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TWO'S COMPLEMENT

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The PDT digital transport combines our PCD transport mechanism with active circuitry which supplies a superior quality digital output to complement an external processor. An ideal component for those seeking the highest level of sonic performance from compact disc.



& PROCEED



SIGNALS & NOISE

For Tweaking, Coke Is It Dear Editor:

I read your article concerning the problem of open-reel tapes encountering excessive friction with the tape drive mechanisms, ("Archival Revival" by Michael N. Stosich, November 1990). Among my collection of openreel tapes, I encountered this problem with two tapes that I was dubbing to cassette. I believe I have come up with an extremely effective (albeit low-tech) and low-cost solution to the problem. (I can't afford to buy high-tech lubricants and gizmos, and I will *not* buy an oven to bake by tapes!)

After several hours of trying various schemes to hold back the spring-loaded tape guides, and applying silicone lubricants to the tape with Q-tips, I determined that the main source of friction came from the metal guideposts of my Sony TC-377 three-head tape deck. To reduce the friction, I improvised a narrow (2 × 1/4-inch) plastic strip from a Coca-Cola six-pack holder, wrapped it around the lead-in tape guidepost, and the friction problem disappeared. This plastic is slick and slippery enough to allow squeaky tapes to play without audible distortion-at least for one pass of the tape when dubbing

The same effect can probably be accomplished by cutting a segment of a Teflon stirring rod (found in any good chemistry lab) and rigging up substitute tape guideposts. The second solution was my original plan, but the tape friction problem occurred on a Sunday, when I was unable to obtain a Teflon stirring rod.

> William K. Tong Chicago, Ill.

It's Over, Over Hair

Dear Editor:

I read with interest F. Alton Everest's "Muffling the Neighbors: Ten Tips To Reduce Noise" in the November 1990 issue.

Early in 1978, we built a sound room in our third-floor store. Downstairs from us is a hair salon. The landlord was concerned that sound from our loudspeakers would disturb the patrons of the salon. Our solution was to put an additional floor in the sound room. We floated it on a layer of sand divided by wood furring strips. About a ton was

added to the mass of the $141/_4 \times 191/_2$ foot floor. And, since sand is inert, noise transmission was substantially reduced. In fact, we've never had a single complaint—even though we often demonstrate speakers at levels up to 105 dB SPL.

The most happy by-product of our construction is that our clients are not distracted by the noises generated by the hair salon. Another is that one of our clients rented our sound room to make noise measurements on some fans he was evaluating. He found the ambient noise in our room lower than in the anechoic chambers available in the greater Boston area!

> Rich Oakley Electric Gramophone Sudbury, Mass.

Of Oil and Water

Dear Editor:

Audio is a great magazine!

Please keep it that way by keeping video out. True audiophiles don't give a damn about Star Wars or Top Gun. Let "vidiots" buy video magazines, and keep Audio a magazine about music and sound! Good tunes, good work!

Leland A. Beaman Vacaville, Cal.

Speaking Out, Loud

Dear Editor:

Audio's 33rd Annual Equipment Directory (October 1990) forcibly emphasizes how the magnitude of consumer choice has multiplied over the decades to overwhelming dimensions.

Look at the Loudspeakers section of the Directory: In 1990 there are nearly 1,800 speaker models by some 280 manufacturers! Surely this is free-enterprise overkill. It's inconceivable that-even in something as subjective as speaker performance-it takes 1,800 variations to accommodate all possible preferences. Further, it's unthinkable that anyone could possibly evaluate 1,800 speakers in choosing. In this era of highly sophisticated, computer-designed technology, surely every need and taste could be precisely met within a range of, say, 350 models. At lower prices.

The existence of so many competing models must deny consumers the benefits of economy of scale. Our ma-



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Also, this CD changer is so flexible it can connect to virtually any existing car stereo with the CY-RM15 or the CY-RM16 controllers.



However, if you also want a new car stereo, there's the CQ-L40 and the CQ-L30 cassette receivers. They both have 50 Watts maximum power, wireless remote, are removable and connect directly to the CD changer to give you full system control.

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Technics developed the MASH one bit DAC_NTT (ESLabs) invented MASH technology_NTT has applied for trademark registration for MASH



Panasonic just slightly ahead of our time Enter No. 33 on Reader Service Card It's inconceivable to me that it takes 1,800 models of speakers to accommodate all possible preferences.

terial standard of living largely results from the fact that the manufacture of a product in large numbers reduces its per-unit cost, so that it can be sold at a price within the reach of large numbers of customers. This is not the case with many speakers today; with so many manufacturers focused on the affluent,

elitist, high-end market, most of these companies must enjoy only a minute share of it. No wonder a pair of loudspeakers may be priced at \$5,000 or more—they're practically custom made! They may be priced to make a profit above research and tooling costs on a volume of perhaps 100 pairs a



year; think how much less costly the same speakers could be if the manufacturer's share of the market amounted to 1,000 or even 5,000 pairs annually. Most specialty manufacturers hope to capture more than their statistically prorated share, naturally at the expense and ultimate demise of less successful competitors. I'm not sure it works this way, though. While one expects the natural attrition of entrepreneurs to winnow out superfluous products, it appears that for each company that drops out, there are two more hopefuls entering the arena.

I don't offer a solution to this inefficient, economy-defeating proliferation of small-volume ventures—this embarrassment of riches in choice. Such is free enterprise, and I don't propose any reins on it. But I, for one, certainly wouldn't enter the speaker manufacturing business today! And I'll never be able to afford any high-end speakers, either.

> R. H. Coddington Richmond, Va.

When Feedback is Positive

Dear Editor:

6

Our audiologists and physicians are most impressed by Dan Sweeney's article, "Digital Signal Processing for the Hearing Impaired: Parallel Universes," in the September 1990 issue. We feel the article provided a thorough yet highly readable overview of hearing aid development. Although not the primary objective, it also provided the normal-hearing person a view into the technological and functional problems encountered by the hearing-impaired person.

This is one of the first articles ever written for consumers regarding differences in hearing aid technology. Only when consumers are educated about hearing aid technology will they understand both the benefits provided by hearing aids and the characteristic limitations of the hearing-impaired ear. Ignorance about hearing aid technology is sometimes the hearing-impaired person's greatest disability. Your article goes to the heart of overcoming that ignorance.

C. Scott Mills, M.A. Director of Audiology Forsyth Head and Neck Associates Winston-Salem, N.C.

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WHAT'S NEW

Klipsch Loudspeaker

The Forte II uses a newly designed hybrid midrange horn for more open and detailed sound and smoother off-axis response, while its woofer section has a vented voice-coil driver and a sub-bass radiator. Total system sensitivity is rated 99 dB SPL, and onaxis frequency response is 32 Hz to 20 kHz, ±3 dB. Price: \$1,198 to \$1,360 per pair, depending on finish. For literature, circle No. 100



Sansui A/V Receiver

Surround facilities are prominent on the RZ-9500AV. Its surround decoder has Dolby Pro-Logic plus three music codes, and five channels of amplification are built in. The Pro-Logic decoder has three surround modes, using all five speakers, front and center only, or



Hi-Fi News Test CD

The British magazine. Hi-Fi News & Record Review, has produced its second test CD. It includes channelidentification and phasing tests, nearly 20 musical tracks to illustrate different recording techniques, two sound-effects tracks, and 77 tracks of test signals. Price: \$30. shipping included

For literature, circle No. 101



Yamaha Car Tuner/CD Player

A new Flex Load system allows CDs to be loaded into the YCDT-720 either in a Yamaha protective cartridge or directly. When



it gets noisy in the car, a compressor circuit can be switched in to reduce dynamic range and raise signal level. The tuner uses Yamaha's Maximum Reception III circuits, which the company says improve multipath rejection and sensitivity, and it has presets for 20 FM and 10 AM stations. The chassis is removable for theft protection. Price: \$599. For literature, circle No. 102 front and rear: the music modes include "Hall" and "Stadium" for stereo music. plus an ambience synthesizer for monophonic material. Variable digital delay is available in all surround modes, and surround settings can be stored in memory. The front amplifiers deliver 100 watts per channel at no more than 0.02% THD, and distortion is no more than 0.05% for the 40-watt center channel and the two 30-watt rear channels; all figures are for 8-ohm loads, from 20 Hz to 20 kHz. Preamp outputs and poweramp inputs are also provided for all five channels. The tuner has usable FM sensitivity of 11.2 dBf, and is rated at 38.2 dBf for 50-dB quieting in stereo. Thirty AM and FM stations can be memorized, together with five-character alphanumeric notations which can include station call letters or program formats. A remote control that can learn commands for other components is included. Price: \$769.95. For literature, circle No. 103

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The Who-Who's Better, Who's Best (MCA) 376+657



George Benson—Big Boss Band Featuring The Count Basie Orchestra (Warner Bros.) 412-478 Steppenwolf—16 Greatest Hits (MCA) Jerry Lee Lewis—18 Original Sun Greatest Hits (Rhino) 369-108 Marvin Gaye—Greatest Hits (Motown) 367-565 Jethro Tull—Thick As A Brick (Chrysalis) 367-136 Trafflc—John Barleycorn Must Die (Island) 364-935 Supertramp—Classics Vol. 9 (A&M) 364-471 Take 6—So Much 2 Say Wilson Phillips. Release Me; Hold On; Impulsive; mare. (SBK) 406+793

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 (Atlantic)
 411.322

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Woodstock—Orig. Soundtrack (Atlantic) 291.864/391.862



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CAFE

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Public Enemy -Fear Of A

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HERMAN BURSTEIN

Maximum Recording Time

In the June 1990 issue, reader Steve Mallon of Chicago raised the question of how to get maximum recording time on a reel of tape. He was inclined to use open reel rather than cassette. Using an 1,800-foot reel and recording four mono tracks at 3³/₄ ips, he would get over six hours on one reel and maintain good quality.

Reader William I. Whitten of Birmingham, Alabama chides me for not having pointed out an alternative: Use of a Hi-Fi VCR. At the EP (slowest) videotape speed, a T-120 tape would provide six hours of uninterrupted high-quality recording. To this I would add that a T-160 videotape would provide eight hours. And going back to open reel, recording at 1% ips on an 1,800-foot reel would yield 12.8 hours, still maintaining good quality if the deck is a good one. A 2,400-foot reel would yield 17.1 hours and a 3,600-foot reel, 25.6 hours. And so on ... and on.—*H.B.*

Use of a Bias Control

Q. According to the instruction manual for my cassette deck, which has a bias control, "10% less bias is provided when the knob is fully counterclockwise, and 10% more bias is provided when it is fully clockwise." Please explain bias and how it is affected by the control. Also, in Howard A. Roberson's review of 88 cassettes in the March 1990 issue, the bias for Sony's UX-Pro tape was listed as +1.3 dB. What setting should I use for this particular Type II tape?—Chris Murphy, Albany, N.Y.

A. The purpose of bias current, which is employed in recording and fed to the record head along with the audio signal, is to maximize the amount of signal recorded on the tape and to minimize distortion. Unfortunately, as bias is increased to minimize distortion, the bias field tends to erase the tape (in the same manner as the erase head does), particularly in the treble range. That is, bias erasure increases as frequency rises. Therefore, the deck manufacturer seeks to optimize bias to have not so little as to incur excessive distortion, and not so much as to incur excessive treble loss.

Optimum bias varies according to tape type: Type I requires the least amount, Type IV (metal particle) requires the most, and Type II falls in between. Cptimum bias for a given tape type also varies according to brand and formulation within brand. The March 1990 article indicates how optimum bias varied with respect to a standard level. Apparently, the Sony UX-Pro tape required 1.3 dB more bias than standard—at least in the decks employed by the reviewer.

Your best way of optimizing bias for a given tape type, brand, and formulation is as follows: Record FM interstation noise at a level about 10 to 20 dB below 0 VU as indicated on your deck. Through trial and error, find the bias setting which yields recordings that sound most similar to this interstation noise when played back. If yours is a three-head deck, which allows simultaneous recording and playback, it's easy to compare results at different settings against the original noise. It's not too hard to accomplish with a twohead deck, because the noise at a given point on your tuner's dial will stay fairly constant, not changing from moment to moment as radio programs do. If you use noise reduction, you should theoretically follow this procedure with NR off; in practice, you may well find it best to follow this procedure with NR on. If you don't have an FM tuner, you will have to adjust bias on the basis of a CD or LP that contains a substantial amount of high frequencies.

A Peak at Levels

Q. My deck has peak-reading meters. At approximately what levels should the peaks read when I am recording? When setting the record level, should I aim for equal readings on the left and right meters? If so, should I aim for equal peaks or equal average levels? Also, when I move the recordlevel knobs to the same physical positions, the meter for the left channel consistently reads higher than the right-channel meter.—Stuart Munro, Brighton, Mass.

A. With peak-reading meters, one should ordinarily set recording level so that the peaks hit 0 dB or a few dB above; consult your instruction manual on this. Also, experiment with successively higher recording levels until you find the point where distortion or treble loss becomes evident, then back down about 1 to 3 dB. Assuming that the meters are properly calibrated, so that equal readings produce equal levels on the tape, one should set the controls so that the two channels produce the same reading on average. If equal physical settings of these controls always produce a higher reading for the left channel, either one or both of the meters or the knobs is miscalibrated. However, if the difference is slight, you should not find it difficult to compensate by adjusting the knobs and live with the situation until something more serious forces you to the repair shop.

LAPF (GL

A Missed Point

From time to time, I have made comparisons between Type I and Type II tapes. In the main, these comparisons have favored Type II, although not always. Donald Bisbee of Columbus, Ohio writes:

You miss one very important point. Type II tapes need a bass boost in order to perform as well as Type I cassettes. Such boost is rarely, if ever, provided by the Type II setting of a cassette deck, so that there can be a loss of over 6 dB at 50 Hz. While Type II tapes at one time did have superior high-frequency response, ferric tapes (Type I) can now equal or surpass them in current formulations. This, combined with superior bass and lower price, make ferrics my usual preference. I think that ferrics sound significantly better.

I consulted on this matter with Howard Roberson, who every few years reviews a batch of tapes for *Audio* (the latest being a review of 88 tapes in the March 1990 issue). He stated that, yes, he has found *some* Type II tapes with appreciable bass compression, so that bass boost is required in playback for flat response. However, he has also found the same problems in some Type I tapes.

I find that Type I tapes have been getting better and better and often do outperform Type II tapes in important respects. As always, one's ears should be one's guide.—*H.B.*

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



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LIVING IN THE PRESENCE

JOHN EARGLE



By the time I joined Mercury Recording Corp. in 1969, the "golden era" of Living Presence recording had passed. The meticulous work of Wilma Cozart Fine, Robert Fine, and Harold Lawrence had ended in the mid-'60s, and Mercury, through its acquisition by North American Philips, was on its way to becoming essentially a distribution company for product generated by Philips in Europe.

During that golden era, Bob Fine was the engineer in charge, and his wife, Wilma Cozart Fine, was Mercury's recording director. Their approach to recording was both simple and demanding. Once the appropriate hall had been chosen, three omnidirectional microphones were very carefully deployed in a left/center/right array across the front of the musical ensemble. In the early years, the outputs from these mikes were fed, with no further signal processing or gain manipulation, to three tracks on half-inch tape. Beginning in 1961, they were recorded to three magnetic tracks on 35-mm film.

After subsequent editing of the master, all lacquer disc transfers for stereo LP production were cut directly from the three-track master sources, with the middle track split equally between left and right. This activity was carried out at Fine Recording Co. in New York, using the same equipment on which the recordings had originally been made.

When the Mercury studios took over the masters during the mid-'60s, twotrack transfers were made and used for cutting disc masters. This was, of course, standard procedure in the industry at the time. During the early '70s, Dolby transfers were made to remove most of the noise generated in this extra step.

The Mercury masters were kept under archival storage conditions at the

As with the first CD reissues from Everest, the first batch from Mercury is cause for music lovers to rejoice.

New York studios on West 57th Street until the studios were closed. All original and working masters were then sent to Holland. Prior to this, however, one last set of transfers from three to two tracks was made and sent to Philips for producing the Mercury Golden Import series, which came out in the mid-'70s. Although the pressing quality was excellent, this later series of records was not able to displace in the minds and hearts of aficionados the early U. S. releases that had been supervised by the original recording and production team.

It had been a while, then, since anyone from the original team had been involved in transferring the originals. However, after an unsatisfactory CD release a few years ago taken from an earlier transfer, PolyGram, now the parent company of Mercury, decided that any further transfer activities should be entrusted to someone who truly knew what had to be done. That person was Wilma Cozart Fine, and she has been working on the project for about two years.

As with the Everest CD reissues I discussed in the January 1990 issue, the first batch of Mercury Living Presence CDs is cause for music lovers to rejoice. I am sure that many strategies were considered, including the digital removal of the very slight tape hiss in these recordings. The strategy chosen was straightforward and remarkably like the original method of disc transfer. Wilma Cozart Fine had kept the original Westrex mixer and film dubber in mothballs for years. These were reconditioned, tube amplifiers and all, and the original equalization curves were painstakingly determined. This array of '60s audio technology was connected to the latest analog-to-digital conversion technology, and digital transfers to the Sony 1630 format were made for Compact Disc mastering and production.

The first 10 CD releases are now available, with more to come on a regular basis. There were about 250 albums in the original Living Presence series, so there is much to choose from. Highlights from the current set include:

• Liszt: Piano Concertos Nos. 1 and 2; solo piano works. Byron Janis, piano, with Kiril Kondrashin conducting the Moscow Philharmonic Orchestra and Gennady Rozhdestvensky conducting the Moscow Radio Symphony (Mercury 432 002-2).

• Ibert: Escales; Ravel: Rapsodie Espagnole, Alborada del Gracioso, La Valse, Le Tombeau de Couperin, and Pavane. Paul Paray conducts the Detroit Symphony Orchestra (432 003-2).

• Hanson: Symphonies Nos. 1 and 2; Song of Democracy. Howard Hanson conducting the Eastman-Rochester Orchestra and the Eastman School of Music Chorale (432 008-2).

• Respighi: The Birds, Brazilian Impressions, Pines of Rome, and Fountains of Rome. Antal Doráti conducting



Sony D PolyGram decided that any new transfer activity would be entrusted to someone who truly knew what was needed, Wilma Cozart Fine.



the London and Minneapolis Symphony Orchestras (432 007-2).

• Dvořák: Cello Concerto in B Minor; Bruch: Kol Nidrei; Tchaikovsky: Rococo Variations. János Starker, cello, and Doráti conducting the London Symphony Orchestra (432 001-2).

Other releases include works by Prokofiev, Mussorgsky, Kodály, Bartók, Schoenberg, Webern, and Berg.

Those who know the originals will notice that these new releases are longer in playing time; most are more than one hour. Albums have been combined or augmented with extra program material, as appropriate, and the original cover art of the main source albums has been retained. The liner notes are likewise taken from the originals.

Having heard the original tape and film sources for many of these releases, albeit many years ago, I am not the least surprised by the sound of the CDs. It is as accurate as I can imagine, and it reinforces my view of the Compact Disc as a medium of archival quality for the consumer. It is interesting to read in the September/October 1990 issue of The Absolute Sound that a group of reviewers from that publication was invited to the PolyGram tape studios in Edison, N.J., to audition the new CDs in an A/B comparison with the analog sources. Most of the reviewers were unable to consistently tell which was which, although this does not necessarily rule out the possibility

that, under more stringent monitoring conditions, differences might have been consistently audible.

I cannot begin to count the number of people who, over the last seven years since the introduction of CD technology, have stated their desires for a CD reissue of Howard Hanson with the Eastman-Rochester Orchestra performing American music in general and Frederick Fennell with the Eastman Wind Ensemble in particular. They can rest assured that if their favorite catalog items are released, at least it will be done right!

A note on Bob Fine's recording technique might be in order. His background was in film mixing, an art that requires quick judgments, accurate reflexes, and an ear for clarity of detail. He was known during the early years of multi-track recording as an engineer who didn't need multi-track! Many of the Enoch Light big band albums on Command Records of the late '50s and early '60s were mixed directly to two or three tracks, an art which is practiced today by too few engineers. When Fine turned his attentions to classical recording, he eschewed any notions of mixing during the recording. He generally chose moderately live acoustical spaces and placed the three microphones fairly close to the source so that the music was never lost in the reverberant field of the room. There is always plenty of detail, yet there is ensemble, too A

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JOSEPH GIOVANELLI

Damaged Subwoofer Dust Cover

Q. During the installation of my subwoofer, my daughter punched in the dome of the woofer cone. After I had calmed down, I repaired it. This was done very carefully with a needle pulling out the dome by pricking the outer layer of material and pulling up. The system sounds great and I can't tell that there has been any loss of sound quality because of this. I am concerned, however, about any longterm effects that may ultimately degrade the performance of the woofer. Do I have to worry?—Jeff Mason, Alta Loma, Cal.

A. I don't think you have anything to worry about regarding your subwoofer. By the way, if the center dome (dust cover) is ever pushed in again, try sucking it out with a vacuum cleaner. That approach works well. As you know, your solution also works, but there is a real danger of tearing the dome with the needle. Even if that happened, the sound would likely remain unchanged. I suppose that over a period of time, dust could find its way into the voice-coil structure. The main purpose of this dust cover is to prevent just that from happening.

Noisy Power Transformer

Q. I recently purchased a new amplifier—very expensive! After it is operating for about 5 minutes, I hear a buzzing coming from the power transformer, not the loudspeakers. For the next half hour, the sound increases in volume and finally levels off. If the room is quiet, I hear the noise very well. If there is music playing, I would have to stand next to the unit to hear the noise. Is this a normal occurrence or is there something wrong with my equipment?—Robert Bigaouette, Brooklyn, N.Y.

A. In most instances, very little sound will emanate from the power transformer. Certainly if the unit is still under warranty, you should ask for a replacement or for a repair.

The sound you hear is the result of the vibration of the laminations that compose the transformer's core. Transformer cores are dipped into a compound to bond each lamination to its neighbor to prevent just the kind of sound you are talking about. When the bond between laminations is poor,

each one is free to vibrate in accordance with the a.c. in the primary winding. As the transformer heats up, expansion may permit the laminations to loosen, making them freer to move.

In some instances, it is possible to stop or reduce this annoyance by tightening the screws that hold the elements of the transformer together. (Unfortunately, not all power transformers have such screws; some are held together with clips.) It is also sometimes possible to improve matters by tightening all of the bolts that mount the amplifier to the chassis.

Sometimes the noise can be reduced by placing the amplifier on a different surface—one that has less tendency to act like a sounding board. If relocating the equipment is not practical, try placing small pieces of foam under each corner of the chassis. The foam must be dense enough so as not to completely collapse under the weight but must still give a bit. These blocks will isolate the amplifier from the shelf and reduce the sounding board effect.

Subwoofer Boominess

Q. My subwoofer is enclosed on the bottom level of a Formica cabinet. Every time I use it, the sound is boomy. I can't remove the subwoofer from this cabinet because I just had the cabinet made specifically to house the subwoofer and 16 other audio and video components. The enclosure housing the subwoofer is felt-lined; there is approximately 1 foot of space between the rear of the subwoofer and the back of the cabinet, and no space on either side. Just the face shows at the front of the cabinet. I should add that this cabinet is next to a wall. Is there hope of solving the boomy sound?-G. Lipton, North Woodmere, N.Y.

A. I am sorry that you can't remove the subwoofer from the enclosure in which you mounted it. Loudspeakers, including subwoofers, are designed to work with enclosures specifically designed to match them—they must be considered as a system and cannot be chosen independently of one another. This does not seem to have been done here. The resonance of the woofer and enclosure is obviously too high, and there is probably too little damping (too high a Q) in the system. It might help a little to temporarily remove the subwoofer system, fill the space behind it with sound-absorbent material, and then put the driver back.

You might also consider replacing the subwoofer driver with one whose characteristics are better matched to the small dimensions of your enclosure. That might well turn out to be a smaller woofer than the one you're using now. If so, mount the new woofer on a piece of heavy plywood or highdensity particleboard large enough to cover the original hole, paint the new board black, and use a grille large enough to cover the original hole completely. You may also find that a woofer designed for an air-suspension cabinet would be the best choice here.

If this does not reduce the severity of the condition, move the cabinet to a new location. (I know this is often easier said than done.) A location near the corner of two walls often reinforces bass, probably making matters worse.

I recall having a problem just like yours many years ago when I designed my first "entertainment center" for a large office complex. The client insisted that the loudspeaker be part of the cabinet housing the rest of the gear. He was decidedly unhappy with the sound. I convinced him to let me remove the single loudspeaker (the system was mono). I had to do some extra woodworking to convert the empty space into additional record storage, but at least the music sounded like music.

I suggest that you do what I didespecially if the subwoofer sounded the way it should before you had your entertainment center constructed.

Overloaded Equalizer

Q. When I play CDs and use my equalizer, loud musical passages, such as full orchestra in classical pieces, become a storm of pops and crackles. This happens only when playing CDs and occurs at all listening levels. When I vary my equalizer's boost settings, the distortion does not change. I do not hear the noise when I

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If you hear good surround from every other source but only mono from your VCR, you may be listening to the wrong soundtrack.

play CDs through the amplifier alone. Obviously, I have a problem with my CD player or my equalizer. Now what? —Robert D. Genung, APO, N.Y.

A. I believe there is nothing wrong with your CD player or your equalizer. If something were wrong with the player, it would sound distorted regardless of what equipment it were fed into. If the equalizer were defective, all program sources would sound bad.

I think that the signal from your CD player is overloading the equalizer, causing it to create the noise you described. If the player has an output level control, turn it down to a point where the overload does not occur. Most equalizers that I have used have input level controls which can also be turned down to prevent the overload we are talking about.

I realize that all other program sources behave as you would expect. However, many CD players produce a great deal of output signal compared to tuners, tape decks, and other components.

No Surround Sound

Q. I have a problem that I can't solve. I've contacted various technicians and I'm still waiting for help. I have a Hi-Fi VCR that loops through a projection TV receiver into a preamplifier. Connected to that is my surround decoder. I also have a CD player connected to my preamplifier. I get very nice surround from most of my CDs. I never hear surround from my video tapes! In fact, they sound more like mono than anything else.

I've had my VCR checked. It's supposed to be fine. I've had a couple of different decoders and all are supposed to be all right. What's wrong? Help!—Steve Metz, New York, N.Y.

A. I do not believe that your decoder is the problem, because if it was, you could not hear the surround effect when playing CDs.

I have a feeling that the problem is a simple one. The linear tracks on most Hi-Fi VCRs are monophonic. It is at least possible that you have set your machine to play this track rather than the Hi-Fi tracks, which are in stereo. Also, some VCRs have switches that allow a mono signal from either the right channel or the left channel to feed both outputs; if your VCR has such

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a switch, make sure it's switched to "Stereo."

Can the TV receiver be switched to mono? Maybe this was done and has remained undetected.

I suggest that you check all these. If you still run into trouble, disconnect the VCR from the TV receiver and connect it to the preamplifier's high-level inputs. That will permit it to operate just as your CD player does. If you do not have stereo then, you'll know that there is a problem with the VCR. If you do have stereo, then there is something amiss with the television receiver and its connections.



The Vandersteen Model 2 series has been the leader in loudspeaker value and performance since 1977. The Model 2Ci uses new materials and technology to establish a new reference for affordable speaker performance. The Model 2Ci is now available at select audio dealers carefully chosen for their ability to assemble a rausicelly satisfying system.

Write or call for a brochure and the name of your nearest dealer.

HOW MUCH SHOULD A GOOD MPLIFIER *Reflections on the esoteric myths and economic realities of power amplifier design, by Bob Carver.*

Thumb through Audio's Annual Equipment Directory and you'll see vivid proof that all power amplifiers are neither created equal nor priced equally.

> Two hundred watts per channel can cost you as much as \$8,400 or as little as \$599. You can own an amp from a multinational mega-manufacturer who also makes TV's, microwaves and cellular phones. Or an amp from a company so small that the designer is also the assembler and

shipping clerk.

Can it be that amplifiers are sonically equal? Some seem to have muscular power reserves far beyond their FTC-rated output. Others sound great

until they're challenged by a dynamic passage and then sound like a Buick hitting a row of garbage cans. Some are (to indulge in audiophile jargon) so "fluid" that you practically need a drop cloth under them. Others seem to sound harsh, "metallic" and brittle at any output level.

A casual comparison of perceived sound quality versus price tags may lead to an erroneous conclusion: that an amplifier must be expensive to sound good.

The truth is a bit more complicated: Cosmetic glitz aside, an amplifier's cost is primarily determined by its power supply.¹ In other words, within reason, you generally do get what you pay for when you buy a conventional amp design. But the key word here is "conventional."

My decidedly un-conventional Magnetic Field Power Supply is capable of outperforming conventional power supplies of the same size. Result: A significantly better power amplifier value for you.

Let me explain.

NO MAGIC. JUST FOUR CRITICAL QUANTITATIVE FACTORS.

When I fervently state that "the sound of an amplifier need not be related to its price," you might think we're veering off into the land of

Snake Oil and Gimmicks. Ouite the contrary.

I and other members of the scientific audio community know that just four factors determine the sonic characteristics of an amplifier:

1.Current output 2. Voltage output 3. Power output 4. Transfer function as evidenced by the interrelationship of frequency response and output impedance.

These factors transcend the usual trivial debates over tubes vs. solid state, MOS-FETs vs. bi-polar, Class A vs. AB, silver Leitz wiring vs. copper, gold-plated front panels, WonderCaps and my favorite: hand-ground-open transistors filled with a proprietary crystalline substance that stops ringing (honest, I'm not kidding!). An amp can have any combination of these entertaining variables (plus special bricks stacked on top) and yes, sound wonderful...provided it ALSO has high current, voltage and power output and the correct output impedance.

Thus the Four Factors explain why expensive amplifiers generally sound better than cheap amplifiers. But also why that doesn't necessarily have to be the case.

FACTORS 1-3: THE POWER SUPPLY **BEHIND THE SOUND**

An amplifier's power supply produces current and voltage. A preponderance of one without the other is meaningless.² To maximize SIMULTANEOUS current and voltage output using traditional design approaches costs serious

money. For example, we recently tested a competitor's \$2,000 amplifier that was rated at 20 watts/channel. Believe me, from a parts and materials standpoint, it was worth \$2,000, with most of that money being spent on an amazingly rugged power supply. Another more extreme example is my own ultra-conventional Silver



Seven Tube amplifier design. Its "money-is-noobject" power supply helps set the price of a pair of S-7's at around \$20,000.00.

Now, since it is universally agreed among amplifier designers that current/voltage/power output directly affects the sound of an amplifier, and since good traditional power supplies are costly, price and sonic qualitv ARE often closely related. But what if

there was a way around the economic constraints of con-

a power supply that could

deliver awesome simultaneous current and voltage into real-world speaker impedances without shocking your pocketbook?

That's just what my patented Magnetic Field Power Supply does. Without gimmicks, mysticism or loss of bass response. Simply put, a Magnetic Field Power Supply uses progressively more of each line voltage swing as amplifier power demand increases. It's just plain more efficient. How and why this works is explained in our new White Paper called "The Magnetic Field Story Parts I, II & III" which you can get free by calling 1-800-443-CAVR.

Right now, let's consider the tangible benefits. The series of comparison charts in this ad shows how my Magnetic Field Power Supply successfully challenges the previously hardand-fast rule that high-performance power supplies must be expensive. Amp X is a highly-



respected solid state design rated at 200 watts into 8 ohms. It cost \$5,500. My TFM-45 is rated at 375 watts per channel both channels driven into 8 ohms 20-20KHz with less than 0.1% THD. It has a suggested retail of \$949.

Even more impressive is this same sort of comparison chart with the TFM-45 vs. other amplifiers in its own price range. In deference to how utterly

we trounce similarly-priced, conventional competition, we've confined those charts to our new White Paper.

To summarize: Magnetic Field Power Supply technology allows reasonably-priced power amplifier designs to deliver simultaneous



TFM-45; 375 watts RMS/ch. into 8Ω ventional, inefficient power 20-20kHz with no more than 0.5% THD supplies? What if there was RMS/ch. into 80.20-20kHz with no more than 0.1% THD (\$399 suggested retail).

current and voltage levels previously only found in extremely expensive "esoteric" designs. Or to look at it another way, in a given price range (say \$900-\$1,000). Carver simply gives vou far more for your money

FACTOR 4: TRANSFER FUNCTION

Consider two hypothetical amplifiers with identical power supplies. Same power rating; same gain, etc. Yet they still sound different when powering identical speakers through identical cables.

Why? A fourth quantifiable factor is at work. One that, unlike power supply output, is totally independent of economic constraints.

I've left Factor 4 (transfer function/frequency response/damping) until last intentionally. Because until an amplifier can deliver sufficient power with simultaneous current and voltage

(Factors 1-3), transfer function is immaterial.

Frankly, I'm guilty of not making this fully clear in the past. Some readers may have gotten the impression that by magically adjusting some arcane parameter called transfer function, one

could somehow cause a cheap amp to sound like an expensive one. Nothing could be further from the truth. If there's no guts (power supply), there's no glory (optimized transfer function).

By transfer function. I mean the effect an amplifier's output impedance has on real world frequency response. I don't mean the flat. "DC to light" Rated Full Power Bandwidth found in column 11 of Audio's Equipment Directory. which is measured using a resistor as a load. Rather, I'm referring to the frequency response curve that occurs when an amplifier and speaker cables interact with a specific speaker.

As distinctive as a fingerprint, this curve determines the "sound" of each amplifier design. Its warmth or harshness. The quality of the bass. The definition of its upper registers. Even the configuration of the stereo "sound stage" it can create.

My engineering department and I are capable of making one amplifier design sound like

another amplifier design to within 99 parts out of 100 (a null of 40dB). For example, we've used Transfer Function Calibration to closely emulate the sonic characteristics of my reference Silver Seven in our TFM-45 and TFM-42 solid state designs. In other cases we've used the process to simply adjust the sound of an amplifier to have pleasant but unique sonic characteristics: in general, a warm "tube" sound with rich, rolling bass and soft yet detailed treble (such as our TFM-22/25, S-7t and TFM-15). Either way, we use painstaking measurement and adjustment processes to finetune output impedance/frequency response. Not magic.

And, needless to say, we start with highly capable power amplifier designs before the Transfer Function Modification process.

ARE YOU INTRIGUED...OR THREATENED?

My Transfer Function Calibrated power amplifiers have suggested retail prices of from \$399 to \$1,000. That I even dare to suggest they can sound as good as designs in the \$2,000 to \$6,000 price range has not endeared me with some audiophiles or underground magazine writers.

That's a real shame, because I have abso-



Same amplifier connected to cables and loudspeaker

ventional amplifiers. Like Rolexes and Lamborghini's, they are a joy to own if you can afford them. But just as a Rolex doesn't tell time any better than the inexpensive watch I'm wearing right now, good sound does not neces-

lutely nothing but respect for

well-made, high-ticket con-

sarily have to be costly.

If this concept intrigues you, please visit a Carver dealer soon. Bring demo material you're familiar with and be willing to do some critical listening. Compare my designs to competition costing about the same amount as well as to more expensive models.

Your ears alone should be the final arbiter. I feel confident that you will join the tens of thousands of audiophiles who have gotten the best possible value by owning Carver.

Kob asver

Bob Carver, President



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1 My definition of cosmetic glitz is any part of an amplifier whose sole audio contribution is to cause one's friends to go. "Ococo?!" when they see one's new ourshass. My new Silver Seven amplifier's nand-nihbed plano lacouer and solid granite surfaces meet this definition. one's new purchase. My own Silver Seven amplifier's hand-rubbed piano lacquer and solid granite surfaces meet th 2 Since power (watts) equals voltage times current, the same wattage can represent significantly different combinations of voltage and current – and thus very different performance into the same load.

THE BOOKSHELF

ACOUSTIC INSIGHT

The Master Handbook of Acoustics, Second Edition by F. Alton Everest. TAB Books, 366 pp., softcover, \$18.95.

This second edition of Everest's successful Master Handbook of Acoustics provides very worthwhile updating. The useful new information includes sections on diffraction-grating diffusors and TDS measurements.

The first chapter of the handbook takes a brief look at the fundamentals of sound, discussing such things as harmonics, complex waves, octaves, and white and pink noise. The next chapter, on hearing, has broad coverage of subjects ranging from the anatomy of the ear through phons, sones, binaural localization, and the Haas effect to hearing loss from aging and environmental factors. The text is relatively brief but is lucid, aided by wellchosen Figures.

The following five chapters are quite short, but each one covers a limited subject area. The result is more than adequate detail on levels and the decibel, sound waves and outdoor propagation, comb-filter effects, sound indoors, and echoes in smaller rooms. Important subjects include refraction, diffraction, and reflections. I thought the coverage on the causes and elimination of comb-filter effects and on room modes was particularly good.

In Chapter 8, Everest discusses the good and bad of reverberation and its relationship to understanding speech and enjoying music. He also covers test sources and equipment for measuring and displaying reverberation decay. The chapter even points out the effect of chart-recorder writing speed on measured decay slope. Optimum decay times, the use of artificial reverberation, and how to calculate decay time for a room are given brief attention. The next chapter, entitled "Common Signals-Noise, Speech, and Music," actually has little on noise, but the material on properties of speech, the vocal mechanism, musical instruments, and dynamic range requirements has satisfactory detail.

"Absorption of Sound" is important for the amateur acoustician. The author gives right-to-the-point rules on the use of various materials. For example, he correctly points out how studio owners cause problems when they use carpet



for the main absorbent material. Almost half of the chapter is spent on the design and characteristics of low-frequency Helmholtz resonators. I won't fault Everest for some extra words on his experiments: They help the reader get a feel for the design process, and there is little practical information on designing and building resonators elsewhere.

The need for the diffusion of sound within spaces, how to evaluate diffusion, and the effect of room shapes and positioned absorbent material are covered briefly but quite lucidly in Chapter 11. The next chapter discusses the important work of Manfred R. Schroeder and the development of various diffusor panels. Information, including diffusion patterns, is included on specific models. A brief chapter on heating, ventilation, and air-conditioning systems for studios has worthwhile recommendations on ducting, plenums, and silencers.

The next four chapters cover the acoustics of home listening rooms. small recording studios, multi-track recording studios, and control rooms, respectively. The author delivers good, practical guidelines for all of these rooms. The chapter on listening rooms is particularly welcome: So many books on sound and acoustics have little or nothing to say about the place most of us usually experience music. The chapter on control-room acoustics emphasizes LEDE (live-end dead-end) approaches, the inital time-delay gap, and use of diffusors. One Figure has a confusing caption, but my second thoughts clarified the point being

made. The wide field of acoustical measurements, Chapter 18, is covered only in part, and most of the brief chapter is on TDS tests and the Techron TEF instruments.

The two-page appendix of absorption coefficients is short, but it's a good list. A 10-page glossary is nice to have but contains some errors. For example, C-weighting is not flat, as stated. A good inclusion is the list of 178 references, in the same order as the chapters, with entries as late as 1987. The six-page index covers the book's contents well. The volume is highly readable both because of the author's style and the large type size. Figures, in general, are very well done. All of the headings are the same size typeface, regardless of importance, and that's slightly confusing. The book is softcover, but the pages are bound in stitched signatures. The book is not really a handbook in the strict sense because it does not cover all aspects of acoustics, and more details would be helpful in some chapters: The Master Handbook of Acoustics, however, provides a great deal of helpful insight in its selected areas for a very moderate price. Recommended to anyone who needs basic guidelines for good acoustics for home listening or a variety of professional needs.

Howard A. Roberson

Electrostatic Loudspeaker Design and Construction by Ronald Wagner. TAB Books, 248 pp., softcover, \$14.95.

It is impossible to compare this to any other book dedicated to the design and construction of electrostatic loudspeakers because, as far as I know, there are none! For this reason alone it should be of interest to anyone who desires to know more about electrostatic loudspeakers, especially how to build one. I met Ron Wagner about 12 years ago, and at the time he was building full-range electrostatic speakers as a dedicated hobbyist. I haven't spoken to him about electrostatic loudspeakers since then, but apparently his dedication has never waned. In the preface, he states his reason for writing the book: "The most obvious reason for writing a book on electrostatic speakers is that it hasn't been done before." His other intentions are to provide a text which can be used as a reference and as a guide for building an electrostatic loudspeaker.

The book can be divided into five areas. Nineteen pages of historical information are presented in Chapter 1; 39 pages of general information on radiation of sound, loudspeaker parameters, and measurements are in Chapters 2 and 3; 105 pages deal directly with electrostatic loudspeaker theory, construction, and testing in Chapters 4 through 13; eight pages on the Quad and Acoustat electrostatic loudspeakers are in Chapter 14, and three excellent articles by other authors are reprinted in the 52 pages of Chapter 15. There is also a three-page appendix, which lists all of the parts needed to build the full-range electrostatic loudspeaker described in Chapters 5 through 13, and a two-page index.

I found the historical background in Chapter 1 to be very interesting, since it gives not only the inventors and dates for specific inventions in sound recording and reproduction but also the patent numbers, so that those interested in pursuing the investigation further may do so. As in all first editions, there are errors which can be blamed on the "poor old typesetter." On page 13, while discussing Fig. 1.13, which shows the lens of the Beveridge speaker, the text describes the channels of the lens as being designed in such a way "that their effective sound paths were equal"; the word should be "unequal," and this is verified by the Figure itself, which shows that the outside lens channels are longer.

Since the author states, in the introduction, that "the book is intended for the audio amateur, musician, craftsman...," I should advise anyone who might think this work lacks mathematics and physics that this is not the case. Chapters 2, 3, and 4 discuss the basic physics of electromagnetics and electrostatics and do require some familiarity with both, as well as a working knowledge of algebra. This should not scare off anyone who is really interested in knowing how electrostatic loudspeakers work; a little brushing up using a very basic physics review-type book is all that may be necessary, and if you are interested in building an electrostatic loudspeaker only, you probably don't even need that.

AUDIO/JANUARY 1991



WORLD NEWS UPDATE



Finul is now available in a 100 CD kit for \$14.95

ITALY

AUDIO Review – September 1990 I must admit that though I am skeptical with regard to miraculous liquids, I remain truly (and really pleasantly) amazed by the action of Finyl; the treated discs acquire, in a manner noticeable by anyone, clarity of timbre, articulation, sonic consistency, fullness and depth, and in addition it helps reduce harshness, glassiness and thinness at high frequencies. Distributor: Linea Audio Italia-Milan

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The treatment with Finyl is more comprehensive than with CD Stoplight because the whole surface is coated. The audible result is also greater, which exposes a more natural sound picture, especially with voices and acoustic instruments. This improvement is very striking. Also, even good recordings experienced a substantial improvement. Distributor: NIPPER-Amsterdam

For complete reprints of these reviews and more information about Finyl call 1 800 24-FINYL (929-4553 in Maine) or write to: Transparent Audio Marketing, Inc., P.O. Box 117, Hollis, ME 04042 Manufactured by Digital Systems and Solutions, Inc. La Mesa, CA

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I can't compare this book's worth as a reference and guide to electrostatic speakers, because, as far as I know, there are none!



Chapter 2 is, in a sense, misnamed. Although "Electromagnetic Speakers" does do into quite a bit of detail describing how they work, it deals mostly with information more appropriate to electrostatic loudspeakers, such as factors influencing sound radiation in general. An interesting aspect is the author's use of Bessel functions to relate the reactance and resistance versus the frequency of a loudspeaker's impedance and, later, the acoustic radiation versus angle and frequency. There are more typos in this chapter, especially on page 35, in the section on "The ka factor," where "k" is given twice, with slightly different numbers. There is also an assumption on this page that the cone radius of an 8-inch loudspeaker is 4 inches, which is not true. This is not only something that could be corrected in a future edition; it could be eliminated entirely, since this is a book dealing with electrostatic speakers and not electrodynamic cone types. Chapter 3 shows how to measure some speaker parameters and uses a Radio Shack 40-1021 8-inch electrodynamic loudspeaker as an example. This is interesting and informative, but I would have preferred that the author use an electrostatic loudspeaker to obtain the parameters since this might not be obvious to at least some of his intended readers.

Chapter 4, "Electrostatic Loudspeakers," discusses the fundamental parameters of electrostatic fields and both single-ended and push-pull electrostatic speakers. In the exposition on

the force created by an electric field, there are some typos in the equations, such as when the force is changed from newtons to pounds; 2.28 and 0.58 pounds in the text become 2.25 and 0.562 pounds in the equations.

Without building the electrostatic loudspeaker, it is hard for me to completely evaluate the material presented in Chapters 5 through 11. However, they seem to contain a very detailed and orderly presentation of how to build the system. There are even checklists with block-shaped "bullets" to be checked off as you complete each task. (You might want to make copies of these, if you do decide to build the system, so that your book can be used again to build another.) Mechanical drawings, perspective drawings, and photographs aid in making the parts and building the complete system. Chapter 12 deals with the high-voltage power-supply electronics necessary for use with the electrostatic loudspeaker. A little more detail would be useful here, especially for amateurs who might not be familiar with electronics construction and, in particular, with high-voltage power supplies; even a photo or some line drawings would be a welcome addition. Chapter 13, "Speaker Evaluation," is only two pages, and perhaps could be expanded a little more in future editions.

Chapter 14, "Commercial Electrostatic Speakers," presents photos and schematics for the Quad Model 63 electrostatic loudspeaker, but only a living-room photo (and no details) for the Acoustat electrostatic loudspeaker.

Chapter 15 consists of three "Noteworthy Articles" by R.J. Matthys, P. J. Walker, and Charles I. Malme. These are very informative articles, and considering the cost of reprints of articles and papers, they're probably worth the cost of the book by themselves.

I do recommend this book to anyone interested in electrostatic loudspeaker theory, design, or construction. I also recommend that you obtain a book referred to by the author in his text; it is *Electroacoustics*, by Frederick V. Hunt, available from the Acoustical Society of America for \$15.00 (500 Sunnyside Blvd., Woodbury, N.Y. 11797). Other sources of interest are Chapter 3 of the *Loudspeaker and Headphone Handbook*, edited by John Borwick and

published by Butterworth and Co. (Boston, Mass). Entitled "Electrostatic Loudspeakers," the chapter was written by Peter Baxandall. I also recommend the various articles on electrostatic loudspeaker systems available in back issues of *The Speaker Builder* magazine (P.O. Box 494, Peterborough, N.H. 03458). *Edward M. Long*



The Motown Album, Foreword by Berry Gordy, History by Ben Fong-Torres, Essay by Elvis Mitchell, and Discography by Dave Marsh. St. Martin's Press, 252 pp., hardcover, \$50.

The release of The Motown Album was timed to help celebrate. Motown's 30th anniversary. Wrapped in a gold cover, the handsome book is primarily a photo album, and the best stuff dates from the salad days of the '60s when the Motown legend was being crafted hit by hit. The history that accompanies the photos is the work of Ben Fong-Torres. He has done a pretty basic job (there certainly is a potentially much larger book that can be done on the history alone), but for the purposes of this volume, it suffices. Dave Marsh's "Critical Discography," placed as a postscript, is more essential reading than the history. Here the songs are the topic rather than the personalities that dominate the bulk of the book. And in the end, it is the songs that Motown is really about. Berry Gordy adds a foreword which is nice, if understandably a bit self-serving.

Let's face it. To shell out \$50 for this photo album, you'd have to be quite the fanatic. I think the bucks are better spent on some sounds.

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DCC CURRENTS



Cassette with a Digital Twist

Philips invented the Compact Cassette and co-invented the Compact Disc, so what could be more natural than the company's combining them? Reports swept the industry through much of 1990 that they'd done just that, with a cassette that would be compatible with all current analog players and recorders but would also carry digital audio for use with players and home recorders yet to come.

Not quite, as it turned out. Philips has now announced that the system, to be called the Digital Compact Cassette (or DCC for short) won't allow both digital and analog recording on the same *cassette* but will permit either to be done on the same *recorder*. And the analog tape format it will use will be today's standard Compact Cassette.

For digital recording and playback, DCC will use a linear track format, similar in principle to S-DAT. (The S-DAT format is still on the books as an official standard, but only the alternative R-DAT helical-scan system is actually in use today.)

Since Philips had been showing the system to record companies (who'd be happy to see a system that can't digitally clone CDs) but not to home recorder manufacturers, rumor had suggested that DCC would use a unique encoding format that would not allow such cloning. And the terse initial press release that Philips issued in October 1990 did state that "The system is based on a new, revolutionary coding technique." However, two Philips sources have confirmed to Audio that this new technique will allow digital cloning of a CD's program material-though not of its subcodes.

Guy DeMuynck, Philips' Senior Director of Marketing in the U.S., says that DCC's cloning of CDs will be subject to limitations "similar to" those imposed by the SCMS system now used in DAT. That's no surprise, as SCMS is based on a Philips anti-copy system called Solo. It has been suggested that the DCC anti-copy system will be more restrictive than SCMS, either preventing any digital recording's being copied more than once or adding a flag to any DCC tape that's been copied so it cannot be recopied thereafter.

Philips won't release much further information until the Winter CES, a few weeks after this issue comes out. But Audio Week, a trade newsletter, reports that DCC's coding technique is Precision Adaptive Sub-band Coding (PASC), a system developed in Europe for digital radio broadcasting. To save bits, PASC rations its resources, encoding audible portions of the signal more precisely than it does those portions less likely to be audible. This technique is said to yield a dynamic range of 110 dB. Digital inputs of any standard sampling rate will be accepted, but all signals will be recorded on the tape at 44.1 kHz. According to the report, DCC will have auto reverse, using a 16-track head to provide eight digital tracks in each direction of play. Tape speed will be the same as for analog cassettes, but the digital cassette will have a tape cover like that on a DAT or an 8-mm videocassette. One Philips spokesperson confirmed without further comment that the Audio Week story is "rather correct, but not completely so."

Why a new digital tape system, just as DAT is reaching the U.S. market?

Besides offering a degree of compatibility with Compact Cassette, DCC will also allow high-speed tape duplication, Philips says, which would lead to far lower digital software costs than DAT. But this presumes that DAT duplication costs won't drop dramatically by 1992, when Philips hopes that DCC will reach the market. Both Sony and BASF have been working on high-speed duplicators that would accomplish this.

Hardware costs for DAT and DCC should be about equal, in any case. Philips says that DCC recorders will be available in the first half of 1992, for about \$500 to \$600, as compared to the \$900 and up charged for DAT machines today. But DAT prices are a moving target and may well drop to Philips' projected levels by that time. Even last June, I was able to pick up a DAT recorder (Aiwa's portable) for about \$650 in Japan—and Japanese stores don't do U.S.-style discounting.

Before the industry settled on the R-DAT standard, there was some talk that S-DAT machines might be unsuitable for use in portable and car players, due to tracking problems. While DeMuynck would not address the question directly, he did say that "Use in the car is certainly very important to us. It is our intention to make DCC as widely applicable a system as the present Compact Cassette," and that the system would allow for use in both home and car.

Tandy has signed on to make and market DCC tapes and players, and the system has been endorsed by several record companies. Those companies include not only PolyGram (which Philips has a stake in) but EMI, Bertelsmann (which owns RCA Records), and Warner Bros.

Philips is not the first company to announce a digital recorder with Compact Cassette compatibility. In 1985, Sharp showed a prototype, the CX-3, that made digital recordings on standard CrO_2 cassettes. The system used a stationary, thin-film head and recorded on 18 tracks, of which 16 were for data and the remaining two were for control and other purposes. While the CX-3 used the same 44.1-kHz sampling rate as CD, it used 14-bit linear encoding rather than CD's 16-bit system.

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Adcom GFA-565 no amplifier.



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*Continuous power output, 20 Hz - 20 kHz < 0.02% THD, measured in accordance with FTC specifications.

The Adcom GFA-565: details you can hear.

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More and more of today's high performance loudspeakers exhibit very low impedances and particularly difficult loads. Many so-called esoteric amplifiers are incapable of delivering large amounts of undistorted power <u>continuously</u> into these complex loads thereby defeating the objectives of the loudspeaker's design.

The GFA-565's highly advanced, triple Darlington output stage featuring 20 rugged, discrete output transistors is designed to deliver extremely high-current at low impedances into reactive loads. No protection circuitry or current limiting devices

Specifications

Power output, watts/channel, continuous, 20 Hz - 20 kHz, <0.02% THD: 8 ohms/300 4 ohms/450 2 ohms/850 Signal-to-noise ratio, A-weighted, full output: >106 dB Input impedance: 50,000 ohms Input sensitivity: For rated output: 2.15 V For 1 watt: 130 mV Damping factor (20 Hz - 20 kHz): >1000 @ 8 ohms Dynamic headroom (at 4 ohms): 1.6 dB Voltage: 120 V/60 Hz (available in 220 V/50 Hz on special order) **Dimensions:** 17" × 8¼" × 11½" D (432 mm × 210 mm × 292 mm D) Shipping weight: 45 lbs (20.50 kg) Available options: 565 FAN: Top mounted, automatically variable, ventilating fan. 565 BAL: Rear mounted, symmetrical (balanced line) input circuit. RM-8 rack mount adaptors.

White front panel and switch.



Adcom components are also available with white front panels. Shown: GFA-545 with GFP-555 preamplifier and GFT-555 AM/FM stereo tuner.

are incorporated which would restrict the delivery of full power output. Protection against short term overloads, short circuits or long term, excessive output is achieved by non-interfering power supply fuses and thermal circuit breakers.

Well Regulated, High-Current Power Supply

Advancements in CD technology and the introduction of digital audio tape have created opportunities to reproduce the full dynamics and psychoacoustic experience of a live musical performance. To realize the full potential of this technology, amplifiers and loudspeakers must be capable of delivering tremendous energy continuously, not just for tiny fractions of a second.

The massive power supply of Adcom's GFA-565, featuring 70,000 microfarads of filter capacitance and a huge 1.25kVA toroidal power transformer, has enormous reserve power capability. This is a no compromise power supply that eliminates all audible limitations. Hum, vibration and noise, the byproducts of lesser power supplies, have also been reduced to an absolute minimum. For most home applications, the optional variable speed cooling fan is unnecessary, making the GFA-565 a silent performer despite its formidable power.

Instantaneous Distortion Alert

A highly accurate LED on the front panel is activated by a unique monitor circuit if any form of distortion—THD, IM, TIM, SID, etc.—exceeds 1 percent. This will provide ample warning that the music system is being operated beyond its design parameters.

Ask for a Demonstration

No amount of words or technical specifications will adequately describe the experience of listening to a music system featuring a pair of Adcom GFA-565 amplifiers. If you are one of those few who are seeking real power and sonic perfection, please contact your authorized Adcom dealer for a demonstration of this most remarkable audio component.



11 Elkins Road, East Brunswick, NJ 08816 U.S.A. (201) 390-1130 Distributed in Canada by PRO ACOUSTICS INC. Pointe Claire, Quebec H9R 4X5
So many recording formats have come and gone that our audio legacy may get lost in the confusion.



Encrypted History

Our legacy of literature is fairly safe. Pick up a centuries-old book and, despite differences from modern language and typography, you'll still be able to read it. Today's books will likewise be readable centuries from now (at least those whose paper doesn't crumble in the meantime).

But what about our legacy of recorded sound? That legacy requires hardware to "read." And as the number of recording formats grows, the odds on a given audio library having the hardware to play each of them diminishes. In just a century and a smidgen since Edison's tin-foil phonograph, we've had at least two kinds of cylinder phonographs and 13 flavors of analog disc (counting only major variations in speed, groove structure, direction of play, and size). Magnetic analog recording has given us at least three media (wire, tape, and magnetic disc), five sizes of tape, six speeds, about a dozen track arrangements, and at least eight kinds of cartridge or cassette.

Digital, being younger, has brought us only one type of cassette, five or six kinds of master tape (not counting variants with different widths and track arrangements), PCM-encoded recordings on three different videocassette formats (in both NTSC and non-NTSC versions), plus the Compact Disc—and there are doubtless more to come. (I know of at least five new digital formats that have been shown in prototype.)

Someday, music lovers will look on audio archivists the way we now look on medieval monks, guardians of knowledge that would otherwise disappear forever. But the monks had it easier—all they had to deal with was hand-copied (often miscopied) manuscripts in Latin, Greek, or, occasionally, Hebrew, Aramaic, or Arabic—a piece of cake, compared to what tomorrow's audio archivists will face.

Bye-Bye Home-Brew?

Home-brew repairs and modifications keep getting harder to do. That's not just because the systems involved (in everything from audio to autos) are growing more complex, but the parts and assembly techniques are also growing harder to deal with. A shade-tree mechanic can no longer count on being able to pull a car's engine out with a mail-order chain hoist and an overhanging oak limb; the way most cars are built today, with engines mounted from below, you have to pull the car up off its engine. In electronics, it's bad enough (from the home-brew standpoint) that big tubes and discrete components have given way to ICs of the caterpillar-like DIP type-now DIP ICs are giving way to surface-mount devices designed for automated mounting. Their pins are so finely spaced that few technicians, if any, will be able to mount and dismount them by hand. Sooner or

later, they'll come up with ways to do without even these components maybe using rays or particles that modify the circuit boards' internal structure to create the necessary circuits.

In electronics, at least, new construction techniques have resulted in lower cost and greater reliability. But they do mean less fun—and less chance for electronics fans to challenge and stretch their ingenuity.



"Did You Hear What Mama Said?"

Babies explore the world through all their senses. Every year. about 5,000 infants—one out of every 750 births—are born with hearing losses that handicap them in learning speech and language and that limit their ability to realize the comfort of their parents' words. Yet such losses are not identified until the children are, on average, 2½ years old. Now, there's a simple test that parents and grandparents can use to check the hearing of children from infancy to 3 years old.

The testing methods are available in a leaflet from the American Academy of Otolaryngology—Head and Neck Surgery. The leaflet first covers factors that put children in high-risk categories for hearing loss. These factors include: Family history of hearing loss; the mother's illness or



drug use during pregnancy; prolonged labor, premature birth, or other problems attending the newborn; and meningitis, chronic ear infections, and/or chronic upper respiratory allergies. Appropriate home tests for children less than a year old and for children from 1 to 3 years old are also in the leaflet. For a copy, send a self-addressed, stamped envelope to the Academy at One Prince St., Alexandria, Va. 22314.

A Balanced View

Balanced-line connections, once restricted to professional audio components, have now become so common that we noted their use in our Annual Equipment Directory last October. A 13-page background paper on balanced lines, written by Mark Levinson and Tom Colangelo of Cello Ltd., is now available from that company for \$2.50 (\$5 for readers who live overseas) to cover postage costs. Requests and checks may be sent to the attention of Ms. Pat McCullough at Cello Ltd., 315 Peck St., Bldg. 23, New Haven, Conn. 06513.

EDWARD TATNALL CANBY

PORTABLE, NOT POTABLE



onsumer audio gear-we used to call it hi-fi-is ever more sophisticated and widely useful in this age of digitality. Also astronomically better in the electronic specs, easily matching plenty of pro equipment and sometimes surpassing it. And yet the old original dividing lines between consumer and professional remain strong. They have to. And that in spite of something called "semi-pro" that keeps surging forward in generation after generation of audio. We mustn't fool ourselves. Professional is professional. This thought came to me as I looked over the specs for the new Carlos Moseley Music Pavilion (which I will pass on to you in part), that enormous and utterly pro "portable" audio system which will take over New York's summer outdoor classical concerts by the Philharmonic and the Met Opera this year in some 24 park locations.

"Professional grade" in any area, including our own, is simply an inescapable necessity, no matter how extensively we may cross it. With high-level consumer gear exists a perennial third category, semi-pro, that meets a lot of pro needs but also appeals to the consumer looking for solid stuff. As who but myself should know, having made use of it throughout my life.

Just so you'll know what I mean, take the reel-to-reel tape recorder. The semi-pro began here at the beginning, with the Magnecorder, and went on, still mono, to the once-sensational Ampex 600 line of the '50s, portable in a spiffy hard-plastic suitcase with a matching speaker case—portable for those with good backs. After that, the semi-pro recorder branched splendidly into dozens of models and on into stereo—from the Concertone to the

Revere/Wollensak and eventually Crown, TEAC, et al. But you will not find such equipment in the Moselely Music Pavilion. This is sterner stuff.

Even the power sources, big groups of heavy storage batteries in each of the 24 speaker towers, are so weighty that they serve a second purpose, to hold the towers down in case of, say, a hurricane. These bats won't fit into your Honda Civic or Bronco II, whose audio gets power from a semi-pro consumertype battery. Moseley's are marine units—designed to start large diesel engines in sizable ships—big, bulky, and potent. Six of these in every speaker tower—that's 144 batteries right there. And no doubt more for the rest of the "portable" audio.

Once set up for a concert, this Moseley Music Pavilion, which looks so much like a weightless, airy kite about to take off, could be dislodged only by military bombardment or an earthquake.

Those in audio who are into professional outdoor/indoor pop music will be amused at all this. Are you bombproof? More practically for exotic travel, protected against tropical thunderstorms and hurricanes? Portable pop goes all over the world. Which prompts me to a further thought—Moseley, remember, is different; it amplifies oldfashioned live classical music played on acoustic instruments numbering in the hundreds, including large numbers of strings. As anybody knows, both symphony and opera are for this reason strictly *dry*. Indoor fun. Or were.

The Carlos Moseley is waterproof. Everything! The speaker towers, 15 feet high and full of electronic gear as well as speakers, could probably operate under water, batteries and all, though the sound might be somewhat muffled. The stage, for all those bonedry-type musical instruments, is 118 feet wide and surrounded by a stretchy plastic reflecting cloth (if that is the word), even overhead, for excellent rain protection. Even a good way out front of the curved stage, as I remember. So on first and hasty thought, the Philharmonic and the Met can easily produce outdoor music in the rain. They'll stay dry, though not the audience, which will get wet or go home.

In New York the chances of rain in the summer, especially in early evening, are very high. It rained the day I went to the Moseley preview, also that night. It *often* rains. And when it does, it comes down hard. Ask ball fans. Games are often called. Concerts too, even with waterproof audio?

In an outdoor concert, you aren't dealing merely with a slippery field and a damp ball. There are priceless ancient instruments involved, Stradivarius and the like, as well as others worth only slightly less. The front of the Carlos Moseley stage is wide open to the public—and to the dampness and fog, maybe drizzle blown in by the wind. Is this a proper environment for such technically unwaterproofed music? Paradoxically, it is the music itself that is the weak link in the waterproof Moseley! That's what we get with old-fashioned classical sound.

Well, suppose we get practical, if unmusical. You can waterproof a pair of leather shoes, so why not a violin? Surely the marvels of current technology...? So let's imagine. First you remove all the strings on all those instruments, pull out the tuning pegs, and *spray* with an appropriate (?) waterproofing medium, outside and, espe-



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You can waterproof a pair of shoes; why not a violin? Say goodbye to Stradivarius, and hail the ungodly screech of the waterproofed fiddle!

cially, inside, where it counts. Spray the pegs and the holes before reinserting, with hopefully enough rosin to make the necessary bind to hold the strings in tune. Restring with all-metal or synthetic strings. Next, remove all the horsehair from dozens of bows, spray them top to bottom, and install a new material that will take enough rosin to grab the new strings and so make music. Reassemble all the instruments. *And play*.

I enjoy, a bit sadistically, the very thought of the first trial of these millions of dollars of music makers—Strads, Guarneris, whatever—all now totally waterproof! A fair first trial would, of course, be in the middle of a thunderstorm on the Moseley stage. Have you ever heard those old mechanical violin players in coin-operated machines that run rollers against the strings to produce the sound? That's about what I would expect, x100. Goodbye, the famous tones of Stradivarius! Hail the ungodly screech of the modern waterproofed fiddle! Do you doubt me?

Perhaps a less disastrous remedy, if even more expensive, might be a vast transparent curtain that would rise up across the stage front at the first sign of excess "hummidity," as one of my New England friends likes to call it. A necessity, even so, would be a huge array of instant dehumidifiers backstage, to dry out the enclosed parcel of air. Totally silent, of course. That would do it. And preserve the Strads.

I do not know what the plans are for a wet night. Not mentioned in the publicity. *Sometimes* its clear, mild, and dry in New York's summers. So let us return to the audio.

As you now can realize, the 24 Moseley speaker towers (fewer in smaller parks) are not only self-powered but controlled, wireless, by radio. No cables anywhere. The radio signal is mono (except the inner stereo arc near the stage) and undelayed; all the delay processing is built into the towers, adjustable before each concert to suit the location and distances. Also, no doubt, the individual volume balance. Each tower includes two speaker systems, each with its own delay. The radio signal comes out of an active, manned, control console, and up to that point, the mike channels and general mixing are relatively what you might expect,

allowing for the peculiar and nonstandard "reverb" situation—very little in the stage space, a great deal generated out in the field.

The ingenious Jaffe-inspired system involves a progressive "forward" delay in the fan-shaped array of towers, so that the speakers-which are all around the audience-do not clash with each other no matter where the audience may sit among them. But it is worth repeating that there is a "reverse" delay out of the second speaker system in each tower that is aimed toward the stage, a longer delay than the front-facing speakers, if I am right. As noted previously, with speaker towers located around the audience. this creates a curious and innovative new kind of "concert-hall reverb" that has absolutely no dimensions or direction and yet gives the classical effect of sound diffusion such music requires. This seems to me a unique advance in our adapting of older indoor acoustic music to large open spaces.

What about feedback, with those speakers aimed at the live sound source? There is virtually none, although I heard for a while at rehearsal a dull tone or hum that was evidently feedback of some sort. It went away. Feedback, for one thing, is much reduced by top-level, "flat" equipment, minus the peaks that used to be all too common. These, when reinforced accidentally by assorted peaks of hall resonance, could set off the awful howls we all know. Moseley's equipment, like so much today, is very low on peaks, in or out of the audible range. And there are no walls! Except for that plastic surround, almost entirely in irregular curves, smoothing out the stage ambience.

Finally, a few Moseley specs and Moseley people: Christopher Jaffe was the sonic architect of the Moseley, acting much like a structural architect, working with a multitude of suppliers and builders whose job was to carry out the system specs, electronically and in all matters of choice, construction, portability, durability, and so on. Much of the Moseley is not audio, though sound is its intention. Jaffe's parallel architect, Peter Wexler, designed the Pavilion itself, and in the same way worked through numerous construction firms and suppliers-a big operation. As the Philharmonic

puts it, Peter Wexler "created" the Pavilion. That's a favorite publicity term and in this case remarkably accurate. I talked to Wexler, and indeed he knew every detail of the system, including the audio. I also talked to Jaffe, the prime audio man, who told me more of the "reverse" delay sound field. (That's my term, not his.) It pays to go to the horse's mouth.

The Philharmonic people whom I contacted were keeping close to the musical side, leaving audio strictly to those who understood it.

Statistics: Those six big batteries in each speaker tower are Exide deepdischarge marine units, 105 amps apiece, with a charger alongside in each tower. They drive, through assorted electronics, four Linear Power 5002 pro amplifiers rated at 250 watts per channel. In each tower, three of these feed-in bridged mono-an 18-inch woofer, two 12-inch low drivers, two smaller midrange drivers, and a separate high-frequency system. Additional speakers at the top of the towers provide the "reverse" delay, toward the stage, presumably powered by the fourth amp. The two delay units in each tower, independently adjustable, are Audio Digital ADD3s. The all-important mono music signal reaches each tower via Sennheiser wireless receivers. (Hey, maybe some New Yorkers can pick up the signal in their nearby apartments.) Each of these has two channels, one kept as a standby. All this and much more, multiplied by 24, doesn't even include stage and console. Not exactly sports-car audio. Nor even semi-pro

The audio system as a whole, under Jaffe's direction, was built by Maryland Sound Industries, which worked with David W. Robb of Jaffe Acoustics. That 18-inch woofer is the Model 1752S servo-subwoofer system, evidently from Linear Power too. Maybe the rest of the speakers also?

Plenty more—a Ramsa WRC 900 console (waterproof), a front-house system (Lexicon, Aphex, Klark-Teknik, Sennheiser), and a monitor system. I counted some dozen mikes, in fat pop screens (thunderstorm?) plus one indubitably coincident stereo array.

Nobody told me how long it takes to set up/take down this gigantic portable music system. I'd rather not hear.



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n the best of all possible worlds. audio systems would reproduce perfectly music's visceral bass, richly sonorous midrange, sparkling transients, and smooth high frequencies and harmonics of the high strings. This is a very tall order. At present, the CD has matured into the prime musical source, providing a reliable format with low-frequency response right down to those 8-Hz organ notes and high-frequency response flat to 20 kHz-all with a great dynamic range. Needless to say, no real-world consumer loudspeaker meets these demands due to the compromises necessary in size, complexity, appearance, and cost.

There have been countless loudspeaker designs since the beginning of the hi-fi era. As a rule of thumb, the biggest, most expensive loudspeakers usually afforded the fewest audio compromises, but many attempts have been made to provide a "10-gallon" performance from a "pint pot." Even with today's most sophisticated computer-aided design, advanced technology, and the availability of new and often exotic materials, the circumvention of the laws of physics is just not possible.

The achievement of the best highfrequency response has fostered exotic tweeters using such things as electrostatic and piezoelectric elements, ionic drive (as in the lonovac), plasma modulation, and even modulated flames! Frequently used were inexpensive ribbon tweeters by JVC, Panasonic, and Pioneer. But obtaining clean, extended high-frequency response was a great deal easier than trying to improve and extend bass response.

With bass frequencies, one usually had to contend with large, heavy, and

complex structures such as front- or back-loaded horns, folded horns (as in the Klipschorn), acoustic labyrinths, larger bass reflexes, and infinite baffles with multiple woofers. Then there were the "cheaters"—slot-loaded woofers, Helmholtz resonators (the "air coupler" and RJ), and acoustic suspension. Acoustic suspension can provide deep bass, but it can also be quite inefficient.

Although the predominant design of today uses dynamic cone and dome drivers (with the better speakers using high-tech cone materials, very sophisticated crossovers, and advanced methods to attenuate cabinet resonance), quite a few audiophiles are enamored of loudspeakers which roughly can be considered diaphragm or membrane-type designs. These include electrostatic, planar magnetic, and magnetic ribbon speakers. They are admired for their inherent transparency of reproduction, their exceptionally fast and accurate transient response, and their overall smoothness of response (particularly in the high frequencies). Unfortunately, as a class, they are not very efficient, they have fairly limited dynamic range, and their low-frequency response is usually not verv extended and is of limited weight. power, and projection. This is especially true when membrane speakers are used in a so-called full-range configuration.

Manufacturers who concede that full frequency response is difficult to get from their membrane-type loudspeakers often resort to the hybrid approach. They cross over the membrane driver at a low frequency that will be compatible with a typical dynamic woofer placed in either a chamber within the main speaker or a separate, dedicated woofer enclosure. But there are problems that are difficult to solve. For example, the dynamic characteristics of the woofer are at odds with those of the membrane driver. Also, the bass enclosure may have inadequate volume, or the type of bass loading may not provide enough bass extension at low distortion.

In more than 40 years, I've used just about every kind of speaker ever marketed. I've had the big back-loaded horns, the folded horns, even a monster exponential horn. I've had the 600-

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Bass was not a separate element, sonically apart in speed of response or musical perspective, as in most hybrids of this type.

pound, sand-filled-panel, 16-cubicfoot infinite baffle. I've had all the smaller electrostatic speakers. I've used the huge Acoustat Model Eight electrostatic with enough panel area to achieve a fairly flat response at 35 Hz. I have auditioned "full-range" ribbon speakers as well as many ribbon tweeters. And I have enjoyed membrane speakers in the sonic ranges in which they excel.

All of the foregoing is a preamble to the main thrust of this column. Many people have asked me if there is a straightforward or hybrid membranetype speaker with wide frequency range for \$2,000 to \$3,000. I found this a rather daunting requirement in respect to performance and price. Frankly, I was prepared to state that I did not know of any speaker of this type that I could comfortably recommend. However, a friend of mine. whose ear and musical perceptions I have long respected, said he had been very impressed by a \$2,595 pair of ribbon hybrid speakers he had heard at the Summer CES. He described the performance and configuration of this speaker, the Reference RT-7 manufactured by Clements Audio of Toronto, Ontario. The name rang a bell, for at a CES quite a few years ago, I heard a large, heavy, full-range ribbon speaker that was made by Clements, then located in Texas. The loudspeaker was around \$6,000, was very clean and had all the good attributes of a ribbon driver, but it just rolled off too high to provide satisfactory bass response.

Intrigued, I arranged for the Clements people to send me a pair of the RT-7 speakers. It seems that Clements had further refined and updated their ribbon driver technology, and sold the design to the Canadian company. Under the direction of president Jim Richards, the decision was made to properly integrate the ribbon driver into a hybrid system.

When the speakers arrived, I was surprised by their heavy weight, 90 pounds each. With dimensions of 45½ inches high, 10½ inches wide, and 19 inches deep, they were also far larger than I had envisioned. Yet the RT-7s are visually quite striking, superbly finished in beautifully grained light oak. (They are also available in several oth-

er finishes.) An acoustically transparent, brown grille cloth covers the top ribbon section and the lower woofer section, but, with their large expanse of wood, the systems are much more attractive if the grilles are removed.

The reason for their size is soon apparent, inasmuch as the bass loading is via a patented Compression Line system. This is a cross between a transmission line and a Hypex horn load. A proprietary 8-inch woofer, made by Clements, uses a cone of 20mil polypropylene, which is very stiff but low in mass. The surround of the cone is custom-made in England and is one of the thinnest in the world. The surround roll is inverted to eliminate any diffraction from it. The driver spider is also custom-made and provides one of the stiffest suspensions used in any driver. The woofer uses a very rigid but light Kapton former, and the 11/2-inch voice-coil is driven by a 20-ounce ceramic magnet. Particular emphasis is placed on the stiffness of the suspension, the low-mass surround, and the Compression Line loading to provide the speed of response necessary to keep pace with the high speed of the ribbon. Speed mismatch and woofer lag are common problems with hybrid speakers.

The woofer is mounted at the top of the bass enclosure. Sound radiated from the rear of the woofer cone traverses the first part of the Compression Line, which is diagonally mounted of wood grooved and mitered into the enclosure. The sound waves continue down the line, and then the line narrows considerably, creating a compression in this zone. The sound is directed into a fiberglass-filled trap tuned to 120 Hz to remove unwanted resonances and distortion. Simultaneously, the sound is sent through the termination of the line, and bass frequencies below 80 Hz are exhausted through a vent on the bottom of the woofer enclosure's front panel. The vent provides up to 10 dB more bass output than the direct radiation of the woofer, yet these outputs are equal at 1 meter because of the smaller radiating area of the vent. Thus, a flat transition to the woofer is achieved, which radiates directly from 80 Hz up to its crossover point of 1,575 Hz. The woofer drivers are individually matched

within 1 dB for efficiency, 1 Hz for resonance, and 0.1 ohm for impedance. Frequency response is matched to a reference driver. The speakers are even packed in left and right boxes of different colors to ensure matched pairs. The main cabinet structure and the Compression Line all use grooved and mitered construction of 3/4-inch, multiple-density fiberboard.

The Clements ribbon midrange/ tweeter is an unusual design. The 7inch aluminum ribbon is bonded to Kapton with a special adhesive. The ribbon is guite durable, handling three to four times more power than a typical dome tweeter. In fact, if its temperature reaches 300° F, the adhesive will deactivate, and the ribbon will delaminate from the Kapton before it can burn out. Each side of the ribbon has a grainoriented ceramic magnet 11/2 inches deep developing a 10,000-gauss magnetic field at the midpoint of the ribbon. Custom-fabricated 3/16- and 3/6-inch steel plates hold the ribbon and focus the magnetic field in the gap. The ribbon coil is typically about one-twentieth the weight of a dome tweeter's voice-coil. This ribbon has virtually a 100% driven area. The ribbon is mounted directly on the magnet structure, so there is no frame that can diffract the sound. This mounting has the added benefit of providing the ribbon with a huge heat-sink and a chimney. The ribbon has almost bipolar radiation from the negative and positive sides in the magnetic gap, and its natural lowfrequency roll-off occurs at a rate of 18 dB per octave. No coils are used in the crossover, and the ribbon is used with a 6-µF Wonder Cap with 0.01-µF Wonder Cap bypass. Solen Fast Cap capacitors and Wonder Cap bypass capacitors are used for the woofer, along with custom-made 50-watt ceramic resistors to ensure constant resistance.

Double Tiffany binding posts permit bi-wiring or biamping. A three-position, 2.5-dB treble-boost switch is provided for setting the high-frequency response to personal preference.

The entire ribbon structure is mounted on 3-inch-thick multiple-density fiberboard, and this plus the crossover are in a separate enclosure at the top of the speaker. The positive and negative halves of the ribbon are separated by a fin, or "lens," made of a very inert

material. The lens keeps the two sides of the ribbon from summing with each other and is also used to provide accurate dispersion. The ribbons are mirror images, with the positive side firing toward the middle of the soundstage. In a normal room, the negative side of the ribbon will reflect off side walls and bounce back in phase. If the sound source is in phase, a horizontal dispersion pattern of equal phase and amplitude is presented at up to 70° off axis. To avoid interface problems, the ribbon is driven directly, without transformers. The systems are tested with a Hewlett-Packard 3561 FFT analyzer. and the test graphs are included with each speaker.

Obviously, the Clements RT-7 loudspeaker employs some formidable technology in the design of its ribbon midrange/tweeter driver and its integration with a synergistic Compression Line bass system. The straightforward performance specs are guite impressive. Frequency response is rated at ±3 dB from 26 Hz to 40 kHz. As a matter of fact, the ribbon is down only 0.5 dB at 150 kHz, and the University of Maryland's biology lab uses a Clements ribbon to "communicate" with bats at about 100 kHz! Sensitivity of the RT-7 is 88 dB SPL at 1 meter with 1 watt of full-frequency pink noise. Distortion is claimed to be no more than 0.8% THD from 30 Hz to 10 kHz. Impedance is rated at 6.5 ohms, and power handling is 200 watts with a 'continuous music source." But raw specs don't begin to define the merits of these remarkable speakers.

I auditioned the RT-7s in my listening room, with my usual complement of RPG diffusors and Abffusors. The speakers were about 8 feet apart on axis, and I listened to them from about 10 to 12 feet away. I drove the RT-7 with McIntosh 2002 amplifiers, FM Acoustics 611 and 811 amplifiers, and the FM Acoustics 244 preamplifier. A Sony CDP-X77ES CD player and a Wadia 2000 digital processor were the source units. It might seem a bit incongruous to partner a \$2,600 speaker pair with such gilt-edged electronics, but any anomalies one hears is unlikely to originate in this kind of equipment.

I played various large-scale symphonic works, and the speakers revealed one of their most outstanding



When I played large-scale orchestra works, the RT-7s revealed one of their most outstanding characteristics: They simply disappeared!

characteristics: They simply disappeared! There was so sense whatever of music emanating directly from either speaker. On particularly well-recorded London, Delos, Telarc, and Chandos discs, the depth perspectives were not only extended, but there was specific front-to-back localization of various in-

struments. Add to this the striking smoothness of response, especially of first violins, with lovely extended harmonics whose freedom from grain or edginess would certainly quiet the disparaging comments of the digiphobes. Along with the midrange and high-frequency smoothness was the virtually



seamless transition to mid-bass and bass frequencies. Contrabasses were clean and darkly resonant, cellos rich and mellow. Most importantly, the bass did not seem a separate element, sonically apart in speed of response or musical perspective from the upper frequencies. The disparity in the speed of propagation between the membrane and dynamic drivers in most hybrids is obvious and musically distracting.

The RT-7s reproduced the huge bass drums in the largo movement of the Shostakovich Symphony No. 13 (London 417261-2) and on Stravinsky's Rite of Spring (London 417325-2) with accuracy of timbre and considerable impact, if not the weight I hear from my reference Duntech Sovereign speakers. (There is also a small matter of some \$13,000 difference in price!) Much the same could be said for the excellent organ reproduction from the RT-7. Transient response was in a class by itself. One hears how incredibly clean Tom Jung's dmp recordings really are-the attack and timbre of acoustic and electric guitars, the plangency of bells, the shimmer of cymbals, the explosive energy of snare drums and rim shots, and the subterranean rumblings of synthesizers

The reproduction of voice is also revelatory. The richness, expressiveness, and all the various nuances which are so important in vocal projection—for example, the resonant baritone of Fischer-Dieskau in the Mahler lieder (Sony Classical SK-44935)—are wonderfully delineated by these speakers. The RT-7 does a good job of handling the extreme dynamics of John Eargle's recording of Bartók's *Miraculous Mandarin* (Delos DE-3083), although not with the massive weight and output of the Sovereigns.

It would be wonderful if sometime in the future a truly full-range membranetype speaker, with high efficiency and full dynamic response, became available. In the meantime, the hybrid membrane/dynamic driver design is a valid approach, especially if it is as well executed as the Clements RT-7. This is not a "flashy" speaker for those who like exaggerated and highly colored sound. But for those who want an accurate speaker which faithfully preserves musical values, the Clements RT-7 is a remarkable achievement. **A**

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HIGH FIDELITY AND HEARING AIDS



he quest for a high-fidelity hearing aid began with the design of hearing-aid sized microphones that were used in recording and broadcast studios in the late 1970s [1]. It continued with the development of damped acoustic coupling systems for hearing-aid receivers [2].

Listening tests which I conducted at Northwestern University back in the late '70s verified that complete hearing

Mead Killion is the founder and president of Etymotic Research, Elk Grove Village, III. and Adjunct Professor of Audiology at Northwestern University. He holds 16 U.S. patents and has five more pending. aids could be assembled with both objective frequency response accuracy and subjective fidelity ratings comparable to those of highly regarded loudspeaker systems. These aids could be substantially superior to the most popular stereo headphone of the time [3]. Hearing-aid microphones and earphones were available with smooth frequency responses over a bandwidth of 20 Hz to 16 kHz.

Two things were missing, however: A low-distortion power amplifier small enough and with a low enough battery drain to be practical for use in the smaller hearing aids, and a broadcastquality input amplifier that could handle loud voices and live orchestra con-

Fig. 1—A magnified view of two highfidelity hearing-aid ICs, a C-MOS Class-D power amplifier (A) and the K-Amp bipolar input amplifier (B).

certs without distortion. Both amplifiers are now a reality in the tiny integrated circuit chips shown in Fig. 1.

Figure 1A shows a high-fidelity Class-D power amplifier chip that is included inside the receiver case of several of the Knowles Electronics hearing-aid receiver models [4]. The Model EP-3074 receiver, for example, has the same transducer mechanism used in the Etymotic Research ER-1 high-fidelity insert earphones. It will produce 110 to 115 dB maximum undistorted output, yet its internal Class-D amplifier idles at about 0.17 mA, a small fraction of the idling current of a typical hearing-aid power amplifier. Even so, the entire EP-3074 package would easily hide inside an ordinary pencil eraser.

High fidelity for the hearing impaired is not the same as high fidelity for normal listeners. Developed with the help of a \$500,000 grant from the National Institute on Aging, the Etymotic Research K-Amp input amplifier chip (Fig. 1B) has a unique feature: It only amplifies quiet sounds. An automatic circuit operates an electronic volume control to make quiet sounds audible and a tone control to provide treble boost for quiet sounds. Loud sounds that present a problem for most hearing-aid wearers (dishes clattering, paper crunching, wind howling, people shouting) pass through without amplification just as if the hearing aid weren't there [5]. Amplification for loud sounds is available to the user if he or she chooses to use it, but it will generally not be required.

Undistorted amplification of intense sound is a very important part of the performance of a high-fidelity hearing aid. Strong vocalization, piano playing, live symphony orchestra concerts, wind noise, a spoon dropped onto a plate, etc. can all generate sounds peaking between 95 and 105 dB SPL on the sound-level meter. These meter readings correspond to instantaneous oscilloscope peaks of 103 to 118 dB SPL, equivalent to sine-wave inputs of 100 to 115 dB SPL. Many hearing-aid circuits, however, are designed to op-



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The woofer cone, for example, is carbon graphite filled

to set a new standard for bass quality and authority in a system of this size. The voice coil of this woofer is vented for increased power handling and effortless reproduction of dynamic musical passages.

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Distortion makes intense sounds even more annoying, so undistorted headroom is vital in high-fidelity hearing aids.

erate without distortion only up to inputs of 90 dB SPL, even at minimum volume-control setting. Distortion often makes intense sounds seem even louder-and thus more annovingthan they would otherwise be, so the input circuit of the K-Amp is designed to operate distortion-free for inputs up to 110 to 115 dB SPL. In many hours of listening tests (including live symphony, choral, and jazz concerts), the only times distortion has been detected have been when car keys were jangled next to the hearing-aid microphone inlet or piano keys were banged when the listener's head was inside the grand piano. Distortion was detected only on clearly unreasonable tests.

The most familiar automatic signal processing (ASP) circuits for hearing aids reduce low-frequency gain as input level increases. This type of ASP is intended for wearers who frequently find themselves in noisy environments. especially environments where low-frequency noise predominates. Existing ASP circuits are primarily designed to filter out low frequencies, which until recently were presumed to contain most of the troublesome noise energy, although the better designs include a broadband reduction of gain at the highest input levels to reduce distortion. Recent indications are that the success of these circuits may relate more to their ability to reduce hearingaid distortion than to their level-dependent frequency response characteristic. The latter acts to increase the relative low-frequency gain of the hearing aid for quiet sounds. This BILL (Bass Increases at Low Levels) type of leveldependent frequency response effectively gives the most treble emphasis for loud sounds.

The K-Amp type of ASP works in just the opposite way, giving the most treble emphasis for *quiet* sounds. This type of ASP is intended for wearers with high-frequency hearing loss. They typically need more gain for quiet sounds, particularly at high frequencies, than they do for loud sounds (a phenomenon known as recruitment). An amount of high-frequency gain that might produce a harsh or shrill sound in a linear hearing aid may become quite acceptable if the treble boost is automatically reduced for high-level inputs. This typical operation of the K-

Amp circuit is illustrated in Fig. 2, where curves of gain versus frequency are shown for different input levels. Figure 3 shows corresponding curves of output versus frequency for various input SPLs, based on KEMAR measurements in a diffuse sound field.

Rather than attempting to reject the noise by filtering it out (which also filters out part of the speech), the K-Amp approach attempts to maximize the clarity of speech by making all speech cues audible [6]. This is accomplished by automatically selecting the appropriate gain and treble boost for each listening level so that all speech sounds will be made audible for the



Fig. 2—Relative gain of the K-Amp for different input levels. Loud sounds pass through unchanged, while quiet sounds receive up to 25 dB of treble boost.



Fig. 3—Output to the ear of a complete K-Amp hearing aid, referenced to a diffuse sound field. In this model, suitable for individuals with mild to moderate high-frequency hearing loss, sounds above 90 dB SPL are passed through unamplified, while progressively greater gain and treble boost are applied as level is reduced below that point. The dashed portion of the 110-dB curve represents high-frequency levels which would overload the amplifier as sine-wave inputs but which do not occur in normal speech and music. hearing-impaired listener. For users with high-frequency hearing loss, this TILL (Treble Increases at Low Levels) form of ASP, combined with the wide bandwidth and low distortion provided by the K-Amp hearing aid, should provide the best intelligibility in noise and the most natural frequency response in the greatest number of real-world listening conditions.

Thus, while the real-ear frequency response of the complete K-Amp hearing aid for *loud* sounds is essentially flat, the frequency response for *quiet* sounds will be high fidelity only as perceived by the hearing-impaired listener. To restore the audibility that has been lost by someone with a high-frequency hearing loss—the most common loss due to aging or exposure to noise—the automatic gain and tonecontrol circuit will provide 20 dB or more of treble boost for quiet sounds.

The K-Amp integrated circuit from Etymotic Research and high-fidelity microphones and Class-D amplifiers from Knowles Electronics are small enough to be incorporated into custom in-the-ear hearing aids. Such aids offer true high fidelity and can now be obtained from several manufacturers.

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RICHARD J. KAUFMAN

he folded dipole antenna is surely the most popular FM antenna there is, for almost every tuner and receiver ever made has been shipped with one. Surprisingly, every one of these antennas has an innate design flaw. This error in construction is easy to correct with only a soldering iron and a bit of wire.

A single half-wave length of wire, tapped at the center, is a dipole antenna (Fig. 1A). A dipole's impedance is approximately 75 ohms. Figure 1B shows a folded dipole antenna. It is made from two parallel wires, each one wavelength long, joined at the ends. One of the wires is tapped in the center to feed the signal to a receiver by a transmission line. In theory, the folded dipole has greater bandwidth than the dipole.

In a folded dipole, two wires carry the same total current as the single wire in a dipole, but the current is divided between them. Each wire has half the current, but the antenna delivers the same power to the receiver. Since power is a function of the square of the current ($P = R \times I^2$), it follows that this results in a fourfold increase in the antenna's impedance. A folded dipole has an impedance of 300 ohms. which matches 300-ohm twin-lead antenna wire. It is very simple to build the whole antenna from twin-lead transmission line, and this is almost always done.

This doesn't give the intended results, however, because the speed of a radio wave in a transmission line is not the same as it is in free space. The presence of an insulator between the wires slows the radio wave, thereby making the line effectively longer than one-half wavelength.

To a radio wave in space, the folded dipole is the correct length, but to a radio wave flowing on the antenna, the folded dipole is also a transmission line—and too long. The result: Instead of feeding all their energy into the transmission line, radio waves bounce around in the antenna, interfering with reception in much the same manner as multipath reflections from buildings and mountains.

Correcting this innate mismatch between antenna length and transmission-line length is not difficult. Figure 2 shows the proper construction of a folded dipole antenna from 300-ohm twin-lead wire. The velocity factor of this kind of wire is 82%; thus, a quarterwave length of transmission line is 82% of the length of a half wave in free space. The dimensions given in Fig. 2

/Fancy Reception

are for 98 MHz, the center of the FM band, an acceptable compromise for general reception. However, if your interest lies at the high or low end of the FM band, you can scale the antenna



for your needs. The formula for a half wavelength (in inches) is 5,616 dividedby the frequency (in megahertz).

Fixing Your Folded Dipole

If you already have a folded dipole antenna, modify it by shorting the wires on each arm, 23 ½ inches from the center of the antenna. Carefully scrape the insulation off the wires with a sharp knife, and solder a piece of wire between them. Solder is necessary for a good connection; otherwise, you might introduce more noise and distortion than you are correcting.

How good is this antenna? I found it gave a noticeable improvement on stations that had been unlistenable because of noise. In the January 1983 issue of Audio, Len Feldman reviewed several outdoor FM antennas. As a point of reference, he measured a folded dipole antenna and found its standing-wave ratio to range between 2.5 and 1.5, depending on frequency. A perfect antenna would have a ratio of 1.0. In theory, measurements of a properly made dipole such as the one described here would be very close to 1.0 at the center of the FM band and would be much lower than 2.5 at the extremes.

Antenna Positioning

Even the best antenna will not work when it is improperly placed. A horizontal antenna should be at least half a wavelength above ground, or most of the signal will be lost. This is approximately 5 feet for FM. If your listening room is on ground level, you cannot simply place your antenna on the floor: on the second floor of a wood-frame house, putting the antenna under a rug will usually work. Be sure the transmission line to the receiver is at a right angle to the antenna for at least a quarter wavelength; a half wavelength is better. Note that if you live in a highrise building, floor placement of an antenna is not a good idea. The floors of such buildings are made by pouring an inch or two of concrete into a metal pan; the pan is an effective ground. In such a building, the ceiling is also a ground. Your best chance is probably with the antenna midway between floor and ceiling. Tacking the antenna to a wall is usually all right, but if there is metal in the wall, it could be a problem. Most houses have an aluminum vapor barrier on the exterior insulation. This, too, is a ground. Windows might work, but they often have screens.

To summarize: In a brick or woodframe house, the best antenna position is probably on a second-story floor or an interior wall. In an older building with no vapor barrier, an exterior wall is probably best, while for a new highrise structure, an interior wall might be best. Putting the antenna outdoors, as on a balcony, will usually increase signal strength by several decibels, though outdoor placement is not always practical.

In any case, experiment with several locations for your antenna, and remember: It is not uncommon for a location that violates these rules to give the best reception in some unusual situations.

Collinear Antennas

If adding two small pieces of wire to a dipole antenna can improve FM reception, imagine what a better antenna design might do. Many different antennas can be fashioned from wire. The best of them offer such an improvement over the dipole that it is surprising they are not better known.

Figure 3 shows a collinear wire antenna. It consists of three half-wave sections, kept in phase with each other by half-wave phasing sections of transmission line. Lamp cord pulled apart into single wires can be used for the half-wave sections, and twin-lead wire for the phasing sections. The dimensions given for the phasing sections assume an 82% velocity factor, as found in standard 300-ohm twin-lead antenna wire. The dimensions in Fig. 3 are for 98 MHz. Although you can scale the antenna for other frequencies, its bandwidth is even greater than the folded dipole so it is probably not worth changing the dimensions except in unusual situations. This antenna's impedance is slightly more than 300 ohms, so it can be used with 300-ohm transmission line with no difficulty. Another alternative is to place a balun transformer at the antenna's center and use coaxial cable to connect to a tuner's 75-ohm input. The gain of this antenna is 3.2 dB, so it delivers more than twice as much power as a dipole.

Don't be too astonished if you get the best reception from antenna placements that violate the rules.











The pickup pattern is like a cylinder running the length of the antenna, with nulls at the ends.

The length of this antenna is almost 10 feet, which can be awkward, especially in a small room. It is possible to bend the antenna at the center so that it forms a "V." The feed line can be run up the wall in a corner, with the antenna arms extending at right angles along the wall (although 15° is the theoretical optimum). Doing this eliminates the end nulls, increases the gain in the direction between the arms of the "V," and reduces gain in the opposite direction. Keeping the antenna basically straight, with only the last foot or two of each arm bent (up, down, or sideways) is another option.

If you want to try putting this antenna under a rug, keep the twin-lead phasing sections at right angles to the rest of the antenna. The feed line to the tuner should at right angles to the antenna, although departures from this ideal are not intolerable.

The Sterba Curtain

Figure 4 shows another antenna, the Sterba curtain, named after its inventor, E. J. Sterba. This antenna has a little more than 6 dB of gain, which should be enough to satisfy anyone within 70 miles-or even more-of a station. Like the three-section collinear antenna, it can be used with a 300ohm feed line or with a balun and 75ohm coaxial transmission line. The actual impedance is 400 ohms, which will not be a significant mismatch. The Sterba curtain's directionality is broadside to its plane. It cannot be used under a rug, unless the FM station you are seeking is on the moon or one of the nearer planets. The horizontal elements of the antenna can be bent in the center or symmetrically at the ends to eliminate the end nulls, as long as they remain horizontal. Do not bend the vertical elements.

FM radio enthusiasts who experience reception problems should consider alternative indoor antennas before spending the money and time to buy and install outdoor antennas. Better reception may simply require modifying or repositioning the folded dipole already in use—or, at most, constructing one of the simple antennas described here.

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BILL LEVENSON



Although he did pause long enough along the way to get a bachelor's degree in mathematics and to begin a career in systems engineering at IBM, PolyGram Records' Bill Levenson was destined for a career in recorded music.

It began with a passion for collecting records. While in his teens and 20s, it wasn't uncommon for Levenson to divide his paychecks between life's necessities and the latest 10 albums to hit the New York City record store racks. In 1980 his knowledge of both computers and music gave him entree into PolyGram's newly opened New York headquarters. By 1982 he was manager of A & R and later was named director of the same department.



But it wasn't until he co-created PolyGram's catalog development department that Levenson's rise up the corporate ladder became widely noticed in the music industry. Serving as both the department's director—a role in which he established PolyGram's Compact Disc reissue program—and its principal record producer, Levenson has overseen the ambitious and commercially successful retrospective compilations of Eric Clapton's *Crossroads*, the Allman Brothers Band's *Dreams*, and The Bee Gees' *Tales from The Brothers Gibb: A History in Song, 1967-1990, Chapters I-IV.*

Having won a Grammy for *Crossroads* in 1988, Levenson has once again delved into the Clapton *oeurve* for *The Layla Sessions: 20th Anniversary Edition.* This three-disc set, consisting of a remixed version of Derek and The Dominos' 1970 release *Layla and Other Assorted Love Songs*, a disc of alternate masters, and another of jams, is the subject of the following interview. Levenson's future projects will include Compact Disc chronicles of the careers of Hank Williams and James Brown. *D.McC.*

a sure hand for

PHOTOGRAPH: ROBERT LEWIS



slow hand

When putting together PolyGram's reissue program, what elements had to be put in place right away?

In any reissue program, you start by filling in the blanks in the catalog. If you have a line item that has an LP or cassette and no CD, that's where you start. Those are the easy ones. Plus you have to work closely with Business Affairs, because you can't just put a CD out; you have to go back to your contracts and see what your rights are. If your rights don't allow you to do another configuration, which is more often the case than not, then you have to go to the artist and get a CD agreement. That's why a lot of key artists were slow coming to the Compact Disc market.

Why would artists have in their contracts that you couldn't issue another format?

It's usually related to the royalty base. When CDs were introduced, they were very expensive to manufacture. Royalty bases are typically married to list price, and paying full royalty rates at list price wasn't really proper for that item at that time. So you needed a break from the artist to make it work. But things have changed. Now, when you sign an artist, that stuff is covered up front. In the past, though, each contract had its own ambiguities that you had to sort through.

There was a period when many record companies had to go back and redo their Compact Discs. Columbia's initial stab at Bruce Springsteen's Born To Run comes to mind, as does Atlantic's first run-through on The Rolling Stones' catalog.... BILL LEVENSON When remixing the album, we took the master and put it alongside the multi-track to match the speeds.

We had some of those too. Eric Clapton's 461 Ocean Boulevard was one. Moving Pictures by Rush another, and Cream's Disraeli Gears was about the worst. The early PolyGram CDs were typically handled out of Germany, and they didn't have the basic premise down that you need a master tape. They were using copies of the master tape. And think about it; you're a German guy and you've got to get 10 discs out a month, you don't really know where tapes are stored, so you go to your tape library and see something that says "master" on it. Then you transfer it to disc. What was occurring was that you were winding up sometimes with a fifth-generation tape.

Disraeli Gears was recorded in Atlantic Studios in New York, Atlantic kept the master copy, and when the Robert Stigwood Organization went to Polydor, they took a production copy. They then copied that for Germany, so God knows what's in Europe. That's what they were making CDs from, and inevitably people began saying, Boy, this CD stuff sounds God awful. What's the deal?" And it was really a case of someone attacking the mastering of the CD from the wrong angle. You really do have to go back to the source and find the master tape. If we've resolved to do anything here, it's to make every effort to track down a master tape. It's a very simple but time-consuming process because the tape can be anywherethe artist can have it. or



the producer, or the manager, or the record company. If the record company has changed hands, you've got to chase that through. I was lucky with Eric Clapton because I got legal clearance to walk into Atlantic Records' library, and everything I ever looked for was pretty much there. And if it wasn't there, it was at Island Records, as was the case with the Blind Faith stuff, or it was overseas in some RSO vault that no one knew to look in. We had to search and search. And as we've tracked down tapes over the years. we've upgraded, so that the Disraeli Gears you buy now is a zillion times better than you might have bought or heard seven years ago. Ditto 461 Ocean Boulevard.

Nipping and tucking has a long history. Didn't the album Allman Brothers Band at Fillmore East have a lot of edits in it?

There's actually two versions of At Fillmore East, the stereo and the guadraphonic, which are two very different records. On the stereo one, they obviously worked very diligently. They nipped and tucked, and some of the songs on that version are composites of multiple performances. If you listen to the quad version, you'll see that there are different things happening in the same song. What happened was, when the quad thing came along, people rushed out to do guad mixes and didn't have the same wherewithal to follow the same pattern. So they took the best choice, the best performance, and mixed it down to guad. The difference is really apparent on "Stormy Monday Blues," because there's a long harmonica solo on the quad version that doesn't appear on the stereo one. The intro to "Statesboro Blues" is different.

The version of "Crossroads" that we all know and love Clapton for was cut down also, wasn't it?

I don't know the true answer to that. All I know is that the master tape we have of Cream's *Wheels of Fire* shows edit points. The edits we have could be EQ points, where they equalized differently and then put it back together. We thought for a while that it was edited down, but we're not quite sure anymore. It's hard to say.

Did Columbia's boxed presentation of Bob Dylan's Biograph give you the freedom to say, "Let's do a boxed set of one of our artists"?

It brought the idea to us. It was a precedent. I probably got *Crossroads* done because I wasn't integrated into the A & R department. If I had been, management would probably have been horrified. "You're going to spend \$100,000 on a catalog item? You're going to pay Ron Wood 10 grand to design a cover? Are you crazy?" The fact that I did it quietly, that I spent money quietly, and that I picked the right artist probably helped me get away with it.

And, you know, even as we went to market, we were looking at it and saying, "It's a bit extravagant, we'll recoup it with 20,000 units, so maybe we'll sell 25 or 50 thousand." That was sort of how we went out with it. I talked to the press, radio got their copies, and the thing exploded. All the right elements were there.

What portions of the collection would you change now, if you could?

I underplayed the Derek and The Dominos thing. I did "Mean Old World" and "Layla," which was good, but I probably should have put "Little Wing" or something else from Layla and Other Assorted Love Songs on it. You could toss a coin, there are so many good songs on that album. I didn't need two live tracks. I should have had two more studio tracks. We found the multitracks far too late to spend a whole lot of time mixing and remixing, and I didn't want to use the tracks off of the two-track because they just sounded dreadful.

The other area is John Mayall's Bluesbreakers. I have a live track—it's "Have You Ever Loved a Woman," if I remember correctly—but I could've taken that six minutes and presented the three pre-Decca singles on the Immediate label. The problem was, nobody knew where they were, and I just ran out of time.

Did any of the feedback that you got for Crossroads influence how you approached The Layla Sessions?

Yes. I took a lot of shit from audiophiles on the remix of "Layla." A lot of people felt it was too bright, that it wasn't authentic, etcetera, and I took that to heart. In retrospect, it's not as bad as they said, but there is a mistake on the remix which we only discovered when we started to do it again.

the piano, and 5% at the tail end. On *Crossroads*, we only had the 3% speedup throughout. It's a mistake. It actually kicks in twice more. When we did the remix of the album, we actually took the master tape and put it along-side the multi-tracks so we could match the speeds, because we had to make sure we were in sync at all times. *Was this done to get the timing on "Layla," or for each and every track?*

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Two of the many faces of Eric Clapton. Above: Around the time of Blind Faith in 1969. Right: Derek and the Dominos in 1970. Pictured are Jim Gordon, Carl Radle, Bobby Whitlock, Clapton, and Jeep. (Duane Allman is not in this photo.)



The intent when doing the remix on this album was to do it as authentically as possible, and what that meant was to pay more attention to tape speed. When we remixed "Layla" the first time, we were aware that the speed was slow. When they cut it the first time, they actually sped it up. We had matched the front end, and there was a 3% difference. What we didn't realize is that they sped it up twice more during the song—3% at the intro, 4% at

Every track. And we not only timed the tracks but also the spirals between the tracks, so that when you put this on, other than the fact that it's a better mix that offers a few surprises, you're listening to the same record. It's just a helluva lot better. We didn't make it a 1990s recording, we made it an optimum 1970s recording.

What was wrong with it, tape degeneration or things that were done in 1970? Things that were done. For instance, when mixing the original album, they put the bass hard left. It's an old concept: Place everything on one side or the other. And for some reason, the bass was always hard left. No one puts the bass hard left anymore, for technical reasons. When cutting records, the bass is best in the center. So the first thing that Steve Rinkoff, the principal engineer on the project, decided was that the bass was going to be centered. After that, your whole plan generations of tape because it was only a record. You cut it, and you probably rolled off the top end if hiss was a problem. So here we are in 1990 with a 16-track master tape and we know in advance what they were doing, so let's do it right, in digital, as we go along, and never incur another second generation. And if there is another generation, it is a digital generation. Ultimately we saved three generations, and most of the hiss has gone away. The only we've come this far, what's another four minutes? So for the person who has to have everything, you now have "Tender Love" also. Eric listened to it and understands that. It was one of the first tracks they cut; they abandoned it because it wasn't working. The booklet has dates in it and this track is labelled as incomplete, but this is what went on for those two or three weeks.

Was it easy, in the end, to say, "Okay, this is finished, put it in the box"?



BILL LEVENSON We couldn't make a 1990s recording out of *The Layla Sessions*, so we made it an optimum 1970s recording.



changed; once you moved the bass,
you had to move things around a bit.
The other thing that was done was done was done was end things were widened so that there's
more stereo spread. Back in 1970, they kept the stereo image very narrow, and over time we've learned to use the whole 180°. After we worked on those two parameters, everything else fell into place.

What they did in 1970 was, they mixed down to a slower speed—possibly to 71/2 ips but maybe 15. Right away you've got a noise problem because your tape is running slower. They also didn't use Dolby NR, which made it worse. Since all the tracks were sped up in different degrees, they had to copy it over. So they took the 71/2 ips on "Layla" and said, "Let's transfer to another tape"-non-Dolby, mind you—"and let's speed this up 3% here, 4% here, and 5% here. Man, that sounds great. Fine. Save it." So they were transferring, making a secondgeneration tape, and either that became the master or, once they had a composite reel of all this varied speed stuff, they made another transfer and marked that "master." That wasn't unusual in 1970. This was how you worked, from analog to analog, and it didn't matter if you were building up

hiss that remains is the hiss that went down when they recorded the musicians in the first place. They didn't have all the Dolby stuff we have now. What criteria did you use to choose what would be included on The Jams disc in the Layla package?

Basically we said we were going to use everything, and it just worked out that we could. The only thing we did was, when we mastered it, it came out to 83 minutes and technically a CD can only hold 77, so we nipped and tucked. Some things needed it, such as bum notes, as any jam would have. The intros stayed in because that's how the multi-tracks are. The musicians were jamming and someone said, "Hey, that's cookin', hit the button." So they'd pick it up in midstream. That's why "Key to the Highway" fades in, because that was impromptu.

What warranted being included on the Alternate Masters disc and what didn't?

Everything made it. Or rather, I should say, everything that was saved. I'm sure there's stuff that they scrapped that I don't have. Where we got down to whether we were going to let something go or not was on something called "Tender Love." In essence, it's a basic rhythm track, and we thought, It's never easy to get to that point. We even had time booked at the Power Station in the event that we mastered and didn't like it. We went into Masterdisc and spent four days mastering, track by track, disc by disc, and if we felt something wasn't bright enough or prominent enough, we were able to equalize and take care of it.

Is this the last Eric Clapton box set? I don't think there is much more. There is one project that could be done, basically of rarities-and I've got tons of them. Just because I found them doesn't mean they made it onto Crossroads. One is Blind Faith's "Can't Find My Way Home," an electric version. They cut it both acoustic and electric. I can build a whole compilation around that track. For Slow Hand, he cut "Before You Accuse Me," which I only discovered recently, and there's a whole unreleased album from the late '70s that would have come between Backless and Another Ticket. I've never heard it, but I understand that it might not be terribly strong. There's lots of live stuff. So, yeah, there's a package out there. There's a BBC live package, a Blind Faith package, a rarities package, and there's probably a live package. But I waited two years for this, and I'm going to wait again. А

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Music of th

ver since the introduction of Compact Disc digital audio technology in 1982, the digital-to-analog (D/A) conversion process has gone through continuous refinement to

improve the audio quality of the reproduced music. The technology has progressed from 14-bit D/A converters in 1982 to 20-bit D/A converters in 1989, with various flavors of oversampling from two-times to 16times. In this article, I will briefly review the existing multi-bit D/A converters and the problems associated with them and then discuss the two basic new one-bit D/A conversion techniques and their advantages.

Today, most Compact Disc players employ oversampling digital filters and multi-bit D/A converters to reproduce music from digital information recorded on the optical disc. The digital oversampling filter and interpolation are used to reduce the quantization noise in the analog audio bandwidth, improve the signal-to-noise ratio (S/N), and allow for simpler and lower order, phase-linear, analog post-filtering. Also within the digital oversampling filter, dither, noise shaping and noise decorrelation are implemented to further improve performance. The 18- to 20-bit D/A converters are used to simulate a perfect 16-bit system. Unfortunately, these D/A converters often fall short on audio performance due to severe component nonlinearities. It is important to dispel the myth about achieving 18- to 20-bit accuracy in sound reproduction from a Compact Disc whose digital mastering has

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COLLAGE: VICTORIA KANN



PRASANNA SHAH e Bitstream



A 16-bit converter produces 65,536 discrete amplitude levels precisely, while a one-bit converter has but one level of amplitude.

only 16-bit accuracy. This can be seen in Fig. 1. The original samples are shown at the two extremes of the analog waveform and the four-times oversampled data points in between. If a signal is reconstructed from the original samples, it would have large steps with very high quantization noise, but if it were reconstructed from the oversampled and interpolated data points, there would be much lower quantization noise.

There are several problems associated with multi-bit conversion techniques. Linearity and gain errors, alitches, slew-rate distortion, zerocrossing distortion, etc. introduce severe harmonic distortion and groupdelay differences which influence the audio focus, depth perception, and stability of sound sources in a stereo image. For good-quality sound reproduction, it is essential to use digital to analog converters with excellent performance at low signal levels and high frequencies, though most manufacturers of multi-bit D/A converters specify their components only at 0-dB level and 1 kHz.

The absolute linearity error of a D/A converter is the deviation from a constant-step staircase output. This type of error causes distortion at large signal levels, which is only observed when the analog post-filters and amplifiers have virtually no distortion. Differential linearity error is the step-size deviation from one least-significant bit (LSB) at any place in the D/A transfer characteristics, and it introduces audible distortion at low signal levels. In multi-bit converters, binary-weighted current sources are switched according to the binary sample value, which then generates an analog current representing the binary sample value. A good 16-bit D/A converter has to generate the full-scale current with an accuracy greater than one part in 65,536 (one LSB) of the full-scale current. Similarly, an 18-bit D/A converter has to have an accuracy that is greater than one part in 262,144 of its full-scale current. To achieve such higher accuracies, techniques such as laser trimming of components, segmentation of current-divider networks, or external

trimpots for adjustments are utilized. These external trimming techniques use potentiometers, current-source segmentation, offset cancellations, etc. in a D/A converter produces transients that can vary over time and tempera- which are known as glitches. These ture. Therefore, they can do more harm glitches have a significant impact on

reproduction since they are subject to aging and production variances.

The switching of the current sources than good to the consistency of sound the sound quality at low signal levels



when the ratio of glitch energy to signal level is at its highest. The "deglitchers" that are used in some systems cause additional linearity problems in the total D/A circuit. When the music signal passes through the zero level, switching of the most-significant

Fig. 4—Eleven-step PWM D/A converter waveforms and their relationship to original sampling and converter oversampling frequencies.



Fig. 6— Frequency response of FIR filter.



bit (MSB) causes zero-crossing distortion, as shown in Fig. 2.

Slew-rate distortion typically occurs in the differential amplifiers used for analog post-filters and deglitchers with D/A converters. The current pulses and glitches produced by these con-



verters have a slope of a few nanoseconds, and their amplitude depends on the signal frequency, signal amplitude. and oversampling rate. The higher the signal frequency and amplitude, the larger the glitches. Because the amplifier bandwidth is low compared to the transition speed of the glitches, the error voltage at the inverting input of the amplifier is determined by the highfrequency output impedance of the amplifier and the response of the feedback network. Slew-rate distortion occurs when the error voltages exceed the linear operating range of the amplifier input stage. The slew-rate distortion is usually very severe when highlevel and high-frequency signals are being converted.

Although commercially available multi-bit D/A converters are typically plaqued with the aforementioned problems, there are exceptions, such as the Philips TDA1541A series of 16-bit D/A converters. These converters use a patented technique called Dynamic Element Matching, involving time averaging of active current dividers (not passive ones as used by Analog Devices and Burr-Brown). This cancels any offsets or mismatches in the current sources and circuit components, and it provides a significant improvement in the accuracy of the current dividers, regardless of temperature variations and aging. This reduces the distortion caused by the linearity and gain errors. The Dynamic Element Matching scheme also alleviates the problems of zero-crossing and slewrate distortion, as the high-speed timeaveraging minimizes the glitch energy.

SINGLE-BIT CONVERTERS

To address the problems associated with the multi-bit D/A conversion, two new single-bit conversion techniques have emerged. One of these, pulsewidth modulation (PWM), is also known as pulse-edge modulation (PEM) or pulse-length modulation (PLM). The other, the Philips pulse-density modulation (PDM) system, is also known as bitstream conversion. Each bit in the multi-bit D/A converter represents a

Comparisons between the noise floors of PDM and PWM converters are meaningless, because PWM converters mute during digital silence.

level in amplitude of the signal. Thus, a 16-bit system has 65,536 discrete levels of amplitude, each corresponding to its 16-bit code. In contrast, the onebit D/A converters have only one level of amplitude. In the PWM scheme, the pulse width corresponds to the 16-bit data word, whereas in PDM bitstream conversion, the density ratio of the positive or negative pulses is associated with the original 16-bit data word.

PWM CONVERTERS

The PWM technique called MASH (for Multi-stAge noise SHaping, a patented technique developed by NTT of Japan) is utilized by converters such as Sansui's LDCS and Matsushita's MN6471. A typical MASH converter (Fig. 3) is composed of a four-times oversampling digital filter followed by a noise-shaping circuit. (For more information on the noise shaper, refer to the sidebar.) The output of the noise shaper goes into the PWM D/A converters, and the analog output is then low-pass filtered.

The digital Finite Impulse Response (FIR) filter has 106 taps and produces 18-bit data from a 16-bit input sample after four-times oversampling. A firstorder noise shaper is in parallel with a second-order noise shaper which converts the 18 bits of sample data into an 11-step PWM output. Within the noiseshaper block, the data is eight-times oversampled again to bring the total oversampling to 32 times. The 11-step output waveform drives the two PWM D/A converters, and the op-amps finally low-pass filter the analog waveforms. Figure 4 shows the 11-step waveforms from the PWM D/A converter. As the value of the sample is proportional to the pulse widths of each step, it is quite essential that the PWM steps have extremely accurate pulse widths and absolutely minimum jitter to maximize the accuracy and linearity of the converted data.

The entire system is operated from a master crystal oscillator at 768 times the sampling frequency, 33.868 MHz. A true one-bit PWM conversion of a 16-bit signal would require 65,536 pulses to represent each different amplitude.

Unfortunately, this would require the one-bit PWM D/A converter to operate at clock rates in excess of 2.98 GHz, which is not possible even with the fastest bipolar technology available today. Hence, bit compression is performed and the 18-bit data word is converted into an 11-step PWM output. These 11-step PWM outputs are then presented to the PWM D/A converter. Even though each PWM step has a fixed duty cycle with predefined high and low voltage levels, the D/A converter can only be considered a 3.5-bit converter instead of a true one-bit converter because of the 11 quantized PWM steps.

PDM BITSTREAM CONVERTERS

The PDM bitstream technique developed by Philips and utilized in the SAA7322/3 is, however, a true one-bit D/A conversion. The block diagram of the bitstream D/A converter is shown in Fig. 5. The device accepts inter-IC sound (I²S) serial-format data from the decoder chip SAA7310 and feeds the four-times oversampling digital FIR low-pass filter. Higher audio performance is obtained because the nonrecursive FIR interpolation filter is phaselinear, with minimum overshoot and



Fig. 7— Simplified schematic and timing diagram of a switched-capacitor one-bit D/A converter. Components R1 and C3 are external. The p + signals include clock and data; p - signals include clock and inverse data.

Fig. 8— Simulated PDM output. The pulses above the center line are ones; the pulses below the line are zeros.



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BITSTREAM VS. MASH NOISE SHAPERS

n one-bit D/A converters, 16-bit data is reduced to one-bit data by the sigmadelta modulation algorithm; this reduction in bits is also known as bit compression. One major problem with bit compression is reduction of dynamic range and increased quantization noise. Noise shaping in the digital domain is a very efficient method of alleviating the dynamic range reduction and noise-floor deterioration in one-bit D/A converters. The main function of the noise-shaper circuit is to change the frequency spectrum of the error signals so that most of the requantization error energy is transposed from the audio band to higher frequencies. This can be seen in Fig. B1.

The block diagram of a third-order, MASH-type noise shaper is shown in Fig. B2. It is actually a first-order noise shaper in parallel with a second-order noise shaper. The input signal is fed into quantizer Q_1 after the residual error signal is subtracted from the delay block in the first-order noise shaper. The residual sig-



Fig. B1—Redistribution of quantization noise by a noise shaper.

nal is also fed into the second-order noise shaper, where the output of the second quantizer (Q_2) is then differentiated and added to the output of the first-order noise shaper to reconstruct the final output signal. Due to physical limitations in VLSI integration and the speed requirements for the MASH converters, the output signal of the noise shaper is translated into 11 discrete PWM steps. In the case of the Philips PDM bitstream D/A converter, a second-order noise shaper converts the 17-bit digitally oversampled and filtered data word into a true one-bit stream.

The two major factors affecting the performance of the noise shaper are the order of the noise shaper and its frequency of operation. The higher the order of the noise shaper, the higher the slope of the noise redistribution and the lower the noise inside the audio band; thus, more noise is shifted to the higher frequencies. A major drawback of this increase in noise at higher frequencies is the requirement



Fig. B2—Block diagram of a third-order noise shaper.



Fig. B3—Noise density vs. frequency for PDM and PWM noise shapers.

for a higher order, analog, low-pass filter after the D/A converter. The higher the operating frequency of the noise shaper, the higher the frequency to which the noise is shifted from the audio band.

The noise-density distribution is given by the equation:

$$N(f) = [2 \sin\left(\pi \frac{f}{f_s}\right)]^n$$

where f is the frequency of interest, f_s is the noise shaper's operating frequency, and n is the order of the noise shaper. Figure B3 shows noise density versus frequency for the MASH and PDM bitstream noise shapers. Since the MASH is a thirdorder noise shaper, it has a noise peak twice as high as the PDM bitstream. Also, the MASH noise shaper has a lower frequency of operation than the PDM bitstream and thus has its noise-density peak at a much lower frequency and closer to the audio bandwidth. Thus, the MASH converter will require a much high-



Fig. B4—Noise density in the audio band for PDM and PWM noise shapers.

er order, analog, low-pass filter to reduce excess ultrasonic noise from the output.

A closer look at the two noise-density distributions in the audio band is shown in Fig. B4. It can be seen that from d.c. to 8 kHz, the noise density for both PDM bitstream and PWM MASH is insignificant: However, as the frequency increases from 8 to 20 kHz and above, the noise level for PWM MASH converters increases significantly, whereas the noise level for the PDM bitstream remains relatively flat. To equivalently reduce the ultrasonic noise for the PWM MASH converters, a much higher order, low-pass filter would be required than is used by the PDM bitstream converter. Thus, it can be concluded that the operating frequency of the noise shaper has more impact on the noisedensity distribution than does the order of the noise shaper. Therefore, the PDM bitstream converter has a better noise performance than the MASH converter.



Fig. 9— Linearity error of PDM and conventional 16-bit D/A converters.

fast settling time. Excellent phase linearity reduces phase distortion and minimizes group delay (delay through the circuit that changes with frequency). Excessive group delay will change the tonal qualities and timbre of the music.

The filter has 128 taps (22 more than the MASH PWM D/A converter) and a 20-kHz bandwidth with a passband ripple of ± 0.02 dB. The stop-band attenuation above 24.2 kHz is -60 dB. First-order noise shaping is performed by the accumulator of the multiplier in the filter. The filter also performs frequency response compensation for the linear interpolator and analog postfiltering roll-off, and performs coefficient scaling to prevent overflow in the noise-shaper circuit. (Figure 6 shows the frequency response of the FIR filter.) The first filter stage shown in Fig. 5 is followed by the attenuator and clipper stage, which provides 12 dB of attenuation during track search.

The second filter stage is composed of a 32-times oversampling linear interpolator and a two-times oversampling sample-and-hold circuit. In this stage, a 352-kHz digital dither signal at -20 dB is added to the sample data. This dither reduces the nonlinearity introduced by correlated quantization noise and also reduces any idling patterns in the noise shaper. This stage brings the total oversampling to 256 times. The 17-bit data at 11.2896 MHz is then fed into the second-order noise shaper. The main function of the noise shaper is to reduce the 17-bit data to a one-bit data stream using sigma-delta modulation and, in due process, redistribute the quantization noise from the audio spectrum to higher frequencies.

The one-bit data stream is then converted into an analog signal by the switched-capacitor network D/A converter, as shown in Fig. 7. When the input data bit is "1," charge p + is transferred from C1 to C3 on the high clock period (CL); on the low clock period (\overline{CL}), C1 is discharged. When the input data bit is a "0," the charge is transferred from C3 to C2 on the high clock period and C2 is discharged during the low clock period. Thus, it can be seen that the accuracy of the

Fig. 10— Transfer functions, showing linearity errors of multi-bit D/A converters (A) and PDM one-bit D/A converters (B). The number of reference points for a converter's transfer function depends on the number of bits employed. With only two reference points, the one-bit converter's transfer function is smoother, causing errors in gain rather than in linearity.



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One-bit D/A converters can represent 16-bit data words by varying pulse width or the ratio of positive and negative pulse densities.





-70 -70 Fig. 13— 19-ыт, ех THD vs. freque

Fig. 12-

Comparison of linearity

multi-bit D/A converters.

error for one-bit and



Fig. 13— THD vs. frequency for different D/A converter types. converter mainly depends on the matching of the two capacitors C1 and C2. With advanced C-MOS technology, it is possible to achieve a very high level of matching accuracy.

In a single-bit conversion, one voltage reference produces two distinct levels of outputs, a "high" and a "low." In contrast, multi-bit (16-bit) converters produce 65,536 levels from 16 different current sources. As there is only a single voltage reference in the bitstream approach, there is no matching requirement for higher accuracy. This eliminates both absolute and differential linearity errors in the D/A conversion and the audio distortion associated with them.

The zero level, or digital silence, is represented in the bitstream converter by an alternating "101010101010..." pattern (which averages to a zero output level) at 11.2896 MHz. This highspeed conversion eliminates any zerocrossing distortion in the bitstream converter. It should be noted that most PWM MASH CD players mute the D/A converter during digital silence instead of producing a true zero-level output, and so the zero-level noise floor specified by these CD players is that of the amplifiers and analog low-pass filters and not the converter itself. If PWM MASH D/A converters do not mute the output at zero level, they can have a much higher noise floor than the PDM bitstream converters. Hence, comparison between the noise floor of CD players based on PDM bitstream and PWM MASH is meaningless.

To generate the positive-going portions of the waveform, a higher density of ones is present in the PDM bit stream, e.g.:

11101011011101011101111...

To generate the negative-going portions, the bit stream will contain a higher density of zeros, e.g.:

100100010001010001000...

This is shown in Fig. 8.

Figure 9 shows the linearity of a onebit PDM bitstream D/A converter. It can be seen that for most of the normal The linearity errors found in one-bit converters are of a less audible variety than those in multi-bit D/A converters.

audio range, the SAA7322/3 PDM bitstream D/A converter is as linear as the ideal characteristics. The multi-bit converter shows severe nonlinearity at low signal levels due to mismatches in the current sources. Since there are no MSB changes around zero level, and a zero is represented by an equal number of full-scale positive and negative pulses, the zero-crossing distortion is absent. Also, there are no major current switches to cause any glitches.

Figure 10 compares the linearity of multi-bit and PDM bitstream D/A converters. It shows that there is a severe linearity error for the multi-bit system, mainly due to mismatch in components. In contrast, the PDM bitstream converter has absolutely no linearity errors; it only has a gain error which can be attributed to any mismatch in the capacitors of the switched-capacitor D/A converter. This is demonstrated by the fact that the transfer function for the PDM decoder has only full-scale positive and negative reference points, with the intermediate points determined by time averaging. Therefore, there is only a gain error in conversion and no linearity errors. The resolution in amplitude for the multi-bit D/A converter is replaced with accuracy in time for the one-bit D/A converter. Since the timing reference is derived from a quartz oscillator, very accurate conversions are possible.

Figure 11 shows the response of a PDM bitstream D/A converter to the sample data signal of Fig. 1. It can be seen that the reconstructed signal is very close to the original signal. And because of the 256-times oversampling, interpolation, and noise shaping, the quantization noise is very much reduced compared to the four-times oversampled signal reconstructed by a multi-bit D/A converter.

It is very interesting to compare the various multi-bit and single-bit D/A conversion techniques for linearity error and THD performance. Figure 12 shows the linearity error of six different CD players with these various D/A converter systems. It can be seen that the one-bit converters have minimum linearity error, whereas some of the very expensive CD players with 18- to 20-

bit, four- to eight-times oversampling D/A converters have as much as ± 3 dB of error at low signal levels. This is due to the mismatches in the current dividers of their multi-bit D/A converter circuits.

A THD test performed on these converter systems reveals a very interesting result, as shown in Fig. 13. The test is performed with a -60 dB, 1-kHz sine-wave signal from the test disc. On the very expensive 18- to 20-bit D/A CD players, the third, fifth, seventh, ninth, 11th, and 13th harmonics (and even the 15th harmonic, in some cases) reach levels greater than -110 dB. On CD players that use the TDA1541A series of dual 16-bit D/A converters with four-times oversampling, only the fifth harmonic is predominant, and all the other harmonics are below - 110 dB. But the best performance can be seen from the CD players based on the Philips PDM bitstream one-bit D/A conversion technique, which has all of its harmonics below -110 dB.

However, no theoretical analysis or laboratory tests will tell you more about the sound reproduction capabilities than an audition of your favorite CD on one of the many players that utilize one-bit D/A converters.

ACKNOWLEDGEMENTS

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EQUIPMENT PROFILE

SONY TCD-D3 DAT WALKMAN RECORDER

Manufacturer's Specifications Frequency Response (±1 dB): 48-kHz sampling, 20 Hz to 22 kHz; 44.1-kHz sampling, 20 Hz to 20 kHz; 32-kHz sampling (standard or LP

mode), 20 Hz to 14.5 kHz.

Signal-to-Noise Ratio: Greater

- than 90 dB, all modes. Dynamic Range: Greater than 90
- dB, all modes. **THD:** Less than 0.008% at 1 kHz,
- standard mode. **Power:** 6 V d.c. with rechargeable, supplied battery; 9 V d.c. with supplied a.c. adaptor or optional car mounting arm.
- Battery Life: Approximately two hours.
- **Battery Charge Time:** One hour (two hours when unit is operated with a.c. adaptor/charger).
- **Dimensions:** Without battery, 3% in. W × 1% in. H × 4% in. D (8.5 cm × 4 cm × 12 cm); battery adds 1 inch (2.58 cm) to depth.
- Weight: Without battery, 14.8 oz. (0.42 kg); with battery, 1 lb., 6.2 oz. (0.63 kg).
- Price: \$849.95.
- Company Address: Sony Dr., Park Ridge, N.J. 07656.

For literature, circle No. 90

Check out those dimensions again! It's not a misprint. Sony has come up with what is surely the world's smallest (and, I might add, the world's most remarkable) portable DAT recorder/player. The company has chosen to call it—rightly enough—a DAT Walkman. In fact, it's actually smaller than the first Walkman that Sony introduced some 11 years ago. When I first was told about this little portable recorder, I feared that Sony might elect to call it a "DATman." Happily, better judgment prevailed!

The TCD-D3 is capable of recording and playing back at sampling frequencies of 48, 44.1, or 32 kHz, It also offers a long-play mode that provides up to four hours of continuous recording or playback, using a standard 120-minute tape. And, of course, in accordance with international standards and agreements reached between software and hardware makers, the TCD-D3 incorporates the Serial Copy Management System (SCMS), which will not prevent making a first direct digital-to-digital copy from a digital source (CD or prerecorded DAT) but will prevent making second-generation copies from that first copy. One of the design features that made this degree of miniaturization possible is a tape head drum only 15 mm in diameter, half the diameter of drums used in typical hi-fi DAT decks. The use of the smaller drum requires a tape-to-drum contact of 180°, as opposed to the 90° of tape contact normally used. However, while head and tape wear are expected to be slightly greater than on home DAT decks, the contact pressure of the tape to the fast-spinning head drum is still far less than is encountered in video recorders. Also, unlike portable CD players, the new DAT mechanism maintains accurate recording and playback even when the recorder is in motion. During my tests, I was able to walk at a brisk pace and even jog while listening to a DAT recording.

Four-layer, surface-mount circuit boards aid in the miniaturization of the TCD-D3. Large-scale integrated circuits (LSIs) designed by Sony handle all digitalsignal processing, servo control, and digital-signal amplification. These LSIs help to reduce power consumption and account, in part, for the fact that battery power can operate the unit, either in the recording or playback mode, for a full two hours. The TCD-D3 employs a pulse A/D converter with 64-times oversampling. During playback, an eight-times oversampling digital filter maintains extended



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Plexiglass boxes courtesy of Digital Storage Systems

Considering the small size of Sony's DAT Walkman, it's amazing how numerous and convenient its controls turned out to be.



frequency response and good phase linearity, while D/A conversion is accomplished by dual 18-bit converters. All digital conversion is built directly into the unit, and no outboard processing is necessary.

The TCD-D3 is supplied with a rechargeable nickel-cadmium battery, an a.c. adaptor/charger, a fiber-optic digital input/output cable, analog audio connecting cords, a 60minute blank DAT cassette, and a soft carrying case.

Control Layout

Considering the unit's small size, it's amazing how many controls Sony was able to provide without having them so closely spaced that human fingers would be unable to access them easily. The controls most often used are conveniently mounted on the top surface of the unit. These include a cassette "Eject" button, an "REW/Review" button, somewhat larger "Stop" and "Play" buttons, and buttons for "FF/Cue," "Pause," and "Rec." The fast-wind buttons serve a dual purpose. During playback, they are used for audibly fast searching in either direction. When pressed while in the stop mode, they fast-wind the tape in either direction. An LCD on the top surface of the unit shows program numbers, various time indications, and current status of the tape transport. The display also includes a dual-channel level meter, calibrated in dB on the scale itself and in percentage of maximum recording level on the surrounding bezel. Unlike many LCDs, which become virtually invisible in dim light, this one is wisely equipped with a pleasing blue backlight that can be turned on only when needed, thereby prolonging battery life.

The backlight pushbutton for the display is on the vertical front of the unit, as are the power switch, a miniature stereo headphone jack and its level control, a pair of buttons for "AMS" (Automatic Music Search) that quickly access specific programs or selections on a tape, and a record level control (used only when analog inputs are being fed to the unit). Also found on this surface are buttons for "Counter" time ("Mode" and "Reset") and "Start ID" ("Mode" and "Enter"). Sequential pushes of the "Start ID Mode" button let you apply Start IDs automatically or manually, erase Start IDs, and renumber programs of a previously recorded tape.

The left side panel of the TCD-D3 is equipped with a miniature seven-pin connector. It is here that the digital input/output cable is connected for taping from sources with digital outputs or for feeding signals to components with their own D/A converters. Interestingly, this connector accepts either fiber-optic or coaxial digital cable. The optical cable supplied to me (but not the one sent to Audio for

photography) had separate branches for input and output, while the single-ended coaxial cable was for input only. The plugs of both cables had mysterious switches labelled "Analog/Digital," which no one at Sony could explain. Also found on this side panel are a miniature stereo line output jack and a connection for the a.c. adaptor.

The opposite side of the TCD-D3 carries the switch that selects standard or long-play operating mode. A miniature stereo input jack on this panel handles analog inputs, with switches to select line or microphone sensitivity levels and to attenuate the input signal by 20 dB when needed for use with high-output microphones. The TCD-D3 also supplies d.c. phantom power to an optional stereo microphone.

When a battery is used, it snaps into place at the rear of the TCD-D3. The battery's width and height match those of the recorder, so that it looks like an integral part of the unit when it's in place.

Measurements

I measured the TCD-D3's performance for both analog and digital inputs, using the analog outputs throughout. I also tested its performance in the LP mode, in which sampling rate is reduced to 32 kHz and a 12-bit nonlinear quantization system is employed. I suspect that most users of this recorder will be feeding signals via its analog inputs (microphone, for example, for live recording work in the field), so I concentrated a bit more heavily on the measurements made via the analog inputs.

Figure 1A shows the record/playback frequency response of the unit for analog input and output signals in normal (48-kHz) mode. In this mode, the left-channel response is off by about 0.5 dB at 20 kHz, while right-channel response is virtually flat from 20 Hz to 20 kHz, deviating by no more than 0.1 dB. Using the digital input and a sampling rate of 44.1 kHz (Fig. 1B), such as the TCD-D3 would use when transcribing a CD in the digital-to-digital mode, response from 20 Hz to 20 kHz is even more uniform than in the analog, 48-kHz mode. The response limitation imposed by the long-play mode (Fig. 1C) is clearly evident, however.

In comparing these frequency responses, bear in mind that the LP mode is still quite useful when transcribing such program sources as FM or TV stereo broadcasts, both of which have about the same frequency limitations as that





Listening in the 90's

Today people have become more and more space conscious. Many apartment dwellers don't want to give up valuable floor space for large speaker systems. Others who are planning a surround sound or home theatre system simply don't have the room for more speakers in their listening rooms or hesitate to commit the floor or wall space to a good sounding pair of speakers.

Until now, serious music lovers have had little, if anything, to choose from that would produce a large, bigger-than-life sound in a small, compact size. Systems that fit one's space requirements have been woefully disappointing in sound quality.

<u>The RM 3000</u> <u>Three Piece System</u>

Polk's engineers had determined long ago that there were indeed certain technical advantages in sonic performance.

The small satellites can be located on shelves, mounted on a wall or placed on their own floor stands. They are very attractive and yet small enough to be hidden from view if desired.

> The RM 3000 subwoofer is also small enough to sit behind your furniture and can be used on its side to fit into tight spaces. And since it is beautifully finished, it can be used as a piece of furniture.

<u>The Legendary</u> <u>Sound of Polk</u>

In the tradition of Polk Audio, Matthew Polk and his team of engineers were determined to make the RM 3000 sound better than any other speaker of its type.

Initial reactions have been filled with superlatives including Julian Hirsch of

Stereo Review magazine who says, "...they sound excellent...spectral balance was excellent—smooth and seamless."

Sound as big as life from speakers

The RM 3000's satellites measure 7"H x 4 1/4"W "x 5 3/8"D and are available in black matrix, gloss black piano or paintable white.

The subwoofer is 12 1/2"H x 20"W x 12 1/2"D and is available with black wood grain sides and a black, mar-resistant top.

small speaker systems. Both high and mid frequencies could be faithfully reproduced with superior transient response and dispersion characteristics, and the convenient, more flexible placement of small enclosures within the listening area could create an ideal sound stage. Unfortunately, reproducing the life-like, full body of the lower frequencies could not be achieved in a truly compact enclosure.

Polk's RM 3000 replaces the traditional pair of speakers with three elements, two compact midrange/tweeter satellites and one low frequency subwoofer system. This configuration makes it easy to properly and inconspicuously place the system within your listening room while offering superior Behind these accolades is an impressive technical story.

<u>The Technical Side</u>

The big sound of the RM 3000 is due, in part, to the unique arrangement of the tweeter and midrange elements. This "time aligned system" delivers the high and mid frequencies at precisely the same instant. The result is a clear, lifelike and expansive presentation.

The cabinet materials selected for the satellites are over four times as dense as typical enclosures. The black matrix finish is a non-resonant polymer aggregate (FOUNTAINHEAD®). The gloss black piano and paintable white finishes are rigid ABS



small enough to live with.

surrounding a mineral filled polypropylene inner cabinet. Polk engineers have all but eliminated any "singing" or resonating of the satellite enclosure. You hear the effortless, free sound of a much larger system.

Most subwoofer systems look alike on the outside, but the Polk is worlds apart on the inside. Utilizing twin 6 1/2" drivers coupled to a 10 inch sub-bass



For deep, well defined bass, Polk uses twin drivers coupled to a sub-bass radiator. Normally, one subwoofer system is used for both channels. For those desiring even greater low frequency performance, a second subwoofer can be added, one fed by the left channel, the other by the right channel. radiator, the bass is tight and well defined. There is no tuned port to create "whistling" or "boominess" of the bass frequencies.

You Have To Hear It To Believe It

You really won't believe how good the RM 3000 sounds until you hear it. We invite you to your nearest authorized Polk dealer for a demonstration. You'll hear sound as big as life...from a speaker you can live with.

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Sony calibrated the meter's 0-dB point a little below the absolute digital limit to give users a few dB more headroom for safety's sake.



imposed by the LP mode's 32-kHz sampling rate. Furthermore, the dynamic range of a 12-bit nonlinear quantization system, such as that used in the LP mode of this and other DAT recorders, far exceeds the dynamic range of either FM radio broadcasts or stereo TV sound transmissions. Therefore, there is no reason not to economize on the cost of blank DAT cassettes by using the long-play mode when recording such fare.

Applying a sweep-frequency test signal to the inputs of the TCD-D3, I next measured THD + N versus frequency for signals recorded at maximum recording level. Results are shown in Fig. 2. Using the analog inputs and the normal recording mode, THD + N at 1 kHz is only 0.006%, as against Sony's specification of 0.008%. Small amounts of harmonically unrelated artifacts, including some spurious "beats," cause the plot to rise at the higher frequencies, but even at that, worst-case combined readings of noise and

distortion never exceed 0.025%. In the LP mode, with its 12bit nonlinear quantization, THD + N is, as expected, somewhat higher: 0.014% at 1 kHz. Notice also that it rises very steeply above 8 kHz. Using the digital input, THD + N at 1 kHz is a shade lower than for normal-mode recording via the analog inputs, approximately 0.0055%.

The previous tests show noise plus distortion, but I wanted to be able to separate the actual harmonic distortion components from the noise components. Therefore, I used FFT spectrum analysis to examine a 1-kHz test signal, and results of these tests for recordings made via the analog inputs are shown in Fig. 3A. For a signal recorded at maximum level (0 dB), significant harmonics are seen at 2, 3, 9, and 11 kHz, but the largest of these (the second harmonic, at 2 kHz) represents THD of only 0.0042%. Even calculating net THD by taking the square root of the sum of the squares of the other, lower amplitude harmonic components, actual THD turns out to be less than 0.005%. For a 1kHz signal recorded at 60 dB below maximum level, major harmonic distortion components amount to 0.7% of the reference signal, while the residual noise floor is at approximately 0.1% of reference. With the digital input, results for a 0-dB signal (Fig. 3B) are very slightly better than for a 0-dB signal via the analog inputs, primarily because of the relative sizes of the two curves' second-harmonic spikes.

Figure 4 is a plot of THD + N versus recorded signal amplitude. Using the analog inputs, THD + N in normal (48kHz) mode measures approximately -90 dB (about 0.003%) for recording levels of approximately -10 dB or lower. Note that although THD begins to rise as the 0-dB mark is approached, the real digital recording headroom limit is not reached until a level of + 6 dB, at which point the curve climbs almost vertically. What this told me is that, to be on the safe side for users who are accustomed to allowing recording meters to go above 0 dB when using analog recorders, Sony really calibrated the meter's 0-dB



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This little device makes Velodyne the best subwoofer ever made.

It's called an accelerometer. And you'll find one attached to the voice coil of every Velodyne[™] Servo Subwoofer System. Our patented High Gain Servo (HGS) technology uses the accelerometer to make Velodyne's bass reproduction superior to any product on the market.

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driver with accelerometer in housing (red) mounted on voice coil (blue). Circuit board contains associated HGS electronics.

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Achieving near-perfect linearity down to -80 dBin a recorder so portable and convenient is a truly remarkable accomplishment.



Having established that 0 dB on the meter does not really correspond to absolute maximum digital recording level, I repeated the test, this time applying signals via the digital input (also seen in Fig. 4). At levels of -20 dB and lower, THD + N is about 5 dB lower than when the analog inputs are used. The rise in THD + N above -20 dB is attributable to limitations of the analog output stage rather than anything

Overall A-weighted S/N ratio of the TCD-D3, measured via the analog inputs and outputs, was 90.8 dB for the left channel and 90.5 dB for the right channel. Recording a nosignal track via the digital input resulted in a considerably higher S/N ratio, 102.5 dB at the left-channel output and 102.8 dB at the right-channel output.

Figure 5 shows a 1/3-octave spectrum analysis of residual hum and noise, referred to 0-dB recording level, when no-signal recordings were made via the analog and digital

Sound quality like this has never been available in so small a form or at such relatively low cost.

inputs and played back. The peak at 60 Hz in the analoginput curve, while all of -100 dB, is attributable to the influence of the a.c. adaptor that was used to power the recorder/player during this test. With battery operation, this peak, however small, would not be present. Actual random noise products range from -120 dB at low frequencies to approximately -100 dB at high frequencies, all referred to 0-dB recording level. As Fig. 5 also shows, performing this test via the digital input reveals that (discounting the powersupply hum component once again) residual noise over much of the spectrum is at least 10 dB lower than when the analog inputs are used.

Results of the linearity tests, using the analog and digital inputs, are shown in Fig. 6. In the case of the analog inputs, a slight deviation from perfect linearity is noted at -80 dB, increasing to around 2.0 dB of error at -90 dB. Using the digital input, there is no deviation from perfect linearity down to -80 dB, but at -90 dB the error is approximately +4 dB. My only explanation for this increase in deviation is that perhaps the A/D error imposed via the analog inputs is opposite in polarity to the error imposed during D/A conversion. In any case, near-perfect linearity down to -80 dB in at DAT recorder having all of the attributes of the TCD-D3 is a remarkable achievement.

Figure 7 shows separation, which is just over 70 dB at 1 kHz, increasing to around -74 dB at lower frequencies. The decrease in separation noted at higher frequencies may well be the result of using the stereo output cable provided by Sony. (It is a dual audio cable of rather small diameter, with left and right conductors contained within a common outer insulation.) Nevertheless, a separation measurement of 54 dB at 10 kHz is hardly cause for concern, and if you are unhappy about this decrease in separation, you can always substitute separate high-quality interconnects, as long as you also use an adaptor with dual RCA jacks and a stereo mini-plug.

Use and Listening Tests

I travelled with the TCD-D3 for more than a week, and used it in a variety of locations and circumstances. As a portable DAT recorder/player, the unit stood up extremely well. I was particularly delighted with its backlit display, which made it much easier to use the recorder in poorly lit environments and at night. Equipped with a single-point stereo microphone, I successfully recorded a variety of sounds and music that would have been impossible to record so conveniently or with such high quality without this tiny unit. While travelling about the country on the last legs of an Audio-sponsored lecture tour, the TCD-D3 also proved to be the highest quality Walkman-type listening device I ever used. Sony loaned me a pair of their MDR-54 stereo 'phones so that I might audition the TCD-D3 even while aboard an aircraft. As for software, I took along some of my own, a transcription of Shostakovich's Fifth and Tenth Symphonies, dubbed from my CD versions using the digital-to-digital mode. The DAT format is ideally suited to the dynamics of Shostakovich's music.

Sony Classical has released some 10 prerecorded DAT titles as of this writing (possibly 20 or 30 will be available by the time you read this), and I was loaned a copy of their DAT



issue of *Vladimir Horowitz—The Last Recording*, which was recorded digitally, shortly before that great pianist's death. Listening to his rendition of the works of Chopin and other composers of piano works as reproduced by the TCD-D3 and a pair of high-quality headphones was an emotional experience that I will long remember and cherish. The sound quality offered by this tiny recorder has never been available from so small a music reproducer or at such a relatively low cost. As I listened in amazement and awe of this technological breakthrough, my thoughts turned to Thomas Edison. I wondered what he might have thought if he could hear what wondrous equipment has evolved some 114 years after his original cylinder phonograph.

Leonard Feldman

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EQUIPMENT PROFILE

BOSTON ACOUSTICS T1030 SPEAKER

Manufacturer's Specifications System Type: Tower-style, threeway, acoustic suspension.

Drivers: Dual 8-in. (20.3-cm) cone woofers, 6½-in. (16.5-cm) cone midrange, and 1-in. (2.54-cm) softdome tweeter.

Frequency Response: 40 Hz to 20 kHz, ±3 dB.

Sensitivity: 90 dB SPL at 1 meter for 2.83 V rms.

Crossover Frequencies: 400 Hz and 3 kHz.

Impedance: 8 ohms nominal.

Recommended Amplifier Power: 15 to 150 watts per channel.

Dimensions: $42\frac{1}{2}$ in. H × $10\frac{1}{4}$ in. W × $12\frac{1}{8}$ in. D (108 cm × 26 cm × 30.8 cm).

Weight: 65 lbs. (29.5 kg)

Price: \$1,200 per pair in walnut veneer, \$1,000 per pair in black ash vinyl.

Company Address: 70 Broadway, Lynnfield, Mass. 01940.

What ever happened to the "East Coast sound"? It's alive and doing well at loudspeaker manufacturer Boston Acoustics in Massachusetts. The "East Coast sound" has traditionally described a speaker whose tonal qualities emphasized a neutral, flat response with minimal emphasis of any particular frequency range. Fortunately, regional differences in the sound and tonal balances of loudspeakers are nearly nonexistent now. Most manufacturers now produce or at least profess to produce systems that meet the traditional meaning of the term.

The T1030 is the recently introduced top model from Boston Acoustics' three-product "tower series" of three-way speaker systems. It is a somewhat large, floor-standing system containing two 8-inch woofers, a 6½-inch midrange, and a 1-inch dome tweeter. The rest of Boston Acoustics'



home speaker line consists of five bookshelf systems, five in-wall speakers, a powered subwoofer, and a three-piece satellite/woofer combination (the SubSat Six).

Andy Petite, president and chief designer of Boston Acoustics, has been in the loudspeaker manufacturing business since 1964, when he started at KLH. (My first systems of any merit were KLH-6s, which I still have.) Later he was at Advent, for nine years starting in 1969, where he was involved with the whole Advent speaker line and was sole designer of the New Advent and the Advent/1, which came out in 1977. At Advent, he worked with Henry Kloss, one of the founders of Acoustic Research, where the first speakers with the "East Coast sound" originated.

In 1979, Petite and Frank Reed (formerly vice president of sales at Advent) co-founded Boston Acoustics, where they

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Boston Acoustics' intention was to make the T1030 sound as good as the best yet be sensibly sized and priced.



have tried to maintain the tradition of making speakers with high performance for their price. One of Boston Acoustics' best-selling speakers, the A40, was reviewed by Richard C. Heyser in the July 1983 issue.

According to Petite, the goal for the T1030 was to make a system for home use that could compete on a sonic basis against any speaker at any price and to do so in a sensibly sized and priced package. A tall order indeed! The tower format was chosen for the T1030 because of its small footprint and the predictable relationship it establishes between the drivers and the floor. It also puts the midrange and tweeter at ear level, for best coverage. A vertical stack of two 8-inch drivers, each in its own sub-enclosure, is used for the low end of the system. This combination, which has roughly the same air-moving capabilities as a 12-inch woofer, minimizes width and provides better vertical directivity, which reduces troublesome floor reflections.

Boston Acoustics manufactures all of their own drivers and thus, they claim, can maintain much tighter control over manufacturing and performance. Petite states that every driver matches its own reference within ± 1 dB (and likewise for the finished systems), which is a much tighter tolerance than any outside supplier provides.

The high-excursion woofers have a voice-coil 1½ inches in diameter that is 0.75-inch long operating in a 0.236-inch gap. A vented pole piece provides cooling, and a shorting ring in the magnetic structure reduces distortion resulting from flux modulation. The midrange uses a Ferrofluidcooled, 1-inch coil and is housed in a separate, sealed tubular enclosure, filled with damping material, which also acts as a front-to-back brace in the top of the cabinet. The wall between the two woofers provides more enclosure bracing. The 1-inch, soft polyamide dome tweeter is Ferrofluid-cooled and is flush-mounted to minimize diffraction.

Mounting the midrange over the tweeter provides a listening window that is tilted upward, which minimizes changes in tonality for seated and standing listeners. The midrange is large enough to permit a relatively low crossover point of 400 Hz, so that the midrange frequencies really come from the midrange driver.

The T1030s are finished on five sides and are available in walnut veneer or black ash vinyl (for \$200 less); both versions have black grilles. The molded plastic grille is fitted to the front panel using eight projections which fit into rubberlined holes. Removal and replacement of the grille was quite easy and occurred without any alignment problems. The build quality and finish of the systems were very good. The bottom of the enclosure has four threaded inserts installed to attach feet or floor spikes, which are supplied.

The rear bottom input connectors are two pairs of quite substantial gold-plated metal binding posts on 0.75-inch centers, worthy of any high-end system. The connectors are recessed at an angle and can be manipulated without much difficulty. A pair of gold-plated straps can be removed for bi-wiring. The manufacturer recommends against biamplifying, however, because an external crossover would probably eliminate the proper acoustic summing caused by the internal crossover's broad, gradual overlap between the woofer and midrange. This, Boston says, would create a dip in the response and change the sound adversely.

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Measurements

Measurements performed on the T1030 to evaluate its performance included on- and off-axis frequency response, energy/time curves, impedance versus frequency, harmonic and IM distortion, and maximum peak input and output capabilities. The system was also evaluated using elevated free-field, near-field, and ground-plane measurement methods in my own listening room and lab, and outdoors. Test equipment consisted of a Techron TEF System 12 Plus Time-Delay Spectrometry (TDS) analyzer, B & K 4007 condenser microphone, Crown Macro-Tech MA-2400 and D-75 power amplifiers, and Leader signal generators, attenuators, voltmeter, and oscilloscope.

The tilt of the system's reference axis, about 8° up from the midrange/tweeter midpoint, is about halfway between the angles for a seated listener $(+1^\circ)$ and a standing listener 3 meters away (+14.5°). This raised a crucial question: Should I define on-axis as being an 8° up angle or should I measure this system, as I have most of the previous systems, using an approximate 0° angle from a point midway between the midrange and tweeter? This is a significant question for the T1030 because it was found that the response through the crossover region is somewhat smoother at 8° up than it is at 0°. I finally decided on using an angle of $+1^{\circ}$, arguing that this is the angle of the axis that is aimed toward the ears of a seated listener when the system is set up in its normal upright position. This choice places much more importance on the response for the seated listener than for the standing listener, as it ought to. If the manufacturer's recommended setup included an 8° forward tilt (which it didn't), I would be much more justified in using the 8° up-angle as the on-axis direction. Of course, the ideal system would have the same response for seated and standing listeners, making these considerations moot.

The on-axis frequency response, with and without grille, is shown in Fig. 1. The measurement was taken at a distance of 2 meters at an angle corresponding to the direction of the ears of a seated listener 3 meters way. The angle is about 1° above a line originating from a point midway between the tweeter and midrange. The response is reasonably well behaved and fits a ± 3.5 dB window from 48 Hz to 20 kHz, quite close to the manufacturer's specifications. The curve has some roughness and a slight depression in the crossover region from 2 to 6 kHz (partially due to the reference axis I chose), with a low-Q peak centered at 16 kHz.

Averaging the axial response over the range from 250 Hz to 4 kHz yielded a sensitivity of 88.5 dB SPL, 1.5 dB lower than the manufacturer's rating of 90 dB. The slight depression in the response at the upper crossover region contributed to the lower measured sensitivity. The grille has minimal effect on the axial response, no more than about 1 dB maximum variation. The maximum deviation of about -2 dB occurred in a narrow, sixth-octave range centered at 5.7 kHz. The right/left matching of the systems was excellent, with no more than ± 0.5 dB variation above 100 Hz. This should be compared with the repeatability of my test setup, which is about ± 0.1 dB. All the following measurements were taken with the grille off.

Figure 2 displays the axial phase and group delay of the system, corrected for the tweeter's time arrival. The phase

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The reference axis tilts up by 8°, aiming the sound at both seated and standing listeners but properly favoring seated ones.



The excursion capability of the woofers was determined by sweeping with a high-level sine wave covering the lowfrequency range. The maximum linear excursion capability of the woofers was a healthy ± 0.25 inch (0.5 inch, peak to peak), while the limiting excursion (high distortion) was significantly higher at about ± 0.4 inch (0.8 inch, peak to peak). The effective piston diameter of a single woofer was about 6¾ inches, and thus two woofers are about the same size as a single driver 12 inches in diameter. The upper woofer of each system exhibited slight ticking sounds at levels above 15 V rms at 50 Hz. A finger touch of the surround would either worsen or reduce the ticking, depending on where the surround was touched (a slight voicecoil rub?). During these sine tests, the enclosure side walls were quite rigid and displayed no significant resonances.

The crossover consists of 11 parts (three inductors, four capacitors, and four power resistors), wired on a piece of hardboard and attached to the rear of the cabinet in the top subenclosure. The woofer section is a second-order low-pass filter (12 dB/octave), the midrange a 6-dB/octave high-pass and a 12-dB/octave low-pass, and the tweeter section a second-order high-pass network (12 dB/octave). The inductors for the midrange and tweeter are small air-core units, while the large woofer inductor is a laminated iron-core unit wound with 16-gauge magnet wire. The three capacitors in the woofer and midrange sections are nonpolarized electrolytics, while the tweeter high-pass capacitor is a Mylar type. The internal cabling is done with 18-gauge stranded wire.

The crossover phase relationships were investigated by reversing the midrange connections and then noting the amount of rejection at the crossover frequencies. The lower crossover exhibited a dip of about 18 dB, which indicated that the woofers and midrange are essentially in phase at their crossover point. The response at the 3-kHz crossover disclosed a dip of only about 8 dB, which indicated that the midrange and tweeter are somewhat out of phase in their crossover region and thus will exhibit some lobing error. As noted before, the midrange is mounted over the tweeter in order to launch the resultant crossover lobe in the upwards direction.

The 1-meter, on-axis, 1-watt energy/time response (ETC) is shown in Fig. 3 for a test signal swept over the range of 200 Hz to 10 kHz. This ETC represents mostly the tweeter's response and emphasizes energy in the range of 2 to 9 kHz. The response is notably tight and followed only by lower level arrivals which are more than 20 dB down from the main arrival.

The normalized horizontal "3-D" axis curves of the T1030 are shown in Fig. 4. The curves are, in general, well behaved but indicate off-axis roughness in the upper crossover region. The normalization actually makes the off-axis response curves somewhat rougher because the on-axis curve is rough through the crossover response range. The response holds up well out to 16 kHz, up to about 30° off the system's axis.

The vertical off-axis curves in Fig. 5 also indicate significant roughness through the upper crossover region of 1.5 to 6 kHz. Not shown in this display is a large dip in the response at 3 kHz, just below the axis, that indicates a Reduce vibration and achieve maximum sonic performance from your audio components with Allsop's new Sonic AEnhancement Series.

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P.O. Box 23 Bellingham, WA 98227 U.S.A. (206) 734-9090 1-800-426-4303 FAX: (206) 734-9858 © 1990 Allsop Inc. The horizontal responses out to 45° off axis are both smooth and extended, indicating good stereo images over a broad area.



sizable amount of lobing error. Fortunately, the response through this frequency region is much smoother above axis than below, as will be shown later.

The NRC-style mean horizontal and vertical on- and offaxis response curves of the system are shown in Figs. 6 and 7. These responses were derived from the previous "3-D" data by calculating response averages of several adjacent curves in specific on- and off-axis angular regions.

The mean horizontal response curves are shown in Fig. 6. The mean axial horizontal response curve exhibits the same depressed, somewhat rough response between 2 and 6 kHz, and the same response peak at 16 kHz, as the axial curve shown in Fig. 1. This curve represents the average frequency balance within $\pm 15^{\circ}$ of the axis horizontally, but on axis vertically. The 30° to 45° response is quite flat and fits in an envelope of ± 2.25 dB from 100 Hz to 13 kHz. The 60° to 75° response exhibits a broad slump between 1 and 3 kHz and a rapid fall-off above 8 kHz. The fairly smooth, extended horizontal responses out to 45° off axis indicate that the T1030s snould produce good stereo images over a fairly broad horizontal listening area.

The mean vertical responses are shown in Fig. 7. The mean axial response is also very similar to the on-axis response in Fig. 1 but has a deeper hole at 3 kHz because the severe response dip just below axis is included in the $\pm 15^{\circ}$ average. Also shown in Fig. 7 is an average of the responses from only 0° to 15° above axis, which includes both seated and standing listeners. This response is considerably smoother and fits within an evelope of ± 2.5 dB from 200 Hz to 20 kHz. The data indicates that the system might benefit from a slight forward tilt of the enclosure to optimize the vertical coverage.

The 30° to 45° averaged response displays the effects of both low-to-mid and mid-to-high crossovers, with dips in the response at both 500 Hz and 2.5 to 3 kHz. A vertical stack of two 8-inch woofers has a narrower vertical radiation pattern in the range from 400 to 500 Hz than the equivalent 12-inch woofer does, and this causes a greater dip in the response. The 30° to 45° response does extend up to about 15 kHz before falling rapidly at higher frequencies.

The 60° to 75° averaged response displays even more directivity in the low-frequency range, as well as a rapid rolloff above 10 kHz. The increased low-frequency directivity of the stacked woofer array is quite beneficial in this situation because it decreases potentially harmful ceiling and floor reflections.

Figure 8 shows the magnitude of impedance versus frequency of the T1030. The curve is quite well behaved and smooth except that it reaches a rather low minimum of 3.4 ohms at 100 Hz. Because the minimum is in the upper bass range, where program material typically has high power content, the speaker should be considered a 4-ohm system for practical purposes. With two of these systems paralleled, some amplifiers may not perform very well if played at loud levels on program material with a lot of power in the range from 50 to 200 Hz, such as rock music.

Figure 9 is a plot of the complex impedance of the T1030, showing how the resistance and reactance vary with frequency. This plot is also quite well behaved and indicates that the system has no irregular resonances except for the



Thresheld founders Nalson Pass (right) and René Besné with the first Threshold preamplifier; the Nodel NS 1C. The NS 10 contained advarcer single ended ultra class A and mon-feedback technology which predated the present popularity of these techniques. Typically for Threshold, the 1977 introduct on pithis preamplifier set state- of-lhe-art standards that are still valid today.

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Figure 11 shows the E₁ (41.2-Hz) harmonic distortion data. Maximum power was limited to 100 watts, which is 20 V rms into a 4-ohm load. (At 24 V rms and above, both systems' woofers generated extraneous noises.) The nonharmonically related spikes, at lower power levels, are due to background noise in the measurement setup and were not generated by the loudspeaker. As with other systems I have measured, at lower power levels the second and third harmonics are evident, while at higher power levels the fourth, fifth, and sixth harmonics join the lower ones. The second harmonic is seen to predominate over the whole power range, which indicates a one-sided nonlinearity. Note that this system generates roughly 100 dB at 1 meter with 100 watts at 41 Hz. These distortion percentages, though not the lowest, are reasonable considering the size of the woofers.

The A_2 (110-Hz) harmonic data is shown in Fig. 12. The graph shows that only the second and third harmonics were significant over the tested power range. The second harmonic increases gradually with power, reaching a level of only 2.7% at 100 watts. The third harmonic, which was significantly lower, reached only 0.8% at full power.

The A_4 (440-Hz) harmonic measurements are shown in Fig. 13. The only measurable distortion was a low amount of second harmonic, which peaked at 0.72% at 100 watts. All other distortion products were below the floor of the display, which was about 0.2%!

Figure 14 shows the IM distortion on a 440-Hz (A₄) tone created by an equal-level (input power, not output acoustic level) 41.2-Hz (E₁) tone. The IM distortion gradually rises with power, reaching the fairly high level of about 22% at 50 watts. The first-order ($f_2 \pm f_1$) and second-order ($f_2 \pm 2f_1$) side frequencies were the only significant ones in this power range. These IM levels are higher than they could be because the midrange is operated quite low in frequency, with only a first-order 6-dB/octave roll-off below the crossover frequency. In the "rub and buzz" test it was noted that the midrange had significant displacement below 100 Hz at high levels.

Figure 15 shows the system's short-term peak-power input and output capabilities as a function of frequency. The tests were run by exercising the system with a high-level, shaped, $6\frac{1}{2}$ -cycle sine-wave tone burst at all the thirdoctave points from 20 Hz to 20 kHz, using an amplifier with very high peak-power capability. The test sequence consisted of determining how much of the burst test signal could be handled by the speaker, at each frequency, before the output sounded audibly distorted or the acoustic output waveform appeared distorted, whichever occurred first. At each frequency, the maximum peak input voltage was recorded and the output level calculated using the 1-watt, 1meter response data.

The maximum peak electrical input power-handling capacity of the T1030 is shown in the lower curve of Fig. 15. The rated impedance of 8 ohms was used to calculate the input power. The peak input power-handling capacity rises with frequency throughout the bass range, reaching a plateau of 4.5 kW above 500 Hz, which is close to the clipping power of the test amplifier. Some limitation of input power was noted between 40 and 63 Hz due to the woofers

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11 Elkins Road, East Brunswick, NJ 08816 U.S.A. (201) 390-1130 Distributed in Canada by PRO ACOUSTICS INC. Pointe Claire, Quebec H9R 4X5 The Boston Acoustics T1030s provided about 90% of the performance of my reference speakers—for about 20% of their cost.

making slight ticking sounds. No dynamic offset problems were observed in the woofers' range. The system can actually handle more power than the curves show but at the expense of much greater distortion and possible risk of damage at higher frequencies.

The upper curve in Fig. 15 illustrates the maximum peak sound pressure levels the system can generate at a distance of 1 meter on axis for the input levels shown in the lower curve of Fig. 15. Also shown on the upper curve is the maximum output with the "room gain" of a typical listening room added at low frequencies. This adds about 3 dB to the response at 80 Hz and 9 dB to the response at 20 Hz. With room gain, a single system can generate peak levels in excess of 110 dB above 50 Hz and 120 dB above 100 Hz. Though not in the subwoofer class, these levels are quite respectable. A pair of these systems operating with mono bass will be able to generate higher levels of some 3 to 6 dB in the bass range.

Use and Listening Tests

All listening was performed in my listening room, which has dimensions of approximately $15\frac{1}{2} \times 27 \times 8$ feet. The room has normal living-room furnishings and a carpeted floor. Equipment used for listening included an Onkyo Grand Integra DX-G10 CD player, a Rotel RCD855 CD player, a Krell KSP 7B preamp, a Krell KSA 200B solid-state power amplifier, and Straight Wire Maestro interconnects and speaker cables. The Boston Acoustics systems were hooked up conventionally, without bi-wiring. As usual, the majority of my listening was done before the measurements were made.

Most of the listening was done with the T1030s placed in my normal evaluation position, about 6 feet away from the short rear wall, and separated by 8 feet. This left a spacing of about 4 feet from the side walls. The systems were aimed horizontally at my normal listening position so that I was on the midrange/tweeter axis of the system. Listening took place on the sofa, about 10 feet away.

My first impressions of the T1030s were very positive. The tonal balance was quite even, with just a hint of very highfrequency emphasis. The systems could be played quite loudly without any stress, while the bass response was extended and full but with some upper bass heaviness. Vertical coverage was quite adequate and did not exhibit any consequential midrange tonal changes between seated and standing listener positions. Imaging and soundstaging were stable and precise, exhibiting no wandering images with changes in the frequency content of the instruments.

On Bob Mintzer's Big Band disc, *Incredible Journey* (dmp CD-451), the systems could be turned up to realistic levels with minimal stress on the loud horn passages. Tracks 4 and 8 were particularly good. On a new CD I recently received of Brazilian arrangements of piano and guitar music (*The New York Chorinhos* by David Chesky, Chesky JD39), the T1030s demonstrated excellent presence and soundstaging and delineated very well the delicate fingering sounds on the guitar. The loud piano intro on track 13 was managed without any harshness.

Boston Acoustics has been running a promotional campaign featuring the "Up Close" series of CDs available by mail order for about \$3.00. (I'm a sucker for a \$3 CD!) recommend heartily Volumes 1 and 3. Volume 1 features an Irish male vocalist and guitarist doing what you might call "minimalist" rock and roll, with just one man and one amplified acoustic guitar (Luka Bloom, Up Close, Volume 1, Reprise PRO-CD-3960; selected songs from the Reprise album Riverside 26092-1). Track 2, "Delirious," was recreated by the T1030s with much presence and excitement, clearly revealing the four separate voices in Bloom's guitar. The systems, however, emphasized the upper bass of the guitar a bit more than my reference B & W 801 speakers. Volume 3 of the "Up Close" series presents Andy Narell. who uses steel drums in contemporary jazz arrangements (Andy Narell, Up Close, Volume 3, WD90-04; selected songs from the Windham Hill CD, Little Secrets, WH-0120). All the songs are of demo quality, and the T1030s did a superb job on the complex percussion passages. The reproduction was, however, somewhat less open than my reference systems'.

The T1030s presented a good, solid, stable center image on the blues vocal and harmonica of Taj Mahal (track 1 of *The Best of Taj Mahal*, Columbia CK 36258). The rock and high-level capabilities of the systems were demonstrated very gratifyingly (and loudly) on track 13 of the *All-Ears Review, Volume 1* CD, where an obscure West Coast group named Crazy-Backwards Alphabet performs a Russian-language version of the ZZ Top hit "La Grange" (*All-Ears Review, Volume 1*, ROM Records 21001).

Reproduction of the band-limited third-octave noise on the B & K test disc held up to below 31 Hz with very usable levels (*Brüel & Kjaer Pro Audio*, CD-4090). Its output was only exceeded on the 20- and 25-Hz bands by the reference B & W 801s. The T1030s actually did better than my reference systems on the difficult passage of the organ version of *Pictures at an Exhibition* that made my reference systems stumble, as noted in the B & W 801 review in the November 1990 issue (Dorian DOR-90117, track 15 at 3:41 and 3:44, played loud!). The T1030s came quite close to my reference systems in handling the very demanding cannon shot on Tchaikovsky's "1812 Overture" (*Sampler, Volume II*, Telarc CD-80002). These systems will satisfy bass freaks!

The T1030s handled the contrabass and pipe organ selections on the d'Albinoni CD with much presence, air, and realism (*Adagio d'Albinoni*, King Record Co. LTD. K33Y 236, a Japanese import, highly recommended if you can find it; if you can't, it is available from Acoustic Sounds in Salina, Kans., 800/525-1630). The systems were quite clean on massed vocals in Handel's Messiah (*The Erato Autumn Collection* sampler, Erato 45580-2, a German import).

I am very pleased with the performance of the T1030 speakers, especially when their price is considered. The systems provide about 90% of the performance of my reference systems but for about 20% of the cost. They also take up much less floor space and, in my opinion, are more acceptable in appearance. Everything considered, the speakers should appeal to anyone who wants good value for the money and near high-end performance in a package of sensible size. I believe the goal stated earlier in this review by the founder of Boston Acoustics has been well met. *D. B. Keele, Jr.*



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EQUIPMENT PROFILE



Alpine has always impressed me as a maker of highquality car audio components, and their Model 7909 combination AM/FM tuner and CD player confirms that impression. It is obvious that a great deal of thought has gone into the design of this head unit, and Alpine has managed to produce a car stereo that is especially easy to use while driving. Consider, for example, the power-loading mechanism that gently takes hold of an inserted CD, slips it inside the unit, and initiates play. One of my chief objections to CD in the car has been the loading process, which usually requires pushing a disc about halfway in before the player takes charge of it; with the Alpine 7909, you need only push the disc in about a third of the way. Ejection is equally smooth and quick.

The CD section abounds with other features too. Track skipping in either direction is easy, as is fast audible search, random play of tracks, and repeat play. Disc scanning locates the beginning of each track and plays for 10 S before going on to the next track. The unit's "CDS" (CD Straight) button bypasses tone and balance controls, should you wish to hear discs played with fewer analog components in the signal path. Not apparent to the user, but of importance in a car player, is the fact that when a CD is ejected, the laser pickup mechanism is locked in place. Of lesser importance, but worth noting, is the ability of the CD mechanism to handle 3-inch discs without use of an adaptor ring. About the only feature missing is the ability to program specific tracks for playback in desired order. The 7909 has facilities for controlling Alpine Models 5952, 5252S, and 5959 CD changers, which can store six discs and play any track of any one of them. I did not have access to these changers when testing the 7909.

As for the tuner section, it too has many useful features. In its auto-memory mode, the six strongest AM or FM stations will be stored automatically. A Direct Access Preset mode allows you to store AM and FM presets on the same band, eliminating the need to press the band button every time you want to change from FM to AM or back again. Up to six AM and FM stations can be mixed in this mode. All together, 24 station frequencies can be memorized by the tuner circuitry (six for the FM1 band, six for FM2, six AM, and six in the Direct Access Preset mode).

Outputs are available for driving front and rear stereo amplifiers. There is also a pair of RCA-type jacks for input from the CD changer, if it is used. A DIN connector is provided at the rear of the unit, to which a DIN plug from the optional CD changer would be connected. A quick-release bracket allows you to remove the 7909 to prevent theft; stored data and clock operation will be maintained when the unit is removed. The 7909 can also be mounted permanently, using an optional installation kit.

Control Layout

At the left end of the panel, closest to the driver, are concentrically mounted rotary controls for turning on the set, adjusting volume and front/rear balance, and, by pulling on the inner knob, adjusting left/right balance. Bass and treble slider controls are mounted above the rotary controls. The CD slot and a nearby button for disc ejection take up most of the upper section.





OUIETING CHARACTERISTICS, FM TUNER SECTION ALPINE 7909



Below the right side of the CD slot are five small pushbuttons. The functions of the first four depend on whether the tuner or CD player is in use, while the fifth button is used to adjust or read clock time. In the tuner mode, the first of these four buttons selects manual or automatic (seek) tuning or automatic storage of the six strongest local stations. Next comes the mono/stereo button, followed by the local/ distant button (which affects the sensitivity only of seek tuning). The fourth buttor switches to the mixed AM/FM station memories for Direct Access Preset. When using the CD player, the first button may be used to bypass the tone and balance controls, the second button is a repeat control, and the third is used for scanning the beginning of each CD Maximum S/N ratio for FM was 68 dB in stereo and 71.5 dB in mono, far better than the 60 dB specified by Alpine.



100

track. The fourth button, labelled "M.I.X.," is used to initiate random play of CD tracks.

To the right of the rotary volume control is a fluorescent display for a variety of indications, including clock time, station frequency. CD track number, mono or stereo reception, and preset numbers.

"Up" and "Dn" buttons to the right of the display are used for both manual and seek tuning. When using the CD player section, pressing either of these buttons advances or reverses the track, while holding them down results in audible fast searching of a disc. Six square buttons nearby are used as preset selectors; two of them are also used to set correct clock time. Finally, at the extreme right are a pair of buttons for selecting the desired tuning band and for initiating or pausing CD play.

Tuner Measurements

Frequency response of the FM tuner section is shown in Fig. 1. Response was down some 4 dB at 10 kHz and was off by a full 10 dB at 15 kHz. It would appear that Alpine has rolled off the response deliberately, thinking perhaps that this sort of overall response would be more pleasant to listen to in an automotive environment. Of course, for those who want more treble output, the tone control is always available. It is interesting to note that in their published specifications, Alpine makes no mention of FM frequency response.

Figure 2 shows noise as a function of signal strength for mono and stereo FM reception. The mono 50-dB quieting point was reached with an input signal level of only 18 dBf, somewhat less than the 20.7 dBf specified. Maximum S/N was far better than the 60 dB specified by Alpine. At 65 dBf, S/N measured 71.5 dB in mono and 68 dB in stereo.

Figure 3 shows how THD + N varied with signal strength for a 1-kHz modulating test signal. At 65 dBf, results were 0.18% in mono and 0.58% in stereo. These graphs were also used to determine mono usable sensitivity, which measured 20 dBf as against 16.3 dBf claimed. Figure 4 shows THD + N versus modulating frequency. In mono, the readings were 0.28% at 100 Hz and 0.32% at 6 kHz; in stereo, results were 0.37% at 100 Hz and about 0.5% at 6 kHz.

Figure 5 shows FM separation. With strong signal inputs, separation was approximately 30 dB over most of the audio range. When signal strength was reduced to 45 dBf, the blending action common to most car stereos occurred, and separation decreased to no more than about 6 dB (the difference between the two middle curves of Fig. 5). Figure 6 is an FFT spectrum analysis of the left and right outputs of the 7909, with 100% modulation of the left channel by a 5kHz signal. The top curve shows output from the modulated (left) channel, and the bottom curve shows output from the unmodulated (right) one. Because the right-channel curve has been moved down for clarity, its levels should be read from the right-hand scale. Despite this displacement, you may not be able to see that the actual 5-kHz crosstalk is down more than 40 dB in the unmodulated channel. The reason why Fig. 5 appears to show only around 30 dB of crosstalk at that frequency is because of all the harmonic and spurious components also present in the output of both the modulated and unmodulated channels.



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require AM response to extend to 7.5 kHz, ± 3 dB. I can't wait to get my hands on one of these "high-fidelity" AM tuners or receivers to see how they sound.

CD Player Measurements

When I measure frequency response of a CD player, I like to expand the vertical scale of my graph so that even the slightest deviations from flat response can be detected. As can be seen in Fig. 8, in the CD Straight ("CDS") mode, with the tone and balance controls bypassed, there was less than 0.2 dB of roll-off at 20 kHz, and channel balance was as close to perfect as I've ever measured. That was not quite the case in normal mode, with the signals passing through the tone-control and channel-balance circuitry. Now, response is down by about 0.5 dB at 10 Hz and 20 kHz, and small variations in mid-frequency output can be noted—all of which provides ample reason for Alpine to have incorporated the "CDS" bypass mode. The measurements that follow were made with the player in this mode to show the 7909's best performance.

THD plus noise as a function of frequency was much lower than I have typically obtained for car CD players (see Fig. 9). For that matter, it was lower than I have obtained for many "high-end" home players. The mid-frequency readings were between 0.0027% and 0.0035% (depending on the channel). At 10 kHz, where many CD players exhibit higher levels of THD + N, this unit exhibited only around 0.005%. These low readings are confirmed by Fig. 10, a plot of THD + N (expressed in dB) versus recorded signal amplitude for a 1-kHz test signal. At maximum recorded level, THD + N for the left channel was -91 dB. This corresponds to 0.0028%, almost perfect agreement with the reading obtained from Fig. 9.

Signal-to-noise ratio was 106 dB for the left channel and 107.3 dB for the right, a bit short of the 110 dB claimed. However, the difference may well be caused by the slight ripple in my d.c. power supply, which can be detected at around 120 Hz (the harmonic of the 60-Hz a.c. supply) in Fig. 11, a spectra analysis of residual noise. With a car battery powering the unit, the ripple would not normally be present.

Separation at 1 kHz was 91.5 dB from left to right channel and 83 dB from right to left. At higher frequencies, separation decreased, as shown in Fig. 12, but was always more than sufficient to yield excellent stereo imaging, especially in an automotive environment.

Figure 13 shows linearity of the CD player section. Results were excellent for undithered signals from 0 dB (maximum recorded level) to -90 dB, with a worst-case deviation of little more than +2 dB for the left channel and an even lower +0.8 dB for the right. For dithered signals, linearity in the range from -70 to -100 dB was likewise excellent. The fade-to-noise test (Fig. 14) also revealed the superb linearity of this player and served as an indicator of its EIA dynamic range, which I estimated to be about 106 dB. The EIAJ dynamic range measured 93 dB for the left channel and 92 dB for the right. SMPTE-IM distortion at maximum recorded level was only 0.008% for either channel. Digital-clock accuracy (and therefore musical pitch of reproduced music via the CD player) was good, only -0.0002%.


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The 7909's ergonomics were pleasantly unintimidating, with control feel, size and placement nicely varied.



Figure 15 shows the maximum boost and cut of the bass and treble controls. In my opinion, a bit too much bass boost is available for a unit intended for cars. With more than 17 dB of bass boost at 30 Hz available (and with the tendency of many uninformed car audio users to boost bass as far as it will go), amplifier power required at this frequency and control setting would be about 50 times higher than would be needed at unboosted middle and high frequencies. Considering the limitations of car speakers, such excessive boost would probably cause severe distortion at the speakers even if the amps could deliver all that extra bass power. Of course, the fact that there's 17 dB of boost available at 30 Hz doesn't mean you have to use all of itever. But I would have been happier if Alpine had "shelved" the bass control's characteristics below 100 Hz so that no greater boost occurred at lower frequencies.

The 7909 was able to track CDs with data gaps as long as 2.0 mm and was able to withstand rather substantial shock and vibrations as I tapped heavily on its top and side surfaces. Of course, the real test of susceptibility to mistracking can only be done with proper road testing. That, as well as performance and ergonomic functionality in an actual automotive environment, are judgment calls I leave to Technical Editor Ivan Berger. From my own laboratory perspective, however, I am willing to predict that he will rank the Alpine 7909 high on his list of favorite car stereos. *Leonard Feldman*

Behind the Wheel

Ergonomically, the 7909 was pleasantly unintimidating. As usual, Alpine varies feel, size, and placement of controls so you can find everything by touch. Finding things by eye is a fraction harder until you learn your way around, because the printed legends are so small—a common failing that's hard to avoid with a car stereo.

Although the volume control was a bit small for my taste, its milled edges made it easy to grip, and grouping the balance and fader with it was very logical. The bass and treble sliders just above are easy to adjust precisely, despite their small size.

As usual, I liked Alpine's 3×2 matrix of preset buttons better than the usual single row of six. I also liked having one memory bank that can store a mix of AM and FM stations in addition to the two six-station banks for FM and the one bank for AM, but I missed having a station scan button. The auto-memory feature, which stores the six strongest local stations automatically, is handy when you're travelling. It does not store the station frequencies it's replacing in memory, as some other stereos do, so you'll have to reprogram your favorite local stations manually when you get home.

Not being able to select CD display options didn't bother me; I rarely need to know time remaining or other esoterica. Nor did I miss being able to program specific tracks, which strikes me as too big a nuisance when driving anyway. While I did not test any of the optional changers, I think that having both in-dash and trunk-mounted CD transports makes sense; in a permanent installation, I'd keep my favorite driving music back in the changer and use the in-dash unit for whatever CDs tickled that day's fancy.



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In the CD Straight mode, which bypasses the tone and balance controls, the sound was excellent on virtually every CD I tried.



Night illumination was good. When the unit is turned off, the clock time glows on the display. When the Alpine is turned on, all buttons and knobs and the major control legends glow, with a very faint glow in the CD slot. Of the four small buttons that handle both CD and radio functions, only the CD legends (which are on the buttons) illuminate— the FM legends on the panel just above do not. On the other hand, since the legends are too small to read in most light, the illumination is not to tell you which buttons are which but to help you find them quickly once you've learned.

I don't normally hold with those who believe that having tone controls seriously compromises a component's sound, but it does in the case of the 7909's CD section. In the CD Straight mode, which bypasses the tone and balance circuits, the sound was excellent on virtually every disc I tried. But with the tone and balance controls back in the circuit, the sound seemed muddy and lackluster on all but one disc. That disc, Scott Joplin's Rag Time by James Kirby (Greener Pastures GP-01), sounded crisper with the controls switched back in. Trying to restore the highs with the treble control just made the sound seem boosted rather than more natural. This is probably a result of that control's behavior, which affects the midrange a good bit more than

the controls on my reference unit and on many others. The differences between the normal and "CDS" modes are so striking that I suspect something beyond the small irregularities seen in Fig. 8 are at work here.

As further evidence, I note that although the FM section has similar but larger irregularities in frequency response (Fig. 1), I found the FM sound more acceptable. My initial reaction was that FM programs sounded as clear but slightly less warm on the Alpine than on my reference unit. Both units picked up about as many clear stations. The Alpine's AM section had less static and birdies than my reference unit but also had less treble (which could be partially compensated for by using the treble control). The Alpine was not as good as my reference on the best AM stations, but on average stations it was a bit easier to listen to. On AM, incidentally, the Alpine sounded warmer than the reference.

As Len Feldman predicted, I heard no evidence of mistracking on reasonably bumpy roads; on unreasonable bumps, the player stopped, collected its wits, and resumed playing from the point where it left off.

All in all, the Alpine is a pretty good unit—provided you use the CD Straight mode when listening to CDs.

Ivan Berger

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THRESHOLD SA/4e POWER AMP

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The Threshold SA/4e is the kind of product that makes me feel sorry for those audiophiles who believe that all amplifiers sound alike, or that they can be chosen solely on the basis of measurement or through the results of a survey. This is the kind of product, like a fine wine, that deserves to be celebrated for its differences. In saying this, I don't mean that the Threshold SA/4e is necessarily better than other top high-end amplifiers; virtually all top manufacturers and top designers have now reached the point where the issue is never one of overall quality or dramatic differences in sound quality but rather the particular mix of sonic qualities presented in a given product.

This makes choosing between topof-the-line amplifiers from firms including Audio Research, Cello, Classé Audio, conrad-johnson, Counterpoint, Krell, Mark Levinson, Jeff Rowland Design Group, Spectral Audio, Threshold, and VTL increasingly a matter of taste. You also have to blend an amp into a given system and listening environment, and tune your system to get the maximum possible synergy. The sport of audio no longer consists of deciding which product is best (if it ever did). It consists of combining affordable equipment to reach the best possible level of audio reproduction.

The Threshold SA/4e provides a unique blend of top- to bottom-octave power, extraordinary detail, and the ability to provide the full range of dynamic contrasts in music without becoming exaggerated or unrealistic. It also offers remarkable compatibility with a very wide range of speakers and preamps. Unlike some otherwise excellent high-end amplifiers, it can cope with very complex speaker systems without losing its quality or distinctive personality.

Some of these performance characteristics almost certainly owe something to the dollars lavished on it. The SA/4e is a \$6,300 amplifier. It does not provide the no-holds-barred performance of the Threshold SA/12e, which costs about \$900 more, but even a casual look at its construction reveals that cost has not been a significant limit in its design. In fact, you get a pretty good idea of its quality the first time you lift it. The amplifier weighs 97 pounds and measures 19 inches wide, 8⁴/₄ inches high, and 23⁴/₄ inches deep.

Once you open up the SA/4e, you find a pair of 800-watt toroidal transformers, 186,000 µF of power-supply capacitance, top-quality resistors and capacitors, and 28 transistors per channel, each of which is a 250-watt, 200-V, 20-ampere device. The wiring, heat-sinks, and panels have the same "feel" of quality, and there are a number of special touches; for example, it has the first set of binding posts I have seen that can really clamp a speaker cable lead to the amplifier without any fear of a poor contact. Also, its balanced and unbalanced connectors are exceptionally easy to use.

I make no claim to be able to assess the sonic impact of a given circuit topology. In fact, 1 am continuously amazed at the differences in sound that similar circuit topologies produce and how similar even amplifiers operating in Class A and Class AB can



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The SA/4e has the ability to provide the full range of dynamic contrasts in music without becoming exaggerated or unrealistic.

sound. There can be no doubt, however, that the circuitry of this Threshold uses a number of sophisticated proprietary design features. The front-end of the Threshold SA/4e employs FETs in a noninverting, complementary-symmetry, d.c.-coupled design. It employs dual optical bias technology to control the current flow within the amplifier and to keep the gain devices at an optimum operating state under a wide range of conditions. Optical coupling is used to achieve outstanding isolation from internal interactions, and the bias circuitry is intended to keep the gain devices at an exceptionally uniform operating temperature.

The pure Class-A output stages do not have an overall feedback loop and include the latest refinement of the Stasis circuit that Threshold has used for many years. It operates both the voltage and current sections in pure Class A, and the term "Stasis" refers to the use of a binary topology in which the voltage amplifier, operating without current change, works in tandem with a high-amperage voltage mirror, without voltage change. The 28 output devices provide an exceptional amount of power reserves, and the large twin 800-watt toroidal power transformers and high power-supply capacitance provide exceptional current-dissipation reserves.

Like the technical specifications of virtually all top amplifiers, those of the Threshold SA/4e say relatively little about its distinctive sonic performance. However, few products in this price range are rated as having such high current capability. Output current capability is 35 amperes continuous and 120 amperes peak. The SA/4e is rated at 100 watts per channel in pure Class A with less than 0.15% distortion into 8 ohms of resistive or reactive impedance. Bandwidth is flat from d.c. to -3 dB at 100 kHz. Slew rate is 50 V/µS. Noise is rated at -100 dB, and the gain factor is +26.6 dB. The input impedance is 600 ohms balanced or 50 kilohms unbalanced, and the output impedance is less than 0.1 ohm from 20 Hz to 20 kHz.

I am not immune to technical glitz, but it is the taste of the wine that counts, not how well it was made or how attractively it was bottled and labelled. Similarly, the key test of an amplifier is its ability to provide every possible nuance of a given performance in a musically convincing manner. Whereas you might not insist that a wine taste equally good with every course of every meal, a great amplifier should provide outstanding and consistent performance with every possible speaker and system. The Threshold SA/4e passes this test in every way I can think of. Further, it does so regardless of whether it is operating in a simple two-channel system, in a complex multi-amped system, in the bal-



anced or unbalanced mode, or with a tube or transistor preamplifier.

I used the Threshold with very lowimpedance ribbons, complex electrostatic speakers, complex hybrid cone and planar systems, and troublesome mini-monitor loads. I used it with tube preamps that irk some other high-end transistor amps and with a wide range of interconnects and speaker cables. I cannot say that it will perform equally well in every possible system, but I can say that it provided excellent performance with a representative range of the most demanding loads any audiophile is likely to encounter.

As for its unique sound characteristics, the Threshold SA/4e is striking for its extended apparent bandwidth. It does not favor any particular part of the frequency range or appear to emphasize any group of instruments over any other. While some high-end amplifiers seem to try to optimize performance in the midrange, this Threshold amplifier provides very transparent midrange performance along with very extended bass and treble. It also did not change in apparent spectral balance at very low listening levels or at sonic peaks.

A number of otherwise good amplifiers seem to lose part of their transparency and neutrality with very soft passages, or when you need to hear a great deal of low-level musical detail. Others lose deep bass energy, midrange and treble sweetness, or resolving capability when they are asked to deliver high power levels, and this appears to alter their spectral balance. This unit did not exhibit any of these inadequacies. It provided the same open sound and extended treble and bass at every level and at any reasonable power level and provided far cleaner high-powered dynamics than I am used to hearing with mid-fi amplifiers rated at well over 200 watts per channel.

The SA/4e delivers strong deep bass by any standard. When really deep bass is present, and the speakers can reproduce it, the SA/4e can provide visceral power. This is not, however, an amplifier that seems to extend the bass of virtually all music. The bass power is only delivered when it is really in the music, and it is very controlled and accurate. There is exceptional resolution of detail and minor frequency differences in the deep bass.

The mid-bass to lower midrange transition is smooth and open. There is no touch of discontinuity and no added warmth. This amp is, however, clearly a transistor design. There is none of the upper bass warmth that some tube amplifiers add to the sound. The Threshold SA/4e is the kind of amp you want to use with a speaker system good enough not to need help in this area, although I should note that the SA/4e provides exceptional control of several speakers whose loads often cause problems in this region with other amplifiers.

The midrange is very neutral and detailed. I could not detect any exaggeration of voice or instruments, and



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A key test of an amp is its ability to provide every nuance of a performance in a convincing manner; the SA/4e passes this test.

the resolving power of the SA/4e was excellent. Midrange dynamics were very natural. The extended bass and treble does, however, mean the midrange has less focus and apparent impact than with some competing amplifiers. Again, this amp will work best with very neutral and transparent

speakers that also have extended bass and treble.

The upper octaves of the SA/4e are exceptionally detailed, extended, and open. With good source material, there is no trace of inherent harshness at any power level—even with very complex musical dynamics. But this Threshold



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Hi-Fi Connection-Marlton, NJ.; Sound Advice-Columbia, SC.;

Audio Dimensions-Oklahoma, OK





** SURROUND SOUND and DYNAMIC LOGIC are tradmarks of SSI Products, Inc. Dolby® is a registered trademarks of Dolby Laboratories, Inc. is not a forgiving amplifier. If the recorded material has too much treble energy, or problems in the upper midrange, the SA/4e will reproduce these flaws with great accuracy.

This kind of upper octave perfor-, mance requires careful attention in choosing a cartridge, adjusting VTA, and selecting a CD player. Quite frankly, it would be foolish to use this amplifier with inferior associated components or to assume that the Threshold SA/4e will fail to reveal any problems in a poor recording. I also would advise the use of a speaker with a very extended, fast, and detailed upper octave response. Amplifiers with this kind of performance capability can sometimes be a bit merciless in revealing the problems in a bad tweeter or a speaker that provides extended treble without providing extended bass

The musical dynamics of the SA/4e are truly exceptional. They combine excellent power and control at every music level and do so throughout the full range of audible frequencies. Musical contrasts are very natural, and there is no exaggeration or surprise. At the same time, the kind of musical dynamics that are stunning in a live performance, whether symphonic or rock, come through in a way very few of even the best high-end amplifiers can match. I don't spend much time listening to sonic spectaculars, but this is an amplifier that gives them real life. More importantly, when you hear a sudden powerful drum shot, or bowing sound from the bass viol, this amp delivers the dynamics you should really hear.

I have stressed the resolving capability of this amplifier so often that I risk repeating myself, but it is remarkably transparent without losing musicality or exaggerating any special aspect of the music. There is no etching of the treble, and there are no surprises in terms of added musical detail where such detail does not seem natural. Once again, however, the extended deep bass and treble mean that there is no special focus on the midrange and no forgiveness of problems in the source material or associated components.

The SA/4e provides a neutral soundstage, which is very wide and just a touch recessed. The sound is dynamic but not forward. There is very good depth, but it is not the kind of extended

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ACCURATE MUSIC REPRODUCTION

RECISION

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STEM

The only component in your aud.o system expected to reproduce the sound of a violin, voice, or symphony orchestra is your speaker system. To do so it must perform many complex electrical and mechanical functions without adding any character or "colouration" of its own. Added colourations may sound impressive at first, but before long they become irritating and much of the enjoyment of listening to music is lost. Musically accurate speakers, however, provide a very satisfying listening experience.

Many people would like to have this high quality sound reproduction in a variety of rooms and locations, but the thought of placing "traditional" speaker systems throughout the home is not especially appealing. Mounting speakers in a wall is much more convenient. The wall, however, has unique acoustic characteristics that require careful consideration in the design of the *complete in-wall speaker system*.



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This unit's upper octaves are exceptionally open, detailed and extended; there is no trace of inherent harshness.

depth that is provided by some competing products.

Imaging is excellent. It combines outstanding detail with outstanding stability and does so without any apparent tendency towards a hole in the middle, a lack of left-to-right extension. or a lack of depth. Some competing

amplifiers do a somewhat better job of resolving the layers of depth you can hear from the very best recordings, but this Threshold still provides very good imaging in this respect. I found it to cope better with the imaging in complex percussion than virtually any other amplifier I have heard.



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As I have mentioned, the Threshold is likely to provide outstanding and predictable performance in a wide range of systems. This also makes it unusually easy to audition. What you hear in a really good dealer setup is very likely to be what you hear at home. The SA/4e does require extended break-in with music to deliver its best performance. I would allow several days after taking a new unit out of its box. It also benefits from several hours' warm up, even after it is broken in, although it provides 90% of its best sound after 20 minutes of warm-up.

I also have noted that it is a bit silly to use an amplifier this revealing with poor associated components or a speaker whose overall balance emphasizes either the treble or bass, or one that does not provide extended deep bass and treble. At the risk of revealing my prejudices that cables really do sound radically different, I also would strongly suggest the use of interconnects with a flat and neutral sound rather than the kind of cables that try to add something to the music. Speaker cables should have the same sound characteristics and be able to handle truly powerful bass.

As I have said from the start, the best high-end amplifiers have evolved to the point where attempts to rank them are largely meaningless. Highend designers and manufacturers have reached the point where the choice of a given amplifier has to be made on the basis of extended listening and personal taste. The special advantages of the Threshold SA/4e are its excellent dynamics, extended bass and treble, transparency, and ability to resolve musical contrasts. Its limitations lie only in its reproduction of depth and lack of emphasis on the richness of the lower midrange and upper bass.

All in all, the Threshold SA/4e is a "reviewer's amplifier" in the sense that it is extraordinarily compatible and revealing without losing any aspect of musicality. If you are serious about trying to build a great high-end system, or if you just want to hear how much better one of the best available highend amplifiers can sound, this is a product that I would strongly recommend you audition.

Anthony H. Cordesman

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AUDIO/JANUARY 1991

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Audio Magazine–Juilliard Scholarship Award

PUBLISHER'S PRESENTATION

Now in its second year, the presentation of the Audio Magazine–Juilliard Scholarship Award is becoming quite the industry event. On September 11th, more than 150 industry notables gathered in New York City's Tavern on the Green to honor this year's recipient of the \$10,000 scholarship, Sharon Kam. An exceptionally fine clarinetist, the 19-year-old Kam

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is in her second year at Juilliard.

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"Supporting the future stars of the music business is our way of giving something back to the industry," says *Audio* Publisher Steve Goldberg. "For in the final analysis, if it weren't for students like Sharon, there would be no *Audio* magazine; there would be no need for the equipment on which recordings are played.

"Taking a long-term view, I think it's the responsibility of the business we're in to

cultivate and nurture musicians, both those of the present and the future."

In keeping with Goldberg's concept, the honorary scholarship committee included dignitaries from both sides of the hardware-software equation: Avery Fisher, founder of Fisher Electronics and a key figure in the classical music world; Juilliard President Joseph Polisi; Goldberg, and Hachette Magazines Executive Vice President Didier Guérin.

Guenter Hensler, BMG Classics President, was the evening's featured speaker. "I wish I could have been associated with Juilliard when I was 15 instead of 50," he joked during a speech that touched on a variety of issues, from preserving the RCA (now BMG) legacy to promoting contemporary serious music. Kam thanked *Audio* and Juilliard in brief remarks as well as in a splendid performance of Schumann's threepart "Fantasiestucke," on which she was ably accompanied on piano by Eric Zivian. "They're very emotional pieces," Kam said when she was asked why she chose that particular repertoire. "And they're maybe a little easier to digest for an audience Juilliard: In December 1988, she played the Mozart Clarinet Concerto with him conducting the Juilliard Orchestra in Carnegie Hall. Members of the conservatory's faculty came to hear Kam during the dress rehearsal. "Afterward, they invited me to come to school," says Kam, who plans to complete her course work for a Bachelor's degree in just three years.

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Born in Israel, which she still calls home, Kam began piano lessons at age five before picking up the recorder two years later. From the time she was 12, she received yearly scholarship awards for private study from the American-Israel Cultural Foundation, the organization that later introduced her to Mehta. She switched to clarinet at age 13, and though at one time thought about becoming a scientist, she now seems determined to

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Steve Goldberg, Audio Publisher; Sharon Kam, and Guenter Hensler, President, BMG Classics.

that isn't all that familiar with the classical idiom."

As the polish and assurance of her playing attested, Sharon Kam is already well on her way to a successful career. Recently signed by Thea Dispeker, one of the top artist managers, she has performed in Carnegie Hall with the Guarneri Quartet and been a soloist with the Toronto Symphony and the Israel Philharmonic. Last April she soloed for a second time with the Israel Philharmonic, in a joint concert with the Berlin Philharmonic led by Zubin Mehta. "It was a big political and musical event," Kam recalls. "It was the first time the Berlin Philharmonic had come to Israel since the War."

Mehta also conducted what turned out to be Kam's official audition for pursue a solo career. Currently she studies at Juilliard with Charles Neidich, the 1985 Naumburg Competition winner.

For all her special gifts, Kam was reminded recently of her obligations as a citizen of Israel, where women must serve a minimum of two years in the army. "Last summer I went into basic training for $3\frac{1}{2}$ months," she says. "They have given me a postponement until I have finished my degree." Then what? "I don't know if they want me to go back, then I'll just have to go back."

Whatever may happen, one hopes Sharon Kam will be able to pursue what looks like an extremely promising career. "It seems like it will all be okay," she says philosophically, "but you can never tell in this world."

—Susan Elliott





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CLASSICAL RECORDINGS

MASTERSTROKES



Mendelssohn: Piano Trio No. 1; Schubert: Piano Trio No. 1. The Rembrandt Trio.

Dorian DOR-90130, CD; DDD; 70:36.

It's nice to see that the Mendelssohn trios, after years of neglect, are coming into their own on CD. The wonderfully rhapsodic First, recorded superbly here, is even available once again in one of its major interpretations from the 78-rpm era (Rubinstein-Heifetz-Piatigorsky on RCA in various formats) following oblivion during the LP era.

The Rembrandt (Valerie Tryon, piano; Gerard Kantarjian, violin; Coenraad Bloemendal, cello) turns in a performance that can stand comparison to any. Perhaps one might find a graciously shaped phrase here or a more idiomatically timed attack there, but the overall level of artistry and musicianship is unlikely to be equalled-let alone surpassed-elsewhere. I have not heard the Beaux Arts account on Philips (probably the most obvious competition), but some of its recent recordings sound slightly bored, which the Rembrandt certainly does not. And the Borodin Trio on Chandos takes the opening movement, marked "molto allegro ed agitato," at what is (to my ear) so lugubrious a gait as to disqualify it outright

The sound of this trio is truly wonderful. The richness of the cello and the violin/cello blend are perfect for the writing, which, like some passages in the Brahms double concerto, treats the two instruments as each other's alter ego so that their sounds swell with a unity of passion that is utterly disarming if you have any taste at all for this repertoire. Moreover, the reverberance of the Troy Savings Bank Music Hall, as captured by Dorian, is just right for the warmth and scope of the music. Kudos all around.

The Schubert is certainly the better known and more beloved of the two recorded works. Its recording and performance values here approximate those of the Mendelssohn, but, despite the identity of time (March 1989) and place for the two recordings, they are not identical. In particular, there is a little less richness in the cello sound, and the acoustics of the hall are allowed to blur the piano slightly in some passages.

To some degree, this must be due to a difference between Schubert's and Mendelssohn's style of writing for piano trio. And perhaps the performers' familiarity of the Schubert contributes: The playing seems a little less involved, with less unanimity of attack at some points and a tendency to more matter-of-fact phrase shaping at others. It certainly is a fine performance, but it falls a hair short of the Mendelssohn's incandescence.

It might be hoped that this disc would be followed by one containing the respective second trios, but Dorian has not (yet) recorded them.

Robert Long

Schubert: String Quartets Nos. 14 ("Death and the Maiden") and 9. New World String Quartet. MCA Classics MCAD-25899, CD; DDD; 66:02.

This is a remarkable record not because it contains a fine performance of "Death and the Maiden" (there are other excellent CDs that do) nor because it includes the undeservedly neglected String Quartet No. 9 as filler (there are other recordings) nor even because it is a first-rate recent recording job by a company that sometimes releases questionably prepared reissues of material recorded by others. All of these factors contribute but what remains in consciousness, like a delicious aftertaste, is the New World's exceptionally personal approach to a masterpiece that has become almost a cliché

A more usual approach emphasizes the kinship between the Quartet No. 14, in D minor, and Symphony No. 9, "Great C Major"—which, as their keys imply, are not quite kissing cousins musically. Both are, admittedly, examples of Schubert at the height of his prodigious powers. But their personalities and their musical means are utterly different. Particularly in the quartet's first movement, the attempt to impose the symphony's rhetoric can lead to some rather awkward posturing.

The New World Quartet reminds us that Schubert always wanted to be a successful opera composer but had little opportunity to practice that craft. By presenting the rhetoric in a theatrical sense, it invests the problematic gestures with a kind of meaning they don't normally have. That opening movement, for example, takes on some of the feeling of an extended operatic *scena*, and its gestures ring true in a surprising way in this context.

Instead of a tragic dirge, the slow movement (whose theme gives the quartet its name) becomes a thing of





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The New World's approach to a piece that has become a cliché is exceptionally personal and remains, like a delicious aftertaste.

delicate pathos, self-aware in its presentation. It's like watching a great tragedienne play a death scene; it is genuinely sad, but at the same time, we are filled with admiration for the way she does it. We, like the actress, view what is happening both from within and from without. It could be argued that this approach dresses greatness in fustian and, subtle though the differences are, ultimately mocks Schubert's deeper properties. Yet it so often carries conviction and so beautifully realizes a side of Schubert's nature, routinely ignored in this piece, that the recording



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Lloyd: Symphonies Nos. 1 & 12. Albany Symphony Orchestra, George Lloyd.

Albany TROY032-2, CD; DDD; 65:42.

You say you enjoy encountering new music as long as it's not "difficult"? Have I got a disc for you! George Lloyd is an old-fashioned composer, as such things are reckoned these days, but by no means a throwback to a former era. He evidently takes great delight in the sounds he can make with a symphony orchestra, and explores its timbres with the glee of a kid in a candy shop. Both symphonies have a good deal of lyrical writing and some bang-up (literally) climaxes. Lloyd really seems to have fun at his craft of composing, which makes his music quite a pleasure to discover.

Both of these symphonies are based on ingenious, complex theme-andvariations forms, and each is cast in a single movement—his only examples of this sort. The First Symphony, dating from 1932, reminds me a bit of Borodin, though I imagine both Borodin and Lloyd might be shocked at the suggestion. Admittedly, Llyod's idiom is much more modern, but there are similarities of orchestration and even of themes.

The 12th Symphony premiered in March 1990, at the behest of the Albany Symphony, which wanted a companion for the First. Lloyd, a Cornishman, had come to Albany before. The orchestra had also recorded both his Fourth and 11th Symphonies—and had commissioned the latter. The 12th is somewhat more involved than the first, but it is not obscure.

The recording was made in April, following the premiere, in the Troy Savings Bank Music Hall, which is fast becoming a legend. If you've wondered why, it's probably because most recordings made there are of chamber music, which is blurred if too much ambience is allowed to overlay the direct sound. In symphonic music, the hall's full ripeness can be captured without fear. And the Albany Records crew has accomplished this with remarkable results.

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Mark Levinson[®] products are designed and manufactured by **MADRIGAL AUDIO LABORATORIES** P.O. Box 781, Middletown, CT 06457 FAX (203) 346-1540 Table courtesy of Fairhaven Woodworks. George Lloyd really seems to have fun at his craft, which makes his music a pleasure to discover.

Also remarkable is the orchestra. In a time when we're told that orchestras across the country are universally suffering severe fiscal and management problems, it's astonishing to see one regional organization after another prove its worth in a wider market, thanks to radio or recordings or both. Now listeners anywhere can judge the mettle of the Albany Symphony. If you think a regional orchestra has to be inferior, you're in for a surprise.

Robert Long

Diamond: Symphonies Nos. 2 and 4; Concerto for Small Orchestra. Seattle Symphony (symphonies); New York Chamber Symphony (concerto); Gerard Schwarz, conductor. Delos DE 3093, CD; DDD; 73:17.

Arnold Schoenberg found refuge from the Nazis in Los Angeles, but not until after World War II did his 12-tone system of composition conquer contemporary music in America as well as



in Europe. Many important composers embraced it; even Aaron Copland and Leonard Bernstein dabbled in it. David Diamond (born 1915) resisted, and unerringly went his own lonely way.

Diamond had attracted attention unusually early, soon after his studies with Bernard Rogers at Eastman and further instruction from Paul Boepple, Roger Sessions, and Nadia Boulanger. Oscar Levant, in his autobiography, *A Smattering of Ignorance*, records Copland's enthusiastic reply when Levant asked what sort of music young Diamond wrote, "Streamlined!"

The passage of time, though, turned Diamond into a neo-Romantic. The album leaflet here quotes him: "It is my strong feeling that a Romantically inspired contemporary music, tempered by reinvigorated classical technical formulas, is the way out of the present period of creative chaos in music. To me, the Romantic spirit in music is important because it is timeless." As quoted by Diamond, Schoenberg told him in 1949, discussing whether Diamond ought to have studied with him, "Why do you need to? You're a new Bruckner. ... I never meant [the technique] for everybody.

These three works range from 1940 to 1945, the years of World War II. The massive, brooding Second Symphony (42:19), unveiled by Serge Koussevitsky with the Boston Symphony, especially evokes that troubled time with power and intensity. On the evidence of this recording, the Seattle Sympho-

"Quite simply, the MC-101 is a superb preamplifier."

Highlights of Hi-Fi Heretic, Summer 1989 review.

B&K's Sonata Series is a new line of upmarket electronics, consisting of two preamplifiers: the MC-101 (on test here) and the Pro-10MC, \$698; two power amplifiers, the M200 monoblock (200 watts into 8 ohms, \$898 each) and the EX-442 stereo amplifier (200 watts per channel into 8 ohms, \$948).

As with B&K's other preamplifiers, the MC-101 is a full-featured design. Included are (take a deep breath) two source selectors for "listen" and "record" functions, a tape monitor function, an external processor loop, highquality Noble volume and balance controls, a mono switch, a line amplifier bypass switch, bass and treble controls (defeatable), a high frequency filter, and a headphone socket. There are inputs provided for a turntable (selection betwen MM and MC stages via a switch mounted on the main circuit board) DAT recorder, CD player, VCR, tuner, and tape recorder. (Obviously, any auxiliary source can be connected to the DAT and VCR inputs.)

One thing is certain: the B&K MC-101 is without a doubt the best full-featured amplifier I have heard in this price range. Resistance and capacitance on the phono input can be adjusted by inserting resistors or capacitors in gold-plated sockets on the main circuit board. Moving to the rear of the unit, all inputs and outputs utilize Premium RCA jacks. There are two sets of main outputs. For only \$200 extra, the MC-101 is available with balanced outputs. The unit's power switch is,

As such, it easily qualified for "BEST BUY" status.

in fact, an output muting circuit, as the preamplifier is always energized when connected to an AC outlet. The headphone output is only activiated when the power switch is turned off.

A rather impressive list of features, eh? Construction quality is equally noteworthy. Built into an exceptionally sturdy steel case, the MC-101's circuitry is laid out on a single glass-fibre board, with an auxiliary board carrying the input/output jacks. Parts quality is extremely high, with all controls and selectors of premium quality. 1% metal film resistors and polypropylene film capacitors are liberally used throughout. The active circuitry is completely discrete, with ICs used only in the servo circuits to control DC offset. The B&K utilizes a remote power supply, with connec tion to the preamp via a high-quality Cannon plug. All told, the MC-101 is remarkably well made for the price.



The MC-101 is quite attractive, though a bit bulky when compared to the slimline Forte and PS Audio units. New silk screening on the front panel makes the MC-101 far more attractive than B&K's other preamps. Both the control knobs and obligatory rack mount handles are black rather than B&K's usual gold, another cosmetic bonus. Overall, a worthwhile improvement over earlier B&K efforts.

Quite simply, the MC-101 is a superb preamplifier. I had expected it to offer the traditional B&K virtue of smooth tonal balance, but I was not prepared for its amazing sense of detail and clarity. Through the MC-101, music has a combination of warmth and immediacy that is all but unprecedented in this price range.

One thing is certain: the B&K MC-101 is without a doubt the best full-featured preamplifier I have heard in this price range. As such, it easily qualified for "BEST BUY" status.



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Erter No. 42 on Reader Service Card

This Second Symphony by David Diamond especially evokes the troubled times of World War II during which it was composed.

ny continues to grow and develop impressively under its imaginative and courageous young conductor, Gerard Schwarz.

If I had to choose one single epithet for Diamond's music, I think I would call it mellifluous; Webster defines it as "flowing sweetly and smoothly." That

quality comes naturally from the composer of some of the finest songs ever composed to English language texts. It occurs to me that Delos, that doughty little Los Angeles firm, might want to follow up its Diamond symphony cycle with a CD of some of the composer's remarkable songs. Paul Moor



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Stravinsky Conducts Stravinsky: Petrushka; Le Sacre du Primtemps. Columbia Symphony Orchestra. CBS Records MK 42433, CD; ADD: 65:26.

We can't often review a CD reissue like this, one of a flood of thousands that is the phenomenon of the CD age. There are even more brand-new recordings, DDD, and these take precedence as state of the art in audio terms.

This one is not even new—you may find it currently with the Sony label attached. But musically it is of tremendous significance (and of very passable sonic quality, both the 1960 originals and the CD transfers). Here is the master himself directing his own works in their earliest format, as of 1911 and 1912 or so, when large orchestras were both common and affordable. In fact, the ballet chief Diaghilev even encouraged Stravinsky to use a huge aggregation. And this to accompany dancing! Not even a concert.

Stravinsky's precise mind included a steely memory. In his many writings the notes here are, of course, by Stravinsky himself—the exactitude of detail is always startling, no matter how far back; a man of this stature would not allow mere passive ghostwriting, you can be sure. And so, in the music, these recordings must be meticulously close to the original performances, so many years before. And in numerous spots quite unlike the more familiar performances of today.

I note particularly the rather fast tempi of the march-like crowd scenes in *Petrushka*, the action scenes dramatically free, as per stage action. *Le Sacre* is similarly dramatic, not lambasting the big dissonant chords and jagged outbursts but, rather, fitting them into a larger frame. It was *his* frame. His performance, in 1960, ties the music to the mental dramatics he remembered from those famous beginnings.

P.S. Stravinsky was visually no show-off conductor at all—I saw him on several occasions. He crouched, bent his legs, rose up flailing his arms, all very ungracefully. Hence his poor rep among those who think conducting is some sort of fashion show. It can be, and good too! But the music is what counts. *Edward Tatnall Canby*





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Shooting Straight in the Dark: Mary-
Chapin CarpenterColumbia CK-46077, CD; ADD; 42:17.Sound: APerformance: AInteriors: Rosanne CashColumbia CK-46079, CD; DDD; 34:18.Sound: A +Performance: A

Rosanne Cash and Mary-Chapin Carpenter both figure to be major forces in country music in the '90s, but their new albums should be appreciated by a much wider audience. Each crafts songs that emanate equally from the heart and conscience with the power of truth.

Mary-Chapin Carpenter received raves for her previous album, State of the Heart, and its cycle of songs about relationships dissolving and the subsequent discovery of one's inner strength. Shooting Straight in the Dark is the next chapter.

There is nothing maudlin or pat here, just keen observation and excellent storytelling. "Going Out Tonight" is an apt opener, a song of yearning for something to break one's loneliness and the determination to find it. The next song, "Right Now"—a 1958 composition by Al Lewis and Sylvester Bradford—is the upbeat flipside with backing vocals by Marti Jones and Don Dixon. Several songs explore the "getting on with one's life" phase that follows a broken relationship. "You Win Again" is particularly effective, both sharply drawn and quite angry.

"Down at the Twist and Shout" is a fun tune that celebrates one of Carpenter's favorite haunts in her hometown of Washington, D.C. It includes appearances by Michael Doucet, Jimmy Breaux, and Billy Ware of the fabulous Cajun band, Beausolais. "Halley Came to Jackson" is a Eudora Welty-like tale of Halley's comet and the effect it had on a small Southern town. The closing song, "The Moon and St. Christopher"—a duet with Shawn Colvin—is a self-evaluation and prayer "for the heart and the nerve" for what will come next.

Carpenter's songwriting is disarmingly open and mature. Her singing is excellent, by turns rueful and sassy, smart and sad, winsome and spiteful. Her band, led by co-producer John Jennings, is crackerjack. They play



crisply and concisely. The Jennings/ Carpenter production is very strong, with direct, clear arrangements and nice extra touches to make them come alive.

Rosanne Cash's Interiors, like Carpenter's album, pushes country boundaries in a different direction. Following her brilliant 1987 album, *King's Record Shop*, which sent Rosanne to the foreground of country music, she returns with the very introspective and acoustically oriented Interiors.

Wrestling with ferocious demons is the core of this album. "Dance with the Tiger" (co-written with John Stewart) addresses this concisely and eloquently, but I keep referring back to the album opener, "On the Inside," which states the key issue of *Interiors*: Questions are clear, answers are not. They are not even apparently forthcoming.

A duet with husband Rodney Crowell, "On the Surface," is about how emotions can get suppressed in an effort to make things go smoother than they should. This is followed by "Real Woman," co-written with Crowell, which conveys Rosanne's determination to be who she wants to be and stand on her own, personally and professionally. The lyrics are so open and plainly laid out that the song could come off as trite and banal. But Rosanne's honesty prevents it.

The recording quality of *Interiors* is superior. It is the warmest-sounding all-digital recording I have heard. The arrangements are stark—often startling—and the strong hand of guitarist Steuart Smith is evident throughout. He is one of those rare players whose very presence seems to elevate everything he lends his talents to. Another major contribution comes from fiddler/mandolinist/guitar player extraordinaire Mark O'Connor.

Rosanne produced the album herself, with assistance from Crowell on "Real Woman" and "On the Inside." Everything she does here is brilliant. She has never sung sweeter, nor have any of her records sounded better.

Interiors and Shooting Straight in the Dark are both triumphs. Rosanne Cash and Mary-Chapin Carpenter are not just superior country artists, they are superior artists, taking pain and transforming it into art. These records are perfect examples of how great songs played effectively will reach anyone who takes the time to listen to them.

Michael Tearson

Set: Youssou N'Dour							
Virgin 2-91426, CD; AAD; 49:13.							
Sound: A	Performance: A						
Aladji: Sam Mangwana							
Shanachie 64017, CD; DDD; 30:41.							
Sound: A	Performance: A						

Are you aware that the world is shrinking? For evidence, just check out Set and Aladji, new releases by two of Africa's top male vocalists, Youssou N'Dour and Sam Mangwana. While both recordings feature the bright, infectious polyrhythms typical of central and western Africa, they also reflect rich cross-cultural fertilization (often gained in European sojourns) and a very polished, contemporary sound that make them very much a part of the world beat scene.

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Although many people only know Youssou N'Dour of Senegal from his work with Peter Gabriel, he has a mega-reputation in both Africa and Europe. Produced by jazz guitarist Michael Brook and recorded in Brussels, Set is N'Dour's first release for Western audiences recorded with his own band, Super Etoile de Dakar, "live" in the studio, as opposed to recorded tracks overdubbed separately. The result is a hot set of what's known as mbalax, high-powered dance music full of urban rhythms from Dakar and spices from around the world, complete with electronic keyboards, horn section, and relentless talking drums.

Singing his own compositions, N'Dour's expressive tenor soars over songs ranging from the jazzy title cut, with its almost-rock guitar licks, to the chimey Arabic/Memphis sounds of "Alboury," to an Afro-reggae romp on "Miyoko" (an international hit sung in English). The Beatles-inspired "Xale" has a melody, strings, and cello line reminiscent of "Eleanor Rigby." Other styles appear, including the funky R&B of "Fenene" (complete with wah-guitar), a sort of Zydeco/French cabaret song, "Hey You," and a lovely acoustic guitar number, "Ay Chono La."

Canadian musician/producer Daniel Lanois guest-produced one tune, "Toxiques," a song protesting that Third World countries are used for dumping toxic wastes. Indeed, these songs, mostly in N'Dour's native Wolof tongue, cover everything from lost love to world peace. (Translations are provided.)

Hailing from Zaire, Sam Mangwana's singing isn't quite as accomplished as N'Dour's, but his reputation as a lead-

Although Youssou N'Dour's *Set* is sung mostly in his native Wolof tongue, this is an extremely accessible album.

ing proponent of *soukhous*, a fusion of Zairean, West African, and Caribbean music, continues to grow. While N'Dour's music shows a more worldly sophistication and variety, Mangwana's is more circumscribed by its influences. That doesn't make it any less attractive or global. Digitally recorded in Paris, Mangwana's vocals show a great sense of humor and style as they playfully range over driving, chirping guitar rhythms and a swinging horn section. His music ranges from the very African "Kabi Bi," "Trans-



Beros," and "Toyaki Kobina" to the syncopated reggae of the title cut. "Antonio" is a tune that you'll almost swear is Brazilian, and "Soweto" has a kind of *m'baquanga* groove with Nash-villean touches.

Both Set and Aladji are extremely accessible albums. Whether you enjoy picking out musical influences or succumbing to the beat, you'll find these a pleasant signal that the continents are. indeed, getting closer. Michael Wright

Poor Man's Dream: Tom Russell Band 800 Dark Angel 8DACD1, CD; DDD; 50:47. (Available from 800 Dark Angel, P.O. Box 744, New York, N.Y. 10101; 800-327-5264.)

Sound: B+	Performance: A+
Tom Russell	is a superlative song-
writer who has	a killer sense of story-

telling and a great ear for melody. His band is crackerjack, and this record, *Poor Man's Dream*, is flawless from beginning to end and loaded with great songs.

"Gallo Del Cielo" tells the story of Carlos Zaragosa, who stole a fighting chicken so that he could win enough money to buy back land Pancho Villa stole from his father. "Walking on the Moon" is a delicious song about the lure of night life. "Bergenfield" describes the plague of teenage suicides in northern New Jersey. "Blue Wing" is the life-and-death tale of an Indian who shared a prison cell with blues singer Willie John, who originated "Fever." "Spanish Burgundy" relates a lost love in Barcelona. "Veteran's Day" is about someone who did not return from Saigon. Strong story songs indeed.

Russell's band features Andrew Hardin's lead guitars and utility man Fats Kaplin on pedal steel, fiddle, Dobro, and accordion. Hot picking abounds.

In essence, Russell's music treads the nether ground between rock and country that artists like John Mellencamp, Tom Petty, and Steve Earle navigate, drawing equally from both sides of the chasm. And Russell's great songwriting skills elevate the album. *Poor Man's Dream* is the goods. Don't miss it. *Michael Tearson*

Midnight Stroll: The Robert Cray Band featuring The Memphis Horns Mercury 846 652-2, CD; AAD; 50:08.

Sound: A Performance: B+

Maybe it's the hype that's hindered Robert Cray. Certainly his career hasn't suffered, but people keep trying to make him into things he's not: The next great bluesman, a guitar hero, the successor to Hendrix (they both hail from the Pacific Northwest). On *Midnight Stroll*, Cray is accompanied by a reconstituted band featuring The Memphis Horns. They yield a consistently tight and punchy groove—more so than on the previous Cray records.

With the addition of a horn section (one with bona fides stretching back to the Stax/Volt glory days), Cray is now pumping out R&B with both authority and an edge. His rhythm section is punchier than ever before, with some excellent drumming by Kevin Hayes. Swell Hammond-style swells from keyORIGINAL MASTER RECORDING"

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Robert Cray's loping solos are marvels of economy and expression, and just enough *outside* to be interesting.

boardist Jimmy Pugh and the just-right brass keep things going. The improvement is attributable to more than just the new band. Cray's guitar playing has been brought up in the mix so you can hear it better. Let's face it: Jimi he ain't, but his ringing, out-of-phase Fender Stratocaster gives the album a pleasing crispness. Some of his loping solos, like those on "Walk Around Time," the title cut, and "Move a Mountain," are marvels of economy and expression, and just outside enough to be interesting. Cray's singing is also stronger than ever, and he's begun to put some English on his phrasing. There are moments on "These Things" and "Bouncin' Back" where he slips into a falsetto wail that brings Little Richard and Al Green to mind, and "The Things You Do to Me" has some of Cray's most varied and soulful expression to date. Lyrically, Cray's songs still pretty much focus on bluesy love laments, but the solid pace and feel make up for the sameness here.

Midnight Stroll is a good R&B record in the old tradition. It's also the first time Cray has sounded like he knows what he wants to do and is going for it, stretching a bit, and enjoying himself in the process. Michael Wright

King Tears: Wa	Iter Hyatt
MCA MCAD-643	34, CD; ADD; 34:11.
Sound: B -	Performance: B

 Dund: B Performance: B +

 I hear a lot of new albums and a lot

of new artists. When Walter Hyatt's debut disc crossed my desk, I expected just another country singer. Wrong!

Hyatt sounds like Harry Connick, Jr. meets Lyle Lovett: Very smart, very urbane, and very stylish. In fact, when I first heard Hyatt's sophisticated wordplay, I wondered if he is meant to be the next Lovett. Then I noticed that Lyle co-produced *King Tears*, this first vocal album on MCA's Master Series, with Billy Williams.

The jazzy and cool *King Tears* is definitely adult entertainment, well thought out and beautifully played. The eight originals are joined by two covers, of which Heinz Roemheld's and Mitch Parish's "Ruby" is a particularly fine read. My one complaint is with the sound, which is almost too cool and laid back. However, the production does work well. *Michael Tearson*

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Cajun, Vol. 1—Abbeville Breakdown Columbia CK 46220, CD; AAD; 61:25.

Lonnie Johnson—Steppin' on The Blues Columbia CK 46221, CD; AAD; 58:29.

Sound: C Performance: A

Vitamins? Well, yeah, or maybe these discs are ear candy or a taste of musical tonic. Whatever, they set my craving to work when they came into the office, the hook being the tastiness of old-time country blues, originally out on 78s. Not the least of the attraction was the centerpiece of this fine series, a two-CD boxed set of all the known recordings of Robert Johnson, 41 in all, along with a 48page booklet containing an excellent essay by Stephen LaVere and appreciations of Johnson by Keith Richards and Eric Clapton. Johnson is one of the most celebrated of the country blues guitarists, and Clapton says of Johnson, "his music remains the most powerful cry that I think you can find in the human voice." Richards uses one of my favorite metaphors: "Suddenly he raised the ante, suddenly you had to aim that much higher."

Johnson is extraordinary—it's almost like hearing two guitarists on some cuts. I wonder, though, how much of that sounding like he's got extra fingers is just the peculiar resonances of these 78s. They are, after all, very early, having been recorded in just five sessions: Nov. 23, 26, and 27, 1936, in San Antonio, and on June 19 and 20, 1937, in



Dallas. In addition, at least to my ears, there's something that's happened to Johnson between that Thanksgiving and mid-June, as if he's had some deep, frightful experience. Some titles of these songs ring like blues anthems: Dust My Broom," "Sweet Home Chicago," "Cross Road Blues," "Walking Blues," "Love in Vain," etc. Others, such as "Hellhound on My Trail," are so personalized by Johnson's treatment that they'll never be adequately covered. If you're anything like a serious collector of or listener to blues, then get this set-if only to hear several cuts not previously released

Legends ... is one of the best compilation albums I've ever come across. Some tunes are the deep country blues, e.g., "Match Box Blues" by Blind Lemon Jefferson and the finest. cleanest version of Bukka White's "Fixin' To Die Blues" I've ever heard. Bessie Smith's "St. Louis Blues" is cleaned up, too, and nice to have, but it sounds intrusive, as does Bo Carter's "Pigmeat Is What I Crave." Other important artists included are Lonnie Johnson, Charley Patton, Leroy Carr, Josh White, Leadbelly, Muddy Waters, and Son House. Collector or not, buy this if you like good blues.

Willie Dixon's *Big Three Trio* comes from the roots side of this series and sounds much more jazz-like than in the blues tradition. Most of the 21 cuts are up-tempo jumps, in a style midway between classic Dixieland and bop, and were made during a five-year period of 1947 to 1952. It's worth buying if only for "Signifying Monkey."

For me, News ... is a rather forced album, despite the obvious topicality of many blues lyrics. Again, there are many important artists included, but to my ears this isn't their best work. I recommend this to the most serious collectors only.

I like the compilation aspect of *The Slide Guitar*..., and I recommend this disc very highly. Bukka White's characteristic riff has never come through so cleanly as it does here on his "Jitterbug Swing." Leadbelly's "Packin" Trunk Blues" uses the same material, both lyrics and melody, as Lemon's "Match Box Blues," and while Leadbelly doesn't take the song away from Lemon, it's a great alternative. Yes, buy this one too.

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While I have to say up front that I have a great deal of respect for Big Bill for keeping at this type of music, not to mention his ever-present welcoming hand to new arrivals to Chicago, he has never impressed me as the most soulful of blues artists. No. I can't play as well as he did, but my ears tell me

that many others can and have. Since 14 of the 20 cuts here are "previously unissued," this might seem like something primarily for collectors, and that's not too far wrong. Broonzy's CD is welcome, but I won't play it much.

The Cajun CD is the first I'd let go, as it seems like a sort of folk music docu-

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mentary to me, with several cuts being discussed in the accompanying booklet in "first ever" terms. The Alley Boys of Abbeville grabbed me most strongly, particularly on their "Abbeville Breakdown," though the accordion of Joe Falcon seems more strongly in the tradition

The single most impressive discfrom my point of view-is the Lonnie Johnson, which includes four previously unissued cuts. Of the 19 sonas on the album, 14 are from the 1920s with the rest from the early '30s. I've always been consistently amazed at the fingering technique of this Mr. Johnson, so much so that on a couple of things I can't even figure out how he's playing what he does. For example, "Guitar Blues," really more of a rag which is played in duet with a nearly pure jazz guitarist, Eddie Lang, has a sort of shimmering, hammering-on effect that is the highlight of this entire series.

Larry Cohen, producer of the series. is pretty happy about getting Columbia to reissue all this material. In the case of the Robert Johnson boxed set, the project had been put back on the shelf in 1974 after an aborted start. Cohen feels that Frank Abbey has done a "terrific job" with the restoration, particularly in staying on the right side of the "thin line between cleaning up and making the resulting music antiseptic." Incidentally, all but the Robert Johnson collection has been digitally processed with CEDAR, described in the liner notes as "an entirely new method of restoring sound recordings, using the latest developments in digital signal processing and microcomputer technology. Developed from a research program initiated by the British Sound Archive and Cambridge Sound Restoration in association with the University of Cambridge." And being the Editor, I can say, yes, we are going to chase this one and find out the how and what. Cohen is pretty positive about the results CEDAR gets on depopping and declicking, saying it rates a 95%, though he is not as satisfied with its performance on swooshing, fried-egg abrasive noise.

One of the nicest things that Larry Cohen told me was that there are nine more of this series in the works, most of which will be released in February 1991 with the balance tentative for AuMark Isham offers music of restraint, order, and balance but also of color and variety.



gust. There's to be a definitive set of Bessie Smith, following the Robert Johnson pattern, as well as discs of Memphis Minnie, Blind Boy Fuller, Muddy Waters, Leadbelly, and compilations of great blues guitars, gospel, and a few more.

All things considered, Roots N' Blues is certainly a terrific series, and I highly recommend it to blues and jazz buffs. *E.P.*

Mark Isham

Virgin 2-91293, CD_AAD; 45:44. Sound: A Performance: A

In this collection, Mark Isham evolves his style in a new direction by incorporating some pop elements, as evidenced by an arrangement of the venerable Rodgers and Hart favorite, "Blue Moon," sung by Tanita Tikaram. Nonetheless, this is unmistakably a Mark Isham recording. All the swirling, dreamy, atmospheric sounds are still present, but other colors are more prominent on Isham's sonic palette this time around.

Isham takes a classical, disciplined approach to the collection as a whole. Each piece has its own character yet stays within a set of limits, giving the record a family feeling. This is music of restraint, order, and balance but also of color and variety. Isham's trumpet tone is big and rich but always laidback and expressive.

The opening track, "Honeymoon Nights," demonstrates Isham's current style quite succinctly. He alternates between two contrasting ideas, beginning with a slow, lyrical trumpet solo accompanied by dreamy synthesizer pads and organ sounds (an Isham trademark) followed by a quietly joyous up-tempo section with intricate percussion accompaniment using woodblock-like sounds. Each reiteration brings greater development of the two ideas, and he ends with the most farreaching variations.

The next track, "I Never Will Know," establishes a similar yet distinctively different sound. Tambourine and cymbal sounds start it off and are followed by an expansive bass, organ filler chords, and acoustic rhythm guitar creating a warm sound that complements the rich, dark vocal quality of soloist Tanita Tikaram, the song's composer. A high-pitched percussion accompaniment continues throughout. Isham's trumpet interludes answer and decorate Tikaram's voice, matching her expressive quality with subtle dynamic inflections.

"Marionette" neatly evokes the ungainly feeling of a puppet with its angular, leaping melodic lines and loose rhythms. Isham's arrangement of "Blue Moon" is unusual, but it works well. A rather slow version, it features Tikaram's vocals against a harmonic accompaniment of woodwind and string colors and some wonderfully imaginative electronic sounds. Recurring touches of vibraphone add a sonic shimmer. "Songs of the Flying Fish" contains the sounds of humpback whales, courtesy of guitarist David Torn's guitar synthesizer. Even the bass imitates some of the low-pitched whale growls. Isham's lyrical trumpet solo flies freely on top of these exotic sounds.

Because of its pop style, this recording should appeal to a much wider audience than Isham has enjoyed before. It has an attractive, pleasant, poplike surface appeal, but for those with a keen ear, it offers delightfully refined colors with a clean, pure, unforced sonic quality. Steve Birchall



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