a 4-ohm power rating is listed will be able to handle 4 ohms; alas, you can't be sure that an amp with only an 8-ohm rating won't handle lower loads.

In any product category, you'll rarely be able to select components based strictly on our listings. What those listings can do for you, however, is help you screen out hundreds of products you definitely don't want, leaving you with just a handful of promising components to check into further.—*I.B.*

KAV–250p.
Stereo Preamplifier with Theater Throughput™ to integrate high-end stereo and home theater systems.

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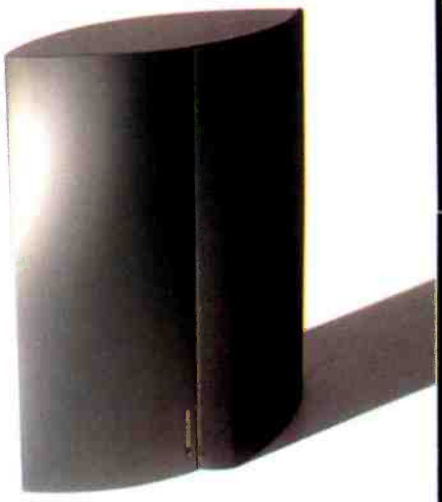
WHAT'S NEW



Bang & Olufsen Powered Speaker

B & O says that its shielded, biamped BeoLab 4000 can serve as a main-, center-, or surround-channel speaker or be part of a multiroom system. The anodized aluminum enclosure is curved to provide cooling for the pair of built-in amplifiers. Its unusual shape is said to allow as many as 52 different mounting positions. B & O says the 4000 can produce the same sound level as speakers three times its size, and its sensitivity is specified at 97 dB SPL. Besides silver, the 4000 is available in anodized black or green. Price: $900 each.
For literature, circle No. 100

NEWFORM RESEARCH SPEAKER

A 60-inch-tall monopolar ribbon driver sits atop the bass enclosure of the No Holds Barred Essential speaker; total height, with the base, is 93 inches. The speaker is said to present a deep and well-focused soundstage because of the ribbon's minimal diffraction and wide horizontal dispersion. Although dual 5-inch woofers handle bass duties, Newform Research recommends use of a subwoofer. Sensitivity is rated at 92 dB/1 watt/1 meter. Estimated assembly time is 20 minutes per side. Price: $2,540 per pair, factory-direct, including UPS shipping.
For literature, circle No. 102

VELODYNE POWERED SUBWOOFER

A high-gain servo system measures the cone movement of the FSR-15's 15-inch driver 3,500 times per second to correct distortion-creating errors, which keeps THD to levels below 1%, says Velodyne. A switch lets you bypass the internal crossover for use with preamps, surround processors, and A/V receivers that contain their own subwoofer crossovers. The FSR-15 has a built-in 250-watt amplifier with automatic on/off. Volume and volume presets are adjustable via a remote control. Frequency response is specified at 18 to 120 Hz, ±3 dB. Price: $1,699.
For literature, circle No. 103

GALANTE AUDIO SPEAKER

Developed to meet the demand for a high-sensitivity speaker for use with low-powered tube amps, the Buckingham employs an Altec/Lansing 604 horn-loaded 15-inch coaxial driver to attain a rated sensitivity of 100 dB/1 watt/1 meter. Galante says that it will function comfortably on as little as 3.5 watts per channel. Frequency response is rated at 50 Hz to 20 kHz, ±3 dB. The rear-ported enclosure is built of ¾-inch Baltic birch and furniture veneers of walnut, cherry, or curly maple. Price: $7,500 per pair.
For literature, circle No. 101

RUARK ACOUSTICS SPEAKER

The Templar II, a two-way floor-standing system, is an updated version of the Templar but with an improved 6½-inch woofer and 1-inch silk-dome tweeter. The woofer now has a phase plug, a cast magnesium basket with a high-flux magnet, and a doped, felted-fiber cone. The front baffle is sloped for time coherence, and figure-eight bracing is used internally to control resonances. Frequency response is specified at 50 Hz to 20 kHz, ±3 dB. A second-order, eight-element split crossover facilitates biamping or bi-wiring. Price: $1,200 per pair in rosewood, African ebony, natural cherry, or poplar veneer.
For literature, circle No. 104

Another beer there Chief?

Sure.

Another beer there Chief?

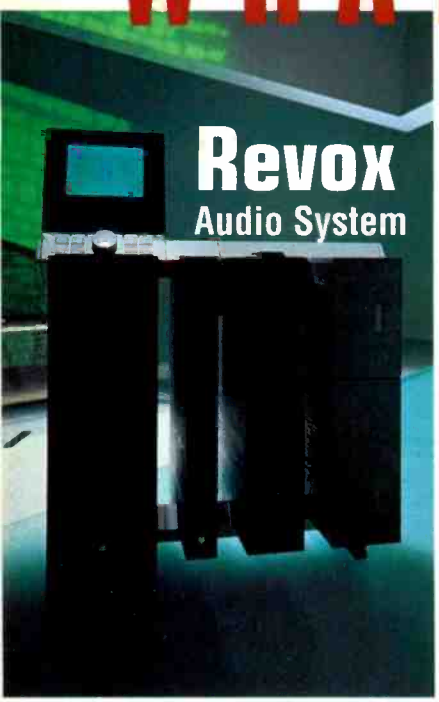
Sure.

Another beer there Chief?

Sure.

The vanilla and cinnamon spiced rum that just won't stand for the status quo.

WHAT'S NEW



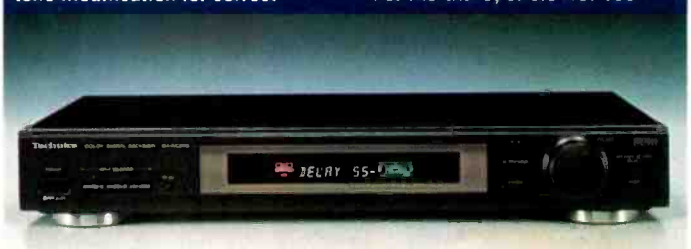
The Evolution, strikingly sculpted by Frogdesign, is said to embody the high quality of past Revox hi-fi components. A large, backlit LCD panel enables easy access to all the controls of the amplifier, CD player, tuner, and cassette deck, and the software menu allows routing and control of sources to as many as 10 rooms. The amp is rated at 150 watts per channel into 4 ohms, 20 Hz to 20 kHz, +0, –0.5 dB, and the CD player has a 1-bit, 256-times-oversampling D/A converter. The modular design is said to facilitate easy upgrading to Dolby Digital and home theater surround sound. Price: $6,695; cassette deck, $2,095.
For literature, circle No. 105

Walker Audio Turntable

With a base cast from crushed marble and lead, the Proscenium Gold Signature air-bearing turntable weighs 210 pounds. Its lead platter is supported by three air jets, the air-bearing arm by eight fixed jets at a pressure of 50 psi. A compressor pumps air to the turntable via two flexible, ¼-inch plastic tubes. The drive motor, set in its own crushed-marble enclosure, has a pulley machined for 33⅓ and 45 rpm and cut for use with a drive belt made of dental floss (unwaxed). Prices: polished brass finish, $11,750; aluminum, $8,995; with 110-pound base, 70-pound platter, and carbon fiber arm, $8,995.
For literature, circle No. 107

TECHNICS DOLBY DIGITAL DECODER

The SH-AC300 decodes AC-3 bitstreams from DVD players and other Dolby Digital sources, yielding 5.1 discrete analog output channels. Besides Dolby Digital, the decoder has Pro Logic and Stereo modes and level controls for each of the 5.1 channels. A cinema re-equalization mode enables tone modification for correct playback at home of soundtracks originally balanced for auditorium-sized rooms. A three-color flourescent display shows operation modes, delay times, and icons for each speaker in use. Optical and coaxial digital inputs for three video or audio components are included. Price: $299.95 with remote control.
For literature, circle No. 106



Beneath the plastic surface of RCA's 18-inch DSS-3 parabolic dish is a bow tie-type VHF/UHF dipole antenna. Depending on dish orientation, this can enable RCA's third-generation DSS receivers to get off-air reception of local TV as well as digital signals from the satellite via the same feed. Other features include a universal infrared remote that also has RF capability, so you can control a DSS receiver from any room in the house; an automation function lets you turn appliances in up to eight rooms on or off using the DSS remote; and a Scout function that searches DSS programming for future shows of your choice and highlights them for viewing. Prices: DS7450RB, $599; DS5450RB, $499; DS5350RB, $449.
For literature, circle No. 108

TDS AUDIO PROCESSOR

Developed over a 13-year period, the TDS-II analog processor is said to restore the harmonic losses that True Dimensional Sound says occur during the normal record/playback process of any audio signal. Compatible with most any stereo audio or Dolby Digital or Pro Logic surround system, the TDS-II's benefits are said to include much-improved clarity, detail, and richness in the reproduced sound. The TDS-II has a black-anodized brushed-aluminum finish, gold-plated RCA jacks, a bypass switch, and a green LED indicator. Price: $295.
For literature, circle No. 109

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Lawrence B. Johnson
Stereophile Guide to Home Theater, Vol.1, No.1, 1995

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AUDIO CLINIC

JOSEPH GIOVANELLI

Hi-Fi VCRs: Price vs. Sound Quality

Q *CD players, whether low-cost or expensive, seem to have excellent sound. Is that also true of Hi-Fi VCRs?*—Steve Matthews, Louisville, Ky.

A I have used inexpensive Hi-Fi VCRs and rather costly machines and have found the audio quality to be substantially the same in all cases. A Hi-Fi VCR uses two frequency-modulated audio carriers (with noise reduction), one for each channel. The tracks are recorded in the 1.5-megahertz region (between the color and luminance signals) by a separate pair of heads on the video head drum. The resulting performance approaches that of digital recordings: a wide bandwidth of 20 Hz to 20 kHz (usually within a 2-dB tolerance), S/N of at least 80 dB, no flutter, and low distortion. Moreover, these specifications remain the same, independent of recording speed. There may be slight audible variations in the operation of automatic level-control circuitry from one Hi-Fi VCR to another and in the way different machines react to peak recorded levels, but overall price is not a determinant of sound quality.

CD Player Hum

Q *The transport of my inexpensive five-disc CD changer emits a strange, high-pitched mechanical hum when it plays certain tracks on some of my CDs. The noise is not on the disc; when I pause the player, the noise continues. I hear it only when listening at low levels, but it is very distracting. All of the tracks that create the problem are toward the first part of the disc. Sometimes, if I remove the offending CDs and reload them, the sound will stop, or be fainter, but other discs always do it. It happens only with this particular CD changer; my high-end player is fine. What gives?*—Adam Leppert, Minneapolis, Minn.

A Since hum is typically low-pitched and electrical in nature (for example, leakage of AC mains hum into the power supply of a CD player), you should hear it at low levels through your speakers with every CD you play, not just on some tracks with certain discs. Consequently, I'm sure it's *not* hum but rather a mechanical resonance resulting from disc eccentricity interacting with the spindle motor, disc-clamping mechanism, and laser transport during the early portion of play.

CDs play from the inside to the outer edge; for the first few tracks, the disc spins rapidly at 500 rpm. The servo mechanisms must react very quickly to any disc eccentricity (slight warpage, etc.) so any slight misalignment of disc, clamping mechanism, and spindle motor might be exacerbated by the high rotational speed and produce the noise you hear. The fact that the noise sometimes stops or becomes fainter when you remove and reload the discs points to mechanical misalignment as a likely cause.

Given the high cost of labor and time required to troubleshoot the problem, I doubt it would be worth having the changer repaired; I'd live with the minor inconvenience or pass the changer on to a deserving relative.

More Bass, More Subs

Q *I have a powered subwoofer, a cheap A/V receiver that's rated at 110 watts per channel, and a variety of bookshelf speakers that I use for my main and surround channels. The subwoofer's crossover frequency is adjustable from 90 to 180 Hz, I believe, and it seems to work best at 90 Hz. But my system doesn't have as much low end as I thought it would. Would another subwoofer help? If so, can my receiver drive two subs? And how do I get them to be in correct phase?*—William Bisher, San Jose, Cal.

A Before you invest in a second sub, I'd suggest experimenting with the placement of your existing sub (see "Placing the Bass," June 1996). Also, check out your crossovers again. If your receiver has a dedicated subwoofer output with a built-in low-pass filter, feeding your bass through the subwoofer's low-pass as well could cut your bass a bit. Also, see if bass improves when you reverse the phase of your sub—it might be out of phase with your other speakers. Then try reversing the connections to your surround and center speakers, to see if that helps or hurts.

If you do still need to add a second subwoofer, phasing them alike should be no problem if the two subs are identical—just connect them the same way. With two different subs, place them side by side and try reversing the phase of one of them; with the right setting or connections, you'll get lots of bass, but if one is out of phase the bass will drop noticeably.

I see no reason why your receiver should not be able to handle two self-powered subwoofers, since they put very little drain on the receiver.

Odd Loss of Highs

Q *I have a problem with my three-head tape deck that is driving me crazy. With many tapes (especially TDK Type II and Metal), when I monitor the tape while recording, the music sounds excellent, virtually indistinguishable from the source. However, when I'm through recording (even in the middle of the tape), and play the tape back, the sound is dull and muffled. Sometimes the tape sounds great on the first replay and muffled later. I keep the deck demagnetized and spotless and use a non-slip formulation on the rollers. When the tape deck works well, it sounds great, but this problem is very frustrating and I am at a loss for an explanation.*—Paul Gossert, Homosassa, Fla.

A There are several possible reasons for your problem, but the most likely is that the tape, on playback, is veering away from its correct path, thus skewing the azimuth at the playback head, so high-frequency response suffers and the highs become muffled. The reason the sound is excellent when you monitor off tape during recording is that the record and playback heads are close enough that the tape doesn't have time to physically deviate from its correct course. But when you rewind, even a little bit, something in the tape-deck mech-

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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, or via e-mail at JOEGIO@delphi.com. All letters are answered. In the event that your letter is chosen by Mr. Giovanelli to appear in Audioclinic, please indicate if your name or address should be withheld. Please enclose a stamped, self-addressed envelope.

anism that holds the cassette shell in place shifts, causing a slight misalignment of the tape with the playback head. I would check the physical position of the cassette shell during recording and see if it shifts at all when you rewind. (You may be able to remove the plastic window in the loading door, or the door itself, to check for mechanical misalignment of the shell.)

Since you mention "rollers," which implies more than one pinch roller, I thought perhaps your deck is one that uses two capstans, one on each side of the heads. Such systems must be perfectly adjusted if they are to perform reliably. When they work, they work very well, keeping wow and flutter to very low levels. When they malfunction, tapes can wander so far out of their paths that they may be damaged. Perhaps a service manual for your deck will contain proper adjustment information for setting up dual-capstan machines, if that's what yours is.

I wonder too if the tapes you are using are thinner than those that play fine. Even though the tape path is cleaned regularly, wear on either the heads or the capstan can cause the tape to wander. The thinner the tape, the more likely such a condition would occur.

Cracked Remote

Q *My remote control was accidentally damaged. It still functions properly, but it's falling apart. The case is all that needs to be replaced. I have written the company twice about my dilemma and have been told that I must buy a new remote for about $90. Is there any way to avoid paying for a new one? I would try to contact a local authorized dealer on the matter, but I have a language barrier problem. The retailer I bought it from isn't much help. I would appreciate any other option that prevents me from having to bite the bullet for a new one.*—F. Moreno, Aviano, Italy

A I do not think there is any way to avoid paying for a new remote control. Manufacturers usually cannot supply small component parts for such accessories. It would be too costly for them to inventory these items. There's an outside chance you might find a less expensive learning remote and "teach" it the codes from the broken remote, but I doubt that you'd save much money.

This does not mean that you have no options. If you have all the broken parts of the case, you could try using a good glue and cementing the case together. Just be sure not to get glue in the keyboard. And keep glue away from the battery compartment door or you won't be able to replace the batteries when needed. The remote won't look like new, but it will function.

Adding Power Meters

Q *I had an old amplifier with power output meters. My new one lacks them, but I am really hooked on meters now. Is it possible to make a cabinet for the five meters needed to monitor the five channels of my home theater equipment? Is it a big job to connect them myself?*—Ron Hutchinson, Earlville, Ill.

A Before considering the cabinet, first determine the physical dimensions of each of the meters you plan to use. I have no specific circuit diagrams you can use to construct the meters. There are bar-graphs one can obtain, but they must be calibrated. It is also possible to acquire more conventional meters that use a pointer moving across a scale. These are often calibrated in volts; in other words, they're voltmeters.

I know we are talking about power, which you think of in watts, but I am also talking about voltmeters. This is because power output can be determined by measuring the voltage developed across a resistor. Ohm's Law states that power in watts is equal to the square of the voltage divided by the resistance (in ohms). In your case we substitute the impedance of the loudspeaker. (There will be some error, but not so much as to make the meters useless.)

As a simple example, if we measure 8 volts across an 8-ohm load, this means that 8 volts squared (8 x 8) is 64, divided by the impedance (8 ohms) of the speakers, which yields 8 watts of power. You can plug any set of numbers into this simple equation and determine power output. One problem you will encounter is that some speakers exhibit wide impedance variations with frequency. This will make it impossible to deduce the overall power fed to such speakers. Alternatively, if you know your speakers have a fairly linear impedance curve (few do) at 8 ohms, 4 ohms, or whatever, the figures you calculate for your meters may be quite accurate.

At any rate, by plugging numbers into this basic equation, we can determine power by reading the voltage scale. Connect each meter across the speaker output terminals for each amplifier channel of your home theater system. If the face of the meter can be exposed, you can write down power at different points on the scale. Our previous example shows us that the 8-volt point also happens to equal 8 watts, assuming an 8-ohm load. If the load impedance were 4 ohms, then the power output would be 16 watts. You would mark the meter "16 watts" at the 8-volt output level. Do this for as many points as may be required.

The task of calibrating the three front-channel meters will be easier if you have a test CD with a constant pink-noise test signal or a 1-kHz tone. You can use the circulating pink-noise test signal that's built into Dolby Pro Logic decoders to calibrate the meters for the surround channels and for the front channels too if you don't have a test CD. Begin with the volume control turned down and gradually increase the level, noting the voltage reading and converting the power output to watts as you gradually increase the volume and calibrate your meters. Be careful not to overdrive your speakers with the test signal.

As for an enclosure, Radio Shack offers project boxes of different sizes. The size of box you choose depends on the physical dimensions of the meters and upon the arrangement on the front panel that you wish to use.

Suspended by Wire

Q *I am considering using a glass platform to hold my stereo equipment. The ½-inch-thick, beveled clear-glass shelf will be suspended by four wires attached to the ceiling and floor. I thought about setting the glass on top of a piece of rubber to isolate each shelf from any vibration. The rubber piece will sit on top of each set screw. The steel wires will go through the four corners of the glass. Is this a good setup for my high-end tube equipment, or will vibration still affect the stereo components? Any suggestions?*—Robert Yu, Flushing, N.Y.

A Vibrations are not likely to interfere with the proper operation of audio components—except for turntables, microphones, and tube equipment. Occasionally there may be a tube that is "microphonic," located in a high-gain stage of a component. Any acoustically or mechanically induced vibration of that tube will produce a ringing sound from the speakers.

Of course, loudspeakers are best mounted on isolation stands so that any cabinet vibrations will not be passed to the floor or other parts of the listening room (this will effectively prevent vibrations from affecting the rest of the audio equipment). Such vibrations may color the sound, which is, of course, deemed undesirable by many audiophiles. On the other hand, some high-end aficionados believe that speakers should be spiked—that is, coupled *to* the floor, not isolated from it—and that floor-borne vibrations are good (or at least that's what seems to be implied in the theory underlying speaker spikes). While your wire-suspended glass platform would effectively isolate your tube gear from floor-borne mechanical vibrations, any microphonic tubes would still be susceptible to vibration triggered by high-volume acoustical energy.

With digital devices, such as CD players, it seems to me that if excessive vibrations shook the player, the signal would fail completely rather than induce some subtle sonic change. This is logical when you consider that CD players are used in automobiles. In that environment there will be far more vibration than you would ever encounter in your listening room, and there seems to be no significant audible difference between a CD system in a parked or a moving automobile, other than effects attributable to road noise and acoustical masking when the car is moving. For these reasons I see no need to spend money on thick glass and exotic suspension systems as a means of improving audio performance.

Powering Up An Unpowered Subwoofer

Q *My receiver has a low-pass output to feed a powered subwoofer, but my sub isn't powered. Can I use an integrated amplifier to power the passive subwoofer?*—Name withheld

A You can use an integrated amplifier to power your subwoofer as long as the amplifier can supply enough output to drive it properly—50 to 100 watts should be adequate. A

Daily Work Planner

Agenda

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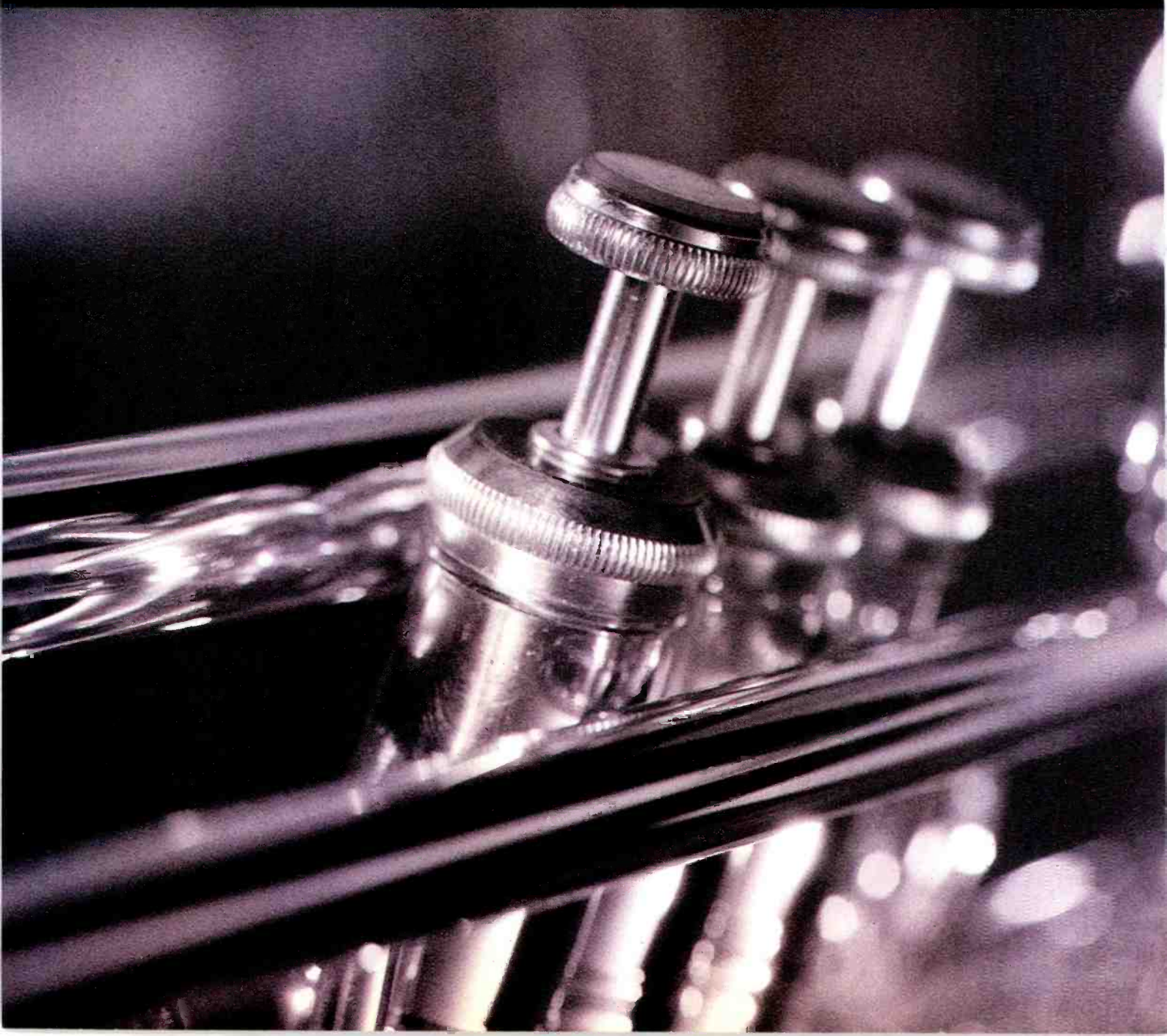

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IVAN BERGER

MORE PIONEERING

At last, a car stereo with RDS *and* ID Logic.

With the DEH-P835R car tuner/CD player ($500), Pioneer has enhanced what was already good in its predecessor, the DEH-P815 (see our review in the July 1995 issue), and ameliorated what wasn't—not to mention adding one feature I've been awaiting for years.

I wound up last year with the DEH-P815 in one of my car's DIN slots and a Denon DCT-950R (see review, May 1995) in the other, firmly expecting to use the Denon most of the time. Both units had automatic station-identifying features, RDS in the Denon and ID Logic in the Pioneer, which let you find stations by program format. I find neither system really necessary when listening to my local FM stations, but RDS is often preferable for travel—one point in the Denon's favor. Also, the Denon had a volume knob, instead of the Pioneer's two pushbuttons, and a CD slot that was always accessible instead of concealed behind a flip-down display. The Denon had up/down tuning buttons on its faceplate, while the old Pioneer had them only on its remote. And the old Pioneer's nine buttons and six rockers made it all too easy to change modes by accident, swapping favorite functions for obscure ones. (It didn't help that the Pioneer's display was almost totally unreadable by daylight, so you couldn't tell which mode you were in.)

Nevertheless, I found myself gravitating more and more to the Pioneer. Although its front-panel control interface was hard to navigate, its remote made operation a breeze. Using hook-and-loop fasteners, I attached it to my Scorpio's center console, right where my fingers could find it without reaching, and almost never had to look at my dash again. From the remote, I could select CD play or radio, shift radio bands, search for new stations or select preset ones, control volume and muting, and do a couple of other things that rarely needed doing. The controls were closely grouped, yet easy to tell apart by touch. And all without accidental mode shifts.

With the new DEH-P835R, I still use the remote most of the time—but I no longer have to. Its front panel works quite well on its own. The display is now bright enough to read by daylight, at least in a closed car, so you know what's happening. You can tune stations without using the remote. The mystery modes are tucked away within menus, and the display shows more clearly when they are invoked. The control count is now up to 13 buttons and four rockers, but they're laid out so cleverly that the new panel seems to have fewer buttons than the old. For example, the newly added tuning buttons are arranged in a cross, with up/down buttons to scan through your presets (also selectable individually, of course) and left-right buttons for scanning by frequency. The new remote repeats this pattern, which makes it easy to get used to.

The DEH-P835R's brighter display and front-panel tuning buttons address two of my three gripes about the older version. The third was a volume indication that lingered on the display too long. On the old model, if I tried to read the station display a half-

The DEH-P835R's remote control is even more useful than its front panel.

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mile after I'd changed volume, all I would see was my volume setting—like, who cares? The new one has this delay down to a block or two, which I find tolerable, though still silly.

But the big news is in the DEH-P835R's features. It is, for example, the first tuner I know of to combine both RDS and ID Logic, the feature I've been waiting for so long. That's a big help when you're travelling. With RDS, the radio can identify any station putting out an RBDS signal (the industry's nomenclature problem, not mine) and tell what kind of program it's currently broadcasting, but it's useless on AM and on the 90% or so of U.S. FM stations that don't yet use RDS. With ID Logic, it can identify any station at all and tell its program type—but ID Logic doesn't know when a station changes its name and programming (you can add or update as many as 63 stations manually) and can't find anything at all until you tell it where you are. Having both systems averts either's pitfalls.

Both the old and new Pioneers theoretically can figure where they are by analyzing the station mix they're receiving. Neither does it quite right. At my home location in New Jersey, the older unit assumes I'm in Middletown (21 miles away); the newer one usually figures Newton (34 miles) or Long Branch (32 miles). In Walden, New York, just West of Newburgh, both told me I was in New York City (75 miles), even though they can't get New York stations there. Pfah! I might have had better results had I gone south to Philadelphia, where there are RDS stations, than North to Walden, where I could find none; the DEH-P835R is supposed to automatically update its location from RDS signals, but I had no chance to try that.

Pioneer hasn't included every RDS feature, just the most important ones. The DEH-P835R can not only identify strange stations and let you search for stations by program type, but can also bring you traffic announcements and emergency alarms, even if you're listening to CD. (However, that's true only if your local RDS stations broadcast these announcements; the ones here in the New York area don't.) And it can display brief RadioText messages, which stations could use to tell you what record you're hearing or for other purposes. Luckily for driving safety, it also stores those messages for later reading, automatically saving the last three but also letting you store four messages on your station-preset buttons so new ones don't overwrite them. (Again, New York City stations aren't cooperating, sending fixed messages, such as "Thank you for listening to WQXR," or nothing at all.)

The DEH-P835R omits two RDS capabilities, but with good reason. It apparently lacks the alternative-frequency feature, which would enable the radio to find a new station playing the same program if the old station fades out. That's a good feature in Europe, where network broadcasting is still pretty much the norm, but it has almost nothing to work on in the U.S. The other, automatic clock setting, was left out because RDS stations don't always check that the clock settings they transmit are accurate, especially after switching in or out of Daylight Saving Time.

SuperTuner V, the circuit that incorporates RDS and ID Logic, is slightly less sensitive than the previous head unit's SuperTuner IV was. Pioneer says the old one's sensitivity was impractically high, but I had problems neither with its high sensitivity nor with the slightly lower sensitivity (16 versus 13 dBf for 50-dB quieting in mono) of the DEH-P835R. On weak signals, the new model seems marginally less subject to breakup, but its noise is a trifle more annoying—a toss-up. As usual with Pioneer, AM reception was relatively good.

The CD player in the new Pioneer has audible search, which is not common in car stereo. It also has repeat and random play (which I rarely use) and track scan (which plays the first 10 seconds of each track to help you find the one you're looking for). Unfortunately, these are available only through a function menu, a distraction when you're driving. And the CD slot is a bit hard to find in the dark. If you hook in a Pioneer CD changer, it will also control the changer's digital compressor, dynamic bass boost, and several programming features.

Sound quality is excellent, and several features help you tailor it to your liking. While the tone controls are buried in a menu (which I don't like), they include midrange as well as bass and treble (which I do). Furthermore, you can set these controls differently for each source; I added one click of bass and treble boost to FM, just one bass click to CD. The switchable loudness compensation provided a shade too little bass boost for my system, which is better than adding too much. A Front Image Enhancer rolls off your rear speakers' high and middle frequencies, to give you some rear fill while keeping the main image up front, a useful and novel feature. You can switch in SRS (Sound Retrieval System) spatial enhancement, which I find makes the musical perspective sound more natural; alas, it works only for CD play, not FM. You can also set the volume from CD, AM, and AUX to match that of FM, preventing volume jumps when you switch sources. Subwoofer-output controls enable you to set its filter frequency (50, 80, or 125 Hz), invert its polarity, or turn it off. I didn't check whether the filtering is a full crossover or merely a low-pass. Fader and bal-

PLUS Ça CHANGE...

There's an old French expression, *plus ça change, plus c'est la même chose*—"the more things change, the more they stay the same." Changers, appropriately enough, are an excellent example. Back in 1921, *Popular Science* ran an item on an early record changer. Unlike the ones that I grew up with, where records dropped down a single spindle, this one had four spindles arranged in a square, with a record on each, and a tonearm tucked in a corner of the cabinet. As each record ended, the tonearm would rise out of the way while the plate underlying the four spindles turned 90° and placed the next disc where the arm could reach it. This was, in other words, a carousel, like most of today's CD changers.

The slot-loading transports used in so many in-dash car CD players aren't all that new, either. When I was small, one of my playmates had a phonograph that worked the same way—a Philco, as I recall. I don't even think it played LPs, just 78s.

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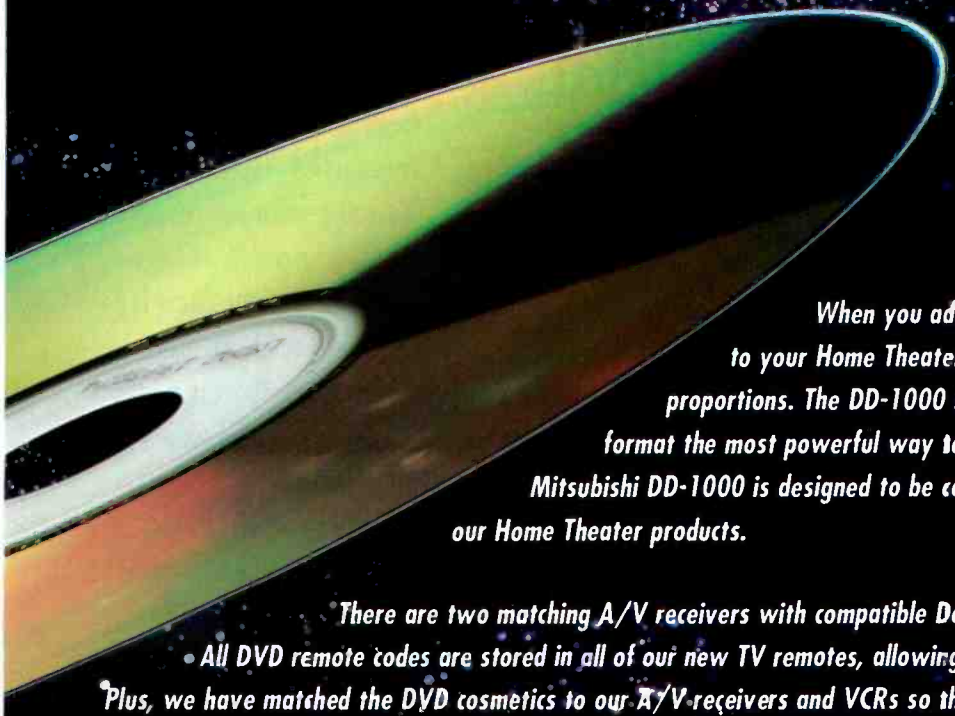

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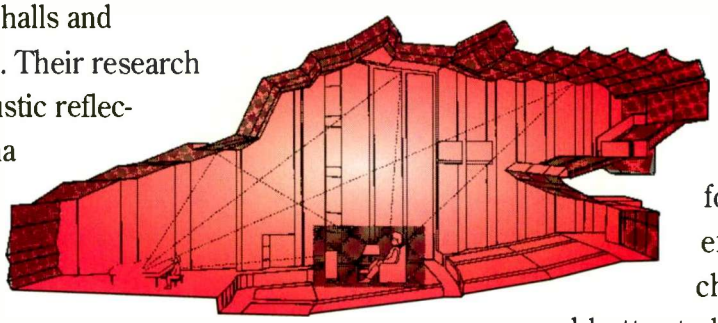

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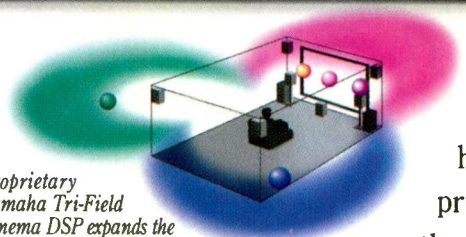

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ance adjustments work together, using the four-button cross on the front panel, so they share a single menu.

More audio adjustments are available if you add Pioneer's DEQ-P800 hideaway DSP unit, which is operated through the DEH-P835R's front panel or its remote. These include the usual sound fields (plus "Audition," a sing-along feature that cancels out centered solo signals), parametric equalization and tone controls, speaker delays, and a circuit that monitors ambient noise and adjusts volume to compensate.

I was prepared to dislike the display's 15-band real-time spectrum display, as I often find dancing lights on my dash a distraction. However, when I set this one to it's "Rainfall" mode, with most of the light show at the top of the display, I didn't find it bothersome at all. A defeatable dimmer function reduces the display's brightness when your headlights are turned on, a good feature.

The new remote's controls are smaller and harder to push than the old one's, but I quickly got used to that. It comes with a stand that can be screwed in place and that lets you lay the remote down or stand it up at an angle. The manual is excellent, especially for such a feature-rich product.

Pioneer's DEH-P835R is definitely a keeper, and it has several features to help you keep it. Its front panel is detachable and beeps to remind you to remove it when your ignition's off; if you do remove it, a red LED blinks on the front panel. There's also "DFS Alarm," designed to drive thieves off by playing loud warble tones through your speakers. If it's activated, it will arm itself whenever the ignition is off, the radio's front panel is removed, and the doors have been opened and closed. Thereafter, it triggers following a preset interval (you select 0 to 60 seconds, in 15-second increments) if the door has been reopened but the front panel isn't replaced or the ignition turned back on. While it has settings for European cars and for Fords (which use different door-switch systems), it wouldn't work in either setting for my European Ford, possibly because I'm having some electrical problems. (Anyone know a good Scorpio mechanic in the 908 area code?)

Ed Foster has said that few things please a reviewer more than finding a new product that improves on a good old one; pity he hasn't more occasions to repeat this. I agree with Ed—and that's exactly what Pioneer has done with the DEH-P835R.

PROGRAMMING PAUSES

Works performed in concert come to an end and leave you time to absorb them before the next one starts. Pop concerts may include some medleys and segues, and the pauses between works are shorter, but the principle of the pause still holds. Only modern recordings let us butt the trailing echoes of one piece against the first note of the next.

On 78s and 45s, having to turn the record over enforced long breaks between songs as well as, unfortunately, within movements of longer works. On LPs, pop songs could be crammed together, but on classical discs one symphony per side was usually the maximum, and you had time to breathe in the silence while you flipped discs. (Not that occasional LPs didn't have bad breaks: Many discs put all but the last movement of a symphony on one side, then followed that last movement with another short work to fill that side out.) Cassettes can hold the equivalent of a full LP on each side, but cassette producers tend to leave a bit of a break between discrete works.

Up to 80 minutes or so of music can now be packed onto one CD. All too often, producers try to do just that, forgetting to include the necessary silences between works. It's gotten to the point where the music-location systems on cassette decks often can't find the spaces between songs on tapes dubbed from CDs. Some CD players can automatically add the necessary pause—a mere 4 seconds—at the end of every cut. But this is no help to the classical music listener, who may not need that much additional time between tracks (which often only mark the ends of movements) but who needs considerably more than 4 seconds between works. I'd love to see a CD player that would let you program in those pauses. You'd just set the pause length you prefer, then tell the player which tracks those pauses should follow. This would be especially good if combined with some sort of permanent track memory so that you wouldn't have to reprogram the pauses when you replayed a favorite disc. A

KEN KESSLER

STEREO IN PERSPECTIVE

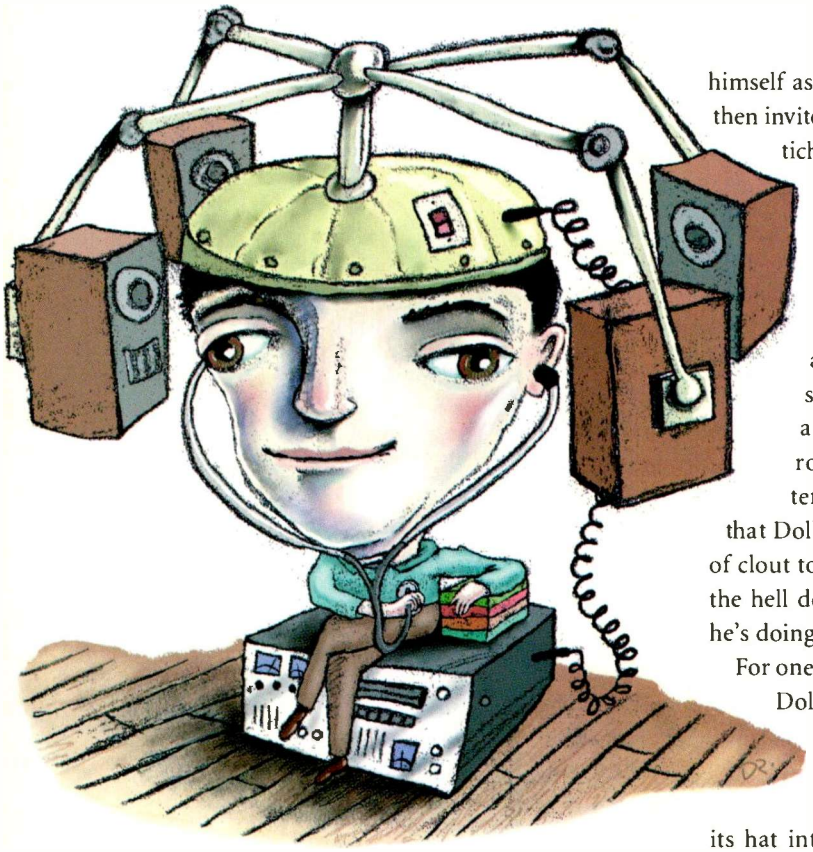

Illustration: David Ricceri

The time: September 1996. The place: TOP Audio, Milan's annual high-end hi-fi show. A slim, well-dressed, seemingly balanced individual approaches. Before he even opens his mouth, my prejudices and conditioning lead me to conclude that he's a professional of some sort; he possesses the style and manners of the Milanese, he's calm and ordered and totally without threat. In other words, this man looks as unlike a bouncing-off-the-walls audiophile as is humanly possible. He introduces himself as Dottore Gubert Finsterle.

Whew. A doctor, not a latent axe murderer. But within moments, the scenario has the potential to turn into a David Lynch flick, for, not only did the gentleman introduce himself as a doctor of some sort, he then invited me to hear his new multichannel playback system.

Remember the date: 1996. Like, uh, wa-a-ay past the point where Dolby tied up the planet for Dolby Digital (née AC-3) as the de facto standard surround sound system and DTS carved out its role as the sole viable alternative. And, considering that Dolby and DTS have the kind of clout to fend off all comers, what the hell does this guy in Italy think he's doing?

For one thing, not taking on either Dolby or DTS.

It turns out that his company, AVS (Audio Virtual Standard), isn't throwing its hat into the 5.1-channel digital surround ring so much as it's trying to fill the gap between conventional two-channel stereo and the multichannel surround systems to which we'll all be accustomed by the end of this millennium. Finsterle senses a change is a'-comin', one that is going to create an Us versus Them situation just as real as the one that occurred at the birth of stereo, an audio civil war between adherents of one channel and proponents of two. And while the surround-versus-stereo battle hasn't been a bloody one—probably because "stereo" has been mostly for music-only listening and "surround sound" for a cinematic experience—the forthcoming increase in music-only recordings with surround encoding might inspire renewed debate.

TWO-CHANNEL STEREO HAS ALWAYS LEFT LISTENERS HUNGRY FOR MORE CHANNELS.

That debate has been festering for years. The pioneering surround technology of the late 1960s and early 1970s had nothing to do with home theater. Early four-channel sound was a music-only proposition, and plenty of observers (including a number of still-active voices) argued that stereo simply wasn't enough and that the only truly convincing reproduction of a musical event in the home would include sound to the sides and the rear. Now, technology enables us to have all those extra channels of sound without any of the problems associated with circa-1972 quadraphonic reproduction; so there's the possibility that today's familiar two-channel stereo will seem as alien to the next generation of listeners as mono does to those who never knew anything with fewer than two channels.

In an archival sense, it doesn't mean that over a century's worth of recordings will suddenly lose most of their appeal. Everyone under the age of 40 knows only a world where stereo is the primary form of playback, yet there are plenty of under-40s who enjoy the mono recordings of the mid-1950s and earlier. But what has been needed is an antidote to the rather nasty, useless pseudo-atmospherics created by the myriad "mode" selectors found on most surround decoders, which attempt to endow a recording with more channels than it actually possesses.

Admittedly, Finsterle might have experienced the same need for re-creating ambience that drove a generation of Japanese designers to come up with DSP settings like "cathedral," "concert hall," "jazz

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club," or other venues. Which leads us back to Finsterle's medical nomenclature: He is indeed a doctor, specializing in psychoacoustics, the psychology of the perception of sound, at the University of Milan. And it's always psychoacousticians who come up with something we didn't even know we wanted, let alone needed.

Move the clock ahead some six months. Although Finsterle's demonstration at TOP Audio was as good as it gets—great room, vivid recordings—it was still in the context of a hi-fi show. And anyone who frequents hi-fi shows knows that there are plenty of reasons *not* to rely on what you hear from a five-minute burst of unfamiliar material in a strange room and with a queue of listeners waiting for your chair. So I returned to Milan for a one-on-one demonstration, armed with my own discs (the AVS system doesn't require pre-encoded software).

Yes, what I went to hear was the full-blown, totally optimized rig; but what better way to determine whether or not the system even works? I was faced with a setup that wouldn't leave much change from $150,000, but—before you turn the page—there are moves afoot to produce the active ingredient, the decoder itself, for less than $1,500 in a form you can add to existing systems with four speakers, e.g., any home theater setup. There's even talk of a version for less than $1,000.

EVEN WITH THE FRONT SPEAKERS OFF, YOU GET A GOOD FRONT-CENTER IMAGE.

Quite what I was hearing remains unclear, because Dr. Finsterle exhibits signs of audio industry-induced paranoia, even though the "perspective correlator" has received an Italian patent. Understandably, he's concerned that competitors could copy the system because it's so genuinely simple. AVS's patent covers the hardware requirements and such details as speaker placement, but the core detail is the correlator, or "perspective corrector," a "black box" that Finsterle was drawn into describing as "a preamp with special tone shaping."

Given that stereo has always left listeners hungry for more channels (early stereo systems included center speakers, though we perceive a coherent central image from two speakers positioned at the right and the left), there will always be those who demand, at the very least, some sort of fill-in at the sides. Some listeners are prepared to compromise, feeling that rear information, even if it means only the reproduction of reflections, might be too much if the integrity of the fundamental stereo signal is to be preserved. The AVS system addresses the needs for a truly coherent central image from two-channel source material and "wrap-around sound," while retaining the purity of the primary signals: The main left and right signals remain untouched.

Although a full-blown AVS system includes the perspective correlator, specially chosen amplifiers and speakers, *and* recordings made with AVS's microphone setup, what interested me most was how the system worked with existing two-channel recordings. AVS, too, has recognized that there's nothing to be gained (other than the alienation of the entire industry) if it were to continue insisting that the system works well only with its own recordings. To defuse this problem, the company (which hopes to license the technology) can remaster existing recordings for AVS playback, even though full compatibility is assured with standard releases. Another benefit, familiar to HDCD and XRCD supporters, is that AVS recordings are compatible with systems that don't have a correlator installed.

AVS's complete system consisted of Claravox floorstanding loudspeakers, chosen for absolute phase coherency, Volta tube electronics, Shinpy cables, and the correlator itself. Just as crucial to the success of the system, particularly for those who wish to add a correlator to an existing setup, is the layout: All four speakers are identical and fire directly at the listener. But this is not a "hot seat" array; my listening sessions included sitting between the front and rear right-hand and left-hand speakers, looking "into" the listening area. Even sitting way off-center and looking into the soundstage from the side, I could discern a truly "3-D" soundstage.

The AVS perspective correlator manipulates specific frequencies in the rear channels to create much better stereo at the front, with very subtle impressions of sound at the sides and rear. When the rear speakers—those receiving the signal from the perspective correlator—are switched on, the bass seems deeper, fuller, and richer, there's a distinct impression of increased stage depth, and most impressively, a wider soundstage that creates close to a 180° arc. As you'd expect, and as the company's original demo recordings confirm, the system works blissfully with live recordings carrying plenty of audience sounds; applause is so lifelike that you'll want to hit up your neighbor for some virtual popcorn. Curiously, though, you soon realize that little, if any, sound appears to come from the rear channels. Then you take a leap into the unknown by switching off the main, full-range, unprocessed, pure stereo speakers, and suddenly you wish Blumlein, RCA, and those other pioneers had left mono alone.

What remains after the main speakers are switched off are full-bandwidth signals from the rear speakers, *even though nothing appeared to be coming from them when the main speakers were playing.* More scary is the solid, coherent center image hovering in front of you. Yes, even without the main speakers, there is an actual, discernible front-center image, as palpable as a mono sound field from a front-positioned single speaker.

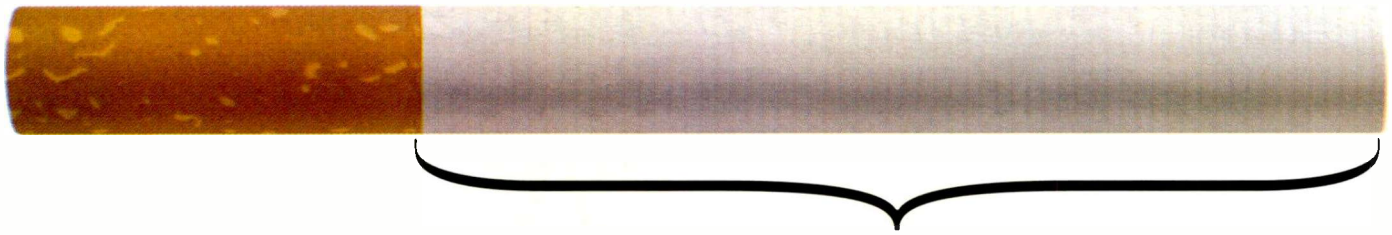
Finsterle stopped just short of clapping me on the shoulder and announcing "Bravo!", but, as you've now guessed, that was precisely what I was supposed to hear when only the rear speakers were working. Switch on the front speakers again, and it was back to "enhanced stereo." And yet, when fed a good Dolby Pro Logic signal, such as the Bond flick *GoldenEye*, the system worked almost as well as a Double-D'd processor, including convincing overhead sounds during the flyover sequence. It's as if the perspective correlator owner gets a surrogate home theater surround decoder for free.

Will AVS take off? The company plans to launch the system outside of Italy at the Hi-Fi Show in London in September. And I'm gonna stand outside the room to see if others heard what I heard. Because if they did, AVS could sell a load of perspective correlators. Even with the clunky name.

(You can fax Dr. Finsterle at 011-39-2-921-40217.) A

"What the heck have you been smoking?"

Yours have additives.*



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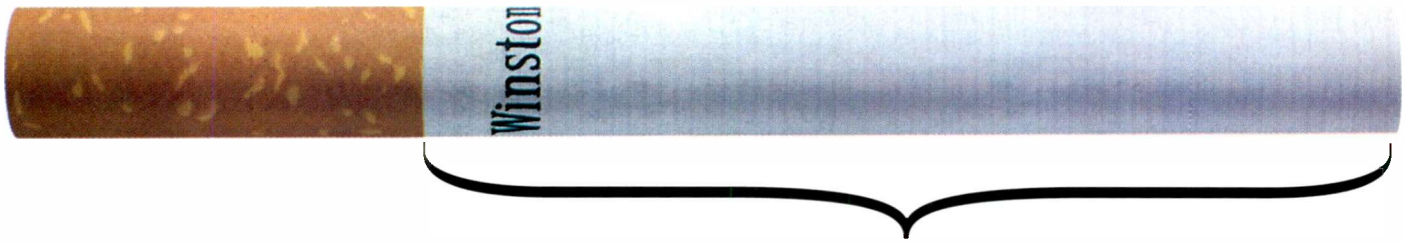

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understanding MPEG-2

how they get all that video

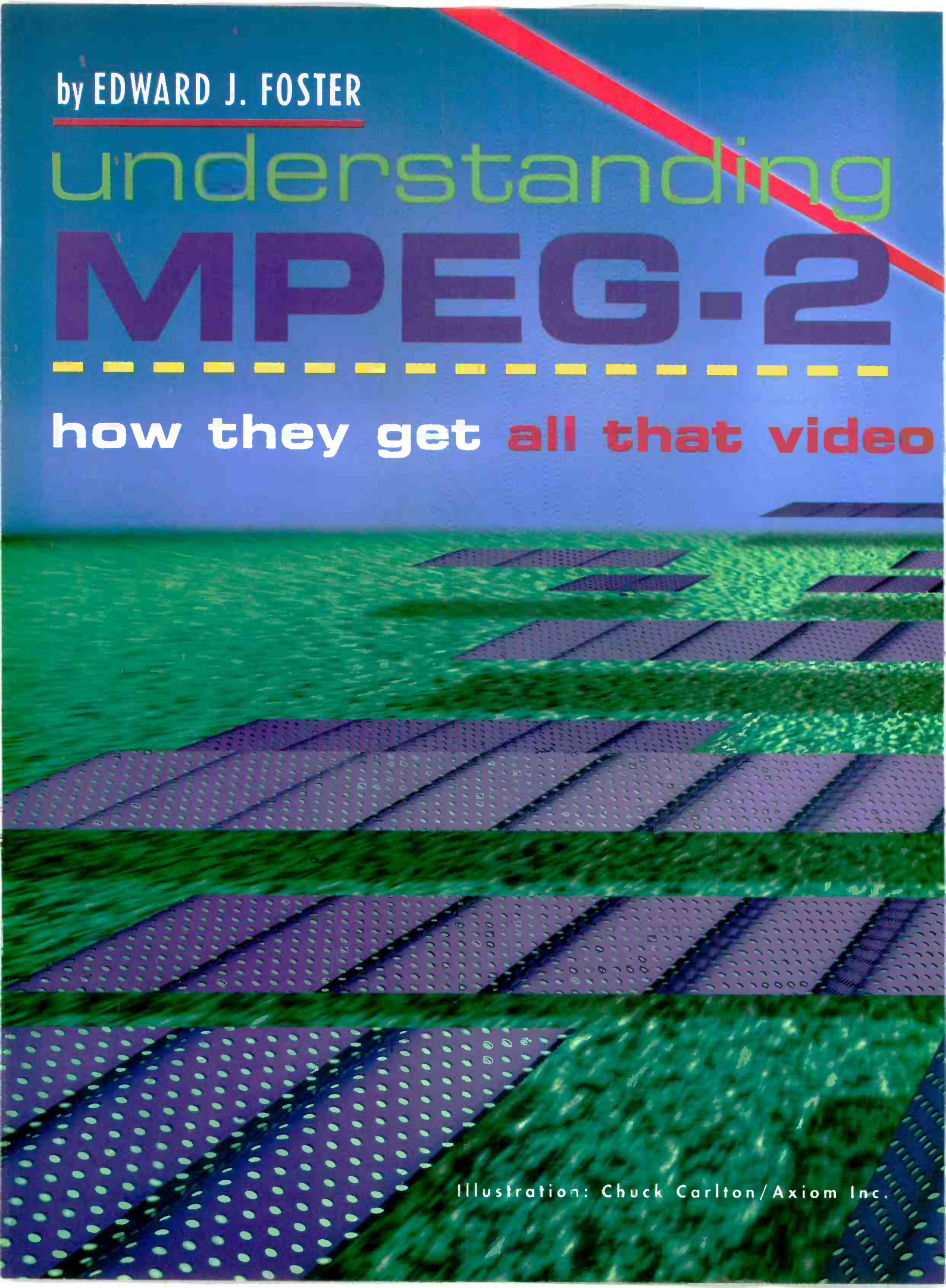


Illustration: Chuck Carlton/Axiom Inc.

A few years ago, Audio ran an article by my longtime friend and former colleague at CBS Labs, Robert Finger, on the subject of MPEG video compression ("Video CD: A Coding Challenge," December 1994.) The impetus for his report was the impending launch of Video CD, an optical disc system that ultimately proved more successful in mainland China than in America. A video CD could hold as much as 74 minutes of approximately VHS-quality full-motion video with stereo (or matrixed-surround) sound on a seemingly conventional Compact Disc (i.e., a disc physically similar vis-à-vis track layout and data rate to an audio CD).

Now that DVD is being introduced and accommodates 133 minutes of near-studio-quality video with the possibility of multiple aspect ratios, multiple viewing angles, multiple MPAA ratings, and discrete 5.1-channel surround sound (in multiple languages, no less!) on a disc of comparable size, it's time to revisit MPEG video compression.

on those little discs

WITHOUT MPEG, OR SOMETHING LIKE IT, THERE WOULD BE NO DVD, NO HDTV,

DIGITAL PROS AND CONS

Before we do, let's clear up a popular misconception about digital audio and video. Digital recording or transmission involves measuring the amplitude of a continuous analog signal at regular intervals (sampling) and representing the value of each sample as a number (quantization), usually in binary (base-2) notation. I've seen it written that signals require less bandwidth (and, therefore, less storage space for a given program duration) when expressed in digital form than in analog form. Quite the opposite, in fact, which is why a CD must hold a 1,411,200-bit-per-second data stream to convey two 20,000-Hz audio channels. Digitizing signals via CD-style linear pulse-code modulation (PCM) has advantages, but bandwidth conservation isn't one of them. Linear PCM produces a bit stream that requires more, not less, bandwidth than the original analog signal.

So, why digitize? There are several reasons. Digital signals can be protected by error-correction codes that cannot be applied to analog signals. Therefore, digital signals are more robust than their analog cousins and are relatively immune to electrical noise (interference) until the contamination gets so bad that the numbers (the binary code of 0s and 1s) get lost beyond the ability of the error-correction system to recover them. The practical result of this is that digital signals can be packed more densely on storage media, such as optical discs, or transmitted at lower power (poorer carrier-to-noise ratio)—for instance, from a direct-broadcast satellite—than analog signals of equivalent quality.

What it boils down to is that the quality of a linear PCM signal with respect to bandwidth, signal-to-noise ratio, distortion, and so forth is determined by the sampling rate and word size (number of bits used to express each sample value) of the A/D converter. Barring catastrophe, the signal quality remains unaffected by what happens between the point of encoding and the point of decoding. Analog signals are strongly affected by what happens in between, and what happens is never good.

TABLE I—*CCIR-601 (D-1) digital video standard vs. MPEG-2 ML@MP video compression.*

CHARACTERISTIC	D-1 VIDEO	MPEG-2 VIDEO
Horizontal Luminance Resolution	858 samples per line	720 pixels
Vertical Luminance Resolution	525 lines per frame	480 pixels
Color Coding	4:2:2	4:2:0
Horizontal Chrominance Resolution	429 samples per line	360 pixels
Vertical Chrominance Resolution	262.5 lines per frame	240 pixels
Temporal Resolution	30 frames per second	30 frames per second
Source Signal	10-bit linear PCM	8-bit linear PCM
Bit Rate	270 megabits per second	1 to 10 megabits per second; 4 megabits per second average
Data Compression	None	Lossy and lossless compression combined, including: preprocessing; spatial-redundancy reduction via Discrete Cosine Transformation, nonlinear quantization, and entropy coding; and temporal-redundancy reduction via forward and bidirectional prediction using motion vectors

Movies on DVD are packaged in jewel cases identical to those used for CDs or in thin, snap-open book-like boxes.

Photo: Len LaGrua

AND NO SATELLITE TV.

An equally important reason for digitization is that digital signals can be manipulated mathematically by digital signal-processing (DSP) circuits. One possible manipulation is data reduction, or *compression*—i.e., eliminating presumedly unnecessary information from the data stream in order to reduce bandwidth and storage requirements. This is where MPEG video compression comes in, and without MPEG or something like it, there would be no DVD, no digital satellite broadcasting, and no digital HDTV.

ALPHABET SOUP

Two MPEG video-compression schemes are in common use: MPEG-1, used for Video CD and for video-enhanced CD-ROMs, and MPEG-2, the version used for DVD and satellite TV. Both are based on JPEG compression. The alphabet soup sorts out as follows: JPEG stands for Joint Photographic Experts Group and MPEG for Moving Picture Experts Group. The "Joint" in JPEG refers to this group (and MPEG, for that matter) being a joint committee of the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC).

The JPEG committee was established to standardize still-picture compression (photographs); the MPEG committee was charged with doing the same for motion pictures. A separate group within MPEG worked on audio coding, but that's a separate issue that I'll not take up here. When I refer to MPEG in this article, I mean MPEG *video* compression—specifically, MPEG video compression of the type used in Video CD (MPEG-1) and DVD (MPEG-2). The standards themselves are far broader in scope than that.

MPEG-1 compression is optimized for use at the relatively low data rate supported by the Compact Disc. In fact, the official title of the MPEG-1 standard, ISO/IEC 11172, is "Information technology—Coding of moving pictures and associated audio for digital storage media at up to about 1.5 megabits/second." Of the approximately 1.4-megabit-per-second (Mbps) bit stream supported by CD, 0.224 Mbps are devoted to sound and 1.15 Mbps to video. Like conventional CDs, Video CDs stream data at a constant rate, so the picture gets the same number of bits per second, like it or not. The relatively low and constant data rate limits the video from Video CD to "VHS quality"; however, as we'll see, it's impossible to make a direct comparison between MPEG-compressed digital video and analog video.

INCREASED DATA RATE

MPEG-2 compression is optimized for generally higher data rates than MPEG-1 and provides results that (in the version used for DVD) approach professional studio picture quality. In MPEG-2's application in DVD, the momentary data rate can vary from about 1 to 10 Mbps, depending on picture complexity. MPEG-2 compression thus offers the possibility of optimizing the trade-off between picture quality and data rate (storage requirement) on a dynamic basis. MPEG-2 also supports interlaced scanning, the system used by consumer TV sets to paint each picture frame as two fields arranged so that the second fills in the blanks left by the first. MPEG-1 supports only the progressive-scan (paint-it-all-at-once) method preferred by the computer industry.

Despite these very important differences, MPEG-1 and MPEG-2 video compression are fundamentally similar. Both reduce the overall transmission and storage requirements by a combination of "lossy" and "lossless" techniques. In this, they are similar to certain audio data-compression algorithms, although there are techniques that

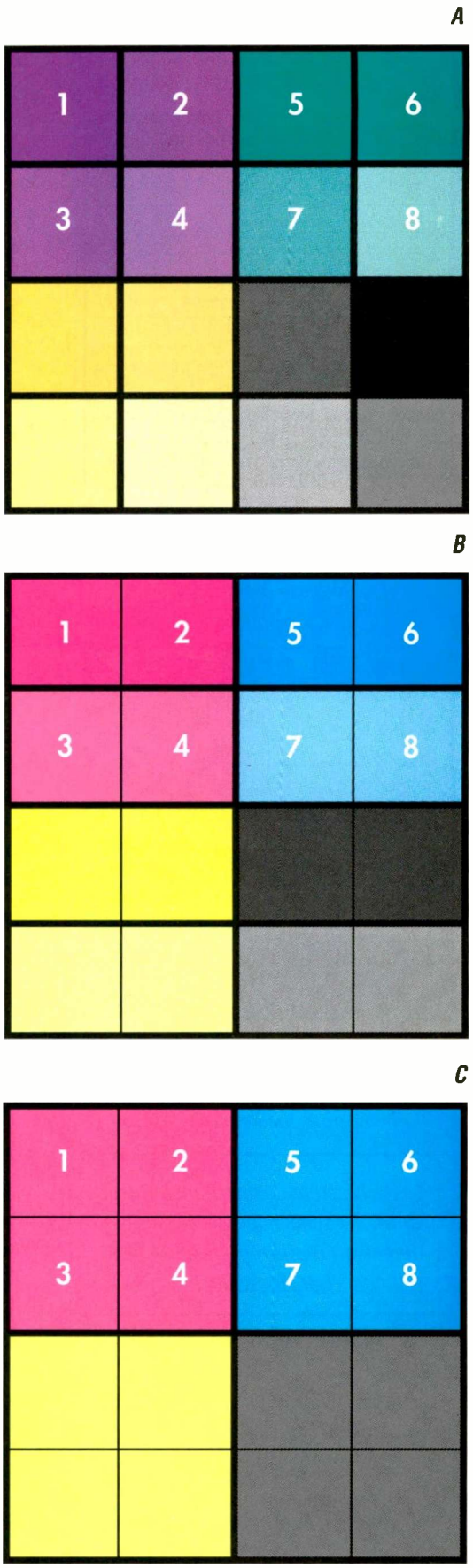


FIG. 1—*Vertical and horizontal luminance and chrominance resolution for computer graphics 4:4:4 color (A), CCIR 601 digital video 4:2:2 color (B), and MPEG-2 ML@MP 4:2:0 color (C).*

Uniform luminance throughout 8 x 8-pixel spatial matrix

250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250
250	250	250	250	250	250	250	250

A

DCT

After lossless Discrete Cosine Transformation

250	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

B

Only the DC term in the upper left corner, representing average luminance, is non-zero in the frequency matrix

Fig. 2—*Discrete Cosine Transformation from the spatial domain (A) to the frequency domain (B) is a lossless transformation.*

can be applied to video that would never fly in audio.

Lossy and lossless compression differ as follows. With lossless compression, the original bit stream can be recovered exactly, bit for bit, with no change whatsoever. When computer users "Zip" files, they're using a lossless compression algorithm. With lossy compression, one cannot recover the bit stream exactly, but one hopes for picture and sound that are visually and aurally indistinguishable from the original (well, almost indistinguishable!).

COMPRESSION RATIOS

MPEG has three lossy compression techniques in its arsenal: prefiltering, to eliminate certain aspects of the picture that are deemed indistinguishable by the normal viewer; reduction in the spatial redundancy of the picture; and reduction of the temporal redundancy in motion pictures. The combination of all three (with a dollop of lossless compression applied along the way) results in compression ratios sometimes quoted as being several hundred to one! If you find it hard to believe that it's possible to eliminate more than 99% of the information and still have a viewable picture, put your mind to rest: MPEG-2 compression ratios are really far lower than that.

DVD video is based on the so-called MPEG-2 Main Level/Main Profile protocol, usually referred to as ML@MP. This is MPEG-2's intermediate level: picture resolution that is not HDTV quality but is better than what you can get from laserdisc or current American or European TV broadcasts. (European broadcast standards afford better spatial resolution than ours.) MPEG-2 ML@MP starts with, and aims to approximate, pictures of CCIR-601 studio quality.

CCIR-601 (or D-1) digital video operates at a data rate of 270 Mbps. If it could be recorded straight to DVD (which it can't), CCIR-601 video would fill a single-sided single-layer disc in less than 140 *seconds*, and that's ignoring the audio! Obviously, we're talking some serious data compression if we aim to get 133 minutes—that's *two hours* and 13 minutes—of audio and video onto a single-sided/single-layer DVD.

At first blush, the required video compression ratio would seem to be well over 57 to 1 (133 minutes divided by 140 seconds) in order to make room for the audio. But all of that doesn't come from eliminating picture redundancies. To begin with, in the NTSC-television world (in general, North and South America and Japan), professional CCIR-601 digital video assumes a sampling rate of 858 samples per scanning line, 525 lines per frame, and 30 frames per second (see Table I). Many of these samples lie off-screen in the horizontal and vertical blanking intervals and needn't be encoded at all. (In the PAL and SECAM world, the specific numbers differ, but the totals remain about the same.)

DVD MPEG-2 assumes a 720 x 480-pixel screen rather than 858 x 525 pixels (the aforementioned studio D-1 digital standard), which reduces the pixel count by about 25% right off the bat. Instead of 270 megabits per second, we're down to 207. Next, we lower our standards a trifle and target video of "near studio-quality." The CCIR-601 video standard specifies 10-bit digital words; DVD's MPEG-2 encodes with 8-bit resolution. Chalk up savings of another 20%, so the input bit rate becomes 165.7 Mbps.

Then there's the matter of color resolution. Video signals originate as three components, one for each primary color: red, green, and blue. With this RGB representation, it's necessary to convey each component at the same resolution. Digital video also needs three signals to convey a color image but uses YCrCb representation rather than RGB. In this scheme, Y is the luminance, or brightness, signal, and Cr and Cb are proportional to the difference between the brightness and the original red and blue images. The third primary color, green, is derived by matrixing the chrominance channels with the luminance channel. With YCrCb representation, it's possible to convey luminance and chrominance informa-

IN MPEG-2'S APPLICATION IN DVD, THE MOMENTARY DATA RATE CAN VARY FROM ABOUT 1

tion at different resolutions, which is valuable because it mirrors the way we see. Since we respond to brightness (luminance) detail with far greater acuity than color detail, there's really no need to have the color resolution be as good as the luminance resolution. That means we can save data!

Figure 1 suggests how this can be put to practical use. Figure 1A depicts 4:4:4 color: equal horizontal and vertical resolution for all components whether they are in RGB format (which requires equal resolution) or in YCrCb (which does not). CCIR-601 specifies 4:2:2 color coding, as shown in Figure 1B. The two chrominance channels (Cr and Cb) are conveyed with the same vertical resolution as the luminance (Y) channel but with only half as much horizontal detail. DVD MPEG-2 (Fig. 1C) uses 4:2:0 color coding, which halves the vertical resolution of the color channels as well as their horizontal resolution. This results in another 25% savings in data. At this point, we've eliminated 54% of the information by prefiltering (the bit rate has dropped from 270 to 124 Mbps) and we've yet to apply what's normally thought of as real MPEG compression.

One final step before we bring in MPEG's really big guns. Movie film is shot at 24 frames per second, not at our NTSC television system's 30 frames-per-second rate. This means that when a movie is converted to video, six out of every 30 video frames are exact repeats and need not be encoded. To facilitate eliminating these redundancies, MPEG-2 carries instructions to the decoder to repeat a field or frame when appropriate. Of course, the trick applies only to movie-film sources, but it's reasonable to assume that most high-quality DVDs (where MPEG can use all the help it can get) will originate from film. This special case brings the source bit rate to less than 100 Mbps; 63% of the data has been eliminated by hacking the fat off the input signal rather than by real compression.

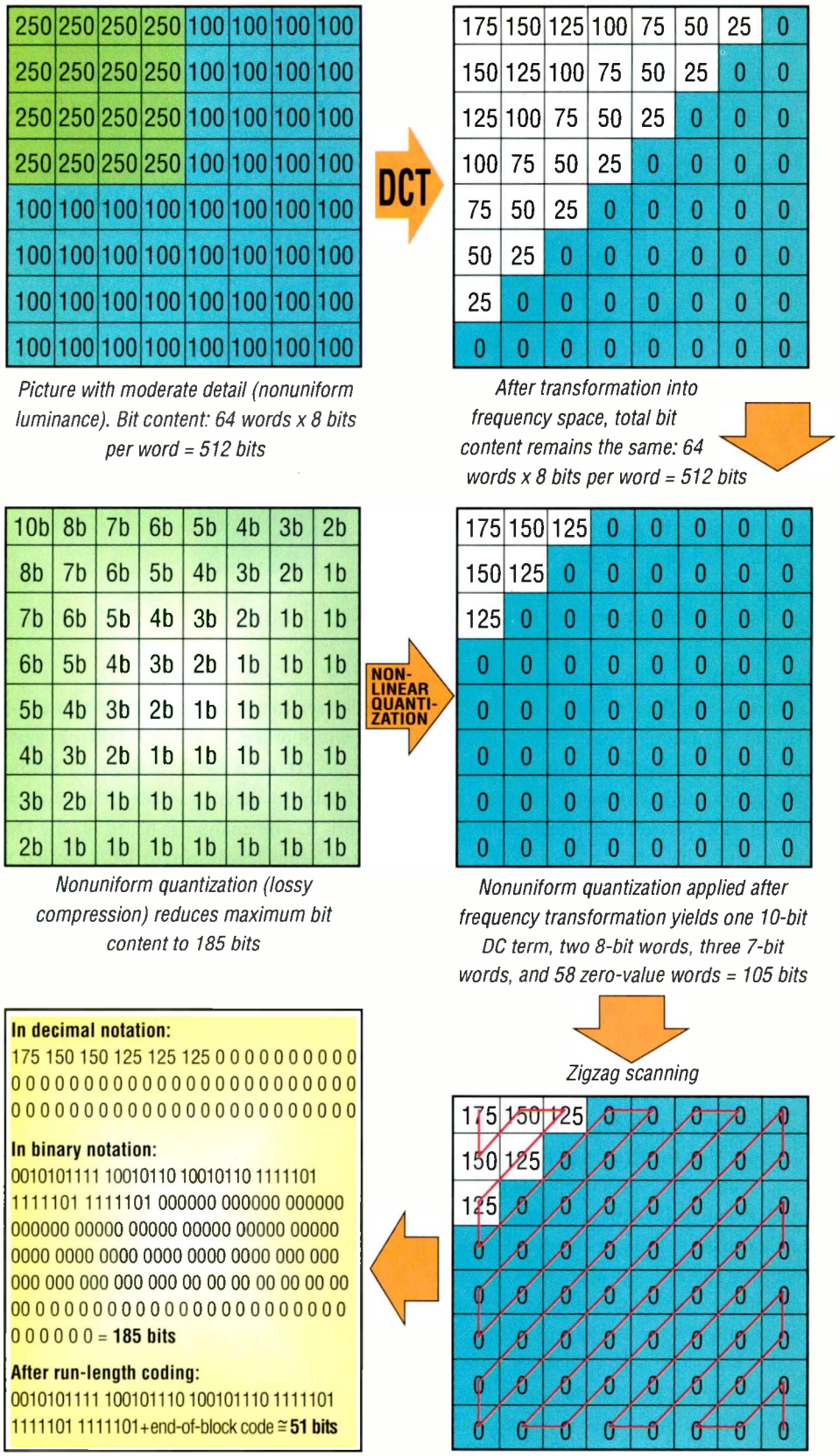


FIG. 3—*MPEG-2 spatial redundancy reduction.*

TO 10 MEGABITS PER SECOND.

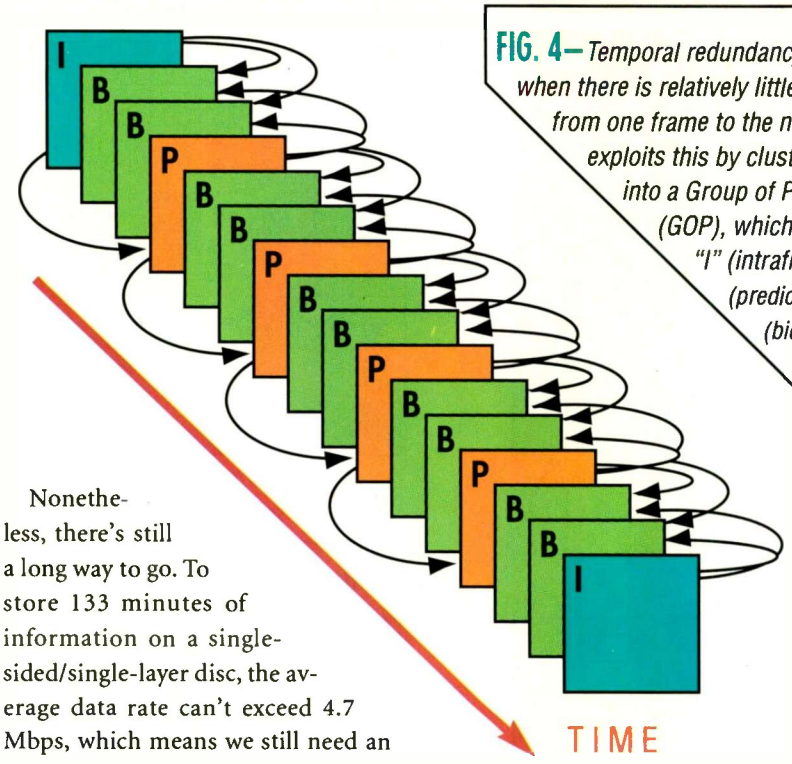


FIG. 4—*Temporal redundancy occurs when there is relatively little motion from one frame to the next. MPEG-2 exploits this by clustering frames into a Group of Pictures (GOP), which consists of "I" (intraframe), "P" (predicted), and "B" (bidirectional) frames.*

Nonetheless, there's still a long way to go. To store 133 minutes of information on a single-sided/single-layer disc, the average data rate can't exceed 4.7 Mbps, which means we still need an average compression ratio of slightly more than 21:1. To leave room for audio, subtitles, and the like, the compression ratio must average over 21:1. MPEG-2 ML@MP accomplishes this by reducing the spatial and temporal redundancies in the motion picture using techniques similar to those described by Bob Finger in his 1994 article. In what follows, I'll use the luminance channel as an example, but with appropriate changes in resolution, the same applies to the two chrominance channels.

REDUCING SPATIAL REDUNDANCY

We start by reducing the spatial redundancy within one frame or field of the picture, using JPEG-like compression. A typical frame usually contains many regions in which there is little or no detail—areas of blue sky, solid backgrounds, and the like are examples of regions that have high *spatial redundancy*. It would be much more efficient (read, save a lot of data) if one could simply tell the decoder to "paint this area with this color at this brightness level" rather than repeat the same color and brightness information pixel by pixel until the region is filled in. That's what is meant by reducing spatial redundancy. Here's how it's done.

First, the picture is divided into tiny 8 x 8-pixel regions called blocks. With a 720 x 480-pixel screen, there are 90 blocks across the width of the screen and 60 blocks vertically. Next, each block is analyzed mathematically to determine the picture detail within it. The analysis is based on the Discrete Cosine Transform, or DCT, similar to the Fast Fourier Transform (FFT) with which you may be familiar. DCT analysis converts the information from the spatial domain to the frequency domain. The transform does not reduce the number of data points—64 components are still needed to represent the 8 x 8 block—but it arranges them in a way that facilitates data compression.

For example, let's assume that all 64 pixels in the block have the same brightness level (Fig. 2A). After transformation, there still will be 64 numbers in an 8 x 8 array, but, except for the one at the upper left corner, they will all be zero (Fig. 2B). The number at the upper left—the DC term in the frequency domain—represents the *average brightness* of the block; the other 63 represent *changes* in brightness (detail) within the block. In our simple example, there were no changes in brightness within the block, so all but the first term are zero. Instead of storing 64 data points, we need only store one (plus information that says the next 63 are zero). Wow! What a savings!

Of course, this example is ridiculously simple. Nevertheless, the technique is powerful because the transformation changes the *entropy* (a measure of disorder or randomness) of the data, and that facilitates compression. Here's what I mean. As stated above, after transformation, the term at the upper left of the array conveys the average brightness of the block, the others, the detail (Fig. 3). If you rearrange the terms of the two-dimensional block into a one-dimensional series by tracing a zigzag pattern about the diagonal, the subsequent terms represent higher-frequency components that convey increasingly fine picture detail. Since most blocks will not contain extremely fine detail (such as sharp edges), some of the later terms in the series (those near the lower right corner of the array) will probably be zero or close to it.

Furthermore, human vision is less acute to fine detail (the high spatial frequencies) than to low, so high-frequency terms need not be conveyed with the same degree of precision as low-frequency terms. This means that we can employ nonuniform quantization, i.e., use larger steps, hence coarser quantization, for the high-frequency (fine-detail) terms than for the low-frequency ones. This technique not only reduces the bit rate, because fewer levels are involved, but also truncates more of the high-frequency terms to zero. Thus, when the 8 x 8 matrix is scanned in zigzag fashion, it's more likely that there will be a string of zeros at the end. These are run-length coded, which means they are replaced by an end-of-block code that tells the decoder "they're all zero from here on."

In essence, transforming the data from the spatial domain to the frequency domain, applying nonuniform quantization, and zigzag scanning reduces the entropy of the data by encouraging a string of zeros at the end of the block. Run-length

coding then further reduces the entropy by replacing the zeros with a simple code; that's where a large measure of data compression takes place. Run-length coding itself is a lossless compression technique. The lossy part of spatial-redundancy reduction occurs in the non-uniform quantization of the data, which effectively encodes picture detail less accurately than it was originally.

A few qualifications, before moving on to temporal-redundancy reduction. Although I've used zigzag scanning to exemplify reorganizing data from a two-dimensional matrix to a low-entropy one-dimensional stream that facilitates run-length coding, MPEG-2 supports an alternate scanning pattern that is said to accomplish the same thing more efficiently when dealing with interlaced video. And, although I've used run-length coding to exemplify entropy reduction because it's simple to envision, there are other methods (like Huffman Coding) that can be even more efficient. Huffman Coding is used when there's a high probability that specific data patterns will recur time and again. These strings of data are replaced with shorter (but unique) bit sequences that are "looked up" in a code table. It's a far more complex method that bears fruit only if long strings of data are repeated over and over.

Also, I noted earlier that MPEG-2 ML@MP uses 8-bit quantization. That is true as far as the original data are concerned. However, as should be clear from the foregoing, fewer than eight bits are often used to represent high-frequency detail after transformation into the frequency domain. (That's where the lossy character comes in.) Finally, with any block-transformation-based video-compression system, the accuracy of the DC term is extremely important because it determines the average brightness of the block—and the eye is acutely aware of posterization, or shifts in average brightness between blocks. Thus, Main Profile MPEG-2 permits up to 10-bit precision for the DC (average brightness) term.

REDUCING TEMPORAL REDUNDANCY

Just as there are areas within a picture that contain little detail and thus are spatially redundant, so, much of the time, there is relatively little change in areas of the picture from one frame to the next—i.e., when there is relatively little motion, there is a high degree of *temporal redundancy*. MPEG compression exploits this as follows.

Pictures are classified into three types: "I" (intraframe), "P" (predicted) frames, and "B" (bidirectional) frames. These are clustered into a group of pictures (GOP) (Fig. 4). "I" frames are fully encoded, using the previously described spatial-redundancy-reduction compression scheme. Many areas of the "P" frames can be predicted from the previous "I" (or "P") frame, using motion compensation (which I'll describe presently) and so need not be fully encoded. "B" frames also rely on motion compensation; they are bidirectionally constructed, or interpolated, from the nearest "I" and "P" frames. Stay with me; this will become clearer in what follows.

In MPEG-2, the GOP sequence is not cast in stone; however, a

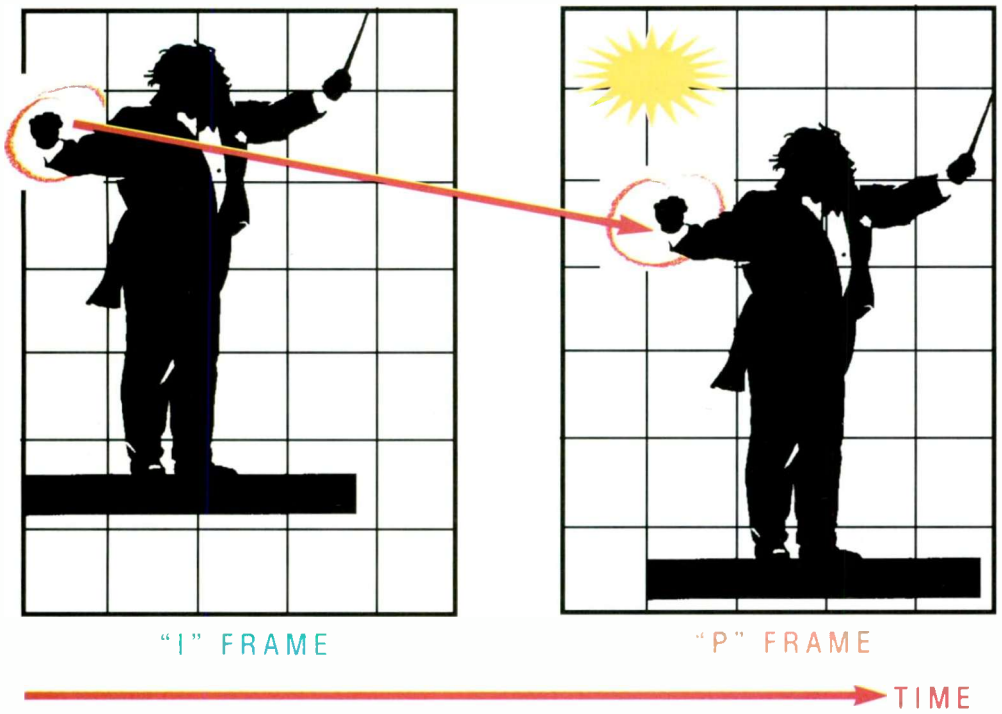


FIG. 5—*Temporal redundancy reduction is also achieved by motion compensation. To calculate a motion vector, the MPEG encoder computes the horizontal and vertical distances a macroblock (circled conductor's hand) moves between the "I" frame and subsequent "P" frame.*

typical picture arrangement might be "IBBPBBPBBPBBPBBI. . . ." That is, every 15th frame is an "I" frame; between "I" frames there are four "P" frames and between each pair of "P" frames there are two "B" frames. In a typical group of 15 pictures, there would be one "I" frame, four "P" frames, and 10 "B" frames, with the "P" frames repeating every third frame.

On the whole, "I" frames require the greatest number of bits to encode, "P" frames about half as many, and "B" frames about one-fifth as many. The exact number depends upon picture complexity, but a reasonable estimate for MPEG-2 ML@MP, encoding at a data rate of 4 megabits per second, would be 400,000 bits per "I" frame, 200,000 bits for each "P" frame, and 80,000 bits for each "B" frame.

Here's a thumbnail description of how the system works. Each picture is decomposed into macroblocks similar to, but larger in size than, the spatial-analysis blocks used in "I" frames. Each macroblock typically consists of a 4 x 4 array of blocks (when frame encoding is used) or a 4-wide x 2-high block array (when field encoding is used). Assuming the GOP arrangement described above, the encoder compares the first "I" frame with the frame third removed (the subsequent "P" frame) on a macroblock-by-macroblock basis, to find which macroblocks (if any) haven't changed (Fig. 5). To construct the subsequent "P" frame, these can be repeated in place, so they require nothing more by way of encoding than a signal to tell the decoder to repeat the block, *in situ*, exactly as it is.

The encoder also searches an area around each macroblock to see if it can find a match. When a match is found, it calculates the horizontal and vertical distances by which the original macroblock moved between the "I" frame and the subsequent "P" frame. This is called a motion vector. The motion vector is encoded and used by the decoder to translate the "I"-frame macroblock to its new location in the "P" frame.

The extent of the search area depends upon the capabilities of the encoder. Up to a point, the wider the search area, the greater the chance of achieving a match and thus reducing the amount of data that needs to be stored on the DVD. However, searching a wider area requires a lot more computational power in the encoder and more bits to represent the motion vector to the required accuracy, so there comes a point of diminishing returns.

Of course, not all macroblocks can be matched, even after translation to a different point in the picture. Objects enter and leave the scene, and movement of one object may reveal what hitherto had been obscured, and vice versa. Areas of the picture that cannot be matched are encoded using spatial-redundancy reduction just like an "I" frame and therefore require more data. Scenes containing fast motion provide fewer macroblock matches and therefore require momentarily higher data rates.

It is important that macroblock matching be accurate, because "P"-frame errors propagate until they're corrected by the next fully encoded "I" frame. That is, each subsequent "P" frame is predicted from the one before it (and every intermediate "B" frame from the adjacent "P" frames) until an "I" frame comes along and "anchors" the picture. That's why MPEG-2 specifies that motion vectors be conveyed with ½-pixel precision. A good encoder, operated by knowledgeable engineers, can break the standard GOP sequence and insert an "I" frame, when needed, to stem "P"-frame error propagation that might, for example, be caused by a sudden, radical change of scene.

While "P" frames are forward-predicted from the nearest preceding "I" or "P" frame, "B" frames are bidirectionally predicted from the nearest (previous and subsequent) "I" or "P" frames. Since a "B" frame never serves as the reference for another frame, the way that "P" frames do, errors in "B" frames don't propagate, therefore less accuracy is needed. Consequently, less data is devoted to "B"-frame handling than to "I"- or "P"-frame storage. Bidirectional prediction is used for "B" frames so that if there's a sudden shift in scene between the frames from which it is predicted, a reasonable interpolation between the two pictures can be made to smooth the shift. Because "P" and "B" frames are based on prediction from other frames, only "I" frames serve as suitable entry points for freeze-frame and other special playback effects.

When possible, MPEG shifts expense from the decoder to the encoder on the assumption that consumer products will more likely be decoding (playback) devices than encoding (recording) devices. A simple example of this is frame organization. Because "B" frames depend on the previous and subsequent "P" or "I" frames, a "B" frame cannot be decoded until the surrounding "P" or "I" frames are available. It saves on decoder field and frame memory to store and reorganize the data on the encoding end so that a "P" frame follows immediately after an "I" frame and is followed by the two "B" frames that originally were in between.

WHAT TO EXPECT FROM MPEG VIDEO

I hope you will have gleaned from the foregoing that MPEG video compression is really just a toolbox of techniques, not all of which need (or even can) be used in every situation. MPEG simply standardizes a syntax so that an MPEG-2 ML@MP-compliant decoder can parse (decompose) the bit stream and properly interpret the instruc-

tions it contains: In other words, it will know whether it's dealing with an "I," a "P," or a "B" frame or field, whether the data corresponds to a motion vector or to spatial data within a block, whether nonuniform quantization was used and what that nonuniformity is, and so on.

MPEG-2's encoding flexibility implies that picture quality will depend on many decisions, not all of which are technical. Consider the encoding of a DVD movie. The major technical limitation is the disc's storage capacity: 4.7 gigabytes for the single-layer/single-sided format. But the disc could be dual-layer/single-sided, single-layer/dual-sided, or dual-layer/dual-sided if the studio decides to make it so.

Now look at the single-layer/single-sided disc for a moment. Its storage capacity restricts the average data rate to 4.7 Mbps, but that's true only if the movie or program runs for a full 133 minutes. Not all programs do, which means that the average rate can often exceed 4.7 Mbps. Whatever the average data rate, it must be shared among video, audio, and subtitles. The division is a "front-office" decision. How many languages are going to be carried? Are all encoded in 5.1-channel discrete surround sound, or are some in matrix surround? How much capacity is used for alternative viewing angles, selectable ratings versions, and the like? Any of these may be nice, but they all require additional storage space. Clearly, the actual average data rate can depend as much on marketing considerations as on technical factors.

Within this framework, however, picture quality is ultimately decided by technical considerations—encoder acumen and operator judgment being two of the major ones. When mastering a DVD movie, the usual procedure is to make a preliminary pass to identify scenes that are difficult to encode and to tentatively allocate bits throughout the movie to optimize the end result. Some encoders can be expected to be more adroit at doing this than others, and all those developed to date seem to benefit from human intervention—i.e., having an operating engineer substitute his or her judgment in place of the encoder's on occasion. To what extent the engineer does this and to what extent his or her judgment is valid will vary according to individual ability.

Encoders also can be expected to differ in capability: for example, the picture area over which they search for macroblock matches, how they perform the search (there are several ways), the facilities they provide for bit-rate optimization and operator intervention (preprocessing, quantization step-size selection), and so forth.

Finally, picture quality is likely to depend on the source material. As mentioned previously, programs that originate on film require less compression than those sourced direct from video. Most difficult of all are live digital broadcasts of sports events, because there's no opportunity to preview the program. (Digital broadcasts are a special case in any event because of the special requirements they impose on variable-rate encoding.)

It's natural to want a nice clean comparison between MPEG-2 video and the analog variety we're all familiar with, but it's not that simple. The strengths and weaknesses of the two systems are quite different. If you compare the potential quality of MPEG-2 ML@MP video with that of typical analog program sources vis-à-vis picture resolution, color accuracy, noise, and so forth, MPEG-2 wins hands down. In theory, MPEG-2 ML@MP has twice the horizontal resolution of VHS tape (in practice, it's much more than that!), 50% more resolution than an ideal NTSC broadcast, and about ⅓-better resolution than is possible with laserdisc. Signal-to-noise ratio and color accuracy are better in practice, too.

Nevertheless, analog program material is not subject to motion artifacts and posterization, as compressed digital video can be. Nor can it by stymied by a multiplicity of frames with far below average spatial redundancy. So, how does one make a comparison? By viewing. And in that light, I'll take MPEG-2 ML@MP over analog any day of the week. A

by Gordon Brockhouse

AUDIO OVER cyber stereo THE INTERNET

As I write this article, I'm listening to the glorious Klaus Tennstedt and the Chicago Symphony Orchestra recording of Mahler's First Symphony broadcast by KING-FM in Seattle. That wouldn't be noteworthy if I lived in the Pacific Northwest. But I live in Aurora, Ontario, Canada, a Toronto suburb 2,100 miles from Seattle. I'm listening to KING-FM's Internet feed through my personal computer's sound card and speakers. To put its programming on the World Wide Web, KING-FM uses a compression technology called RealAudio, developed by Progressive Networks, a Seattle-based company.

To tune in KING-FM, I activated my Web browser and entered KING-FM's address (www.king.org). When KING-FM's page appeared on my screen, I clicked the RealAudio icon to listen to the live feed. A few seconds later, the RealAudio player software in my computer opened, and shortly after that I heard the announcer introducing the Mahler recording.

Before RealAudio was introduced in April 1995, the only way to capture audio from the Internet was to download the entire file, then launch media-player software to listen to it. Even a short digital audio clip would take several minutes to download. RealAudio Version 1.0 brought "streaming audio" to the Internet, so you can listen to the file before it's completely downloaded.

Here's how it works. Audio feeds are digitized and stored on a computer called a server. When someone requests the file, it's sent via the Internet and flows into a memory buffer in the user's computer. It's then read and decompressed by player software and sent to the computer's sound card and speakers. While the sound is being played, more data flows into the buffer.

Rather than a continuous stream, the Internet transmits data in packets. Different packets may take different paths from the sending to the receiving computer. Occasionally, packets can be lost or arrive out of order. When this happens, the buffer gives the player

software time to rearrange data packets in the correct order or request the originating computer to resend a packet.

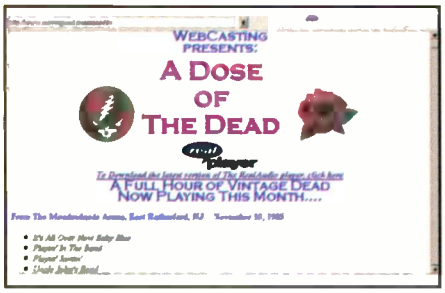
Most home computer modems work at speeds ranging from 14.4 to 33.6 kilobits per second. The bandwidth required for 16-bit PCM audio sampled at 44.1 kHz is 1.2 megabits per second. To transmit audio over the Internet in real time, the sound has to be sampled at lower rates, encoded with fewer bits per word, and then heavily compressed.

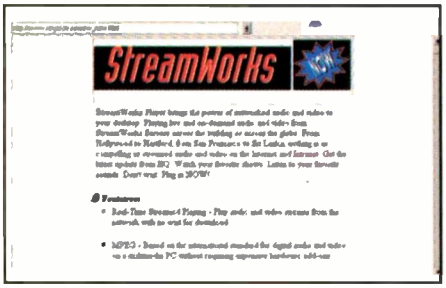
RealAudio has gone through two major upgrades since its introduction. Version 2.0 enabled live feeds—not just archived audio files—to be sent over the Internet. Version 3.0, introduced in September 1996, added stereo audio capability for users with 28.8-kilobit (or faster) connections. RealAudio 3.0 uses DolbyNet, an aggressive form of Dolby Labs' AC-3 compression system, to squeeze two channels of streaming audio through a 28.8-kilobits-per-second pipe.

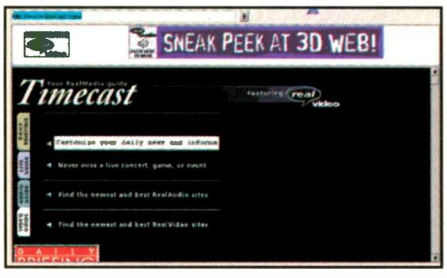
RealAudio sites can be configured to send higher-quality audio to users with faster connections—for example, users with ISDN hookups to the Internet. (Integrated Services Digital Network, now available from many telephone companies, costs about twice as much as normal voice-grade service and can deliver connection speeds up to 128 kilobits per second, but you need an account with an Internet Service Provider--ISP--that supports ISDN.) Progressive Networks claims RealAudio 3.0 can deliver "near-CD quality sound" over ISDN and faster connections as well.

RealAudio isn't the only streaming-audio scheme used on the Internet. Macromedia's Shockwave, a popular software system used to create animated Web pages, also supports streaming audio. Xing Technology's StreamWorks delivers streaming MPEG audio and video. Liquid Audio has its own streaming audio system. But now that RealAudio is used by nearly 20,000 sites, it's by far the most popular scheme for streaming audio over the Internet. And it's the

Illustration: Marina Sagona







only system that streams audio from live as well as archived sources.

Depending on the site you're visiting and the speed of your connection, sound quality ranges from dreadful to not too bad. Bearing in mind the limitations of the Internet as a medium for streaming audio, you can look at it another way. Sound quality isn't as good as you'd like, but it's a lot better than you'd expect.

Progressive Networks claims RealAudio will deliver "broadcast quality" stereo audio over a 28.8-kilobits-per-second connection. Nothing I heard sounded like good FM radio—or even good AM. Compared to radio, the best I heard on RealAudio was compressed and lacking in highs, but certainly intelligible. There was often a mild buzz superimposed on the sound. Predictably, monaural sites sounded better than stereo sites. Occasionally I heard a disturbance that sounded exactly like what you hear when a CD player locks up.

The announcer's voice on KING-FM had a raspy edge. In Mahler's First Symphony, the brass instruments sounded quite good, but strings and woodwinds had a distinctly electronic sound. In Beethoven's Choral Fantasia the sopranos sounded chirpy and choral sections congested.

On an NHL pregame show, there was a raspy buzz over the commentator's voice. Frequency response was broader than a telephone's, but not as wide as AM's. "A Dose of the Dead" sounded like an AM station at the fringe of its reception range.

The audio also suffered seriously from dropouts, or to use the correct term, "re-buffering." This results when data throughput drops and the buffer becomes exhausted. Until the buffer's contents are replenished, sound stops dead. I experienced dropouts at nearly every site I visited. On some they were rare and on others frequent. The mono Shockwave audio at the Ultra-Lounge site sounded quite good except for the constant re-buffering I experienced on my first visit.

Used by nearly 20,000 sites, RealAudio is the most popular scheme for sending audio over the Internet.

I did most of my listening on my PC through a Bose Acoustimass Multimedia Speaker system. Its two satellites flank my monitor, and the bass module is at my feet. The system may not be the last word in high fidelity, but it's infinitely better than most other computer speaker systems and arguably the best PC speaker system available. I also did some listening on my PC through Sennheiser HD560 headphones.

Playback equipment aside, sitting in an office chair in front of a monitor isn't the best way to listen to music. Wouldn't it be nice if there were a way you could sprawl on a couch and listen to Internet audio through a top-notch audio system, remote control in hand?

Well, there is. Last fall, Sony and Philips introduced Internet set-top boxes that hook to your TV and audio system. WebTV Networks developed the technology used in these boxes and provides Internet access for them.

This fall, several companies, including RCA, plan to introduce TV Internet set-top boxes based on the Network Computer (NC) standard championed by Oracle Corporation, a major database software company. RCA's NC set-top box was still under development at the time of writing, and NetChannel, which will provide Internet service for RCA and possibly others using the NC standard, was still developing its service.

I was able to check out Sony's WebTV box for several days. Sony's WebTV is priced at $299, including a remote control; an optional wireless keyboard is $99.99. Connecting the device and getting up and running is dead simple. I hooked the video up to my Toshiba 35-inch direct-

what you can hear on the net

Given the huge number of Internet sites with streaming audio, it's possible to provide only a sample of the things you can listen to on the Internet. You can go to www.timecast.com to locate links to thousands of RealAudio sites. There are links to Shockwave sites at www.macromedia.com, to Liquid Audio sites at www.liquidaudio.com, and to StreamWorks sites at www.xingtech.com.

Here is a sampling of Web sites and their programs that I've recently heard on the Net.

Live Radio

Besides the Mahler symphony, I heard a performance of Beethoven's Choral Fantasia on KING-FM at www.king.org. If classical music isn't your thing, U.S.-based radio stations of virtually every stripe are available on the Internet.

News

I listened to newscasts from ABC Radio and the Canadian Broadcasting Corporation. Many radio services on the Internet maintain archives of their most recent newscasts accessible through their Web sites, so you don't have to tune in at a specific time to catch the news. Internet radio is a nice way for travelers to keep up with events at home.

Sports

I was working on this story in the midst of the Stanley Cup semifinals, so I visited the NHL site to hear exclusive pregame interviews. I could have listened to the game over the Internet had I wanted to, but opted to watch it on TV. However, many sports events available only regionally on radio or TV, such as college sports, are broadcast live over the Internet. With a little luck, travelers can keep up with the home team while they're away.

DXing

Besides radio stations from all over North America, many foreign shortwave services have a presence on the Internet. The easiest way to find them is through the World Radio Network at www.wrn.org. I pointed my browser at WRN and caught newscasts from Vatican Radio and Johannesburg's Channel Africa.

Music Clips

Many record labels, artists, and online record stores let you preview recordings on their Web sites. You could go to www.davidbowie.com to grab a sample of *Earthling*, Bowie's latest album, and avoid wasting money on this drearily pretentious production. At Music Boulevard, an online record store, you can hear snippets of featured albums. When I visited, one of those was *Portrait*, by the medieval-music vocal quartet Anonymous 4. Deutsche Grammophon had a clip from the *Dvorák for Two* recording by Gil and Orli Shahan. At www.ultralounge.com Capitol Records has samples of a series of music from the '50s and '60s, such as "Peter Gunn Mambo" from the *Mambo Free* album.

Many independent bands distribute their music solely via the Internet and let you sample their wares first. You can also hear material from established artists that's hard to find through regular channels. Deadheads can go to www.morningdeal.com/dose.htm for "A Dose of the Dead," a healthy 45 minutes of recordings from Grateful Dead concerts between 1970 and 1985.—G.B.

I found surfing the Web from my couch an appealing way to experience Internet audio.

view TV set and the audio to a Marantz AV600 preamp/processor. The amplifiers were Marantz MA500s driving PSB Stratus Gold speakers in the front (I don't use a center-channel speaker) and PSB Stratus Minis in the rear.

Besides the obvious benefit of better audio equipment, I found surfing the Web from my couch an appealing way to experience Internet audio. The interface is wonderfully intuitive. You point the remote control at the TV and use scrolling buttons to move through the pages on the screen, then hit enter when you find what you want. When you need to enter text, you can hook up a computer keyboard or the optional wireless keyboard. The remote control and the wireless keyboard both work well, and the whole experience bridges the gap between home computing and home entertainment. But this ease of use comes with a sacrifice in performance.

Media players for RealAudio and Shockwave work as "plug-ins" or "helper applications" for your Web browser. When a new scheme for delivering multimedia over the Net or an upgrade is introduced, you download the player software to your computer (almost always for free) and then you're able to access content for which the player was designed.

Things work differently with the Internet set-top boxes. WebTV Networks, NetChannel, and other service providers, rather than the user, maintain the Web-browsing software. That's good, because you don't have to go to the trouble of finding and installing new software and upgrades to access new media content. It's bad, because you have to wait until the provider issues a software update, and since player software usually has to be rewritten to work on Internet set-top boxes, that can take a while.

As an example, WebTV was introduced last fall, but RealAudio capability was made available last December—and for RealAudio 2.0, not 3.0, with no support for Shockwave audio. When I tried to tune in RealAudio 3.0 sites, such as KING-FM or Ultra-Lounge, I just got error messages. In early June, WebTV Networks said support for RealAudio 3.0 and Shockwave audio in late June or July, nine months after RealAudio 3.0's introduction.

The RealAudio 2.0 sites I sampled sounded similar to what I heard on my PC, except, of course, that I was hearing them through much better electronics and speakers. At the David Bowie site, the sound was muffled and noisy, as it was on my PC. Vatican Radio and Channel Africa sounded like so-so AM radio, but better than shortwave. The Dvorák on the Deustsche Grammophon site sounded pretty good, up to AM radio standards.

SONY'S WEBTV ADAPTOR LETS YOU USE YOUR TV TO SURF THE WEB FROM THE COMFORT OF YOUR COUCH.

What remains to be seen is how quickly Internet set-top companies are able to deliver software updates as new systems for delivering multimedia over the Internet materialize.

We're just at the beginning of audio on the Internet. In a few years, multi-megabit Internet access will be broadly available. CD-quality streaming audio will be a piece of cake, and high-quality streaming video will be deliverable. How other areas of the Internet are able to cope with large-scale demand for rich multimedia content is still an open question, however.

But you don't have to wait for this high-bandwidth future to enjoy audio on the Internet. If you don't mind tying up a phone line and you have an Internet account with a generous (preferably unlimited) monthly connection time, it's a very pleasant way to discover new music or engage in a modern form of DX-ing. The compromises in audio quality aren't so severe that they prevent you from enjoying what you're hearing. As I listen to the Chicago Symphony Orchestra playing the Mahler First on KING-FM, I'm far more conscious of the glowing account of the first movement than of any limitations in sound quality. I'll pick up the CD downtown, or maybe I'll order it online. A

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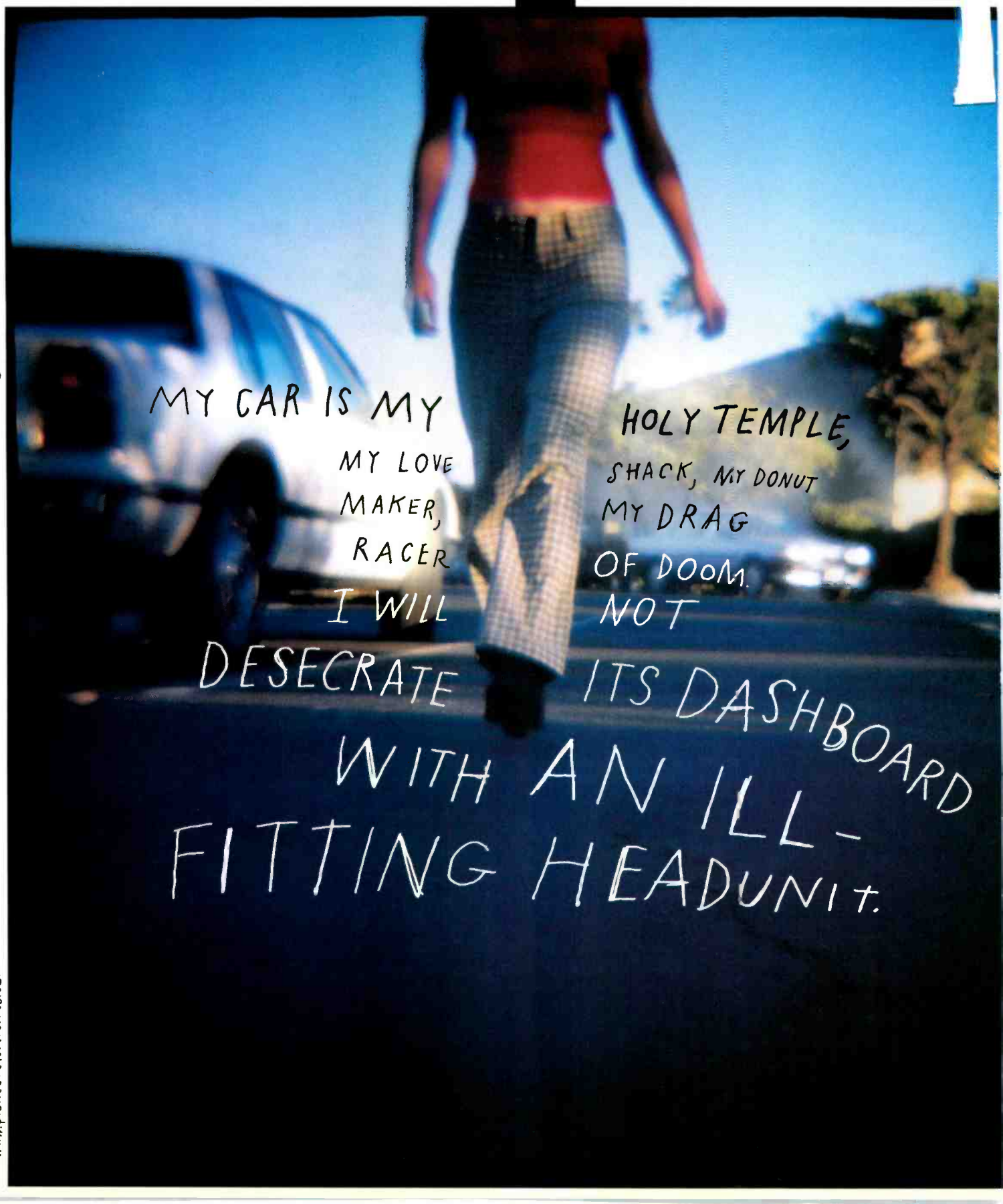

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EQUIPMENT PROFILE

EDWARD J. FOSTER

YAMAHA RX-V2092 A/V RECEIVER

You know you're aging when encountering a still-living tradition gives you a warm fuzzy feeling, like the one I got when I saw Yamaha's "Natural Sound" logo on the RX-V2092. And when I flipped down the hinged door and saw a "Tone Bypass" button and an independent recording selector ("Rec Out"), the feeling got a warmer and fuzzier. Sadly, such goodies, formerly expected of any receiver that claimed audiophile stature, are now usually sacrificed on the altar of cost saving. Yet it's still desirable to be able to bypass unwanted tone-control circuits and obtain unadulterated (dare I say "Natural"?) sound, or to have an independent recording selector that also ensures unenergized recorders will not affect the sound you're listening to. But enough about tradition; the Yamaha RX-V2092 A/V receiver is as up-to-date as tomorrow's news.

YAMAHA'S RX-V2092 FOLLOWS SOME SOLID TRADITIONS YET IS AS UP-TO-DATE AS TOMORROW'S NEWS.

The RX-V2092 replaces the RX-V2090 that I reviewed last year (*Audio*, April 1996). It costs a hundred bucks more, but the new model's additions and improvements are well worth the money, even in this low-inflation era. While the 2090 was "Dolby Digital Ready" (well, almost—we complained about its LFE-channel signal routing), the RX-V2092 has an internal Dolby Digital decoder (arguably worth more than $100 in its own right), and the routing problem has been solved.

The RX-V2092 also features an updated version of Yamaha's Cinema DSP processing, called Tri-Field, first introduced in the DSP-A3090 seven-channel Home Theater Amplifier a little over a year ago. The updated Cinema DSP claims to take better advantage of Dolby Digital's stereo surround channels to create a more satisfying home cinema experience, i.e., one that more accurately reflects the sound field of a first-run movie theater.

Yamaha also has upped the power rating of its premier receiver from 100 watts x 3 in the main front channels with 35 watts x 4 for the surround and front-effect channels (in the RX-V2090) to 100 watts in all five Dolby Digital channels plus 25 watts x 2 for the front-effect speakers. (The RX-V2092 and RX-V2090 are seven-channel receivers, to take full advantage of Yamaha's Cinema DSP processing.) Finally, toss in a very nifty main remote with programmable macros—and a simpler one for operating from a second room—and I think you'd be hard pressed to begrudge Yamaha an extra C-note for the RX-V2092.

The RX-V2092 uses a Yamaha-developed 20-bit chip (the YSS-243) for Dolby Digital decoding and has dual inputs for AC-3 bitstreams. If you want Dolby Digital sound from laserdiscs, however, you'll need an outboard demodulator to extract the AC-3 bitstream from a laserdisc player's RF signal. (Yamaha offers the APD-1 demodulator, for $100.) That's a nuisance, but I think it's the way things will go in the future. I've

Rated Power With 8-Ohm Loads: Main, center, and rear effects channels, 100 watts/channel at 0.02% THD, 20 Hz to 20 kHz; front effects channels, 25 watts/channel at 0.05% THD and 1 kHz.
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Photos: Michael Groen

never understood why laserdisc players with AC-3 capabilities don't have onboard RF demodulators, because they're the only AC-3 program source that needs them. I guess manufacturers were afraid to up the price of their players when they weren't (and aren't!) sure whether Dolby Digital laserdiscs will take off before DVD kills them.

In any event, the RX-V2092 handles two Dolby Digital audio sources, one tied to the "DVD/LD" video path and the other to the "TV/DBS" video path. The AC-3 signal can come optically or electrically from the "DVD/LD" source, since both Toslink and RCA jacks are provided. The "TV/DBS" AC-3 signal must be via coax. Stereo analog inputs are provided for both these sources as well. Other audio/video connections are provided for two VCRs via rear-panel jacks (with recording outputs for each), a "Video AUX" input behind the front-panel door, and one set of "Monitor Out" jacks. An S-Video connector parallels each composite-video RCA jack.

THE RX-V2092 DOESN'T FORCE YOU TO USE ON-SCREEN DISPLAY OR THE REMOTE, EVEN FOR SETUP.

The Yamaha also has provisions for one audio recorder (with analog, but not digital, connections), a CD player, and a moving-magnet phono cartridge. The FM antenna connects via a 75-ohm jack, the AM antenna via spring-loaded terminals. Reasonably sturdy multiway binding posts on standard 3/4-inch centers are used for each speaker. Two pairs are provided for both the center and the main front speakers, one pair each for rear- and front-effect speakers.

Preamp outputs are available on each channel, including two each for the center and subwoofer signals, but power-amp inputs are furnished only for the main front channels, with external links from the appropriate preamp outputs. (Yamaha presumably supplies these inputs so you could use these 100-watt amps in place of the front-effects channels' 25-watt amps, should you add larger, external amps for the main channels.) Stereo audio and composite video outputs are provided for "Room 2." All rear-panel RCA jacks are nickel-plated; the "Video AUX" and headphone jacks on the front panel are flashed with gold.

The rear panel also carries "Remote Control" input and output jacks for the second room. The input is for use with an infrared signal receiver in that room. The output can feed an infrared emitter to relay commands from the second room to other components in your main room's A/V system.

Also on the rear are four setup switches and three switched convenience outlets (which can handle a total of 100 watts). The setup switches include a button to series-connect the center speakers when two are used, an "Impedance Selector" for the main-front speakers, and two small slide switches: "Front Mix," to mix the front-effects channels into the main front pair where no front-effects speakers are used, and a second to drop the level of the main channels by 10 dB. The manual (which is well written and quite thorough) describes two other switches: one to choose between PAL and NTSC video, the other to change the "Frequency Step" of the tuners. Presumably these are available only on universal models (they'd be useful in Europe); they didn't exist on our sample.

With the door closed, the RX-V2090's front panel is pretty simple. The power switch is, as usual, on the left. For the tuner there are eight station-preset pads below the display and a bank-selector switch that cycles through five memory banks, bringing the total preset count to 40. To the right of the display is a nine-pad source selector for "VCR 2," "VCR 1," "DVD/LD," "Video AUX," "Tape (MD)," "TV/DBS," "Tuner," "Phono," and "CD." Just above are 10 pads that enable you to choose the sound processing mode ("Digital/Pro Logic," "Enhanced," "Movie Theater," "TV Sports," "Stadium," "Disco," "Rock Concert," "Jazz Club," "Church," and "Concert Hall"). At the right above the volume knob is an "Effect" pad that disables the center and effects channels and restores the system to stereo operation.

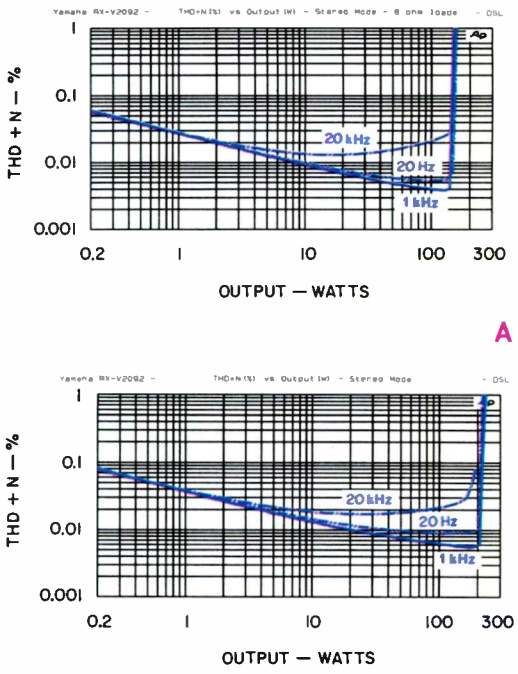


Fig. 1—THD + N vs. amplifier output into 8 ohms (A) and 4 ohms (B).

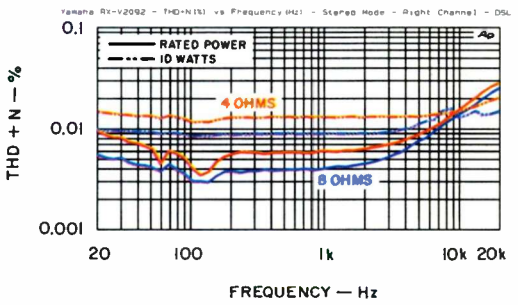


Fig. 2—THD + N vs. frequency.

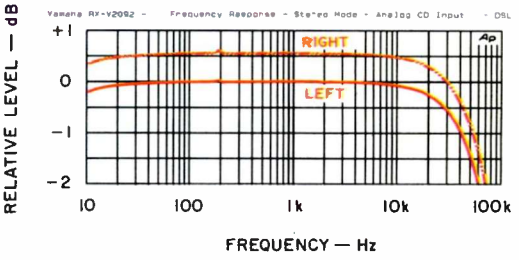


Fig. 3—Frequency response, stereo mode, using analog CD input.

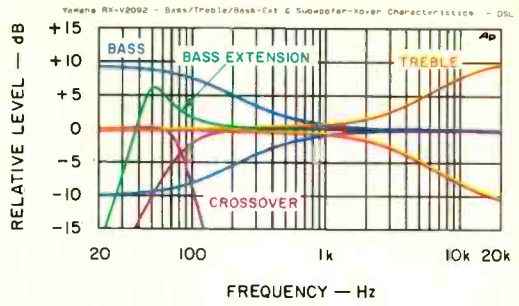


Fig. 4—Characteristics of tone controls, subwoofer crossover, and "Bass Extension" circuit.

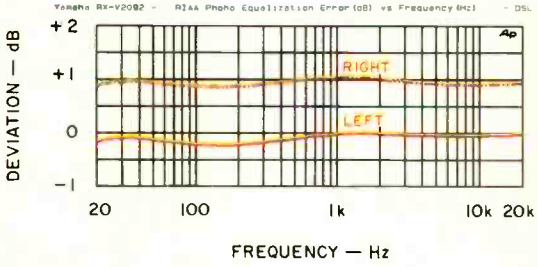


Fig. 5—RIAA phono equalization error.

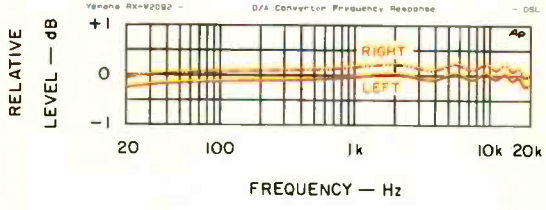


Fig. 6—D/A converter frequency response.

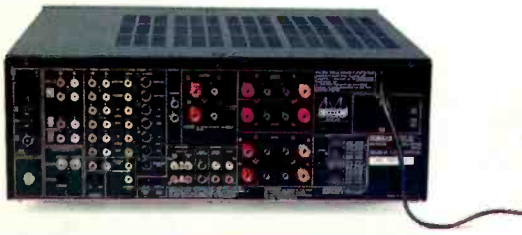
Opening the front-panel door reveals the "Video AUX" and "Phones" jacks and the "Tone Bypass" and "Rec Out" selector mentioned previously, as well as detented bass, treble, and balance knobs and a "Bass Extension" button. Here, too, are the two speaker-selector buttons for the main front channels, five pads for tuner operation ("FM/AM," tuning down/up, "Memory," "Edit," and "Tuning Mode"), and three for system setup: "Delay/C/R/F/SWFR," "Set Menu," and an up/down rocker.

The RX-V2092 is one of the few home theater receivers that you can set up and operate without having to use the remote control or turn on your TV to get an on-screen menu. Nevertheless, it comes with the two remote controls mentioned above: an unusually versatile programmable remote for the main room and a smaller, more conventional one for Room 2. With its lid closed, the main remote is unimposing—12 buttons along the right, four "Operation Control" pads arranged as the quadrants of a circle, a "Master Volume" semicircles divided into up and down surrounding a central muting button, and to the left, "System Power" and off pads and two additional pads ("TV" and "VCR") that can be programmed with the power-control codes of other products. On the right edge are a "Light" bar to briefly illuminate the 12 buttons and "Operation Control" cluster, a three-position "Macro" switch, and an "A/B/C" switch used to alter other buttons' functions.

The first nine buttons of the main remote are grouped (by markings molded into the remote's side) into three triplets, corresponding to the three positions of the "A/B/C" switch. The top triplet (the "A" group) consists of the "Tape," "CD," and "Tuner" selectors; the next three (the "B" group) contains the "VCR1," "DVD/LD," and "TV/DBS" selectors. The "C" group carries "VCR2" and two undesignated sources, one with a disc-like symbol imprinted on it, the other with a squiggle. The fourth, unmarked, triplet selects "V-AUX" or "Phono" and toggles the "Effect" circuits on and off.

Behind the door are several control areas, three of which are arranged logically to command different types of devices. The top area has pads for tape-deck control (play, fast forward, rewind, and stop arranged in quadrants of a circle, plus buttons for "REC/Pause," direction, etc.), the next group has disc-player controls (play, skip forward, skip back, pause/stop in a circular arrangement, and stop, scan forward, scan back, and disc-change buttons). The next area contains pads to move up and down among the tuner's station presets and select preset banks.

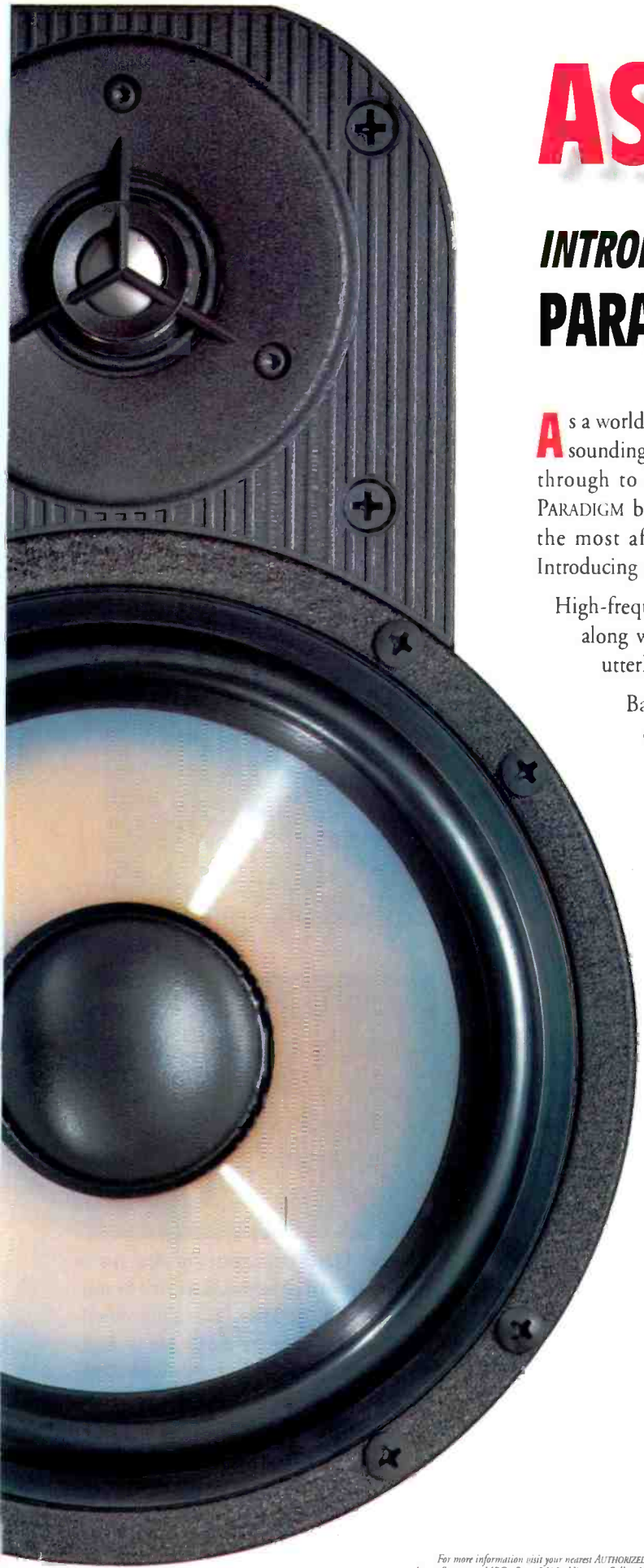
Now the selector arrangement and "A/B/C" slider begin to make sense. The first, fourth, and seventh selector buttons (the first of the "A," "B," and "C" groups, respectively) are for tape recorders or players ("Tape," "VCR1," and "VCR2") and are controlled by the pads in the first control area. The second, fifth, and eighth sources ("CD," "DVD/LD," and the undesignated button with the disc symbol) are for disc players and are controlled by the second group of buttons; the third, sixth and ninth sources ("Tuner," "TV/DBS," and the second undesignated button) are for receiving devices and are operated by the tuner-control buttons.



THE RX-V2092 HAS AN UPDATED VERSION OF YAMAHA'S SEVEN-CHANNEL CINEMA DSP SYSTEM.

The setting of the "A/B/C" switch governs which component each set of control buttons operates. For example, the controls in the second, disc, area operate a CD player when that switch is set to "A" and a laserdisc player when the switch is in the "C" position. The remote is preprogrammed with codes for a Yamaha tape deck, CD player, laserdisc player, and, of course, for the RX-V2092's own tuner. The codes for other equipment can be learned in the usual manner via the remote's "Clear" and "Learn" buttons. When the lid is closed, the "Operation Control" cluster substitutes for the similarly shaped groups under the lid. The last two program sources ("V-AUX" and "Phono") can be selected, but not controlled, from the remote.

Behind the lid of the remote, below its control clusters, are buttons to choose the DSP program ("Digital/Pro Logic," "Enhanced," "Movie Theater," "TV Sports," "Stadium," "Disco," "Rock," "Jazz Club," "Church," and "Hall") and to activate the



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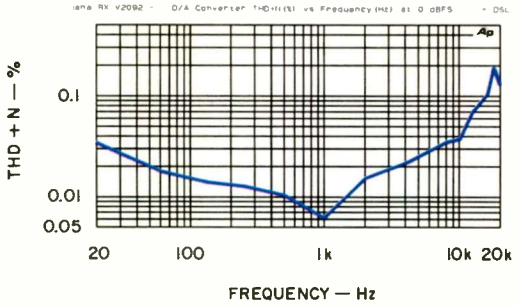


Fig. 7—D/A converter THD + N vs. frequency.

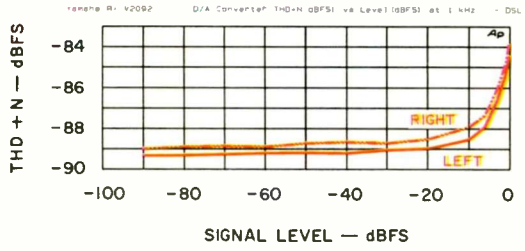


Fig. 8—D/A converter THD + N vs. level.

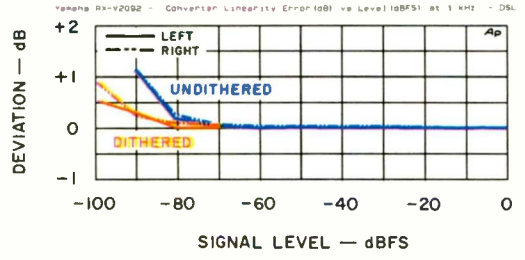


Fig. 9—D/A converter linearity error.

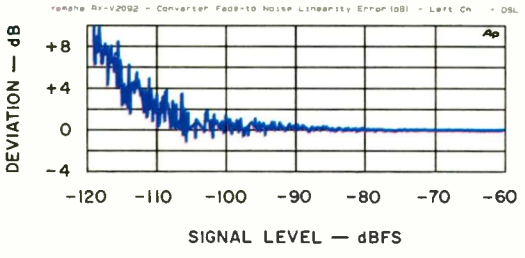


Fig. 10—Fade-to-noise test.

test signal for balancing speaker levels. These buttons double as a keypad for numerical entry of broadcast frequencies. There also are buttons that activate the "A" and "B" speakers and the "Sleep" timer. Finally, there's a setup switch, with one position labeled "Time/Level" and the other labeled "Set Menu."

Want more? You can use the main remote to start 13 macros—sequences of up to seven commands. A macro could, for example, turn on system power, turn on the TV, select a source, and activate playback at the touch of one button. Each of the 11 source-selector buttons is preprogrammed with a macro appropriate for its genre, but it can be reprogrammed as desired. The "Macro" switch on the side selects "Slow" or "Fast" transmission of commands and can also be used to turn the macro function off.

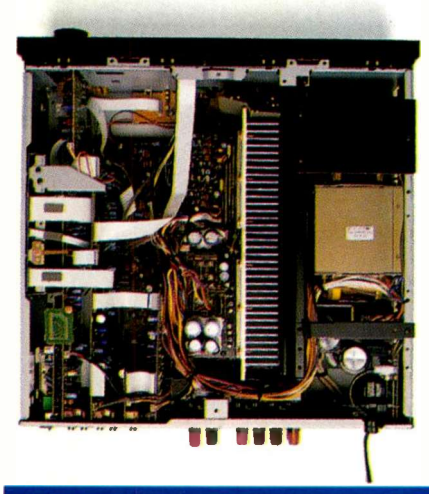
Compared with the main remote, the second-room remote control seems like a toy, but it's competent and arranged sensibly. Tape and CD transport controls are adjacent to their respective selector buttons, and the tuner preset selectors are near the "Tuner" selector. A partial exception to this is that the LD transport controls are arranged across the top above the "V-AUX," "VCR2," "VCR1," "TV/DBS," and "DVD/LD" selectors. "Phono" is at the lower right below "CD." The remote also controls the volume in the second room and can switch the RX-V2092 in and out of standby mode.

Measurements

Yamaha has consistently impressed me as being among the best and most conservative of the Japanese manufacturers when it comes to designing amplifiers. They've usually managed—as they have in the RX-V2092—to adroitly balance amplifier characteristics such as open-loop gain-bandwidth product and closed-loop characteristics so as to achieve flat response, negligible distortion, and low output impedance over the audible range without destroying the distortion-reducing benefits of feedback by rolling off the loop gain prematurely.

From my measurements, it's clear that Yamaha chose to stick with a traditional Class-AB topology in the RX-V2092 rather than using a multirail Class-H design, whose increased efficiency is often accompanied by higher distortion at middle output levels. Certainly, the 20-Hz and 1-kHz curves for total harmonic distortion plus noise (THD + N) versus output (Fig. 1) have the classic, smoothly falling shape characteristic of an amplifier whose THD + N is predominantly noise up to the point of clipping. The 20-kHz curve flattens above 10 watts and begins to rise slowly at higher power levels, suggesting that distortion, rather than noise, predominates in this power range. That's to be expected, as the amplifier's loop gain is purposely diminished to ensure stability. It's also reflected in the increased output impedance in the treble range (see "Measured Data").

But note how low the 20-kHz distortion remains, right up to the point of clipping (less than 0.03% with 8-ohm loads) and (in



LOW TREBLE DISTORTION AND A FLAT IMPEDANCE CURVE DEMONSTRATE ADROITLY BALANCED AMP CHARACTERISTICS.

"Measured Data") the rather modest rise in output impedance between 5 kHz (45 milliohms) and 20 kHz (123 milliohms). That's what I mean by a deft use of feedback and an adroit balance between open- and closed-loop gain. Note also how similar the 4-ohm curves (Fig. 1B) are to the 8-ohm ones (Fig. 1A)—the mark of an amplifier whose output transistors do not sag when delivering extra current into a low-impedance load. The careful observer will note that the 20-kHz curve taken with 4-

ohm loads stops abruptly just below 200 watts. At that point, the RX-V2092's protection circuitry kicked in and shut down the amp; however, it emerged from hibernation, no worse for wear, after the driving signal was removed.

Yamaha doesn't specify the RX-V2092's continuous power into 4-ohm loads. Based on Fig. 1, I chose a 4-ohm stereo rating of 150 watts per channel, 1.8 dB below clipping (230 watts/channel). That's the same relationship to clipping that existed between Yamaha's 8-ohm continuous power rating (100 watts/channel) and the measured clipping point with 8-ohm loads (150 watts/channel). I plotted THD + N versus frequency on both main channels, with both loads, at 10 watts and at "rated" output (Fig. 2). Again, the curves are classic; noise predominates to about 3 kHz at rated power and to about 10 kHz at 10 watts per channel. And again, as with my measurements of THD + N versus output, there's relatively little difference between operation into 8- and 4-ohm loads. With an IHF tone burst, dynamic power clocked in at 170 watts/channel (stereo) for 8-ohm loads, 280 watts a side for 4-ohm loads, and a whopping 415 watts/channel for 2-ohm loads.

FOR ONCE, A RECEIVER WITH TONE CONTROL DEFEAT, AND IT TURNS OUT NOT TO NEED IT.

Wouldn't you know it? Although the RX-V2092 is one of the few receivers that have passed through my lab recently that has a tone-control defeat switch, it's one of the few that doesn't need one! Response from the analog CD input is almost as flat with the bass and treble controls at their detents as it is with the circuitry bypassed! And it's very good either way: within +0, –0.25 dB from below 20 Hz to 20 kHz, with –3 dB points below 10 Hz and above 70 kHz. Figure 3 shows the response on an expanded scale; it also shows an 0.5-dB channel imbalance with the balance control at its detent.

As Fig. 4 demonstrates, both tone controls shelve to a maximum range of about ±10 dB at the extremes of the spectrum; at my standard test points of 100 Hz (bass) and 10 kHz (treble), the range is just under ±8 dB. The "Bass Extension" boosts output by 6.2 dB at 55 Hz, then rolls the response off sharply below that frequency. It should prove useful with small bookshelf speakers, to augment bass output while preventing driver overload. The subwoofer crossover's low-pass filter is down 3 dB at 81 Hz and 6 dB at 92 Hz and falls with a nominal slope of 24 dB/octave, pretty much in accordance with standard home theater practice. The high-pass filter to the main speakers is down 6 dB at 66 Hz, 3 dB at 88 Hz and has a 12-dB/octave slope.

Figure 5 shows RIAA phono equalization error, including the response error in the main-channel amplifiers. Overall response is remarkably flat (within +0, –0.22 dB from 20 Hz to 20 kHz), and channel imbalance is 1 dB with the balance control centered. As you'll see under "Measured Data," the phono input impedance was well chosen and the phono sensitivity and overload point should be adequate for any moving-magnet cartridge you're likely to use. The same can be said for the analog DVD/CD input vis-à-vis input impedance, sensitivity, and overload point. Although channel separation through the analog DVD/CD input isn't shown, it was surprisingly good: better than 71 dB from 100 Hz to 10 kHz. The level at the recording jacks seemed adequate, although the rather high source impedance suggests that you'd be well advised to keep cable runs to the tape deck on the short side.

When I analyzed output noise for the analog and digital DVD/CD inputs and the MM phono input, I noted that, measured in dBW, the curves taken from the two DVD/CD inputs were almost exactly parallel and only a couple of decibels apart, suggesting that the predominant noise source was the

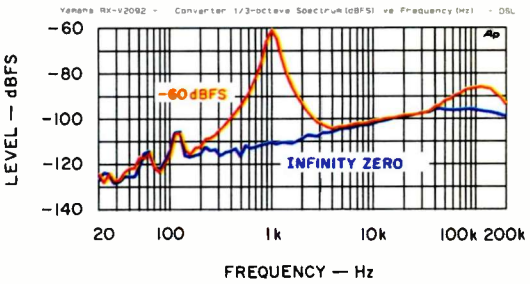


Fig. 11—D/A converter noise spectra.

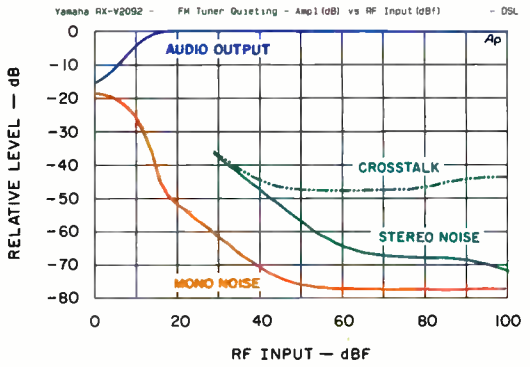


Fig. 12—FM tuner section quieting characteristics and stereo crosstalk.

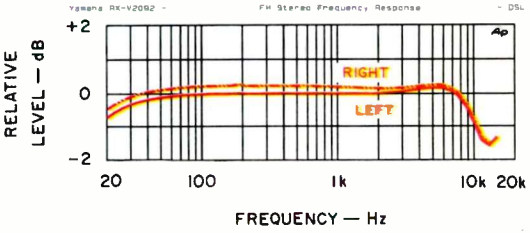


Fig. 13—Frequency response, FM tuner section.

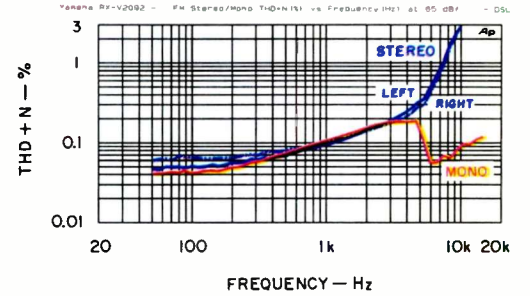


Fig. 14—THD + N vs. frequency, FM tuner section.

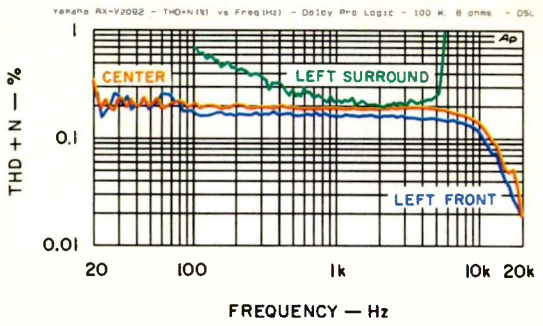


Fig. 15—THD + N vs. frequency, Dolby Pro Logic mode.

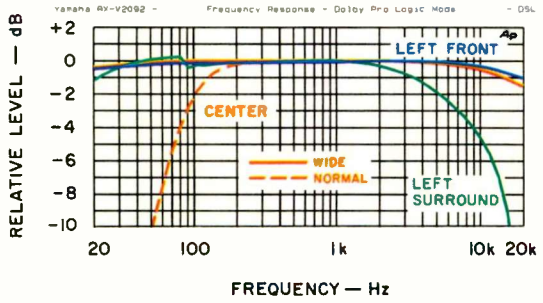


Fig. 16—Frequency response, Dolby Pro Logic mode.

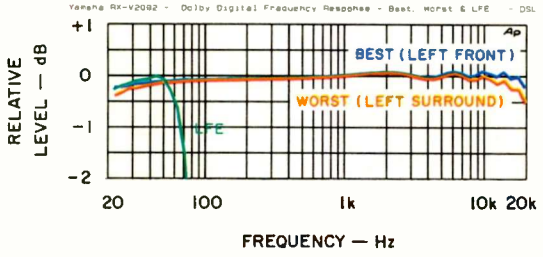


Fig. 17—Frequency response, Dolby Digital (AC-3) mode.

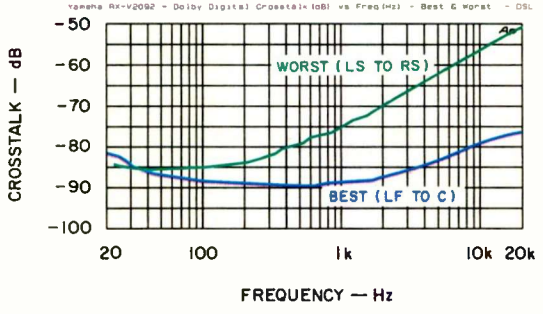


Fig. 18—Interchannel crosstalk, Dolby Digital mode; see text.

power amp. Both curves had the same 120-Hz power-supply ripple component, but the 60-Hz peak (magnetically induced, more than likely) was more prominent via the analog input than via the digital one. The phono preamp introduced more noise in the low midrange and bass, as one would expect because of RIAA equalization, but otherwise was remarkably similar to the analog DVD/CD curve. A-weighted noise through the MM phono input was very low compared to what I've seen recently.

Nowadays, you're often forced to use an A/V receiver's D/A converters, so I've been giving those converters a lot of attention lately. Alas, many are subpar. In some respects (linearity and distortion versus level come to mind), the RX-V2092's DACs are quite good; in others, they're less impressive. I took my D/A-converter data at the speaker outputs, using stereo operation and 8-ohm loads; thus, they include the noise and distortion introduced by the power amplifiers as well as that of the DACs. To make the measurements, I set the volume control for an output of 10 watts per channel into 8 ohms from a 0-dBFS digital signal.

Overall response (Fig. 6) is quite flat (+0.06 dB, –0.20 dB from 20 Hz to 20 kHz), but the curves show the ripples characteristic of a relatively low-order digital filter. When I used the digital DVD/CD input, channel balance was much tighter than with the analog input (within ±0.1 dB) but channel separation was a tad worse.

Probably because of the low-order filter, distortion peaks to nearly 0.2% at 18 kHz (Fig. 7); the two channels performed identically, so only one is shown. This isn't ordinary harmonic distortion; it's intermodulation with the sampling rate, which, arguably, is more likely to be audible. Below 10 kHz, however, distortion remains under 0.04%, which isn't bad. The RX-V2092's THD + N is lowest at 1 kHz; that helped improve all distortion readings taken at this test frequency, especially THD + N versus level (Fig. 8). The latter curve is quite impressive, considering that the data include power-amp noise.

Figure 8 suggests that the converters themselves are quite linear, and Fig. 9, deviation from linearity, confirms that. Linearity error is less than 1.2 dB at –90 dBFS on undithered signals and less than 0.9 dB at –100 dBFS with a dithered signal. The fade-to-noise linearity error measured with a 500-Hz signal (Fig. 10) is quite good, too.

YAMAHA'S ENGINEERS HAVE BALANCED CONFLICTING TUNER REQUIREMENTS WITH UNUSUAL ACUMEN.

Figure 11 shows the RX-V2092's third-octave spectra for "digital silence" and for the 1-kHz, –60 dBFS signal used to measure dynamic range. The S/N ratio relative to 0 dBFS came in at 83.5 dB, A-weighted, and 74.1 dB, CCIR-weighted. Quantization noise (a more meaningful measurement) was –78.2 dBFS on an unweighted basis. Dynamic range (which takes into account low-level distortion) ranged from 82.4 dB (CCIR-weighted) to 91.9 dB (A-weighted). The unweighted number (89.1 dB) was better than the CCIR-weighted one because CCIR weighting emphasizes the region above 1 kHz where the lower-order distortion components of the test signal lie. Neither the S/N nor the quantization-noise figures were as good as I would have hoped to see, but dynamic range is probably par for the course.

Before proceeding to measurements of surround performance, let's take a look at the FM tuner, another area in which Yamaha frequently excels. Overall, the RX-V2092 has a pretty competent tuner compared with those in many of today's A/V receivers. As shown in Fig. 12, background noise drops quite sharply in mono, and the tuner attains 50-dB quieting with a 19.0-dBf input. Ultimately, it can attain a 77.3-dB S/N when mono reception is chosen.

Set for stereo reception, the tuner remains muted until the input signal reaches

MEASURED DATA

AMP SECTION, STEREO MODE

Output Power at Clipping (1% THD at 1 kHz): 8-ohm loads, 150 watts per channel (21.8 dBW); 4-ohm loads, 230 watts per channel (23.6 dBW).

Dynamic Output Power: 8-ohm loads, 170 watts per channel (22.3 dBw); 4-ohm loads, 280 watts per channel (24.5 dBw); 2-ohm loads, 415 watts per channel (26.2 dBW).

Dynamic Headroom re 8-Ohm Rating: +2.3 dB.

THD + N, 20 Hz to 20 kHz: 8-ohm loads, less than 0.0247% at 100 watts per channel (rated output) and less than 0.0155% at 10 watts per channel; 4-ohm loads, less than 0.0281% at 150 watts per channel and less than 0.0201% at 10 watts per channel.

Damping Factor re 8 ohms: 300 at 50 Hz.

Output Impedance: 28 milliohms at 1 kHz, 45 milliohms at 5 kHz, 76 milliohms at 10 kHz, and 123 milliohms at 20 kHz.

Frequency Response: Tone controls bypassed, 20 Hz to 20 kHz +0, –0.25 dB (–3 dB below 10 Hz and at 77.4 kHz); tone controls at detent, 20 Hz to 20 kHz +0, –0.27 dB (–3 dB below 10 Hz and at 70 kHz).

Tone Control Range: Bass, ±7.9 dB at 100 Hz; treble, ±7.9 dB at 10 kHz; Bass Extension, +6.2 dB at 55 Hz.

Subwoofer Crossover: High-pass, –3 dB at 88 Hz, –6 dB at 66 Hz, 12 dB/octave; low-pass, –3 dB at 81 Hz, –6 dB at 92 Hz, 24 dB/octave.

RIAA Equalization Error: +0, –0.22 dB, 20 Hz to 20 kHz.

Sensitivity for 0 dBW Out: CD input, 15.1 mV; MM phono input, 0.257 mV.

A-Weighted Noise: CD input, –82.6 dBW; MM phono input, –80 dBW.

Input Impedance: CD input, 44.5 kilohms; MM phono input, 44.5 kilohms + 160 pF.

Input Overload for 1% THD at 1 kHz: CD input, 6.9 V; MM phono input, 120 mV.

Channel Separation: Greater than 71 dB, 100 Hz to 10 kHz.

Channel Balance: ±0.27 dB.

Recording Output Level: CD input 485 mV out for 500 mV in; MM phono input, 285 mV out at 1 kHz for 5 mV in; FM tuner, 510 mV out for 100% modulation at 1 kHz.

Recording Output Impedance: 3.8 kilohms.

DOLBY PRO LOGIC MODE

Output Power at Clipping, 8-ohm Loads: Main channels, 145 watts per channel (21.6 dBW) with "Phantom" center setting; center channel, 170 watts (22.3 dBW) with "Wide" center setting; rear, 145 watts per channel (21.6 dBW) with "Wide" center setting.

THD + N at Rated Output, 8-ohm Loads: main channels, less than 0.18%, 100 Hz to 20 kHz; center-channel, less than 0.21%, 100 Hz to 20 kHz; rear channels, less than 0.73%, 100 Hz to 5.6 kHz.

Frequency Response: Main channels, 20 Hz to 20 kHz, +0.04, –1.06 dB (–3 dB below 10 Hz and at 32.6 kHz); center channel ("Wide" mode), 20 Hz to 20 kHz, +0, –1.49 dB (–3 dB at below 10 Hz and 30.2 kHz); center channel ("Normal" mode), 92 Hz to 30.2 kHz, +0, –3 dB; rear channels, 94 Hz to 7 kHz, +0, –3 dB, set for "Small" speakers and 11 Hz to 7 kHz, +0.25, –3 dB, set for "Large."

A-Weighted Noise: Main channels, –81.9 dBW; center channel, "Wide" mode, –81.5 dBW; rear channels, –78.2 dBW.

Channel Separation at 1 kHz: 49.8 dB or greater.

DOLBY DIGITAL OPERATION

Channel Balance, Relative to Left Front Output: +0.41, –0.37 dB.

Frequency Response: Main channels, 22 Hz to 20 kHz, +0.07, –0.25 dB; center channel, 22 Hz to 20 kHz, +0.06, –0.43 dB; rear channels, 22 Hz to 20 kHz, +0.05, –0.51 dB; LFE channel, below 20 Hz to 80 Hz, +0, –3 dB, –6 dB at 90 Hz.

THD + N for 0-dBFS Signal: Front and surround channels, 0.0089% or less at 1 kHz; LFE channel, 0.271% at 30 Hz.

Channel Separation, 100 Hz to 10 kHz: 56.1 dB or greater.

D/A CONVERTER SECTION

Frequency Response: 20 Hz to 20 kHz, +0.06, –0.2 dB.

THD + N at 0 dBFS: Less than 0.193%, 20 Hz to 20 kHz.

THD + N at 1 kHz: Below –83.8 dBFS, 0 to –90 dBFS; below –88.6 dBFS, –30 to –90 dBFS.

Maximum Linearity Error: Undithered signals, 1.2 dB to –90 dBFS; dithered signals, 0.9 dB to –100 dBFS.

S/N, re 0 dBFS, for Infinity-Zero Signal: A-weighted, 83.5 dB; CCIR-weighted, 74.1 dB.

Quantization Noise: –78.2 dBFS.

Dynamic Range: Unweighted, 89.1 dB; A-weighted, 91.9 dB; CCIR-weighted, 82.4 dB.

Channel Separation: Greater than 65.4 dB, 125 Hz to 16 kHz.

FM TUNER SECTION

Sensitivity: For 50-dB quieting, 19 dBf in mono and 42.6 dBf in stereo.

S/N at 65 dBf: Mono, 77.3 dB; stereo, 66.2 dB.

Frequency Response, Stereo: 20 Hz to 15 kHz, +0.18 –1.58 dB.

Channel Balance: ±0.1 dB.

Channel Separation, 100 Hz to 10 kHz: Left to right, greater than 38.5 dB; right to left, greater than 38 dB.

THD + N at 65 dBf, 100% Modulation: Mono, 0.051% at 100 Hz, 0.117% at 1 kHz, and 0.051% at 6 kHz; stereo, 0.075% at 100 Hz, 0.115% at 1 kHz, and 0.25% at 6 kHz.

Capture Ratio at 45 dBf: 1.3 dB.

Selectivity: Adjacent-channel, 11.5 dB; alternate-channel, 77 dB.

Image Rejection: 53 dB.

AM Rejection: 61.5 dB.

Stereo-Pilot Rejection: 80.2 dB.

Stereo-Subcarrier Rejection: 89.3 dB.

Although imposing, Yamaha's main remote control is unusually versatile and has macro command capability.

28.5 dBf. It then snaps to life with a S/N ratio of 35.4 dB, with the noise dropping at nearly 1 dB for each additional dBf of signal; so 50-dB quieting is attained with a 42.6-dBf input. At 65 dBf, S/N ratio is better than 66 dB. It hits 67.9 dB at 85 dBf (another semi-standard test point) and ultimately can reach 72 dB.

The tuner section's stereo frequency response (Fig. 13) is flat through the midrange, droops at 20 Hz and 10 kHz by about 0.8 dB, and is down by just less than 1.6 dB at 13.5 kHz, the low point. Channel balance is within ±0.1 dB; however, it should be mentioned that I make tuner measurements at the recording outputs rather than at the speaker outputs, in order to document stereo pilot and subcarrier rejection (which, by the way, were excellent). Channel separation was excellent, too, at more than 38 dB from 100 Hz to 10 kHz.

Figure 14 shows the tuner section's THD + N versus frequency, taken with mono and stereo signals at 65 dBf input power. In mono, distortion remains below 0.2% across the full FM audio band; in stereo, it rises gradually from the bass region to 4 kHz and then more sharply, reaching 0.25% at 6 kHz. The distortion figures are quite good, in light of the tuner's great selectivity (11.5 dB adjacent-channel, 77 dB alternate-channel). The excellent selectivity, surprisingly good capture ratio (1.3 dB), and good AM rejection (61.5 dB) suggest that the RX-V2092 tuner will work well under almost any conditions: country or multipath-prone city. Once again, Yamaha's engineers seem to have balanced conflicting requirements with unusual acumen.

Finally, we turn to the Yamaha RX-V2092's surround decoding circuits. I measured both the Dolby Pro Logic and Dolby Digital (AC-3) modes. For Pro Logic testing, I simulated various combinations of surround sound information with my Audio Precision generator; for Dolby Digital, I used a new Dolby Labs test DVD. All measurements were taken at the speaker outputs, with each channel driving an 8-ohm load.

Output power at clipping (1% THD) in the front and surround channels was the same 145 watts (21.6 dBW) per side when using Dolby Pro Logic as it was with stereo operation of the front channels. The center channel appeared to have a higher clipping point (170 watts, or 22.3 dBW), but that's because no other channel makes demands on the power supply during the center-channel test.

The Pro Logic section's THD + N versus frequency at rated power (100 watts per channel) is given in Fig. 15 for the left front, center, and left surround channels. (The right front and right surround channels' performance was essentially the same.) All front channels performed similarly, producing THD + N of 0.2% or less from 100 Hz to 20 kHz. Typically, for Pro Logic operation, distortion is higher in the surround channels than in the front, but on the RX-V2092, it's still under 0.75% over the pertinent test range.

THE RX-V2092'S D/A CONVERTERS ARE QUITE LINEAR AND LOW IN DISTORTION.

The Pro Logic decoder frequency response is shown in Fig. 16. (Again, I'm showing only the left front and left surround channels; the response of the corresponding right channels was the same.) As is my custom, I'm showing the response of the center channel in both its "Wide" and "Normal" modes. However, with the advent of Dolby Digital, it's becoming common to describe these modes as suiting "Large" and "Small" speaker sizes rather than as "Wide" and "Normal." In the Yamaha RX-V2092, "Large" and "Small" can be chosen for the front and surround speakers as well for the center. The curves of Fig. 16 show the "Large" option; with the "Small" setting, bass response rolls off in the front and surround channels just as it does in the center for that setting.

The response of the main front channels at the large-speaker setting in Pro Logic mode is within +0.04, –1.06 dB from 20 Hz to 20 kHz, with –3 dB points below 10 Hz and above 30 kHz. The center channel is similar except for a tad more treble droop (–1.5 dB at 20 kHz). The surround channels are down 3 dB at 7 kHz, as called for by Dolby Pro Logic standards; the surround channel's low end extends to 94 Hz or 11 Hz (at –3 dB), depending upon whether the system is set for small or large surround speakers. Residual noise was very low: less than –81.5 dBW in all front channels, –78.2 dBW in the surround channels. Steady-state separation at 1 kHz ranged from 51.6 dB (from the center to the left-front channels) to more than 76 dB the other way.

As for Dolby Digital (AC-3), Dolby Labs' new test DVD doesn't provide every test signal I could hope for, but it's vastly better than the laserdisc I've used heretofore. There's a stepped frequency sweep that my Audio Precision System One analyzer locks onto by 22 Hz (the 20-Hz datum is still absent) and follows all the way to 20 kHz; this was never possible with the laserdisc sweep. Furthermore, you can actually plot channel separation using the new disc, which was impossible on the AP System One with the laserdisc. But it's like going from famine to feast; you risk indigestion. I took six response curves and 20 separation curves. Had all been plotted, you'd not be able to discern a thing; I've summarized the results in "Measured Data."

With Dolby Digital signals, the left front channel had the best frequency response and the left surround was the "worst"—albeit by a mere 0.25 dB at 20 kHz (Fig. 17). Needless to say, the digital-filter ripples that appeared in the D/A-converter response curves appear here as well. I've superimposed the response of the LFE channel in Fig. 17, too. It's down 3 dB at 80 Hz and 6 dB at 90 Hz, but I couldn't determine its low-frequency –3 dB point with the test DVD.

Channel separation varies more than frequency response, as you can see in the final

figure. Fig. 18 plots crosstalk (the inverse of separation) as a function of frequency for the "best" (left front to center) and "worst" (left surround to right surround) pairings. The other 18 curves lie between these two; the separation is so good in all cases that more information would serve no useful purpose.

The stepped-sweep tracks on the Dolby Digital test DVD move too quickly for me to get accurate distortion measurements, so I was limited to measuring distortion at 1 kHz in the main channels and at 30 Hz in the LFE channel. These figures, measured at 0 dBFS, ranged from 0.007% (left front) to 0.0089% (center) and were really negligible. The LFE channel came in higher (0.271% at 30 Hz), but name me a subwoofer that wouldn't introduce an awful lot more! The main-channel measurements looked excellent, but I expected that; had I been able to measure distortion at higher frequencies, I would have found results comparable to those I measured on the D/A converters alone.

Use and Listening Tests

Cinema DSP is Yamaha's proprietary approach to enhancing the movie-theater illusion. Cinema DSP strives to simulate the sound field produced by the array of side and rear speakers used in a theater by adding a pair of "front-effect" speakers to the home system and feeding them and the rear-effect speakers a DSP-generated cocktail of information that synthesizes the sound field created by multiple side and rear speakers. The goal is similar to what Lucasfilm had in mind for THX, but Home THX is technically far less adventurous; it simply alters the frequency response and radiation patterns of the speakers to diffuse surround sound so the viewer cannot locate its source. (For the record, I should mention that, in Yamaha's lexicon, "DSP" means Digital Soundfield Processing rather than Digital Signal Processing, albeit Digital Signal Processing is used to do Digital Soundfield Processing. Got it?)

Because of the way Cinema DSP generates sound fields, both front and rear "effect" speakers should have direct, not dipolar, radiation patterns and be mounted above the viewing position (Yamaha recommends a height of 6 feet), facing each other. The rear speakers should be behind the viewer, with the front effect speakers spaced more widely (and preferably behind) the main front pair. This differs from the sidewall placement across from the listener that is usually recommended for surround speakers but may prove more convenient in many rooms because it enables the effects speakers to be mounted on the room's front and rear walls.

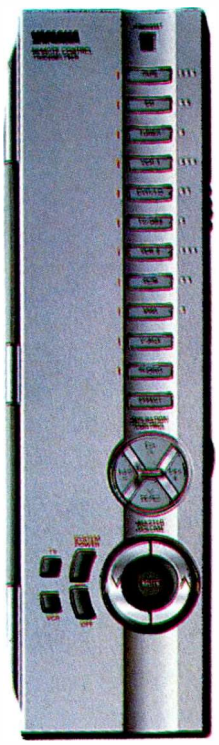
Yamaha has championed seven-channel Cinema DSP for some years; Tri-Field, the version in the RX-V2092, has been updated to recognize the stereo nature of the Dolby Digital surround channels. In the RX-V2092, front-effect signals are generated in every DSP mode other than straight Dolby Digital or Pro Logic. The characteristics of these DSP-based signals (and the sound they create) depends upon the mode chosen. For example, "Enhanced" seeks to simulate the surround sound field of a relatively conventional 35mm theater, while "Movie Theater" aims at reproducing the sonic character of the newest 70mm Dolby Digital theaters. "TV Sports" targets a tight frontal sound field with a wide rear that places you "in the action." "Stadium" goes one further, with long delays between direct and effects sounds to simulate the spacious feel of a huge stadium. The names of the other alternatives—"Disco," "Rock Concert," "Jazz Club," "Church," and "Concert Hall"—describe the effects they seek to create.

YAMAHA'S CINEMA DSP IS TECHNICALLY MORE ADVENTUROUS THAN HOME THX PROCESSING.

In my experience, the plausibility of simulated sound fields is affected in roughly equal portions by the adroitness of the digital-signal-processing algorithm and by the program material. Since Yamaha was first to introduce DSP-based simulation to the consumer market, one can presume that they have more experience in creating such algorithms than anyone else. That shows in the RX-V2092, which can generate some pleasantly realistic effects, given suitable program material and appropriate control settings.

The RX-V2092 doesn't give you control of decay time, liveness, and so forth, as did early Yamaha ambience simulators that were designed primarily for music applications; this makes it far easier to use. Yes, it can produce some pretty garish effects if you go overboard with the delay or effect-level settings, but that's been true of every similar system I've used. The Yamaha RX-V2092 distinguishes itself from the crowd through its use of separate front-effect speakers. The ability to adjust the front-effect level independently of the other channels and having the simulated sound emerge from a physically different location from that of the main-front channels goes a long way toward attaining realism without garishness. To take advantage of this, you will need an extra set of speakers; if you "fold" the front-effects channels into the main-front ones, you lose a lot of what this receiver has to offer.

Overall, I was pleased with the Yamaha RX-V2092. Perfect, it's not; I'd appreciate better DACs—but I'm getting tired of saying that. The DACs in the RX-V2092 are comparable to those in other A/V receivers I've tested and better in some respects. I don't fault them when it comes to reproducing movie sound, which is more bombastic than subtle; for pure music applications, the DACs in the average audiophile CD player are usually superior. That aside, I give the Yamaha RX-V2092 very high marks for user friendliness, for the excellence of its remote control facilities, for its clean, potent power amps, and for its adherence to those Yamaha traditions that have earned the company its fine reputation. A



With its lid closed, the RX-V2092's programmable remote presents a clean and uncluttered appearance.

The horse, the automobile. The typewriter, the computer. The cassette tape, the Digital Recordable MiniDisc. The ability to record music and play it back anywhere—what you've always loved about tape. Digital sound and instant access to any song—what you love about CDs. All in one 2.5-inch MiniDisc. Record or mix up to 74 minutes from your CDs on one MiniDisc. Then play it back on your car deck or portable player. Now that's progress.

Look for this symbol at your Sony dealer and get a free gift when you buy select Sony MiniDisc products for a limited time only.

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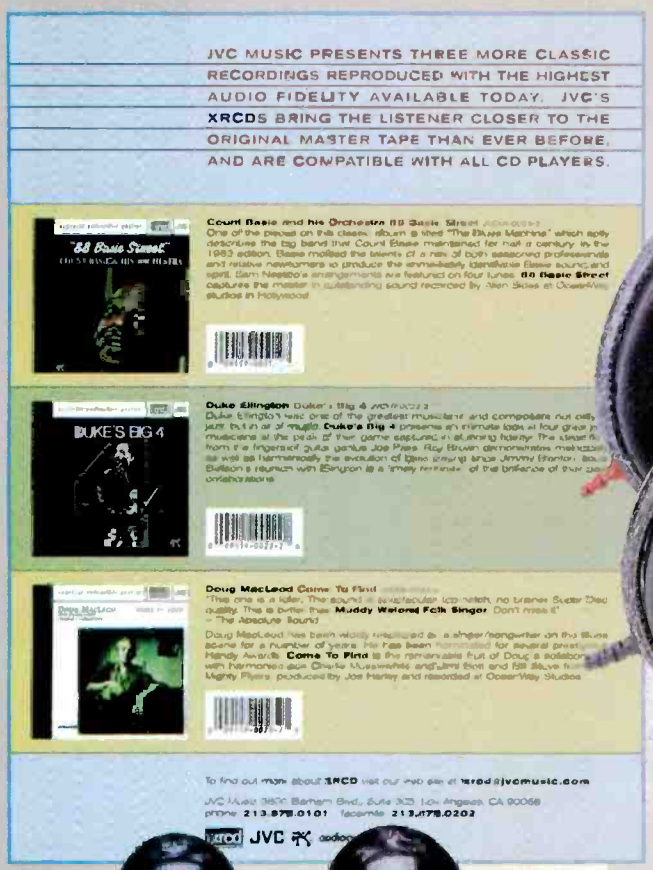

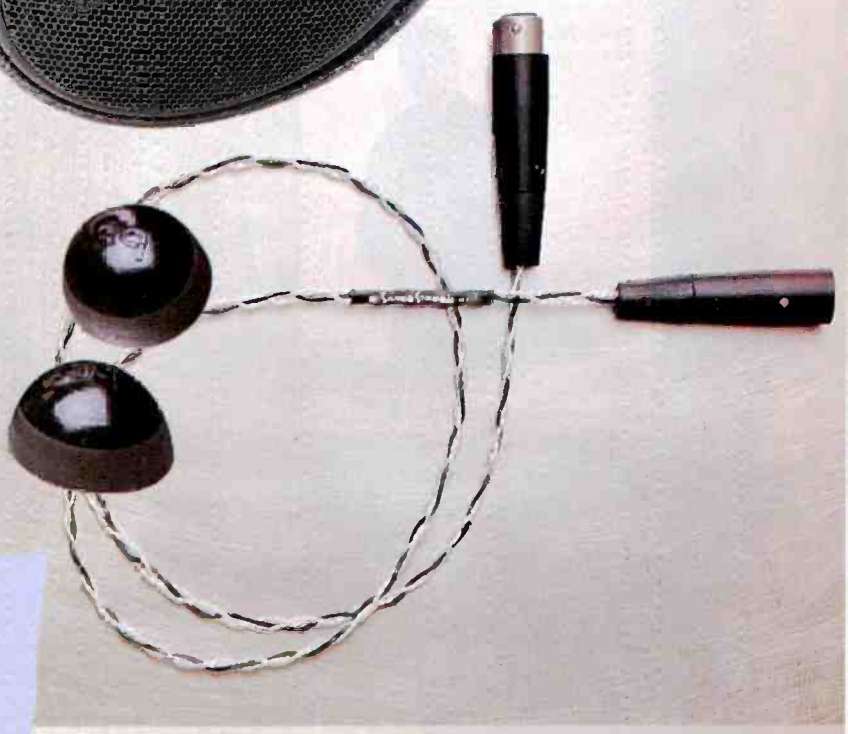

GREAT details 4

"attention to or treatment of a subject in individual or minute parts."

That's the dictionary's definition of "detail." Enthusiasts deeply understand how important individual parts are for a powerful home entertainment experience...whether it's choosing cables, a stylus, a pair of headphones...even the discs themselves. In the "Great Details 4" special advertising section you'll find some of the finest examples of details that deliver audio and video at its best.

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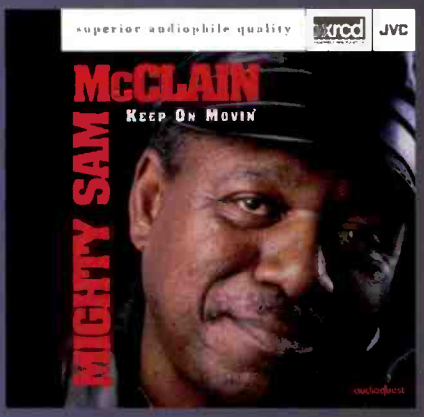

MIGHTY SAM McCLAIN
KEEP ON MOVIN'

JVCXR-0026-2

"Recording Of The Month. Some of the most convincing primal blues singing I've ever heard." – Stereophile

"The Mighty One has done it again! The singer has gone and made another album as outlandishly good as his 1993 blockbuster *Give It Up To Love*."

Featuring a blazing nine piece band, *Keep On Movin'* is a showcase for Mighty Sam's ever evolving vocal and songwriting prowess.

DOUG MACLEOD
YOU CAN'T TAKE MY BLUES

JVCXR-0027-2

"A big, relaxed, spacious sound; oh my this disc is a treat." – Stereophile

"MacLeod is one of the vibrant voices that will keep this sound alive into the next century." – Blues Review

Joined by the legendary harpsman Carey Bell and the great Mighty Flyers rhythm section, Doug MacLeod takes to the core of deep, intimate blues.

ELLA FITZGERALD & JOE PASS
TAKE LOVE EASY

JVCXR-0031-2

"Ella, in absolutely first class form, duetting with Joe Pass."
– Jazz: The Rough Guide

Of Ella, what can be said? She is sublime, the ultimate jazz singer and nowhere is that more apparent than here, where she appears in duet with guitar virtuoso Joe Pass. Fitzgerald and Pass show why they are among the supreme interpreters of the popular song repertory. *Take Love Easy* is sheer perfection.

THELONIOUS MONK & GERRY MULLIGAN
MULLIGAN MEETS MONK

JVCXR-0032-2

"★★★★ 1/2" – Downbeat

Three decades ago, when Riverside paired Thelonious Monk and Gerry Mulligan on this album, it seemed like a daring move. It is now clear that both men were the kind of revolutionaries who had respect for the jazz tradition. It was more than a meeting of giants, it was proof of the strong bond connecting theoretically opposing (bop vs. cool) forms of modern jazz.

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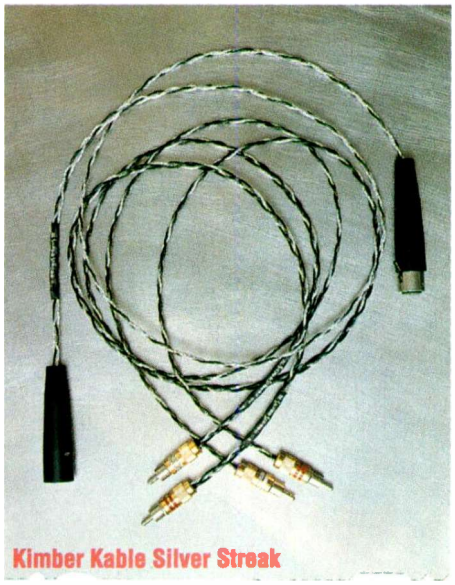
CIRCLE NO. 20 ON READER SERVICE CARD

The World of Accessories

A SUPERB INTERCONNECT

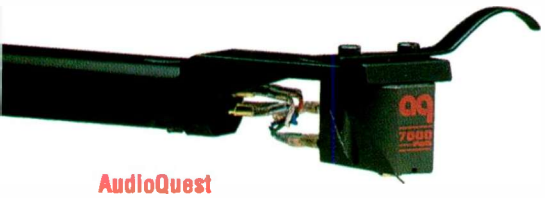
"Through the correct application of our braiding technology, we are able to manufacture loudspeaker cables and interconnects that are extremely responsive



Kimber Kable Silver Streak

and tonally accurate," said Ray Kimber. Since 1979, his company has supplied audio enthusiasts cables ranging from the Silver Streak to the legendary Model 88: The Black Pearl Reference Loudspeaker Cable (priced at $15,000 per 8-foot pair).

"The Silver Streak is a superb interconnect for the finest audio and video applications," Kimber added. The cables have many of the company's most respected and advanced technologies, including tri-braid VariStrand cable geometry, custom Teflon dielectrics and advanced metallurgical techniques. The



AudioQuest
AQ 7000Fe5 Cartridge

Silver Streak features AG VariStrand conductors made from hyper-pure silver. The Silver Streak is available with RCA or XLR connectors, and is single ended or balanced.

What goes into this highly regarded cable? The Silver Streak (single ended) has a #19 American Wire Gauge (AWG) silver wire for the positive or signal-carrying conductor and two #19 AWG copper conductors as ground and return. In single-ended cable and equipment, the signal is carried in the positive domain. The nonsignal-carrying conductors are ground and also negative return. By using a silver VariStrand wire as a signal-carrying conductor "we are able to offer a reference quality cable for a reasonable price." The balanced Silver Streak has twin #19 AWG silver wires for signal and a single TCSS copper wire as ground.

Also part of the Kimber Kable lineup are BiFocal-XL ($1050 for an 8-foot pair) and KCAG interconnect with hyper-pure silver ($390 a meter pair). Many reviewers consider the KCAG their affordable reference interconnects. The BiFocal-XL loudspeaker cable consists of 36 Teflon insulated, VariStrand copper conductors; cable diameter is 1.25 inches. The XL is designed for full range biwired speakers. The BiFocal-L is meant for small two-way biwired speakers and systems using single ended tube amps which wouldn't benefit from the XL's extra conductor mass.

GET TO KNOW US

While innovations continue in the world of audio cables, "credit is now being earned in the video world, where people believe what they see," said Bill Low, president of AudioQuest. "It's a revelation with even a simple demo. With audio you have to be in the right mood and it requires a controlled setting. We've done demonstrations using an inexpensive LD player, our VideoQuest versus a competing cable showing side-by-side freeze frames on screen. The difference is startling...it's that obvious." The winner? VideoQuest. "And it isn't black magic; you can see for yourself."

Low noted that the same attention to detail necessary for a world-class audio interconnect is vital for video. "There's almost an artisan's relationship between the designer and the cable. They have to make purposeful compromises to get the balance just right. There's a sensitivity to materials, the dielectric inside and outside the shield. The goal is bringing the state of the art to a higher level."

AudioQuest and their dealers believe self-guided demonstrations—at home—are the best way to appreciate superior audio/video cables and entertainment's other little details. Their "Get To Know Us Kit" offers speaker cables, interconnects, video cables and RF Stoppers, jitter reducing feet, banana plugs—even two reference CDs to use for comparison. Depending on your system, there are two levels to try.

GREAT details 4

Sennheiser RS 6
Cordless
Headphones

And now that DVD players have arrived en masse, AudioQuest has special cables for component and S-video outputs, as well as Sorbothane feet that isolate and damp unwanted energy created by motors spinning the discs. Low added that AudioQuest has not forgotten those older spinning discs—vinyl records. The AQ 7000Fe5 MC phono cartridge is "a very high-resolution cartridge and it reveals the quality of your playback equipment."

PURELY PERSONAL

Listening to music is an intensely personal experience—whether it's vinyl or a compact disc. And nothing makes it more personal and intense than a superior pair

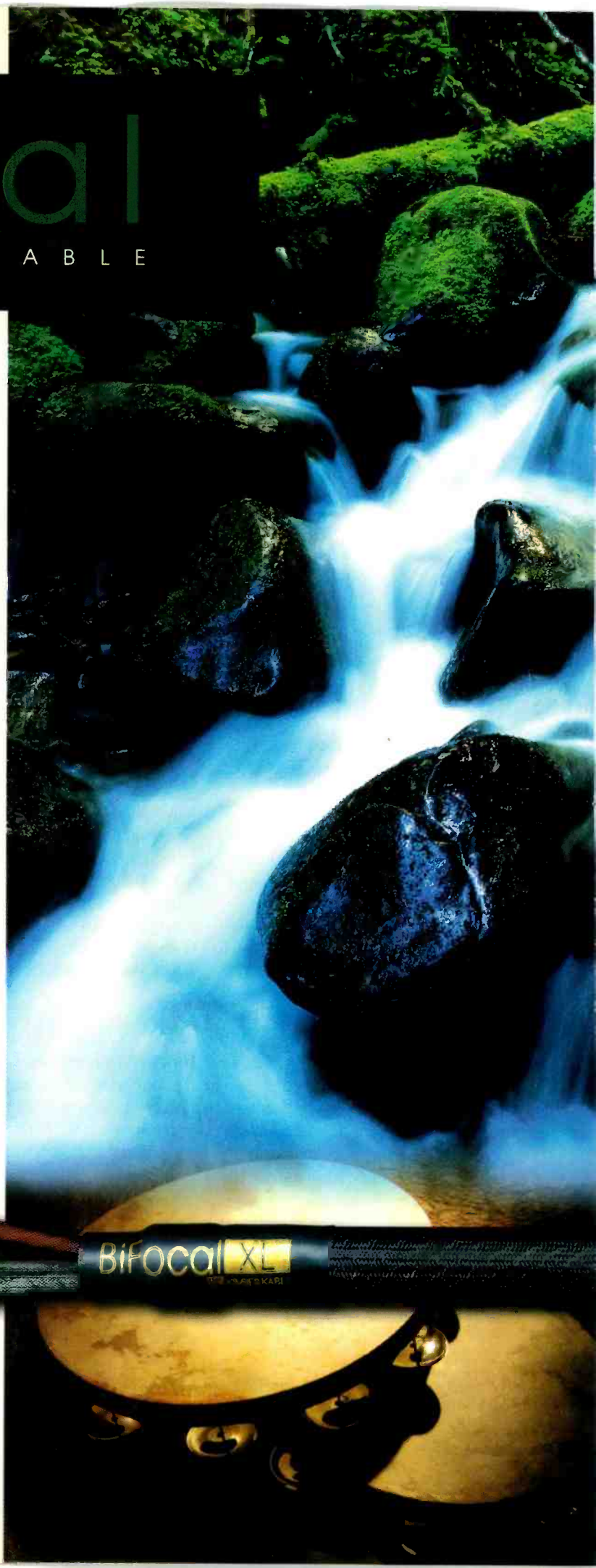
BiFocal

LOUDSPEAKER CABLE

Inspired by nature

The new Kimber Kable **BiFocal** loudspeaker cables control vibration, shield against RF interference, and dramatically reduces electromagnetic interactions between mid/high and low frequencies.

BiFocal, revealing the nature of music.



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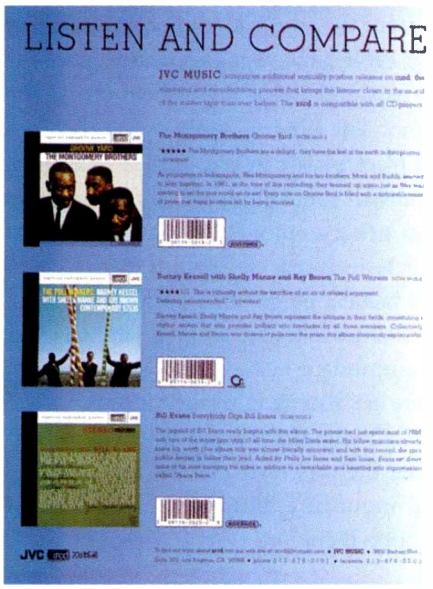
CIRCLE NO. 3 ON READER SERVICE CARD

of headphones. "We've earned an excellent global reputation for wired headphones," said John Bevier, Manager of Consumer Products at Sennheiser Electronic Corporation. "Now we're utilizing our wireless expertise so enthusiasts can listen to their music almost everywhere." The company's new RS 6, a 900 MHz RF wireless headphone system, has a range of 250 feet in all directions from the base. "It offers absolute freedom of movement and freedom from distortion," Bevier said. The RS 6 joins the highly regarded RS 8 with the HiDyn Plus system that reduces noise and interference while increasing the signal-to-noise ratio to 110 dB; frequency response is 20-22,000 Hz.

All of Sennheiser's RF wireless headphone systems (RS 8, RS 6, and RS 4) have three switchable frequencies and volume controls on the headphones.



A sample of JVC XRCDs.

They are supra-aural designs and feature soft cushions for extended wearing comfort. Their batteries last for over three hours before recharging is necessary.

"Many consumers have asked us for 'personal' Dolby Surround Sound," Bevier said. "With the Lucas Personal Home Theater, you can experience Pro Logic right through your headphones." Lucas is connected between your surround source—even a TV— and your headphones. It generates the necessary Dolby Surround Sound signals via electronics, creating a virtual five-speaker listening experience. Settings can be fine tuned to your preference at a touch of a button. Up to 15 preprogrammed "ear types" are built into the system.

While exploring new horizons, Sennheiser hasn't forgotten its main claim to fame—wired headphones. The latest addition to the lineup is the HD 600 open dynamics headphones with an advanced diaphragm design. Computer optimized magnet systems minimize harmonic and intermodulation distortion. Frequency response is a scintillating 12-39,000 Hz, making them ideal for studio professionals—or anyone who loves great sound.

MUSIC AT ITS FINEST

Attention to detail is evident throughout the entire audio chain. More companies than ever are expending engineering know-how on the reproduction of compact discs. One firm in the forefront is JVC Musical Industries and their widely praised XRCDs—Extended Resolution Compact Discs. Simply put: They deliver higher fidelity by enhancing the mastering and manufacturing of CDs with the goal of retaining the highest sonic purity of the original music. JVC has worked this magic on classic recordings ranging from jazz and fusion to blues.

"We got the master tapes to that first Mighty Sam McClain recording I did," said XRCD Creative Consultant Joe Hartley. "I supervised the XRCD mastering and the results are very similar to the master tape," Hartley noted. "I'm not saying it's exactly like analog, but in some ways it's the most analog-sounding CD I've ever heard. XRCD sounds more of what I know is on the original recording."

The XRCD process starts at the mastering level. The analog signal is taken directly from the mastering console and digitized using JVC's 20-bit K2 Super Coding, which has a dynamic range of 108 dB. The 20-bit signal is transferred to a Sony PCM-9000 which stores the information on a magneto-optical disc instead of the more commonly used U-matic 1630 tape. The XRCD process takes advantage of the stability of the disc as well as its 20-bit capacity. At the JVC manufacturing plant in Japan, the 20-bit Sony disc is converted to 16 bits using the K2 Super Coding in a bit down mode. The 16-bit signal is then EFM encoded. The K2 laser is used to reshape the EFM signal right before going to the laser of the glass cutter. The end result of this process is the highest quality digital transfer— from mastering to compact disc— with higher accuracy in sound quality and imaging. And just as important, no special boxes or decoders are required to enjoy the over 30 XRCD discs currently available.

Among the artists available on XRCD include Grammy Award-winning Bill Holman, Carmen Lundy, Oscar Castro-Neves and Tom Coster. You'll also find Tiger Okoshi, Nakagawa, Hiroko and Spirit Traveler. AudioQuest Music licensed a number of its classics for XRCD treatment, including Mighty Sam McClain, Bennie Wallace, Terry Evans and Doug McLeod. Fantasy Records and Concord Jazz have also joined the bandwagon, featuring jazz greats Count Basie, Mel Torme, Wes Montgomery, Bill Evans, Cal Tjader and Duke Ellington. JVC Music has just finished their first pop discs: *The Band*, Tina Turner's *Private Dancer*, and Steve Miller's *The Joker*; they're due out in October and November.

JVC also has an XRCD sampler disc that offers audio enthusiasts a taste of the superior sound. "All of this attention to detail allows the listener to enjoy the music just as the artist, producer and engineers originally intended it," Joe Hartley said. ●

Buyers' Guide

For more information, please write, call or contact the manufacturers below.

AudioQuest
PO Box 3060
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JVC Musical Industries
3800 Barham Blvd. Suite 305
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Kimber Kable
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Sennheiser
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This special advertising section was specially prepared for the publisher of *Audio* magazine. None of the magazine's editorial personnel were involved.

EQUIPMENT PROFILE

EDWARD M. LONG

KEF RDM ONE SPEAKER

In 1962, Raymond Cooke, who had worked for a number of years with G.A. Briggs of Wharfedale, started his own speaker company. Since his factory building was owned by the Kent Engineering Foundry, he called his company KEF. The company was a pioneer in the use of plastic diaphragms; the first KEF speakers had woofers with large, flat, polystyrene diaphragms and treble drivers with polyester domes. Now 35 years old, KEF has gained an enviable reputation for producing excellent loudspeaker systems.

The RDM One's small, sealed enclosure houses a single 6½-inch driver, yet it's a two-way speaker. The driver, which KEF calls Uni-Q, has a 1-inch tweeter mounted on the pole piece at the center of the 6½-inch woofer's magnet. This puts the treble diaphragm near the apex of the bass diaphragm. The Uni-Q driver is mounted off-center on the front baffle. The enclosure is made of ¾-inch medium-density fiberboard (MDF) and weighs 14.3 pounds. The bevelled sides have a beautiful red gloss finish, while the other four surfaces are finished in matte gray; high-gloss cherry veneer and charcoal gray finishes are also available. The enclosure's internal volume is 8.78 liters (536 cubic inches) and is filled with two rolls of polyester acoustical damping material; this absorbs sound from the rear of the driver that could be reflected back through the cone and color the sound.

The Uni-Q driver is recessed ⅜ inch into the ¾-inch-thick baffle and held by three Phillips-head sheet-metal screws, which are hidden by a decorative black-plastic ring that covers the rim of the driver.

The ½-inch-thick grille, covered with black cloth, is a solid panel except for a single hole in front of the driver; this allows the driver's sound to pass while effectively blocking baffle vibrations that could color the sound. The hole's diameter increases from 6¾ inches near the driver to 7¾ inches at the front of the grille; this reduces the chance that reflections from the edge of the hole could roughen the frequency response. The grille fastens securely by four pins that mate with rubber sockets in the baffle; the rubber also isolates the grille from enclosure vibrations.

Two pairs of gold-plated binding posts are mounted in a recess on a wide plastic plate that occupies nearly all of the enclosure's rear panel. One pair is connected to the crossover's high-pass filter, which feeds the tweeter; the other pair connects to the low-pass crossover filter that feeds the woofer. A gold-plated strap connects the positive terminals of the woofer and tweeter, and another connects the common terminals. The straps can be removed for bi-wiring; if the RDM Ones must be located far from the power amplifier, necessitating long cable runs, using separate cables for the bass and treble might help clarify the sound. The binding posts come with red and black plastic inserts in their end holes, to prevent some European AC power plugs from being connected to the speakers, but their ¾-inch spacing enabled them to hold dual banana plugs when I removed the inserts. Holes in the sides of the binding posts accommodate heavy-gauge speaker wire. There are also two threaded inserts, spaced vertically about 2¼ inches apart, in the rear panel; they appear to be for some kind of wall mounting, but the manual doesn't mention them.

Rated Frequency Response: 100 Hz to 18 kHz, ±2 dB; –6 dB at 75 Hz.
Rated Sensitivity: 87 dB at 1 meter, 2.83 V rms applied.
Rated Impedance: 6 ohms.
Recommended Amplifier Power: 30 to 125 watts.
Dimensions: 11⅞ in. H x 9¼ in. W x 8¾ in. D (30 cm x 23.4 cm x 22 cm).
Weight: 14.3 lbs. (6.5 kg).
Price: $900 per pair.
Company Address: c/o Adcom, 11 Elkins Rd., East Brunswick, N.J. 08816; 908/390-1130.
For literature, circle No. 91

Photos: Michael Groen

The crossover, behind the rear-panel plate, consists of three inductors, four capacitors, and five resistors. Three of the resistors are rated at 5 watts while two large, 1-ohm resistors are rated at 11 watts each. The high-pass filter, which feeds the tweeter, is a third-order design with two series capacitors and a shunt inductor; a two-resistor pad attenuates the tweeter's level to match the woofer's. The low-pass filter, which feeds the woofer, is a modified fourth-order design with two series inductors and two shunt capacitors, a 12-ohm resistor (between the first shunt capacitor and the junction of the negative binding post and the negative woofer terminal), and the 1-ohm, 11-watt resistors mentioned above. The 1-ohm resistors are paralleled with each other, for a resistance of 0.5 ohm, and connected in series with the positive woofer terminal.

THE KEF RDM ONES HAD A FORWARD SOUND AND PRODUCED CLEAR, PRECISE IMAGING.

The series resistance acts as a kind of equalizer by interacting with the woofer impedance. In the bass range, where that impedance is highest, the 0.5-ohm resistance appears relatively small and the output is reduced very little. In the lower midrange, where the impedance is much lower, the resistor reduces the output, so the bass will be louder by comparison.

Use and Listening Tests

I'm presenting this section before "Measurements," to better correlate my test results with the comments from my listening panel. For the panel's evaluations, I placed the KEF RDM Ones on Tekna Sonic speaker stands, which have Tekna Sonic C5 absorbers attached under their top plates. Each stand is 27 inches high, which placed the RDM One's Uni-Q driver at the same height as my reference speaker's midrange and treble drivers. (Those drivers cover the range from 150 Hz to 20 kHz; frequencies below 150 Hz are reproduced by the speaker system's woofer, which is down only 3 dB at 32 Hz.) The RDM Ones and the reference speakers were toed in so that centered listeners would be on axis.

Most of the listening evaluations were done by one panel member at a time; this is more time-consuming, but I think it gives each listener a better opportunity to sit in the best spot when evaluating the loudspeakers' stereo reproduction of instrument positioning and space. Each panel member was asked for written comments on how the KEFs' reproduction of various instruments' sound and the spatial effects of different recordings compared to that of the reference speakers.

I began each listening session with the Sheffield recording of Toccata, by Alessandro Piccinini, performed by the Newman & Oltman Guitar Duo on *Passions* (Sheffield Lab 10058-2-F). The comments were: "fingering sounds brighter," "slightly more forward," "less body to guitar sound," and "guitar sounds slightly clearer and more precise."

The next selection was Franz Doppler's "Duettino Américain," Opus 37, played by Jean-Pierre Rampal, Claudi Arimany, and John Steele Ritter on *Romantic Music for Two Flutes and Piano* (Delos DE 3212). This caused panel members to comment: "less breath sound on flutes," "flutes are slightly forward," "piano well centered but back in space," "piano sounds smaller," "good instrument placement," and "slightly less spacious."

The comments for "Horse and Rider," by the Steve Miller Band on *Wide River* (Polydor 314 519441), were: "voice is very good but less articulate," "voice is brighter," "voice is more forward," "harmonica is more prominent," "bass not as deep," and "much less bass."

When I played the Allegro non Troppo movement from Dimitri Shostakovich's Symphony No. 8 (performed by the Dallas Symphony Orchestra conducted by An-

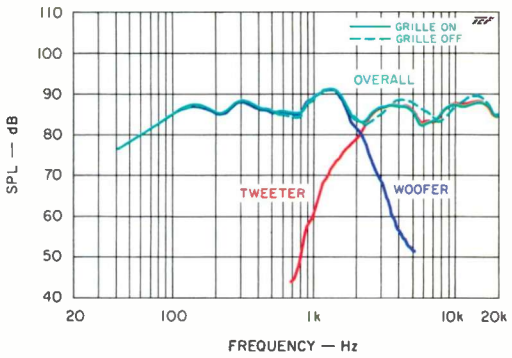

Fig. 1—Frequency response.

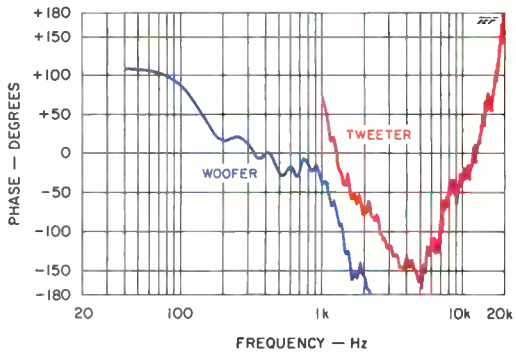

Fig. 2—On-axis phase response.

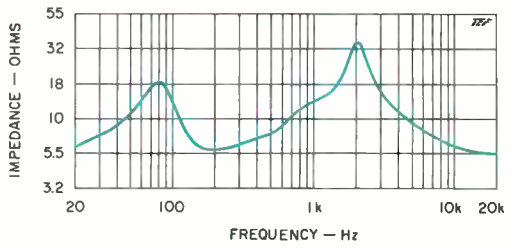

Fig. 3—Impedance magnitude.

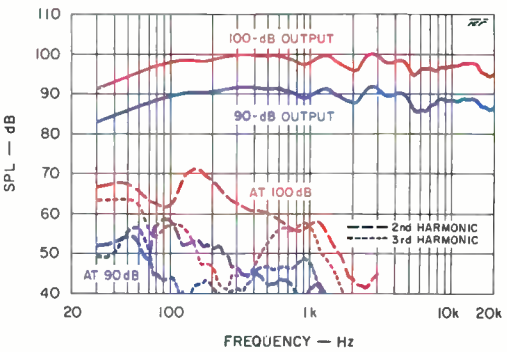

Fig. 4—Ground-plane frequency response and second and third harmonics, for output levels of 90 and 100 dB.

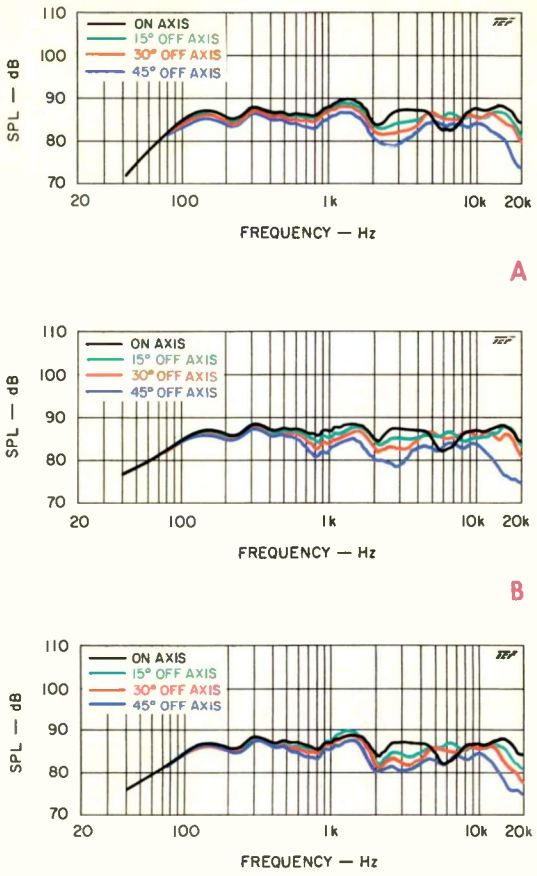

Fig. 5—Horizontal on- and off-axis responses for upright speaker (A), speaker on its side, measured from driver end (B), and speaker on its side, measured from other end (C).

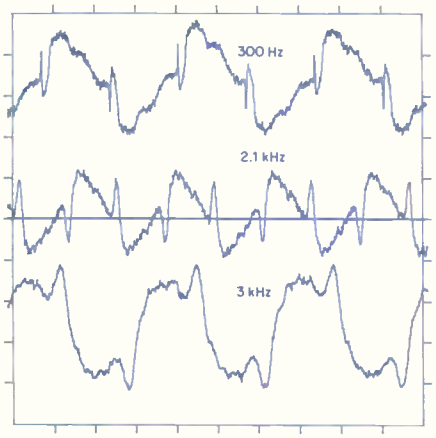

Fig. 6—Square-wave response at 300 Hz (top), 2.1 kHz (middle), and 3 kHz (bottom).

drew Litton, Delos DE 3204), the comments were: "trombones bright but less body," "trumpets brighter," "brass sounds sharp," "strings slightly zingy," "strings more forward," "less upper sheen on strings," "snare drums similar," "snare drums very good but with slightly duller attack," "a little more congested on loud passages," "bass not as deep," "instruments are easy to place," and "slightly less spacious."

The KEFs' reproduction of Mozart's "Ave Verum Corpus" (performed by the Daughters of Mary on *De Profundis*, available from Daughters of Mary at 518/622-9833) elicited the comments: "voices are brighter," "voices are clearer and more pleasant," "voices slightly less articulate," "fricative sounds are less hissy," "oboe is clearer," "less deep bass," and "a little less sense of space."

Measurements

As an example of how measurements can explain the panelists' comments, note the bump between 800 Hz and 2 kHz in the frequency response (Fig. 1). This bump explains why the panel members consistently called the RDM One's sound "bright" and "forward." My measurements indicate that the crossover frequency is at 2.1 kHz (as specified) and that output is very well controlled above and below this point. It's common for grilles to roughen a speaker's response, but the RDM One's grille seems rather to smooth it above 2 kHz. I therefore kept the grille on for all other measurements and the listening evaluations. All my lab tests, with the exception of harmonic distortion, were made with the speaker and microphone away from all reflecting surfaces, a 4-pi-steradian measurement.

At the crossover frequency, the woofer's phase is –172.7° and the tweeter's is –75.6°, a difference of 97.1° (Fig. 2). This amounts to a time offset of about 128 microseconds, equivalent to a displacement of 1¾ inches between the woofer and tweeter. The comments about the RDM One's slightly less articulate rendering of voices and the slightly duller snare-drum attack may be partly due to this offset.

The terminals' plastic inserts prevent the use of banana plugs but can be removed.

The impedance (Fig. 3) never drops below about 5.8 ohms, so the RDM One should be easy to drive by any reasonably designed power amplifier. The maximum impedance, 34 ohms (reached at the crossover frequency), is 5.9 times the minimum, enough variation for the resistance of your speaker cables to affect the frequency response. The cable resistance will act as a resistive dividing network that can attenuate the signal more where the RDM One's impedance drops low and less where its impedance is high.

Figure 4 shows the RDM One's output and its second- and third-harmonic distortion at sound pressure levels of 90 and 100 dB. These curves were made with the microphone and the RDM One on a cement surface; this is called a 2-pi-steradian, or half-space, measurement. With equal input power, the sound output from the RDM One is approximately 6 dB greater than in the 4-pi-steradian measurements of Fig. 1. At the 100-dB level, the second harmonic at 50 Hz is 4.5% and the third harmonic is 3% at that frequency, both very good for a 6½-inch woofer. At 150 Hz, however, although the third harmonic drops to a very low 0.5%, the second harmonic bumps up to 4%. The only comment by the listening panel that might relate to this was the one about congestion at loud levels, but this could also have been caused by the KEF speaker's second- and third-harmonic distortion in the range between 500 Hz and 1.6 kHz, which measured a little less than 1%. At 90 dB SPL, the distortion dropped to 2.5% second and 3.2% third at 50 Hz. At 900 Hz, there was about 0.8% third-harmonic distortion and the second harmonic dropped to less than 0.3%.

"Bravo, Bryston! A landmark...a reference...a triumph...a steal!" *Stereophile, May 1997*

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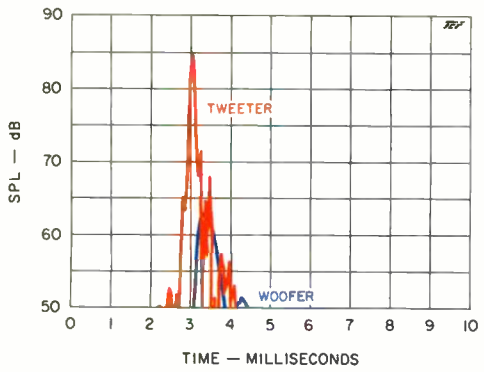


Fig. 7—Energy-time responses. Woofer response has been raised 10 dB for clarity.

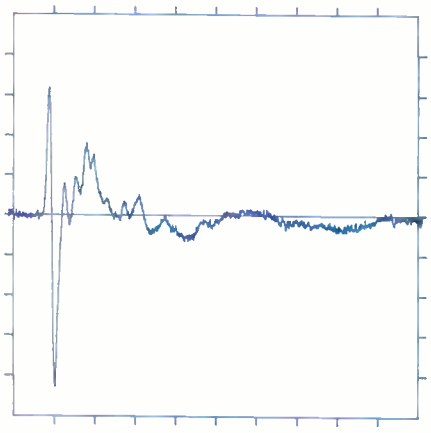


Fig. 8—Response to a 20-kHz cosine pulse.

The panel members were each seated on the listening setup's center line, equidistant from the RDM Ones (sometimes called the sweet spot), but your listening position may not always be as ideal. The curves in Figs. 5A, 5B, and 5C give some indication about how the RDM Ones perform when you listen to them while seated off their central axis. The three graphs are almost identical, which demonstrates the advantage of having the tweeter mounted in the center of the woofer. Figure 5A shows horizontal dispersion with the speaker in its preferred orientation, upright and with the Uni-Q driver toward the top. Figures 5B and 5C show horizontal dispersion but with the speaker lying on its side (equivalent to vertical dispersion with the speaker upright). If you must place the RDM One on its side—on a bookshelf, for instance—you'd probably get slightly better response if you place it with its Uni-Q driver toward the outside of the array, away from you (Fig. 5C), rather than with the driver facing toward the inside (Fig. 5B). But try both orientations before deciding which is better.

The RDM Ones reproduce square waves reasonably well (Fig. 6). The shape of the 300-Hz square wave attests to the time offset between the woofer and tweeter that is seen in the phase plots of Fig. 2. The initial positive spike confirms that the woofer's output lags the tweeter's by about 128 microseconds. This doesn't seem like much, but once you are used to listening to speaker systems that have much less time offset between drivers, you can hear how it affects voice articulation and the attack of transient sounds such as rim shots, cymbals, and brass instruments.

The energy/time responses for the bass and treble drivers (Fig. 7) show the energy and its time spread for the frequency range. This data, too, indicates that the woofer's output lags the tweeter's. Depending on which points on these curves you use as references, the delay is 250 to 350 microseconds, equivalent to an air-path delay of 3.4 to 4.75 inches.

When fed a positive-going cosine pulse, the RDM One initially responds with a positive output, but this is followed by a negative-going output of even greater amplitude (Fig. 8). Ideally, the output should be a positive acoustical output that returns to zero and stays there (like the input waveform), with no further output in either direction; unfortunately, the characteristics of real-world loudspeaker drivers and crossover networks don't allow this, so loudspeaker designers must choose between various compromises. Because I made my measurements before I began the listening sessions with my listening panel, I was aware of the RDM One's response to this test. I therefore used familiar CDs to determine that the RDM Ones sounded more realistic when connected in opposite polarity to my reference systems and wired the KEFs with this reversed polarity for the listening tests.

I also measured the RDM One's near-field bass response with a B&K 4133 microphone close to the woofer. As the input frequency was lowered from 1 kHz down to about 150 Hz, the output gradually rose and then rolled off slowly below 150 Hz. The RDM One's maximum output, which was reached at 150 Hz, was about 7 dB higher than at 1 kHz.

To measure the KEF RDM One's enclosure vibration, I placed an accelerometer in the center of a side panel; vibration was greatest between 720 and 900 Hz, and there were lesser peaks at 290, 1,100, and 1,600 Hz. Some of these vibration peaks correspond to the distortion maxima seen in Fig. 4; it might be possible to reduce the RDM One's distortion and make its sound even clearer by judiciously placing vibration absorbers on the inside cabinet walls, but I didn't try this.

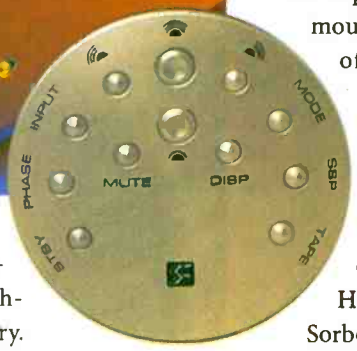
After all the lab tests and the listening sessions were completed, something jogged my memory about the sound of the Rogers version of the famous BBC LS3/5a monitor. (The LS3/5a was jointly developed by the BBC and KEF, and though other companies built these speakers, KEF made all the drivers and most of the crossovers for them.) I pulled out some measurements that I had performed years ago on this loudspeaker, and I was struck by the similarity of its frequency and square-wave responses to those of the RDM One. Although I no longer have the LS3/5a for sound comparisons and know that I can't rely on my long-term auditory memory, I am convinced that there would be similarities between the two systems. In any case, I'm sure that the KEF RDM One sounds as clear and precise as the Rogers LS3/5a did but can do so at much higher SPLs; it also goes deeper in the bass. For music like the first two selections used in the listening-panel sessions, the RDM Ones are excellent. For movie soundtracks and for more dynamic music that covers a broad frequency range, you will need a subwoofer. Either way, the KEF RDM Ones are an excellent value—and very good looking, too. A

THE RDM ONE REMINDED ME OF THE CLASSIC BBC LS3/5a, BUT WITH DEEPER BASS AND HIGHER OUTPUT.

EQUIPMENT PROFILE

BASCOM H. KING

SONIC FRONTIERS LINE 3 PREAMP



The Line 3 is the top model in a series of three new tube preamplifiers from Sonic Frontiers. Like the company's Power 3 tube power amps, the Line 3 takes a serious shot at the state of the art. The three Line series preamps share the same functions and front-panel layout, differing only in the extent and sophistication of their circuitry and power supplies. All three units come with an unusual, circular remote control, a mere 3 inches in diameter, that looks cute and feels good in your hand.

All three models have fully balanced, differential active circuitry, which I consider a big plus for sonic performance. It ensures that both phases of a balanced input signal are represented in each output phase and thus are represented in the unbalanced output, too. Further, this arrangement enables balanced output from single-ended input signals without additional circuitry.

The Line 3 has several interesting, useful features. A memory system enables you to store startup volume and balance settings for the various inputs. Although the Line 3 does not have built-in surround decoding, it has a surround sound processor mode, which bypasses all the preamp's functions and routes the signals from your surround processor's main-channel outputs directly to the preamp's output jacks. Instead of providing a simple headphone amplifier of its own, Sonic Frontiers incorporated one from HeadRoom with spatial processing that makes stereo recordings sound more natural through headphones. The rear panel also has an input jack for commands from infrared repeater pickups in other rooms and an output jack for a relay trigger that can be used to operate retractable screens or other home theater accessories.

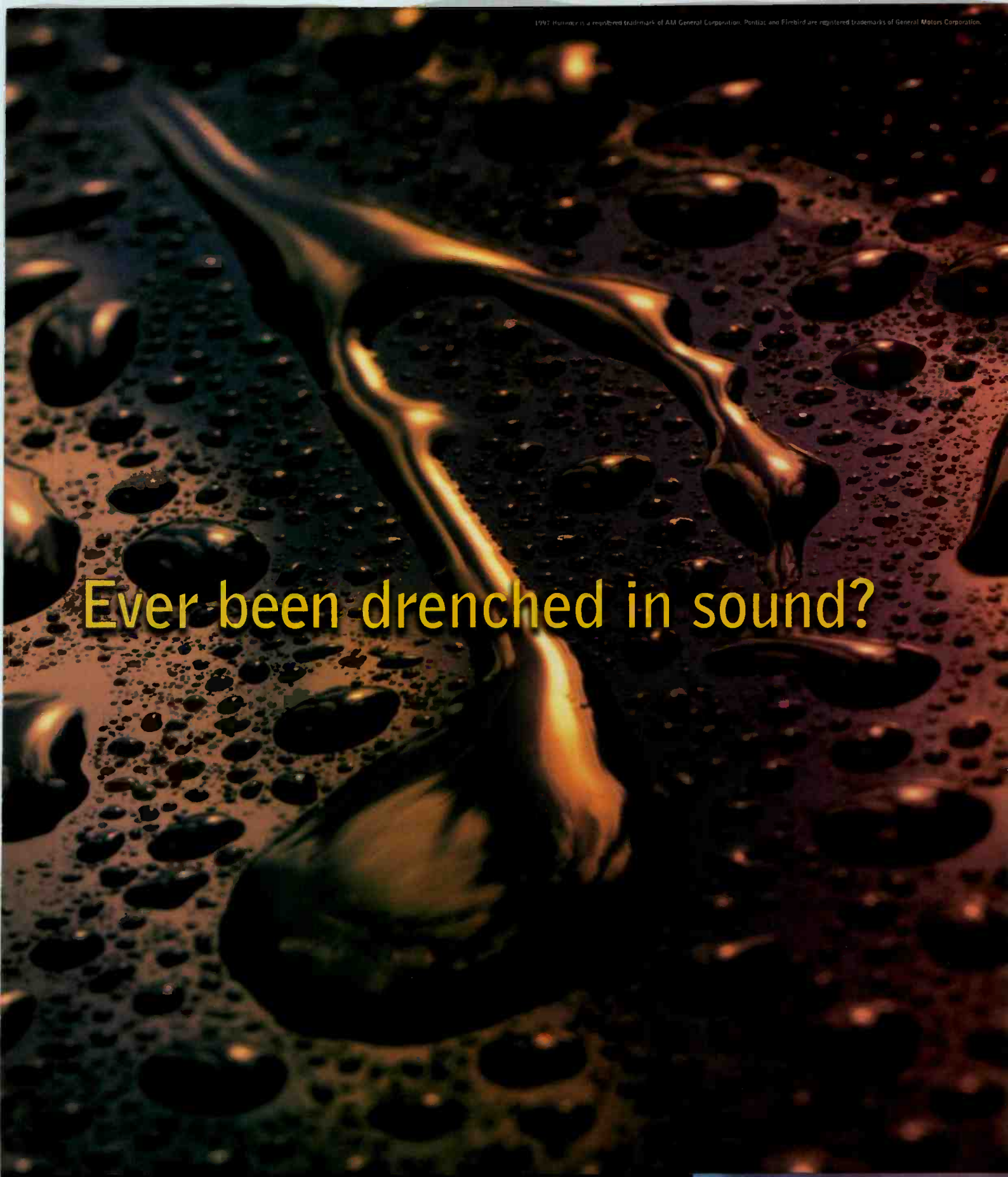
The display window in the front panel shows each channel's volume setting and the status of the switches for the input selector, stereo/mono mode, output polarity, and muting. The display is flanked by the eight input-selector buttons on one side and the volume control and "Standby/Operate" switch on the other. Below the display are the headphone jack and pushbuttons for output polarity, balance, mono/stereo mode, and muting. The main power switch is on the front panel of the power supply, which has the same size and general appearance as the preamp.

On the Line 3's rear panel are two sets of balanced and four sets of unbalanced normal inputs, a tape monitor, and the unbalanced bypass inputs for your surround processor. Each channel has two balanced and two unbalanced preamp outputs and an unbalanced tape output. Also on the rear panel is a multipin connector for the cable from the separate power supply and the infrared-repeater and relay-trigger jacks.

All input and output connectors are mounted to a circuit board at the rear of the Line 3's interior, together with the signal-switching relays. Most of the interior is taken up by the main board, which holds the tubes and associated signal circuitry, the power regulator circuitry and heat sinks, and the HeadRoom headphone amplifier. Sorbothane mounts protect this board from external vibrations. All control circuitry is in a shielded subenclosure just behind the front panel.

Dimensions: Two chassis, each 19 in. W x 4½ in. H x 14¼ in. D (48.3 cm x 11.4 cm x 36.2 cm).
Weight: 60 lbs. (27.2 kg).
Price: $4,995.
Company Address: 2790 Brighton Rd., Oakville, Ont., Canada L6H 5T4; 905/829-3838; SFI@sonicfrontiers.com; www.sonicfrontiers.com
For literature, circle No. 92

Photos: Michael Groen



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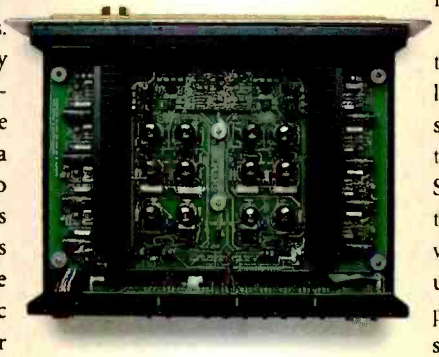
In the Line 3, all input and output switching is handled by relays. All inputs except the selected one are grounded. The input jacks are therefore connected to the relay contacts through series resistors, so that sources connected to the unselected inputs won't see a brutal short. The value of each resistor is 475 ohms, high enough to give the desired effect yet low enough to keep from slowing down the circuit and making it roll off high frequencies. The balanced inputs, of course, have such a resistor in each signal leg.

If a balanced input signal is selected, both of its phases are taken to the tape monitor selector relay; when an unbalanced input is selected, an additional relay switches the monitor input's ground connection from the negative phase of the balanced input circuit to ground. The tape output, which is also unbalanced, receives the selected input's positive phase through a buffer.

From the tape monitor relay, both phases of the signal go to the volume control. Between that relay and the control is the relay for the stereo/mono mode selection; in mono mode, it connects the corresponding phases of the two channels together through resistors. Because of these resistors, the "mono" mode actually leaves about 8 dB of stereo separation, for natural stereo reproduction through headphones and, Sonic Frontiers says, to avoid altering the timbre of stereo recordings through unpredictable cancellations and reinforcements of different frequencies.



The volume control consists of two digitally controlled attenuator ICs made by Crystal Semiconductor, one per channel, that adjust the Line 3's volume and balance in 0.5-dB steps over a 95.5-dB range. Each of these ICs is a stereo unit, to handle the two signal phases. This attenuator has tight tracking between its sections, which insures good common-mode rejection over the volume control's range. A technical paper from Sonic Frontiers states that this volume control, together with its new tube circuitry, yields even better sound than its past designs that used four-gang, switched-attenuator volume controls.

Next in the signal chain is the heart of the preamp, the vacuum-tube line amplifier circuit. Its input stage is a differential amplifier consisting of one 6922 twin triode per channel, with an AC balance control between its cathodes. This control's wiper is connected to the plate of a 6GH8 pentode/triode tube's pentode section (more about its triode section later). This pentode functions as a constant-current source for the input differential pair and is connected to a regulated –125-volt supply. The plate outputs of the differential pair are connected through 12-kilohm plate-load resistors to a regulated 176-volt supply; each input triode conducts about 4.7 milliamperes.

From the input stage's plates, signals are capacitor-coupled to the output stage, which is configured as a cathode follower with a constant-current source. In this case, the cathode follower consists of paralleled halves of two 6922 dual-triode tubes while the constant-current source uses the other halves of these tubes, also in parallel. Each channel therefore uses four 6922 dual-triode tubes, two per signal phase. This stage receives power at +125 and –125 volts from dedicated voltage regulators. The signal is directly coupled from the cathodes of these 6922s to the output.

A separate servo circuit for each output phase compares the DC level at the output to ground. The amplified error signal is applied to the middle of a voltage divider that is connected across the output stage's positive and negative 125-volt supplies. Another point, close to the –125 volt end of the divider, is connected to the grids of the cathode follower's paralleled current source. A third point on this divider, which is slightly negative with respect to ground, is connected to the cathode followers' grid-leak resistors. Thus, the servo keeps the output cathode at ground potential. It also keeps the output of the error amplifier at or near zero, maximizing the range over which the error amp can control the output's DC offset.

The two phases of the output are summed through matched resistors and applied to the grid of the 6GH8's triode section. Its cathode feeds a two-resistor voltage divider that ends at the –125 volt supply. The output of the voltage divider drives the control grid of the 6GH8's pentode section; because a capacitor bypasses this divider's upper resistor, the AC signal is coupled to this grid. This error-correction system helps keep the amplitudes of the two output phases equal, whether the input signals are balanced or unbalanced: Any difference between the two output phases modulates the pentode current source, modifying the effective drive in the input differential amplifier so as to restore the output balance. This error-correcting topology has been used in tube and solid-state instrumentation amplifiers, but I don't recall seeing it in tube audio circuits before. This is definitely not your everyday tube preamp!

Between the tube section and the output jacks, the balanced signal passes through three more relays. The first of these selects the surround-processor input, bypassing the Line 3's main input selector, tape monitor, volume control, and gain stages. Since the surround-processor input is unbalanced, the negative-signal leg of this relay is grounded when that input is selected. The second relay is used for polarity reversal. The final relay mutes the preamp by disconnecting its output jacks from the signal circuitry and grounding them.

The Line 3's power supply regulators are as unusual as its signal circuitry—shunt regulators instead of the usual series type. In series regulators, voltage passes through the regulating element. In a shunt regulator, a fixed resistor is connected between the unregulated input and the regulated output and its output end is shunted to ground; the shunt is a variable element that passes just enough current to keep the output voltage constant. In both designs, the regulator is controlled by an error amplifier, which senses the regulator's output and feeds a corresponding error signal to the regulator's control input. For the concept to work, the amount of current flowing through the shunt element when the circuit is idling is typically about equal to the output load current. When the load current increases, the current in the shunt element decreases by the same amount. Since the total current flowing in the series resistor is therefore the same, the output voltage doesn't change. The disadvantage is that shunt regulators dissipate more power than series regulators do. Sonic Frontiers chose this topology because shunt regulators are said to maintain a very low output impedance out to high frequencies; the regulators in the Line 3 are said to hold their output impedance to less than 0.05 ohms up to 200 kHz, no mean feat. This low regulator output impedance helps the tube circuitry perform optimally over a frequency range wider than the audio band. Each channel's active circuitry has four of these regulators, two for its input stage and two for its output.

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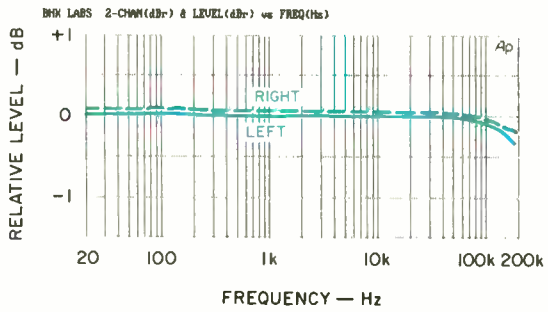


Fig. 1—Frequency response with instrument load for balanced input and output (A) and unbalanced input and output (B).

Table I—*Input sensitivity with volume control at maximum and IHF load (10 kilohms paralleled by 1,000 picofarads).*

	Sensitivity	
	LEFT	RIGHT
Unbalanced Input to Unbalanced Main Output	114.2 mV	113.1 mV
Unbalanced Input to Tape Output	524.9 mV	524.0 mV
Unbalanced Input to Balanced Main Output	56.8 mV	56.2 mV
Balanced Input to Unbalanced Main Output	113.4 mV	112.2 mV
Balanced Input to Tape Output	1,071.4 mV	1,066.6 mV
Balanced Input to Balanced Main Output	56.8 mV	56.3 mV

Table II—*Output noise levels for minimum and maximum settings of volume control. IHF S/N ratios with balanced input and output were 87.4 dB for the left channel and 87.2 dB for the right; with unbalanced input and output they were 89.7 and 89.4 dB.*

	Noise, µV			
	LEFT		RIGHT	
Bandwidth	Min.	Max.	Min.	Max.
Balanced Input and Output				
Wideband	119.2	195.2	119.9	197.4
A-Weighted	29.8	37.9	22.9	38.7
Unbalanced Input and Output				
Wideband	117.5	141.9	135.7	158.2
A-Weighted	18.4	23.7	20.4	25.5

The interior of the Line 3's power supply is almost completely occupied by a large circuit board, whose mirror-image layout shows that this is a dual-mono supply. Each channel's supply has a shielded and potted toroidal power transformer, two high-voltage filter chokes, four Solen metalized-polypropylene filter capacitors, and heat sinks for its low-voltage regulators. Between the two channels' heat sinks is a third power supply, for the control logic, with its own power transformer. Parts and construction quality are first-rate in this beautifully made component.

THE LINE 3 IS BEAUTIFULLY MADE, WITH FIRST-RATE PARTS AND CONSTRUCTION.

Measurements

Frequency response with the volume control fully clockwise and instrument loading is plotted in Fig. 1. With balanced input and output (Fig. 1A), the channels act very much alike, but with unbalanced input and output (Fig. 1B), there is a noticeable difference between the channels at frequencies above about 40 kHz. Changing from instrument to IHF loading dropped the output by 0.05 dB for unbalanced connections and 0.07 dB for the balanced ones, but left the shapes of the curves pretty much unchanged. For unbalanced input and output, the frequency response did not change with volume-control setting down to –40 dB, but there was some high-frequency rolloff at lower settings, hitting 10 dB down at 200 kHz when the attenuation reached –70 dB; with balanced input and output, the rolloff was not as great.

Rise and fall times with unbalanced input and output were 0.8 microsecond in the left channel and 0.4 microsecond in the right at an output level of ±1.25 volts; IHF loading did not change these times appreciably. At ±5 volts, some slewing became apparent and rise and fall times increased to 1.1 microseconds and 0.8 microsecond, respectively. Slew rate was about ±10 volts per microsecond. A 20-Hz square wave exhibited a just noticeable tilt of about 5%.

The common-mode rejection ratio (CMRR) is shown in Fig. 2 for the left channel; the right channel performed similarly—which is to say, quite well. For the unbalanced outputs, CMRR is an indirect measure of the circuit's ability to represent both phases of the balanced input signal equally in the unbalanced output; the better the CMRR, the more balanced the two phases of the output are. As mentioned earlier, only a circuit with fully balanced, symmetrical topology can represent both balanced input phases equally in an unbalanced output signal.

Output impedance was a low 50 ohms for the unbalanced main outputs, about 78 ohms at the balanced outputs, and less than 1 ohm at the tape outputs. Input impedance was 10.4 kilohms for the unbalanced jacks and 20.8 kilohms for the balanced ones.

Figure 3 shows total harmonic distortion plus noise (THD + N) as a function of output level with IHF loading. Compared to instrument loading, the IHF load did not increase distortion very much and had very

little effect on maximum output. Distortion was generally lower with balanced input and output (Fig. 3A) than with unbalanced (Fig. 3B). As you can see, the Line 3 has the desirable property of maintaining virtually the same low distortion at all audio frequencies. The sudden increase in distortion at high levels, which normally indicates clipping at a circuit's output, is actually a function of input level in the Line 3, caused by overloading of its digital volume control, not its tube circuitry. With balanced input and output, the first measurable effect occurs at an input level of about 7.85 volts, and the onset of clipping becomes visible in the output waveform at an input voltage of 8.2 volts. For unbalanced input and output, the corresponding figures were 3.9 and 4.2 volts. I'm not stating this to find fault—the Line 3's input acceptance is certainly adequate—but merely to clarify which portion of the circuit is doing what.

Interchannel crosstalk, with the volume control at its maximum, was lower in the balanced input and output mode, less than –110 dB up to 2 kHz, rising to about –90 dB at 20 kHz. For unbalanced input and output, crosstalk was less than –110 dB up to 200 Hz, rising at 6 dB per octave to about –73 dB at 20 kHz. Results were essentially the same at lower volume settings.

In the right channel, DC offset at the preamp outputs was –5.0 millivolts for the positive phase and –0.7 millivolt for the negative; right-channel measurements were +2.3 and +5.1 millivolts. The Line 3 drew 0.7 ampere of AC from the line in the standby mode and 1.56 amperes when switched on.

Input sensitivity measurements for various input/output combinations are enumerated in Table I. Noise measurements, which were very similar for the two channels, are given in Table II.

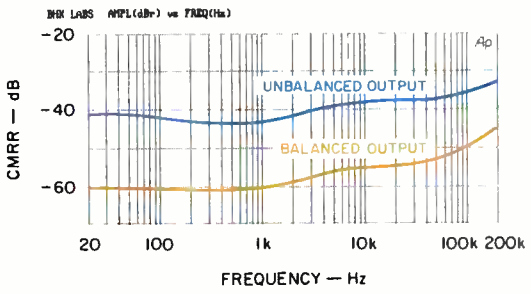
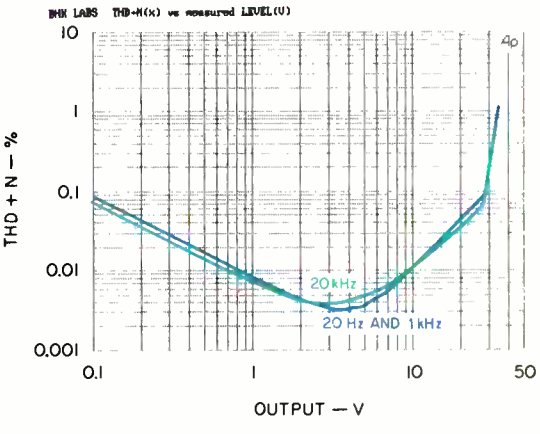
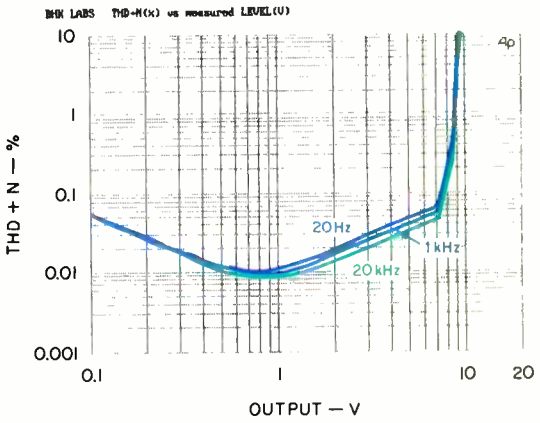


Fig. 2—Common-mode rejection ratio.



A



B

Fig. 3—THD + N vs. level for balanced input and output (A) and unbalanced input and output (B).

Use and Listening Tests

The Line 3's ergonomics and sound impressed me when I first put it in my system and kept on impressing me as I used it. I found myself enjoying music with the Line 3 and having no desire to go back to another preamp to improve the sound. Reproduction was very clear, spacious, and musically believable. Bass was tight, articulate, and solid; mids and highs were open and airy, with very little irritation. This is a very fine preamp, indeed.

The design of the Line 3 and its remote control make it a delight to operate. The clear, easy-to-read display of volume settings also makes it easy to repeat previously set levels and to adjust balance for particular recordings. It's also a great reviewing tool, as it's equally at home with balanced or unbalanced inputs and outputs. There were no surprises or glitches in the Line 3's operation, just perfect behavior.

If you get the idea that I like the Sonic Frontiers Line 3, you're right. It is one of the best preamps I've had the pleasure of using in my system, and it's become my current reference preamplifier. I highly recommend an audition—though it might also be rewarding to look into Sonic Frontiers' less expensive Line 1 and Line 2 models. A

Associated Equipment Used

Equipment used in the listening tests for this review consisted of:

CD Transports: Sonic Frontiers SFT-1 and PS Audio Lambda Two Special

CD Electronics: Z-Systems rdp-1 digital preamp, Genesis Technologies Digital Lens anti-jitter device, and Sonic Frontiers SFD-2 MKII, Classé Audio DAC-1, and Threshold DAC 2 D/A converters

Phono Equipment: Oracle turntable, Well Tempered Arm, Accuphase AC-2 moving-coil cartridge, Vendetta Research SCP-2C phono preamp, and phono stage of Anthem Pre 1 preamp

Additional Signal Sources: Nakamichi ST-7 FM tuner, Nakamichi 250 cassette deck, and Technics 1500 open-reel recorder

Preamplifiers: Threshold T2 and Forssell balanced tube line driver

Power Amplifiers: Sonic Frontiers Power 3 and Quicksilver M-135 mono tube amplifiers, Houston GSP-02 stereo tube amp, and Threshold 600D stereo amp

Loudspeakers: Audiostatic ES-500s, B&W 801 Matrix Series 3s, and Genesis Technologies Genesis Vs

Cables: Digital interconnects, Illuminati DX-50 (AES/EBU balanced); analog interconnects, Transparent Cable MusicLink Reference (balanced) and Tara Labs Master and Music and Sound (unbalanced); speaker cables, Transparent Cable MusicWave Reference and Tara Labs RSC Master Generation 2

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Q Should I purchase a new big screen TV now or wait until the new Digital TV's start arriving in late 98'?

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—Bjorn Dybdahl
Bjorn's Audio Video
San Antonio, TX

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Q What makes an electrostatic speaker work?

A The *electrostatic* principal states that like charges repel and opposite charges attract. In an electrostatic speaker, a diaphragm is charged with a high voltage and supported between two stators. Signal is increased in voltage by a transformer and applied to the stators so that when one stator becomes positive, the other one becomes negative. The diaphragm is attracted to one stator and repelled by the other. As the signal changes polarity, so do the stators. The diaphragm's movement in unison with the signal moves the surrounding air and creates sound. Detail and transient response are superior to dynamic drivers. Bass is typically enhanced in modern electrostats by a dynamic woofer.

—Donald Manigold
GNP Audio Video
Pasadena, CA

GNP

Each month, Audio Magazine's feature "See a Specialist" showcases the finest audio/video dealers from across the country. The dealers, chosen as a result of recommendations from equipment manufacturers, Audio Magazine staff and industry organizations, exemplify the best audio/video dealers from New York to California. The chosen dealers offer solutions to problems that can best be handled by a specialty audio/video retailer.

If you would like to submit questions to dealers in your area please write to :
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AURICLE

COREY GREENBERG

PARADIGM REFERENCE ACTIVE/20 SPEAKER

Active speakers are the audiophile equivalent of pantyhose on a guy. Even though you're never really told as a boy that it isn't kosher to wear pantyhose under your Tuff-Skins, you just know it's wrong. C'mon! Guys don't wear pantyhose, and that's that. Unless, like me, your high-school football coach tells you to wear them under your pads and football pants because it helps you run faster and the pads don't scrape as much. And besides, the pros do it, so it must be okay.

So you decide to try it out first in the privacy of your bedroom, with a pair of L'Eggs you swiped from your mom. Quick check down the hall, close the door behind you, and moments later you're pulling on your first pair of ladies' hosiery. And they feel good! I mean, really good! Your legs feel better than they've ever felt before, smooth and sleek, with control that just won't quit. You feel like you've stumbled onto a hallowed secret of life: Pantyhose rule! Pretty soon you've got Gloria Gaynor on the stereo and you're kickin' up your heels when all of a sudden the door swings open and it's your dad telling you to turn down the music, and the two of you just stand there staring at each other for a few seconds without saying anything until he slowly backs out of the room, you quickly wriggle out of the L'Eggs, and that's the end of that. Hey, I didn't say this happened to me! I said *you*, you! I'm all man, and I'll lick any fella says otherwise.

The point is, an active speaker is—that is, a speaker with an active line-level electronic crossover and separate internal amplifiers for each driver—the same thing. All things being equal, active really is the best way to go. But aside from Meridian's outstanding line of active speakers, most audiophiles tend to shun the concept like a leper.

Why? I guess the biggest mental hurdle is the no-more-amps-on-the-floor thing. With powered speakers having their own internal amplifiers, you no longer need to own a separate amp. You just run some interconnects between your preamp and the speakers and away you go. So you can't use your favorite audiophile amplifier with active speakers. But picking and choosing amps is so much fun, right? Zzzzz. Wake me when it's over.

The fact is, a well-designed active speaker will kick the crap out of the passive version of that same speaker driven by the best amplifier in the world. Because no matter how great the amp is, it's never quite in control of the speaker's drivers: It's still got to slap around a highly reactive, easily saturated passive crossover before the power can get to the woofer and the tweeter. By replacing this bottleneck with an active line-level electronic crossover and giving each driver its own separate amp with nothing between them but a few inches of wire, the drivers are locked into much tighter control and a whole host of sonic problems that plague even the finest conventional speakers are neatly sidestepped. The difference between a passive and an active version of the same speaker can be jarring if you've never heard it before; all kinds of distortions and colorations you always attributed to driver limitations are suddenly not there anymore. I'm not kidding—it's a difference you hear immediately.

Incidentally, this is not a new idea. Linn has been selling active versions of its speakers for many years, and

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"the RC2000 has transformed my life"

Al Griffin
Home Theater Magazine
November 1996

ALL YOU NEED IS ONE!

Get total control and complete convenience with the Marantz RC2000 learning remote.

I've even got an Ampex active speaker from the '50s (tube-driven, no less). Powered subwoofers have become almost *de rigueur* these days, but still the active speaker remains that forbidden pair of pantyhose that every audiophile would fall madly in love with—if only he'd try them on just once.

Which brings me to Paradigm. This Canadian high-end speaker manufacturer has become one of my favorites in recent years, producing some of the best-sounding, best-value speakers on the market, like the Mini Monitor ($369 per pair) I reviewed back in the June issue. So I was especially eager to hear the company's first full-range powered speaker, the Paradigm Reference Active/20 ($1,600 per pair). I got my first taste of the powered Paradigms at the Winter '97 Consumer Electronics Show, and I was floored—I thought they were hands-down the best new speakers at the show. A few months of final whipping-into-shape later and the first production pair has found its way into my living room for review.

ALL THINGS BEING EQUAL, ACTIVE REALLY IS THE BEST WAY TO GO.

The Active/20 is a sealed, two-way bookshelf system that measures 14 x 8¼ x 11 inches deep. An internal electronic crossover splits the incoming line-level audio signal with a third-order crossover at 1.5 kHz, feeding the bass to a 6½-inch polycone woofer driven directly by a 110-watt amplifier and the treble to a 1-inch aluminum dome tweeter driven by a 50-watt amp. Both drivers are designed and manufactured by Paradigm, as are the active electronics, amplifier modules, and even the exceptionally well-damped, medium-density-fiberboard cabinet, which is available in either black ash or gloss cherry veneer.

The heat sink, power-cord jack, and controls are tip-offs to the amps inside the Paradigm Active/20.

It's on the back panel where you notice that this isn't just another two-way 6-incher. Your first clue is the heat sink for the internal amps, which takes up nearly two-thirds of the back plate. Since it's a powered speaker, each Active/20 has a female IEC power connector and a removable, 12-foot AC power cord, as well as a 23-foot pair of Paradigm's house-brand AudioStream A-400 interconnects. (I have no explanation for the non-standard length of the interconnect except that perhaps 23 Canadian feet equals 25 U.S. feet, depending on the exchange rate.)

The usual red and black speaker binding posts are nowhere to be found on the back of the Active/20. Instead, there is a single gold-plated RCA input jack for hookup to your preamp's main output. A balanced XLR input is also provided (with pin two hot, as it should be), along with a miniswitch to choose between XLR and RCA connection. Another miniswitch engages a 100-Hz, 18-dB/octave high-pass filter for use with a subwoofer, while yet another miniswitch toggles between the Active/20's two power modes: always on and automatic on/off in the presence or absence of an input signal.

The Paradigm logo on the front of the speaker grille does double duty as a power indicator, lighting up green whenever the amps are activated. The illuminated logo also serves as a clipping indicator, turning red to let you know the Active/20's amps are hitting their limit so you'd better turn the system down a peg. I got the speakers to turn the red light on a few times, but they were really loud, and I'd twiddled the bass EQ knobs for some added boost, which was taxing the amps even further. The Active/20s more than filled my cavernous loft (2,500 square feet) with clean, loud sound before hitting their output ceiling, which is remarkable given their size and price. But that's the kind of surprise you get with a good active speaker.

The back panel also sports a trio of small knobs, one to adjust input level and two for EQ tweaking. The input level control has a detent in the middle of its range to duplicate the gain relationship of the typical amp/speaker scenario, but you can crank up or cut back the gain if your preamp has lower- or higher-than-normal output levels. The two equalization knobs let you tweak the Active/20's low-frequency and high-frequency responses in order to compensate for room acoustics and placement difficulties. The range for these tone controls is only ±2 dB to prevent gross tonal yuckiness, but I found the low-frequency adjustment to be quite useful in firming up the Paradigm's bass response when the speaker was mounted on a stand and placed well into the room, a location that tends to make most bookshelf speakers sound too lean.

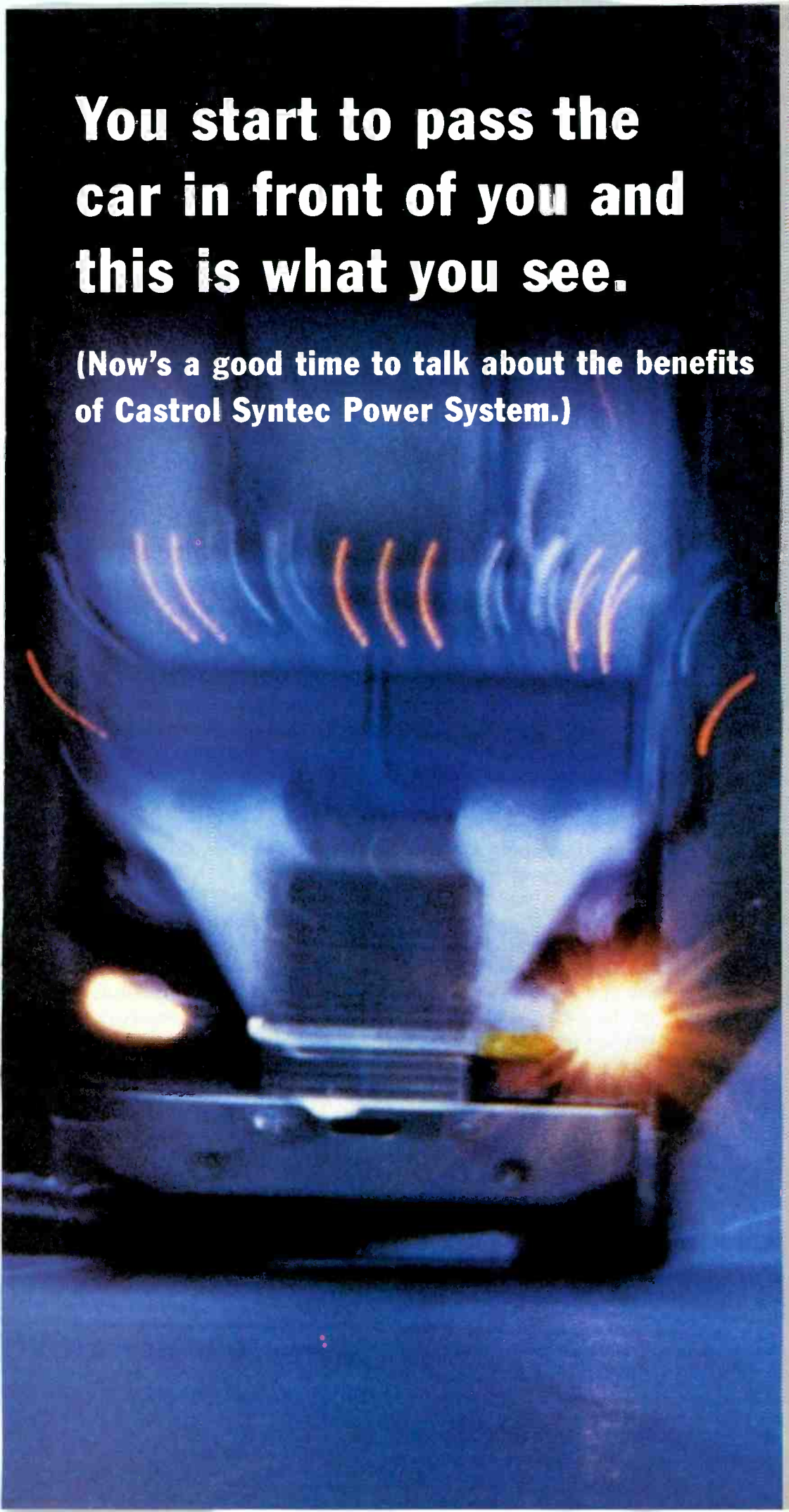
Eagle-eyed audionuts will notice a striking physical similarity between the Active/20 and the existing Paradigm Reference Studio/20, the company's high-end, two-way 6-incher that's $650/pair. Even the author himself made an ass out of u and me by assuming that the Active/20 was just a Studio/20 with a built-in amp. But Paradigm says the Active/20's drivers, especially the 6½-inch woofer, were upgraded from those of the Studio/20. It was designed with higher power-handling capability so that active low-frequency boost in the electronics could be applied to extend the Active/20's deep bass response below that of the passive Studio/20.

I auditioned the Active/20s in my main system, setting them atop a pair of heavy, sand-filled, 24-inch Merrill stands. I also compared their sound to that of my long-term reference speakers, the NHT 3.3s ($4,300/pair), driven by the Aragon 8008ST 200-watt-per-channel stereo amp ($2,000) via $300 worth of Kimber 8TC speaker cable. For those of you keeping score, that's a $5,000 difference between the two amp/speaker/cable setups.

Theta Digital's Casablanca surround preamp alternately drove the Paradigms directly and the NHT/Aragon/Kimber setup, with a Theta Data III digital transport as the source. LPs were spun on a Rega Planar 3 turntable fitted with a Sumiko SHO cartridge and a McCormack Micro Phono Drive phono stage. Canare 75-ohm digital

You start to pass the car in front of you and this is what you see.

(Now's a good time to talk about the benefits of Castrol Syntec Power System.)



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cable and Audio Power Industries' Power Pack AC filters rounded out the picture.

Long before I received the Active/20s for review, Paradigm had sent me a pair of the regular Studio/20s to listen to, which I did. To be honest, even though I liked them okay, I couldn't really get all that excited. The Studio/20 is a good, $650-per-pair speaker, but it's not the kind of amazing, overachieving steal that Paradigm's $369-per-pair Mini Monitor is. So the Studio/20s sat around for a while until I finally sent them back to Paradigm. Like I said, nice enough speaker, but it didn't do the fire-under-the-butt thing.

That's why I was so stunned by the sound of the Active/20. Paradigm was right—this isn't just a powered Studio/20. This is a miracle of nature. This is something you've got to hear for yourself, if only to open your ears to the wonders of powered speakers done right. This is hands-down the best-sounding two-way 6-incher I've heard at any price. I'd put it up against the most "in" audiophile two-way, driven by the most "in" amp, and I'd fully expect the Active/20 to kick the crap out of it. It's that good.

THE ACTIVE/20'S GREATEST STRENGTH IS ITS AMAZING, MICRO-FOCUSED IMAGING.

Now, before the jizz begins in earnest, let's put this into harsh perspective. The Active/20s should be considered as not just a pair of speakers, but as a stereo power amplifier (actually two stereo amps, in a bi-amped setup) driving a pair of speakers via a pair of speaker cables, because the $1,600 you pay for these babies covers all three—amp, speaker, and cables. You and I both know that many audiophiles would be hard-pressed to name any amplifier they considered truly outstanding that sells for 1,600 clams, much less a pair of conventional passive speakers for the same price. And yet here's this small, sturdy, *powered* two-way 6-incher that sounds more focused, transparent, and musical than passive two-ways costing many times the Active/20's price. Are you starting to see why I'm loving this speaker?

Without a doubt, the Active/20's greatest strength is its amazing, micro-focused imaging. That was the first thing I noticed about the Paradigms once I'd broken in the review pair and sat down for a listen. They should call this speaker the Time Slicer—these speakers etch out a finely detailed soundscape like nothing else I've had in my listening room, my reference NHTs included. Instruments and voices are more clearly carved in space with sharply defined sizes and edges. I sure don't remember hearing this kind of imaging from the Studio/20s—not even close. The Active/20's image focus is uncanny, and a new high-water mark for my listening room.

But coming right on the heels of its imaging magic is the Active/20's astounding transparency. Simply put, these are very, very see-through speakers. The Paradigms exhibit absolutely none of the crossover-induced colorations inherent in passive speakers—none of the phasiness around the crossover points, the nasal midrange, the glare when the speaker is driven hard. Drive the Paradigms hard, and all you hear is the same sound, only louder. I've heard a similar cleaning up of the sound from the Meridian active speakers, as well. It's an unmistakable absence of the usual colorations you hear with even the best passive speakers, and once you've heard it, you instantly recognize it when you hear it again. There's just none of the slowly-mounting strain I hear from passive speakers as they're driven up to their limits. Even when the Paradigm logo flashes red, the sound doesn't get dirty or coarse. Paradigm says the red light comes on just ahead of the amps' actual upper limits, kind of like a gas gauge that spots you a gallon even as it reads empty.

In terms of coloration, the Active/20 is easily the least colored speaker I've heard at its price. It's very, very neutral, with just a bit of that lower-midrange woofer yaw that's almost a Paradigm family trait. This was an area where I felt the Active/20 was bettered by the $5,000-more-expensive NHT/Aragon/Kimber setup. My reference speakers had lower coloration overall through the midrange, as I'd expect given the huge difference in price—the Aragon amp alone costs more than the Active/20s, and it's rated at only 35 watts per channel more than the Paradigm's internal amplifiers!

The Active/20's high end is startlingly clean and detailed, a reviewer's dream treble. It's airy without sounding soft, detailed without sounding edgy. It's the best high end I've heard from a dynamic speaker since I reviewed the Meridian digital active speakers several years ago. This was an area of performance where the Paradigm came out ahead of the NHT/Aragon/Kimber setup. There is a slight tendency to brightness with the treble EQ at its "flat" setting, but this can be totally eliminated by turning the control down just a hair. I also found that the AudioStream interconnects Paradigm includes with the Active/20s work extremely well with them—I actually preferred the combination to the sound I heard when swapping the AudioStream cable for a 5-meter pair of Kimber Silver Streak. The AudioStream's warmer top end balanced the Active/20's slight tendency toward brightness very nicely.

I also found that turning the bass EQ knob all the way up to add 2 dB of boost helped flesh out the low-end balance of the Active/20s when they were mounted on a pair of stands placed out into the room. Set up as such, it was hard to believe that I was listening to a pair of two-way 6-inchers. I've never heard such deep, strong, tightly-defined bass from such a small speaker before. This is one realm where the advantages gleaned from the active approach pay off in triple cherries: The lock-tight grip between the 110-watt amp and the high-output woofer and the bass EQ combine to deliver the kind of bass clarity and extension I normally expect from a good 10-inch powered subwoofer. Now, don't get me wrong—the Active/20 welcomes the chance to sing and dance with a good powered sub, and I got excellent results mating it with NHT's 12-inch SW3P ($1,350). But don't think for a second that the Active/20 has the bass extension of a typical two-way 6-incher's low end. Close your eyes and you'll think you're hearing a three-way 10-incher, in tonal balance if not in ultimate output.

Finally, it would be a crime to finish this review without praising the Active/20's dynamics. There's such a natural ease to the sound of these speakers at high volume that I just wanted to keep turning them up. The

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red lights would flash at very high levels, but the speakers still sounded great. I'd drive them a little harder, and I'd hear some fairly graceful amp clipping, but it was much more benign than what you would normally hear from a separate amp driving passive speakers. Because when an amp clips into a passive speaker, it sends all of its harmonic distortion to the tweeter with a nasty crack. But an active speaker doesn't do that; when the woofer's amp clips, none of its distortion ever gets to the tweeter. It just gets attenuated by the woofer's own mechanical rolloff at the top of its range. Meanwhile, the tweeter just keeps cruising along on its own overkill amplifier (50 watts is a lot of power for just a tweeter). It all adds up to a two-way 6-incher that sounds much, much bigger and much,

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much better in every way than any other speaker its size I've heard.

As you can tell, I was floored by the Paradigm Active/20. In many ways it sounded as good or better than my $5,000-more-expensive reference amp/speaker combo. All of the advantages of good active speaker design—lower coloration, more see-through transparency, better dynamics, uncanny imaging—are present in the Active/20, and at what must be considered a bargain price for such a high level of performance.

Although I don't expect the Active/20 to single-handedly turn the audiophile tide of acceptance when it comes to powered speakers, I strongly recommend that you go hear this speaker at your local Paradigm Reference dealer, even if you're not in the market for new speakers, just to hear the magic of active speakers for yourself. At just $1,600 per pair, including a set of good-sounding interconnects long enough for even a large listening room, the Paradigm Active/20 is not only the best two-way 6-incher I've heard to date but one of the greatest bargains in high-end audio. Highly recommended! A

9 NEW DATES & LOCATIONS

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Archive Photos

AUDIO 50th ANNIVERSARY/COREY TOUR LOCATIONS

DATE	DEALER
WED., SEPT. 17TH 7:00 PM	AUDIO PERFECTION 7401 LYNDALE AVE. S. MINNEAPOLIS, MN 55423 (612)866-0083
THURS., SEPT. 18TH 7:00 PM	SOUND HOUNDS 333 EAST ALAMEDA DENVER, CO 80209 (303)722-3200
FRIDAY, SEPT. 19TH 7:00 PM	ABT ELECTRONICS 9000 N. WAUKEGAN RD. MORTON GROVE, IL 60053 (847)967-8830
WED., SEPT. 24TH 7:00 PM	MYER-EMCO 11611 OLD GEORGETOWN RD. ROCKVILLE, MD 20852 (301)468-2000
THURS., SEPT. 25TH 7:00 PM	WORLDWIDE STEREO 104 EAST VINE STREET HATFIELD, PA 19440 (215)368-5506
FRIDAY, SEPT. 26TH 7:00 PM	TWEETER Etc. HARVARD SQUARE 104 MT. AUBURN STREET CAMBRIDGE, MA 02138 (617) 492-4411
WED., NOV. 5TH 7:00 PM	CHELSEA AUDIO VIDEO 3700 SOUTHWEST HALL BLVD. BEAVERTON, OR 97005 (503)641-3533
THURS., NOV. 6TH 7:00 PM	MAGNOLIA Hi-Fi 6308 ROOSEVELT WAY N.E. SEATTLE, WA 98115 (206)525-1961
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CLASSICAL RECORDINGS

The Mower by Kasimir Malevich, Russian State Museum, St Petersburg/SuperStock

Shostakovich: String Quartet No. 8 (orchestrated by Rudolf Barshai); Vasks: Musica Dolorosa; Schnittke: Trio Sonata (orchestrated by Yuri Bashmet)
Stuttgart Chamber Orchestra, Dennis Russell Davies
ECM NEW SERIES 1620
DDD; 67:31
Sound: A, Performance: A+

This is a truly remarkable recording. All three of its compositions were written as private expressions of grief suffered by Soviet composers—two as chamber works that have since been recast for small orchestra. A triptych of dirges may not sound like very attractive fare, but these dirges express their composers' grief so compellingly that their emotional black hole ineluctably draws you in.

Most compelling—and justly most famous—is Dmitri Shostakovich's Eighth String Quartet, here orchestrated, with the composer's full blessing, as the Chamber Symphony. Curiously, though Shostakovich's own instrument was the piano, his piano music tends to be much less personal and inward than his string quartets. And none of his quartets is more personal than the Eighth. Whether it is dedicated to the heroic Russian dead of World War II (as the Soviet authorities were content to assume) or to the victims of Soviet oppression (as Shostakovich stated privately to friends) or to his own political and moral "death" on being forced to join the Communist Party (as some assert, with hints that he may have contemplated suicide at the time), it is a complex and masterful work. It has been recognized as among the very greatest string quartets of the century; in the present guise it may lose intimacy, but it gains in power.

Peteris Vasks, a Latvian, may not have been quite so despairing in writing "Musica Dolorosa," but it shares intensity of emotion with the Shostakovich. Alfred Schnittke speaks to me, personally, with somewhat less conviction, though I suspect his Trio Sonata's position as the CD's finale here is based on the judgment that he will carry more weight with most listeners than will Vasks. Well, perhaps so.

The sound is exemplary, and without access to scores (except for the original version of the Shostakovich) I find it hard to imagine how the performances could be improved upon. My only reservation is that the track listings and their timings are buried inside the booklet. That you must open the booklet to know what is going on is admittedly a trivial complaint; the implication that the whole is all-important and the constituent parts of little consequence is not. These are three very individual pieces, whatever their outward simi-

TURLOUGH O'CAROLAN

Carolan's Harp: Music of Turlough O'Carolan
Andrew Lawrence-King, Irish and renaissance harps, French cittern, and psaltery; The Harp Consort
DHM 05472-77375; DDD; 77:51
Sound: B+, Performance: A+

Turlough O'Carolan, the blind Irish troubador/composer, performed his own music on the country roads and in the courtly halls of the British Isles during the first part of the 1700s. The Harp Consort, under the direction of Irish harpist Andrew Lawrence-King, captures the charismatic dual nature of Carolan compositions, which could range from courtly dance to popular jig. The sounds on this thoroughly beguiling CD range from wistful solo flute, harp, or cittern to the heady, rollicking sound of the entire ensemble, with Caitriona O'Leary and Nigel Rogers providing stellar vocals on several tracks. The sound is quite resonant, flirting with boominess at times, yet has a welcome warmth and allows the ensemble's finely detailed work to show through. The CD contains exceptionally informative notes by Lawrence-King and complete texts of all the songs. *Rad Bennett*

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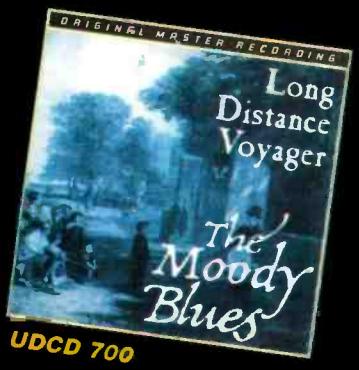

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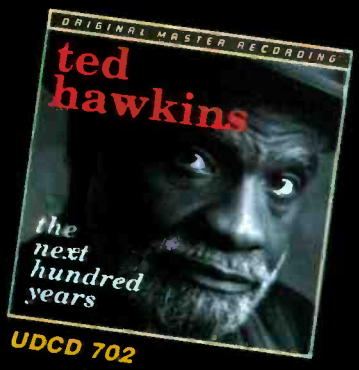

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larities. Most companies list track numbers on the back of the booklet or the back of the jewel box, or both, where they are readily accessible should you want, for example to play only the Vasks. Let's keep it that way. *Robert Long*

Scriabin: Etudes

Arthur Greene, piano
SUPRAPHON SU 3324-2131;DDD; 57:55
Sound: A, Performance: A

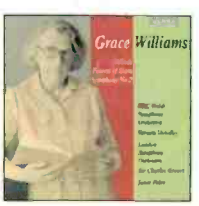
Though Vladimir Horowitz and others have recorded a few of Alexander Scriabin's études on some of their programs, this is the only CD I know of devoted entirely to the mystical Russian master's piano études. Within a conservative structural shell, they slowly become more complex harmonically, melodically, and rhythmically—from Chopin-like early pieces to the unearthly Opus 65. Among the 26 expertly played études are two often heard as encores: Opus 2, No. 1, in C-Sharp Minor and Opus 8, No. 12, in D-Sharp Minor. The best Scriabin performances have usually come from Russian pianists, but the exciting performance here is from American Arthur Greene, who is recording for this Prague-based label. *John Sunier*

Williams: Ballads for Orchestra, Fairest of Stars, Symphony No. 2

Janet Price, soprano; BBC Welsh Symphony Orchestra, Vernon Handley; London Symphony Orchestra, Charles Groves (in Fairest of Stars)
LYRITA SRCD.327; ADD; 69:15
Sound: A, Performance: A+

Grace Williams (1906-1977) was a pupil of Ralph Vaughan Williams. Born in Wales, she grew up on the Glamorganshire coast but spent some time in England during World War II, where she became friends with Benjamin Britten, declining an invitation by that composer to become his assistant. When the war ended she returned to the Welsh seacoast where she worked as a freelance composer for the rest of her life.

This CD of her music is the second to be released by Lyrita and contains exciting compositions that should prove a welcome discovery to those who love Nationalistic music fashioned in bold, declamatory style. Her music is highly dramatic, evident right from the beginning of the first Ballad, with its fortissimo timpani strokes supporting slashing full orchestra chords that incorporate a dramatic Scotch snap, a recurring characteristic in Williams' compositions. This arresting opening calms down for a moment of lyricism, but it is a calm loaded with underlying tension, for there are few moments of total repose in Williams' music. Similar to the sea itself, with which she was so familiar, there is always something going on. If there are no whitecaps in evidence on the surface, there are currents underneath.



The Second Symphony, the major work in this compilation, begins in a fierce manner, with nervous trumpet and side drum proclamations, and though broader melodic ideas are established, the menacing trumpets win the day. The second movement provides only nervous repose, and the ensuing Scherzo is more malevolent than playful. The final

The Romeros

Rodrigo: Concierto de Aranjuez and Concierto Andaluz; Vivaldi: Guitar Concertos in B Minor and G Major for Two Guitars and Orchestra

The Romeros; San Antonio Symphony, Victor Alessandro
MERCURY LIVING PRESENCE
434-369; ADD; 76:47
Sound: A, Performance: A

The Romeros are an extraordinary family of guitarists. Celedonio Romero, himself a virtuoso, taught his three sons—Celin, Pepe, and Angel—to play guitar almost as soon as they were big enough to hold one. Each became a master, and together they have a sound that is the envy of many an ensemble. Each performs as a soloist, but often they perform as a duo, trio, or quartet.

On this album are three concertos by Vivaldi, two originally composed for mandolin, and two concertos by the blind Spanish composer Joaquin Rodrigo. Rodrigo's Concierto de Aranjuez is the most celebrated guitar concerto in the repertoire, and Angel, the youngest Romero, plays it with confidence and gusto. The Romeros commissioned the Concierto Andaluz, and Rodrigo dedicated it to them.

The music on this CD was originally recorded in 1967, in the Municipal Auditorium in San Antonio, Texas. Mercury used its usual array of three Telefunken 201 microphones (plus a fourth 201 for minimal augmentation of the center channel), and the recording was on three-track, half-inch tape. Now that the original masters have been converted to two channels and transferred to Compact Disc, we can enjoy this excellent Mercury Living Presence recording of the Romeros in their prime. *Patrick Kavanaugh*

movement is a slow one, for exhaustion seems the only response to the tension that has gone before, and this largo is not one of resignation but rather of peace. The trumpet fanfares from the first movement return and struggle with the other themes till a truncated ending stops everything dead on the chopping block.

This is music of the first rank, worthy of keeping company with almost anything William Walton, Malcolm Arnold, or Vaughan Williams ever wrote. It is performed to a fare-thee-well. The original front-row center BBC Artium and slightly more distanced EMI (Fairest of Stars) recordings have been beautifully transferred to Compact Disc and are as bold, robust, and detailed as this tense music demands. This disc has to be summed up as one of the biggest discoveries of the decade. *Rad Bennett*

The Five Sacred Trees

London Symphony Orchestra, John Williams
SONY CLASSICAL SK 62729; DDD; 57:23
Sound: A, Performance: A

The program consists of "The Five Sacred Trees" (a concerto for bassoon and orchestra, with Judith LeClair as soloist) by John Williams, "Tree Line" by Toru Takemitsu, the "Mysterious Mountain" Symphony (No. 2) by Alan Hovhaness, and "Old and Lost Rivers" by Tobias Picker. Aside from the obvious environmental references, the pieces share some beguiling sounds and a sense of fresh air. The

Hovhaness symphony is airier and more delicately detailed on this disc than in the Delos recording (DE 3157) with Gerard Schwarz and the Seattle Symphony, fine as that recording is. If you think of John Williams as all Star Wars and Boston Pops, think again. *Robert Long*

Berlioz: Te Deum, Op. 22

John Aler, tenor; Mark Kruczek, organ; Young Singers of Pennsylvania; Voices of Ascension Chorus and Orchestra, Dennis Keene
DELOS DE 3200; DDD; 72:36
Sound: A, Performance: A

As with his much better known and more dramatic Requiem, Hector Berlioz conceived this massive ceremonial work to be performed by a colossal number of musicians in a giant cathedral with highly reverberant acoustics. New York's Cathedral of St. John the Divine, the world's largest Gothic structure, fits the bill as the giant cathedral; its 5-second-plus reverb has enhanced previous recordings made there. For this Dolby Surround recording of *Te Deum*, nearly 400 musicians assembled there under the baton of Dennis Keene in July 1996.

Berlioz had no commission to create this liturgical work, and unlike the Te Deums of other composers, his celebrates no specific

event. Its Latin texts praise God and stress the grandeur and immensity of the Divine and the smallness of humankind. This is expressed musically via Berlioz's usual contrasts of joyous noise-making with everything at hand against quietly withdrawn solos or small ensemble passages.

This live event was a natural to be captured in Delos' Virtual Reality Recording process of taping to six or eight discrete channels. However, until multichannel, audio-only DVDs become established, the multiple tracks are mixed to matrixed four-channel Dolby Surround for present CDs.

Since this *Te Deum* is less than 50 minutes' long, Delos has thoughtfully filled out the disc with a detailed spoken commentary and musical illustrations by conductor Keene. Though the commentary basically repeats the notes in the CD booklet, it will likely increase the appreciation of the music by listeners who are unfamiliar with the work. *John Sunier*

ROCK~POP RECORDINGS

Photo: Adrian Boot

Arkology

Lee "Scratch" Perry
ISLAND JAMAICA/CHRONICLES
314-524 379
Three CDs; 3:55:37
Sound: B+, Performance: A

In the evolution of reggae, producer Lee Perry's influence is equal to (and arguably greater than) that of such recognized founders as Coxsone Dodd (the impresario who discovered and recorded some of reggae's biggest artists) and even Bob Marley. As a young, impertinent (at least then) disciple, Perry insisted on cutting his own renegade swath, applying radical dub (a mixing technique that involves isolating, mixing, and matching the elements of a song and adding echo or delay effects) and a serious dose of unrepentant lunacy. This lunacy, the mark of Perry's personality, is stamped all over his massive, hit-and-miss body of work. Even at its worst, Perry's productions are uniquely his. Further, his rudimentary dub methods (using only an Echoplex) created a unique sound that, more than that of any of his peers, still echoes (ahem) loudly today.

This magnificent three-CD collection focuses on recordings released on Perry's Black Ark label, during its prime years (1975-1979). Although none of Perry's work with Bob Marley is represented (this material was released on Coxsone Dodd's Studio One label.) Arkology serves to document a mad genius at his peak. Tracks from such "unknowns" as Max Romeo or The Congos are as brilliant as those from better-known artists such as The Heptones and, of course, Perry's Upsetters. With a full complement of dubs, outtakes, and extremely hard-to-find gems, this collection will certainly please die-hard reggae fans and shed some new light on Perry's madcap genius. *Jason Ferguson*

KURT WEILL

September Songs: The Music of Kurt Weill

Various Artists
SONY CLASSICAL
SK 63046, 68:57
Sound: A, Performance: B–

Nobody interprets Kurt Weill as well as German singer Dagmar Krause does. It's evident on her 1986 album *Angebot & Nachfrage* (no longer in print) and on *Lost in the Stars*, a 1985 "all-star" Weill tribute on which she steals the show. *September Songs*, a soundtrack to a film documentary that's little more than an extended video for the soundtrack, is similarly composed of star-turn readings of Weill. A generally enjoyable affair, it's nevertheless missing more than just Dagmar.

Undoubtedly, the high point of the collection is bassist Charlie Haden reinterpreting "Speak Low," the song he covered on *Lost in the Stars*. Here, however, Haden creates a spooky bridging of the past and present by playing with a recording of Weill at the piano and singing. Also worth hearing is a loony reading by William S. Burroughs and original period recordings by both Lotte Lenya (Weill's wife and frequent collaborator) and Bertolt Brecht (his lyricist and librettist). Conversely, performances by Lou Reed, Nick Cave, David Johansen, and PJ Harvey are melodramatic and uninspired, weighing the album down. Still, redemption can be found in top-notch contributions by The Persuasions, Betty Carter, and Mary Margaret O'Hara, all of whom add their own voices to Weill's distinctive style.

Jason Ferguson

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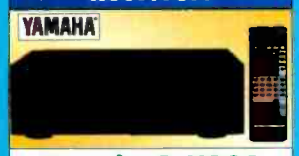

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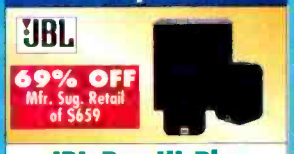

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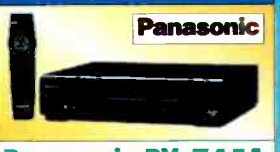

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So Long So Wrong

Alison Krauss and Union Station

ROUNDER CD 0365, 48:14

Sound: B+, Performance: B–

Bluegrass is probably popular music's most democratic genre. Aside from its common-folk roots, it's music where most every player gets a lead break in almost every song, and the harmonies all but invite everyone who can sing to join in. Even the biggest bluegrass festivals seem dedicated to the proposition that everyone who thinks he can play should play.

It's that same sense of democracy, admirable as it is, that keeps Alison Krauss and Union Station from following up their recent platinum sales success with a bang on *So Long So Wrong*. But even with a breakout to a mass audience that confounded music-business conventions, Krauss, the gifted young fiddler and singer at the center of it all, isn't about alter her chosen musical course.

The result is an album of straight-ahead—sometimes virtuosic—bluegrass that shows a special spark only when Krauss steps up to the mike to sing (and play). Union Station is a fine, state-of-the-art band, but neither guitarist Dan Tyminski nor banjo player Ron Block is a singer of note. Krauss, however, continues to infuse her vocals with an enchanting sense of heartbreak that makes them as compelling as her fluent fiddling. Although it runs counter to Krauss's devotion to her band and the precepts of bluegrass to say so, what this album could have used is a lot more of her and a bit less of Union Station, or a little less democracy. *Rob Patterson*

Stoosh

Skunk Anansie

EPIC EK 67555, 77:02

Sound: B, Performance: B+

English band Skunk Anansie's first album, 1995's *Paranoid and Sunburnt*, was brash and aggressive while lacking all-important dynamics and hooks—flaws that are remedied on the followup, *Stoosh*. If anything, this record is almost too eclectic, leapfrogging between driving funk-metal, Scorpions-style power balladry and heartrending soul. Fortunately, frontwoman Skin's passionate, multidimensional vocals bring *Stoosh*'s dissimilar elements together. Whether railing against hypocrisy and ignorance or lamenting a crumbling relationship, her courage and conviction shine through every track.

Señor Bl

Señor Blues

PRIVATE MUSIC 01005-82151, 51:45

Sound: A, Performance: A–

Can this be? Thirty years after Taj Mahal recorded his eponymously-titled debut album, he sounds like time never went by! *Señor Blues* is a classic Taj Mahal record—vibrant and eclectic, with the good times revelling in various shades of the blues. While the set begins with an original ("Queen Bee"), *Señor Blues* is, otherwise, an album of excellently chosen covers.

On "Think," a song made famous by James Brown in 1960, saxophonist Joe

The side effect of having such an outspoken frontwoman is the perception that Skunk Anansie's every move is political. And while fighting apathy and promoting equality are clearly part of the agenda, the band is not above peppering the gristle with a bit of humor and irony.

Stoosh's diversity may take a little more time to digest than your average pop product, but the strength of Skunk Anansie's melodies and message will outlive even your favorite Bush songs. *Jon Wiederhorn*

Tellin' Stories

Charlatans U.K.

MCA MCAD 11622, 56:21

Sound: A, Performance: A–

As one of the bands that emerged from Manchester, England's late '80s "house music meets pseudo-psychedelia" scene, Charlatans U.K. were always seen as a second-tier outfit, ranking firmly underneath over-hyped bands such as The Happy Mondays and The Stone Roses. But in ensuing years, while those bands floundered and distributed press releases chronicling their difficulties instead of releasing albums, Charlatans U.K. released four recordings of varying quality. That's not to say Charlatans U.K. hasn't had its own problems—it just hasn't sat around moping about it.

Tellin' Stories, the band's fifth and best album to date, is the first since keyboardist Rob Collins was killed in a car accident on his way home from the recording studio (working on

Mr. Taj Mahal

Sublett borrows the spotlight from Taj for a Coasters'-style solo. "Irresistible You," a 1962 hit for Bobby Darin, is presented as a rocking rhumba. "Señor Blues," a Horace Silver tune from the '50s, swings in 6/8 time with a sizzling horn chart and Taj's most subtle singing. He delivers a down-home run through Washboard Sam's "Sophisticated Mama" and transforms "You Rascal You" (originally recorded by Louis Armstrong in the '20s) and the Freddy Simon-penned "I Miss You Baby" into T-Bone Walker-style Texas shuffles. A stirring cover of Otis Redding's "Mr. Pitiful" closes the show in grand fashion. *Michael Tearson*

a few songs that appear here). Collins' organ was always integral to the band, washing over the hectic, groove-heavy syncopation with a grounded yet ethereal touch. And where Charlatans would previously jam extensively on its records, *Tellin' Stories* emphasizes succinct, hook-laden pop songs in addition to instrumental moments. And songs such as "North Country Boy," "You're a Big Girl Now," and "How Can You Leave Us" all sound like '60s AM pop radio—the kind that current rage Oasis would love to write. Oasis's Gallagher brothers have always considered Blur their immediate competition, but maybe they should take a look in Charlatans U.K.'s direction. *Rob O'Connor*

OK Computer

Radiohead
CAPITOL CDP 8 55229, 53:26
Sound: B, Performance: A+

Radiohead's Thom Yorke is a pale-faced, runny-nosed twenty-something, and a walking testament to the power of suffering. Bellowing songs like a wounded saint, Yorke infuses his lyrics with bitter accusations and self-recriminations and swaths them in gripping melodies and angelic choruses. It's Yorke's sensitively beautiful, brooding soul that provides Radiohead with its cathartic, swelling characteristic.

Improving on 1995's critically praised *The Bends*, *OK Computer*—a loosely conceptual album with a quasi sci-fi theme of space aliens merging with computers—veers between blistering noisefests and despondently pretty ballads. It's an album that's ominous as well as darkly majestic.

On the album's ethereal opener, "Airbag," the story's hero stumbles out of a car wreck and into the epically arranged "Paranoid Android." "Karma Police," a lumbering tale about a man who "buzzes like a detuned radio" and a girl with a "Hitler hairdo" is cut from The Kinks' school of pop-craft. This song, like much of *OK Computer*, is intimate, delirious, captivating. The album closes with the gently waltzing waves of "The Tourist," where the story character admonishes an alien to "Hey man, slow down, slow down," so he can board their departing ship. The plea seems better aimed at Yorke's own tortured psyche, but as with aliens and earthlings, misery loves company. *Ken Micallef*

Songs From Northern Britain

Teenage Fanclub
COLUMBIA CK 68202, 43:24
Sound: B, Performance: A

The Glasgow quartet Teenage Fanclub has gained a reputation for building an album catalog mercilessly lifted from prime American sources. Not that it lacks vision. It's just that Teenage Fanclub is so good at copping Big Star, Neil Young, The Beatles, and The Byrds, that it almost needn't bother chasing enigmatic notions of originality. Lesser groups, in fact, would kill for the songs on the band's three previous releases.

Songs from Northern Britain finds Teenage Fanclub still mining the jangle-pop vein, and its beautiful harmonies and galloping guitars approach the grandeur of the glistening harmonies, undeniably yearning melodies, and swaying rhythms of The Byrds' *Notorious Byrds Brothers*.

"Start Again" opens the album with layered acoustic and electric guitars under gorgeous vocals. The good vibes continue with "Ain't That Enough," in which glockenspeil and chiming guitar spin a mellow mood for more McGuinn/Crosby-style harmonies. "I Don't Want Control of You" begins with a quasi-bluegrass intro before hitting its stride with a chugging groove adorned with subtle horns and an irresistible melody. "It's A Bad World" is sassy and smart, like Rumours-era Fleetwood Mac with guts, while "Mount Everest" rocks like an outtake from Neil Young's masterpiece, *After the Goldrush*. "Speed of Light," which alludes to the space-age dayglow dreams of The Byrds' *Fifth Dimension*, closes an album that's true to Teenage Fanclub's songwriting muse—however derivative it may be. *Ken Micallef*

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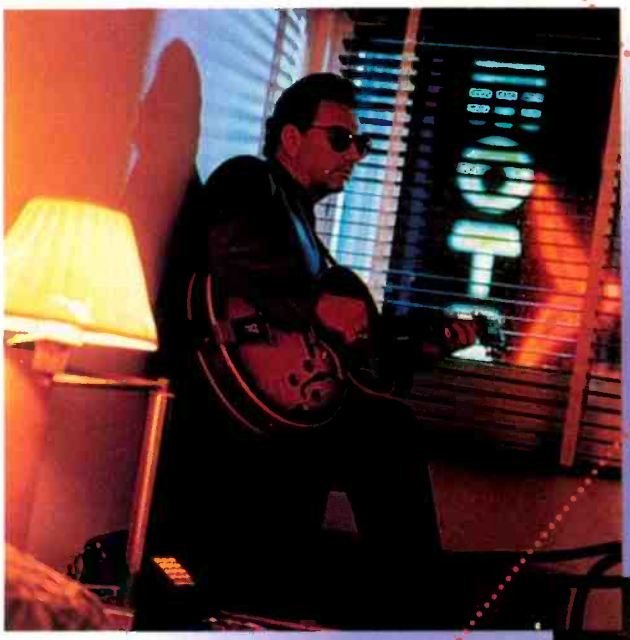

Photo: Jeff Dumas

DUKE ROBILLARD

Duke Robillard
Dangerous Place
POINTBLANK 8 42857, 46:22
Sound: A–, Performance: B+

RONNIE EARL

Ronnie Earl and the Broadcasters
The Colour of Love
VERVE 314 537 562, 68:31
Sound: B+, Performance: A

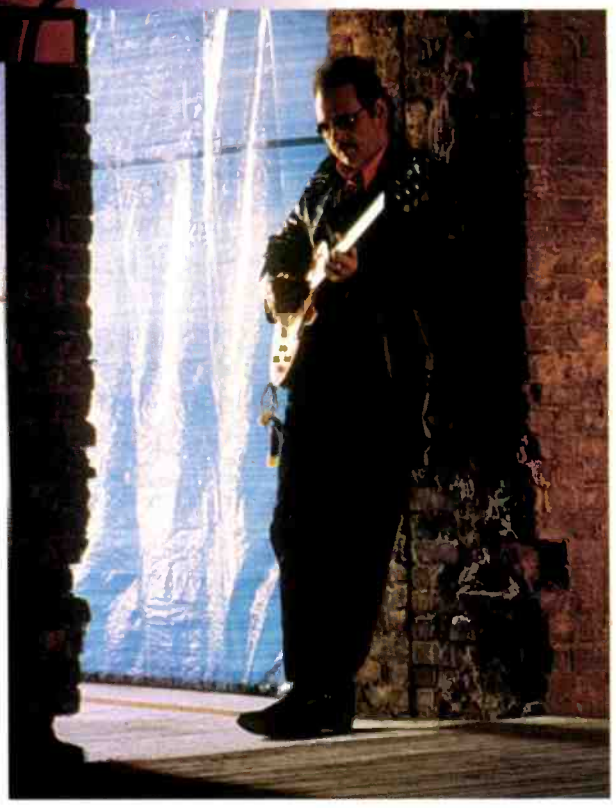

Photo: Stephen Stickler

oomful of Blues, Rhode Island's popular vintage swingers, has spawned its share of world-class musicians, two of whom are guitarists Ronnie Earl and Duke Robillard. Both came to Roomful with mighty impressive chops and left the band to pursue solo careers with enough depth and innovation to succeed in mainstream blues.

On *The Colour of Love*, a fiery album that's almost completely improvised, Ronnie Earl shifts between blues, jump, and R&B. On tracks like the Monk standard "'Round Midnight" and "Heart of Glass," Earl's playing is tactile and supple, with lightly-picked, eggshell-fragile licks resonating in dark, delicate spaces. Inspired by Gregg Allman and Allman Brother's drummer Jaimoe—who guest on "Every Kind of Man" and the title track—Earl sounds for all the world like Gregg's brother Duane. With drummer Per Hanson providing solid rhythm support, he swings eloquently on "Deep Pockets," friskily on "Hippology," and romantically on "Anne's Dream," while his intricate spontaneity on "Mother Angel" is endearing and dazzling.

Duke Robillard comes up with his fair share of dazzle on the swing-dominated *Dangerous Place*. Propelled by horn players Gordon Beadle (saxes) and Al Bastile (cornet), the set illuminates Robillard's jump and swing licks as well as his ever-maturing vocals, particularly on the title track, the jaunty "Going Straight," and the slinky "Duke's Advice." Although Robillard doesn't have quite the improvisational reach of Earl (in other words, he takes fewer chances), he nevertheless comes up just as big when he steps into the spotlight on songs such as the slide-driven "Don't Get Me Shook Up" and the after-hours jazz of "I May Be Ugly (But I Sure Know How to Cook)."

In greater risks come greater rewards, and Ronnie wins the adventure game hands down on *The Colour of Love*; tamer in comparison, *Dangerous Place* doesn't place Robillard in quite the sort of danger he proclaims. Regardless, both of these recordings—historically redolent and full of sexy style—would certainly have made the original Roomful of Blues proud. *Bob Gulla*

Five Facings

Steve Lacy
FMP CD 85, 77:12
Sound: A, Performance: A

Few jazzmen have explored the duet setting as extensively as soprano saxophonist Steve Lacy, who is most famous for recordings with pianist Mal Waldron. On five consecutive nights in 1996, at the Workshop Freie Musik in Berlin, Lacy recorded these eight duets, in which the personality of each partnership is clearly evident.

On the album's openers, "The Crust" and "Blues for Aida," Lacy moves around pianist Marilyn Crispell like a child acting coy. The two flirt with their instruments, taking turns playing in each other's shadows and unifying to such an extent that, at one point, it's hard to tell whether Lacy is playing alone over his own reverberations or above Crispell's dying sustain.

In the company of fellow Monk enthusiast Misha Mengelberg, there's a different kind of meeting. The two have played together previously, but this set of Monk tunes was unrehearsed. The result is like two art critics discussing their favorite paintings, respectfully telling each other their interpretations. The rehearsed duet Lacy performs with Ulrich Gumpert is different yet again. For this piece, the Lacy composition "Art," it's as if the musicians set into motion two compatible but independent ideas. Interaction is downplayed, and the beauty that comes of chance is the focus. The joint composition with Fred Van Hove, "Twenty One," is the only freely improvised piece on the album. And on Lacy's "The Wane," Vladimir Miller takes a back seat, serving more as an accompanist than partner. *R. Dante Sawyer*

XIAME

The Shadow of My Soul

TRAUMTON 4421, 53:12
Sound: A, Performance: A

German/Brazilian fusioneers Xiame have been crossover from the get-go. But The Shadow of My Soul, the group's third album, will likely raise its profile among contempo jazz, Brazilian, Acid Jazz, and even pop audiences for a number of reasons.

Most noticeable here is Danish vocalist Naja's voice, front and center, and singing mostly in English (previous recordings found her singing mostly in Portugese). Confident in breezy jazz settings like the title track or more Sarah McLachlan-ish territory on "Always Almost," she's the final element needed for Xiame's accessibility.

The more lasting allure lies in the instrumentalists, especially Jorge Degas's fluid bass playing, which hints at melodic/rhythmic interplay that's usually the province of bossa nova. And bossa nova's where such songs as "Nossa Terra," with its pandeiro nods to samba and bowed bass, get their start. The flowing, melancholic "Muxima," where Degas takes on vocals, shares a sentimental vibe with Cape Verdean and even African sources. Equally versatile is the mesh of ex-Defunkt drummer Kenny Martin and Andreas Weiser's wide-ranging percussion, as well as Michael Rodach's guitar, which, whether strumming choro style or arcing wide in electric washes, is relentlessly pretty. *Mark Schwartz*

Textures

Jim Hall
TELARC JAZZ CD-83402, 51:33
Sound: A, Performance: A

Jim Hall is a fixture in jazz guitar history, often mentioned alongside Django Reinhardt and Charlie Christian. And Hall's associations with Jimmy Guiffre, Sonny Rollins, and Bill Evans have yielded some of the finest jazz ever put to wax. However, a lesser-known fact about Jim Hall is that, prior to becoming a jazz guitar legend, he studied composition at the Cleveland Institute of Music. *Textures* showcases Hall as a composer of serious music but with jazz influences intact and (of course) with his guitar.

Does *Textures*, with its seven opus-like compositions, constitute a jazz recording? That's a call each listener will have to make according to his own criteria. Improvisation certainly plays a vital role in every piece, often encased within the strict notation of Hall's various ensembles. Here, assertive, romantic brass fanfares alternate with the tremelo of orchestral strings, and at one turn, we even hear the mellow acoustic properties of a steel drum. Although rhythmic interplay has an important function, the standard jazz rhythm section appears only in semblance.

Textures is very thoughtful, polished, and beautifully recorded. Drawing upon his affinity for good music of every design, Jim Hall has indeed outdone himself. *James Rozzi*

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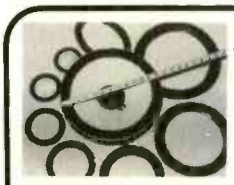

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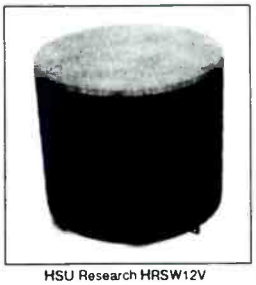

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AD INDEX

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PlayBack

Proton KS-530CD
Under-Cabinet Radio/CD Player

I used to bring a radio into my kitchen for my favorite shows—then take it out again when I was cooking, to save counter space. Now, I can hear AM, FM, and CDs in my kitchen when I cook. Under-cabinet appliances aren't new, but Proton brought a lot of intelligence to this one. Pressing a button for CD play or any station preset brings it to life, without your touching the on-off switch. The instant you plug it in, it programs itself with up to 20 local stations on each band, for instant listening—you can program your own favorites later. It has sleep and turn-on timers, plus a separate timer for an alarm beep. (The alarm settings stay in memory if the power goes out.) There's also a count-down timer I can hear in other rooms. The CD player has audible fast forward and reverse (but no programming or direct track access), and its loading drawer moves like its tracks were buttered. Rated output power is 5 watts per channel at 5% distortion, and there's usable output from about 90 Hz to 9 kHz. The sound from the two downward-angled 3½-inch speakers is warm,

over-accentuating the lower registers of singers like Amanda McBroom, and the soundstage is very narrow; after all, it's not a hi-fi system but a radio, albeit a good one. The controls are off-beat, but not illogical; read the manual once and you'll do fine. The display is easy to read from my breakfast nook; I longed for a remote control. My only real complaint is that the Proton shifts *very* slowly from one preset to another. And if your cabinet is less than 11 inches deep, take care you don't pinch the power cord behind the radio. At $250, it's not a fabulous bargain, but it does give good value for the money. (**Proton:** 13855 Struikman Rd., Cerritos, Cal. 90703; 562/404-2222.) **Ivan Berger**

GRADE: B-

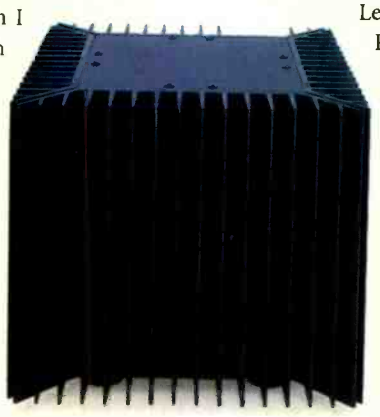
For literature, circle No. 120

Pass Laboratories Aleph 2 Amplifier

The Pass Aleph 2 Class-A mono amp with MOS-FET output transistors ($3,300 each) is one of the most musical-sounding amplifiers I have ever heard. Designed by Nelson Pass of Threshold fame, the 100-watt amp is completely single-ended and has just two gain stages.

This rather monolithic-looking amp is quite large and heavy (60 pounds) with enough heat sinks on its front and sides to handle the 300 watts of power it dissipates continuously. Around back, the Pass Aleph 2 includes four gold-anodized speaker connections (for bi-wiring, if desired) and inputs for balanced XLR and unbalanced RCA input connection. A rear-mounted power switch brings the amp to life and turns on a blue indicator LED on the front.

With jazz, classical, and minimally-processed pop, my review pair of Pass Aleph 2s excelled on everything I put through it. Playing CDs through the variable outputs of the highly regarded Sony CDP-XA7ES CD player into Legacy's Classic II ribbon-tweeter loudspeakers, the Pass amps revealed audible layers and textures and space around instruments that I have rarely heard. The amplifiers' total lack of harshness meant hours of fatigue-free listening, even to highly dynamic brass and other music. This lack of harshness is like a tube amp's—but, unlike many tube amps, the Aleph 2 has incredible low-frequency power and speed, for bass that is tight and deep.



GRADE: A

The trade-off for all this glorious sound is lots of heat, which means you'll have to leave lots of space around the Alephs in your rack, or just leave them in the open. But it's worth dealing with the extra heat to have an amp that sounds this wonderful. (**Pass Laboratories:** P.O. Box 219, Foresthill, Cal. 95631; 916/367-3690; http://www.passlabs.com) **John Gatski**

For literature, circle No. 121

JVC FS-2000 Mini Stereo System

I was struck with technolust the moment I saw the FS-2000 Executive Desktop System. It's a very sleek, compact, hi-tech design with cherry wood speaker cabinets. The three pieces together are only 15 inches wide. But you can spread the speakers for better stereo. Each vented enclosure holds a 3⅛-inch shielded driver with flat response from 80 Hz to 16 kHz; but the sound is far better than those numbers suggest. The real treasures are in the center unit: an AM/FM tuner with 15 presets per band, a programmable CD player, an amp that delivers about 10 watts/channel at listenable distortion levels, and such neat features as an AUX/Tape input and line output; a subwoofer output; a Toslink digital output from the CD player; And all the features of a clock radio. When the clock turns the unit on, it fades gradually to the volume level you've preset. And you can dim the display. The price of the JVC's compactness is that many functions are only on its remote: bass and treble controls, station-preset assignment, and direct access to specific presets. I had only two complaints: AM reception drowns in static when a nearby lamp is on. And off is *off*, with no illumination, annoying, since I use it as my bedside clock radio. Looks, features, sound, all for $380—easy to love. There's also an FS-1000, with unshielded speakers in a cabinet of medium-density fiberboard with a grey finish, for $330. (JVC: 41 Slater Drive, Elmwood Pk., N.J. 07407; 201/794-3900.) **Ivan Berger**

GRADE: A

For literature, circle No. 122

S O L U T I O N S

Every "Bit" of Every Signal to Everywhere

Today, your sound and pictures start as "bits". The information stored on a CD, LaserDisc, DVC, or transmitted to a DSS receiver...it's all bits of digital data.

AudioQuest offers a complete range of cables optimized to transfer all four digital standards with an absolute minimum of interference: S/PDIF (75Ω coax), AES/EBU (110Ω balanced), TosLink (EIA-J fiber optic), and ST (AT&T type fiber optic).

Even though pictures and sound may begin as digital signals, they must be converted back into the world we live in, the world of analog. Most of your components and most of your cables are handling analog signals, whether audio or video.

Under the VideoQuest name we make high performance cables for all the different video signal systems. We also make several different grades of cable for each system. The cable in one system is not better than the cable in another, only the number of channels of information is different. The same type of wideband 75Ω coax is needed for every channel, no matter how many.

• Coaxial RF (radio frequency, also called RG for radio guide) cable carries the combined audio and video signal from an antenna or a DSS dish, or a cable TV box.

• Composite Video cable carries the entire picture signal between most VCRs and LaserDisc players to the monitor.

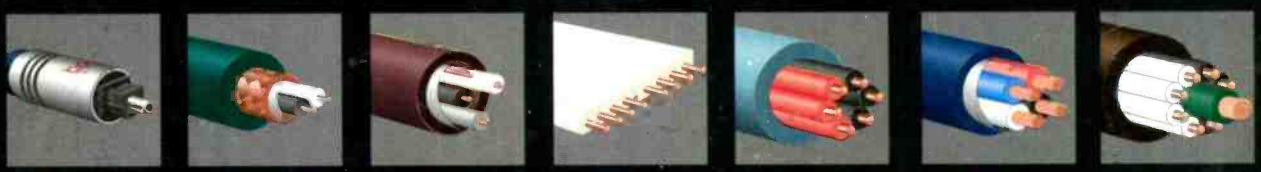
• S-Video (Y/C), carries the same information, but in two pieces. The "Y" signal carries the b/w picture and the "C" signal carries the color information. When color TV became available it had to be compatible with existing b/w TV sets, so the extra information for color was kept separate. S-VHS machines, video cameras, DSS receivers, LaserDisc and DVD players are among the equipment often featuring S-Video outputs.

• Component Video (YIQ): Even the "C" in Y/C is a combination signal. Since there are three colors (red/green/blue), there must be two color difference signals. Y-I is the red signal, Y-Q is the blue, and Y minus red and blue is green. DVD players are the first to feature YIQ outputs.

• RGB: Red, Green and Blue are the real components of a video signal. RGB cables carry the three color signals, plus the vertical and horizontal marker information that allows the monitor to draw a picture and not just a continuous line of changing colors. RGB is most common for feeding separate video projectors.

Audio: As important as it is to get the video right, it's the audio that carries the drama, the power, the emotion...whether it's a system with or without a picture.

Unfortunately, it's late in this ad and we've run out of room to "talk" about AudioQuest double balanced and triple balanced audio interconnect, Hyperlitz speaker cables, UL CL/3 in-wall cables, on wall cables, AC power cables, high purity long-grain metals, exotic insulating materials and patented constructions. We'll just have to hope that you ask an AudioQuest/ VideoQuest dealer to demonstrate for you how very important all these things are. We'll also be pleased to send you the "long" version (our literature). Please use any of the communication media listed below to let us know where you want it sent.



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