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SONY

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in our January issue, John Gatski reported on where things stand in the effort to establish a digital radio standard for the United States. Since then, the Consumer Electronics Manufacturers Association (CEMA) has filed its final report on the subject with the Federal Communications Commission (FCC). The report is based on a six-year evaluation in which nine proposed digital radio technologies were subjected to extensive laboratory and field testing. And its conclusions are discouraging.

The report states that of the systems tested, only Eureka-147 could be expected to deliver satisfactory performance in actual use. That shouldn’t be a problem—Eureka-147 is the system that has been adopted by almost every other country contemplating digital radio, including our neighbor Canada—but it is. The sticking point is that Eureka-147 operates in a block of the radio-frequency spectrum known as the L band, which in this country is owned by the military. They use it, very occasionally, for telemetry in weapons testing. Given that the L band is dead more than 99% of the time, one would think the Pentagon could just move the little bit of work it does there someplace else in the spectrum, thereby clearing the way for Eureka-147 to be used. Unfortunately, CEMA has concluded that existing IBOC systems have not, so Eureka-147, the de facto world standard for digital radio, is effectively locked out of the U.S.

The proposed alternatives are IBOC (in-band, on-channel), IBAC (in-band, adjacent-channel), and S-band satellite transmission. The first two are schemes for terrestrial broadcasting of digital radio within the existing AM and FM radio bands, either inside or alongside analog transmissions. Unfortunately, CEMA has concluded that existing IBOC systems have a number of performance deficiencies with respect to both reception and audio quality and that IBAC systems cause unacceptable interference with conventional FM transmissions. And S-band transmission, it says, suffers from signal blockages for which there may be no practical remedy.

Work has not stopped on these alternatives, particularly IBOC and S-band, but many observers are skeptical that anything other than the L-band-dependent Eureka-147 will ever prove good enough to deploy. If you would like more detail, the CEMA report, Technical Evaluations of Digital Audio Radio Systems: Laboratory and Field Test Results, System Performance, Conclusions, is available from the FCC and is posted on the Internet at CEMA’s Web site (www.cemacity.org/works/pubs/dar.htm).

On a brighter note, I recently spent a couple of days at the convention of the National Association of Music Merchants, which proved remarkably interesting. Today’s music stores range from shops that sell nothing but band instruments and sheet music to large chains that carry everything from traditional musical instruments to sophisticated pro audio electronics and loudspeakers.

Over the last few years, progress in digital audio and computer technology has fostered a revolution in music-making. It is now possible to perform recording and editing feats at home or in a small studio, using just a few thousand dollars’ worth of equipment and software, that not long ago would have required the services of a full-blown professional recording studio. I was particularly amazed at the bang for the buck provided by a lot of the electronics, right down to things as simple as stand-alone A/D and D/A converters. Look for coverage of some of this gear in future issues.

Meanwhile, if you have a serious interest in recording of any type, you owe it to yourself to locate a well-stocked music or pr audio store and kick a few tires. You might be as surprised as I was at what’s available to hobbyists these days.
Work for a living. Play for a life.

Take it easy.
Quibbles and Bits

Dear Editor:

In Anthony H. Cordesman’s review of the Krell Audio + Video Standard (December 1997), he stated that “only Theta Digital’s Casablanca currently offers 20-bit DACs for the surround and subwoofer outputs—as an option.”

This isn’t correct. The Proceed PAV/PDSD uses identical 20-bit DACs for all channels (six standard, eight optional). It also uses the next-generation Motorola DSP chips and already features a 96-kHz digital input receiver.

The advanced technology of Proceed’s PAV/PDSD comes at a price approximately $3,000 less than for the Krell.

Seth Bradley  
via e-mail

Burning Issue

Dear Editor:

Regarding Robert Long’s “Living with CD-R” (February), I take issue with his total dismissal of using a computer CD-R “burner” for audio recording. Many of his comparisons are valid. However, his weighting of the comparisons are quite opinionated. I suspect that Long is not computer-literate.

I have a computer CD-R recorder and find the control I get over the resulting disc is the best reason to use a computer over a dedicated audio CD recorder. I copy cuts from my audio CDs to WAV files on my hard drive. I have editing software that enables me to edit the WAV files for length and level. Once I have everything as I like it, I burn the CD-R.

I hear very large differences in recording level from commercial CD to CD. Using a straight digital copy from an audio CD player to an audio recorder provides no means for level matching. The resulting “compilations” have vastly different levels between cuts from different source CDs. I can match levels on the computer hard disk before burning. The software I use (Goldwave, a $15 shareware program) allows me to edit the WAV files down to the bit level. I have even “cut and pasted” from one WAV file to another. This level of control is simply impossible using an audio recorder—just try standing at your equipment, hands on the pause and level controls (when using analog inputs), hoping you can press buttons and turn dials while recording.

Another reason to use computer CD-R is cost. Initial startup costs may be similar, but I’m paying no more than $1 per blank CD-R disc (after rebates). The computer solution also has no copy protection, unlike digital audio recorders. I can make copy after copy of any disc I record, which is prohibited with audio CD-R recorders.

I had no trouble at all installing my SCSI HP4020I CD recorder in my PC, and now most computer recorders are EIDE, making installation a snap. I strongly urge everyone to seriously consider the computer CD-R over the audio CD-R. The results will be much better (and cheaper).

Author’s Reply: Well, you’re entitled to your opinion. I thought I’d made plain that the fundamental assumption most readers are likely to make is that burning CDs is best left to a computer CD-R drive and that, therefore, it was up to me to present the contrary case—for the free-standing, consumer-grade, music-component-style CD recorder.

As a matter of fact, I’m trying to set up a computer-based system so it, working from analog originals, will let me use Cool Edit Pro to do editing that I think is best handled in the digital domain. But I want my DAT recorder to do the A/D conversion for two reasons: Any reasonably priced sound card I can find seems to have a vastly inferior ADC to begin with, and the extremely noisy computer environment is one to which I don’t want to subject my analog signals.

Then there’s the question of FireWire technology, which may be just around the corner to replace the multichannelly-challenged S/P DIF and AES/EBU connections that are presently the standard digital interconnects. I know, I know: You gotta go ahead and do it, because there’s always change just around the corner and you can’t afford to wait for it. But that still leaves the other consideration.

I’ve already picked out the CD-R drive (no, I don’t plan to go with CD-RW—maybe eventually with DVD-RAM), the added hard disk, and the SCSI card (don’t ask—it’s too complicated to explain). So once I’ve decided on the S/P DIF sound card… Maybe when I get it all working Ye Olde Editor will let me do another article called “Living with a CD-R Setup in a Musical Household.”

You’re right that if you lift recordings off existing CDs you’re much better off doing it with a computer-based system. I just don’t happen to cotton to that idea. As an Audio CD reviewer, I have too much respect for the integrity of a well-produced CD and too little interest in one that is badly produced. I prefer playing the originals, therefore. My homemade CDs are derived from LPs, 78s, and private recordings of various sorts, all of which are unavailable on commercial CDs. I suppose I could also raise the issue of copyright, but as a Usenet junkie I’m sick of the whole subject.

Anyway, enjoy your setup. I’ve certainly been enjoying mine.—Robert Long

Fantastic Fogerty

Dear Editor:

Daniel Levitin’s interview with John Fogerty, in the January issue, was great! This is just the kind of article I’ve always wanted to read but have never been able to find. Rolling Stone and Spin focus too much on musicians’ personalities, and Musician talks too much about gear and the fuzzy ideas of songwriting inspiration. In Levitin’s interview, I felt like I was overhearing Fogerty talk with a fellow musician about his work.

I have long thought of Fogerty as one of the great creative forces in rock music, but I had no idea how much influence he had on the sound and music of CCR. Levitin was able to get just the right information out of him, too. I would like to see more articles like this—maybe with other self-producers, such as Paul Simon, Stevie Wonder, or Steely Dan. The focus on how recordings are made is just as important as the equipment we use to play them back. After all, when we listen, we have to be listening to something.

Larry Spencer  
North Hollywood, Cal.
The 3.3 Loudspeaker System

Design:
Ultimate expression of NHT philosophy.
System accuracy:
Acoustical accuracy rivaling finest audio electronics.
Resolution:
Spatial/spectral soundfield fully responsive to recording.
Enclosure:
Radical enclosure optimizes radiation over full audio frequency range.
Componentry:
Individually matched components assure laboratory precision within 0.3dB.

Patrick Smith.
Music Mixer, The Tonight Show with Jay Leno.
Berklee College of Music grad. Husband, Formula 1 racing fan. Big proponent of NHT 3.3s and the rather sizeable hand-wrapped Dominican torpedo.

Knows a pure note when he hears it.

For a NHT dealer in U.S. or Canada: 1-800-NHT-9993 • www.nhtf.jpg.com NHT is a Recoton company. ©1998 NHT
Hiding conventional speaker cable under a carpet is futile, because a bump is always visible. However, the F (solid-conductor, Hyperlitz) or FF (stranded, flexible) series of flat cables, just 2 millimeters thick, should solve the problem. The F-14 and FF-4 have four, 17-gauge, long-grain copper (LGC) conductors per cable; the F-18 and FF-8 have eight, 14-gauge LGC conductors. The FF type is available in white or black; the F, in white, brown, or blue. Prices: F-14 or FF-4, 95¢ per foot; F-18 or FF-8, $1.95 per foot. (AudioQuest, 714/498-2770)

Panasonic Portable DVD Player

You can watch DVD movies anywhere you want on the 5¼-inch, high-resolution LCD display of the DVD-L10, the world's first portable DVD player. A touch of a button will select the aspect ratio (4:3 for standard-width TV screen or 16:9 for widescreen), and there's an optical output for the Dolby Digital (AC-3) sound bitstream, so you can plug the DVD-L10 into your home theater. Other features include a rechargeable two-hour battery, a 96-kHz, 24-bit audio D/A converter, 10-bit video DAC, and composite- and S-video jacks. Price: $1,299. (Panasonic, 800/222-4213)

The ED-301 uses a Motorola 56009 processor and 20-bit D/A conversion to decode an AC-3 bitstream into 5.1 discrete analog channels. Outputs include a multipin DB-25 and six RCA jacks, and there are optical and coaxial digital inputs and six discrete RCA inputs, the latter for future upgrading (e.g., DVD-Audio). A six-way test signal aids system balancing and subwoofer level adjustment. The ED-301 has Home THX Cinema Re-EQ to tame strident soundtracks and a Midnight Theater compression mode. Price: $450. (Onkyo, 201/825-7950)

Intended for high-end audio components or guitar amps, the SV572 series of triode tubes have directly heated tungsten filaments and graphite anodes rated for 125 watts of dissipation. These attributes are said to help produce excellent power output and rich sound. The SV572 tubes are available in four types for different modes of operation. Price: $57 each. (Svetlana Electron Devices, 650/233-0429)

AMC INTEGRATED AMP

Rated at 20 watts per channel into 8 ohms, the Model 3020 has an unusual feature that lets you blend computer and audio sources (CD, tuner, and so on) by adjusting source input level controls. The mixed signal is available at the tape output jacks, enabling you to record mixed-down recordings from your computer and audio systems. The 3020 is said to produce peak output current of 17 amperes into 1-ohm loads. Total harmonic distortion is specified at 0.03% or less, from 20 Hz to 20 kHz. Price: $249. (AMC, c/o Weltronics, 818/799-6396)
Before you buy an expensive power amplifier, read the fine print.

Adcom's dedication to uncompromising sonic reproduction, innovative circuit design, and the highest quality electronic parts guarantees that, dollar for dollar, you're getting the best value in the audio world. At 300 watts per channel into 8 ohms and 450 watts per channel into 4 ohms, our new GFA-5802 combines innovative all MOSFET circuitry with a tremendous power supply to outperform the so-called 'super amps' retailing for two to three times the price.

To produce this remarkable amplifier, Adcom started with an enormous toroidal power transformer. Totally separate secondary windings and independent ground connections assure each channel is completely isolated from crosstalk and AC line interference. Lots of clean power for lots of clear and powerful sound. Even the neighbors will enjoy it.

In addition to the GFA-5802's main toroidal transformer, a separate front end transformer is also used. This additional device isolates the front end input stages from the main output section so any peak demands from the output stages will not decrease the operating voltages for the input sections. This design also contributes to improved separation at the inputs for precise soundstaging and imaging.

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

The well organized and simple design of the GFA-5802's glass epoxy circuit boards assures outstanding and reliable operation. Class A circuitry in the front end, the Adcom GFA-5802 delivers the pure sound that other amplifiers can only talk about. All devices are precision matched for maximum performance, negligible distortion, and higher output currents.

We use only International Rectifier Hexfets transistors in the signal path of the Adcom GFA-5802. These Hexfet circuits are reference grade, hybrid MOSFET transistors which reproduce all the punch and muscle of bipolar devices but with the musical sound of tube amps. And since the GFA-5802 has only three gain stages it outperforms comparable amps which usually have five stages or more. The shorter the path of power resistance, the better the sound.

The GFA-5802 comes with versatile binding posts for easy speaker hook-ups. Accepting either standard stripped or 'tinned' wires, single or dual banana plugs or spade lug connectors, the GFA-5802 is a great match for any system. And since it can drive virtually any speaker system regardless of its impedance, even the most demanding speakers will sing beautiful music. Additionally, the GFA-5802 also comes equipped with two sets of binding posts for each channel. These extra binding posts allow the GFA-5802 to accommodate speaker systems that have 'bi-wire' capability.

Adcom makes sure that the sound created by your other components can be flawlessly transferred to the GFA-5802's balanced power and optimum circuit technology. The GFA-5802 is equipped with two types of input connectors for complete compatibility, high quality gold-plated RCA jacks and XLR jacks. The GFA-5802's professional grade three pin XLR jacks provide both positive, negative and shield properties. The result is a balanced line connection between the GFA-5802 and your other components. This connection is essentially immune to electromagnetic and radio frequency interference and provides a significant reduction in 'common mode noise'.

Dependable technology and efficient use of the highest quality parts make the GFA-5802 one of the most sought after audiophile products in recent years. And because it's an Adcom component it will benefit from a high resale value and an outstanding dealer service network. After you hear the GFA-5802 you'll agree that it's an incredible value in high end audio.

The most important detail to look for before you buy your next amplifier is the Adcom name. Adcom audio and audio/video components are designed to be second to none. It's this driving passion for accurate, musical sound and performance that has made Adcom components sought after by the discriminating audiophile. Through a combination of technology and innovative engineering techniques, the Adcom GFA-5802 is quite possibly the best amplifier you may ever hear. From its toroidal transformer and giant capacitors to its reference grade Hexfet circuitry, the Adcom GFA-5802 is built to be the best amplifier money can buy.

Your ears will thank you.

And so will what's between them.

*20 to 20,000 Hz with both channels driven at less than 0.18 THD.
WHAT'S NEW

VELODYNE POWERED SUBWOOFER

Using a high-gain servo system that measures woofer cone movements 3,500 times per second and corrects distortion-creating errors, the FSR-18 is said to deliver clean, accurate sound from 1.5 to 120 Hz. THD is specified at less than 1%. A built-in Class-D amplifier, which is rated at 1,250 watts continuous output, powers the magnetically shielded 18-inch driver. Other features include signal-sensing on/off circuitry, remote control with volume presets, adjustable low-pass filter (40 to 120 Hz), high-pass outputs (80 and 100 Hz), and a switch to bypass the internal crossover. Price: $2,399 in black vinyl, $2,499 in high-gloss black or rosewood. (Velodyne, 800/835-6396)

AUDES SPEAKER

Built in Estonia, the Model 75AC-105 is a two-way, bass-reflex system with a frequency range specified at 50 Hz to 20 kHz. The front-ported cabinet, internally braced for stiffness, is 13 1/2 inches tall and 9 1/2 inches wide. The nominally 8-ohm system has a 6 1/2-inch woofer and a 3/4-inch tweeter. Sensitivity is specified at 86 dB (1 watt/1 meter) and power handling at 100 watts. Price: $400 per pair. (Audes, c/o Savva Group, 212/938-9283)

JAMO THX HOME THEATER SYSTEM

With all signals digitized, including analog inputs, the Digital Cinemaster system is said to provide unprecedented clarity, low distortion, and ease of use. Additionally, crossovers, active equalization for each speaker driver, automatic calibration to the listening room, and even THX surround decorrelation are done digitally. The three front speakers, two surround speakers, and the sub are self-powered. Total continuous power output is said to be 1,900 watts; peaks of 4,000 watts are possible. The motion- feedback subwoofer has two back-to-back 15-inch drivers and a 750-watt, Class-D amp. Price: $30,000. (Jamo Hi-Fi, 847/465-0005)

ACOUSTIC RESEARCH SPEAKER

Inside each P315 HO floor-standing speaker is a Bob Carver-designed, 500-watt Sunfire amplifier that drives a servo-controlled 15-inch woofer, side-mounted to improve bass coupling to the room. The woofer/amp combo is said to be capable of dramatic bass output levels down to 20 Hz. A three-way, acoustic-suspension system, the P315 HO has two midrange drivers and a diamond-coated, 1-inch titanium-dome tweeter. Frequency response is specified at 20 Hz to 20 kHz, ±3 dB. Price: $1,199.50 each. (Acoustic Research, c/o Recoton Home Audio, 800/648-9993)

Audio/April 1998
World's Best Subwoofer Technology...

Patented True Accelerometer-Based High Gain Servo Control

- Low distortion, clean, accurate sound that Velodyne is famous for.
- Smoothest frequency response of any subwoofer.

Revolutionary New Energy Recovery Switching Amplifier Design

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Tandem Voice Coil in Push-Pull Motor Structure

- High linear excursion capability 1/4" peak to peak, 2" max.
- Four times the heat dissipation for high power handling and long life.
- Less than 1/2 the distortion of conventional motor designs.

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Fixing Scratched CDs

Here's an easy method to fix scratched CDs, one I used years ago to polish a scratched watch crystal. Use a bit of toothpaste and a soft cotton cloth, like an old T-shirt. Wrap a small part of the cloth around your index finger, but make sure it doesn't bunch up when you polish the disc's surface. Apply a tiny amount of toothpaste, rubbing it back and forth radially in a straight line across the disc, and then buff off the residue in the same manner. I practiced this on an unwanted CD until I perfected my technique. It works very well! —Richard Lester, Raleigh, N.C.

Taking a Stand

Q What would happen if I used cinder blocks, filled with sand or lead shot, as speaker supports in place of traditional steel stands? I assume I wouldn't need to use the spikes that screw into the bottom of steel stands, because the cinder blocks would be very solid. —Robert Yu, Flushing, N.Y.

A I have to think that cinder blocks filled with sand or lead shot would work well as speaker stands. The purpose of the stand (if you accept the premise of one audiophile faction) is to provide a support that does not transmit vibration from the speaker enclosure to the floor; in other words, it isolates the speaker. This is best achieved by means of some sort of resilient shock mounting. However, if you examine the physics of sound propagation, it is evident that no stand can ever provide total isolation of any speaker. The reason? Because it's the acoustical energy radiated by the woofer, and the standing waves triggered by that energy (and by the interaction of the room's dimensions and the speaker's location), that ultimately stimulate the vibrations and resonances of various objects and room surfaces. Other audio enthusiasts endorse using spikes to couple a speaker to the floor, thereby encouraging the transmission of vibration to the listener's feet.

In my view, the arguments pro and con are greatly overshadowed by the aforementioned effects of acoustical propagation. For most listeners, the principal acoustical benefit of speaker stands (of whatever type) is to raise the speaker's tweeter to ear level and move the woofer far enough above the floor to eliminate or reduce woofer/floor interactions that might otherwise color bass reproduction. Incidentally, most experts agree that the layering of dissimilar materials—e.g., rubber, cinder blocks, sand, and so on—will discourage the transmission of vibration.

CB Interference

Q On summer nights and on weekends, the highway 50 feet from my house turns into a haven for high school kids cruising in their cars. They use CB radios to communicate with each other, and if someone is transmitting as he passes my house, I hear that transmission over my speakers. I have three identical receivers located in various rooms. Their power is on with no audio source plugged in. Volume is turned down, and it does not matter which program source is selected. Under these conditions, I still receive 3-second bursts of CB interference about 15 times a week. I have tried other receivers and some integrated amplifiers; all receive the interference. I haven't tried components with balanced inputs. No speaker cable is longer than 10 feet. One of the engineers at a local radio station suggested putting 0.01-microfarad capacitors across the speaker outputs. I have wound a part of the power cord around a ferrite choke, placed very close to the receiver. What else can I do? —Dave Popovich, West Allis, Wis.

A You should determine if the capacitors or the ferrite will help. Often it is necessary to add even more ferrite to the power cord. Ferrite increases impedance to the flow of RF into the equipment via the power cord.

As for using bypass capacitors, well, they're almost a good idea. Try connecting a bypass capacitor of perhaps 0.01 microfarad from each speaker output terminal on the back of the receiver to a screw on the chassis. Do this even if the common side of the speaker is connected to chassis ground.

Inductance can make what should be a ground virtually useless. Use the shortest possible leads on these capacitors.

You may find that the speaker cable should be wound onto ferrite, if this is physically possible. Keep this as close to the chassis as you can.

You should also consider using shielded speaker wire, with the shield connected directly to the chassis rather than to the common ground usually employed. Leave the shield unconnected at the speaker ends. Of course, connect the two inner conductors as you would any speaker cable.

Dolby Digital Connections

Q I'd like to connect a Dolby Digital (AC-3) decoder to my five-channel power amp, but my preamp doesn't have inputs that can be fed directly from the decoder. Therefore, I think I should hook up the decoder between my preamp and the inputs to the amp. Will this suffice? And, for the surround and center-channel speakers, must I use the same expensive speaker cable that I use for the front speakers? —Name withheld

A You need not use identical cable. The main criterion for speaker cable is that the gauge of the wire be thick enough for the distance required, in order to keep resistance low. You must also take into account the impedance of the speakers; if it dips below 4 ohms and the cable run is 30 or 40 feet, use AWG No. 8 or 10 cable. Otherwise, 12-gauge cable should be more than ample for most cable runs in domestic settings.

I see no problem with your planned wiring; it's what I would do. As you indicate, the various outputs from the processor are connected to their appropriate power amplifier inputs. The two preamplifier output channels are connected to the inputs on the processor. However, coaxial or optical digital sources that carry the AC-3 bitstream must be routed directly to the appropriate digital inputs on the Dolby Digital decoder.
The Krell® Full Power Balanced 600 power amplifier and the Krell® KAV-300i integrated amplifier establish new standards for performance and design. Both amplifiers are among the few products holding the distinguished Class A rating from Stereophile.

A fully regulated output stage in the Full Power Balanced 600 enables the amplifier to produce up to 2400 watts per channel of clean power for open, effortless sound.

Distinguished Quality

Complementary, discrete circuitry in the KAV-300i delivers 300 watts per channel of pure Krell-quality sound.

The robust designs of all Krell® Full Power Balanced and KAV-Series amplifiers feature proprietary output devices that are yet another hallmark of Krell® design.

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Your preamp must have enough inputs to accommodate all the audio sources you plan to use. This applies even when some of these sources will not present encoded signals for processing, i.e., when you want to listen to plain stereo. Use the bypass switch on the decoder to circumvent the decoding circuits.

If your preamplifier has tone controls, do not use them when feeding analog signals to the processor for Dolby Pro Logic decoding; otherwise, the decoding will be degraded.

**VHS Hi-Fi Incompatibility**

**Q** Tapes that I record on my VHS Hi-Fi VCR will play back only in mono on other Hi-Fi VCRs. Rental movie videos play back fine on my machine. However, I have recorded many TV broadcasts and fear that when this VCR wears out, my tape library will be virtually worthless.—Donna S. Cofield, Katy, Tex.

**A** I have worked with VHS Hi-Fi VCRs since they first appeared. Assuming that all machines are properly adjusted, there is no tape incompatibility problem. Were this not the case, it would not be possible to sell commercially prerecorded movie videos, because they wouldn't play on the millions of different Hi-Fi VCRs made over the years.

The fact that your VCR plays standard movie videos okay (which normally play on any Hi-Fi VCR), as well as playing back your own tapes, is odd. It prompts a question: What is different about your recorded tapes that renders them unplayable on other machines yet playable on yours? It means that something about your recordings is different from most other tapes.

I think that the audio record current is too low; have a technician set it to the proper level. When it's too low, your tapes will fail to play on most other machines. I suspect your machine can play them because its playback sensitivity is also misadjusted and compensates for the deficiencies in your recorded tapes.

Next, see if the Hi-Fi tracks on your tapes, at least those made with the higher current, play back properly on other Hi-Fi VCRs. You may wish to buy another machine, but it must have the means by which you can adjust its playback sensitivity. Make these adjustments to the point where your tapes play properly. In the worst case, you may want to consider borrowing or buying a second Hi-Fi VCR and copying your library to it.

**Buzzing Amplifiers**

**Q** Each of my power amps (same brand, different models) produces a loud and distracting buzz from the transformer whenever I turn on a halogen light. The lights are in a different room and on a different circuit from the amplifiers. The larger amp produces a louder buzzing, presumably because of its larger transformer. The noise is just from the transformer and is not reproduced through loudspeakers. Why do halogen lights cause this interference? Is there any way to eliminate it? And will the buzzing shorten the life of the transformer or the amplifier? I checked my house's AC wiring, tried different halogen bulbs, and installed an AC noise filter to remove RF and electromagnetic interference.—Name withheld

**A** Noise of this kind is usually a sign of loose laminations in the core of an amp's transformer. The core of a power transformer is made up of very thin sheets of soft iron, insulated from one another by varnish. These laminations are supposed to be dipped into varnish and then tightened securely with bolts. Although it is not possible for you to add more varnish, you might be able to tighten any bolts that are holding the transformers together (I am not referring to the mounting hardware).

In any case, you should consult the amplifier's manufacturer. Have the serial numbers of your two amplifiers handy when you call, because the factory may have received a supply of defective transformers, and the serial numbers of the affected amplifiers would be on record. I can scarcely believe that your amps were the only ones that were affected.

I have not had problems with lights making transformer cores mechanically vibrate or buzz. One possibility is that the power transformers may be on the verge of buzzing, and turning on the halogen lights makes the waveform on the AC line very dirty. Maybe, and only maybe, the asymmetry of these waves jogs the laminations more than when the waveforms are sinusoidal.

I don't believe the buzzing will influence the longevity of your equipment.
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Learn more about the heart and science of the Klipsch sound by calling 1-800-KLIPSCH, or for the surfing savvy, visit us online at www.klipsch.com.
When your car's speed goes up, so does road noise—and the volume, on this JVC and certain other car stereos.

The greater a car stereo's dynamic range, and the greater the dynamic range of the music we play on it, the more we have to crank the volume up and down to cope with varying road noise. Compressors, which reduce dynamic range, can help—but they also reduce the life and excitement of music. What's needed is something that changes the audio signal in response to road noise.

For years, I've been suggesting a complex solution that would raise volume, boost bass, and boost low-level passages in response to road noise. Chevrolet Corvettes have long had stereos that simply boost volume as your speed goes up. I've recently been using two stereos that also do this, the factory head unit in my '96 Saab 900SE and a JVC KD-GS929 in my '88 Scorpio. And although I'm confident that some speed-dependent bass boost and a wee touch of compression might improve things further, this simpler approach turns out to work quite well.

The three systems I've mentioned actually monitor speed, not ambient noise. The Corvette system is linked to the car's speedometer. I don't know how the Saab's system (which was built by Clarion) gets its speed information. And the JVC's Audio Cruise mode senses the frequency generated by the car's alternator, which varies with engine speed. (Audio Cruise was surprisingly accurate, once I got it calibrated to my Scorpio. But that took a while, what with two operating modes and 15 boost levels to play with.)

The JVC 929 also has Voice Support System (VSS), which announces what button you've pushed. (It also says "See you," in a girlish sing-song, when you switch the JVC off.) Until I learned the 929's control layout, VSS proved handy in thick traffic and on twisty roads, since I didn't have to take my eyes off the road to find out what I was doing to the stereo. Once my fingers no longer needed training wheels, I switched VSS off. But I wished for an intermediate setting that would announce functions I rarely use and let me know when I've pressed the "Sound" button the right number of times to bring up the balance control. JVC's KD-GS939, which replaces the 929, has Audio Cruise but not Voice Support. Sony, however, will have Voice Confirmation on a few '98 car stereos.

Some Pioneer car stereos now combine two systems for identifying radio stations ("Spectrum," September 1997). If you tune in an FM station that transmits RDS-encoded signals, the radio will read and display its call letters. For any other station, it will check a built-in ID Logic database to find what call letters are assigned to nearby stations on its frequency. But the ID Logic system works only if the radio knows rough-

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ly where it is, and Pioneer’s system for updating location data isn’t always accurate. So, pleased as I am to find car stereos that combine both systems, I think the combination could be more synergistic.

The updating system could be greatly improved by using RDS to check the ID Logic system’s sense of location. For example, if RDS identifies the FM station coming in at 93.9 MHz as WNYC when ID Logic was expecting WKYS, then the system should be able to figure out that the car is somewhere in the New York City area rather than near Washington, D.C. And if the radio also picks up a signal at 101.5 MHz with RDS-encoded call letters of WKXW, the system should be able to figure out that you’re somewhere between New York City and Trenton, N.J., rather than in Long Island or Connecticut (where WNYC comes in but WKXW doesn’t). An “Update” button on the radio could automatically scan for RDS stations, then calculate your car’s position from that—within a county or two, anyway.

So why do commercials sound louder? Many commercials use audio compression, boosting quiet passages to make the ads consistently loud. Some also use filtering to divide the audio spectrum into bands, then compress the sound within each band to make sure every part of the spectrum is packed with energy.

In Britain, at least, a cure may be at hand. A meter that registers both peak electrical levels and subjective loudness is now available, for about $5,000. And though no law limits commercials’ aural intrusiveness, British TV networks have begun using this meter to identify offensively loud ads.

Now Lirpa Laboratories has the missing link, the Lirpa Home Theater Authentication Kit.

The basic kit has two-sided sticky tape to simulate soda on the floor and simulated chewing gum to place under the seats. (Unlike genuine gum, it will maintain its stickiness for at least a year.) An upgrade option randomly fires popcorn from a simulated adjacent balcony, but only when you play Westerns on Saturday afternoons.

With our two ears, several inches apart, we can localize sounds, tuning into those in front of us while ignoring others. But how does Ormia ochracea do it?

*O. ochracea* is a small parasitic fly whose ears are virtually adjacent to each other. Yet it tracks crickets, its prey, by homing in on their chirps. Scientists hope to use its auditory secrets to produce small, efficient hearing aids that not only amplify high frequencies (the major area of human hearing loss) but also preserve stereo information.

*O. ochracea*’s ears are only half a millimeter apart, about five times the size of its ear membranes. But the secret of its stereo hearing may have less to do with that spacing than with a pivoted bridge of cuticle connecting the two membranes, say researchers studying the phenomenon (Ron Hoy of Cornell, Ron Miles of Binghamton University, and Daniel Robert of the University of Zürich). When one membrane picks up a sound, the bridge transmits it to the other, with a tiny delay. The bridge also sets up complex vibrations, which build up at the membrane that receives the sound first. This concept, it is hoped, could be adapted for an in-ear hearing-aid microphone that will emphasize frontal sounds.

**LIRPA HITS HOME THEATER**

For some home theater fans, big-screen TVs and neighbor-shaking surround sound aren’t theatrical enough; even installing genuine movie seats doesn’t quite suffice.

Now Lirpa Laboratories has the missing link, the Lirpa Home Theater Authentication Kit.

The basic kit has two-sided sticky tape to simulate soda on the floor and simulated chewing gum to place under the seats. (Unlike genuine gum, it will maintain its stickiness for at least a year.) An upgrade option randomly fires popcorn from a simulated adjacent balcony, but only when you play Westerns on Saturday afternoons.

**SPEAK UP! A COMMERCIAL’S ON!**

Laws limit how heavily broadcasters can modulate their signals. That puts absolute limits on maximum audio levels, for programs and commercials alike.

**HELMHOLTZ REFRIGERATOR**

Today’s loudspeakers often have bass drivers in vented enclosures, commonly described as Helmholtz resonators. Tomorrow’s refrigerators could also have speaker drivers and Helmholtz resonators (albeit with external drivers)—but to preserve the ozone layer, not sound quality.

Freon or similar chlorofluorocarbon (CFC) refrigerants that leak into the atmosphere attack the ozone layer. Most industrial countries have therefore stopped producing CFCs and switched to other, less efficient, refrigerants. But developing countries, such as China, still make CFCs—and make or buy a rapidly growing number of refrigerators.

Luc Mongeau and other researchers at Purdue’s School of Engineering have therefore developed a refrigeration system that uses sound waves for heat extraction. At the heart of things is a tube with a speaker and a heat exchanger at one end and a Helmholtz resonator at the other. The speaker fires 300-Hz sound waves down the tube, where they’re reflected by the resonator. The sound waves compress and decompress the gas in the tube (a mixture of helium and neon); compression heats the gas, while decompression cools it. Excess heat is segregated by a honeycomb-like “stack,” placed near the speaker. Heat exchangers at the cool end of the stack suck heat out of the refrigerator, and exchangers at the hot end dump it outside the fridge.

The sound levels within the tube and resonator can reach 180 dB SPL. Tight sealing and good insulation, however, keep the sound—and the cold—inside the fridge. A
A Revelation In High-End Sound!

"I was floored by the Paradigm Active/20...this is hands down the best sounding two-way 6-incher I've heard at any price...highly recommended!"

- Corey Greenberg, Audio Magazine

"this particular system is...ten leaps forward in terms of performance...destined to become a legend."

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GEAR AND LOATHING IN LAS VEGAS

necessary evils in hi-fi are numerous—cables, reviewers, retailers, CD jewel boxes—but none is quite so irritating, exhausting, and yet potentially "curable" as a Consumer Electronics Show. Readers who do not work in the hi-fi industry and therefore are precluded from attending these trade-only events might think that they must be the place to see it all, schmooze with buddies, and overindulge in a four-day audiofest. But the reality is often quite different. A typical CES is a hustle on a scale unmatched by any other electronics trade show on earth, not even the physically larger (yet infinitely more civilized) Berlin show. And CES remains the single most important event on the hi-fi calendar—that is not open for argument.

Just look what’s at stake if you are a manufacturer. You exhibit at the show so that you may seduce the press into publicizing your new models. At the same time, you are wooing retailers and foreign distributors so they will pre-order for the following year. You get one shot, one 96-hour attempt to impress upon all observers that you have one of the hottest lines around—for the next 12 months, at least.

All of this should take place for the benefit of the entire industry (the vendors, the makers, and the critics) and, eventually, for the consumer’s benefit, but the nature of the hi-fi beast is such that priorities are skewed and maturity is at a premium. And so overwhelming is the CES, held in Las Vegas every January, that no visitor can escape without the nagging feeling that he missed something important or wasted time on something unimportant. Worse, the CES—or, more specifically, the specialty audio segment, which matters most to us—no longer knows why it exists. Is it for the visitors or the exhibitors?

Before you read any further, I swear that this diatribe is not entirely a self-serving kvetch written in the hope that next year’s event will be more visitor-friendly; it’s much too late for that. Rather, my purpose here is to convince each and every non-trade reader who would kill to visit a CES that such a desire should be squelched. Frankly, you’re better off reading about hi-fi than schlepping around the Hotel from Hell.

But let’s backtrack for a moment. Editor Michael Riggs recently wrote about the aforementioned Funkausstellung show in Berlin (“Fast Fore-Word,” January), an event that never fails to attract about 500,000 public visitors—the trade be damned. Every country in Europe and many in Asia host shows open to the public, not just the trade. Why can they do it, while the United States has to make do with regional events?

Simple: The United States is too large to host a single event that would be open to the public. Many members of the trade can afford to travel anywhere for a show if they have to, because the costs are tax-deductible. But how many audiophiles in Tampa, for example, could make a trip to Boston, let alone one to Seattle or San Diego? In most European or Asian countries, the distances are relatively manage-
"...smooth...refined...I've heard highly regarded $2,000 2-way 6-inchers that could not keep up with the Mini Monitor."

- Cory Greenberg, Audio Magazine

As a world leader in speaker design, PARADIGM knows what it takes to make great sounding speakers – from superb best-value budget audiophile speakers, right through to sensational PARADIGM® REFERENCE high-end systems. And now PARADIGM brings its comprehensive design expertise to an all new generation of the most affordable high-performance speakers the market has ever seen. Introducing the exceptional new MONITOR SERIES.

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able, so some hi-fi-lovin' consumer in Rome might make the trip to Milan.

Given that the public, if allowed to attend, would be unlikely to turn out in droves for a CES anyway, it's up to the press to visit the show, scope out new products, and report about them to their readers. So what does the CES management do? It seems to run the show solely to meet the needs of the exhibitors, ignoring the visitors' needs.

So unfocused and ill-conceived is the way that CES deals with high-end audio that it has forced a situation where major brands—not just insignificant little malcontents—now practice what is known as outboarding. This happens when a show is so expensive or the designated hotels so sonically challenged, disgusting, or inhospitable that certain brands choose to hold their own little unofficial shows. They must then pray that their market clout is strong enough to induce the various elements of the trade to visit them, even if they set up shop in a hotel on the other side of town.

However much I detest the official hotel, I refuse to visit outboarders. Whether it's a maker of world-class amps or some lone lunatic who thinks he's reinvented the 300B, I do not believe that outboarders deserve any coverage. The term "a free ride" isn't exactly appropriate, even given the lower costs of exhibiting unofficially, but these companies attract traffic at the expense of those who play by the rules. Any sneaking admiration I might hold for an outboarder rapidly disappears once I remember that the round trip from the busy end of the Strip to, say, the Golden Nugget can eat up an hour of precious time, time that could be spent at the booths of "official" brands.

Adding insult to injury, especially for those companies that do try to support the CES, is the choice of venue for high-end audio. (It's why the outboarders laugh at the official exhibitors.) The Alexis Park may serve perfectly well in its capacity as a motel ("hotel" seems far too grand a word for two floors of rooms built around mini-courtyards with no linking corridors), but it has few, if any, qualities that make it suitable for a hi-fi show. One can only guess at the politics that led CES organizers to choose a site that is (1) not near any of the other venues and (2) a rabbit warren so badly laid out for show purposes that it takes 40% longer to cover than it would if the near-200 exhibitors were on five or six floors of a real hotel.

God bless the weather: It actually rained in Las Vegas during CES this year, so those who find the Alexis Park less than a delight have even more ammunition against the place. Nobody could visit more than a couple of rooms without getting soaked in between. I was also reminded of an unpleasant hypocrisy in the American character. The United States purports to be the guide-light when it comes to matters Politically Correct, especially on issues involving the handicapped. So why did CES opt for a hotel whose design precludes the wheelchair-bound from visiting its upper level?

Aah, what's the use; I'm peeing up a tree. And to show that I'm not a total (post-Xmas) Scrooge, I must tell you about some outrageous new toys on display at CES. The most impressive demonstration I attended was for a product that isn't yet on the market: It embodies a new technology, Imersa, that I hope will find its way into every system having a headphone socket. Lake DSP, an Australian chip manufacturer, showed that you really can have out-of-the-head, discrete surround sound via headphones. Its demonstration was clever in the extreme. The listener sat in a chair in the middle of the room and wore headphones, even though the sound was coming from speakers. With the lightweight and open-backed 'phones, I could hear the system exactly as expected; the sound was fully encompassing, despite the fact that cans were in place. Then, at an undisclosed point, the speakers were switched off and the headphones activated. (It was impossible to tell when the changeover occurred.) So convincing was the out-of-head experience, so all-enveloping the surround, that it more than compensated for all of the previous compromises and false starts down this path, from binaural to holophonic sound to whatever other gimmick passed for surround sound from cans. And the reason why I felt confident that the Imersa demo wasn't a ruse? A well-known producer and studio habitué with a low boredom threshold was in the room with me, and he was blown away, too.

Equally unobtainable (but not because it doesn't exist) is Krell's new Master Reference amplifier [see the interview with Dan
D'Agostino in this issue. It's a monoblock good for a kilowatt into 8 ohms but doubles its power every time the impedance is halved, down to 0.5 ohm. Weight? Said to be 600 pounds each. Size? Like a small refrigerator on its back. Price? About $80,000 per pair. Which is why it's as likely to be chez Kessler this year as Imersa.

Cable skeptics should note that although prices continue to skyrocket, Tara Labs has come up with a new approach to system grounding, via external devices called Ground Stations. If you thought tri-wiring was complicated, wait 'til you get a load of these black boxes. Classic Records, in cahoots with Chesky and a bunch of hardware guys, announced a new two-channel, 24-bit/96-kHz format using DVDs—and it abides by the existing DVD-Video standard. Nagra showed a stunning prototype tube amp to match its acclaimed PL-P preamp, and Sonic Frontiers made good on its promise to deliver a CD transport with a hatch that opens up like an iris. I saw some working NXT flat-panel speakers hither and yon, which probably caused investors to issue a sigh of relief, while Quad reappeared with new electrostatics—totally unexpected but indicative of plans announced by the new Managing Director (and described in this column last month) to restore the brand to its former glory.

Voce Divina of Utah gave Italian speaker makers plenty to worry about, and Evett & Shaw showed that small speakers flanking a computer monitor needn't be plastic lumps with the fidelity of a kid's walkie-talkie. Speaking of the Italians, Unison Research turned up with a neat preamp/power amp combination that has the preamp driven by the amp's overkill power supply, and GRAAF offered a multichannel amplifier for tube devotees who want to enter the world of home theater. Jeff Rowland, too, debuted a multichannel amp (are there any high-end majors still resistant to multichannel?), and Meridian introduced what must be the world's costliest high-end DVD player, in its 800-series chassis.

Acurus returned to CES, abandoning outboarder status, with the impressively feature-laden ACT3 surround processor (my choice for Bargain of the Year). Martin-Logan finished its flagship Statement speaker and still found time to produce a new hybrid electrostatic center-channel model, the Cinema. B&W entered the home-automation field with Casa; Lexicon added DTS to its DC-1 preamp/processor; TACT showed a digital amplifier, the Millennium; WBT now offers the world's most expensive screwdriver (with adjustable torque, of course); Western Electric announced a whole new range of tubes to accompany the reborn 300B; LAMM has a new amp using Russki military bottles; Z-Systems has a multichannel digital preamp in the wings; Arcam joined forces with dCS to produce an affordable 24-bit CD player called the Alpha 9; Corey Greenberg wore a suit; the smutmeisters were isolated from the audiophiles; and everyone who attended the otherwise delightful DTS party at the Harley-Davidson Club now has impaired hearing (which, to some observers, already described most reviewers).

With all of the above going on, I suppose the indignity of visiting the Alexis Park pales to insignificance. CES is still the greatest show on earth; I just wish someone would sweep up the elephant droppings now and then.
Steve Hoffman,
DCC's master remasterer

ELVIS HAS RE-ENTERED THE BUILDING

Listen, I know I've always said that it doesn't matter how crappy your favorite records and CDs sound, they're still the best test discs to take along when you're trying to judge new gear because you're only going to notice sonic differences that are right and wrong if you care about the music in the first place.

But I have a confession to make: Even though I worship Elvis's '50s recordings on Sun and RCA, I've never used them when I've auditioned equipment. They just don't sound good enough to judge hi-fi gear with; they sound like—well, like crap! There, I said it! They're cloudy and muffled, they've got no bass, The Jordanaires all sound like they're overloading the same cheap microphone, and not one of the instruments sounds anywhere near as clear and natural as in the best recordings of the era. You put on the best Sinatra from the same period, and his voice rings like a bell. But even my cleanest Elvis records and RCA/BMG CD reissues sound like bad cassette dubs.

So it was with a mixture of shock and joy that I first heard a new CD from Dunhill Compact Classics (DCC, 800/301-6874), Elvis: 24 Karat Hits! (DCC GZS-1117). I'm telling you, I've never had an experience with an audiophile remastered CD like this one. Mobile Fidelity's CD reissue of Muddy Waters, Folk Singer shook me to my core a few years ago, but then the original LP sounded very good to begin with. DCC's own reissue of Dylan's Highway 61 Revisited was incredible, but again, the original LP was pretty good, too. Even the latest Jimi Hendrix reissues on MCA, as amazing as they are, are just the latest in a series of remastered versions that start with something good and make it just that much better.

But this DCC Elvis CD is something entirely different. Here's a case where the old CDs and LPs sound like garbage, and the remastered disc actually sounds sweeter and cleaner than most of Tower Records' Top 100! I can't believe how good this thing sounds! You have no idea what it's like for me to finally hear Elvis's voice in pure, lifelike clarity—with full, warm, natural-sounding bass and clear, open highs—and where the stereo mixes finally sound like true, wide stereo. It's just too much.

I'd always chalked up the lousy sound quality of Elvis recordings to the myth of the King bursting through the doors of a recording studio full of squares and sidemen and shouting, "Awright, man, lez GO!" before launching into the only take the frenzied engineers would have the chance to cut before Elvis hopped on his Harley and tore ass out of there with Sonny and Red in search of cheeseburgers, danger, and blank prescription pads. But I was wrong. These recordings sounded

RCA/BMG CD reissues sound like bad cassette dubs.

This Elvis disc is the most miraculous remastering job I've ever heard, bar none.

Audio/April 1998
Get serenaded by violins or trampled by dinosaurs.

Introducing the new Cinema Systems from Carver, each with powered subwoofers utilizing Carver amplifier technology.

During the past decade, there has been tremendous interest in adapting new theories, technologies and materials to loudspeaker designs of every type. As a result, "stereo" two-channel systems have been improved in accuracy and imaging, while multi-channel "home theater" systems have progressed in dynamics and clarity. However, the final evolutionary stage – where spectral, spatial and power aspects achieve perfect balance in a single design – had yet to be realized. This is the concept behind Carver's new Cinema System series – speaker systems ideal for every form of recorded sound.

Carver's own amplifier research program provides the electronic muscle for the subwoofers. Extreme bass presentation is further ensured by the use of either one, two or four extended-excision 10-inch woofers, depending on the system.

Each system element – drivers, crossovers and enclosures – was evaluated and ultimately selected from the realm of "audiophile" quality speaker components, to create systems that let you have it all – superb music reproduction combined with the power and dynamic range demanded by home theater.

Audition these new systems today – before the stampede.
great all along; they just never got transferred properly.

DCC's Elvis: 24 Karat Hits! is an all-new compilation of two dozen of the King's greatest RCA hits, featuring all-new cover art and liner notes by legendary engineer Bill Porter. With this new disc, DCC has restored some of the greatest pop music of all time to a level of sound quality that is astounding, far exceeding any previous version of this music you may have heard, even the original records. This isn't merely a better-sounding version of an already decent recording. All it took was a track-by-track comparison between RCA/BMG's best-sounding Elvis on CD, 1992's five-disc The Complete 50's Masters (RCA 07863), and this new DCC disc to convince me that this is the most miraculous remastering job I've ever heard, bar none. If you like Elvis even peripherally, you'll want to own this CD. And if you're one of the 50,000 LP Fans Who Can't Be Wrong, you'll be happy to know that DCC also did an analog-mastered two-disc LP version.

Steve Hoffman, DCC's Vice President of A&R/Engineering, is the man responsible for this and so many other extraordinary remastering jobs the label has produced over the past several years. I've admired his work for years, and the release of 24 Karat Hits! seemed the perfect reason to finally sit down and interview him.

How did you get into the audiophile remastering business?

Well, I started out in broadcasting and then I went to work for MCA Records' historical department, and that's where I learned about all the old songs, the old masters— who Bing Crosby was, things like that. Eventually I became an expert in the old stuff, the musicology and the technology. Because they really do go hand in hand. If you have a master that was recorded before magnetic tape was used in 1948 but you don't know how to properly transcribe it back so you can hear it to its fullest, then you're cheating the public out of the great joy of hearing something old that still sounds musical. So I had to learn how to do it, because no one could tell me; all the old-timers were long gone. And all these tapes were sitting around decomposing.

How good was the mastering gear you had to work with at MCA?

Oh, it was state of the art for the 1980s, but when you use modern gear, it doesn't sound as good as when you hear an old recording played back on machines of the same era. So I started collecting and restoring old acetate players and tape recorders, just so if I ever came across a certain type of recording, I could reproduce it correctly.

There's a big market today for vintage Ampex tape machines with upgraded circuitry. Basically, most of these people are audiophiles who like the old gear, but immediately they start modifying it. They don't use the original circuitry; they change it, upgrade the parts. They make it sound like a modern vacuum tube unit. But what I like to do is to take an old piece of gear and restore it exactly to the original specification. Then you can begin to get a glimmer of what they heard in the old days and why they got the sounds they did.

While you were still at MCA, you were responsible for 1985's Buddy Holly: From the Original Master Tapes (MCAD-5540), one of the best-sounding reissues ever from a major label. Were you already leaning in an audiophile direction back then?

Well, I tried there to release things that sounded as lifelike as possible. It was hard, because if you take a song like "That'll Be the Day," there might be 50 versions of it in the vault, and they're all on old tape. It was just a matter of patience. You have to sit there and listen to every single version in order to find the actual master, because none of the tapes were marked.

So how could you tell which version was the master? Just by sound?

By the sound and also by the certain type of recording tape used. I knew that Buddy Holly's producer, Norman Petty, used Audiotape brand. So I weeded out all the Scotch and all the Irish, and when I finally got down to just the Audiotape reels, the master tape wound up being in a box marked "Do Not Use!" It's almost an axiom: If it's in the box marked "Do Not Use," it's probably the master!

Shortly thereafter, you left MCA to go work for the new audiophile reissue label, Dunhill Compact Classics. What was the biggest difference between working for one of the largest record companies in the world and working for a small upstart?

DCC's owner, Marshall Blonstein, gave me absolute carte blanche to do whatever I had to do in the mastering and compiling to make things sound the best. And that's very rare in the music industry. Usually it's the producers and artists who get spoiled, but in this case, I was the one who got all the leeway and toys I needed to make it happen. Some reissue labels, like Rhino, tend to apply a pretty heavy hand to the EQ on their releases, sometimes even going as far as remixing the original instrument levels. What
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is your philosophy on remastering old recordings for new release?
I want to restore the breath of life. If it’s there on the tape, I want the listener to hear it on the CD or LP that we put out. By breath of life, I mean the illusion that this performance could actually be happening. It’s never going to really sound like it’s happening; they can argue about this in audiophile magazines from here to eternity. But if you listen to, say, one of the Nat King Cole reissues we did last year, and it sounds like it’s possible that he’s right there with you, then that’s the breath of life.
Do you use the same setup for all of your remastering projects at DCC?
No. It changes for every project. You can’t just master The Eagles’ Hotel California and The Doors and Roy Orbison on the same gear. I always try to use the same kind of tape machine, equalizer, and other gear that was used in the original mastering sessions. And I never use any kind of Sonic Solutions-type noise-reduction processing. I always stay straight in the analog mode until the very last second, when it has to go into bits.
Given that RCA/BMG has already remastered and reissued the Elvis catalog on CD several times over, what was their response when you came along and told them you wanted to do another remastering?
They were very enthusiastic. Elvis for audiophiles, that was how we pitched it, and they were overjoyed to do it. RCA/BMG was very cooperative, and they made it extremely easy for me. We got to use the original non-EQ’d, uncompressed master tapes—which, incidentally, were the same masters they’d used for the RCA/BMG CDs. I can’t believe the same masters were used for the DCC and the RCA CDs. They just couldn’t sound more different.
It’s true; we all used the same exact tapes. The RCA/BMG people were the ones who actually went through the RCA vault and found all the original tapes. If it hadn’t been for them, I would never have been able to do this disc.
If you both used the same master tapes, how can there be such a night-and-day sonic difference between your reissue and theirs?
The differences I heard go way beyond a little EQ and running the signal through tubes. The RCA discs have layers of distortion and compression, and a lot of the stereo stuff is collapsed into mono. I always attributed these characteristics to the original recordings, but they just aren’t there at all on the DCC disc.
For one thing, a lot of engineers and people in the music industry don’t like wide stereo. They don’t want to hear that; they want to hear things practically collapsed into mono. That’s their problem. I know audiophiles and I know music lovers, and they want to hear what was on the tapes. They don’t want to hear some truncated, EQ’d version. Fortunately, Elvis’s engineer, Bill Porter, and I—thanks to Michael Fremer’s introduction—corresponded back and forth, and he explained to me exactly how he engineered the sessions, exactly how he wanted them to sound, and exactly what kind of EQ he used. That helped me immensely to re-create what he was looking for.
What kinds of things did you learn from Porter about how he wanted the Elvis recordings to sound?
I remember reading an interview he did years ago where he was complaining about the sound of the Roy Orbison reissues on CD. Bill was the original engineer on those recordings, and he complained that the CD versions shaved off all the upper bass and had no warmth. So I remembered that and wanted to make sure I asked him what he was trying to achieve on the Elvis recordings. I always try to ask the original engineer, if he’s still alive, “What was your idea here?” I don’t ever want to change someone’s vision; I just want it to sound good.
You know, I read that interview too, and I have to tell you, it wasn’t until I heard the DCC Elvis CD that any of the “Bill Porter’s a genius” stuff made sense to me. The DCC reissue is such a revelation, because I can finally hear what all the fuss was about. You really expose his sonic expertise on this disc. Well, that was the idea. I worked long and hard on Elvis. It took many weeks, and
some of the songs took four or five days alone to remaster. A lot of it was just removing certain equalization things that Bill had added on there; he told me exactly what kind of equalizer he used, so I went out and found the same model, a special old Universal Audio tube EQ that boosted the high end in 5-dB steps at 12 kHz and the bass at 50 Hz. I used it to remove the added EQ, because Bill had EQ'd extra everything on those tapes, and when you do that, everything starts to overload.

**Why was he adding so much EQ?**

He was boosting the frequency extremes, so when it finally ended up on LP, there would be some high end and some low end. That was his idea. But now that we don't have to worry about that anymore and things can be cut and mastered fairly accurately, I asked him if I could please remove some of that added EQ. He said yes, by all means. And when you remove it, everything else falls into place: The hiss goes down, the distortion goes away, and it starts to sound like it actually sounded when they were doing it straight.

**Did you ever get to play Bill Porter your Elvis CD?**

Oh, yeah. He teaches a college class in engineering, and he's been using my Elvis and Orbison reissues of his original recordings as a comparison to all the other ones that are out there. He's extremely happy with them.

**Are there any plans for more Elvis on the DCC label?**

Yes. We're working on Elvis: 24 Karat Hits, Volume II.

**Will you please put "Don't" on there?**

[Laughing.] I'd love to! Those original metal parts sound so good. I heard one at Columbia back in 1985, and I almost fell on the floor. It sounded so wonderful—so much dynamic range, so much ambience coming from that little hotel room in San Antonio. But when the CD was finally released, it just sounded like an old, filtered 78. I was extremely disappointed.

See, here's what happens: There's a little bit of surface noise, so that's filtered off. Then it's compressed, and the dynamic range goes down. Then there's a lot of rumble down there, so the bass is filtered off. And after all that, it starts to sound like an old record.

But I know those original metal parts sound wonderful. They sound as lifelike and dynamic as anything I have ever heard in any other era. I remember listening to "Hellhound on My Trail" and thinking, my god, I'd never heard anything like this on the LP. So we'll see. I would love to do a reissue of Robert Johnson for DCC. You bet.
PART 2

Digital Audio for

Photograph: David Hamsley
Last month, Part 1 of this article examined in detail what is required for digital audio coding that can be guaranteed transparent for all listeners with all types of signals. This month, we turn our attention to how most effectively to code such audio for distribution.

In its analysis of this question, the Acoustic Renaissance for Audio (ARA) concluded that uniform, linear, multibit pulse-code modulation (PCM) offers the following overwhelming benefits, against which other contenders should be judged: (1) Its uniform sampling and quantization gives the option of scalability. (2) Optimal dither offers effectively infinite time and amplitude resolution and is demonstrably linear, both mathematically and in practice. (3) Psychoacoustically based pre-emphasis schemes are easily incorporated. (4) Stationary, psychoacoustically based noise shaping can be applied as a straightforward optimization technique. (5) Transparent data compression is an option to save bandwidth or storage capacity.

A distribution channel need not carry raw PCM. In fact, the choices currently available include: (1) PCM at sampling rates between 32 and 192 kHz and with word lengths from 8 to 24 bits. (2) Pre-emphasized PCM with complementary de-emphasis on playback. (3) PCM using psychoacoustically optimized noise shaping to deliver higher resolution for a given word length. (4) PCM combining the techniques of options 2 and 3. (5) Losslessly compressed PCM (what the ARA has called “packed PCM”). (6) PCM with losslessly cascadable lossy encoding. (7) PCM compressed using a lossy method (psychoacoustically based variants of which include Dolby Digital, DTS, and MPEG). (3) Bitstream coding.

We in the ARA have contended that current technology can guarantee transparency in a channel only if lossy perceptual coding (option 7 above) is not used. Underlying this point is an extremely important observation: With the exception of bitstream coding (option 8 above), all the systems start and end with linear PCM. Linear PCM, when used correctly, provides an infinite-resolution (but noise-limited) representation of the output of a microphone. We in the ARA take the purist view that we want to convey as nearly as possible the acoustic waveform of the original performance. By coding that waveform, we can attempt to replay the audio by reversing the process—the traditional goal of high-fidelity sound reproduction. This does not exclude certain legitimate concessions to psychoacoustics: bal---

J. Robert Stuart is Chairman and Technical Director of Meridian Audio and Chairman of the Acoustic Renaissance for Audio, an organization founded to campaign for establishment of a DVD-Audio standard that would assure the highest possible quality of sound reproduction.
Among the other coding methods, lossless compression, or packing, of PCM data is simply a method of delivering a bit-accurate output while reducing the quantity of data stored or the data rate transmitted in the channel. This is no different in concept from the well-known methods, such as Zip files, used in computers for storing data in less space than occupied by the original files, although the techniques for packing audio are quite different from those used to compress text and pictures. Such lossless compression is an important tool in the quest to optimize resolution and deliverable sound quality.

The ARA has strongly supported the use of lossless packing, not only because it enables much more efficient data storage and transmission but also because such compression lowers the correlation between bit patterns and audio data. This, in turn, can lead to reduced levels of correlated jitter, which is a critical factor in high-resolution digital audio systems.

For sampling rates of 96 kHz and above, designers of both lossy and lossless compression schemes have considered reducing the fundamental word rate in the distribution channel, principaliy to enable easy transmission through existing carriers or interfaces. A lossless processor, for example, can offer at least 2:1 compression on most 96-kHz audio material, effectively allowing the distribution sample rate to be halved as one expression of the reduced data rate. In principle, this lowered rate can be treated in two ways: (1) as a single, compressed, high-rate (e.g., 96-kHz) signal or (2) as a combination of a half-bandwidth version suitable for reproduction at the channel sample rate (e.g., 48 kHz) and a high-frequency touch-up signal for highest-quality playback, either of which may use lossless or lossy encoding.

**MULTIBIT PCM**

I have argued that if a well-executed PCM channel is to guarantee transparency to a human listener, it will require more than 16 bits and a sampling rate higher than 48 kHz. I have also pointed out that normal practice still does not exploit the full potential of the current 44.1-kHz, 16-bit Red Book CD channel.

If we were to change the parameters purely according to audio considerations, we might well propose 20 bits at 66.15 kHz. Such a channel would require a data rate of 1.4 megabits per second, which is twice the rate required by the current 44.1-kHz, 16-bit channel. In fact, however, there are very strong practical reasons for maintaining 2:1 relationships with the Red Book release format, with the current archive, or with video-related formats (48-kHz sampling).

Realistically, therefore, the next useful sampling rates for pure audio are 88.2 and 96 kHz.

It should be clear that increasing the bandwidth in this way will double the required data rate. In conventional audio engineering terms, that could look like a bad deal, depending on one's views concerning the value of audio content above 20 kHz and the desirability of setting standards defensively (using more data to cover up bad implementations). With that in mind, let's examine the options for reducing the data requirements of channels that run rather too fast (at 96 kHz, for example).

**NOISE SHAPING AND PRE-EMPHASIS**

There are two linear and psychoacoustically correct coding methods for improving the performance of linear PCM channels, particularly if the distribution channel uses a word length shorter than that of the original. These methods are: (1) noise shaping during a word-length reduction process to maintain a high effective dynamic range in a channel of fewer bits and (2) pre- and de-emphasis to better match channel capacity to the energy spectrum of music and to human hearing. Noise shaping can also be combined very effectively with pre-emphasis/de-emphasis, particularly if the noise shaper is designed to exploit the pre-emphasis curve.

Because the use of a high sampling rate (such as 96 kHz) allows the bandwidth of the channel comfortably to exceed the...
The unique advantage of using noise shaping alone as a method of minimizing data rate or maximizing the perceptual performance of a channel is that it requires no new options for noise shapers that can provide perceptual gains of as much as 6 bits in a 96-kHz channel!

Although pre-emphasis followed by de-emphasis was first implemented in analog systems, it can very usefully be applied to digital channels. When a link in the transmission chain requires a shorter word length (for example, when a 20-bit recording is transferred to CD), very real benefit can be obtained by performing pre-emphasis in the digital domain, quantizing with a noise shaper designed to exploit the pre-emphasis curve, and performing de-emphasis in the analog domain (or in the digital domain to a digital channel using a larger word size).

So far, all standards for digital audio have permitted the use of pre- and de-emphasis. The universal characteristic is currently 50/15 microseconds, as shown in Fig. 1. This pre-emphasis characteristic makes an increase in subjective dynamic range possible by boosting audio frequencies above 3 kHz in the transmission channel and attenuating them (and channel noise) on replay. It has not been overwhelmingly popular with the recording industry, mainly because some close-miked material does not offer in-band high-frequency headroom and because pre-emphasis brings on a mastering management issue, as its use has to be flagged. (Once again, a great potential squandered by poor practice.)

The ARA committee has proposed a new pre- and de-emphasis scheme to the DVD Forum for material recorded at sampling rates higher than 88.2 kHz. It combines a very suitable pre-emphasis characteristic with a matched noise shaper (Fig. 1 again). Figure 2 shows the output noise spectrum after application of the proposed pre- and de-emphasis scheme. You can see from the figure how a 16-bit channel operating at a 96-kHz sampling rate can have an effective dynamic range of 23 bits in the critical 4-kHz region; note also that the channel is still offer-

---

**Figure 3**—Output noise spectrum and headroom for 16-, 20-, 24-bit channels. The graph expresses dynamic range in bits. The example illustrates a capacity of almost 25 bits at 4 kHz for a 16-bit channel, a perceptual gain of 7 bits.
Lossless compression can allow the audio data more efficiently. Table I summarizes the benefits noise shaping and pre-emphasis can offer.

**Lossless compression of PCM**

Any stream of digital data representing coded audio information is in principle compressible, for two basic reasons. First, the full capacity of a rectangular channel is not occupied continuously by audio that conveys meaning. This leaves room for simple techniques like noise shaping and pre-/de-emphasis to work successfully. Second, material of interest to human listeners contains some structure that can in part be predicted. It is therefore possible to design a coding and decoding scheme that reduces the quantity of data transmitted or stored.

Doubling the data rate from 48 to 96 kHz to convey any less than twice the information is inefficient. One elegant solution is to use lossless compression in the channel. There are many methods of implementing lossless compression; most are based on the use of prediction, which reduces the quantity of data to be conveyed. An appropriate lossless compressor should: (1) return the original data intact, bit-for-bit; (2) be robust in dealing with errors in the channel; (3) be effective in reducing the data rate at high sampling rates (i.e., recognize ultrasonic content); and (4) control the peak data rate (a factor of importance in DVD playback).

The ARA has strongly recommended that high-quality audio channels be losslessly compressed (packed). Signal processing has advanced to such a level that the data-reduction benefits of this sort of coding are too good to pass by. Unlike perceptual coding or other forms of lossy data reduction, lossless compression does not alter the final, decoded signal in any way; it merely packs the audio data more efficiently into a lower data rate.

Existing lossless audio data-compression systems are optimized for reducing the average data rate but not for reducing the peak data rate or for obtaining good results at high sampling rates, such as 88.2 or 96 kHz. The process of packing PCM becomes more efficient as the sampling rate is increased. For example, packed 96-kHz audio does not double the data rate of packed 48-kHz audio, as you might expect; the increase is more like 30%.

Lossless compression can also allow the record producer to choose what trade-offs should be made between playing time, frequency range, number of active channels, and precision. The packed channel can convey this choice implicitly in its control data, and the system’s operation will be transparent to the user. This arrangement has the following benefits: (1) A producer mastering at 48 kHz can control the incoming precision of each channel and trade playing time or channels for noise floor. (2) A producer mastering at 96 kHz can also trade bandwidth for playing time, active channels, and precision. Playing time or precision can be extended, for example, by prefiltering information above 30 kHz or supplying only a two-, three-, or four-channel mix. (3) Lossless packing offers an opportunity to make a much better product, in that more precision and more channels can be provided.

**Lossless compression for DVD**

It should be apparent that any lossless compression scheme will, of its nature, be more successful in some passages than in others, so that the compressor’s output data rate will not be constant. Recently, however, a lossless compression scheme has been developed that is optimized for (but not exclusive to) DVD, in that it delivers a constant data rate in the packed domain. With this scheme, 16-bit, 96-kHz-sampled audio signals can almost always be losslessly compressed to 8 bits (and 16-bit, 48-kHz-sampled signals to 12 bits), with exact reconstruction of the original on playback.
The properties of the lossless coding scheme proposed for DVD audio are as follows: (1) output data filled out to a constant data rate to meet disc constraints; (2) output data rate typically lower than that of PCM input at 48 kHz; (3) output data rate significantly lower than that of PCM input at 96 kHz; (4) input word length continuously adjustable between 16 and 24 bits; (5) bandwidth continuously adjustable between 22 and 48 kHz, with efficient coding for these options; (6) good compression; (7) seamless transition from lossless to lossy operation (if necessary); (8) extremely simple decoder; and (9) auxiliary data stream exactly synchronized to the audio. This scheme, which uses a simple hardware or software decoder that takes instructions from the bit stream, enables great flexibility at the mastering stage. And the option remains open of substituting a more sophisticated encoder at some future time to achieve better compression.

Figure 4 shows the lossless encode/decode process. Low-frequency effects channels do not require special handling, as the encoder automatically makes bit-rate savings according to signal bandwidth. The encoder core produces a data rate that varies with the audio signal, being greatest during peaks of high treble energy. Because the peak data rate is a limiting factor in DVD, the complete encoder includes a buffer that smooths the peaks in the data rate. A corresponding buffer on the playback side allows peak data rates higher than the DVD can handle to be delivered to the decoder core. Table II shows the reductions in peak and average data rates achieved by the proposed lossless compression scheme. These levels of compression very comfortably exceed the tentative projections put forward by Gerzon in the original ARA proposal.

In DVD applications, the peak data rate is the important parameter, whereas for hard-disc storage, the average rate would be the one to examine. At 44.1 or 48 kHz, the proposed scheme can almost always reduce the peak data rate by at least 4 bits/sample in lossless mode—i.e., 16-bit audio can be losslessly compressed so that it fits into a 12-bit channel. At 96 kHz, this scheme can reduce the peak data rate by 8 bits/sample in lossless mode, which means that 24-bit audio can be compressed to 16 bits and 16-bit, 96-kHz audio can be losslessly compressed so that it fits into an 8-bit channel.

These numbers indicate that lossless compression enables more audio channels to be transmitted on a given carrier. For example, the following intriguing arrangements are possible: (1) three channels of 16-bit, 44.1-kHz audio in a Red Book CD data stream (allowing, for instance, Ambisonic B format to be issued on CD); (2) two channels of 16-bit, 88.2-kHz audio in a Red Book CD data stream; (3) four channels of 24-bit, 96-kHz audio in a DVD stream of 6.144 megabits/second (currently only two channels fit); (4) 5.1 channels of 20-bit, 96-kHz audio in a DVD stream; and (5) eight channels of 20-bit, 48-kHz audio in a DVD audio stream.

**PCM WITH LOSSY COMPRESSION**

Lossy compression schemes attempt to evaluate the component of the microphone output that is irrelevant to human listeners (either because it falls below the hearing threshold or because it will be masked by adjacent content) and to convey the essence of the sound rather than the waveform. Now, perceptual coding is not a ridiculous idea: After all, that is exactly what happens in our hearing system, and such techniques have been shown to be capable of excellent performance. However, no one in the ARA believes that any existing lossy coding system can be said absolutely to have passed the test of time with respect to complete sonic transparency. Furthermore, our current understanding of human psychoacoustics is such that it would take a very brave (or foolish) person to suggest we understand all we need to design a lossy compression coding scheme that meets all the ARA requirements.

This is not to say at all that lossy compression is wrong; it is very useful in appropriate contexts. However, if we are to be confident that we are conveying the original music event with complete transparency, then our current understanding can offer nothing beyond passing all the captured data, bit-accurate, to the playback system. That may well change in the future, but for now, I don't feel that lossy compression can be advocated for audio of the highest resolution.

**BITSTREAM CODING**

It has been suggested that a suitable distribution format might be the single-bit, perhaps 64-times-oversampled, data streams produced by many modern-day A/D converters (see Fig. 5) or even hybrid bit streams, such as eight-times oversampled 8-bit. The argument for the 1-bit scheme is that simple DACs complete the chain, allowing the stages of digital filtering in the A/D and D/A converters to be bypassed, and that the bitstream signal represents a superior archive. The data rate of such a channel is high (around 3.1 Mb/S), and even with lossless compression, a bitstream channel requires nearly three times the data required by a losslessly compressed PCM equivalent.

While it is not appropriate here to go too deeply into the arguments for and against bitstream coding, there are some very pow-

<table>
<thead>
<tr>
<th>Table II—Reduction in data rates, in bits per sample per channel, when the proposed lossless compression scheme is used.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sampling Rate</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>48 kHz</td>
</tr>
<tr>
<td>96 kHz</td>
</tr>
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**Fig. 5**—Block diagram of a delta-sigma A/D converter, showing both PCM and bitstream outputs.
Table III—Data rates per channel, relative efficiencies, and jitter susceptibility of a number of coding options. Also shown are the number of whole channels that can fit into a DVD data stream of 6.144 megabits/second (Mb/S).

### CODING EXAMPLES

<table>
<thead>
<tr>
<th>( f_s ) kHz</th>
<th>Precision, Bits</th>
<th>Noise Shaping?</th>
<th>Pre-Emphasis?</th>
<th>Lossless Compression?</th>
<th>Data Rate, Mb/S</th>
<th>Efficiency</th>
<th>Number of Channels at 6.144 Mb/S</th>
<th>Jitter Sensitivity</th>
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<tr>
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<td>3.07</td>
<td>26%</td>
<td>2</td>
<td>High</td>
</tr>
</tbody>
</table>

erful negatives, beginning with the fact that we should be aiming substantially higher for the future than accepting a 1-bit, 64-times modulator. The best current-day converters use 4- or 8-bit modulators. Furthermore, most recordings are multibit and originate in a multibit DSP environment (for example, as a result of performing a mixing or editing function). So, if the capturing A/D converter uses a different modulator architecture (such as 4-bit, 128fs) or the recording is multibit as an original, it makes no sense to convert the signal to bitstream—especially as the conversion process is inherently lossy and nonlinear. I believe that it would be a very great mistake to try to standardize the archive format, particularly to anything of such questionable audio promise as 64fs, 1-bit code.

In addition, any attempt to introduce a low-bit distribution format would face a significant difficulty because the industry has no interfaces, DSP methods, or machinery that would permit the change to be effected gradually. In fact, the inherent simplicity of bitstream coding rapidly disappears when any subsequent operations on the data are required, such as in normal editing.

Bitstream coding might be appropriate to very simple two-channel systems, but its data-rate requirement becomes unacceptable when the needs of multichannel are taken into account. It is also difficult to guarantee perfect linearity when bitstream coders based on delta-sigma modulation are used. That is because, unlike a multilevel quantizer with dither, a two-level quantizer, even with dither, is not linear. Linearity is improved by negative feedback, but performance cannot be guaranteed for all signals.

### BIT-BUDGET COMPARISONS

Thus far, we have reviewed a number of important features of the eight coding methods listed at the beginning of this article. Because we are interested here only in the highest-quality sound, I have set aside lossy compression schemes. All the remaining options on the list can be engineered to provide equivalent resolution. In the context of real applications, such as DVD, a crucial comparison is the quantity of data used by each method. Channel coding that requires more data to convey the same sound quality uses up bandwidth that could otherwise be used to convey more channels or higher-quality associated video information.

Table III offers a useful comparison. The base data rate is taken to be a 14-bit, 58-kHz channel with noise shaping, suggested last month in Part 1. If the sampling rates are

Acoustic Renaissance for Audio, "High-Quality Audio Application of DVD (Draft 0.5)," private publication, November 1996; available for download at www.meridian-audio.com/ara.


Acoustic Renaissance for Audio, "DVD: Pre-Emphasis for Use at 96 kHz or 88.2 kHz," private publication, November 1996; available for download at www.meridian-audio.com/ara.


limited to multiples of 48 kHz, then a simple rectangular PCM channel using 20 bits at 96 kHz (example 5 in the table) can meet the target performance.

When sampling is at 48 kHz, the perceptually equivalent 21-bit channel (example 2 in the table) uses 24% more data to convey less bandwidth than may be needed. Noise shaping with pre-emphasis (example 3) is close to 100% efficient, and its losslessly compressed version, at 106% efficiency, is very effective indeed, enabling eight nearly transparent channels to fit into a DVD audio stream.

Moving up to 96-kHz sampling guarantees adequate bandwidth. Examples 5 and 9 in Table III show that raw 20- and 24-bit channels use up to three times the base data rate and restrict a 6.144-Mb/S stream to two or three channels. Example 8 indicates how using the new pre-emphasis scheme alone increases efficiency, and when noise shaping is added (example 7), we see 60% efficiency, with four channels accommodated. The PCM options have medium jitter susceptibility.

When lossless compression is added (example 10 in the table), efficiency rises to 70% and five channels fit into the data stream. The highest efficiency in this group (88%) is achieved with 30-kHz band-limited lossless compression (example 11). The losslessly compressed examples exhibit low jitter sensitivity.

The bitstream options (examples 15 and 16) have the lowest efficiency of all, at 26%. They are also highly susceptible to jitter and manage to fit only two channels into the data stream. With bitstream coding, it is very difficult to offer multichannel audio or high-quality associated video.

**SUMMING UP**

In Part 1 of this article, I reviewed the issues surrounding the transmission of high-resolution digital audio. The conclusion was that audible transparency can be guaranteed by a channel equivalent to one that uses PCM coding at a 58-kHz sampling rate with either 14-bit representation and appropriate noise shaping or 20-bit representation and a flat noise floor (i.e., a “rectangular” channel). This implies that the current CD channel standard—44.1-kHz, 16-bit coding—may not always be adequate (even with noise shaping to extend the resolution) and that raising the sampling rate to 48 kHz is still not quite enough.

Sampling at 88.2 or 96 kHz is too high, on the other hand, and therefore wasteful of storage capacity or transmission bandwidth. The use of sampling rates above 96 kHz to convey a wider audio bandwidth cannot currently be justified at all. But on the assumption that practical considerations of downsampling will lead the industry to choose sampling rates for DVD-Audio that are integral multiples of 44.1 or 48 kHz (i.e., 88.2 and 96 kHz), we have looked in this installment at options for improving coding efficiency at these rates.

Noise shaping combined with a new pre-emphasis/de-emphasis characteristic for 96-kHz (or 88.2-kHz) applications can result in an effective increase of 2 to 7 bits' worth of dynamic range to the channel. At these sampling rates, in other words, a 16-bit channel should be sufficient. (Actually, a 14-bit channel can be made to yield a 21-bit dynamic range via these techniques, but the examples given are based on 16-bit channels because that is the smallest option in the current DVD standard.) This coding scheme compares very favorably with other methods of reducing the data rate, in that it offers a very low implementation cost, assures transparency, and is compatible with existing systems. I and the other members of the ARA strongly urge its adoption as a standard.

And though we consider bitstream coding and lossy compression schemes inappropriate for an audio system intended to deliver the highest possible resolution and transparency, we see considerable advantages to well-implemented lossless compression. Consequently, I have also presented here a lossless compression method that provides significant savings in peak data rate at both 48- and 96-kHz sampling rates. The savings made in the high-rate channels are sufficient to allow more than five channels to be carried in a 6.144-Mb/S DVD audio stream or to leave room for video on a DVD-Audio carrier.

**ACKNOWLEDGMENTS**

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Audio Adventure Magazine

Rotel’s RTC940 Stereo FM Tuner/Preamp with Remote
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Rhythm and music. Who could ask for anything more?
Rotel. Real hi-fi.
Dan D'Agostino is a driven man: His all-consuming passions for sound, technology, and music have made his company, Krell Industries, the Lamborghini of high-end audio. Indeed, the name Krell is now synonymous with American high-end virtues (state-of-the-art construction wrapped around powerfully transparent sound), but D'Agostino plucked the appellation from an old sci-fi flick, Forbidden Planet. It surely was the portentous line from Dr. Morbius (played by Walter Pidgeon) that caught D'Agostino's imagination—"In times long past, this planet was the home of a mighty and noble race of beings, which called themselves the Krell"—because those qualities describe his design goals so perfectly. Having chosen a marque, Dan and his wife, Rondi, launched the company in 1980 with just one product, the KSA100 power amplifier.

Dan D'Agostino's entree to audio began at age 11, when he started putting together more than his share of Heath and Eico kits. At the same time, his father was building Klipsch corner-horn speakers from plans straight out of Wireless World. By 14, Dan had graduated to a Marantz 7C preamp, a Marantz 8B power amp, and AR-1 speakers with Janszen electrostatic tweeters, all bought with money he earned "polishing the tubes and sweeping up the floors" at his hometown hi-fi shop, the Audio Center, in Niagara Falls, N.Y. He went on to receive his degree in electrical engineering at the University of California, Berkeley.

Though Krell Industries currently has nearly 100 employees, D'Agostino remains involved in nearly every aspect of his company. He conceives products, designs the cosmetics, and specifies production methods. Even the engraving tools for the faceplates and back panels of Krell components have his original stamp on them. During the course of this interview, conducted in Dan's small office, we were interrupted by a nearly constant stream of questions from various staff members, all of whom needed decisions from him.

**How did you two meet?**

Rondi: At a Consumer Electronics Show. Lord knows which one.

Dan: I'd been working on this little head amp [low-output moving-coil cartridge preamp] for myself. This was in the days of Mitch Cotter and all that business.

Rondi: For whom I worked at the time!

Dan: I told Rondi, "That guy you work for is a snake-oil salesman, 'cause the stuff he's making is really expensive and it doesn't sound that good." I'd listened to the Cotter transformer at a place called Stereo Emporium [in Buffalo, N.Y.] and thought, jeez, there's something wrong with this thing. I have a really keen set of ears for vinyl, and when I listened I thought there was some filtering going on. Something was not right. What Cotter's transformer had was an incredibly low noise floor—it had a moving-magnet...
noise floor—with moving-coil gain. And no RF interference. So I thought if I could build an active moving-coil stage that didn’t do any filtering, was immune to RF, and was extremely quiet, then I would have something better than the Cotter transformer, and it would certainly be a lot cheaper. I built perhaps 30 or 40 versions until I was happy, and then I sent one to Rondi. And when she listened to it at home and compared it to the Cotter, of course it sounded a lot better. Then she didn’t think I was as crazy as I came off.

Rondi: He was so arrogant....

Dan: I was arrogant, but when you’re 30 years old and in the business for 11 years, you have to be really arrogant or you’re not in audio anymore. If you’re not arrogant, you’re going to get your teeth kicked in a lot before someone says, “Yeah, that’s pretty good.” You have to start off from a really high place to get knocked down to where you’re a normal person again.

Rondi: I had a tube amp that blew up, and Dan romanced me with a Class-A, solid-state amplifier. [Laughter.] It was 25 watts, and it was great!

Dan: Back in the late ’70s, early ’80s, there was a shakeout in the high-end audio industry, and I looked around and I saw that there were only two high-end companies left making big solid-state amplifiers—Threshold, which had already abandoned the audiophile, and Mark Levinson Audio Systems, which embraced the audiophile. Their stuff really didn’t sound that good and was really expensive; their only Class-A amp was 25 watts, but it was $5,000 or $6,000. So I realized that what the world needed was a 100-watt, stereo Class-A amplifier of reasonable size, with big power supplies, that didn’t cost a fortune. I figured the only way to do that was with fan cooling and discrete mono power supplies. I threw the book at it, but the KSA100 retailed for just $2,200. It had a lot more power than the Levinson Class-A amp and delivered more into some speaker loads. It also was a lot cheaper than the 200-watt Levinson ML-3 Class-AB amp. I think the first amps we delivered all went to Levinson dealers. The Mark Levinson company got really paranoid, because our product came out of nowhere, from someone with no reputation in the industry. Their dealers were saying our amp was really good, that Levinson should take a look at it, and they did. Then Levinson’s president, Sandy Berlin, sent out a directive to the dealers: No one can have Krell and Levinson. So we got thrown out of all those stores, and we started going around to other dealers. Then we picked up foreign distributors.

You were on your way.

Dan: Rondi and I started Krell on a shoestring in October 1980, and we showed the first product at the 1981 CES. It was just two of us: Rondi built the first 80 amplifiers, I tested them, and together we boxed them. It was hand-to-mouth. We’d build two amplifiers, put them in our car, drive them to a dealer, get a check, and then build two more and do the same thing. So if that took 22 hours a day, then that’s what we did.

That’s how we lived; today I think it would be impossible for a company that small to survive. I think it would be really difficult to do now what we did back then. Even some of the more established names in our industry are starting to fall behind because they haven’t addressed market trends. I think two-channel audio is shrinking at such a rate that most of the dealers who would have taken on a product like our original amplifier are now gone.

Which brings us to home theater.

Dan: Home theater is growing because it’s a family thing. Audio is a hermit’s hobby, let’s face it. It’s one guy sitting between two speakers playing music he likes. Typically his wife can’t even turn on his system because it’s so complicated. What I like about home theater is that that doesn’t happen. Their kid is going to watch a cartoon, or at night they might make popcorn and put on a movie. Yeah, it’s going to shake the house, but the whole family is going to love the fact that the audio makes the movie more exciting. Everybody is going to use it. We’re not losing the two-channel audiophile, we’re just gaining the approval of his wife and family.

Rondi: I have another thought about home theater. Now that there’s more of a focus on it, the guys with the really nice sound systems are adding home theaters to those systems. They still have their two-channel audio, but they also have their home theater.

Dan: I’ve had home theaters in various forms for 10 or 12 years, and I’ve hated the sound. So when I designed the Audio + Video Standard [reviewed in Audio, December 1997], I made it an audiophile-quality processor. It was a huge undertaking; we probably have invested a couple of hundred thousand dollars in engineering in it and a year and a half of time. It uses six DSPs, and it works exactly like a computer. If you ask it to load DTS or
Ah, yes, but Krell built its reputation by pushing the limits. …

We think there’s going to be one more really good play on ultra-high-end two-channel audio, and we’re just about ready to introduce something for that market: the Master Reference monaural power amplifier. It’s going to be expensive to do that.

How expensive?

I wouldn’t be surprised if the amps will cost $70,000 or $80,000 or even $100,000 per pair. I don’t care. I’m building the Master Reference as a statement of what I can do, and I don’t want any limitations. There are no compromises with this amp, except the wall voltage, and we took care of that too. This amp draws more juice than a clothes dryer, and you wouldn’t hook up a clothes dryer yourself, would you? You’ll have to hire an electrician to do it. It’s a 220-volt appliance, but with a smart power supply. It will operate on one 117-volt, 20-ampere line or two 117-volt, 20-ampere lines, or on a single 220-volt or two 220-volt lines per amplifier! But if you want to get 24,500 watts of output power into 1 ohm, you need to run two 220-volt, 60-ampere lines. And you can do that; this amplifier has that capability. I believe there are dynamic resonances and impedances that may, in fact, go as low as 0.5 ohm, and if you’re playing your speakers really loud, you may need that much power. If the speaker can’t handle it, that’s the speaker designer’s problem. The amp will put out huge amounts of power.

I pity the poor speakers! Do you ever sit down with speaker designers to find out what they need?

You know what? I don’t; we have different design objectives. They’re trying to make speakers that can be driven by most of the popular amplifiers on the market and still sound good. If I were making a speaker, it would be very, very difficult to drive, because I know, in my heart of hearts, that I could make better speakers if I didn’t pay attention to impedances. The bottom line: If you don’t mind paralleling six identical drivers, you could make better speakers. But remember, out there in the world there are lots of single-ended tube amplifiers, push-pull tube amps, and solid-state amplifiers that are less capable and less powerful. Speaker designers have to devise speakers that work with those amps. And, by the way, the Master Reference amp also plays extremely well at low levels. Its low-level linearity is a quantum leap better than anything I’ve ever made before.

Speaking of low output levels, what do you think about the vogue for single-ended triode tube amps?

I lived this stuff before most of the guys doing single-ended amps were around. And back then there were great tubes that are no longer available. I remember single-ended amps and Williamson push-pull amplifiers with Klipschorn speakers, and I want to say, I would never pick the single-ended tube amplifier. The single-ended tubes were nice, but when you turned that Williamson on, the sound bloomed and it got big; there was dimensionality. When I see single-ended stuff coming back, I think we’re going backwards. You’re not going to pull the wool over my eyes and tell me that something that looks like that, measures that way, and sounds that way is good. I’ve eaten my spinach, and I’m sorry to say, it does not sound good. In the final analysis, there is a reason that circuits got more complicated. They did more things. They got a little bit better in one area, maybe at the expense of another, and then the engineers did more work, and they kept building on the research. Listen, I think if you took a panel of people, even nonaudiophiles, put them in a room, played music for them with a big amplifier, and compared that to a little single-ended amplifier, they would never pick the small amp. No one would pick it. It’s amazing to me that the industry embraced this. We’ve lost those people.

Your company has built its reputation on the strength of stratospherically priced gear, but in recent years, with the KAV line, you’ve introduced fairly reasonably priced components.

I never wanted to do that. But I was talking to my French distributor, and he said that integrated amplifiers were selling really well and suggested that Krell make a $2,000 integrated amp. I thought it was feasible, but I wasn’t so sure I wanted to do it. I started batting it around, and in its first iteration, it couldn’t sell for less than $4,500 to $5,000. But then I came up with a front end and output stage that embraced all of the things we do in the big stuff, but it wasn’t really expensive to build. We started using extrusions for front panels instead of solid billets. That was the KAV-300i, which came out at $2,350. As it turned out, the French distributor probably sold five pieces. But the rest of Europe got on board, the Far East got on board, and our U.S. dealers did as well. Now we’re selling 250 to 300 units a month and have been for more than two years. We’ll be adding a Day Sequerra-designed tuner to the KAV-300i. …

The Krell receiver!
It's kind of full circle, eh? There'll be a 150-watt/channel receiver, the KAV-300r.

You've done some outside consulting over the years. We designed the output stage for the Day Sequeria Reference tuner, the original Aragon 2004 and 4004 power amplifiers, and Aragon's first preamp. We've also designed electronic crossovers for Martin-Logan, JBL, and B&W, and we built the amplifier and power supplies for the Apogee Grand loudspeakers.

When you're working on a design, how do you "know" what it sounds like? What's the process?

It does take a fair amount of time to hear that, usually weeks and weeks. I start by listening with Etymotic Research ER4 headphones that were specially adjusted to compensate for the frequency response of my hearing. Later, I'll do more listening on the Wilson Audio X-1 speaker or something like that. For the Master Reference power amplifier, I probably put in close to a year of listening to different stages during its development.

It's amazing that you're known for designing massive amplifiers, but the bulk of your critical judgments are made listening over headphones.

Let's take as a given that I know how to drive speakers. Now, if I have that part figured out, then the only thing I'm interested in is the tonality. By using headphones, I'm eliminating the room and all sorts of variables; I'm just listening to tonality. And I'm also looking for low-level information, 'cause I know what the big stuff is supposed to look like. I'm looking very, very closely at the low-level stuff, the dirt—the stuff that's way down there around -110 dB, where all the dirt lives. That's why I really need headphones to tell me how an amplifier sounds. It's interesting. Seven or eight years ago big amplifiers had to be driven to a certain level before they began to sound decent; at lower levels they didn't do so well. That's something we worked on. I think the secret to making really good solid-state amplifiers is paying attention to their low-level resolution. So when our customers are listening at very low levels over speakers, the amps sound great. And when they turn them up, they'll still sound great. They shouldn't shift gears.

What is it, exactly, that you're listening for?

I like the sound to be big and robust. I don't want it to be bright or hard, but I do like definition. I don't want to leave the detail on the floor. I like it to be there, but I don't want it to be aggressive.

High-end companies like yours do substantial export business.

High-end companies like yours do substantial export business.

It represents around 50% of our production. We were the first American high-end company to crack the U.K.; until that point American product was labeled "agricultural." [Rondi laughs.] Hong Kong is one of our top markets, followed by Germany, Japan, Korea, and the rest of Europe. I dedicate 50% of my output to the U.S. market, though I sometimes have foreign distributors screaming for more product. There are some high-end companies whose sales are 80% to 90% export.

You're still driven; what keeps you going?

My mission won't be complete until I make Krell the largest single-proprietor high-end audio company ever. I'm a driven person; I don't like failing at anything, so I just keep at it until I make it right. I'm still doing it. It's still never good enough for me, so I just keep making my designs a little better and then a little better still. But it's never good enough. I look at the stuff—I do—and I say, that's great, but I think I can do better. Let's do it over. I talk to customers on the phone. I want to know how they've been treated by the receptionist and how the salespeople treated them. I want to make improvements. And you know what? There's a niche market for people who want the best, and everything we do is based on quality first. Everything else is secondary.
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Newport Beach, California .............................................. Home Theater Expo • Hyatt Newport (Ocean Room) • October 9th - 13th
Oakland, California ....................................................... 4231 Park Blvd. (Oakland Hills) • J. Nelson & Co. • October 17th & 18th
Atlanta, Georgia .......................................................... 3315 Chamblee-D bonus Rd. • Alber Organ Studio of Atlanta • November 14th & 15th

All show times are Saturday 12 pm - 6 pm, Sunday 11 am - 4 pm unless otherwise noted
When the New York Philharmonic issued its 10-CD set of historic broadcasts (1923 to 1987) late last fall, even the crustiest critics hastened to sing the collection's praises. Among the most significant orchestral compilations ever to see the light of day, the set's artistry is as much in the music-making as in the technology that serves it.

Having made the savvy decision not to go with a commercial label and issue the disc independently, the orchestra—the players as well as the administration—had a hand in everything, from repertoire and soloists to producers and packaging.

Given the immense amount of material—12+ hours of music comprising 32 performances, 21 conductors, and 18 soloists—and the ragged shape that much of it was in, it's surprising that it took less than 10 months to compile and issue this set. Especially surprising given that the producer, historic recordings buff Sedgwick Clark, likes to polish things endlessly before letting them go, that every selection had to be approved by both the orchestra and music director Kurt Masur, and that engineer Seth Winner moved his studio in the middle of the project.

Before commencing his hundreds of hours of listening, Clark—a writer whose credits include editing the late, great Keynote—asked for a list of all the orchestra's broadcasts, from 1923 to 1987. (In 1922, the Philharmonic was the first major orchestra to broadcast a live concert.) "The first thing I looked for was whether the conductors recorded these pieces commercially or not. I also looked for rare combinations of artists," for instance, Artur Rubi-
stein and Bruno Walter performing Chopin's First Piano Concerto. This collaboration never saw the light of day on a commercial record, since the artists were under contract to different labels.

The set abounds with such heretofore unissued rarities: Walter conducting Richard Strauss's underappreciated tone poem *Symphonia Domestica*, Nadia Boulanger in a rare stint on the podium with Fauré's Requiem, Arturo Toscanini conducting Henry Wood's delightfully bloated orchestration of Bach's Toccata and Fugue in D Minor. Clark's goal was to showcase the orchestra in as broad a context as possible, balancing historical significance with, heaven forfend, audience appeal. "The whole idea of this set is to present
the virtuosity of this orchestra over 64 years," he says.

After a couple of months of listening, Clark brought his wish list to Masur, who checked off those performances he liked. The music director's input was by no means token. Consider the case of the 1960 broadcast of Brahms's Symphony No. 2; it was led by Fritz Reiner, who never recorded the work commercially. "I told Masur I thought it was a good, solid performance but that I found it lacking in energy," says Clark. "And he said, 'Well, you know, sometimes Americans like fast performances, and those are the kind they find the most exciting. But a slower performance might just appeal to me—I might like that.' And I said, 'Great, it's in.'"

Clark auditioned material over a five-month period, usually in his living room in East Hampton, Long Island. "Sedge was in heaven," reports the set's other engineer, Jon Samuels. "He used to say, 'And I'm actually getting paid to do this!'"

"And then," interjects Winner with droll humor, "he roped us in."

Winner and Samuels, friends and colleagues for more than 20 years, have their own studios and are collectors in their own right. Winner, a sound-preservation engineer for the Rodgers and Hammerstein Archive at Lincoln Center (from which much of the early source material came) worked on both the Heifetz and Toscanini collections for BMG, among other projects. Samuels, a freelancer at BMG studios, was also involved in those projects and served as producer for a recent nine-CD William Kappell reissue set.

"The input from both of these guys was invaluable," says Clark. "While I was the one who chose the performances, they're the ones who knew where the bodies were buried. It's one of the major reasons I chose them, because their knowledge of historical recordings is second to none."

The later material, from 1963 to 1988, came from the orchestra's own archives, stored at Lincoln Center and in Iron Mountain, N.Y.; earlier broadcasts were culled from the R&H Archive and, significantly, from private collections. As word of the project spread, collectors, in turn, suggested other sources; Clark, ever vigilant, had to hear them all. "If it had been up to Sedge," laughs Samuels, "we never would have finished."

"And if it hadn't been for [Philharmonic archivist and the set's executive producer] Barbara Haws telling me we have to get this out," says Clark, "I'd still be listening."

The two engineers divided up the project: Samuels, working on his own, did most of the tape material—the last three CDs; Winner worked with Clark on the rest.

"Since I have a full-blown CEDAR system with a digital editor, it was logical I should get all the lacquer material," says Winner. "I also did the final remastering and assembling of the package. Sedge and I sat there and discussed things like audience noise, fade in, fade out on the applause, level corrections, and so forth."

While Samuels had professionally-made original tape recordings from which to work, Winner was dealing with far dicier sources—usually air checks made by amateurs. "Just the collector sitting there with his tuner and tape recorder putting on a reel of tape [or, earlier, a disc] and letting it fly," he says. "In a way," says Samuels, "I had too much, Seth too little. And either way, there wasn't a single source in the entire collection that was easy to reproduce."
Samuels’ biggest problem was documentation. Determined to reconstruct the original master tapes rather than simply use one of the copies sent to the radio stations, he started from scratch. “Sedge and Barbara would send me every single tape they could find for a particular series of concerts. There would be about 10 different tapes, all unlabeled.” In one instance, he spent 18 hours just searching for the right takes—before beginning any editing or processing. Fortunately for the Philharmonic, the producer and engineers agreed to work for a flat fee rather than charging by the hour.

“One wonderful thing I did for Jon was to find him six different sources of the Brahms Second with Reiner,” recalls Clark. “Yeah, after I had finished it twice,” retorts Samuels. “Sure, but better sources kept turning up,” says Clark with a big grin. “Michael Gray at the Voice of America sent me copies that had been sitting in his office since 1987, and they were better than anything else we’d heard.”

Other sources were farther afield. Determined to include Bruno Walter’s 1945 broadcast of the Symphonia Domestica, Clark hopped on an airplane to Columbus, Ohio, to borrow a recording from 83-year-old collector Robert Buchsbaum of Coro-net Recordings. “The discs at Lincoln Center had two gaps in them, at the turnover points,” Clark reports, “and we wanted to plug the holes. Buchsbaum’s source turned out to be better than what we had, so we used his for most of it. But one of his discs was cracked.”

“I had never seen one like it,” Winner remarks. “During the War, they used glass-based discs, but this was the strangest one I’d ever seen. It was cracked only on one side; the other side was intact.”

“Of course, the side we wanted was cracked,” continues Clark. “There were two 16-inch discs and a 12-inch, which was the one giving us problems. After three minutes into the side, it would not track.”

“It was a bit frustrating,” says Winner, “but I finally got it, then cut back into the library source, then back again to Buchsbaum’s.”

“Now, you might ask, why did we go through all this?” says Clark rhetorically. “Richard Strauss’s Symphonia Domestica is generally considered his least successful tone poem. Everyone says to me, ‘Oh, I hate that piece.’ But I felt it was very important that people hear what can be done with it. Walter never recorded it, this is the best performance I’ve ever heard, and the orchestra plays fabulously.”

But Clark did not always get his way; he has maintained from the beginning that both the orchestra’s and the music director’s contributions were key to the project’s success. “The thing that makes me the happiest about this set is that the players seem to love it. That means we did our jobs well, which pleases me no end.”

He and Winner had two two-hour listening sessions with the orchestra. The players were welcome to attend, and in at least one case they rejected a performance. Clark had chosen a 1948 broadcast of Charles Munch conducting Chabrier’s “Marche Joyeuse.”

“It was a little three-minute piece, a lot of fun,” he recalls. “I put it at the beginning of the disc; it would have been a great curtain raiser. But one of the musicians commented, ‘They’re not playing very well.’”

“Masur said, ‘This is sloppy; they’re not together,’ ” recalls Winner. “To me, it was a devil-may-care performance, very boisterous,” continues Clark. “Sure, it was loose, but there was a great deal of verve and excitement and fun. However, they thought it was sloppy, so out it went.”

The musicians were also on the lookout for technology overkill. When Winner
played the 1940 broadcast of Stravinsky conducting Tchaikovsky’s “Little Russian” Symphony in its pre- and post-processing versions, the orchestra raised a red flag. Recalls Clark, “Masur said, ‘Sometimes you can do too much, and it takes the music out.’ They suggested that we go back and do a different mix. We did, and they liked it very much.”

To be sure, the performance is the thing on this set, for this is a case where technology—in the form of CEDAR and Sonic Solutions’ NoNoise—has been applied artfully. So aural smog and snow are still in evidence. Says Clark, “I think a lot of producers and engineers go overboard in historical releases; in trying to get detail, they lose tone quality. There were times when I’d say to Seth, ‘Yes, you’re getting more detail, but the tone doesn’t strike me right.’ So we’d work on it, and he’d say, ‘Yes, okay, but now you’re losing this detail.’ He was right, but I felt we had to go with what sounded the most musical to my ears.”

“Actually,” inserts Samuels, “it’s extraordinary that Seth didn’t kill Sedge. On the other hand, it’s an extraordinary product. And, to be fair, you only get one chance, so you may as well do it right.”

Virtually all of the source material had problems, whether from the pickup in the hall, the broadcast signal, the actual recording, poor storage, stone-age technique, or all of the above. Samuels recalls how the channels were reversed on the 1977 premiere broadcast of John Corigliano’s Clarinet Concerto, conducted by Leonard Bernstein; Winner remembers that his primary source for the third movement of Shostakovich’s Violin Concerto with David Oistrakh (1956—the American premiere) muted for 30 seconds and that a 1952 broadcast of Kirsten Flagstad singing the “Immolation Scene” from Wagner’s Götterdämmerung sounded like there had been “a trained orangutan at the controls.”

“The broadcast engineer had no clue of how big her voice was,” Winner explains. “When she opened her mouth, the sound not only came at you, it went around you, underneath you, and totally enveloped you—no matter where you sat in the hall. Well, she’s standing in front of the mike, or at least one of two for that broadcast, and every time it gets loud, you hear them bring the level down. Then, when they think it’s safe, they bring it back up. Then, of course, another wild cry out of her, and down it goes.

“Actually, I worked with two different sources,” Winner continues. “In the major source I used, the guy started the tape recorder too late; he missed the opening bar or two. So I literally taped the beginning from another tape, EQ’d it, pitched it properly, and then dubbed it in. Then there were little dropouts that had to be fixed, a little piece of oxide missing on the tape, curl damage, and so forth.

“But the most fun, before I even did any level correction, was that this was a very bass-deficient broadcast. I tried some of the wackiest digital curves I have ever come up with to get the bass back in.” In fact, throughout that alternate source, the recording level was too low. “About two minutes in,” continues Winner, warming to the subject, “the guy suddenly realizes that his levels are too low and jumps it about 10 dB, so I had to do a level correction and then create a cross-fade.” All told, Winner estimates he performed about 100 level corrections on approximately 161/2 minutes’ worth of music. By the time Clark approved the final mix, admits Winner, “I never wanted to hear the thing again.”

He may get another chance to relive the experience, however—if not with Götterdämmerung, then perhaps, as rumor has it, with Mahler or Bernstein. The success of this set, despite its hefty price tag of $185, has prompted the Philharmonic to consider doing another archival project. Whatever that may be, if the same tender loving care is applied by the same team, it’s sure to be another triumph for the artful cohabitation of historic recording and modern technology.
“Everyone who heard the Vienna Acoustics speakers — including the snobbiest listener in our office — loved the sound, loved the looks, and wanted to take them home.”

[Home Theater]

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Paul Klipsch, who founded his speaker company in 1946 (when I was just six years old!), has always been a maverick. He was a vociferous advocate of horn-loaded speakers—so much so that he named his first conventional box speaker the Heresy. During the '60s, '70s, and '80s, he wrote a series of consumer-oriented monographs on speakers and related technical topics (no longer available, alas) and, since the company was in Hope, Ark., named that series “Dope from Hope.” The company, now owned and operated by Paul’s second cousin, Fred Klipsch, still has its manufacturing and engineering facilities in Hope, but its head office is in Indianapolis.

Unlike the original Klipschorn (which is still available, for $5,798 per pair), the Model KSF 10.5 uses a bass-reflex woofer rather than a horn-loaded one; its tweeter, however, is a horn. Poorly designed horns can color sound, but well-designed horns offer many advantages. For one thing, they match the speaker diaphragm’s mechanical impedance to the acoustical impedance of the air. This improves dynamic range by increasing power handling, output, and efficiency and by reducing distortion. Because efficiency reduces heat buildup, horn speakers can be more reliable. Horns can also offer precisely controlled horizontal and vertical coverage patterns.

The KSF 10.5 is the larger of two tower speakers in Klipsch’s 18-model Synergy line (which includes bookshelf, center-channel, and surround speakers as well as powered subwoofers). Its vented enclosure holds two 8-inch, long-throw woofers, coupled with a medium-sized constant-directivity horn tweeter; these drivers are all designed and manufactured by Klipsch. Although the horn is square (63/4 x 63/4 inches), it provides 90° horizontal and 60° vertical coverage. The enclosure’s vent tube has a large, 23/4-inch diameter, and is 7 inches long. Its exit, near the bottom of the rear panel, is generously flared to reduce air turbulence.

To minimize diffraction, the KSF 10.5’s woofers and horn are flush-mounted on the front panel, which is about 5/8 inch thick. The rest of the cabinet (made of medium-density fiberboard) comprises 3/4-inch panel.
els, stiffened by a brace, 2 inches x 1/4 inch in cross section, between the sides. The molded-plastic grille frame plugs into six rubber bushings on the front panel. On the bottom are large, molded-plastic feet, 2 inches in diameter x 1 inch thick. Spikes are not provided, but you can unscrew the supplied feet and replace them with spikes if you prefer.

The tweeter’s molded-plastic horn flares out in a complex curve called a tractrix, whose properties were described by Klipsch engineers in the March 1991 issue of Audio. The horn emerges from a small compression driver, so-called because sound waves from the tweeter’s diaphragm are compressed as they travel through the horn’s much smaller throat (which is actually inside the driver); the area of the entrance to the throat is usually just 10% to 20% that of the driver’s radiating diaphragm. The tweeter has a large ceramic magnet, 2 3/4 inches in diameter x 3/8 inch thick. An identical magnet attached to the rear of the driver, in reverse magnetic polarity, acts as a bucking magnet to cancel or reduce external magnetic fields. This, and similar bucking magnets on the woofers, enable the speaker to be used near a TV screen.

The woofers have mica-filled polypropylene cones, butyl rubber surrounds, and high-temperature Kapton voice-coil formers. Their ceramic magnets are 4 inches in diameter x 1/2 inch thick.

The crossover feeds the parallel-connected woofers through a fourth-order (24-dB/octave) low-pass filter, while the tweeter is driven by a third-order (18-dB/octave) high-pass filter; the nominal crossover frequency is 2.2 kHz. The crossover’s 11 components (three resistors, four iron-core inductors, and four nonpolarized electrolytic capacitors) are mounted on a small circuit board behind the input terminal cup, which is just above the port on the rear panel. The speaker’s input is a single pair of gold-plated, five-way binding posts spaced 3/4-inch apart, enabling use of double-banana plugs. The crossover is connected to the drivers by 16-gauge stranded wire and clips.

Measurements

Figure 1 shows the KSF 10.5’s anechoic frequency response; the curves combine ground-plane bass measurements with midrange and treble measurements taken in a large anechoic chamber. Response is quite smooth and flat below 1 kHz but rises and becomes bumpy above that frequency, then rolls off above 13 kHz; this is more evident in the unsmoothed curve (taken with the grille on) than in the smoothed (grille-off) curve. Overall, the curve taken without the grille fits a loose, 9.5-dB, window between 49 Hz and 20 kHz (+5, -4.5 dB, referenced to 1 kHz) and fits a much tighter, 2.5-dB, window between 66 Hz and 1.4 kHz. Between 2 and 7 kHz, the grille causes significant response deviations. Averaged from 250 Hz to 4 kHz, the KSF 10.5’s sensitivity measured a high 92.5 dB.

Figure 2 shows the KSF 10.5’s phase and group-delay responses, referenced to the tweeter’s arrival time. The phase response of direct-radiator speakers typically slopes off at a roughly constant rate. But in this case, the phase response has nonlinear characteristics, with distinctly different slopes in the region below 400 Hz, from 400 to 800 Hz, from 800 Hz to 4 kHz, and above 4 kHz. This is reflected in the group-delay curve, which exhibits peaks and dips in these regions. In addition, this curve indicates that there is significant delay through the crossover region, reaching a maximum of 0.4 millisecond at 2.5 kHz. To
To minimize waveform distortion, a device must have linear phase response (which would be visible if the graph had a linear frequency scale rather than the log scale I use in order to cover the entire audio band) and constant group delay. And its phase curve must pass through 0° (or a multiple of ±360°) when extended to 0 Hz, the phase intercept. The curve of waveform phase that I sometimes present in my reviews displays the phase-intercept angle as a function of frequency. The KSF 10.5's waveform phase (not shown) is near zero only between 500 Hz and 1 kHz, so this speaker will preserve wave shapes only in that frequency range. In general, however, the only speakers that do preserve wave shapes are those specifically designed to do so, which are few in number. So the Klipsch is actually fairly typical, or even a bit better than usual, in this respect.

To investigate the phase relationship between the tweeter and woofers at crossover, I measured on-axis frequency response with the tweeter connections reversed. Reversing the tweeter's phase caused an octave-wide response dip between 1.2 and 2.3 kHz, reaching 13 dB at 1.9 kHz, and a rise in response between 2.3 and 4.6 kHz, which reached a 7-dB peak at 3.2 kHz. This indicates that the tweeter and woofers are mostly in phase around 2 kHz and somewhat out of phase above 2.3 kHz. Lobing (which makes a speaker's output higher above or below the axis than on it) will therefore be minimal around 2 kHz but significant above 2.3 kHz.

The KSF 10.5's horizontal off-axis responses (Fig. 3) are extremely uniform all the way to 20 kHz within the main, ±15°, listening window. As you move farther off axis, the coverage above 12 kHz narrows. The vertical on- and off-axis responses of the KSF 10.5 (Fig. 4) are quite uniform except in the crossover region, between 1 and 4 kHz, where response is flat only within ±5° of the axis. Farther off axis, significant peaks and dips emerge. Although you can't see it clearly, the upward and downward responses are not symmetrical, because of lobing.

The KSF 10.5's impedance magnitude (Fig. 5A) exhibits the classic twin peaks of a vented-box enclosure. The frequency of the dip between the peaks indicates that the enclosure's tuning frequency, where the woofer's excursion and distortion are at a minimum, is approximately 30 Hz. The 23-ohm impedance at 61 Hz is rather high, but overall the Klipsch is closer to being a 4-ohm load than its rated 8 ohms. From 20 Hz to 20 kHz, the impedance range is a moderate 5.8 to 1. As a result, cable series resistance of 0.05 ohm or less should keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet, that would correspond to 14-gauge (or larger), low-inductance cable. The maximum impedance phase (Fig. 5B) within the audio range is about +38°, and the minimum is about −50°, so a single KSF 10.5 should be a relatively easy load for any amp.

A high-level sine-wave sweep revealed that the cabinet was fairly rigid, though its back panel did vibrate at 148 Hz. The slight buzz I heard with this test signal seemed to come from inside the bottom rear of the cabinet, so it may have been caused by vibration of the crossover board or input terminal cup.

The 8-inch woofers had a generous 0.55-inch excursion, peak to peak, and didn't make harsh sounds when overdriven. Excursion reached its minimum at 31 Hz, the vented enclosure's resonant frequency. Only a slight amount of dynamic offset distortion was evident.

To measure raw and smoothed 3-meter room responses (Fig. 6), I placed the KSF 10.5 in the right-hand stereo position and aimed it toward a test microphone placed at ear height (36 inches) at the listening position. The smoothed curve fits within a fair-
ly tight, 10.6-dB, window overall and within a much tighter, 5-dB, window between 2.3 and 15 kHz. No significant peaks or dips are evident.

The KSF 10.5’s E₁ (41.2-Hz) harmonic distortion is shown in Fig. 7. At a maximum power of 50 watts (20 volts rms into the 8-ohm rated impedance), the speaker sounded fairly clean, as implied by the moderate second and third harmonic distortion levels of 13.5% and 13.6% and the very low, 1%, levels of higher harmonics. At 41 Hz, the KSF 10.5 generated a fairly healthy 100 dB SPL at 1 meter in a free field from a 50-watt input.

At A₂ (110 Hz), the only significant harmonic is the second, at a moderate 17.2% (Fig. 8). The level of the third harmonic is just 1%, and higher harmonics are essentially below the floor of the display. At 110 Hz, a 50-watt input generated a loud 109 dB SPL at 1 meter in a free field.

Figure 9 shows the KSF 10.5’s intermodulation (IM) distortion versus power, created by 440-Hz (A₄) and 41.2-Hz (E₁) tones of equal power. The IM distortion increases gradually, reaching a moderate but quite audible 13.9% at 50 watts.

THE KLIPSCH KSF 10.5s SOUNDED VERY DYNAMIC, PLAYING LOUD AND CLEAN.

Short-term peak power input and output are shown in Fig. 10. Peak input power starts out fairly strong, 55 watts at 20 Hz, and rises quickly to 360 watts at 35 Hz. It then swings between 230 and 620 watts to about 250 Hz before falling into a trough of about 230 watts between 500 Hz and 1.5 kHz. At higher frequencies, in the tweeter’s range, the power-handling capability rises rapidly, reaching 4 kilowatts above 6.5 kHz.

Why the trough at 500 Hz? Most two-way speakers I’ve tested have significantly greater power handling (and acoustic output) in this range, but the Klipsch sounded harsh and distorted at higher levels. Suspecting crossover-inductor overload, I disconnected the woofers from the crossover and drove them directly from my test amplifier. As I suspected, the maximum power I could feed to the woofers was dramatically higher, reaching about 4.5 kilowatts at 1 kHz (see Fig. 10, “Direct to Woofers” curve), an increase of nearly 13 dB! Driven directly, the KSF 10.5’s output at 1 kHz was very loud and clean. Driven through the crossover (at a level just below the point where distortion was objectionable), the speaker sounded rather anemic.

Not surprisingly, the same trough can be seen in Fig. 10’s curve for peak acoustic output. At 20 Hz, peak output starts quite strong at 96 dB SPL and rises rapidly through 100 dB at 24 Hz, 110 dB at 32 Hz, and 120 dB at 148 Hz. After staying around 120 dB SPL to about 300 Hz, the output then decreases, reaching about 115 dB between 500 Hz and 1 kHz. At higher frequencies, the maximum output rises rapidly to around 130 dB, which is very loud. Judged by the frequency at which its acoustic output reaches 110 dB SPL, the KSF 10.5’s bass response is in the top third of the speakers I’ve tested, a very good ranking for its size.

Use and Listening Tests

It was refreshing to handle a tower speaker that’s not a hundred-pound behemoth. The 55-pound Klipsch KSF 10.5 was significantly easier to unpack, move around, and set up than other speakers I’d reviewed recently.

I was quite impressed by the Klipsch’s overall look and by its build quality. The speakers supplied to me had a rosewood finish except for the grille and front panel, which were black. The “rosewood” is a vinyl veneer rather than real wood, but it’s so well done that only close inspection by an experienced eye is likely to reveal this. The cabinet’s good looks are greatly enhanced by the bezel, carrying the distinctive Klipsch logo, that runs across

Fig. 7—Harmonic distortion for E₁ (41.2 Hz).

Fig. 8—Harmonic distortion for A₂ (110 Hz).

Fig. 9—IM distortion for A₄ (440 Hz) and E₁ (41.2 Hz).

Fig. 10—Maximum peak input power and sound output.
The KSF 10.5’s owner’s manual covers the whole Klipsch Synergy series, including the KSF-C5 center channel and the KSF-S5 surround. It goes into moderate detail about speaker placement, connections, warranty, and general setup of your stereo or home theater system. But if you’re in the market for a Klipsch speaker, I suggest you ask your dealer for a chance to read his copy of the company’s 30-page New Product Training Manual. I was quite impressed by this tutorial, which even includes lists of CDs and specific tracks that demonstrate certain features of these speakers.

The KSF 10.5’s readily accessible input connections made the speakers easy to hook up. The system I used them with included an Onkyo CD player, a Krell KRC preamp, a Crown Macro Reference power amplifier, Straight Wire Maestro cabling, and a pair of B&W 801 Matrix Series 3 speakers for comparisons. The first thing I noticed when I listened to the Klipsch KSF 10.5s was their high sensitivity. They were significantly louder than the B&W 801s when driven by identical signal levels. For direct comparisons, these Klipsch speakers needed to be attenuated by 7 dB (using a passive line-level attenuator in the tape loop of the preamplifier) to make them approximately equal in loudness to the B&Ws. For speakers of equal impedance, that would translate to an input power requirement only one-fifth as great for identical output levels. Two main virtues Klipsch claims for its speakers are high efficiency and sensitivity, and this claim is certainly justified for the KSF 10.5.

The 10.5s sounded quite dynamic. They could play loud and clean, particularly on rock, big-band jazz, symphonies, and sound effects. Bass was smooth and extended, and the impressive reproduction of pipe-organ pedal notes is unsurpassed by all but a few speakers of the 10.5’s size. When listening to female vocals, I could hear that the Klipsch’s upper midrange and treble were not as smooth as the B&W’s. The KSF 10.5’s imaging and soundstaging, however, were first-rate; center images were very stable, even when the frequency content of the centered image changed.

The KSF 10.5s superbly re-created the near-live excitement and impact of Dave Younger’s Western Hero (Clarity Recordings CCD-1011) at realistic levels. (I highly recommend this CD, which was made with two microphones and no editing or processing. It is one of the very few audiophile country recordings around.) Younger’s vocals sounded slightly more up-front through the KSF 10.5s than through the 801s, and I noticed a slight harshness on his voice through the 10.5s that I did not hear through the 801s.

On the low-frequency, third-octave, band-limited pink-noise test, the KSF 10.5 generated some usable output at 20 Hz, good usable output in the 25-Hz band, and strong output (equal to the 801’s) from 32 Hz up. Wind noise from the 10.5’s port was quite low.

The Klipsch KSF 10.5 was only average in its ability to maintain the same tonal balance for seated and standing listeners; the tone of the upper midrange changed noticeably when I changed positions. The octave-to-octave spectral balance on pink noise was quite acceptable, although there was some upper-midrange and treble tonality. The 10.5’s voicing was tilted somewhat toward the high end, providing slightly less low bass and more treble than the 801.

When I tried the Klipsch KSF 10.5s in the main channels of my home theater setup, they performed faultlessly. They were particularly good in reproducing loud effects, such as explosions and gunshots, yet also capable of delivering depth and realism on symphonic soundtracks.

I give the Klipsch KSF 10.5s a solid thumbs-up, with only minor reservations—particularly considering their modest price. Their high sensitivity is a refreshing change compared to other speakers of equal or higher price. And their fine looks and overall performance will make them a good addition to any stereo or home theater setup.
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Although the Philips CDR 870 isn't the first CD recorder on the consumer market, it's currently the least expensive, by a wide margin. Even more exciting, it is the first stand-alone unit that records CD-RWs (rewritable CDs) as well as CD-Rs (record-once CDs).

The CDR 870 can use only "consumer-audio" CD-Rs and CD-RWs, on which a royalty has been paid to compensate musicians, composers, and lyricists for the possibility that their works might be copied. This makes consumer-audio CD-Rs five to ten times more expensive than computer/ professional CD-Rs, which are identical except for the royalty code that home audio recorders check for.

Needless to say, the CDR 870 checks the Serial Copy Management System (SCMS, known as "scums") flag before permitting digital dubbing. With SCMS, you're allowed to make digital copies of original material but you can't digitally dub a dub, even though you've paid a royalty on the recordable disc. (Bootleggers, of course, know how to get around this nonsense, and professional recording gear doesn't use SCMS. Therefore, the law doesn't really protect artists; it just gets in the way of consumers enjoying their hobby.) The CDR 870 also encodes a 97-bit Recorder Unique Identifier code on all discs it records, so that any unauthorized recordings you do make can be traced back to you.

Rewritable CDs, i.e., CD-RWs, cost more than CD-Rs, but you can erase and rerecord them a thousand times or more. (I doubt you could do that to a cassette without wearing it out.) However, there are limits on CD-RW rerecordability. You can delete the last track if the disc hasn't yet been "finalized" (which involves copying the disc's temporary table of contents, or TOC, to the area on the disc where CD players look for it). You can also wipe the entire disc clean, before or after finalization. But you can't cherry-pick tracks for erasure.

Being able to erase the last track on a CD-RW means that you can fix mistakes and recoup the recording space that otherwise would be wasted. This isn't possible with CD-R, although some CD recorders (but not this one) permit you to "edit" CD-Rs by "deleting" tracks prior to finalization. This doesn't erase the "deleted" tracks; it just removes them from the disc's TOC. Some players may then skip over that portion of the disc, but you don't get the recording time back.

Ordinary CD players cannot read unfinalized CD-Rs and can't read CD-RWs at all. (Recorders, of course, can read unfinalized discs.) We can expect the ability to read finalized CD-RWs to be included in many future CD players, however. Also, DVD players that use one multifocus laser instead of dual lasers usually don't recognize CD-Rs. (See "Giving Proper Recognition").

Except for a few more buttons and knobs on its front and a few extra jacks on its rear panel, the Philips CDR 870 looks very much like an ordinary CD player. Its disc tray is under the display, the on/off switch and the headphone jack and level control are at the far left, and the transport controls are off to the far right.
From here on, things are different, as indicated by the recording level knob and the four buttons with red legends ("REC," "Finalize," "Erase," and "CD Sync") below it. The level knob affects both channels; there's no channel-balance adjustment. The display incorporates nine-segment recording level indicators for each channel, calibrated from "-50" to "0" and then "Over."

The display incorporates nine -segment recording level indicators for each channel, calibrated from "-50" to "0" and then "Over."

In digital dubbing, of course, the level control is disabled and the level indicators are merely informative, as the source's channel levels are copied exactly.

As with many cassette decks, pressing "REC" puts the CDR 870 into record/pause mode, and recording begins when you then press "Play"; if the disc has already been partially recorded, the laser will move just past the last recorded track. If you're recording a CD-RW, pressing "Erase" once removes the last track and pressing it twice in quick succession wipes the entire disc, but erasure begins only when you follow these commands by pressing "REC." It takes several seconds to erase the disc.

The fourth button, "CD Sync," is used to synchronize digital dubbing from CD, DCC, DAT, or MD, starting and stopping the CDR 870 when the source player starts and stops. You press the button once to copy a single track, twice to copy the complete source disc or tape (but only if you play that source's tracks in their original order). The display flashes a warning ("DIG") if no digital carrier is present and shows the current track number and elapsed recording time; you can check how much time remains on the disc by pressing the "Display" button.

The recording input (analog, coaxial digital, or Toslink optical) is selected by pressing a bar just to the right of the display window. Legends in the display indicate which input has been selected.

The "Auto/Manual" bar just beneath "Input" controls track numbering. In "Auto" mode, the CDR 870 automatically increments the track number when it detects a 3-second pause in an analog input signal or, with a digital signal, when the source's track number changes. In "Manual" mode, you increment track numbers by pressing "REC" (or the "Track INCR" pad on the remote), whether you're recording from an analog or digital source.

The CDR 870 automatically stops recording when it detects a 20-second pause in the source material (again, whether the source is analog or digital) or, of course, whenever you press "Stop." Every time the Philips stops recording, it updates the temporary TOC, locking the controls and displaying "Update" for the few seconds this takes.

The controls also lock during the several minutes it takes to finalize the disc by writing its permanent TOC. The display indicates the time required. During this period, it is imperative that the CDR 870 not be turned off. If you lose power while finalizing a CD-R, you're likely to scramble the TOC irreparably, since the disc can't be erased. (However, the CDR 870 may be able to repair the damage in some cases.) A CD-RW, on the other hand, can be erased even after finalization. To finalize a disc, you press "Finalize" and "REC."

On the back of the CDR 870 are a Toslink optical input and output, as well as base-metal RCA jacks for coaxial digital and analog input and output. The Toslink sockets are protected with plugs when not in use. A removable two -wire IEC line cord supplies power.

The Philips CDR 870 comes with a 27 -button remote that replicates basic transport and recording functions, opens and closes the disc drawer, and provides direct track access via a 10 -key numeric pad. The remote enables you to fast-search through discs at two- or eight -times normal speed, to program playback of as many as 20 tracks in any order, and to repeat playback of an individual track, the full disc, or the contents of the program memory. You can also set up synchronized or normal recording from the remote and initiate the finalization process.

Measurements

1 bench-tested the Philips CDR 870 as a conventional player and as a recorder for digital and analog sources. I used the CBS CD-1 test disc for playback and digital dubbing and used signals from my Audio Preci-
The remote handles recording as well as playback functions.

The reason that some players can't recognize certain types of discs is that the information layers of CD-Rs, CD-RWs, and prerecorded CDs differ in reflectivity. Old CD players expect a greater contrast between the recorded zeroes and ones than rewritable media provide. Commercially recorded CDs have three-dimensional pits and lands pressed into their recording layers. The deformable dye that carries a CD-R's information is lower-contrast. And CD-RWs, whose recording layer changes its physical state from amorphous to crystalline and back again under the recording laser, provide even lower contrast between the zeroes and ones—in fact, only about a third as much as CD-Rs.

That's why many players that recognize regular CDs and CD-Rs can't read a CD-RW.

In playback, the channels were balanced within ±0.02 dB, which I consider excellent. There was plenty of drive for both high- and low-impedance headsets, and the output impedances of the line and headphone jacks were well chosen.

Figure 1 shows frequency response, plotted at 0.1 dB per division to reveal even minor deviations. The playback response has a trace of filter ripple and a rising treble characteristic, but performance is really very good, within +0.17, −0.1 dB from 20 Hz to 20 kHz. Interestingly, the response curves for record/play via the analog inputs do not exhibit the same treble rise as the playback curves; there seems to be fortuitous compensatory rolloff in the analog-to-digital (A/D) converter. The filter ripple is essentially the same for playback or record/play, which means that the A/D converter's anti-aliasing filter doesn't damage the signal. Although it's hard to see in Fig. 1, the record/play response starts to drop just below 20 kHz as that filter kicks in. There is a bit more bass rolloff when recording from the analog input, but overall, record/play response is within +0.03, −0.28 dB from 20 Hz to 20 kHz. That's very fine indeed! The digital dub I made was virtually identical to the CD-1 test disc I copied, so I omitted these results from Fig. 1. In this (and many other) respects, the CDR 870 proved capable of making perfect digital dubs. But for some strange reason, it would not recognize the emphasis flag if it was present in a digital source's subcodes. This means that pre-emphasized recordings will have an excruciatingly hot high end; luckily, few modern CDs are pre-emphasized, so you'll probably not be affected by the problem.

When recording via the analog input, I initially set the level control for 0 dBFS from a 2-volt, 1-kHz signal. However, the distortion at 0 dBFS was substantially greater than when I was recording from the digital jacks. That's why, in "Measured Data," I've listed total harmonic distortion plus noise (THD + N) at −1 dBFS instead of 0 dBFS. Higher distortion at 0 dBFS when recording from analog inputs is quite common in digital recorders; at 0 dBFS, their A/D converters are almost clipping.

In Fig. 2, THD + N versus frequency, record/play curves taken via the analog inputs are a little higher across most of the band (especially on the left channel), even though I measured them at −1 dBFS. However, the figures in "Measured Data" seem to indicate the contrary because the recording from the analog input did not have the 18-kHz distortion peak that was present in the other recording (not shown) or in playback. This is a clear example of why curves are sometimes more meaningful than tabulated data.
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In Fig. 3, THD + N versus level at 1 kHz for the worst (left) channel, the curves for record/play via the analog input lie above the others, but by a relatively small amount until the level approaches 0 dBFS and the A/D converter starts to act up. Overall, these results are very respectable.

Linearity error (Fig. 4) is quite modest for playback or digital dubbing, but it tops 2 dB at -90 dBFS for record/play from the analog input. It’s questionable how significant this is, since most analog source material is likely to bottom out on noise before it gets down to -90 dBFS, but I’ve seen better performance. The record/play curves taken from the analog input also indicate that there’s a fair amount of nonlinearity in the A/D converter below -70 dBFS. (There are, of course, no “undithered” curves for analog input; digital recordings of analog signals tend to be dithered by the signals’ inherent noise.)

The fade-to-noise linearity test (Fig. 5) is for playback only. I could not run this test for record/play, because the CDR 870 assumes that recordings at the levels used for this test represent silence. It therefore stopped after 20 seconds, long before the test sweep ended. (I checked the level below which the CDR 870 considers the source to be “silent”; it was -54 dBFS.) Based on the linearity error seen in Fig. 4, I expect that the digital dub would have been fine but that the analog-source recording (had it been possible to make one) would have contained substantial error at low levels. Consumer digital recorders commonly shut themselves off this way, to keep you from wasting tape or disc space by recording silence. As long as they don’t shut off during a long pianissimo, I guess that’s beneficial, but I wish I could have defeated this feature for my tests.

The noise floor for the recording via the analog input lies about 9 dB above the playback curve for digital silence, but that’s to be expected. In fact, I’m quite pleased that the CDR 870’s analog electronics are as quiet as they are. And there’s little hum; all power-line-related components lie at or below -100 dBFS. The difference of approximately 9 dB between the playback and the analog record/play curves carried over fairly consistently when I tested S/N with A-weighting (see “Measured Data”).

The curves in Fig. 6 for 1-kHz signals at -60 dBFS are closer together than those for digital silence (and are identical above -100 dBFS). Dynamic range, which is based on measurements using the same test signals, was also quite similar for playback and record/play of a digital dub. The fact that the results in “Measured Data” correspond so well with the curves suggests that the A/D converter is pretty clean at this recording level (and reinforces what we learned from Fig. 3). Quantization noise is essentially the same for playback and for record/play via either input.

Channel separation (Fig. 7) is more than adequate, even with analog input.

All of these results are gratifying and signify that the Philips CDR 870 is a product to be reckoned with. It’s also nice to see analog inputs that combine good sensitivity and high input impedance with a virtually bulletproof overload point of 8 volts!

Use and Listening Tests

I was impressed with how easy the CDR 870 is to use. Pop a disc in, and the Philips automatically checks to see what kind of CD it is. If it’s a commercial disc or a finalized CD-R or CD-RW, the 870 informs you that it’s “Reading” the TOC and displays the number of tracks. If it’s an unfinalized recordable CD, it tells you the type of disc.

| Channel Balance: Playback, ±0.02 dB. |
| Frequency Response, 20 Hz to 20 kHz: |
| Playback, +0.17, -0.1 dB; record/play via analog input, +0.03, -0.28 dB (at -1 dBFS); record/play via digital input, +0.15, -0.12 dB. |
| THD + N at 0 dBFS, 20 Hz to 20 kHz: |
| Playback, less than 0.0517%; record/play via analog input, less than 0.0237% (at -1 dBFS); record/play via digital input, less than 0.051%. |
| THD + N at 1 kHz: |
| Playback, below -84.3 dBFS from 0 to -90 dBFS and below -93.2 dBFS from -30 to -90 dBFS; record/play via analog input, below -79.9 dBFS from -1 to -90 dBFS and below -90.2 dBFS from -30 to -90 dBFS; record/play via digital input, below -84.3 dBFS from 0 to -90 dBFS and below -91.5 dBFS from -30 to -90 dBFS. |
| Maximum Linearity Error: Playback, 0.63 dB to -90 dBFS with undithered recording and 0.33 dB to -100 dBFS with dithered recording; record/play via analog input, 2.1 dB to -90 dBFS and 2.2 dB to -100 dBFS; record/play via digital input, 1 dB to -90 dBFS with undithered recording and 0.47 dB to -100 dBFS with dithered recording. |

**Quantization Noise:**
- **Playback:** -85 dBFS; record/play via analog input, -84.4 dBFS; record/play via digital input, -85 dBFS.
- **Dynamic Range:**
  - **Playback:** 94.6 dB, unweighted (99 dB, A-weighted, and 89.4 dB, CCIR-weighted); record/play via analog input, 90.7 dB, unweighted (94.6 dB, A-weighted, and 85.9 dB, CCIR-weighted); record/play via digital input, 92.7 dB, unweighted (96.7 dB, A-weighted, and 87 dB, CCIR-weighted).

**Channel Separation:**
- **Playback:** greater than 103 dB from 125 Hz to 16 kHz; record/play via analog input, greater than 90.9 dB from 100 Hz to 17 kHz; record/play via digital input, greater than 95.6 dB from 125 Hz to 16 kHz.

**Analog Input Characteristics:**
- **Sensitivity:** 0.81 V for 0 dBFS recording level; overload, 8 V; impedance, 49 kilohms.

**Line Output Characteristics:**
- **Level:** 1.92 V for 0 dBFS recorded level; impedance, 200 ohms.

**Headphone Output Characteristics:**
- **Maximum output voltage:** 5.91 V at clipping; maximum power, 43.3 mW into 600 ohms and 63.6 mW into 50 ohms; impedance, 120 ohms.
(CD-R or CD-RW), after which it goes through a brief Optimal Power Calibration procedure.

That calibration is needed because a number of different materials can be used for the recording layer of a CD-R or CD-RW, and optimum recording power depends on the specific material used. As a result, CD recorders must calibrate themselves for each disc. The 870 does this automatically, trying various power levels and evaluating the results. (CD-Rs and CD-RWs have a special area for this test.)

During calibration, "OPC" appears in the display. If you’ve calibrated the power so many times that there’s no room left in the test area, "Final" appears in the display to request that you finalize the disc. If the disc is defective or calibration fails, you’re told “OPC Fail.” If there’s no recordable space left on the disc (but the disc hasn’t yet been finalized), the display reads "CD Full."

It’s pretty hard to goof up with the CDR 870. This is especially true when you’re making a digital dub of a CD, DAT, or similar source; level setting is a nonissue in this case. The owner’s manual doesn’t mention it, but I discovered that the 870 converts signals sampled at 48 kHz (the "professional" rate usually used by DAT recorders) to the CD sampling rate of 44.1 kHz. (In fact, as I later learned from a brochure, it also converts signals sampled at 32 kHz.) Copies of 48-kHz DATs sounded pretty good—perhaps not quite so transparent as the original, but pretty darned close. Sampling-rate converters can have audible side effects, and good ones tend to be quite expensive.

So considering the price of this Philips recorder, I was impressed with the sound quality that its converter delivered.

However, the CDR 870’s facilities for recording analog signals could be better. Proper level setting is important to avoid overloading the A/D converter, so better recording level indicators (and a way to adjust channel balance) would be highly desirable. As it is, if either of the top two indicator segments ("0" and "Over") lights up, you’re into clipping, leaving only seven useful indicator segments. (Cassette recorders get away with such crude metering, but they overload far more gracefully than digital recorders do.) Fortunately, this does not affect digital dubbing, which is probably what most people would use the 870 for.

Sound-wise, I rate the CDR 870 on the high end of average. It’s not the equivalent of the finest CD players I’ve used, but it’s competent, quiet, and reasonably transparent. Considering the price and all that this recorder can do, it’s definitely a winner. If you thought that CD recorders were forever out of reach, think again. Try the Philips CDR 870—highly recommended!
For me, the main attraction of this component, which Z-Systems calls a Reference Digital Preamplifier, was its built-in equalizer. I needed a good equalizer to help iron out some in-room response anomalies I was getting with a pair of electrostatic speakers, and the RDP-1 looked like it would fill the bill nicely.

Analog equalizers have gotten a bad reputation for introducing distortion, noise, and colorations, which digital equalizers can avoid. But, says designer Glenn Zelniker, “finding the right ‘recipe’ for implementing a digital filter is a brutal task.” As the co-author of Advanced Digital Signal Processing: Theory and Applications (Marcel Dekker, New York, 1994) and designer of digital processors used in CD mastering, he speaks from experience. According to Zelniker, the proprietary filter architectures in the RDP-1 avoid problems of coefficient quantization, round-off noise, and low-level nonlinearity that often occur in textbook designs. Although phase linearity has been cited as an advantage of digital filtering, the RDP-1’s filters are not quite linear-phase designs; Zelniker says true linear-phase filters sound less natural.

Like its six-band parametric equalizer section, which Z-Systems calls a Transparent Tone Control, the RDP-1’s volume control and source selector operate in the digital domain. All six inputs are digital, of course, but Z-Systems offers an accessory, the RADC-2 ($650), which adds two stereo analog inputs and an A/D converter. Because it has no analog outputs, the RDP-1 must be used with an external D/A converter. A remote control is supplied.

The Transparent Tone Control (TTC) is one of the RDP-1’s most significant features. (It will soon be available separately, as the RDQ-1 equalizer, for $3,000.) Said to have no sonic character of its own, the TTC incorporates bass and treble shelving filters and four bell-shaped peak/dip filters, which can be used simultaneously. The turnover frequencies of the shelving filters and the center frequencies of the bell filters can be set from 28 Hz to 18 kHz at intervals of one-sixth of an octave, and each filter can provide up to 12 dB of boost or 95 dB of attenuation. The bell filters’ relative sharpness, or Q, can be adjusted, too. However, Z-Systems calls this adjustment “slope,” because it’s actually a number by which the filter’s base Q is multiplied. The RDP-1 has a slope adjustment because the Q of its filters rises at frequencies from 8 kHz up—e.g., the base Q is 0.4 below 8 kHz, 0.44 at 8 kHz, 0.48 at 9 kHz, and so on. The adjustment range runs from 1 (corresponding to a broad Q, 0.4 at 1 kHz) to 12 (a quite sharp Q, 8 at 1 kHz). Each filter’s gain can be set from +12 to −95 dB. These controls enable a broad range of equalization for program material and are useful for speaker and room equalization.

The RDP-1 accepts data words up to 24 bits long. Its output word lengths can be set to 16, 20, or 24 bits, with defeatable dither for 16- and 20-bit output and fixed dither for 24-bit output.

The three large control knobs on the RDP-1’s refreshingly modern-looking front panel aren’t labeled, because their functions change according to operating mode. The display window shows their functions and settings. Operating modes are usually set with the three buttons to the left of the knobs (“Input,” “Presets,” and “Bypass”) and the “Volume” button to the knobs’ right.

When you press “Input,” the first knob becomes the input selector, the second selects output word length (16, 20, or 24 bits) and dithering, and the third sets the controls to affect the left channel, the right channel, or both.

Pushing “Presets” once enables you to retrieve any of 100 combinations of tone...

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**Dimensions:** 17 in. W x 4½ in. H x 10 in. D (43.2 cm x 11.4 cm x 25.4 cm).

**Weight:** 14 lbs. (6.4 kg).

**Price:** $5,000.

**Company Address:** 4641-F N.W. 6th St., Gainesville, Fla. 32609; 352/371-0990; z-sys@z-sys.com; www.z-sys.com.
control setting, volume level, input selection, and output mode and to make instant comparisons between any two presets. In this mode, you select presets by using the six-button array to the right of the control knobs. To save settings, press "Presets" twice; you then use the left-hand control knob to select which preset you'll store your selections in and the lower left button of the six-button array to store them. The presets are numbered from 0 to 99. Preset 99 is active whenever you turn the RDP-1 on, which makes it a good place for the settings you use most often. Preset 0, whose settings cannot be changed, disengages all filters, sets the output to 24 bits, and leaves your current input selection unchanged.

The "Bypass" button defeats all controls and sets all of the TTC's filters for flat response. However, it retains current input and volume settings, to help you evaluate the impact of the filter settings.

Pressing the "Volume" button and turning the left-hand control knob enables you to boost volume by up to 12 dB or to cut it by up to 95 dB. In this mode, the volume setting is displayed in dBFS (dB relative to digital full scale), preceded by "L," "R," or "S" to remind you whether the control is set to left, right, or stereo. The adjustment steps for volume (and filter amplitude) are quite gradual from +12 to -12 dB, broadening from 0.2 dB until they reach 5 dB for 70 to 95 dB of attenuation.

To set equalization, you select the filter you want by means of the six-button array at the right. After that, you adjust the selected filter's parameters with the three control knobs.

The rear panel carries the six digital inputs—two XLR jacks, three coaxial jacks, and one Toslink optical connector—and the digital outputs—one XLR, one coaxial, and one Toslink. (The Toslink input and output can be replaced with ST glass-fiber connections at extra cost.) A Crystal Semiconductor CS8412 digital receiver and CS8402 digital transmitter are used for input and output, coupled to the outside world through high-quality Scientific Conversion transformers.

Lacking a schematic, I could not analyze the circuitry to the extent that I usually do. I was able to ascertain that a Texas Instruments TMS320C31 floating-point digital signal processor is used for generating the filter functions and for overall system control. Further, the power supply includes a potted toroidal power transformer.

Measurements

I made the bench tests with Audio Precision dual-domain System One instrumentation. I obtained the filter-response curves by feeding in test signals at -10 dBFS and setting the RDP-1's volume control for 0 dB of gain; this allowed me to set the filters for up to 10 dB of boost without exceeding digital full scale (0 dBFS).

When I measured the frequency response of the RDP-1's filters, it quickly became obvious that their cut and boost curves were not the usual mirror images. This is readily apparent in Fig. 1, which shows the response of one bell filter set for 10 dB of boost or cut at 1 kHz with various slope settings. The curves for cut are noticeably sharper than the corresponding boost curves.

The response curves in Fig. 2, for varying degrees of boost and cut at 1 kHz, look symmetrical at first glance, but that's because I used different slopes for boost and cut (the specific settings were 4 and 1, respectively). Here, even though the curves at +10 and -10 dB look the same, they differ more and more as the amount of boost and cut is reduced. I could usually find a mirror image for any particular boost or cut curve, but doing so was hardly intuitive. For example, the response curves for the low-frequency shelving filter (Fig. 3) look symmetrical only because I did not use identical frequency settings for boost and cut. The boost curves have a constant turnover frequency, 28 Hz. But to make the other curves match them, I had to change turnover frequency each time I changed the filter's gain. (For 2, 4, 6, 8, and 10 dB of cut, I used turnover frequencies of 35, 45, 56, 70, and 90 Hz, respectively.) Using this technique, I was also able to generate complementary cut and boost curves with the high-frequency shelving filter.

Next I turned my attention to a more common phenomenon. Many synthesis
techniques for generating digital filters are based on the mathematics of analog filter design. When the center or cutoff frequencies for such digital filters approach one-half the sampling frequency (the high-frequency end of the audio bandwidth), their curve shapes deviate from their analog prototypes, making them lean to the right. I believe that this accounts for the behavior of the curves in Fig. 4, response for 10-dB boost with center frequencies of 4, 8, and 12.5 kHz. (The slope was 3, which equals a Q of 1 at 4 kHz but a slightly higher Q above that frequency.)

The RDP-1 can generate some very complex curves. In Fig. 5 is a response curve that has alternating 10-dB peaks and dips for frequencies of 200 Hz, 800 Hz, 3.15 kHz, and 12.5 kHz; the slopes are 12 (a Q of 8 or higher) for the peaks and 8 (a Q of 4 or higher) for the dips. Note that the last dip, which has the same center frequency as the lopsided peak in Fig. 4, does not lean appreciably to the right. Its high Q makes the curve rise back to its origin so quickly that the deviation caused by the approaching high-frequency cutoff has little effect.

To assess total harmonic distortion plus noise (THD + N), I fed the RDP-1 a 16-bit signal with triangular dither and set it for 0 dB of gain and 16-bit, undithered output. Under these conditions, THD + N was essentially constant, at -93.4 dBFS, across the audio band and, for 1-kHz signals, at all levels. Distortion also remained basically unchanged for filter settings from full boost to full cut, as seen in Fig. 6 for a combination of high-frequency rolloff from the shelving filter and four bell-filter dips at octave intervals. It would appear that Z-Systems’ claim of superior filter architectures is justified.

I got roughly the same results for signal-to-noise ratio, quantization noise, and dynamic range as I did for THD + N. With the exception of S/N for digital silence, all of these were about 93.4 dB for 16-bit undithered signals, about 114 to 118 dB for undithered 20-bit signals, and about 122 to 128 dB for 24-bit signals (which the RDP-1 automatically dithers). Predictably, adding dither lowered the 16- and 20-bit results by about 3 to 4 dB, again except for S/N with digital silence.

With digital silence, S/N for undithered signals improved by about 30 dB for 16-bit signals and by nearly 20 dB for word lengths of 20 bits. For dithered signals, it improved by about 3 to 4 dB for both word lengths.

Most of my measurements of THD + N, signal-to-noise ratio, quantization noise, and dynamic range were virtually identical for the two channels, usually differing by no more than 0.3 dB. The notable exceptions were for 24-bit signals, where results for S/N with digital silence and for dynamic range were about 3 dB worse in the right channel than the left.

To find out what effect the RDP-1’s volume control has on low-level linearity, I set my Audio Precision test system to generate a 500-Hz tone whose level was swept from -60 to -120 dBFS, passed that signal through the RDP-1, bandpass-filtered the output to eliminate noise effects, and plotted the filtered output’s level against the input’s. I repeated this test procedure for several settings of the RDP-1’s volume control, 10 dB apart. With the preamp’s word length set to 24 bits, the full-volume curve looked good but linearity looked poor at volume settings lower than -10 dB. However, as you can see in Fig. 7A, there is little linearity error for low-level signals with dithered 16-bit output. With dithered 20-bit output (Fig. 7B), linearity is, predictably, even better.

Interchannel crosstalk for 16-bit dithered input and output was better than -110 dB up to 8 kHz, increasing to about -105 dB at 20 kHz. This held true whether I was examining crosstalk from the left channel to the right or vice versa.
Use and Listening Tests

For my initial listening tests, I connected my CD transport to a digital input of the DGX DDP-1 preamp (which provides digital equalization specifically designed for the B&W 801 speakers I used), fed the DGX's output to a Genesis anti-jitter device, and connected the Z-Systems RDP-1 between the output of the jitter reducer and the input of my D/A converter.

I set the RDP-1's volume control to 0 dB and all of its filters for flat response, and disconnected the RDP-1 from my system and reconnected it many times, to see if I could hear any change. This preamp was almost completely transparent! On some recordings, I thought a minuscule amount of air and space may have been taken away, but I was never really sure about this.

I found the RDP-1's equalizer section very useful for taming bright-sounding CDs; setting the high-frequency shelving filter to 3.5 kHz with 2 dB (or a bit more) of attenuation defanged the sound nicely. And setting one of the bell filters to 100 Hz, with a few dB of cut and a slope of 3 (a Q of 1), tamed my system's tendency to sound a little thick around that frequency on some recordings. I also used the equalizer to tame weak midbass and lower midrange from a pair of electrostatic speakers, in this case using a few dB of boost and a broader slope setting.

I really appreciated being able to save and recall the different filter settings that I devised, and it was most handy to be able to switch back and forth between any two filter settings for instant comparisons. I was also pleased that saving settings, recalling them, and making instant comparisons could be done from the front panel or by using the remote control.

After listening to CDs, I connected an Ayre preamp's tape output to an analog input of the DGX digital preamp and fed my analog sources into the Ayre. In this setup, I used the Ayre as the analog source selector, the Z-Systems for system volume and tone control, and the DGX as an A/D converter and speaker equalizer and for switching between CD and the analog sources. Once again, even though the RDP-1's equalization was superimposed on the speaker equalization provided by the DDP-1, the RDP-1 did not change the sound in any way other than performing the volume and tone changes I set it for. That's a most unusual and commendable state of affairs!

I had three small complaints about the RDP-1's operation. When I turned its knobs quickly, the display didn't change fast enough to register what I was doing. Furthermore, I sometimes had to turn a knob to the left before turning it to the right would have any effect. And I sometimes had to turn the RDP-1 off and on again to get any output from it. (This wouldn't have happened, however, if I had left the unit on. And doing so wouldn't have been a problem, since its power consumption is very low.)

Nitpicking aside, I think the RDP-1 is a terrific device. I found it useful for equalizing room acoustics and other response anomalies and for making some recordings more enjoyable. Every audiophile should have tone controls, but few do. The RDP-1 gave them back to me, and I love it.
The Servo-15, Paradigm’s top subwoofer, is part of the company’s Paradigm Reference line, which includes the Eclipse/BP, Studio/100, and Active/20 speakers (reviewed in the August 1995, July 1996, and September 1997 issues, respectively), along with other models. The Servo-15 is one of five powered systems comprising the Active subgroup of the line.

The Servo-15’s beefy 15-inch woofer is housed in a solidly constructed, sealed enclosure and driven by a built-in 400-watt amplifier. The amp incorporates a servo circuit that monitors the woofer’s activity via an instrumentation-grade piezoelectric accelerometer on the driver. The subwoofer comes with an electronic controller that provides crossover functions and phase adjustment for the subwoofer and line-level high-pass filtering for the wide-band signal driving the rest of your audio system. Two versions of this unit are available: the X-20, which has speaker-level inputs, and the X-30, with line-level inputs, that I reviewed. (Each is also sold separately, for $159.)

The Servo-15’s nearly cubical enclosure has a grille on its front that covers the driver; the power amp’s controls, input jack, and power cord are on the rear. The controls are minimal, consisting of a level knob and a tiny three-position power switch ("Always Off," "Auto On/Off," and "On"). There is a line-level RCA jack, but no speaker-level input, because the Servo-15 is intended to be driven from its controller or directly from a low-pass-filtered subwoofer output on a surround processor, preamp, or receiver.

Although the Servo-15’s driver is nominally a 15-inch unit, it is actually 16 to 17¼ inches, depending on where you measure the diameter of the heavy-duty, die-cast aluminum frame. The cone is a Kevlar-fiber reinforced composite (whose high internal damping and stiffness are said to significantly reduce unwanted resonances and distortion) and has a multilayer surround. Rated excursion is a healthy 1 inch, peak to peak.

The driver’s large motor assembly has three ceramic magnets, each 6 inches in diameter and ¾ inch thick: Two power the woofer, and the remaining one is a bucking magnet that reduces external magnetic fields. The magnet assembly, computer-optimized for low distortion and high field strength, has a low-turbulence center vent that exits to the rear. Two aluminum shorting rings around the pole piece are intended to improve heat transfer and lower distortion. The voice coil has bifilar windings on an aluminum/Nomex former that’s 2.1 inches in diameter and 1.4 inches long. The accelerometer is bonded to the front of the voice coil, under the woofer’s dust cap. Three leads connect it to the built-in amplifier.

**Rated Frequency Response:** 17 to 80 Hz, ±2 dB.

**Rated THD + N:** Less than 0.3% at 50 Hz and 90 dB SPL.

**Dimensions:** Speaker, 20 in. H x 18 in. W x 21¼ in. D (50.8 cm x 45.7 cm x 55.2 cm); controller, 1¾ in. H x 7¼ in. W x 5 in. D (4.8 cm x 18.4 cm x 12.7 cm).

**Weight:** Speaker, 78 lbs. (35.5 kg); controller, 2.7 lbs. (1.2 kg).

**Price:** Speaker, $1,500 in black ash laminate or $1,750 in light cherry or rosenut wood veneer (price includes controller).

**Company Address:** c/o AudioStream, M.P.O. Box 2410, Niagara Falls, N.Y 14302; 905/632-0180.
The Servo-15’s power amplifier is a purely linear design, using no switching output or power-supply circuitry. It is mounted to a removable rear subpanel that includes a large heat sink. The amp’s circuitry is on a large glass-epoxy board that is at right angles to the rear panel; its eight output transistors are attached to that panel, just behind the heat sink. The amp’s large toroidal power transformer is on the bottom of the cabinet.

The accelerometer and the amp’s servo circuits form a closed-loop system that compares the accelerometer’s output to the audio input signal and then corrects any discrepancies in the driver’s motion. The amp also has limiting circuitry to prevent clipping and guard against excessive cone excursion.

Paradigm’s patented automatic circuitry turns the subwoofer on quickly whenever there is an input signal and turns it off about 15 to 20 minutes after the signal stops. Paradigm says the amp consumes less than 1.5 watts while it’s waiting for a signal, which should be enough to extend from a controller stacked with your other components to a Servo-15 at the opposite end of your listening room. Paradigm sent me the X-30 for review; it has controls for subwoofer level, low-pass cutoff (which is variable from 35 to 150 Hz), and subwoofer phase (which affects only one of the two mono subwoofer output jacks on the rear panel).

The latter two controls enable the Paradigm Servo-15 to be used with virtually any main speaker system, located at any distance from the subwoofer. The X-30 also has 18-dB/octave high-pass filters, with separate line-level stereo output jacks for 50-, 80-, and 120-Hz cutoff frequencies.

Measurements
The Servo-15’s on-axis anechoic frequency response (Fig. 1) is quite flat and well behaved, with a bandwidth of about 20 to 150 Hz at the 3-dB-down points and a maximum output at about 60 Hz. These are ground-plane measurements, made with the subwoofer’s level control at its mid position and an input of 0.1 volt rms.

Figure 2 shows response at the X-30 controller’s subwoofer outputs for various low-pass frequency settings. (The input was again 0.1 volt rms, the X-30’s subwoofer level control was in its mid position, and the test load was 1 megohm. With these settings and the cutoff control at 150 Hz, the X-30’s gain was +2 dB at 50 Hz.) Infra-sonic frequencies are rolled off at 6 dB/octave below about 8 Hz, while the high-frequency cutoff, specified as 18 dB/octave, actually has a 12-dB/octave slope. As can be seen, a relatively large gap exists between the 150- and 120-Hz positions. (In this and the following graph, note that the frequency scale extends down to 2 Hz.)

Figure 3 shows the frequency response of the X-30’s high-pass outputs. (Response above the graph’s 2-kHz limit was perfectly flat to 20 kHz.) Each curve exhibits a classic third-order, 18-dB/octave, high-pass response, as specified. The measured cutoff
Figure 4 shows the combined frequency response of the Servo-15 and X-30 controller. The frequencies indicated on the X-30 are significantly different from the measured -3 dB points, instead corresponding roughly to the -6 dB points. The exact cutoff frequencies are listed in Table I.

I was quite impressed with the Servo-15’s low-frequency output and general sonic cleanliness at high levels. I found it impossible to make this subwoofer sound bad by overloading it, no matter what the input frequency or level. Furthermore, the cabinet was essentially vibration-free. The woofer’s maximum excursion was about 0.8 inch, peak to peak, and occurred at 20 Hz. By removing the woofer from the cabinet and driving it directly from my amplifier, I found that it could easily reach excitations of 1 inch, peak to peak, with fairly low distortion. No dynamic offset distortion was evident. I would suspect that even without the accelerometer servo feedback, distortion would be quite acceptably low.

Figure 5 shows the Servo-15’s harmonic distortion versus frequency and SPL (and includes the effects of room gain). The distortion presented is the sum of the first 10 harmonics, expressed as a percentage of the power in the fundamental. (This method yields essentially the same results as measuring total harmonic distortion, which includes all harmonics—even those above the tenth—and excludes noise.) The second and third harmonics predominate at most frequencies and levels.

At each test frequency, the Servo-15’s limiter put a cap on the maximum sound pressure level; beyond a certain point, increasing the input level produced no further increase in output level or distortion. The limiter allowed the subwoofer to generate 113 dB SPL at 40 Hz but only about 98 dB at 20 Hz. At all the test frequencies, the Paradigm Reference sub sounded quite effortless and clean, and its distortion was less than 10%. In fact, as you can see in Fig. 5, it rose to only 9% at 20 Hz, was just 6.8% at 25 Hz, stayed below 5% at 32 and 40 Hz, and was less than 2% from 50 Hz on up.

Figure 6 shows the Servo-15’s short-term peak sound output versus frequency. The subwoofer was driven directly, without the X-30 controller. The maximum peak SPL at each frequency was constrained by the subwoofer’s limiter. The tone-burst test signal sounded quite clean and powerful at all levels up to the limit. However, if I turned up the input level well past the limiting point, the signal changed its tonal characteristics (though it still seemed undistorted). Observing the output on an oscilloscope, I saw that the shape of the tone burst changed significantly: Levels were highest near the start of each burst instead of in the middle. Although the tone burst’s envelope changed significantly at high overload levels, the sine waves making up each burst were still essentially sinusoidal. The sound was thus fairly clean.

With room gain, the maximum peak output in Fig. 6 starts quite strongly, at 110 dB SPL at 20 Hz, and then rises quickly to a peak of 115 dB SPL at 50 Hz. At higher frequencies, the maximum SPL drops smoothly to a still strong 108 dB at 200 Hz, passing through 113 dB at 100 Hz. The Servo-15’s low-frequency output is very nearly the highest of all subwoofers I have tested.

Use and Listening Tests
The Paradigm Reference Servo-15 weighs nearly 80 pounds and is 23 inches deep with its grille on, making it somewhat of a chore to move around and reposition. The large plastic feet, which look like hockey pucks, make it easier to move the speaker and provide convenient handholds for lifting it. My review sample, supplied in the black ash finish, was quite attractive. (I found it a lot more attractive than my wife did. Any

### Table I—Low-pass frequencies of Servo-15 subwoofer when driven by X-30 controller.

<table>
<thead>
<tr>
<th>Low-Pass Setting</th>
<th>-3 dB</th>
<th>-6 dB</th>
</tr>
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<tbody>
<tr>
<td>150 Hz</td>
<td>135 Hz</td>
<td>156 Hz</td>
</tr>
<tr>
<td>120 Hz</td>
<td>85 Hz</td>
<td>105 Hz</td>
</tr>
<tr>
<td>80 Hz</td>
<td>62 Hz</td>
<td>75 Hz</td>
</tr>
<tr>
<td>35 Hz</td>
<td>51 Hz</td>
<td>63 Hz</td>
</tr>
</tbody>
</table>

(-3 dB) frequencies are quite close to those indicated on the jacks: 48 Hz at the 50-Hz output, 75 Hz at the 80-Hz output, and 119 Hz at the 120-Hz output.
speaker that can generate lots of clean, powerful bass must be attractive, right?)

With its grille removed, the woofer looks more like a heavy-duty 18-inch than a 15-inch. Hookup was simple and easy, thanks to the Servo-15’s single RCA input jack and the facilities of the X-30 controller. I used this subwoofer primarily in my home theater and judged it with stereo music CDs and laserdiscs. The Servo-15 was driven by the X-30, which provided a convenient bass volume control.

The Servo-15’s manual is short but informative and detailed. It covers, among other things, placement, controls, and operation with an X-series controller (which is covered in greater detail in the X-30’s own manual).

For comparisons, I used two other powered subwoofers. One was the Velodyne F-1500B, a servo-controlled sealed system with a 15-inch woofer, which is similar to the Servo-15. (The F-1500B is an upgraded version of the F-1500 I tested in the November 1992 issue.) The other sub was a Boston Acoustics VR2000, whose 12-inch woofer is in a vented enclosure and whose built-in amplifier has no servo-feedback or limiter/ compressor circuitry (Audio, January 1997).

I positioned the Servo-15 to the left of my right front speaker (a KEF Reference Four) and faced it into the room. For A/B comparisons with the other subwoofers, I placed the Velodyne on top of the Paradigm Reference and the Boston on the floor in front of the right front speaker, facing across the room. This kept the woofers as close together as was reasonably possible.

All three subwoofers were driven by the X-30 controller through a line-level A/B switcher. I set the Velodyne and Boston subwoofers’ low-pass cutoff controls to their highest frequencies. I set the X-30’s cutoff control to its middle position (halfway between the 80- and 120-Hz markings), which actually channeled all the bass below about 65 Hz to the subwoofers. When playing pink noise in the octave around 31 Hz, I used the subwoofers’ level controls to match output levels.

The Servo-15 proved to be an excellent all-around performer, clean and powerful with particularly good output in the very low bass. It played significantly louder than the Velodyne at all frequencies and easily dusted off the Boston at 40 Hz and below. (The Boston was a very able performer above 40 Hz, however.) On loud rock music, such as heavy metal with strong kick drum (whose energy is mostly above 40 Hz), I slightly preferred the Boston to the Paradigm, while both the Paradigm and the Boston were significantly more dynamic than the Velodyne, with bass that rivaled a live concert’s.

On recordings having high levels of low bass, such as the organ pedal notes on the Jean Guillou CD of Mussorgsky’s Pictures at an Exhibition (Dorian Recordings DOR-90117, one of my favorite bass demos), the Servo-15 was the clear and decisive winner. On other pipe-organ recordings that had bass below 20 Hz, this sub was an outstanding performer.

On the bass drum on track 1 (at 1:08 and 1:10) of Winds of War and Peace (Wilson Audio WCD-8823, another favorite bass demo), the Paradigm blew off the Velodyne and Boston Acoustics subs, playing much louder and cleaner. Compared to the Paradigm, the Velodyne whimpered out: Its limiter acted so aggressively that its output was anemic compared to the Servo-15’s, and low notes accompanying bass-drum whacks were considerably modulated.

A particularly useful test signal for subwoofer output is the 6.5-cycle, third-octave tone bursts that I use for my peak power tests (available on Syn-Aud-Con’s Sound Reinforcement test CD). Like music, but unlike such test signals as sine waves, the signal is quite transitory in nature yet also very restricted in frequency content. By design, its energy is concentrated in a fairly narrow bandwidth. Just by listening, it’s relatively easy to detect the onset of nonlinearities and distortion when the signal level is raised and to compare the outputs of different speakers.

As I pointed out in my review of the Boston VR2000, the Syn-Aud-Con test CD provides bursts at the rate of one per second in one channel and one every 2 seconds in the other channel. Summing the two channels into a monophonic signal yields a train of bursts that alternate in level by 6 dB. This is also a very useful test signal for comparing speakers by ear. Just turn the level up until the higher burst is distorted or, in the case of systems that have limiters or compressors, until the alternating bursts sound about equally loud. When this point is reached, compare the loudness of the two speakers. On this signal, the Paradigm could play much louder than the Velodyne and still preserve the tone burst’s alternating high-and-low volumes, though it did not sound as clean as the Velodyne. The Velodyne’s output sounded very pure and distortion-free, but all the tone bursts were equally loud instead of alternating in level. (During this test, I noticed that the Servo-15’s woofer motions were significantly greater in amplitude than the Velodyne’s on the high-level burst. Apparently, the Velodyne’s limiter was holding back its excursion and therefore restricting its acoustic output. The Velodyne’s limiter is set so that distortion does not rise above a very low 1%, greatly reducing the speaker’s potential maximum output.) Below 40 Hz, the Paradigm could also play much louder than the Boston, which distorted quite badly on the higher-level bursts.

The Paradigm was also an excellent performer with movies. The sound effects and bass stood out, especially on The Mask and Terminator 2: Judgment Day. The Servo-15’s solid bass underpinning added a high degree of realism to both movies. Particularly memorable were the “Future War” sequence in Terminator 2 (just preceding the intro credits), where the explosions and other special effects were outstanding, and the ’40s nightclub sequence in The Mask, where the acoustic bass and live drum sounds were quite notable.

The Paradigm Reference Servo-15 powered subwoofer proved to be a very strong and extremely capable performer. Paradigm has struck a very good balance between the Servo-15’s maximum output and its maximum distortion. Its distortion, although not super-low (it seldom is in subwoofers), nevertheless sounded quite acceptable. The Servo-15 should be seriously considered for any situation where the highest caliber of bass performance is required.
Someday there will be audio discs that use DVD's huge data capacity to bring us higher sampling rates, longer data words, and multiple channels. Meanwhile, DVD sound is mostly mediocre, in my opinion, and nobody knows what the DVD-Audio standard will be or how many years it will take to achieve full acceptance—which leaves CD as the format for serious music listening. It offers an immense library of performances and can deliver sound that's musical, if not the absolute state of the art. So buying a good CD player makes as much sense now as it did before DVD loomed on the horizon.

At $2,195, Theta Digital's Miles CD player is at the affordable end of the high-end price spectrum. (The transport section of the Miles is available separately as the Pearl, which costs $1,235.) The Miles may not have all of the technology or the sound quality that Theta's DS Pro Generation V-a DAC converter and Data III transport have, but it comes surprisingly close. More important, it takes you out of the "ho-hum" level of CD sound, giving you music with real dynamics, excellent soundstaging, and the transparency and sweetness you need for serious long-term listening.

The Miles comes with a coaxial digital output. An AES/EBU balanced output is $50 extra; I strongly recommend getting it if your D/A converter has AES/EBU inputs, because it will almost invariably improve low-level resolution and transparency. Theta also offers AT&T (ST) and single-mode glass-fiber outputs, at $250 and $800, respectively. However, I think the time of glass optical fiber connections is over; in practice, a coaxial connection is generally better. As for Toslink, which has several technical limitations, Theta doesn't even offer it.

The Miles is available with single-ended analog outputs and, for an additional $400, with balanced analog outputs. Both versions use the high-grade K version of Burr-Brown's PCM67P stereo DAC chip but otherwise differ noticeably. The single-ended version uses one PCM67P. Separate high-speed devices for each channel convert the DAC's analog current output into discrete voltage steps. (This stage uses Vishay bulk foil resistors and Wima polypropylene capacitors.) The balanced version uses two of the Burr-Brown stereo DACs in a dual differential configuration, each DAC converting both the positive and negative phases for its channel. Separate high-speed op-amps for each phase convert the DACs' current output into discrete voltage steps. The balanced version offers lower noise, slightly better low-level resolution, as well as more refinement of upper-octave harmonics and soundstage detail. In both versions, digital filtering and interpolation are performed at an eight-times oversampling rate, using the same proprietary algorithm as Theta's far more expensive DS Pro Generation V-a D/A converter.

The Miles has an analog volume control that is bypassed entirely.
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**the steve miller band  the joker**  JVCXR-0043-2

When you hear the name Steve Miller, the first thing that comes to mind is *The Joker*. Miller's classic 1973 album features the title track, which was his first huge #1 single, as well as "Sugar Babe" and "Something to Believe In." During rehabilitation following a car accident that put the artist out of commission for a year and a half, Miller began to reinvent his style. Leaving behind a more blues based rock style to compose compact, catchy and melodic pop songs, Miller created *The Joker*. It was this turning point recording that set the stage for Miller's exquisitely crafted material that would follow in the mid and late seventies. This historical rock recording is available for the first time as an audiophile disc. The critically acclaimed XRCD technology reveals nuances previously unheard and presents this platinum-selling disc the way it was originally intended.

**tina turner  private dancer**  JVCXR-0044-2

It has been said that Tina Turner is "the woman who taught the world to dance in heels." From the early days to the present, the fabulous Tina has managed to captivate listeners with her electrifying vocals and mesmerizing presence. Perhaps nowhere is her unique musical personality more completely captured than on her solo breakthrough *Private Dancer*. Few artists can claim to have had two distinct careers, however, Tina Turner can claim just that as *Private Dancer* exposed this compelling artist to an entirely new generation. Containing the title track as well as "What's Love Got to Do With It," "Better Be Good to Me" and "Let's Stay Together," *Private Dancer* is practically a greatest hits collection itself. Recorded with a variety of producers, this disc also features a blistering Jeff Beck solo on the track "Steel Claw." Now this multi-award winning disc is brought to new life utilizing the critically-acclaimed XRCD technology...listen and compare.

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when you set it for zero attenuation. Theta, like most manufacturers, has found that digital volume controls degrade sound quality. The analog outputs have high-speed buffers to drive even very long interconnects, circuitry Theta first developed for its Casablanca A/V preamp.

For the transport section of the player, Theta used Pioneer's Stable Platter mechanism and made major improvements to its power supply and digital circuitry. The clock circuitry, taken from Theta's top-of-the-line Data III transport, has a custom-manufactured low-jitter oscillator. The clock/digital-output section has its own highly regulated power supply that uses a custom-made low-flux transformer. This power supply's very high isolation, together with extensive use of ground planes, is said to suppress AC line noise and help keep digital noise and hash from corrupting the purity of the clock signal.

The control and audio circuits are also well isolated, with extensive shielding to keep the comparatively noisy transport clocks from polluting the clock signals that drive the DACs. Three additional low-flux transformers are in the power supply, feeding six separate regulation stages on the DSP and analog boards. These power supplies are similar to those used in Theta's highest priced transports and D/A converters. High-quality Nichicon Muse capacitors are used in the power-supply, clock, DSP, and analog sections.

In short, the Miles has much of the technology you'd pay more than $8,000 for if you bought a Data III transport and DS Pro Generation V-a converter. As you might expect, this shows up in sound quality, especially in dynamics, transparency, low-level resolution, and deep bass.

I found the dynamics of the Miles to be far more musically natural than those in most players in its price range. There are good-sounding CD players at much lower prices, but those I've heard have had restricted dynamics; some even sounded compressed. (I suspect that this lack of natural dynamic energy and transient response is one reason many audiophiles prefer the dynamics of LPs; I believe that CD recordings often get the blame for this technical limitation of CD players.) The dynamics of the Miles approached some of really fine CD transport and D/A converter combinations I've auditioned.

On the Miles, chamber music did not have the peculiar flatness often heard from CD, and strings and woodwinds took on more life. Jazz bass lines were clear, without the beat compression that makes some listeners think that CD players lack proper musical tempo. The Miles also opened up the dynamics of full orchestral music and big-band jazz—and not just on “audio-ophile” CDs.

Transparency and low-level resolution are clichés in audio reviewing, but words cannot properly convey these qualities. The best I can say is that for transparency and low-level resolution, the Miles scores an 8 out of 10 (where 10 would be top-of-the-line Krell, Mark Levinson, Theta, and Wadia Digital equipment); I'd give most of the competition in its price range a 5 or a 6. (If you find such rankings as suspect as I do, I suggest you to go to a dealer and do some comparative listening—a good idea, in any case.)

When auditioning CD components, I often use string quartets or trios and Bach
harpsichord music to test transparency and resolving power. For some reason, both types of music seem to expose the limits of CD gear more quickly than most orchestral music, jazz, or rock. In fact, many CD players and D/A converters miss a significant portion of the “air” and sweetness of the strings and harpsichord on good recordings. The Miles may not have had quite enough transparency and low-level resolution to challenge the very best transport and converter combinations, but it did reproduce enough of that “air” to give strings and woodwinds the sweetness and harmonic integrity they deserve. Bach’s harpsichord music sounded like real music on the Miles, not an atonal exercise in mathematics (though I have yet to hear any CD playback equipment reproduce harpsichord in a way I find totally convincing). Considering its price range, the Miles also did an exceptional job of providing the low-level details of hall ambience and of musicians at work; these are things that help you forget you’re listening to a sound system and get involved in the music.

As for low frequencies, the Miles had both dynamics and deep bass punch. Here again, top-of-the-line Krell and Theta CD gear can provide more resolution, dynamics, and deep bass extension, but the margin of superiority is small. The Miles provided outstanding bass excitement, not just bass power, for its price. It helped give ordinary CDs far more natural musical realism than run-of-the-mill players could.

Theta Digital’s Miles shows what happens when a manufacturer takes technology from ne-plus-ultra equipment, with ne-plus-ultra prices, and makes it more affordable. Far too many high-end manufacturers seem obsessed with raising the ante and pursuing the ultimate design at the ultimate price. It’s nice to see one devote a major design effort to a product in a more reasonable price range.
choosing a speaker is like choosing a partner for a love affair. You can never find perfection, merely maximize delight. And the choice isn't easy, because speakers have more individual character than anything else in your audio system and have the greatest influence on its overall sound character. The selection is further complicated by the fact that there are thousands to choose from (Audio's most recent Annual Equipment Directory lists more than 3,000 models).

Luckily, some companies' speakers really do stand out from the rest. Take Vienna Acoustics, whose speakers offer exceptional bass and dynamic range for their size, embody a musically convincing mix of design trade-offs, deliver excellent soundstaging, and are equally good for stereo and home theater listening. What's more, these speakers are unusually small and quite stylish. For this review, I auditioned two pairs of floor-standing systems from Vienna Acoustics, its largest, the Beethoven Mk. II ($3,990 per pair), and the smaller Mozart ($2,500 per pair). I also tried the Maestro center-channel speaker ($995).

The Beethoven Mk. II, Vienna Acoustics' flagship, is relatively compact for a floor-standing speaker: Although it's 40 inches high, it's only 7½ inches wide and 14½ inches deep. Even so, it weighs 54 pounds, perhaps because its cabinet has five internal braces. This extensive bracing, and the quality of the cabinet, keep the enclosure's walls exceptionally inert during loud passages. The finish is very attractive; the Beethoven looks even better in real life than it does in photographs.

The Beethoven II's two 7-inch woofers operate in a quasi-Butterworth, bass-reflex enclosure. Its other drivers are a pair of 5½-inch midranges and a 1¼-inch tweeter. The three-way crossover, a Bessel-filter design with 9- and 12-dB/octave slopes, uses such high-quality components as air-core coils and noninductive metal-film resistors. The midranges are said to cross over to the woofer at a relatively low 110 Hz and to the tweeter at 3 kHz, so they can cover most of the human vocal range.

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range seamlessly. The Beethoven's rated frequency range is 30 Hz to 22 kHz, its rated sensitivity is 91 dB, and its nominal impedance is 4 ohms.

The reason Peter Gansterer, Vienna Acoustics' chief designer, gave the Beethoven II a pair of smallish woofers rather than one large woofer was to keep the front baffle narrow, for good imaging, while still providing bass down to about 35 Hz in most listening rooms. (Such low bass response is far rarer in the real world than most speaker specifications imply.) The woofer cones are made of a medium-weight, silicone-based polymer called XPP, which the company says is stiffer and better damped than polypropylene. The individually cast cones are further stiffened by spider-web-shaped molded ribs, said to make them even stiffer than metal cones. The midrange cones are also of XPP, but Gansterer left off the spider-web ribs to make them less stiff, for speed and delicacy. The tweeter is the highly regarded ScanSpeak D29. It has a silk dome, which some audiophiles believe produces a smoother and sweeter treble than metal or plastic tweeter domes.

The Mozart, which shares many features with the Beethoven II, is 37 inches high, 6¼ inches wide, and 11⅛ inches deep and weighs 44 pounds. It has two 5⅛-inch XPP woofers (in separate enclosures of different sizes) and a ScanSpeak D29 ¼-inch tweeter. Like the Beethoven II, the Mozart is a quasi-Butterworth bass-reflex system, and it has a Bessel crossover with 9- and 12-dB/octave slopes. Frequency range is rated at 35 Hz to 22 kHz, sensitivity at 90 dB, and nominal impedance at 6 ohms.

Each speaker's midrange and treble blended exceptionally well; I heard no discontinuities, response peaks, or harshness. These systems sounded slightly warm, and their upper-octave balance was sweeter than the high-frequency energy balance some other manufacturers define as "flat." (Even so, no one will criticize these speakers for a lack of high-frequency detail or "air.") That sweetness worked very well with many CDs, laserdiscs, and DVDs that had a bit too much upper-midrange energy. The Vienna Acoustics speakers produced a more musically natural balance with them, yet there was still enough high-frequency detail to keep LPs and more natural digital recordings from sounding soft.

The Beethoven and Mozarts proved particularly good in reproducing the tonal differences of different models of guitars, violins, and pianos, and they reproduced all the character of brass and woodwinds. They did a lovely job of reproducing solo voices and choruses without favoring one gender over the other and could handle all types of music well, from the grittiest blues to the most delicate soprano arias.

I was struck by the unusually good job these did of maintaining instrumental timbres over a very wide dynamic range. The Beethoven II performed better in this regard. Don't let its size fool you, for this is one speaker that lets you glory in Mahler's excesses at full tilt without compressing the sound or losing detail.

The Beethoven's bass was unusually deep and powerful for a speaker its size, as long as I spiked it to the floor and followed the manufacturer's placement instructions. It does need an amplifier that provides a lot of control and bass power, however, and I found it to be sensitive to cables. (It worked better with the Wire World Atlantis II and the Kimber KS 3033 than it did with my MIT and Alpha-Core Goertz cables.) Amplifier and cable interactions are a fact of life with almost all speakers, but the Beethoven II required more attention in this area than most.

The Mozart did not have the deep bass extension and dynamic range of the Beethoven II, but the differences were smaller than I'd expected and mattered only on recordings having true deep bass or extreme musical dynamics. The Mozart was less sensitive than the Beethoven to room placement and to amplifier and cable interactions—but then, the price of deep bass response is often greater difficulty with room interactions and cables.

The Beethoven II produced a very wide, deep, and stable three-dimensional soundstage over a broad listening area. Definition was unusually good, with no blurring or smearing. This speaker spread the instruments evenly and provided exceptional center fill. Its superior dynamics also ensured that the soundstage and imaging did not change when volume did, even when played at loud orchestral levels. These qualities came through clearly on grand opera, large 19th- and 20th-century orchestral pieces, and big-band jazz. They also showed up on several rock recordings that happen to deliver an actual soundstage rather than random, console-mixed effects.

The Mozart's soundstage was also very good. However, this speaker didn't quite match the Beethoven II's outstanding detail in really loud passages or its precision in reproducing complex choral and orchestral passages.

The Beethoven II and Mozart were at their best when driven by high-quality, high-powered solid-state amplifiers. With several medium-powered tube amplifiers, the sound was warm and the bass lacked proper tightness and definition, though this was less noticeable with Audio Research's VT200 tube amp. The Vienna speakers performed very well with moderately priced but powerful solid-state amplifiers, such as the Adcom GFA5802 and GFA5500 and the Classe Audio CA-400. The solid-state Krell KSA-300S provided even more bass control and definition, as, to a lesser extent, did the Pass Laboratories Aleph 1.2.

After stereo music listening, I put the Viennas into a home theater system, using the Beethoven IIs for the main channels and the Mozarts for the surrounds. For the center channel, I used the Maestro, a shielded speaker that has the same driver complement as the Mozart but is much smaller.

I was very impressed by this combination. The Viennas could handle the dynamics of the most demanding Dolby Digital (AC-3) or DTS soundtracks, and the sound field was large and stable. Dynamics and transient definition were very good, even when I drove the Viennas to levels best suited to reproducing World War II.

The speakers had virtually the same overall sound, or "voice," making them an excellent choice for use together in a home theater system. The timbre and dynamics of the Beethoven II and the Maestro were
much better matched than those of many competing speakers whose makers specifically claim good matching. The Beethoven II had enough deep bass power and definition to match an outstanding subwoofer like the REL Stentor II (which I reviewed in the April 1997 issue) and to deal with Dolby Digital and DTS soundtracks. The Mozarts did surprisingly well as surround speakers, projecting a broad sound field despite having just one tweeter apiece. For really good home theater, you need full-range surround speakers like the Mozarts, with response to well below 40 Hz and excellent dynamics throughout their frequency range. Using main and surround speakers that can reproduce deep bass well makes the sound far more exciting and natural than using smaller speakers that force you to funnel every channel’s deep bass through a common subwoofer.

I greatly appreciated the Vienna speakers' superior dynamic performance. Many speakers can play loud, but few can play loud, fast, and accurately. You can hear far more soundtrack detail with speakers whose timbre and definition don’t change when the level does. I was impressed with how well the Vienna Acoustics setup did relative to the Polk Audio Signature Reference Theater setup I compared it to. (I reviewed the SRT system in the September 1996 issue.) I was also struck by how well the Viennas reproduced different types of music and how well they blended into different listening rooms.

In the price ranges where the Vienna Beethoven Mk. II and Mozart compete, there are no world beaters. Instead of searching vainly for perfection, you must listen at length to find which speakers’ design trade-offs are ones you can accept. I think you’ll find that, although the Viennas may not sound exciting or different at first listening, they do sound right—and should sound increasingly right over time.

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Handel: Messiah

Dorothea Röschmann and Susan Gritton, sopranos; Bernarda Fink, contralto; Charles Daniels, tenor; Neal Davies, bass; Gabrieli Consort & Players, Paul McCreesh

ARCHIVE 453 464; DDD; 2:12:19

Sound: A, Performance: A

Charles Jennens (1700-1773), the librettist for Messiah, was a devout Christian and, moreover, a fundamentalist who feared that church reforms of his day would eat away at basic Christian doctrine. It is no wonder, then, that in choosing texts for the oratorio to be composed by George Frideric Handel, he came up with words of affirmation and unhampered faith. These texts inspired Handel to compose some of his most emotional music.

Messiah does not exist in any one authentic version; Handel kept rewriting sections, often to accommodate a particular soloist or set of soloists, sometimes in an apparent effort to improve them. (Here, Paul McCreesh basically uses the Foundling Hospital version of 1754.) After Handel's death, other changes were perpetrated by greater and lesser arrangers. Mozart provided a version better suited to the instrumentation of the classical period. More recently, an even larger-scaled version was credited to Eugene Goossens that obviously had some contribution from Thomas Beecham as well.

It became standard to assay Handel's masterpiece with choirs of 100+ singers and gigantic orchestras (including trombones and even percussion). In the mid-1960s, the English scholar Watkins Shaw came out with an edition that went back to Handel's original manuscripts, restoring much of his more modest intent. This was recorded, with modern instruments, by Robert Shaw for RCA and by Colin Davis for Philips, and the race for the "authentic" Messiah began. Christopher Hogwood's baroque original-instrument version opened the floodgates, and in the two decades since, we've had notable original-instrument, baroque-scaled recordings from Andrew Parrott, Martin Pearlman, Trevor Pinnock, and William Christie.

As good as these have been, most have missed the dramatic element of Messiah. This piece is unusual in Handel's opera-inspired oratorio output because it doesn't have a specific plot or characters; it would be foolish to think that a composer of dramatic music would suddenly turn his back on the devices he had developed to convey human emotion and action.

Paul McCreesh's recording is proper in the same way as that of the other baroque forces. It uses a small chorus of about two dozen singers and an orchestra of just under 40 players that employs original instruments or facsimiles thereof. McCreesh also observes the period pen-
chant for large numbers of double reeds, with four oboes balancing 14 violins and four bassoons enriching the sound of three cellos and two double basses during tuttis. He employs horns doubling trumpets and gives the timpani a lot to do in the “Hallelujah” and “Worthy is the Lamb” choruses. Interpreted ornamentation is correctly and amply applied, and tempos are brisk and incisive but never rushed. Going a step further, McCreesh and his forces set forth the text in a dramatic manner that sometimes made me feel like I was hearing the piece for the first time.

Neal Davies, the best bass singer I’ve ever heard in this work, displays a ghostly tone at the beginning of “The People Who Walked in Darkness” and produces resplendent open tones as the text dictates “upon them the Light hath shined.” The chorus adopts a derisive “crowd” tone for “He trusted in God,” the tenor really “dashes” those disbelievers, the contralto holds Christ to the most vile splitting ever from those smiters, the final “amens” peal as church bells, and so forth. At every turn there seems to be deeper meaning or color applied to a familiar text often taken for granted.

Davies is not the only stellar soloist in the lineup. McCreesh uses an alternative soprano version of “But Who May Abide,” which gives Susan Gritton an opportunity to bring “Queen of the Night” virtuosity and presence. Indeed, would dare The other soloists have wonderful moments as well, although soprano Dorothea Röschmann seems a bit over her head in “Rejoice Greatly.”

The recorded sound is detailed yet warm, tending to a bit of congestion only in the very loudest moments.

All in all, this is not just a magnificent performance of the familiar work but a new insight and statement. Rad Bennett

Wind Visions:
The Music of Samuel Adler
Keystone Wind Ensemble, Jack Stamp
CITADEL/KLAVIER 88120; DDD; 69:41
Sound: A−, Performance: B

Klavier, one of the few companies since Mercury to have an ongoing commitment to band and wind ensemble repertoire, boasts not one, but two wind ensemble series. One, conducted by Eugene Corporon, is on its own label, and the other, helmed by bandmaster Jack Stamp, is on Citadel, which Klavier distributes. This CD, from the latter distinguished series, is devoted entirely to the prolific American composer Samuel Adler. The music is diverse, ranging from the folk-tinged “Southwestern Sketches” to the driving Stravinskian dissonance of the latter portion of “A Little Night and Day Music.” The Force of Credulity is an arrangement for bands from the first American opera, written in 1767. Its thoroughly consonant harmonies seem to catch the players of the professional-sounding Keystone Wind Ensemble by surprise. Throughout the more recent works, the ensemble plays with great assurance. The recorded sound is revealing and awesome; the percussion section is captured with uncanny realism, and all the woodwind and brass balances seem just right. Rad Bennett

The Art of the Toy Piano
Margaret Leng Tan, toy piano and other instruments
POINT MUSIC 456 345; 48:47
Sound: A+, Performance: A

John Cage’s Suite for Toy Piano, written in 1948, was the first serious composition for the toy piano. This instrument’s gamelan-like bell sonorities intrigued him, as later they did pianist Margaret Leng Tan—dubbed “the diva of avant-garde pianism” by The New Yorker. She searched out a high-quality toy piano on which to demonstrate in recital what she calls the “off-key poignancy” of the instrument’s unique sound. (She now owns nine of them.)

Leng Tan’s composer friends, fascinated with this “new” sound, began writing pieces for the toy piano. Soon there were enough for her to record an entire album. The Cage suite is not among the dozen tracks here, but the delightfully varied fare includes originals by Toby Twining, David Lang, Julia Wolfe, Stephen Montague, and accordionist Guy Klucsevek. There are also a few unexpected transcriptions, such as the Adagio from the “Moonlight” Sonata, a Gymnopédie by Satie, and The Beatles’ “Eleanor Rigby.”

What you won’t find is a maddening sameness of sound. The use of the toy piano as well as a number of other melodic/harmonic instruments (including standard piano, toy accordion, and melodica), the addition of various noisemakers on some tracks (whistles, cap guns, and percussion), and the selection of wildly contrasting pieces contribute to this fascinating and satisfying program.

The direct-to-two-track recording nicely captures the extreme high frequencies, preserving the delicate overtones generated by plastic hammers striking tiny metal bars. It makes a fine and welcome contrast to bass demo material.

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Friends of Mine
Ramblin' Jack Elliott
HIGHTONE RECORDS
HCD 8089, 48:50
Sound: B, Performance: A-

In the rusty chain of folk singers linking Woody Guthrie to Bob Dylan, Ramblin' Jack Elliott lies about midway, not early enough to be anointed an "influence," not late enough to steal much wind from Dylan's sail. Having played folk, cowboy country, and acoustic blues since the '40s—he even helped popularize Guthrie himself in the '60s with an album of Woody's songs—Elliott's main claim to folk music fame has been his eye-bulging longevity. Today, at 67, one of the best storytellers around continues his search for a way to stay faithful to the folk foundations he helped lay yet be relevant to the world of contemporary acoustic music.

One way to straddle that fence is to invite some well-known friends over to your place for a recording session. Heck, you amble through the tumbleweed-strewn folk and country scenes for nearly five decades, and you're bound to find a friend or two, right? So Elliott made a few phone calls, and cronies like Tom Waits, Guy Clark, Emmylou Harris, Bob Weir, John Prine, Arlo Guthrie, Peter Rowan, Rosalie Sorrels, Jerry Jeff Walker, and Nanci Griffith moseyed on down to his place. Set that talent to songs by Joe Ely ("Me & Billy the Kid"), Tim Hardin ("Reason To Believe"), Merle Travis ("Dark As a Dungeon"), and Gene Autry ("Ridin' Down the Canyon"), among others, and you've got the stuff for a mythical folk album.

Of the baker's dozen tunes here, only two are new. In "Louise," written by Waits specifically for this album, he and Elliott sidle up to a grand folk ballad dotted with an accordion and slide guitar. And "Bleeker Street Blues" is a spoken-word thing Elliott wrote for Dylan after hearing about his friend's recent life-threatening illness.

No, you couldn't build a new folk movement around Elliott's rickety henhouse of a voice, nor could you hang one on the aging timbres of Clark or Walker. But there's a great deal of charm in the oaken rasp of these performers, and the esprit de corps spills from each song. Alongside angelic warblers Harris and Griffith, Elliott sounds thuggish crooning Townes Van Zandt's soul-stirring ballad "Rex's Blues." And, of course, beside the steely throated Prine on Dylan's "Walls of Red Wing," Elliott sounds like an old bleater whose best time has already past. But if Friends of Mine doesn't exactly shine in terms of pure performance, it will most certainly live on in the folk album pantheon as a passionate gathering of some of our generation's greatest folk and roots talents.

Bob Gulla

CELTIC CRYSTAL
Dean Shostak, glass armonica; Jacqueline Schwab, piano; Sue Richards, Celtic harp; Ulysses Kirksey, cello
DEAN SHOSTAK DS-0121
DDD, 48:28
Sound: A, Performance: A

Benjamin Franklin believed that the glass armonica (his invention) was the ideal instrument on which to play Scottish folk tunes. Dean Shostak and friends prove his judgment correct, offering Scottish traditional tunes as well as many Celtic favorites on this enchanting album. The eerie, somewhat ghostly sound of the glass armonica, punctuated by harp and piano, creates a timeless sound that gently transports you to a peaceful past. (Available from Dean Shostak, P.O. Box 465, Williamsburg, Va. 23187; phone, 800/588-3526; fax, 804/642-1452.)

Rad Bennett
Perhaps no other nation in the world has as rich a musical heritage as Cuba. From rumba to danzon to trova, the island air is saturated with danceable, singable sounds. American guitarist Ry Cooder knew all that when he ferried over to play and record with Buena Vista Social Club, a loose agglomeration of musicians of modest reknown, which has, in a quiet way, helped preserve the deeply funky music known as son de Cuba.

Because of its casual approach, every moment of Buena Vista Social Club comes across as pure musical pleasure. Cooder is joined by a long list of prominent island players, including major Cuban composers and musicians Ibrahim Ferrer, Compay Segundo, and Rubén González. The album feels like a Folkways historical document, but it sounds more like a good-time fiesta.

This is a trove of sparkling Cuban jewels. “Chan Chan,” the opening peasant ode, features guitar giant Eliades Ochoa on lead. His half-jubilant, half-melancholy guitar (bolstered by Cooder’s) is wide-open and sounds positively heart-warming. “El Cuarto de Tula,” an extended Cuban-style jam, also features Ochoa, this time flanked by Ferrer and “Puntillita” Licea on vocals. “Dos Gardenias,” a prototype of the boleto style, hinges on Ferrer’s passionate voice and “Guajiro” Mirabal’s devastating trumpet.

No matter where your laser lands on this disc, you’ll hear a brilliant example of energetic and passionate Cubanismo. Because of that passion and Cooder’s open-mindedness, Buena Vista Social Club is, hands-down, one of the best World Music discs of recent memory.

Bob Gulla

So Much for the Afterglow
Everclear
CAPITOL CD5 72438 36503, 48:49
Sound: A-, Performance: A+

Songwriter Art Alexakis has been called an opportunist, a mimic, a martyr, and a hero; more than anything else, however, Everclear’s frontman is a realist. After the band’s grungy Sparkle and Fade rocketed up the pop charts in 1995, Alexakis was showered with praise, cash, and fan mail, but, through it all, his cynical nature remained intact. On this new album, So Much for the Afterglow, that may be changing. Much of the distorted fury of Sparkle and Fade is absent from Afterglow, to attain a listener-friendly sheen that some have associated with Alexakis’s pre-punk hero Tom Petty. Everclear also makes its music more dynamic by experimenting with a variety of sounds, including alt-country banjo twang, layered samples, braying horns, and clanging cowbell.

Whether Everclear churns up a storm of noise or unravels strings of sticky pop confection, it does so with joyous abandon. As a result, songs about abandonment (“Father of Mine”), shameless ass-kissing (“Everyone to Everyone”), and mental illness (“Normal Like You”) are ultimately uplifting instead of bleak or enervating. Yet even when the music sounds triumphant, a bit of underlying angst seeps through, thanks largely to Alexakis’s raw, raspy drawl.

So Much for the Afterglow may not be the mainstream hit that Sparkle and Fade was for Everclear, but it’s far more eclectic and satisfying. It’s also more confessional, exposing the machinations of an artist who’s proud to be passionate, pain-stricken, and iconoclastic.

Jon Weiderhorn

**FAST TRACKS**

Those Were the Days: Cream (Polydor/Chronicles 31453 9000, four CDs, 5:05:48)

This package contains all of Cream’s studio work, live albums, and unreleased demos. The original power trio’s blues material and “hits” stand the test of time, while much of the rest is dotted art rock. Peeks and valleys, with the earliest album, Fresh Cream, still the strongest.

Jon Tiven

Roni Size/Reprazent: New Forms (Mercury 136, two CDs, 2:13:52)

Last year, Roni Size snatched England’s coveted Mercury Music Prize from commercial favorites Prodigy and The Chemical Brothers. Now the Bristol sensation is poised to break live drums and upright bass to the masses in music that fuses electronic and hip-hop with jazz and soul. It’s as funky as classic James Brown and destined to be a cornerstone of the next decade’s music.

Chris Gill

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**Buena Vista Social Club**

Buena Vista Social Club
WORLD CIRCUIT/
NONSENUS 79478, 60:09
Sound: A-, Performance: A+

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Since making his first recording in 1986 at the age of 22, trumpeter Dave Douglas has received a lot of attention. He's been playing in various avant-garde jazz ensembles in New York, leading some of them, but he's best known for his work in saxophonist John Zorn’s Masada. Last fall saw the release of two Douglas studio recordings, Sanctuary and Stargazer. They are vastly different in concept: Sanctuary, according to Douglas’s notes, was inspired by the music of John Coltrane, Ornette Coleman, Pierre Boulez, and Arnold Schoenberg as well as pre-Renaissance Florentine literature and architecture; Stargazer is a tribute to saxophonist/composer Wayne Shorter.

Sanctuary consists of two hour-long parts that progress with the development and abandonment of composed themes, tempos, and solo space. The ensemble is a variation on Ornette Coleman’s double quartet, and Douglas also enlists a pair of sampler manipulators, Yuka Honda and Anthony Coleman. In the album’s mix, these two trios are split-channeled—one issuing from the left speaker, the other from the right. Mixed in the center are Dougie Bowne (drums) and Chris Speed (tenor saxophone and clarinet).

Sanctuary develops as if following a dramatic storyline, with the musicians improvising through aleatoric sections to predetermined moments. These moments are often marked by the introduction of themes or sampled beats and textures. Take the way “Part one” negotiates one of its first turns: Douglas’s dynamic solo ex-hausts itself into a soft bleating and is then overcome by Coleman violently churning out a rhythmic sucking sound. Coleman’s plunger serves as a noisy transition into a hard-hitting hip-hop backbeat sequenced by Honda. The beat is given some time to establish its dominance before Cuong Vu and Douglas loosely tag a noirish series of long, contoured phrases over it. The trumpets then suddenly drop out to reveal Speed’s demure tenor—sometimes flowing freely, sometimes intentionally struggling—naked over the programmed beat.

Music of the moment, Sanctuary could not have existed 30, 10, or even five years ago. Less momentous, but
The Heart of Things
John McLaughlin
VERVE 314 539 153, 47:20
Sound: B, Performance: A

In "Acid Jazz," the opening track of the fine album The Heart of Things, John McLaughlin manipulates mood through metric superimposition. It's become something of a trademark for McLaughlin, who, as far back as Mahavishnu Orchestra's 1972 Birds of Fire, arranged odd meters with the dazzle of a fleet-fingered Indian tabla player. And although the Indian influence in his mind-boggling guitar solos can still be heard, his music has become airier and more refined, if no less passionate. The Heart of Things finds McLaughlin back in blistering fusion form with a band capable of pushing him to soaring, if brief, heights of improvisation.

One of only six songs on the album, "Acid Jazz" begins with jazz-lite meandering, then sinks into a funky, furious groove courtesy of drummer Dennis Chambers. The odd-metered pulse boils over a darting be-boppish line and from McLaughlin's dizzying guitar explosions.

"Seven Sisters" is another tongue twister in time, over which McLaughlin and Thomas engage each other like battering warlords. "Mr. D.C." refers to Chambers, of course, and is a showcase for the drummer's astounding chops, which embellish his bedrock feel for any rhythm McLaughlin throws his way. The wistful "When Love Is Far Away" closes the album. McLaughlin is on acoustic guitar, his notes ringing with remarkable grace and power.

The Heart of Things seems a throwaway title, but the music proves John McLaughlin hasn't lost his touch. With his crack band and expressive tunes, fusion is no longer a dirty word. 

Ken Micallef

Thoughts of Dar Es Salaam
Horace Tapscott
ARABESQUE JAZZ AJ 0128, 59:48
Sound: A, Performance: A

Pianist Horace Tapscott has a long-standing penchant for changing time signatures and textures within a single song or theme. On Thoughts of Dar Es Salaam, however, he explores only one time signature per tune, while his love of textures—of creating feeling where none would have been discovered by lesser pianists—remains very much intact.

On his original "Bibi Mkuu: The Great Black Lady," Tapscott teases the supporting line, weaving his solos in and out of Ray Drummond's jumping, blues-heavy bass line and drummer Billy Hart's ferocious time-keeping. On "Wiletta's Walk," it is the conversation between piano and bass that drives the tune forward, while Hart answers Tapscott's deceptively simple melody with an equally soulful and lighthearted solo.

Tapscott takes the familiar melodies of standards like Gigi Gryce's "Social Call" and Charlie Parker's "Now's the Time" and reinterprets them with a fluid subtlety that may take one by surprise. On the title track, Tapscott lets his fingers imagine the secrets yet unearthed in the Tanzanian port city; one can feel his absorption in the riches of a still mysterious continent. 

Marie Elsie St. Léger

Cuba: I Am Time: Various Artists [Blue Jackyl] BJAC 5010, four CDs, 4:31:29. Here's a comprehensive box (cigar box, no less) of CDs that examine the history of Afro-Cuban music as it evolved on Cuba (as opposed to other Caribbean islands on which slavery existed). Included are examples of Afro-Cuban music's roots, from rhumba and son styles that evolved after slavery was abolished through the current, jazz-influenced progenitors of Afro-Cuban. Spread across four CDs, Cuba: I Am Time is a fascinating and quite enjoyable study. [Available from Blue Jackyl, 322 Hicksville Rd., Bethpage, N.Y. 11714.] Mike Bieber
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When I reviewed the Biró t2, an inexpensive Toslink-to-coaxial S/P DIF converter (November 1996), my sole complaint was that it didn't also convert electrical digital signals to optical. The Fostex COP-1 ($95) converts in both directions.

Many of today's consumer digital audio components have only Toslink optical connections, which makes it impossible to use them with gear having only coaxial digital connectors. The COP-1, a product Fostex developed for its professional line, allows separate, even simultaneous, Toslink-to-coaxial and coaxial-to-Toslink conversions. This box is a snap to use: Just plug in its 9-volt DC adaptor, connect your signal source's output to the appropriate input jack, and connect the appropriate COP-1 output jack to the next digital component in your system. The device accepts sampling rates from 32 to 48 kHz. It also lets Serial Copy Management System (SCMS) anti-copying subcodes pass through.

I used the COP-1 to link my DVD player's Toslink output to my Dolby Digital preamp, whose only unused digital input was coaxial. The Fostex also enabled me to link a DAT recorder's coaxial digital output to my Pioneer PDR-04 CD recorder's Toslink input.

I am a sucker for interface boxes like this, and the Fostex is a great one. (Fostex: 15431 Blackburn Ave., Norwalk, Cal. 90650; 562/921-1112.)

John Gatski

I have several noise-cancelling headphones to choose from. The one I usually take along on trips is the Koss Quiet Zone 2000 ($200). It's ideally configured for travelling, because its headset folds and the anti-noise electronics package (built for Koss by Andrea Electronics) just fits within the folded headset. The electronics box has a multipin jack for connection to the headset and a stereo mini-jack for an audio connecting cord. That cord has right-angled stereo mini-plugs at each end; adaptors for quarter-inch jacks and the double mini-plugs used in some airplanes are included, as is a soft zippered pouch to keep everything together.

The 2000's headset, like that of Koss's other folding models, has no top padding but does have foam pads that press against your temples to relieve pressure on your ears; I've found the 2000 comfortable enough to wear continuously while crossing the country or the Atlantic.

Because the frequency extremes roll off a bit, the sound is neither as rich nor as clear and open as that of my Grado SR325, but that's not very noticeable under the noisy conditions I carry the Koss 2000 for. If the two AA batteries go dead or if I turn the electronics off, volume drops and the frequency response tilts more toward the bass, but I don't lose the signal entirely—which I do with some other noise-cancelling 'phones. (Koss: 4129 North Port Washington Rd., Milwaukee, Wisc. 53212; 414/964-5000; www.koss.com.)

Ivan Berger

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