Audio

NOVEMBER 1988 • $2.50

RANGE ROVER PROJECT CAR

YAMAHA DSP-3000 DIGITAL SOUND FIELD PROCESSOR
THE PREMIER ENHANCER UNIT

CAD/CAM PROGRAM:
SPEAKERS BY DESIGN

TESTED
MEITNER PA-6i PREAMP
VERY LISTENABLE

DUAL CS 5000 TABLE/ ORTOFON X3-MC CARTRIDGE
INEXPENSIVE QUALITY

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Technics
The science of sound

Now you can experience surround sound and live to tell about it. Thanks to the technology found in the Technics SA-R530 A/V receiver. A receiver so advanced, it can help you get more out of almost every piece of audio and video equipment in your home.

For example, just hook up four speakers, and your VCR will have the added dimension of Dolby surround sound.*

Digitally-processed Dolby surround sound, to be exact. Which means the SA-R530 can give movies something even more impressive than the sound of most movie theaters. The sound of real life.

You'll hear footsteps creeping up behind you, cars screeching to a halt right in front of you, gunshots coming at you from every direction. In short, it's the next best thing to being there.

And to enhance the music on your CD player, cassette deck and turntable, there's also a special feature that lets you change your listening environment.

Press a button and the SA-R530 can simulate the acoustics of a small club; a theater; or even a concert hall. So finally, you can hear music in the environment where it was meant to be heard.

But even with sound this realistic — and a full 100 watts of power per channel (at 8 ohms, 20Hz — 20kHz with 0.007% THD) — our A/V receiver won't have you jumping out of your seat. For it comes with a remote control that also operates most other Technics audio components, as well as many brands of remote controllable TVs and VCRs. So no matter how complex the technology behind this receiver may be, operating it is surprisingly simple.

For your own free demonstration, just go to any Technics dealer. We think you'll find surround sound a lot more entertaining today than it was in 1876.

*Compatible video software required. "Dolby" and the double-D symbol are registered trademarks of Dolby Laboratories Licensing Corporation.

IN 1876, GEORGE CUSTER HAD A FREE DEMONSTRATION OF WHAT SURROUND SOUND WOULD BE LIKE IN 1989.

Technics Surround Sound A/V Receiver with Remote Control.

Enter No. 50 on Reader Service Card

Audio

NOVEMBER 1988 VOL. 72, NO. 11

Range Rover, page 72

Speaker Design, page 64

Meitner Preamp, page 140

Audio Research Amp, page 152

FEATURES

EQUIPMENT PROFILES

MUSIC REVIEWS

DEPARTMENTS

The Cover Subject: Range Rover project car.
The Cover Photographer: ©1988, Bill Ashe.

Audio Publishing, Editorial, and Advertising Offices,
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AUDIO (ISSN 0004-752X, Dewey Decimal Number 621.381 or 778.5) is published monthly by DCI, a wholly owned subsidiary of Hachette Publications, Inc., at 1515 Broadway, New York, N.Y. 10036. Printed in U.S.A. at Dyersburg, Tenn. Distributed by Warner Publisher Services Inc. Second class postage paid at New York, N.Y. 10001 and additional mailing offices. Subscriptions in the U.S., $19.94 for one year, $35.94 for two years, $49.94 for three years; other countries, add $6.00 per year.

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The Price Isn't Right

Dear Editor:

I am delighted to see that the days of CD rationing are over. The stores are filled with new releases, and the press is talking of a CD glut! Unfortunately, the prices of the discs have not reflected these new developments. There seems to be no explanation for this, except for the greed of the record companies.

As a consumer and audiophile, I am interested in hundreds of CDs. If their cost were to drop to a more reasonable $10 or $11 apiece, I would spend more, not less, on these little silver platters. Furthermore, a new legion of music lovers would jump on the CD bandwagon and permit us to retire the vinyl format forever.

It is time for the audio press and the CD-buying public to demand fairly priced digital sound. If the record companies are unable to see this for themselves, then we, their strongest supporters, must tell them.

Timothy Hanks
Minneapolis, Minn.

Avoiding Coincidence

Dear Editor:

Reading Edward Tatnall Canby's columns, "One-Point of View" and "Forced Coincidence" (June and August 1988), piqued my interest in the coincident versus spaced miking debate. As an audio professional who makes recordings for broadcast, I have had many opportunities for direct comparisons of miking techniques. The August column was rather startling to me because the unnamed public-radio recordist described by Mr. Canby reminded me of myself. In a public radio world that prefers coincident pairs as a miking technique, I unreservedly endorse spaced omnis.

I agree with Mr. Canby (and his anonymous friend in public radio) that the phase differences between microphones help the listener in mentally recreating the spatial acoustics of the original performance. I subscribe to the theory that an omnidirectional microphone is superior to a cardioid since any cardioid is designed to reject some sound waves reaching it, while an omni is not.

As Mr. Canby suggests, National Public Radio does advocate coincident miking techniques (specifically M-S) for member stations that make location recordings. To a station with small financial resources and no ear-training program, a "safe" mike technique such as M-S makes sense. However, as Technical Director for New York Public Radio, I have used spaced omnis for classical recordings for six years and have obtained excellent results.

Although the out-of-phase content of such recordings may be a problem for disc cutting, it can be broadcast on FM by carefully choosing and adjusting quality signal-processing equipment at the transmitter site. Furthermore, in this age of the CD, extreme left- or right-channel information, or even 180° out-of-phase information, is not a consideration at all. The major reason I prefer spaced omnis over coincident mikes is that they sound best in most circumstances. The phase cancellation problems caused by summing to mono are an entirely different issue and should not be cause for sacrificing the best stereo sound.

Christopher Czeh
Technical Director, WNYC
New York Public Radio
New York, N.Y.

Opening Musical Minds

Dear Editor:

The other day, I received a purely digital (DDD) Compact Disc of recorder concerti by Georg Philipp Telemann. As I lie back on my couch and listen to the first few tracks and gaze out my window upon the trees, I cannot help but think how ridiculous the argument against the digital medium is. I have suspected for a long time now that "old veteran" audiophiles are letting their bias toward the analog record cloud their thinking in regard to this format. I have heard all the arguments in favor of the record with respect to the CD, but I cannot agree.

If you analyze the situation, you will see a common thread among veteran audiophiles: A large percentage of them like to deal with things that are tangible, things that are easy to see, touch, or understand.

As a photographer, I would compare the digital medium to a film negative. All photographs are made up of grains of silver bunched together in varying densities. This is perceived as a photograph, which sometimes is more pleasing to the eye than the original scene. The CD is made up of microscopic bits of information which the ear perceives as music—no more, no less. Some people say that the harmonics produced by the clock frequency of the CD player and other frequencies of the source material can wreak havoc on the nervous system. This is pure hogwash, extolled by people who have nothing better to do than to analyze and rationalize everything, thereby missing the intrinsic value and beauty of life.

Please stop analyzing and start listening. You might let your defenses down and start enjoying yourself.

Robert DelGavio
Huntington, N.Y.

We Blush

Dear Editor:

I am pleased to note what appears to be a very positive trend in your record reviews. The regular reviews by Edward Tatnall Canby, Bert Whyte, and especially Frank Driggs are always valuable, due to the particular experience and perspective each author brings to his subject. The recent overview by John Sunier of Miles Davis' recording history (April 1988) was superb. As well, the July issue contains a review by Christopher Greenleaf which combines sufficient detail and historical background with a lucid and elegant style of writing.

As some of your readers may know, McMaster University established the first graduate program in music criticism in North America. It is for this reason that we are particularly interested in outstanding examples of this discipline.

Dr. Hugh Hartwell
Chairman, Dept. of Music
McMaster University
Hamilton, Ont.

Erratum

In the September 1988 "What's New" column, prices for the KEF Custom Series in-wall speakers were quoted in a potentially misleading way. The correct prices are $550 per pair for the CR200F two-way system and $550 per pair for the CR250SW subwoofers, not including installation.

Some of the Reasons

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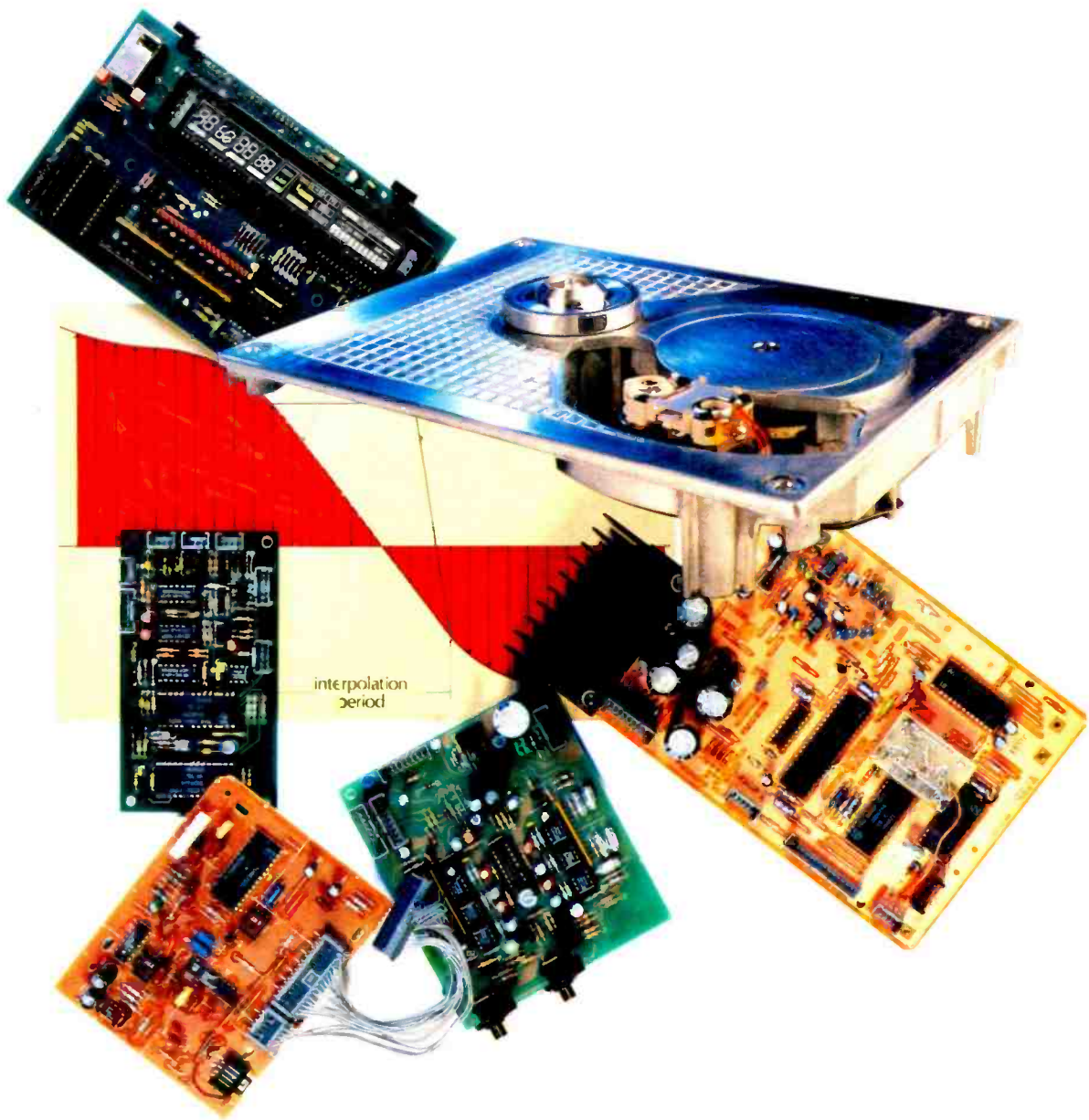
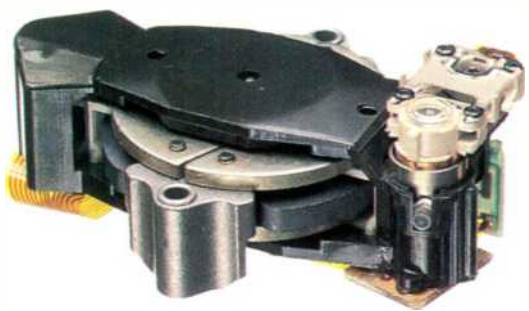


McIntosh®

MCD7007 Compact Disc Player

SOUNDS BETTER

With the MCD7007 McIntosh Compact Disc Player performance moves to a new pinnacle of cutting edge technological achievement and highest quality music reproduction. It introduces a new massive cast disc drive platform whose variable reluctance suspension system is adjusted and tuned to reduce or eliminate the impact of vibrations and shock and a low mass, and a new high compliance laser pen assembly. Every aspect of performance is improved: focusing and tracking, decoding, error correction, digital filtering, digital to analog conversion (converters are specially selected for matched channel to channel linearity). Even with dirty or damaged discs, even when the player is bumped or knocked, the music retains its surpassing purity. The full integrity of the sound is preserved beginning with the readout from the compact disc through to the gold-plated connectors on the output.



Laser Scanning Assembly
The McIntosh laser scanning assembly has more integrated electronics, and more compact mechanics with fewer parts. Lower inertia provides for even more accurate control, less friction, less wear, outstanding trackability and longer life.

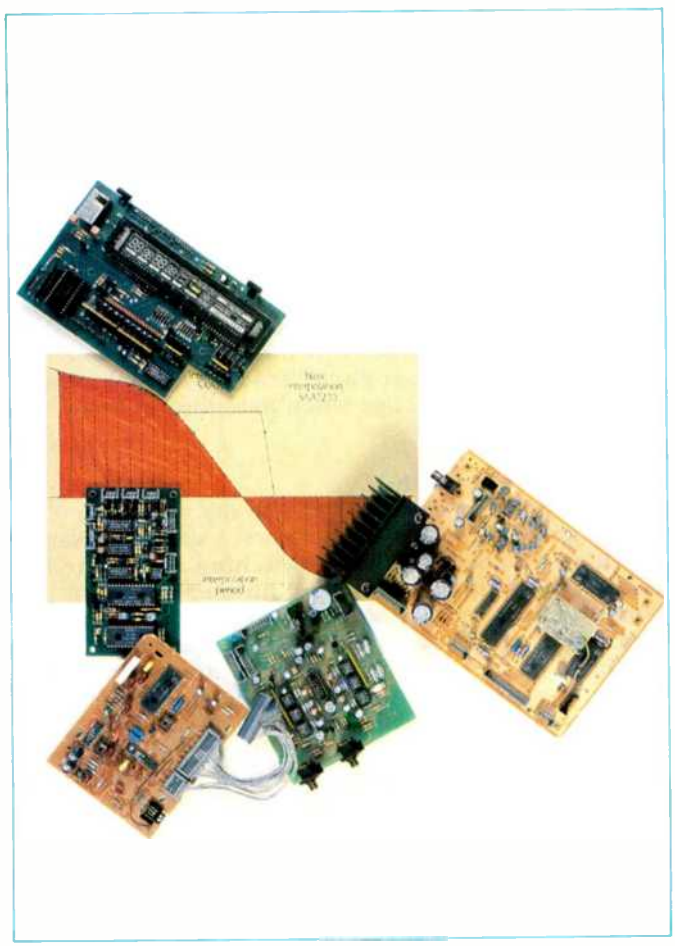
Trackability is the extent to which a player stays on track to read out all the encoded information on a compact disc. The McIntosh player is engineered to track better than others, even when the disc has deposits, fingerprints, scratches, etc.

A laser beam cannot sit in a groove. It has to be steered along a microscopically narrow track and held at the exact focal distance. The quality of the read-out depends on built-in trackability. The McIntosh solid-state laser unit avoids unnecessary bulkiness and complexity to insure ideal trackability.

The elegantly compact single beam laser pen is precisely balanced. It is held on track by a servo that responds to disc eccentricity or unevenness, has built-in compensation for varying disc reflectivity or changes of the laser, and remembers its proper position if atmospheric deposits, fingerprints, scratches etc. should interrupt the light beam. The focus servo is equally impervious to light variations, and it is exceptionally fast and accurate on the initial run-in where it is vital to establish the focal distance quickly. Better trackablility produces a higher quality readout, refined still further by superior error correction.

The new low mass laser pen accesses tracks faster and more accurately. Average access time is no more than 1 second. It's easier to skip tracks or indexes, forward or backward, to go to any required piece of music, or to find the exact point wanted within a music passage.

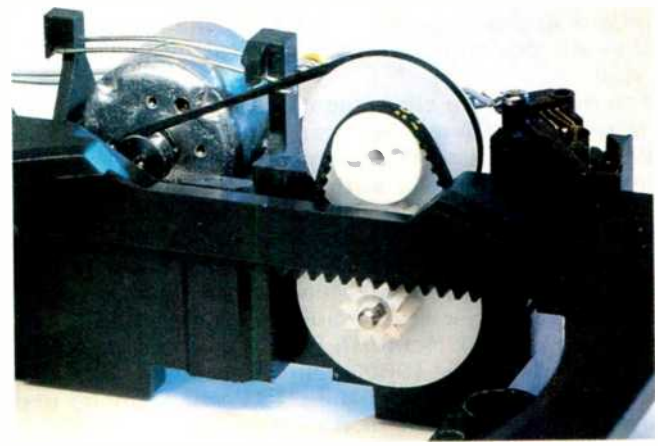
Maximum-strategy Decoding and Error Correction
The single-chip Decoder and Error Corrector achieves the maximum obtainable performance. The digital audio signal read from the disc is thus as clean and undistorted as it can possibly be, with scratched or soiled discs equal in quality sound to new ones.



Improved Digital Filter Reduces Audio Ripple, Increases Stop Band Attenuation
The quadruple oversampling digital filter now has 2 x 24 more taps. Ripple within the passband is reduced to an utterly inaudible level, and the stop band attentuation is more than a 120dB: both significant contributions to the extra sound purity. Enhanced soft muting ensures that there are no clicks or pops when starting, stopping or pausing, and smoothly silences any readout interruption too large for the error correction circuits.

Dual Digital-To-Analog Converters
The dual DAC-specially selected for high matched input to output linearity - incorporates separate 16-bit converters for left and right channels. There is no multiplexing, no delay time between channels, fully equal to 18 bit resolutions.

Laser Focusing and Tracking
Dual high-precision servos are integrated to a higher degree than ever, embodying many functions that have to be performed with discrete components in other players. For these functions, there is no wear, no deterioration with time, no adjustments to go wrong, a permanent improvement in readout accuracy.



- Motorized front-loading tray with illumination and anti-jamming protection. A touch on the drawer's front closes it for automatic play or standby for additional programming.
- 10-key pad selection of tracks, indexes or times for immediate programmed playback.
- "Music scan" auditioning with programming facility.
- Track or index replay: next track or back track to any previous or following track or index. Fast access.
- Fingertip random order programming of up to 20 tracks, indexes or time periods.
- 3-speed forward or backward music search. First two speeds with sound sampling for auditive search. Unique search protection during playback when laser reaches first or last track.

McIntosh®

C31V Audio/Video Remote Control Center

SOUNDS BETTER

Audio magazine's product review on the McIntosh C 31V AUDIO/VIDEO REMOTE CONTROL CENTER stated:

"McIntosh audio components enjoy a worldwide reputation that few others can claim. It has been said that once you become a McIntosh customer, you will remain one for life. . . Futhermore, judging by the internal construction, I would guess that it will continue to provide unimpaired service long after many other currently popular or highly publicized preamplifier/control units have been relegated to the trash heap. I know several audio enthusiasts who still own and swear by McIntosh products which they purchased in the early 1960's, and there's every reason to believe that owners of the C 31V will enjoy its performance well into the next century."

Cutting edge technology does not mean the sacrifice of versatility nor the abandonment of simplicity of operation. Proper engineering weds the two into usefulness with ease of use. Even though the back panel is populated with an abundance of connecting facilites the front and operating panel remains easy to use. Because it is self illuminated, it can be readily read in any light and the nomenclature is descriptive of functions.

Again to quote *Audio:*

"The C 31V has enough inputs (six high-level pairs, two tape monitor loops, two loops for external processors, and a low-level phono input pair) to accommodate numerous audio program sources as well as the audio signals from VCRs, TV monitors, and videodisc players. . . The two tape monitors, whose switching is also electronic, can be used for audio tape decks or for the audio from VCRs: also available in an optional video selector, the MVS-1, which automatically switches video signals along with the audio.

Overall volume level is adjusted by an electronically switched ladder attenuator, with left/right tracking accuracy controlled to a fraction of a decibel. In fact, in my test I could detect no difference in output level between channels at any volume setting from maximum to 70 dB below maximum."

"The loudness-compensation control is independent of the volume control. In any audio system, correct compensation depends on many variables besides volume-control setting, including recorded level, output level of the signal sources, amplifier sensitivity, speaker efficiency, and room acoustics. The C 31V's design allows you to dial in the precise degree of compensation needed for low listening levels in your particular system.

Instead of tone controls, the C 31V is equipped with a five-band equalizer. A built-in headphone amplifier feeds a front-panel headphone jack, and all controls are effective when listening to headphones."

Audio concludes with:

"After hooking up the C 31V to my reference power amplifier and loudspeakers, I was impressed by the total absence of any switching noise, the inaudible background noise and hum-level - even when no program material was present to mask it - and the accurate and totally transparent musical qualities of this preamp. I listened to a variety of program sources, but frankly, the majority of my listening was done using some of my newer CDs. . . . McIntosh, too, has adapted itself perfectly to the requirements of the new, digital program sources. Even a brief listening session with the C 31V will convince you, as it did me, that there's nothing behind the times about the good folks who turn out those magnificent McIntosh components, year after year, for all of us to enjoy."

Handcrafted with pride in the United States by dedicated, highly trained craftspeople.

McIntosh®

MC7270 Digital Dynamic Power Amplifier

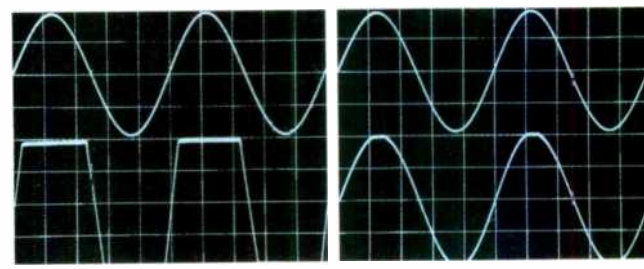
SOUNDS BETTER

The McIntosh MC7270 is the first and only amplifier specially designed to fulfill Digital Dynamic Range demands. It outperforms all others when listening to sound derived from digitally recorded tapes, records and compact discs. The MC7270 has been designed to perform flawlessly because of this capacity for overload: **10 decibels of overstress at less than an average of 0.3% of distortion!**

The noise level of digitally recorded sound is 30 decibels below that of analog recordings. The compact disc is capable of **real life dynamic** range while noise generated from compact discs is inaudible. With the noise restraint removed it is both easier and dramatically more enjoyable to listen to music at much louder levels. To fully enjoy this new capability your amplifier must be able to receive three to ten decibels of overstress from music, and it must do this without severely distorting the sound!

For an amplifier to handle a three-decibel overload, it must have a full time capacity of twice its full power, 10 decibels is 10 times the full power capacity of an amplifier. To provide 2500 watts of overload for a 250 watt amplifier is expensive both in the amplifier and in the loudspeaker system as well. This is the real world of Digital Dynamics Range demand. How to achieve the performance demanded, which often lasts from minutes to only a few thousandths of a second, and to achieve the goal economically, is a real achievement. Power Guard is that achievement.

If good enough will do, there are at least 100 answers for you. But if the best is what you need then there is only one real answer . . . the amplifier that in 40 years has outlived 60 others who have simply faded away.



Without Power Guard: top wave form is the input to a power amp. It exceeds input rating by 10 dB. Lower clipped wave form is the output of a typically overdriven amplifier.

With Power Guard: top wave is the input, overdriven by 10 dB. Lower wave form is the output with Power Guard. Power Guard provides an unusual margin of safety for loudspeakers by the prevention of amplifier clipping yet permits the MC7270 to deliver designed maximum power. You get music, not distortion.

The McIntosh autotransformer provides the output transistors an ideal load and is the path that conducts any DC away from the loudspeaker. It also contributes a versatility in loudspeaker connecting capability not otherwise possible. In stereo, the McIntosh autotransformer perfectly matches the output circuit to 1, 2, 4, or 8 ohms. In mono, (McIntosh stereo amplifiers can be interconnected for mono and deliver twice the power) the autotransformers provide matching 2, 4, 8 or 16 ohms.

It is no accident that a McIntosh is a better investment.

It sounds better
It is more reliable
It lasts longer
Its resale value is the highest

Handcrafted with pride in the United States by dedicated, highly trained craftspeople.

McIntosh®

XRT18 Loudspeaker System

SOUNDS BETTER

The McIntosh XRT 18 system produces sound images that are amazingly life-like. You'll hear stereo images that have depth and space dimensions that are so realistic, so satisfying that you will feel aware of the dramatic emotional intensity of your first experience of live music.

This miracle of sound recreation does not happen by accident. To reproduce the power, the clarity, and the pure musical expression of a triple fortissimo it takes a lot of individual speaker mechanisms. All of these must be coordinated in time and intensity to achieve the uniformity of sound field from left and right, to produce sound images, wide, deep, accurate, realistic and satisfying. How we combined all of these radiators in the correct combination of pairs of radiators, controls of energy and time is the story of the XRT 18 system.

The many ways to connect 16 (per side), high frequency radiators, the many combinations of time control, energy control and radiator pairs must be explored to unlock the secret of the XRT 18 performance is truly amazing and could never be explored in several lifetimes by trial and error. Only by using mathematical processes could all of the possibilities by analyzed in search of the one right solution.

The complete mathematical expression for any point in the sound field of these systems contains 128 terms! This equation, to achieve even sound spectrum, required a solution for each five degrees of elevation and each *five degrees of azimuth in front of and to the sides of the speakers.* Every term was varied to search for the optimum combination. In all, some 92 million calculations were made. This effort would have taken years on an advanced desk top scientific computer. It required 91 hours of calculations by a super digital equipment computer to unlock the secret of the one of these millions of possible solutions!

The core of the concept of the XRT 18 system involved not only the usual guidance from years of experience and the intuitive vision of a new possibility, but in this case it centered, as well, around a one and only choice from hundreds of possible cones, suspensions, magnets, magnetic assemblies, crossover network components, enclosure volume, stiffness and geometry. That one critical choice is an optimized interrelatedness which yields, via computer modeling, the extra smoothness of the time and energy response fields which has eluded researchers for decades.

XRT 18 Available in Oak, Walnut or Satin Black. Bass Cabinet: Select veneer protected by a multicoat, satin lacquer finish covering ¾" (1.9 cm) high density partical board with internal bracing, airtight assembly. Tweeter Column Array: Machined from solid Walnut or Oak, protected by a multicoat, satin lacquer finish, CS 18 Tweeter Stand (accessory): Mouldings machined of select solid oak or walnut.

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Tube Receiver With Solid-State Equipment

Q. I recently acquired an old tube-type H. H. Scott receiver. The AM section works quite well, outperforming my newer tuner's AM section. If I wanted to use only the tuner section of this receiver with my stereo system, could I hook it up to my integrated amp without causing any problems?—Gary Semnoski, Southington, Conn.

A. You can connect the Scott receiver to your present gear by using the tape outputs on the Scott to drive one of your amp's high-level inputs. If the receiver is monophonic, use a Y connector between the tape-out jacks and the high-level stereo inputs on your integrated amp.

The amount of signal produced by tube equipment is higher than is usual for all solid-state gear except for some CD players. This means you must turn down the volume before switching to this program source. It is possible that the tube equipment's signal will be sufficient to overload the circuitry ahead of the integrated amplifier's control volume. If this happens, place an attenuator between the Scott and the inputs of your equipment. (These attenuators are available because of overload problems with CD players.)

Speaker Fuse Size And Amplifier Power

Q. I have a receiver capable of 50 watts per channel, and my speakers are rated at 6 ohms impedance. I notice that the back of my amp has speaker fuses rated at 5 A/250 V. Does this mean that only 5 amperes of power flow through my speakers, even though my amplifier can produce 50 watts? Will this be enough power to permit my speakers to reproduce very low frequencies, even though the impedance of my speakers dips well below 6 ohms?—Gary C. Powell, East Orange, N.J.

A. Because power is measured in watts and not amperes, the 5-amp fuses will work well. If 5 amperes were fed into your loudspeaker, it would mean that (at 6 ohms) about 180 watts of power would be supplied.

If your system provides you with sufficient volume and bass, there is no need to make changes. The fact that the impedance of your loudspeakers falls at low frequencies will not come into play. If you have enough overall volume but lack bass at really low frequencies, you may be able to improve this somewhat by adding an equalizer—which is much less expensive than replacing your amp.

Wow and Flutter With Digital Recordings

Q. I have read various equipment reviews of CD players and, recently, of a few DAT recorders. I would like to know why wow and flutter specifications are not listed for these devices but are listed for turntables and cassette recorders. Is it possible that CD players and DAT recorders have no wow and flutter?—Wesley S. Mayeda, Oxnard, Cal.

A. Yes! It s true that CD players and DAT recorders don't have wow and flutter. Because of the digital format, slight speed variations of their mechanisms are not reflected as the small changes in musical pitch which we call wow or flutter. Even severe speed variations will not result in such pitch changes. Rather, these fluctuations will cause dropouts or other sounds that are not program related.

The reasons for this are difficult to explain. Remember that analog systems are very direct. The pitch of the music relates directly to the lengths of the magnetic fields impressed on tape or the lengths of successive LP groove undulations. A wave's frequency depends on the length and velocity at which it passes the playback head or the stylus. You can see that speed variations must change the wave's frequency, which the ear perceives as a change in pitch.

With digital recording, wave information is not directly set down on the tape or disc; only a string of numbers is stored. When a sufficiently large group of these numbers has been "studied," the nature of the waves can be reconstructed. Speed variations will increase or decrease the quantity of numbers being detected. To oversimplify, there is a clock in the CD player or DAT recorder which must be in step with the material being reproduced. Each number is presented for a given amount of time (a matter of microseconds). Slight speed variations will still permit the clock to receive the pulses and recognize them. If the speed change is too great, however, the clock may get ahead of (or fall behind) the stream of numbers. This can cause errors, but they will not be heard as wow and flutter.

Loose Speaker Mounting Screws

Q. Can acoustic suspension speakers be harmed by occasional, but not extreme, tightening of all the driver mounting screws? I serve as a DJ at dances and notice that, after long periods of loud bass, the mounting screws seem unusually loose, so I tighten them cautiously. Will this cause trouble?—Alan Harper, Seattle, Wash.

A. There is no harm in tightening speaker mounting screws. If they are coming loose, and you permit them to do so, eventually the drivers will separate from their mounts and perhaps be damaged when they fall.

Be sure that you tighten these screws evenly, however. Do not tighten one fully and then go on to the next. Rather, tighten each screw a bit, working your way around until you have tightened all of them securely.

I do wonder why the screws are loosening in the first place. Have any of the drivers been replaced, and were lock washers lost in the process? If the drivers are mounted with nuts and bolts, lock washers are important. If the screws are wood screws, perhaps the holes into which they fit are stripped. Fill the holes with plastic wood and re-drill them when the plastic wood has set.

Setting Component Levels

Q. I recently purchased a component system for my car, consisting of a tuner/cassette deck, an equalizer, and a power amplifier. The system sounds great! I am not sure, however, that I am getting the best sound possible from it, because each piece of equipment has its own level controls. The tuner/cassette deck has output adjustments, the equalizer has both input and output level controls, and the power amplifier has input level controls.

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

If you can get adequate volume without background noise or distortion, your system's level controls are probably set correctly.

My problem is that I do not know how to set these levels for optimum performance, and the owner's manuals do not provide explicit directions. Please give me an accurate way to set the level controls. How important is it for these controls to be set correctly?
—Kevin Miller, Lenoir, N.C.

A. I do not have an absolute answer to your question, though I don't believe that these settings are critical. If the controls you mention are not properly set, you may have some background noise even with no signal present, or you may experience distortion even when the power amplifier is not driven to anything like maximum power. On the other hand, you might discover that all of the controls can be set wide open with no problems. What *could* happen, in that event (even if the sound is clean), is that the actual volume control might be touchy; turning it up to perhaps one-third of its full rotation could produce more volume than you want.

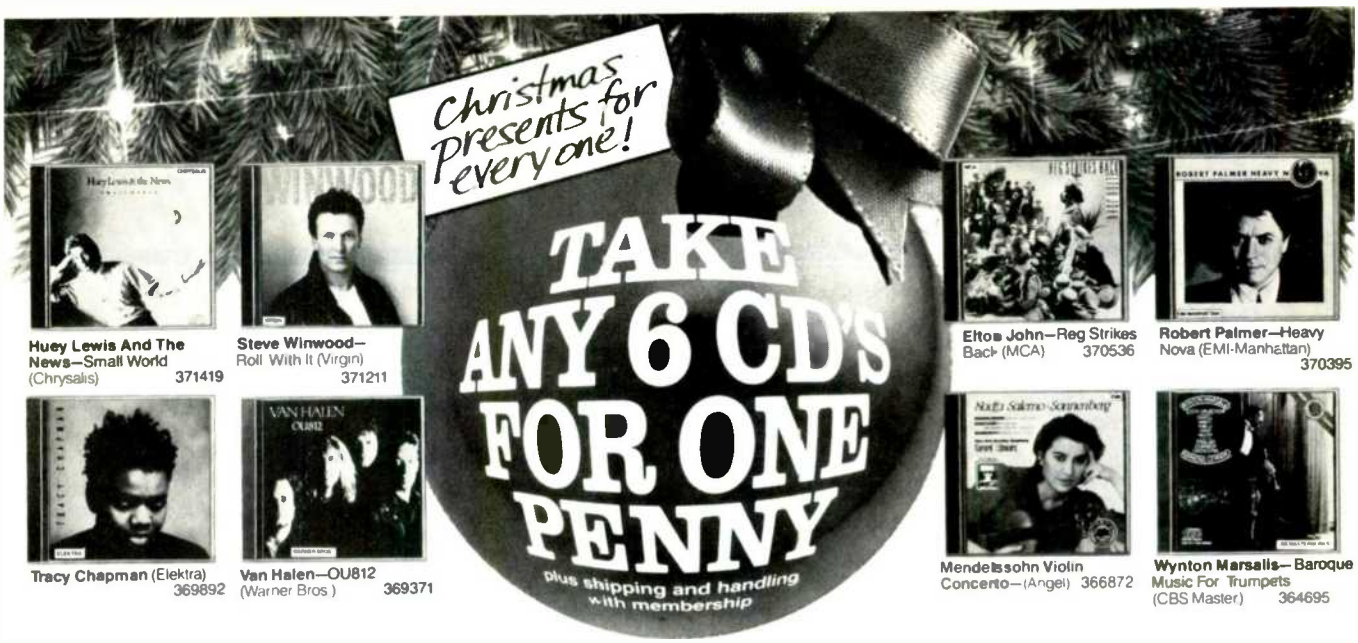
If your volume control works properly, if you don't hear background noise in the absence of a signal, and if you can drive your system to as loud a listening level as needed, you probably can leave well enough alone.

If faced with your problem, I would start out this way: I would turn down the input level control on the equalizer to a point where I could no longer produce enough volume from the speakers. I would turn up the cassette system until it became distorted. (Of course, that might not even happen.) Then I would back its volume control down to a point where the sound once again was clean, and then back it down just a bit more so that "super hot" program material would not cause distortion.

I would next turn up the equalizer's input level control until I once again had as much sound as I could stand. Then I'd turn down the equalizer's output level control so that I could not obtain enough volume from the speakers (as with the input control). I would next turn up the input control on the equalizer (with the equalization settings I found useful), listen for distortion, and then back the input down until that distortion cleared up.

Next, I would do the same with the equalizer's output controls. I would turn down the amplifier control until the sound level was too low, and then I'd advance the equalizer until I heard distortion. (You might never hear any; this will surely be true if the output volume control is located right at the output terminals and if the level controls on the power amplifier are located right at the input.) If you do, continue as above.

If no distortion were heard, then I would back the equalizer's output volume down somewhat, perhaps to a bit more than half open, and advance the level controls on the power amplifier until I had enough volume, without overdriving the power amplifier.



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Van Halen—OU812 (Warner Bros.) 369371

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TAPE GUIDE

HERMAN BURSTEIN

Bass Loss in Duplicating

Q. In order to duplicate my collection of prerecorded tapes so I could use them in my office, I recently purchased a second cassette deck. In duplicating tapes, however, I seem to lose bass, whereas the high end appears to be faithfully reproduced. Is this bass loss inherent in dubbing, or can I remedy the situation? I do not have a problem with bass response when recording from discs on my new deck.—Paul Burstein, Milwaukee, Wisc.

A. If you lose bass response when dubbing from tapes but not from albums, this suggests that the fault lies in the deck being used to play the original tape. Conceivably, there also may be some loss occurring in the recording deck. It could be that the loss is sufficiently small in each deck so as not to be noticeable, but that the sum of the losses becomes apparent.

In playback, you could compensate for the loss by using the bass control of your audio system, or by using an equalizer. Alternatively, an equalizer could be used in recording.

Most preamplifiers (or integrated amplifiers or receivers) do not permit one to apply equalization to the signal fed to a tape deck for recording. If yours is the rare exception, you could apply bass boost to the signal being recorded in this manner. If not, you'll find that many equalizers can be switched to affect the frequency balance of the signals at their tape-output jacks.

Test Frequencies

Q. Why is 400 Hz used for level adjustments and 15 kHz for other adjustments?—Wayne J. Jernigan, San Diego, Cal.

A. In cassette recording, for the purpose of having a reference such as Dolby level (200 nWb/m) or DIN level (250 nWb/m), it is desirable to employ a frequency that not only corresponds approximately to the point where we find maximum energy in typical audio material, but is free from the substantial treble boost which occurs in recording. A frequency in the neighborhood of 400 Hz (used by Dolby) or 315 Hz (DIN) meets these requirements.

The Dolby reference is used for matching the recording and playback levels—essential in order to avoid treble aberration. The DIN reference is employed for measuring S/N ratio and obtaining figures for THD at various recording levels. Also used for these two purposes is the recording level which produces 3% THD at 400 or 315 Hz. Use of these frequencies, rather than one that is much lower or higher, produces a more realistic representation of what we hear.

Bias adjustment, to obtain substantially flat response, is achieved in some decks by using two frequencies. One is 15 kHz or thereabouts, and the other is much lower. Bias is adjusted for equal playback response at both frequencies. In the case of azimuth adjustment, a test tape with a high frequency is needed because azimuth becomes more critical as frequency rises. Therefore, 15 kHz or so is used for azimuth adjustment.

Dynamic Range

Q. I recently acquired a CD player and have questions about taping CDs. I have heard that the great dynamic range of CDs may pose problems for taping. Are there any special amplification or other requirements presented by CD players? I also heard recently of "digital-ready" tape. Can you enlighten me as to whether it would be helpful in taping CDs?—Stuart Munro, Melrose, Mass.

A. With a good cassette deck that incorporates Dolby C and/or dbx noise reduction, and with high-quality tape of any type, generally there should be no problem in satisfactorily taping CDs. Seldom is the dynamic range of music in excess of about 70 dB. (In fact, when the range does become this great, it tends to become a nuisance in the home and, especially, in the car. Soft passages are difficult to hear without the loud passages becoming thunderous.) With Dolby C NR, a good deck can achieve a signal-to-noise ratio, and therefore a dynamic range, of around 70 dB. With dbx NR, this figure goes up into the 80s and sometimes gets close to 90 dB. If a deck has only Dolby B NR, there may be a problem at times, depending on the source material, inasmuch as the S/N ratio is then around 60 dB.

I don't believe that CD players really present new problems with respect to amplification or anything else. "Digital-ready" tapes for analog decks fall into the category of marketing hyperbole. High-quality tapes are already able to cope with CDs.

Left-Channel Decline

Q. Recently I have had a problem with my cassette deck when recording from any source. If I set both the left and right record-level controls to the same point, in playback the meters seem to show a relative drop in level of the left channel. The meter for the right channel shows the same reading in playback as in recording. Therefore, in recording, I have to adjust the left level control to a higher setting in order to get equal playback readings for both channels.

I sent the deck to a factory service center, and it came back with a note saying that they found nothing wrong. I know, however, that the problem didn't exist 2½ years ago, when I first got the deck. Apart from this problem, I am very happy with the quality of my recordings. Thinking that perhaps the head is getting old, I have considered having it changed. If I do, will this new head match the azimuth of the original?—A. Harrison, Nashville, Tenn.

A. The gain of the left playback channel may have dropped for some reason, such as a change in the characteristics of a transistor, potentiometer, resistor, etc. It could also be that gain has dropped in the left recording channel at a point following that from which the signal is fed to the record-level meter. Another possibility is a change in the value of a component that affects the reading given by the left meter in playback. Least likely is the possibility that the tape head's left channel has changed its characteristics. You probably have nothing to gain by changing the head, and a good deal to lose in the way of cost and possible head misalignment. Note that azimuth alignment takes place after the head has been installed, and is done by means of a test tape bearing a high-frequency tone. The head is ad-

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justed for maximum output of this tone in playback.

I would opt to live with the problem, making the necessary adjustments in recording or playback, provided the decline in the left channel is less than about 3 dB. However, if the left channel's decline is serious, you should get the deck to an authorized service shop which has a good reputation. Be prepared to show clearly and briefly that the problem does exist—don't simply describe it. Not all service shops are eager to spend time watching the customer demonstrate the problem. But that is your right.

A Formula Explained

Q. In the October 1987 issue, you state that the turnover frequency of an RC (resistance-capacitance) circuit can be obtained from f = 159,155/μS. Where does this come from?—Charles Warwick, Anaheim, Cal.

A. We start with the formula for impedance (capacitive resistance) of a capacitor:

$$Z = \frac{1}{2\pi fC}$$

where Z is impedance, π is 3.1415927, f is frequency in Hz, and C is capacitance in farads. (For the derivation of this formula, see an advanced physics textbook.) Using μF (microfarads, or millionths of a farad) instead, and inserting the value of π, we obtain:

$$Z = \frac{1{,}000{,}000}{2 \times 3.1415927 \times f \times C}$$

$$= \frac{159{,}155}{fC}$$

In an RC circuit, the turnover frequency f occurs when R and Z are equal. At this frequency, the amplitude response will have risen or fallen, depending on the circuit, by 3 dB. Thus, at f we find:

$$\frac{159{,}155}{fC} = R.$$

Transposing terms, we get:

$$f = \frac{159{,}155}{RC}$$

where f is frequency in Hz, R is resistance in ohms, and C represents capacitance in μF.

The product of R × C, or simply RC, is called a time constant and is given in μS (microseconds) when C is in μF. RC denotes the time required for a d.c. current to charge C through R to 63.2% of the charge ultimately reached by C (as explained in physics textbooks). Whatever the individual values of R and C, so long as their product remains the same, the charging time stays the same. (For example, charging time is the same if R is 100 and C is 10, or if R is 20 and C is 50.) Hence the term time constant.

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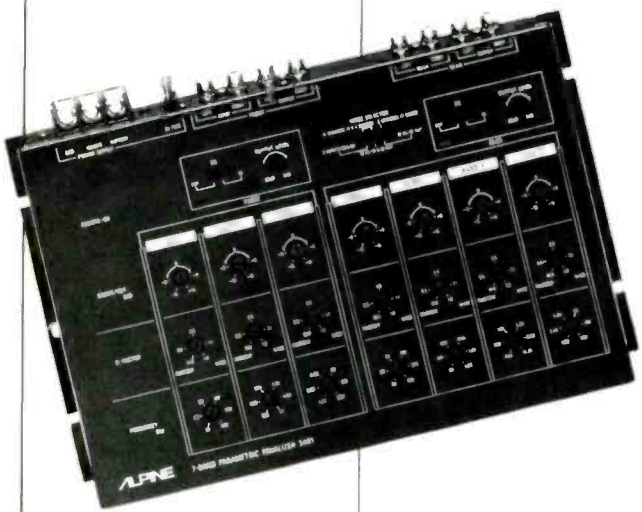
Sansui CD Changer

The CD-X510M uses two magazine cartridges, each holding six CDs, for a 12-disc total capacity. Cartridges operate independently, which permits reloading of the cartridge not in use while playing discs from the other. The unit has complete random programming as well as a Variable Music/Intro Scan feature that allows previewing the first 1 to 59 S of each selection. The design of the CD-X510M uses dual D/A converters and two-times oversampling digital filtration. A remote control is included. Price: $630.
For literature, circle No. 100



Alpine Car Equalizer

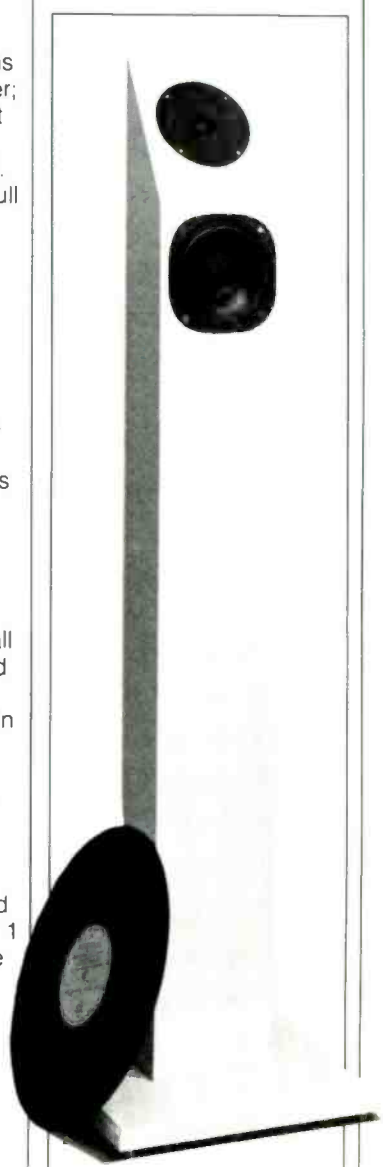
Designed for trunk mounting, the Model 3401 is a true parametric equalizer, with screwdriver-set, adjustable center frequency and Q (bandwidth) as well as boost/cut for each of its seven bands. The 3401 can be configured to use all seven bands for one pair of channels or to provide three bands for the front channels and the other four for the rear. In the latter mode, it can provide separate front and rear equalization from either a single stereo signal or from separate front and rear signals. Output levels can be independently adjusted for both front and rear, and both front and rear equalization can be switched in or out independently. The filters can be adjusted for center frequencies from 20 Hz to 22 kHz, in overlapping ranges. Price: $500.
For literature, circle No. 101

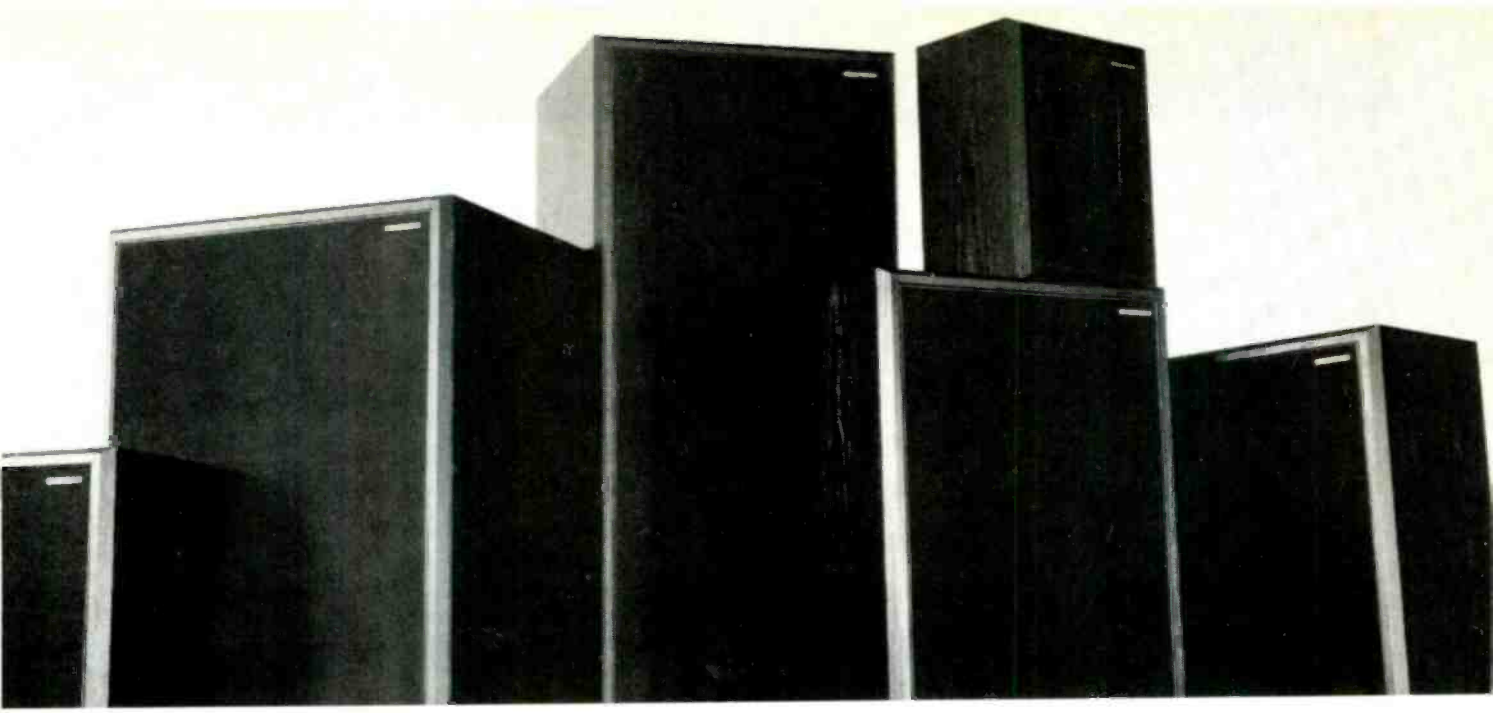
NEC Surround-Sound Decoder

In addition to Dolby Pro-Logic Surround, the PLD-310 offers three modes of processing. "Normal" steers the audio signal to left, center, right, and surround channels. "Phantom" mode is intended for audio systems not using a center speaker; signals are directed to left and right channels to simulate a center channel. "Wide" mode generates full frequency response in all speakers. The PLD-310 uses a 20-mS digital delay and includes a wireless remote control. Price: $449.
For literature, circle No. 103

Delaware Acoustics Loudspeaker

The Delac S10 is a two-way, three-driver system using two 4½-inch woofers (one rear-mounted) and a ¾-inch, ferrofluid-cooled tweeter. Special compensation circuitry is used to enhance bass response below 40 Hz. Tall and narrow, the sand-filled S10 cabinet minimizes floor-space requirements in the listening room. The crossover is a computer-optimized, near minimum-phase design, with connections for bi-wiring and biamplification. Impedance is 4 ohms, and sensitivity is 85 dB SPL at 1 meter for 1 watt input. The S10 is available in a wide assortment of colors and veneers. Price: $499 per pair, $599 in veneer.
For literature, circle No. 102





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Because we know today's listener will be tomorrow's listener, too. See your American Acoustics dealer soon and hear the future.

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Enter No. 4 on Reader Service Card

Mitsubishi Dual Cassette Deck

Along with cassette-to-cassette dubbing capabilities, the MT-4100 includes an automatic cassette changer for two-sided playback of up to

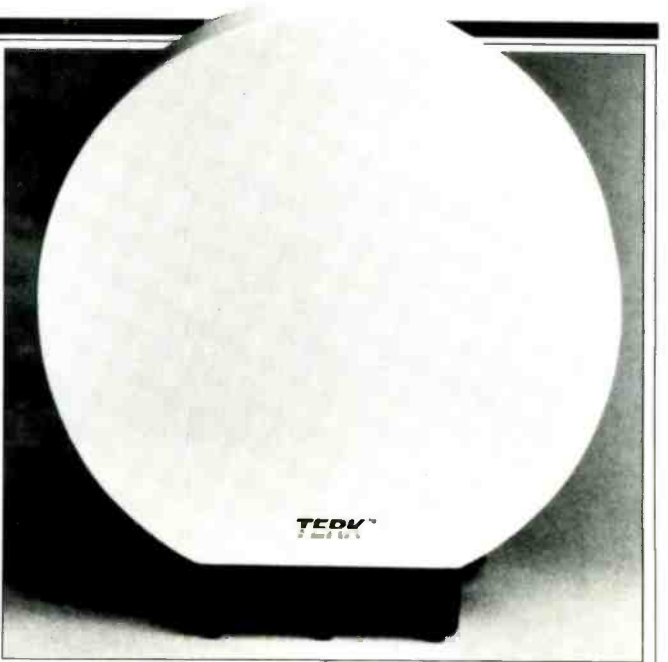
seven cassettes. The model also features programmability of up to nine selections and music search for quick access to specific tracks. A blank-skip function automatically activates fast-forward after 10 S of blank tape has passed. Dolby B NR is included, along with automatic bias switching. Price: $349.

For literature, circle No. 104

Harman/Kardon Removable Car Stereo

Featuring a removable, pull-out chassis, the CR 151 is a 12-watt-per-channel AM/FM receiver and cassette deck with digital-synthesized quartz-lock tuning, automatic noise suppression, and six AM and 18 FM presets. The cassette player uses the same heads that appear in Harman/Kardon's home decks and incorporates a dual-azimuth-adjust head assembly. Additional features include mechanical tape load, auto-replay, music search, and Dolby B and C NR. The CR 151 has 0.1% wow and flutter and response of 20 Hz to 18 kHz, ±3 dB. Price: $659.

For literature, circle No. 105



Terk FM Antenna

Approximately the same size as a Compact Disc, the Pi FM antenna uses a low-noise design created by Larry Schotz and provides up to 30 dB of gain. A 75-ohm shielded cable carries power to the antenna and signal to the FM tuner. Price: $85.

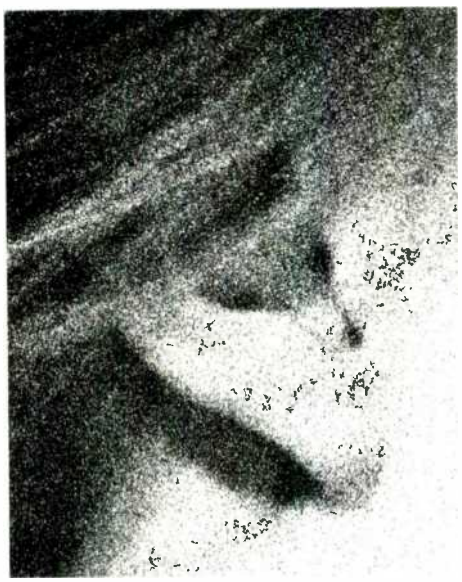
For literature, circle No. 107

Signet Headphones

The EP400 is a moderately priced headphone which uses a high-flux samarium cobalt magnet together with oxygen-free silver/copper wire for the voice-coil winding. Oxygen-free copper wire also is used in the 10-foot audio cord. The EP400 has an adjustable double headband system for maximum comfort and even distribution of weight. Rated response is 20 Hz to 22 kHz. Price: $100.

For literature, circle No. 106

Who we are. And how you can hear the difference.



NAD is the world's leading designer of reasonably priced audiophile-quality stereo components. From enormously powerful amplifiers to modest-appearing receivers. From unique multi-CD players to advanced tuners and cassette decks. NAD equipment is the best in design and performance, in value, in ease and simplicity of operation, and in genuine usefulness of features.

But there are so many good components out there, you might say. Well, consider this. Designed in Boston and London by American and European engineers, NAD equipment happens to be the insider's choice. It is the equipment secretly owned by the technicians and staff of other audio companies. It is the equipment those companies' engineers recommend to, and buy for, their parents, grandparents, even their in-laws. It is the equipment that journalists and audio-society members get for themselves. In fact, NAD has become the ovewhelming choice of the most knowledgeable consumers.

Why? Because it performs brilliantly, it sounds superb, it's rugged and reliable, and it is utterly easy to understand and use.

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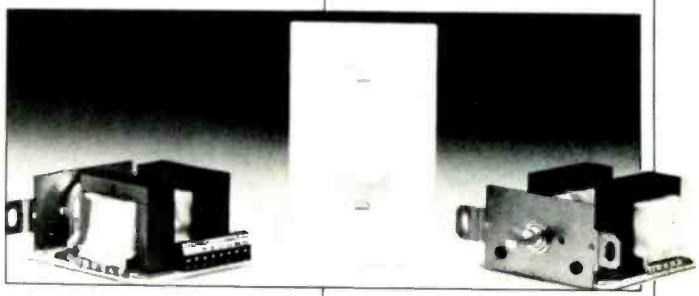
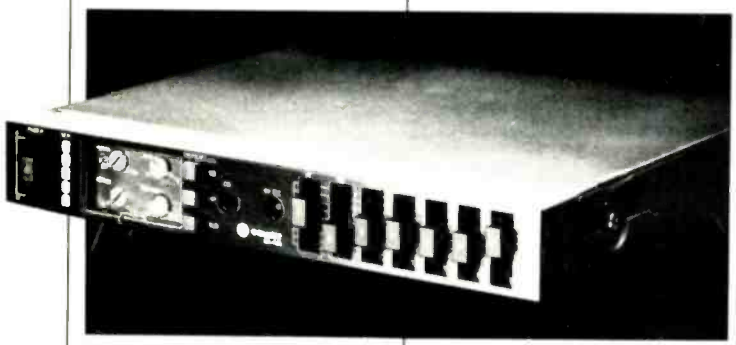
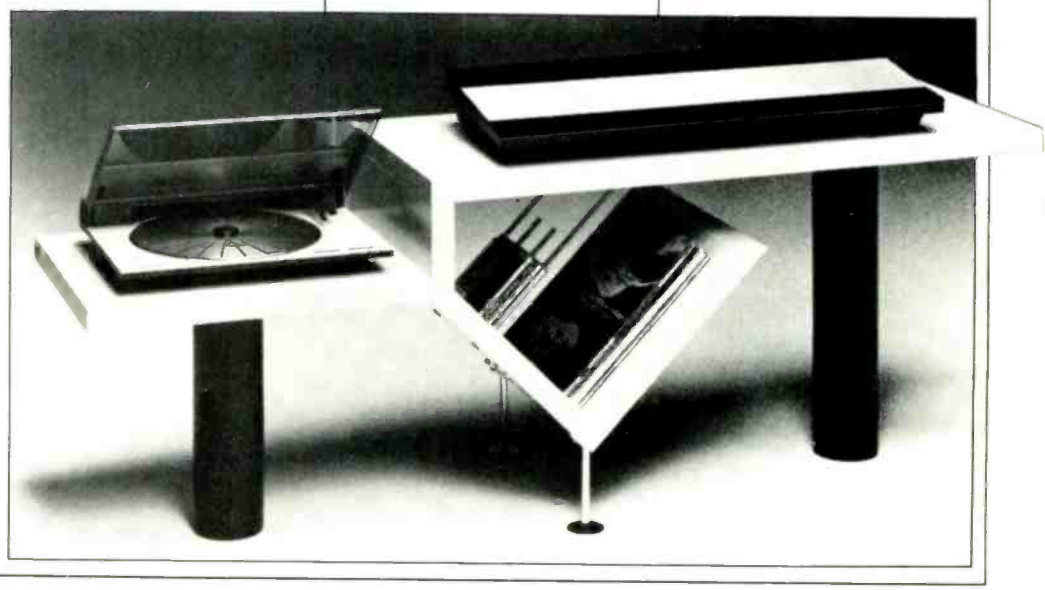
Audio Dynamics Tuner
Sleekly styled, the T-2000E features Schotz noise reduction and preset memories for 10 AM and 10 FM stations. Usable FM sensitivity is 11.2 dBf; sensitivity for 50-dB quieting is 16.2 dBf in mono and 40 dBf in stereo. Other specifications include capture ratio maintained at 1.5 dB for all signal strengths from 25 to 65 dBf, and separation of 30 dB across the audio band. The remote control supplied with Audio Dynamics' CA-2000E amplifier can operate the tuner, too. Price: $349.
For literature, circle No. 110

Sonance
In-Wall Volume Control
Said to be the first high-quality volume controls designed for in-wall installation, the VC100 (shown) and VC50 use inconspicuous, standard light-switch wallplates. Using auto-transformers instead of L-pads or commercial transformers, the controls can handle 100 or 50 watts per channel, respectively. A matching speaker switcher is also available. Prices: VC100, $70; VC50, $60; ABW1 switcher, $30.
For literature, circle No. 109





Coustic Car Equalizer/ Crossover
The crossovers built into many car equalizers have only a limited range of adjustment. The one in Coustic's EQ-1100 has high- and low-pass filters whose crossover points are independently adjustable from 32 to 400 Hz. In addition to its seven-band equalizer section, the unit also has both a front-panel input for portable CDs and a 9-V d.c. output to power such portables; input automatically switches to the CD jack when a signal is detected there, and switches back to the main inputs when the signal stops. Price: $199.95.
For literature, circle No. 111



Bang & Olufsen Cabinet
The Attyca 2 allows components and recordings to be on convenient open shelves while signal and power cables are concealed in grooves. Excess wiring and speaker cables can be stored in the support legs, which are available in chrome or matte black. Price: $685.
For literature, circle No. 108


There's a revolution going on
in CD changers.
SONY

Once again, Sony is changing the way people listen to Compact Disc.

The best ideas are often the simplest. So, when Sony engineers set out to establish a new standard of performance in compact disc changers, they found an ingenious solution that, in hindsight, seems obvious. The carousel. Sony engineers saw in the carousel a classic engineering design with inherent advantages that make it ideal for CD changer operation. This includes ease of loading, fast access time, and high reliability.

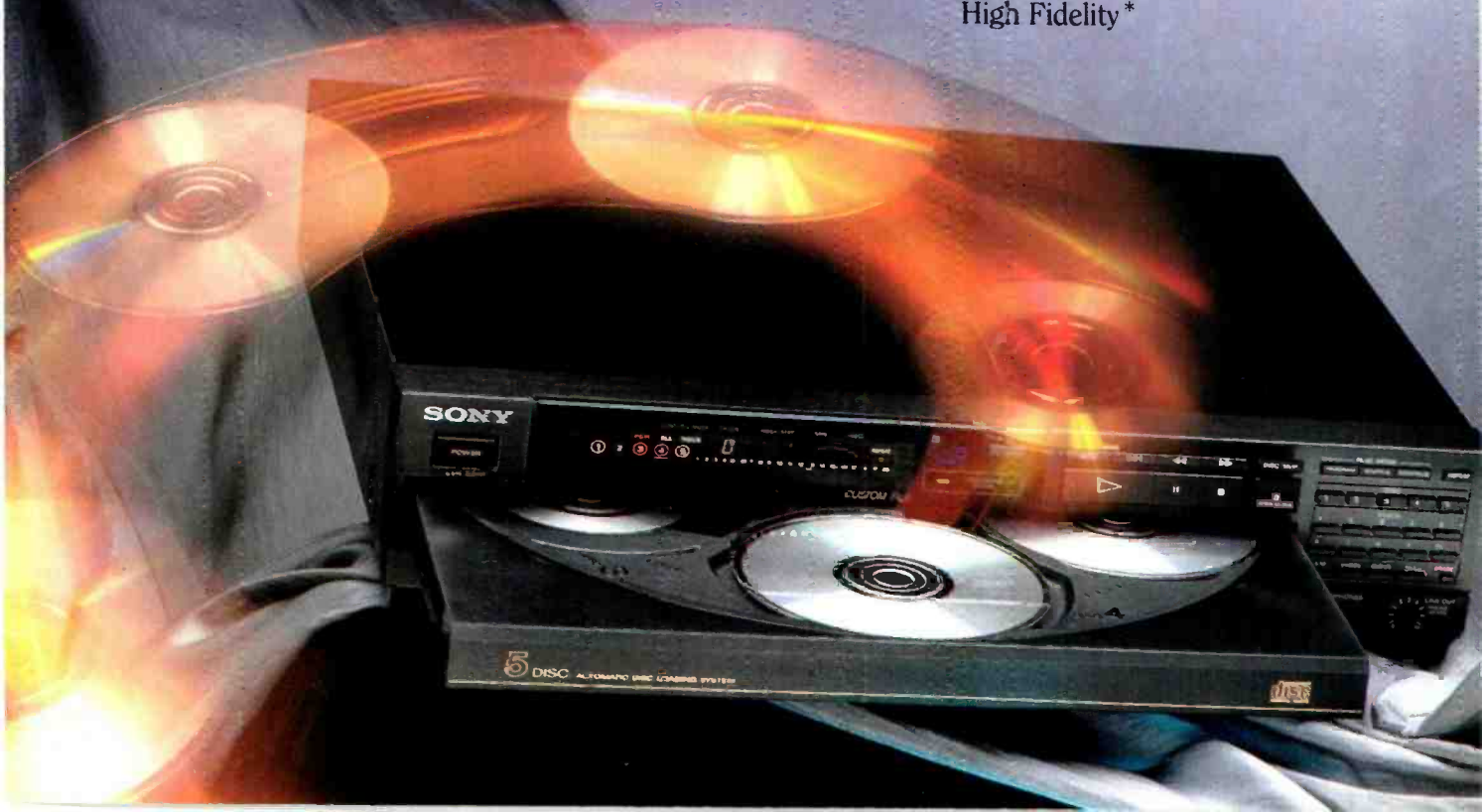
The exclusive Sony DiscJockey® carousel design: an open and shut case.

Sony carousel CD changers do not require a magazine or cartridge. So loading a disc is simple. You just open the drawer, and insert the disc. If you want to play that particular disc, simply press the play button. Or, you can rotate the carousel tray and load up to four more discs. You can even mix 5" album CDs and the new 3" discs because the Sony carousel design plays the CD-3 software without the need of an adaptor. And, with the drawer open, you can easily note each disc's title at a glance. The carousel mechanism also has less moving parts, for greater overall reliability. And, since there are no complex disc magazines to contend with, the Sony carousel changers have the fastest disc-to-disc access times of any CD changer in the industry. So you spend less time waiting and more time enjoying your music.

The Convenience of a CD Changer... The Performance of a Sony.

As the inventor of the Compact Disc format, Sony endows each of its DiscJockey carousel changers with the type of advanced technology that you'd expect. In fact, such refinements as dual 16-bit linear D/A converters, Unilinear Converter System™ circuitry and 3-spot Aspheric Lens laser design are included in every model. With Sony DiscJockey changers, you get sophisticated convenience and superb musical performance every time.

"Sony's latest CD changers should remove any audiophile's lingering doubts about the appropriateness of the product..."
High Fidelity*



CDP-C70.
An advanced DiscJockey® carousel changer with superb sonic performance.

No other similarly-priced compact disc changer offers the level of convenience found in the CDP-C70. And, with its impressive complement of advanced Sony CD player technology, the C70's outstanding sound reproduction will satisfy the most critical listener.

4X Oversampling Digital Filter permits the use of a gently-sloped analog low-pass filter for smoother sound reproduction. **Dual 16-Bit Linear Digital-to-Analog Converters,** unlike single converter designs, decodes both channels simultaneously. With no interchannel time delay, stereo imaging is more precise and stable. **8-Stage Power Supply** ensures stable performance and helps eliminate noise leakage between stages for cleaner reproduction. **Envelope Differential Detection** (EDD) circuitry ensures superior tracking response and servo stability for improved handling of disc defects. **Full-Function 5+10 Key Wireless Remote Commander® Unit** (supplied) provides total control of all operating and programming features, including variable line output and disc selection. **Extensive Playback Options** include 32-Track Random Music Sensor (RMS), Automatic Music Sensor™ (AMS) and High-Speed Music Search, to give you disc programming capability and a wide variety of track access modes. **4 Repeat Modes** (single, all, RMS, Shuffle) give you a variety of extended listening options. With Shuffle Play, you can randomize selections within each disc or among all loaded discs.

The CDP-C70 has Sony's Custom File™ feature. It includes a Disc Memo™ feature, which displays a 10-character "message" of your choice, such as title, artist, or catalog number, each time the disc is loaded.

The Program Bank™ feature stores and recalls a particular track selection and sequence for each disc, so you won't have to re-enter track programming each time. You can make Custom File entries for up to 226 different discs, and a battery memory backup protects your programming during power interruptions.

"The C70's data represents fine performance even in comparison to more costly single-disc models." High Fidelity

CDP-C50.
A full-featured DiscJockey® carousel changer for the discerning listener.

The Sony CDP-C50 delivers all the advantages of the DiscJockey carousel changer concept together with some of the extraordinary digital audio technology found in Sony's best single-disc player models. With its supplied full-function Remote Commander® unit and numerous operating features, the CDP-C50 provides a unique combination of convenience, versatility and flexibility in multi-disc playback.

4X Oversampling Digital Filter permits the use of a gently-sloped analog low-pass filter for smoother sound reproduction. **Dual 16-Bit Linear Digital-to-Analog Converters,** unlike single converter designs, decodes both channels simultaneously. With no interchannel time delay, stereo imaging is more precise and stable. **6-Stage Power Supply** ensures extremely stable performance and helps eliminate noise leakage between stages for cleaner reproduction. **Full-Function 5+10 Key Wireless Remote Commander® Unit** (supplied) provides total control of all operating and programming features. **Extensive Playback Options** include 32-Track Random Music Sensor (RMS), Automatic Music Sensor™ (AMS) and High-Speed Music Search to give you disc programming capability and a wide variety of track access modes. **16-Track Music Calendar** provides disc playback information, elapsed/remaining time, and programming status at a glance. **4 Repeat Modes** (single, all, RMS, Shuffle) give you additional playback versatility. And with Shuffle Play, you can randomize selections within each disc or among all loaded discs.

DiscJockey CD changers accept standard 5 inch CDs as well as the latest 3 inch CD-3 software without the need of a special adapter.

CDP-C30/CDP-C20. DiscJockey® carousel changers for the value-conscious music enthusiast.

Both the CDP-C30 and CDP-C20 represent an exceptional value among CD players. Never before has such CD changer convenience been available at such affordable prices. And, with Sony's compact disc heritage, you're assured outstanding CD player performance.

Wireless Remote Control (CDP-C30 only) lets you select various CD player functions, including disc selection, track selection, Shuffle, Repeat, Automatic Music Sensor™ (AMS) and High-Speed Music Search, from the comfort of your chair. **2X Oversampling Digital Filter** ensures smooth, natural sound reproduction. **Dual 16-Bit Linear Digital-to-Analog Converters,** unlike single converter designs, decodes both channels simultaneously. With no interchannel time delay, stereo imaging is more precise and stable. The **5-Stage Power Supply** ensures extremely stable performance and helps eliminate noise leakage between stages for cleaner reproduction. **4-Function Fluorescent Display** provides track elapsed time, disc and track remaining time, and track number at a glance. **Extensive Playback Options** include 32-Track Random Music Sensor (RMS), Automatic Music Sensor (AMS) and High-Speed Music Search to give you disc programming capability and a wide variety of track access modes. **Repeat and Shuffle Modes** give you extended playback versatility.

The remote-capable CDP-C20 DiscJockey carousel changer (shown above) can be conveniently operated by the system Remote Commander unit supplied with many Sony receivers and audio rack systems.

"The carousel design is inherently less complicated both operationally and mechanically." High Fidelity

"I can't think of any reason to prefer the cartridge-loading format other than extra disc capacity or the desire to swap magazines with a compatible car CD changer." High Fidelity

The CDP-C100 DiscJockey® changer features a 10-disc magazine loading system. Like all Sony magazine-based changer models, it is fully compatible with all Sony car DiscJockey changers, including the CDX-A20 system pictured here.

Sony DiscJockey® carousel CD changers.

Comparison Chart

MODEL	CDP-C70	CDP-C50	CDP-C30	CDP-C20
Sampling Frequency	176.4 k Hz	176.4 k Hz	88.2 k Hz	88.2 k Hz
Dual D/A Converters	yes	yes	yes	yes
Power Supply	8-way	6-way	5-way	5-way
Error Protection	EDD	EDD	EDD	EDD
Unilinear Converter System	yes	yes	yes	yes
3 Spot Laser	yes	yes	yes	yes
Remote Control	yes, 5+10 key	yes, 5+10 key	yes	†
Custom File	yes	–	–	–
Music Calendar	20 track	16 track	–	–
RMS	32 track	32 track	32 track	32 track
Repeat Play	4-way	4-way	via remote control	–
Shuffle Play	yes	yes	yes	yes
Display	FL	FL	FL	FL
Variable Line Out	yes	–	–	–
Direct Access	yes, 5+10	–	–	–
Headphone w/volume	yes	yes	yes	yes
CD3 Compatible	yes	yes	yes	yes
Timer	yes	yes	–	–

Specifications Chart

Frequency Response	2-20 kHz, ±0.3 dB	2-20 kHz, ±0.5 dB	2-20 kHz, +1, −2 dB	2-20 kHz, +1, −2 dB
S/N Ratio	over 100 dB	over 100 dB	over 100 dB	over 100 dB
Dynamic Range	over 90 dB	over 90 dB	over 88 dB	over 88 dB
Distortion	.05%	.05%	.05%	.05%
Separation	over 95 dB	over 95 dB	over 95 dB	over 95 dB
Wow and Flutter	Below Measurable Limits			
Dimensions (WHD)	17"x 4¾"x 15¾"	17"x 4¾"x 15¾"	17"x 4¾"x 15¾"	17"x 4¾"x 15¾"
Weight	12 lb. 10 oz.	12 lb. 10 oz.	12 lb. 13 oz.	12 lb. 13 oz.

†Has remote control sensor and can be operated via Sony System Remote UniCommander® units.

SONY

THE LEADER IN DIGITAL AUDIO™

Features and specifications subject to change without notice. Non-metric weights and measurements are approximate. Sony, The Leader in Digital Audio, Automatic Music Sensor, Custom File, Disc Memo, Error Prediction Logic, DiscJockey, Program Bank, Remote Commander and Unilinear Converter System are trademarks of Sony. "Quotations reprinted with permission of *High Fidelity* magazine © 1988

Linear Power Car Subwoofer System

The 1752S servo-subwoofer system consists of four 8-inch, dual voice-coil subwoofer drivers plus a special servo amplifier. One voice-coil of each driver is powered; the other generates a feedback signal which the amplifier's servo circuits use to maintain constant bass response from a wide variety of enclosures (including "infinite baffle" trunk mounting). The servo circuitry also protects against amplifier clipping. The mono amplifier, which sums left and right stereo signals together, delivers 175 watts into the drivers, at 0.09% THD. Gain is adjustable for full power output from 150 mV to 5 V rms input signals, and current draw at maximum output is 38 amperes. Price: $1,500.

For literature, circle No. 113

Audiometrics CD Changer

If the hundred-CD capacity of the AMCDS-1000A CD changer isn't enough for you, you can link two changers together with an optional remote, or four through an optional switcher and 2,000-event programmer. Designed for broadcast and other professional uses, the 1000A has both unbalanced and 600-ohm balanced outputs. The unit is elaborately programmable, and maximum access time from disc to disc is 28 S. The CD compartment can be locked. Prices: $5,295; Model XTC controller, $995; Model SMC CDP-1 programmer, $4,995.

For literature, circle No. 114

Allison Powered Speakers

The amplifier built into the Mini 2P speakers develops 15 watts per channel and can be operated from 120-V a.c. or from 12-V d.c. sources such as automobile cigarette lighters. The amplifier, which is built into one speaker of the pair, has separate level controls for each channel and a switchable high filter. Price: $359 per set.

For literature, circle No. 112

Monster Cable Interconnects

Coming from the side of this RCA plug is an extra connection that accommodates a spade terminal or banana plug from a speaker cable. When used between a preamp and an amplifier, the M1000 Mk. II PowerDrive interconnect bypasses the amplifier's internal ground circuit. According to the manufacturer, this solves impedance and grounding problems that commonly occur in amplifier-to-speaker interfacing. The plug's ground contacts are of Monster Cable's new "Turbine" design, engineered for a tighter fit.

Existing M1000 cables can be upgraded with the new connectors, which are not sold separately. Prices: 1-meter pair, $300; 2-meter pair, $350; 20-foot pair, $650; upgrade, $150.

For literature, circle No. 115

the Soundcraftsmen STORY

MADE IN U.S.A.

SECTION OF PRODUCTION AREA IN MAIN PLANT

Soundcraftsmen celebrates its 20th year of manufacturing audio components for the discriminating audiophile.

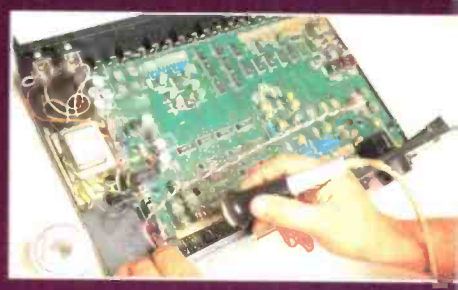
Soundcraftsmen engineers are highly respected in audio design circles as being very forward thinking, yet practical, when engineering new products, by using proven design principles from the past with tomorrow's technology.

From the finest equalizers, the most accurate analyzers, to the unique preamps, to the revolutionary Class H and Power MOSFET amplifiers, you cannot purchase finer audio components.

The next few pages will answer many of your questions. If you have more, our customer service department will be pleased to assist you by telephone or letter. We invite your questions and appreciate your interest.

One hundred percent quality control is seen on EVERY unit manufactured. EVERY completed unit is electronically tested for specification accuracy and then EVERY unit is connected to a high fidelity system and listened to—just like you would at home. If your unit meets or exceeds the critical standards set forth on these tests, it is then packaged for shipment.

INDIVIDUAL CERTIFICATE OF PERFORMANCE WITH EVERY AMPLIFIER



Soundcraftsmen

Pro-Power Ten 2/3/4 Channel

The New Soundcraftsmen PRO-POWER TEN 2/3/4 channel Power Amplifier stands alone, in a class by itself, in power amplifier circles. Designed and manufactured in the USA using State-of-the-Art MOSFET power output stages and our ultra-smart phase control power supply, the PRO-POWER TEN is your best buy in a power amplifier. The MOSFET amplification stages provide superior sonic purity, compared by many to that of vacuum tube amplifiers. Unlike most other supply designs whose supply voltage drops (and hence the amplifier's output capability) when operating at high volume levels containing dynamic peaks of more than a few milliseconds duration, our smart phase control power supply adjusts its supply voltage to match the demands of the loudspeaker. Helping to maintain this constant supply voltage are ultra high storage capacity filter capacitors and two independent power transformers.

The PRO-POWER TEN front panel features four independent 12-segment LED power output meters (0–800 watts at 8 ohms) and True Clipping indicators for each channel. As in most all Soundcraftsmen components, the new PRO-POWER TEN features a Professional rack-mount front panel with optional hardwood side panels.

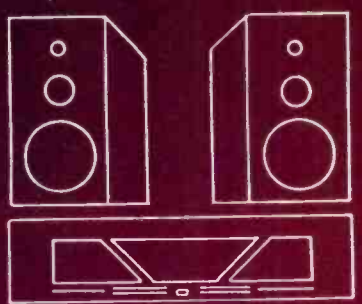
SPECIFICATIONS

POWER: 205 watts per channel (4-channel) @ 8 ohms, 20Hz–20kHz, at less than 0.05% THD...300 watts per channel (4-channel) @ 4 ohms, 600 watts per channel (2-channel) at 8 ohms...IM Distortion: less than 0.05%...Frequency Response: 20Hz–20kHz, ±0.1dB...Signal to Noise Ratio: –105dB...Slew Rate: 50 volts/microsecond...Dimensions: 19"Wx5¼"Hx12"D...Weight: 55 pounds

TWO-CHANNEL MODE

600 WATTS PER CHANNEL INTO 8 OHMS.

When the PRO-POWER TEN is used in this mode it is transformed into the ultimate in high power amplifiers...If your loudspeakers and/or environment require a lot of power, the PRO-POWER TEN is right for you.



Ultra High Power Systems

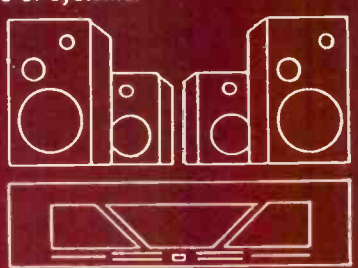
THREE-CHANNEL MODE

Many of the more modern loudspeaker systems have been designed primarily with the total living environment and/or integrated audio-video systems in mind. These systems incorporate a stereo pair of satellite speakers for reproducing the midrange and high frequencies. Since the very low frequencies are non-directional, and hence non-critical to proper stereo imaging, they are reproduced by a single, large sub-woofer. The PRO-POWER TEN in the Three-Channel mode is ideally suited to these applications.

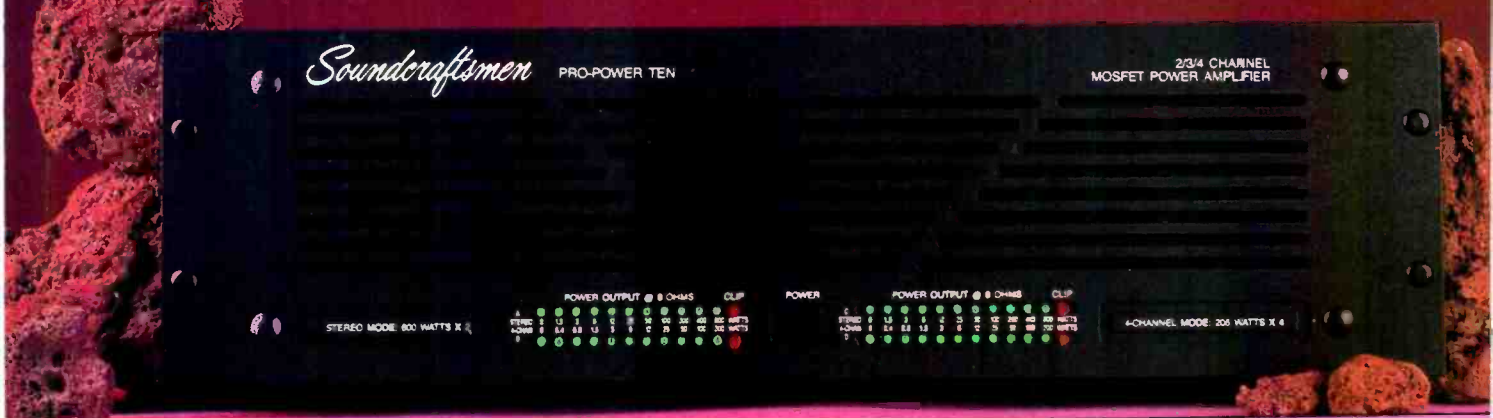
Sub-Woofer/Satellite Systems

FOUR-CHANNEL MODE

The ultimate in audio/video systems is the Surround Sound system, where the theatre environment is re-created in the home by utilizing front and rear speakers. The PRO-POWER TEN in the Four-Channel mode is the perfect match for these systems. Some higher quality loudspeakers benefit from bi-amplification, i.e. having separate amplifiers for their low frequency and high frequency components. The PRO-POWER TEN in the Four-Channel mode is equally well suited for these types of systems.



Surround Sound Systems



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16-PAGE, FULL-LINE, FULL-COLOR BROCHURE, AND $19.95 SYSTEM-EVALUATION KIT: *1-12" LP Spectrum Analysis Test Record, 2-sets of Computone Charts, 1-Connector Cable for comparison test, 1-instruction folder for use with your present stereo system.* ***JUST WRITE TO US OR CIRCLE READER SERVICE CARD*** *for* ***FREE SPECIAL OFFER DETAILS.***

Soundcraftsmen, 2200 So. Ritchey, Santa Ana, CA USA. Prices and specifications subject to change without notice.

Enter No. 30 on Reader Service Card

EDWARD TATNALL CANBY

. . . AND THEY IS US

Illustration: Bob Scott

The audio show began and continues as one means whereby the products of our audio art may be brought to the notice of the interested public.

That's what I might say if I were in a mood for formality. I seldom am. And, as noted last month, I am lately having some curious thoughts as to what events *are* indeed audio shows. The two biggest, in my view, are the twice-a-year CES and the twice-a-year U.S. conventions of the AES, as you may have read, somewhat to your surprise, last month. Neither is billed as an audio show. Just a Canby notion. But having started on this line, I've come up with more. First, let us revert to the dim past: The first audio show ever.

The first audio show—the first that was nominally all hi-fi, at least—was organized back in our beginning years under a tricky title, the Audio Fair, long since forgotten. The inspiration might have come from the big Book Fairs, held in this country and Europe to bring the publishers directly to the reading public. I was innocent of politicking in those days, and so I can tell you nothing of the management intricacies that got the Audio Fair going, the deals that were undoubtedly put together to make it a surprisingly big event right from the start, and out of nothing previous. I am aware that our then Editor somehow had his finger in the pie—he was *there*, at the show, practically everywhere and full time. And so this magazine was there, too. (We always had a room or a desk where I could leave my hat and coat and armfuls of printed propaganda.)

The man I recall who did the actual organizing job at the top—his reign was short and brilliant—was one Harry Reises (if I spell him right), a shortish, genially pudgy and cheerfully forceful character whom you could immediately figure was a "Promoter." This small man with a huge cigar could get things going, any old things—like maybe a rodeo, a Broadway spectacular, a beauty pageant, fashion show, political powwow—anything that could be made three times bigger than life. He looked the part. He was obviously taken on in order to blow up "hi-fi," which was a modest little biz at that point, into something much, *much* bigger.

Now Harry Reises suddenly had a falling out, after a few years—with whom, I do not know, nor under what circumstances, dire or merely casual. Anyway, he vanished and so did the Audio Fair, the idea to be taken up by other groups and institutions—the IHF (Institute of High Fidelity), for instance, if you can call a trade organization an institute. (You can.) But while the Audio Fair was around, it certainly flourished. It was a brand-new thing and very exciting to all, inside and out of audio.

This was a Big Show, of the sort that was common enough in other areas, and still is, such as automobiles, motorboats, flowers, sporty goods, major appliances, and so on, all offering dazzling visible wonders from many manufacturers. But the crazy plan for the new venture was to feature *sound*. Of all unlikely subjects, that seemed the most impossible, wouldn't you say? At least with multiple makers and multiple sound sources on hand.

And so it almost proved. To this day, the actual sound at our hi-fi shows is mostly cacophony. Frankly, I've always hated it. One piece of music at a time is my taste, and at a *reasonably* loud volume, please. (I didn't say soft music! I dislike that almost as much because I *always* have to listen, and soft music can be a strain, like reading in poor light.)

Audio shows are mostly noise, noise, and more noise—except, of course, where prohibited, as in the AES Convention public areas. What made the idea of a sound show workable was product to look at and people to persuade. That's what really mattered: Product in vast quantities and variety; people of, shall I say, every persuasion, including company engineers and presidents. You could talk to them. (You could even bait them, I might add.) So the new idea of an audio show—a sound show, at least in name—got off to a whale of a good start.

Now once in each audio generation, I think it necessary to repeat an extraordinary technical aspect of the first audio shows, in case you didn't know. The first and subsequent Audio Fairs were held in an oldish, high-rise New York hotel furnished throughout with *direct current*. Can you imagine anything more preposterous?

I don't know the politics of that remarkable situation—ask Harry Reises, if you can locate him. But I do know all too well that, until after WWII, most big American cities were heavily invested with d.c., often in large areas of many blocks, but also, via piecemeal conversion, in sections of town that had both


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Who would believe the first audio shows were held in a high-rise hotel furnished with direct current only!

a.c. and d.c. side by side in utter confusion. When you went apartment hunting in those days, your first question was, "Are you on d.c.?" Somehow I seemed always to end up on d.c. in my more impecunious days.

I am afraid I have been guilty of more than one audio disaster in this respect. Just plug a piece of a.c. equipment into a d.c. outlet (identical to the a.c.), and whatever you had immediately melted down, with acrid clouds of smoke and hideous sizzling noises. I also remember one furnished room, d.c., in which I mounted a huge d.c.-a.c. "motor generator" in the back of my closet. To silence its objectionable noise, I unceremoniously piled blankets and pillows on top of the thing—a wonder I didn't go up in flames. The filtering was imperfect, as might be expected, so your music buzzed nastily. And the pitch, unadjustable, was always wrong. (Unregulated a.c. alternator.) The manufacturers of these obviously had tin ears.

So the Hotel New Yorker, on Eighth Avenue just north of 34th Street, had d.c. They probably couldn't help it. And this was the chosen venue for the first hi-fi show! Does seem strange, doesn't it?

There was, of course, some rationality. In the tenth or so subbasement of that building, there was an in-house a.c. alternator, a big one, clearly an emergency installation to forestall what was obviously a growing problem. *Some* of the hotel's private rooms, not all, thereby had acquired *two* sets of outlets, a.c. and d.c. The lights in these rooms were d.c. (you did not plug in extension cords); all the public areas, all corridors and so on, were d.c. Only the special extra outlets provided the juice that we in audio rather definitely needed. I do not remember any special identifying marks on them, though I might be wrong.

So the Audio Fairs took place on top of a thousand electrical time bombs set to trap the unwary. How many pieces of equipment died of d.c., I do not know, but at least our people were aware of the horrible consequences of a mistake. Throughout the day, the familiar cacophony of multiple loud sound sources continued unbroken, as it does today, and I remember no cordoned-off areas smelling of short circuit. That alternator could cope, in-house or no, since obviously it was a large professional machine. No buzz of interference, the pitch an accurate 60 cps on the nose. The audio played very nicely on our hi-fi gear in all its multiplicity.

Obviously, in the planning for these first shows, *somebody* must have brought up the matter of sonic interference as between so many manufacturers. There must have been heated discussions and plenty of high-minded suggestions that wouldn't work in a real world. Set up a ballroom schedule, giving each manufacturer 10 minutes

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What made the idea of a sound show workable was product to look at and people to persuade.

to do his own demo, solo? Fat chance *that* would work! Nor any other plan that might curtail the manufacturer's right to make a loud noise with his equipment. The procedure that was finally adopted, insufficient and full of holes (audio holes), shaped all the audio shows that have come since: Shut 'em all up in the hotel rooms. Let 'em blast away to their ears' content *inside* those rooms.

Well, we all know how that worked out. Who's to keep the hotel doors shut? There's only one way to do that—lock them. (Or shut off your sound and take a 15-minute break.) In any case, mere doors are hardly enough to contain the kind of audio we were (and are) putting forth. Nor hotel room walls. I can hear 30 years of loud thumpings and squallings next door while I tried to listen to some esoteric trifle on the highbrow side. So from the very first Audio Fair to the latest miracle in Singapore or Tokyo, the corridors continue to be filled with toxic audio mishmash and there's nothing much to be done about it. Except to turn up *your* sound still higher in *your* room, and overwhelm the competition.

Even that dignified organization, the AES, gave way to sonic practicality when it sanctioned closed-door demos inside private rooms. Somehow, I'll admit, the AES has managed better than most to restrict corridor cacophony. Is it stricter enforcement? Or is it that they sometimes leave five empty rooms between exhibits as a sonic barrier?

There was one aspect of the original Audio Fairs that I haven't mentioned in detail to this generation of readers. Yes, the in-house a.c. wasn't bad at all, and you could forget it in short order while the now-familiar roar of sound grew louder and louder as each day wore on. In effect, the d.c. problem was very well solved. In those days, I was at the Fair just about every minute, from the opening (at a decent morning hour) until . . . .

Wham! At exactly the time when, after hours and hours, the general excitement had mounted to an awful and exciting crescendo, the very peak of cacophony, in a few brief seconds there was total silence. Not a squeak, not a whisper of audio anywhere. The a.c. was turned off.

Was it 6 o'clock? Or 10? I don't remember. But I vividly recall the shock of that moment. It always caught everybody unawares. By that time, we were immersed in a thousand enthusiastic shouted conversations and in a solid blast of audio you would never believe if you hadn't heard it plenty of times since. Suddenly, we were in an audio ghost town. Yes, the exhibits were still there, the personnel still could talk, there was no darkness because, of course, all the lights were on d.c. But an eerie hush settled quickly over us. Shouts faded to whispers. And in maybe 10 minutes, the place was empty. Who wants silent audio?

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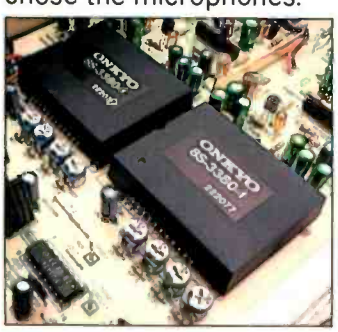

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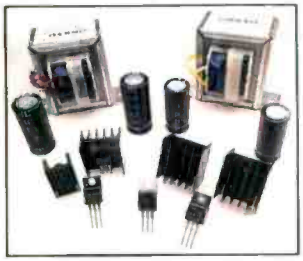

Dual transformers in the DX-7500 thoroughly isolate digital and analog stages.

In addition, the critical D/A converters benefit from Opto-Drive, a new Onkyo technology that uses LED/phototransistor arrays for the ultimate in current stability and operating accuracy. Which means that any sonic variations you hear will be in the music, not in the disc player.

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BERT WHYTE

SUPER-COLOR BLACK BOX

In describing my Dolby Surround Sound home-video theater installation in the February 1988 issue, I pointed out the system's three interrelated elements: The acoustically treated dedicated room, the video equipment, and the audio setup. With movies on high-quality videocassettes and laser videodiscs, the audio/visual experience has been quite spectacular. Many professional audio people have seen and heard this system and have been most impressed by it. Even the most die-hard audiophiles, who generally sniff disdainfully at anything video, commented favorably.

Now that the audio/video marriage is on a firm footing, many new products have been developed. Some specifically enhance the visual aspects of the home theater, while others upgrade the audio quality. With the recent acquisition of some new hardware and software, my system's performance has considerably improved.

David Fletcher—who heads Sumiko, a company well known for high-end phono cartridges and tonearms—is a physicist who has always had a passionate interest in video technology. Fletcher has developed an outboard "black box," 8½ in. W × 2 in. H × 7¼ in. D, which he calls his S-RGB processor. The "S" refers to the new Super VHS videocassette recorders. These VCRs have "S" input and output connectors which provide separate "Y" (luminance) and "C" (chrominance) signals.

While Super VHS VCRs are capable of 420 lines of resolution, achieving this performance requires that certain conditions be met. First off, one needs a program source with 420-line resolution, ideally a prerecorded Super VHS tape. Then the "S" outputs (Y and C) of the VCR are connected to the "S" inputs on a TV monitor or projection TV. Many new monitors and projection TVs are now equipped with "S" connectors—but they are absent from all older TV units.

This is why Fletcher is offering the S-RGB processor. The "RGB" refers to red, green, blue—the three primary colors—which, combined in the proper proportions, give the full color picture. Many current TV monitors and projection TVs are equipped with analog RGB inputs. Normally, they are used to connect computers and video games. The "S" output of a Super VHS VCR is connected to the Sumiko processor, where the Y and C signals are converted to RGB and then fed to the RGB inputs on the TV.

The Sumiko processor derives its RGB signals from the Y and C signals of the VCR in a proprietary process too complex to detail here, but it includes the use of temperature-compensated crystal oscillators and wide-band (6.875-MHz), complementary-symmetry, d.c.-coupled output amplifiers. These amps use four transistors for each RGB output to achieve a much more powerful and linear drive, as compared to the usual monitor or projection TV in which the equivalent circuits use two transistors per RGB output in a nonsymmetrical configuration.

With the Sumiko processor connected to the RGB inputs of monitors or projection TVs, their hue, color, contrast, and brightness controls are disabled. These controls are provided on the front panel of the Sumiko unit; with an "S" connector cable of sufficient length, they can be remotely operated. There is also an edge-enhancement control, and two special red and blue controls adjust white balance. These white-balance controls offer one of the major benefits of the Sumiko processor. As Fletcher explains, "For colors to reproduce accurately, the color temperature or white balance of the picture must match that of the video camera. Cameras are set to match a color temperature of 6500° K. In other words, television 'white' is very slightly bluish with proper white balance. As a monitor or projector ages, the light outputs of the three guns in a three-color tube (or of the three separate tubes in a projector) change relative to each other. This changes the white balance and, consequently, the color fidelity of the picture. Normally when this happens, a service technician must be called in to adjust the internal gun or tube-drive controls to restore proper white balance. The S-RGB obviates this need. The white balance can be restored with the red and blue controls on the front panel.

"On the back of the S-RGB is a switch labelled 'Notch.' When non-Super VHS tapes are played, the extra resolution may allow some annoying color artifacts; this switch will allow one to reduce these artifacts."

What does Sumiko's magic box do? It certainly provides distinct benefits in terms of color temperature (white balance) and resolution with monitor TVs, but it really shines in the improvements it can bring to projection TVs. A few points to consider: Thus far in the brief history of Super VHS, virtually no prere-

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High Fidelity Magazine

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Where to buy Polk Speakers? For your nearest dealer, see page 186

The Sumiko S-RGB processor yields a whopping 30% more contrast and brightness than the equivalent circuits of monitor and projection TVs.

corded S-VHS videocassettes of feature films are available (although some are supposed to be released in the near future). This may have deterred some people from buying Super VHS recorders. However, if one owns a TV set with RGB inputs, consider this: Even if you have a really good antenna in a good signal area or you have a good cable connection, about the best resolution you can normally expect is 240 lines because of the composite signal (and other factors). And this is in spite of the fact that the horizontal resolution of the NTSC broadcast luminance channel is more than 330 lines!

In other words, with a Super VHS VCR, the Sumiko processor, and RGB inputs on the TV set, even broadcast TV has improved resolution. (True, one usually must use the VCR's TV tuner in order to operate the S-RGB.)

Because of the wide bandwidth and the more powerful and more linear drive of the Sumiko processor, as compared to similar circuitry used in most monitor and projection TVs, a whopping 30% more picture brightness and contrast is available. For most projection TVs, which usually are lacking in picture brightness and contrast, this is a real boon. Even with the essentially good picture of the Infinity projection TV I use, the difference is startling. Many low-light scenes have far more detail. Most important, skin tones, which are usually more difficult to balance naturally on projection than on direct-view TVs, are easy to correct with the white-balance controls. You can imagine what it is like to see an 8½-foot-diagonal picture with brightness, contrast, color saturation, natural skin tones, absolutely clean whites and blacks (in the color picture) almost on a par with direct-view TV! It puts projection TV into another realm of visual accuracy. It has terrific impact and is very involving! I also found I could use the Sumiko with CD Video discs by feeding the video output of the videodisc player into the video input on the JVC Super VHS, then feeding the "S" output of the VCR into the Sumiko processor. With the superb 420-line resolution of the CD Video discs, plus the enhancements of the Sumiko, the result is visually stunning. The Sumiko S-RGB processor sells for $485 and is also compatible with ED Beta VCRs. For devotees of projection TV, its performance speaks for itself.

Laser videodiscs were introduced in the early 1970s and, after some teething problems, became a prime source for those who wanted the best picture quality. Perhaps at that time, laser technology was too exotic, for it did not gain broad consumer acceptance. Now, with the tremendous success of laser-read CDs, the public knows about and has enthusiastically accepted laser technology. Polygram feels this is true, and with improved disc processing, has decided to re-enter the laser videodisc (now dubbed CD

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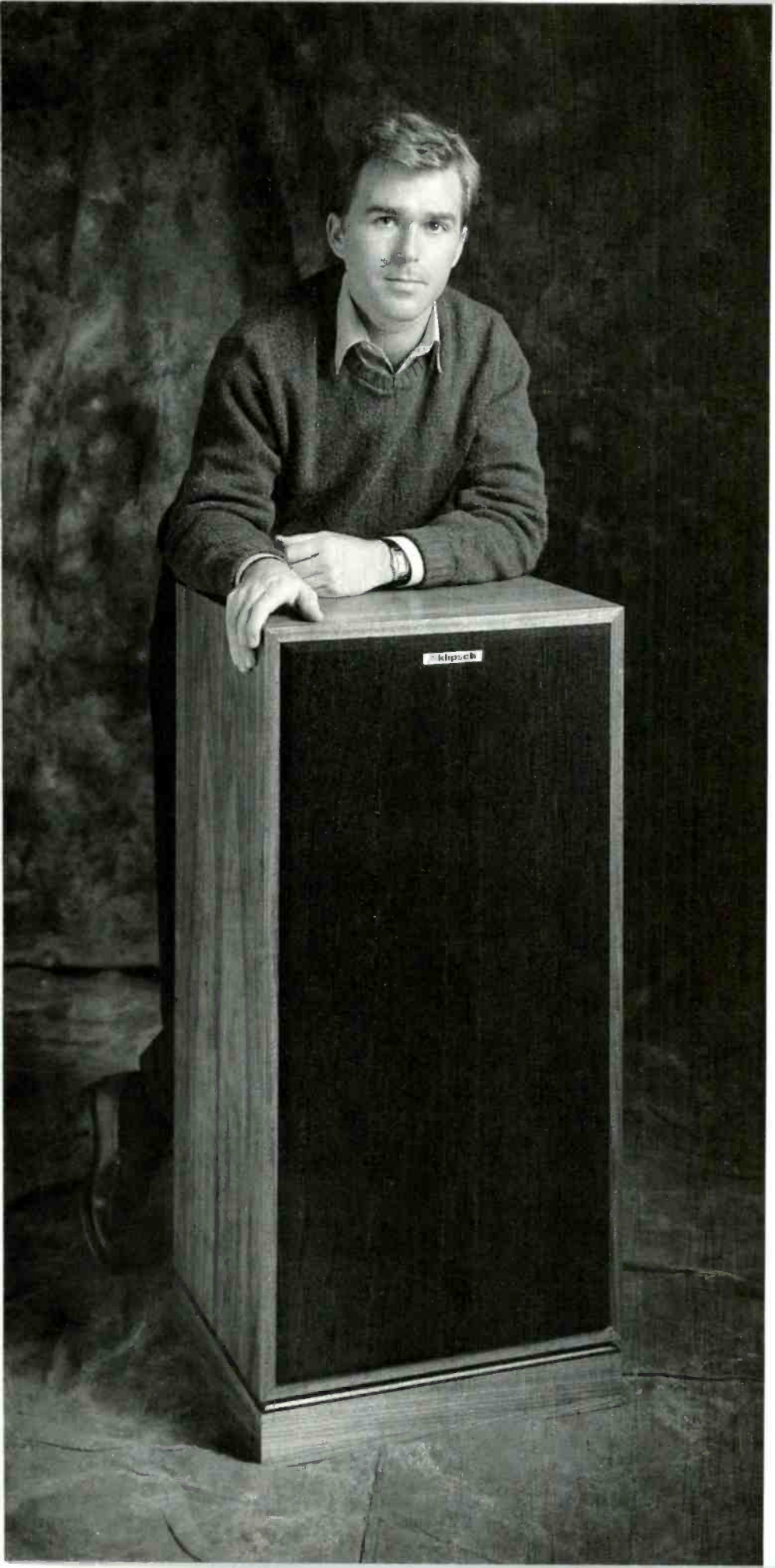

Say "No" To Oatmeal

I've been a studio drummer for eight years. So, I'm very critical about speakers, mostly because I know what drums are supposed to sound like. Most speakers make a kick drum sound like someone's playing a bowl of oatmeal. I don't even like the way oatmeal tastes, let alone how it sounds.

One day, a friend and I stopped at a hi-fi store to pick up some cassette tapes. Off in one of the listening rooms, I heard some music that sounded live. It was the drums I noticed first. Forget oatmeal, what I heard was a really tight, clean, punchy sound.

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Polygram has an ambitious CD Video release program which calls for more than 100 discs to be available by the end of the year.

Video) market with a bang. They have released 14 initial programs. All have digital soundtracks (mostly digitally remastered from the original analog tapes) as well as analog soundtracks for compatibility with older laser videodisc players. Many of them utilize film and TV productions from Unitel; you've probably seen some of these productions on the TV series "Live from Lincoln Center." The quality, both visually and sonically, is on a very high level—pictures are crisp and clean, and sound is exceptional because of excellent stereo, wide dynamics, and little or no noise.

These CD Videos are real treasures. How about a breathtaking version of *Tosca* (London Records 071 502-1 LHE2) filmed on location in Rome with Placido Domingo as Cavaradossi and Sherrill Milnes as Scarpia in a lavish production? Or the great Luciano Pavarotti swaggering as the Duke of Mantua in London's *Rigoletto* (071 501-1 LHE2), which features Riccardo Chailly conducting the Vienna Philharmonic? How about the brilliant Franco Zeffirelli film of *Pagliacci* with the La Scala Chorus and Orchestra on Philips Classics (070 204-1 PHI)? A high point of this CD Video is Domingo with a heartrending "Vesti la Giubba." Then there are Rudolf Nureyev and Dame Margot Fonteyn tripping the light fantastic in an opulent production of *Swan Lake* (Philips 070 201-1 PHG). More ballet, with Philips' *Giselle* (070 202-1 PHG) and the American Ballet Theatre, and back to opera with the glorious voice of Mirella Freni in *La Bohème* (Deutsche Grammophon 072-205-1 GHI), another Zeffirelli/La Scala production with Herbert von Karajan conducting. Among other gems are a thrilling Bernstein performance of the Mahler Second Symphony in the Ely Cathedral in England (Deutsche Gramophon 072-200-1 GHG) and Carlos Kleiber in acclaimed performances of Beethoven's Fourth and Seventh Symphonies with the Concertgebouw Orchestra of Amsterdam (Philips 070 200-1 PHG).

Polygram has a very ambitious release program—over 100 CD Videos by the end of this year. I am looking forward to them with anticipation, especially if all the releases are as exceptional as the ones mentioned above.

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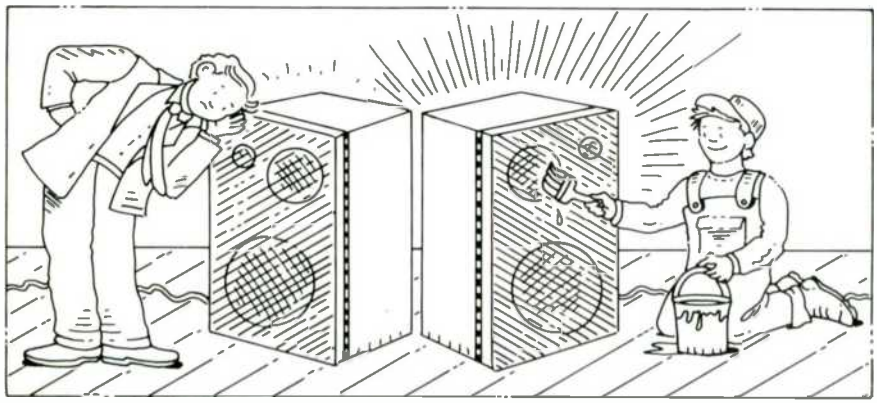


Optical Inputs

People with hearing problems often put their glasses on to answer phone calls—and not just when those glasses have hearing aids built in. The phenomenon is well known, but its cause is still a mystery. A while back, the British magazine *Electronics and Wireless World* suggested that clearer vision might lighten the load on those areas which process both hearing and sight. The item also suggested that "if our glasses make us see better, then subconsciously we expect all our senses to improve."

Our sight affects our hearing in other ways. For example, we're likely to perceive more and lower bass from big speakers than from small ones which measure the same. Philips used to demonstrate a small, feedback-controlled speaker by hiding it within a huge speaker enclosure until listeners got used to its bass.

More recently, researchers at Wharfedale proved that perceptions of a speaker could be altered by changing the color of its grille cloth! More than 300 college students were asked to compare ostensibly different speakers, which could be identified by their grille colors. Actually, the speakers were identical except for the color of the cloth. To the students, speakers with red grilles seemed more bassy, speakers with yellow grilles seemed louder, and blue grilles made the sound seem clearer. Speakers with black or brown grilles—the colors most commonly used—were considered lifeless or dull. When the grilles were secretly interchanged, the listeners continued to feel that red meant more bass, and so on, even if during the swap, the red grille was put on the "clearer-sounding" speaker that previously had sported a blue grille.

Illustrations: Teresa Anderko

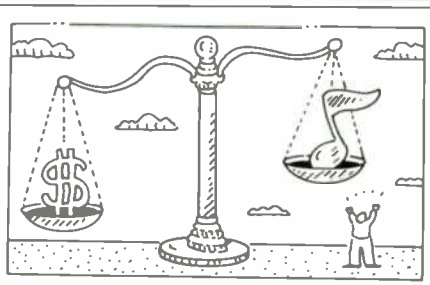
Cost vs. Culture

The LP record offered music lovers better sound and greater convenience than the 78-rpm disc which preceded it, just as CD offers the same advantages over LP.

But the LP also cost less than the format it replaced. As a result, the 33⅓-rpm disc (and the new convenience of record mastering on tape) spawned a musical revolution, allowing listeners to hear composers and performers they had never heard before. I doubt that Pachelbel, Neville Marriner, or Philip Glass would be well-known names today without the low-risk appeal of LP's economy. I suspect the same would be true of many pop, jazz, and rock artists.

So far, the CD is spawning no such revolution. Quite the reverse, in fact. It is, as Francis Davis recently wrote in *The Atlantic Monthly*, "a format still so expensive that consumers feel safer sticking with the tried and true." It's easier to take a flier on the unknown when the price of the flight is $6 rather than $16.

However, the price of CDs *is* creeping downward, for three reasons: Initial investments in CD



plants have been partially amortized. Improved production technology is cutting costs. And a temporary excess of production capacity is forcing manufacturers to cut prices, both to attract business away from their competitors and to increase overall CD sales.

At the same time, DAT offers a relatively inexpensive, portable mastering medium that should encourage recording companies to try new musicians in new venues, just as tape did in the '50s. So far, DAT does not match open-reel tape's ease of editing, but because digital tapes can be copied with no loss of quality, there should be no problem dubbing DAT masters to other digital formats for which studio editing facilities are available.

Because DAT is a two-channel medium, it may lead to better sound by forbidding the sloppy techniques and overmiking which 24-, 32-, and 48-track tapes allow. Just as they did in stereo's early days, engineers will have to get their mike placement and mixing right, and musicians will have to perfect their performances, rather than "fixing it in the mix." This, too, harks back to the early days of stereo tape mastering (except that many early stereo masters were on three-track tape).

Add DAT convenience to CDs priced below the $10 consumer-acceptance barrier, and you could easily have another flowering of musical adventurousness. Nonetheless, there are voices in the record industry crying against any reduction in CD prices, arguing that lower prices will cut CD profits without expanding the market. Only people who get their recordings free from friends in the business could believe that lower prices would not increase sales. And while lower prices *would* cut industry profits in the short term, market expansion would eventually make up for that.

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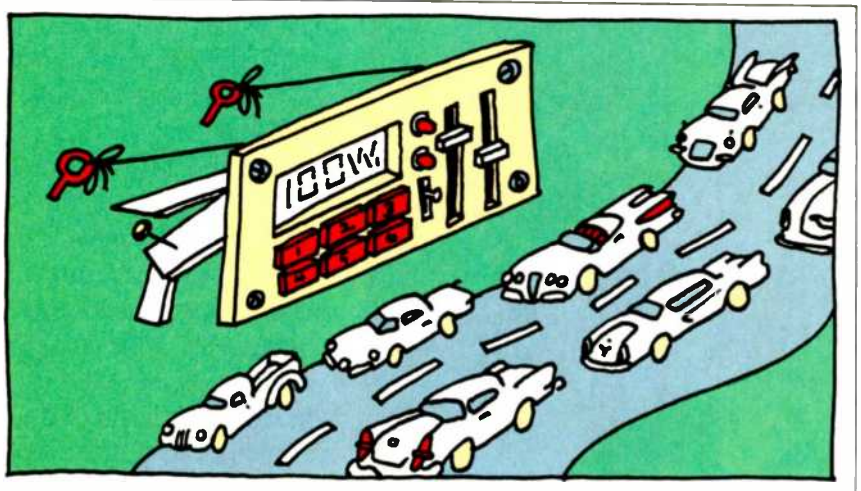


Lax Listings

The FTC rules that govern how makers of home amplifiers must define their power specs do not apply to amplifiers for car use. Nonetheless, many makers of car amplifiers, especially those whose background is in home components, follow most of the FTC requirements. These companies' amp specs state power per channel into 4 ohms and give the frequency range and maximum distortion level at which that power can be achieved, as spelled out in the EIA Standard for car amps.

Other companies, however, are a bit more lax about things, listing only so-and-so many watts, without further details. How do you compare such companies' power specs with those that comform to the EIA Standard? Is a semi-specified "100 watts" the same as "100 watts per channel into 4 ohms, at 0.5% THD or less, from 40 Hz to 20 kHz"?

Usually it's not. I translate sketchy specifications into real-world (EIA) terms by using a few rules of thumb:

If the unit is described as a "100-watt amp" with no mention of power per channel, divide by the number of channels. If no distortion spec is given, assume the rated power is only achieved at 10% distortion. To estimate power at realistically listenable distortion levels, deduct one-third to one-half of the power rating. If a "maximum" power rating is given, assume that it has been measured at 10% THD or *more*, and deduct half.

By these rules, a stereo amplifier listed as delivering "100 watts maximum power" comes out looking comparable to one rated at a decent 25 watts per channel.

Robert Ain of Polk suggests substituting a "rule of fuse" for my rules of thumb. If you know the rating of an amplifier's power fuse, you can use Ohm's law (watts = voltage × current) to calculate the maximum power it can draw. By this law, the maximum power a 100%-efficient amplifier could deliver from a car's 13.8-V supply is 13.8 watts per ampere of current. In practice, amplifier efficiency usually runs a bit less than 50%. I calculate that the eight car amps reviewed in our last group test ranged from 30.4% to 58.0%, with 46.4% being the average. So the maximum power a car amplifier can actually deliver is more like 4 to 8 watts per ampere (total for all channels, of course).

Based on these figures, a stereo amplifier delivering 100 watts per channel should have about a 30-amp fuse. In practice, it might only have a 20- or even a 15-amp fuse, like the Carver M240 and the Hafler MA-1, both of which deliver a bit more than 100 watts per channel. This is because fuses can stand momentary current draws beyond their rating, and amplifiers playing music rarely deliver their full power for more than a few milliseconds at a time. But if that "100-watt" amp has only a 5-amp fuse, its rating is a prime example of power puffery.

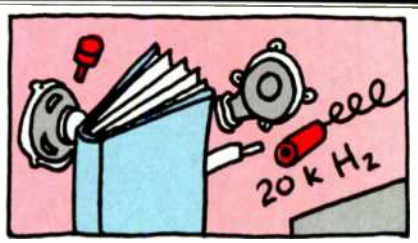
Voltage, High and Low

There's some prospect, as I wrote a few months ago, that the nominal 12-V standard for car electrical systems will go up to 24 or 48 V. But that's off in the future. What's happening now is, in part, a drop from 12 to 5 V and a rise from 25,000 to 40,000 V.

The voltage drop is in new Jaguars, which still use 12-V batteries and alternators but which also power their dashboard electronics with a 5-V supply. (A factory service bulletin, issued in April '87, tells how to wire in 12-V accessories such as audio or telephone equipment.)

The voltage rise is in an ignition system which will be fitted to some Saab models, chiefly in Scandinavia, this year. Raising the voltage by 60% would seem to increase the risk of audio and radio interference. But the new system sends out only 400 V from its distributor. This voltage is then stepped up 100 times by a capacitor and coil fitted directly to each plug, so there are no long, high-voltage wires to radiate interference. Saab's distributed ignition system will therefore probably be easier on car sound than conventional systems are.

Illustrations: John Tom Cohoe



Illustrated Info

Want to see what goes on inside a car stereo, without taking yours apart? Clarion has some well-illustrated technical bulletins (originally intended for dealer training) that will show you. The most edifying are probably those on Clarion's key-off pinch-roller release, dual azimuth adjustment, and d.c. servo motor drive. It's easier to show the workings of mechanisms than to show how circuits work (such as the RCA line-level output with fader control and the "Clean Z1" impulse-noise reducer, covered by other bulletins). For copies, write to: Marketing Dept., Clarion, 5500 Rosecrans, Lawndale, Cal. 90260.

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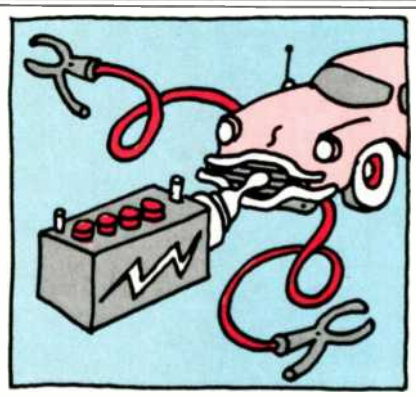
If you don't drive your car very often, the stereo gear draws enough juice—even when it's off—to slowly make the battery go flat.



Down the Drain

For the average driver, the power drawn by a car stereo system is most significant when the system and the car are in operation. We've all heard tales (and maybe seen examples) of systems which drew so much current that the headlights dimmed on every beat. For city-dwellers like me, however, what matters most is the drain on the electrical system when everything's shut off.

For moving around within the city, it's usually easier (and faster) to take a cab than to take my car; as a result, I sometimes do not drive my car for three or four weeks at a time.

When my car was full of stereo equipment, it usually wouldn't start after two weeks in the garage, would rarely start after three weeks, and never started after a month of inaction. The drain from an inactive stereo is minor—a few pilot lights, some preset station memories, the amplifiers' turn-on sensing circuits, and perhaps a digital clock—but it does add up, over time. Assuming a 50 amp-hour battery must lose three-quarters of its power before it can no longer start the car, then a constant drain of only 100 milliamps or so will render the car unstartable after two weeks. That's why I've mentioned battery problems several times in this column. When the system was in, my jumper cable was my most valuable audio accessory.

But then I removed the stereo system, in preparation for my shift to a new car. I didn't drive the old buggy again for six weeks after that; when I did, it started right up.

In my new car, I think I'll add a cut-off switch to limit the battery drain when the car is not used for several weeks. Anyone know where I can get a big, fat, 12-V relay that can stand the underhood environment?

Phasing the Music

Books on stereo, and most amplifier or speaker instruction books, stress the importance of ensuring that the left and right speakers are in phase with one another. Otherwise, if the left speaker pushes when the right one pulls, low bass frequencies are cancelled, and imaging becomes uncertain.

In car stereo, we must also make sure that the rear speakers are in phase with the front ones. A red-faced industry executive just told me he'd belatedly discovered that this had not been done for his car. When he corrected the anomaly (a simple matter of reversing the leads of both rear speakers), bass response picked up considerably.

The simplest way to check the phasing of your car's system is to slowly move your system's front-rear fader control from one extreme position to the other while playing music with plenty of low bass. If you hear less bass when the fader's at its middle setting than when it's set to full front or full rear, then you probably have this problem, too.

If this is inconclusive, reverse the wiring on your rear speakers and run the test again. Whichever wiring setup gives you more bass when the fader's centered is the correct one.

How much more bass will correct phasing yield? We recently compared frequency response curves from two cars of the same model, one with improperly phased rear speakers, the other with correctly phased speakers. The results are not 100% accurate because the tests were performed in different labs, but even allowing for that, the difference is striking. With all speakers playing, the misphased system had a substantial roll-off below 160 Hz, and its output was down (re: 1 kHz) about 15 dB at 40 Hz; the correctly phased system's output was actually *up* 2 dB at 40 Hz!

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These quotes about Linn loudspeakers come from highly respected reviewers. We could literally fill this entire page with similar quotes (but then, so could any other manufacturer). Fortunately for us, it takes a lot more than a rave review to make a good speaker. It takes solid engineering.

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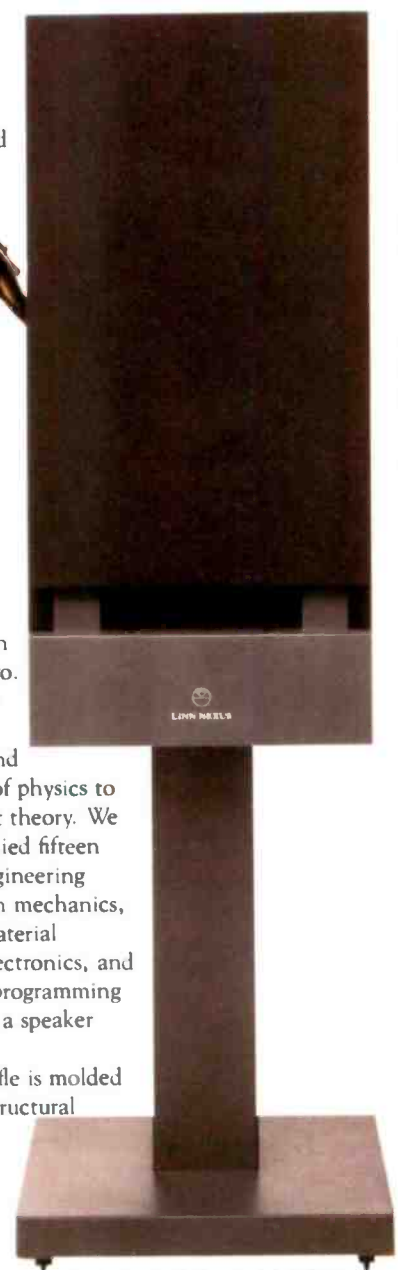


See dealer list on page #62.


Part I
SPIE AI

Ken Kantor

KERS BY DESIGN

It's no great secret that computers have impacted the field of loudspeaker design in a big way. Remember all those corny photos of very serious-looking engineers looking very seriously at computer screens aglow with 3-D plots and response curves? Well, the days are gone when only the biggest and richest manufacturers could advertise, with any justifiable pride, their use of computerized design techniques. The news now is that personal computers are entering the picture. As processing capabilities expand, powerful speaker design software is becoming available for the IBM PC family. Programs for crossover, enclosure, and driver design are providing fast and accurate results to professional and amateur speaker designers alike.

Probably the best way to illustrate the role that personal computers play in loudspeaker design is to develop a working speaker system of our own, step by step. We will confront the kind of design decisions that professional designers face every day, and call on the personal computer to help support these decisions. The reader is encouraged to construct the loudspeaker we develop; the result will be at least the equal of high-quality commercial offerings.

Computers influence each step of the speaker design process, from beginning to end. For example, to initiate the development of any new loudspeaker system, decisions must be made about general system architecture . . . how big, how many drivers, what type of enclosure, etc. These decisions are heavily influenced by the designer's individual philosophy, and by particular application requirements, such as size or price constraints. At this early stage, the computer is useful for running the kind of tedious, repetitive analyses that are necessary to cull through the thousands of available driver types in order to zero in on the most suitable units. A computer can also help the loudspeaker engineer quickly perform "what-if" tests to study the interaction of drivers with each other and with enclosures.

Next, the designer must plow through the tedious mathematical procedures required to implement the real details of the speaker. Exactly how does the cabinet match the chosen woofer? What happens when the crossover network interacts with the tweeter's impedance curve? How many grams of polyester fiber should be used inside the enclosure? These are among the many questions professional designers must answer for each and every new loudspeaker. Because calculations which used to take hours now take but moments, a credible prototype can be specified far more quickly, and with greater success, than even a few years ago.

Final product refinement can take months and can involve literally hundreds of recalculations of box "tunings" and crossover responses. The human ear is inevitably the ultimate arbiter in refinement decisions, so listening tests are an essential part of the final design phase. By rapidly weeding out blind-alley modifications, computers have actually increased the amount of time most designers spend listening to final prototypes. Freeing engineers and designers from the need to calculate for a day in order to listen for an hour, allows much more time to be spent on well-focused and productive listening.

In case you are worried about automation heralding an era of bland, ho-

Photography: David Hamsley

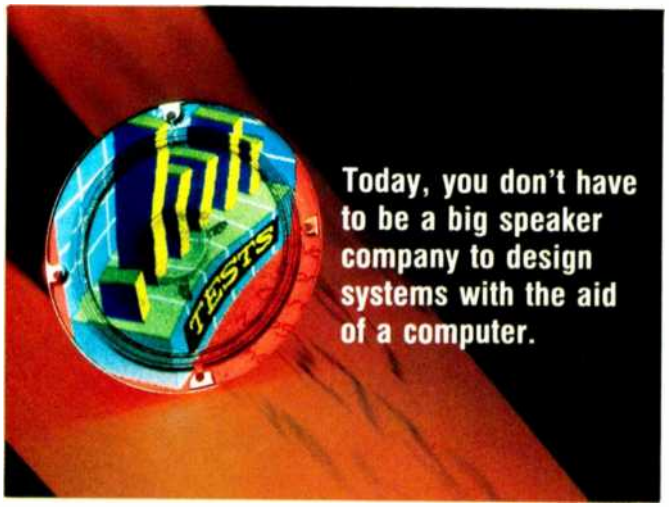
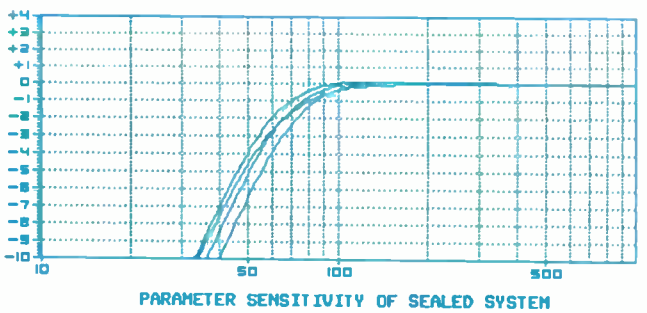


Table I—Steps in the design process.

1) Choose overall system configuration, size of woofer, number of drivers, etc.
2) Choose vented or sealed system
3) Select actual woofer
4) Measure woofer's Thiele-Small parameters
5) Design and construct enclosure
6) Test woofer frequency response in enclosure
7) Choose crossover point
8) Choose tweeter
9) Measure tweeter frequency response
10) Design and construct crossover network
11) Measure response of complete system
12) Conduct listening tests
13) Revise crossover network as necessary
14) Finalize construction details



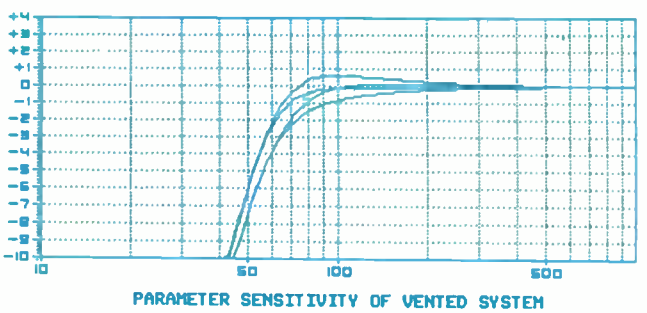


Fig. 1— *How performance of sealed and vented speaker systems is affected by small changes in woofer parameters.*

mogenous speaker sound, remember that computers can't really design loudspeakers. First off, speakers are frighteningly complex systems. Accurate, full-range prediction of frequency, time, and polar response are beyond even the largest computers available to engineers. Even more important, nobody seems to know how to put into words and numbers what it is that a good speaker is supposed to do. There are as many theories about the relationships between measured factors as there are designers. So computers remain tools, helping designers to achieve what they want and to understand what they hear.

A Design of One's Own

The question of where to begin a speaker design is difficult to answer definitively. One could, for example, develop an entire system design around some particular crossover capacitor value deemed to have mystical sonic properties. Or one might, perhaps, attempt to develop a full-range system using a single 18-inch cone woofer. Anything is possible, and silly things have been tried.

The general design approach we will follow is outlined in Table I. Probably the most useful point of embarkation is a decision about how many drivers are to be used, considering what the system application is to be. As a design exercise, a two-way system makes good sense. It enables one to realize excellent sound from an affordable configuration, without getting bogged down in overly complex crossover issues. Faced with the choice of starting with a box and designing the drivers, or vice versa, we'll go for the latter; that's because few hobbyists construct their own drivers.

In a two-way system, a 6½-inch woofer is a good choice. It's a popular size, and one that works well in an enclosure of moderate volume. Finding a driver with good midrange response, together with a reasonable amount of bass, will be relatively easy. As we get started on woofer selection, we will gradually gain all the information we need to choose an appropriate tweeter for the system.

The Low-Down on Woofer Parameters

The primary role of a loudspeaker box, besides physically supporting the drivers, is to prevent the woofer's antiphase rear wave from cancelling the

Ken Kantor is president of Product Design and Evaluation Services, in San Francisco, and is co-founder of speaker manufacturer Now Hear This.

desired low-frequency output from the front of the speakers. This role leads to a close interdependence between woofer and cabinet. The woofer/enclosure relationship is the essence of low-frequency loudspeaker design. To get a handle on things, it is necessary to understand the mechanical, electrical, and acoustical properties of woofers.

The behavior of any given woofer can be partially characterized by a set of numbers generally called "low-frequency parameters." These parameters measure factors like cone weight and suspension springiness, and can be used to predict how a woofer will respond to input signals and how it will be affected by a speaker box. Parameters are most useful for predicting the low-bass frequency response of the speaker; they only hint at upper-range response, and at the issues of power handling and distortion. While woofers with identical parameters might have very different frequency response curves at the middle and top of their ranges, it is a safe bet that they will have very similar curves at the lowest frequencies, where the enclosure has the greatest influence.

In the early '70s, the speaker theorist Richard H. Small, expanding on the earlier work of Beranek, Thiele, and others, began an ambitious effort to organize and simplify the problem of low-frequency loudspeaker design. He suggested the use of a particular set of parameters, now commonly called "Thiele-Small Parameters," for use in developing both sealed and vented enclosures. In fact, Small suggested that the behavior of any piston woofer can be reduced to only three numbers, for purposes of calculating low-frequency response and box interaction (Table II).

Small's work was a major advance in saving time and increasing accuracy. But the mathematical effort required to measure and derive the necessary parameters, and to calculate and display their effects, still prohibited much exploration of alternatives and possibilities in a new design. The automation of Thiele-Small computations was one of the first tasks speaker engineers gave to their computers. Now there are a number of commercially available speaker design programs, selling at anywhere from under a hundred to several hundred dollars. Scientific Design Software, a Southern California firm, offers a very useful and affordable software package to help measure drivers and to perform Thiele-Small calculations on a personal computer. Called "Computer-Aided Speaker Design" (CASD, for short), the package maintains extensive files of the offerings of driver manufacturers, and can also assist with basic crossover design tasks. CASD will help us as we progress, generating the enclosure-design graphs.

Table II—Important Thiele-Small parameters.

Parameter	Symbol	Typical Woofer	Description
Free-air resonance	f_s	20 to 100 Hz	The frequency at which a woofer tends to vibrate naturally, like a tuning fork.
Total Q	Q_{ts}	0.2 to 0.8	Sharpness of resonance. Affects the length of time a woofer will tend to keep vibrating after its input signal stops.
Volume-equivalent compliance	V_{as}	10 to 500 liters	The volume of trapped air which would have the same amount of springiness as the woofer.

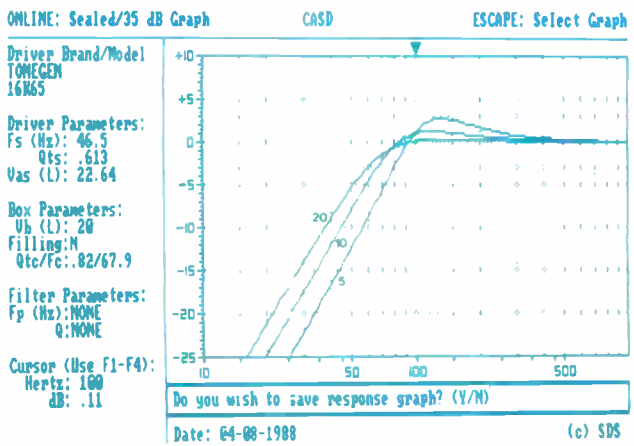


Fig. 2— *Computer-predicted response of Tonegen 16K65 woofer in 5-, 10-, and 20-liter sealed enclosures.*

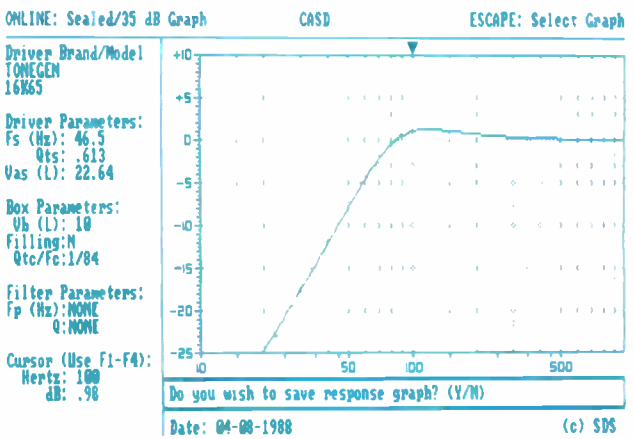
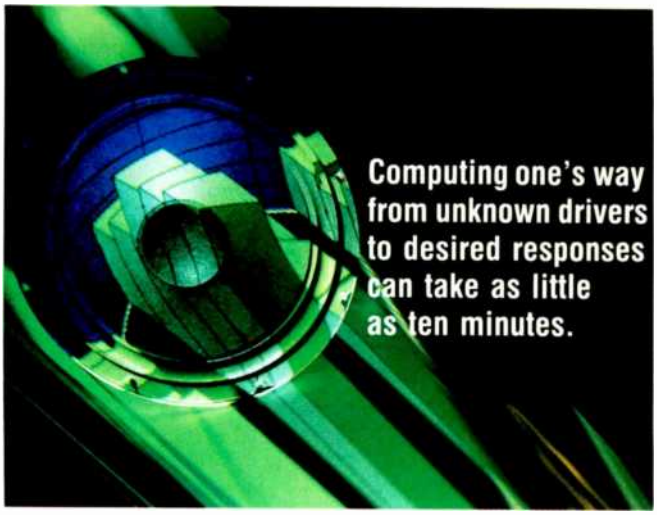


Fig. 3— *Computer-predicted response of Tonegen woofer in 10-liter sealed enclosure. Note the gentle peak just above the cutoff point (see text).*

To Vent or Not to Vent?

For any given woofer, there is one, and only one, enclosure volume that will yield flat bass response in a sealed acoustic suspension configuration. This volume must be known before a speaker is constructed, as there is no way to easily adjust the response after completion. Mainly for this reason, amateur speaker builders have tended to prefer vented systems, which can be "tuned" after completion by adjusting



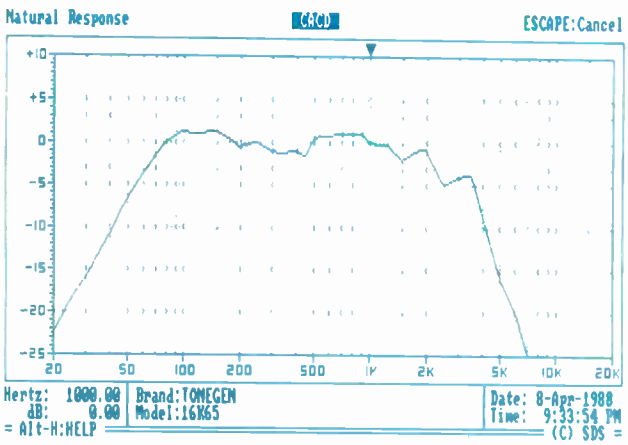


Fig. 4— *Measured performance of the Tonegen woofer in a test chamber. Compare to Fig. 3.*

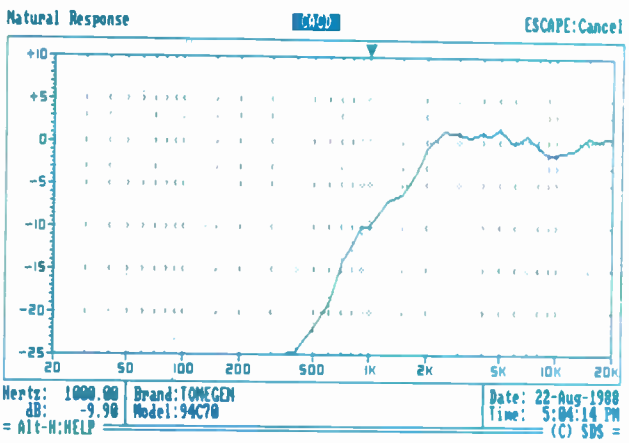


Fig. 5— *Measured response of the tweeter.*

the area and length of the vent. However, with the help of our computer, we can determine the correct sealed-box size initially, and there are two reasons why we might wish to use this approach. The first is that sealed systems are better behaved when driven by signals below their operating frequency range. In a larger system, this wouldn't be as serious an issue, but with a 6½-inch driver, the lowest musical notes will certainly fall below the woofer's capability.

The second reason for going with a sealed approach in a home-built system is the effect that driver and box variations have on the final response. Sealed systems are generally more tolerant of the errors that can arise when determining a driver's parameters, and of the variations from one production driver to the next. To show this, we can use our computer to calculate and plot the different response curves that result when various Thiele-Small parameters depart from the values around which an enclosure has been designed. Figure 1 compares two speakers in this manner; one of the speakers is vented and the other is sealed. When the parameters are correct, the systems have a very similar response, maximally flat with a bass cutoff just below 60 Hz. As the parameters drift, by an amount not all that unusual, the sealed system can be seen to vary most below its bass cutoff, where the effect on tonal balance will be reduced. In contrast, the vented system might exhibit significant changes in its overall balance, as the critical bass frequencies between 80 and 200 Hz change by almost 2 dB.

A Choice Woofer

For this construction project, woofers from several of the top driver manufacturers in the U.S. and abroad were considered. Important requirements were defined to be:

1) Thiele-Small parameters appropriate for flat bass response in a sealed box of roughly 10 liters,

2) Good, clean response up through several kHz, and

3) Consistent performance from unit to unit.

The recommended unit is a 6½-inch driver made by Tonegen of Japan, from their 16K65 family. As well as meeting the criteria set forth above, the 16K65 has low distortion and a well-controlled, natural roll-off that will simplify our crossover requirements.

Woofer parameters are most commonly determined based on data obtained from the driver's impedance curve. This is generally done in "free air" (no enclosure), using an unmodified driver, but certain parameters are most accurately calculated from the impedance changes seen when a driver is modified by adding mass to its cone or by placing it in a test enclosure whose volume is precisely known. Of course, many driver suppliers provide a list of important parameters for their products, but the possibility of error, and the effect that small test details can have on results, mean that most professional speaker designers use published specs for general selection only. Exact parameter determination is always done in the designer's lab.

The CASD software package includes a subprogram, called "DATA," used to help calculate parameters from a driver's impedance curve. Table III shows the results of a DATA program test on the 16K65 woofer we will be using. All the engineer need do is connect the driver to impedance-measurement equipment and enter into the computer the information that DATA requests. At one point in the

procedure (which takes about three minutes with advanced measurement equipment), the impedance must be recalculated with a small weight placed on the cone, or with the driver in a box of known volume. This is necessary to calculate the compliance, or springiness, of the driver.

Of all the parameters displayed by DATA, only three—f_s, Q_{ts}, and V_{as}—are necessary to design an appropriate enclosure. By typing these three parameter values into the CASD program, we can easily generate a family of curves showing the predicted response of the woofer in 5-, 10-, and 20-liter enclosures (Fig. 2). The entire process of going from an unknown driver to a predicted response takes, including setup, perhaps 10 minutes. A far cry from the many hours an engineer with a calculator must spend!

The 5-liter enclosure is clearly too small, resulting in reduced bottom-end response and a peak in the mid-bass. The 20-liter enclosure exhibits a relatively flat response and the best deep bass. For a 6½-inch woofer, the 10-liter enclosure, with a bass cutoff of 62 Hz, is probably the best choice (Fig. 3). Almost all small loudspeaker systems are designed to be underdamped, with a slight peak near the bass cutoff point. If this peak is kept small—less than 3 dB or so—it will not add boominess, and will help achieve a natural tonal balance by complementing an extended top end. Maximally flat response on systems that have a bass cutoff above about 50 Hz almost always yields a speaker that subjectively is overly bright.

Our next step will be to construct a 10-liter box and test the actual acoustic response of our system. There are two important questions we can answer with this test: "Are our computer predictions correct?" and "What is the upper frequency limit for good response from our woofer?"

Figure 4 shows the curve of our woofer in a test chamber. To a practiced eye, there is good correlation with the predicted low-frequency response; the bass cutoff frequency and degree of peaking are just about what CASD described. At higher frequencies, out of the range of Thiele-Small estimation, the 16K65 is flat within ±1 dB or so, up to its high-end limit. Considering that this is a high-resolution, non-smoothed plot, that represents excellent performance.

Look, Listen, then Crossover

Because woofers can typically handle much more power than tweeters, it is tempting to raise the crossover frequency of a two-way design as high as

Table IIIA—Measured woofer parameters entered into CASD program.

Driver d.c. resistance (R_e)	5.00 ohms
Driver resonance frequency (F_s)	47.00 Hz
Driver maximum impedance at F_s	43.20 ohms
Lower resonance-width frequency (F1)	35.40 Hz at 14.70 ohms
Upper resonance-width frequency (F2)	61.20 Hz at 14.70 ohms
Calculated square root of (F1 × F2)	46.50 Hz
Calculated error factor	1.10%
Compliance Calculation Method	**Test Box**
Test box volume	7.00 liters
Driver resonance in test box	90.80 Hz
Driver piston diameter	131.00 mm
Driver magnet gap depth	14.50 mm
Driver voice-coil length	8.70 mm

Table IIIB—Woofer data calculated by CASD.

Thiele-Small Parameters	
Free-air resonance (F_s = V F1 × F2)	46.50 Hz
Total system Q (Q_{ts})	0.6132
Total electrical Q (Q_{es})	0.6934
Total mechanical Q (Q_{ms})	5.30
Equivalent acoustic compliance (V_{as})	22.64 liters
Piston area (S_d)	0.0135 square meter
D.c. resistance (R_e)	5.00 ohms
Volume displacement (V_d)	39.09 cc
Linear displacement (X_{max})	2.90 mm
Reference efficiency (Ref Eff)	0.32%
Efficiency bandwidth product	67.06 Hz
Other Calculated Data	
Moving mass of diaphragm alone (M_{md})	11.89 grams
Moving mass of diaphragm and air load (M_{ms})	13.16 grams
Mass of air load on diaphragm (M_{ma})	1.27 grams
Compliance (C_{ms})	0.00078 m/N
BL product (BL)	5.26 Newtons/ampere
Sensitivity (SPL 1 w/1 m)	86.99 dB

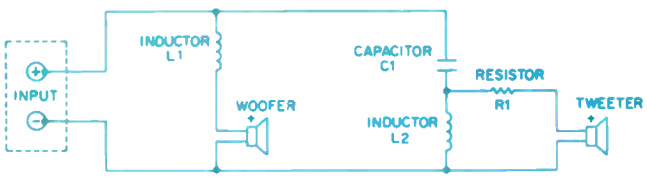
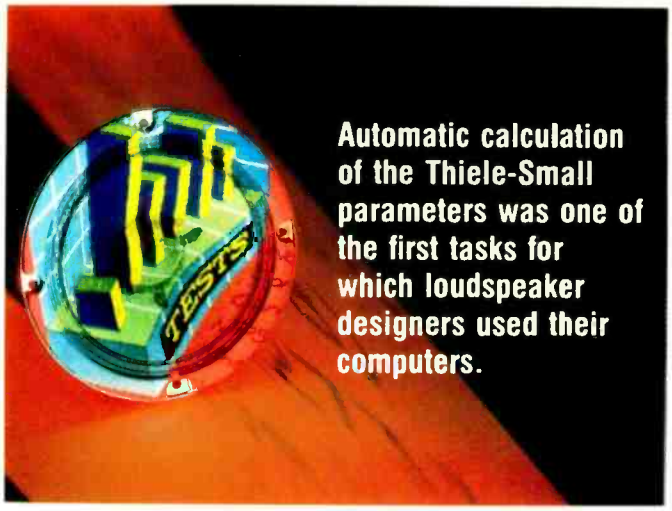


Fig. 6—*Crossover network, with a first-order low-pass filter for the woofer and a second-order high-pass filter for the tweeter. Resistor R1 is for use in matching tweeter and woofer output levels.*



Automatic calculation of the Thiele-Small parameters was one of the first tasks for which loudspeaker designers used their computers.

Software of Note

Computer Aided Speaker Design (CASD)
General purpose Thiele-Small enclosure design; extensive driver library files; basic crossover tasks; miscellaneous speaker design utilities; includes "DATA" parameter calculation program.
Company Address: Scientific Design Software, Attn: Ted Telesky, P.O. Box 3248, Chatsworth, Cal. 91313; (818) 718-1201.
Price: $199.95.

Computer Aided Crossover Design (CACD)
Advanced crossover network design; driver impedance modelling; system response prediction; sophisticated electrical network analysis and optimization.
Company Address: Same as above.
Price: $349.95.

Loudspeaker Enclosure Analysis Program (LEAP)
Advanced enclosure design and analysis; handles multi-driver and multi-enclosure systems; modelling beyond Thiele-Small limitation; output includes phase, delay, impedance, etc.
Company Address: CNS Electronics, Attn: Chris Strahm, P.O. Box 42389, Portland, Ore. 97242.
Price: $199.

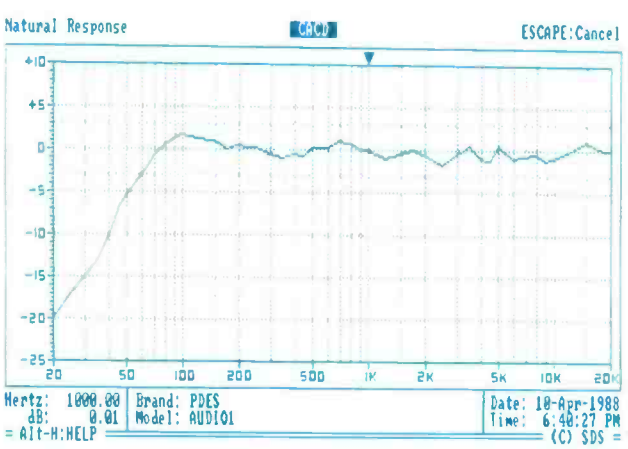


Fig. 7—*On-axis frequency response of the completed system, measured at 1 meter.*

possible. This sends more energy to the woofer and less to the tweeter. There are two basic factors that restrict how high a woofer can be run. First is the question of directivity. All piston drivers begin to beam their output into a narrow angle as frequency increases. The larger the driver, the lower the frequency at which this happens, regardless of the individual frequency response of the driver. This places a limitation on how high we can take our 6½-inch woofer—about 4 kHz, as an approximation.

The second issue to consider is how high in frequency a particular woofer can maintain an ample and smooth sound output. The 16K65 Tonegen woofer starts a gradual roll-off above 2 kHz, with a rapid roll-off above 3.5 kHz. This suggests opting for a crossover point of about 3 kHz, in line with directivity considerations. Since all crossovers necessitate a region where both woofer and tweeter are overlapping to some degree, the reduced woofer output above 2 kHz, but below our crossover point, will provide a good transition range and will help avoid a midrange bump. Above the crossover point, our electrical filter will combine with the woofer's natural response to provide a very fast cutoff. Now we can select a tweeter and begin a theoretical network design. Precise determination of the final crossover characteristics will be left until we can measure and audition the complete system.

Referring back to Table III, we can see that the DATA program estimated our woofer's sensitivity at just about 87 dB/W/m. It is very difficult to balance driver levels exactly before building a test system, so it is wise to consider ways to adjust levels using the crossover network. Since padding down the output of a tweeter to match a woofer's output is much more practical than the opposite approach, we should select a tweeter that has a sensitivity of at least 89 dB, to be safe. The Tonegen 94C70 is a good unit, and one that meets our frequency and sensitivity requirements. (The response of this unit is shown in Fig. 5.) This 1-inch dome tweeter will have no problem with a 3-kHz crossover point.

A first-order (6 dB/octave) filter will work well on the woofer because it has a rapid and well-behaved natural roll-off. For maximum power handling and the smoothest midrange, a second-order (12 dB/octave) filter will be used on the tweeter. (The network topology chosen is shown in Fig. 6.) A resistor is included in series with the tweeter, so that the tweeter's output level can be trimmed to exactly match that of the woofer.

Crossover network design is perhaps the most misunderstood aspect of amateur speaker construction. The complex impedance curves of loudspeaker drivers and the interaction between electrical and acoustical responses make cookbook crossover design a myth. Many hobbyists design circuits that assume drivers look like resistors or purchase prefab crossovers based on the same assumption. If either of these approaches gets within two miles of the desired response, it is a rare accident indeed. Accurate design requires many hours of measurement, calculation, and refinement.

A new offering from Scientific Design Software, the creators of CASD, is useful in reducing the amount of trial and error involved in network development. Called CACD (you can guess what for), the program processes detailed descriptions of actual impedances and responses, applying advanced mathematical optimization techniques to adjust the values of a user-entered circuit. The real power of CACD is that it can handle just about any kind of circuit and driver accurately. There is no need to work with standard designs. Tables IV and V show examples of some of the kinds of data CACD processes as input and output, respectively. To illustrate the evolution of a simple crossover through four phases, from concept to final design, Table VI compares specific crossover component values:

1) Derived from a "cookbook" approach,

2) Suggested by CACD,

3) Refined by measuring electrical and acoustical responses, and then

4) Exhibited in the ultimate version, refined by listening tests.

Table IV—Input data for CACD program.

Parameter	94C70	16K65	16K65 (In Box)	Scale
F_s	1150.00	46.50	76.00	Hz
R_v	7.00	5.65	5.63	Ohms
R_e	6.40	5.00	5.00	Ohms
Z_{max}	22.60	45.00	28.90	Ohms
Q_{ms}	—	5.30	5.62	
Q_{es}	—	0.69	1.17	
Q_{ts}	—	0.61	0.97	
1 kHz	—	9.30	—	Ohms
2 kHz	—	14.40	—	Ohms
4 kHz	7.30	22.00	—	Ohms
8 kHz	7.80	36.00	—	Ohms
16 kHz	8.80	61.00	—	Ohms
20 kHz	9.50	—	—	Ohms

Table V—Output data from CACD program.

Computer-Aided Crossover Design 2:04:11 PM
File Circuit Graphs Utilities Model CAP

Circuit File

Brand : TONEGEN
Model : 16K65
Topology : LP

BRANCH	PART	FROM	TO	(+)	(-)	OPT	VALUE
1	L1	1	2			Y	.6 mhy
2	R1	2	3			N	.5 ohms
3	RV	3	4			N	5.63 ohms
4	LVC1	4	5			N	.64 mhy
5	LVC2	5	6			N	.47 mhy
6	RVC1	6	0			N	7.06 ohms
7	RR	6	0			N	23.25 ohms
8	LR	6	0			N	8.66 mhy
9	CR	6	0			N	506 uf
10	0						

OUTPUT NODE > 3

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File Circuit Graphs Utilities Model CAP

Filter's Ideal Target

Brand : TONEGEN
Model : 16K65

Freq	Mag	Freq	Mag	Freq	Mag	Freq	Mag
20	22.5	125	-1.2	800	-1.5	5000	10.1
25	18.4	150	-1.3	900	-1.4	6000	13
30	15.8	175	-.5	1000	-.5	7000	16.9
35	13.1	200	.2	1250	-.5	8000	20.9
40	10.6	250	-.2	1500	1	9000	25
45	8.400	300	.8	1750	-.4	10000	29.2
50	6.6	350	1	2000	-1	12500	32.4
60	3.7	400	.7	2500	2.5	15000	35.9
70	1.5	450	1.3	3000	.8	17500	39.6
80	-.1	500	-.8	3500	0	20000	43.4
90	-.8	600	-.9	4000	4.2		
100	-1.4	700	-1.2	4500	7.3		

ESC to Exit

Table VI—Crossover network values.

Method	L1	C1	L2	R1
Cookbook	0.41 mH	3.3 uF	0.86 mH	4.2 ohms
CACD	0.53 mH	2.9 uF	0.57 mH	7.0 ohms
Refined by meter	0.60 mH	2.5 uF	0.60 mH	8.0 ohms
Final by ear	0.60 mH	2.2 uF	0.60 mH	10.0 ohms

The Solution

Listening tests with a variety of program material revealed a slight excess of upper-midrange energy. This was manifest as a slight harshness on some recordings and particularly affected female vocals. This prompted a new round of detailed measurements, which indicated that perhaps the tweeter output was extended too low in frequency. Minor adjustments to the tweeter crossover point smoothed out the measured and perceived response. Overall balance between woofer and tweeter was judged to be subjectively correct.

Figure 7 shows the measured response of the system at 1 meter, on-axis. Measurement data above 300 Hz was obtained in a listening room, using FFT impulse techniques. Data below 300 Hz was achieved using a near-field method. The low-frequency response shown should be representative of placement on stands at least 1 meter from the side and rear walls. Placement closer to room boundaries would increase deep bass output.

As is good practice with any new design, an impedance curve was run to assure that the system did not present an unduly difficult amplifier load. Average impedance ran well over 8 ohms, with a minimum of 6 ohms at 190 Hz . . . a very easy load.

In our next installment, we'll discuss the construction of our loudspeaker enclosure, concentrating on the general issues involved.

4 x 4

Shure microphone, clipped to shoulder belt, was used for hands-free telephone calls.

IVAN BERGER

Audio outfits a luxury off-road vehicle with posh sound—and someone else, with car sound contests in mind, tops it.

Showpiece car stereo installation projects tend to be in sports cars or luxury sedans. So when Range Rover suggested we might wish to do a system for their $34,000, luxury, four-wheel-drive product, we leaped at the chance. Our goal was to design a system that would mirror the car's own unique combination of posh and practicality. As we were completing this project, we learned of a rather more elaborate installation in the same 4 × 4 vehicle; for details of that second system, see the accompanying sidebar ("Going for Gold").

When I first drove a Range Rover, over a decade ago, it struck me as the world's plushest truck. Over the years, it's gotten plusher and less truck-like, but it's still a workhorse, with a 3.5-liter V-8 engine, full-time four-wheel drive, and plenty of cargo capacity. With the rear seats up and the removable cover shielding the trunk's contents from view, the trunk measures 36.2 cubic feet; removing the cover raises the total further, as does folding down the rear seats.

On the plush side, the Range Rover has some of the best car seats I've ever ridden in. They're power-adjust-

This wedge-shaped Z-Box enclosure looks like factory stock but positions the new speaker for clearer response and better imaging.

BY TWO

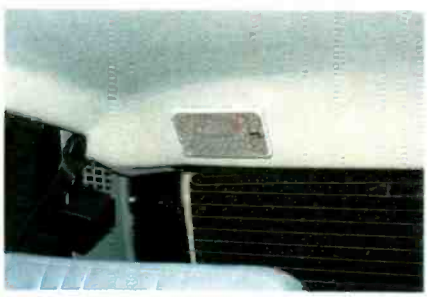
Photographs: ©1988, Bill Ashe

4 X 4 BY TWO

Bill Ashe

The Range Rover lets you take shortcuts like this in style.

John Bishop



The new rear speakers were mounted in the car's original enclosure.

able, with optional Connolly leather upholstery, but their main virtue is their combination of firm cushioning and a superb shape. Cruising comfort is also promoted by a good suspension, factory-standard air conditioning, four-speed automatic transmission, and a stereo system.

The stock sound system's head unit has AM/FM tuning, auto-reverse tape with Dolby NR, and the usual, built-in, low-powered (4 × 6 watts per channel at 1% THD) amplifiers. The stock speakers are 4½-inch dual-cone drivers fairly high on the leading edges of the front doors, and 4-inch rear speakers mounted in an enclosure just above the tailgate opening. The rear-window defroster grid doubles as the radio antenna.

The Path to Better Sound

We wanted to upgrade this system into one whose sound and imaging would satisfy the reasonable audiophile, while taking care not to infringe on the car's utility. This is, after all, not just a luxury sedan but a luxury working vehicle. At this point, Range Rover chimed in that they'd like to consider the possibility of offering whatever sound system we came up with as an extra-cost option; we therefore added the requirement that our system be one that could easily be installed at the port of entry, as the original system now is. For the same reasons, we used a radio/cassette head unit rather than a radio/CD unit, and looked for ways to add a CD player. We also sought a single source for the amplifiers and speakers.

Some of the upgrade paths to follow from that original system were immediately obvious. Because off-road vehicles are often used far from major radio stations, we wanted to replace the head unit with one that had diversity FM reception, plus good AM performance for areas where FM isn't available. We'd also have to supplement the window-grid antenna with a conventional whip, as a further aid to good reception. The stock speakers merited replacing, as such speakers almost always do, and any good speakers that

Bill Ashe

To keep the sound from changing too drastically when faded from front to rear, we used the same speakers at both ends of the Range Rover.

replaced them would probably need more amplifier power in order to do their best. We wanted to maintain the existing speaker positions, both to preserve the car's looks and to avoid calling thieves' attention to the fact that we'd installed anything special. Since those speaker sites did not allow much bass to be developed, we'd need to add subwoofers, too.

The Range Rover, however, put some unconventional hurdles in the way of those conventional ideas. The dashboard radio slot is tilted, so that the head unit's faceplate faces up, rather than straight back. That meant we needed a head unit that could successfully eject tapes upward. Also, space behind the dash is limited.

Finding a spot to put the amplifiers and subwoofer system was a problem, too. Because Range Rovers haul bulky cargo fairly often, their parcel shelves are light and thin, for easy removal and replacement. Reinforcing the shelf enough to hold subwoofers would compromise the vehicle's utility, so we ruled the shelf out as a woofer location. There was no space to put subwoofers under the seats. There was precious little room below the folding rear seats, too, which give access from the interior to the trunk (handy in mud or deep water) and allow long loads to be carried. Conventional subwoofer boxes, which are normally bolted just behind the rear seats, would limit this access and load capacity.

Lastly, we felt that Range Rover customers would be more likely than most to want cellular telephones, which meant we had to find room for one of those, too.

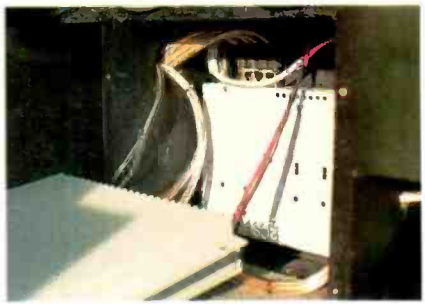
Speakers, Amps, and Crossover

We used a/d/s/ speakers and amplifiers, since they were of suitable quality and likely to fit into the spaces available. That also gave us the chance to use the valuable expertise of John Bishop, Vice President of the automotive division at a/d/s/, who oversaw installers Bob Hazelwood and Steve Ravinski of the a/d/s/ Design and Installation Center.

We wanted to use the same speakers at both ends of the car, to keep the sound from changing drastically when it was faded from front to back. In a sedan, such changes are hard to avoid even when the speakers are the same, because the front speakers usually fire directly at the listeners while the rear speakers bounce up off the window glass. In the Rover, where the rear speakers are mounted high, we had a better chance of getting similar sound from both sets of speakers. However, space limitations in the front entailed our using fairly small loudspeakers; we selected the a/d/s/ 200i plates, with 4-inch cone woofers and 1-inch dome tweeters.

For better imaging and clearer high-frequency response, we wanted to mount the front speakers higher in the doors. John Bishop therefore had Classic Research (see sidebar) make small, wedge-shaped surface-mount enclosures, which not only kept the speakers from interfering with the window and door mechanisms, but also angled each speaker at the listener in the opposite front seat. The rear speakers were mounted in Range Rover's original overhead enclosure. These loudspeakers have a rated frequency response of 150 Hz to 20 kHz, ±3 dB.

Low bass was handled by the subwoofers, two pair of a/d/s/ S6.2 6-inch drivers, which are rated to cover the



John Bishop

The crossover is recessed deeply into the side of the subwoofer cabinet to leave room for the amplifier.

Bill Ashe

The subwoofer cabinet (A), nestling in the trunk, also held the amplifier and the crossover (mounted behind the amp). The black box at the right is the cellular-phone transceiver. A carpet over the subwoofer cabinet (C) protects the contents from cargo shifts and prying eyes—and may even help the sound a little.

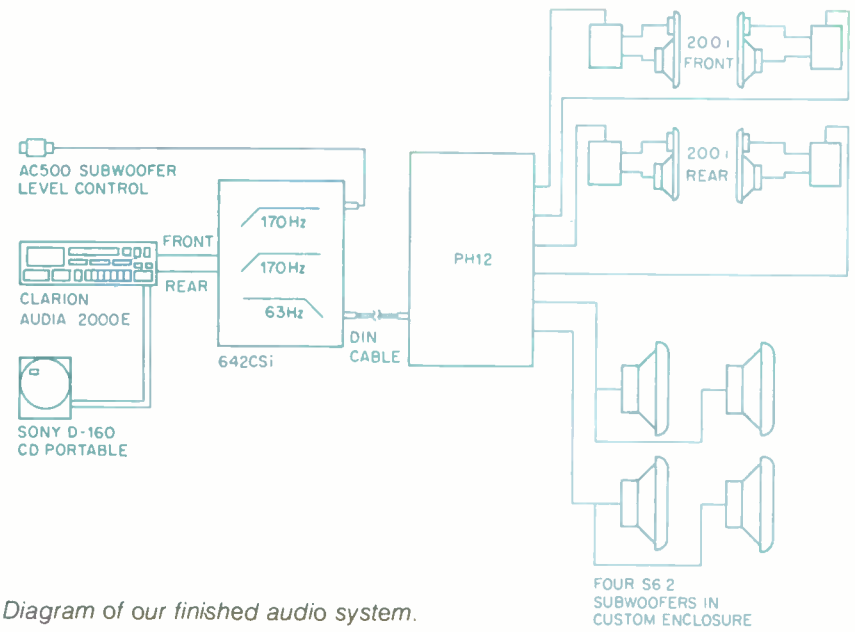


Diagram of our finished audio system.

The Clarion Audia 2000E head unit was an easy substitute for the original Clarion. To its left are the subwoofer level control (just above the lighter) and part of the Nokia-Mobira telephone handset.

The sound system cabinet (at right of trunk) infringes on trunk space less than the factory-supplied panel that covers the spare tire (left).

The subwoofer's enclosure had to be custom-built to tuck neatly into one side of the trunk, thus leaving the car's loadbed clear.

range from 30 to 85 Hz, ±3 dB. They were mounted in a 0.7-cubic-foot enclosure, which was custom-made to fit into the right side of the trunk, between the wheel well and tailgate. Recesses were built into the wall on the trunk side of the enclosure, to hold the amplifier and crossover. (Similar bass could be obtained at less cost by substituting the a/d/s/ SB7 subwoofer, which uses two 7½-inch drivers in a factory-built enclosure, and sells for $400. This woofer system would not tuck neatly out of the way like our custom one, but can be easily removed from its mounting brackets when the space it occupies is needed for cargo.)

The amplifier was the a/d/s/ PH12, a six-channel model rated to deliver 20 watts per channel into 4 ohms. This was plenty for the 200i satellite speakers, especially as they were not handling any deep bass. The subwoofers actually received 35 watts per pair, or 70 watts total, because each pair was hooked up in parallel, making a 2-ohm load.

For a crossover, we used the a/d/s/ 642Csi. This is one of the few aftermarket crossovers I know of which sums the bass output from the front and rear channels to keep bass constant, regardless of fader position. It also can be used with an external subwoofer level control (the a/d/s/ AC500), which we mounted in the dashboard near the head unit. The desired effect was to roll the subwoofers off above 85 Hz and roll the satellites off below 170 Hz. Such staggered crossover frequencies are commonly used in cars, most of which have strong acoustical resonances in the frequency range where you'd expect the gap between the speakers' response ranges to be audible. Because the smallish enclosure volume had a fairly high system resonance, the crossover low-pass filter was actually set at 63 Hz; the net effect of this roll-off and the woofer's response hump gave us the 85-Hz roll-off we wanted.

The main transceiver section of the cellular phone, a Nokia-Mobira 412 (which was installed by 800 Cellular, here in New York), was mounted to the rear of the woofer cabinet, where it can easily be removed for portable use. The woofer cabinet and the attached phone transceiver then were covered

GOING FOR GOLD

What we wanted from our Range Rover system was a combination of good sound, cost-effectiveness, and practicality. Todd Kane of Beverly Hills had a simpler goal for the sound system to be installed in his Range Rover: He wanted to win auto sound contests.

It's too soon to tell how well he'll do, since moving to another state delayed Mr. Kane's quest (he'll be entering his first Car Audio National contest as we go to press). But the system that Classic Research and Engineering, of Tucson, set up for him looks like a winner.

From inside the passenger compartment, Classic's system looks much the same as ours did. Their head unit (actually the control head for Alpine's 5950 CD changer), like ours, is mounted in the dashboard's radio slot. The front satellite speakers are also a/d/s/ 200i plates, mounted in the same Classic Z-Box enclosures as a/d/s/ used for our system. The rear satellites, also 200i plates, appear at first to be mounted in the factory stock positions, as ours were. A closer look, however, reveals that they're mounted in other Z-Box enclosures, which tilt them up and toe them in a bit, for better imaging.

Look closer, and you'll notice additional differences between their system and ours. For example, Classic's system adds a center-channel speaker, another 200i, mounted in the top front center of the dash; the

Front speakers, including a/d/s/ S7 woofer in kick panel below dash and 200i system in Z-Box enclosure on door.

Rear speakers in original locations, but re-aimed by Z-Box enclosures.

With the parcel shelf in place, the system enclosure cramps the trunk space.

Carpeting protects and conceals all components except the CD changer.

Woofer enclosure and grilles. Relays at left rear of enclosure switch power to system components.

Subwoofer enclosure and left side cabinet. Note crossovers, fan, and S7 woofer set into cabinet top, and Alpine 5950 changer and a/d/s/ PQ20 amp on shelf.

Cabinet on the right side of the trunk holds the remaining amplifiers and crossovers, plus another S7 woofer and cooling fan.

Photographs: Balfour Walker

amplifier driving it is bridged and is fed the summed left and right channels. Two a/d/s/ S7 drivers in Z-Box enclosures are mounted in the kick panels by the driver's and front passenger's feet, and two more are mounted on the rear subpanels which flank the removable parcel shelf. In an ordinary system, these drivers (whose rated response is 30 to 85 Hz, ±3 dB) would probably be called subwoofers; here, they're called mid-bass drivers.

The reason for that change of nomenclature becomes obvious once you look in the trunk. The trunk's original floor level has been raised about a foot, to accommodate a 4.1-cubic-foot enclosure holding four a/d/s/ S10 10-inch woofers, whose −3 dB point is rated at 20 Hz. Flanking this mammoth woofer system are two cabinets. The one on the left side of the car holds one S7 speaker, two of the four crossovers, the CD changer (near the tailgate, for easy access), and one of the system's three a/d/s/ PQ20 amplifiers. The one on the right holds the other two crossovers, three amps, and the remaining S7. Twelve-volt fans force cooling air into each cabinet.

As the two rear views show, all this does take a big bite out of the trunk when the parcel shelf is in place, but there's still plenty of room when the shelf is removed. There'd be even less room if the spare tire, jack, and tools had remained in the trunk, but Classic Research built a bracket to mount the spare outside the tailgate, and found ways to store the jack and tools under the hood.

That was just the first of several under-hood changes. A second battery was added to power this 1,290-watt audio system—and to make room for that, the power-steering reservoir had to be moved, and the air-cleaner snorkel shortened. Stone guards also had to be installed inside the front wheel wells, to protect the backs of the Z-Box enclosures in the kick panels.

From a sonic standpoint, this system should do the job. But will it win contests? Time will tell. And if Mr. Kane will keep us posted, we'll let you know, too. *I.B.*

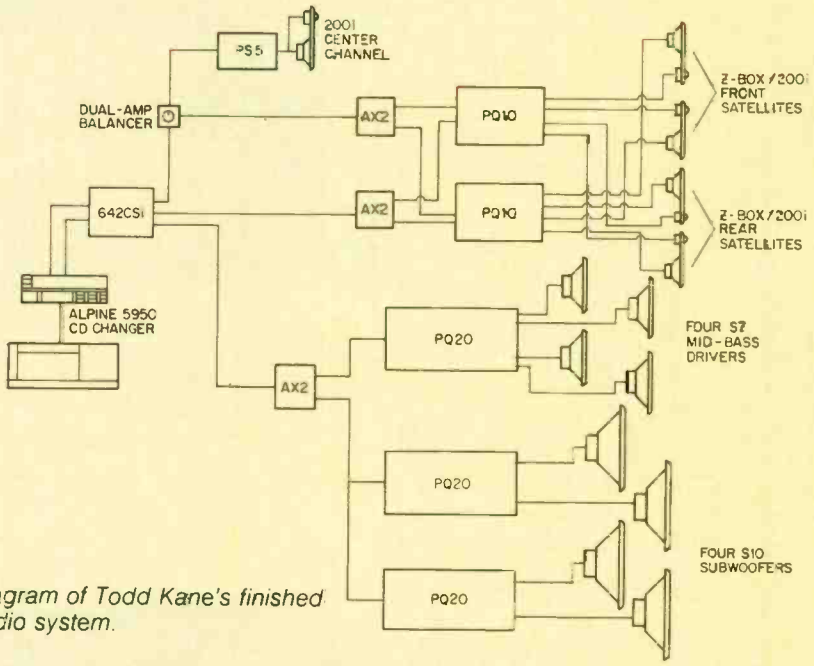


Diagram of Todd Kane's finished audio system.

SYSTEM CONTENTS

Source	
Alpine 5950 CD changer	$ 1,500.00
Electronics	
a/d/s/ PS5 amplifier (40 watts × 2 or 90 watts × 1)	280.00
a/d/s/ PQ10 amplifier (40 watts × 4; two units)	1,020.00
a/d/s/ PQ20 amplifier (80 watts × 4 or 200 watts × 2; three units)	2,310.00
a/d/s/ 642CSi crossover	230.00
a/d/s/ AX2 crossover (three)	390.00
Speakers	
a/d/s/ 200i panel-mount two-way satellites (five)	650.00
a/d/s/ S7 woofers (four)	440.00
a/d/s/ S10 subwoofers (four)	880.00
Enclosures	
Z-Box RRF2 front satellite enclosures (one pair)	560.00
Z-Box RRR2 rear satellite enclosures (one pair)	560.00
Z-Box RRKSW front woofer enclosures (one pair)	500.00
Miscellaneous Parts	
Cooling fan, dual batteries, fans, lumber, etc.	461.62
New carrier for spare tire	385.00
Equipment Subtotal	$10,166.62
Labor (Design and Construction, 168 hours)	5,880.00
Grand Total	$16,046.62

with a Range Rover carpet, so they would blend unobtrusively into the trunk's interior and would be protected against accidental damage from loose cargo. To my surprise, the amplifier did not overheat with this carpet cover on, even in warm weather. In really hot weather, however, it might be wiser to roll the carpet up and off the units. Covering subwoofers with a rug does not muffle them, since their low frequencies pass through it readily. If anything, this covering may improve subwoofer performance a wee bit, by acoustically filtering out higher harmonics of the bass that could call attention to the woofers' location.

To install the subwoofer cabinet, we'd had to move the jack and tools to the opposite side of the trunk, and mount them inside the hollow hub of the spare tire. The stock Range Rover trim panel hid all this.

Up-Front Matters

One of the reasons we'd decided to use a head unit with diversity tuning was that, at the time, we were testing two such head units—the Blaupunkt Berlin and Clarion Audio 2000E, reviewed in the May 1988 issue—and were impressed by their performance. The Range Rover's in-dash space limitations ruled out the Blaupunkt, which occupies two DIN-size chassis. Luckily, the Clarion did fit, and had no trouble with tape ejection. We know of no radio/CD head units with diversity tuning, but if we had chosen a CD-based head unit, it would probably have been one of the new Kenwood models that are specifically designed for angled as well as level mounting.

There's no room for a separate CD player in the dash, so we had to find another spot to put it. Luckily, the hollow center armrest console, which serves as the Range Rover's glove compartment, was wide enough to hold a small portable CD player; unluckily, putting a player there eliminates the glove compartment, though the player and its mount are easily removable (all connections are plug-ins) and there are still map pockets in both front doors.

We initially picked Sony's D-160 portable player, which comes with a power adaptor and shockmount for car use, and which has oversized controls

Bird's-eye view of the system, with CD player at the bottom and head unit, subwoofer level control, and cellular phone at the top. (The CD fader control was installed later.)

Bill Ashe

The dash wouldn't hold the tape and CD players, so we put the CD into the Range Rover's center-armrest glove compartment.

John Bishop

The shockmount for the Sony D-160 CD player was installed in the center glove-compartment/armrest console, and wires run to it. The black switch inside the compartment (lower left) selects which signal, CD or head-unit, will go to the amps; the black knob on the front of the console (upper left) is the fader for the CD player.

We only used one amp, a six-channel model that pumped 150 watts into the four subwoofers and four satellites we installed.

and good night illumination. Power and audio leads were run into the glove compartment. A switch was mounted there with the player, to turn on the CD power and select either the head-unit or CD-player signal to be fed to the amplifier.

We'd hoped to run the CD player's signal into the CD/AUX input on the Clarion, so the same volume and other controls could be used with all sound sources. However, the player's output level was far too high for the Clarion's input, and padding the level down gave us noise problems.

Analyzing the situation, we realized that the sound from the CD was good enough to obviate the need for tone controls, and that the cross-firing front speakers controlled imaging well enough so that we did not need a balance control either. What we did need was a front/rear fader for CD play, so we added one to the front of the armrest console.

Because Range Rovers do go into brush, we had briefly considered using another snag-free window-grid antenna in the front to allow for diversity tuning; such an antenna is supplied with the Clarion Audia 2000E. However, units like this provide only mediocre reception, on both AM and FM, so we stayed with our original idea of adding a regular mast. A Hirschmann Auta 6000 EL power antenna was therefore mounted in one front fender and connected to one of the Clarion's antenna inputs; the other input was connected to the car's original rear-window antenna. Normally, the antenna goes up whenever the head unit is on, but a switch on the console near the gear-selector lever allows it to be lowered when the car is moving through brush. Another Hirschmann antenna system was mounted on the roof for use with the cellular phone. Because of our off-road requirements, we used Hirschmann's Moba 1119.02 base, with two interchangeable masts: Normally, we'd use the 13¾-inch Moba 3128 collinear mast, with 5 dB of gain, but when going through overhanging brush, we could substitute the 2½-inch Moba 3127.

The telephone's handset was mounted on the driver's side of the center shift console, for convenience. For easier hands-free phoning, and to get rid of the barrel-like sound that callers hear when the microphone is far from the person speaking, we added Shure's 800HF ClearVoice mike. This is a supercardioid unit which attaches to the driver's shoulder belt.

Did It Work?

This was hardly a cheap system (see Table I), but we felt that its price was not unreasonable in a vehicle this expensive, and that its quality was a good match for the car's. Acoustical measurements made in the a/d/s/ Design and Installation Center (Fig. 1) show the response of the amplifiers and speakers to be quite reasonably flat from 25 Hz to 16 kHz, with substantial response still on tap in the 20-kHz band. I had originally asked a/d/s/ to prepare one of their custom equalization systems for this car, and I assumed from these test results that they had done so. As it happened, they had not—"No need," said Bishop, and I had to agree.

TABLE I—SYSTEM CONTENTS

Sources	
Clarion Audia 2000E AM/FM/cassette head unit	$ 699.95
Sony D-160 CD player with shockmount, 120- and 12-V power supplies, patch cord, and cassette adaptor	259.95
Electronics	
a/d/s/ PH12, 120-watt six-channel amplifier	330.00
a/d/s/ 642CSi crossover	230.00
a/d/s/ AC500 remote sub-bass level control for 642CSi	70.00
Speakers	
a/d/s/ 200i panel-mount two-way satellites (two pairs)	520.00
a/d/s/ S6.2 subwoofers (two pairs)	320.00
Enclosures	
a/d/s/ custom four-subwoofer enclosure	380.00
Z-Box RRF2 front satellite enclosures (one pair)	560.00
Antenna	
Hirschmann Auta 6000 EL motorized AM/FM antenna	249.95
Equipment Subtotal	$3,619.85
Labor (Design and Construction, 21 hours)	840.00
Installed Audio System Subtotal	$4,459.85
Telephone System	
Nokia-Mobira 412 car/portable cellular phone	1,895.00
Hirschmann Moba antenna system with two mast stubs	94.85
Shure 800HF ClearVoice microphone	134.75
Labor	300.00
Telephone Subtotal	$2,424.60
Grand Total	$6,884.45

Using CD as a source, what we heard was just about what the measurements showed; with tape, results were less exceptional, probably indicating high-frequency losses in our head unit. The sound was a little bit woody and distant when using only the rear speakers, but it was fine when using the front speakers alone or with the rear ones. Imaging was mixed, with good left-to-right positioning of instruments, but there was very little apparent front-to-back depth. Stereo ambience (which I find more important, in a car) was excellent.

So much for the posh—but what about the practicality? The Clarion's position in the dash was a bit of a reach, but not the worst factory radio-slot position I've encountered. Its ergonomics were pretty good, too.

I wish I could say the same about the ergonomics of using the CD player as we installed it. To play a CD, you must leave the armrest open, since closing it usually jars the player's laser off-track (normal road bumps don't) and would make the track-select and volume controls inaccessible. Even with the armrest open, the volume and track-select controls are hard to use, and the track numbers are hard to read—always upside-down, from the driver's viewpoint—and very hard to read at all, in daylight. I learned as I was writing this that Sony offers a $29.95 wired remote control for the D-160 and several other Sony portables, which would have simplified most of these control problems—though I'd still have had to open the armrest to change the CD's volume. We did know about Sony's optional, $34.95 gooseneck mount, on which we could have mounted the D-160 anywhere we pleased, had we not wanted to keep the player out of sight. Also, with a smaller portable CD player, the controls might have been more accessible—and Sony's other portables, at least, have clearer displays than the D-160. In addition, I found it a tremendous nuisance having to shift mental gears about control locations when I changed sound sources—I kept reaching for the Clarion in the dash when I wanted to change CD volume.

A cover of carpet protects the amp from loose cargo while concealing it from view and discouraging the light-fingered.

There was no way to avoid infringing a bit on the utility of the Range Rover itself. The basic sound system narrows the trunk, and the CD player wipes out the glove compartment. The player, however, can be removed (or omitted altogether), and it's still possible to expand the trunk by removing the parcel shelf and/or folding down the rear seats.

For city-dwellers (a surprising number of whom own Range Rovers), practicality also includes a discreetly understated look that won't attract thieves. The satellite speakers and head unit are in plain sight, but the satellite enclosures are color-matched to the car's interior, so only the practiced eye would realize that they and the head unit weren't just humdrum factory stock. The rear speakers, being in an unusual location, might escape notice altogether. The CD player, amp, and subwoofer system are invisible. The cellular antenna gives away the presence of a phone, but the phone handset is easily removable, and the transceiver section can be taken out (and used) at will.

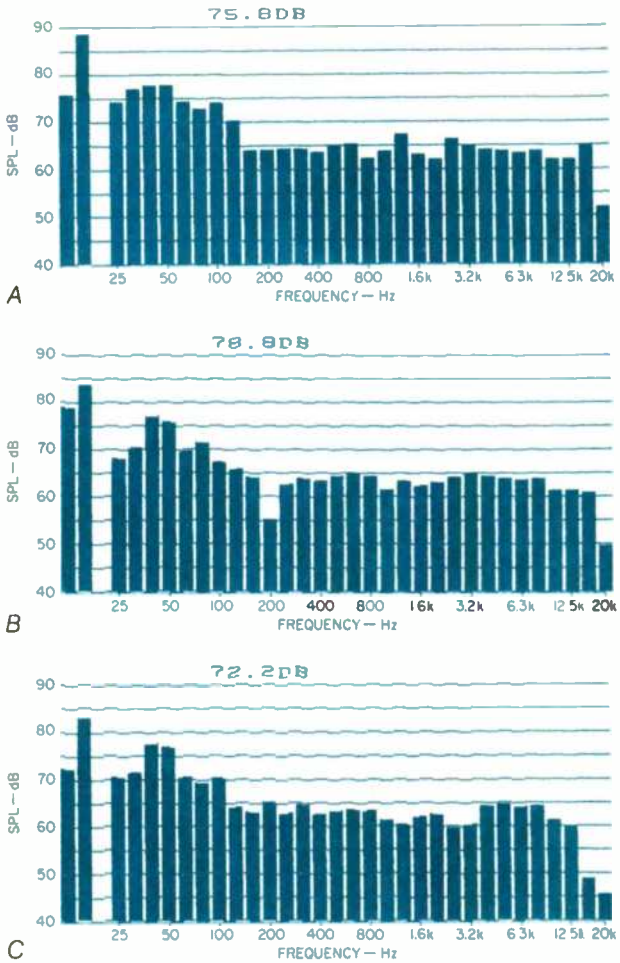


Fig. 1—The frequency response of the CD player, measured at the driver's ear, was reasonably flat with the fader set to its mid-position (A), all the way to the car's front (B), and all the way to the rear (C). The test system used a third-octave analyzer and pink noise from a Compact Disc. Subwoofer level control was set at mid-position; the low-frequency rise shown is deliberate, to keep road noise from masking bass. In each graph, the first vertical column at the left shows the A-weighted overall level (also shown numerically at top of each graph); second vertical column is unweighted.

1

YAMAHA DSP-3000 DIGITAL SOUND FIELD PROCESSOR

Manufacturer's Specifications

Analog Inputs and Outputs: 2.5 V rms maximum.
Analog Output Gain: 0, +0.5 dB.
Digital Input and Output Levels: 0.5 V peak-to-peak.
Sampling Frequencies: 32, 44.1, and 48 kHz, with automatic selection.
Video Input and Output Levels: 1 V peak-to-peak.
A/D Converter: 16-bit linear quantization with 48-kHz sampling frequency, independent stereo channels, and internal dither circuitry.
D/A Converter: 18-bit (Main) and 16-bit (Effect) quantization.
Processing Programs: 35 preset and 20 user-set.
Harmonic Distortion: 0.002% on Main outputs and 0.005% on Effect outputs with analog input; 0.003% on Main outputs and 0.005% on Effect outputs with digital input.
Frequency Response: 10 Hz to 100 kHz for Main and 20 Hz to 20 kHz for Effect with analog input; 20 Hz to 20 kHz, ±0.5 dB, for both with digital input.
S/N Ratio: 110 dBA Main and 94 dBA Effect with analog input; 110 dBA Main and 105 dBA Effect with digital input.
Channel Separation: 80 dB at 1 kHz with analog input, 90 dB with digital input.
Power Requirements: 120 V a.c., 60 Hz.
Power Consumption: 45 watts.
A.c. Outlet (Switched): 300 watts maximum.
Dimensions: 17⅛ in. W × 3¾ in. H × 13⅞ in. D (43.5 cm × 9.55 cm × 35.2 cm).
Weight: 21.1 lbs. (9.6 kg).
Price: $1,899.
Company Address: 6660 Orangethorpe Ave., Buena Park, Cal. 90620.

For literature, circle No. 90

When Yamaha introduced the DSP-1 digital sound field processor, I was among many that marveled (June 1987) at what it accomplished for the listening experience. Because of the great sophistication of that unit, I forecast (to myself) that the next unit would be less complex at a lower price. The DSP-3000, however, is more sophisticated in a number of respects, and the price is roughly twice as high.

Let's take a look at the features with attention to the changes made. The new Yamaha processor offers 20 sound fields with a total of 35 variations. There are 17 new environments, including concert halls sampled in several countries. There also are two new presence modes and a new surround program. There are four new movie-theater modes which simulate the effects of commercial movie theaters. The self-descriptive program names are "Adventure," "Classic," "Musical," and "Standard."

The master volume control changes output level on all channels simultaneously with the use of the remote control or a rocker-type switch on the front panel. (The DSP-1 requires external means such as the Yamaha MVS-1 for such control.) An internal pink-noise generator can be switched on for setting system balances. This s a great convenience when setting up, and it is always available if a recheck is needed.

There is a video input/output loop to superimpose program parameters and other function readouts on the screen of a TV monitor. There are menu for this program to set the preferred type and time-duration of display and one of the nine background colors. If video is fed in, the background color disappears, and the display is superimposed in white. The DSP-3000 can select among two analog and a direct digital input. The digital input allows direct effect processing of CD or DAT signals and eliminates one stage of analog-to digital conversion. There are also the obligatory tape recorder input/output connections and monitor switch.

Yamaha's proprietary Hi-bit, floating 18-bit approach combines with a dual-converter configuration for improved signal-to-noise ratio and dynamic range, and lower distortion when the direct digital input is used. The digital processing of the DSP-3000 uses four-times oversampling digital filters for improved time-base resolution, phase coherence, and transient response. The four effects channels and the two main channels use one filter each. The main-channel filters are activated only when the digital input is used.

The new processor has a front-panel program-stepping switch which provides some convenience. The remote control selects any basic program directly and allows making the great majority of possible changes from the listening position. The DSP-3000 contains stored acoustic data based on a number of different performance environments. An original Yamaha VLSI (Very Large Scale Integrated) circuit chip, operating in real time, calculates dozens of discrete early reflections based upon this data. Each of the Yamaha YM-3818 VLSI chips used in the DSP-3000 incorporates a high-speed multiplier and an adder and subtractor. These enable the DSP-3000 to produce up to 88 discrete reflections, 22 for each of the four effect channels. Figure 1 is a block diagram of the processor.

The digitally processed delays create time lags between the sound arrivals from the main speakers and the arrivals from the effect speakers. These delays, in the relatively small listening room, are the same as those between the direct sound and the reflections from the walls in a concert hall or other venue. The generated sound field removes the boundaries of the home listening room, as it were, and replaces them with the characteristics of the performance hall. The processor offers a wide variety of possible fields by providing control over many of the parameters involved in the synthesis. It is easy to vary such things as "liveness," initial time delay, and reverberation level over wide ranges for the most satisfying home listening experience.

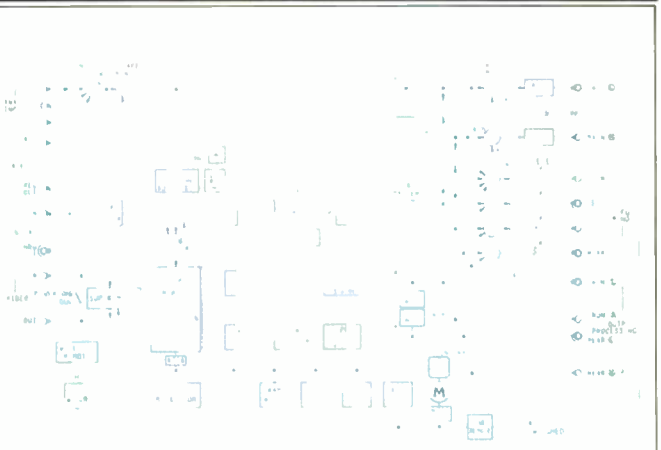


Fig. 1—Block diagram. Note that all surround processing takes place in the digital domain.

Control Layout

The push on/off "Power" switch is at the lower left of the front panel. Above it is a display panel that extends from the left end almost to the middle. At the left of this display is the receptor for the remote control. To the right of that are the red-LED "Mute" indicators for "Main" (top) and "Effect" (bottom). The LEDs are not large, but the mute status can be seen at least 25 feet away. The separation between them prevents confusion as to which function is muted. Just to the right of the LEDs are the yellow annunciators for "Preset" (top) and "User Prog" (bottom). They are not easily read at a distance, but relative position shows which function is being used.

Further to the right is the bright, yellow-LED program-number display. The numbers are large enough to be read over any normal listening-room distance. They immediately dispel any doubt about which program is in use. Last in the display panel is the large, 2-line by 16-character LCD display. Its alphanumeric characters are gray on a white background and are quite easy to read at normal distances. The

Four-times oversampling digital filters are used for better phase coherence, time-base resolution, and transient response.

default mode shows the program name on the top line and the first changeable parameter below. Pushing buttons on the remote control causes this display to report, at least momentarily, what has happened. I will give more detail on this very useful feature later on.

Just to the right of the display panel are the "Input Selector" switches (from left to right, "Digital/1, 2, 1") and the "Master Volume" rocker. There are bright yellow LEDs above the left end of each Input Selector. Pushing any of these switches gets a 2- to 3-S display of the selection made. Push "Digital/1" without an actual digital signal, and the LCD display shows that the DSP-3000 has automatically switched to analog input 1, instead. (It makes this decision even if the analog 2 input was in use before.) This is a very minor perturbation, in my view, considering the advantage of the automatic decision.

The volume rocker has "Down" printed above its left end and "Up" above its right. With a push on either end, "Volume Level" is displayed with a row of up to 28 small, vertical bars on the second display line. (No bars are shown at the zero-volume setting.) The user needs to keep in mind that this horizontal bar graph shows the setting of the six-gang, motor-driven volume control: It does not show the actual signal level within the unit. I really like being able to control all output levels at the same time, and the status display makes this feature even more convenient.

Below the Input Selector switches are the "Tape Monitor" switch and the down/up "Program" rocker. A red LED indicates "On" for the monitor switch. Changing the switch position results in a momentary status display each time. Holding in the Program rocker steps the programs up or down at about three per second. Going below "1" of the "Preset" programs calls up "20" of "User Prog"; going above "20" of "Preset" calls up "1" of "User Prog." (Some presets, as we'll see later, have multiple modes, making a total of 35 preset programs.) All of the above button switches and rockers have good tactile and audible clues with actuation, although the monitor switch has a soft sound.

The back panel has 24 gold-plated phono-jack input/output connections. From the left, there are stereo (L/R) pairs for "Analog Input" (two sets for "1" and one set for "2"), "Tape" ("Tape PB" and "Rec Out"), "Main," and "Processing" ("Front" and "Rear") outputs. The two sets for Analog Input 1 allow looping the signal through to other equipment. Above the Main output jacks is a "Main Level" slide switch with "0 dB" and "−10 dB" positions; this can be an aid in getting the desired system balance. (I have been using the −10 dB setting most of the time with the original DSP-1, which I use as a reference system.)

A "Front Mix" slide switch above the "Front" jacks selects "4 ch" or "6 ch" to match the system configuration. The normal system has four separate effect channels, in addition to the two main channels. When the system will have just two effect speakers, "4 ch" is used to get a mixing of effects into the main stereo speakers. In this fashion, a good part of the created sound field is maintained even with the compromise.

In the center of the back panel, from left to right, are four "Output/Mono" jacks ("Front," "Right," "Left," and "Rear") for reinforcing the lower frequencies. Each output has a level control and a low-pass filter with slide-switch settings of "80," "150," and "5k" Hz. The pot knobs are very small, but knurling makes them easy to turn. As Fig. 1 will show, appropriate effect channel outputs are summed to feed each of the mono outputs: Front Left and Rear Left feeding Left, for example. Front, however, is also fed from the left and right main channels, as well as from Front Left and Front Right effect channels.

To the right are the "Digital" "In" and "Thru/Out" jacks. This configuration allows sending the digital signal from a CD or DAT player to other equipment, as well as to the DSP-3000. (The processor's power does have to be on for feeding through.) "Video" "In" and "Out" jacks allow similar looping through, but in this case, power does not have to be on. There is superimpose circuitry under the unit's control for TV-monitor display of programs and any other material that would appear on the front-panel LCD display. The back panel also has a switched a.c. outlet which will handle up to 300 watts; this is quite high, and much better than on many other units.

I removed the heavy top cover to get a look at the internal construction and found that two side-by-side sheet-metal covers remained. I took off the one that covered the power supply and the majority of the circuitry—mostly digital. The three Yamaha YM-3818s are quite apparent from their large size and grouping on the excellent p.c. board. The layout is very neat and clean, and parts and functions are well labelled. The transformer was hot to the touch—but not to the point of being painful—after hours of operation. It is well encased in a heavy cover, and I did not notice any ventilation paths. I could see why the transformer would be on the warm side, but I could also appreciate that the construction would minimize any coupling and radiation problems. A sheet-metal cover/shield enclosed the analog circuitry, and I did not remove it. The chassis construction was very rigid, even with the top covers removed.

Remote Control and Programs

Operating the Yamaha DSP-3000 is best understood by discussing the remote control, the sound-field programs, and other functions. The remote control is not heavy but it is larger than most. The wide power on/off button is the first one at the emitter/transmitting end of the control; a white-on-red label next to it catches the eye. Next is a row of three "Input" selector buttons, and then a row of three more buttons: "Memo" (labelled in red) is used for enabling the system to put user-generated parameter values into one of the user-program positions. To the right, "Preset" and "User" (in white) select the class of program. Pushing either button always gets the program that was last used under that category.

The next four rows, with five buttons each, select programs identified by name and number. Each button has a white number on its face, and above each button or group of buttons is the designation in gold lettering. The first row of five buttons are all designated "Concert Hall": "1" gets "Hall A (or B) in Europe"; "2," "Hall C (or D) in Europe"; "3," "Hall E (or F) in Europe"; "4," "Hall G (or H) in U.S.A.," and "5," "Live Concert A (or B)." The first listing, in each case, is the default choice; the Parameter decrease or increase button

The generated sound field replaces the boundaries of the home listening room with the characteristics of the performance hall.

(discussed below) is used to get the second choice for these or other programs.

Buttons "6" to "10" are in the second row: "6" selects "Opera," with "Balcony" and "Mezzanine" choices; "7," "Cathedral "; "8," "Church," and "9" and "10" select "Jazz Club" "1" and "2," respectively. Jazz Club 1 offers "Village Vanguard" and "Village Gate," based on acoustical data from those two New York City clubs. Jazz Club 2 has "Cellar Club" ("small and cozy") and "Cabaret" ("fuller, richer sound").

The third row ("11" to "15") selects "Chamber," for chamber music, and "Rock Cnct," which provides "The Roxy Theatre" of Los Angeles and "Arena." Next is "Disco," with "New York" and "Tokyo" based on locations in those cities. "Pavilion" is for recreating the sound field of a multi-purpose enclosed pavilion, and "Stadium" selects the sound fields of "Anaheim Stadium" and "Bowl."

The fourth and last row of program buttons ("16" to "20") includes: "Presence A (or B)" for a close-up effect; "Surround A (or B)" for a feeling of being surrounded by performers and the sound; "Movie Theater" "1" and "2" ("18" and "19," respectively), which are synthesized modes for "Adventure" and "Standard" ("1") and "Musical" and "Classic" ("2") movies. Last is the standard Dolby Surround mode, labelled with the double-D symbol plus "Sur."

Beneath these program selection buttons is a row of four white-labelled "Parameter" buttons: "Down," "Up," "Dec," and "Inc." "Down" and "Up" move selection in the parameter menu. "Dec" and "Inc" decrease or increase the value of the selected parameter. Below this row, on the left side of the control, is the "Title Edit" button, which selects the mode to generate an original title up to 16 characters long for any user program. Upper- and lower-case letters, plus numbers and symbols, are available. I didn't take advantage of this feature, but it would be very nice for some users.

The "Utility" button, next below, brings many desirable functions under its rather dull name. Two pushes, while in any program, put the display in "Bit Monitor" mode, and the level status of the incoming signal is displayed in terms of the number of bits that can be extracted from the highest levels. With the level of the source adjusted for "16 bit," the user knows that he is getting all that's possible in this regard. The lowest level indication is "<13 bit" and the highest is "Full," which calls for a reduction back down to "16 bit." "Utility" also accesses the menu for "Display Control for Superimpose" to define the TV monitor display, and enables system balancing in combination with "Preset" and the built-in pink noise source. (The measurement section of this profile will provide more details.)

To the right of "Title Edit" and "Utility" are the "Effect" level buttons: "Balance" ("Rear" and "Front") and "Level" ("Down and "Up"). A push of any of these four buttons displays the existing balance or level and the change while holding the button. The final setting is displayed for about 3 S after the button is released. Below are the two large "Master Volume" buttons, "Up" and "Down." A push of either displays "Volume Level" and its horizontal bar graph. To the left of these are the "Main" and "Effect" "Mute" buttons. As mentioned earlier, actuation of a mute mode turns on a red LED on the front panel.

Measurements

First, let me point out that all measurements were made after completing the listening tests. When I stood straight out from the DSP-3000 and pointed the remote directly at the front panel, the effective range was greater than 27 feet. At 10 to 15 feet, the remote position could be off axis up to 80° in the horizontal plane and at least 30° up or down from the horizontal axis. The pointing of the remote was actually noncritical. The LCD display could be read at 15 feet or more and up to 45° off axis horizontally. The highest contrast of the display was when looking at it in the same horizontal plane or from slightly higher. There was less contrast when viewing it from a lower angle.

The bit monitor displayed "13 bits" with 0.146 V at the input, "14 bits" with 0.295 V, "15 bits" with 0.594 V, "16 bits" with 1.214 V, and "Full" with 2.440 V. Clipping in the main output appeared with 7.34 V. These figures apply from 20 Hz to 1 kHz: With increasing frequency above 1 kHz, there was increasing reduction in the input voltage for any number of bits. By 20 kHz, for example, 16 bits was reached with 0.442 V. The reductions appeared quite acceptable in comparison with the spectral content of actual music. With a 1-kHz tone burst, it was possible to reach clipping without turning "Full" on. The clipping point, however, was greater than 10 dB above where "16 bit" appeared with the same burst.

The frequency response of the main channels was down 0.05 dB at 20 Hz and 0.4 dB at 20 kHz. The −3 dB points were at 1.7 Hz and about 80 kHz. The output levels were −0.8 dB, relative to the input for left, and −0.7 dB for right. The harmonic distortion for the main channels was 0.002% at 1 kHz. (Frequency response and distortion tests cannot be run on the effect channels because their responses are purposely modified internally. However, I heard nothing from these channels which I could classify as distortion or frequency-response errors.)

Noise in the main channels was more than 100 dBA below 1 V for any position of the volume control. The front- and rear-channel output noise was 88 dBA below 1 V with the volume control at maximum and 100 dBA below 1 V with the volume at minimum. The output impedance was 966 ohms, and channel separation was 79 dB at 1 kHz. Spectrum analysis of the six outputs showed no evidence of a 48 kHz residual or any sidebands from a high-level 1-kHz test tone. All such components were at least 87 dB below the level of the test tone.

The tracking of volume control for the two main channels was within ±0.1 dB over the range from 0 down to at least 65 dB of attenuation—much the best that I have ever seen. With a little practice, I was able to set any exact level I wanted within ±0.1 dB for up to 35 dB of attenuation. There is no need to be that precise, of course, but I have had frustrating experiences with other motor-driven pots that I could not set even roughly close. The two front-channel volumes tracked each other within 1 dB over the whole range, which is excellent. The two rear-channel volumes tracked within 1 dB for about 50 dB of attenuation, which is quite good. The effect-channel volumes tracked the main-channel volume within 1 dB for about 45 dB, which is really very good for the six sections involved.

Obviously, you run this from your easy chair, since the remote control has 43 buttons and the faceplate carries only nine.

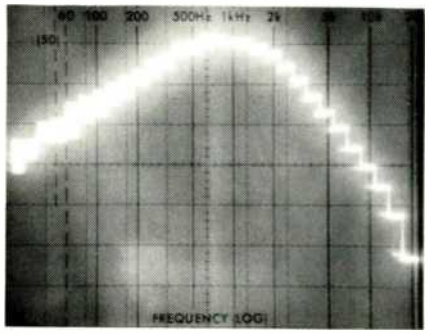


Fig. 2—Balance test signal generated by the DSP-3000. Though called "pink noise," its frequency content is actually optimized for speaker balancing. See text.

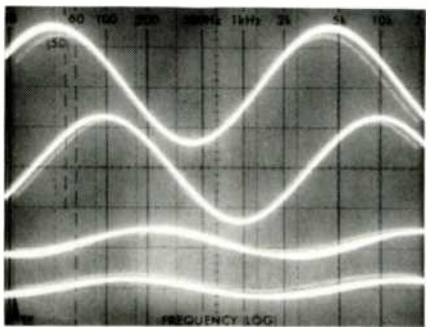


Fig. 3—Output from effect channels in Movie Theater/Adventure mode, with 742.6-Hz test tone. Traces are (top to bottom): LF, RF, LR, and RR. Changing the test frequency would change the phase and amplitude relationships between the channels. (See text.) Vertical: 2 V/div.

The effect-level and balance displays each had 10 vertical bars, one for each 10%. The balance display had a double bar right at the 50% point. A check of the Dolby Surround input balance demonstrated that the best setting for the minimum sound to the surround speakers with a mono input was with the Dolby input balance at 54% to the right. All of the effect levels could be changed in 1% steps.

The results of level tests of the DSP-3000's mono outputs were a little confusing, but the majority of times, the Left, Right, and Rear output levels were about 7 dB below the power total for the two summed channels. The Front output level, with its contributions from four channels, was more variable but usually was at least 4 dB below the total from the sources. My own judgment was that these levels might be too low to drive some amplifier/subwoofer combinations. A check of the memory function showed that effect balances and levels were saved but not the overall volume.

Figure 2 presents the ⅓-octave spectrum of the DSP-3000 test-noise output, which the owner's manual refers to as "pink." If it were truly pink, the response would be flat. (Personally, I would prefer that the noise be flat for response comparisons.) The purpose of the noise source, however, is to facilitate setting levels, so peaking the noise at frequencies where most speakers work quite well might be better, in some cases, than true pink noise. The level of the noise at the main outputs was 25 mV. Figure 3 is just one example of how the four effect-channel outputs can differ from each other. Notice that the test-tone frequency is stated quite precisely as 742.6 Hz. Just small changes in frequency caused noticeable shifts in level and relative phase in the four channels, compared to what is shown here.

Parameters for the various programs include such elements as room size, liveness, initial delay, reverberation time, reverberation level, and settings for high- and low-pass filters. Simple stepping tests demonstrated the excellent resolution of parameter values. "Room Size" is adjustable in 40 steps, from 0.1 to 4.0, and "Liveness" has a range from 0 to 10 in steps of 1 (both in arbitrary dimensions). "Initial Delay" can be set in 1-mS steps from 1 to 150 mS. "Reverberation Time" has a range from 0.3 to 10.0 S, with 0.1-S steps. "Reverberation Level" can be set from 0 to 100% in 5% steps. The high-pass filter can be set for "Thru" (flat) or in ⅙-octave steps from 32 Hz to 1.0 kHz. The low-pass filter can be set for "Thru" or in ⅙-octave steps from 1.0 to 16 kHz.

Parameter values could be stepped with a series of pushes on "Dec" or "Inc." Holding in either of these buttons caused a rapid changing in value after a second or two. All of the programs have preset values which are protected under the "Preset' function. Any combination of original and modified parameters can be saved as a "User" program. User-program memory is maintained by a special long-life backup battery which should last about five years. If the battery voltage is getting low, "** Warning ** User Mem. Error" appears in the LCD display when the unit is first turned on. Yamaha states that a qualified service center should replace this battery. They also recommend that the user fill in the manual's program parameter tables to ensure that important program information is not lost.

Setting Up

Yamaha makes specific recommendations on the listening room and the placement of the loudspeakers. They state that the sound-field creation is best if the room is "as acoustically dead as possible," which really calls for much more surface absorption than it makes sense to have. However, the manual does mention normal means to keep the

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There are programs within programs, so 20 buttons can select 35 factory-set and 20 user-set simulated acoustical environments.

room from being too live. For one thing, it states that the main speakers should be three to six feet from the front wall, with the front effect speakers a few feet above and behind them. However, the user's main speakers might need to be closer to the wall for good bass performance.

It is probable that most users will not be able to meet all of Yamaha's criteria. Having said that, let me reassure the reader that perfection of equipment, its arrangement, and the acoustics of the room are *not* essential for great listening. The six-channel arrangement, however, is noticeably better than the four-channel arrangement and a center speaker and subwoofer are very desirable, in my view.

Figure 4 shows the arrangement of the evaluation system that I have been using for surround-sound systems of any type. The Yamaha DSP-1 is the reference processor. To help in making comparisons, all of the in/out connections for the processor are normalled through a jack field which allows for easy insertion at all nine of the DSP-3000 inputs and outputs shown. A Yamaha AVC-50 serves as the preamplifier and the main amplifier. Other equipment includes Magnavox and Pioneer CD players, a Dual turntable, a Sanyo Beta VCR, JBL main and center speakers, a Lafayette center-channel amplifier, Dynaco effects speakers, a Triad subwoofer, and a Yamaha FM tuner, video-disc player, and effects-channel amplifier. My VHS VCR with MTS failed at the start of the evaluation, so I picked up a Realistic TV-100 TV-sound receiver at the local Radio Shack. I used a Radio Shack Archer r.f. modulator on the video output of the DSP-3000 to show the superimpose function on my TV set.

Use and Listening Tests

As stated earlier, I did all of the listening before any measurements. The owner's manual has 64 pages of helpful and interesting information. The format is open, and the large type and illustrations make for very easy reading. However, discussions on room acoustics, speaker placement, and program parameters and their effects would benefit from more detail. The section on adding auxiliary speakers never states what the four mono output signals (Front, Right, Left, and Rear) really consist of. It would be easy to assume, for example, that Front is simply a mono summing of the main channels, but the summing also includes the front effects channels. The actual combinations are clear in the block diagram at the back of the manual, but at least a few words are needed in the earlier text.

I ran through various setup operations, using the functions available on the DSP-3000 remote control. I adjusted the volume of the preamplifier to get the 16-bit display with the first source. The manual suggests that this is a one-time setting, but I checked it frequently. Source levels, even from CDs, varied greatly from one time to another. I had come to a fairly prompt conclusion: The DSP-3000 sounded quieter than the DSP-1, and yet I hadn't driven it into distortion. I believe a good part of the improvement came from being able to set exactly the level which would yield full 16-bit processing.

I used the built-in noise source to match main and effect levels, and found that I had to switch the main output to −10 dB to have the desired level range. Throughout my listening tests, I shifted effect levels and front-to-rear balance to suit. I set the operating conditions for the video superimpose, which made it easier to set parameters because of the much larger display on the TV.

In the listening evaluation, I purposely picked sources to match the various programs, and then tried other programs if that seemed worthwhile. Unless stated otherwise, CDs were the sources.

First was the assessment of the five Concert Hall programs, each with two choices. For Berlioz's "Symphonie fantastique" with Dutoit and the Montreal Symphony (London 414203-2), I liked Halls A, B, and E in Europe and G in the U.S.A. during the first part of the listening. I ended up concluding that I really liked Hall B in Europe best of all, with Hall H in the U.S.A. in second place.

With Dvořák's "Symphony No. 9" with Solti and the Chicago Symphony (London 410116-2) I preferred Hall G in the U.S.A., but I also liked Halls B and C in Europe and Live Concert A (Program 5). Some overtures by Elgar, with Gibson and the Scottish National Orchestra (Chandos CHAN-8309), sounded best with Hall E in Europe, although Hall B and Live Concert B also were quite enjoyable. Tchaikovsky's "Serenade in C for String Orchestra" with Marriner and the Academy of St. Martin-in-the-Fields (Philips 411471-2) was a very good match for Hall C, with very satisfying sound also possible with Halls A, D, and H.

LPs were used for the assessment of "Opera/6." Puccini's "La Bohème" with Freni, Gedda, Schippers, and the chorus and orchestra of the Rome Opera House (2-Angel 4AVB-34025) sounded better with "Mezzanine." Gounod's "Faust," on the other hand, with de los Angeles, Gedda, Cluytens, and the chorus and orchestra of the National Theatre of Opera (Angel 3622) was more satisfying with "Balcony." I tried "Church/8" during the scene in the church and it didn't sound right at all. The "Soldiers' Chorus" was smoother in "Mezzanine," but there was less excitement in the singing.

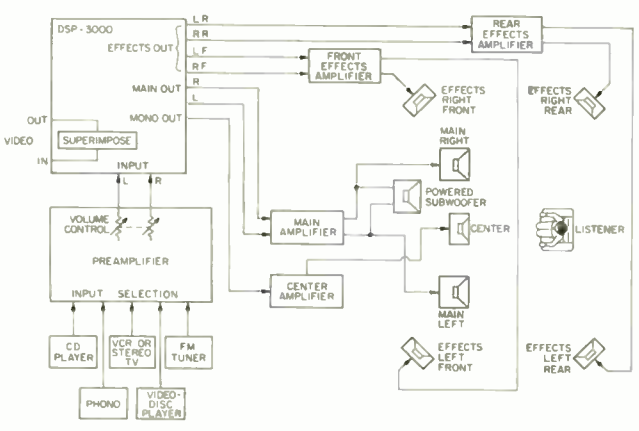

Fig. 4—Layout of the sound system used in evaluating the DSP-3000.

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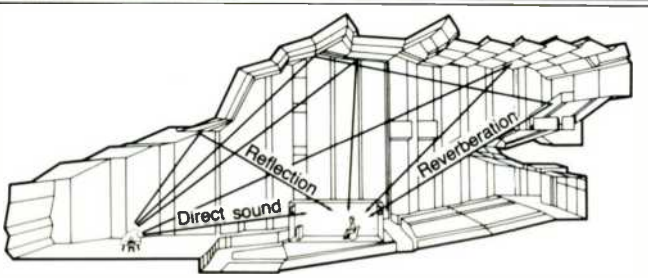
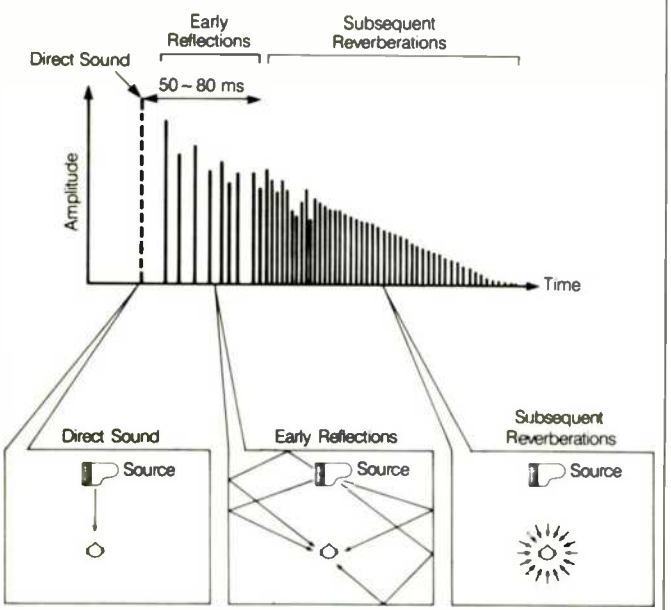


Sound field in a typical concert hall.



Directional characteristics of direct sound, early reflections, and reverberation.

I generated a user program for "Cathedral/7" by reducing reverberation time from 4.0 to 3.2 S and the initial delay from 95 to 85 mS. These changes may not seem large, but they gained important changes in the sound field. On *20 Christmas Carols* with St. George's Chapel Choir (Abbey CDMVP-827), the preset program was a very good fit—except for "Ding, Dong, Merrily on High," which benefited from the changes in the user program. It sounded even better, however, with the user version of "Church/8." Victoria's "Requiem," with The Tallis Scholars (Gimell CDGIM-012), was best overall with one of the "Cathedral" versions. I preferred Michael Murray on *The Organs at First Congregational Church, Los Angeles* (Telarc CD-80088) with the user program, but most other people preferred the preset.

My user version of "Church/8" had reverberation time reduced from 2.5 to 1.5 S and the initial delay reduced from 40 to 35 mS. The *20 Christmas Carols*, Victoria's "Requiem," and many of my own in-church recordings were very good matches to the sound fields of either the preset or user versions.

"Jazz Club 1/9" and "Jazz Club 2/10" have similar sound fields in general, but the differences can be easily heard with most music. Jennifer Warnes on *Famous Blue Raincoat* (Cypress YD-0100) matched well to "Village Vanguard," "Village Gate," and "Cellar Club," but not to "Cabaret." This CD also was good with "Rock Cnct/12/Arena" but not "Disco/13." Creedence Clearwater Revival on *Chronicle* (Fantasy FCD-CCR2-2) and Air Supply on *Love & Other Bruises* (Columbia CK 35047) sounded better with the "Jazz Club 1" choices. The former did sound good with "Jazz Club 2," but I kept switching between "Cellar Club" and "Cabaret," depending upon the tune. The Air Supply tunes were better with "Cabaret." I judged "Village Vanguard" to be the best choice overall among all programs for recorded dance music from the big band era. It might seem strange, but I thought that an NBA play-off game sounded quite good with either "Village Vanguard" or "Cellar Club."

"Chamber/11" was modified for a user program by reducing the reverberation time from 1.1 to 0.8 S. A collection of short baroque works with the Paillard Chamber Orchestra and others (Erato ECD-55018) sounded better with the user program for all of the works. I found that even if the reverberation was reduced by only 0.1 S, the change was noticeable. I came to the same conclusion with Mozart's "Eine kleine Nachtmusik" with Mackerras and the Prague Chamber Orchestra (Telarc CD-80108) and Bach's "Brandenburg Concerti" with I Musici (2-Philips 412790-2). With these CDs, however, the preset program was the better choice quite a few times. Other possible programs for this music were "Opera/6," "Jazz Club 1/9," "Jazz Club 2/10," "Rock Cnct/12," "Stadium/15," and "Presence/16." In other words, don't be afraid to try any program: There might be particular sound-field qualities that you like.

"Rock Cnct/12" was another good choice for Jennifer Warnes and Creedence Clearwater Revival, particularly "Arena." Air Supply sounded good with "The Roxy Theatre," as well. I thought "Disco/13," with its "New York" setting, was a better match to Creedence Clearwater Revival and Air Supply, but the heavier bass of the "Tokyo" position could be the preference of others.

"Pavilion/14" and "Stadium/15" were possibilities for some of the pop/rock groups, but they weren't my choices. The music of Sousa in *Peaches and Cream* with Kunzel and the Cincinnati Pops (MCD 10005) did sound quite good with both of these programs. After listening for some time, I moved the high-pass filter up to 63 Hz to reduce what sounded like a form of bass hangover.

"Presence/16" is a good choice for all types of sources when an up-front sound character is wanted. It's a good compromise setting for listening to FM music programs: The effects are quite pleasurable and the announcer won't sound like he's in a garage. "Presence A" and "Presence B"

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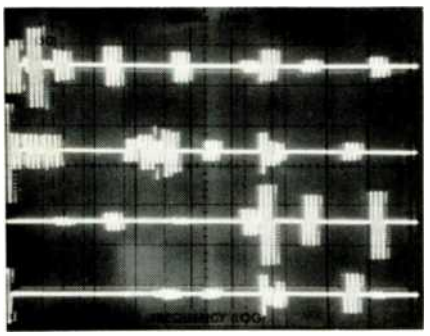

Fig. 5—Output from effect channels in user-modified Presence A program, with 3-cycle, 700-Hz tone burst. Traces are (top to bottom): LF, RF, LR, and RR. (See text.) Vertical: 1 V/div. Horizontal: 11 mS/div.

are usually quite different in the listening. *Kiss of the Spider Woman*, with William Hurt and Raul Julia (Showtime simulcast), had much centered dialog and I much preferred "A" over "B." *Ladyhawke*, with Matthew Broderick, Rutger Hauer, and Michelle Pfeiffer (videodisc), had more spread, but I still preferred "A." I thought that the NBA playoff game had a being-there quality with "A." In fact, I thought that this was the best choice of all for sports listening, including the announcing.

I decided to use the editing capability of the "Presence" program to create my own sound field. I put in 11 reflections each for the left and right channels. I purposely increased the angle off axis for each increase in reflection delay. I varied the levels and reversed polarity somewhat randomly. Figure 5 shows the output from the four effect channels with a 3-cycle, 700-Hz tone burst. The channel levels of the delayed bursts correspond to the levels and angles that I programmed in. The sound was smooth in character for different types of music, and quite enveloping but not very exciting after listening more than a few minutes.

"Surround/17" was very satisfactory for the two movies with either "A" or "B." *Spenser for Hire*, on ABC television, was similarly successful.

"Movie Theater 1/18" and "2/19" provided good choices for movies and TV shows. "Standard" was the best choice for *Kiss of the Spider Woman* and *Spenser for Hire*. "Adventure" was my preference for *Ladyhawke* and for the 1960 movie, *Heller in Pink Tights* with Sophia Loren and Anthony Quinn. *Lucas* (1986), with Corey Haim and Kerri Green (cable simulcast), was best with "Standard." *Kingdom of the Spiders* (1977), with William Shatner and Tiffany Bolling, was a good match for "Classic." The limitation of all of them was that the dialog seemed disembodied. It was centered, but it was also spread. I tried using "Front" to drive the center speaker, but the level was too low and the sound character wasn't what I wanted.

I did find that I could improve the dialog by reducing "C. Sptl Exps," "C. Liveness," and "C. Ini. Dly" in a variety of combinations. Unfortunately, the more dialog was improved, the poorer the background music and effects became. I added left and right connections from the main channels to the center-speaker amplifier (in mono mode) and put the voices back with the bodies. I returned the three parameters mentioned above to their preset values, getting the best results for all of the movies and TV shows.

Each main output can be Y-connected to drive both the main amplifier and a stereo amplifier with a mono function for driving both the center speaker and a subwoofer with its own low-pass filter. (Readers, please note that a Y connector *cannot* be put *across* the left and right outputs.) I do feel that the DSP-3000 lacks in not having mono center and subwoofer outputs from the main channels. Most powered subwoofers can be connected across the main speakers, so I see the missing mono center output as more of a limitation. I should note, however, that turning on the speaker of the TV set or monitor at a low level may be sufficient if the sound quality is adequate. The DSP-3000 does not have the Sound Effector programs of the DSP-1, but they have little value for normal music listening, and they have no value for movie or TV program sound.

"Dolby Surround/20" was a very good choice for Dolby-encoded movies. Although the surround channels did not match the results with other programs, there was excellent dialog centering and the voices were embodied—where they belong! For even better results, Yamaha offers the DSR-100 Dolby Pro Logic decoder, which provides the directional orientation, dialog channel, and front/rear separation of commercial theater systems. The $599 cost is high, except perhaps for confirmed movie buffs.

Conclusions

Yamaha has added to its DSP-1 laurels by bringing out the DSP-3000. Features such as the bit monitor, the excellent displays, the direct digital input, and the noise source all contribute to the value of this superb equipment. New programs such as Opera and Movie Theater, more concert halls, jazz clubs, and all the other venues provide very worthwhile one-button choices to match specific sources. The system delivers no-fuss selection of an incredible variety of sound fields. Changing parameters is very easy for those who want to, and "Presence" offers an opportunity for involved sound-field creation. Muting the effect channels emphasizes what is lost, and collapse of the sound field to stereo is *not* pleasurable.

The Yamaha DSP-3000 is an expensive device but it is *the* premier means of enhancing the listening experience. Additional dollars would need to be spent for the effect channels equipment, but whatever is invested will bring much more than simple enjoyment. The DSP-3000 lacks the main mono center and subwoofer outputs of the DSP-1. Outside of that, the DSP-3000 sets new and higher standards in quality, performance, and flexibility in the creation of exciting, realistic sonic illusions. *Howard A. Roberson*

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is opening a new age in super-high fidelity.

The JVC Super Digifine Series — More accurate digital sound and more digital applications.

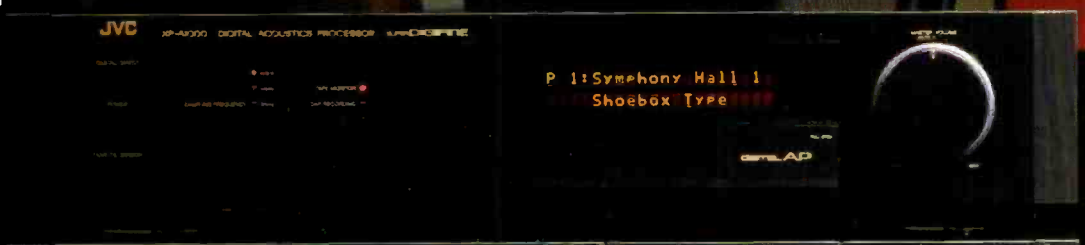
As super-fidelity digital becomes more and more established in the audio market, we find ourselves entering a new phase of the digital revolution — one in which the quality of sound is determined by much more than just the program source.

At JVC our leading-edge expertise in digital technology has helped us to develop newer, more diverse applications in which digital techniques have enhanced sound reproduction. We call the components that embody these new radical digital applications "Super Digifine." They are the successors to our original "Digifine" series of components that ushered in the first phase of the digital age.

Our "Super Digifine" series includes components from amplifiers to speaker systems, and even features a revolutionary digital acoustics processor designed to recreate a live performance ambience at home.

Enter the new age of digital with JVC.

SX-911WD
3-Way Speaker System



XP-A1000BK
Digital Acoustics Processor

AX-Z911BK
Digital Pure-A Integrated Amplifier

SUPER DIGIFINE

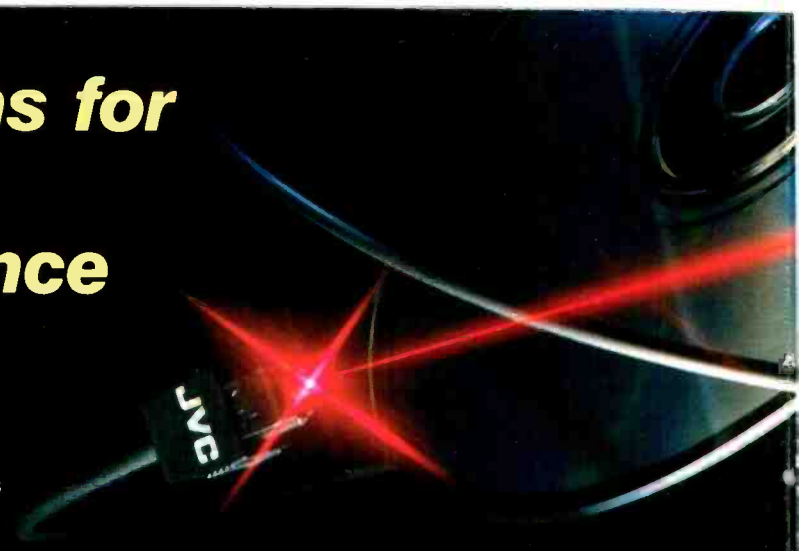
JVC's line of new-generation digital-ready audio components is opening a new age in super-high fidelity.

XL-Z555BK
Compact Disc Player

TD-V711BK
Discrete 3-Head
Cassette Deck

RX-1001VBK
Programmable
Remote/Computer-Controlled
Receiver

Digital Applications for Higher Sense of Power and Presence



AX-Z911BK Amplifier — Digital Pure-A for pure and powerful sound

JVC's innovative Digital Pure-A Circuit provides both true class-A operation and a high power of 100 watts*, thanks to the newly developed digital "signal prediction" circuit. As you may know, class-A amps have long been the serious audiophile's dream because, unlike common class-B amps, they don't allow output transistors to switch on and off, hence pure, low-distortion sound is possible. But because of their high cost, they have been out of reach of most music lovers until now.

* Per channel, min. RMS, both channels driven into 8 ohms, from 20Hz to 20kHz with no more than 0.003% total harmonic distortion

High-power class-A operation — that's Digital Pure-A

The new Digital Pure-A Circuit is a class-A amplifier combining pure sound, high power, high efficiency, and compact size. It takes advantage of the fact that digital signals can be stored in memory temporarily, without degrading phase response or frequency response.

During operation, our made-for-digital circuit takes digital signals direct from the output (optical or coaxial) of a CD player, and splits them into two: the main and the "prediction" signals. The main signal is sent to a time base processor where it's stored in memory for about 150msec. before it goes to the D/A converter. The other, the prediction signal, is sent to a prediction circuit where the level of the upcoming main signal is measured, and a prediction output signal is generated by analyzing the level of the D/A-converted main signal and the amplifier's output signal. Based on this prediction, the power-supply voltage control circuit adjusts the voltage supplied to the power amp.

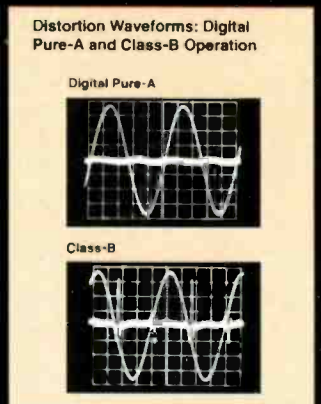
Programmable power supply for high efficiency

Most of the time, our Digital Pure-A Circuit provides the power amp with low power-supply voltage. But when the "predicted" power output exceeds the threshold of 20 watts, the circuit increases the power-supply voltage to provide higher power — no less than 100 watts.

Switching the power-supply voltage occurs approximately 120msec. *before* the temporarily stored main signal is read out of memory. In this way, signal prediction gives the power supply time enough for it to switch from low to high before the musical signal reaches the power amplifier.

Thus the power amplifier operates in low-distortion class-A most of the time, but without creating excessive heat. The result: both delicate and dynamic sounds are reproduced with clarity and an extra sense of power.

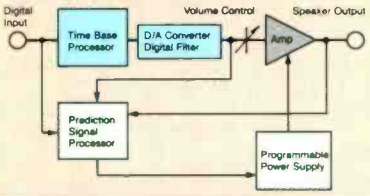
Distortion Waveforms: Digital Pure-A and Class-B Operation



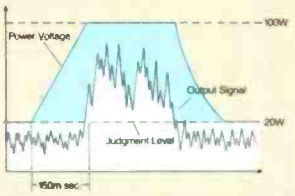
Customized for digital reproduction

The AX-Z911BK is custom designed for superb digital reproduction. It's complete with a D/A converter featuring a 4X oversampling digital filter. There are terminals for direct connection of digital equipment: an optical input, a coaxial input and an in/output for DAT. A "D/A CONVERTER DIRECT" circuit directly connects the D/A converter to the power amp. And the digital and analog circuitry are completely separated to reduce digital noise.

Digital Pure-A Circuit



Conceptual Operation of Digital Pure-A Circuit



If the level of the output signal is predicted to go beyond the judgment level 150 msec. *later*, the power voltage is automatically increased to a high level to prevent the signal from clipping.

AX-Z911BK Digital Pure-A Integrated Amplifier

- 100 watts per channel, min. RMS, both channels driven into 8 ohms, from 20Hz to 20kHz with no more than 0.003% total harmonic distortion
- Digital Pure-A Circuit for class-A operation to provide low-distortion digital sound (For digital signal)
- Dynamic Super-A with Gm Driver for better in-use performance (For analog signal)
- "D/A CONVERTER DIRECT" for direct D/A converter-to-amp connection
- Built-in D/A converter with quadruple oversampling digital filter
- 3 digital connections: one for optical, one for electrical (coaxial) and an in/output for DAT
- Separate layout for digital and analog circuits for reduced interference
- Circuit layout for shortest signal path to ensure "pure" signal transmission
- High-gain phono equalizer for MM/MC cartridges
- Low-noise motor driven volume control
- Bass response control
- Gold-plated terminals
- "Dimensional" multi-function display
- Wireless remote control

XP-A1000BK Digital Acoustics Processor — life-like ambience

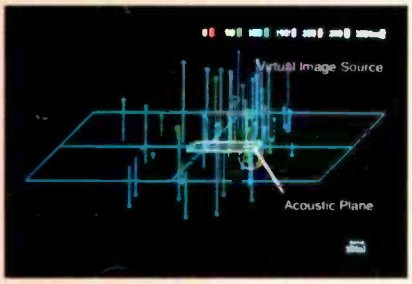
No matter how faithfully your stereo system reproduces music, there is one thing missing from the sound it plays back: that sensation of "being there." The acoustics of a hall produce certain reverberations that just can't be realistically reproduced with a standard stereo system. The new JVC Digital Acoustics Processor gives you a digital way to simulate the acoustics of a live performance, recreating a realistic "sound field" right in your own listening room. It's a revolutionary engineering concept that gives you all the pleasure of live music.

The sound field — what makes the sound come alive

A sound field is simply the ambient characteristics of a live music environment. When a sound is generated it disperses in all directions. First you hear the direct sound from the source. That's followed by the early reflections — a group of sounds that are reflected by the walls and ceiling. Finally, you hear reverberations from random directions over a relatively extended period. Each live music space has its own individual sound field, or pattern of reflections and reverberations. And it's basically this pattern that gives you a clue to the size of a space.

JVC's Digital Acoustics Processor

Our Digital Acoustics Processor simulates the sound field where live music is performed, by accurately replicating directions and levels of reflections and reverberations in the digital way. To make it possible, JVC even developed the computerized way to measure live music environments: the "symmetrical 6-point sound field analysis method." The processor contains a ROM (Read-Only Memory) where the vast amount of data from actual measurements is stored. A newly-developed digital acoustics processing LSI synthesizes the early reflections with proper direction, timing and reverberation, according to data stored in the ROM. Digital processing is performed in 16-bit quantization at sampling rate of 48kHz, combining a 4X oversampling D/A converter and a 64X oversampling A/D converter. The entire process operates channel by channel, to ensure accurate recreation of sound fields.



Symmetrical 6-Point Sound Field Analysis Pattern
In order to develop the XP-A1000BK, we first had to develop a computer-aided acoustics measuring system to analyze a variety of sound fields. In this analysis, the center of each circle represents the location of a "virtual image source" relative to the direct sound source, and the size its intensity.

Symmetrical 6-Point Sound Field Measurement Device

Custom-Designed "Digital Acoustics Processing" LSI

Accurate sound field pattern generation in any environment

Each recording site has its own sound field, and so does your listening room. To accurately reproduce a desired sound field in your room for a particular type of recording, therefore, ambience of the listening room must be "neutralized" when a program is played back. Otherwise there may be excessive reflections and reverberations, which can totally ruin the sense of realism. Our Digital Acoustics Processor lets you adjust not only the parameters for the source program (size, liveness, etc.) but also those for the listening room and the recording site. As a result, our processor can recreate the ambience of any musical environment in any listening room and from any kind of musical program — a feat no other similar processor can duplicate.

20 memory-resident and 20 user-programmable sound field patterns

Our Digital Acoustics Processor has 20 programmed sound field patterns in memory — patterns for concert hall, recital hall, church, jazz club, stadium, and so forth — so that you can choose the one that best suits the type of music you select. Moreover, you can create and store in memory twenty of your own sound field patterns, the patterns that are customized to the acoustic conditions of your listening room and to your listening habits.

XP-A1000BK Digital Acoustics Processor

- Newly-developed LSI for digital signal processing
- Digital processing using 16-bit quantization and 48kHz sampling
- 4X oversampling D/A converter and 64X oversampling A/D converter
- 20 programmed sound field patterns in ROM and 20 user-programmable sound field patterns
- Adjustable acoustic parameters: Sound field size, liveness, frequency response, etc.
- Accurate compensation for ambience of listening room and source program
- Direct digital inputs and outputs: optical and coaxial
- 4/6-channel system configuration selectable
- 6-ganged motor-driven remote-controlled volume control
- Programmable fluorescent display

20 Preset Sound Field Patterns

NO.	PROGRAM NAME	TYPE	NO.	PROGRAM NAME	TYPE
1	SYMPHONY HALL 1	SHOEBOX TYPE	11	LIVE CLUB 1	JAZZ CLUB
2	SYMPHONY HALL 2	SHOEBOX TYPE	12	LIVE CLUB 2	DISCOTHEQUE
3	SYMPHONY HALL 3	SHOEBOX TYPE	13	PAVILION	IVE CONCERT
4	SYMPHONY HALL 4	VINEYARD TYPE	14	GYMNASIUM	HARD FLOORED HALL
5	SYMPHONY HALL 5	VINEYARD TYPE	15	STADIUM	OUTDOOR LIVE CONCERT
6	SYMPHONY HALL 6	VINEYARD TYPE	16	MOVIE THEATER 1	SMALL SPACE
7	RECITAL HALL	SMALL MUSICAL SPACE	17	MOVIE THEATER 2	MEDIUM SIZED SPACE
8	OPERA HOUSE	WITH TIERED SEATING	18	MOVIE THEATER 3	LARGE SPACE
9	CATHEDRAL	GOTHIC SYTLE	19	MOVIE THEATER 4	XTRA LARGE SPACE
10	CHURCH	HIGH-CEILINGED SPACE	20	MOVIE THEATER 5	STANDARD

Adjustable Parameters

	PARAMETER	ADJUSTABLE RANGE		PARAMETER	ADJUSTABLE RANGE
1	ROOM SIZE	0.5—2	7	REAR DELAY	5—30 ms
2	LIVENESS	0.5—2	8	SPREAD POINT	SPREAD POINT
3	LOW PASS FILTER	1—16kHz, THRU	9	LISTENING ROOM REVERB	0.2—0.6 ms
4	REVERB LEVEL	0—2	10	LISTENING ROOM SIZE	10m² or less, 10—16m² 16m² or more
5	HIGH FREQUENCY REVERB	0.1—1			
6	OFFSET DELAY	0—200 ms	11	SOURCE REVERB	1—5 sec

XL-Z555BK CD Player — high-tech features for better digital sound

Some people seem to think that today's CD players have reached the limits of digital technology: after all, they say, digital is digital — so there's no difference in sound quality between players. We've found, however, that there *is* a difference between models, and it is intimately related with the digital and analog technologies built into the players. With our advanced engineering in audio behind, JVC has come up with a series of technologies to provide even better digital sound. And the XL-Z555BK is proof.

New high-precision 3-beam laser pickup design
Our newly designed pickup combines high sensitivity, precision, stability and immunity to resonance and vibration.

New High-Precision 3-Beam Laser Pickup

Stability and resistance to vibration and resonance are improved thanks to a new suspended actuator. The pickup is also compact and lightweight, improving tracking accuracy and reducing "servo noise."

4X oversampling digital filter
Our 4X oversampling digital filter uses a sampling frequency that's four times higher than normal (176.4kHz instead of 44.1kHz). Used in combination with a gentle-attenuation quality analog filter, it reduces noise and phase distortion to give you clear, well-defined digital sound.

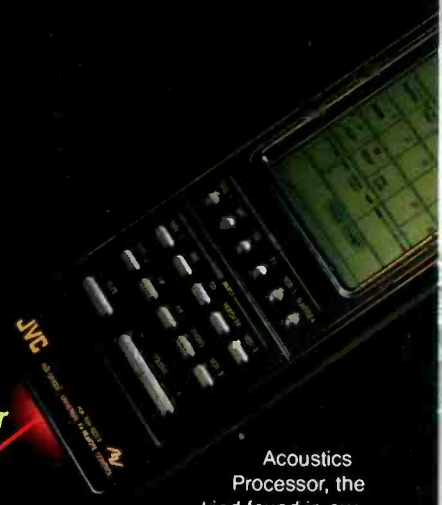
"New Y Servo System" for superior tracking ability
Our new servo system uses two special tracking beams — one leading and one trailing the main beam. The difference between the two signals is compensated for, and they are compared so as to cancel each other out. The result: The pickup remains locked on the correct track, even when the disc is dirty or scratched.

Disc/track indication and multi-disc editing
Two special features make the XL-Z555BK easier to use. You can give a name up to 10 characters long to a disc or a track, and store as many as 512 of them in memory for display on playback. And you can program up to 48 tracks chosen from six different discs so you can easily transfer them to tape.

XL-Z555BK Compact Disc Player

- Quadruple oversampling digital filter for smooth, precise response
- Twin high-speed D/A converters for precise imaging
- JVC high-precision 3-beam laser pickup
- New Y Servo System for superior tracking ability
- JVC "Opticalink" system for low digital noise
- Digital outputs: one optical and one coaxial
- Double-floating Independent Suspension System
- Disc/track title indication to name tracks and discs
- Remote control with volume control and numeric keypad
- Ready to play 3-inch (8cm) "CD singles"
- Random access programming of up to 32 tracks
- Auto/multi-disc editing key for cassette recording
- Random play, intro-scan, 5-way repeat, index play

RX-1001VBK Receiver — exquisite ease of use with computer control



The JVC RX-1001VBK is a supreme example of how computers make your life easier. From remote operation to graphic equalizer, a computer takes charge to provide you with the exceptional operating versatility and flexibility that simply defy your imagination.

"Programmable" A/V remote control
Our "programmable" A/V remote control means that you can operate not only the receiver itself but also other JVC audio components *and* video components from a single remote. What's more, it has capacities to learn more functions of any audio and video component, whatever its make. And the RX-1001VBK's remote even comes equipped with a touch-panel LCD (Liquid Crystal Display) that serves as a multi-page menu and convenient touch panel.

To Program, Place Our Remote End-to-End with Other Remote.

JVC's Digital Acoustics Processor
The receiver features the Digital Acoustics Processor, the kind found in our XP-A1000BK. The realistic sound field it creates puts you where music is performed live — right in your own home. Conveniently, five types of sound fields (SYMPHONY HALL, RECITAL HALL, CHURCH, LIVE CLUB and STADIUM) are preset for instant recall.

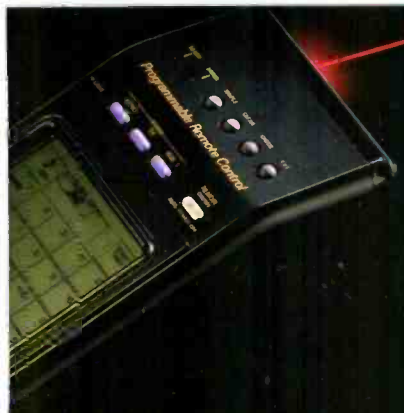
Computerized S.E.A. graphic equalizer
With a computer at command, our S.E.A. graphic equalizer is more versatile and easier to use than ever. You can equalize the sound from the remote, recall any from five "programmed" equalization curves, and create and put into memory the equalizations you've created, along with custom names.

Computerized digital tuner
Again, by using a computer, we've improved ease of tuning and added new tuning conveniences. Up to 40 FM and AM stations may be preset and recalled instantly. Preset scan lets you "sample" stations. A signal strength indicator is dB-calibrated for accurate direct readout. It's even possible to give each station the name of your choice.

RX-1001VBK Programmable Remote/Computer-Controlled Receiver

- 4-channel amplifier for front/rear speaker operation
- 120 watts per channel, min. RMS, both channels driven into 8 ohms, from 20Hz to 20kHz with no more than 0.007% total harmonic distortion (2-channel operation)
- "Programmable" remote control with touch-panel LCD
- Digital Acoustics Processor for precise sound field control
- Digital-delay Dolby Surround with adjustable delay
- Ready to control 3 video inputs, with dubbing and "Sound Selector"
- Computer-controlled 7-band S.E.A. graphic equalizer with 5 user-created and 5 "namable" programmed preset equalizations
- Computer-controlled digital synthesizer tuner, with 40 FM/AM presets, auto memory, more
- Dynamic Super-A with Gm Driver
- Interactive CCS (COMPU LINK Communications System)

The red beams in the photo are drawn for illustration only.



TD-V711BK Cassette Deck — wider dynamic range, flatter response and purer sound

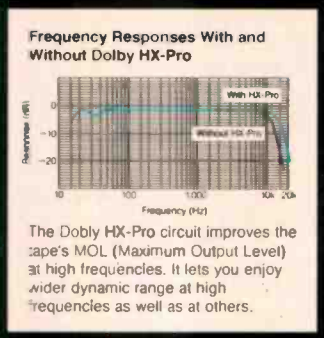
With extremely wide dynamic range and low distortion, digital sound has been a single program source that conventional cassette decks cannot compete in terms of specifications. The TD-V711BK, however, is the cassette deck expressly designed for recording digital sounds whole and complete.

Closed-loop dual-capstan drive
With a sophisticated closed-loop dual-capstan drive, the portion of tape that runs across the heads is constantly held taut, pinched by two capstans/rollers. This design improves the head-to-tape contact for better response, and also shuts out external disturbances from vibrating the tape. This results in reduced intermodulation noise. It's thanks to our solid tape drive (and the 3-head design) that you can enjoy pure and clean taped sound.

Designs for purer sound
Another way we've ensured higher sonic purity is using a direct and straightforward circuit design, to reduce the chance of noise and distortion pickup. That's why input selector switches and the volume potentiometer are located at the back of the chassis, and operated by "remote shafts." For the same purpose, we also use PCOCC (copper of highest purity) wire and OFC (Oxygen-Free Copper) in the heads and in the circuit board, and provide two direct inputs to accept outputs from source programs like a CD player. Dolby HX-Pro contributes to purer sound, too, by expanding the high-frequency dynamic range.


Discrete 3-Head Design Featuring SA Head and Amorphous Head


Two-Motor Full-Logic "Silent" Mechanism



The Dolby HX-Pro circuit improves the tape's MOL (Maximum Output Level) at high frequencies. It lets you enjoy wider dynamic range at high frequencies as well as at others.

SX-911WD Speaker System — designed for high purity and transparency

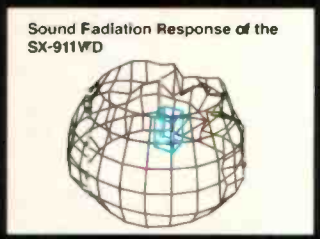
JVC has designed the SX-911WD from the ground up, with the sole purpose of making a speaker system matched with digital programs in every way. Now you can enjoy pure, clean and transparent sound, completely stripped of any trace of muddiness and fuzziness of conventional systems.

Cloth carbon woofer and midrange
Light weight, high ridigity, high speed of sound and optimized internal loss — our new cloth carbon diaphragm for the woofer combines the most ideal properties demanded of a diaphragm material. The result is the bass sound that's extended, crisp and rich. The midrange uses a similar material called "fine" cloth carbon to provide clear and natural mids.


Rigid Pure-Aluminum Frame for SX-911WD Woofer

Amorphous-diamond coated tweeter
Much of the reason for high transparency of the SX-911WD lies in the high-tech tweeter design. It uses a dome diaphragm with a titanium base on which a thin layer of amorphous diamond is coated by chemical vapor deposition. Featuring uniform thickness, high purity and smooth surface, this coating increases the diaphragm's speed of sound to almost that of natural diamond. So the transient response is dramatically improved, as are purity and transparency.

Unresonating, solid frames and enclosure
Every speaker unit is housed inside a solid, unresonating die-cast aluminum frame cylindrical in shape to disperse vibrations efficiently. The enclosure is constructed by solid 1-inch (25mm) particle boards. The panels are conifer-based to provide superb musical sonority. Front and rear baffles are mounted with additional cleats to increase the rigidity of the cabinet and make it resistant to resonance and vibration. And the front baffle has rounded corners to reduce diffraction and provide better definition.



TD-V711BK Discrete 3-Head Cassette Deck

- Monitor-capable 3-head configuration: SA head for record and amorphous head for play
- Computer-controlled two-motor full-logic mechanism
- Closed-loop dual-capstan drive with direct-drive motor
- 2 "DIRECT" inputs for direct connection with CD players, etc.
- PCOCC coil and lead wired in heads, and OFC plating on circuit boards for higher purity
- Straightforward circuit layout for clean signal transmission
- Separate circuit construction for low interference
- Low-impedance voltage-tracking regulated power supply
- High-rigidity chassis and large insulators for low resonance and vibration
- Dolby HX-Pro and double-Dolby B/C noise reduction

SX-911WD 3-Way Speaker System

- 12-3/8-inch (31.5cm) cloth carbon woofer for the bass sound that's crisp, extended and rich
- 5-inch (12cm) "fine" cloth carbon midrange for rich and natural midrange sound
- 1-3/16-inch (3cm) amorphous-diamond coated tweeter — transparency and superior transient response
- Low-resonance/vibration die-cast aluminum speaker frames
- High-density conifer-based particleboard enclosure for musical sonority
- Round-cornered front baffle to provide razor-sharp definition
- 3-part crossover network to prevent interference
- Computer-optimized speaker layout for natural sound field reproduction and clear sonic imaging
- High power handling capacity: 150 watts/300 watts (music)

SPECIFICATIONS

AX-Z911BK Digital Pure-A Integrated Amplifier

OVERALL CHARACTERISTICS	
Output Power	**100 watts per channel, min. RMS, both channels driven into 8 ohms from 20Hz to 20kHz, with no more than 0.003% total harmonic distortion** 105 watts per channel, min. RMS, into 8 ohms at 1kHz, with no more than 0.0005%* total harmonic distortion
Total Harmonic Distortion	
AUX to SP OUT	0.003% at 100 watt output, 8 ohms, 20Hz to 20kHz 0.0005%* at 105 watt output, 8 ohms, 1kHz
PHONO to SP OUT	0.007% at 100 watt output, 8 ohms, 20Hz to 20kHz, −20dB volume
Power Bandwidth	7Hz to 60kHz (IHF, both channels driven, 8 ohms, 0.02% total harmonic distortion)
Frequency Response (8 ohms)	
TUNER/AUX/CD/TAPE	DC to 200kHz +0dB, −3dB
REC Output Level/Impedance	400mV/400 ohms (ANALOG) 2.0V/550 ohms (DIGITAL)
Input Sensitivity/Impedance (1kHz)	
PHONO MM	2.5mV/47k ohms (+6dB)
PHONO MC	200μV/470 ohms (+6dB)
TUNER/AUX/CD/TAPE	400mV/30k ohms
Signal-to-Noise Ratio ('66 IHF/'78 IHF)	
PHONO MM	90dB/80dB (REC OUT)
PHONO MC	74dB (250μV input)/73dB (REC OUT)
TUNER/AUX/CD/TAPE	112dB/85dB
PHONO EQUALIZER SECTION	
Phono Overload (1kHz): MM	100mV (0.007% total harmonic distortion)
MC	7mV (0.007% total harmonic distortion)
RIAA Phono Equalization: MM	±0.2dB (20Hz to 20kHz)
MC	±0.2dB (20Hz to 20kHz)
D/A CONVERTER SECTION	
Sampling Frequencies (Auto Selection)	32k, 44.1k, 48kHz
Total Harmonic Distortion	0.0035% (1kHz)
Dynamic Range (1kHz)	97dB
Signal-to-Noise Ratio	102dB
Dimensions (W×H×D)	18-3/4×6-9/16×17-7/16 inches 475×166×442mm
Weight	44.1 lbs. (20kg)

* Measured by JVC Audio Analysis System.

XP-A1000BK Digital Acoustics Processor

Level/Impedance: Input	2V/47k ohms
Output	2V/500 ohms
Total Harmonic Distortion:	
MAIN OUT	0.002% (1kHz, 2V output)
D.A.P. OUT	0.005% (1kHz, 2V output)
Frequency Response:	
MAIN OUT	5Hz — 100kHz (+0, −3dB)
D.A.P. OUT	5Hz — 20kHz (±0.5dB)
Dynamic Range: MAIN OUT	110dB
D.A.P. OUT	94dB
Signal-to-Noise Ratio:	
MAIN OUT	110dB
D.A.P. OUT	94dB
Dimensions (W×H×D)	18-3/4×4×14-3/16 inches 475×101×360mm

RX-1001VBK Programmable Remote/Computer-Controlled Receiver

AMPLIFIER SECTION	
Output Power:	
2-Channel Operation	**120 watts per channel, min. RMS, both channels driven into 8 ohms from 20Hz to 20kHz, with no more than 0.007% total harmonic distortion** (Front Channels)
4-Channel Operation	**110 watts per channel, min. RMS, both channels driven into 8 ohms from 20Hz to 20kHz, with no more than 0.007% total harmonic distortion** (Rear Channels) 15 watts per channel, min. RMS, into 8 ohms at 1kHz, with no more than 0.07%* total harmonic distortion
Total Harmonic Distortion (8 ohms, 1kHz)	0.003%* at 125 watt output
Input Sensitivity/Impedance	
PHONO MM	2.5mV/47k ohms
PHONO MC	250μV/100 ohms
VIDEO SOUND/AUX/CD/TAPE	230mV/47k ohms
Signal-to-Noise Ratio ('66 IHF/'78 IHF)	
PHONO	80dB/80dB (REC OUT)
VIDEO SOUND/AUX/CD/TAPE	100dB/85dB
Frequency Response	
PHONO	20Hz — 20kHz (±0.5dB)
VIDEO SOUND/AUX/CD/TAPE	5Hz — 50kHz (+0, −1dB)
S.E.A. SECTION	
Center Frequencies	63, 160, 400, 1k, 2.5k, 6.3k, 16kHz
Control Range	±10dB
FM TUNER SECTION (IHF)	
Usable Sensitivity	10.3dBf (0.9μV/75 ohms)
50dB Quieting Sensitivity:	
MONO	14.8dBf (1.5μV/75 ohms)
STEREO	38.3dBf (22.5μV/75 ohms)
Distortion (1kHz)	
MONO/STEREO	0.08%/0.08%
Signal-to-Noise Ratio (IHF-A Weighted)	
MONO/STEREO (at 85dBf)	84dB/78dB
Selectivity (±400kHz)	70dB
Capture Ratio	1.5dB (10mV/300 ohms)
Frequency Response	30Hz — 15kHz (+0.5, −0.8dB)
AM TUNER SECTION	
Usable Sensitivity	250μV/m (Loop antenna) 30μV (External antenna)
Signal-to-Noise Ratio (100mV/m)	50dB
Selectivity (±10kHz)	38dB
VIDEO INPUTS/OUTPUTS	
Output Signal Level	1Vp-p (at 1Vp-p input)
Impedance	75 ohms unbalanced
Synchronization	Negative
Signal-to-Noise Ratio	45dB
Crosstalk	45dB (3.58MHz)
Dimensions (W×H×D)	18-3/4×6-3/16×15-1/8 inches 475×156×383mm
Weight	29.8 lbs. (13.5kg)

*Measured by JVC Audio Analysis System

XL-Z555BK Compact Disc Player

Frequency Response	2Hz — 20kHz
Total Harmonic Distortion (1kHz)	0.0035%
Dynamic Range (1kHz)	97dB
Signal-to-Noise Ratio	100dB
Channel Separation (1kHz)	92dB
Wow and Flutter	Unmeasurable
Output Level	2.0V RMS
Dimensions (W×H×D)	18-3/4×4-9/16×11-1/2 inches 475×115×291mm
Weight	12.6 lbs. (5.7kg)

TD-V711BK Discrete Three-Head Cassette Deck

Frequency Response (at −20 VU)	
Metal Tape	10 — 22,000Hz (15 — 20,000Hz ± 3dB)
SA/Chrome Tape	10 — 20,000Hz (15 — 18,000Hz ±3dB)
Normal Tape	10 — 20,000Hz (15 — 18,000Hz ±3dB)
Signal-to-Noise Ratio	59dB● (Metal)
Wow and Flutter	0.022% (WRMS)
Crosstalk (1kHz)	65dB
Channel Separation (1kHz)	40dB
Harmonic Distortion	
Total (0VU, 1kHz)	1.0% (Metal)
K3 (0VU, 1kHz)	0.5% (Metal)
Input Sensitivity/Impedance	
Line Input×2	80mV/50k ohms
Output Level/Impedance	
Line Output×2	300mV/600 ohms
Headphones	0 — 1mW/8 ohms (Matching impedance: 8—1k ohms)
Dimensions (W×H×D)	18-3/4×5-1/4×13-1/4 inches 475×132×336mm
Weight	18.3 lbs.(8.3kg)

● Measured from peak level, weighted, without NR. The S/N is improved by about 15dB at 500Hz and by about 20dB above 1kHz with Dolby-C NR on, and by 5dB at 1kHz and by 10dB above 5kHz with ANRS/Dolby-B NR on.

SX-911WD 3-Way Speaker System

Type	3-way, acoustic suspension
Speakers:	
Woofer	12" (30.5cm), cloth carbon cone
Midrange	4-1/2" (11.5cm), cloth carbon cone
Tweeter	1" (2.5cm), amorphous-diamond coated dome
Power Handling Capacity	150 watts 300 watts (Music)
Impedance	6 ohms
Sensitivity (1m on axis)	91dB/W·m
Frequency Range	40 — 50,000Hz
Crossover Frequencies	500Hz, 4kHz
Dimensions (W×H×D)	15×26-3/16×13-7/8 inches 380×665×351mm
Weight	62.8 lbs. (28.5kg)

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2

DBX TX1 TUNER

Manufacturer's Specifications

FM Section

Usable Sensitivity: Mono, 9.4 dBf.
50-dB Quieting Sensitivity: Mono, 11.2 dBf; stereo, 38 dBf.
S/N: Mono, 85 dB; stereo, 79 dB.
THD + N: Mono, 0.06% for wide i.f. and 0.3% for narrow i.f.; stereo, 0.07% for wide i.f. and 0.5% for narrow i.f.
Frequency Response: 20 Hz to 15 kHz, ±0.35 dB.
Capture Ratio: 1.5 dB.
Alternate-Channel Selectivity: 70 dB.
Adjacent-Channel Selectivity: Wide, 7 dB; narrow, 26 dB
Image Rejection: 100 dB.
I.f. Rejection: 100 dB.
Subcarrier Rejection: 70 dB.
SCA Rejection: 80 dB.
I.f. Bandwidth Switching Threshold: 20.7 dBf.
Stereo Switching Threshold: 20.7 dBf.
Muting Threshold: 20.7 dBf.
Output Level: 1 V for 100% modulation.

AM Section

Sensitivity: 250 μV/m.
S/N: Greater than 45 dB at 1 mV/m, 30% modulation.
THD: 0.5% at 5 mV/m.
Frequency Response: 40 Hz to 5 kHz, ±2 dB (NRSC pre-emphasis).
Selectivity: 70 dB.
I.f. Rejection: 70 dB.
Image Rejection: 45 dB.
Maximum Radio Frequency Input: 3 V/m.
Output Level: 1 V for 1 mV input, 80% modulation.

General Specifications

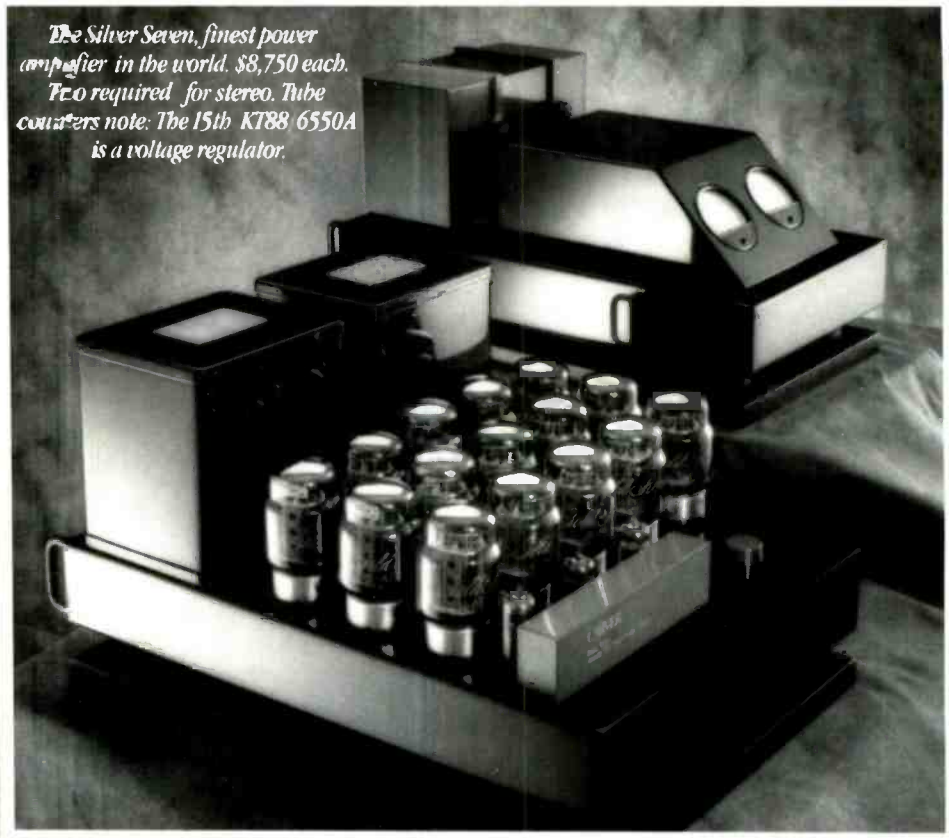
Memory Backup: More than 10 days.
Dimensions: 17.1 in. W × 1.75 in. H × 9 in. D (43.4 cm × 4.4 cm × 22.9 cm)
Weight: 3 lbs. (1.4 kg).
Price: $800.
Company Address: P.O. Box 100C, Newton, Mass. 02195.
For literature, circle No. 91

Larry Schotz, who helped design the dbx TX1 tuner, is one of the foremost consumer electronic product designers practicing in the United States. You may remember that some 10 years ago, it was Schotz who startled the audio world with his remarkable Micro/CPU 100 tuner (first sold by Sherwood Electronics, later under the Draco Labs label). To the best of my recollection, that was the first commercially available tuner to employ frequency-synthesized tuning. Among its novel features was the ability to program the alphabetic call letters of its preset stations.

During the intervening years, Schotz has built up an outstanding reputation, primarily in the area of r.f. product design. He has executed successful designs for such companies as NAD, Proton, Nakamichi, and Parsec, to name just a few. When dbx decided to broaden their product line to include a tuner, they sought his help. It was a wise move!

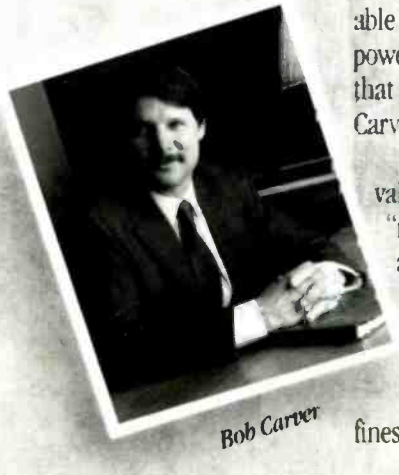
Over the last couple of years, I've often been troubled by the fact that rarely, if ever, was I able to realize claimed usable sensitivities for most of the FM tuner products I've tested. Oh, it's not that they miss by much. A claimed 10.8 dBf might work out to be 12 or 13 dBf, for example. But that consistent pattern has caused me, more than once, to suspect miscalibration of my Sound Technology FM generator. Thanks to the dbx TX1 tuner, those doubts have now

"Because I wanted to have the world's finest amplifier and the world's greatest transfer function, I built the astonishing Silver Seven."



The Silver Seven, finest power amplifier in the world. $8,750 each. Two required for stereo. Tube counters note: The 15th KT88 6550A is a voltage regulator.

Before you meet the new M-4.0t, Bob Carver wants you to meet its inspiration, the money-is-no-object Silver Seven.



Bob Carver

"One of my important design precepts is that power amplifiers should be easily affordable but last year, when I began designing a powerful new amplifier, I temporarily set aside that precept of affordability. The result is the Carver Silver Seven Mono Power Amplifier."

Destined to redefine ultra-high-end values forever, the Silver Seven is truly a "money-is-no-object" design. In fact, just a single pair of its fourteen KT88/6550A Beam Power output tubes cost more than some budget amplifiers.

The Silver Seven employs classic, fully balanced circuit topology and the finest components in existence.

A-450 Ultra Linear output transformers with oxygen-free primary leads and pure silver secondaries.

- *Wonder Cap capacitors throughout.*
- *Interconnects are Van den Hul Silver.*
- *Internal wiring is pure silver.*
- *Wonder Solder throughout.*
- *Gold input connectors and high current gold output connectors.*

The Silver Seven's polished granite anti-vibration base floats on four Simm's vibration dampers. The separate power supply's power transformer end-bells are machined from a solid block of high-density aluminum.

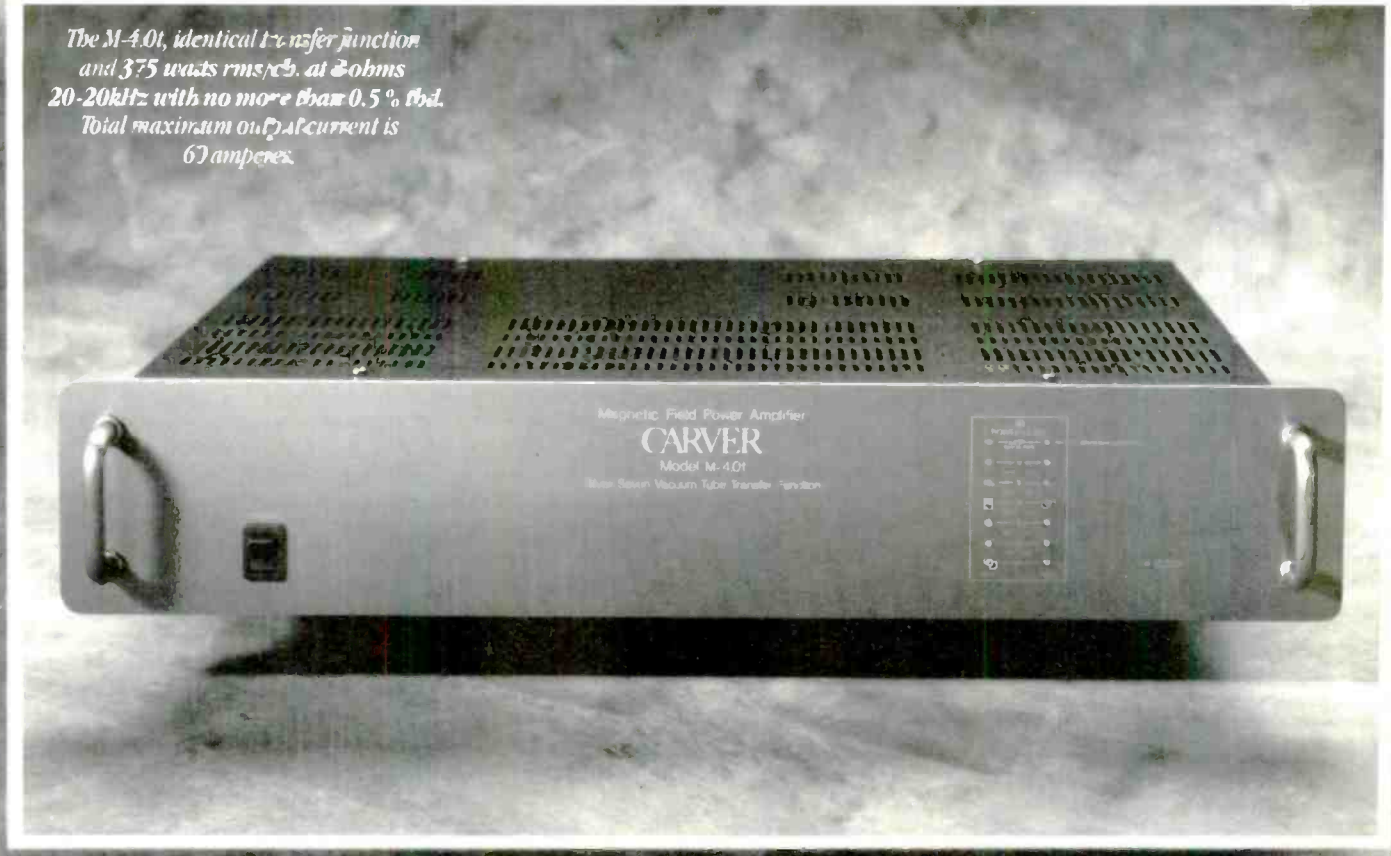
Capable of an astonishing 390 joules energy storage, the Silver Seven delivers ***a conservatively rated 375 watts into 8 ohms from 20Hz to 20kHz with no more than 0.5% distortion.*** On the 1-ohm tap, peak current is in excess of 35 amps!

Sonically, a pair (for stereo) of the flawless Silver Sevens almost defies description.

Powerful

Distributed in Canada by: evolution technology

"Because I wanted to share its magnificent sound with you we built the new Carver M-4.0t."



Superlatives are insufficient.

What does this have to do with the new M-4.0t?

Everything. Because the M-4.0t precisely duplicates the transfer function of the Silver Seven.

Ever wondered why two amplifiers of identical wattage can sound different? Or why two designs with different output ratings can sound much the same? In many cases, it's because each power amplifier exhibits a unique relationship between its input and output signals. Like human fingerprints, this *transfer function* is subtly distinct, defining much of the sonic character of the design. Bob has not only perfected the art of measuring an amplifier's transfer function, but is able to duplicate it in a completely dissimilar amplifier design! That's how he invested his solid state M-1.0t with the transfer function of a set of $5000 esoteric tube amps several years ago.

This time he's gone one better. Or two.

He's used this powerful scientific method to duplicate the transfer function of the Silver Seven in the new M-4.0t (now you know what the "t" signifies). Mind you, we are not saying the M-4.0t is *identical* to a pair of Silver Sevens. An M-4.0t weighs 23 pounds versus the Silver Seven at 300 pounds a pair. The Silver Seven stores 390 joules of energy while the M-4.0t stores none. As a Magnetic Field Power Amplifier the M-4.0t instantly draws the power it needs directly from the AC line.

Though in choosing the M-4.0t you may miss the warm glow of the Silver Seven's silver tipped vacuum tubes reflecting in polished black lacquer, be assured both amplifiers are the most musical, effortless, and open sounding you have ever heard. Bass is full and tight, midrange is detailed, treble is pure and transparent.

Each can float a full symphony orchestra across the hemisphere of your living room with striking realism.

Bob Carver developed this incredible design for one reason: to bring you the best the world has to offer and the best amplifier value ever, and he has succeeded handsomely.

Listen to the new, incredibly affordable M-4.0t at your nearest Carver dealer. Or write us for more information. We'll even send you data on the Silver Seven. After all, if you ever want to move up from the M-4.0t, there's only one possible alternative.

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The dbx TX1's mono usable sensitivity was better than specified, even though that spec was so good it looked like a typographical error!

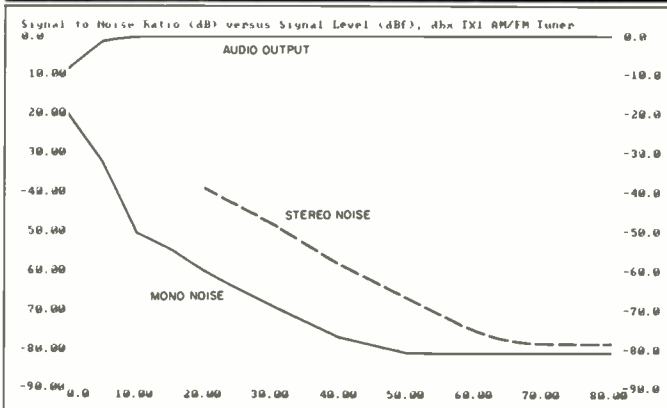
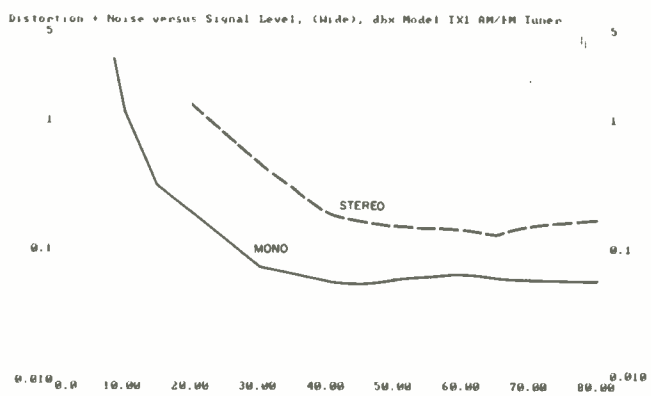


Fig. 1—Mono and stereo quieting characteristics, wide i.f. mode. Ultimate S/N in narrow i.f. mode was identical, although usable sensitivity was not quite as good.



A

B

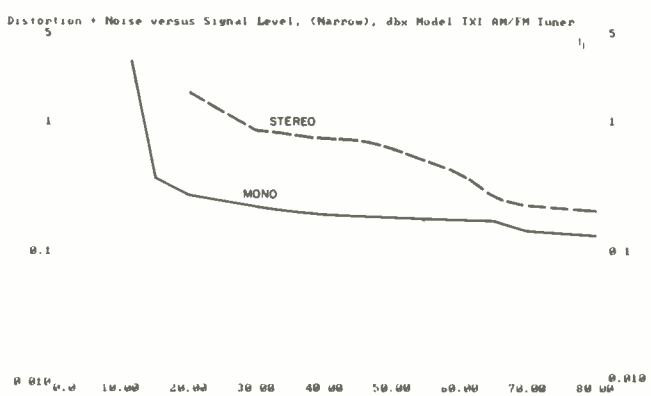


Fig. 2—THD + N vs. signal strength at 1 kHz for wide (A) and narrow (B) i.f. modes.

been dispelled. The claimed mono usable sensitivity of 9.4 dBf (that's *not a* typo) turned out to actually measure *8.5 dBf*. (That's not a typo, either!) But I'm getting way ahead of myself.

The low-profile TX1 incorporates automatic circuits for reducing noise from weak FM stations. The tuner constantly monitors the FM signal for noise, which is normally concentrated at the higher audio frequencies. When noise is detected, the circuit blends together the high frequencies of the two stereo channels to reduce it. Since this blending occurs dynamically, it is only activated when necessary. It also can be introduced, if needed, by the user.

As an aid to tuning in weak stations that are close in frequency to stronger signals, whenever the TX1 senses such situations, it automatically chooses the narrow i.f. mode for greater selectivity and adjacent-channel rejection. (This feature also can be manually selected.) The unit's circuitry can memorize six AM and six FM station frequencies, and it employs frequency-synthesized tuning with 100-kHz increments on FM and 10-kHz increments on AM. As indicated in the published specs, in the event of a power outage (or if the tuner should be unplugged from an outlet), preset information will be retained for at least 10 days. Usually, the information will be retained for about two weeks.

Although most designers of AM/FM tuners treat the AM section pretty much as an afterthought, in this Schotz design, careful attention has been given to the AM circuits as well as the FM section. For years now, I've been complaining about the poor AM frequency response of so-called high-fidelity tuners and receivers. In one sense, my criticism has been unfair. The fact of the matter is that most manufacturers roll off the high end of their AM tuners in order to reduce background noise and interference, especially during nighttime listening. To compensate for this design approach, most AM stations boost or pre-emphasize the high frequencies of their program content. The situation is not unlike that in FM, with the 75-μS pre-emphasis curve used at the transmitting end and the 75-μS de-emphasis curve employed in all FM tuners intended for use in the United States (it's 50 μS in Europe). Until recently, however, there's been one major difference between the FM and AM approaches to pre-emphasis and de-emphasis: AM stations did pretty much as they pleased. Some pre-emphasized a great deal, some didn't pre-emphasize at all, and there was everything in between. Tuner manufacturers were therefore at a loss to know exactly *how* to roll off the response of their AM circuitry. Recently, the National Radio Systems Committee (NRSC) decided to do something about the chaotic status of AM. They came up with a defined pre-emphasis curve and urged stations to employ it. Simultaneously, they urged makers of AM tuners to build in the inverse de-emphasis curve. It is no surprise to find that Larry Schotz's AM circuit, as found in the TX1, is one of the first to comply with this voluntary standard.

Control Layout

A power on/off button at the left of the tuner's all-black panel has a tiny LED indicator above it. To the right are four very small buttons that select i.f. bandwidth, mono or stereo reception, the Schotz noise-reduction circuitry, and muting.

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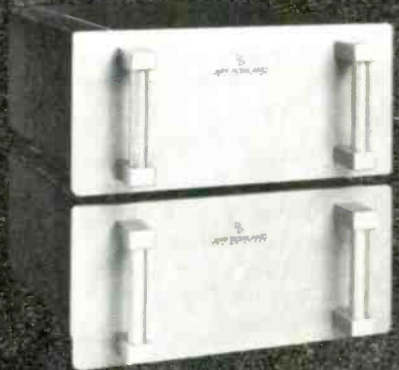

Model 7 Differential Mode™
Mono Power Amplifier

No afterthought, the TX1's AM section clearly received as much careful attention as the FM circuitry.

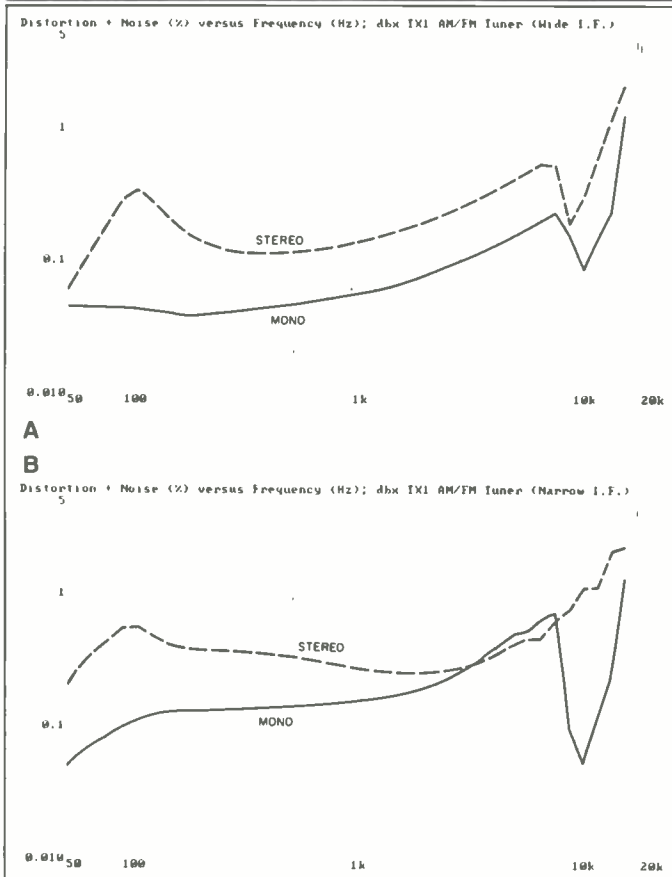

Fig. 3—THD + N vs. frequency for wide (A) and narrow (B) i.f. modes.

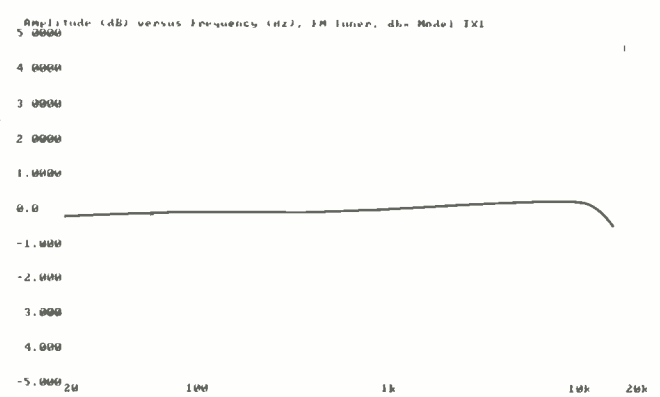

Fig. 4—FM frequency response. Note vertical scale of 1 dB/div.

When either of the last two controls is pressed, a small indicator LED lights up above it. These buttons are of the light-touch variety and do not stay pushed in when activated, so there would be no way of knowing which settings were operating without the LEDs. The i.f. bandwidth and mono/stereo indications, rather than appearing above their respective touch buttons, show up in the main display at the center of the panel, which also has a five-LED signal-strength meter. Below are AM and FM band-selector buttons. Further to the right are the six preset buttons, plus the "Set" button, for storing specific AM or FM station frequencies. At the extreme right is a welcome rotary tuning knob.

How can a tuning knob work with a frequency-synthesized tuning system? Simply by coupling the knob to an optical disc fitted with small holes. As the holes pass in front of a beam of light, that light impinges upon a sensor which tells the tuner section how far to move up or down in frequency. To me, there's something more ergonomically pleasing about spinning a tuning knob than leaning on a button and watching the digits change on a display.

The rear panel is equipped with a 75-ohm coaxial connector for a transmission line from your FM antenna, and a pair of terminals for connecting an external AM antenna, if needed. The usual AM rod antenna will probably suffice in most locations, but the owner's manual wisely urges FM listeners to use something better than the supplied T-wire antenna. (The manufacturer devotes 1½ pages of their well-written manual to the subject of FM antennas, and it ought to be required reading for anyone who owns an FM tuner or receiver.) If your incoming transmission line is of the 300-ohm, flat twin-lead type, there's no need to buy an accessory transformer; dbx supplies one. Left and right output jacks are located on the right half of the rear panel.

Measurements

As I've mentioned, I was astounded to find that the TX1's mono usable sensitivity measured even lower than its low published specification: 8.5 dBf as against 9.4 dBf claimed. For you folks who still think microvolts, that's a usable sensitivity of *0.73 μV into a 75-ohm antenna impedance*! Stereo usable sensitivity was determined by the stereo threshold rather than by the tuner's actual front-end performance. That threshold (as well as the muting threshold) was set at 20 dBf, which is exactly where I felt it ought to be in terms of optimizing S/N, distortion, and other parameters.

A plot of S/N versus signal input is shown in Fig. 1. Ultimate S/N measured 81 dB for mono and a very high 79 dB for stereo. Since S/N was the same whether the tuner was in the wide or narrow i.f. mode, I saw no point in plotting both, though it should be noted that the usable sensitivity in the narrow mode was slightly worse than in the wide. This is attributable to the higher level of THD in the narrow mode rather than to any increase in noise.

Figure 2 shows how THD + N varied as a function of signal input level. In the wide mode (Fig. 2A), THD + N measured 0.06% in mono and 0.13% in stereo at 65 dBf for a 1-kHz modulating signal. In the narrow i.f. mode (Fig. 2B), THD + N increased to 0.17% in mono and was 0.25% in stereo. Both results in the narrow mode are only about half of those specified by dbx.

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If you would only buy audio from a *real* hi-fi company and video from a *real* video manufacturer, from whom do you buy audio/video? The company that builds both *high-end* audio and video. Akai.

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The AA-V435-B's extensive video capabilities include the widest assortment of audio/video inputs and outputs including S-VHS, front panel video, and video RF.

The true beauty of the sleek AA-V435-B is the way it ties everything together. Featuring the most logical rear panel and internal switching designs, it takes full control of your audio/video system, even remotely with its universal remote (capable of "learning" up to 35 functions from almost any remote audio or video components).

Sight and sound are brought together to create a genuine theatrical experience via the AA-V435-B's Dolby® Surround Decoder, which even includes extra stereo amplifiers for two rear speakers.

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*Continuous average power output, both channels driven into 8 ohms, from 20 Hz to 20 kHz at no more than 0.05% THD.
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AKAI

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The dbx TX1 tuner handled weak signals or interference from powerful adjacent stations as though it had a mind of its own.

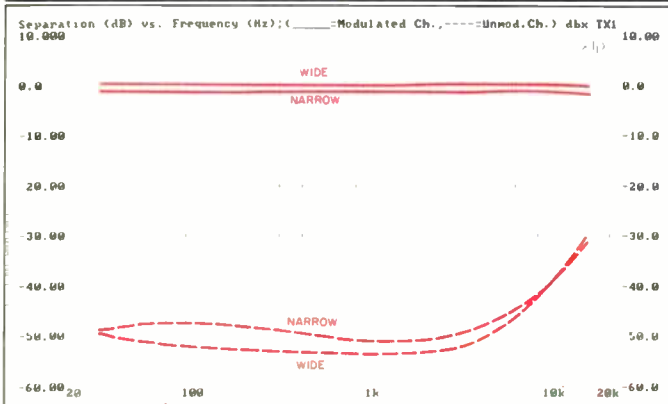

Fig. 5A—FM frequency response (top curves) and separation (bottom curves) for both i.f. modes, with signal input of 65 dBf.

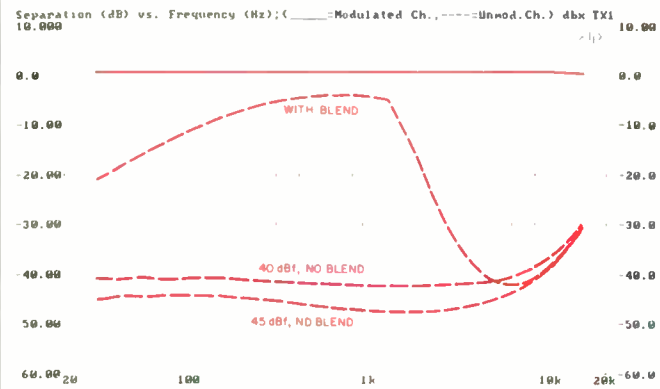

Fig. 5B—Blending effect of Schotz noise-reduction circuit (see text), which is constant at all signal levels, and separation without NR at levels of 40 and 45 dBf.

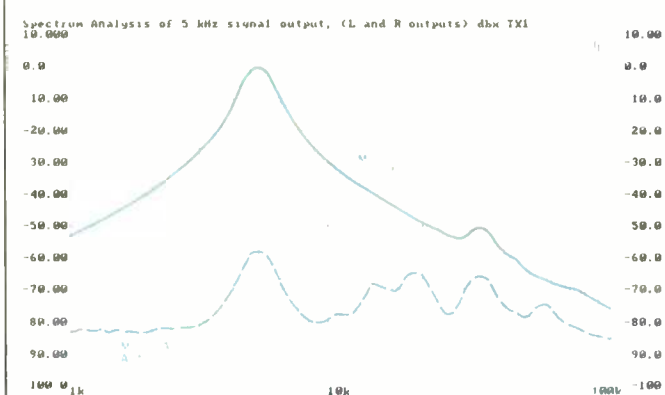

Fig. 6—Separation and crosstalk components for a 5-kHz modulating signal.

Plots of THD + N versus frequency are presented in Fig. 3. For the wide i.f. mode (Fig. 3A), the rather odd shape of both curves, above 7.5 kHz or so, is due to a filter whose use is mandated by the EIA/IEEE Tuner Measurement Standard. This filter's cutoff frequencies are set at 200 Hz and 15 kHz (the second harmonic of 7.5 kHz). At 100 Hz and 6 kHz (the two frequencies other than 1 kHz at which distortion is supposed to be reported), THD + N was 0.042% and 0.18%, respectively, in mono and 0.32% and 0.5% in stereo. Switching to the narrow i.f. mode (Fig. 3B), again at 100 Hz and 6 kHz respectively, THD + N was 0.11% and 0.6% in mono; for stereo, results were 0.57% and 0.49%.

Figure 4 shows FM frequency response from 20 Hz to 15 kHz (the highest audio frequency broadcast on FM). Maximum deviation from flat response was no more than +0.2 dB and −0.35 dB. An important point concerning good FM design is illustrated in Fig. 5. Conventional wisdom has always maintained that switching from a wide to a narrow i.f. tuning mode (to overcome adjacent- or even alternate-channel interference) inevitably means giving up separation as well as lowest possible distortion levels. In this Schotz-designed tuner, "conventional wisdom" holds as far as the higher distortion is concerned. But look at Fig. 5A, a plot of frequency response of one modulated stereo channel (solid curves) and of separation or output of the unmodulated channel (dashed curves). In this case, the decrease in separation when switching from wide to narrow i.f. bandwidth was insignificant, even when you take into account the slight change in output level shown by the two response curves. Separation at 1 kHz, for example, decreased only from 54 to about 50 dB at 1 kHz. It remained virtually unchanged at 10 kHz (around 39 dB) and decreased from 52.5 to about 47.5 dB at 100 Hz. That's what I call good stereo multiplex decoder and i.f. circuit engineering.

Separation measurements were repeated and plotted in Fig. 5B to ascertain the effect of the Schotz "blend" or noise-reduction circuitry. If these curves are to be believed (and I repeated the tests several times to make sure that I wasn't doing something wrong), the blend characteristics of the Schotz NR circuitry are like no others I have ever measured. Maximum blend occurs at midrange frequencies, while separation increases almost to its original levels (those measured with the Schotz feature turned off) above 5 kHz. The lower curves in Fig. 5B represent separation at 45 and 40 dBf, lower signal levels than the 65 dBf of Fig. 5A. This accounts for the slightly lower separation, even with the Schotz NR circuit switched off.

I pondered for a long time the strange blend separation characteristics seen in Fig. 5B. The only conclusion I could reach was that perhaps Schotz created this kind of blend action because he recognized that human ears are most sensitive to noise in the midrange and upper midrange region, where we see the greatest blending (least separation). He may have also reasoned that the upper midrange is most useful in stereophonic localization and therefore allowed the separation to increase at those frequencies. Whatever the reasoning, I can attest to the fact that, under weak-signal stereo reception conditions, the Schotz circuit does make a big difference, reducing annoying background noise without sacrificing stereo effects altogether.

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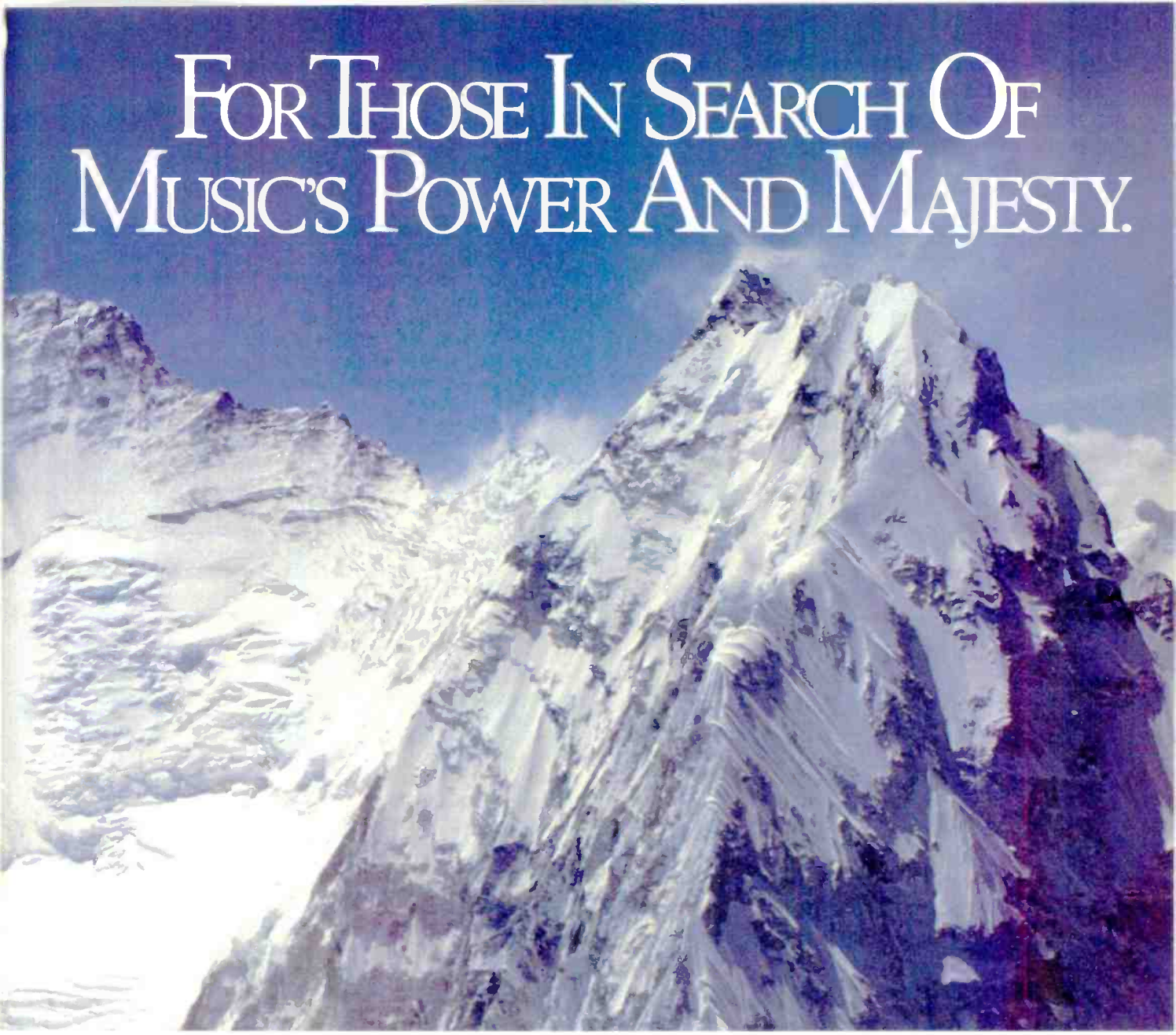

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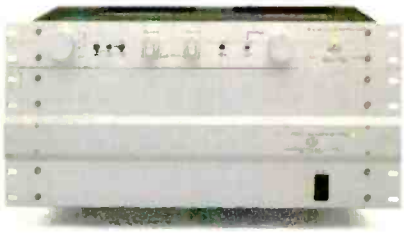
As you well know, rare and beautiful things are often hard to find. So if you haven't found an SA-20 to listen to, call 800-247-6468 (in California, 619-598-9090) for the dealer nearest you.

Otherwise, you may never find what you're searching for.



C O U N T E R P O I N T

SUPER NATURAL SOUND

Thanks to the TX1's excellent quieting and usable sensitivity, I was able to capture every station I've ever picked up in my area.

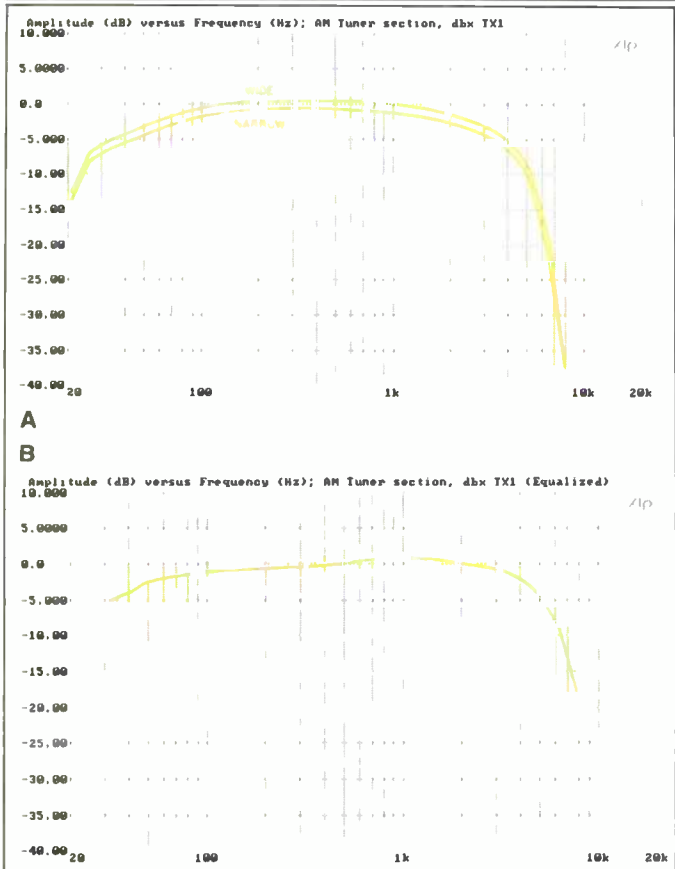


Fig. 7—AM frequency response without pre-emphasis in both i.f. modes (A) and with NRSC pre-emphasis in wide mode (B).

Next, I modulated one stereo input of my FM generator with a 5-kHz signal and did a spectrum analysis of the left- and right-channel outputs, using the ⅓-octave bandpass filter of my Audio Precision System One test equipment and sweeping from 1 to 100 kHz (Fig. 6). The solid curve represents the output from the modulated channel, in which we see the peak at 5 kHz. The dashed curve was plotted by reading the output of the opposite, unmodulated channel. At 5 kHz (the modulating frequency), separation was an impressively high 58 dB. There is also some evidence of third-harmonic crosstalk at 15 kHz (about 70 dB below maximum modulation level), some residual 19-kHz pilot carrier output (about 66 dB down from maximum modulation level), and some 38-kHz residual product signal (about 68 dB down).

Capture ratio was exactly 1.5 dB, as claimed. Alternate-channel selectivity measured 73 dB, and adjacent-channel selectivity was 7.5 dB in the wide mode and 28 dB in the narrow. Image and i.f. rejection were both above 100 dB. Muting and stereo threshold both measured 20 dBf, and AM rejection was 68 dB.

Since dbx published more specifications for AM tuner performance than most makers of AM/FM tuners, I decided to test the AM section a little more extensively than usual. To begin, I measured frequency response without regard to the NRSC pre-emphasis characteristic discussed earlier. Results are shown in Fig. 7A. The only real difference between the curves for wide and narrow i.f. bandwidths was a slight shift in output level. Without pre-emphasis of the signals modulating the AM generator, response rolled off to −6 dB at just over 4 kHz. When I applied pre-emphasis to the modulating signal (Fig. 7B), response was considerably flatter, extending beyond 5 kHz for the −6 dB roll-off point. As soon as more manufacturers recognize and begin to use this NRSC pre-emphasis characteristic, I will omit the type of plot shown in Fig. 7A and will show only the net response using pre-emphasis.

At a signal input level of 5 mV/m, THD of the AM section measured 0.45%, and S/N (referred to a 30% modulation level) was 47 dB. Sensitivity, with a signal applied directly to the external AM antenna input, was 30 μV. (I have no easy way to measure sensitivity via a supplied loopstick or ferrite rod antenna.)

Use and Listening Tests

The dbx TX1 almost seemed to have a mind of its own when it encountered weak signals or signals that were interfered with by strong adjacent signals. Both of these conditions are easy to find in my listening location, and not once did I feel the need to override the "decisions" made by the Schotz logic circuitry as it switched from wide to narrow or turned the Schotz noise-reduction/stereo-blend circuit on or off. This Schotz blend circuit, as strange as its response appeared in the lab tests, really did the job it was intended to do. There were at least three instances where I encountered stereo signals so noisy that I normally would have switched to mono. Instead, with the Schotz NR circuit automatically activated, those signals became tolerable—although, of course, there was still some background noise. A fourth signal, one that had a moderate amount of noise but could have been tolerated, became virtually noise-free when I manually activated the Schotz NR. Interestingly, for that signal, the Schotz circuit did not automatically switch in; I had to do it manually to enjoy its benefits.

With the kind of usable sensitivity and 50-dB quieting characteristics this tuner exhibits, it almost goes without saying that I was able to log every station I have ever picked up in my location—a total of over 58 at last count. However, atmospheric conditions affect this, too. Some days are better than others, and, as I write this report, there has been unusually violent sun-spot activity which, in the past, has impaired FM reception. Still, the TX1's performance need not take second place to the reference tuner against which I compared it. When you consider that my reference unit costs about twice as much, this is another milestone in the long list of Larry Schotz's achievements and a component that should prove extremely successful for dbx.

Leonard Feldman

Until now, separates this good had to be inconvenient.

Since time immemorial, dedicated audio buffs have been forced to choose between all-out performance or all-out convenience.

Such a decision is no longer necessary.

Introducing seriously sophisticated separates that not only offer performance designed to bring tears to your eyes, but also uncompromising remote control capabilities, as well.

The heart of this remarkable new stack is the CX-1000U digital preamp.

You'll find audio and video switching with 10 audio and 4 video inputs. 5 audio and 2 video record outputs.

Even optical and coax digital audio inputs and outputs.

And Yamaha's Hi-Bit, 8 times oversampling digital filter moves unwanted digital noise so inaudibly far above your music, it can't possibly interfere.

While our Hi-Bit twin D/A converters ensure even the lowest level signals are reproduced with excellent linearity.

Anchoring the power portion of the trio is the new MX-1000U power amp.

Featuring specs nothing short of sensational, with a rather awesome 260 watts RMS per channel. (Both channels driven into 8 ohms, 20-20,000 Hz at no more than 0.003% THD.)

And dynamic power capable of delivering a phenomenal *1000 watts* per channel into *1 ohm.*

All made possible by Yamaha's exclusive Hyperbolic Conversion Amplification (HCA) circuitry that eliminates crossover and switching distortion and provides extremely high dynamic power to drive the greatest possible range of speakers.

Quite possibly the most potent remote to ever grace your coffee table.

And as a versatile complement to the CX and MX-1000U, we proudly introduce our new TX-1000U tuner.

You'll find a 6-way multi-status memory to lock in 6 different parameters to give you optimum reception.

Plus 24 station presets. Even programmable station call letters. And more.

Drop by your Yamaha dealer for a demonstration today.

The experience may be a bit unnerving at first.

All that uncompromised power and performance. *Plus* the convenience of a full-function remote control.

But we have a feeling you'll get used to it.

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Introducing the most powerful expression of a new technology:

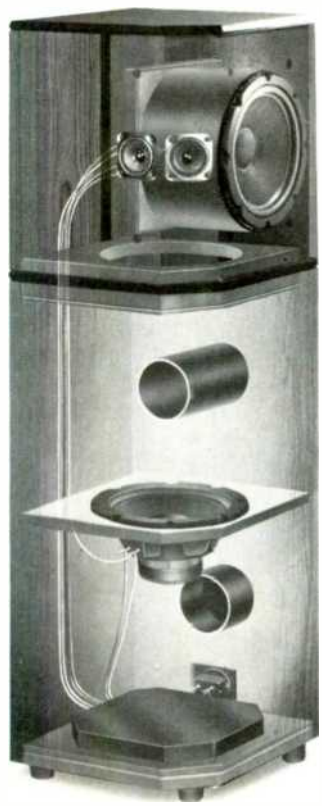
The Bose® 10.2™ Series II Direct/Reflecting® system with Acoustimass® speaker technology.

Inside and out, it's a speaker unlike any other.

The new Bose 10.2 Series II speaker successfully harnesses a *series* of audio technologies to take the listener one step closer toward the goal of all speakers: the realism of live music. The 10.2 Series II speaker combines the most powerful version of Acoustimass speaker design available for the home with the proven, critically-acclaimed benefits of a Bose Direct/Reflecting® system. The result: a musical listening system with *no* compromises —one that's at home in any environment.

Technology in harmony with home aesthetics.

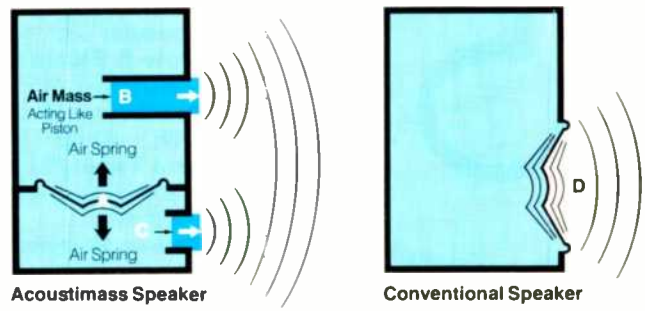
Moreover, the 10.2 Series II system brings lifelike sound into the living environment without overwhelming it. Each speaker's genuine wood veneer, hand-crafted Acoustimass enclosure produces the bass necessary to make even the most demanding music come to life, yet requires just *one square foot* of floor space. The system's Stereo Targeting® arrays precisely shape and control sound, providing listeners—regardless of where they stand or sit—with full, balanced stereo sound from both speakers. Where the speakers look best is also where they *sound* best.



Greater musical realism with any sound source.

Like all Bose Direct/Reflecting® speakers, the 10.2 Series II system is designed to accurately reproduce much of the clarity and spaciousness of live music. This strict attention to sonic detail is carried through to the lowest notes, where Acoustimass speaker technology provides much of the realism and impact normally experienced *only* in the concert hall. The system's purer sound provides the dynamic range and high power capability required for optimum results with any audio or video system and software—especially digital.

How an Acoustimass® speaker works.



Improving speaker performance means first reducing distortion. The design of an Acoustimass® speaker *substantially* reduces distortion (see diagrams and graph). The benefits of this patented speaker technology are purer sound and an increase in the dynamic range of bass performance.

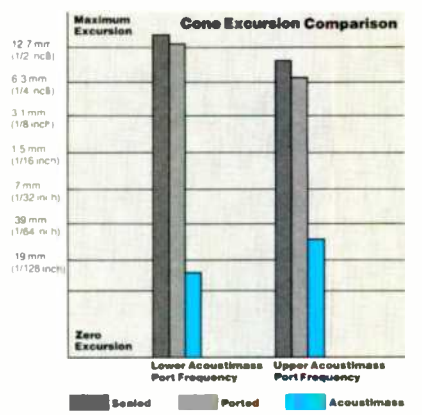
Left: An Acoustimass speaker *launches* sound into the room using two masses of air working like pistons (B&C, darker blue) rather than by a surface vibrating directly into the room. *The sound launched into the room by the Acoustimass speaker's air pistons is the purest sound that can be produced by present technology.*

Right: A vibrating cone radiating directly into the room (D) produces unfiltered sound.

Cone Excursion Comparison.

(lower excursion means lower distortion)

Graph: The distortion produced by any speaker rises dramatically with its cone motion, or *excursion*. At port-tuned frequencies, a typical Acoustimass speaker's cone has less than *1/16* the maximum excursion* of sealed and ported cones. Inside an Acoustimass speaker, the interaction of the air springs with the air masses in the ports produces a very high pressure at the surface of the cone. This greatly reduces the cone's excursion, and therefore reduces distortion. The air springs act with their respective masses to form low-pass filters, removing any small distortion components generated by the cone.



*based on cone travel measurements at 128 watts input

Judge for yourself.

Ask your authorized Bose dealer to demonstrate the new Bose 10.2 system with Acoustimass speaker technology against any other speaker—and hear the difference for yourself. For more information, call Bose Corporation toll-free at 1-800-444-2673 between 9 a.m. and 5 p.m. EST.

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Better sound through research.

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3

DUAL CS 5000 TURNTABLE AND ORTOFON X3-MC CARTRIDGE

Manufacturer's Specifications

Turntable

Drive: Belt.
Motor Type: Hall effect.
Speeds: 33⅓, 45, and 78 rpm.
Wow & Flutter: ±0.025% DIN wtd., ±0.015% wtd. rms.
Rumble: −56 dB, DIN unwtd.
S/N: −80 dB.
Arm Type: Pivoted, with interchangeable headshells and ±5° VTA adjustment.
Power Requirements: 115 or 230 V a.c., 50/60 Hz.
Dimensions: 17½ in. W × 5¼ in. H × 15¼ in. D (44.5 cm × 13.3 cm × 38.7 cm).
Weight: 17 lbs. (7.7 kg).
Price: $500 including tonearm.

Cartridge

Type: High-output moving coil.
Stylus: Fine line, nude diamond.
Cantilever: Aluminum.
Stylus Tip Radius: 35 × 7 µm.
Equivalent Stylus Tip Mass: 0.75 mg.
Output: 2 mV for 5 cm/S at 1 kHz.
Tracking Ability: 70 µm lateral at 315 Hz.
Recommended Load Impedance: 47 kilohms.
Internal Resistance: 80 ohms.
Frequency Response: 20 Hz to 40 kHz, +4, −1.5 dB.
FIM Distortion: Less than 1.0%.
Channel Separation: 25 dB at 1 kHz.
Channel Balance: Less than 2 dB at 1 kHz.
Lateral Compliance: 13 µm/mN (13 × 10^{-6} cm/dyne).
Recommended Tracking Force: 2 grams, ±0.2 gram.
Weight: 4.1 grams.
Price: $200; replacement stylus, $100.

Company Address: 122 Dupont St., Plainview, N.Y. 11803.
For literature, circle No. 92

Dual is a company in West Germany whose reputation for making top-quality turntables has endured for many years. I looked back through some old electronics catalogs and found a Dual Model 1006 record changer listed in 1961. At $79.95, it was considered an expensive, top-quality unit. In those days, most people opted for record changers rather than separate turntables and tonearms because most pop recordings were available on 45- and 78-rpm singles. The purists could still play their 33⅓-rpm LPs manually with some of the record changers available back then. In 1961, the catalogs featured record changers made by such companies as Garrard, Webcor, Collaro, Glaser-Steers, VM, and Miracord as well as Dual. I must admit that I am a bit surprised to see that Dual is still in business since most of the other companies are gone now, or at least are not making record players. Dual still flourishes, located in the famous Black Forest area of West Germany, which has a reputation for craftsmanship going back many centuries.

The CS 5000 was a pleasant surprise because it combines both elegance and simplicity at a modest price. The Dual OPS (Optimum Pivot System) tonearm, which is an integral part of the CS 5000, is quite sophisticated for a semi-automatic unit of this kind. The turntable was tested and auditioned using an Ortofon X3-MC moving-coil phono cartridge. Ortofon is also a name from the past which continues to command respect from even the most dedicated audiophiles. They were one of the first companies, if not the first, to begin producing high-quality moving-coil cartridges. The X3-MC is reasonably priced, and when it is mounted in the Dual OPS tonearm, the cost of the total package is quite low. The price is low enough, in fact, to elicit skepticism as to the level of performance which can be expected, when compared to the high cost of most audiophile record playing systems.

First Impressions

As I have indicated, I was pleasantly surprised to see that Dual had produced a record player which appeared to be both elegant in design and simple to use. It is very light; the whole unit, including the base and dust cover, weighs only 17 pounds. The walnut-veneer base is nicely styled, and the finish is excellent. The combination of walnut, satin-brushed aluminum, black rubber mat, and smoked plexiglass dust cover is very striking. The power switch is on the left front of the platform, while the three speed-selection buttons are on the right. I tapped the tonearm tube with a metal rod. Tapping the tube near the main pillar produced a "tik" sound; tapping near the headshell produced a "tak." When I grasped the armtube, while holding the main pillar steady, I noticed that the bearings have a very slight amount of play. I also observed that the headshell is different than others I have seen, because it has a system for adjusting the vertical tracking angle (VTA) of the phono cartridge stylus. There also is quite a delay between starting the turntable and the auto descent of the tonearm to the record. At 33⅓ and 45 rpm, the delay is about 7 to 8 S; at 78 rpm, the delay is 12 S. It appears that the speed-sensing system is slow in determining that the platter is up to speed.

For a number of reasons—among them reputation, price, and appearance—I was anxious to set up the Dual CS 5000/Ortofon X3-MC combination so I could listen to it. I controlled myself, however, and completed the technical measurements first. By doing so, I was able to ensure that the turntable, tonearm, and cartridge were functioning optimally and that the listening evaluations were made under ideal conditions.

MEASURED DATA

Dual CS 5000 Turntable

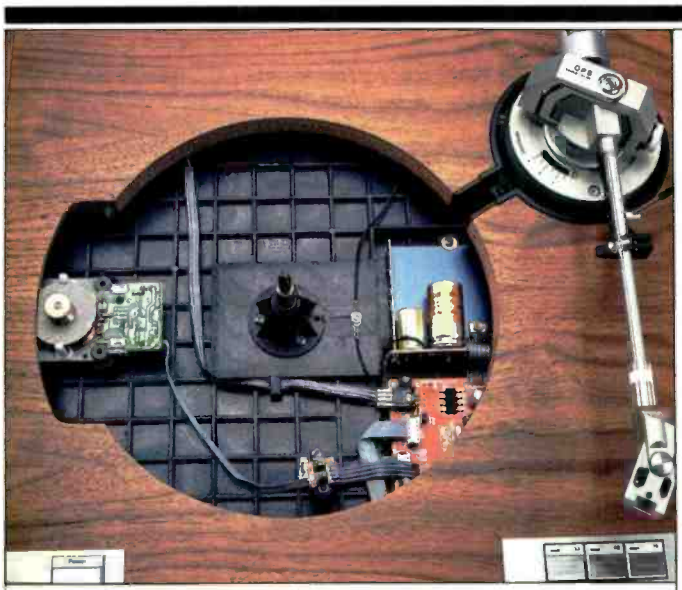
Parameter	Measured	Comment
Speed (at 33⅓ rpm)	+0.40%	No adjustment
Speed Stability	±0.20%	Very good
Wow, Unwtd. Peak	0.18%	Very good
Wow, DIN Wtd. Peak	0.09%	Excellent
Flutter, Unwtd. Peak	0.08%	Excellent
Flutter, DIN Wtd. Peak	0.03%	Excellent
W & F, Unwtd. Peak	0.25%	Very good
W & F, DIN Wtd. Peak	0.18%	Good
Long-Term Drift	±0.17%	Very good
Rumble, Unwtd.	−74.7 dB	Excellent
Rumble, Wtd.	−90.9 dB	Excellent
Suspension Resonance		Too highly damped to measure readily

Features

The CS 5000 turntable has three speeds, including 78 rpm, which is rather unusual. The speed of the Hall-effect motor is electronically controlled by comparing the speed of the platter's rotation to the exact frequency of a quartz reference oscillator. (This oscillator also serves as the reference for an automatic cueing system which lowers the arm only when the platter reaches full speed, and raises the arm if the speed changes.) The electronic circuit boards are mounted to the molded plastic subchassis. There is no vernier control to vary the speed, which would have been nice for use with older 78-rpm recordings, many of which were not recorded at exactly 78 rpm. The cast-aluminum alloy platter weighs 2 pounds and has a ring of damping material inserted around its inside periphery. The thick, 2-pound, black rubber mat also provides damping for the platter's bell-like ringing modes. The platter is driven by a belt that runs from the motor pulley to an 8⅝-inch-diameter ring on the underside of the platter. Two access holes in the platter allow the belt to be installed or removed easily. (If the platter needs to be removed for any reason, the belt must be taken off the motor pulley.) The main bearing and the center post are captive and fixed to the subchassis. A hole in the platter's center allows it to be slipped over the center post, which rotates with the platter. A ground wire is connected to the center post and to other metal parts of the turntable, exiting through the back of the base with the phono leads. These leads are not detachable and have ordinary phono plugs with red and white plastic insulators.

The speed sensors consist of a small extension from the bottom of the platter, about 3¾ inches from the center, which looks like a flat screwdriver blade, and a U-shaped plastic part fastened to the subchassis. The blade passes

Dual's CS 5000 turntable is a pleasant surprise, combining elegance and simplicity while offering a modest price.



through the U-shaped sensor with each revolution of the platter. Perhaps this is why the speed-sensing system is so slow, since it is updated only once per revolution.

Four feet on the bottom of the base contain the springs that are used to suspend the subchassis on which the platter's main bearing and the tonearm are mounted. The method of adjusting these springs is not very clear in the booklet that accompanies the turntable. While adjusting them, I unintentionally popped off the little plastic inserts at the bottom, so I glued them back on. Dual says that these inserts are designed to be used only where extra isolation is required—with systems set on springy floors, for instance—and that leaving them off would "improve the bass response." Unfortunately, this information (which was not in the instruction manual) reached me after my tests were completed.

The a.c. power cord is detachable and has only two prongs. The smoked plastic dust cover can be removed by sliding it out of the hinges on the back of the base. These hinges have coil springs which hold the cover up even in intermediate positions. When the cover is fully open, 16 inches of clearance is required above the shelf or platform upon which the turntable rests. The CS 5000 will fit into an opening 17⅜ inches wide by about 15 inches deep; if you remove the cover, you could change records and operate the turntable with only about 6 or 7 inches of clearance.

The CS 5000 is supplied with the Dual OPS tonearm. The vertical pivots are located in line with the surface of a record, which is considered to be the optimum location with respect to tracking any warps in a record. The counterweight, on the rear of the tonearm, is mounted below the record surface, which is also considered optimum. Part of the counterweight is isolated by a rubber compliance, which is meant to provide a sort of anti-resonance at the main tonearm/cartridge resonant frequency. This has been a feature of Dual tonearms for many years.

The OPS tonearm is of the dynamic balance type, which means that its tracking force is set by a coiled spring once the tonearm mass, including the cartridge mass, has been balanced statically by the counterweight. The calibrated knob for tracking force adjustment is located on the side of the main pillar. A calibrated anti-skating or sidethrust adjustment lever is on the front of the tonearm base.

The headshell includes a spring-loaded, plastic, cartridge mounting platform with an adjusting knob. This knob allows the VTA of the stylus to be adjusted to the optimum setting without having to use separate shims.

There are several ways by which the tonearm can be raised and lowered. The automatic feature is most useful at the end of a record because is raises the tonearm and turns off the motor. To start a record, you bring the tonearm off the armrest and place the stylus over the record. When the turntable is up to speed (as determined by the underplatter sensor and quartz reference oscillator mentioned earlier),

MEASURED DATA

Dual OPS Tonearm

Pivot-to-Stylus Distance: 8.875 in. (22.5 cm).
Pivot-to-Rear-of-Arm Distance: 2.688 in. (6.8 cm).
Overall Height Adjustment: None.
Tracking Force Adjustment: Spiral spring, adjusted by knob on main pillar.
Tracking Force Calibration: 1 to 3 grams, within 0.1 gram.
Cartridge Weight Range: 2 to 10 grams.
Counterweights: One, 80 grams.
Counterweight Mounting: Positioned below record surface; plastic mount with threaded insert; rubber-mounted subweight.
Sidethrust Correction: Sliding lever on base of main pillar.
Pivot Damping: None.
Lifting Methods: Automatic at end of record; manual by damped cueing lever or fingerlift on headshell.
Headshell Offset: 26.5°.
Overhang Adjustment: Slots in headshell.
Bearing Alignment: Very good.
Bearing Friction: Very low, with slight play.
Bearing Type: Dual gimbal.
Lead Torque: Very low.
Arm-Lead Capacitance: 160 pF, both channels.
Arm-Lead Resistance: 1.7 ohms, both channels.
External Lead Length: 40 inches (1 meter).
Structural Resonances: 200, 1600, 2350, 4400, and 5750 Hz.
Base Mounting: Center hole for arm post and three screws for base.

Ortofon X3-MC Cartridge

Coil Inductance: Left, 394 μH; right, 385 μH.
Coil Resistance: Left, 82.0 ohms; right, 75.9 ohms.
Output Voltage: Left, 0.41 mV/cm/S; right, 0.35 mV/cm/S.
Tracking Force: 2.1 grams recommended.
Cartridge Mass: 4.2 grams.
Microphony: Very low.
Hum Rejection: Very good.
Rise-Time: 9 μS.
High-Frequency Resonance: 23.3 kHz.
Low-Frequency Resonance: 8.7 Hz (in Dual OPS tonearm).
Low-Frequency Q: 7.3 (in Dual OPS tonearm).
Recommended Load Resistance: 47 kilohms.
Response to Load: No effect from resistances greater than 1 kilohm or capacitance less than 1,000 pF.
Polarity: Plus, for RIAA Standard.

"Why all Boston Acoustics speakers sound alike. (More or less, that is.)"

Andy Petite, chief designer, Boston Acoustics.

"At Boston Acoustics, live music is our basic reference standard. And since we design each of our speakers to sound musically accurate, all of our systems have a remarkable sonic resemblance.

"Any full-range speaker system, whatever its size, should have good octave-to-octave tonal balance and wide dispersion. We provide these qualities in *all* of our speaker systems—from the A40 bookshelf to the T1000 tower. (From our long experience in listening to many competitive speaker lines, the same can be said of only a few.)

"In larger rooms and at higher listening levels, the differences—and the superiority—of our more expensive systems begin to emerge. They can play louder without strain, and reproduce deeper bass. *But this doesn't detract from the musicality, accuracy and tonal balance of our smaller speakers.*

"How much sound a speaker produces in your listening room also depends on the room's size, the music you listen to, and how loud you play it. Because all Boston Acoustic speaker systems—bookshelf, floor-standing and tower—meet all *our* standards, there's at least one that should meet *your* special requirements and conditions.*

"So when you visit a Boston Acoustics dealer, ask to hear a Boston speaker. *Any* Boston. We can't promise you perfection, but we *will* bring you as close to the music as the state of the art allows."

*"It certainly helps that we design and build our own speakers—all with the same high quality materials. Further, we manufacture all our speakers to such tight tolerances that any two samples of a given model are virtually identical. And to insure this, we test each completed system—every single one—before it leaves the factory.

"Finally, sonic similarity is especially important with surround-sound systems. An all-Boston system assures the greatest sonic impact."

The A40 Series II.
$170 a pair.† Our most popular bookshelf system."...attains an aura of spaciousness surpassed only by some of the far more expensive multi-directional speakers." *The New York Times.*

The T830.
$500 a pair.† Our most popular tower system."...we were enormously impressed...superb sound, practical size and proportions, and affordable price." Julian Hirsch, *Stereo Review.*

† Suggested retail price.

Boston Acoustics

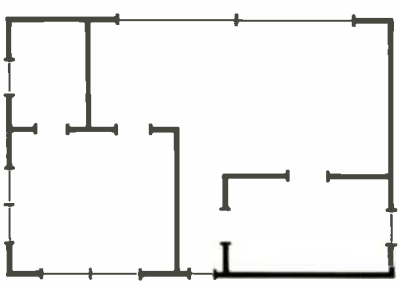
247 Lynnfield Street, Peabody, MA 01960 (508) 532-2111

There are two tests for of a system.

As you know, a/d/s/ began life as a speaker company. But it was only a matter of time before our interest in accurate musical reproduction led us to think seriously about the electronic portion of a sound system.

As you can plainly see, the R4's displays are extremely legible and easy-to-read from anywhere within a wide viewing angle. The unit provides you with full information about its operating status, so you know what you're doing and not flying blind.

What we wondered was whether we could improve upon that which was available at the time. The results appeared first in this country in 1983.



The R4 gives you true multi-room capabilities, while the RC1 provides the means to control the system no matter what room you're in.

Lean, spare and understated, the Atelier Series was an articulation of our belief that high-grade electronic components needn't look like laboratory instruments. Nor require an engineering degree to coax into operation. Nor surrender to the indignities of planned obsolescence.

That philosophy today finds its expression in the Atelier R4 and its perfectly matched family of components.

A new class of component, as a look under the hood will attest.

At first glance, the R4 may appear to be a receiver. And it's true that the unit functionally incorporates the classic elements of that category of product. But beyond the impressive amplifier, pre-amplifier and tuner sections, the R4 bears about as much resemblance to a receiver as a BMW 735 does to a motor scooter. A look inside will illustrate the point.

We draw your attention first to what you'd least expect to find in a high fidelity product—a computer. Specifically, a microprocessor designed by a/d/s/ to provide a level of functionality never available before. For example, you can program the R4 to automatically turn on any combination of sources within your Atelier system for listening and recording, whether you're at home or off on an extended vacation.

When you <u>are</u> at home, you'll appreciate the fact that the R4 can give you access to any source from any room in your house—

The R4. Its slim, spare design gives little hint of the technological sophistication and sonic power that reside inside.

all by remote control. And when we say control, we mean control. With the RC1, you can control the nuances of every remote-ready Atelier component in your system—the compact disk player, the cassette deck, the tuner, even Atelier components which have yet to leave the drawingboards at a/d/s/.

If you're a computer buff, you'll be pleased to know you have the option of controlling Atelier functions by connecting your pc to the RS-232 port in the R4.

With the RC1 remote control unit, you can control every important function of every remote-ready Atelier component. You can do it standing up, sitting down or lying on your back. It issues more than 200 different commands.

the electronic heart Music and time.

Pertinent to the subject of control is the large scale integrated chip that's embedded within the R4's control circuit. This chip makes it possible for you to control volume, bass and treble settings in precise, digital increments—channel to channel, and with none of the variation in levels that are typical of "twirl-knob" systems.

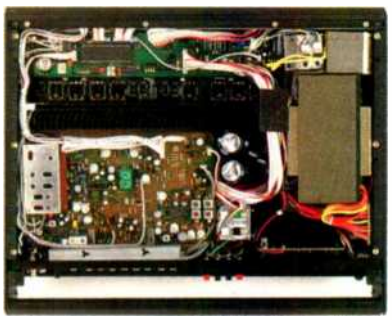
The sonic purity is uncommon because the design is uncommon.

The R4's preamp signal paths are unusually noise free. That's because all circuits have been painstakingly protected from stray radiation by ample amounts of shielding—one of just many steps we've taken to preserve the extremely low distortion of the amplification stages.

As audio purists, we also feel compelled to tell you that the R4's microprocessor exists entirely outside the path of the audio signal. In other words, it keeps to itself, which is as it should be.

The FM portion of the R4 is as impressive as everything else about the unit. Finetuning is done in small, digital increments, which results in superb signal acquisition—the best possible, in fact—and eliminates distortion and "fuzzy" reception. Working down the signal chain, we come to the IF amps. Their bandwidth has been carefully designed to yield exceptional selectivity. Finally, stereo decoding is, in a word, impeccable. The result: optimum stereo separation.

As for the prodigious amount of power the R4 produces for its size, that was accomplished thanks to our use of a proprietary rail-switching technology that automatically and instantaneously increases power for high-energy music transients—well beyond its rated 75 watts per channel.



A glimpse inside reveals how carefully thought-out the R4 is. No space is wasted. Electronic circuitry, heat sinks, transformers, etc., are all contained within a box that stands only 2¾" high.

When you need more power, we have more amplifier. Our PA4 amp provides 150 watts per channel, and nearly double that amount when bridged. Whether you use one or two PA4's in tandem with the R4, operation remains completely automatic. Moreover, you don't surrender any of your remote control capabilities—a fact that nicely differentiates Atelier from its competitors.

One final point deserves to be repeated. When we entered the electronics arena in 1983, our stated goal was to produce superb audio equipment that never became outdated. The R4 is the product of that vision, and it won't.

For more information about any a/d/s/ products, phone a/d/s/, toll-free, at 1-800-345-8112. (In PA, call 1-800-662-2444.)

The Atelier system of electronic components. From top to bottom, the R4, the CD4 compact disk player, the C4 cassette deck and the PA4 power amp. That's even an Atelier storage module they're sitting on.

a/d/s/

Both the vertical pivots and the counterweight of the Dual OPS tonearm have been optimally positioned.

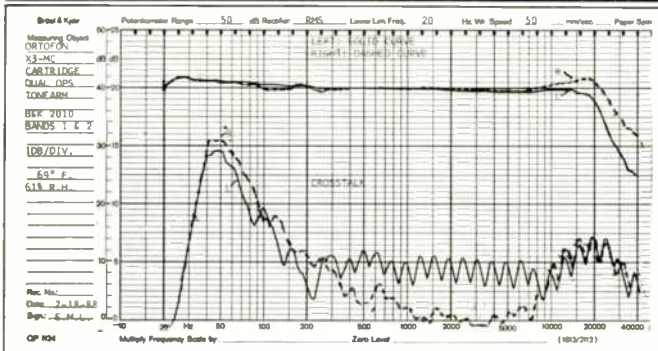


Fig. 1—Frequency response and crosstalk, Ortofon X3-MC cartridge in Dual OPS arm of CS 5000 turntable.

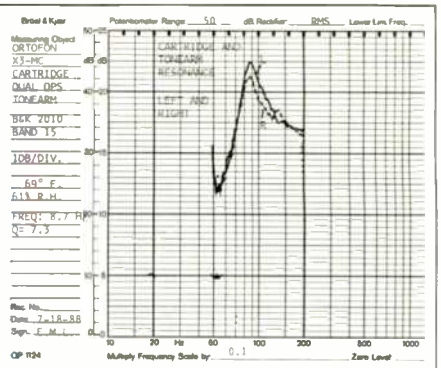


Fig. 2—Low-frequency tonearm/cartridge resonance is at 8.7 Hz, with a Q of 7.3. Test was conducted using slow sweep from 5 to 20 Hz.

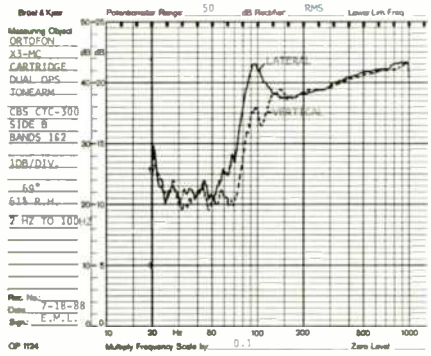


Fig. 3—Response to vertical and lateral modulation from 2 to 100 Hz (slow sweep); damping is better in the vertical plane. Note the anti-resonance at around 11 Hz. This is probably due to the counterweight suspension, which helps control vertical tonearm motion.

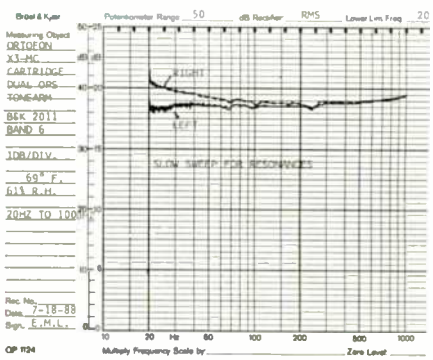


Fig. 4—Check of structural resonance in OPS tonearm, using slow sweep from 20 Hz to 1 kHz. A number of resonances are apparent.

the tonearm descends to the record groove. Pressing any speed selector during play raises the tonearm. If the record ends, or if you pick up the tonearm with the fingerlift on the headshell (or the damped cueing lever) and place it on the armrest, the turntable shuts off, and the automatic lift rises. The headshell is removable and is secured by a metal locking collar. Slots in the headshell allow cartridges to be mounted and adjusted using a supplied plastic template.

The Ortofon X3-MC phono cartridge is of the moving-coil type, which means that its magnets are fixed and that the coils for each channel are attached to the rear of the stylus which moves with the modulation in the record grooves. The X3-MC is a high-output design, so it can be connected directly to the MM phono input of a preamplifier or receiver without the need for the usual MC transformer or pre-preamp stepup device. High-output MC cartridges used to require more turns of wire in the coils. The slightly higher electrical resistance and inductance of these coils made the resistance of the tonearm wiring less of a problem. However, the coils' higher mass resulted in poorer high-frequency characteristics. Now, with stronger magnets available (and by clever des gn), this can be overcome.

Measurements and Listening Tests

Even though the Dual CS 5000 turntable and Ortofon X3-MC cartridge combination is much less expensive than my reference system, I decided that it would be very enlightening to compare them. A group of listeners was assembled to act as a panel. After I gave them the usual cautions about not talking or making outward signs of approval or disapproval during the playing of the program material, they listened to a wide variety of musical selections on both systems. The panel members were given forms which allowed them to rate the systems (designated as "A" and "B") from 0 to −5 for each selection. Panel members were encouraged to make written comments describing the sound. After the listening session, I try to correlate these ratings and comments with the technical measurements.

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"Henry Kloss. Member of the Audio Hall of Fame. Creator of Acoustic Research in the 1950's, KLH in the 1960's, and Advent in the 1970's—the dominant speakers of their decades—now brings you Ensemble: the best-sounding speaker system of this era."

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Ensemble is the first of a new generation of stereo loudspeaker systems. It combines two bass units, two mid- to high-frequency satellite units and something you won't find in any hi-fi store on earth:

Your living room. Which now, because of Ensemble's unique "double-dedicated" design, becomes a totally integrated part of the sound propagation process giving you perfectly balanced energy throughout the full ten octaves of music.

The first speaker system that doesn't cheat you out of either bass or space.

The fundamental octaves that so much of music is built on...

The almost subaudible but palpable sounds generated by the big pipes of the organ, the bottom of the acoustic or electric bass, the low notes of the synth...

The frequencies completely ignored in the so-called "mini-speakers" now in vogue...

Ensemble provides them. With two dedicated, acoustic-suspension loudspeakers whose jobs are solely to reproduce the bottom two octaves of musical significance.

At a compact 12"×21"×4.5," they're small enough to be placed where they'll produce the best sound, minimizing "standing waves," and without visually overpowering your room.

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As for the other 8 octaves of music.

The rest of the sound spectrum, from a nominal crossover of 140 Hz, is reproduced by a stereo pair of two-way satellite units. Each incorporates a low-frequency driver, crossing over at 1,900 Hz to a direct-radiator tweeter that goes beyond audibility.

They are small enough (4"×5"×8" high) to set the sound stage wherever you want it. Finished in scratch-proof, gunmetal grey Nextel, they will look good for a lifetime.

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In fact, the easiest way to buy Ensemble is to call us with your credit card in hand, and speak with an expert who will be happy to walk you through everything you want to know about the system. For literature, for information—or to order—the toll-free number is 1-800-252-4434, Mon.–Thurs., 9–9, Fri. and Sat., 9–6 Eastern Time. (In Canada, 1-800-525-4434.) Fax # (617) 332-9229.

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The counterweight and its suspension set up a sort of anti-resonance that helps to control the tonearm's vertical motion.

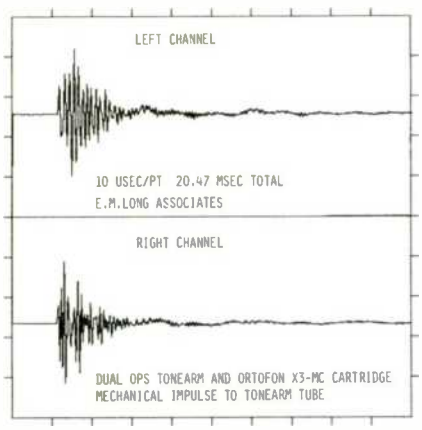


Fig. 5—Output vs. time of arm/cartridge when mechanical impulse was applied to armtube, with arm on rest.

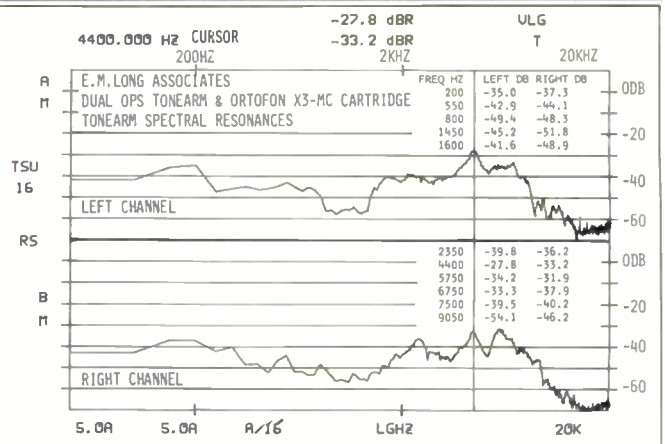


Fig. 6—Spectral output (averaged) of arm/cartridge for 16 mechanical impulses applied to armtube. See text.

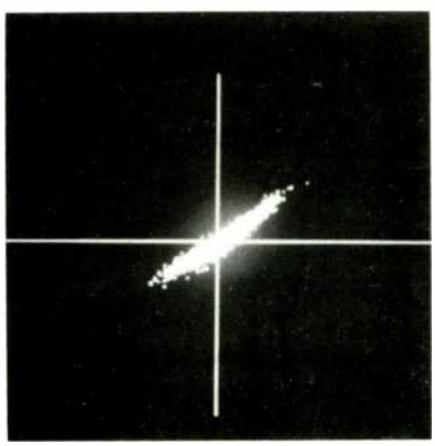


Fig. 7—Interchannel phase difference, using pink noise from B & K 2011 test record, band 7.

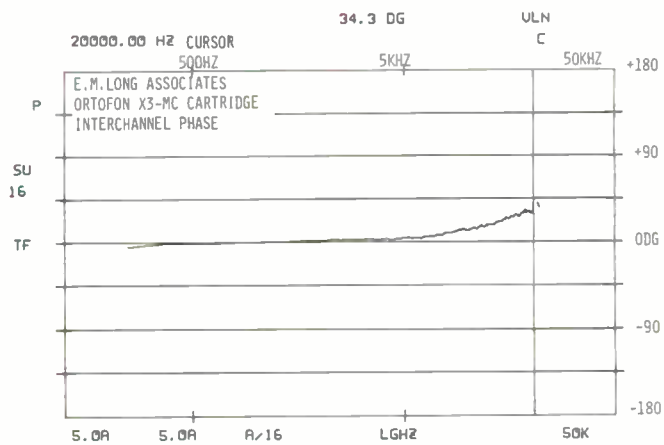


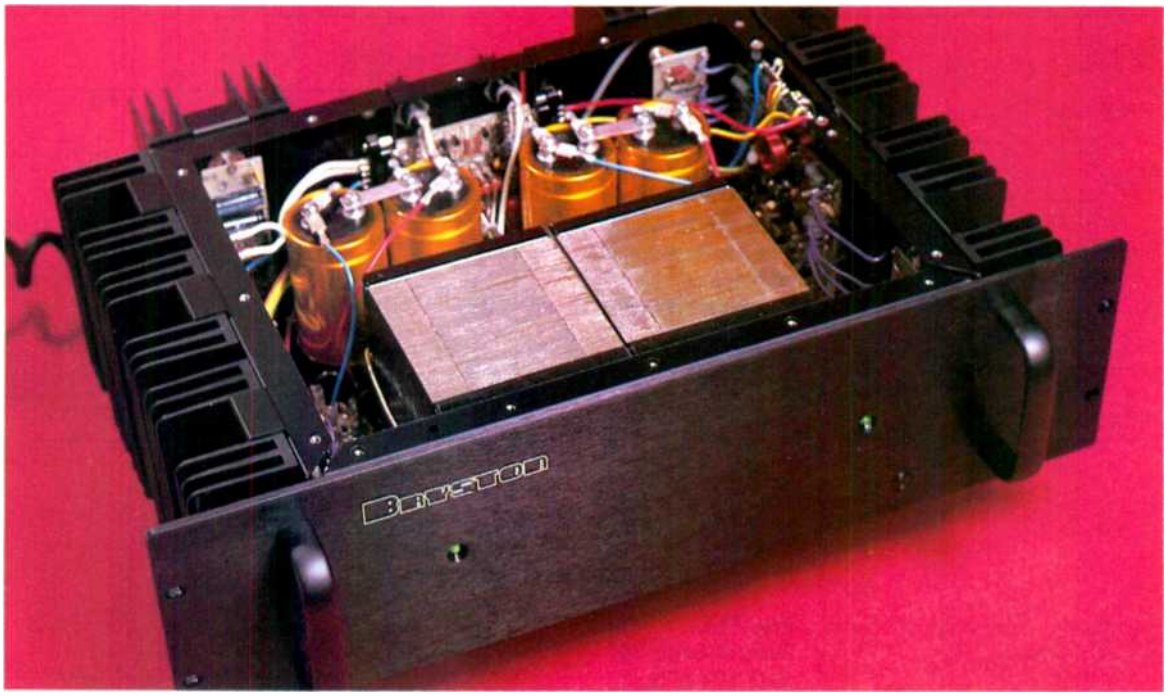
Fig. 8—Interchannel phase difference vs. frequency for B & K 2011, band 7, pink noise. Phase difference at 20 kHz is 34.3° (4.8 μS).

As I mentioned previously, the measurements were completed before the listening tests to ensure that the systems were in optimum adjustment. Special absorptive panels were installed at the sides of the monitor loudspeakers to soak up any nearby reflections. These speakers are a new generation of my CSI Time Align monitors, which also incorporate the patented ELF (Extended Low Frequency) system. The monitors have high sensitivity and high power handling and are flat from 24 Hz to 24 kHz, with exceptional time domain characteristics. (I have been tempted to call these monitors "Ming" because they are so merciless in revealing everything, including the fact that we still don't make completely realistic, flaw-free recordings.)

My audio system includes an absolute-polarity switch, and I have marked each musical selection with a plus or minus, indicating in which position the switch should be set. Of course, each system is also checked for polarity. The Ortofon X3-MC cartridge gives a positive output for modulation toward the outside of the record, which follows the RIAA recommendation (in a bulletin issued September 12, 1973). Over the years, every cartridge that I have tested for *Audio* has followed this convention; because of this, I sometimes forget to mention the cartridge output polarity in my reports—even though I always check it.

Figure 1 shows the amplitude versus frequency response and the interchannel crosstalk of the X3-MC cartridge mounted in the OPS tonearm. The very slight swayback in the response between about 2 and 7 kHz, which reduces the output about 1 dB, may account for comments by most of the panel members that the Dual/Ortofon combination sounded a bit less forward than the reference system. The reproduction of voice and trumpets was deemed better than that of the reference system. The excellent separation between the channels allowed the tested combination to

BRYSTON



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- *"The Bryston TF-1 is superb, in fact the very best transformer we can recall hearing."* **Hi-Fi Sound Magazine**

- *"The Bryston TF-1 is the best MC transformer I have yet heard, and is so well shielded that its signal-to-noise figure matches any other step-up device on the market, and probably exceeds most."* **Audio Ideas Guide**

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The excellent separation between channels allows the tested combination to match the reference in imaging and spaciousness.

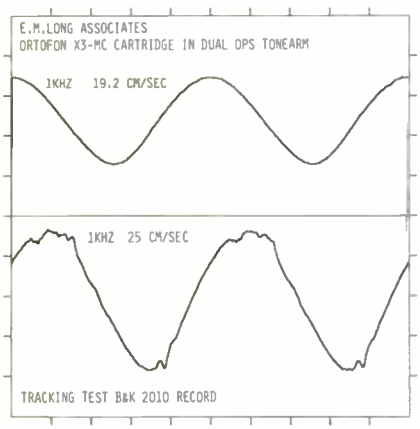


Fig. 9—Tracking of arm/cartridge with 1-kHz test tones at 25 cm/S (highest level on B & K 2010) and 19.2 cm/S. Even the highest level is tracked moderately well.

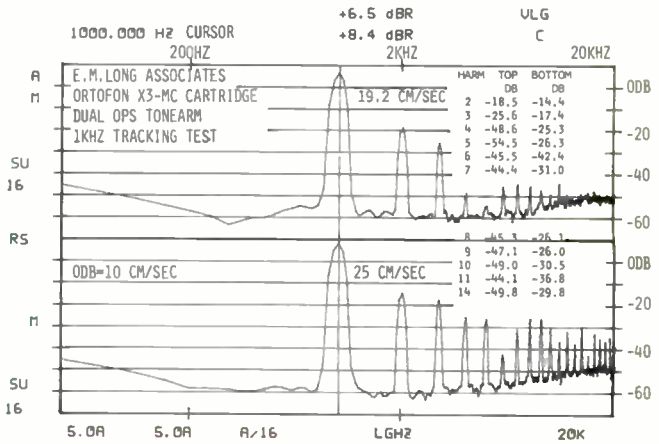


Fig. 10—Spectral analysis of arm/cartridge output when reproducing the signals of Fig. 9.

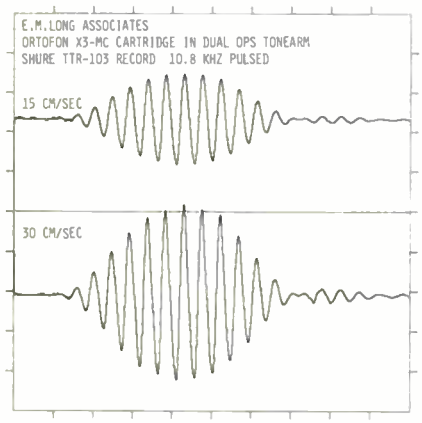


Fig. 11—Output from 30- and 15-cm/S, 10.8-kHz pulse test, Shure TTR-103 test record.

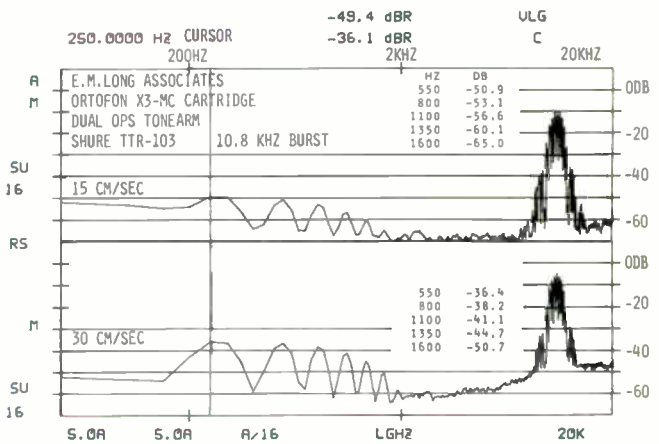


Fig. 12—Spectral analysis of distortion products from signals shown in Fig. 11. Output at 30 cm/S is 8 dB above the 10-cm/S, 0-dB reference level. Output at 250 Hz is 0.63% for the 30-cm/S band.

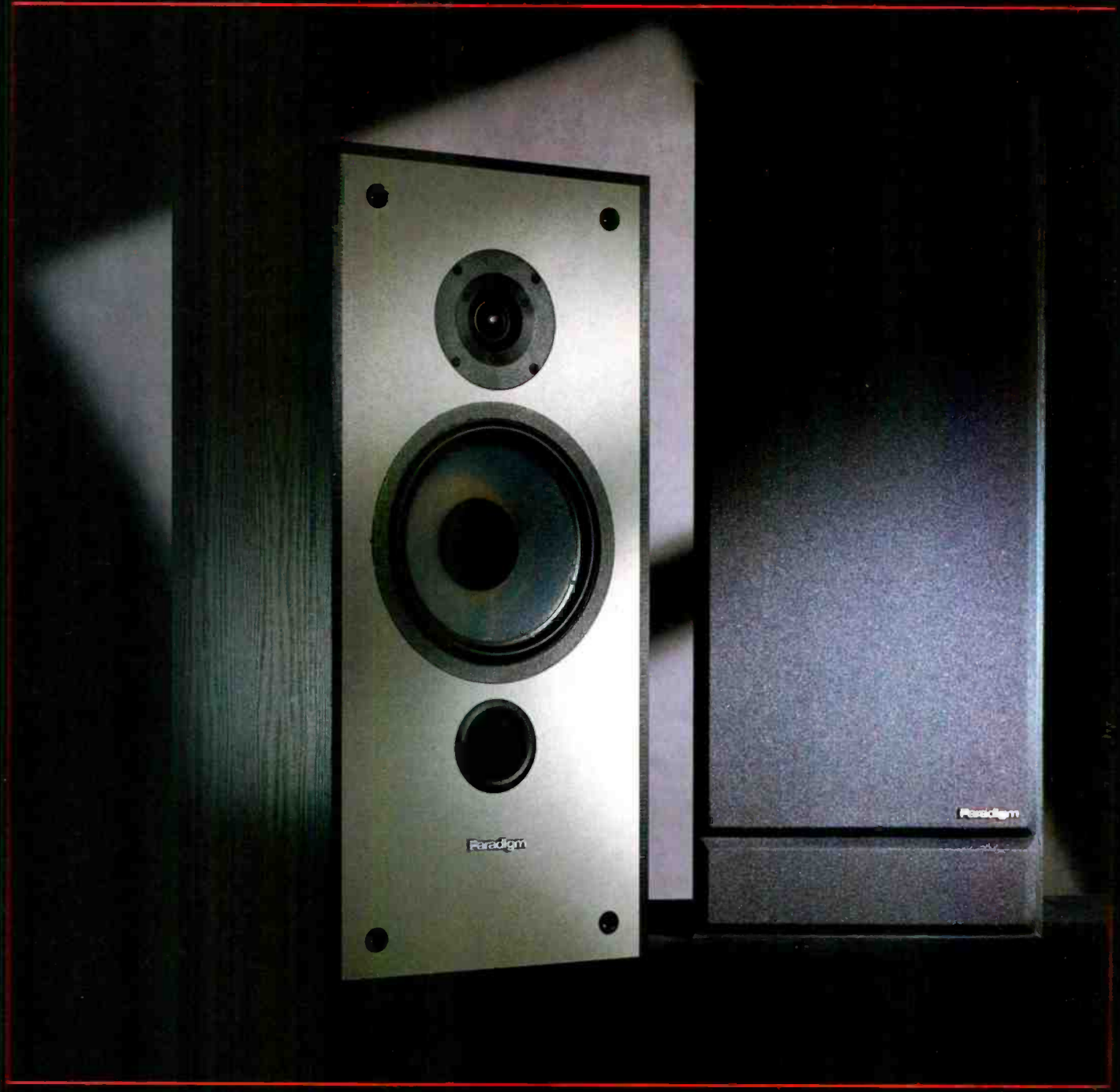
match the reference system regarding any comments about the imaging and spaciousness of the sound.

Figure 2, which is the result of a slow sweep from 5 to 20 Hz, shows the low-frequency resonance due to the compliance of the Ortofon cartridge and the mass of the Dual tonearm. The Q, which is related to the sharpness of the rise in output at the resonant frequency, is quite high. Low-frequency sounds, such as those produced by the double bass and kick drum, are affected by this characteristic. The listening panel's comments indicated that the reference system was superior in the quality of the bass produced, even though the quantity was sometimes greater with the Dual/Ortofon combination.

Figure 3 demonstrates that the main effect of the low-frequency resonance is in the lateral plane of motion. The scale is from 2 to 100 Hz, and the output is due to a slow sweep through this range. The dip in output at about 11 Hz, in the vertical plane of motion, is due to the anti-resonance effect of the counterweight mass and the compliance of its rubber suspension. This anti-resonance helps to control the tonearm motion in the vertical plane, which could be caused by record warps, and shows that the Dual design technique really does work.

Figure 4 shows the output of the right and left channels for a very slow sweep from 20 Hz to 1 kHz. The dips at 67, 100, and 250 Hz show that resonances are present, very likely due to the headshell coupling and the main pivots. These results also indicate that there is delayed reflected energy present. This energy could be partly responsible for some panel members' comments about a slight veiling of the sound on full orchestra and on strings and brass. The most interesting aspect of these delayed reflections is that, al-

....remarkable!



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It was only at very high recorded levels that the Dual/Ortofon combo sounded inferior to the reference.

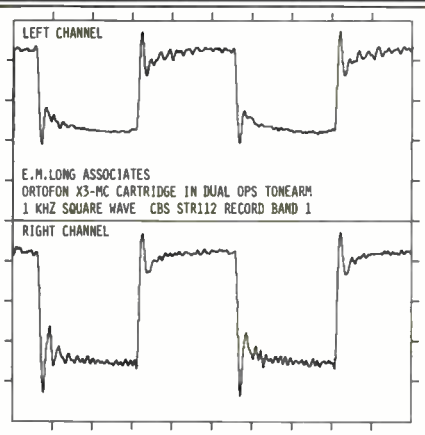

Fig. 13—Output from 1-kHz square wave, using CBS STR-112 test record.

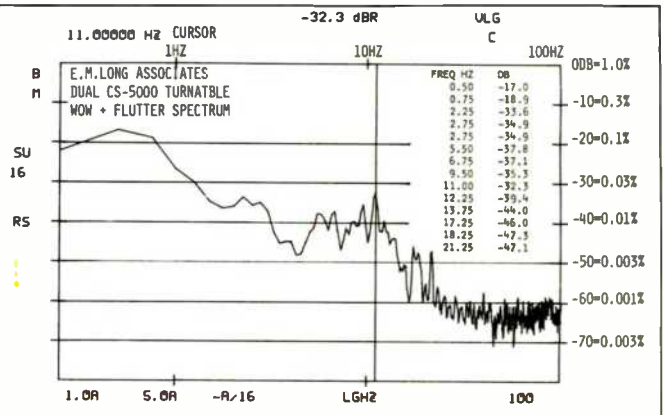

Fig. 14—Wow & flutter spectrum, from 0 to 100 Hz. Tonearm/cartridge resonance is visible at 11.0 Hz. See text.

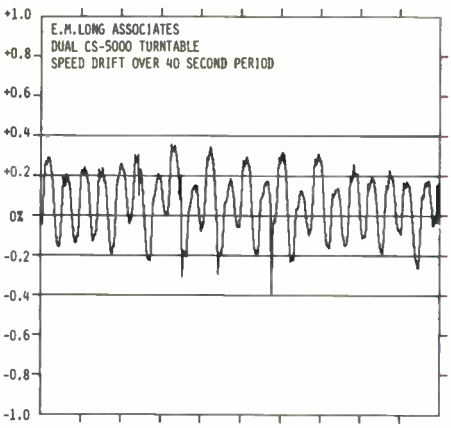

Fig. 15—Speed drift over a 40-S period. The variations are at 1.8 S per cycle (0.56 Hz), related to the 33⅓-rpm speed. Actual average speed was 0.4% fast, so the 0% line has been adjusted to show pitch variations symmetrically.

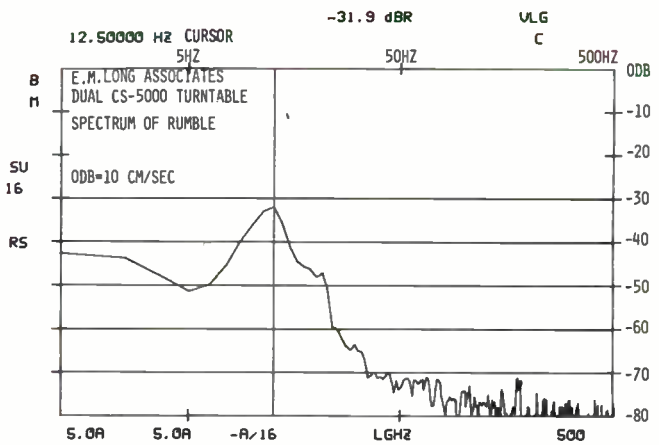

Fig. 16—Rumble spectrum.

though the dips appear at relatively low frequencies, the effects are heard in the higher frequency range.

This phenomenon is seen more clearly in the next two figures. Figure 5 shows the output of the left and right channels due to a mechanical impulse applied directly to the tonearm tube, near the headshell. Although the impulse is quickly damped, it definitely illustrates that the output is at higher frequencies and that there are delayed reflections present. Figure 6 represents the spectrum due to a series of impulses which were applied and averaged. Most of the output is in the range between 1,450 and 7,500 Hz. This delayed mechanical energy could affect the sound in such a manner as to reduce the perceived transparency.

Figure 7 demonstrates the excellent interchannel phase relationship between the left and right channels, with very little random scatter of energy. This good interchannel phase response is also indicated by the phase versus frequency response (Fig. 8); these results also show that image stability should be very good. The comments from the panel members regarding image stability bear this out, since the listeners rated the Dual/Ortofon combination as the equal of the reference system in this respect.

Output versus time for the two highest levels at 1 kHz on the B & K 2010 test record is illustrated in Fig. 9. The output at 19.2 cm/S shows an excellent sine wave, while the output at 25 cm/S indicates that the stylus has difficulty tracing the peaks of the wave. This is still a very good result and demonstrates that the fine-line stylus is doing a pretty good job, since many cartridges will not do even this well. The effect of this performance upon the spectral output is shown in Fig. 10. It is easy to see the increase in level of the upper harmonics from 7 to 10 kHz. One panel member, who seems to be particularly sensitive to this kind of upper frequency distortion, said, after the listening sessions were over, that she changed her opinion about which combination was better during the high-level orchestral passages of

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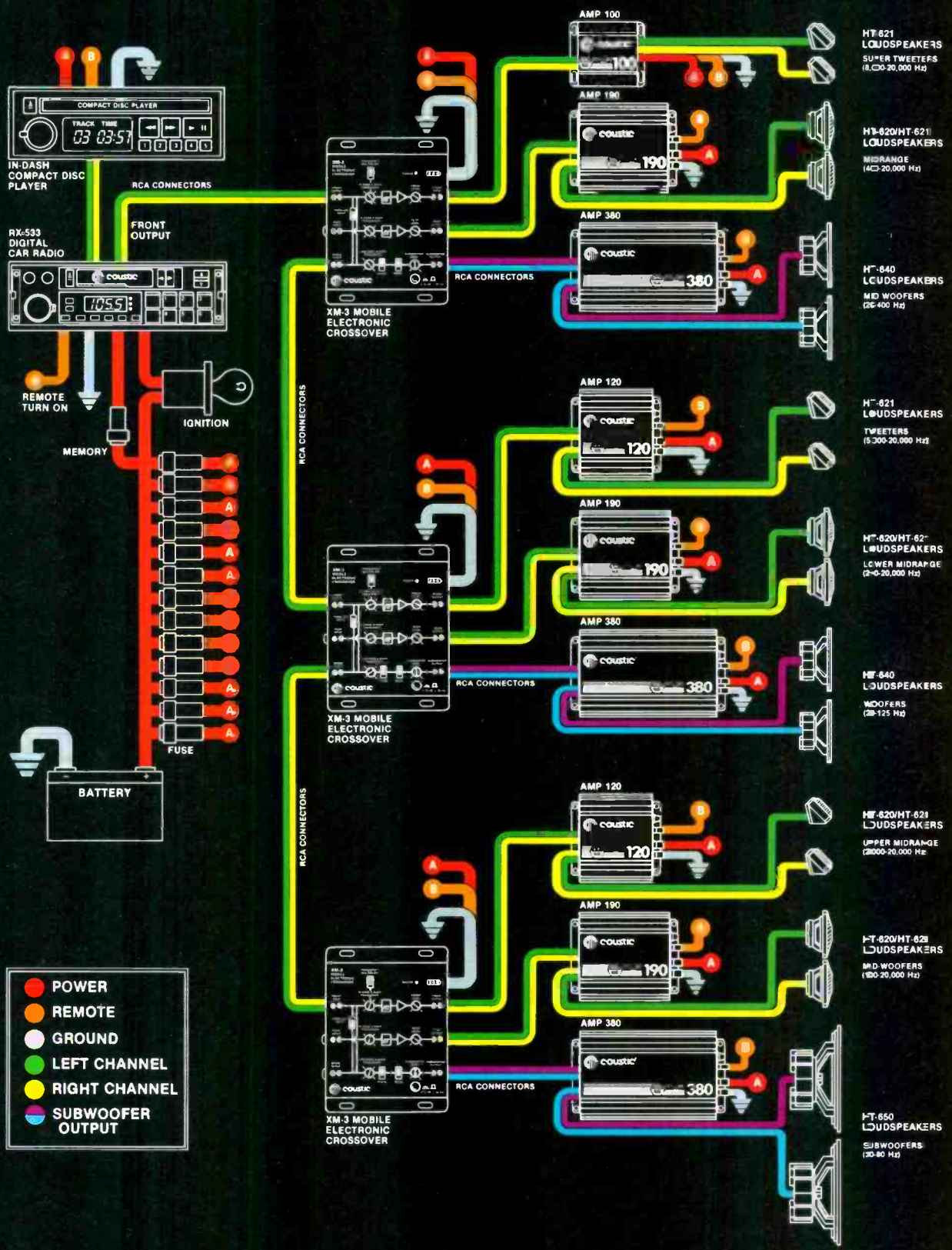

coustic ...a sound investment.

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I can easily recommend the Dual/Ortofon combination to anyone who wants high quality but can't afford expensive audiophile gear.

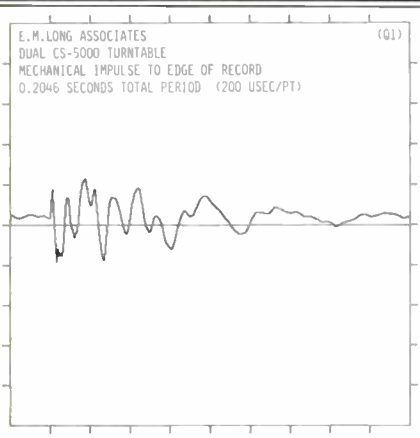

Fig. 17—Output vs. time for mechanical impulse applied to edge of record, with stylus resting in groove. The turntable mat absorbs energy from the record fairly well and dissipates it quickly.

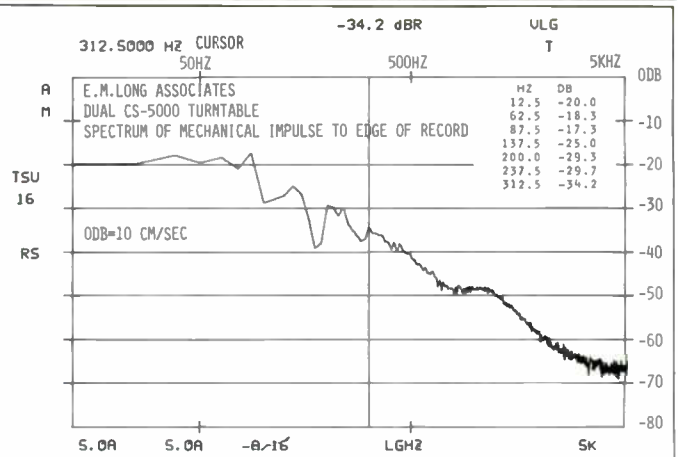

Fig. 18—Spectrum (to 5 kHz) of impulse response shown in Fig. 17 (average of 16 samples).

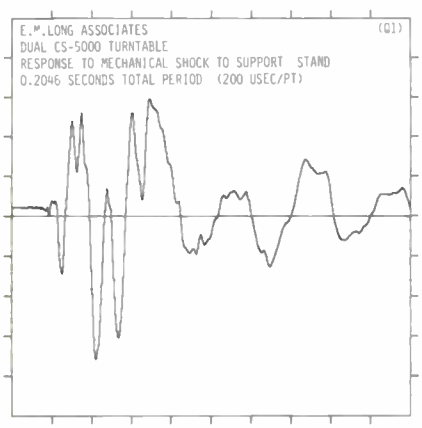

Fig. 19—Output vs. time for mechanical shock applied to the support stand on which the turntable rested.

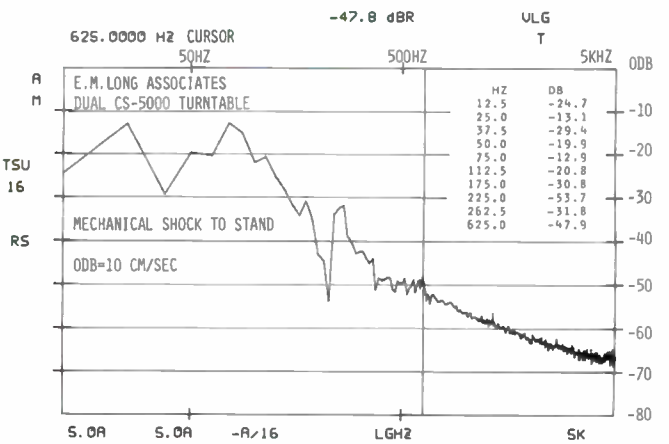

Fig. 20—Spectrum (to 5 kHz) of impulse shown in Fig. 19 (average of 16 samples).

one of the selections. For most of the previous pieces, she had rated the Dual/Ortofon combination equal to or better than the reference.

This is why, in the beginning of this section, I wrote about my monitor speakers being so merciless. They reveal aberrations and anomalies in recorded program material to such a degree that the slightly subdued and veiled sound of the Dual/Ortofon combination, which tends to mask these things slightly, can make many recordings more listenable. It wasn't until the Dual/Ortofon combination and the reference system were really stressed, by high-level program material, that the reference system demonstrated its superior quality.

Figure 11 is a graph of output versus time for two different levels of the 10.8-kHz pulsed tone-burst signal of the Shure TTR-103 test record. The Dual/Ortofon combination tracks the higher level very well, with the output showing very little asymmetry or compression. This good result is verified by the output spectra at these different levels (Fig. 12). Comments by panel members about the sound of cymbals and bells indicate that the tested combination was considered to be excellent. If the high-frequency tracking were not this good, these instruments would take on a leaden quality.

The output of the Dual/Ortofon combination for the 1-kHz square wave of the CBS STR-112 test record is shown in Fig. 13, and the result is quite good. The spectrum due to this output is not shown, but it revealed a very even distribution of harmonics; the odd-order harmonics were predominant, as they should be. The right channel showed slightly higher square-wave output, verifying Fig. 1, which shows greater high-frequency output from this channel.

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To borrow a phrase from a well-known computer company, this might be the record-playing system "for the rest of us."

Figure 14 illustrates the wow and flutter spectrum of the CS 5000 turntable. The contribution made by the tonearm/cartridge resonance can be seen in the range from about 7 to 15 Hz. The anti-resonance of the isolated counterweight is probably responsible for the lack of a single, clearly defined resonance, which is good.

The way that the pitch of the sound is affected during each revolution of the turntable is demonstrated in Fig. 15. The 0% line has been adjusted so that, even though the average speed is 0.4% fast, the variations in pitch are shown as plus and minus. The Dual CS 5000 performs well compared to other—even more expensive—turntables, and no comments were made by listening panel members which could be directly correlated with the cyclical pitch variation. Even during high-level musical passages, where stylus drag increases, the motor torque was sufficient to keep the pitch from lowering.

The spectrum of the turntable's rumble components is quite low (Fig. 16), and the main components occur around the tonearm/cartridge resonance, which is normal. Comments were made by some panel members about rumble, but these were traced to the records themselves, since other program material was heard with practically no rumble at all.

Energy absorption from the record by the turntable mat is fairly good and is dissipated quickly. This is indicated by Fig. 17, which shows that the upper frequency components are greatly reduced in the first 100 mS. Figure 18 represents the spectral components due to a series of mechanical impulses applied to the edge of a stationary record, with the stylus resting in a groove. The distribution is reasonably uniform and decreases considerably in the range above 500 Hz. I also made acoustical measurements of the platter alone, and these showed that the damping material around the inside periphery is not very effective in reducing these modes. However, the turntable mat does do a good job of absorbing energy from the platter and completely eliminates the tendency to ring.

Figures 19 and 20 show the output versus time and the spectrum of the output due to mechanical shocks applied to the heavy support stand on which the turntable was resting. These figures demonstrate that the CS 5000's suspension provides very good isolation from outside vibration.

Acoustical isolation tests were also made but are not shown. They indicated that the Dual/Ortofon combination has reasonably good isolation from airborne sounds, especially with the lid closed.

Conclusion

I have to admit that I was pleasantly surprised by the performance of the Dual CS 5000 turntable/Ortofon X3-MC cartridge combination, with regard to both the technical measurements and the listening evaluations. Over the years, I have tested many very expensive turntables, tonearms, and cartridges that have definitely increased the amount and quality of information which can be retrieved from the grooves of phonograph records. I have also tested, for my own information, some low-cost combinations. The differences between these and the audiophile combinations are quite obvious when comparing technical measurements and during listening evaluations. Even untrained listeners can hear the differences. The Dual/Ortofon pairing, however, is not as easily distinguishable from the expensive, top-quality systems. I can easily recommend this combination to anyone who desires high-quality phono performance but lacks the resources needed to purchase one of the more expensive systems. I congratulate Dual and Ortofon for having come up with a simple, integrated, and excellent-sounding turntable, tonearm, and cartridge combination. To borrow a phrase from a well-known computer company, this might just be the record playing system "for the rest of us."

Edward M. Long

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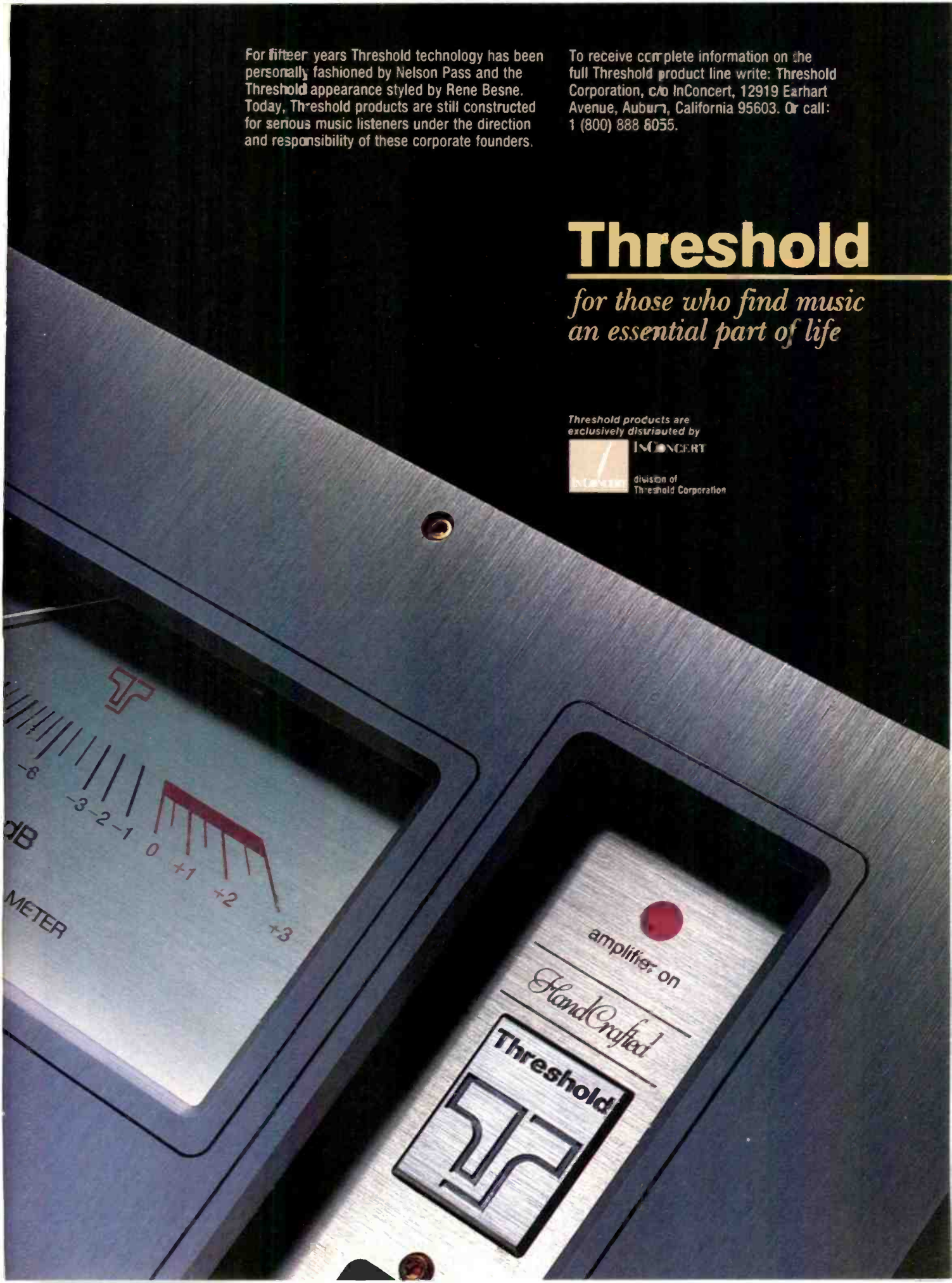

4

ECLIPSE EST-240 CAR DAT PLAYER

Manufacturer's Specifications
Frequency Response: 10 Hz to 20 kHz, ±3 dB.
S/N Ratio (A-Weighted): 90 dB or greater.
THD: 0.006%.
Wow & Flutter: Below measurable limits.
Tone Control Range: Bass, ±12 dB at 100 Hz; treble, ±12 dB at 10 kHz.
Bass Boost: +10 dB at 60 Hz.
Output Level: 1.4 V.
Power Requirements: 14.4 V d.c. (11 to 16 V, negative ground); 1.0 ampere.
Dimensions: 7 in. W × 2 in. H × 6⅛ in. D (17.8 cm × 5.1 cm × 15.5 cm).
Weight: 4.4 lbs. (2 kg).
Price: $1,599.95.
Company Address: Eclipse Mobile Sound Systems, 19281 Pacific Gateway Dr., Torrance, Cal. 90502.
For literature, circle No. 93

The number of manufacturers who have introduced play-only Digital Audio Tape machines continues to grow, despite the reluctance on the part of those same manufacturers to introduce DAT recorders into the U.S. and despite the sparse amount of prerecorded DAT software available. One of the most recent companies to offer a DAT player for mobile use is Eclipse, the high-end division of a large OEM mobile-sound manufacturer.

It's interesting that Eclipse is making a DAT player the flagship of its first product line this early in the DAT era. How early that is was pointed out to me when I noted a claim in a press release that the EST-240 "skips over the blank space at the end of the tape for faster cueing from one side of the tape to the other." Apparently, the copywriter didn't yet know that this new medium has only one side, albeit a side that can play for as long as two hours in standard home-recording format or 80 minutes in one prerecorded format. What the EST-240 *does* do is rewind automatically when it finds an "end" flag subcode on the tape—and the automatic rewind can be defeated, if there's material after the end flag that you want to hear.

Be that as it may, there is much worth crowing about regarding the features of the EST-240. I don't know if this player has the quickest start time in the industry, as claimed by Eclipse. However, it is certainly a lot faster than the start time (threading up, cueing to the first track, and beginning playback) than the home DAT units I have tested.

The EST-240 has provision for storing up to 30 program numbers in any random order; pressing a single button plays the selections in the order specified. In addition to the usual fast-forward and fast-rewind modes, the player has a scanning function that plays the first 12 S of each numbered selection on a tape. Stored programs can be repeated over and over automatically; individual selections can also be repeated. Since this DAT player is intended to serve as a complete head unit—even in the absence of a tuner, cassette player, or CD player—it is equipped with volume, front-rear fade, and bass and treble tone controls. You can also "store" up to three preferred volume-control settings so that you won't have to constantly readjust listening levels for different driving and listening conditions. There's even a fixed bass-boost switch that acts somewhat like a loudness control and is intended for use when listening at fairly low levels.

The Eclipse EST-240 was obviously designed for car use. Besides employing two multi-purpose pushbuttons that simplify front-panel layout for the driver, the designers have incorporated a moisture sensor and heater circuit for improved reliability in the car's hostile environment. When the heater circuit is activated by the sensor, it automatically removes any moisture that may have formed on the tape head drum.

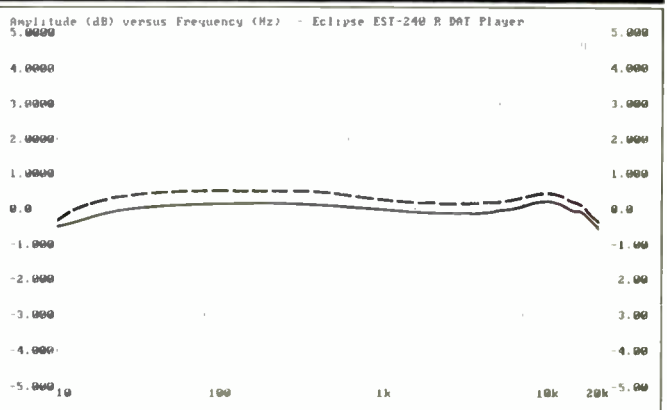

Fig. 1—Frequency response of left (solid curve) and right (dashed curve) channels. The curves, separated here for clarity, are almost identical.

Control Layout

The array of buttons on the front panel of the EST-240 struck me as completely logical and easy to understand and use. At the extreme top left of the panel (closest to the driver), there is a stop/play button. Pushing it once initiates tape play; pushing it again terminates play without ejecting the tape. The program repeat button is just below, while still further down along the left edge of the panel are a clear button, operable only with the tip of a ball-point pen (for restoring normal operation in case the microprocessor gets hung up) and a function-selector button. The latter reduces the number of buttons needed to handle all of the unit's capabilities. Repeated pushes switch the function of the two adjacent "−" and "+" buttons from volume to front-rear fader, bass, treble, balance, and, finally, back to volume adjustment. When the unit is first turned on, the function of the "−" and "+" buttons is for volume control.

Slightly inboard from the left edge of the panel are the other major buttons: Forward and backward program-finders, fast forward and fast reverse, a button for initiating play of a memorized program, memory clear, and two memory store buttons.

The tape insertion slot is near the upper right of the unit. A DAT must be inserted to turn on power to the player; when this is done, the display below the slot illuminates. The three fixed settings of volume level are stored and selected by means of three numbered buttons at the lower right corner of the panel. Other controls along the panel's right edge are bass boost, music scan, and eject.

The display indicates the function currently selected for control by the "−" and "+" buttons, volume level, whether or not a memorized program is being played, and several other features such as scan, repeat, bass boost, and the presence of moisture. In addition, it shows the music selection number, while a counter displays either arbitrary four-digit numbers as the tape advances or actual elapsed time (if that information was originally encoded on the tape).

The EST-240 has a separate control-illumination lead, which would normally be connected to a car's dashboard-lighting circuit, enabling the player's controls to illuminate whenever the dashboard lights are on. The EST-240 also will glow brighter or softer according to the setting of the car's

The EST-240 allows you to store three different volume settings, to suit different listening and driving conditions.

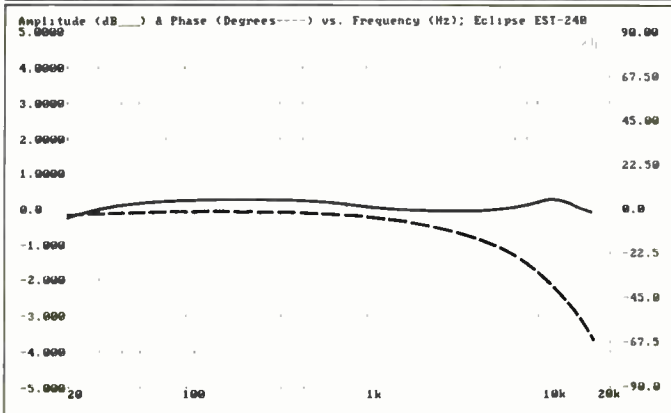

Fig. 2—Comparison between amplitude response of one channel (solid curve) and relative phase response (dashed curve) of opposite channel. See text. Phase, in degrees, can be read from right-hand scale.

panel-illumination dimmer. If this lead is left unconnected, however, the player will stay dark until a tape is inserted. At night, this could pose a bit of a problem if other dashboard lighting is insufficient for locating the dash slot.

Measurements

Figure 1 is a plot of the frequency response of this player, measured at maximum recorded level, using a new DAT test tape I was able to acquire. (See "Problem & Solution," which accompanies this report, and note that I used a 14.4-V supply voltage for all tests.) The dashed curve (right channel) was deliberately offset by a few tenths of a dB for clarity, but the solid curve (left channel) was virtually identical. Response was down only −0.4 dB at 10 Hz and −0.5 dB at 20 kHz.

Figure 2 shows a comparison between the frequency response of one channel (solid curve) and the relative phase response of the alternate channel (dashed curve). It is obvious that the EST-240 employs only a single D/A converter, which causes the usual time delay of approximately 11.3 μS between left and right channels. This delay results in a phase displacement of about 81.3° at 20 kHz.

PROBLEM & SOLUTION

Until now, my tests of DAT players (those that only play back tapes but cannot record them) have been limited to a check of frequency response, distortion versus frequency (at the same recorded level as the response test), and the S/N ratio of the DAT's analog stages. The two test tapes I was able to acquire early in the DAT era lacked the signals I needed to perform the more meaningful tests that I do for CD players. Because of the digital-to-digital limitations imposed upon the current R-DAT format by its standardization committee, I was unable to transcribe my CBS CD-1 test disc to DAT *via the digital-to-digital route*. This is because the sampling rate of the CD-1 is 44.1 kHz (as it is on all CDs), and consumer DAT units record only at 48 kHz. Even if I could overcome the sampling rate difference, there would still be the matter of the digital copy-inhibit flag, which would be sensed by home DAT players and would prevent copying in the digital mode.

Naturally, I could copy the CD-1 disc onto a DAT cassette by going from the analog outputs of my CD player to the analog inputs of my R-DAT recorder. Such a DAT test tape would be meaningless, however. The program material on it would have gone through two needless conversions of format (from digital to analog and then from analog to digital) and would have been altered by the characteristics of the analog audio stages in both devices. Of course, someday an enterprising company will come up with an appropriate R-DAT test tape for use by people such as me (and for production testing of DAT recorders and players by manufacturers), but I had to test R-DAT car players *now*. What to do?

Clearly, the solution was to convince someone who had access to a professional R-DAT machine to make a digital-to-digital copy of the CD-1 test disc. Since such a copy would not be sold but would only be used for test purposes in my own lab, I saw nothing wrong with this solution. Happily, I am acquainted with an expert in digital technology, who did have access to some of these professional machines. I immediately telephoned him and explained my problem. Fortunately, he was willing to help me; I had confidence that he could, since he has published several scholarly papers concerning digital signal processing, digital/analog conversion, etc. and has appeared at many local AES meetings. He double-checked his access to the professional R-DATs, and kindly agreed to attempt to produce a true digital replica of the CD-1 test disc for my use. Interestingly, the first time he tried, the pro DAT would not transcribe the CD-1 disc to tape, even though it did have 44.1-kHz sampling-rate recording capability. The "inhibit" bit present in the CD-1 disc evidently was not being ignored, even by this pro machine. This was a surprise, since these pro DATs are not supposed to lock up in this fashion. Fortunately, my friend was able to do some manipulation of the signal so that, just hours before I needed to test the Eclipse, I received an envelope containing the precious DAT version of the CD-1!

I must mention at this point that my friend has requested that we keep his identity out of the magazine, which is why we are not naming him. In any case, both *Audio* and I are extremely grateful for his efforts and to have had access to his knowledge. He was able to produce a proper test tape, where we could have done only a DAD copy if left to our own devices. Thus, we are happy to extend public thanks to this gentleman and scholar. *L.F.*

The "−" and "+" buttons control volume, treble, bass, balance, and fading, simplifying the layout and saving panel space.

Overall A-weighted S/N was 88.1 dB for the left channel and 88.4 dB for the right. As is true of such measurements made for CD players, the results obtained using the "quiet track" of my DAT test tape had little to do with the unit's digital portion, since the "quiet track" does not activate or exercise its D/A converter. Rather, this noise measurement gives an indication of the S/N capability of the analog, or output, section of the player. As is evident from the spectrum analysis of this residual noise (Fig. 3), most of the residual noise contributing to the overall S/N figure (just over 88 dB) consists of high-frequency noise. There is no evidence of hum components or their harmonics, since the unit is powered by a d.c. supply.

Figure 4 is a plot of quantization noise and distortion relative to the maximum recorded level of a 1-kHz reference signal, plotted in dB, as a function of signal level. The curve remains nearly constant all the way down to −90 dB, except at the very highest output levels, where it rises slightly because of the beginnings of analog-stage overload. Even then, however, quantization noise is 86 dB below maximum recorded level.

Figure 5 shows how THD + N varied with frequency for signals recorded at maximum level. I felt that something was wrong with the analog amplifying stage(s) of this unit's left channel (solid curve), since its distortion was considerably higher than that of the right channel (dashed curve). Even so, at all but the low-frequency and extreme high-frequency ends of the spectrum, the distortion of the left channel was around 0.2%. For car applications, that's not worth worrying too much about. And, as mentioned earlier, at lower recorded levels, distortion and noise recede to barely measurable levels. My sample's left-channel analog section also was deficient, compared with the right channel, when I measured SMPTE-IM distortion at maximum recorded level. The right channel registered a reading of 0.127%, while the left measured 0.78% under the same condition.

Figure 6 is a plot of stereo separation. Left-to-right separation (solid curve) was 84 dB at 1 kHz, and right-to-left separation (dashed curve) was 75 dB at the same frequency. Even at 10 kHz, separation was 68 dB from left to right and 58 dB from right to left.

I tried to measure undithered linearity as a function of level for this player, in much the same way as I would for a CD player. My Audio Precision System One test setup registered the points quite nicely from 0 dB (maximum recorded level) down to −70 dB, and linearity was virtually perfect over that range (Fig. 7). For some reason which I have yet to figure out, however, the test system failed to register any points below −70 dB, even though they are recorded on the test tape! Whether this is because the undithered signals are buried in noise or because some test-gear parameter was set wrong, I cannot yet say. The same thing occurred when I tried to use the low-level, dithered test signal found on both the CD-1 test disc and on my DAT replica of it. The test equipment picked up the −70 dB section but then failed to pick up values for −80, −90, and −100 dB. Accordingly, I am unable to show a graph of linearity—or deviation from linearity—for the dithered signal.

I was able to plot the deviation from perfect linearity for the special "fade-to-noise" signal available on the test tape.

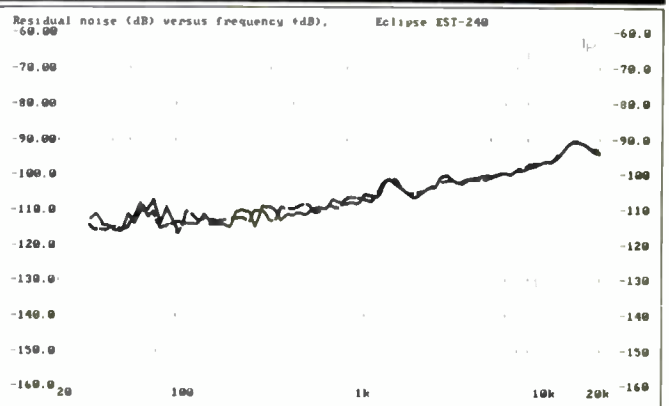

Fig. 3—Residual analog-section noise vs. frequency for "quiet" track of R-DAT test tape. In this and the following two figures, the solid curve is for the left channel and the dashed curve for the right.

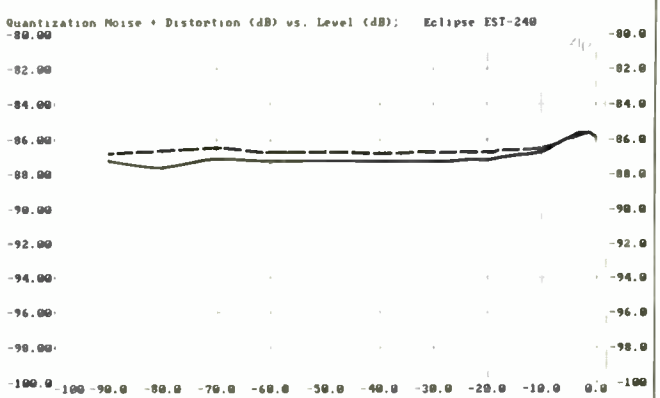

Fig. 4—Quantization noise and distortion vs. signal level. See text.

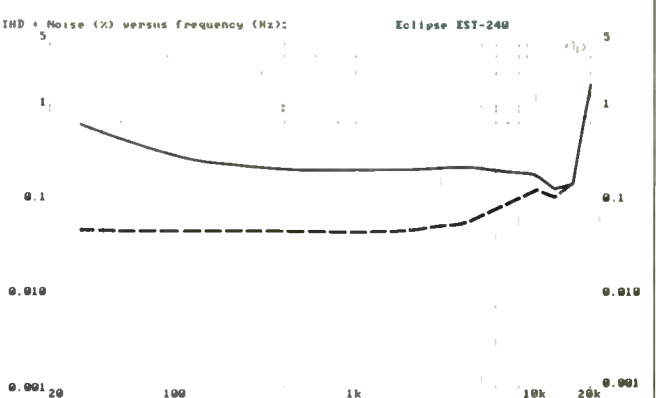

Fig. 5—THD + N vs. frequency at maximum (0-dB) recorded level. Note the difference between channels; see text.

I have only high praise for this unit's features. All operated unerringly in the lab, and should do as well on the road.

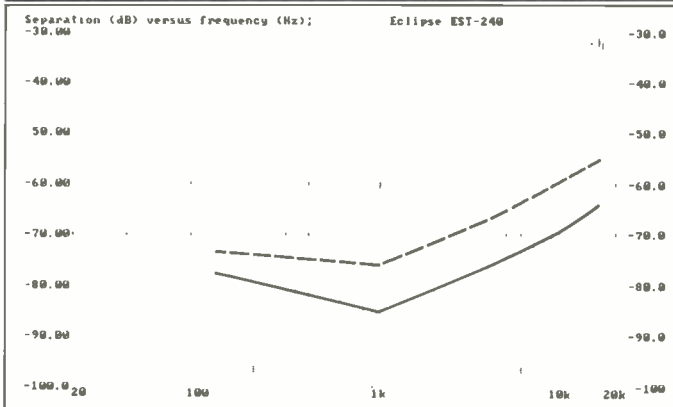

Fig. 6—Separation vs. frequency. Separation is greater in the left-to-right direction (solid curve) than from right to left.

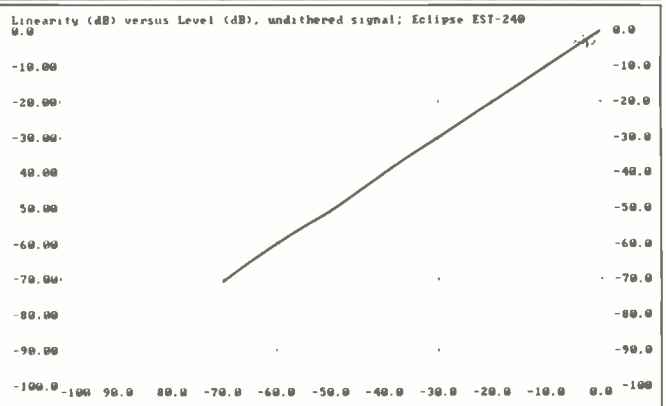

Fig. 7—Linearity vs. level, using undithered signals. Test equipment was unable to register readings below −70 dB; see text.

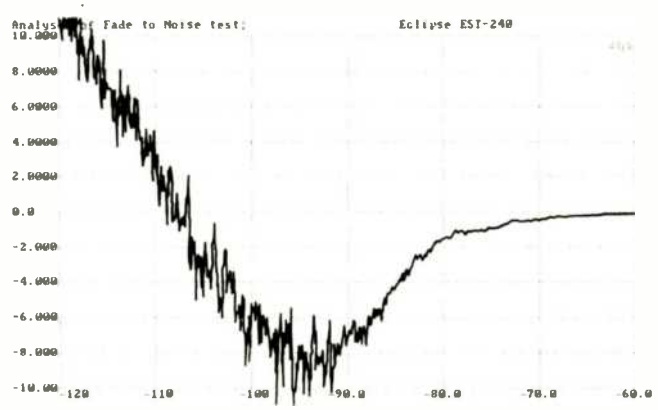

Fig. 8—Deviation from perfect linearity for EIA "fade-to-noise" test for dynamic range, using dithered signal.

This signal starts at −60 dB and decreases in amplitude at a uniform rate down to −120 dB. As shown in Fig. 8, linearity remained quite good down to −80 dB or so, but below that point, linearity "fell apart" and noise dominated the remainder of the sweep.

Reverting to the EIAJ-recommended method of measuring dynamic range (the EIA method is currently being finalized and has been modified since it was first conceived), I came up with a figure of 81.3 dB for the left channel and 82.6 dB for the right. The results of Fig. 8 would tend to corroborate these readings, since dynamic range is supposed to take into account the range (from maximum recorded level downward) over which a properly dithered signal can be extracted or differentiated from residual noise, distortion, and any other spurious signals present at the output of the device under test.

As has been true of most DAT players and recorders and of most CD players tested to date, wow and flutter was unmeasurable. I did, however, measure the accuracy of the player's internal "clock," which determines the 44.1-kHz sample-reading rate and other digitally related timing sequences. I found it to be accurate to within 0.0268%.

Use and Listening Tests

Operating a car DAT player—or, for that matter a car CD player or cassette deck—on the lab test bench is no way to evaluate its ease of use in a car. I can only say that the Eclipse EST-240 player includes those features I would consider important if I had a DAT unit in my car.

I have only high praise for the way Eclipse has configured the EST-240. All of its features operated unerringly on the test bench, and I presume they will do as well on the road. As for sound quality, I did play several DAT selections on this player, using an Eclipse Model EUM-1420 power amp to drive a pair of home reference speakers. I was perfectly satisfied with the way the combination sounded, but again, the real test of sound quality must be made with the units installed in a vehicle—preferably one that is driven under a variety of road and climate conditions.

The measurements I made using my newly acquired DAT test tape clearly indicate that, while this player certainly can provide music playback which is far smoother in response and lower in distortion than you will get with even the very best analog car cassette player, the EST-240's performance does not quite come up to that of the best CD players I have tested. Whether this is characteristic of the breed or is particular to this unit remains to be seen. I'll let you know after I've been able to test a few more car DAT players in this more meaningful manner, using the same test signals I use to measure home and car CD players.

Leonard Feldman

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5

MEITNER PA-6i PREAMPLIFIER

Manufacturer's Specifications

Frequency Response: 1 Hz to 100 kHz, +0, −3 dB.

RIAA Equalization Accuracy: Within 0.2 dB; channels matched within 1%.

THD: Less than 0.01% (−80 dB) from 20 Hz to 20 kHz, at +10 dB output.

IM: Less than 0.01%.

Input Sensitivity: Tuner and AUX/CD inputs, 500 mV; phono, 0.6 mV or higher with MM input module.

S/N (A-Weighted): Line inputs, 96 dB; phono inputs, 80 to 100 dB with MM input module, 75 to 90 dB with MC input module.

Maximum Input Voltage: Line inputs, +26 dB (re: 500 mV); phono input, +30 dB.

Maximum Output Voltage: 8 V into 600 ohms at rated THD.

D.c. Output Offset: ±2 mV, maximum.

Input Impedance: Tuner and AUX/CD inputs, 33 kilohms; tape input, 100 kilohms.

Power Requirements: 117 or 220 V; 50/60 Hz; 20 watts.

Dimensions: 12⅝ in. W × 2 15/16 in. H × 12¾ in. D (32 cm × 7.5 cm × 32.4 cm).

Price: $2,395 with wired remote control, $2,495 with wireless remote.

Company Address: Museatex Audio, 6695 Thimens, St. Laurent, Que., Canada H4S 1W2.

For literature, circle No. 94

The Meitner PA-6i preamplifier is one of several components made by Museatex Audio of Quebec, Canaca. They also make an unusual turntable, a CD player, and two solid-state power amps. Most, if not all, of these are the brainchild of Edmund Meitner, a talented, innovative designer who also is responsible for Amber Electro Design audio test equipment. The preamp and the two power amplifiers are housed in very attractive wooden cabinets of similar appearance and identical size.

What is unusual about the PA-6i is that the front panel is devoid of the usual knobs and pushbuttons that typically control preamplifier functions. This is a remote-control preamp, with input selection, tape monitor, output polarity, mute, balance, and volume all remote operated. Two kinds of remote units are available—wired and wireless. The wired remote has rotary controls for volume and balance; the wireless is more like the usual video controller, with up/down buttons for volume and left/right for balance. On both remotes, other functions are handled by selector pushbuttons. The wired remote plugs into a socket on the back of the preamp; when the wireless remote is used, a separate receiver box plugs into the rear-panel socket.

A vertical row of LEDs on the front panel indicates which input is selected and whether the tape monitor, output phase inversion, and mute are on. Adjacent to these indicator LEDs is a panel area that, when pushed, activates the mute function. On the rear of the PA-6i are two DIN connectors (one for power input from the remote power supply, the other for remote control), two sets of main output jacks, a set of tape in and out jacks, AUX/CD and tuner inputs, and a slot for installing one of three available types of phono-circuit plug-ins. Tiffany signal connectors are used throughout this preamp.

The chassis metalwork is quite simple, consisting of three pieces. The main piece, which forms the bottom of the unit, is bent up to form the front panel. Other bends on the sides of this piece form a mounting surface for the main p.c. board. A second piece, bent into a shallow "U," serves as the rear panel. A third flat piece joins the top of the front and rear panels as a top cover. The sides of the enclosure are not covered by metal. A beautifully finished shell of highly polished wood, open in front and rear, forms the outer cover of the unit.

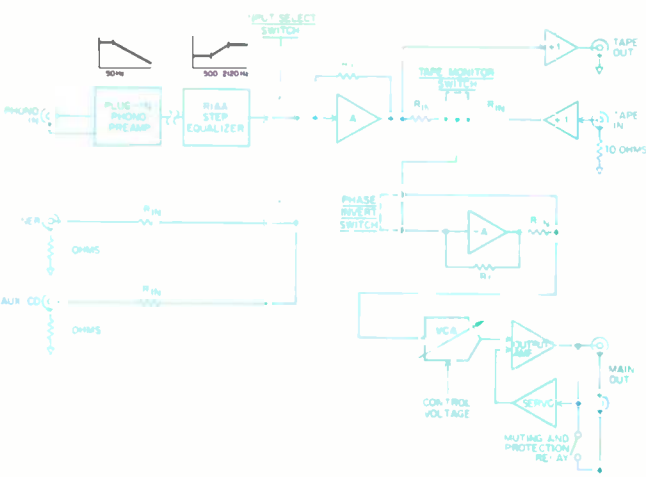
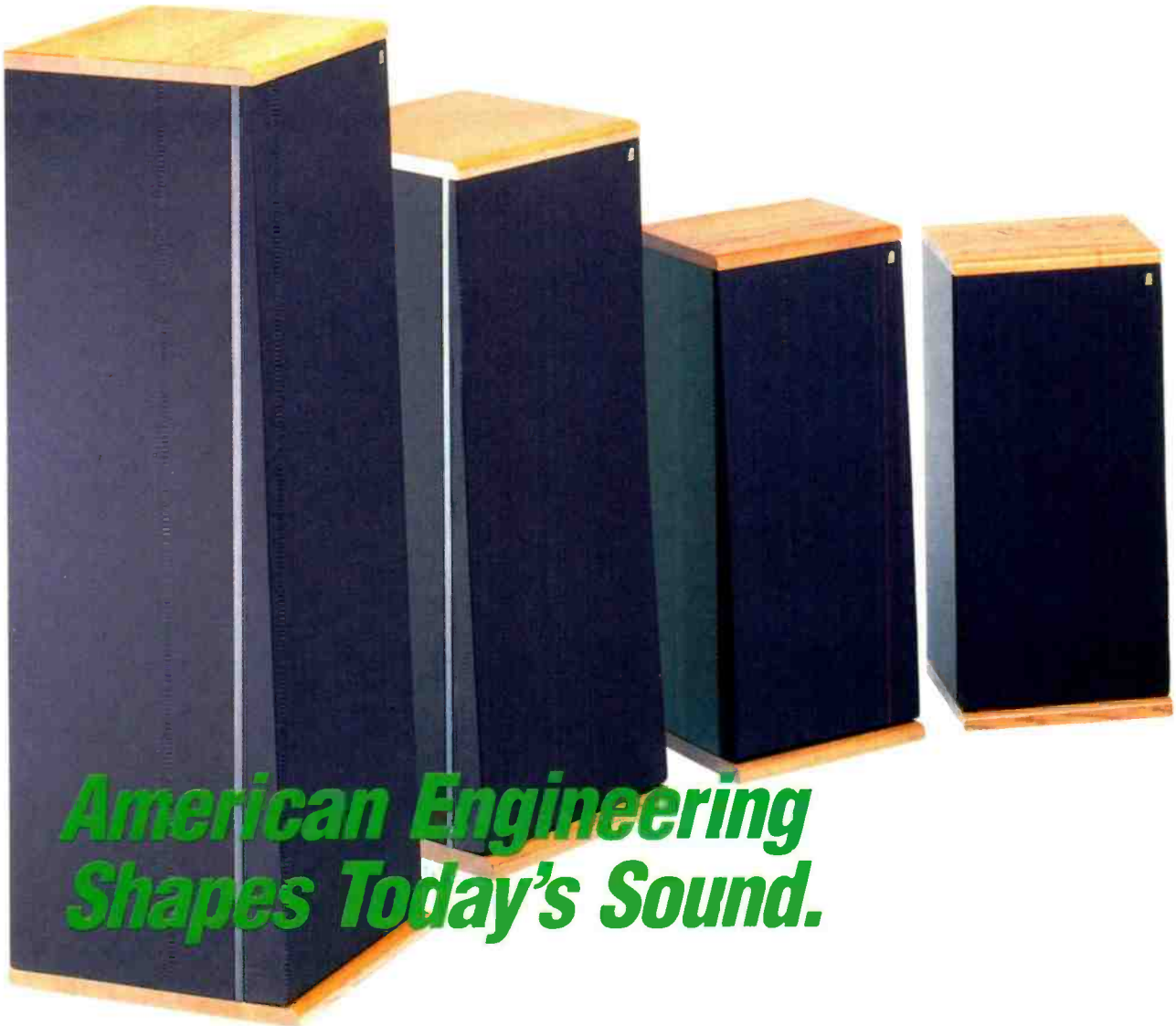


Fig. 1—Block diagram of signal path (one channel shown).

The main preamp p.c. board is double-sided (printed traces on both sides) and takes up almost the whole area of the chassis. Numerous parts are mounted on both sides of the board and appear to be of high quality. Compared to the picture in the brochure for the Model PA-6, the PA-6i reviewed here had some visible internal modifications, such as a pair of film capacitors laid flat on the board and shielded with copper foil, multiple transistor devices which are not covered up or potted and are presumably in the voltage-controlled amplifier (VCA) area, and some hand-wired buses used for interconnections on top of the board. The board's traces are not plated, as is usual, because the designer feels that unplated traces sound better. The board is coated with a green solder mask that protects the traces from corrosion. The separate power-supply enclosure houses the power transformer, filter chokes, capacitors, and two three-terminal TO-220 voltage regulators.

Ed Meitner, upon request, provided me with some generalized information on how the PA-6i works. However, no specific circuit schematics with values were given.

The main thing that distinguishes the circuitry in the PA-6i from conventional preamps is the way its signal-switching, volume, and balance functions are accomplished. Input-selection, tape-monitor, and phase-reversal switching are all done with what Meitner calls current-mode FET switches. In Fig. 1, a block diagram of the PA-6i, every place marked "X" is a C-MOS FET switch. By placing the FET switch at the summing junction of an op-amp, the signal voltage on the drain and source of the FET is low because of the "virtual ground" of the summing junction. Further, and more important to the linearity of the "on" resistance of the FET switch, the signal level at the source and drain is low in respect to the d.c. gate-control voltage. In the case of the input selector, only one switch is on at a time. Since the feedback



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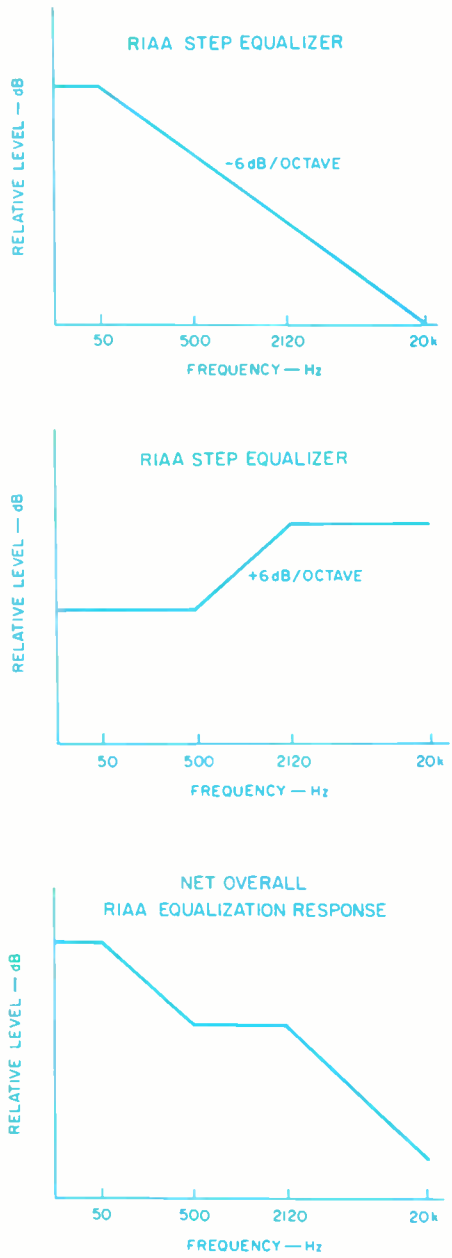

Fig. 2—Two-step phono equalization system used in the PA-6i. Adding the results of the integration circuits on the plug-in phono board (top) to those of the RIAA step equalization circuit on the main board (middle) yields the overall RIAA equalization response shown (bottom).

resistor (R_f in Fig. 1) is the same value as the high-level input resistors (R_{IN}), the selected output is transferred, inverted in polarity, to the output of the selector-switch op-amp. The output of this op-amp is equivalent to the wiper of a conventional selector switch, which usually goes directly to the tape-out jack. In the PA-6i, it feeds this jack through a noninverting, unity-gain buffer amplifier.

The output of the selector-switch op-amp and the buffered tape input, each through its own series resistor and FET switch, feed a new summing junction. This junction feeds a VCA, a circuit whose gain varies with the control voltage applied to it. Depending on which switch is activated, the selected input or tape play will be routed to the VCA summing junction.

Also in series with the tape-monitor/input-signal choice going to the VCA summing junction is a further function choice of signal polarity. If the polarity-inversion function is not activated, the signal from the tape monitor or input selector goes straight into the VCA summing junction. If the polarity-inversion function is activated, the signal is routed to the summing junction of a polarity-inverter amplifier, whose output goes through a summing resistor into the VCA's summing junction. The "Phase" LED is off when the polarity-inverter amp is switched out; by implication, that's the normal output-signal polarity. It's interesting, however, to note that my measurements show the absolute phase of this preamp to be inverted from every input except tape in, at both the main and tape outputs! If one doesn't want polarity to be inverted at the main outputs, the signal must go through another amplifier. Again, for tape recording, all inputs are inverting.

The control signals for all of these switches come from interface circuitry that connects to either the wired remote or the separate receiver box for the wireless remote.

The voltage-controlled amplifier is a circuit whose gain is set by a d.c. control voltage. Here, the VCA serves as the electrical equivalent of the usual mechanical potentiometer, functioning as a volume or balance control. There are two VCAs in a stereo preamp, one for each channel. Balance between channels is achieved by having the balance control alter the relative control voltages to the two VCAs. Design of a good VCA is very difficult. The major problems involve obtaining adequate S/N ratio, low enough distortion, and low control feedthrough (output d.c. surge with changes in d.c. control voltage). Finally, after getting decent measured performance, acceptable sonic quality must also be achieved.

When the wired remote is used, the d.c. control voltages for the VCAs come, in a straightforward manner, from the volume and balance controls in the remote itself. For the wireless remote, the derivation of the d.c. control voltages is a bit more complex. Volume and balance controls are of the up/down pushbutton type, which generate a digital code that modulates an infrared transmitter. Volume and balance are adjusted in increments of 0.25 dB, which means that 0.25 dB of change takes place with each button push. Of course, larger changes of level take place in proportion to the length of time the buttons are pressed. A special button restores balance to center with a single push. In the receiver box that plugs into the PA-6i, the information is demodulated

The RIAA equalization is split in two; half takes place on the main p.c. board and the other half on the plug-in phono board.

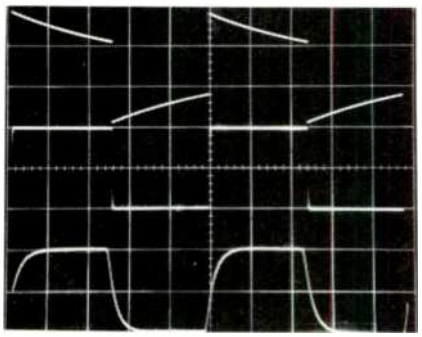

Fig. 3—Line-section response to square waves of 20 Hz (top trace), 1 kHz (middle), and 20 kHz (bottom). See text. Scales: Vertical, 5 V/cm; horizontal (top to bottom), 10 mS/cm, 200 μS/cm, and 10 μS/cm.

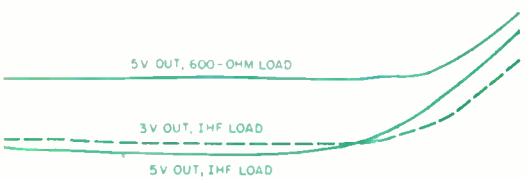

Fig. 4—THD + N (measured over 80-kHz bandwidth) of line section, for various output levels and loads.

and fed into a D/A converter, which generates the appropriate d.c. control voltages for the VCAs.

Following the VCA stage, which is signal-inverting, is the output amplifier (also inverting), resulting in a noninverting configuration from the VCA's input summing junction to the main outputs. A d.c. servo amplifier is applied around the output amplifier to keep d.c. offset to a low value.

A turn-on delay muting circuit operates a relay that automatically shorts the main outputs during turn-on delay or when excessive d.c. is sensed at the main output jacks. If the muting function is engaged, the relay will also mute the output when the volume control is turned down to the bottom 20% of its range, to prevent audible bleedthrough.

Not to be outdone by the rest of the preamp, the phono circuitry is unusual as well. Meitner has three phono system options available for the PA-6i. All three break the generation of the RIAA equalization curve into two parts, in a manner I haven't seen before. As can be seen in Fig. 2, each of the three phono circuits integrates the response above 50 Hz (i.e., response is flat up to 50 Hz, and then a 6-dB/octave roll-off occurs over the rest of the audio range and beyond). In the coupling of the phono circuit boards to the input-selector summing junction, there is, on the main circuit board and common to each type of phono circuit that might be plugged in, an RC step network that boosts frequencies between 500 and 2,120 Hz. The net result, as seen in Fig. 2, is the RIAA equalization playback curve.

To place a constant-bias polarizing voltage on the capacitors associated with generating the RIAA equalization, a circuit technique called charge biasing is employed. This is said to increase the clarity and transparency of the phono circuitry.

The first option for the phono circuit is a straightforward moving-magnet board with high-impedance input. Output from the pickup goes into the noninverting input of an IC op-amp. The 50-Hz roll-off is accomplished in the feedback loop from output to the inverting input of the op-amp, as in the usual feedback equalizer that generates the more complicated complete RIAA curve. Provisions on this particular board allow, via plug jumpers, resistive loading on the pickup of 100 ohms or 1, 10, or 51 kilohms; capacitive loadings of 50, 100, 150, 200, or 250 pF, and a gain selection of ×1, ×2, or ×4.

The second phono circuit is what Meitner calls a "Trans Impedance" moving-coil stage, for cartridges whose output ranges from perhaps 100 to 1,000 μV. This circuit has an input stage ahead of an IC op-amp that looks like an npn-transistor differential-amp topology. Input from the cartridge goes (schematically) into the left-hand transistor. The right-hand transistor is diode-connected, with its collector tied to its base and grounded. The gain of this stage can be selected by plugging in a jumper to short out a resistor between the emitters of the two transistors. The emitters are fed by resistors from a negative supply; the amplifying collector, fed by a resistor from a positive supply, feeds the inverting input of the following op-amp. A parallel RC combination, from the op-amp output to this summing junction, provides the necessary integration above 50 Hz. This circuit has a high input impedance, according to Meitner, and, by looking at the board, it doesn't appear easy to load down the cartridge short of soldering a pair of resistors to the input jacks or to the board itself. The unit reviewed here was sent with the standard moving-magnet board and with the moving-coil board just described.

Probably the most "out there" circuit of all is the third, which is custom-tailored for specific, high-inductance moving-magnet pickups and is available on special order. This circuit provides a specific amount of negative input resistance such that, when subtracted from the positive value of the specific cartridge's winding resistance, a 50-Hz low-

I'm impressed by Meitner's floating-charge power supply. It very cleverly isolates the signal from line and rectifier noise.

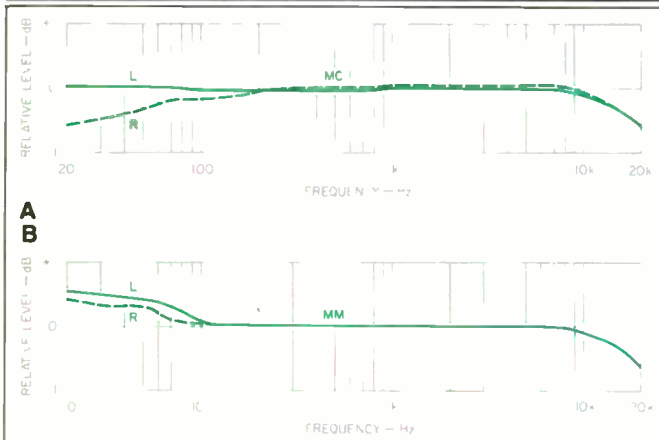

Fig. 5—RIAA phono equalization error for MC board (A) and MM board (B).

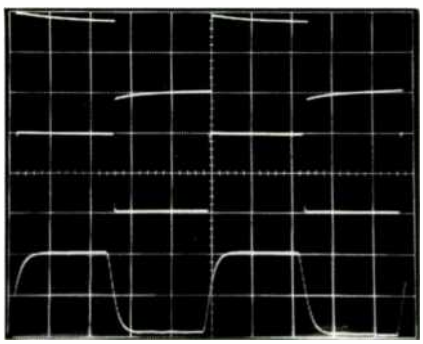

Fig. 6—MC phono response to pre-equalized square waves of 40 Hz (top trace), 1 kHz (middle), and 10 kHz (bottom). Scales: Vertical, 0.5 V/cm; horizontal (top to bottom), 5 mS/cm, 200 μS/cm, and 20 μS/cm.

pass filter with 6-dB/octave slope is formed by the cartridge's inductance against the net positive circuit resistance. Topologically, this is accomplished, again, by an IC op-amp connected with a resistor from output to the inverting input (which is also the cartridge signal input). A resistor of similar value is connected from output to the noninverting input of the op-amp. A small-value resistor, selected for the particular cartridge model, is connected from the noninverting input to ground. This latter is a positive feedback loop and causes the impedance in the inverting input (which is normally low in value and positive in magnitude) to assume the required negative input resistance. A small capacitor across the feedback resistor that goes to the inverting input helps to equalize out a mild rising response in the high end; this rise is due to the elimination of the usual LRC low-pass filter network formed by the L of the pickup, the 47-kilohm resistive loading, and perhaps 50 to 200 pF of cable capacitance. This circuit is covered by a U.S. patent assigned to Amber Electro Design of Montreal, Canada, with Edmund Meitner and Howard Burman as co-inventors.

The power supply of the PA-6i also is innovative, employing a design concept that Meitner calls "floating charge." Inductors separate the bipolar, capacitor-input, unregulated power supply from the final filter and TO-220 regulators. The beauty of this arrangement is that it isolates the regulators and preamp circuitry from rectifier circuits whose current and voltage waveforms have high harmonic content, and from high-frequency line hash. The regulators need only contend with virtually sinusoidal 120-Hz ripple voltages, at lower amplitude than is the case with conventional rectifier/regulator circuitry. The sound is much nicer if 120-Hz ripple signals with high harmonic content are not circulating within the IC regulators, potentially modulating the signal currents being regulated. A very clever idea, this power supply—I'm impressed.

Measurements

Line-section gain was measured with three loads: Instrument (91 kilohms in parallel with 200 pF), IHF (10 kilohms in parallel with 1,000 pF), and 600 ohms. By slightly adjusting the balance control, both channels were trimmed to have the same gain. Results were 9.4× (+19.46 dB) with the instrument load, 9.3× (+19.37 dB) with the IHF load, and 8.5× (+18.59 dB) with the 600-ohm load. Output impedance of the main outputs was about 60 ohms.

Not mentioned in the circuit description is the presence, on the p.c. board, of three one-turn pots that adjust line-level gain or sensitivity in order to equalize the two-high-level signal sources and phono. These pots are presumably switched in along with the input selection and affect the VCA gain range independently of the volume and balance controls. The line-selection gain just mentioned was measured with these pots centered, as supplied by Meitner. It was found that the line-level gain could be varied about ±10 dB from this factory-set midpoint. In effect, the line-section gain is variable from +10 to +30 dB, separately and independently for phono and the two high-level inputs. The balance control, at its extremes, raised the favored channel's gain by about 6 dB and attenuated the other channel by about 6 dB from center values.

Frequency response, with volume at maximum and balance centered, was down 1 dB at 10 Hz, 0.25 dB at 20 Hz, 0.3 dB at 20 kHz, 2.35 dB at 60 kHz, and 4.8 dB at 100 kHz. No difference was found between response with instrument and IHF loads. With the volume set for 20-dB attenuation from maximum gain, the output at 100 kHz was down 0.2 dB more. A pair of plug jumpers in the output amplifier affects the low-frequency response of that circuit; the response just quoted was with the jumpers in the 3-Hz (−3 dB) position. The other position lowers the output amp's cutoff frequency

BACK TO THE FUTURE

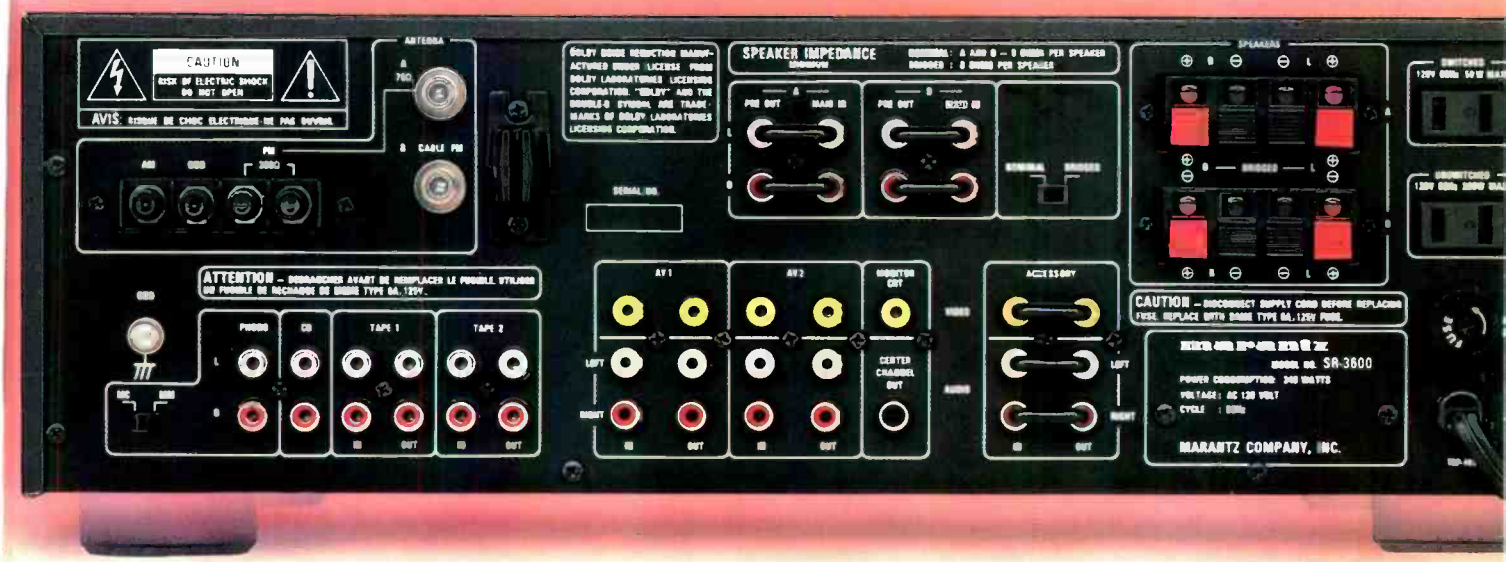

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Table I—Gain and sensitivity for IHF load. Gain figures for instrument load are 0.1 dB higher at main output, 0.5 dB higher at tape out.

	Gain, dB	IHF Sens., mV
AUX to Main Out		
Low Gain	9.3	171.0
Medium Gain	19.5	53.5
High Gain	29.4	17.0
AUX to Tape Out	−0.5	540.0
Phono to Main Out, High Line-Amp Gain		
MM, ×1 Setting	73.9	0.10
MM, ×2 Setting	77.5	0.066
MM, ×4 Setting	83.4	0.033
MC, ×1 Setting	84.5	0.030
MC, ×2 Setting	90.7	0.0145
Phono to Main Out, Medium Line-Amp Gain		
MM, ×1 Setting	64.1	0.32
MM, ×2 Setting	67.7	0.21
MM, ×4 Setting	73.5	0.108
MC, ×1 Setting	74.6	0.092
MC, ×2 Setting	81.0	0.045
Phono to Main Out, Low Line-Amp Gain		
MM, ×1 Setting	54.3	0.98
MM, ×2 Setting	57.8	0.65
MM, ×4 Setting	63.7	0.33
MC, ×1 Setting	64.7	0.292
MC, ×2 Setting	71.0	0.145
Phono to Tape Out		
MM, ×1 Setting	44.2	3.09
MM, ×2 Setting	47.7	2.06
MM, ×4 Setting	53.7	1.03
MC, ×1 Setting	54.8	0.91
MC, ×2 Setting	61.1	0.44

to 0.1 Hz. Rise- and fall-times were 4.4 μS at maximum gain and 4.8 μS with the volume down 20 dB. Waveform was exponential (normal) from small signal levels up to clipping. Square-wave responses of the line section are shown in Fig. 3. The 20-Hz waveform was obtained with the 3-Hz, low-frequency jumper-plug setting. Tilt would be about one-third as much with the 0.1-Hz setting.

Channel-to-channel crosstalk was measured with the volume at maximum and with it set 20 dB down. In general, crosstalk was worse in the left-to-right direction and was measurably poorer at full gain. In the left-to-right direction and at full gain, crosstalk was down more than 83 dB up to 1 kHz, decreasing to −77.6 dB at 5 kHz, −66.6 dB at 20 kHz, and −59.5 dB at 50 kHz. In the right-to-left direction, crosstalk was better: Down 82.5 dB or more up to 20 kHz, decreasing to about 80 dB at 50 kHz. With the gain down 20 dB, crosstalk improved some 3 to 8 dB, depending on frequency. In all cases, crosstalk was in-phase.

The IHF S/N ratio (A-weighted noise below 0.5 V output, with unity gain at 1 kHz) was −83.7 and −83.5 dB for left and right channels, respectively, with line-amp gain set at normal (approximately 20 dB).

Volume-control tracking was found to be within 0.2 dB, down to the −30 dB volume setting, decreasing to 0.4 dB at −55 dB. What's being measured here, of course, is not really the tracking of a traditional, dual-element volume pot, but the precision with which the gain of the two VCAs tracks changes in a common control voltage.

Much to my surprise, maximum attenuation with the volume fully counterclockwise was only about −57 dB. With the mute function engaged, the output-shorting relays come on when the rotary control on the wired remote is set at or below about the 9 o'clock position.

Harmonic distortion of the line section as a function of frequency is shown in Fig. 4 for several output levels and loads. This unit will drive 600 ohms very nicely. Harmonic residue with IHF or instrument loading was dominantly second harmonic, while with a 600-ohm load, distortion content was mostly second and third. Clipping occurs at about 9.5 V rms for IHF or higher loads, and the negative half-cycle clips first. At 20 kHz, there is a mild degree of sticking on the positive half-cycle when clipping. Input impedance was 30 kilohms for line-level inputs and 100 kilohms for the tape input.

As can be seen in the block diagram, there is a buffer feeding the tape-out jacks. Output impedance was found to be about 600 ohms, and clipping level into IHF loads was 9 to 10 V rms. Low-frequency response at tape out extends down to d.c.

Gain and IHF sensitivity are shown in Table I. Phono RIAA equalization errors for the two boards I tested are plotted in Figs. 5A and 5B, as measured at the tape output. Oscilloscope photos of square-wave response through the MC board, as measured at the tape output, are depicted in Fig. 6.

Phono overload versus frequency and load is tabulated in Table II for both the MM and MC plug-in boards. Overload for the MC circuit showed up as an aberration near the negative peak up to about 500 or 600 Hz, and above about 600 Hz was simple peak clipping of the negative half-cycle. Above 15 or 20 kHz, the output waveform was turning into a symmetrical triangle wave, a sign of slewing. Overload in the MM circuit was peak clipping, with the positive half-cycle clipping first, below about 300 Hz. Above 500 or 600 Hz, the negative half-cycle clipped first.

Crosstalk as a function of frequency, for both phono circuits terminated with 100 ohms, was better than 80 dB from 20 Hz to 20 kHz. In the MM unit, with the undriven channel terminated in the IHF dummy moving-magnet source, crosstalk was better than 80 dB from 20 Hz to 30 kHz in the L-R direction. In the R-L direction, it was better than 80 dB up to 10 kHz, decreasing to −78.5 dB at 20 kHz and −76.5 dB at 30 kHz. Crosstalk was in-phase. These results are outstanding.

Referred input-noise levels for the two phono circuits are listed in Table III. IHF S/N ratios are shown in Table IV. Noise levels are quite good here, but not state of the art.

For the MM board, THD + N was found to be less than 0.01% at 5 V rms output from 20 Hz to 10 kHz, with either IHF or higher loading. At 20 kHz, distortion rose to 0.015%.

Use and Listening Tests

Equipment used to evaluate the PA-6i consisted of an Oracle turntable fitted with a Well Tempered arm and a Koetsu Black Goldline cartridge, a California Audio Labs

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The Meitner PA-6i is a very good, listenable preamp, and I have been favorably impressed with its sound.

Tempest CD player, a Nakamichi 250 cassette deck, and Siefert Research Magnum III speakers. Power amplifiers included my own 845 triode 100-watt Class-A mono amps, a YBA_1, and a Motif MS100. Preamps on hand were a Sumo Athena and a Motif MC8. During the review period, I also had occasional use of a Cook-King tube phono preamp, owned by a friend.

First of all, it's great to have remote control of volume and balance at one's listening position! After you get used to it, it's hard to give up. Subtle changes of volume and balance, while one is in position and critically listening, help get the most out of each recording. I found that I preferred the wired remote, with its real rotary controls for volume and balance. The wireless remote, while neat, doesn't make it for me, with its up/down pushbutton controls for volume and balance. One thing that takes a bit of getting used to is the time constant on the PA-6i's VCA control voltage. When volume or balance settings are changed abruptly, it takes about 1 or 2 S for the changes in actual gain to catch up. All functions worked very nicely, with no hangups or surprises in practice. In the lab, however, I was able to paralyze the controls in a manner that required the unit be turned off and on again to recover.

I approached the sonic evaluation of this preamp by listening to how the line section altered the sound of CD reproduction, as compared to listening to the CD player through the best volume control I've heard yet, a pair of switched attenuators, made by a friend of mine, which directly drive the system's power amplifier. Compared to this reference condition, going through the line section of the PA-6i took away some of the openness and "thereness," and added a mild bit of edginess. Depending on such variables as my mood, when I did it, what program material was playing, and so on, the effect ranged from "there's no contest!" to "mild but noticeable." I have listened to a lot of CDs, tapes, and tuners through the line section of this preamp, and my overall impression is that it's pretty good and doesn't destroy the essence of the music, which occurs too often.

Listening to records using the MC phono circuit and going through the whole preamp was also a satisfying musical experience. If one bypasses the line section and goes through the stepped volume-control attenuators into the power amp, the sound is more open and transparent. With the reference tube preamp used to feed the external volume control and power amp, the sound was more relaxed, easier, and more real and "there" in the room.

I consider the PA-6i to be a very good, listenable preamp. It serves the music well. I have heard one of these units driving the Meitner power amplifiers a number of times at hi-fi shows, and have always been favorably impressed with the sound. I recommend that prospective preamp buyers give the Meitner gear a listen. *Bascom H. King*

Table II—Phono overload vs. frequency and load at tape out (left channel).

	MC BOARD, ×1 GAIN SETTING			
	Instrument Load		IHF Load	
Frequency, Hz	Input, mV	Output, V	Input, mV	Output, V
20	1.25	6.5	1.32	6.0
50	1.60	6.3	1.66	5.8
100	2.52	6.35	2.58	6.0
300	6.9	7.2	7.0	6.8
600	13.2	9.2	13.5	8.8
1k	16.8	9.35	16.8	8.75
3k	29.0	9.35	29.0	8.75
5k	43.5	9.15	43.5	8.6
7k	61.5	9.1	61.5	8.55
10k	100.0	8.9	100.0	8.35
20k	135.0	4.8	135.0	4.55
	MM BOARD, ×2 GAIN SETTING			
	Instrument Load		IHF Load	
Frequency, Hz	Input, mV	Output, V	Input, mV	Output, V
20	3.0	7.3	3.0	6.9
50	3.9	7.2	3.9	6.8
100	6.2	7.25	6.2	6.85
300	17.0	8.25	17.0	7.75
600	29.2	9.35	29.2	8.8
1k	36.0	9.35	36.0	8.75
3k	62.0	9.4	62.0	8.8
5k	91.0	9.25	91.0	8.7
7k	123.0	9.3	123.0	8.75
10k	178.0	9.4	178.0	8.8
20k	355.0	9.4	355.0	8.75

Table III—Phono-section noise, referred to input.

Bandwidth	Source Impedance, Ohms	Referred Input Noise, μV LEFT	RIGHT
MM BOARD, ×2 GAIN			
Wide-band	0	0.45	0.425
Wide-band	1k	0.625	0.6
Wide-band	IHF MM	1.5	1.5
20 Hz to 20 kHz	0	0.375	0.35
20 Hz to 20 kHz	1k	0.525	0.525
20 Hz to 20 kHz	IHF MM	1.5	1.5
400 Hz to 20 kHz	0	0.23	0.22
400 Hz to 20 kHz	1k	0.31	0.30
400 Hz to 20 kHz	IHF MM	1.0	0.95
MC BOARD, ×1 GAIN			
Wide-band	0	0.25	0.25
Wide-band	100	0.30	0.30
20 Hz to 20 kHz	0	0.16	0.145
20 Hz to 20 kHz	100	0.19	0.18
400 Hz to 20 kHz	0	0.09	0.086
400 Hz to 20 kHz	100	0.11	0.107

Table IV—S/N, phono section.

Phono Board	Source Impedance, Ohms	IHF S/N, dB LEFT	RIGHT
MC, ×1 Gain	100	73.5	73.5
MM, ×2 Gain	IHF	76.0	75.5

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The search for the ultimate audio system is a sport which ultimately involves a form of gambling. First, you really have to enjoy the actual search for the best possible equipment and for the best synergy between the components of a complex equipment mix. Second, you must be willing to take major risks in terms of money. And the whole effort is pointless unless you are willing to risk making a major commitment to your own taste. Anyone can spend a vast amount of money, trusting to the taste of a reviewer or dealer as a substitute for his or her own judgment, but no intelligent audiophile would. Without the excitement and satisfaction of knowing you have personally chosen the equipment you really want to hear and a combination of components that is tailored to your taste, there is no point in buying more than a good mid-fi system.

High-end audio is a sport that goes far beyond the mere enjoyment of music. If music is all you want, it is important to realize that great music can survive virtually any quality of reproduction. The quest for the ultimate audio system is important only for its own sake. You have to be willing to listen to the sound of different cartridges, electronics, and speakers, and make the effort to judge between what are usually relatively minor improvements in sound quality.

Choosing the best components and blending them into a system also means choosing between different approaches to reproducing sound. Every major high-end designer sets different goals and accepts different trade-offs. No high-end speaker designer I have ever talked to tries to design his equipment to do its best in every room, or to perform at its peak with every kind of music and every type of component.

In the case of electronics, the designers of the world's top equipment—Audio Research, Cello, Classe Audio, conrad-johnson, Counterpoint, Jadis, Krell, Mark Levinson, Jeff Rowland, Spectral, Threshold, et al.—all produce equipment which will work well with other brands, but they design their preamplifiers and amplifiers to work together and to produce a unique balance and combination of trade-offs. The end result of mixing brands may well suit a given ear, but it almost inevitably involves using a slight coloration in one brand to compensate for a coloration in another. To my ear, the cost is a loss of detail, performance, and excitement.

This may seem like a long introduction to a review of one component. Yet such an introduction is necessary because this particular component challenges the ultimate limits of the high end. The Audio Research M-300 is a mono power amplifier that costs $4,995. No one is going to casually buy this product. Its sole rationale is that there are audiophiles who treat audio as a sport and who want the ultimate.

There is no doubt that the Audio Research M-300 has high-tech glamor. It is the product of one of the top design teams in audio, headed by William Z. Johnson. It is a transistor-tube hybrid amplifier with an all-FET front-end and an all-tube output stage. Its styling has the kind of "form follows function" look that exemplifies current design, and it is physically impressive by any standard. The amp weighs 110 lbs. (50 kg) and is 19 in. W × 10½ in. H × 16 in. D (48.3 cm × 26.7 cm × 40.6 cm). There also are just enough front-panel switches and LEDs to complete the visual image and to provide a useful way of saving tube life without creating warm-up problems.

Unlike previous all-tube Audio Research power amps, the tubes have been removed from the drive stage to eliminate problems with hum, microphonics, noise, and frequent replacement. The FET drive stages, however, are combined with enough output tubes (eight 6550s) to literally warm the heart of any bottle freak. As for the output circuit, it follows the precedent set by previous Audio Research designs in that it is partially cathode coupled. The M-300, however, keeps the signal voltage of screen grids precisely in phase with the cathode voltage.

Audio Research feels this circuit combines the advantages of true pentode operation with partial cathode

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coupling, and can achieve the sonic advantages of Class-A operation without the disadvantages. It achieves high efficiency versus Class-A designs, and the manufacturer also claims that the circuitry virtually eliminates switching distortion and makes the question of class of operation largely irrelevant. The M-300 also has a special output transformer with fewer turns and lower impedance. This design minimizes d.c. in the transformer core, allowing the M-300 to perform better with complex speaker loads. Bias adjustment is not critical, and output tubes can be replaced without precise matching. There are two fans to ensure proper cooling with minimum noise, and the fuses are front-panel replaceable. (Like most reviewers, I test for product life and reliability by intentional careless handling and irresponsible negligence. The M-300 proved absolutely reliable in spite of many moves, being left on for days, overload, a speaker with an internal short, and all the other quirks that so endear reviewers to manufacturers.)

The M-300 is rated at 300 watts per channel into 4 and 8 ohms, with a bandpass of 10 Hz to 60 kHz. Its "clipping" power is 330 watts, and it can drive an unusual range of loads for a tube output stage: There are 1-, 2-, 4-, and 8-ohm taps. Input sensitivity is 900 mV, and input impedance is 60 kilohms. These technical specifications are excellent for a unit using tube output stages, although by transistor standards, they are not as impressive. Total harmonic distortion is rated at less than 0.8%, and typically as below 0.005% at 1 watt. The claimed slew rate is 25 volts per microsecond, hum and noise are below 90 dB, and the nominal damping factor is 30.

Make no mistake, however: If all Audio Research wanted was lots of power with good specs, it could have copied some two-decade-old transistor amplifier design. The M-300 is a product for people who can hear, and it is clearly optimized for one type of listener: The audiophile who is seeking the ultimate in musical transparency, detail, and dynamics.

I don't want to overhype this product. The real-world sonic differences between the M-300 and many good high-end amplifiers are relatively limited, and they are only going to be fully apparent with the best possible front-ends, sources, and speakers. Nevertheless, this amplifier is probably the state of the art if you are seeking to extract every possible bit of information in the audio range, from the upper bass to the upper treble.

This amp's overall sound quality is difficult to describe to anyone who has never directly compared good with great audio electronics. In brief, however, the M-300 can provide a level of detail, with virtually every kind of music, that is missing in lesser designs. It constantly makes you pause to hear information you did not hear before. This is most apparent with percussion, but you can hear more sonic detail on every instrument from cello to brass. It also allows you to hear this added detail with every kind of music, from instrumental solos to the most complex passages in grand opera. This makes it remarkably easy to lose yourself in the performance, and to ignore the fact that you are listening to a recording. There is no artificial drama in the M-300, but there is always that added nuance which involves you more deeply in the performance.

I never have been able to relate the apparent *audible* speed of an amplifier to measured speed in electronic terms. Specifications of the M-300 do not show it to be particularly fast, but it sounds exceptionally dynamic when music should sound dynamic. Further, the M-300 does so without making *every* passage or instrument sound dynamic, as some other designs tend to do. This amp is particularly impressive with ribbon, electrostatic, and EMIM/EMIT speakers because it brings out their natural coherence and speed; it is a natural way to show just how good the best cone and dome tweeters really are. At the same time, the M-300 is merciless in revealing how much music is lost by most speaker designs, particularly those which lack coherence or which roll off the upper midrange and highs in ways that cost music much of its apparent speed.

The midrange is consistently excellent, although it comes close to being analytic. There is none of the warmth or softening of the highs typical of most tube amplifiers. The M-300 sounds very different from older Audio Research amplifiers or any conrad-johnson or Jadis designs I have heard. It provides more upper midrange and treble detail than any Counterpoint or output transformerless design I've heard. There is almost too much upper midrange and treble information when playing many recordings, particularly the newer digital ones. In a lesser amplifier, this tonal balance would be slightly hard because the amp could not resolve enough inner detail to communicate the full musical character of the recording. With really good and naturally balanced recordings, however, few units can come close to the M-300 in providing so realistic an illusion of sitting close to a live performance and hearing all the information you would hear if you actually were there.

This amplifier is more for music lovers than for lovers of audiophile or trick recordings. It makes ordinary music come alive and restores the glory of many classic recordings, and it does so with effortless conviction. The M-300 never seems to strain in handling the midrange of musical dynamics and detail. Recordings you may have criticized in the past will emerge as being better than you previously imagined.

The bass is also very good, even with complex loads like the larger Infinity speakers and the Apogee Duettas. Driving the few speakers with extended, powerful deep bass, this amp fares better than any tube output stage I have heard. In fact, in the deep bass, it outperforms most transistor amplifiers, including many top high-end designs. Nevertheless, the M-300 is just slightly lacking in bass control and extension, and even with the shortest possible speaker wires, the bass never quite has the full power and excitement of the top competing designs. Further, a number of other high-end transistor designs do a more convincing job of dealing with instruments such as the cello, bass viol, and bass guitar. This amp is at its best with speakers that do not quite extend down to the lowest bass, and in applications where a little extra power adds bass extension and emphasis.

The practical problem, for most audiophiles, is not going to be judging whether or not the M-300 is a superb amplifier. It is! Rather, it will be judging

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The M-300 has a slightly forward apparent listening position, very good though not outstanding depth, and excellent imaging.

whether this is *the* superb amplifier for their system and, if so, getting the best sound this unit can deliver. In most cases, this will mean visiting a dealer who can really show the product off, and then doing some extensive listening and having a long discussion on how to blend the unit into the system. As with all top high-end products, the problem of achieving synergy with other components is likely to be at least as important as the M-300's inherent sound quality. This amp is not particularly forgiving. As already mentioned, it is wasted on a speaker that is not exceptionally well integrated and that is unable to reproduce every nuance of the upper midrange and treble. You may wish to consult *The Best of Audio '88* for my prejudices regarding the world's best speakers, but I strongly suggest that you listen very carefully to how the M-300 interfaces with the particular speaker with which you intend to use it.

No amplifier is a universal match for all speakers, and the best high-end speakers seem particularly prone to interact in different ways with different power amplifiers. Further, I have found, at my own expense, that the prominence of this interaction can vary from one listening room to another, since so much bass performance is room dependent—as is the proportion of reflected sound at all frequencies heard at the listening position.

The M-300 also does not perform at its best with preamps that do not match its emphasis on apparent speed and transparency. This includes many preamps from competing manufacturers. With the exception of the latest top-of-the-line Krell and Spectral preamps, I found that my efforts to blend the M-300 with transistor preamps tended to combine two different sets of sound characteristics in a way that resulted in a slight, but still significant, amount of information loss.

I got excellent results with Audio Research preamplifiers, however, using the settings that put the absolute minimum of controls and active gain stages in the signal path. This was particularly apparent with their SP11, which has a great many options for eliminating controls and gain stages, although it was a bit annoying to find that the combination sounded best with the balance control switched out of the circuit.

The best performance of all came when I fed CD players directly into the M-300, set loudness and balance with the amp gain controls, and used either the Adcom SLC-505 or The Mod Squad Line Drive passive "preamps" with short ultralow-capacitance interconnects. I did have gain problems in using some CD players with these passive preamps, and I obviously could not use a turntable. Nevertheless, under ideal conditions, a relatively inexpensive passive preamp like the Adcom SLC-505 provided a purer and more coherent signal, with less upper midrange emphasis, than the SP11. This is a considerable compliment to the M-300 since few amplifiers could reveal coloration in one of the world's best active preamplifiers.

These compatibility and interface problems also affect the M-300's soundstage, and some aspects of this are constants. The M-300 always has excellent imaging, a slightly forward apparent listening position, and very good though not outstanding depth. Like many mono amplifiers, this one reveals a very wide soundstage, although it is one that tends to produce a "hole in the middle" effect in some stereo recordings. I found that I had to move most of the speakers I tried slightly closer together than usual to get the proper central focus.

One simple punch line emerges from all of the above complexities: The Audio Research M-300 is a superb power amplifier! I hope, however, that this review will also convert a few heathens to the sport of "high end." I realize that the foregoing description of my efforts to obtain a personal best out of the M-300 may seem as dull to some readers as listening to a camera buff discuss lenses. For a precious few, however, it will be their introduction to a game that can be almost as enjoyable as listening to music.

Anthony H. Cordesman

(*Editor's Note:* At press time, Audio Research told us that the M-300 has been replaced by the M-300 Mk. II, for $5,495. This will have a five-position attenuator switch in place of the tested unit's input level control, a new capacitor network in the output stage, and a different front panel and top cover.)

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Warner Bros. 25750-1, LP.

Sound: B Performance: A–

This is a season for regrouping a lot of old favorites (Deep Purple, The Doobie Brothers) and for the returns of Patti Smith and Gary Wright, among others. Add to that list Little Feat. I felt antsy about all of it. There just seem to be so many ways that projects like this one can really disappoint. But taking the time to get close to *Let It Roll* has eased my anxiety and erased my doubts. From the very first note, there can be no doubt that this band plays and sounds like the Little Feat of blessed memory.

Still, at this point there are questions that must be answered. First, do their songs make it? Second, and most important, can the band survive the shadow of Lowell George? After one listen, I could do no more than give a tentative yes to the first question. After three, I upgraded that to an enthusiastic yes and added a yes to the second—at first begrudgingly, and then with whole heart.

There isn't a single bad cut on the album. The opener, "Hate to Lose Your Lovin'," features Bonnie Raitt adding vocals to the stew just as she did on *Dixie Chicken*. It's a grand song. "One Clear Moment" follows with an upbeat "Time Loves a Hero" kind of groove. Then comes "Cajun Girl," the song that finally melted my cold, cold heart and got me all the way behind the album. On this one, new recruit Craig Fuller's button accordion—a new texture in the Little Feat firmament—propels the song like an Atlas booster to make it irresistibly happy. "Hangin' On to the Good Times" and "Listen to Your Heart" complete an excellent first side.

"Let It Roll" starts off side two with an open-throttle, horn-powered rocker. "Long Time Till I Get Over You" is a funkier slice that lets Paul Barrère sing in his best, most soulful style. "Business as Usual" keeps up the bubbling pace, followed by "Changin' Luck," one of those Feat songs with a percolating, meandering melody line that suddenly resolves into a refrain strong enough to imbed itself into your genetic code. "Voices on the Wind," the finale, adds Linda Ronstadt's pretty singing to an aching song that is the saddest one here. It is nicely placed as the album's coda.

Lowell George's big, big shoes are well filled by guitarist Fred Tackett (who has played with the band sporadically over the years and has written several Feat songs) and Pure Prairie League alumnus Craig Fuller as a vocalist/accordionist/guitarist. Bill Payne, Paul Barrère, Kenny Gradney, Richard Hayward, and Sam Clayton all take part in the band's revival. Long-time associate and producer George Massenburg again helms the project with the necessary steady hand. (Payne coproduced *Let It Roll*.) And what Little Feat album would feel complete without a painting by Neon Park on the cover?

Naturally, the album is dedicated to Lowell George. It had to be. Rest assured, Feat fetishists, *Let It Roll* is no smarmy attempt to cash in on a revered name. It is a worthy addition to the canon of a band that, though beloved by many, still sold far too few records. Ironically, it would be no surprise to me if *Let It Roll* proved to be Little Feat's commercial breakthrough. They have played faithfully to their own heritage. Maybe by this time, everybody else will have caught up.

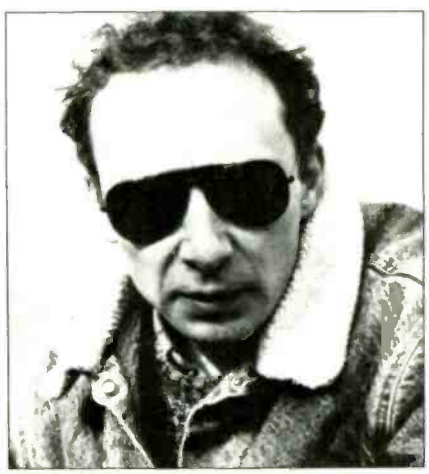
Michael Tearson

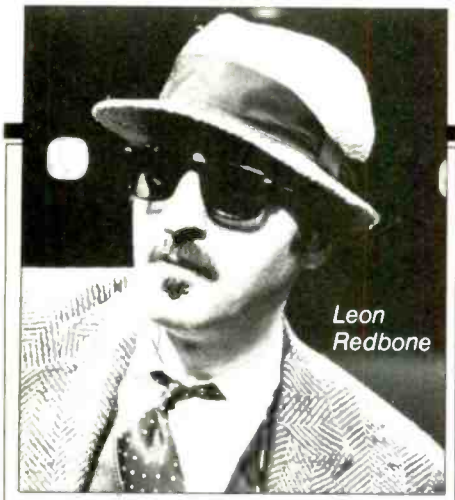
The Mona Lisa's Sister: Graham Parker
RCA 8316-2-R, CD.

Sound: B+ Performance: B+

Graham Parker sounds spiteful again on *The Mona Lisa's Sister*, and that is good news for the rest of us. When he is too happy, his muse doesn't deliver as well.

Here, his band includes two key members of his original band, the Rumour—bassist Andrew Bodnar and lead guitarist Brinsley Schwartz, who





coproduced the album with Parker. The sound is sparse, with a strong emphasis on Parker's acoustic rhythm guitar and Bodnar's bass, which in turn puts added emphasis on the singer. Accordingly, Graham sings with his most focused delivery, especially on the slow songs like "I'm Just Your Man," in which he lets real vulnerability shine through, and the lilting, playful reggae of "The Girl Isn't Ready." Still, my favorites are such spitfires as "Don't Let It Break You Down," "Get Started, Start a Fire," "Under the Mask of Happiness," and "OK Hieronymus," which was inspired by Bosch's infamous triptych, "The Garden of Earthly Delights." Wearing his influences on his sleeve, Parker closes this album with a cover of Sam Cooke's "Cupid" that is nice, if extraneous.

Happily, *The Mona Lisa's Sister* is the best album Graham Parker has made since his early days on Arista, back at the beginning of the '80s. After several biteless, rather tepid records, it is good to have him back in top form.

I must recommend listening to the CD because the acoustic elements, which are so important to the record, are rendered so much more crisply, separation is so much better defined, and the bite in Parker's voice is so much keener. *Michael Tearson*

No Regrets: Leon Redbone
Sugar Hill SH-3761, LP. (Available from Sugar Hill, P.O. Box 4040, Duke Station, Durham, N.C. 27706.)

Sound: B+ Performance: B+

Dapper in white suit, fedora, and walking stick, Leon Redbone continues his career of caricaturing early, popular American music forms with *No Regrets*, this time turning his eccentric vision to country/country-swing.

With bluesy, nasal vocals sounding a bit like they're sung while chawing a plug of tobacco, Redbone cuts loose on a variety of bittersweet standards and *obscuranta* including Hank Williams' "Long Gone Lonesome Blues" (complete with yodel!), Ernest Tubb's "It's a Lonely World" and "You Nearly Lose Your Mind," Jimmy Rodgers' "My Good Gal's Gone Blues" plus the plaintive ballad "Crazy Arms," and the funkily nostalgic "Somewhere Down Below the Dixon Line." On the classic "Are You Lonesome Tonight," Redbone pulls out the plug to evoke the '30s with throaty crooning that's as smooth as can be.

Although backed by crackerjack musicians such as Mark O'Connor, Jerry Douglas, and Bela Fleck, Redbone has kept his arrangements sparse, simple, and in the background, giving this a folksy, mainly acoustic feel, with his quirky vocals dominating the mix. This lends an old-time air to music which was often fairly highly "produced" in the original recorded versions.

As with all good caricatures, *No Regrets* walks a fine line between believable re-creation and humorous distortion of its inspiration. If you're a country or folk fan, you'll probably enjoy the camp, Keilloresque perspective that Redbone brings to these antique chestnuts. If you're a Leon Redbone fan, you'll find him in slightly slower paced, yet excellent form.

Michael Wright

Live 1980/86: Joe Jackson
A&M SP-6706, two LPs.

Sound: B Performance: A–

Live albums usually bore me. Most often they are greatest-hits collections,


Joe Jackson

Live 1980/86 shows how songs evolve through the chemistry of live concerts and how the passage of time has affected Joe Jackson's performances.

played faster and muddier than the originals, and usually they are not as well recorded as the studio sessions. But for his live album, Joe Jackson has done something really unique. Each side of this two-record set comes from a different tour with different personnel and instrumental lineups. Thus, *Live 1980/86* communicates time's passage and how it has affected Jackson's performance ideas. Jackson's intent is to show how songs can evolve through the chemistry of live performance.

Nothing demonstrates this evolution more clearly than the three versions of "Is She Really Going Out with Him?" This perennial crowd pleaser gets the rock treatment from the original Joe Jackson Band on its final go-round during the 1980 "Beat Crazy" tour. For the '82-'83 "Night and Day" tour, the song became an a cappella number, and on the 1984 "Body and Soul" tour, it was accompanied by a weird and funny acoustic arrangement.

On this album, you get a strong sense of Jackson's restlessness, which is ever prompting him to challenge his audience to go with him to places they hadn't even considered. Indeed, *Live 1980/86* is generously loaded with intimate, spontaneous moments of artist/audience sharing.

Recording quality is very nice, with plenty of concert-hall ambience and that little bit of extra distance that usually comes with remote recording. The performances translate beautifully, and Jackson's peculiar love/hate relationship with touring becomes quite clear.

As hoped, this album does emerge as a document of Jackson's evolution as a performer, writer, and bandleader. It covers the many different phases of his career, from angry young rocker experimenting with world rhythms to a very sophisticated, worldly artist. It is more than just a rehash of studio recordings, because Jackson regularly takes his songs into places the originals didn't have a chance to go. *This* is what live albums should attempt to be and, unfortunately, usually are not.

For completists, the nearly two-hour concert video, *Tokyo '86*, released simultaneously with the album, includes a bonus CD-3 with several selections not included here. In all, *Live 1980/86* is a more than generous project—at over 100 minutes, it has to be—that should quench the thirst of anyone who's ever loved a Joe Jackson song.

Michael Tearson

Goodbye Blue Sky: Godley & Creme
Polygram 835 348-1, LP.

Sound: C Performance: A–

If the apocalypse is anything like Godley & Creme envision, we'll all be dancin' and singin' and kickin' up our heels and our hells. Sing hallelujah, brothers and sisters! Judgment Day is coming and it's bringing along harmonicas!

Godley & Creme's new album, a doo-wop and gospel-tinged romp about the end of the world, is simply heavenly and as visual as hell!

Kevin Godley and Lol Creme's seventh album as a duo is a doo-wop and gospel-tinged romp about the end of the world. As they sing it, it shore is purty. Imagine a Salvador Dali cartoon of benign grotesqueries wandering around, wondering just what the hell happened, as harlequins float by singing harmony on invisible street corners. Using (so they brag) a low-tech 16-track recorder and (though I'm doubtful) no synthesizers, Godley & Creme have cobbled together an updated doo-wop album that's a lot less self-conscious than Billy Joel's *An Innocent Man*.

They clue you in on the joke right away, with a gooey a cappella number called "H.E.A.V.E.N." As it segues into the lovely, calypso-inflected "A Little Piece of Heaven," you begin to sense a dichotomy between "heaven" as a metaphor and as a literal concept. Literalness descends with "10,000 Angels," a rousing, apocalyptic cowboy song. Oh, you should see it: 10,000 angels playing gold guitars, chased by 10,000 devils, as the music swells from surreal Max Fleischer/Betty Boop cartoon-danger sounds up to a rampaging gospel rave-up. Seriously wacky.

There are a couple of sidelong excursions into the kind of personal regrets I suppose we all face when disaster walks up to us and says howdy: "Golden Rings," a sweetly bitter, vindictive song about an ex-wife, done up with terrific background vocal counterpoint and harmony, and the bland "Sweet Memory." But mostly we're talking Nuke and Improved: "Crime and Punishment," a ditty about God's wrath, using the album's trademark harmonica sound like a dark rhythmic spear poking through the underbrush ahead, and "Air Force One," a reminder that in the event of a real emergency, no one here gets out alive. (I mean lush, four-part harmony to the lyric "bomb on board"!)

The melodies never stray much outside their prescribed boundaries, and "The Last Page of History" is a grating cacophony, but the music overall is sweet and the lyrics heartfelt (a bit marred on my copy from the occasional pops and crackles). The same impulses that make Godley & Creme such grand rock-video directors make their album as visual as hell—make that as visual as Hell. If no one turns *Goodbye Blue Sky* into the West End musical that it is, then God is not in his h.e.a.v.e.n. *Frank Lovece*

Dylan's *Down in the Groove* has some good moments, but overall it sounds like it was made by a guy whose engine was low on steam.

Down in the Groove: Bob Dylan
Columbia OC 40957, LP.

Sound: B Performance: B

Unlike most Bob Dylan records, *Down in the Groove* is not a consistent set of songs from a series of related sessions but a mish-mosh of recordings from a period spanning several years and featuring a host of musicians. All of this follows a six-month postponement of its release and rumors that Dylan was doing: A record of other people's songs, an album with The Grateful Dead, or a bluesy record with Keith Richards' drummer, Steve Jordan. If the truth be known, this album is more or less a compilation of all of these projects.

Two tracks were written by The Dead's wordsmith, Robert Hunter. One, "Silvio," features Jerry Garcia, Bob Weir, and Brent Mydland (of The Dead) on backing vocals and L.A. session kings Nathan East and Mike Baird on instrumental backing. The other, "Ugliest Girl in the World," stands as the best-conceived and best-played track on the record. Here, Dylan is backed by Jordan, guitarist Danny Kortchmar, and bassist Randy Jackson. It's a song full of fire and humor. Other cuts include the previously released "Had a Dream About You, Baby," with Eric Clapton and Ron Wood, and "Death Is Not the End," an outtake from the *Infidels* album, which features the Mark Knopfler/Sly Dunbar/Robbie Shakespeare axis sweetened by the background vocals of Full Force. Wilbert Harrison's "Let's Stick Together" and Arthur Alexander's "Sally Sue Brown" (here, Dylan is supported by ex-Sex Pistol Steve Jones, Paul Simonon of The Clash, and Myron Grombacher of Pat Benatar's band) stand out as the two songs which seem to have some life to them. All the others on this record are a bit on the melancholy side.

There are some well-advised moments here, but even in all fairness to Dylan, at least half of this album sounds like it was made by a guy whose engine is low on steam. The fact that Dylan wasn't satisfied going into the studio with one set of musicians to complete *Down in the Groove* is itself a pretty good indication that this album is a patch job. Although some of the patchwork does help hold this collection together, it never really sails like *Infidels*. It is, however, much more listenable and memorable than *Empire Burlesque*.

There's a grand chasm between Bob Dylan's aesthetic ambitions and his recent execution. We can only hope that soon he'll find the musical support to inspire him to write a whole album's worth of new songs. Until then, we'll just have to make due with interim albums like this. *Down in the Groove* seems more like light entertainment than a serious statement.

Jon & Sally Tiven

Living Colour is a creature unusual: A group of four young black men who play loud, brash, politically astute rock 'n' roll.

Vivid: Living Colour
Epic EK 44099, CD

Sound: B+ Performance: A

Every now and then, about as often as that proverbial blue moon rises in the evening sky, executives at major record labels come out of hibernation long enough to sit down and sign an interesting group. Just such a group is guitarist Vernon Reid's bombastic music revue, Living Colour—a tribute to American music at its best.

Living Colour is a creature unusual: Four young black men who play loud, brash, politically astute rock 'n' roll. (This is music record labels aren't tripping over themselves to release.) Their music is high-grade ear fuel—a hybrid which might have sprouted to life if a musical experiment had been conducted by Jimi Hendrix, George Clinton, and Talking Heads. Lots of power and movement. Instrumentation is basic—bass, drums, guitar, and vocals—and played with funk-filled, frenetic intensity. But while it's true the guitar amps are cranked up to create sustain and distortion, this is not head-banging music. This is innerspace punk/funk, American style.

Some of the 11 songs are segued together with lines from political speeches made popular by, among others, Winston Churchill and John F. Kennedy. This technique adds strength and continuity to the album—especially when a song takes a slight sociopolitical turn. And despite an occasional trite lyric, there are some messages here. The final song on the CD is "Which Way to America?", the first verse of which relates, "I look at the TV, your America's doing well/I look out the window, my America's catching hell . . . ." The chorus continues: "I just want to know which way do I go to get to your America?"

Most of the tracks were produced by veteran engineer Ed Stasium, but Mick Jagger produced two, on one of which, "Glamour Boys," he also sang background vocals. The sonic quality is very good—perhaps too good for those who might find crunching guitars, captured in the digital domain, a bit much. This is true particularly on this CD, where the players and Stasium have opted for a bright, upfront, guitar-oriented mix.

Vivid is not going to be everyone's favorite; it's (gratefully) too far left of center for that. But it is well played and thoughtfully made, proving that intelligent rock 'n' roll is still out there, looking for a home. *Hector G. La Torre*

HARPIN' ON THE BLUES

Extra Napkins: James Harman Band **Rivera RR505,** LP. (Available from Rivera Records, P.O. Box 1848, Orange, Cal. 92668.)

Sound: B Performance: B

James Harman has licks worth stealing, and there's no higher compliment you can pay a young blues harp player. With the death of Big Walter Horton, the art of blues harmonica seemingly plunged into decline. Today's harp players appear to be intimidated by the banks of amps behind the guitarists, content to recycle classic riffs from the fringes of the stage. Not our boy James. On the leadoff track, "It's Alright Now," he immediately grabs the spotlight, his harp echoing his vocals and challenging the guitar. He's got the chops to do it, too. His solo is a dazzling display of amplified Chicago harp that should inspire followers and send much of the competition back to the woodshed. Harman at once keeps faith with the old masters and proves he's his own man—all in 3:43.

Extra Napkins, produced over a period of months with changing personnel, features Harman easily switching from one style to another and emulating many of the great harmonica players on various cuts: Sonny Boy Williamson ("All Night Boogie"), Rice Miller ("Sad to be Alone"), and Big Walter Horton ("Rambler's Blues"). Yet Harman has the greatest affinity for Little Walter Jacobs, as he proves on the title track. Harman describes the cut in the liner notes as "one of them 1949-51, back room of a record store, on a Wollensack tape recorder kind of records, like Little Walter, when he was 18 years old." He's right on the money. "Extra Napkins" is a rip-roaring, nonstop instrumental that cements Harman's reputation as a musician to watch.

Harman's band has spent as much time listening to old 45s as he has. The guitar interplay between the late Hollywood Fats and Kid Ramos reminds listeners that Chicago rhythm players were rarely satisfied with mere chording, preferring to play a simple pattern in a lower register than the lead guitar. The result is a rare density which is characteristic of deep blues. *Extra Napkins* assures that the future of the blues harp is in capable hands. The album comes with a postcard for joining Harman's fan club. Send it in—I already did.

Roy Greenberg

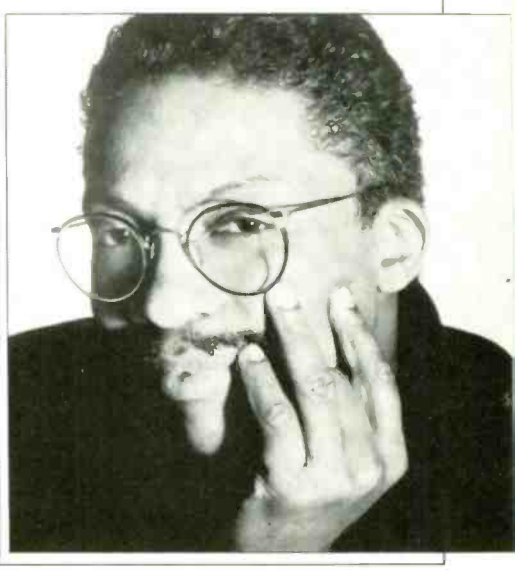
Perfect Machine: Herbie Hancock **Columbia CK 40025,** CD

Sound: A Performance: B

Herbie Hancock's recent releases could be utilized as primers in electronic music. If a listener ever wanted to know what can be done with electronic instruments, Hancock has got the answer. He mates keyboards, samplers, drum machines, and computers via MIDI. MIDI, an acronym for Musical Instrument Digital Interface, is a means by which electronic instruments can communicate with each other in a "master-slave(s)" relationship. The process enables several keyboards—and other instruments—to play simultaneously. Using a keyboard instrument or drum machine, notes are put into a computer or dedicated sequencer in much the same manner letter characters are put into a computer programmed for word processing. The notes then can be slightly or drastically edited, stored, and played back at the press of a button. *Voilà*—one-person orchestras! This musical approach has brought Herbie Hancock a new-found popularity over the past few years, especially with the 1983 release of *Future Shock*.

The musical formula on Herbie Hancock's latest, *Perfect Machine*, is similar to that of past releases: A high-tech mixture of jazz, funk, and rock. (Even the vocals are processed through electronic hardware called vocoders.) There are repetitive patterns framing all six compositions, but they are kept interesting by a constant flow of changing tones and textures.

There is a clever mix of past and present on this CD. High-tech music is used as a backdrop for traditionally



Photograph: Frank Driggs Collection

based R&B vocals by Sugarfoot (Ohio Players) and Bootsy Collins (Bootsy's Rubber Band). "Maiden Voyage/P.Bop" is a combination of new and old intertwined. The new part is "P.Bop," while the old is Hancock's rearranged version of his Blue Note Records' classic, "Maiden Voyage." Traditionalists will begin to enjoy *Perfect Machine* more with this track and the final one, "Chemical Residue," because these compositions rely more on melodic lines.

The CD exhibits excellent fidelity. Interestingly, while the CD case states that the recording is "DDD" (digitally recorded, mixed, and mastered), the tracking sessions were actually recorded on a Studer A80 analog multitrack as well as on a "veteran" Ampex MM-1200 warhorse analog multi-track. Mixing was done on the Sony 3402 digital two-track recorder. Production was handled by Bill Laswell of Celluloid Records fame and recorded by Robert Musso, an engineer who often works with Laswell and who is very well versed in electronic music.

Perfect Machine is a clever combination of old and new. It has a lot to offer dance-music aficionados and those generally into the groove, but it also fills the bill for those looking for a taste of melody with their funk. Some listeners may find the tracks somewhat tiring in their seeming repetitiveness, because the tracks are musically and sonically dense. If you really pay attention, though, you will find something new with each successive listen.

Hector G. La Torre

The Erroll Garner Collection•1: Easy to Love
EmArcy 832 994-1, LP.

Sound: B+ Performance: B+

Pianist Erroll Garner was an immensely popular music figure and a prolific recording artist for more than 20 years, until his death in 1977. His best-known composition, "Misty," remains one of ASCAP's most performed standards of the past decade, and his recordings for both Mercury and Columbia are being remastered and reissued for the digital '80s.

Garner, who could neither read nor write music, was a totally instinctive player and, in many ways, could be considered the quintessential jazz performer. His style was one of elemental spontaneity, graced with personable good humor. The interplay between left and right hand, which he used with rare rhythmic freedom, frequently interpolated witty quotations from other melodies and could be patently kaleidoscopic within and around a compositional structure.

Therein lies the key to Garner's genius and acclaim. Audiences appreciated his live performances as much for the entertainment aspect as they did for his display of natural musical dexterity. An enormous concert and nightclub draw during his long career, Garner and his music were synonymous with a good time.

Continuing their auspicious resurrection of important jazz and vocal works, Polygram (EmArcy's distributor) has begun to make available for worldwide release some of Garner's hitherto unissued recordings. *Easy to Love* is the first in this series, called "The Erroll Garner Collection." The nine titles on this LP date mainly from July and August 1961, with a couple of cuts from June 1964, and one, "For All We Know," from 1965. Despite the lapse of more than four years, there is no immediate disparity noticeable in the sound quality.

Garner brought to his studio work the same kind of exuberance which he exhibited in his on-stage appearances, and he almost always preferred that the first take be used for the master. Most of these tunes will be familiar, but in Garner's hands, accompanied by his longtime musical cohorts bassist Eddie Calhoun and drummer Kelly Martin, even old chestnuts like "Somebody Loves Me" and "My Blue Heaven" have his characteristic liveliness.

This album offers more than a fond memento of Erroll Garner's very special talent. If you're unfamiliar with his unique ability, here is a good place to start. The rewards of the discovery will enchant you, for much of Garner's music is . . . easy to love. *Michael Aldred*

Rockin' the Boat: The William Clarke Blues Band
Rivera RR-503, LP. (Available from Rivera Records, P.O. Box 1848, Orange, Cal. 92668.)

Sound: B– Performance: B–

Democracy may be the best way to run a country, but it wreaks havoc on blues bands. Case in point: *Rockin' the Boat*, the new album from The William Clarke Blues Band. Clarke, a protégé of the late, underappreciated George Smith, has been drawing rave notices for his rocking, muscular harp at a time when harp players are in short supply. So, with hordes of blues fans waiting for him to cut loose and wail on this live set, what happens? The solos are evenly divided with his band members, whose work is unexceptional. Clarke

The Jazz Warriors have created an exciting live recording with this LP. The arrangements are as tight as the solos are free.

concentrates his own efforts on the chromatic harmonica, an unwieldy variant of regular harp on which no performer has sounded truly comfortable since the late Little Walter Jacobs. Throw in his mediocre vocals, and *Rockin' the Boat* adds up to little more than an appetizer for the definitive William Clarke LP still to come.

Roy Greenberg

Out of Many, One People: The Jazz Warriors
Antilles/New Directions 90681-1, LP.

Sound: B Performance: B+

Leave it to the British to take American music and sell it back to us in a new package. This time it's not blue-eyed soul singers or long-haired blues guitarists but black jazz players. England is experiencing a jazz revival, which might make you wonder if there was anything to revive. Although many brilliant jazz players have come from the Isles, especially on the avant-garde fringes, there was never an important, purely British jazz sound.

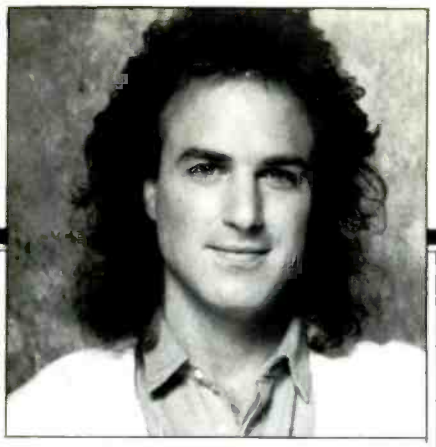
The Jazz Warriors share much with the mid-'60s American jazz that sprang from the political/spiritual forays of John Coltrane, The Art Ensemble of Chicago, Sun Ra, and the orchestrations of George Russell. "In Reference to Our Forefathers' Fathers' Dreams" even has a spoken introduction of African ancestry that would've been perfectly in place on a socially conscious jazz record from 1967.

A 20-piece ensemble, The Jazz Warriors showcase many young players and a few veterans. Their battle cry is sung by saxophonist Courtney Pine, the Wynton Marsalis of British jazz and the torch-bearer of a new spirit. His solo album showed promise, but on this live recording, Pine and The Jazz Warriors reach fulfillment.

Out of Many, One People brims with deft rhythm and mood changes. After the gurgling meditation of "Warriors," the album leaps into "In Reference to Our Forefathers' Fathers' Dreams." The rhythm churns through interlocking solo and ensemble passages, one emerging from the other. Pine shows he's the star with a spiralling soprano sax solo that darts through the rhythm and horn passages.

Fayez Virji's composition, "Minor Groove," combines polyrhythmic percussion with a straight-ahead bop drive that seems to spit soloists out and then swallow them whole. Trumpeter Kevin Robinson and vocalist Cleveland Watkiss engage in an amusing duet which gives way to Philip Bent's earthy flute solo. Bent manages to be gutsy without overblowing, a difficult feat on flute.

Side two is less successful, but exciting nevertheless. "Saint Maurice (of



Kilimanjaro, featuring Russ Freeman, is a breezy foray into contemporary fusion. There really isn't a bad song on this record.

Aragon)" is a furious, hard-driving big-band stomp that's hampered by tepid solos from guitarist Alan Weekes and pianist Adrian Reid. Yet the adroit ensemble passages carry the piece. "Many Pauses," on the other hand, lives by its soloists, with 10 individual performances in less than 17 minutes. Written by one of the veterans of British jazz, trumpeter Harry Beckett, it manages to hold together despite going from the echo-delayed flute solo of Bent to the cool bop of trumpeter Robinson to Middle Eastern exotica from altoist Brian Edwards to a Latin dance by tenor saxophonist Ray Carless and so on. Drummer Mark Mondesir proves resourceful, supplying the right rhythm for every mood shift.

The Jazz Warriors have created an exciting document; the arrangements are as tight as the solos are free. This live recording captures the full presence of their sound, from the twin double-basses to the percussive colors.

John Diliberto

Kilimanjaro: Rippingtons featuring Russ Freeman
Passport Jazz PJ88042, LP; **PJCD88042,** CD.

Sound: A– Performance: A–

Squeaky clean and highly polished, the all-instrumental *Kilimanjaro* is a breezy foray into contemporary fusion that crosses over into pop (even making a pop-chart appearance).

Just *who* the Rippingtons are is a mystery, since the only constant here is Russ Freeman. He did almost all the songwriting, arranging, and producing; played guitar synths, keyboards, and acoustic, classical, and electric guitars, and programmed keyboards and a Linn 9000. Freeman's versatility is overpowering. His guitar chops range from mellow slink ("Morrocco"), to nylon finger-style à la Earl Klugh ("Northern Lights"), to phased funk ("Backstabbers"), to speedy rock riffola ("Dream of the Sirens"). There really isn't a bad song on this record, although "Los Cabos" and "Love Notes" get a little predictable in a fusion sort of way.

As it turns out, the Rippingtons include excellent performances by such luminaries as saxist Brandon Fields, bassist Jimmy Johnson, and drummers Vinnie Colaiuta and Tony Morales.

Sonically, Freeman has gone for a tight mix that is fairly close to each channel, which results in a big, full sound. Both CD and LP were very quiet, and the music reproduced very well.

As a solo tour de force, *Kilimanjaro* by the Rippingtons featuring Russ Freeman is impressive and sports a nice variety. Maybe next time it'll be Russ Freeman featuring the Rippingtons. . . .

Michael Wright

BON MOTETS

Illustration: Rick Tulka

Lully: Petits Motets. Les Arts Florissants, William Christie.
Harmonia Mundi HMC 901274, CD.

This is a charming CD of short and lively church pieces by the famed 17th-century composer Lully, who came out of Italy but sounds, to our ears, as French as Handel sounds English. Lully's work is what might now be called middle Baroque, considerably before Bach, Vivaldi, et al. The small pieces, mainly for three voices with modest continuo accompaniment (organ and plucked string instruments, with an occasional violin), were definitely not for the hoi polloi, the common people. More likely, they were for performance at one of the exalted and high-style nunneries which existed in France around the great court of the Sun King at Versailles; perhaps the motets were performed by the ladies themselves. There is a baritone involved—no impiety!—also, briefly, two tenors. But the ladies dominate the music throughout.

The female vocals are perhaps a new sound for many of us, and a lovely one, once the ears adjust—very French, small, light, clear, and accurate. The men's voices match, and the gentle organ provides a low bass line and harmony that balance the higher music. It is beautifully written music.

But best of all here is the performing style, creditable to the glaringly non-French name of William Christie, the director and organist. For once, there is lilt and rhythm and dance, irresistible, behind the formal Latin texts of the church. Why not? Only in recent times has church music turned solemn. Christie's "Flowering Arts" group operates with French government support in south-central France, not far from the Harmonia Mundi label's headquarters at Arles, near the Mediterranean coast. Christie has discovered—or comes by instinctively—a profound rule ignored by far too many musicians: The changes in time within a piece, especially in older music like this, *should share a common pulse* for a rhythmic drive and continuity that hugely strengthen the impact. This principle holds true even for such as Brahms, and we recognize it, carefully written out in the score, in Stravinsky's foot-tapping beat through all sorts of time changes. This innate sense of rhythm makes a vast difference in these works, as you will quickly begin to hear, and the same goes for the nice contrasts of tempi between the different movements and motets.

The singing is dedicated and persuasive, if gentle, and there is plenty of variety, text by text, in spite of the similar sound throughout. Very nice, for instance, are the enthusiastically repeated alleluia (hallelujah! in English) and gloria, and the real pathos of the more serious texts.

This, keep in mind, was music to rekindle and reinforce Catholic tradition in the face of the Protestant revolt. It had a mission, to persuade, and that mission was strictly in terms of music. It should persuade almost anybody, in this performance.

Edward Tatnall Canby

Eclectic Clarinets: Eugene Marquis **Grenadilla Records 87015,** LP. (Available from Grenadilla Records, P.O. Box 19864, Cincinnati, Ohio 45219.)

Multiple clarinets? On this recording we get as many as 23 of them, and not sequentially, either. Eugene Marquis is the proverbial one-man band, carried to a semi-modern extreme. Except for the last item on side two, where the rhythm section makes its only appearance (with Marquis on five saxes and and E-flat clarinet), the entire recording is made up of overdubbed clarinet tracks. Works include the Mozart orchestral overture to "The Marriage of Figaro," a couple of Bach items (organ and cantata), a "Serenade" by Richard Strauss, and, among the pop selections on side two, an unlikely Debussy "Sarabande" for piano. Multi-track witchery melds it together, complete.

Some of us remember Les Paul, who began all this multi-track stuff many a year ago. The overdub technique is now elderly and, though still essential to almost all pop music, has more or less run its course. Nobody is ever surprised by it any more. Digital, of course, comes as the ultimate tool in the multi-track art, replacing mere copies with precise clones, clone after clone to the nth generation, but I assume that Eugene Marquis' work, extending back for some three years of extraordinary effort, has been done mostly in state-of-the-art analog.

So—all this, to what result? Sorry not to be able to enthuse, although I found it interesting. First, clarinets, dubbed or otherwise, do not mix at all well (though, oddly, saxes do much better).

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On *Eclectic Clarinets*, we get as many as 23 of them, as Eugene Marquis carries the proverbial one-man band to a semi-modern extreme.

The special and wonderful nasal sound of the instrument becomes snarling and metallic when multiplied by itself. Orchestral Mozart transcribed for an all-clarinet ensemble—high, medium, and low—is unlistenable, except perhaps for clarinet specialists. Bach is not much different, though an intelligent try at "scoring" the clarinets in the manner of a Bach organ does help. And Debussy's "Sarabande," uncomfortably lodged on the pop side of this LP, is a travesty of a great work. The liquid, watery tones of his remarkable piano sound are turned into an almost meaningless set of honks and metallic scrapings. It just doesn't work.

The pop music is decidedly better. There, the music is arranged in a more natural fashion, since pop generally uses less string and more wind and percussion than the classics. In addition, there is very little room sound or ambience, just fine for pop music but definitely deadening in effect for the classical items here—especially, of course, the organ music.

The copying or mixing-down, whatever you choose to call it, is perfection. These "ensembles" play more accurately together than most live musicians! Considering that each separate part had to be recorded on its own, against other sounds in earphones, this is surely a technical miracle. You'd never know. The recording, digital or not, is of the highest tech, and any snarling or other unsuitable sounds (as I hear them) are simply the musical product of the arrangements. I expect that the record would sound very much the same to our ears if each clarinet, or sax, had an individual player in real time.

I quake at the thought of how much all this has cost Eugene Marquis, who has done the project on his own! But the cash must be there—the product is offered in all three formats.

Edward Tatnall Canby

Sibelius: Symphony No. 2. The Royal Philharmonic Orchestra, Sir John Barbirolli.

Chesky CR3, LP. (Available from Chesky Records, P.O. Box 1268, New York, N.Y. 10101.)

The only info as to recording that is provided for this really superb LP is

Sibelius' Symphony No. 2 has never been better served than on this Chesky release. It's close to a definitive recording on all counts.

that it was "reproduced from the original master tape," which is not exactly enough to satisfy my curiosity! More on dates and mikes, please, Chesky; with results like this, you have absolutely nothing to lose.

Sir John Barbirolli is remembered by some Americans as the rather wimpy and colorless conductor who led the New York Philharmonic for a few unnotable years, long ago. Curiously, though, his European reputation was already high and continued to grow, as witness the "Sir" attached. It should be added that England has always worshipped Sibelius—in the earlier years, he was thought of as the greatest composer of the century. We over here liked the old boy too, but after the '30s, he fell off in our favor: Too old-fashioned in the sound. Well, Sibelius is definitely back. His sound is now consonant with much of the neo-Romantic stuff that goes on today, and there are aspects of his symphonic construction that turn out to be surprisingly up to date.

This is an exemplary LP in several respects. Direct-metal cutting has allowed closer grooves without any compression or other signal processing. Thus, you will find a recent rarity: Wide, blank bands of vinyl on the inside of both faces, for better sound. But the timing is not overly short—15 minutes on side one, around 20 on side two. The recording itself is musically excellent and sonically clean, and also remarkably quiet. (Sibelius is always good for anybody's well-placed mikes.) And do I seem to hear a hint of wide-spaced stereo, with a good deal of interesting out-of-phase impact? Just a guess.

The music has never been better served, even if Sir John is a bit on the emotionally conservative side—which does no harm at all to this flamboyant music! I'd call it close to a definitive recording on all counts.

Edward Tatnall Canby

Monteverdi: 18 Madrigals from the Second Madrigal Book. Collegium Vocale Köln, Wolfgang Fromme. **CBS IM 42131,** LP.

Claudio Monteverdi was one of those rare "originals" who shaped the future while playing to the present. He

The Collegium Vocale Köln is the right group to sing Monteverdi madrigals. Their voices are well blended but not too chaste and skinny.

was the first really big opera composer, but his important work (some of us think) was in the eight published books of madrigals issued periodically over a long time span. They began—when Monteverdi was in his early 20s—with this second book, following a first book composed as a teenager. These are madrigals more or less as then was expected: Short but concentrated part songs, five voices, largely set to the poetry of famous Italians of the day and earlier (as we set Shakespeare and Whitman, or perhaps e.e. cummings). But already in the second book, there are new things that we can recognize as the beginnings of much in later music. By the time Monteverdi reached his eighth book, the "madrigals" included large works with instruments and orchestra, incipient opera, cantata, and even a number of instrumental segments like so many Baroque concertos.

Only the Germans and the English, plus a very few resolute Americans who avoid our standard vocal training for loud music in large places, can sing these madrigals with any sort of listenable effect. Big, unblending voices ruin them. This German group is of the right sort, well blended but not too chaste and skinny sounding. They sing out when the emotion is strong, as it often is, but the blend stays good. Their main fault is a sometimes rather slow pace and, inevitably, the lack of a strong and pointed Italian diction. The German heritage is just too much for that!

So why not use Italian singers? That effervescent nation does not export much of its own historic music, the great Italian operas excepted. Music such as these madrigals by Monteverdi is not for a batch of Enrico Carusos, high and low!

I note an interesting audio facet of this digital recording made in a German Evangelical church in Paris. The sound is taken down in "real-phase" stereo. This should mean that, instead of the usual one-point dual stereo microphones (directional but in phase), the sound is heard from separated mikes to provide the out-of-phase information that is the best part of stereo concert ambience. Not much danger of bass overload in this procedure. There is only a single human basso, whose tones are not very low and blend well with the other voices.

Edward Tatnall Canby

Dvořák: Piano Quartet in E Flat, Op. 87; Fauré: Piano Quartet No. 2 in G Minor, Op. 45. Lydian Trio; Eugenia Monacelli, piano.
Rizzoli Records 2002, LP. (Available from Rizzoli Records, 31 West 57th St., New York, N.Y. 10019.)

Some extraordinarily nice recordings have been made in New York City's Rutgers Church, a well-hidden, dowdy little structure on the Upper West Side. It has been the favorite haunt of Marc Aubort and Joanna Nickrenz (Elite Recordings, as they call their production team) for decades. Long-time *Audio* readers will recall many delightful LPs, and not a few CDs, made here.

This is not, perhaps, *the* most alluring job Elite Recordings has done, but it is nonetheless exemplary chamber sound. It lacks only the slight bloom that a bit more of the gorgeous room sound would have lent this pair of important works. Also, the piano, though neither tubby nor muddy, does not have the dimension, bass profundity, and great clarity the best recordings from Aubort and Nickrenz have. The editing, as always with this team, is impeccable.

But let's not ignore the music! The performance of the Dvořák, a splendid four-movement piece that never dulls, is marginally the better and more interesting of the two. If the playing does not have that extra sparkle necessary to the most idiomatic Czech orchestral and chamber music, it does have a fairly compelling pulse. The languor and sensuality of the two middle movements are successfully poised against their quicker portions. The same balance is not present in the outer movements, where the snap and spirit, so indispensable an icing to Dvořák's special cake, give an intermittent gleam but are not uniformly present.

The Fauré is lovely in parts, yet suffers from a slight somnolence. The feeling is of a late-night reading, not of a performance. The usual Fauré scamper at the end does kick up its heels and gets the work moving.

One element of the performance impossible to miss is that the string in-

COMPACT DISCLOSURES

November CDs of Note

If you think you've heard every song FRANK SINATRA has ever recorded, there's a big surprise in store for you this month. New York City radio personality, Jonathan Schwartz and producers Joe McEwen and James Isaacs (the team behind the previous Columbia/Sinatra compilations) have dug deep into the Sinatra archives and hit upon a trove of "Sinatra Rarities." Dating from the late 40s and early 50s, the selections have been remastered from extremely rare 78s – eleven of the sixteen songs are so rare, in fact, they were never legally released. The Chairman Of The Board takes his seat on CD this November.

Slowly but surely, all the greatest musical cast recordings are becoming available on CD. CBS is not only doing its part to keep the shows going on, it's making them a specially-priced CD "Best Value." Literally dozens of the greatest Broadway cast albums and an equal number of Hollywood soundtracks are coming your way on CD. Starting with seventeen clasics, including everyone's favorite, *My Fair Lady* (the Broadway version with Julie Andrews), *A Star Is Born* (the Garland version) and *Pal Joey.* The Great White Way unrolls on CD this November.

OTHER NOVEMBER CD RELEASES:

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MY FAIR LADY
Original Cast/Julie Andrews & Rex Harrison
SARAH VAUGHAN
The Divine Sarah Vaughan
The Columbia Years 1949-1953
CHET ATKINS
Chet Atkins, C G P
DORIS DAY
A Day At The Movies
JULIE ANDREWS
A Little Bit Of Broadway

LUTHER'S SIXTH

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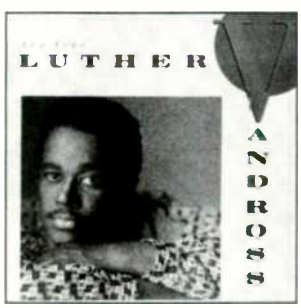


Ironically, the metal the music industry associates with OZZY OSBOURNE isn't merely heavy. It's platinum. Every one of Ozzy's four solo studio albums and all of the albums he made with Black Sabbath are platinum-plus. Lately, Mr. Metal has been busy assaying "No Rest For The Wicked." The song titles alone are like a coming attractions trailer "Bloodbath In Paradise," "Fire In The Sky" just to mention a few of the eight cuts. "No Rest For The Wicked" also marks the debut of Ozzy's latest guitarist discovery, a twenty-year-old American named, Zakk Wylde, who has become the talk of the Metal World. "No Rest For The Wicked" metalicizes on CD this month.

LUTHER VANDROSS is another artist who has a way of turning everything he touches to platinum. *The* male soul artist of the 80s, Vandross has had a string of five solid-platinum platters, includ ng last year's "Give Me The Reason," which sold nearly two million copies. Now, "Any Love" looks certain to be his sixth. The new recording, produced by Luther himself along with Marcus Miller includes the title song, "Any Love," a format-transcending ballad, as well as a cover of the classic "Love Won't Let Me Wait." Now through the end of 1988 you can catch Luther, along with Anita Baker, on his "The Heat" tour. Or you can pick up, "Any Love" on CD this month.

The Lydian Trio and pianist Eugenia Monacelli perform two concertos in a manner that is not uninteresting, but merely a bit pedestrian.

struments used are of unusual warmth and fullness, especially the cello and viola. The piano is good without being outstanding.

In listening a second time to both sides of this very quiet, Masterdisk-mastered LP, no edits were at all apparent, yet it was hard to shake a sense of this recording's being more of an assembly of individual segments of the two scores than of one sweeping playing of either. Harris Goldsmith's excellent notes and a beautiful jacket should attract a fair number of listeners. The playing here is not uninteresting, it is merely a bit pedestrian.

Christopher Greenleaf

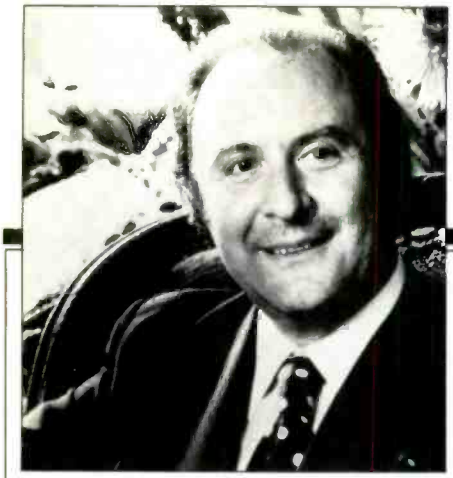
Villa-Lobos: Trio; Zwilich: String Trio. Lydian Trio.
Rizzoli Records 2001, LP.

Two works for three strings (violin, viola, and cello) on this well-made record from a fairly new company, although the listening is a bit difficult here, for sonic reasons. As any audio buff knows, strings, with their abundance of high overtone material, are not easy to record—especially in solo form at close range. When the music begins to get hectic, the mikes pick up all sorts of scratchy and shrill effects that are normal for the medium but unpleasant for the unpracticed ear—even with the best engineering. The problem is in recording, not live performance, because the mikes must be closer than any live listening ears.

This group of three players is highly professional, out of the Juilliard-Eastman conservatory axis, and they are enterprising enough to want maximum variety for their restricted medium, including commissions for new music. This is good, but the unfamiliar listener may find the going sonically rough. These players share a familiar convention of string performance, a tendency to get out of tune in more strident and taxing passages as well as to produce harsh, drumming sounds. Those who know strings simply discount this, taking it as evidence of strong expression—which indeed it is.

More important, many present composers virtually force their players to produce these ungainly sounds in their striving to expand expression in new ways. A string trio, an abbreviated medium that often tries to sound like a quartet, is especially subject to such treatment.

So when I say that we have here one of the better works of that endlessly prolific Brazilian, Villa-Lobos, full of good counterpoint and melody and expansive sounds, I have to admit that



Jean-Pierre Rampal is as skillful as always, but like his loud modern flute, he is much too big for this stuff.

there are still squawks and strain at the more passionate moments. Perhaps they are even intentional on the composer's part. Ellen Zwilich is a prize winner and formidable competition for old Villa-Lobos, but she strains the medium even more than he does. I still was able to enjoy her "String Trio" as a good piece of music, understanding what was involved.

I'd call this record a challenge—worth trying, if you dare.

Edward Tatnall Canby

Carulli: Concerto in G for Flute, Guitar & Orchestra. Franz Liszt Chamber Orchestra; Jean-Pierre Rampal, flute; Alexandre Lagoya, guitar; Janos Rolla. **CBS MK-42130,** CD.

Even at this late date, maybe 95% of the music we hear via audio was composed—past or present—strictly for live performance. The recording is always an adaptation, for better or worse, depending. No criticism! Just the way things are.

This gentle and pleasing music would be ideal for background purposes, you might think, since it was pretty close to that in its own time (around 1800). Just mildly virtuoso, to fill the need for a sudden popularity of the then extant forms of guitar, plus the ever-popular flute. Its content is gossamer-thin, its impact about the same, but a lot of people probably enjoyed playing it. The sound is slightly pre-Mozart—in the times of Beethoven's great works. Not exactly a revolutionary, this character, but a competent handler of the techniques required for such music.

On this record? First, there is Jean-Pierre the Great, a lot more than a gentle nobody. He is as skillful as always, but he is much too big for this stuff, and so is his very loud modern flute. And do I detect a bit of the usual superstar mike placement? Anyhow, Rampal easily makes this into a flute record, as CBS and Hungaroton surely intended, though the guitar was the original lead instrument.

Everybody, in those days, wrote in flute parts—for practically everything. Moreover, the flute of the time was no doubt wooden, and much less loud and rich sounding than Rampal's instrument, though highly esteemed even so. It surely balanced the 19th-century guitar nicely, and did not need artificial "balancing" to let the guitar speak on its own.

So what do we have? Jean-Pierre Rampal in another celebrity record. Much ado about not very much.

Edward Tatnall Canby

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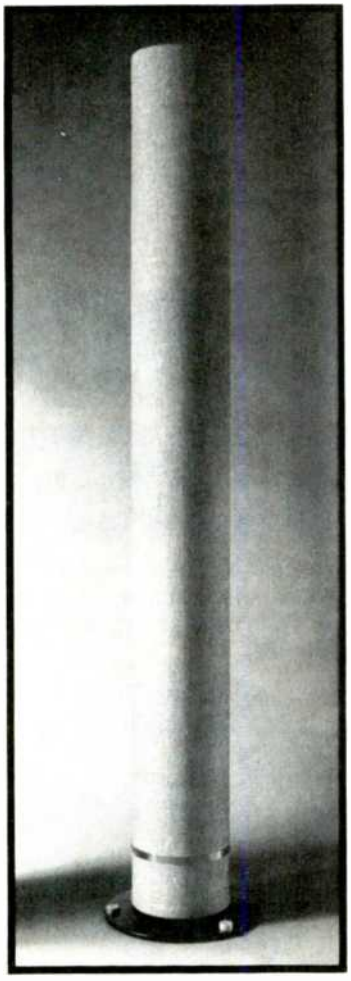

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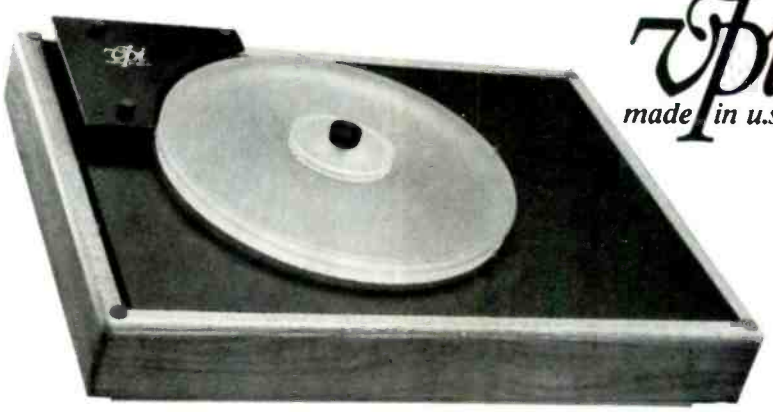

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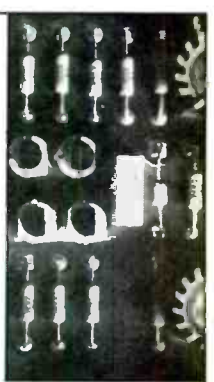

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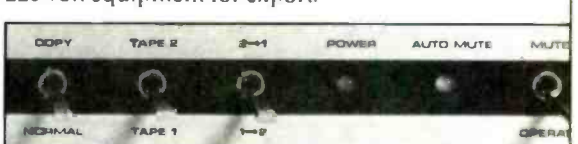

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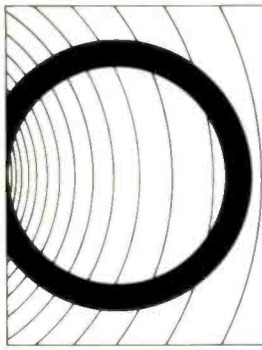

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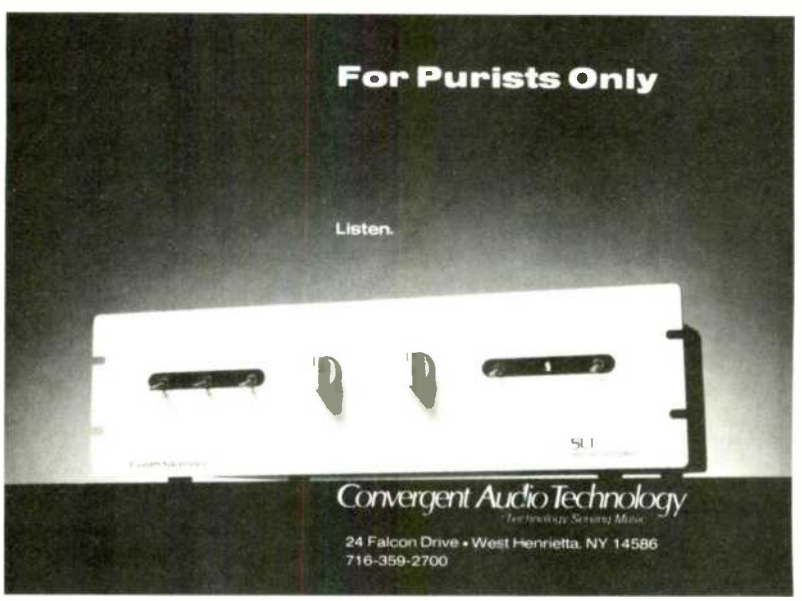

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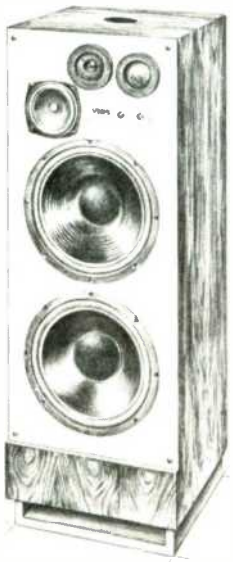

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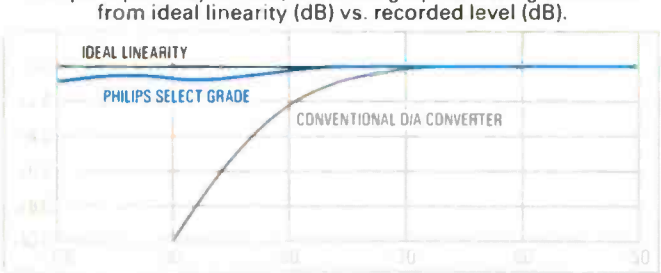

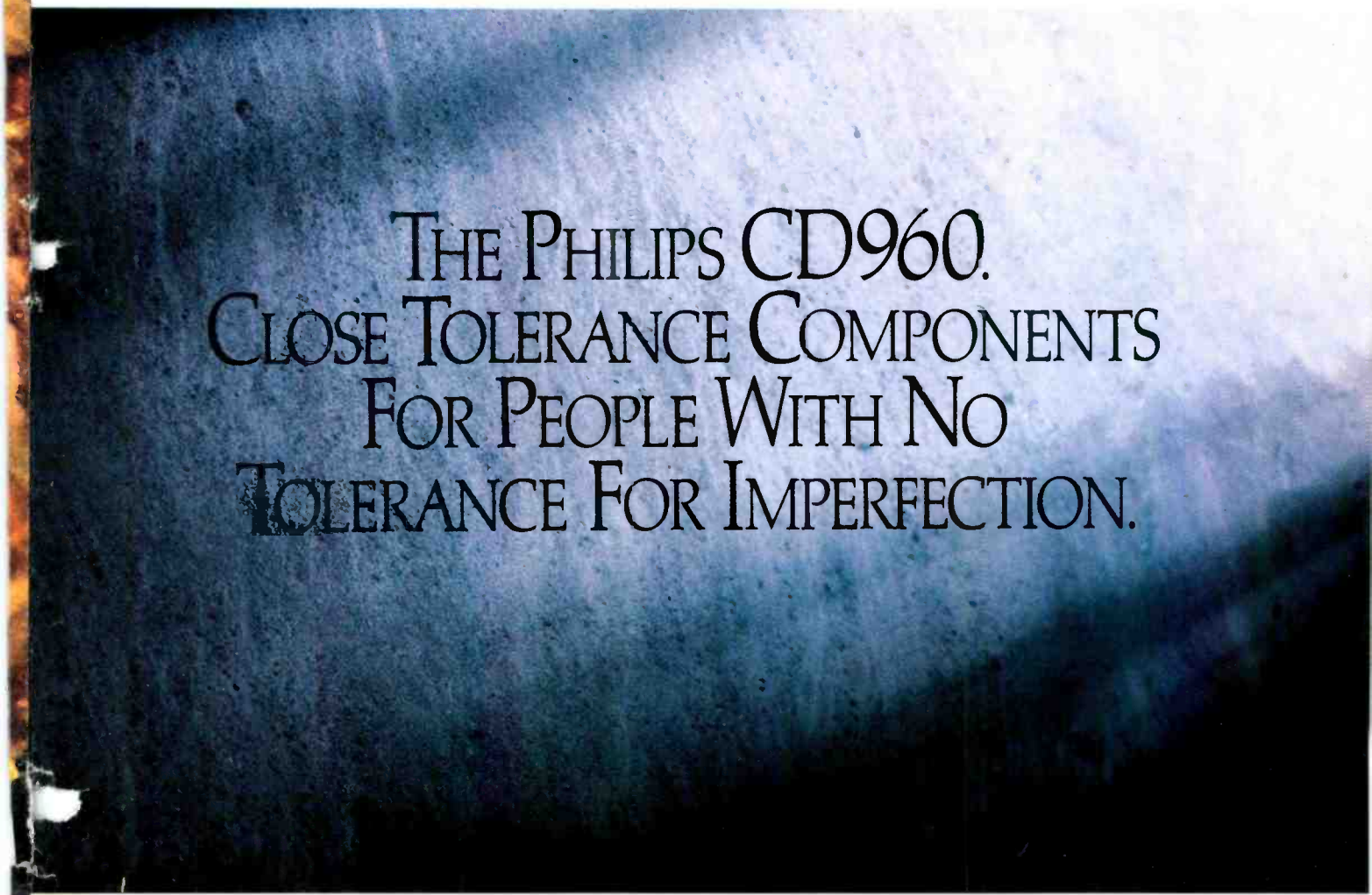

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