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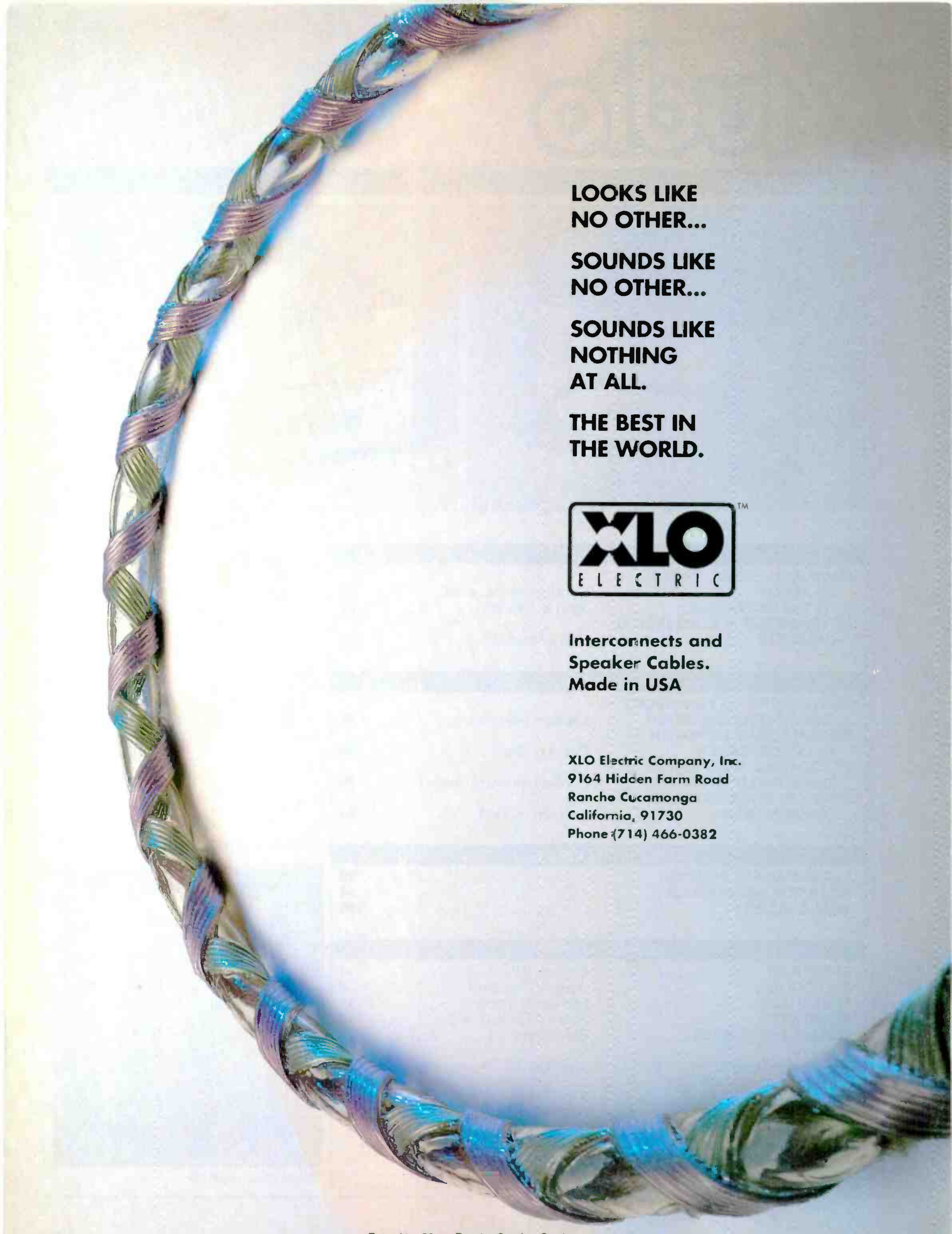

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The Audit Bureau

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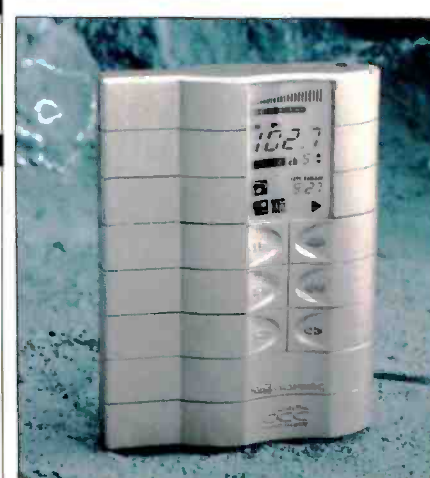

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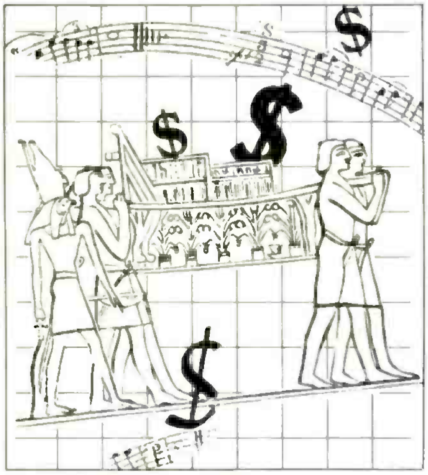

Collage: Linda Zerella

Call It What You Will

"Rough justice" was what Jason Berman, president of the Recording Industry Assn. of America (RIAA), called an agreement to seek legislation establishing a new royalty on digital audio recorders as well as any form of media for them. The compromise was announced at a hastily announced press conference July 11 in Manhattan's New York Hilton Hotel by Gary Shapiro of the Electronic Industries Assn., Edward P. Murphy, president and CEO of the National Music Publishers Assn. (NMPA), and John Roach, president and CEO of Tandy Corp., in addition to Berman.

The royalty for recorders would be 2% of the maker's wholesale price or customs value with an $8 maximum and $1 minimum, while units with two or more recorders would be subject to a $12 cap. Both caps can be adjusted upwards after five years, though the minimum is a fixed fee. A flat rate of 3% would be applied to blank digital audio media.

Record companies will receive the largest chunk of the royalty pie, 38.41%, with 25.6% going to featured artists, while songwriters and music publishers each get 16.66%. Tiny slices go to the American Federation of Musicians, 1.75%, with the American Federation of Television and Radio Artists receiving 0.92%.

Other key provisions of the proposed legislation are that all consumer-oriented digital audio recorders must contain the Serial Copy Management System (SCMS) circuitry, which would prevent making digital copies of copies, and that consumers would be specifically exempted from any potential copyright infringement lawsuits for having made *either* analog or digital recordings for private, noncommercial use. Further, the proposals would apply to all present and future digital audio recording technologies.

A press release handed out at the conference by the NMPA announced that Federal Court in Manhattan had approved an agreement to "dismiss without prejudice" a class-action suit against the Sony Corp. Originally brought July 9, 1990, the suit contended that "unauthorized home taping on DAT recorders would displace sales of Compact Discs, cassettes, and records . . . ." The plaintiffs were Sammy Cahn, Hal David (for Jac Music Co.), Trio Music (owned by Jerry Lieber and Mike Stoller), Fort Knox Music, and Peer International. Four songs were involved: "Three Coins in the Fountain," "What the World Needs Now is Love," "Fever," and "Walk Like an Egyptian."

In discussing the ramifications of the proposal, Shapiro called the royalty "an ordinary part of doing business, which paid for a very clear right, one equivalent to a patent." He said that all significant audio makers had been polled and that the overwhelming majority of the EIA board had voted in favor of the agreement. Asked about the total amount of money that would be generated by the new levy, Shapiro—clearly with tongue in cheek—termed it "equivalent to the lawyer's fees to date."

U.S. Representative William J. Hughes, chairman of the Subcommittee on Intellectual Property and Judicial Administration, told *The New York Times*, "It is very significant that the major players have gotten together." His subcommittee should be assigned the measure after it is introduced in Congress this fall.

The passage of the legislation could set the stage for another full-scale format war with the various combatants siding with the two developers of the Compact Disc. Philips entry into the digital recorder field, Digital Compact Cassette, is the subject of an article on its PASC data-compression system in this issue. The Mini Disc from Sony was described briefly in the August 1991 issue. *E. P.*

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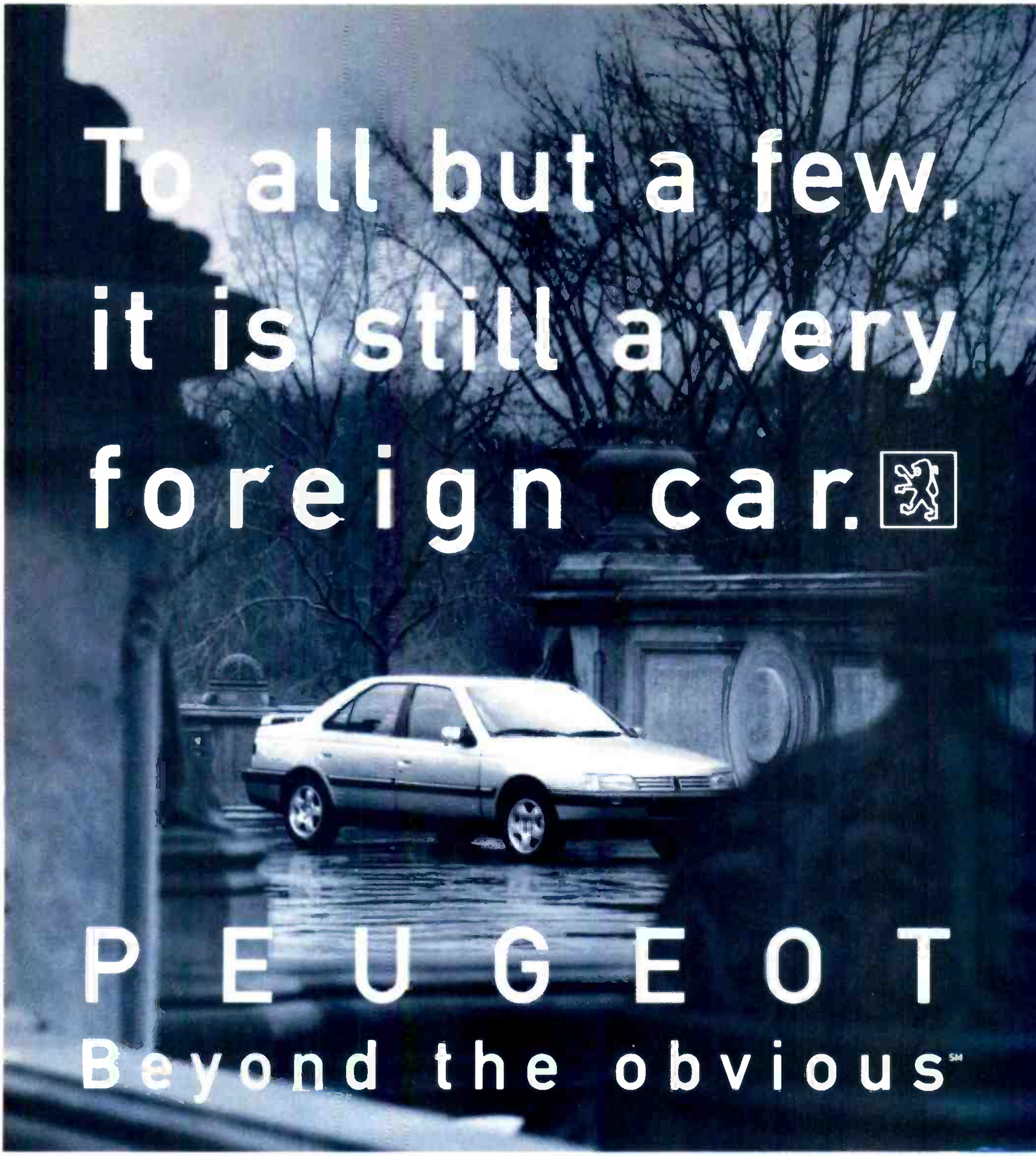

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AUDIOCLINIC

JOSEPH GIOVANELLI

Author's Note

Keep those letters coming! I'll do my best to answer them.

Some of you need a fast reply, but unfortunately this is not possible. I do not work in the magazine office; letters must be forwarded to me. Also, quite a bit of time can pass before I can do the research for any given letter.

It would be helpful if, as you write, you let me know if I have permission to use your name along with your question. If you do *not* grant permission to use it, I will still use your question—signing it "Name withheld."

Now it's time to get to work!—*J.G.*

Equalizing During Record/Playback

Q. I usually record cassettes with my equalizer out of the circuit and play them back using the equalizer. What advantage would there be to recording with the equalizer, and when would be the best time to use it?—Ernie Poggie, West Babylon, N.Y.

A. If you wish to make a tape that will sound as close as possible to the original program source, you would probably not use the equalizer except to compensate for anomalies in the frequency response of the recorder.

You might also use the equalizer to reduce the treble before recording any program material whose treble is so strong that it might cause treble saturation on the tape—a sound much like that of a mistuned AM radio. You could then use inverse equalization in playback to bring the treble back to normal.

On the other hand, if the program source's treble is too soft, you might want to boost it during recording rather than compensating for its lack during playback. When you boost treble during playback, you are also increasing the amount of audible tape hiss. Thus, boosting treble during recording avoids this problem for the most part.

It is helpful if your tape deck is capable of simultaneous recording and playback, because this makes it possible to hear any treble saturation or tape hiss without having to make numerous tests, rewinding the tape and playing it back.

(*Editor's Note:* You can also use your equalizer in recording to pre-equalize tapes for special purposes, such as to compensate for problems with your car's acoustics. However, such tapes will then sound a bit odd when used for more normal purposes. And remember that excessive boosting of any frequencies, especially high ones, in recording can cause saturation.—*I.B.*)

More on Removing Vocals

I'd like to add to the answer you gave, in the November 1989 issue, to Tom Tuttle's question on removing vocals from recordings. You suggested using a mixer for this. However, there's another way, which involves equipment more likely to be found in home sound systems.

I assume first that the lead track he wants removed is monophonic—that is, center-channel information. I have had good results by using the Dolby Pro-Logic surround sound decoder incorporated in my receiver. I set the receiver to "Dolby Surround Pro-Logic" and turn the center-channel volume fully down. All that remains of the lead is the echo, or reverb, heard in both the left and right main loudspeakers (and in the rear loudspeakers, of course). These speakers can be switched off as necessary. The best part is that what remains of the recording is in stereo!

Any Dolby Pro-Logic surround decoder or any decoder with a center-channel output should provide the same result. Mr. Tuttle wouldn't need to rerecord the stripped-down version, and he can practice by using the original as run through the decoder.

When it comes time to make a recording, the left and right output jacks of the decoder can be routed to the appropriate inputs of his recorder. The stereo information will be present here, minus the center channel. Presumably, when he makes this recording, he will be dubbing his voice or instrument onto the processed recording. By removing the intermediate recording step, better fidelity will be obtained.

The small amount of echo or reverb that remains in the main loudspeakers after processing should not be too annoying—at least not for the purposes of practicing. In most cases, once the new part has been dubbed in, the echo of the old part will be masked and so will not be heard.—Greg Lawrence, Darien, Ill.

Distortion on Phonograph Records

Q. Is there any way to distinguish between distortion caused by the cartridge's mistracking and distortion from damage that has been done to the disc? Assuming the record surface to be okay, would there be any point in upgrading a cartridge or turntable when I could replace several records, which are most definitely worn, with CDs for the same money?—K. Nelson Harper, Fort Smith, Ark.

A. Play any discs which seem to have distortion on other phonographs. If the disc plays well on other machines, your system is to blame and corrective remedies can be taken.

If you examine a disc carefully, sometimes you will see a gray color. This often indicates that the disc was indeed damaged by either a defective stylus or one which was set to track with entirely too much force.

Assuming that the discs are fine on other systems, check your system to see what corrections can be made to it. First, is the stylus damaged? If you accidentally dropped it onto the turntable or whatever, it could be chipped or its shank could be bent. On the brighter side, it may just be that all you need to do is increase the tracking force. It is usually best to track at the heavier end of the cartridge's recommended tracking force range, rather than at the lighter end, to avoid distortion during loud passages. Reducing distortion this way will also reduce record wear. You should also check the anti-skating force. Be sure to set it as close to the proper setting as possible.

Styli with low compliance will have problems tracking highly modulated passages regardless of tracking force. The obvious cure for this is to replace the cartridge with one whose stylus is compliant enough to track your records. Because phonograph records are disappearing, you will want to be kind to them so that you can enjoy many quiet, clean plays. You should replace any damaged discs as soon as possible, while they may still be found. A

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019. All letters are answered. Please enclose a stamped, self-addressed envelope.

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Randy Travis—Heroes And Friends (Warner Bros.) 413·328

ZZ Top—Recycler (Warner Bros.) 418·491

King's X—Faith Hope Love (Atlantic/Megaforce) 413·039

The Replacements—All Shook Down (Sire/Reprise) 412·668

Elvis Costello—Girls Girls Girls (Columbia) 412·619/392·613

Dolly Parton—Eagle When She Flies (Columbia) 412·171

Rolling Stones—Flashpoint (Rolling Stones Rec.) 418·715

Jeffrey Osborne—Only Human (Arista) 411·637

Garth Brooks—No Fences (Capitol) 411·587

Reba McEntire—Rumor Has It (MCA) 411·538

The Traveling Wilburys—Vol. 3 (Warner Bros./Wilbury) 413·872

Paul Simon—The Rhythm Of The Saints (Warner Bros.) 412·809

Johnny Mathis—In A Sentimental Mood (Columbia) 411·223

Paul McCartney—Tripping The Live Fantastic-Highlights (Capitol) 417·477

L.L. Cool J—Mama Said Knock You Out (Def Jam/Columbia) 411·165

Grateful Dead—Without A Net (Arista) 410·365/390·369

Living Colour—Time's Up (Epic) 410·357

Trixter (Mechanic) 410·266

Iggy Pop—Brick By Brick (Virgin) 409·854

Concrete Blonde—Bloodletting (I.R.S.) 409·706

Anita Baker—Compositions (Elektra) 408·989

Poison—Flesh & Blood (Capitol/Enigma) 408·963

Keith Sweat—I'll Give All My Love To You (Elektra) 407·791

Johnny Gill (Motown) 406·991

Bell Biv Devoe—Poison (MCA) 406·819

Bad Company—Holy Water (ATCO) 406·694

Winger—In The Heart Of The Young (Atlantic) 406·678

Harry Connick, Jr.—We Are In Love (Columbia) 406·645

Damn Yankees (Warner Bros.) 405·886

Depeche Mode—Violator (Sire/Reprise) 405·423

Sinead O'Connor—I Do Not Want What I Haven't Got (Chrysalis) 405·001

Deee-Lite—World Clique (Elektra) 412·742

INXS—"X" (Atlantic) 412·106

Slaughter—Stick It To Ya (Chrysalis) 404·830

Eddie Money—Greatest Hits Sound Of Money (Columbia) 403·428

Warrant—Cherry Pie (Columbia) 411·389

Robert Palmer—Addictions, Volume One (Island) 400·937

Tangier—Stranded (Atco) 416·883

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John Scofield—Meant To Be (Blue Note) 418·749

Joey DeFrancesco—Part III (Columbia) 417·790

Wynton Marsalis—Intimacy Calling-Standard Time, Vol.2 (Columbia) 417·675

Earl Klugh—Midnight In San Juan (Warner Bros.) 416·776

George Howard—Love And Understanding (GRP) 416·644

Marlon Jordan—Learson's Return (Columbia) 416·297

Yellowjackets—Greenhouse (GRP) 416·198

The Chick Corea Akoustic Band—Alive (GRP) 416·081

Diane Schuur—Pure Schuur (GRP) 415·331

Mark Whitfield—The Marksman (Warner Bros.) 414·490

Joe Sample—Ashes To Ashes (Warner Bros.) 414·151

Gerald Albright—Dream Come True (Atlantic) 414·003

Kenny Garrett—African Exchange Student (Atlantic) 413·781

Take 6—So Much 2 Say (Reprise) 413·310

George Benson—Big Boss Band Featuring The Count Basie Orchestra (Warner Bros.) 412·478

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David Benoit—Inner Motion (GRP) 411·751

Branford Marsalis—Music From Mo' Better Blues (Columbia) 410·928

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Basia—London Warsaw New York (Epic) 401·752

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Paul Simon—Negotiations And Love Songs 1971-1986 (Warner Bros.) 400·721

Linda Ronstadt—Cry Like A Rainstorm, Howl Like The Wind (Elektra) 389·874

The Vaughan Brothers—Family Style (Epic/Associated) 411·306

George Michael—Listen Without Prejudice, Vol. I (Columbia) 411·181

Aerosmith—Pump (Geffen) 388·009

Motley Crue—Dr. Feelgood (Elektra) 387·944

Faith No More—The Real Thing (Reprise/Slash) 387·399

Billy Idol—Charmed Life (Chrysalis) 386·789

The B-52's—Cosmic Thing (Reprise) 383·877

Fleetwood Mac—Greatest Hits (Warner Bros.) 375·782

Journey—Greatest Hits (Columbia) 375·279

Dire Straits—Money For Nothing (Warner Bros.) 375·055

REO Speedwagon—Greatest Hits (Epic) 367·672

Pretenders—The Singles (Sire) 362·541

The Cars—Greatest Hits (Elektra) 339·903

Billy Joel—Greatest Hits Vols. 1 & 2 (Columbia) 336·396/396·390

ZZ Top—Eliminator (Warner Bros.) 319·624

Foreigner—Records (Atlantic) 318·055

Dan Fogelberg—Greatest Hits (Full Moon/Epic) 317·149

Neil Diamond—12 Greatest Hits, Vol. II (Columbia) 314·443

Aerosmith—Greatest Hits (Columbia) 306·225

Joe Walsh—Ordinary Average Guy (Epic/Associated) 418·012

Chicago—Twenty 1 (Reprise) 414·599

Nelson—After The Rain (DGC) 411·009

Wilson Phillips (SBK) 406·793

Susanna Hoffs—When You're A Boy (Columbia) 411·140

Toto—Past To Present 1977-1990 (Columbia) 411·371

AC/DC—The Razor's Edge (Atco) 410·662

Alexander O'Neal—All True Man (Tabu) 409·169

Squeeze—A Round And A Bout (I.R.S.) 409·078

Jeff Healy Band—Hell To Pay (Arista) 407·569

Rolling Stones—Steel Wheels (Rolling Stones Rec.) 387·738

Great White—Hooked (Capitol) 416·784

Alannah Myles (Atlantic) 404·475

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HERMAN BURSTEIN

Speed Mismatch

Q. I have a top-of-the-line dubbing deck and have noticed one problem with it, although I am not sure if it is of audible importance. One of the deck's transports takes 13 to 15 S less than the other to play a 45-minute cassette side. Is this something that can be fixed? Need it be fixed? An error of, say, 14 S in 2,700 S (45 minutes) is about 0.5%. I do not know if this really means something.—John F. Page, Monterey Park, Cal.

A. Some decks have internal speed adjustments; I do not know whether yours is one of these. However, the speed deviation is quite minor, resulting in a pitch deviation that is probably inaudible to the overwhelming majority of listeners. Most people can detect a pitch deviation of a semitone—the difference between C and C sharp, for example, which is a deviation of nearly 6%. Many would have difficulty detecting a deviation of a quarter-tone, or about 3%. An eighth-tone difference is 1.45%, and a 16th-tone difference is 0.7%; very few people can detect them. Your deviation is still less, only about 0.5%, and those who can detect it are extremely rare. Only if you have absolute pitch might you consider doing something about your deck's mismatch between the speeds of the two transports. Matters are probably best left alone.

Recording FM on a VCR

Q. Supposedly I can make copies of simulcast programs by recording onto videotape the video signal from TV along with audio from an FM tuner. I am concerned about the problem with the 19-kHz carrier frequency for FM stereo since I am not aware of any VCR with an MPX filter. Is there any way to record FM stereo onto a videocassette?—Romel Ramsey, Oxford, Ga.

A. Conventional VCRs (those not called *Hi-Fi*; do not be misled by the appellation HQ) ordinarily only accommodate mono sound; very few provide for stereo. Conventional VCRs perform linear recording along the edge of the videotape. The 19-kHz pilot signal of a stereo FM tuner could interfere with proper operation of the Dolby NR circuits in some conventional VCRs, and its harmonics could beat against the bias frequency to produce spurious sounds. However, modern FM tuners often incorporate MPX filters, preventing a problem. Look in your tuner's manual, or ask your dealer about it.

For the most successful recording of stereo, you are probably best off with a Hi-Fi VCR. The tuner's multiplex signal does not present a problem here. A Hi-Fi VCR gives excellent audio results in terms of extended frequency response, high signal-to-noise ratio, low distortion, and accurate motion (low wow and flutter).

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1633 Broadway, New York, N.Y. 10019. All letters are answered. Please enclose a stamped, self-addressed envelope.

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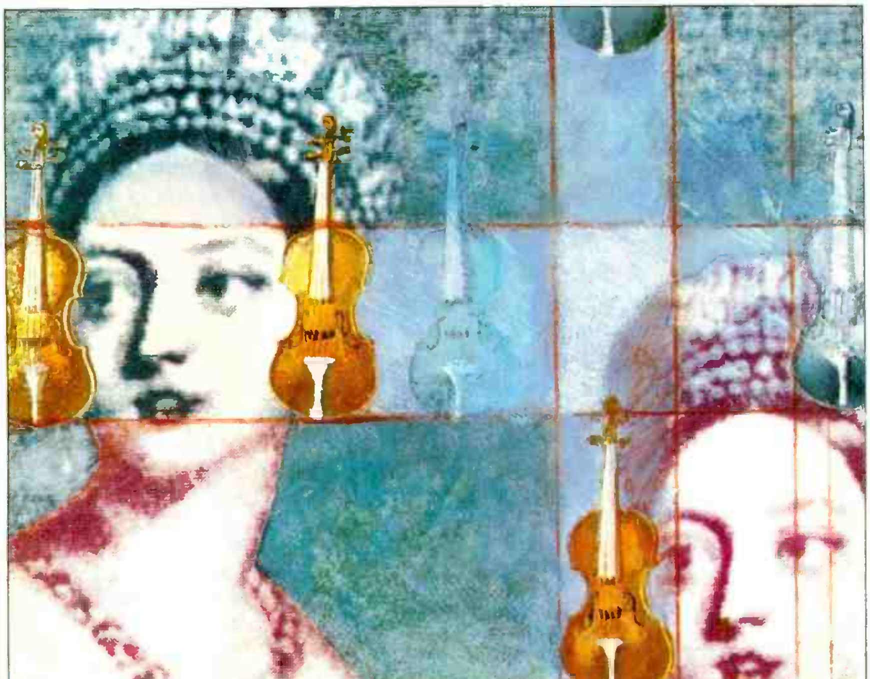

Illustration: Mary Schuck

I wish I could remember just when I heard my very first stereo, audio out of two channels. That was back some 40 years when stereo was called "binaural" in most minds, as described in my August account of this period. It was a giddy time, this brief "binaural" era, as Bert Whyte by coincidence (and in his own language) recently confirmed in the June issue, just a few pages away from this department. But at the very beginning, like Queen Victoria, I was not amused. I thought "binaural" was a silly idea. TWO loudspeakers spouting sound at you instead of the familiar and appropriate single system. And I didn't like the effect I heard.

Yeah, a solo violin, maybe it was in a concerto or a sonata, and what I heard was *two* violins, one on each side of the demo stage. Phooey! Who wanted that? Hi-fi was complicated enough without having doubled-everything coming at you from different directions.

I will admit that this has caused me some discomfiture in the years since, and I've tried to find reasons, though to be sure, plenty of other listeners at the time had exactly this same reaction. Why should I have disliked what in a very short time became a major enthusiasm, not only "binaural" sound through loudspeakers widely separated but, in time, true binaural via the first available two-channel 'phones, from Permoflux Corp.? (Whyte also mentions these in his account of the period.) As early as 1952, indeed, I was off to a long stint of "binaural" experiments at Washington University in St. Louis as a temporary visiting member of the Music Department. So my Queen Victoria phase had to be very early on, no doubt around 1950; others may know the precise dates of those first audio "binaural" demos.

For at least a year or so, I do recall a wholly dedicated member of our audio fraternity who was stone blind—and a "binaural" nut, as we might put it. This man, despite his physical infirmity, was everywhere, garnering a host of faithful friends, most of them audio engineers, to fetch and carry the clumsy equipment for "binaural" recording and playback, such as it was in those times, giving the widest possible professional "exposure" for his pioneer two-channel sound. It was some of his younger audio friends who hauled me, ever so reluctant, to hear the new sound, and to hear it again. And again.

For a long time, I was not convinced. I snorted, I sneered, I talked about the double concerto for a single violin simultaneously in two places. I suppose, alas, I wrote all about it. (I am not planning to find out what I said.)

And yet, I think there are constructive reasons why I felt as I did, out of the blue, "knowing from nothing" as they say in New Yorkese. These are worth exploring for the audio light they shed on our current stereo.

First—always first—comes habit and what is familiar. A zany example: In 1927, as a child I watched Queen Victoria's grandson George V and his wife, Queen Mary of the famous hats, drive by in one of those royal open carriages with lots of horses out front—this was at their home castle, whichever it was at the time. Do you know what my instant reaction was? HEY, THEY'RE IN COLOR! Look at their pink faces! Why? Because I had seen these two in hundreds of black and white, or brown, photographs, rotogravure news shots, and in my mind they were familiar, but monochrome, people. All public figures were monochrome, just as all such figures today have a TV screen around them.

Habit? On some other occasion I will hope to describe the immense sophistication of our 1950s mono sound reproduction, essentially created from virtually nothing (the old acoustic sound, minus a trace of reverb or space) in the electrical era after 1925. I was deeply involved, as a writer/consumer, in the later years of that superb development, and by 1950 I was, maybe, a practicing connoisseur in the means by which we created space in mono recordings and, equally important, how we could bring out that space in the mono listening room. It was thus "habit" on an enhanced scale, and I think I at once sensed that this new two-channel sound was going to upset my world of mono playback. It was joltingly new, for myself and many others, both pro and amateur. Of course, it sounded WRONG, especially if you were well versed in the old.

It took a long time for our audio public to adjust to serious stereo appreciation—I mean, those who really listened to their sound reproduction. Literally, this took ear training. One had to learn to glean the good effects of separation and ignore a few harmless falsities that really did not get in the way. Never forget that even a theoretical 100% perfect music reproduction, in engineering terms, will be no more than a complex and nonliteral illusion, the

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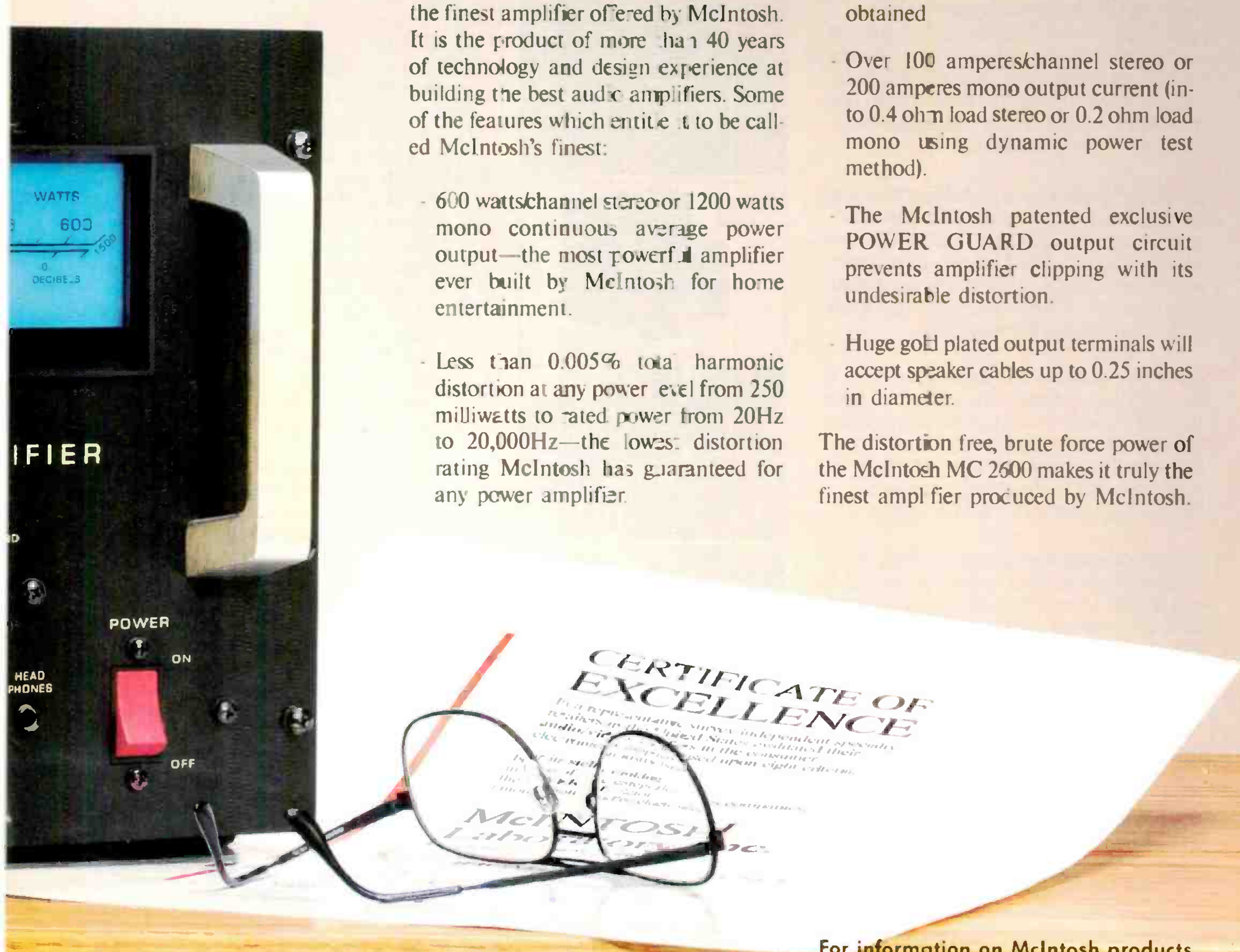

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At first I didn't like the effect of "binaural"; hi-fi was complicated enough without two of everything coming at you.

kind of illusion we prize, of course. Stereo ("binaural") was a fundamentally new effect. I suspect that most of us simply did not hear stereo, as we now mostly hear so easily. We did not mentally synthesize a space with music, with players and singers, inside it.

But there was a lot more. I would not bring this up if there weren't other and less controversial factors in the earliest "binaural" stereo. They most decidedly contributed to what now would seem a very faulty stereo effect.

In the days of mono hi-fi and before, we did not worry about precise *matching* from one component to the next in an outwardly identical series or model. True, there were areas where differences in response could make plenty of trouble, often unrecognized—the "match" between woofers and tweeters, for instance, when multi-speaker systems first began to sell in various forms. The same counted in our all too casual enclosure of speakers, whether in one enclosure or in several—for example, the generally unrecognized "edge effect" of the speaker box or the need for a precise vertical plane to align the units for better cooperation. These things, which are automatic today, were largely ignored when we first began to play music in two channels.

Moreover, speaker sound was much more a matter of (mono) taste preference in those days. I well remember what was euphemistically called the "golden" sound, often so advertised. You name the distortion, the nonlinearity; it was part of the "golden" mystique! Inevitably, with such a pleasantly loose-limbed concept of reproduced sound, there were vital differences, if on a tiny scale, between almost any speaker and the next one. Each was just fine in a good mono hi-fi system, but put two of these together on two different channels that were supposed to fuse into one sound, and you heard two highly individualistic speakers, and not much blend—the unfortunate impact of early stereo.

On a more micro scale, the same went for the other end of the chain, the recording microphones. Ask any broadcaster. Microphones have their own personalities, their individual sounds, to be exploited for the best but avoided for the worst. Would two mikes of *the same model* blend as one in the

> Remember that even perfect music reproduction, in terms of engineering, is nothing more than an illusion.

stereo reproduction? Maybe. I suspect that a mix of mikes was too often used in early stereo, just for this reason, but we were lucky in that much "binaural" took advantage of newer omnidirectional condenser (capacitor) mikes for smooth and easily blended response.

Then there was the "binaural" listening room, or hall. Who knew anything about that? All-new effects out of our speaker pairs—and plenty of frustrations. As I later found out, any architectural imbalance from one side to the other—say, a space, a corridor, a room behind one speaker and a wall behind the other—was disastrous for the fragile stereo blend we wanted. Indeed, my subsequent explorations showed me most discouragingly how tough it is to find a good stereo setup in the many different places where I tried to show off the new medium to audiences.

At home, most people put room decor first and stereo last. They still do. But at least today we have a general sense that there must be a nominal symmetry in the speaker placement, and so we do better, with our much better stereo material. If we are real listeners, not background types, we tend to give our speakers equal treatment, which is as it should be. (The background types would never know the difference.)

With all these blind spots (or, should I say, deaf spots?) in our 1950s understanding of stereo sound, it is a wonder we got anything at all out of all the "binaural" ballyhoo. I think it must be admitted that stereo survived and went forward mainly because of the sheer momentum and excitement of the times, the ancient bandwagon phenomenon. Practically nobody *really* heard stereo as it can be, but for a while it didn't much matter—it was the newest fad. There was potential, substance, in that trendy stuff, and in the end it established itself as a nearly immortal factor in our audio business.

I haven't forgotten the most preposterous, the silliest, and the most devastating fault that cropped up in early two-channel sound, from start to end of the entire audio chain: Phasing! I mean, the simple sort, so that if a mono signal emerged from both of your "binaural" speakers, the cones would move backward and forward together. As simple as that. Out of phase, connected wrong way around, one speaker cone moves out as the other moves in. All sorts of cancellations as the two signals meet in mid-air at the edges and find themselves going in opposite directions. In this case, there is no middle—just a jagged, fluctuating hole. And the mostly nondirectional bass simply departs or is dismally attenuated. People or instruments situated in the middle are bifurcated. Nobody there. Instead, there are two of them, one on each side, weakly. (You have probably seen the ads for solo eliminators in pop recordings, so you can dub in your own voice. That's how they work.) My first-ever stereo sound, the double solo violin? I'll bet you anything the speakers were out of phase.

I think only an older audio man who was around then can confirm the enormous extent of this simple problem in the first years of two-channe' sound. I heard dozens of examples, in the highest circles, as soon as I learned to recognize the trouble. It was scandalous! But understandable.

The problem was the adding up. In mono days, polarization, as we might call it, really didn't matter anywhere in the audio chain except within speaker systems and when more than one mike was used in a mono circuit. Nothing, thus, was marked! Speakers were uniformly haphazard, two terminals with no plus, no minus. (I just looked at a few oldies.) Amps had unmarked inputs, at least until the ubiquitous RCA plug and its pro relatives appeared. Some amp circuits or sub-circuits changed polarity inherently; others didn't. Phono cartridges, preamps, control units, all the rest contributed to the chaos. And the silliest aspect was that however many complications there were en route, it all added up to 50-50—either you ended up in phase, as between two "binaural" channels, or you were out of phase! Maybe 50% of our two-channel music was out of phase in playback. Don't think this didn't add to the confusion.

As for me, after I discovered this interesting phenomenon I had a homemade phase switch in my hand, always, as I listened to "binaural." That way, I could get most of my stereo right side around, not inside out. It helped, and for more years than the audio profession would like to remember.

BERT WHYTE

BATTLE OF THE FORMATS

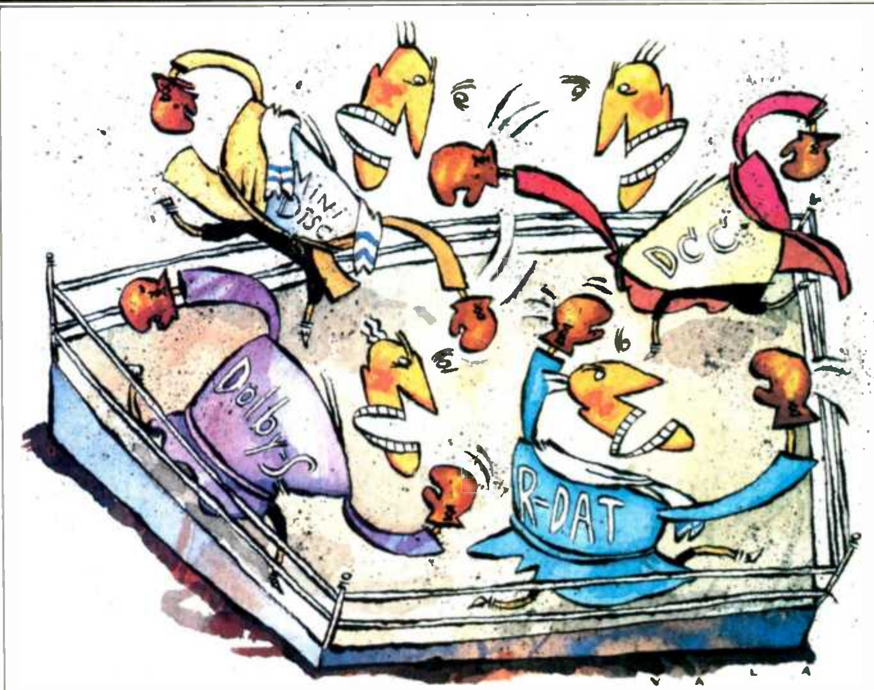

Illustration: Vala Kondo

With nine years to go before we enter the 21st century, there is a great proliferation of new developments and technologies that will profoundly affect the audio and video industries. It would probably be more accurate to say they will affect "home entertainment electronics," considering the ever-increasing interaction between audio and video.

Most of the new developments and devices utilize some new, advanced digital technology such as magnetic, optical, or thermal recording of CDs and various forms of digital data compression in audio and video systems. Unfortunately, a number of these technologies conflict with each other, and each proponent is trying to emerge with the absolute standard format for its particular medium. Currently, the emphasis is on digital recording devices such as the R-DAT, DCC (Digital Compact Cassette), and the MD (Mini Disc). And there's also the Dolby S-type analog cassette system.

In spite of all the travails with the RIAA and copyright organizations, R-DAT recorders are now generally available to consumers in the United States. But even with list prices as low as $750, the R-DAT units have not been selling in any significant quantities; it seems that the R-DAT format is now only widely accepted by professional recording engineers. The limited catalog of prerecorded R-DAT cassettes and their high prices due to one-to-one duplication apparently have adversely affected R-DAT recorder sales to the general public. Nonetheless, no one questions the capability of R-DAT recorders to provide wide-range, high-fidelity digital recordings.

Philips' Digital Compact Cassette recorder (DCC) is scheduled to be introduced in the spring of 1992. The concept is that of a unit which can play conventional analog audio cassettes but also record and playback a Digital Compact Cassette on the same machine. Some future DCC units may record analog cassettes as well.

The DCC is the same size as the analog cassette but is of a different, more complex construction. The digital recording heads are stationary, with eight tracks plus an auxiliary track for each stereo channel. (The DCC, which uses chrome videotape, is not turned over but reverses automatically.) The heads are made by lithographic techniques similar to IC chips. The head gaps are extremely small; tracks are recorded at 185 microns and read at 70 microns to compensate for mechanical irregularities in the tape drive. Philips has developed Precision Adaptive Sub-band Coding (PASC) for DCC. The sound is sampled and digitally processed into 32 bands. Each band is separately coded with a variable number of bits depending on the content of the signal, averaging out to four bits. The recording speed is the same 1⅞ ips as analog cassette, and the sampling rate is 48 kHz for record, as in R-DAT units. (For more information on DCC see page 32.)

Philips states that prerecorded DCC tapes will be available with duplication done at the usual 64× speed, with slaves using the special DCC stationary heads. The SCMS "one digital copy only" system is included in the circuitry. Philips also plans to introduce portable and car DCC machines.

Sony's new MD (Mini Disc) system is an ultrasophisticated digital recording system. A small 2½-inch disc, coated with rare-earth alloys, is encased in a 2¾-inch square plastic caddy only ⅛-inch thick. When inserted into the recording deck, a rectangular plastic tab on the caddy is slid aside, allowing the disc to be scanned by the infrared laser for recording or playback. When recording or playback is ended, the tab is returned to its original position. Thus, there is no direct handling of the disc, avoiding all contamination. Recording is a complex process, in which the infrared laser heats the rare-earth disc coating in the presence of a strong magnetic field. Data-compression techniques are used, with psychoacoustic masking a part of the process. As this system is said to slightly compromise the sound quality, the MD is not intended as a replacement for CD and its main use will be in portable and car units. A clever memory circuit makes the MD particularly good in combating the bumps and vibration in cars and portable use. If the laser "jumps the track," a memory chip, already loaded with 3 seconds of music, will permit uninterrupted playback, and, during that time, the laser beam will have been refocused on the proper track. In other words, the music is really being output from the memory buffer while the memory is being continuously updated for 3 seconds of music (save in the case of bumps).

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Neil Young: Ragged Glory (Reprise) 34621

Kentucky Headhunters: Pickin' On Nashville (Mercury) 24740

Anita Baker: Compositions (Elektra) 00921

Don Henley: The End Of The Innocence (Geffen) 01064

Chick Corea Akoustic Band: Alive (GRP) 10721

Bob Marley: Legend (Island) 53521

Hi-Five (Jive) 10542

The Bonnie Raitt Collection (Warner Bros.) 00569

Suzanne Ciani: Pianissimo (Private Music) 11047 ✻

Technotronic: Pump Up The Jam-The Album (SBK) 34781

Hank Williams, Jr.: America (The Way I See It) (Warner Bros.) 20612

Van Halen (Warner Bros.) 14620

The Cars: Greatest Hits (Elektra) 53702

Metallica: ...And Justice For All (Elektra) 00478

Jeff Lynne: Armchair Theatre (Reprise) 00803

Dirty Dancing/ Original Soundtrack (RCA) 82522

Pat Benatar: Best Shots (Chrysalis) 44319

ZZ Top: Afterburner (Warner Bros.) 64042

Skid Row (Atlantic) 01038

ZZ Top: Recycler (Warner Bros.) 73969

Rick Astley: Free (RCA) 53656

Bell Biv DeVoe: Poison (MCA) 00547

Jane's Addiction: Ritual de lo Habitual (Warner Bros.) 10020

Aerosmith: Pump (Geffen) 63678

Reba McEntire: Rumor Has It (MCA) 44609

Tony! Toni! Tone!: The Revival (Polydor) 00565

Best Of Robert Palmer: Addictions (Island) 10819

Damn Yankees (Warner Bros.) 14852

Keith Sweat: I'll Give All My Love To You (Elektra) 51603

Too Short: Short Dog's In The House (Jive) 54304

Greatest Gospel Hits (Malaco) 44366

Edie Brickell: Ghost Of A Dog (Geffen) 73923

Eric Clapton: Journeyman (Warner Bros.) 53940

Carly Simon: Have You Seen Me Lately? (Arista) 20912

The Glenn Miller Orchestra: In The Digital Mood (GRP) 43293

James Taylor: Greatest Hits (Reprise) 23790

Raffi: Evergreen Everblue (MCA) 10492

Lionel Richie: The Composer (Motown) 24700

Lenny Kravitz: Mama Said (Virgin) 10041

Solti: Tchaikovsky, 1812 Overture (London) 25179 ✻

Clint Black: Killin' Time (RCA) 01112

En Vogue: Born To Sing (Atlantic) 14187

Paula Abdul: Shut Up And Dance (The Dance Mixes) (Virgin) 80326

Sinéad O'Connor: I Do Not Want What I Haven't Got (Chrysalis) 33512

Talking Heads: Stop Making Sense (Sire) 24560

The Police: Every Breath You Take—The Singles (A&M) 73924

Lisa Stansfield: Affection (Arista) 34198

The Robert Cray Band: Midnight Stroll (Mercury) 73659

America: History (Greatest Hits) (Warner Bros.) 23757

Peter Gabriel: Shaking The Tree-16 Golden Greats (Geffen) 11089

Another Bad Creation: Coolin' At The Playground (Motown) 10456

Kathy Mattea: A Collection Of Hits (Mercury) 10791

Yanni: Reflections Of Passion (Private Music) 24223

Nelson: After The Rain (DGC) 74079

Mötley Crüe: Dr. Feelgood (Elektra) 33928

Fleetwood Mac: Behind The Mask (Warner Bros.) 43766

Crusaders: Heal The Wounds (GRP) 34744 ✻

AC/DC: Back In Black (Atlantic) 13772

Scorpions: Crazy World (Mercury) 14795

Paul Simon: Graceland (Warner Bros.) 72315

U2: Rattle And Hum (Island) 00596

Grateful Dead: Built To Last (Arista) 72230

Patsy Cline: 12 Greatest Hits (MCA) 53849

Gipsy Kings: Allegria (Elektra) 11178

Vince Gill: Pocket Full Of Gold (MCA) 73599

Clint Black: Put Yourself In My Shoes (RCA) 24690

Guy!...The Future (MCA) 14875

Steve Winwood: Refugees Of The Heart (Virgin) 54232

Styx: Edge Of The Century (A&M) 74498

Deep Purple: Slaves & Masters (RCA) 11145

Linda Ronstadt: Cry Like A Rainstorm, Howl Like The Wind (Elektra) 52221

Stevie B: Love And Emotion (RCA) 00539

Atlantic Records: Hit Singles (1958-77) (Atlantic) 10514

The Cole Porter Songbook: Night And Day (Verve) 10613

Keith Whitley: Greatest Hits (RCA) 10728

The Jeff Healey Band: Hell To Pay (Arista) 00544

Robert Plant: Manic Nirvana (Es Paranza) 54122

Big Daddy Kane: A Taste Of Chocolate (Cold Chillin') 01095

King's X: Faith, Hope Love By King's X (Atlantic) 74229

Spyro Gyra: Fast Forward (GRP) 00829

Pat Benatar: True Loves (Chrysalis) 44663

AC/DC: The Razors Edge (Atlantic) 33379

Roger McGuinn: Back From Rio (Arista) 81997

White Lion: Mane Attraction (Atlantic) 54209

Debbie Gibson: Anything Is Possible (Atlantic) 24815

Extreme: Pornograffitti (A&M) 43557

Faith No More: The Real Thing (Reprise) 63719

Catching Up With Depeche Mode (Sire) 00560

Kenny G: Live (Arista) 64505

Randy Travis: Heroes And Friends (Warner Bros.) 74597

Contraband (Impact/MCA) 32031

Bon Jovi: New Jersey (Mercury) 00516

Big Band Bash (Compose) 10458

Twin Peaks/TV Soundtrack (Warner Bros.) 63540

Hank Williams, Jr.: Pure Hank (Warner/Curb) 60351

Jeffrey Osborne: Only Human (Arista) 00545

Vanilla Ice: To The Extreme (SBK) 24689

Chicago: Twenty 1 (Reprise) 10533

Billy Idol: Charmed Life (Chrysalis) 62264

Peter Gabriel: So (Geffen) 14764

Johnny Gill (Motown) 00738

Tom Petty: Full Moon Fever (MCA) 33911

Starship: Greatest Hits (RCA) 90207

Monie Love: Down To Earth (Reprise) 44752

Tesla: The Great Radio Controversy (Geffen) 00839

Alabama: Pass It On Down (RCA) 00531

Tears For Fears: The Seeds Of Love (Fontana) 33653

Paul Simon: Graceland (Warner Bros.) 72315

The B-52's: Cosmic Thing (Reprise) 14742

Guns N' Roses: Appetite For Destruction (Geffen) 70348

Take 6: So Much 2 Say (Reprise) 53580

Alannah Myles (Atlantic) 30045

The Cure: Kiss Me, Kiss Me, Kiss Me (Elektra) 42404

Bulletboys: Freakshow (Warner Bros.) 34757

Carreras, Domingo, Pavarotti: 3 Tenors (London) 35078

Depeche Mode: Violator (Sire) 73408

Scorpions: Crazy World (Mercury) 14795

U2: Rattle And Hum (Island) 00596

Traveling Wilburys, Vol. 1 (Warner Bros.) 00711

Bobby Brown: Dance! ...Ya Know It (MCA) 73660

Charlie Parker: [illegible] Original [illegible]ordings ([illegible]e) 01044

Dwight Yoakam: If There Was A Way (Reprise) 64310

Bruce Hornsby & The Range: A Night On The Town (RCA) 63689

Boogie Down Productions: Live Hardcore Worldwide (Jive) 44584

Lita Ford: Stiletto (RCA) 63893

Jasmine Guy (Warner Bros.) 54384

Lita Ford: Lita (RCA) 24793

Jimmy Buffett: Greatest Hit(s) (MCA) 42157

Tracy Chapman (Elektra) 53582

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4 ☐ **POP/SOFT ROCK** Madonna, Elton John
5 ☐ **CLASSICAL** Luciano Pavarotti, Vladimir Horowitz
6 ☐ **JAZZ** Kenny G, George Benson
7 ☐ **HEAVY METAL** AC/DC, Slaughter

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INSTANT 50%-OFF BONUS DISCOUNTS!

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You earn INSTANT 50%-OFF BONUS DISCOUNTS *every time you buy a CD at regular Club price.* In a nutshell ... buy 1, take another at half price. With other clubs, you must first buy 6 or more at full price and become a "Preferred Member" before you earn savings like this!

New devices are now in conflict with each other and each is trying to emerge as the standard format for the medium.

will permit up to 72 minutes of recording. In the near future, Sony might incorporate what they call an Irister circuit in the MD. This is a system in which the infrared laser and an extremely small lens can reduce the size of the light spot in recording to improve packing density by a factor of six, so that the 2½-inch MD could provide over seven hours of recording. Further down the line, Sony is expecting to develop a blue laser, which would increase recording density by a factor of 20. The tiny MD would provide a mind-boggling 24 hours—a full day—of recording! It is interesting to speculate that an artist like Frank Sinatra could have about 320 of his songs recorded on a single MD! The problem, of course, is that performing royalties would make this MD prohibitively expensive. Sony's MD system is due to reach the market in the fall of 1992.

After all this high-flying digital technology, let's look at the latest offering from Dolby Labs, long a champion of analog audio. Dolby S-type noise reduction is the consumer version of their highly successful Dolby SR (spectral recording) professional noise reduction system. You may have noted that quite a few movies are now using Spectral Recording for their soundtracks. Dolby S-type is derived from SR and has in common with it such developments as having both fixed and sliding bands, spectral skewing, anti-saturation, and control of modulation noise. S-type provides 24 dB of noise reduction at high frequencies and 10 dB at low frequencies. Headroom at high signal levels is considerably improved at both low and high frequencies. Dolby Labs claims that cassettes with S-type NR can be played back on Dolby B cassette decks with good compatibility. In this case, although there is an audible reaction in dynamic range, the sound is said to be spectrally balanced and dynamically stable. The same claim is made for S-type playback through Dolby C circuitry. The late Howard Roberson, *Audio*'s highly respected authority on compact audio cassette technology, tested S-type recording on an early Teac Esoteric deck (June, 1990), was quite impressed with the system, and verified the Dolby claims, stating that, "Overall the sonic compatibility with Dolby B and C NR was definitely better than I thought it would be." Dolby Labs also claims that S-type is far more tolerant of level and response errors than Dolby B or C NR. Roberson deliberately misadjusted bias and level calibrations several different ways and confirmed Dolby's claims.

The compatibility of S-type with Dolby B and C NR is of great importance in respect to prerecorded cassettes. Duplicators all over the world are set up for Dolby B replication, and they would be very reluctant to set up S-type duplication facilities if S-type cassettes could be played back only on S-type cassette machines. Neither they nor the audio dealers want a double inventory problem. There is, at present, a very small population of S-type cassette decks, but in early tests by Warner Bros. Records using Dolby Labs' new professional Model 422 reference encoder for B, C, and S-type NR, the S-type cassettes got a very positive response. Negotiations for S-type cassette duplication with several record companies are ongoing and look promising. At last report, Dolby Labs had licensed more than 15 companies to manufacture S-type cassette decks. The S-type circuitry has been reduced to a single chip—the Sony CXA 1417 IC—and is now in full production, so more companies are expected to go into S-type deck production. However, there is a proviso: Dolby Labs will not grant a license for S-type use unless the manufacturer's decks meet new Dolby Labs parameters for mechanical tape-handling performance with improved wow and flutter specs and the capability of more precise azimuth adjustment.

Irrespective of the individual merits and drawbacks of R-DAT, DCC, and MD digital recording formats or the Dolby S-type analog recorders, in terms of performance and ergonomics, all are just at the starting gate in the marketplace and are jockeying for position. Any consumer recording format will likely perish or flourish on the availability and cost of its particular prerecorded programs.

I dare to ask: If there were no prerecorded music for any of these four new recording formats, how many units could be sold solely on the basis of their recording capabilities?

Any consumer recording format will flourish or perish on the availability and cost of its particular prerecorded programs.

In essence, what kind, and what amount, of recording activity is actually done by either audiophiles or the average consumer? Considering the millions of blank audio cassettes sold every year, there is a lot done on cassette decks. I would venture to say that a majority of this activity is in the youth market and oriented to pop music. The kids exchange and copy prerecorded cassettes and CDs borrowed from friends. They record pop music from radio broadcasts. They probably do more live recording than any other group, even though most of it is of home-brew rock bands. It is claimed that pop music accounts for 95% of the total record market in the United States. That is a formidable group, especially since most of the people in that group record on audio cassettes. While acknowledging that a large part of this huge market would not have the ancillary hi-fi system to appreciate the higher quality of Dolby S-type recording, it still represents a definite plus for Dolby Labs' new format.

One must ask, in these circumstances, how many people in this pop music group will have an interest in and will be able to buy these more expensive digital recorders? While the CD is the premier music format, many people still consider the discs expensive as they cost an average of $13 or $14 each. DCC tapes and MDs are likely to be less expensive than CDs, and this may incline more people to these formats. At present, prerecorded R-DAT tapes are few in number and too expensive for most people.

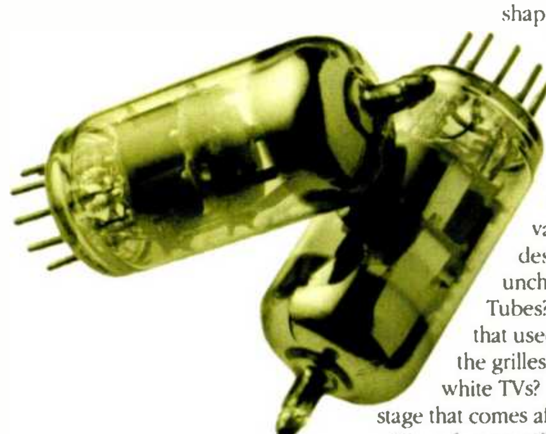
For the 5% of the record market who want classical music, and ostensibly this group includes many audiophiles and others interested in high-quality recording, all of the new recording formats would be competitive. But here again—what would they record? Forget live recording, requiring good mikes, requisite skill, and opportunities to record musically worthwhile groups. There are precious few live music concerts to record off FM. Recording CDs would be pointless, except for "customized" programs to play back in cars or on portables. And recording at a live concert can get you arrested!

I certainly cannot be described as anti-recording. For over 40 years I have been in every segment of recording activities, which includes engineering many pioneering commercial stereo recordings. Undoubtedly, many people enjoy recording, and more power to them, but as an activity on which to base a market for recorders of any type, it is limited.

So, we are back to square one—high-quality prerecorded music is the rock-ribbed foundation of any recording format, digital or analog. One thing is certain: Neither consumers nor dealers will support multiple inventories for differing tape or disc formats. Something has to give. So let the games begin!

CAN TUBES WARM UP CD SOUND?

How a very old technology can make a brand new compact disc player sound extraordinarily good.



Our new SD/A-490t has a clock that "ticks" 33 million times a second, multi-stage noise shaping, pulse width modulators and enough other edge-of-the-art circuitry to finally qualify us for entry into the hallowed Compact Disc Techno-Jargon Hall of Fame.

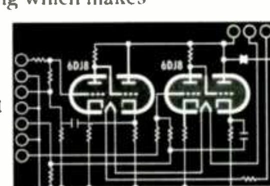
But it also includes two vacuum tubes whose classic design has remained unchanged for over 35 years.

Tubes? Those warm glass things that used to glow cheerily through the grilles of old radios and black & white TVs? Yes. In an important circuit stage that comes after all the digital wizardy.

We and many other critical listeners believe that this anacronistic addition to an already excellent CD player design significantly enhances its sound. Read on and decide for yourself.

THE AMPLIFIER THAT DOESN'T AMPLIFY.

Between a CD player's D/A converter and external outputs is circuitry called a buffer amplifier stage. When you hear the word amplifier, you think of something which makes a signal louder. But that's not a buffer amp's purpose. In fact, contrary to popular lore, a CD player's buffer amplifier doesn't boost the signal strength at all — the final output of a CD player's D/A converter already has sufficient voltage to directly drive a power amplifier!



Instead, the buffer amp is a *unity gain* device which *1) increases output current, and 2) in the process, acts as a sort of electronic shock absorber.

A signal emerging from a CD player's digital-to-analog conversion process has sufficient voltage but insufficient current for proper interaction with a preamplifier or power amp. By acting as a current amplifier, the buffer stage helps lower impedance to a level that's compatible with modern components — about 50 ohms in the case of the SD/A-490t.

At the same time, the buffer stage helps isolate the relatively fragile D/A chip set from the nasty outside world of demanding analog components.

TUBES VERSUS SOLID STATE.

All compact disc players have buffer amplifiers. But more than 98% of them use solid state devices for this stage: either integrated op-amp circuits or discrete transistors.

A handful of hard-to-find, esoteric designs in the $1200 to $2500 range employ one or more tubes instead. As does our readily-available $699 SD/A-490t. For fundamental physical reasons, tubes have different transfer function characteristics than transistors. When used in ultra-expensive, audiophile preamplifiers and power amplifiers, their sound is variously described as "mellower", "warmer", "more open and natural" or simply "less harsh than solid state".

At the heart of these perceived differences are three basic facts:

1. Tubes produce *even*-order distortion (i.e. 2nd, 4th, 6th harmonics, etc.) while transistors create *odd*-order distortion, particularly 3rd harmonics which are less psychoacoustically pleasant.
2. In a buffer stage, a tube acts as a pure Class A device, which is considered the optimal amplifier configuration. Op-amps function as Class A in and Class B out, with potential crossover distortion as voltage swings from positive to negative.
3. Tubes "round off" the waveform when they clip. When over-driven, solid state devices cut off sharply, causing audible distortion.

THE SD/A-490t'S OUTPUT SECTION

Our new CD player uses two 6DJ8 dual triodes (each literally two separate tubes in a single glass envelope) placed between the digital-to-analog converter and a motorized volume control.**

Operated at less than 30% of their maximum capacity, these tubes achieve a highly linear output voltage with very low static and transient distortion while providing very high dynamic headroom.

And because they're "loafing" at 1/3 their rated current capability, the SD/A-490t's tubes are designed to last the life of the CD player without replacement or need for adjustment.

A "LESS IS MORE" DIGITAL APPROACH FOR CLEANER ANALOG SOUND.

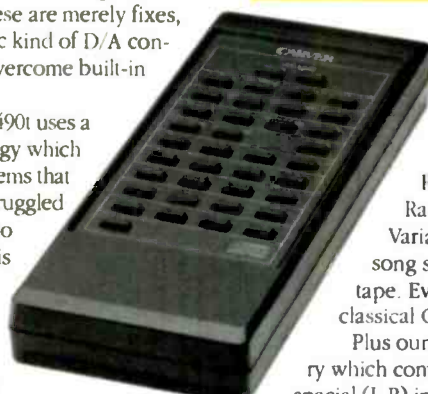
It would be pointlesss to have a tube output stage if the digital circuitry which precedes it

The Carver SD/A-490t.
*At $699, its suggested retail is $500 less than the nearest competitor with tube output****

wasn't first rate. The SD/A-490t uses Single-Bit D/A circuitry to eliminate a form of exceedingly audible distortion inherent in most current CD player designs, and to provide better signal linearity than ever before.

If you've read current CD player brochures, you've probably stumbled across descriptions of de-glitcher circuits, laser trimming and even 22-bit converters. All these are merely fixes, applied to the same basic kind of D/A converter in an attempt to overcome built-in shortcomings.

In contrast, the SD/A-490t uses a completely new technology which avoids many of the problems that older approaches have struggled to surmount. We'd have to buy a whole section in this magazine to fully explain the differences (if you're interested, call 1-800-443-CAVR for an appropriately long and detailed brochure), but here's a short synopsis.



Traditional converters require 16 separate reference circuits, each of which must be accurate to one part in 65,536 — but, due to the realities of mass production, rarely are. If they're not "dead-on", an unpleasant form of noise called *zero-cross distortion* is produced. Because Carver's Single Bit D/A Converter transforms a 16-bit signal into a 1-bit pulse signal array, the "ladder" of 16 ultra-high-precision reference devices is not required: In effect, the SD/A-490t need only manipulate a stream of varying-width on/off pulses instead of having to accurately create 65,536 different amplitude levels at all times.

Zero-cross distortion is non-existent, and the SD/A-490t's Single Bit converter is able to decode linearity in excess of 115 dB below peak level with exceptionally low noise. You'll particularly notice the difference in the heightened purity and clarity of music during very quiet passages. Every nuance, intonation and harmonic of the original recording is there. Yet "digital" harshness is noticeably absent even before it enters the SD/A-490t's mink-lined tube stage.

AN ARRAY OF FEATURES AS RICH AS ITS SOUND.

We've designed the SD/A-490t to be both useful and easy-to-use. 21-key front panel or remote programming. Fixed and variable output. Programming grid display. Random "shuffle" play. Variable length fade. Automatic song selection to fit any length of tape. Even index programming for classical CD's.

Plus our proprietary Soft EQ circuitry which compensates for variables in spacial (L-R) information and midrange equalization found in many CD's mastered from analog tapes.

BRING YOUR TWO BEST CRITICS TO A CARVER DEALER.

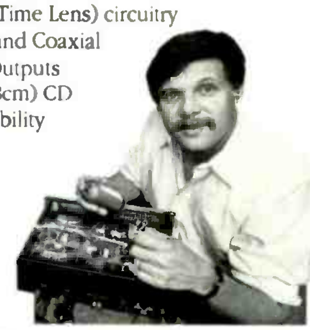
It's tempting to further regale you with how well we think the SD/A-490t's tubes and Single Bit circuitry improve the sound of a compact disc. But your own ears should be the final arbiter of quality.

Thus you are invited to bring a few familiar compact discs down to your local Carver dealer and compare for yourself, hopefully creating your own superlatives in the process.

Suffice it to say that almost all critical listeners not only are able to hear a difference, but prefer the sound of the remarkably affordable SD/A-490t's dual triode transfer function.

THE SD/A-490t

- Dual 6DJ8 Vacuum Tube Output Stage
- Over-sized Disc Stabilizer Transport
- 24-Track Programming with 21-key front panel & remote input
- Music Calendar Display
- Indexing
- Random Play
- Motorized Volume Control
- Time Edit/Fade Taping Feature with user-variable time parameters
- 2 to 10 Second Variable Length Fade
- Exclusive Carver Soft EQ (Digital Time Lens) circuitry
- Optical and Coaxial
- Digital Outputs
- 3-Inch (8cm) CD Compatibility



Bob Carver

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Call 1-800-443-CAVR for information and dealer listings.

**A device which neither amplifies nor attenuates a signal is said to have unity gain. In other words, what goes in comes out unchanged. Or does it?*

***Remote control variable output is a wonderfully convenient feature, but it would be pointless to eliminate solid state circuitry in the buffer amp stage and then use a solid state circuit for the final gain attenuator. So the SD/A-490t changes volume the old fashioned, physical way: a nice, clean carbon potentiometer, in this case, physically rotated by a small motor.*

****Source: 1990 Audio Magazine Annual Equipment Directory.*

Have DAT...

To The Islands of Japan

Christopher Greenleaf

"The Omni mike is, I think, underrated and underutilized. In the sort of acoustic spaces where music *should* be recorded, it is the only kind of microphone that can capture all the direct and reflected energy in a room properly." These were the words of Wieslaw R. Woszczyk, whose simple yet inspired microphone development allowed me to make a vivid recording, far from home, with just a single pair of microphones. This radical departure in mike technique is the outgrowth of research by the Faculty of Music at McGill University in Montreal, where Woszczyk is Director of the Graduate Program in Sound Recording and of the University's Recording Studios. Under normal circumstances, recording in five utterly different rooms, as I did, might have required five different types of microphones. Even if you do not make live recordings, the tale is an interesting one.

In May 1990, Japanese organ builder Hiroshi Tsuji asked, at a Tokyo concert, if I might record a number of his historically modelled instruments. "Who's going to play?" I asked. That it was Peter Planyavsky, the highly respected organist of the Stephan in Vienna's St. Stephen's Cathedral, got my attention pretty thoroughly. We discussed dates, repertoire, and the eventual purpose of the recordings (making a CD).

Last fall, the dates jelled. I got my tickets and then got in touch with Barb

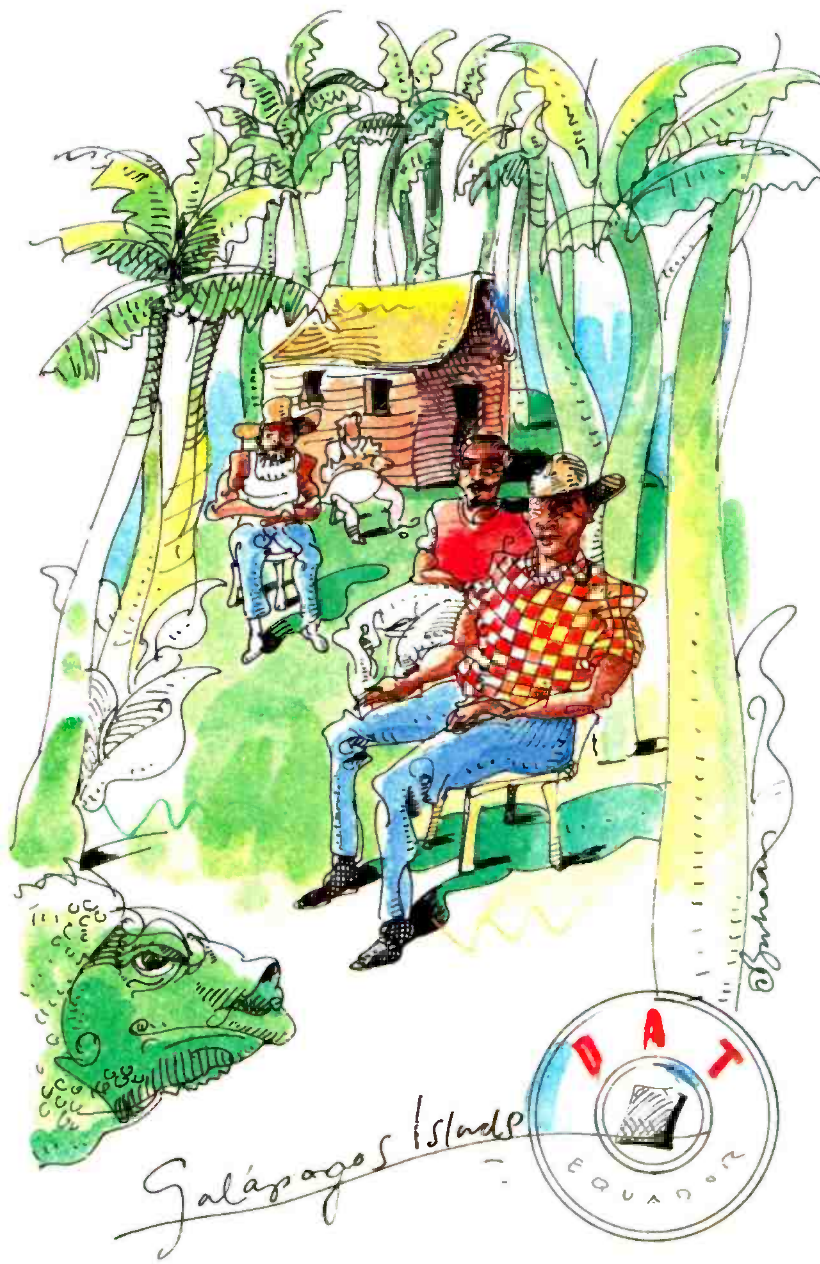
Continued on page 28

Illustrations: Yvonne Buchanan

.Will Travel

To The Galápagos Islands

John M. Woram



In 1854, Herman Melville wrote of the *Encantadas*, those distant and desolate "enchanted" islands that were "like split Syrian gourds left withering in the sun, are cracked by an everlasting drought beneath a torrid sky. In no world but a fallen one could such lands exist." Melville had just returned from a visit to the Galápagos Islands, which lie several hundred miles off the Pacific coast of Ecuador. Cut by the equator, the islands had not yet been discovered by the tourist trade. Even today they are—for very good reason—mostly uninhabited, save for giant tortoises, ugly iguanas, and, of course, Darwin's famous finches.

During the years before World War II, a handful of European settlers came out in search of a better life. Most of them didn't find it. They either died, or left quickly. Yet a hardy few did manage to hang on in this land where Mother Nature does not look kindly on humans. After the war, the pioneers were joined by others who came to scratch subsistence from the inhospitable soil. Still later, others arrived in search of making a fortune from tourism. Today, for better or worse, the Galápagos are no longer terra incognita. Much to the horror of the earliest settlers, the enchanted isles are well on their way to becoming, as the glossy brochures put it, a tourist "destination."

This remote land, where the paved street is still a bit of a novelty, where

Continued on page 30

In Japan

Continued from page 26

Crofoot and Adrian Weidmann, who were then responsible for the American activities of Brüel & Kjaer. Not long before, they had announced the availability of a tiny professional mike-cum-recorder kit. Friends in audio and recording were aware of the system and curious about its field performance.

Having wrestled the loaner system from the previous writer who had evaluated it in the lab, Weidmann gave me a long, level look that underlined his wish to have it back on time. He went over its operation and, to my delight, B & K's experience with some unusual omni applications. To the standard system, packed in its aluminum Halliburton case with close-fitting foam cutouts, one then unavailable option was added. More on *that* shortly.

After a concert recording that evening to check out the system under realistic working conditions, I packed for the Japan trip. Without going into what might read like a laundry list (shudder), here is what I took:

I carried an under-seat suitcase with clothing, maps of Honshu and Kyushu islands and greater Tokyo, and a book for the flight. In another case, also sized for carrying aboard a 747, were a Panasonic SV-255 professional DAT portable (a 48-kHz recorder with balanced XLR inputs, a superior A/D converter, and an adequate headphone amp), two 30-meter shielded cables, a stereo bar, microphone shock mounts, the tiny Neumann BS 48i mike power supply (one 9-V battery), a reserve of 120-minute TDK DAT blanks, Sennheiser HD250 headphones (which easily knock down for compact travel), minimal tools, a roll of black gaffer's tape, a flashlight, my camera, and the mike package. This last consisted of two B & K 4006 omnis with three standard capsule grids and a strange-looking, 5-cm plastic sphere for each mike body.

I walked out the door with just the two cases in hand and with a light, collapsible Manfrotto 5-meter microphone stand slung, carbine-fashion, over one shoulder. The whole load was compact—a bit heavy, but manageable. After convincing Northwest Airlines that the mike mast did not fire 9-mm rounds or rockets, I was allowed to carry it on board. Whooppee. . .no luggage to check and, fortunately, three seats to stretch out on for the 14-hour flight to Narita airport.

After a mad dash from customs to Tokyo Station, I caught my bullet train to Nagoya with minutes to spare. Two hours later, the 200-kph *Shinkansen* let me out, exactly on schedule, a five-minute walk from my hotel. At 8:00 the next morning—with my body unsuccessfully trying to ignore the fact that it was 6:00 the previous evening at home—Peter Planyavsky, the Tsujis, and I drove to the first recording site, Nagoya Gakuin, a college outside the city, to set up. For the record, my average time from walking in to being ready to press the record button for test takes of mike position was about a half-hour, including taping down cables the public might walk over.

To be on the safe side, I purchased an inexpensive Denon DAT portable during the trip and used its digital input to take a feed from the Panasonic's flimsy but workable sub-mini digital-out jack. The result was two absolutely identical tapes of each session take or concert work. An indispensable benefit of having this second machine, aside from the security of safety copies, was its ability to record absolute time, the DAT format's version of the time code CD players read from a disc. The very expensive Panasonic recorder, in both its pro and consumer versions, inexplicably omits this otherwise standard Digital Audio Tape feature.

Even with *two* DAT portables, the equipment visible to the kibitzers who always stopped by to ogle our recording process and attend the concerts was so minimal as to evoke amazement. "*Ano ne* (the Japanese equivalent of "well" or "um"), you can make a recording for Compact Disc on *that*?" ran the spirit of the comments.

The splendid sound of the Japanese organs, based on 17th- and 18th-century North German or Italian originals, is certainly due in large part to the beautiful pipe voicing that is Hiroshi Tsuji's hallmark. But putting this almost visceral sonic fabric onto tape requires more than just the transparency of good analog-to-digital converters. The openness and power of even a small pipe organ on authentically low wind pressure are not well served by the coloration most directional microphones seem to have, no matter how good they are. For organ recording, the engineer must contend with the critical interrelation of instrument and room. *All* good organs are custom-built, then painstakingly voiced to fit the rooms in which they live and breathe. Just one microphone type works truly well to capture this meld of direct sound with the surrounding acoustics. In my experience, and as Wieslaw Woszczyk and many other experienced engineers have found, the omni microphone functions, as Woszczyk put it, according to "a principle embodying no compromise." One gets great clarity, with no ragged performance at angles outside the main axis of mike orientation.

"But don't you have to space them very far apart, say, 2 meters or so, to get real stereo?" Popular myth certainly asserts that, uh, *fact*. The truth is that

Photographs: Christopher Greenleaf

Hiroshi Tsuji's organ, in St. Paul's Church in Tokyo, was built in the European tradition.

Another Tsuji organ, this one in Seinan Gakuin, Fukuoka, Japan; note placement of mikes in the close-up. Lower photo is the Brüel & Kjaer portable digital recording system with its Panasonic DAT recorder.

very fine omnis, as these B & K 4006s are, can achieve credible stereo with spacings as close as 10 cm (that's 4 inches, to the non-metrically inclined). On average, my spacing was 25 to 35 cm, at heights from 2 to 4.5 meters above the floor, depending an organ location, and up to 3 meters away from the closest part of the instrument.

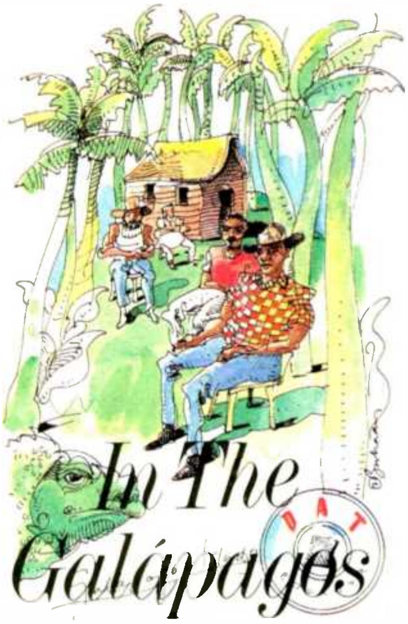
The B & K mike body cannot be separated from the diaphragm, so there is no conventional mike capsule. One alters the sound characteristics by using differently configured grids or screens. I used the bright metal grid (flat on axis, very small high-treble roll-off off axis) for relatively close pickup in one rather dead room. But, where I wanted a certain distance from the instrument yet aimed to preserve the presence of each individual pipe's speech, the black grid (excellent high-treble "reach" on axis, essentially flat off axis) was more accurate and musical. In rooms offering lots of usable reverberation, I planted the black nose cones (very close to a perfect omni pattern all around) relatively close to the organ facade but still far enough away for true 16-foot bass to develop. And where the room acoustics were just not pretty enough to complement the organ sound, the mysterious little spheres proved their worth.

What do these odd-looking addenda to the accessory list do? They are, in effect, mechanical frequency filters. They slip over the mike body and sit flush with the front surface of the transducer diaphragm. At bass frequencies and in the lower midrange, the mikes act like normal omnis; above 1 kHz, though, these 5-cm turned balls of nonresonant, highly reflective plastic attenuate off-axis sound by up to 5 dB at 90° and up to 14 dB at the back of the mike body.

The electronic chain, as well as the critical area immediately surrounding the diaphragm, stays simple and unaltered, giving omni "sweetness" while it performs as a cardioid or sub-cardioid. I used the two 4006s in a variation of one traditional cardioid array: 100° at 35-cm separation, as opposed to the "orthodox" 110°/17-cm ORTF configuration. The recorded sound is warm, full, totally lacking in cardioid coloration, and possessed of both good center-fill and astonishing mono compatibility!

In summing up the 10 frenetic days of travelling, recording, consuming meals in hotels and scattered Japanese eateries, and listening to takes on the bullet train, I must say that the convenience and sound quality of the B & K/Panasonic package were exemplary. But the real heroes of this trip were the musical, bulletproof, sweet-sounding omnidirectional microphones. Who, just a few years ago, would have thought it possible to make a recording good enough for a Compact Disc out of gear that could be carried in one small travel case? And that you would be relying solely on a single pair of omnis in the bargain!

Even with two DAT portables, the amount of visible equipment was amazingly small.



One reluctant subject nearly froze to death from mike fright—quite a feat on the equator.

Continued from page 27

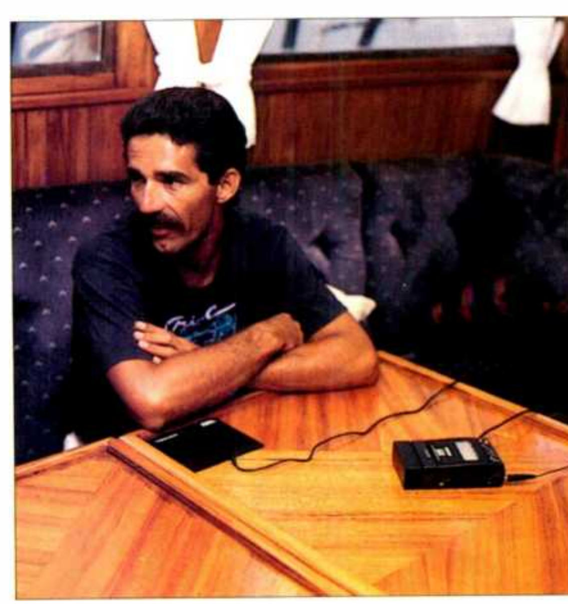
the telephone has just begun to show up, and where electricity is a sometime thing, might not seem a likely venue for a digital recording session. There are no beautifully voiced pipe organs here, no string quartets, possibly not even an in-tune piano. Yet there I was, armed with a Sony TCD-D3 DAT Walkman and an assortment of support equipment, ready for "Enchanted Islands, Take 1." To make a long, and no doubt dreadfully boring, story short, I was back again in my favorite hide-out from the world of high-tech. The purpose of this visit—my ninth—was to assist colleague Jerry Emory in recording the oral histories of these islands' early settlers. They're all getting on in years and won't be with us much longer, so we hoped to preserve their stories on tape while there were still some stories to be preserved.

Unlike Chris Greenleaf's Japanese trip, this was to be low-tech all the way. Given the work at hand, phone-line fidelity was about all we required. Stereo? Not necessary. In fact, even my best microphone—the superb Neumann KM140 that any interviewer might kill for—was of little use. I found out why the hard way, after one reluctant subject was finally persuaded to chat with us *mañana*. When the great day arrived, he almost froze to death of mike fright—quite an accomplishment on the equator. So I made a great show of unplugging the KM while Jerry dusted off his best Spanish to speak of days gone by. I casually placed a Radio Shack PZM on the floor next to my open camera bag, then tossed the Sony into the bag (carefully, of course, so as not to defeat the record mode). Our subject watched the proceedings with mild curiosity, then started to tell Jerry all about the old days. And I busied myself cleaning some camera lenses. After a pleasant morning of anecdotes and a tall tale or two, we bid our friend a pleasant adios and beat it back to the boat where we kept the battery charger.

Given our low-fi requirements, going digital might seem a bit of overkill, perhaps even silly. For even under the best of conditions, the Galápagos environment is not hospitable to the accoutrements of civilization. And this year was not the best of conditions. Every 10 years or so, the west coast of South America and the islands are tormented by El Niño, a complete disruption of the normal weather pattern. Like children everywhere, some Niños are

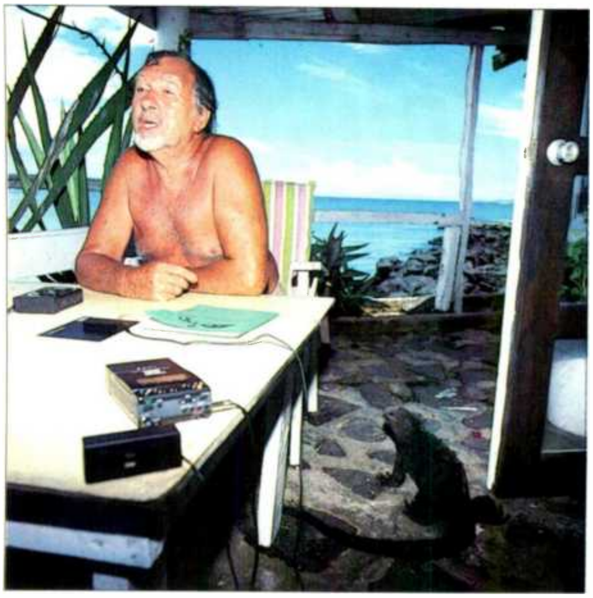
Photograph: John M. Woram

A Galápagos Island native, the iguana



Photograph: ©Stacy H. Geiken

Felipe Cruz, who spends much time evaluating the impact of tourism on the island, served as guide for this trip.



Photograph. ©Stacy H. Geiken

Carl Angermeyer came to the Islands in 1937 and waxes nostalgic of his early days in abandoned pirate caves.

Photographs: John M. Woram

Sally Lightfoot (top) and driftwood

worse than others: The last biggie, in 1983, was described as possibly the worst natural disaster in recorded history. Nothing like that this year, but the islands were experiencing heavy rain, which in other years is so infrequent as to be considered a special event. Actually, there were only about two days in as many weeks in which the rains came, but on other days it might just as well have been pouring, so high was the humidity. At 9 a.m. the temperature was over 110°, and it got up to 122° on one sunny day.

All this takes its toll on humans and hardware. Camera straps and leather belts disintegrate before one's eyes. Clothes get wet and stay wet. Books come unglued (to say nothing of their readers), and fungus begins growing in the most inconvenient places. Now, then, is this a fit environment for a digital tape recorder? Well, yes. After taking some minimal precautions, the damned thing worked without incident through it all. Even the batteries lasted about as long as they were expected to last when used under normal conditions by normal people (both in short supply down there).

The first thing to do is get rid of all shiny black plastic cases. Protect your toys in a neutral-color canvas bag or you'll have barbecued electronics before you can say "Golly, it's hot here." And try to keep that PZM mike (again, black) in the shade. Unfortunately, manufacturers of cameras and recorders—digital or otherwise—seem to have studied at the Henry Ford Fashion School, where the motto is: "Any color you like, provided you like black." It all looks very elegant up in *el Norte*, but it can mean instant death on the equator.

As another precaution, tape down the various slide switches so you don't wind up in the wrong mode. Every now and then I'd find the DAT in its LP (four-hour) mode but soon found this was no big deal. I could flip back to normal mode during recording at a cost of about one syllable of voice as the machine switched modes. Other than that, the transition was inaudible (not recommended for serious music recording, though).

Perhaps the strongest argument for the DAT recorder was its running time. Given the problems of interview technique that are so often a function of this kind of work, the ability to record two uninterrupted hours is a luxury not to be underestimated. On at least a few occasions, our subject would be distracted when our backup analog recorder ran out of tape. The simple act of flipping the cassette would bring conversation to a screeching halt and it would take at least a little while to get back up to (conversational) speed.

Looking back, perhaps I should have recorded everything in the LP mode, since the slight loss in fidelity meant nothing under the circumstances. However, the two hours available in normal mode more or less matches the useful battery life. So when the tape runs out, it's time to change the battery. If the battery light comes on, change the tape when you swap batteries. Not elegant but it works.

What about next time? Well, a four hour battery would be nice, as would some means of recharging the recorder batteries from a 12-V d.c. source. Galápagos is not the only place in this world where a.c. cannot be taken for granted. But there's usually a storage battery in someone's boat that can be pressed into service.

Oh, and a sturdy gray case would be nice too.

NOTEWOR

How PASC Data Compression Works In Philips Digital Compact Cassette

By now you must have heard about Philip's Digital Compact Cassette (DCC) system, a system whose decks will also be able to play analog cassettes. DCC is the first proposed digital audio medium that is playback compatible with the technology it is meant to replace. Tandy (Radio Shack and Memtek) is also a prime exponent of DCC and has supported the format in tandem with Philips since the initial announcement. Although DCC tapes will play only on DCC machines, you'll be able to play your old analog tapes on a DCC machine as well. The DCC system has other innovations and features (see the first sidebar), but this article will concentrate on only one of them. For many audiophiles, the most controversial aspect of the DCC system will be Precision Adaptive Sub-Band Coding (PASC), the data-reduction scheme that enables this degree of old/new compatibility.

DCC marks the first time that an audio product has employed the power of digital signal processing to create an electronic model of certain properties of human hearing. The PASC system inside a DCC recorder uses this model to calculate how much digital audio data is redundant or irrelevant to our perception of music. Information found to be unnecessary is then removed(!) from the data stream, and the "compressed" data is recorded using stationary heads on a tape running at the analog cassette speed of 1⅞ ips.

DCC (front) and its competition.

Those who still think the CD doesn't carry enough audio information will be scandalized to learn that DCC carries even less, about one-quarter as much. Yet Philips makes the claim that DCC has CD-equivalent sound quality on music, and that their golden-eared listening panel can't detect the difference between music from a CD and a DCC-encoded recording of it.

Getting the Gist

Since Philips' January announcement of DCC, the company has been reluctant to release details about the system's principles of operation. If DCC follows the path taken by the Compact Disc, a great deal of information may remain trade secrets, at least until DCC is proposed as an official worldwide IEC standard. The lack of hard facts is why most previous articles you will have seen on DCC, including mine, have been glosses on the initial Philips press kit.

But DCC didn't spring fully formed from the heads at Eindhoven. For PASC especially, there are other sources of highly relevant information. It turns out that important parts of the PASC process are identical or very similar to the corresponding portions of the MUSICAM data-reduction system being proposed for digital-radio broadcasting both here and in Europe. (MUSICAM is an obviously forced acronym standing for Masking-pattern Universal Sub-band Integrated Coding And Multiplexing.) Philips is one of the co-developers of MUSICAM and one Philips engineer told me that a PASC chip could also decode certain MUSICAM signals, a fact that carries many important implications about the way PASC operates.

THY

DAVID RANADA

Various non-Philips sources have been kind enough to provide me with some details of MUSICAM operation, and it is on these details that much of this article is based. It covers only the fundamental principles applicable to both MUSICAM and PASC and, to

A working DCC prototype by Philips.

Design study for a Memorex DCC recorder by Memtek.

DCC is the first audio product to use the power of digital signal processing to model the masking system found in human hearing.

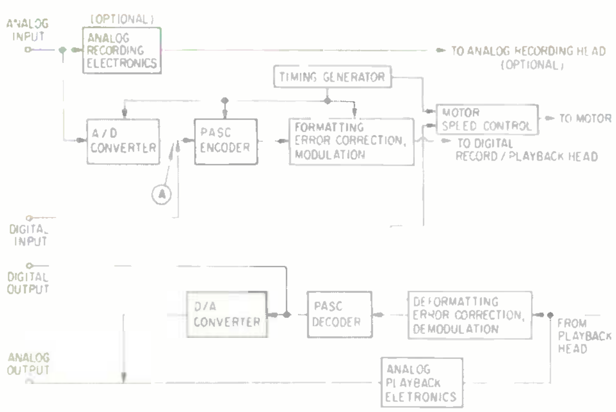


Fig. 1—*Block diagram of a DCC deck.*

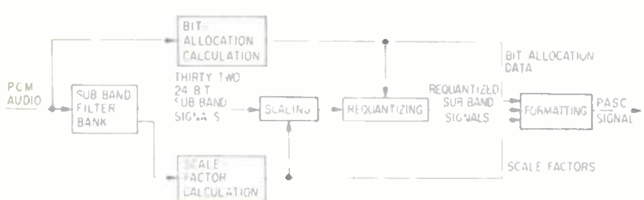


Fig. 2—*Block diagram of a PASC encoder.*

LOCATION		COEFFICIENT	LOCATION		COEFFICIENT
M(28, 20)	=	0.195090322	M(28, 32)	=	0.707106781
M(28, 21)	=	0.146730474	M(28, 33)	=	-0.903989293
M(28, 22)	=	-0.471396737	M(28, 34)	=	0.995184727
M(28, 23)	=	0.740951125	M(28, 35)	=	-0.970031253
M(28, 24)	=	-0.923879533	M(28, 36)	=	0.831469612
M(28, 25)	=	0.998795456	M(28, 37)	=	-0.595699304
M(28, 26)	=	-0.956940336	M(28, 38)	=	0.290284677
M(28, 27)	=	0.803207531	M(28, 39)	=	0.049067674
M(28, 28)	=	-0.555570233	M(28, 40)	=	-0.382683432
M(28, 29)	=	0.242980180	M(28, 41)	=	0.671558955
M(28, 30)	=	0.098017140	M(28, 42)	=	-0.881921264
M(28,·31)	=	-0.427555093	M(28, 43)	=	0.989176510

Fig. 3—*A short excerpt from the PASC digital encode/decode filter bank's coefficient table.*

some extent, other psychoacoustically based data-reduction schemes. When it comes to those areas where PASC and MUSICAM differ, there may be errors here in the details, especially in the graphs, charts, and any numerical specifications, so you won't be able to use this article to design your own homemade PASC decoder. (I've already tried, and it's very difficult.)

Inside a DCC deck

To another audio component, a DCC deck will look like just another cassette deck or DAT machine. It will have standard analog and digital inputs and outputs. But to get to the PASC data-reduction encoder embedded within a DCC deck, the audio signal must be in standard digital form (linear pulse-code modulation, or PCM). Analog signals fed to the inputs of a DCC deck are therefore digitized by standard analog-to-digital converters, just as in a DAT machine. I have been told that Philips' first PASC chips will accept data quantized with up to 18 bits of resolution, although the individual DCC licensee must decide whether to use cheaper 16-bit A/D converters on the analog inputs or deluxe 18-bit units with their potential dynamic range of greater than 100 dB.

With audio data now safely in the digital domain, we are at Point A of Fig. 1, which shows a conceptual block diagram of the primary subsections of a DCC recorder. It's what happens in the next block, the PASC encoder, that sets DCC apart from all other digital recording systems.

Band Splitting

In the first step of PASC encoding, the full audio signal is split into 32 sub-band signals, each sub-band spanning 1/32nd of the audio spectrum, by a bank of special digital filters (Fig. 2). The most important property of the PASC filter bank can be gleaned from the technical phrase used to describe the technique: Perfect reconstruction. Using perfect-reconstruction filter banks, the frequency splitting of an encoding bank is completely and exactly reversed by the band-combining decoding bank. If no other processing were applied in between the encoding and decoding filter banks, the sequence of digital-audio samples coming out would be nearly identical to what went in—no phase shifts, no added distortions, no frequency-response changes, only a slight time delay, and possibly, depending on the precision of the calculations, a smidgen of added noise.

Perfect-reconstruction filter banks are feasible only with digital signal processing. Any attempt to use analog techniques would immediately be thwarted by unmatched and drifting component values, not to mention horrendous circuit complexity. A digital filter uses computer arithmetic in which operations can be precisely reversed or cancelled. Indeed, in a PASC chip, the same circuitry can be used for both the encoding and decoding filter banks.

For the math to come out right, the same table of numerical filter coefficients must be used in encoding and decoding. A small sample of such numbers is shown in Fig. 3. There are 2,048 of them in this portion of the PASC filter-bank process, and they are used in the repetitive multiplications and additions that make up the filter bank. The number of decimal places in these coefficients illustrates the precision to which the mathematical operations must be executed at these crucial stages to preserve sound quality. The numbers in Fig. 3 are decimal equivalents of 24-bit binary numbers. Calculations in the PASC filter bank are performed with 24-bit precision, which means that the mathematical results have a potential dynamic range (the span between the largest and smallest representable numbers) of about 146 dB. In practice, the dynamic range will probably be limited by the music signal. (In what follows, it is convenient to think of "precision" as the number of decimal places or binary bits used to portray a number.)

An interesting characteristic of the filter bank used in PASC is that its sub-bands are equally spaced in frequency, not in pitch. When plotted on a standard logarithmic frequency scale, like those in test reports and data sheets, the sub-bands get progressively smaller as they ascend in frequency; in Fig. 4, contrast the logarithmic frequency scale (bottom) with the PASC filter-bank bands (middle). For all three DCC sampling rates (48, 44.1, and 32 kHz), this spacing equals the Nyquist frequency (half the sampling rate) divided by 32 (the number of bands in the bank). For the 48-kHz sampling rate, there is a sub-band border every 750 Hz (750 Hz, 1.5 kHz, 2.25 kHz, 3 kHz etc.).

Musical pitches are equally spaced by a constant multiplicative factor (around 6% for a semitone) and the ear hears such logarithmic spacing as "even." This is why the horizontal axis of a frequency-response chart is logarithmic. You might therefore think that splitting the signal into sub-bands equally spaced in numerical frequency, as shown in the middle of Fig. 4, would be wrong—too few bands for the lows, too many for the highs. You're actually right, but, for reasons that should become clear shortly, this doesn't turn out to be a problem. Besides, the math for logarithmic-interval filter banks is more difficult and would result in more complex and expensive PASC chips.

It is important to remember that the signals from the outputs of the 32 filter banks do not contain mere level information, as found in a spectrum-analyzer display, but contain the actual audio information from each sub-band, essentially modulated down in frequency by a factor of 32. The filter-bank outputs are still sampled signals in the digital equivalent of alternating current as seen in Fig. 5, which shows graphically the numerical outputs of the six lowest sub-bands in a selection by—who else—Madonna. This illustration, derived from my home-brew computer program that performs the PASC filter-bank calculations using the full list of 2,048 coefficients, contains 512 filter-bank samples for each sub-band and spans about 0.37 second of real time. Even though it's hard to tell, Madonna is still there, albeit mathematically transformed, and none of her information has been lost—yet.

Data Reduction

It is in the next step—the key stage in PASC—that information is deliberately lost and encoding artifacts are introduced. This step is the *requantiza-*

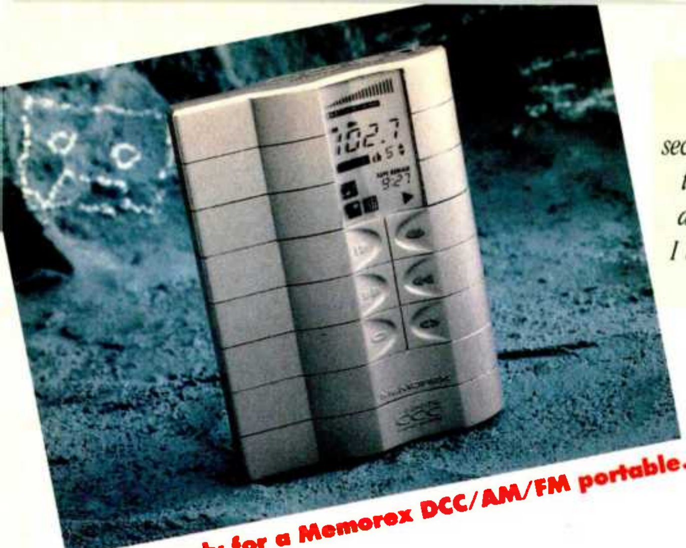
DCC: A Compressed Review

Digital Compact Cassette is a digital audio recording system utilizing a tape housing that is deliberately almost identical to that of a conventional analog cassette. The main differences are the inclusion of a sliding protective tape cover, like that found on mini-floppy discs, and DCC's use of videotape-quality chromium-dioxide magnetic particles. There are still two playable sides to a DCC cassette, but the tape cannot be flipped over. Instead, DCC machines will have some form of auto-reverse system. The tape speed, width, and playing times per side of DCC tapes are identical to the analog cassettes'.

In addition to making digital recordings, DCC decks will also play analog cassettes. To make this possible, DCC machines will contain a head capable of analog playback (but not analog recording) as well as digital playback and digital recording, where applicable. The combination analog/digital head is made with thin-film techniques similar to those applied to making integrated circuits. Thin-film heads are already used extensively in computer disk drives. Analog recording on a PASC deck requires the addition of a conventional analog record head.

The analog playback portion of a DCC head has the standard two audio tracks but the digital record/playback portion has eight tracks spaced 195 micrometers apart, each track being 185 micrometers wide. These tracks carry two channels of specially encoded digital audio data. A ninth digital track carries auxiliary information for rapid machine-controlled cueing and other advanced features. The DCC digital error-correction system is said to tolerate the loss of an entire digital track with no audible side effects.

DCC has three sampling rates, 32 kHz, 44.1 kHz, and 48 kHz, which are used according to the digital signal source (respectively: European digital radio, CD players, and analog inputs or a DAT machine). Philips explicitly intends DCC to ultimately replace the analog cassette and hopes that such versatility, combined with DCC's analog cassette playback capability, will make the transition easier.



Design study for a Memorex DCC/AM/FM portable.

Much of PASC is still secret, so you won't be able to build your own PASC decoder from this article; I should know—I've tried.

DIGITAL
dcc
COMPACT CASSETTE

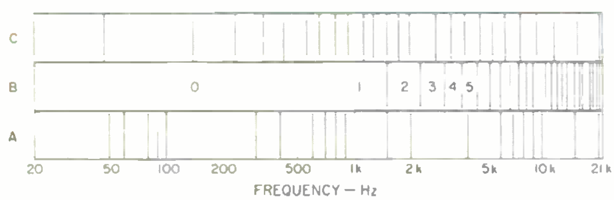


Fig. 4—*While logarithmic frequency scales (bottom) correspond to our sense of pitch, the PASC filter bands (middle) are based on linear frequency divisions. The critical bands for PASC encoding will probably resemble the roughly third-octave critical bands used in one version of MUSICAM (top).*

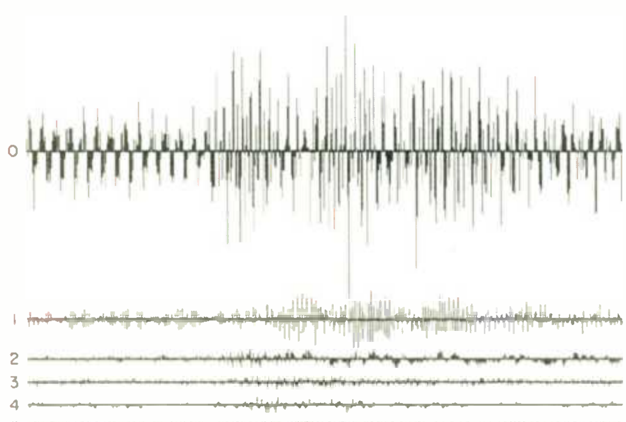


Fig. 5—*Numerical outputs in 0.37 second of the six lowest sub-bands in a selection from Madonna.*

tion of each of the 32 digital filter-bank signals of Fig. 5, as if they were again analog waveforms being converted by analog-to-digital converters. But since all the signals at this point are numerical, the requantization is done by computer math. This requantization reduces the precision—the number of bits—used to represent each sub-band signal. At the filter-bank output, you recall, each of the sub-band signals is encoded with 24 bits of precision. After the requantization process, each sub-band signal is encoded, with between 15 and 0(!) bits of precision, together with a multiplicative "scale factor" that is determined by the highest level attained in each sub-band over a span of 12 consecutive samples of that sub-band.

Requantization with fewer bits is like taking measurements with a ruler having 1/32-inch subdivisions and then switching to one with ¼-inch or larger gradations. Information is lost—and in electronics the loss of information about a waveform is the same as adding noise to it. During playback of a PASC-encoded DCC tape, the differences between the original 24 bit sub-band signals and the fewer-bit requantized signals will survive reconversion into the analog domain and will appear as noise and distortion, both of which must be made as low as possible so as not to become audible.

In PASC, the precision allocated to each sub-band's signal can vary from one sub-band to the next and from one group of 32 sub-bands to the next in sequence. The allocation of precision is done according to the amount of noise added by the requantization process, according to the following two primary rules: First, a sub-band is requantized only if the signals it contains are audible to begin with (neither masked by other signals nor below the threshold of hearing). Second, the precision applied must be at least enough so that any added noise will be sufficiently masked by the music signal to be inaudible during playback. Preferably, there should be a margin as wide as possible between the added noise and the masking produced by the music. (See the second sidebar for a review of the psychoacoustical principles of thresholds and masking; for details, see F. Alton Everest's "The Filters in Our Ears," *Audio*, Sept. '86.)

Some bands are not requantized because they carry sounds that are deemed inaudible. The requantization precision for these sub-bands is set to zero, and the "space" freed up is made available for storing bits allocated to other sub-bands. Bands carrying complex, nonmasked signals will be encoded with many bits; other bands will get only a few, if any. This is why the nonlogarithmic spacing of the sub-bands is not all that important. With typical music, a substantial fraction of the audio signal will lie below 3 kHz, in the first few sub-bands (as in Fig. 5). These sub-bands usually will receive the dominant portion of the data stream. The remaining sub-bands, according to their contents, will get fewer bits. The bit allocations are constantly adjusted to keep the DCC audio data stream a constant 384 kilobits per second. Compare this figure to the standard DAT audio-data rate of 1,536 kilobits/S, and you'll realize how effective psychoacoustically based coding procedures can be in reducing audio storage and transmission requirements, in this case by a factor of four. (The data rates for PASC and MUSICAM are, not coincidentally, convenient ones for ISDN—the Integrated Services Digital

Network—which, it is envisioned, will bring all sorts of information-age goodies into one's house via optical cable.)

Philips' name for this process, Precision Adaptive Sub-band Coding (PASC) may imply to the lay reader that this is a very precise coding method. However, it would be better to say that PASC is sub-band coding that is Precision-Adaptive (note the hyphen): The precision to which every sub-band is coded changes on an adaptive basis according to the signal content.

Masked Information

Just how does PASC decide how many bits to allot to each sub-band? Ah, that's the secret—literally. Repeated inquiries to various Philips authorities have shown me that the "psychoacoustical model" (a MUSICAM term) used to determine bit allocation is one of the more closely held secrets of PASC, probably because the derivation of the bit allocation is the primary factor determining DCC sound quality. Give too few bits to any sub-band, and the various masking and threshold perceptual effects that make PASC feasible may collapse, with a corresponding decline in sound quality.

Another possible reason for Philips' reluctance to talk about this portion of PASC is that any *encoding* scheme they describe now could later be succeeded by a sonically or electronically superior one *without changing the decoding system*. All that really needs to be specified in sub-band coders like PASC is the decoding scheme. In

The Psychoacoustics of PASC

Decades of research in psychoacoustics, the science of sound perception, have provided the two fundamental principles by which PASC can operate. These two concepts are thresholds and masking.

The most basic principle behind PASC—indeed, behind much of psychoacoustics—is the *threshold*, the minimum level of sound that can be heard. Thresholds are measured by isolating the listener (or subject, in psychophysics lingo) in an anechoic chamber or soundproof booth and playing sine waves or band-limited noise over headphones, or a loudspeaker. The *absolute threshold* is that sound level that is just detectable in the absence of all other sounds. This is the well-known *threshold of hearing* and it varies across the audible spectrum. It is lowest (our hearing is most sensitive) at around 3 to 4 kHz, where the absolute threshold is actually lower than 0 dB sound-pressure level (0 dB SPL is just a reference sound level; it doesn't mean the absence of all sound). If a sound is below the absolute threshold, you cannot hear it even under the best conditions, and it is certainly not necessary to record it, even if microphones do pick it up. The threshold-of-hearing curve forms the lowest limit of PASC encoding; any sounds falling below it are not encoded.

Fig. B1—*The PASC absolute threshold curve will resemble this curve, for one version of MUSICAM.*

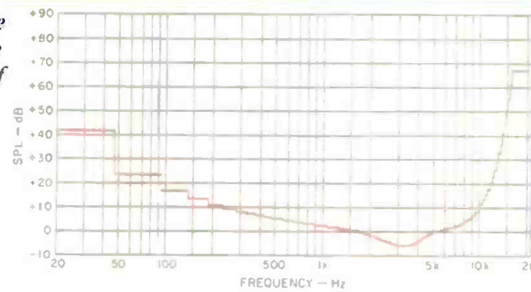


Fig. B2—*Single-tone masking curve, showing how masking thresholds change in the presence of other sounds.*

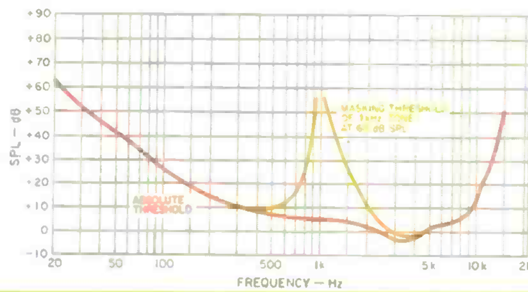


Figure B1 shows the absolute-threshold curve used in one version of a MUSICAM encoder. While the shape of this diagram resembles the absolute threshold curve used in PASC, the two differ in several ways. PASC, for example, has its lowest and highest frequency thresholds set at 60 dB SPL, and its curve never drops below 0 dB.

It is a very important phenomenon of hearing that thresholds change in response to sounds. Even a single sine wave will raise the threshold around itself so that tones both above and below its frequency have to be louder than the absolute threshold to be detected (Fig. B2). This raising of thresholds by sounds is called masking since a low-level sound can be hidden by playing a louder sound. Masking is why a whisper that is plainly audible in a quiet room becomes inaudible at a rock concert. The sound is still there (the air molecules still move in response to the whisperer) but the loud music masks it.

An extensively studied phenomenon, masking is understood well enough for a model of it to be embedded within a PASC encoder. The model calculates the masking produced by a music signal so as to determine what we are actually hearing in the music. Everything else doesn't need to be recorded, and in DCC it isn't.

Optimus DCC recorder by Tandy.

In PASC, the precision of each sub-band varies in a way designed to minimize both noise and bit rate.

PASC, that comprises primarily the choice of scale factors, the bit-allocation method, and the input/output filter banks. A PASC encoder, which would be used only in DCC recorders, could take various forms as long as it created data arranged in a way that a standardized PASC decoder could understand. One can easily imagine there being both an extremely good and expensive encoder usable at the professional tape-duplicator level and a slightly less capable but far less costly device operating in home DCC decks. Despite the lack of hard information from Philips on this subject, I have been assured by one Philips engineer that the following very generalized, graphically oriented interpretation (based on MUSICAM papers) is "not way off the mark" for PASC encoding as it is presently conceived.

The specific reason for the importance of the psychoacoustical model is that it generates what is called the *signal-to-mask ratio* within each of the 32 sub-bands. This ratio is the distance between the sub-band's sonic contents and the masking provided by those contents, the contents of other sub-bands, or the threshold of hearing. This signal-to-mask ratio also identifies the worst (highest) requantization noise level that is acceptable for that sub-band, for the noise could become audible if it became too loud to be masked by the music signal. The signal-to-mask ratio determines the minimum number of bits to be allocated for that sub-band: The larger the signal-to-mask ratio, the more bits are needed. Now for the probable details of the process:

Step 1: Obtain a detailed spectrum (Fig. 6A). The bit-allocation scheme starts with a map—a spectrum—of the frequencies contained in the audio signal at any moment. This can be obtained by any number of methods, all of which involve digital calculations made on the incoming audio data stream. The most familiar of these methods is the fast Fourier transform (FFT). The use of an FFT is another way of compensating for the relative wideness of the lowest sub-bands, since spectral information is derived not from the sub-band contents but the psychological model's FFT. While the sub-band filter divides the frequency range into 32 bands, a suitable FFT for the bit-allocation process divides the audio band into *hundreds* of equally spaced (in frequency, not pitch) "spectral lines."

This amount of spectral detail is essential for the calculations of masking and threshold effects, because these effects occur over far narrower frequency spans than are taken in by the lowest sub-bands. Specifically, important masking and threshold effects occur across what are called *critical bands*, spans averaging about ⅓-octave wide across the audible range. The critical-band boundaries specified for one version of MUSICAM were shown in the top segment of Fig. 4; you can see that several critical bands fit into the lowest filter sub-band (band 0 of the figure's middle segment). In the PASC system, the FFT's spectral lines are grouped according to their critical band.

Step 2: Find the dominant spectral lines (Fig. 6B). Next, a multi-step process removes all except the "loudest" spectral lines in each critical band. These are then classified as to whether they are tone-like (higher than other nearby lines) or noise-like (clustered lines of approximately equal loudness). Only those spectral lines above the threshold of hearing are retained for further calculations. And since spectral lines obtained by FFT techniques become superfluously close together in the upper treble range, many of the higher frequency lines are also simply ignored.

Step 3: Calculate masking thresholds (Fig. 6C). Once the stripped-down spectrum is obtained, the masking produced by the dominant spectral lines is calculated, with each surviving spectral line producing a triangle-shaped masking area whose shape depends on the line's amplitude, the critical band the line is in, and whether the sounds the line represents are tone-like or noise-like. These areas are overlaid on the absolute-threshold curve (see the second sidebar) to compute the "minimum masking threshold" (Fig. 6C).

- Calculate signal-to-mask ratio. For each sub-band (not critical band), the distance between the highest spectral line and the lowest minimum masking threshold *in that sub-band* is the signal-to-mask ratio. This marks the end of the psychoacoustical model portion of PASC. Bit allocation occurs next.
- Maximize the mask-to-noise ratio. The shaded areas in Fig. 6C are the areas into which the requantization noise can be introduced without becoming audible beneath the music. Requantization of each sub-band with fewer than 24 bits will, as mentioned before, introduce noise to the output signal. So a repetitive process is used to minimize the amount of noise (or, in other words, to maximize the mask-to-noise ratio). Starting with the minimum number of bits calculated from the signal-to-mask ratio, each cycle of this process increases the number of bits allocated to each sub-band's signal until the full PASC data rate of 384 kilobits per second is reached, as shown in Fig. 6D.

It is here where PASC departs from radio-oriented MUSICAM encoders, since the latter have a maximum stereo-audio data rate of 256 kilobits/S. The highest nonradio MUSICAM data rate, suitable instead for "production and professional storage," as one paper puts it, is identical to that of PASC. So it is likely that some of the "extra" data of PASC, like that incorporated into the highest MUSICAM data rate, represents an added safety margin between the requantization noise and the minimum masking threshold, so that there is an increased mask-to-noise ratio. But there may be other crucial differences between MUSICAM and PASC that Philips is keeping hidden for the moment.

Coming Out

The 384-kilobit/S data rate is not the rate at which data is actually fed to a

DCC cassette. That figure is 780 kilobits per second; the difference is due to error-correction data, cueing points, and subsidiary information like that on CD (such as lyrics or graphics), and modulation to make the signal suitable for magnetic recording. Since this article is really only about PASC, I'll conveniently skip over the actual recording and readout processes.

We next meet the audio data during playback after it has been demodulated and error corrected. The data consists of basically three parts: The series of relatively slowly varying scale factors for each sub-band, the bit-allocation information that tells the PASC decoder which sub-bands have been encoded and with how many bits of precision, and the sub-band samples themselves.

The rest is fairly easy. Using the scale factor as a multiplier, each sub-band sample is digitally projected into a 24-bit range and fed into the output filter bank. The output of the filter bank is, lo and behold, standard PCM "ready to convert into analog" audio when fed to a standard digital-to-analog converter (Fig. 7).

But remember that, even though the samples fed into the output filter bank are 24-bit numbers, the resolution of each sample is effectively limited to that of the corresponding encoded sub-band signal. When ultimately reproduced as an analog signal, the signals in those sub-bands that actually had been recorded will have noise added beneath them. Whether that noise is audible depends on how adequately the PASC's psychoacoustical model anticipated its audibility.

This article has concentrated on masking and thresholds in PASC encoding and has ignored many other sonically relevant aspects of PASC operation such as the rate of spectrum generation or the calculation of scale factors. And it has also left uncovered some things crucially important to DCC's ultimate sonic and commercial success, such as error-correction effects, tape and head durability, and reproducibility. Of course, the big question—What does PASC sound like?—can't be answered without a critical listening test using actual PASC or DCC equipment. For Philips' sake, PASC shouldn't sound like anything at all. Despite all the processing and an output waveform that intentionally differs from the input, the goal of PASC is sonically transparent encoding and decoding.

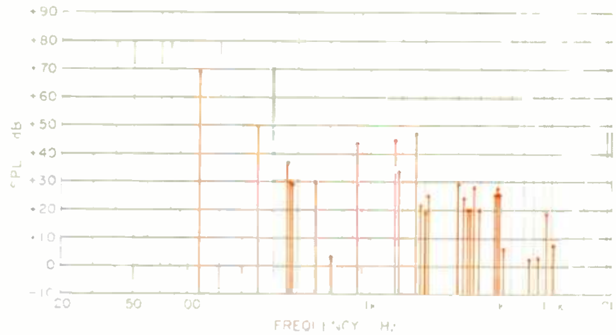


Fig. 6A—*Detailed audio spectrum (FFT) before PASC encoding.*

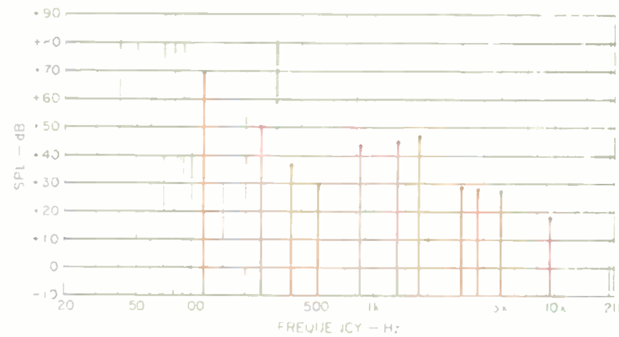


Fig. 6B—*Dominant spectral lines (reduced FFT).*

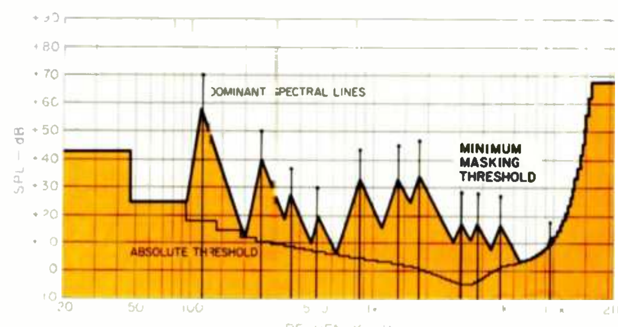


Fig. 6C—*Calculated minimum masking thresholds and corresponding dominant spectral lines. Requantization noise in the shaded areas will not be audible.*

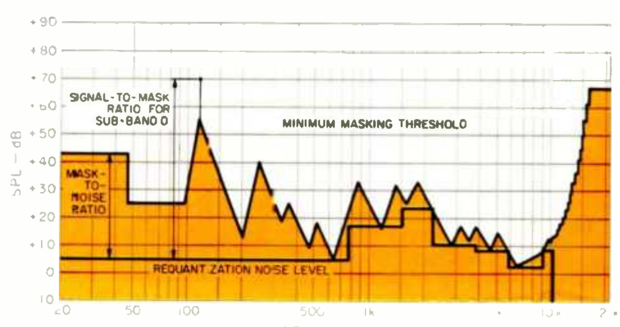


Fig. 6D—*After maximizing mask-to-noise ratio, remaining requantization noise is at or well below the minimum masking threshold for each band.*

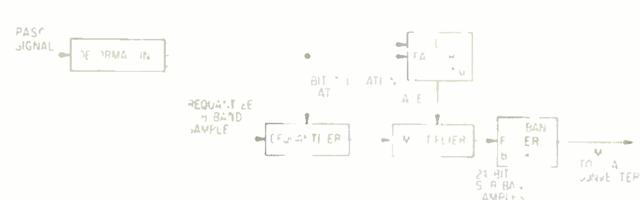


Fig. 7—*Block diagram of PASC decoder.*

Signature Reference Series: The Very Best of the Best

The legendary sound of Polk loudspeakers has for years been exemplified by its flagship Signature Reference Series (SRS), the speakers that carry Matthew Polk's signature.

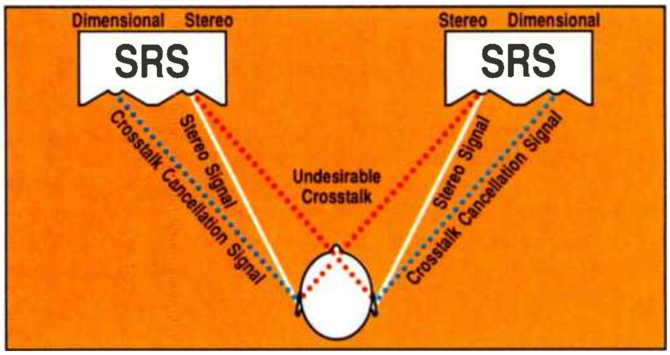
Polk now introduces its SRS 1.2TL, 2.3TL, and 3.1TL, each featuring the latest breakthroughs in loudspeaker technology. Following is a technical brief of why the SRS speakers sound so remarkably like a live performance. After reading this information, it is hoped that you listen carefully to the SRS loudspeakers at your Polk Audio dealer. While you will probably hear things you have never heard from a stereo system, you can be assured that everything you hear is true.

It All Begins With the Sonic Excitement of Polk's Stereo Dimensional Array (SDA)

Years ago Polk Audio recognized the importance of more absolute separation of information reaching each ear. Of course, the fundamental concept of stereo reproduction is that there are two separate channels of information, each intended for one ear only (i.e. "true stereo").

To more accurately reproduce sound as it was originally created, it is vital that the integrity of this separation of information be maintained. With conventional speaker systems, each ear hears both speakers, and the separation is minimized. The resulting soundstage is reduced to the small space between the speakers. A large symphony orchestra is reduced to only a few feet wide and a few inches deep.

Polk's "True Stereo" SDA technology delivers left signal information to your left ear and right signal information to your right ear. Each ear only hears its proper signal, thereby maintaining full stereo separation. The resulting soundstage is dramatic.



Each Polk SDA incorporates a special extra set of drivers which radiate a difference signal that cancels the undesirable signal going from the wrong speaker to the wrong ear (interaural crosstalk distortion). The result is True Stereo reproduction.

...everything you hear is true.

Experts have called the Polk SRS Series featuring the revolutionary Stereo Dimensional Array (SDA) technology "mindboggling... astounding...flabbergasting...a new dimension in sound." Others have discovered new life in their favorite musical selections.

It is "True Stereo" by Polk.

Yes, Everything You Hear is True

Listen to what the critics say: "Mindboggling.. astounding...flabbergasting." Listen to what other Polk owners say: "I've never heard anything like it...it's whole new world."

But no number of written accolades will prepare you for the experience of listening to the SRS loudspeakers at your Polk Audio dealer.

We invite you to your local Polk Audio dealer for a demonstration of this technology. Because everything you hear is true.

You will hear the next generation of loudspeakers.

polk audio

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Where to buy Polk Speakers?
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1

ESOTERIC P-2 CD TRANSPORT AND D-2 D/A CONVERTER

Manufacturer's Specifications

CD Transport

Digital Audio Outputs: Two coaxial, 0.5 V peak to peak, and two standard optical outputs.

Number of Programmable Selections: 40, random order.

Power Requirement: 10 watts.

Dimensions: 8⅞ in. W × 5¼ in. H × 19 15/16 in. D (22.5 cm × 13.4 cm × 49 cm).

Weight: 28.7 lbs. (13 kg).

Price: $4,000.

D/A Converter

Sampling Frequencies: 48, 44.1, and 32 kHz.

Frequency Response, ±0.3 dB: 48-kHz sampling, 0 Hz to 22 kHz; 44.1-kHz sampling, 0 Hz to 20 kHz; 32-kHz sampling, 0 Hz to 15 kHz.

Signal-to-Noise Ratio: Greater than 110 dB.

Dynamic Range: Greater than 100 dB.

THD: 0.0014%.

Channel Separation: Greater than 110 dB at 1 kHz.

Digital Input Format: Coaxial, 0.5 V peak to peak; optical, standard.

Analog Output Levels: Unbalanced, 0 to 2.5 V; balanced, 0 to 2.5 V.

Digital Output Levels: Coaxial, 0.5 V peak to peak; optical, standard.

Power Requirement: 21 watts.

Dimensions: 8⅞ in. W × 5¼ in. H × 19⅛ in. D (22.5 cm × 13.4 cm × 48.5 cm).

Weight: 24.3 lbs. (11 kg).

Price: $4,000.

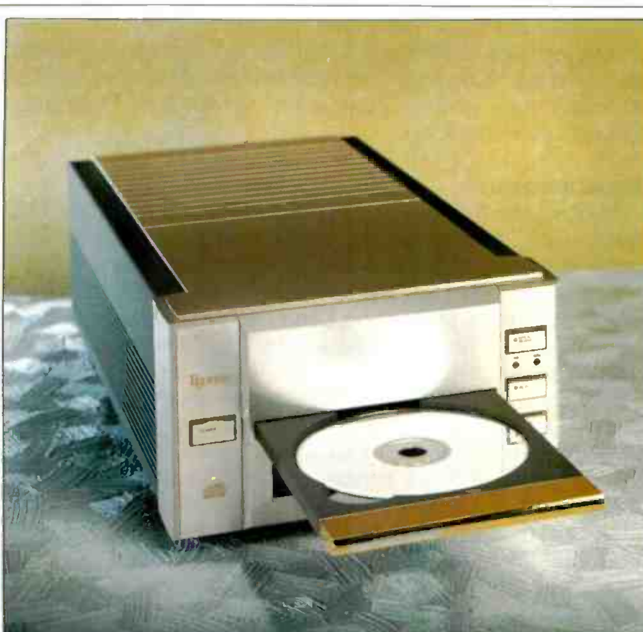
Company Address: Teac, 7733 Telegraph Rd., Montebello, Cal. 90640.

For literature, circle No. 90

Makers of high-end CD playback equipment seem to have reached the conclusion that it makes sense to separate the CD transport from its D/A converter and associated audio electronics. If these two components from Teac's Esoteric brand are typical of this approach, it may well be worth the extra cost.

To begin with, the Esoteric D-2 D/A converter is much more than just the "second half" of a two-piece CD player. Its digital inputs can accept signals at 44.1, 48, and 32-kHz sampling rates. Thus, any existing or future digital signal sources can be connected to the D-2. This D/A converter has several circuit innovations, not the least of which is the ZD circuit, which lowers distortion by adding and subtracting dither signals to substantially reduce conversion error. Following the D-2's ZD circuit, a newly developed automatic subtraction circuit further increases accuracy of D/A conversion. The D-2 utilizes direct-coupled, linear-phase circuits, making possible ultra-wide frequency response from 0 Hz (d.c.) to 20 kHz. No coupling capacitors are in the signal path following D/A conversion. The analog sections of the D-2 employ MOS-FETs, which, according to the manufacturer, help to eliminate odd-order harmonic distortion from the reproduced output signals.

The D/A conversion process itself employs four true 18-bit D/A converters and 45-bit digital filtering with eight-times oversampling. Third-order Butterworth analog filters are employed in the post-D/A output circuitry, and MOS-FET devices are used in the analog output stages. The D-2's power-supply transformer has a capacity of 100 VA, far more than required. (This is one example of the conservatism of design employed in these Esoteric components.) The D-2 lets you select the polarity of the recorded sound while the signal is being processed digitally, since some programs were originally recorded with inverted polarity from others.



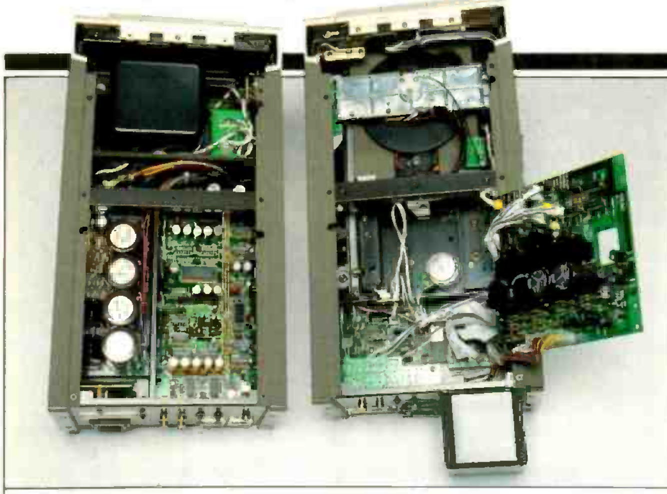
The P-2 CD transport is identical in size and general appearance to the D-2 companion unit; the two sections are designed to stand side by side. A vibration-free rigid clamping system corrects any warping or eccentricity of the disc. The optical system, and the mechanism that supports it, use a floating suspension that completely isolate them from both internal resonances and external vibrations. A three-beam, linear-tracking laser pickup is used. The P-2 is built on a rigid, dual-construction chassis with an 18-mm-thick, brushed-aluminum, one-piece front panel and large, heavy insulators. The disc tray is made of machined aluminum, 8 mm thick, with Nextel coating and a 24-karat gold-plated front. The inner chassis of the P-2 is 17 mm thick and is essentially a die-cast base for the drive mechanism, while the external chassis is made of 1.7-mm-thick sheet steel and aluminum. A pulse-detection servo motor is used for disc-tray movement, and believe it or not, the user can vary the disc tray's opening and closing speeds independently. A bit of lily-gilding, perhaps, but it shows the design luxury that pervades this two-piece system.

The remote control supplied with the P-2 and D-2 operates virtually every function of both components, including opening and closing the disc tray and volume adjustment via a motorized pot.

Control Layout

The front panel of the P-2 transport is equipped with its own on/off switch and pilot light at the left. The right side

Variable disc-tray speed may seem like gilding the lily, but it shows the degree to which luxury pervades this two-piece CD player.



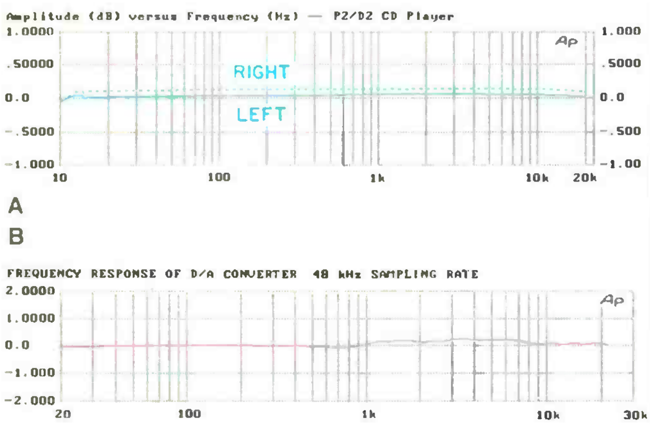


Fig. 1—Frequency response of P-2 and D-2 for signal from CD with 44.1-kHz sampling rate (A) and of D-2 for signal from test generator with 48-kHz sampling rate (B).

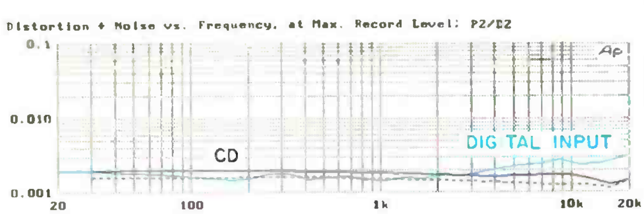


Fig. 2—THD + N vs. frequency at 0-dB (maximum) recorded level, for CD signal from P-2 transport and dithered test signal with 48-kHz sampling fed to D-2 digital input. Solid CD curve is for left channel, dashed curve is for right channel.

carries the "Pause," "Play," track advance, track reverse, and "Open/Close" buttons. Below the disc tray is a multi-function display window that shows the status of operational modes. Display indications include track and program number, remaining or elapsed time for the track or disc, and notifications of such functions as auto cue, single play, auto space, repeat modes, and programming modes. On the right side panel of the P-2 are a control that lets you adjust the brightness of the display and the two tray-speed controls mentioned earlier. The rear panel is equipped with two optical and two coaxial digital outputs, and an a.c. socket to which the polarized power cord is attached.

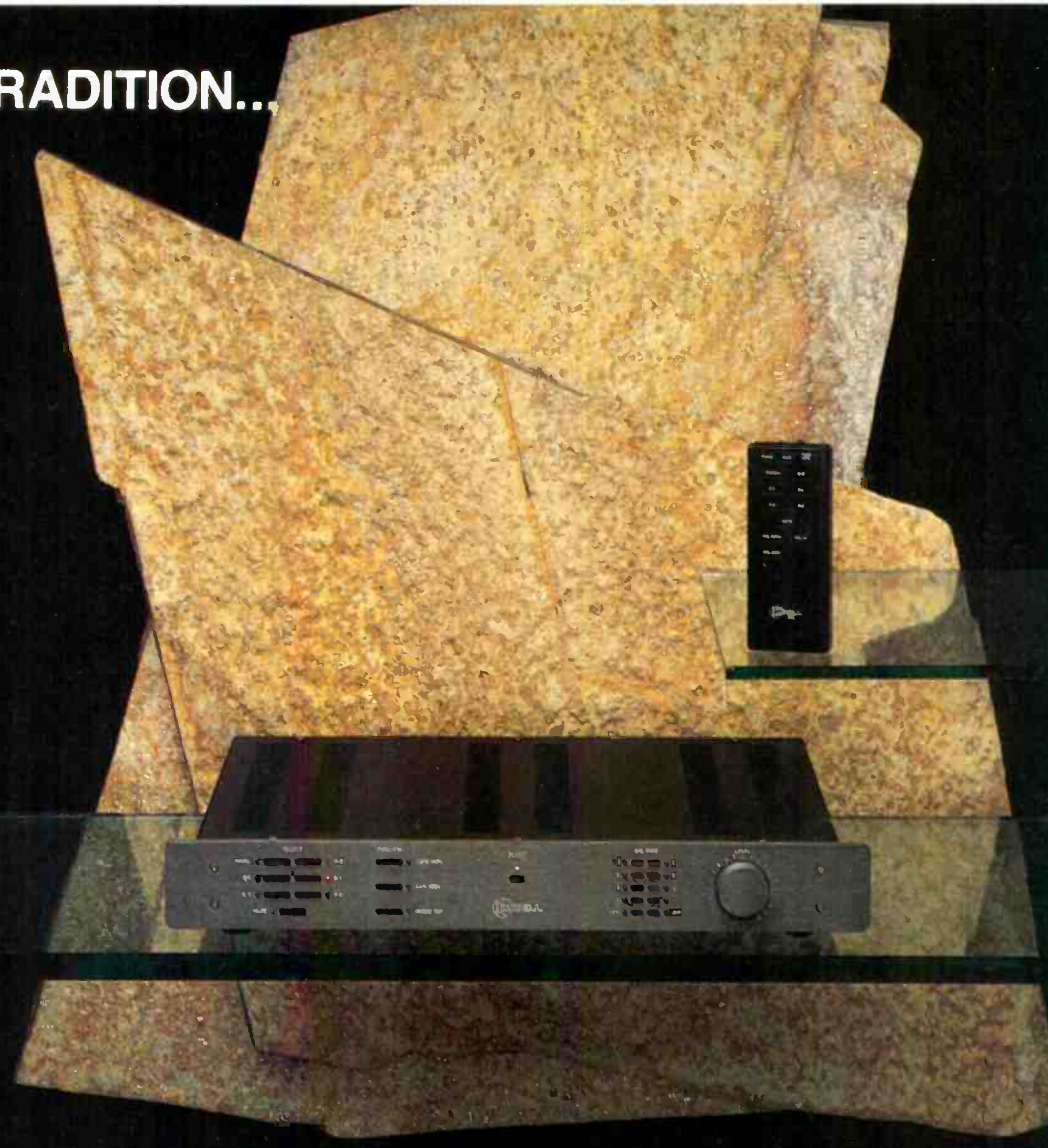
The D-2 D/A converter's front-panel layout resembles that of the P-2. Again, the on/off switch and pilot light are at the left. At the right are an output level control, the polarity-inversion switch, and a muting button. In place of the P-2's disc tray, the center section of the D-2 has a long slim bar that is, in reality, an input selector. Pressed repeatedly, this switch cycles through the four possible inputs (two coaxial and two optical). A display area beneath this switch shows "Sampling Frequency," "Emphasis" (if present), muting indication, "Input" source, and indication that a digital signal applied to one of the inputs has stabilized. The rear panel of the D-2 has two coaxial digital inputs, two optical inputs, and a single, coaxial digital output. The analog outputs include balanced XLR-type jacks as well as unbalanced phono connectors.

The remote-control unit supplied has most of the switches found on the P-2 and D-2 plus buttons for three kinds of repeat play, time-counter mode selection, time searching, "Index" accessing, and programming. It also has numeric buttons from 0 to 9 and a "+10" button for accessing or programming track numbers higher than 10. A "Delete" button, when pressed, allows you to skip tracks of a CD. Volume up and down controls let you adjust the level of signals appearing at the output jacks. A "Check" button can be used to display programmed contents, and a "Clear" button deletes previously programmed selections. Muting can also be done from the remote control, and in another example of lily-gilding, there is an "Open/Close" button on the remote control too.

Measurements

I tested the P-2 and D-2 just before the start of their U.S. distribution, so my samples were supplied directly from Japan and had to be operated at 100 V a.c. The units now being sold in the U.S. are, of course, configured for 120-V, 60-Hz operation, and I have been assured by the manufacturer that their performance will be identical to that of the samples I measured.

Figure 1A shows overall frequency response of the complete P-2/D-2 system. The test signals for this plot were derived from the sweep track of my CBS CD-1 disc. Figure 1B, on the other hand, shows frequency response obtained at the output of the D-2 D/A converter for digital signals with 48-kHz sampling generated by my test equipment. It is clear from both plots that response was flat to a closer tolerance than the ±0.3 dB claimed. There was no measurable difference between left- and right-channel amplitudes or frequency responses.



The Esoteric P-2 and D-2 exhibited superb linearity, which is probably the most revealing measurement I make on a CD player.

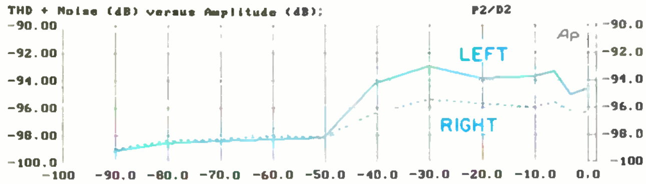


Fig. 3—THD + N vs. signal amplitude.

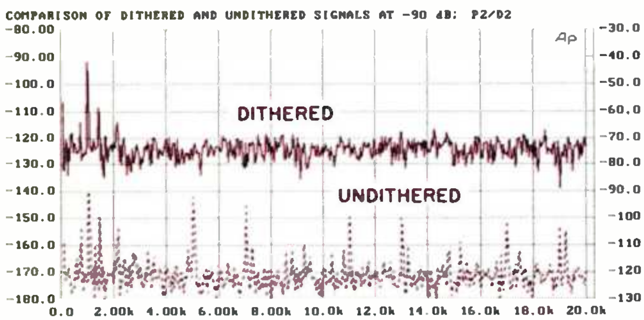


Fig. 4—Spectral analysis of dithered and undithered signals at −90 dB recorded level. Amplitude scale for dithered signals is at left, scale for undithered signals is at right.

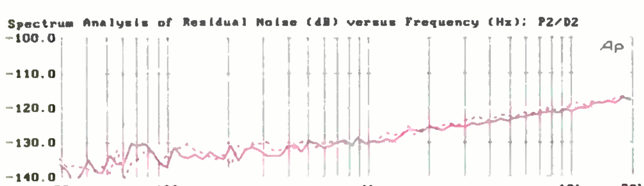


Fig. 5—Spectrum analysis of residual noise when playing "no-signal" track. Left channel is solid curve, right channel is dashed.

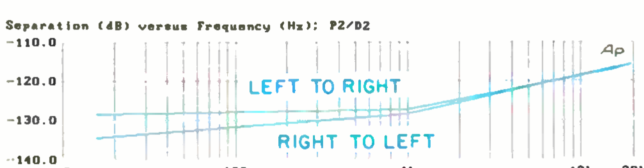


Fig. 6—Separation vs. frequency.

Figure 2 illustrates how THD + N varies with frequency, for a 0-dB (maximum) recorded signal. Distortion when the Esoteric combination was playing my CD-1 test disc was about the lowest I have ever measured for a CD player, remaining at or below 0.002% for all frequencies. Figure 2 also reveals that, over much of the frequency range, the distortion generated by feeding dithered signals directly into the D-2 D/A converter is even a bit lower—as low as 0.0015% at mid-frequencies!

Figure 3 shows THD + N, expressed in dB below maximum recorded level, for a 1-kHz test signal varying in amplitude from 0 to −90 dB. The slight rise above the −50 dB recorded level is puzzling, especially since the right channel exhibits much less of this rise than the left channel does. Even at that, however, worst-case THD + N is −93 dB, which corresponds to a percentage (relative to maximum recorded output) of only 0.0022%.

In previous tests, we've seen how dither (random noise added to digital program sources in recording) can reduce low-level distortion and make it possible to extract signal information at levels below what one would expect from the number of quantization bits alone. A CD player such as the Esoteric P-2/D-2 combination makes this even more dramatic, since its distortion and noise figures are already so low, as seen in the spectrum analyses of Fig. 4. For an undithered −90 dB signal from the test disc, random noise (read from the right-hand scale) was mostly about 120 dB below maximum recorded level, but distortion spikes, one of them approaching the −90 dB mark, appeared across the entire spectrum. By contrast, from the curve obtained with the test disc's dithered −90 dB signal, you can see that most of the distortion spikes are no longer present and that those which are present are substantially reduced in amplitude. In this case, the average random noise level appears to remain about the same, though theory (and careful analysis) indicate that, in fact, it has risen slightly.

I measured an A-weighted signal-to-noise ratio via the unbalanced analog outputs of 109.3 dB on one channel and 108.6 dB on the other channel, using a coaxial interconnect between the P-2 and the D-2. When I switched to an optical interface between the units, S/N ratio improved by about 2 dB for each channel. A spectral analysis of the residual noise from 30 Hz to 20 kHz is shown in Fig. 5. This plot was made using the coaxial digital interface once more. Note that there is virtually no contribution to the overall noise content from 60- or 120-Hz power-supply hum. At these frequencies, noise content was 130 dB or better below maximum recorded level!

Left-to-right and right-to-left separation are both much better than the 110 dB claimed at 1 kHz. A plot of separation versus frequency in both directions is shown in Fig. 6.

The Esoteric P-2 and D-2 had superb linearity, which I consider the most revealing CD tests I can perform. Figure 7 shows deviation from linearity for dithered and undithered signals. With undithered signals from 0 to −90 dB, deviation at −90 dB is a mere +0.75 dB for the left channel and about −0.9 dB for the right. With low-level dithered signals from −70 to −100 dB, deviation ranges from slightly less than −1 dB to less than −0.2 dB at 100 dB below maximum recorded level.

In my opinion, the Esoteric P-2 and D-2 combination ranks with the best players I have tested since CD first came to market.

In the fade-to-noise test, with a dithered test signal that gradually fades from −60 to −120 dB (Fig. 8), the Esoteric P-2 and D-2 reproduced the test signal with virtually perfect linearity right down to −120 dB! The increase in noise level at lower and lower signal levels can be used to determine the EIA dynamic range, which, in this case, was around 112 dB—very close to the theoretical maximum attainable in a 16-bit system with dithered signals. I also checked dynamic range using the EIAJ method of obtaining distortion plus noise for a −60 dB recorded test signal. The reading was −38 dB, which, when added to the −60 dB starting point, results in an EIAJ dynamic range of 98 dB.

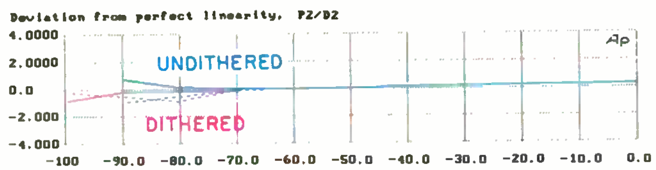


Fig. 7—Deviation from perfect linearity. Left channel is solid curve, right channel is dashed.

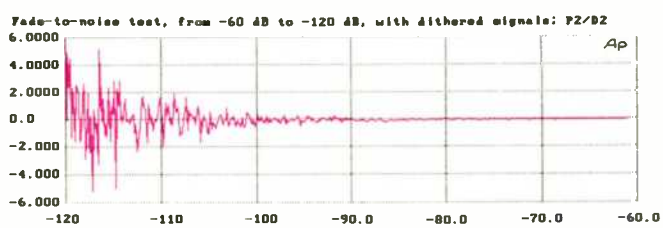


Fig. 8—Fade-to-noise test.

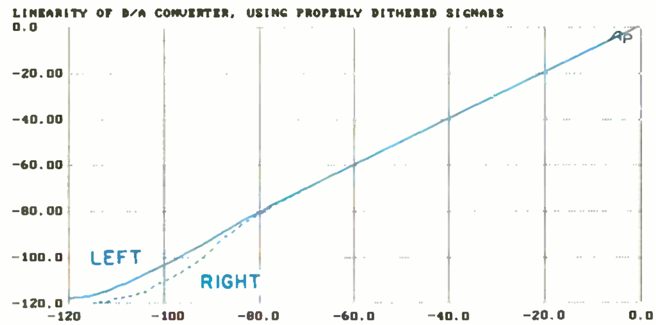


Fig. 9—Output vs. input linearity for 500-Hz dithered signal with 48-kHz sampling rate fed to D-2 D/A converter.

Figure 9 is a plot of output versus input linearity at 500 Hz for the D-2 D/A converter only, using dithered signals of linearly decreasing amplitude and a sampling rate of 48 kHz.

Measurements of SMPTE-IM distortion were made for a signal at maximum recorded level. The IM obtained during this test was 0.0040% on one channel and 0.0064% on the other. Clock frequency accuracy was within −0.0059%. This means that if a musician had recorded a middle A tone of 440 Hz, you would hear it at 439.97404 Hz. I doubt if even a person with perfect pitch would be able to detect that "error." Last, I checked the ability of the D-2 D/A converter to invert the polarity of decoded analog signals prior to D/A conversion. I was somewhat surprised to learn, however, that the depressed position of the front-panel "Phase" button (with the indicator light illuminated) corresponded to noninverted polarity, while the normal position resulted in an inverted pulse.

Use and Listening Tests

I was not able to detect any audible difference in sound quality when switching between optical and coaxial connections from the P-2 transport to the D-2 converter. I was, however, able to distinguish a difference between the sound of a portable DAT recorder playing through its own D/A conversion system and playback using the digital output of that DAT machine connected through the D-2. The latter method produced cleaner low-level sound that was fully as crisp during soft passages as it was during the crescendos of the discs that I used for auditioning the Esoteric units. These, by the way, were a couple of Delos releases, Volumes 1 and 2 of the complete cycle of Beethoven quartets (DCD 3031 and DCD 3032) played by the Orford Quartet, and a demo disc from that same organization called *Second Stage* (DCD 3504). The sixth selection on this "ultimate" demo disc really showed off the P-2/D-2 combination to best advantage. It is an excerpt from Shostakovich's Symphony No. 11, which I had also heard performed live recently. Frankly, the balance and integrity of the performance—recorded by Delos with the aid of my good friend John Eargle, who served as recording engineer for most of these demo excerpts—were superior to that of the live performance. This particular symphony was recorded for Delos by the Helsinki Philharmonic Orchestra, under the direction of conductor James DePreist, in a fairly live concert hall. The excerpt contains everything from the quietest, most subdued passages to crescendos recorded at or near maximum CD recording level. It served as a perfect test for the Esoteric combination, in that silent pauses in the midst of the selection were truly silent, even with level turned up so far that the dynamic, louder passages strained the capabilities of the rest of my system.

As I test more and more CD players, I have come to realize that the differences between them are best illustrated and heard only if proper program material such as these Delos discs are used. And in my opinion, the P-2/D-2 combination ranks with the best CD players I have tested since the first ones were brought to market some eight years ago. It certainly seems longer than that, doesn't it?

Leonard Feldman

2

MARTIN-LOGAN MONOLITH IIIx LOUDSPEAKER

Manufacturer's Specifications
System Type: Sealed-box woofer, electrostatic midrange/tweeter.
Drivers: 12-in. cone woofer, 23½ in. × 47½ in. electrostatic panel.
Crossover: 125 Hz, active.
Frequency Range: 28 Hz to 24 kHz, ±2 dB.
Sensitivity: 90 dB SPL at 1 meter for 2.83 V.
Impedance: Woofer, 4 ohms nominal, 3.5 ohms minimum; midrange/tweeter, 6 ohms nominal, 1.4 ohms minimum at 24 kHz.
Power Handling: 200 watts continuous.
Dimensions: Speakers, 26¾ in. W × 74 in. H × 12 in. D (68 cm × 188 cm × 30.5 cm); electronic crossover, 17 in. W × 2 in. H × 10 in. D (43.2 cm × 5.1 cm × 25.4 cm).
Weight: Speakers, 120 lbs. (54.4 kg) each; crossover, 12 lbs. (5.4 kg).
Price: $7,000 per pair; passive-crossover version, Monolith IIIp, $6,500 per pair.
Company Address: 2001 Delaware St., Lawrence, Kans. 66044.
For literature, circle No. 91

The Martin-Logan Monolith IIIx is a fantasy of high-end extremes. Striking in appearance and size, and outrageously expensive, it is one of the best-sounding speaker systems made. One's eyes scan a room and stop at the two monoliths standing out from the wall. Contrasting textures, rounded shapes, and refined finishes frame the naked functionality of the curved electrostatic panels. As you move towards the speakers, reflections and patterns of holes move in response. You realize that you are looking through the metal-film-metal sandwich that is the speaker mechanism. You feel compelled to first gently touch them and then to listen to these speakers.

The hybrid dynamic/electrostatic Monolith was the first product of Martin-Logan, a company formed in 1982 by two gentlemen with the middle names of Martin and Logan. Gayle Martin Sanders, who survives as president and chief visionary, explained the development cycle to me. The Monolith was followed by the CLS, an exercise to explore the limits of the full-range electrostatic concept. It is currently produced and is considered by many to be the finest speaker made, even given its lack of output at very low frequencies. Next was a downsized and more affordable follow-up to the Monolith, appropriately named the Sequel. This speaker has received high critical acclaim in its price range and has been a commercial success. Next came the Statement, an all-out, 2,000-lb., electrostatic/dynamic hybrid for $55,000 ($60,000 with a balanced crossover) exploring the limits of cost-no-object design.

It takes some creativity to measure such large dipole speakers in ways that truly reflect how they'll sound.

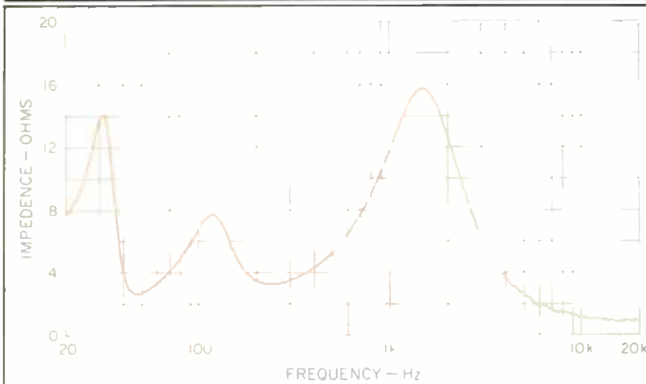


Fig. 1—Magnitude of impedance, using passive crossover.

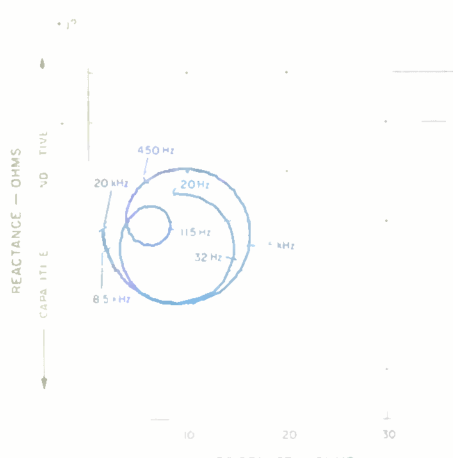


Fig. 2—Complex impedance with passive crossover, showing resistance and reactance vs. frequency.

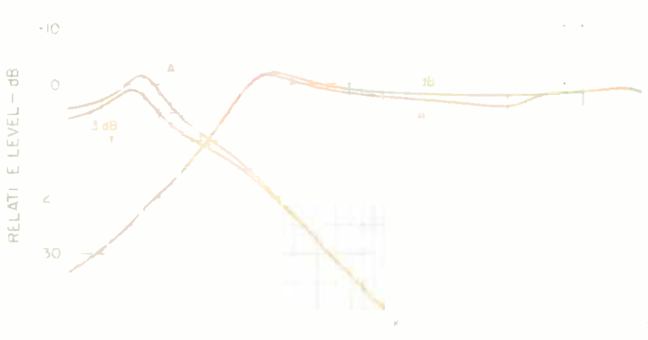


Fig. 3—Frequency response of passive crossover. Note the deliberate underlap of drive signal around the crossover frequency.

With this development work behind them, Martin-Logan took a fresh look at the Monolith. Sanders slimmed and refined the appearance and the company developed an electronic crossover and new woofer driver. Many small improvements were imported from the other designs. A passive crossover of new design is also available for those who prefer to use a single amplifier.

I recommend biamping. This is the use of a low-level or electronic crossover to divide the frequency range for separate woofer and tweeter amplifiers. These two amplifiers per channel connect to the woofer and tweeter directly. The amplifiers need not be identical. A stereo amp of the appropriate type may be used for the woofer of each channel and a different mode, stereo amp may be used for the tweeter of each channel. The advantages are the elimination of distortions produced or allowed by the high-power passive filter components normally used between amplifier and driver. Also, the electronic filters can be more complex, to better compensate for known drive-unit, cabinet, and room irregularities.

If you insist on using an extremely expensive stereo amplifier, but you can't afford two as required for a biamplified system, I suggest that you use the golden amp on the electrostatic tweeters, which receive everything above 125 Hz. A mid-priced, mid-powered amp will work perfectly with the conventional 12-inch dynamic woofers below 125 Hz. The extra $500 for the active crossover plus an extra $500 or so for a capable woofer amplifier is well worth it.

Dynamic woofers are commonly used for bass in electrostatic speaker systems. One might think that electrostatic force fails to work at low frequencies, but this is not the case. It, and the magnetic force of a dynamic speaker, can each produce a steady continuous force equivalent to 0 Hz. Stepping back from practical considerations, physics would imply that the electrostatic speaker is nearly ideal for all frequencies because its diaphragm has almost no structural requirements and so can be made nearly as light as the air into which it delivers acoustic energy. This produces an inherently high efficiency, low distortion, and unlimited bandwidth.

Back to reality and long wavelengths: An electrostatic panel (or the cone of a dynamic drive unit) cannot radiate acoustic power unless something separates the outputs from its front and rear, which are of opposite polarity. For wavelengths that are smaller than the panel or cone, there is no problem. The sound is beamed forward and backward pretty much independently. For long wavelengths, however, the panel size will not direct the radiation, and cancellation will occur. The solutions are to make the surface larger or to seal off the rear radiation with a box. Since the wavelength of a 30-Hz tone is about 37 feet, we look at the box solution. Containing the rear radiation of a diaphragm produces a pressure that must be overcome for the front to radiate. With the materials we have available on this planet, the dynamic drive unit is a far more suitable high-pressure device. It is the need for a box that causes practical electrostatic speakers to be inefficient for deep bass.

Other practical considerations keep electrostats from performing up to the theoretical ideal. The thin film diaphragm must have a high resistivity and be positioned midway

The Monoliths have one of the most uniform 3-meter response curves I've seen, even flatter than their anechoic response.

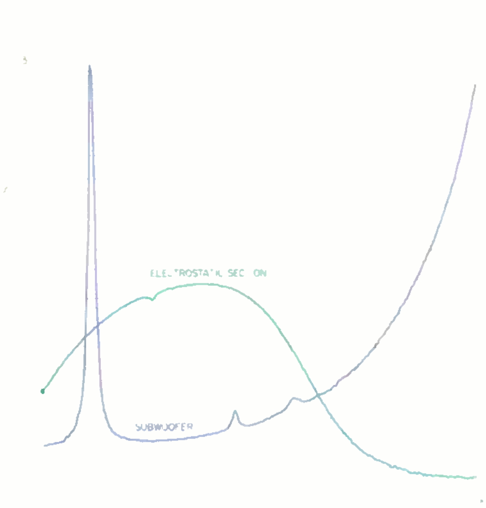


Fig. 4—Magnitude of impedance with woofer and tweeter driven directly.

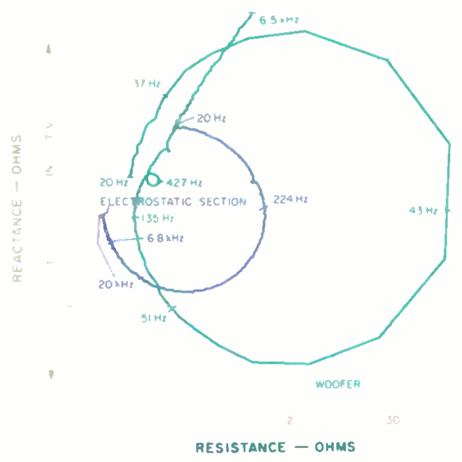


Fig. 5—Complex impedance of woofer and tweeter driven directly.

between the two stationary, perforated conducting plates. This means the film must be stretched slightly and clamped at its edges. Now, we have a resonant panel with a less than ideal "ballooning" motion that produces waves travelling across its surface. This results in some radiation pattern and frequency response irregularities. Also, to interface with conventional amplifiers, an audio transformer is required to bring the high impedance of the electrostatic panel down to a normal range. This transformer will have winding resistance, interwinding capacitance, and magnetic nonlinearities to some degree. In the end, it is designer finesse, not operating principle, that is responsible for producing a superb speaker system.

The Monolith III's 2-foot × 4-foot panels poised above the woofer box are the bare essence of 'stat. There are only four basic parts: Two perforated steel stators insulated by a vinyl coating, spacers, and the mylar diaphragm—all visible and unobstructed. The panels are curved to control horizontal directivity and segmented into horizontal strips by spacers to force the diaphragm to follow the curve of the stators. The stator-diaphragm sandwich is held in a rounded plastic frame, which in turn is fixed between slim wood uprights running the entire 6-foot height of the system. The woofer box is gloved in a stitched leather-texture cover except for the front, which is covered by a snap-on grille frame and sheer fabric.

A detachable IEC power cord is used for the 3000-volt polarizing voltage power supply for each speaker. There is no power switch because the current required to maintain charge is extremely low; in fact, the speakers will play for half an hour after being unplugged. You have a choice of using flat or spiked adjustable feet to level the speakers. Audio connections for the woofer and midrange/tweeter section are made to multi-way terminals on standard ¾-inch double-banana spacing. The crossover is external, allowing owners of the passively-connected Monolith IIIp to upgrade to the electronic crossover of the IIIx. For this reason, I performed some of my tests with both the passive and active crossovers.

The electronic crossover for the IIIx is built to the highest quality standards for audio equipment. Audio connectors are gold-plated RCAs. Inside, discrete-component amplifiers are used and other components are close-tolerance types. This is particularly important for the frequency-determining components. Front-panel controls include rotary switches for "Frequency" (30 to 50 Hz, in 5-Hz increments) and "Boost/Cut" (−4 to +4 dB, in 2-dB steps). A pair of internal DIP switches, accessed through cutouts in the rear panel, alter the gain of the low-pass channel from −6 to +6 dB, in 18 steps, to compensate for any differences in gain between the user's amplifiers. As with the speaker, there is no on/off switch, but heat and power consumption are low. The line is detachable via an IEC socket.

The Monolith III system is available in a variety of fine woods and finishes. It can be customized by the factory and is even available with the electrostatic panels covered by a fabric "sock."

Measurements

Some creativity was required to measure these speakers properly. The basic problem is that the speakers are so large that the standard measurement distance of one meter is proportionately too close to predict response at a greater distance. Technically, it would be in the "near field." However, even at 3 meters (almost 10 feet), a listener is also in the near field. In addition, the speaker radiates equally to the front and rear. Truly anechoic measurements give you only half the sound that fills a room. In the following measurements, I attempted to relate to in-use conditions while maintaining a reference to *Audio*'s standard practices.

Equipment that I use includes the Techron TEF 10 analyzer, Brüel & Kjaer 4007 microphones, and many custom-designed circuits and fixtures. In addition, I am now using a Tektronix 2630 Fourier analyzer for impedance and distortion measurements. This two-channel instrument is based on digital signal processing (DSP) chips and a host DOS computer.

Starting with the passive crossover option, Fig. 1 plots input-impedance magnitude of the system. Figure 2 plots

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Naturally, IM is low when the test tones are separated by the outboard crossover, but in this case it's also low when they are not.

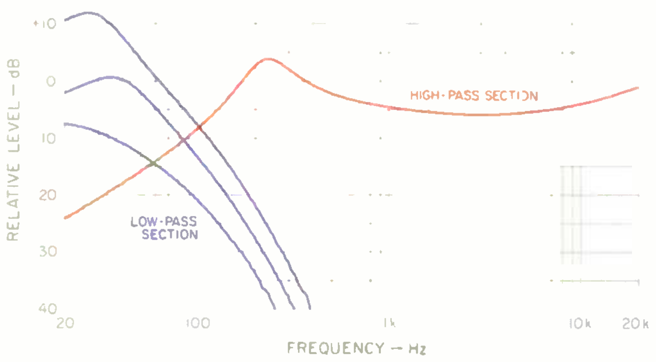


Fig. 6—Frequency response of electronic crossover. Woofer-section responses are, top to bottom: Maximum setting ("+4 dB") of front panel "Boost/Cut" control (+6 dB bass gain, and "Frequency" dial at 30 Hz) best setting for my room (0 dB gain, "Frequency" dial at 40 Hz, and 0 dB "Boost/Cut" setting), and minimum setting (−6 dB bass gain, "Frequency dial at 30 Hz, and "Boost/Cut" at "−4 dB").

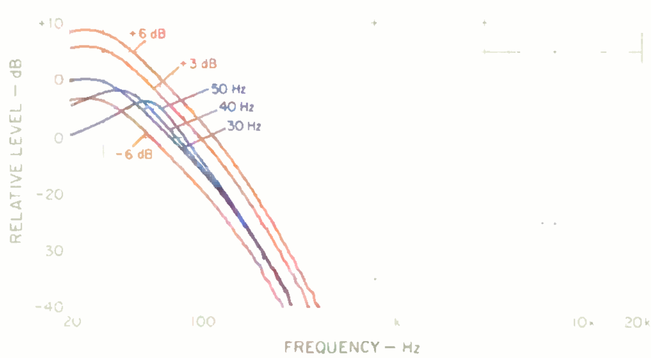


Fig. 7—Frequency response of electronic crossover with −3 dB bass gain for all three "Frequency" control positions, and for three additional bass gain settings with "Frequency" at 30 Hz.

the same information in polar form, showing the capacitive and inductive effects with which the amplifier must deal. This could be considered a typical 4-ohm rated speaker were it not for the drop to 1 ohm above 10 kHz. You may not need full power or lowest distortion in this range, but make sure that the amp manufacturer says that the amp is "safe" with a 1-ohm load.

Figure 3 shows the passive crossover's output to woofer and tweeter with some of its useful response-trimming options. Note the reduced amplitudes at the 125-Hz crossover frequency. Did Martin-Logan blow it here? I don't think so! The same underlap is found in the active crossover, proving that Martin-Logan deliberately did this to provide a seamless blend from woofer to tweeter in the listening room, as we'll see shortly.

With the active crossover and biamp option, the amps must drive the woofer and tweeter input impedances directly. The magnitude of these impedances is shown in Fig. 4 and the reactance and resistance are shown in Fig. 5. The woofer load is normal for a sealed-box design but the tweeter presents the same nasty high-frequency load as it did with the passive crossover.

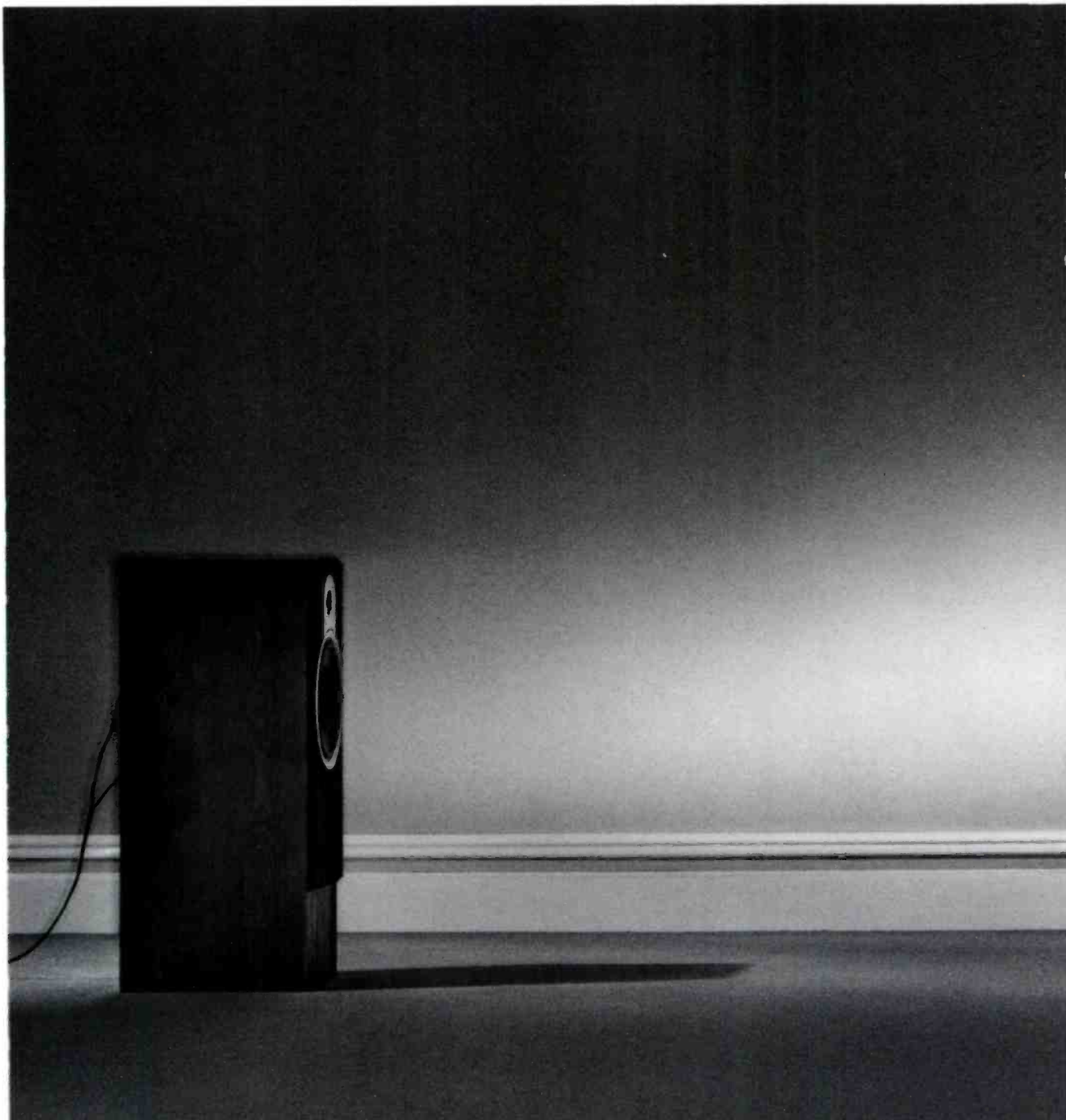
Figure 6 plots the amplitude response of the active crossover. This is the signal presented to the woofer and the tweeter amplifiers. The extremes of the response options for the woofer drive are shown along with the one found most suitable for my listening room and used in testing. The system's low-frequency response can be matched to the room by the "Frequency" selector switch. The three frequencies are plotted in Fig. 7. This option can help cope with peaks and dips caused by room modes. Low-frequency gain and attenuation are variable via eight computer-style DIP switches accessed from the rear of the crossover. Their effect is also shown in Fig. 7.

Anechoic frequency response was measured with the speaker lying on its side in a large parking lot at a distance of 2 meters with 0.2 V input to the crossover. This voltage produces an average of about 4 watts into the speakers. Remember, with the response shaping in the crossover, the true power varies with frequency. Sound Pressure Level (SPL) was mathematically normalized to the standard 1-meter, 1-watt equivalent. Several tests confirmed that this strange configuration produced a good representation of the first arriving sound heard by the listener. Figure 8 plots the amplitude response, which shows a rather wide variation. Keep in mind that this speaker is a dipole radiator above 125 Hz and is designed to perform in a room. With the active crossover circuitry, any response shape would be possible. This has to be what Martin-Logan wanted.

The phase shift associated with the amplitude response of Fig. 8 is plotted in Fig. 9. The normal high-pass response of the woofer produces the low-frequency phase lead. The crossover at 125 Hz produces a lag of 360°, which affects the range from below 100 Hz to nearly 1 kHz. Above that, the electrostatic panel shows essentially no additional phase shift. This amount is common in many speakers.

Moving into the listening room, the 3-meter response, including early reflections, is one of the most uniform I have seen. It is actually flatter than the anechoic response. This is plotted in Fig. 10 for on axis and 30° off axis.

MAXELL RELEASES A NEW HIGHER PERFORMANCE TAPE.



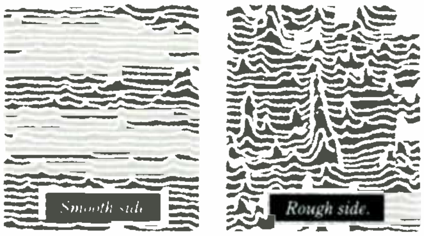
Since its introduction only a few weeks ago, Maxell's new XLII-S has been blowing away critical listeners. It's also had a major impact on listening critics.

In a recent analysis of 27 tapes conducted by *CD Review* magazine, they named Maxell's new XLII-S first choice in the Type II high bias category, which places it, in the words of their reviewer, "Head, shoulders and torso above the rest."

"Bass response that doesn't stop, staggering dynamics, real music," is how *CD Review* described the listening experience. And they called XLII-S,

HOW WE TAKE YOUR MUSIC TO THE MAX:

Maxell XLII-S achieves new highs in Maximum Output Levels, offers a wider dynamic range, together with significant reductions in AC Bias Noise and modulation noise.



Maxell dual-surface base-film reduces modulation noise caused by tape jitter.

This superior performance begins with our unique "dual-surface base-film." One side is smooth, the other rough. The rough side rides across the tape transport without sticking and causing tape jitter.

HI-OUTPUT
BLACK MAGNETITE

A powerful reason for trying Maxell XLII-S.

Gamma ferric oxide is the standard magnetic coating on nearly all audio cassettes today.

But standard wasn't what we were shooting for. So we harnessed a higher powered magnetic particle we call Black Magnetite. Black Magnetite has 13% more magnetic energy than conventional particles and is the major contributor to the outstanding MOL of this new tape.

We also use superior manufacturing technology called "multi-orientation." It allows near perfect alignment of smaller particles packed in greater density onto the tape. The result: a smoother, more uniform coating with less AC Bias Noise.

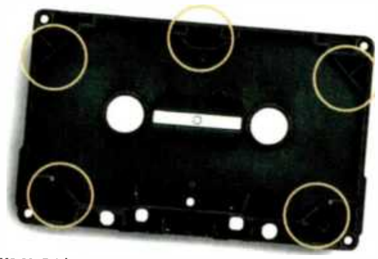
IEC Tape Specifications				
Tape Selector Position				IEC II High (CrO_2)
			Unit	XLII-S 100
Physical Properties	Backing Material-			Dual Surface Tensilized Polyester Base-Film
	Tape Width		mm	3.81
	Coating Thickness		μm	4.5
	Total Thickness		μm	11.0
	Yield Strength		N	5.5
	Breaking Strength		N	10.5
Magnetic Properties	Magnetic Material		—	Black Magnetite
	Coercivity		kA/m (Oe)	58(720)
	Retentivity		mT(G)	190(1900)
	Squareness		—	0.90
Electro-acoustic Properties	Optimum Bias		dB	+1.0
	Sensitivity	315 Hz	dB	+0.5
		6,300 Hz	dB	+1.5
		12,500 Hz	dB	+3.0
		16,000 Hz	dB	+4.5
	Output Uniformity at 315 Hz		dB	0.3
	Output Uniformity at 8 kHz		VU	0.4
	Dynamic Range	315 Hz	dB	65.5
		10 khZ	dB	57.5
	MOL (Maximum Output Level)	315 Hz	dB	+6.0
		10,000 Hz	dB	-2.0
	AC Bias Noise		dB	-59.5
	Erasing Effect		dB	70
	Print-Through		dB	51
All features and specifications are subject to change without notice. (Specifications are measured with reference to: IEC Type II Reference Tape U564W in accordance with established IEC procedures.)				

The XLII-S Performance Story.

Through the use of a new composite material—a blend of plastic and ceramic resins—we have created a *high resonance-damping cassette shell.* More rigid and weightier than any standard cassette, it reduces modulation noise. Also, by making the tape window smaller, we were able to improve the cassette's overall structural integrity, building in five support points instead of the standard three.

All in all, we think you'll find that Maxell XLII-S is the finest high bias audio cassette available today. For program material demanding the highest standards of performance, make it your first choice.

Buying anything less is like knowingly setting out to take your music to the min.



XLII-S high resonance-damping cassette shell has five support points for increased rigidity and durability.

The highs were neither dull nor forward, and I could follow instruments in a complex orchestration with uncanny ease.

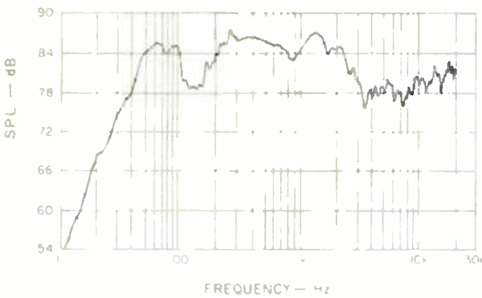


Fig. 8—On-axis anechoic frequency response at 1 meter, referenced to an input of 0.1 V into the electronic crossover. This input results in approximately 2.0 V (1.0 W into 4 ohms) into the speakers from amplifiers of 26 dB gain.

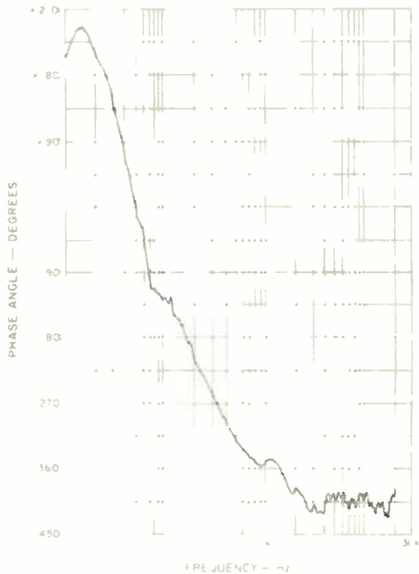


Fig. 9—On-axis anechoic phase response using electronic crossover.

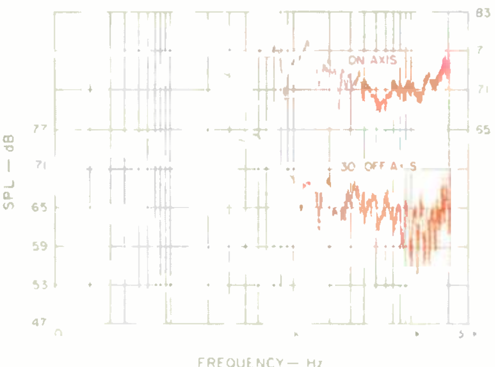


Fig. 10—Three-meter room response measured on axis and 30° off axis. Scale for on-axis curve is at right. The off-axis curve has been lowered for clarity.

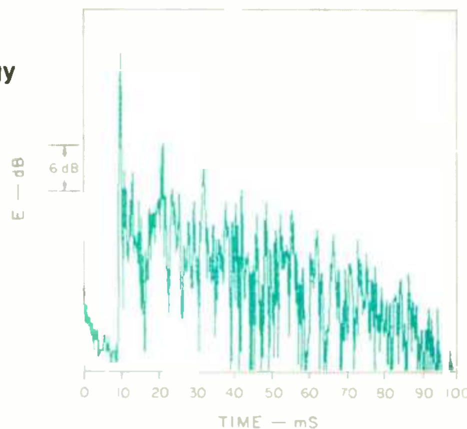


Fig. 11—Energy-time curve of one speaker in listening room for energy centered at 2 kHz.

When I use instruments to set up a speaker system, I try for minimization of early reflections and a high density of delayed reflections in the midrange. This is best accomplished through room geometry, speaker placement, and speaker directivity control, not by gross application of sound-absorbing foam. Dipoles like the Monolith are my preference for directivity control. Figure 11 shows why. This in-room energy-time curve plots energy around 2 kHz received by the microphone at the listening position as a function of time. We see a strong first arrival at 10 mS and a suppression of any significant reflections for another 10 mS, followed by the desired onset of dense reflections dying out steadily as dictated by room reverberation time.

This room time response is characteristic of that sought in a live end/dead end room design. Frequently however, unknowledgeable "deadening" of the walls around the speakers does not achieve it. Here, we achieve it with a free-standing speaker near a live corner, with only a sound-diffusing reflector behind it Part of the secret is in the dipole radiation pattern, which avoids side-wall reflections. Another part is the combination of woofer at floor level and a limited vertical "beam" of mid and high frequencies that eliminates the floor-bounce problem. Either a sizable distance to the rear wall or a diffusing reflector, as I used, is required to delay the rear sound.

Figure 12 is another non-standard room plot. This one is frequency response of the Monolith pair averaged over third-octave bands and over several positions in the center-line listening area. Note that there is no "hole" at 125 Hz as one might have expected from the anechoic response. Also, bass response is increased and extended and the upper range is smoothed and falls with the desired slope. Normal-

The Monoliths had no trouble reproducing concert grands at full volume with clarity, detail, and openness.

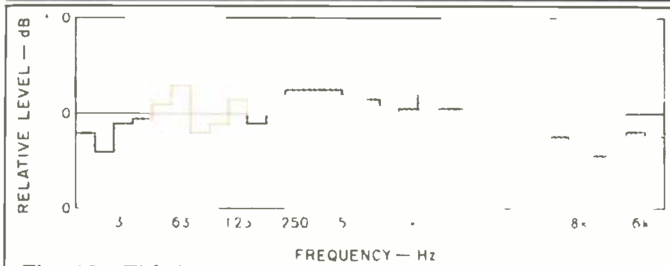


Fig. 12—Third-octave average frequency response of two Monolith IIIx speakers in listening room setup.

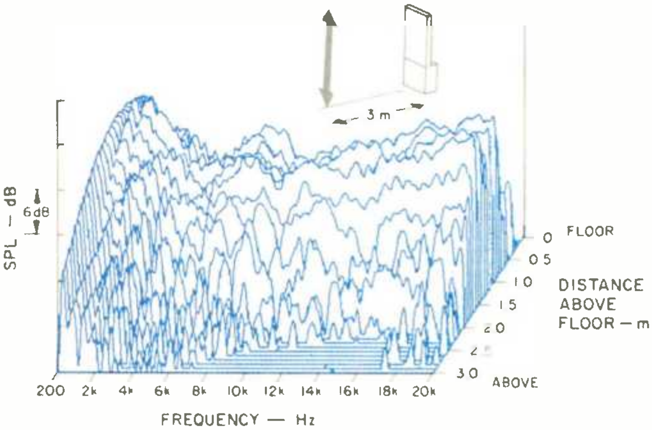


Fig. 13—Vertical off-axis frequency response, taken along a straight vertical line from ground to 3.1 meters up, 3 meters from speaker.

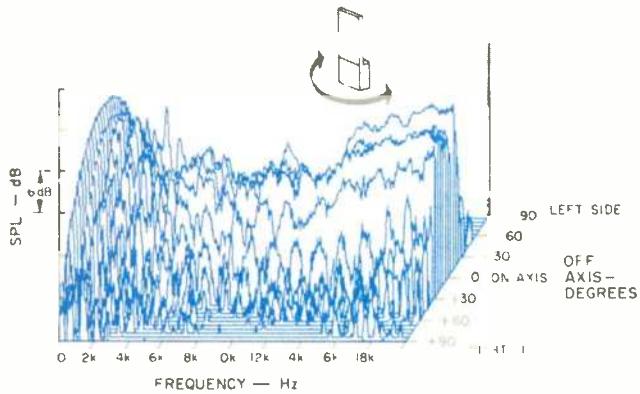


Fig. 14—Horizontal off-axis frequency response, taken from one side, around front, to the other side of speaker.

ly, *Audio* does not include data that are specific to one listening room, but I wanted to show that there is a reason for the Monolith's non-flat anechoic response.

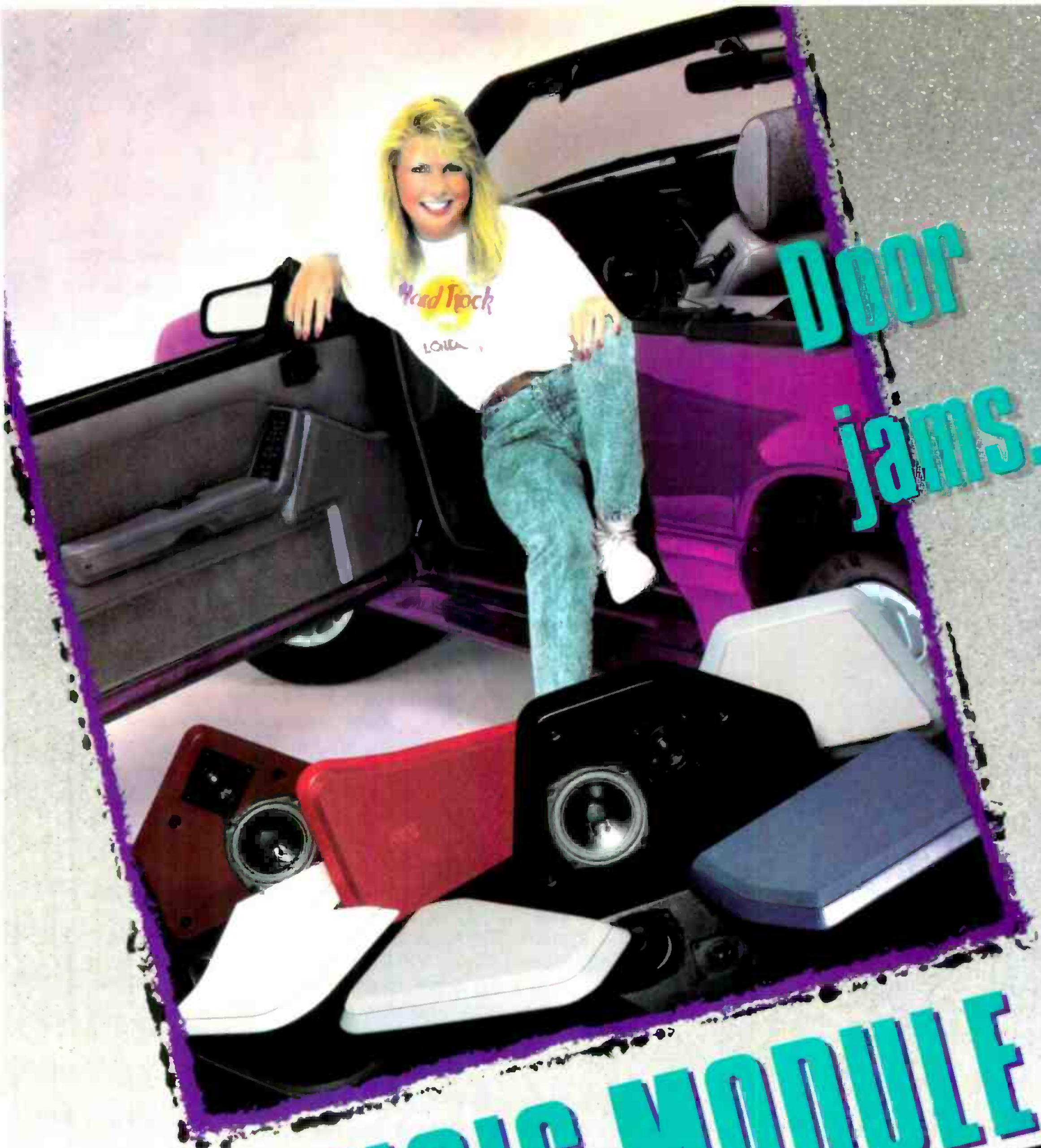
Back to the anechoic environment: Fig. 13 plots the vertical off-axis response. Since the usual listening distance is in the "near field" of these speakers as far as vertical directivity is concerned, a measurement method that represents this was used. Instead of plotting the "launch angle," the response variation with height above the floor at a 3-meter listening distance is plotted. The range of height plotted is from floor level to a height of 3.1 meters. The "beam" of acceptable response extends from just below 1 meter to just below 2 meters. This accommodates seated and standing listeners while avoiding early floor and ceiling reflections.

Horizontal directivity is plotted through 180° from one side, around the front, to the other side in Fig. 14. Note the fall-off of energy to the sides. This is due to the dipole radiation and, as noted earlier, it prevents early reflections from side walls if the speakers are rotated properly. There is an approximately 30° angle of acceptably flat response. When a speaker exhibits a fairly consistent response off-axis over a wide frequency range, as the Monolith does, it is called "constant-directivity." Constant directivity, which is possible only with quite large speakers, ensures that the reverberant sound matches the direct and early sound.

Figures 15, 16, and 17 show the fundamentals and harmonics of the musical test tones E_1 (41.2 Hz), A_2 (110 Hz), and A_4 (440 Hz), respectively, for input powers up to 100 watts. These plots were made with the Tektronix 2630 Fourier Analyzer and look somewhat different from the previous plots made with the TEF. First, they include the fundamental as the series of 31 uniform peaks on the left. Second, harmonics out to at least the eighth are plotted. Third, the "floor" is limited to 0.1%, which is an extremely small amount of distortion. The Monolith has moderate distortion at 40 Hz at high levels and exceptionally low distortion above that.

Modulation of A_4 (440 Hz) by E_1 (41.2 Hz), mixed in a one-to-one ratio is shown in the "3-D" plot of Fig. 18 for the frequency range covering 50 Hz on either side of the 440-Hz test tone. Modulation by the 41.2-Hz tone will produce undesired new tones 41.2 Hz on either side of 440 Hz. Input gain to the analyzer was adjusted for each power level applied to the speaker, to maintain a constant level to the analyzer. This is seen as the constant level of 440 Hz in the center. The modulation sidebands just rise out of the 0.1% measurement floor at high levels. This extremely low distortion is due to the separation of the test tones by the crossover. Additional tests, not shown, were run with both tones in the electrostatic panel's range, and IM distortion was still extremely low.

Power linearity over the entire frequency range is plotted in Fig. 19. The curve shows the power input and frequency at which the acoustic output fails by 1 dB to respond in a linear manner. Woofer distortion limits output in the range from 20 to 80 Hz. A mechanism unknown to me limits the electrostat between 200 Hz and 10 kHz, and my power amp protected itself from the 1-ohm load above 10 kHz. I would recommend 100 watts per channel for the woofer and a robust 200 watts per channel for the tweeter.



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While the Monolith woofer looks small, it not only integrates flawlessly with the electrostats but outdoes many so-called subwoofers.

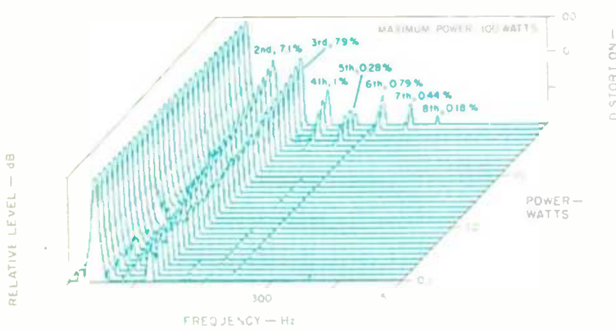


Fig. 15—Harmonic distortion products for the musical tone E_1 (41.2 Hz).

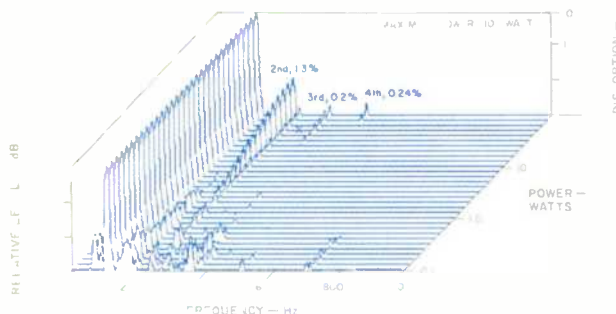


Fig. 16—Harmonic distortion products for the musical tone A_2 (110 Hz).

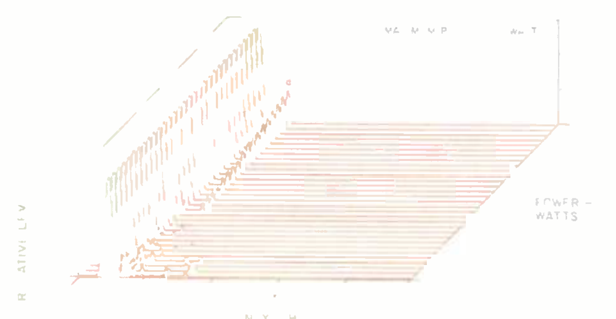


Fig. 17—Harmonic distortion products for the musical tone A_4 (440 Hz).

Figure 20 is the Monolith's time response at 1 meter with an analysis of energy centered around 10 kHz. The initial peak is quite sharp, considering that the tweeter is physically spread out over 8 square feet. Energy at a reduced level is radiated for several more mS. This could be the arrivals from panel segments which are off axis, diffraction from the frame, or traveling waves in the diaphragm.

Use and Listening Tests

I first set up the Monolith in my home listening room, which is approximately 18 feet × 25 feet with an 8-foot ceiling. For aesthetic reasons, I placed the speakers less than 3 feet from the wall behind them and angled them in slightly. The sound bothered me until I installed an equalizer and reduced amplitude in the range from 200 to 500 Hz. Still, it didn't sound quite right; vocals lacked presence.

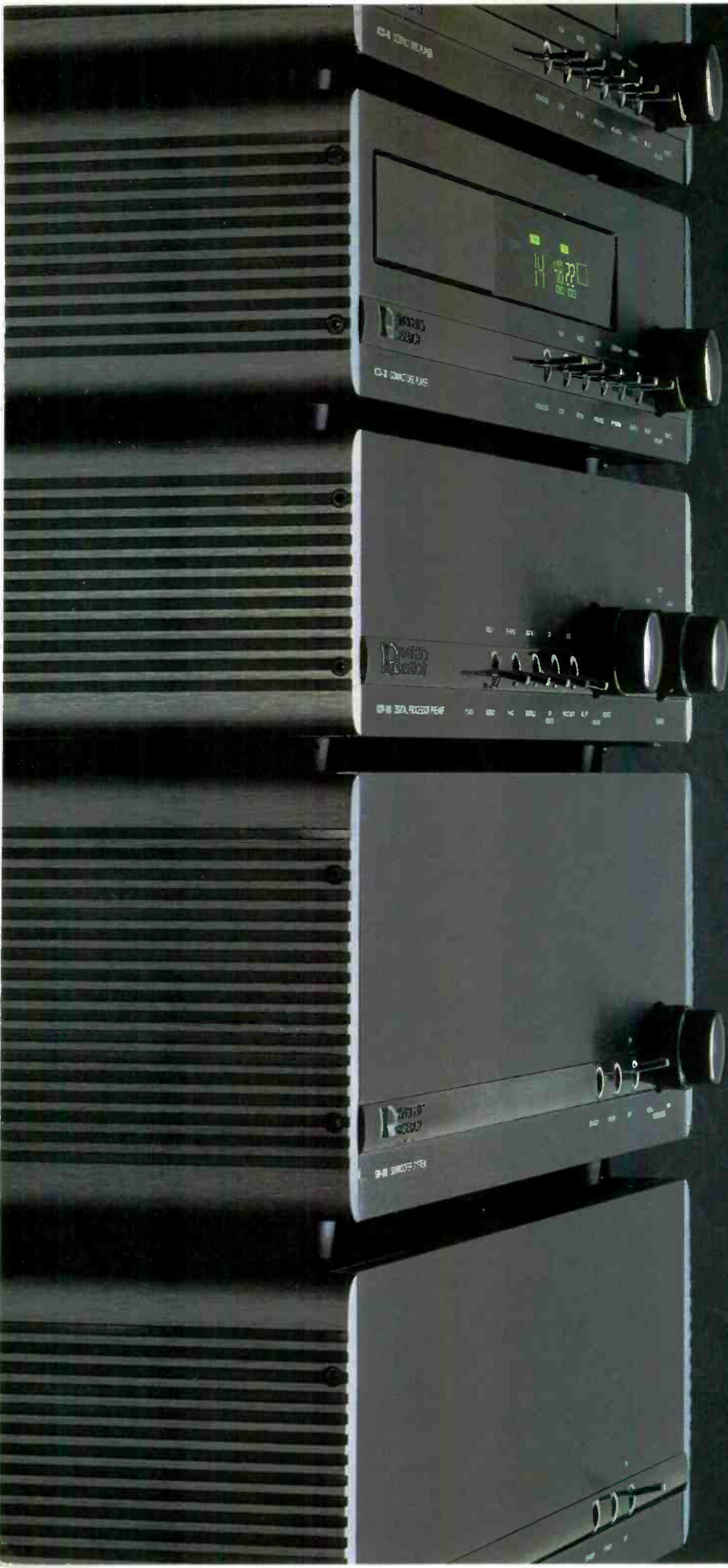
Before I could find time to experiment with repositioning, I purchased a large rear-projection TV. This was installed between the Monolith speakers and forced me to move back other furniture. I was now able to pull the speakers out more than 4 feet from the wall behind them. Whether it was the increased distance or the large object between them I don't know, but the sound was dramatically improved. The equalization was no longer needed and the absence of presence was, well, absent.

In addition to stereo music, I used the Monolith in conjunction with four dynamic speakers in a video surround-sound system. The source was a digital LaserDisc player feeding a Sony TA-E1000-ESD DSP preamp in surround mode. Despite the sonic mismatch between the dynamic speaker in the center and Monolith speakers on the left and right, the effect was quite good. Much of the center information is dialogue and the music is mainly left and right so it worked out. Occasionally, when an effect, such as a passing car, would pan from left to center to right, the difference in tonality was somewhat distracting.

I mention this use because I believe that a top-quality audio system can co-exist with a surround-sound video system. The best of the LaserDiscs have CD-quality digital sound. I find it most enjoyable to view an orchestra or related scene while listening. In addition to surround-encoded films, I listened to and watched the following LaserDiscs: Antonin Dvořák, Symphony No. 9, Vaclav Neumann, Pioneer MC036-22LD; *New Year's Eve Concert 1987*, Herbert Von Karajan and Vienna Philharmonic, Sony SLV4598J; *The Six Brandenburg Concertos*, J.S. Bach, Nikolaus Harnoncourt and the Concentus Musicus, London 071 204-1; *Jimi Live at Monterey*, Jimi Hendrix, HBO Video ID6573HB.

Next, I moved the speakers to my lab and its adjacent listening room, which measures 18 × 27 × 10 feet. This room has variable acoustic panels, and I elected to make the area behind the speakers reflective but with diffusion for the rear sound radiation. I placed the Monolith pair about 6 feet out from an 18-foot wall, about 8 feet apart and angled inward about 20°. Angling was somewhat critical for high-frequency balance and maximizing acceptable listening area, but as it happened, the first position tried just worked.

At the listening location, about 10 feet away, the Monoliths sounded much like other high-quality speakers, especially dipoles like the Magnepan and Quad ESL. Image height



The Monoliths demand space, but if you have the space and the money, you must audition them.

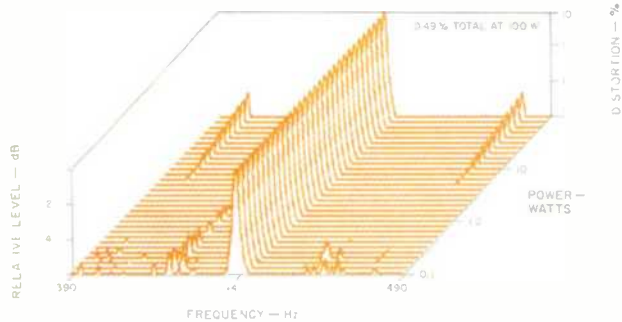


Fig. 18—IM distortion on 440 Hz (A_4) produced by 41.2 Hz (E_1) when mixed in one-to-one proportion.

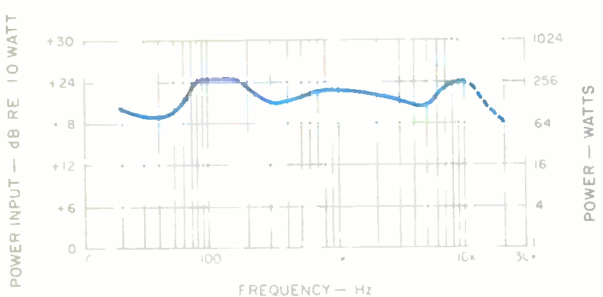


Fig. 19—Power linearity. Input power handling (approximation based on 0.1 V into electronic crossover) versus frequency for 1-dB compression of the output.

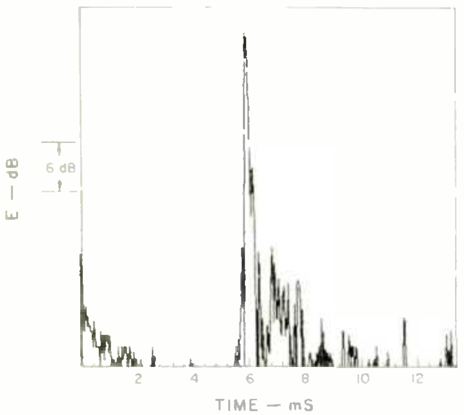


Fig. 20—One-meter on-axis energy-time response.

was a bit high, but it was easy to get used to. Overall timbre was a bit on the dark or rich side, with extended, clean bass. There is no criticism implied here, just an observation such as one might make about a fine concert hall. High-frequency sounds were never forward or obvious, but neither was the sound dull. I discovered that I could pick out and follow single instruments in a complex orchestration with uncanny ease.

Imaging on the stereo centerline was very accurate and uniform across the soundstage. Centered, forward vocals could have been a little more tightly focused. Likewise, distant pickup, such as the bass and conga of "Tinden bara Går," Opus 3, *Test Record 1*, CD 7900, could have been rendered with more stage depth. However, on the really difficult stuff with orchestra, organ, and choir, like Andrew Lloyd Weber's *Requiem* (EMI CDC 7 47146 2), the Monolith came through with the chilling sense of space, texture, and power contained in this music.

Hosting a local Audio Engineering Society meeting presented an interesting opportunity to test the Monoliths. An old friend of mine, Don Fostle, is writing a book on the Steinway piano company and wanted to compare the sounds of four brands of concert grand pianos. I agreed to provide a sound system and blind comparison of the four piano recordings he had. The professionally made recordings were of the same artist performing the same music in the same hall on the same day. Only the brand of factory tweaked piano changed.

There were 15 AES members crowded into my listening room to judge the recordings. The Monoliths had no trouble reproducing the full volume of a concert grand. Despite some difficulty in covering the entire listening area with upper-mid and high frequencies, there were numerous comments regarding the remarkable clarity, detail, and openness.

These speakers will play very loudly even though they never sound like they are blasting. Uncompressed recordings of percussion can cause temporary ringing in the ears if you are careless with the volume control. Ultimate woofer output will not satisfy bass freaks, but it is adequate if no bass boost is used.

The Monolith woofer deserves special comment. At first viewing, this ordinary looking 12-in. woofer in a sealed box would seem to be a mediocre solution, at best, to the electrostat's problem with low bass frequencies. Not so. This woofer integrates flawlessly with the dipole upper range, thanks to its low distortion and the finessing of the crossover slopes. No buzzes or distortion were heard on music. When overdriven, it simply stopped getting louder in a graceful manner. This is a better speaker than many so-called subwoofers on the market.

If you get the impression that I am mightily impressed with the Monolith, you are right. Is it the best that I have heard? It is a contender for the honors, but I would have to make that judgment from a side-by-side comparison of speaker/room systems. The Monolith demands space. From my experience, they must be placed well out from the wall behind them and used in a room not much smaller than 18 × 25 feet. If you are an avid audio enthusiast with the space and the money, you must hear these speakers. *David L. Clark*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3

DELCO/BOSE GOLD SERIES CAR AUDIO SYSTEM

Manufacturer's Specifications

Dimensions: Head Unit, $7^{1}/_{16}$ in. W × $3^{15}/_{16}$ in. H × $6\frac{1}{8}$ in. D (18 cm × 10 cm × 15.6 cm); AM/FM Tuner unit, $7^{15}/_{16}$ in. W × $4^{1}/_{16}$ in. D × $1\frac{5}{8}$ in H. (20.06 cm × 10.32 cm × 4.2 cm).

Weight: Head unit, 7.1 lbs. (3.2 kg); AM/FM Tuner unit, 1.22 lbs. (0.553 kg).

Note: Delco does not normally publish performance specifications for the entertainment electronics components they supply to General Motors for use in GM vehicles.

For literature, circle No. 92

Conventional wisdom among car audio enthusiasts has always been that "factory" car audio systems are necessarily inferior to car audio systems manufactured by companies that sell such equipment for installation after the car's purchase. That generalization began to change some years ago, when the Bose Corp. teamed up with General Motors' Delco division to create the first Delco/Bose music system customized for specific vehicle interiors. Other car companies have followed suit, of course, including Ford (whose Ford/JBL systems grace several Ford, Mercury, and Lincoln models), Lexus (with a choice of audio systems engineered by Pioneer and Nakamichi), and several imports with systems by Bose. Recently, I auditioned a Panasonic DSP system that is available in the new Acura Vigor, a sports model from that high-end division of Honda Motors. We at *Audio* have been interested in evaluating a Delco/Bose factory installed system for some time, not only in terms of how it *sounds* and *works* in a mobile environment in one or more GM automobiles, but how its elements compare on the test bench with aftermarket products.

After much persuasion and negotiation, we acquired the electronic components of the latest Delco/Bose music system. Technical Editor Ivan Berger took the system on the road twice—once in a Chevy Corvette and a second time in a Cadillac. His reactions to the system's sound and the control panel's ergonomics will be found immediately following this report.

My job was to hook up the head unit and the separate AM/FM tuner module to my test equipment and to measure their performance in much the same way as I measure aftermarket equipment. Unlike aftermarket car audio equipment, Delco does not have to be concerned about consumer installation and can configure the components with any sort of connectors they please. Because of this, Delco had to supply a harness that enabled me to interface the components with my test setup, but there were still some things that I was unable to check.

When installed in an actual vehicle, this head unit makes use of a feature called Speed-Compensated Volume (SCV). Specifically, the SCV circuit reads the car's speed from the digital speedometer, then raises or lowers the stereo system's output level to compensate for changes in road noise. Obviously, with the system standing quietly on my test bench, there was no need (and no way) for me to hook up or evaluate this interesting feature. Here, too, you and I can turn to Mr. Berger for his evaluation of this particular system enhancement.


Delco/Bose Gold Series system in a Cadillac Seville.

Close-up of the Cadillac version.

The '92 model Delco/Bose head unit I tested incorporates both a cassette player and a CD player, as well as a tuner with stereo on both AM and FM. The actual tuner circuitry is in a small, separate chassis that is installed out of sight and has no user controls. The head unit is approximately 1½ times as tall as a normal DIN head unit, and its front panel carries all sound-system controls as well as the cassette and CD loading slots. As has been true of all Delco/Bose systems since their introduction, the power amplifiers are contained in individual speaker modules supplied to Delco by Bose Corp. These active speaker modules provide the required customized equalization for the various vehicles in which the systems are installed. Response of the head unit electronics is, therefore, essentially flat. While I was given four active speaker modules that are normally used in a Chevrolet Corvette, they were supplied only so that I would understand how the entire system goes together in an automobile. I did not measure the performance of the active speakers, since there would be little meaning or relevance to testing, in my 14- × 25-foot room, speakers equalized for specific cars.

Control Layout

There are three rotary controls positioned at the left of the head unit, closest to the driver. These are the master volume control (which, in its most counterclockwise setting, turns off power to the unit), concentrically mounted bass and treble tone controls, and a front/rear fader control. A lever mounted behind the volume control knob activates the previously described SCV feature, while pushing on the volume control alters the main LCD display from its time clock mode to current program recall. When playing a CD, pushing this knob once displays the current track number being played, and pushing it again shows the elapsed time on that track. Inserting a CD even partway into the slot at the top of the panel activates a motor system that completes the loading process. An up/down manual tuning rocker bar is just to the right of the volume control. Below this tuning bar are the "Auto" button (which switches the tuning bar's action from automatic signal-seeking to manual tuning), an AM/FM band selector, a tape type selector (marked "CrO2") and a "Set" button used for programming station presets (and also, in conjunction with tuning bar, for setting clock time). Further down along the left side of the panel is a button marked "CA/CD." Pressing this button lets you switch between listening to a cassette and a CD, provided that both program sources are loaded.

My compliments to Delco for a control panel one can use while driving briskly and a display that can be read by day or night.

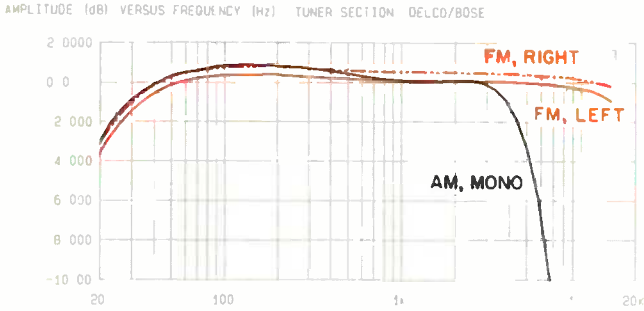

Fig. 1—Frequency response, FM tuner section, with AM monophonic frequency response for comparison.

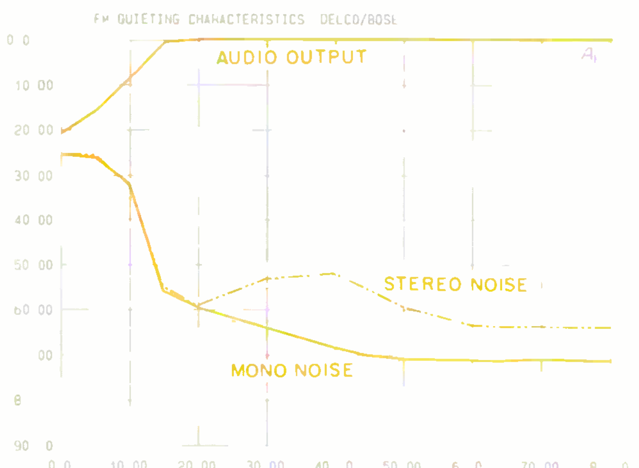

Fig. 2—FM quieting characteristics, FM tuner section.

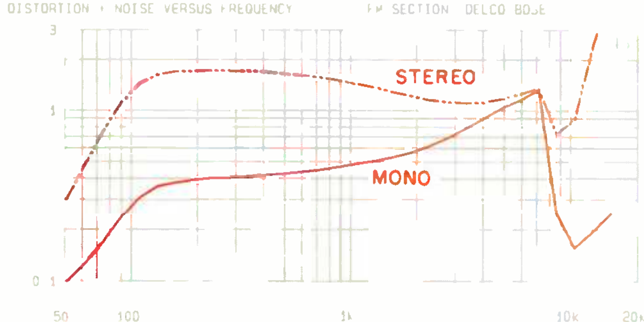

Fig. 3—THD + N vs. frequency, FM tuner section.

The LCD display is positioned beneath the CD slot, and just below it are eight dual-purpose buttons. In tuner mode, six of these buttons are used to call up preset AM or FM stations. When listening to either tape cassettes or CDs, these same buttons assume other functions, such as fast-forward or reverse winding of a cassette or fast motion in either direction of the CD laser pickup, search and scan functions, and repeat play. Preset button number 3, if activated during CD play, also introduces a moderate amount of compression—a feature that's almost a must in car audio systems, in view of the wide dynamic range inherent in the program material of most CDs. The remaining two buttons in this cluster, labelled "Eject" and "Stop/Play," perform these functions for either a tape cassette or a CD. The tape cassette slot is located at the lower right of the panel. The side facing upward when you insert the cassette is the side you're going to hear first.

Before I tell you about the results of my bench tests, I must compliment Delco's designers on the legibility of all the control buttons on this head unit and on the intelligent layout of all of the controls just described. All too often, car audio buffs are confronted by complex panels with buttons that can hardly be read in bright daylight inside an automobile, let alone at night. There is nothing quite as frustrating as trying to access a control or feature while driving at fairly high speeds, only to hit the wrong button because the labels are too small to be seen from the driver's seat or because each button has so many functions that one needs an owner's manual perched on the steering wheel to figure them all out.

Measurements

As always, I measured tuner performance first. Figure 1 shows frequency response of the FM tuner section, with that of the AM tuner in mono mode overlaid for comparison (more on that later). Unlike many car FM tuners I have measured, this one has virtually flat response all the way out to 15 kHz and, with tone controls set to their mid-points, response is down by only about 2 dB at 30 Hz. Figure 2 shows the mono and stereo quieting characteristics of the FM tuner section. For 50-dB quieting in mono, only 13.5 dBf of input signal strength is required. That figure would be remarkable in a home FM tuner and is nothing short of superb in a car unit. Note, too, the way full limiting occurs in this tuner. Unlike many car FM tuners, this one attains virtually full audio output level at around 15 dBf of input signal. Many car FM tuners seem to take forever (or at least 30 to 40 dBf of signal) to reach full audio output level or full limiting. I was particularly pleased to see that Delco doesn't allow the stereo mode to "collapse" into full mono until signal levels decrease to around 20 dBf. Indeed, there is no reason for them to "blend" to mono more quickly, since even at such low signal levels as 30 dBf (where stereo effect was still present), signal-to-noise ratio remains well above 50 dB. At strong signal levels, mono signal-to-noise ratio measures 71.5 dB, while in stereo, best signal-to-noise ratio is around 63 dB. That last figure could have been higher were it not for the fact that, as with most FM tuners, there is little need (and therefore little is done) to attenuate residual subcarrier products.

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The FM tuner's 50-dB quieting figure of 13.5 dBf, remarkable even for home tuners, is nothing short of superb in a car unit.

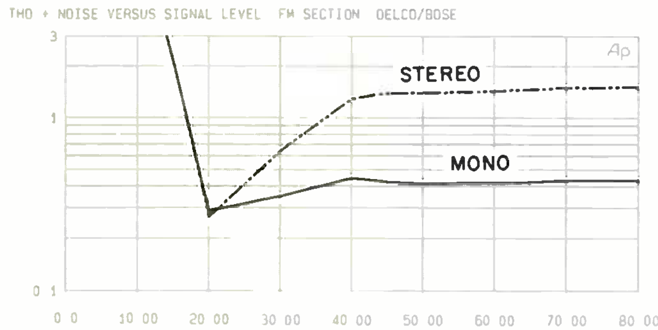

Fig. 4—THD + N vs. signal level, FM tuner section.

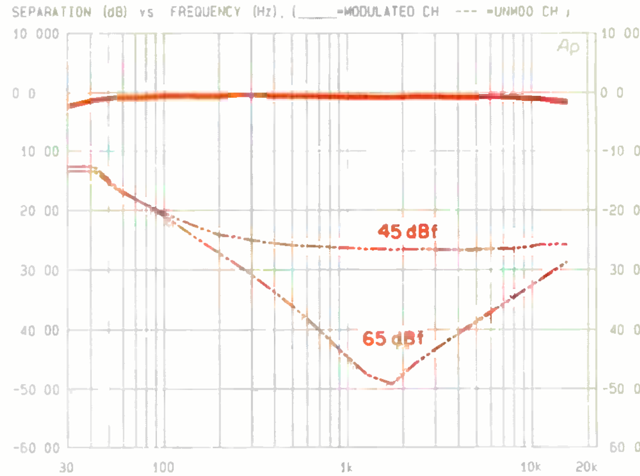

Fig. 5—Frequency response (solid curves) and stereo separation (dashed curves) at two FM signal levels. Note the close match between the two response curves; see text.

Fig. 6—Spectrum analysis of crosstalk and subcarrier products for FM stereo signal with one channel modulated by 5 kHz (solid curve) and other channel unmodulated (dashed curve). Scale at right is for bottom curve.

Figure 3 is a plot of harmonic distortion plus noise versus modulating audio frequencies, for mono and stereo signal reception. At 1 kHz, mono THD + N is an acceptable 0.47%. It is under 0.2% at 100 Hz and about 1.2% at 6 kHz. Stereo THD + N is somewhat higher than I would have hoped, measuring 1.4% at 1 kHz, 1.2% at 100 Hz, and 1.3% at 6 kHz. Since slight detuning of the generator enabled me to obtain lower THD readings (but somewhat poorer ones for mono), I suspect that slight realignment of the i.f. and FM detector circuits might have resulted in the THD figures for stereo being closer to those obtained in mono.

Figure 4 shows how THD + N varies with signal strength for mono and stereo. THD + N for the 1-kHz modulating test signal used in this test remains practically constant in mono all the way down to 20 dBf, while in stereo, it remains constant down to 40 dBf, at which point gradual blending to mono begins to take place. From this graph I was also able to obtain the mono usable sensitivity figure, which is 14 dBf.

The FM stereo separation characteristics of this tuner section are depicted in Fig. 5. With strong signals, separation at 1 kHz measures about 45 dB, decreasing to 32 dB at 10 kHz and 21 dB at 100 Hz. Reducing the signal strength to 45 dBf results in a somewhat lower separation figure of about 27 dB at 1 kHz, virtually no change in separation at 100 Hz, and separation of roughly 26 dB at 10 kHz. These separation figures for weaker stereo reception are still more than high enough to yield excellent stereo effects. Notice, too, that thanks to this tuner's excellent limiting characteristic, audio output from the modulated channel (solid curves on the "0 dB" line) remain virtually the same when signal strength was reduced from 65 to 45 dBf. That's something we rarely see, even in tuners designed for home use.

Figure 6 is an analysis of harmonics and crosstalk products that are present in the modulated (solid curve) and unmodulated (dashed curve) channels of the tuner when a 5-kHz signal is used to modulate just one stereo channel. In addition to the several harmonic multiples of the 5-kHz signal, you can see some residual 19-kHz pilot carrier about 58 dB below 100% modulation levels and high-amplitude 38-kHz sideband components at 33 kHz and 43 kHz. These high-frequency components, though substantial in amplitude, are, of course, inaudible.

I was delighted to find that the AM tuner's frequency response in mono mode reaches the −6 dB cutoff point at 6 kHz, as was seen in Fig. 1. When you consider the fact that even so-called home "high fidelity" tuners and receivers seldom exhibit AM tuner response much beyond 2 to 3 kHz, you can imagine how much better AM radio will sound when listened to on a tuner such as this one. This tuner provided me with one of my first opportunities to measure AM stereo

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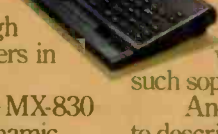

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Delco wisely resisted the temptation to provide the usual boost of 10 dB or more in the bass and treble tone control circuits.

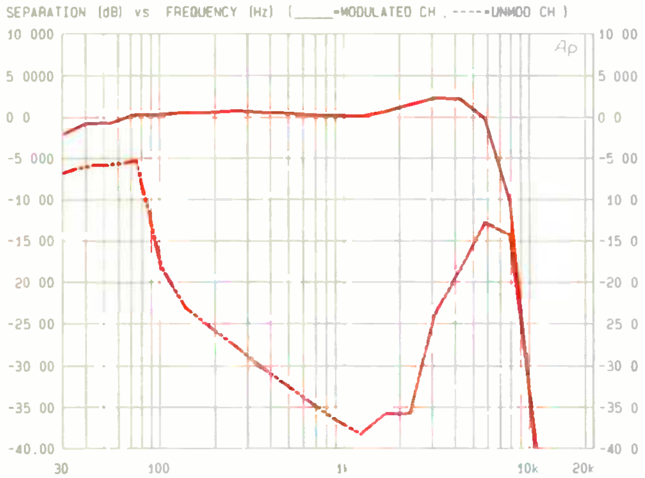

Fig. 7—Frequency response of AM tuner section in stereo mode (solid curve) and stereo separation (dashed curve); see text.

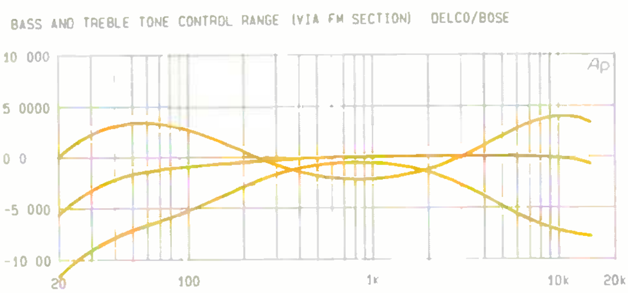

Fig. 8—Bass and treble tone control range, with signals applied via FM tuner; see text.

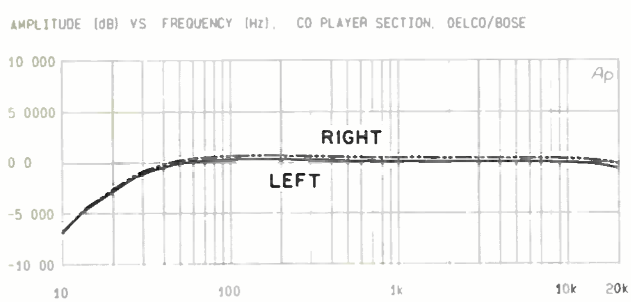

Fig. 9—Frequency response, CD section.

separation, using a recently acquired lab AM stereo generator for that purpose. In the stereo AM mode, frequency response extends even a bit further, out to around 7.0 kHz, and separation is excellent, measuring more than 37 dB at mid-frequencies (Fig. 7).

Before moving on to the CD player section and its performance measurements, I used a swept audio signal to modulate my FM signal generator so as to plot the control range of the bass and treble tone controls of this Delco/Bose head unit. Results are shown in Fig. 8. Again, Delco engineers wisely resisted the temptation to provide 10 dB or more of bass and treble boost in these tone control circuits, limiting them to less than 5 dB of boost at the frequency extremes. In a car audio system, excessive boost (particularly bass boost), serves no purpose and only increases distortion and amplifier/speaker overload.

CD Player Measurements

Using my CBS CD-1 test disc, I measured the frequency response of the CD player section of this head unit. Results are shown in Fig. 9. Left- and right-channel outputs are within 0.4 dB of each other and response is down approximately 0.7 dB at 20 kHz and 2.8 dB at 20 Hz. At maximum recorded level, harmonic distortion plus noise for the CD player measures 0.22% at 1 kHz, as shown in Fig. 10. I soon discovered, however, that this higher than usual THD reading was not the fault of the CD player circuitry itself, but rather of the analog stages following D/A conversion. This became apparent when I measured THD + N versus recorded amplitude, from maximum (0 dB) to −90 dB as shown in Fig. 11. All values are plotted in dB with respect to maximum recorded level and, once recorded levels are lowered to about 10 dB below maximum, relative THD drops significantly and remains relatively constant for all lower level signals, at around −72 dB. Were it not for the slight increase in distortion at high recording levels caused by stages following the D/A converter, THD would be about −72 dB (0.025%) referred to maximum recorded level.

Further confirmation of this is seen in Fig. 12, an FFT spectrum analysis of a maximum-level 1-kHz signal reproduced from my CD-1 test disc. The nature and amplitude of the many harmonics shown are typical of the beginnings of overload or clipping of an analog buffer stage rather than of any problem within the digital circuitry of the CD player section itself.

Channel separation of the CD player section is plotted in Fig. 13 for several spot frequencies. At 1 kHz, separation measures better than 70 dB from the left to the right channel and nearly 80 dB from the right to the left channel. At 16 kHz, the right channel exhibits less separation than the left, with a reading of approximately 45 dB as compared with 61 dB for the other channel.

Signal-to-noise ratio for the CD section measured 86.2 dB, but I suspect that actual S/N was much better than that. Since I had to power these Delco components using a d.c. power supply derived from a.c. line voltage, some ripple was present in the d.c. voltage obtained in this manner. It's obvious from the spectrum analysis of Fig. 14 that the major contribution to my single-number S/N reading was from power-line hum and not from random noise generated by

The CD player can handle unreadable disc areas as well as some of the best home players I've ever measured do.

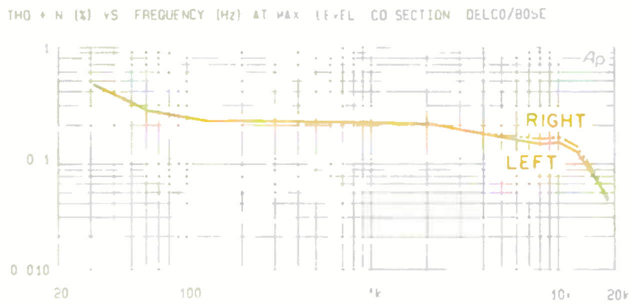

Fig. 10—THD + N vs. frequency, CD section.

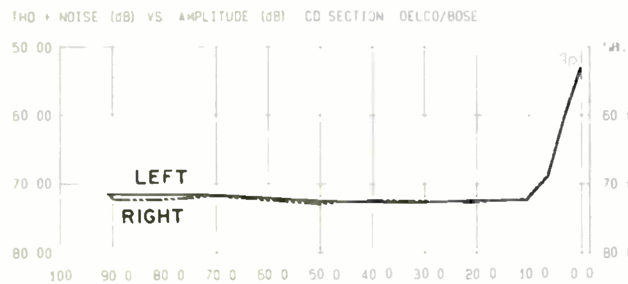

Fig. 11—THD + N (in dB re: maximum recorded level) vs. signal amplitude, CD section.

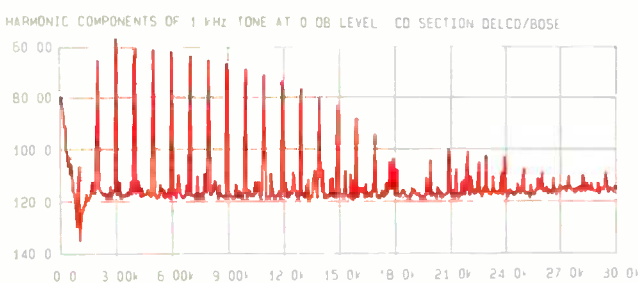

Fig. 12—Spectrum analysis of harmonics of 1-kHz signal, CD section.

the CD player. This 60-Hz noise was probably also responsible for the lower than usual 85-dB EIAJ Dynamic Range reading that I obtained by measuring the distortion (in dB) of a −60 dB test signal and adding 60 dB to the resulting number.

Figure 15 shows how accurate the CD D/A conversion process was, in terms of linearity. The plot shows that even at −80 dB, deviation from perfect linearity is no more than 0.2 dB, and that worst-case deviation for dithered signals, even at −90 dB, is less than 1 dB.

An important measurement for a CD player, especially one that is to be used in a mobile environment, is its resistance to shock, vibration, and mistracking in the absence of data on the CD being played. (It's no secret that CDs handled in cars often are more abused and subjected to minute scratches, dust, etc., than in the cleaner and more predictable home environment.) As for resistance to shock and vibration, I can attest that I had to really pound this rugged chassis to cause mistracking. As for the player's ability to stay "on track" even when confronting missing data, this CD player was able to handle opaque disc areas extending to 2.0 mm in length without any audible muting or skipping. That's comparable to some of the best home CD players that I've measured.

Tape Player Measurements

After measurements such a those in the CD player, it seemed almost anticlimactic to turn my attention to the tape player section. Why, I wondered, would anyone owning a car CD player choose to play "archaic" analog cassette tapes? The answer wasn't long in coming when I examined my own collection of several hundred prerecorded and home recorded tapes, which I have no intention of discarding. So I dutifully approached the task with as much enthusiasm as I could muster. Immediately, I was confronted by a problem. To make life simpler for the user, Delco made no provisions for turning Dolby B noise reduction off. That made it impossible for me to use my usual calibration tapes, which are not encoded with Dolby B, since their tests signals are recorded at such low levels that the NR system would try to "correct" them. If these tapes were to be played with Dolby B, the resulting response plots would be anything but flat—even if the tape player itself were capable of yielding ruler flat response.

The solution was to prepare my own calibration tapes, using my reference Nakamichi tape recorder with Dolby B applied. My calibration must have been pretty accurate, as evidenced by the superb response curves I obtained for both tapes when they were played back on the tape player of the Delco heac unit. Results for Type I tape are shown in Fig. 16A, while those for Type II tape are shown in Fig. 16B. The two graphs speak for themselves.

Signal-to-noise ratio of the tape player, as measured while playing a Type I tape on which only bias had been recorded, measured 59.5 dB referenced to 250 nWb/m. Of course, this number is highly dependent on the tapes used, and some grades of tape may yield somewhat better signal-to-noise ratios while others may give somewhat poorer S/N.

Lastly, I measured wow and flutter of the tape player section. For this measurement, I was able to use a high-quality calibrated tape in a very stable cassette housing. Results are shown in Fig. 17, using two methods. The upper trace, showing more wiggles, uses IEC peak weighting, while the lower trace uses the familiar weighted rms measurement. Wow and flutter averaged around 0.07% weighted rms and just over 0.1% for the IEC peak method.

Unless Technical Editor Ivan Berger discovers some negative aspects of this system that eluded me during my static bench tests, I am ready to concede that this "factory equipped" car audio equipment is, in every sense of the

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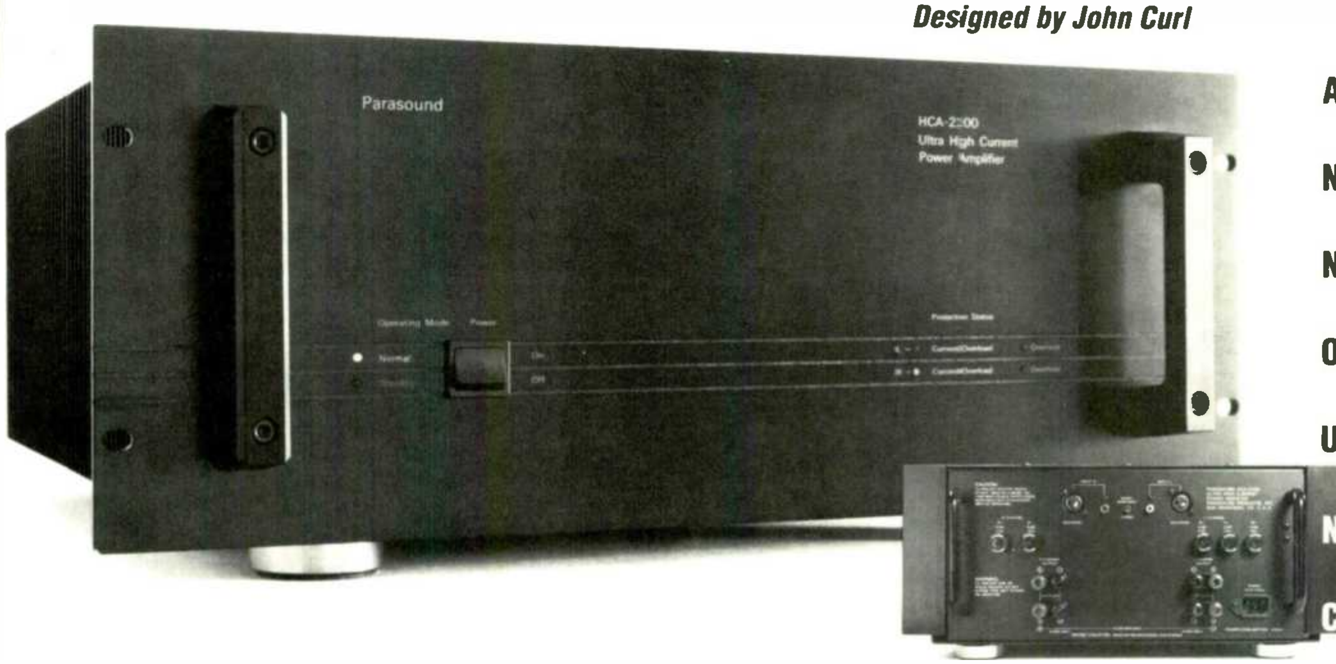

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In the context of Bose car systems, the Corvette's limited-dispersion tweeters are a double heresy that makes good sense.

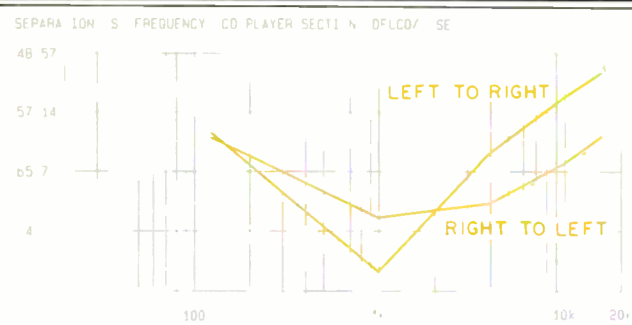

Fig. 13—Separation vs. frequency, CD section.

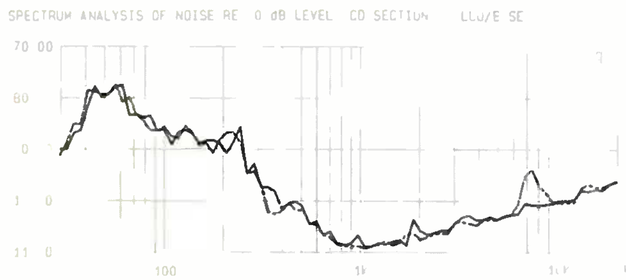

Fig. 14—Spectrum analysis of residual noise when playing "no signal" CD track, for left channel (solid curve) and right channel (dashed curve).

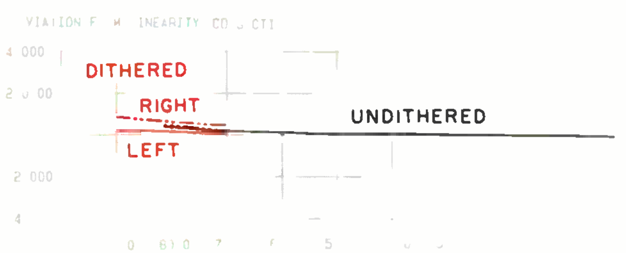

Fig. 15—Deviation from perfect linearity for dithered and undithered signals.

word, in the same class as some of the very best aftermarket car audio electronics I've measured. In one way, at least, it surpasses many of those units—in the matter of ergonomics and control layout as well as control visibility. Now, all that remains is for all of us to read about Mr. Berger's experiences with the system in the real world of roads—both bumpy and smooth. *Leonard Feldman*

Behind The Wheel

Since the performance of a factory stereo system depends a great deal on how it's installed and on the car it's installed in, we dic our on-the-road evaluations in two drastically different cars—an L98 Corvette Coupe (with exactly the same components as our laboratory test system) and a Cadillac Sedan deVille (with different equalization, speakers, and enclosures, and without a cassette transport).

Both systems had big, easy-to-find controls, due both to their oversized panels (the Cadillac's head unit measures 8¼ by 3⅝ inches, the Corvette's 7¹/₁₆ × 3¹⁵/₁₆ inches, versus about 7½ × 2¼ inches for DIN-sized aftermarket head units) and to the fact that these systems have fewer controls than many of the fancier aftermarket head units. Not that much seemed missing: Bose's variation on cross-firing speakers obviates the need for a balance control, and the Cadillac's "Seek" tuning (but not the Corvette's), worked only up the dial, not in both directions. The Corvette's tape section automatically applies Dolby B noise reduction, but few other tapes are likely to be played on it these days. Like most players whose tape slots accept the wide side of the cassette, it did not automatically switch equalization for the tape type in use.

Both the Corvette and Cadillac Delco/Bose Gold systems have 50 watts per channel, twice as much as standard Delco/Bose systems. The speaker differences between the two cars, however, are substantial. The Cadillac uses Bose's standard 4½-inch full-range drivers with helical voice coils (similar to those in the Bose 901), in custom-molded enclosures, for its front speakers; in the rear, it has 6 × 9-inch full-range speakers that use the trunk as their baffle. Because the Corvette's 4½-inch front speakers fire into deep footwells and can't be properly positioned for good imaging, they're supplemented with 2-inch cone tweeters. In the rear, the coupe uses 6½-inch full-range drivers in 600-cubic-inch enclosures, the largest used in any Delco/Bose system.

The Corvette's tweeters are a double heresy: Bose systems normally don't use tweeters, while aftermarket systems use smaller, dome tweeters to broaden high-frequency dispersion. In Bose systems, limited dispersion ensures that the off-axis sound each listener hears from the nearer speaker will be softened enough to balance the more on-axis sound from the speaker across the way. So a tweeter with limited dispersion was the obvious choice.

Differences between the cars affect more than speaker size and placement. Judging from published test reports, the Cadillac is more than 12 dB quieter at idle, about 6 dB quieter at 70 mph, and about 18 dB quieter in full-throttle acceleration, thus providing less competition for the music. The Corvette's Speed-Compensated Volume system compensates, in part, by raising volume as the car's speed goes

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The Delco/Bose system's bass was more solid and tight in the Corvette, somewhat pillowy in the Cadillac.

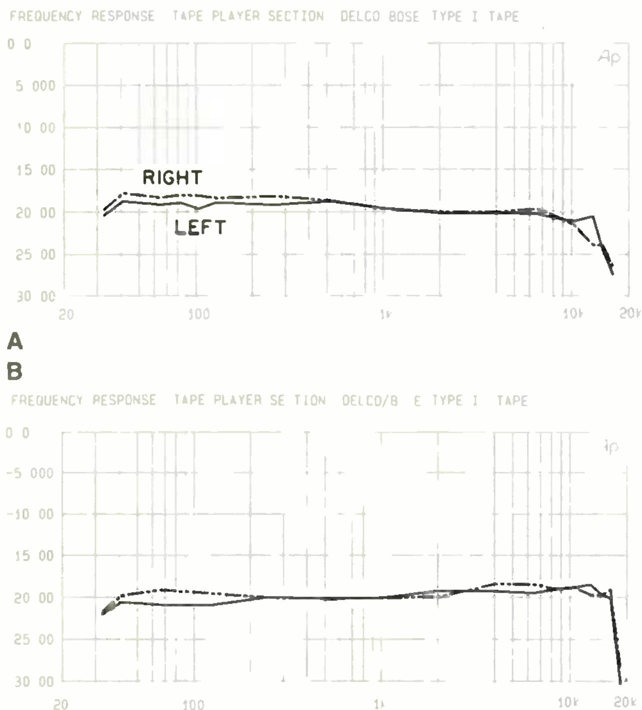

Fig. 16—Frequency response playing Type I (A) and Type II (B) calibration tapes; 0 dB equals 250 nWb/m.

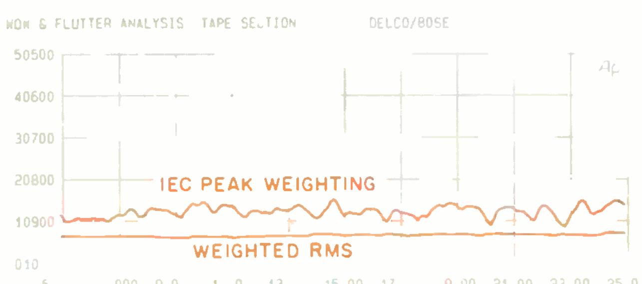

Fig. 17—Wow and flutter.

up. Both have compression on CD, but only in the Corvette did I feel the need to use it. The Cadillac's all-metal body also makes a better ground plane for its antenna than does the metal plate implanted in the Corvette's, so the Cadillac gets better FM and AM reception than the 'Vette does, even though its tuner section is precisely the same. In Manhattan's Lincoln Tunnel, the Corvette picked up some two-way radio signals, while the Cadillac ignored those and managed to play AM broadcasts for the tunnel's entire length—the first tuner we've tried that has accomplished this.

Ergonomically, the Cadillac was good and the Corvette even better. The controls on both were big, widely spaced, and logically laid out. Pressing the center of the Cadillac's bass, treble, and volume rocker switches set the tone controls to flat and the volume to a low, almost muted, level. I liked the Corvette's knob controls even better, though I would prefer a slightly larger knob for volume, and I found the Corvette's bidirectional seek tuning more useful than the Cadillac's unidirectional seek and scan—though not as useful as scan plus bidirectional seek would have been. Future Cadillacs will have bidirectional seek, however. Tape insertion was awkwarc, but I liked the fact that the same controls operated both the CD and cassette transport functions. The Corvette's stereo controls are nearer to hand than the Cadillac's, but then the 'Vette is a cozier car—and its panel layout makes stereo operation a bit awkward for the passenger. Editor Gene Pitts found the Cadillac's controls a long reach and the Corvette's to be somewhat obscured by the shift lever; perhaps because I'm taller, I had no such problems.

I got my first brief exposure to these sound systems last year, at which point I thought the Cadillac was lushly spacious but a little woody sounding, and the Corvette was warm and intimate; this time around, I found the Cadillac less woody. Bass extension was okay, almost to the bottom of Ray Brown's lowest bass-fiddle run on "You Look Good to Me" (*We Get Requests*, Oscar Peterson Trio, Verve 810 047 2); sine-wave checks of the Corvette system showed a gradual roll-off but still substantial output at 40 Hz, faint output at 32 Hz, and nothing audible at 20. Bass was a bit tighter in the Corvette than in the Cadillac, whose low end Editor Pitts described as "pillowy." Overall, the Corvette's sound was rich and mellow, with a very faint nasality, and a top end that lacked some crispness and excitement but also avoided stridency. (The treble seemed softer in our L98 test coupe than I'd remembered from the ZR-1 that had been demonstrated to me last year, enough so that I needed reassurance from Delco that the L98 also had the heretical tweeter.) On tape, the sound got a bit steelier but was otherwise okay. Announcer voices were crisp and natural but with some car-radio boom in the Cadillac. Frequency response on AM was pleasantly wide, in the "Stereo" position, a virtue of many Delco head units; looking back at Len Feldman's measurements now, I'm surprised at how small the measured difference is. I thought overall sound balance was about right when on the road and consequently a bit bass-heavy when sitting still.

In both cars, centered (mono) sound sources seemed to be coming neither from dead ahead of the listener nor from the car's center line, but from a point between. The stereo image seemed rather shallow, especially in the Corvette. We noticed a slight whir from the Cadillac's CD drive during fast forward.

The price of the Delco/Bose Gold system varies with the car. Both the Sedan deVille and the Corvette come with sound systems comparable, according to installer Tony Igel of Stratford Mobile Sound in New York, to aftermarket sound systems in the $650 to $700 range. Trading up to a Delco/Bose Gold system with tape alone adds $576 to the price of the Sedan deVille, $823 to that of the Corvette. Substituting CD, in the Cadillac, raises the ante to $873, while adding CD to the Corvette raises it to $1,219. (So far, the only Cadillacs that offer dual-play systems are the Allanté and the Brougham.)

Ivan Berger

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I remember when I first heard Spica's TC-50 speakers demonstrated at a Consumer Electronics Show. These little speakers with sloped front surfaces were on fairly tall stands, way out into the room. What I remember about the sound was that there was music in the room in three-dimensional space, and none of it seemed to be coming out of the speakers themselves.

I also remember reading about the introduction of the Angelus model, a good account of its theory, and a favorable review in another publication. My longtime friend and mentor, Gordon Mercer, who appreciates honesty of reproduction in speakers, has a pair of Angeli. I recently visited him in Prescott, Ariz. and was impressed with the sound of these speakers. A call to Spica's Claus Whiteacre got me a pair to evaluate.

The Angelus is a two-way system using an 8-inch woofer with a plastic rather than a paper cone and a 1-inch, impregnated-cloth dome tweeter. Price is $1,275 per pair. I understand that the Angelus was conceived quite a while before its final design was completed, due to the research required to get a suitable woofer. Not surprising; since the woofer is handling the majority of the musical range, it is extremely important to get a good one. As on the TC-50, the front baffle is slanted backward to get alignment in time of the two drivers on the listening axis. The shape of the enclosure is certainly unusual—like some kind of modern sculpture. The large enclosure size allows a nicely damped low-end response down to 35 Hz. Tapered, nonparallel sides of the enclosure, in addition to making for interesting aesthetics, reduce coherent resonances within. The unusual baffle shape helps keep the woofer radiating into 4-pi space over its operating frequency range. This is because the panel is narrow where the woofer is mounted. The larger panel width where the tweeter is mounted helps to keep the tweeter radiating into 2-pi space. Energy travelling along the baffle from the tweeter is absorbed by thick felt so that little energy is diffracted from the baffle's edges. Having such a large tweeter baffle carries the additional advantage of increasing the tweeter's radiating efficiency. All in all, this is an extremely clever and well-executed design.

The accompanying owner's manual, while not saying much about the design aspects of the speakers, is very informative about how to set them up and get the best sound from them. A nice sentiment in the introduction says that the Angelus design is dedicated to the memory of Richard C. Heyser, inventor of Time Delay Spectrometry, and that it is on the fruits of his labor that the work at Spica rests.

I had heard that these speakers take quite a long time to break in, so I had the factory beat on them for a while before delivering them to me. The first sound I heard out of these speakers was from my video system. I was immediately taken in by the potential of the speakers in this setup. Bass quality was especially good in that room.

Next, I set them up in my main listening room. After fooling with positioning and such, I got a sound that was indeed spacious, with a wide and deep


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Tonal honesty over most of the fundamental range covered by real instruments and voice is definitely one of the Spica's strong points.

soundstage. Tonal balance was good, with a tendency to be bright in the high end. Herein lies a tale. I found myself going through power amplifiers to get the softest sounding ones in order to help ameliorate the bright high end. The speakers sounded quite good driven by a pair of Cary Audio CAD-50SL mono amps, giving a much more natural high-frequency balance.

I have set up the Angelus speakers a number of times since, and each time, the high-frequency balance has gotten better, to the point where I can more or less use most of the amplifiers that I have and get good high-frequency sound. Since it took a fair number of listening hours to get to this condition, I have to agree that they take quite a long time to break in.

What do they sound like after a break-in? Tonal honesty over most of the fundamental range of real instruments and human voice is definitely one of their strong points. A critical friend thought he could hear a mild "honk" in the woofer's upper range. I have not been particularly aware of this in my listening. Dynamic contrasts are well reproduced within the power capability of the drivers. Low-level details and spatial cues are nicely delineated. At one point in my listening evaluation, when using the very powerful Carver Silver Seven tube amplifiers, I was playing a cut on *Däfos* (Reference Recording-12 CD) that I especially like, and I started turning it up and saying, "Wow, this sounds good! More level!" A horrible crack from the right woofer at a level that wasn't all that loud overall informed me that these speakers won't play real loud, and to do so with big amplifiers just invites woofer destruction. In this case, the one-time bottoming of the woofer voice-coil didn't seem to damage that driver. I would say from this experience that the speakers do a good job of playing classical music at close to realistic levels, but you shouldn't expect to play heavy metal loudly.

I am quite impressed with these speakers and have learned a lot by listening to them. For a modestly priced system, they do a very credible job of reproducing music. I would certainly recommend them to those whose priorities are in the music rather than the equipment. *Bascom H. King*

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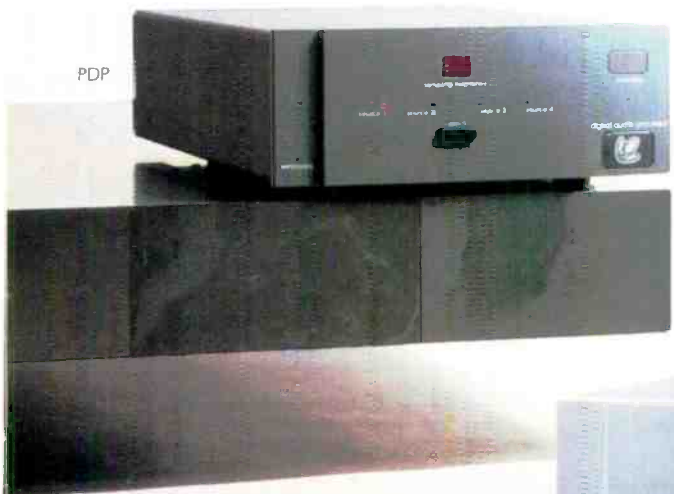

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WESTERN ROUNDUP

Illustration: Rick Tulka

Out West! Tone Poems of the American West. Seattle Symphony, Gerard Schwarz.
Delos DE 3104, CD; DDD; 73.52.

All three of the popular works on this Delos CD, Grofé's *Grand Canyon Suite*, and Copland's *Billy the Kid* and *Rodeo*, are unabashedly programmatic. There are no pretentions here—the music is meant to tell a tale and evoke romantic images of an old American West that always was more of a fantasy than a reality.

If there is such a thing as an "American" musical idiom, surely conductor Gerard Schwarz has a particular affinity for it, as exemplified by his splendid Delos recordings of symphonies by Howard Hanson, Walter Piston, and David Diamond. Schwarz is a very versatile conductor covering a broad spectrum of the classical music repertoire as is obvious from the diverse music he has recorded for Delos.

A certain synergism exists between Schwarz and Delos recording engineer John Eargle. Eargle is a trained musician—a pianist and an organist—as well as a brilliant recording engineer. Schwarz knows that whatever demands he makes on the Seattle Symphony in respect to dynamic expression or textural or instrumental clarity, Eargle will provide a very accurate recording with correct acoustic perspectives, and without sonic exaggerations for the sake of "sensational effects."

Thus, Schwarz performs the *Grand Canyon Suite* and *Billy the Kid* as if they were tone poems, secure in the knowledge that Eargle's recording will precisely mirror his performance. On the other hand, the music of *Rodeo* is quite clearly balletic in its scoring, and Schwarz emphasizes this especially in the foot-stompin', knee-slappin', ebullience of the final "Hoe-Down" section.

Schwarz elicits some truly magical orchestral colors and textures in his reading of the *Grand Canyon Suite*. The conductor continues to follow the European practice of "strings divisi," with first violins on the left side of the orchestra and second violins on the right. Thus, in the beginning of the final "Cloudburst" movement, we hear the hushed, ethereal, high-pitched strings of the first violins on the left, followed by the strings of the second violins on the right. Their tonal opulence and precision of ensemble playing are clearly revealed in Eargle's recording. Anyone who still harbors the notion that digital recording imparts a hard, strident, edgy quality to strings should listen to the smooth, sweet, natural quality of the strings in this recording.

Later on in the "Cloudburst," Schwarz whips his forces into an orchestral whirlwind in depicting the cataclysmic violence of the storm. In most recordings of this section, there is sound and fury, but usually rather amorphous and lacking in detail. Eargle's recording has tremendous dynamic expression but with all the clashing elements of Grofé's intricate scoring starkly detailed and stunningly realistic.

Billy the Kid opens with a passage of oboe and clarinet, which are soon joined by a flute, then a detached French horn on the left. This is then echoed by a distant flute, which clearly establishes an open prairie, "big sky" feeling of emptiness and loneliness. As Copland's evocative score develops, it conjures up images of a cowboy lopin' along on his cayuse. Copland has cleverly integrated a number of traditional cowpoke ditties such as the "Streets of Laredo," "Git Along Little Dogie," and "Bury Me Not on the Lone Prairie" into his score. In the climactic "Gun Battle" section, Eargle wanted to emphasize detail and dynamic impact. Eargle had the bass drum, normally tuned to 31 to 32 Hz, retuned to 35 to 36 Hz, which provides considerably more acoustic output. Be warned: This is a violent, high-level sound on this CD. To cleanly reproduce the gut-thumpin', explosive transients of these bass drums on this recording requires gobs of power and loudspeakers that can move a lot of air!

Take the superbly disciplined playing of the Seattle Symphony Orchestra, the perceptive, insightful performances of Schwarz, and John Eargle's exquisitely balanced, revelatory recording of these landmark works of musical Americana, and the result is a truly extraordinary CD. *Bert Whyte*

Lazarof: Poema; Tableaux; Icarus. Garrick Ohlsson, piano; Seattle Symphony, Gerard Schwarz.
Delos DE 3069, CD; DDD; 65:04.

Henri Lazarof is a contemporary Bulgarian whose compositional style is certainly not going to be Everyman's cup of tea, so to speak. But if you value

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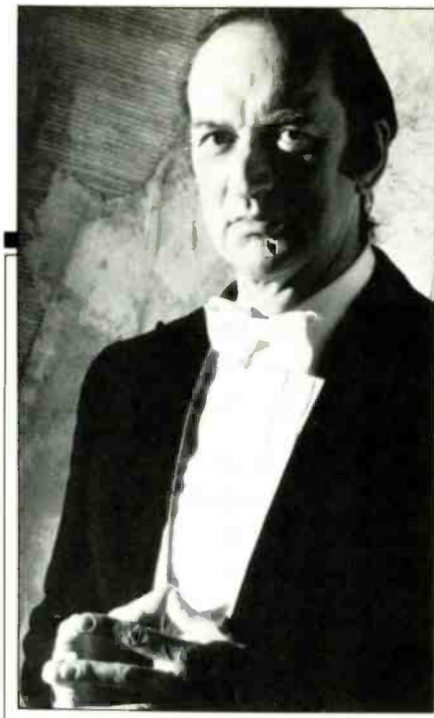

Nikolaus Harnoncourt is an elder statesman of the "authentic instrument" era, and most of us will enjoy these Mozart recordings.

gorgeous sounds gorgeously recorded, you owe it to yourself to hear this disc. From the most delicate of whisperings to the massive chords of its climaxes, Delos has captured all with outstanding sensitivity to timbre and internal detail.

"Poema" is an orchestral poem. "Tableaux," for piano and orchestra, is a suite of nine "pictures" inspired by the paintings of Wassily Kandinsky. "Icarus," which is Lazarof's second concerto for orchestra, was commissioned by the Houston Symphony and inspired by the work of NASA. Relationships between these seminal factors and the actual musical content of the works themselves can sometimes be guessed at, though none is intended as a literal, programmatic evocation of its subject. "Icarus" is probably the least baffling in this regard.

Robert Long

Schubert: Complete Songs, Vol. 6. Anthony Rolfe Johnson, tenor; Graham Johnson, piano.
Hyperion CDJ33006, CD; DDD; 73:21.

Schubert: Complete Songs, Vol. 8. Sarah Walker, mezzo-soprano; Graham Johnson, piano.
Hyperion CDJ33008, CD; DDD; 72:22.

Hyperion's project to record all of Schubert's songs moves on apace with its standards undiminished. These two volumes deal with "Schubert and the Nocturne." What might have been a lugubrious essay elsewhere—given the strong connection among the Romantics between night and life's darker emotions—is saved by Schubert's genius.

Graham Johnson is the factotum of the project. He not only accompanies all discs but writes the extremely illuminating (if somewhat effusive) notes, which contain full bilingual texts. His playing is very sensitive and expressive, and these singers match his work at every step. Tenor Anthony Rolfe Johnson has a fine, mainstream Lieder voice: Somewhat baritonal and unencumbered by quirks or mannerisms of vocal production. Sarah Walker's voice is exceptional in both quality and (but for a couple of very minor instantaneous lapses) her management of it.

With the obvious exception of "Der Erlkönig" in Volume 8, there are no "old favorites" on these discs. Don't let that slow you down. Schubert is Schubert, and this series really makes the most of it.

Robert Long

Mozart: Eine Kliene Nachtmusik; Ein Musikalischer Spass; Divertimento No. 11 in D, K. 251. Concentus Musicus Wien, Nikolaus Harnoncourt.
Teldec 244 809-2, CD; DDD; 70:30.

The "Little Night Music" of Mozart and the almost modern "A Musical Joke" are often put together. The Night Music is one of the most perfect gems of pure entertainment ever assembled and, unusual for Mozart, was not a commission but just done for himself. The Musical Joke is very much the opposite, a parody of all the student mistakes in composition that one could have imagined in that day of precision music. Being Mozart, the first of this pair seems offhand and unprofound to a first hearer—it grows over the years. The second is a parody mainly for the real professional in music, many of the "mistakes" being, one could say, very advanced. Perhaps like the mistakes an engineering student might make in designing an all-digital receiver. Even so, a few are hilarious, the horns playing extraordinarily wrong notes (horns are unique in their interpretation of ordinary notes on paper), the end of the piece a marvelously dissonant blat, hardly believable in that pure composer! The most untrained ear can sense the remarkable clumsiness, redundancy, stumbling harmonies that go nowhere, themes that are too short, endings that are too long. It's fun. And if you know all about parallel fifths, direct octaves, the (then) proscription against V moving to IV, you will be enchanted.

Nikolaus Harnoncourt is, by this time, one of the elder statesmen of the "authentic instrument" era whose style of conducting already has an oddly old-fashioned sound to it, a faint memory of the 19th century. There are for today's taste too many mannerisms and distractions; the tempi tend to be "different" and not necessarily those of Mozart's day—more likely those of Mr. H. himself. But he remains a fine musician, and most of us will enjoy his production.

The recording is long—this divertimento is one of Mozart's most endearing (or should I say diverting?) light works. Again, oddly unexpected tempi from Harnoncourt, not like anybody else. Other than that, the music he puts out from the original instruments (including horns) is generally communicative and respectful. This may be dinner music, more or less, but there is greatness for those who can enjoy it. *N.B.*: If I remember rightly, most of this little divertimento was contained in one of the very first post-World War II U.S. record albums, from a new label, Vox, a fat batch of 10-inch 78s. I loved the music then, I love it still.

Edward Tatnall Canby

Tangos. Arminda Canteros, piano.
McGill Records 750035, CD; DDD; 61:31 (Available from McGill Records, 555 Sherbrooke St. West, Montreal, QC, Canada H3A 1E3).

The full title tells what we are listening to and places it in time: *Tangos de la Guardia Vieja* (by the Old Guard). These are the best examples of the stylish, naughty, compelling Argentine dance to come out of its first great period at the beginning of this century. Arminda Canteros, the performer, pianist, and teacher, has the solid classical background so necessary for playing this demanding music with assurance but draws on a long life of playing tangos live and on the air in her native Argentina. This is as authoritative piano playing as you'll find, and the recorded piano sound is magic.

The way Canteros' sinewy, sensuous touch has been miked will be something of a surprise to those used to the

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Arminda Canteros is such a natural player that she coaxes lifelike, unforced sound in big and small moments alike on *Tangos*.

shallow, dimensionless sound this sort of music has often been accorded in studio recordings. The big, robust instrument is endowed with warmth and startling presence. Canteros is such a natural player that she coaxes lifelike, unforced sound in big and small moments alike. There is space around the piano, but not so much as to distract from the impact and gutsy thunder of the frequent low notes.

I was privileged to hear Arminda Canteros play these same pieces as the second half of a program of Argentine music at Lincoln Center's Alice Tully Hall. She moved slowly out from the wings—she is 78 and fought her way back to a playing career from a mid-50s accident that broke her spine—and sat down at the keyboard in a way more reminiscent of someone in her teaching studio than of a performer on stage. The moment her hands hit the keys was electric; out came sounds as unlike slick modern playing as it is possible to imagine.

There are some contemporary tangos on this CD. They hew very much to the half-formal, half-fantasia line of their '10s and '20s forebears, but tease "modern" harmonic rules delightfully. Though the disc is all tangos, it is not at all a same-tasting meal of unvarying small courses. The stunning piano sound and bewitching sensuality of the works by the *Guardia Vieja* are reason enough to send off for this disc, but Arminda Canteros' brand of sorcery at the piano is a welcome and very ear-opening antidote to the faceless glitziness of many recent piano recordings. Required listening!

Christopher Greenleaf

Sibelius: Symphony No. 6; "Scènes Historiques." Finnish Radio Symphony Orchestra; Jukka-Pekka Saraste, conductor. **RCA Victor Red Seal 60157-2RC.**

This CD is a real winner! The performances are quite exceptional, the playing of the orchestra is extraordinary from every aspect, and the sound is beautifully balanced and vividly realistic. The Sixth Symphony, a wonderfully evocative score, has been unjustly neglected. This performance, along with the rarely performed "Scènes Historiques," will truly delight any Sibelius devotee. *Bert Whyte*

Chausson: Symphony in B Flat; Fauré: Pelléas et Mélisande. The Radio Philharmonic Orchestra, Netherlands; Jean Fournet, conductor. **Denon 81757 3675 2.**

Ernest Chausson was a pupil of César Franck, and his Symphony in B Flat uses much of the same cyclical construction as Franck's D Minor Symphony. Fournet's performance is full of Gallic intensity and emphasizes the lush romanticism of the Chausson symphony. Fauré's brief "Pelléas et Mélisande" suite is an appropriate filler on this well-recorded CD. *Bert Whyte*

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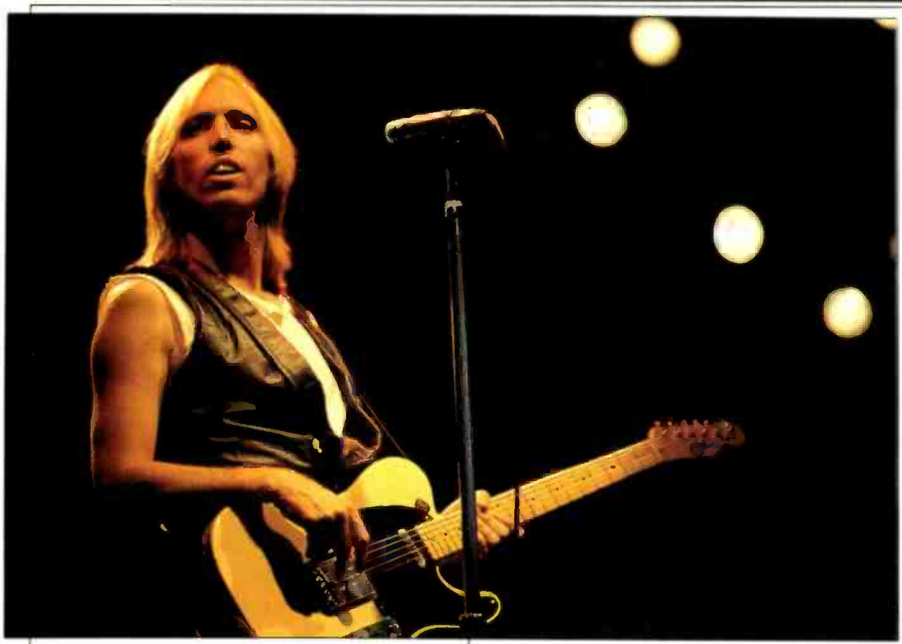

Photograph: ©Ken Settle

Into the Great Wide Open: Tom Petty and the Heartbreakers
MCA 10317, CD; AAD; 44:12.

Sound: A– Performance: A–

While it's almost unfashionable in 1991 to be a plain old rock band, Tom Petty manages to keep fresh. Last time you thought he'd run out of gas, he hooked up with producer/Eurythmic Dave Stewart and delivered a very successful record (Southern Accents). After several subsequent records, which seemed to indicate that he was falling into a rut, along came producer Jeff Lynne. Lynne and Petty's involvement in the Traveling Wilburys led to further collaboration on *Full Moon Fever*, Petty's first "solo" record. While we were both enthused and a little disappointed with the results of that joint project, it is with great pleasure that we can report that *Into the Great Wide Open* lives up to the promise of the Lynne/Petty collaboration, and stands as one of the more consistent Tom Petty and The Heartbreakers records.

First off, the stamp that Lynne seems to put on all his records—be they Wilburys, Brian Wilson, or Randy Newman—is still very much apparent; acoustic guitars blend in with the hi-hats to give songs like "Learning to Fly" the happy drive that radio embraces without a second thought, and the familiar backing vocals (most probably Lynne) makes one thinks he's listening to *Full Moon Fever* II. Mike Campbell's guitars fill a whole range of styles, from George Harrison-type bends on the excellent title track to his neo-metallic stabs on "Makin' Some Noise," a song he co-wrote.

Keyboardist Benmont Tench's contributions are not as noticeable here as they have been in the past, but he always has exercised great taste. It is Lynne, however, as producer, arranger, and co-writer of three-fourths of the songs, whose presence is felt almost as much as Petty's. No doubt this may not sit well with the band—Lynne is hardly the laissez-faire producer type who simply records what the band does—but the results speak for themselves. Not since the first three Heartbreakers records have these guys sounded this interested in what they're doing, and it's a given that the album will have more chart action than this group has gotten in a long time.

There should be no reason to complain given the previous text, but several things should be mentioned. "The Dark of the Sun" owes a little too much to Chrissie Hynde's "Back on the Chain Gang." There's not one track on here that sounds like it was made by a live rock 'n' roll band. And while Stan Lynch is a great drummer, his playing here sounds suspiciously like a machine. Some of the lyrics are a little self-conscious, but there is probably a critic who will love lines like "a rebel without a clue" on the title track.

This is classic Petty. In an age where the radio seems dominated by dance, rap, and metal, it's a pleasure to find an album that doesn't pander to what's in vogue on the charts. If this is state-of-the-art dinosaur rock, then Tom Petty and The Heartbreakers have a long way to go before becoming extinct.

Jon and Sally Tiven

Wild in the Backyard: Don Henry
Epic EK 46034, CD; ADD; 37:18.

Sound: A– Performance: A

Don Henry's album comes via Nashville, but Henry is no ordinary country singer/songwriter. He writes wry song-stories with richly etched characters and memorable melodies. The influences of such songmen as Steve Goodman, John Prine, and especially Randy Newman are keen in his work.

"Into a Mall" is about the evolution that has turned neighborhoods into malls and small towns into suburbs. "Mr. God" plays the flip side to Lyle Lovett's "God Will," as a last-resort supplicant hears an answering voice say, "That's *Mr.* God to you." "Heart Cut in Half" has one of the most heart-breaking melodies ever, upon which Henry spins the tale of a Catholic woman's growing discontent: "She went off to college/To unlearn the facts/And held the Bible differently/When she came back"—wonderfully tuned lyric play. His "Beautiful Fool," about Martin Luther King, is an eloquent closer.

Co-produced with Ray Kennedy, this is a superbly executed album. Henry's excellent fingerpicking guitar is at the core, and the support comes from a team of Nashville's best.

Wild in the Backyard is an auspicious debut by an artist who could easily fall through the cracks between genres but deserves far better.

Michael Tearson

88 Elmira Street: Danny Gatton
Elektra 9 61032-2, CD; ADD; 69:42.

Sound: A Performance: A

The Washington, D.C. area seems to have a knack for turning out guitar legends who build monster reputations locally before the rest of the country

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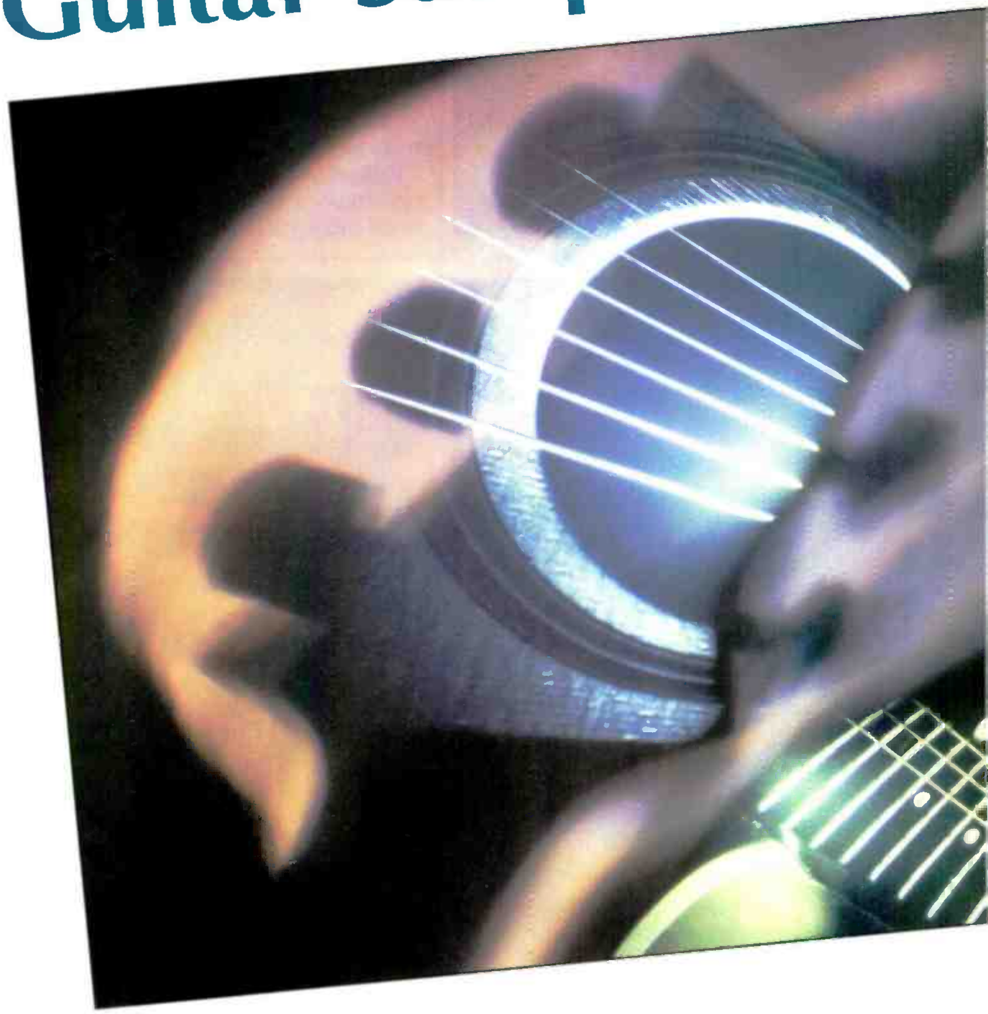

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On *88 Elmira Street* you can hear that Danny Gatton is more concerned with working the songs than just showing off chops.

even hears them. The late Roy Buchanan comes to mind. So does Danny Gatton, who's produced a few records on his own and now makes his major label debut with *88 Elmira Street*.

Probably the best way to describe this album is as a cross between countrified blues rock and '50s instrumental pop. Gatton's liquid guitar technique is truly phenomenal, although, like all the best artists, he's always more concerned with working the song than just showing off chops. Those listeners more musicologically inclined will pick out some definite influences. The raspy pickin' and Memphis horns of songs like "Funky Mama" and "Blues Newburg" owe more than a little to the Hoosier blueser Lonnie Mack, while Gatton's poppier moments pull together generous helpings of multi-tracked Les Paul, steel-bent Grady Martin (recalling Grady's solos on Marty Robbins' classic "El Paso"), reverb-heavy Jorgen Ingmann (remember "Apache"?), and the axeman behind the sax, Duane Eddy.

If these pedigrees aren't enough to whet your appetite, Gatton even continues his tradition of reworking popular TV themes with a boss, duelling banjo version of "The Simpsons." In short, *88 Elmira Street* is chock-a-block full of masterful licks and plain old fun.

Michael Wright

Guitars and Other Cathedrals: Adrian Legg
Relativity/MMC 88561-1045-2, CD; DDD; 55:37.

Sound: A Performance: A

A Peculiar Point of Balance: Tracy Moore
North Star Records NS0026, CD; ADD; 44:26 (available from North Star Records, 116 Chestnut Street, Providence, RI 02903).

Sound: A Performance: B+

A curious counterpoint is provided by Adrian Legg's and Tracy Moore's new records of "acoustic" guitar music. While both Legg and Moore play their own compositions in a fairly traditional finger-style manner, their approaches to exploring new sonic possibilities are quite different.

Englishman Adrian Legg (known for his books on customizing guitar electronics) plays a variety of acoustic-electric guitars that allows him to approach his tonal canvas with a palette of electronic effects at his command. Thus, for example, on songs like the country-tinged "Cajun Interlude" and the jazzy "Montreux Ramble" he employs touches of phasing and chorusing respectively. When his guitars fea-

Legg's *Guitars and Other Cathedrals* and Moore's *A Peculiar Point of Balance* are entertaining and sophisticated music.

ture less treatment, as on the ethereal "Thump the Clouds" or the cascading, almost Oriental arpeggios of the title cut, he still plays with wonderful stereo imaging effects, splitting his output into different channels in "real time." As a composer, Legg has a sense of humor and an excellent ear for folk-like, guitaristic melodies that will be hard to dislike. As a player, Legg favors a very precise, distinctive arpeggio technique, at times bringing to mind a comparison with either Albert Lee or John Renbourn. Not bad company.

A Peculiar Point of Balance, from Pacific Northwesterner Tracy Moore, paints tones using more traditional miking techniques on his twelve string guitar. Moore's compositions are folk-inspired although the source here is clearly American. Indeed, a "Swanee River Boogie" is included. Following what's now typical for finger-stylists, other instrumentals feature titles such as "Prelude—Brand New Sneakers" and "Bob Takes His Truck to the Dump;" in other words sit back, relax, and apply your own interpretation to each mood. Moore's style tends to be only slightly less "chordal" than Legg's. It is more in the mode of Windham Hill guitarists Will Ackerman and Daniel Hecht, and often carries more than an echo of the classic 12-string work of Leo Kottke.

Neither *Guitars and Other Cathedrals* nor *A Peculiar Point of Balance* offers revolutionary perspectives, but both are sophisticated and entertaining enough to warrant the consideration of anyone who likes instrumental acoustic guitar music. *Michael Wright*

Somebody: Connie Dover. **Taylor Park TPMD 0101.**

Connie Dover may be from Kansas City, but her musical heart surely lies in the British Isles. A veteran of playing Celtic music around K.C., she recruited Phil Cunningham to produce her debut disc. He brought her home to Edinburgh so that noted Scots musicians Manus Lunny and fiddler Aly Bain could take part. The result is an almost too-lovely album of mostly traditional songs and ballads. Dover's voice is a wonderful instrument, rich in tone with a sadness in it as old as the hills. *Somebody* is a truly auspicious debut. (Available postpaid from Taylor Park Music, P.O. Box 12381, North Kansas City, Mo. 64116; $11 for cassette, $16 for CD.) *Michael Tearson*

All American Boy: Vinnie James. **RCA 2387-2-RSP.**

Vinnie James' songs reflect a keen sense of being black in America. In a way that's more positive than confrontational, he addresses problems such as drugs that bleed neighborhoods, self-image, relationships, and politics. He ranges from folk to medium hard, with melodies sung in a voice that glides with ease from soulful grit to Elvis Costello to Prince. *Michael Wright*

LOST TRANE

Photograph: Frank Driggs Collection

Live in Japan: John Coltrane
GRP/Impulse GRD-4-102, four CDs; mono; AAD; 4:08:33.

Sound: B+ Performance: A

So what if it's mono; the point is, it's not monotonous. Rather, this John Coltrane four-CD set is downright cathartic. It's not intended for the timid, that's for sure. *Live in Japan* is thick with intricate passages, interplay, and extremely difficult improvisations.

Nonetheless, let's give credit where it's due. GRP—recently acquired by MCA and largely interested in issuing formulaic pop-jazz and uninspiring though Grammy and Oscar winning soundtracks—has done the right thing. The parent company's execs didn't want to bother with another of their properties—namely the famed Impulse catalog—so they instructed GRP to handle material from the prized vault. In turn, GRP serendipitously placed independent producer Michael Cuscuna in charge, and *voilá, Live in Japan*—an extraordinary set that marks the launching of the company's *The Legendary Masters of Jazz* series.

Quite a kickoff, indeed.

Live in Japan, a series of performances originally taped in mono for Japanese radio broadcast, contains much music never previously released in this country. In fact, only disc III, a 25-minute version of "Peace on Earth" and a nearly 45-minute reading of "Leo," appeared in the United States previously. The other recordings have been issued only in Japan.

This set documents Coltrane's only visit to Japan, a July 1966 adventure. At that point in time, a year before the master saxophonist's untimely death, Trane's band consisted of Pharoah Sanders (heard on tenor and alto saxophones, bass clarinet, and percussion), Alice Coltrane on piano, Jimmy Garrison on bass, and Rashied Ali on drums.

The six-song display captures Coltrane and band performing a series of the saxophonist's "tone poems." The Compact Disc format, of course, allows us to hear, uninterrupted and unimpeded, nearly hour-long renditions, and that makes this CD collection worth owning. And while Alice Coltrane's piano playing sometimes appears off in the sensory distance, little is lost aurally.

Disc I opens with "Afro Blue." Coltrane, with the help of his quintet, dissects this material on soprano sax for nearly 40 minutes before tackling "Peace on Earth" for some 26 minutes. Each of the half-dozen entries here are delivered with the intensity that only Coltrane had command of, particularly in the latter stages of his career.

Each composition requires several listenings, for the level of execution by all parties is impressive. Ali's drums and percussion work may be among his best ever—which is saying a lot. And for Garrison, who had numerous "greatest" days working with Coltrane, the nearly 15-minute, unaccompanied bass solo (one of two heard on the set), which opens and sets the tone for 57 minutes of "My Favorite Things," will send goose bumps up and down your back—especially when various percussion and Alice's modal chords enter the picture at the conclusion of this solo. All of this supporting music occurs, of course, before we hear John Coltrane's majestic and hypnotic saxophone (this time on alto before he returns to soprano) on what became his signature tune.

Disc II houses "Crescent," a familiar Coltrane composition of the day that, unfortunately, has since become somewhat lesser known. It, as does the entire set, showcases the multiple talents of Sanders who remains Trane's most successful progeny. While there may be a discussion concerning Sanders' capabilities and execution today, there is little doubt that a quarter-century ago the multi-reedman sounded fresh, thoroughly innovative, and possessed the ability and skills to act as Coltrane's ideal foil.

Live In Japan stands as an important entry and makes one wonder just how much more Coltrane material will—and should—become available in the future. *Jon W. Poses*

Triple Play: Lucky Peterson
Alligator ALCD 4789, CD; AAD; 41:46.

Sound: B+ Performance: A–

Cuttin' Loose: Chris Cain Band
Blind Pig BP74090, CD; AAD; 45:43

Sound: B Performance: B+

Lucky Peterson is a 21-year veteran of the blues world—at the ripe old age of 26. Already a hit novelty act while in kindergarten, Peterson honed his keyboard and guitar skills in his father's blues club. Tours with Little Milton and

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Blues multi-instrumentalist Lucky Peterson is probably the only blues organist you'll ever want to hear more than once.

Bobby Bland followed, along with steady studio work for both Alligator and King Snake Records.

Triple Play suggests that Peterson spent as much time listening on the road as he did playing. He's become a convincing vocalist in the gospel-based style favored by Milton and Bland. As if to prove the point, he more than holds his own in a Sam and Dave-styled duet with Lester Chambers on "I Found A New Love." His keyboard experience taught him how to anchor a band, but credit his years as a sideman with teaching him the value of airtight arrangements. "Six O'Clock Blues" shows how well he's learned. His moving performance is built around thundering horn crescendos that would overwhelm most singers.

Lucky Peterson is among the best of the new generation of blues pianists and probably the only blues organist you'll ever want to hear more than once. To top it all off, he's also got guitar chops sufficient to launch a second career. *Triple Play* is a great album from a truly multi-talented bluesman who will make his mark in the '90s.

Was *Cuttin' Loose* shipped in the wrong jacket? That might well be your first reaction to this polished, hard-driving blues set which is concealed beneath some misleading cover art. Chris Cain's vocals transform lyrics into unmistakable truths, and songs into hard-won lessons in life. To hear him lament "Sometimes I think that I should call/ But I can't figure out what I want to say" is to share pain tempered with obligation and confusion. His B. B. King-styled guitar work flows with a rare melodic sense that's often abandoned in the rush towards screaming distortion. Titles like "You're The Kind of Woman That Ain't That Hard To Find" hint at his considerable skill as a songwriter.

Authority and conviction don't come easily. Yet the Bay Area bluesman on the jacket is a smooth-faced kid who's barely 30, according to the press notes. B. B. may be his major influence, but he's long past the clone stage. No imitator would ever have the assurance to sing behind the beat or mix guitar styles while his band cooks. There's not a stiff track among the album's shuffles, piano blues, and romps through New Orleans syncopation. If Cain is this good live, he won't be obscure for long. *Roy Greenberg*

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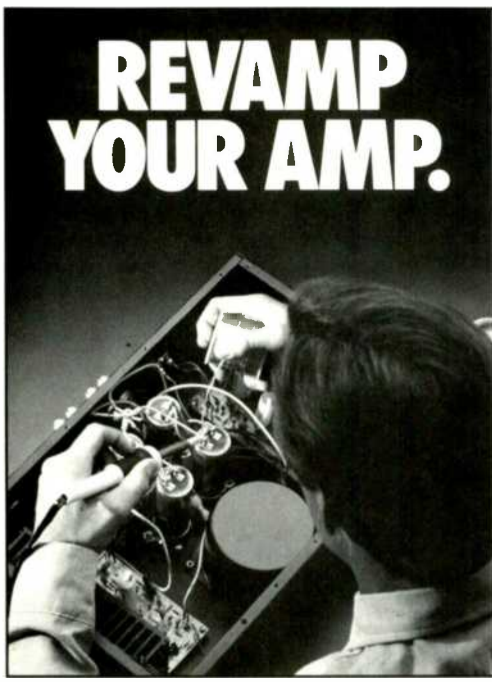

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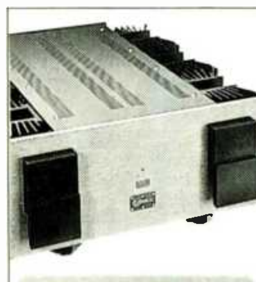

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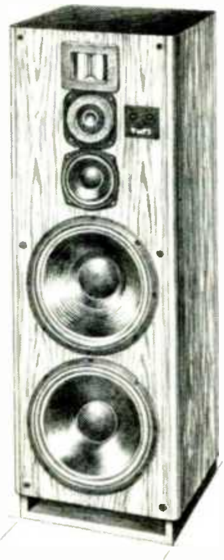

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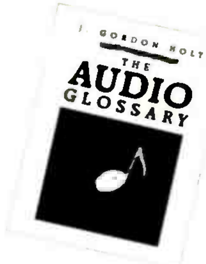

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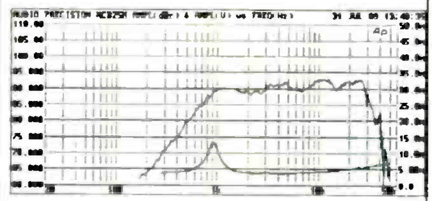

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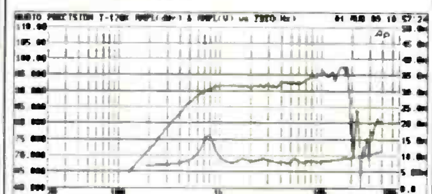

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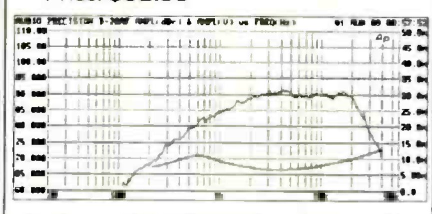

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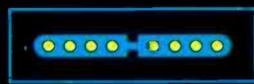
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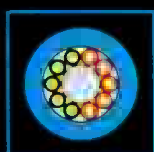
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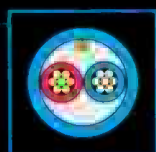
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