

Audio

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • JULY 1979 \$1.25

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**FIRST TEST—
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**SPECS ON
CAR RADIOS,
SPEAKERS &
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NONE DO.



**UNDER LABORATORY CONDITIONS,
FEW HIGH PRICED TURNTABLES
SOUND AS GOOD AS THIS ONE.**



UNDER REAL CONDITIONS,

For years, people have been selecting turntables based on specs obtained in a lab, without knowing what kind of sound they'll obtain in their homes.

And while a few turntables today look as good as Pioneer's PL-630 on paper, you'd be hard pressed to find one that sounds as good in your living room.

A SUSPENSION SYSTEM THAT ELIMINATES SHAKE, RATTLE & ROLL.

In your home, simply walking across the floor can cause the stylus to skate across your records.

And acoustic feedback can make even the most lively piece of music sound dull and lifeless.

Pioneer's PL-630, however, has a free floating suspension system that isolates the platter and tone arm from the rest of the turntable. So that while the base may vibrate, the platter and tone arm won't. Which means you don't have to tip-toe across the floor just to prevent vibration. And you can turn your music up loud enough to rattle the walls without fear of rattling the turntable.

A DIRECT DRIVE MOTOR THAT WON'T DETERIORATE WITH OLD AGE.

All DC direct drive motors start out to be incredibly accurate.

Unfortunately, they don't always stay that way.

After a while, the quality of sound could deteriorate because the motor is left exposed and free to collect dust and foreign objects.

This is not the case with the PL-630. Unlike most of the competition, its motor is totally enclosed. Which means that the incredible wow and flutter figure of 0.025% will still be an incredible 0.025% years from now. And so will the 0.002% speed accuracy.

What's more, the electronic circuitry of this Quartz PLL Hall element system constantly monitors itself. When it senses the slightest deviation in speed, it corrects itself. By just switching the quartz "lock" on, you lock onto the correct speed, so you're assured of accurate platter speed at all times and under all conditions.

And because of its extremely high torque, the PL-630 reaches full platter speed in a mere third of a revolution.

But more importantly, it stops almost as quickly as it starts. Reverse current is fed into the drive system eliminating both excessive wear on the turntable and the need for a brake.

ONLY ONE THING COMES THROUGH THE TONE ARM. MUSIC.

The tone arm of the PL-630 rests on a massive die-cast aluminum base.

And while other tone arms may rest on a similar base few, if any, are mounted to it in a similar manner. Instead of piano wire or cheap plastic casings that vibrate, the PL-630's tone arm is gimballed on spring mounted pivot bearings. This not only reduces tracking error due to tone arm pivot wear, but increases the overall performance of the turntable.

Which brings us to the magnesium headshell. It has far better acoustical properties than the headshell you'll find on most turntables. This new construction reduces the chances of hearing any howling or distortion.

FEATURES OUR COMPETITORS PRETEND THEY'VE NEVER HEARD OF

Our platter mat is concave so that even if your records are slightly warped, they'll sound like they aren't.

Our spindle is only 0.8 microns larger than most, but it can make a big difference in keeping your records perfectly centered.

And our massive platter is less vulnerable to fluctuations in speed than smaller platters that come with most turntables.

Even the way the platter is coupled to the motor is unique. It doesn't have bearings. It's precision machined to a tapered fit so that it's less likely to wobble.

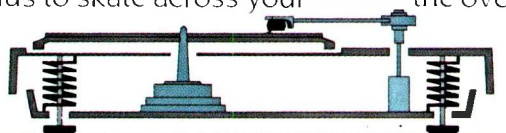
And while you'll find a strobe on most direct drive turntables, you won't find one on the PL-630. Simply because there's no need for one. Instead, there's a pitch display that gives you visual confirmation of accurate speed.

You'll also find super sensitive controls that even shut off the power automatically when the tone arm comes to rest.

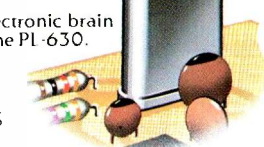
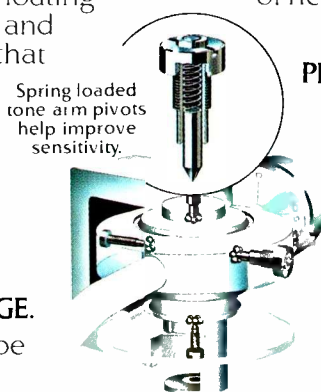
If you're beginning to get the idea that Pioneer's PL-630 would sound great in your home, we suggest you go to your nearest Pioneer dealer.

After all, you may not live in a sound room, but it doesn't mean your living room can't sound like one.

PIONEER®
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When the base of the PL-630 vibrates, the platter and tone arm don't.





THE PL-630.

WHAT PRODUCT

1. Prevents "record chatter" on your turntable?
2. Looks unimpressive?
3. Is very thin and gray?
4. Is more anti-static than similar products*?

*according to tests by the Swedish National Test Institute.

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July 1979

Vol. 63, No. 7

Audio

"Successor to **RADIO** Est. 1917"

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About the Cover: Installing a car stereo system might prove to be a very long job with a helper like our cover model, Linda Powell, but for some professional tips on installing car speakers, see page 52. Ferrari 308 GTS courtesy Frank Donatoni, Sales Manager, Algar Enterprises, Paoli, Penna. Photo: Photographic Illustrations, Philadelphia.



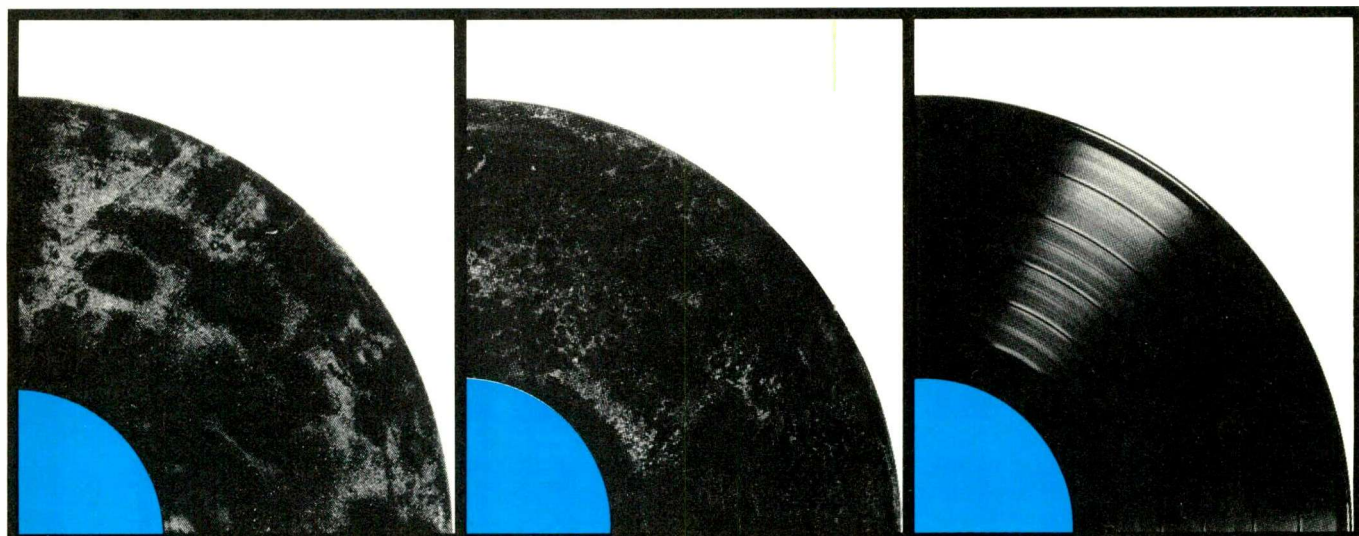
Audio Publishing, Editorial, Subscription, and Advertising Production offices, North American Building, 401 No. Broad St., Philadelphia, Penna. 19108. Telephone: 215/574-9600.
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one application!

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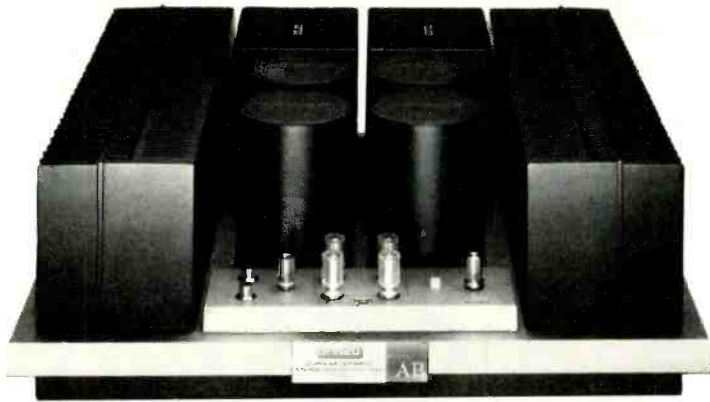


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AUDIO is published monthly by North American Publishing Company, Irvin J. Borowsky, Founder and President
Frank L. Nemeyer, Vice President/General Manager
Joseph Florentine, Chief Financial Officer
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545 Madison Ave., New York, NY 10022
Telephone (212) 371-4100

East Coast Sales Office: Laurel Carr, 545 Madison Ave.,
New York, NY 10022 Telephone (212) 371-4100

West Coast Sales Office: Jay Martin, 17000 Ventura
Blvd., Encino, CA 91316. Telephone (213) 788-9900.

Continental European Representative: Y. B. Sanders,
International Publishers Advertising Service,
Raadhuisstraat 24, P.O. Box 25, Graft-De Ryp, Holland.
Telephone, 02997-1303

England: The Paul Singer-Lawrence Media Group,
54 Burton Court, London SW 3 5Y4, England. Phone,
01-730-3592

World Library Congress Number 155N0064-732X

Dewey Decimal Number 621.381 or 778.5

Editorial Contributions are welcomed but should be accompanied by return postage. Submissions will be handled with reasonable care, but the publisher assumes no responsibility for return or safety of manuscripts, photographs, or artwork.

Printed in U.S.A. at Columbus, Ohio. Second-class postage paid at Philadelphia, PA and additional mailing offices. USPS Number 036-960

U.S. Subscription Rates: 1 year \$12.00, 2 years \$22.00, 3 years \$30.00.

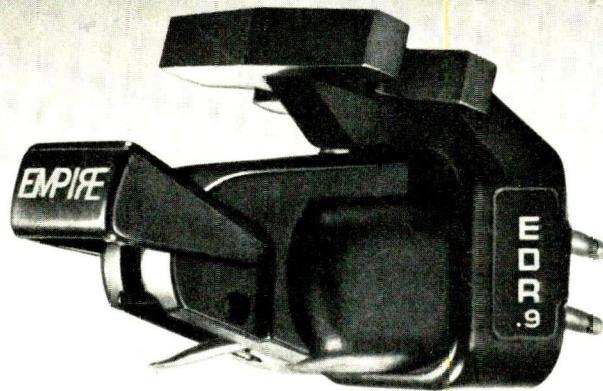
Other Countries: 1 year \$18.00, 2 years \$34.00, 3 years \$49.00.

Back issues, when available, \$5.00 postpaid.

Audio Publishing, Editorial, Subscription, and Advertising Production offices, North American Building, 401 North Broad St., Philadelphia, PA 19108.

Telephone: (215) 574-9600.

Postmaster: Send Form 3579 to above address.



INTRODUCING THE EMPIRE EDR.9 PHONO CARTRIDGE. IT SOUNDS AS GOOD ON A RECORD AS IT DOES ON PAPER.

It was inevitable . . .

With all the rapid developments being made in today's high fidelity technology, the tremendous advance in audible performance in Empire's new EDR.9 phono cartridge was bound to happen. And bound to come from Empire, as we have been designing and manufacturing the finest phono cartridges for over 18 years.

Until now, all phono cartridges were designed in the lab to achieve certain engineering characteristics and requirements. These lab characteristics and requirements took priority over actual listening tests because it was considered more important that the cartridges "measure right" or "test right"—so almost everyone was satisfied.

Empire's EDR.9 (for Extended Dynamic Response) has broken with this tradition, and is the first phono cartridge that not only meets the highest technological

and design specifications—but also our demanding listening tests—on an equal basis. In effect, it bridges the gap between the ideal blueprint and the actual sound.

The EDR.9 utilizes an L. A. C. (Large Area Contact) 0.9 stylus based upon—and named after—E. I. A. Standard RS-238B. This new design, resulting in a smaller radius and larger contact area, has a pressure index of 0.9, an improvement of almost six times the typical elliptical stylus and four times over the newest designs recently introduced by several other cartridge manufacturers. The result is that less pressure is applied to the vulnerable record groove, at the same time extending the bandwidth—including the important overtones and harmonic details.

In addition, Empire's exclusive, patented 3-Element Double Damped stylus assembly acts as an equalizer. This eliminates the high "Q" mechanical resonances typical of other stylus assemblies, producing a flatter response, and lessening wear

and tear on the record groove.

We could go into more technical detail, describing pole rods that are laminated, rather than just one piece, so as to reduce losses in the magnetic structure, resulting in flatter high frequency response with less distortion. Or how the EDR.9 weighs one gram less than previous Empire phono cartridges, making it a perfect match for today's advance, low mass tonearms.

But more important, as the EDR.9 cartridge represents a new approach to cartridge design, we ask that you consider it in a slightly different way as well. Send for our free technical brochure on the EDR.9, and then visit your audio dealer and listen. Don't go by specs alone.

That's because the new Empire EDR.9 is the first phono cartridge that not only meets the highest technological and design specifications—but also our demanding listening tests.
Empire Scientific Corp.
Garden City, N.Y. 11530 **EMPIRE**

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Joseph Giovanelli

FM Noise Problem

Q. I have a reception problem with New York City FM radio station WQXR (96.3 MHz), with which I hope you can help. I receive a perfectly clear, noise-free signal from every other local station with the single exception of this station, in which case I experience a background noise similar to SCA "chatter" or "swishing." However, this noise disappears when my tuner is switched to mono. — Alfred Cocchini, Glendale, N.Y.

A. The i.f. of most tuners is 10.7 MHz, and if you multiply this frequency by nine, you come up with a frequency of 96.3 MHz, the frequency on which WQXR broadcasts.

When your tuner is receiving any station, the i.f. system radiates energy to some extent. It not only radiates the 10.7-MHz i.f., but also the various harmonic frequency multiples of 10.7 MHz. The 9th and 10th harmonics of 10.7 appear to be the only ones which can interfere with FM reception. In your case, the 9th harmonic has sufficient energy to be picked up by the front end, perhaps by a small piece of the twin lead used to feed signal from the antenna terminals to the input of the front end. This internal signal mixes in the front end with the external signal to form a beat; the audible effect of this beat is less apparent in mono because there are no pilot or other higher frequency signals to form other beats. In the stereo mode, there will be other beats, all dependent upon the instantaneous deviation of the desired signal. Because of the various possible beats, and because they are constantly changing, the effect is that of background noise rather than a pure tone.

My own tuner exhibits this problem, and I cure it by slightly mistuning the station, which does not degrade the sound in the slightest. The result is that the i.f. is now something other than 10.7 MHz, just different enough to prevent this beating effect from being audible, but not so different as to result in the signal being out of the bandpass of the i.f. system. I think you should write to the maker of your tuner to see what he can suggest by

way of better shielding for the i.f. system, so that its energy cannot be picked up by the front end.

Transient Pulses

Q. I hooked up an equalizer to my amplifier at its preamp-out, power-amp in jacks. Whenever the amplifier is on and the equalizer is turned on, there is a loud pop and the speaker fuses blow. This also occurs when turning the equalizer off while the amp is still on. The problem, however, doesn't occur when the equalizer is turned on first. Can I just leave the equalizer on all the time, or is there a better solution? — Dennis Fischer, Denver, Colo.

A. You should consider putting the equalizer into the tape loop, rather than between the preamplifier and power amp. I know that this can be a problem when a tape recorder is already connected to this set of jacks. However, most equalizers have tape-loop facilities, so this is probably the best solution.

Test Equipment Impedances

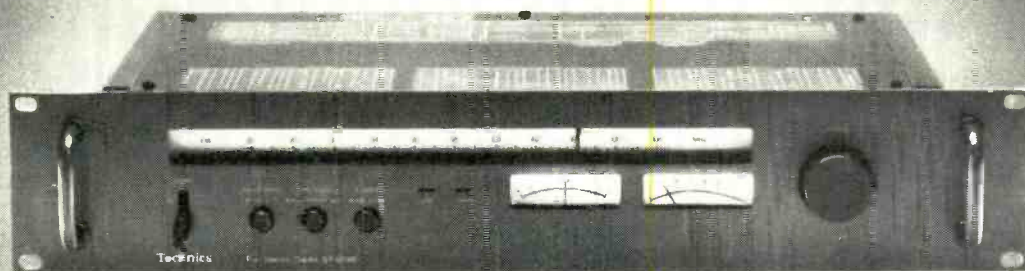
Q. I recently purchased electronic test equipment in order to test and repair my audio equipment. Suppose I want to connect my 50-ohm sinewave-oscillator output to the 100-kilohm input (AUX) of my amplifier. Would the impedance mismatch cause problems? — Michael Bartholomew, Hellertown, Penna.

A. Keep in mind that most of the time we don't match impedances in audio, contrary to all the talk being thrown around. This is true for the audio oscillator used to test the power amplifier; there is no need to match impedances. Matching impedances produces a maximum transfer of power between two circuits. With the circuits we are discussing, we are more interested in transferring maximum voltage, which doesn't occur at the point of maximum power transfer.

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 401 North Broad Street, Philadelphia, PA 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

AUDIO • July 1979

The Technics ST-9030 tuner. Purists would feel better if it cost over \$1,000.



To some, tuners that offer 0.08% THD, 50 dB stereo separation, a capture ratio of 0.8 dB and waveform fidelity should demand a price tag of over \$1,000. But with the ST-9030 this performance can be yours for less than half that price.

That's quite a feat for a tuner. But then the ST-9030 is quite a tuner. It has two completely independent IF circuits: A narrow band for ultra-sharp selectivity. And a wide band, for ultra-high separation and ultra-low distortion. It even selects the right band, depending on reception conditions, automatically.

Both bands give you the same extended flat frequency response. Because, unlike conventional tuners, the ST-9030 utilizes an electronic pilot cancel circuit that cuts the pilot signal, without cutting any of the high end. It's ingenious. And a Technics innovation.

The Technics ST-9030 has one of the quietest, most sensitive front ends of any tuner. With an advanced linear frequency 8-ganged tuning capacitor and 3

double-tuned circuits, plus dual gate MOS FETs in the 2-stage RF amplifier and balanced mixer circuit. What's more, there's a servo tuning circuit that locks into the tuned frequency, regardless of minor fluctuations. The result: Negligible drift, distortion and maximum stereo separation.

Technics ST-9030. Compare specifications and prices. And you'll realize there's really no comparison.

THD (stereo): Wide—0.08% (1 kHz). Narrow—0.3% (1 kHz). S/N: 80 dB. FREQUENCY RESPONSE: 20 Hz—18 kHz ± 0.1 , -0.5 dB. SELECTIVITY: Wide—25 dB. Narrow—90 dB. CAPTURE RATIO: Wide—0.3 dB. Narrow—2.0 dB. IF IMAGE and SPURIOUS RESPONSE REJECTIONS (98 MHz): 135 dB. AM SUPPRESSION (wide): 58 dB. STEREO SEPARATION (1 kHz): Wide—50 dB. Narrow—40 dB. CARRIER LEAK: Variable— -65 dB (19 kHz). Fixed—70 dB (19 kHz, 38 kHz).

Technics ST-9030. A rare combination of audio technology. A rare standard of audio excellence.

Technics

Professional Series

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Behind the scenes

Bert Whyte

As I write this column, I'm within a few days of traveling to Los Angeles for the annual May convention of the Audio Engineering Society. As you might expect at this stage of development, digital audio will be a prominent feature of the convention. Some digital recording equipment, seen in prototype form as recently as last November's 61st AES convention, will appear in production models. Needless to say, prototypes of new digital recorders will be forthcoming at the convention, including one that is rumored to have a capacity of 64 channels on one-inch tape!

While digital audio is still in a relatively embryonic state, some digital recording for the production of commercial recordings is, in fact, taking place on a fairly regular basis. Dr. Tom Stockham's Soundstream digital recorder is being kept busy with his custom recording service. Telarc Records initial release of their Fred Fennell and Atlanta Symphony productions using the Soundstream service will soon be followed by their recording of Moussorgsky's *Pictures at an Exhibition* and *Night on Bald Mountain* performed by Maazel and the Cleveland Orchestra. Telarc is said to have a number of on-going digital productions with Soundstream. Just recently, the Sound-

stream digital recording service was employed by RCA to record Bartok's *Concerto for Orchestra* with Eugene Ormandy and the Philadelphia Orchestra. Soundstream's current digital recorder has a maximum capacity of four channels, so it will be interesting to hear this production since RCA usually opts for 8- and 16-channel recorders in their normal recording activities in their Philadelphia Orchestra ventures.

Digital Recordings

As noted recently, the 3M 32-channel digital recorders have been delivered to A&M Records, Warner Bros., The Record Plant, and Sound 80, and the units are now in use. Thus far, no analog recordings resulting from this digital mastering activity have been announced, but I expect we will hear some during the Los Angeles AES convention.

Speaking of the 3M multi-track digital recorder, Columbia Records is supposedly awaiting the availability of one of these recorders so that they can record Zubin Mehta and the New York Philharmonic in yet another version of Moussorgsky's *Pictures at an Exhibition* and Stravinsky's *Petrouchka*. While Columbia has purchased some of the Sony 1600 digital recorders and

undoubtedly has done some experimental recording with them, their well-known proclivity for multi-miking explains their bias toward the 32-channel 3M recorder. They are, in addition, using a one-inch, 24-channel, fixed-head Sony unit, shown in prototype at last fall's AES convention, to do a recording of Straus' *Till Eulenspiegel* and *Don Juan* by the Cleveland Orchestra early in May.

EMI, the British parent company of Capitol/Angel Records, is said to have developed a digital recorder, and a unit is supposed to be in the hands of Capitol. I have no information at present as to whether their recorder is of the fixed-head or helical scan variety.

In a recent conversation with Arthur Haddy, Director of Decca Records in London, he told me that they now have four of their digital recorders in operation and are building more recorders on a high priority basis. As I write, a Decca recording team has one of their digital recorders in Chicago, and we will soon hear what Sir Georg Solti and the Chicago Symphony Orchestra sound like from a digital master. The first fruit of Decca's digital recording activities has arrived in the form of a two-disc analog LP recording of the annual New Year's concert of the Vienna Philharmonic conducted by Willi



TELARC DIGITAL RECORDING:

**It spells
enchantment,
intoxication,
and your utter
involvement in
the music.**

Stravinsky's Firebird is a challenge. In 1910 it dared listeners to embrace new tonalities, and it has remained fresh and alive ever since. It is a formidable test of the resources and musicianship of the orchestra. And it makes fantastic demands of the art of recording.

Even the finest conventional tape recorders have been unable to capture the full dynamic range and complex sonorities of this remarkable composition. Digital recording techniques are likewise put to a significant test in capturing the full impact of this performance. That this unique digital effort has succeeded will be immediately apparent with the opening notes. And the benefits of the digital process will persist to the final echo.

Briefly, this Telarc recording uses Dr. Thomas Stockham's Soundstream digital recording system which converts the original electronic signal from the recording console into a series of digital numbers... a new number every 1/50,000 of a second! Each of these "samples" uses a 16-bit binary code to describe the signal more precisely than

TELARC
DIGITAL
STEREO RECORDING

Stravinsky:
The Firebird
(Suite, 1919 version)
Borodin: Overture and
Polovetsian Dances
from Prince Igor

Robert Shaw
The
Atlanta Symphony Orchestra
and Chorus



you can hear it. These numbers are stored on tape, with quartz-locked accuracy, then recalled later without loss to make the master disc recording.

While digital techniques lower distortion, increase signal-to-noise ratio, and eliminate speed problems which limit most recording quality, it is just the first step to an outstanding disc. Half-speed mastering and the finest of European pressing also contribute to the high standards this disc achieves.

This impressive technology does more than simply reveal the impressive performance of Robert Shaw and the Atlanta Symphony Orchestra and Chorus. Uninhibited by artificial

restrictions of dynamics, the interpretation of the Firebird Suite is memorable. Borodin's Prince Igor is no less spirited.

Indeed, digital recording completely removes many of the long-standing barriers between musician and listener. Enjoy this new freedom at your Audio-Technica dealer, where the finest digital, direct-to-disc, and high technology recordings are sold.



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The Elegant Solution



With few exceptions, loudspeaker systems have always been designed to have flat response in anechoic chambers (test rooms with completely sound-absorptive boundaries).

This is odd, because loudspeakers are hardly ever used in anechoic environments. Most are used in domestic living rooms. Recent research shows that a real room changes a loudspeaker's performance drastically, and designing for flat response in an anechoic chamber simply doesn't make sense any more.

The most intense room effects occur when a loudspeaker is used in a corner, where reflections from the nearby room surfaces can cause a variation of 20 dB in acoustic power output. A corner, therefore, is the worst place to put a conventional loudspeaker system.

But if a corner imposes the most severe penalty for a misdirected design, it also gives the reward of maximally enhanced performance for a loudspeaker system correctly matched to that location. The woofer's radiation load, when stabilized by proper design, will be at its peak value in a corner.

The ALLISON: THREE™ Room-Matched™ loudspeaker system is the only high-fidelity speaker designed for proper use in a room corner that we know of, except for very much larger and more expensive corner horn enclosures. It is the elegant solution to the loudspeaker/room interface problem.

Price of the ALLISON: THREE system is \$290.* Descriptive literature, complete specifications, a statement of Full Warranty for Five Years, and a list of dealers are available on request.

*Higher in the South and West because of freight cost.

ALLISON ACOUSTICS

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Boskovsky, London/Decca LDR-10001-2. Recorded live, the hand-clapping of the audience between selections has not been deleted (probably quite deliberately) since hand-clapping is well-known as a severe test of recording quality. On these discs, the clapping is remarkable for its accuracy and realism. Except for a slight miking problem, wherein the first violins have too much forward projection and consequent brightness, the overall sonic qualities are outstanding. As you might expect, the repertoire is in the main waltzes and polkas by various members of the Strauss family. However, the most impressive demonstration of the sonic excellence of the recording is on side two, a sparkling performance of von Suppe's overture to *The Beautiful Galatea*. The sound of the strings, brass, and woodwinds is full and rich, yet ultra-clean with high definition; bass drum has plenty of weight and impact, and other percussion is sharply etched and very accurate. The wide dynamic range challenges the limits of the medium. To complement the high quality of the sound, the pressing is exemplary, exhibiting virtually no surface noise. With music like this, the performance is a labor of love, and the Vienna Philharmonic plays with their customary elan. Arthur Haddy states that for the present, we can expect at least one major digital recording every month! Obviously, Decca is trying to establish the same sort of "beach head" in digital recordings, as they did with stereo recordings over 20 years ago.

Real Dynamic Range

The foregoing covers what I presently know about digital recording activities. Before I leave this subject, however, a word about dynamic range would seem to be in order. Frankly, it is getting to be quite a pain in the "you know where" to read articles and reviews about the "super wide dynamic range" of analog LPs cut from digital masters. It is bad enough to read this and assorted other drivel about digital recording by uninformed and misinformed "hi-fi experts" in newspapers across the country. When the experts of more specialized and responsible journals start espousing this same "blather," it is time to set the record straight.

It is absolutely true that most digital recording systems can produce master recordings with a dynamic range of 90 dB or better. It is also absolutely true that the basic noise level of a really good unprocessed lacquer can be as high as 78 to 80 dB. Now, it matters

not one whit, whether that lacquer is cut as a direct disc, cut from a digital tape master, or from extraordinary analog tape, the limitations of the cutting system and the degradation caused by the processing of the lacquer are a universal limiting factor in the amount of dynamic range that can be reproduced from a standard analog PVC recording. Under the very best conditions, with every parameter absolutely optimized, about the maximum dynamic range you can hope for, is on the order of 62 to 64 dB. Believe me, that kind of dynamic range is the exception ... not the rule! In no way does the fact that an LP record was cut from a digital master confer on that record any extraordinarily wide dynamic range. 'Nuff said!

Metal Tape Doings

If digital recording is going to be the watchword at the upcoming AES convention in Los Angeles, then metal-particle tape will be the rallying cry at the June Consumer Electronic Show in Chicago. A friend of mine, who is "in the know" in the business end of the audio industry and with wide contacts in Japan, tells me that the CES there will probably be "over 100" different cassette models capable of recording metal-particle tape. Furthermore, some of these machines will be priced as low as \$279! Obviously, faster than anyone believed possible, metal-particle tape will be a major factor in the cassette recorder business. Whether the rush to this new technology was precipitated by the "softness" of the audio business in general is a moot point. The EIAJ is supposed to have formulated so-called standards ... mainly relating to coercivity ... for metal-particle tape, but those companies who can produce this kind of tape are plunging ahead and not waiting for everything to be "nailed down." A few voices who are urging a "wait and see" policy and advocating restraint with respect to the adoption of metal-particle tape, are cynically being dismissed as just companies who have been "caught with their pants down." There is no doubt that in some circles, metal tape is being hailed as the salvation for the current audio ills, and there is probably a good likelihood that it will be ballyhooed all out of proportion and technical boo-boos will occur.

I had an opportunity to experiment with some metal-particle tape recently and familiarize myself with some of its characteristics, its advantages and its drawbacks. My good friend Jim Kawada of JVC kindly loaned me one of

AUDIO • July 1979

**“Overall amplifier performance rating: excellent.
Sound quality: superb.” Len Feldman***



Len Feldman

The Sansui AU-717 DC integrated amplifier.

When Len Feldman tested the Sansui AU-717 for Radio-Electronics a year ago, he concentrated primarily on its traditional, steady-state performance measurements. Power output capability. Total harmonic distortion. RIAA phono equalization accuracy. Signal-to-noise ratio. Usual tests, though applied to an unusual amplifier. Here's some of what he said:

“One clear advantage of DC design is apparent. Even at the low 20Hz extreme, the amplifier delivers a full 92 watts – the same value obtained for mid-frequency power – compared with its 85-watt rating into 8 ohms ...

“The equalization characteristic of the pre-amplifier was one of the most precise we have ever measured, with the deviation from the standard RIAA playback curve never exceeding more than 0.1dB... The 380-mV overload figure for phono is far greater than would ever be required using even the highest output magnetic cartridges available.”

At the time, dynamic response measurements – such as slew rate, rise time, and Transient Inter-Modulation distortion (TIM) – were still in their infancy. Indeed, even now, engineers have not yet fully agreed on a standard method of measuring TIM, though its audible effects have been increasingly recognized. Mr. Feldman sensed this when he commented: “Sansui claims that this unit has reduced transient intermodulation distortion...and, indeed, the model AU-717 delivered sound as transparent and clean as any we have

heard from an integrated amplifier...”

The fact is that while conventional amps are designed to reproduce sine-wave test signals – which have a smoothly-changing, endlessly repeating character – with negligible THD, they usually do so at the cost of increased TIM. The excessive negative feedback used to reduce steady-state distortion to the vanishing point can (and usually does) reduce the ability of the amplifier to respond fully to the dynamic, rapidly-changing, pulsive signals which are the music itself. Thus, you get the harsh, metallic sound of TIM.

That's why Sansui has not only led the way in DC amplifier design (circuits whose low-frequency response extends down to zero Hz), but has also concentrated on the high slew rate, fast rise time designs needed for the faithful reproduction of music, not just simple test signals. Slew rate is a high 60V/ μ Sec; rise time a fast 1.4 μ Sec. And the frequency response of the power amp of the AU-717 extends to a full 200,000Hz.

Visit your authorized Sansui dealer. You'll hear the difference Len Feldman heard, and you'll understand why the Sansui AU-717 is about the most popular integrated amplifier available today.

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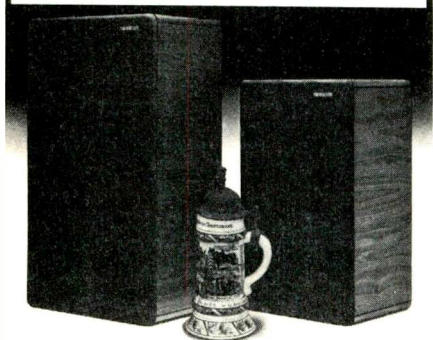
*Reprinted in part from Len Feldman's test report in RADIO-ELECTRONICS, January, 1978.



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Q&A



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Dear editor

Lirpa Reprint Rights

Dear Sir:

Early this year a group of dedicated Minnesota and western Wisconsin audiophiles organized the Audio Society of Minnesota and established a newsletter. As much of the "class" of the Society will be reflected by the newsletter, it is important that it contain class material. Your permission to reprint the *Audio* review of your revolutionary Lirpa 1 Showermike would, we feel, ensure that this effort gets off to a clean start.

I softsoap you not when I relay the high regard and affection in which you are held by Minnesota's large, knowledgeable population of sophisticated electronics and computer people. We wish you, Dr. Lirpa, and especially Noj Knas, further success in your mutual endeavors to burst the phychoacoustic bubbles which still remain.

Roderick Riese
Audio Soc. of Minn.
Minneapolis, Minn.

The Editor replies:

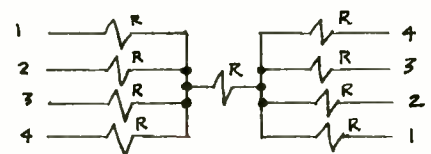
Okay, but the reprint has to be in Romanian, and be certain not to mix up Figs. 5 and 6. —E.P.

"Warsaw Box" Update

Dear Sir:

I have carefully studied the "Warsaw Box" invented by Prof. I. Lirpa, as discovered by John Woram while he was being smuggled out of Bucharest in the bottom of a canary cage, and I find that Prof. Lirpa must have made a mistake. The circuit shown by Woram is a 1-4 quad system, not a 4-1-4 system for quad.

Below is the correct circuit as Mr. Woram should have realized:



Of course, the Rs can be replaced with Cs and a phase shift will result, giving much improved separation.

Mr. Woram need not worry about having an insufficient quantity of playback speaker systems since one unit can be merely disconnected and quickly connected to another channel.

This is satisfactory because the symmetrical characteristics of the "Warsaw Box" provide built-in intelligence to force the new channel to be identical to the first.

Almon Clegg
Manager, Audio Engineering Dept.
Technics by Panasonic
Secaucus, N.J.

FCC's AM Proposal

Dear Sir:

I hope that all of us recognize the tremendous importance of Lawrence D. Swift's letter regarding the AM clear-channel proposal of the FCC (Forum, p. 6, May, 1979).

This proposal is another attempt to restrict freedom of speech and suppress the American citizen's "right-to-know." Canadian news broadcasts and English-language news broadcasts from the major European countries are highly critical of our foreign policy as practiced in the Middle East and Africa. These foreign short-wave broadcasts are now difficult to receive because of a continuous staccato-like interference which is currently and officially being blamed on the Russians. However, friends of mine with direction-finding equipment report that this interference originates in three different spots within this country: Bremerton, Washington; Grand Island, Nebraska, and Portsmouth, New Hampshire.

I believe the FCC proposal is an attempt to jam reception on the broadcast band from Canada and Mexico, and as such should be emphatically rejected.

Curtiss R. Schafer
Newtown, Conn.

The Editor replies:

Well, Mr. Schafer's statements about such interference are bound to raise some hackles, but it would be interesting to find out whether other folks have had any experience with such short-wave interference, particularly originating from the areas he names. —E.P.

Coincident Conversion

Dear Sir:

After your microphone issue (November, 1978, pp. 40-50, "A Guide to Coincident Mikes") came out last year I simply had to try the O.R.T.F.

AUDIO • July 1979

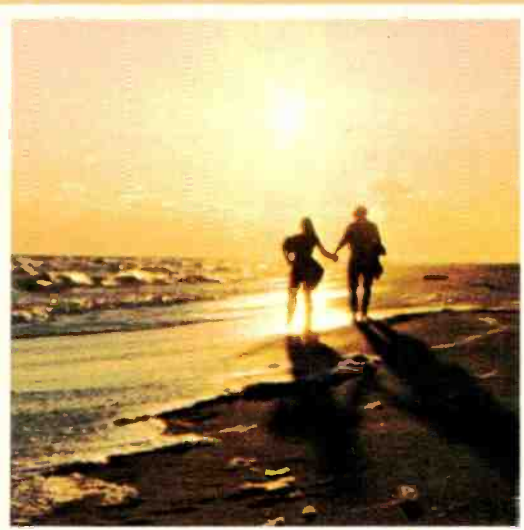
The Fisher CR5150 cassette deck. Gorgeous up close. Even better from a distance.

Great styling and state-of-the-art performance are two things this new Fisher cassette deck has plenty of.

But it's got something even more exciting: full-function remote control—without wires! It's the first tape deck ever to offer this sensational feature.

Think of it: by touching a button on the remote infrared transmitter, you can control Play, Record, Pause, Stop, Fast Forward, and Rewind modes—from up to 20 feet away! You can record, edit, search, and listen to cassettes—without leaving your easy chair. And the CR5150 is just plain fun to operate.

Wireless control would probably make the CR5150 a big seller even if its performance was only average. But Fisher went all out, and gave it 3 heads for 30-19,000 Hz response, dual-



process Dolby** for 68dB S/N ratio, and a servo-controlled transport with 0.04% wow & flutter (WRMS). Superb specs that only a handful of ultra-high priced cassette decks can match.

Feature-wise, there's a built-in digital clock that will turn on the CR5150 deck (or your receiver)

to record anything you want at a preset time, whether you're home or not. The clock display doubles as an electronic tape counter with memory rewind. Silky-smooth, feather-touch buttons control the solenoid tape mechanism.

But considering the prices of other decks with similar performance and far less features, the Fisher CR5150 at \$650* has to be one of the greatest values in high fidelity today. No matter how you look at it. Available at better audio stores or the audio departments of fine department stores.

*Manufacturer's suggested retail value. Actual selling price determined solely by the individual Fisher dealer.

New guide to buying high fidelity equipment. Send \$2 for Fisher Handbook, with name and address to Fisher Corp., Dept. H, 21314 Lassen St., Chatsworth, CA 91311.

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CR5150

system for myself. After a quick dip into my nearly empty piggy bank, I dashed down to the local hardware store and purchased a cross, two close nipples, two elbows, a 3/4-in. nipple, a 1 1/2-in. nipple, and a 2-in. nipple . . . all in 1/2-in. galvanized pipe fittings. With all this equipment, I ran back home, put the whole thing into a vise, wrestled it around for about 15 minutes, and came up with a three-channel O.R.T.F. microphone stand for less than \$5.00. Since Nakamichi microphones have 1/2-in. pipe threads on their holders, the three holders screwed onto the ends of the upright

nipples, with the mike bodies crossing over each other to fit the 110° and 6.7-in. separation between the right and left channels.

Then I took the whole "shootin' match," Nakamichi 550 cassette deck, two CM-1000 mikes, and one CM-300 mike for the center channel, and then went on vacation recording pipe organs in Portland, Oregon, and Seattle, Washington.

You cannot believe the results! Absolutely stunning! Perfect and glorious organ sound with all the ambience captured. And I'm sure you can appreciate that it was a lot easier to carry

around one mike stand, rather than three.

I just had to let you know the results and to say "Thank You" for putting such useful information into my hands. Once again, *Audio* magazine has demonstrated its worth. Now, all you have to do is to use your "good offices" to persuade Nakamichi to institute a Metafine-capability refit program for their 550 cassette deck.

Lewis J. Smith
Fairfield, Cal.

Historical Interest

Dear Sir:

In response to David Greep's letter in the "Dear Editor" column (April, 1979) about the explanation of the "green room," I found it very interesting. As a professional actor and performer of some 15 years experience, I can only say that among professional actors it's called the "green room" or the "ready room." One enters it when prepared to go "on-stage." An actor's presence there is an indication that all is okay and he is ready.

The stage manager often operates from the green room so he knows who is ready and who is not. At the very least, he checks it at critical junctures.

If Mr. Greep is correct, he has added an interesting historical anecdote for many an actor's repertoire of tales. It is, at least, an interesting example of how we change the meanings of words to suit our own needs.

Johnny Schott
Cincinnati, O.

Cutter Head Query

Dear Sir:

A recent inquiry in your magazine as to early embossing styli characteristics provided me with many replies from a lot of people. I have another similar request to make. I have been trying to find out how disc recording heads are rebuilt and information as to establishing proper low-frequency crossover, level indication, and drive power.

I have had surprisingly good results making monophonic recordings with a 1961-vintage Rek-O-Kut 12-in. lathe and some old heads in my possession — to a limit, that is. The heads I have been using are an Audax R-56, RCA MI-4887 and MI-11853, and Astatic M-41-10. Specification sheets would be appreciated for the Audax and Astatic heads, and rebuilding information would be greatly appreciated for the others. Should I obtain information, I will be glad to share it with other readers who are interested.

Michael Stosich
414 Assembly Dr.
Bolingbrook, Ill. 60439

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18

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	CW, SSB	5 μV	1.5 μV	0.5 μV	0.75 μV
	AM	10 μV	3.0 μV	1.0 μV	1.5 μV
■ Selectivity:	-6dB @ ±2 kHz or ±4 kHz and -60dB @ ±5 kHz or ±14 kHz				
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The ACTILINEAR Recording System's extremely linear frequency response ("ruler flat" according to some test reviewers) not only makes the TD 20A essentially immune to slew-rate limiting and transient intermodulation distortion (TIM), but also means better transient response and lower distortion overall.

Adding to the TD 20A's superior level of quality & performance is its unique PROM computer-controlled four-motor transport, as well as its many standard operating features that permit a degree of performance and control flexibility that you would expect only from Tandberg—the world leader in tape recorders.

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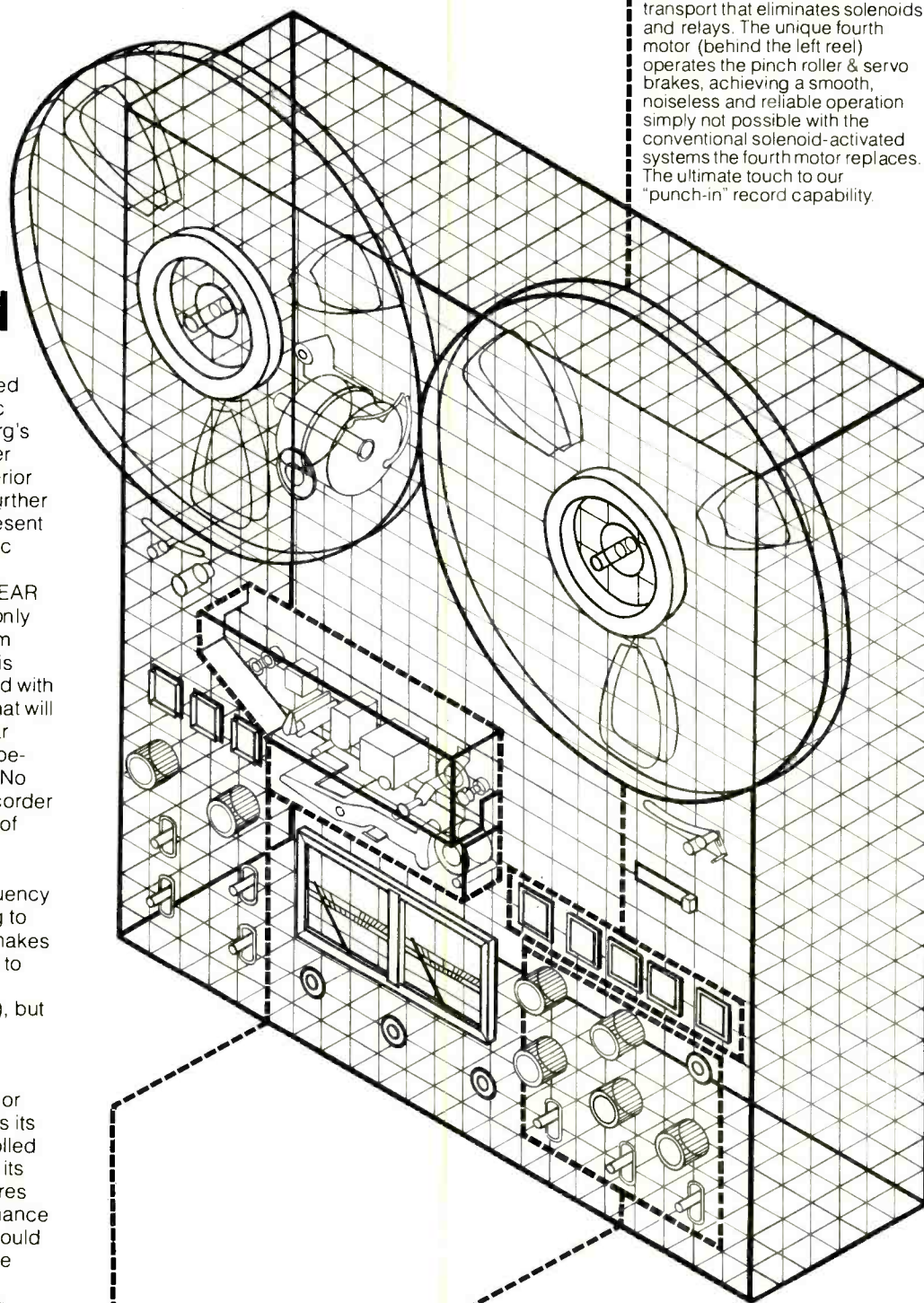
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This incredible 100 watt capability gives the Triax II an unparalleled clarity of sound throughout the entire spectrum.

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The 6" x 9" woofer of the Triax II boasts a new large diameter barium ferrite 20 oz. magnet. Which means better heat dissipation and more efficiency for clearer, truer sound at higher listening levels.

A new high power 1½" voice coil on the Triax II translates into less distortion and the ability to achieve higher sound pressure levels.

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And the Triax II is fully compatible with the advanced bi-amplified power sources for outstanding clarity and separation.

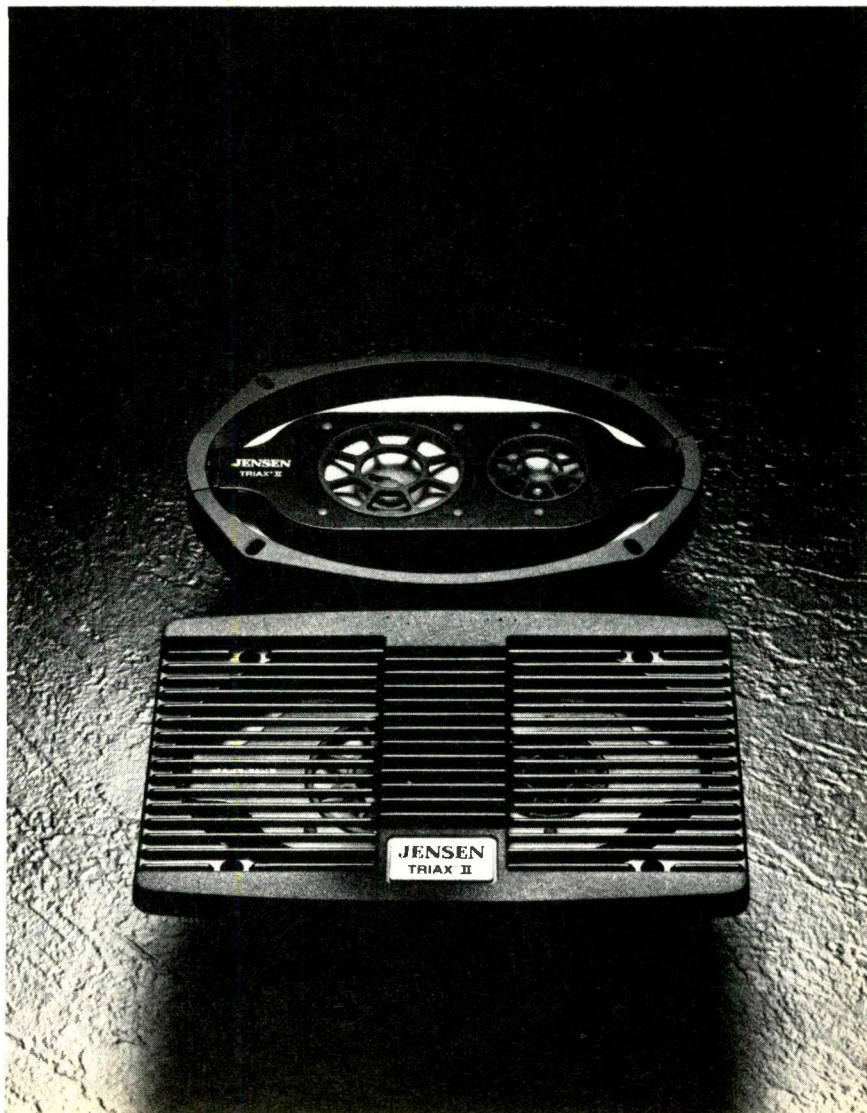
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Herman Burstein

Tape guide

Magnetic Query

Q. *The operating manual for my cassette deck says not to place magnets, magnetic screwdrivers, etc. near the heads. Is it safe to demagnetize the heads? — Thomas Burt, Las Vegas, Nev.*

A. the reason for keeping magnets, screwdrivers, etc. away from the tape heads is that these may magnetize them, causing noise and possible erasure of the high frequencies of the cassette. However, it is safe to demagnetize the heads by means of the demagnetizer made for this purpose. The demagnetizer is not a permanent magnet, but has an alternating magnetic field, which means that it will demagnetize the heads as it is gradually withdrawn from them.

Faster Cassette Tape Decks

Q. *What factors contribute to preventing 2- or 3-speed cassette tape decks from appearing? — Rajiv Mehta, New York, N.Y.*

A. At speeds faster than 1½ ips, the running time for a cassette would be too short. At speeds lower than 1½ ips, it would be very difficult to maintain good treble response along with low distortion and low noise; also, wow and flutter would become more troublesome. On the other hand, development of revolutionary new tapes, such as those with a coating of fine metallic particles, may lead to introduction of 15/16 ips as a second speed.

Performance Parameters

Q. *In comparing the high frequency performance of my open-reel deck at 7½ and 3¾ ips, using FM broadcasts as the program source, I notice no difference in treble performance. Is this because the treble content of FM broadcasts is limited to the capabilities of the 3¾ ips speed? — Jeffrey Pratter, Brooklyn, N.Y.*

A. Today's open-reel decks of good quality can maintain flat treble response well beyond 15 kHz — often beyond 20 kHz — at 3¾ ips. Hence there is, often, no apparent difference between this speed and the higher speeds in terms of treble response.

However, the higher speed of 7½ ips offers greater "headroom" — namely, less chance of high amplitude signals in the treble range causing tape saturation. If you were recording live program material with very strong transients, as caused by a guitar, you would probably need the greater headroom provided by 7½ ips. But in recording from FM, you deal with a signal which has been limited and/or compressed, so that the danger of tape saturation is much less.

S/N Ratio Differences

Q. *Why is the playback signal-to-noise ratio on an open-reel deck always greater than, or at least equal to, the record/playback signal-to-noise ratio? — Jeffrey Pratter, Brooklyn, N.Y.*

A. Playback signal-to-noise ratio tends to be greater than the record/playback signal-to-noise ratio because the former excludes noise in recording. Recording noise is due to noise in the record electronics and to bias employed in recording. Unless the bias waveform is very, very pure — containing a minimum of distortion — it can add appreciable noise to a tape recording.

Tape Backing

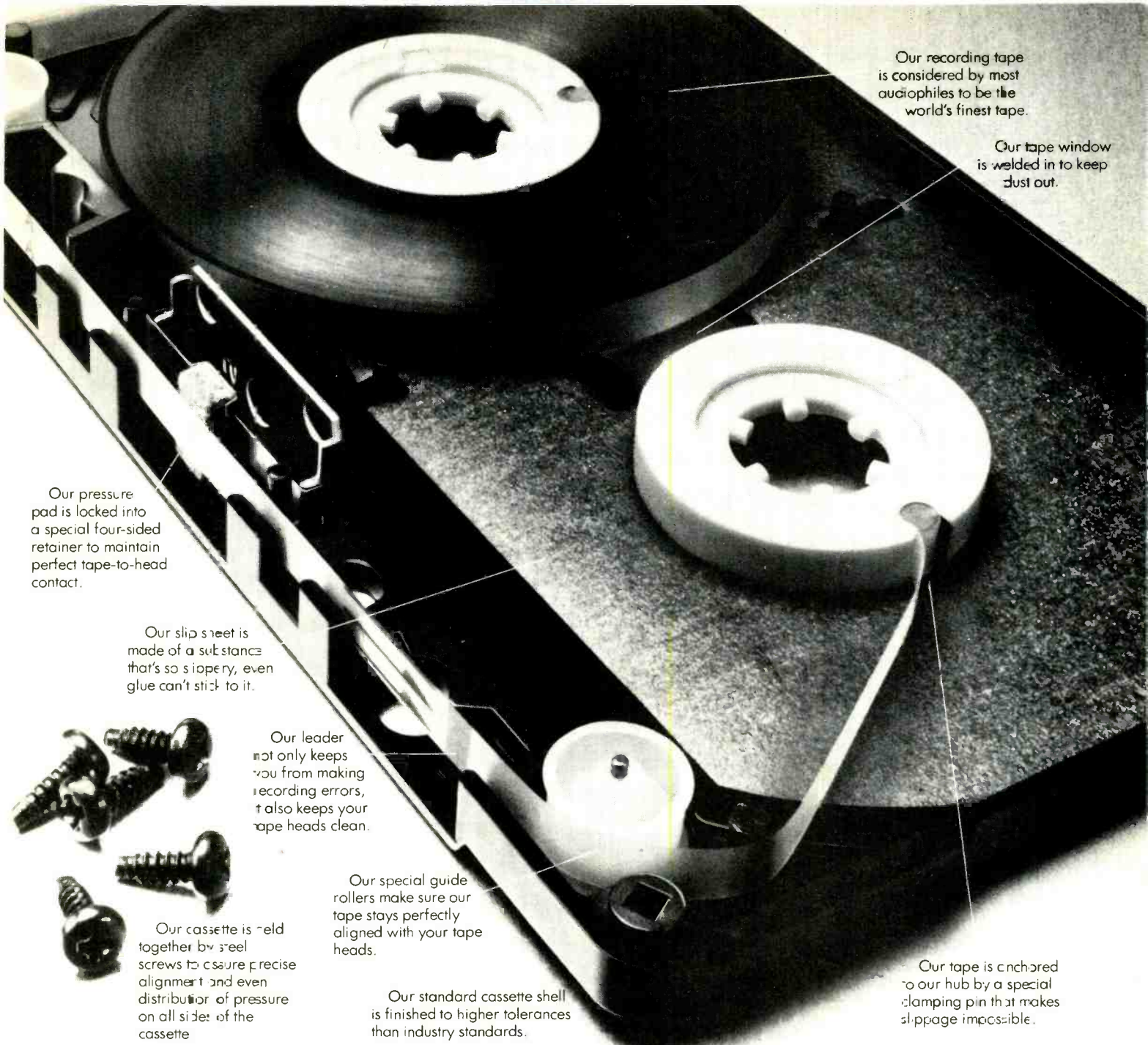
Q. *Some of the tapes have a rough backing to provide better traction for the drive mechanism. Will these tapes cause excessive wear of the crossfield head of my tape deck? — Morris Schoenberg, Madison, Wis.*

A. First let me explain, for the benefit of the other readers, that the crossfield head, which supplies bias in recording, is located opposite the recording head so that the back of the tape goes past the crossfield head.

There is no problem in using a crossfield head with back-coated tape. The tape is kept a very small distance, something like one-thousandth of an inch, away from the tape.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 401 N. Broad Street, Philadelphia, PA 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

AUDIO • July 1979



Our recording tape is considered by most audiophiles to be the world's finest tape.

Our tape window is welded in to keep dust out.

Our pressure pad is locked into a special four-sided retainer to maintain perfect tape-to-head contact.

Our slip sheet is made of a substance that's so slippery, even glue can't stick to it.

Our leader not only keeps you from making recording errors, it also keeps your tape heads clean.

Our special guide rollers make sure our tape stays perfectly aligned with your tape heads.

Our cassette is held together by steel screws to ensure precise alignment and even distribution of pressure on all sides of the cassette.

Our standard cassette shell is finished to higher tolerances than industry standards.

Our tape is anchored to our hub by a special clamping pin that makes slippage impossible.

There's more to the world's best tape than the world's best tape.

Our reputation for making the world's best tape is due in part to making the world's best cassettes.

In fact, we put more thought

and more work into our cassettes than most manufacturers put into their tape.

We do all this, because at Maxell

we believe in a simple philosophy.

To get great sound out of a cassette takes a lot more than just putting great tape into it.

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Face Reality.

Introducing The DM Factor. Dual Monaural construction. Exclusively Mitsubishi.

It means inside our stereo preamplifier are two perfectly matched mono preamplifiers.

Just like our dual monaural power amplifiers.

Just like your ears.

It means Mitsubishi has achieved more than stereo. But inter-channel separation at more than 80dB at 20kHz. For separation 30dB more than conventional designs.

For THD at less than 0.002% from 20Hz to 20kHz. For effective elimination of leaks, crosstalk, any influence able to distort the stereo image. In both the depth and breadth of the image.

Our new preamplifier was also developed to effectively

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Introducing our new frequency synthesizing tuner. With new capabilities, new features, new design.

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And along with unique electronic engineering, Mitsubishi offers unique mechanical engineering.

Like The Docking System.

It means preamplifier can be linked with amplifier neatly and compactly. Without a myriad of crossed wires.

But no matter what we tell you, the truth is, nothing will

tell you more about our audio equipment than your own audio equipment.

So, use your ears, and by all means compare.

Compare the difference The DM Factor makes. Compare the convenience The Docking System makes. Compare the capabilities of our new tuner.

And you'll know why Mitsubishi made them part of The System.

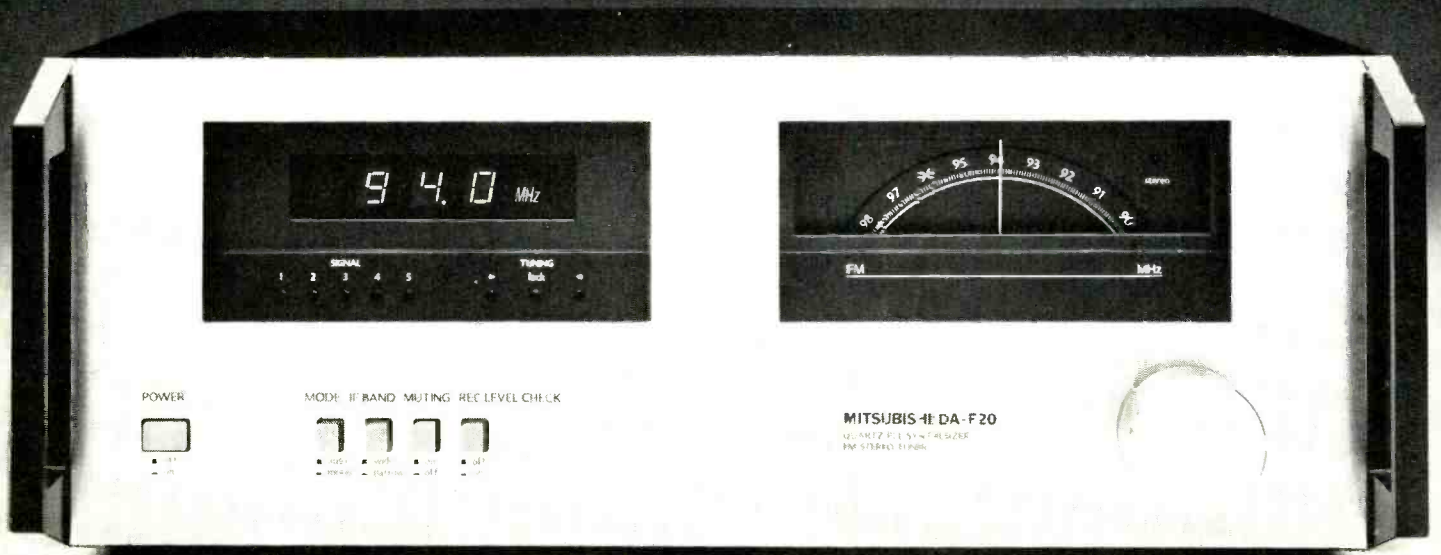
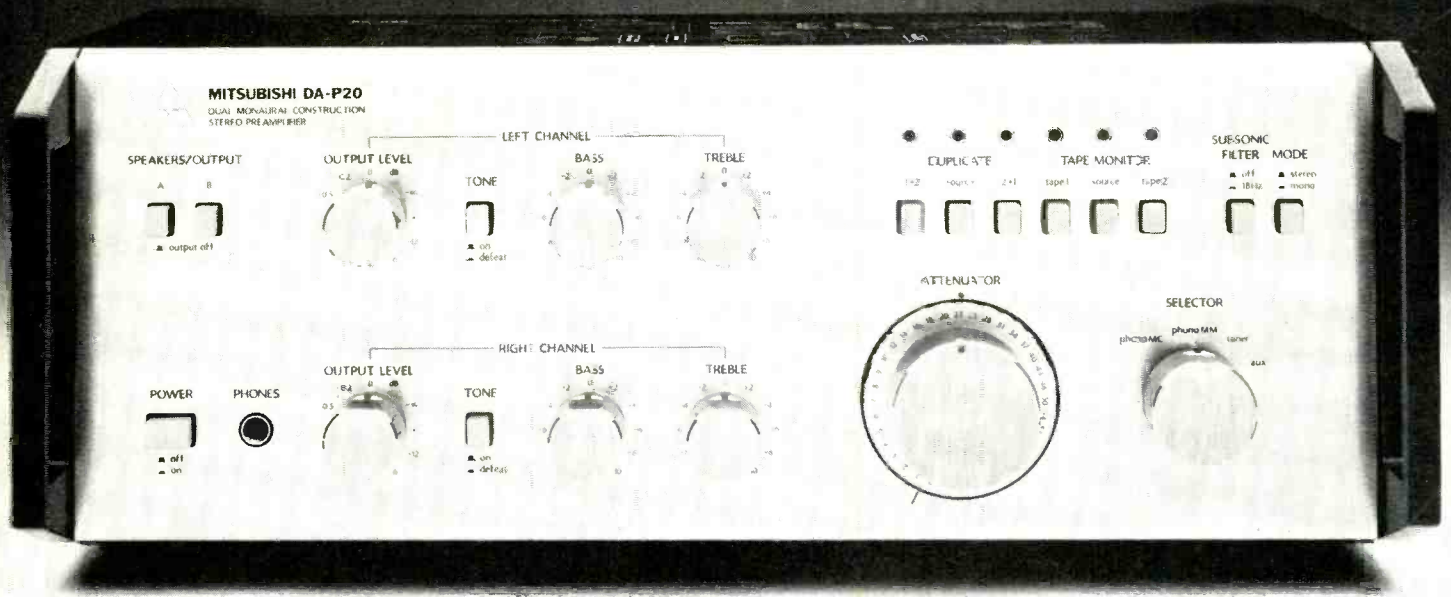
The only high performance audio system with one name, one look, one warranty, one standard: what comes out must be as real as what went in.

Because reality is what it's all about.



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Audio etc.

Edward Tatnall Canby

I am hopeful this will make our July issue. I am late. July! Often I used to miss that month, and almost missed this. In times past, it saw our very thinnest product, what with manufacturers on vacation and the public in no mood to listen to hi fi. Nor, it would seem, to buy fi. Result: Our July mag had an uncanny tendency to blow away with the slightest breeze. I was seldom blown away because I often wasn't there. Not heavy enough.

No longer. And it is not our undoubted success in a busy field that has wrought the change, laudable as the thought may be. I suspect the transistor and, equally, the printed circuit and its successor the IC. They enormously widened hi-fi applications and usefulness, especially in summer. Then came the big industry trade events such as the "summer" (i.e. spring) C.E.S., which sets an urgent early stage for the fi of the coming autumn season. Those big shows are not accessible to the public, so do you think all that stuff can wait? You begin to hear about it in July and continue right on through August and September and October . . . and then it's "winter" C.E.S. time.

So I hereby put aside my July lethargy in a hurry, if only to tell you that I have now discovered an important offshoot to a law that vitally affects every facet of our industry, Murphy's Law. This one is called Murphy's Subset and states that if you correct an error in print you will make two more.

Murphy's Subset neatly tripped me in our May issue, where — of course — I was correcting in print an earlier misstatement concerning the infinitely low S/N in the new digital recording systems. It exists, the residual or added noise, and I quoted my informant, reader Brian Berkeley, to point out that it is specifically determined by a digital formula having to do with significant bits.

Eheu, dolor! Murphy got hold of perhaps the most important single word in the Berkeley quotation, aided by myself, and the result was strictly according to the Subset. "Least" became "last." In print it sounded plausible and to me the same, though quite meaningless as it turned out. The "last" significant bit.

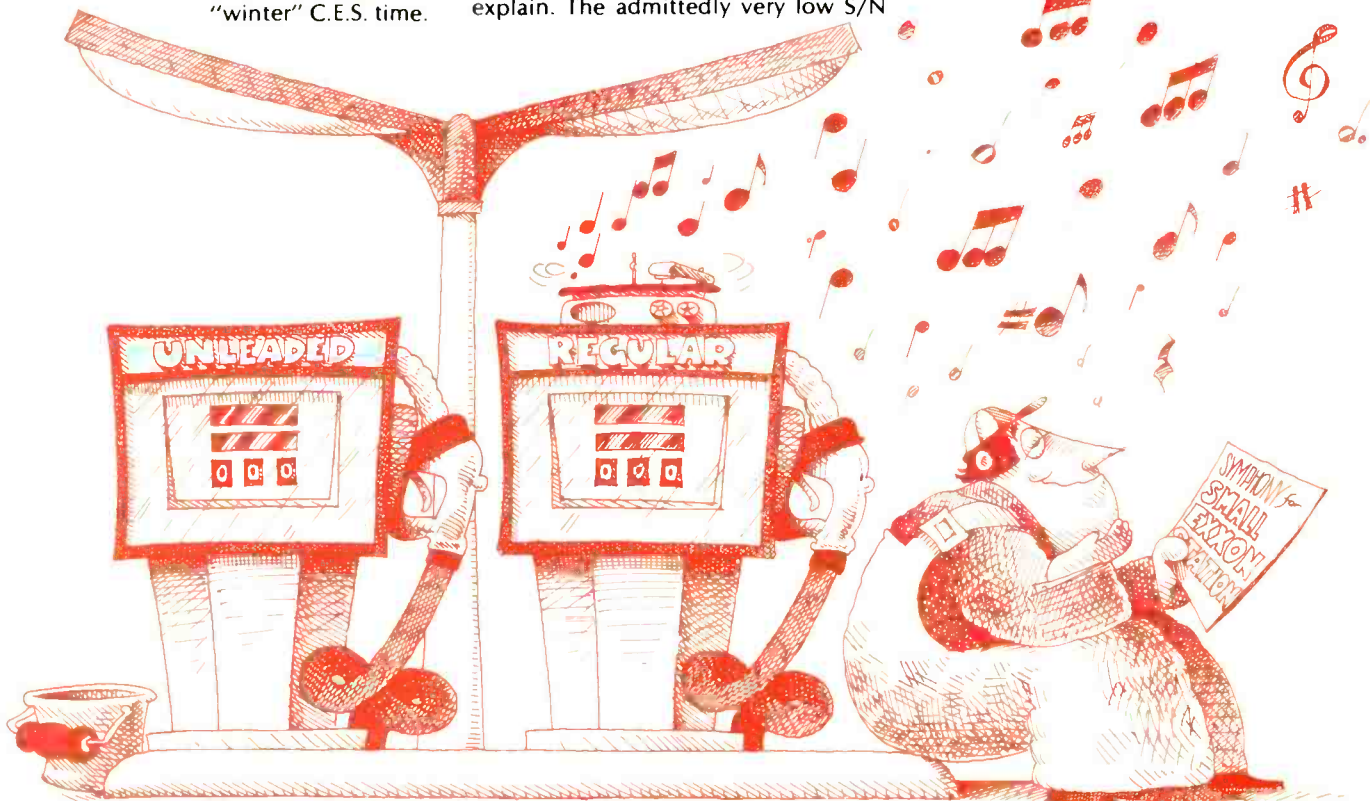
Now I know better and thanks again to B.B. Go away, Murphy, while I explain. The admittedly very low S/N

in digital recording is determined by the LSB of the particular coding system in use. Look out, now, let's not go wrong again. That's LSB, which is to say, the LEAST Significant Bit. LEAST, Mr. Murphy — get it? There is also an MSB, a Most Significant Bit, or sign. But at least we may safely ignore that one. For the most part, anyhow. It's all a matter of getting used to the digital lingo.

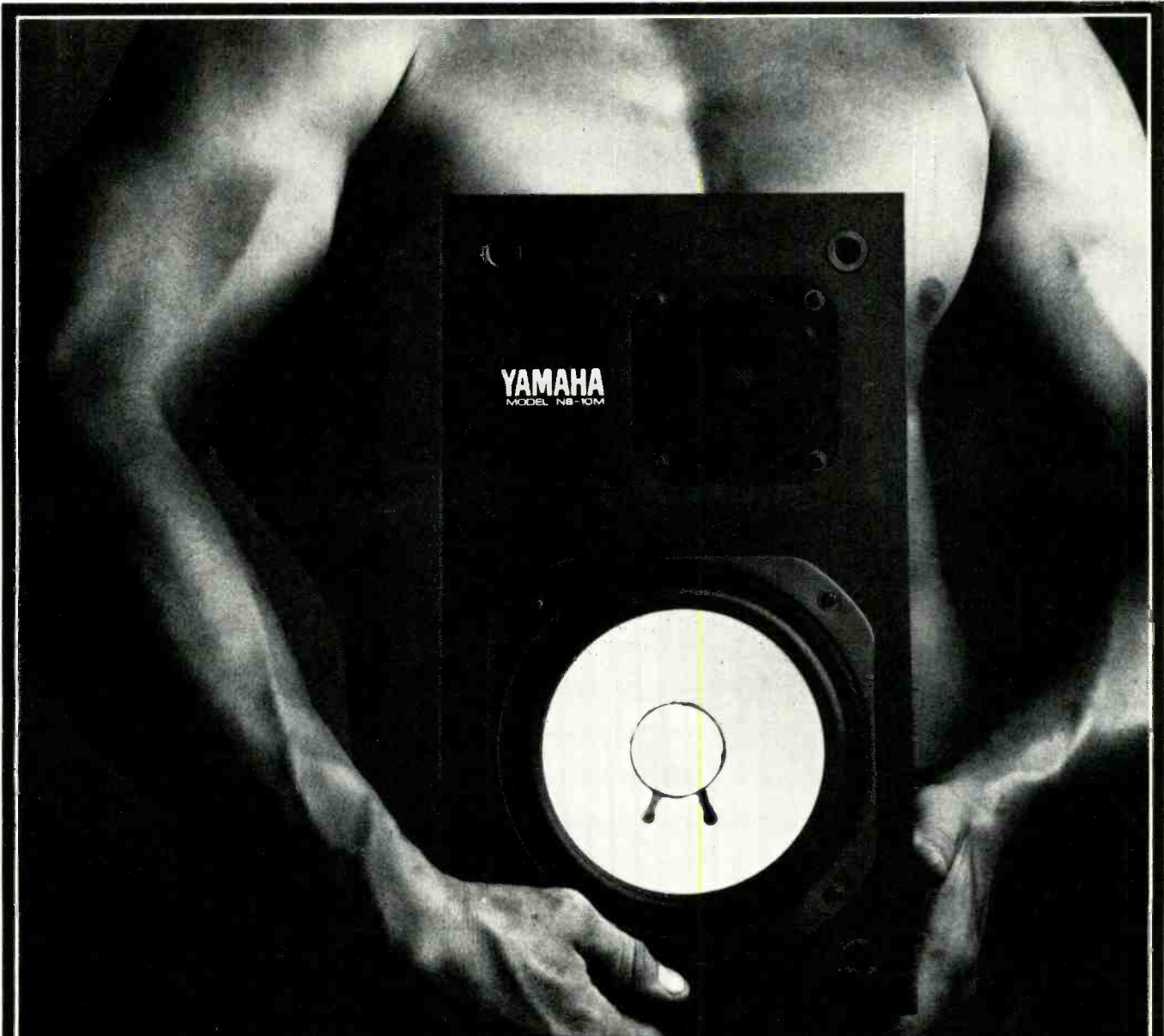
I will be curious (see May) to find out how many of you will have caught this one and reported same to us. Too early at this writing.

While I am at it, I should report that in respect to June's "Audio ETC" and after a number of months of digital delay combined with decode/enhance in my living room, the six-way system I described is a continuing success and on the way to permanence. Regularly now, for my own listening pleasure, I continue to check out each recording first of all with the delay unit (Advent SoundSpace) in the "direct" position, i.e. with no delay in the extra set of speakers, so that I may hear what the recording people had in mind as actu-

26



AUDIO • July 1979



Incredibly smooth, well-defined, powerful. Yet small.

Presenting Yamaha's new NS-10M Mini-Monitor. With wide, even dispersion, high sensitivity and accuracy, the sound is distinctively Yamaha: a rich, solid sound with a tight, firm bass that respects every nuance of tonal shading.

What you're going to wonder, is where it's all coming from. Because for the sound, the Mini-Monitor is amazingly small. Weighing in at 13 lbs. the speaker measures only 15.4" high, 8.5" wide. Inside, a 7" cone woofer and a 1.5" dome tweeter produce 90 dB SPL with 1 watt at 1 meter.

The Mini-Monitor was made in the image of the NS-1000. It has an identical finish, and like its bigger brother, is sold in mirror-image matched pairs. At low volume levels the sound is virtually the same. It's a primary monitor with the NS-1000 look and sound, for places the NS-1000 won't fit.

Our new Mini-Monitor with the powerhouse sound is currently contending with the heavyweights at your Yamaha Audio Specialty Dealer. And holding its own, thank you.



YAMAHA

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If you can't find your nearest Yamaha Audio Specialty Dealer in the Yellow Pages, just drop us a line.

The TDK machine because it moves



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At TDK, we're proud of our reputation as the leader in recording tape technology. We got that reputation by paying attention to all the little details other manufacturers sometimes skim over. But there's more to a cassette than just tape. There's a shell to house that tape, and a mechanism that has the function of transporting the tape across the heads. Unless that mechanism does its job evenly and precisely, the best tape in the world won't perform properly, and you won't get all the sound you paid for.

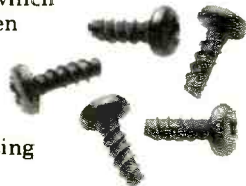
The TDK cassette shell and mechanism are every bit as good as our tape. And when you begin to understand the time and effort we've spent in perfecting them, you'll appreciate that our engineers wouldn't put TDK tape in anything less than the most advanced and reliable cassette available.

The Shell Our precision-molded cassette shells are made by continuously monitored injection molding that creates a mirror-image parallel match, to insure against signal



overlap, channel or sensitivity loss from A to B sides. We make these shells from high impact styrene, which resists temperature extremes and sudden stress better than regular styrene or clear plastic.

The Screws Our cassettes use five screws instead of four for warp-free mating of the cassette halves. We carefully



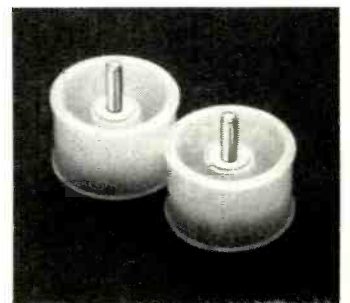
torque those screws to achieve computer-controlled stress equilibrium. That way, the shell is impervious to dust, and the halves are parallel to a tolerance of a few microns.

The Liner Sheet Our ingenious and unique bubble liner sheet makes the tape follow a consistent running angle with gentle fingertip-like embossed cushions. It prevents uneven tape winding and minimizes the friction that can lead to tape damage. Also our cassettes will not squeak or squeal during operation.

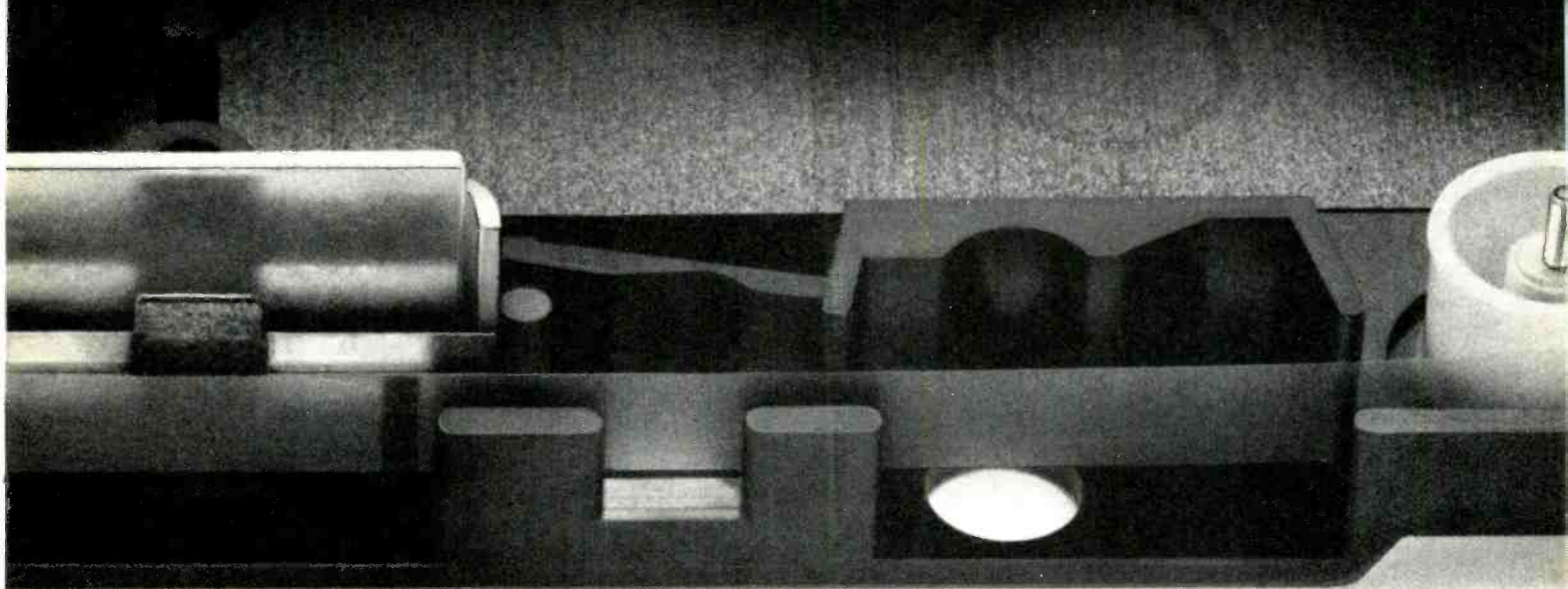


The Rollers Our Delrin rollers are tapered and flanged, so the tape won't move up and down on its path across the heads. This assures a smooth transport and prevents tape damage.

The Pins In every cassette we make, we use stainless steel roller pins to minimize friction and avert wow and flutter and channel loss. Some other manufacturers "cheat" by using plastic pins in some of their less expensive cassettes. We don't.

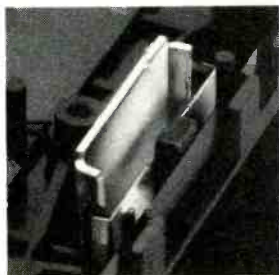


sounds better better.



The Pressure Pad

Our sophisticated pressure pad maintains tape contact at dead center on the head gap. Our interlocking pin system anchors the pad assembly to the shell and prevents lateral movement of the pad, which could affect sound quality.



The Shield We use an expensive shield to protect your recordings from stray magnetism that could mar them. Some manufacturers try to "get by" with a thinner, less expensive shield. We don't.

The Window Our tape checking window is designed to be large enough for you to see all the tape, so you can keep track of your recordings.

The Label We've even put a lot of thought into the label we put on our cassettes. Ours is made from a special non-blur quality paper. You can write on it with a felt-tip pen, a ballpoint, whatever. Its size, thickness and placement are carefully designed and executed so as not to upset the cassette's azimuth alignment.

The Inspections When it comes to quality control, TDK goes to extremes. Each cassette is subject to thousands of separate inspections. If it doesn't measure up on every one of these, we discard it. Our zeal may seem extreme, but it is this commitment

to quality which allowed us to offer the first full lifetime warranty in the cassette business—more than 10 years ago: In the unlikely event that any TDK cassette ever fails to perform due to a defect in materials or workmanship, simply return it to your local dealer or to TDK for a free replacement. It took guts to pioneer that warranty, but our cassettes have the guts—and the reliability—to back it up.

A Machine for All Your Machines Now that we've told you how we move our tape, let us remind you about our tape. SA, the first non-chrome high bias cassette, is the reference tape most quality manufacturers use to align their decks before they leave the factory. It's also the number one-selling high bias cassette in America. For critical music recording, it is unsurpassed. AD is the normal bias tape with the "hot high end." It requires no special bias setting, which is why it is the best cassette for use in your car, where highs are hard to come by, as well as at home. Whatever your recording needs, TDK makes a tape that offers the ultimate in sound quality. But it's our super precision shell and mechanism that make sure all that sound gets from our tape to your ears, year after year. TDK Electronics Corp., Garden City, NY 11530



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The machine for your machine.

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ally recorded in the grooves. (Decode/enhance makes use of this information specifically.) Only then do I pick a suitable room size and a suitable degree of reverberation, both synthetic, to complement the sound of the recording itself. It is easy and quick, and the more you do it the more unerring it becomes. No fumbling, no uncertainty. Just a brief listen, then a flick of the readout numbers to the right place, the right delay for that music. The modest but very definite further enhancement of already-enhanced four-way sound is a pleasure for any musical ear. Only an occasional faint

T-T-T-ttt as a scratch or tick goes by or I drop my pickup a mite too fast betrays the presence of all that sophisticated synthesizing circuitry — see Len Feldman in May.

Was It Murphy?

A further curious and useful habit of this unit has cropped up since my last writing. I thought someone was using my equipment — the numbers on the readout changed. It seems, I now discover, that when you turn your system off the readout cancels as in any calculator or larger computer — but not to zero. Instead, when you switch back

on again you find an invariable reading of 50, which is the halfway point. In delay terms this corresponds to a room or hall of middle size, somewhere between a "chamber music hall" or studio and a large symphony hall, or the median equivalent in the synthesized spaces found in pop music. Excellent idea, and a good setting to start with, making the going easy either upwards or downward, to smaller or larger synthesized space. Somebody used his musical brain designing this, for sure.

Speaking of concert halls and other halls for music, I have just been examining a piece I wrote some time ago in a brave attempt to get ahead of the game, even before my copy was actually due, and to store up some reserve, incidentally, in case of disaster or forgetfulness. Well, it never works. This one, it seems, just never got published at all. It went into the perpetual reserve file. So to heck with getting ahead, but I will mine a bit of it — which means, of course, I will come out with something entirely different; I always do. No matter.

The Space of Sound

Music and architecture are one, or should be. Just as the product fits the market and vice versa, these two arts have developed side by side, and it is never easy to tell which came first, if either did. They have progressed coincidentally, though occasionally one or the other has taken the lead for the moment. Before we in audio came along, music was designed to be heard in a particular and suitable space, an architecture, and it wasn't ever the home living room as we now know it — most certainly not for a hundred sorts of large-scale music. Do you think operas were designed for Texaco? Or for "stereo" headphones or the TV? But all that is another story.

In the 17th century, they built sumptuous new-style buildings to house a new-fangled musical idea, the King's 24 Violins (Louis XIV) or equivalent in other up-and-coming royal preserves all over Europe. Needless to say, these buildings were designed to suit the occasion, not only visually but with acoustics ideal for the music itself. If you have seen the kind of ornate elegance in which this music was heard, you know what I mean.

In Venice of the 16th century the peculiar architecture of St. Mark's Cathedral, many domed and Byzantine, prompted a whole school of multi-choir music that was imitated all over the continent. It was devised simply to take advantage of major performing difficulties, a number of wide-

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5. EQ defeat
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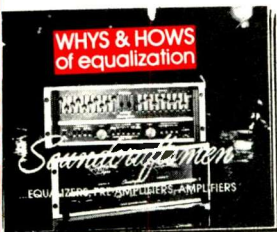
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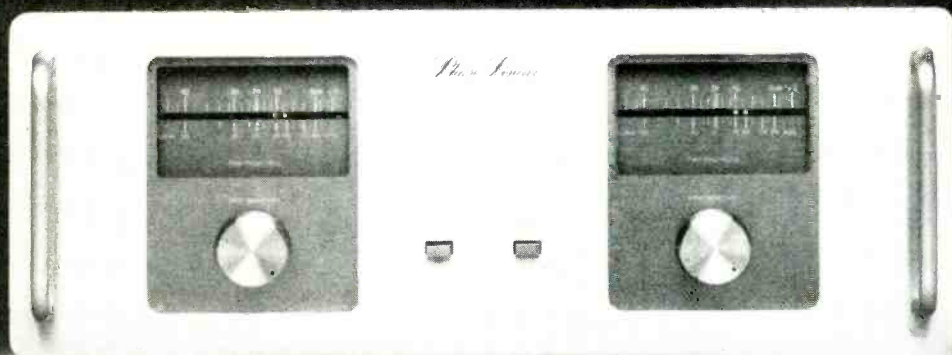
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Naturally, the skeptics scoffed. But audio critics and music-lovers worldwide listened. And for the first time, they heard recorded music reproduced in the home accurately. No muddy rumble at the low end. No harsh, distorted clipping of the highs. The era of great power amps had begun!

Today, it's generally accepted that you need an amplifier with a massive reserve power to drive inefficient high-technology speakers and reproduce all the musical transient peaks without clipping. The amplifier with unquestioned ability to meet this criteria is the Phase Linear 700 Series Two.

GREATER POWER RESERVES MEAN GREATER HEADROOM

The Phase 700 Series Two is rated at 360 watts per channel,

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The original Phase 700 was designed for home use, but it rapidly won the approval of the pros. Its proven dependability on the road made the 700 a favorite touring amp for super groups and sound reinforcement companies.

The Phase 700 Series Two retains this legendary reliability, and improves sonic accuracy by utilizing an advanced BI-FET input stage. This integrated circuit keeps the output virtually identical to the input. Beautiful music in, beautiful music out.

The 700's instantaneous LED output meters move at lightning speed, accurately monitoring the output voltage, with calibrations for 8 and 4-ohm applications. If you're listening at quiet levels, you can activate a Meter Range Switch to upscale the meter by 20dB. You have a visual indication of output activity, in addition to the Electronic Energy Limiters that prevent damage from accidental overloads.

If you demand great performance, don't settle for less than a great amplifier.

SPECIFICATIONS:

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Weight: 45 lbs. (20 kgs).

Dimensions: 19"x7"x10"

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Optional Accessories: Solid Oak or Walnut Side panels. E.I.A. standard rack mount configuration.

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32

Edcor

Not enough headphones to go around? EDCOR'S AP-10 Headphone Amp is designed to be used by either a hi-fidelity enthusiast or a studio engineer. The AP-10 distributes one program source to four headphones that can be operated in a switchable mono/stereo mode. Separate low noise amplifiers deliver up to four watts per channel with a master gain control. Either stereo or mono input signals are acceptable. The AP-10 is available at better stereo and pro sound stores. For your nearest dealer Call: (800) 854-0259 — In California (714) 556-2740. "or write EDCOR at 16782 Hale Avenue • Irvine, California 92714"

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ly spaced but extremely cramped locations where musicians could be squeezed into place, not one of them big enough for the forces at hand. So why not use more than one, or all, and write different music for smaller groups of performers at each location, to be performed separately for a dramatic directional contrast or simultaneously for a marvelously wide "stereo" spread? Thus out of severe architectural problems was achieved what is now called polychoral music, voices and instruments, the glory of works by the Gabriellis, A. and G., and others from Schutz to Brahms. Architecture determining the very nature of music.

In the 19th century this pairing of music and architecture, far from fading away, reached its most spectacularly successful level. This was the age of bigness, in all respects from wars to nations and empires, from roads and railroads to the Eiffel tower, from Beethoven to Mahler, and from small, intimate concert rooms to the vast spaces, holding thousands, that we collectively know as the concert hall. Right through the 19th century, until Tchaikovsky himself came over to dedicate Carnegie Hall in New York, that close relationship between existing music — the sound of music — and existing architecture remained the norm everywhere. And ever larger.

Soundless Spaces

Then came the modern age. For the first time in Western history, we now depend very largely on *past* music, of other times, for our concert fare. Not to mention our recordings — again another story. And every year this past is farther diversified and extended. What about the architectural spaces? Should not each type of music be performed, at least in the live format, within the enclosure that corresponds or is close facsimile thereof?

The big concert hall, the concert hall, as it happens is just fine for the prevailing (still prevailing) mostly-19th-century music that is played by our monster symphony orchestras, to the tune of giant deficits and enormous fund-raising campaigns plus government and foundation support. Fine, that is, in the case of the older halls. Carnegie in New York, the Academy of Music in Philadelphia, Symphony Hall in Boston, even the quite-late Severance Hall in Cleveland, art deco rather than modern; also some others of the oldie type in our more recently settled West.

The big old symphonies that we often hear, the even bigger concertos, were designed for this type of extravagantly large hall out of the last centu-

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REALISTIC® Minimus-7

This amazing little hi-fi speaker costs only about a third as much as some mini speakers, but we think they compare very favorably. How could they? Well, we gave ours a heavy-magnet large-excursion 4" woofer, a soft-dome wide-dispersion 1" tweeter, a precise L-C cross-over network, and a diecast aluminum enclosure. The result is astonishing bass and crisp highs from a 7-1/6" tall system that fits on any bookshelf. Audio response is 50-20,000 Hz and power capacity is 40 watts RMS. All for only 49.95* each.



Now listen to this! Just 14.95* buys you a pair of the fully adjustable mounting brackets pictured here, so you can install two Minimus®-7s in your car. Or van or pickup or RV. Discover Minimus -7, the mini-size, maxi-value speaker for home or mobile use. Sold only at Radio Shack.

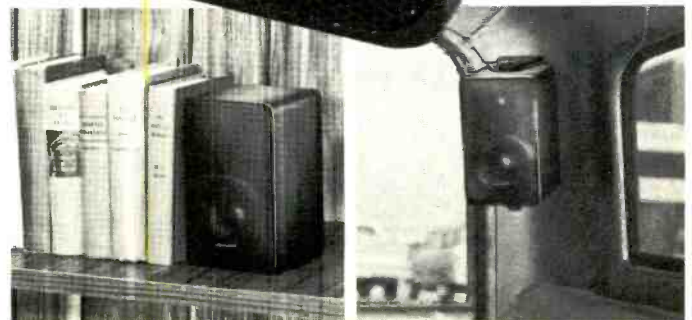
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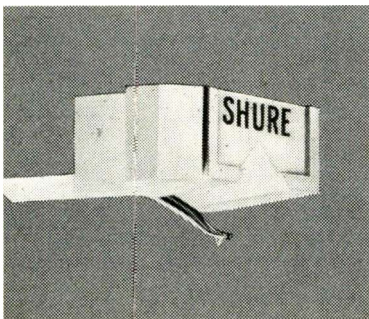


Needle in the hi-fi haystack

34

Even we were astounded at how difficult it is to find an adequate other-brand replacement stylus for a Shure cartridge. We recently purchased 241 random styli that were not manufactured by Shure, but were being sold as replacements for our cartridges. Only ONE of these 241 styli could pass the same basic production line performance tests that ALL genuine Shure styli must pass. But don't simply accept what we say here. Send for the documented test results we've compiled for you in data booklet # AL548. Insist on a genuine Shure stylus so that your cartridge will retain its original performance capability—and at the same time protect your records.

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Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

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ry. The two grew up together, as always in the past, music and performing space united harmoniously. And it is not possible to say which was in the lead. Aiding and abetting. The original concert halls, of course, many more of them, are in Europe; the music, after all, is European, and until quite recently our own homegrown concert music followed the same tradition and belonged in the same space. Not until the 1920s did the hegemony of Europe begin to crack, at least for contemporary music. It began to try to move elsewhere. It is still trying. Where can it go? Does it have any close and enduring relationship with our present

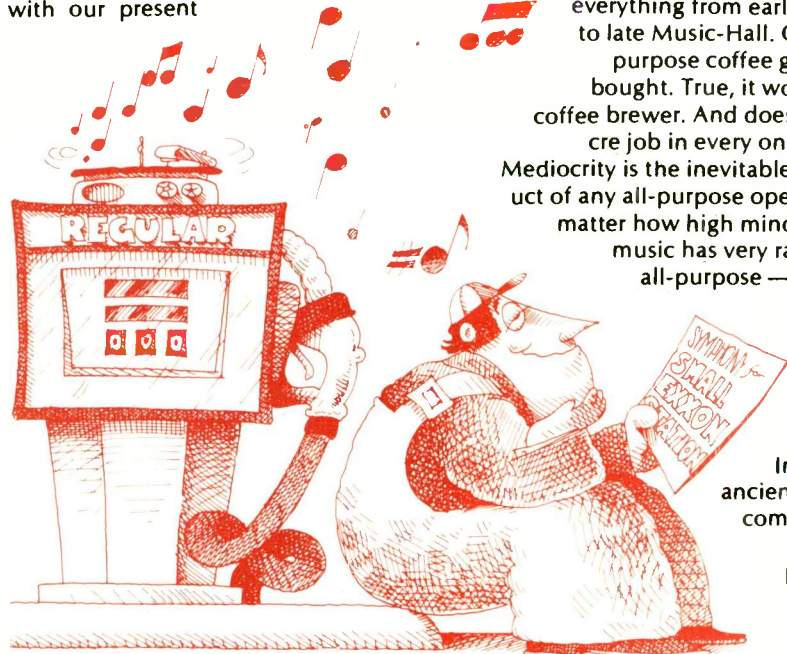
fake Carnegie or another Academy of music in molded plastic. Unthinkable! A modern building, first of all. And let the sound fall where it may.

I do go along with the idea that we should build modern. Today is for today. It's OK to restore or convert our existing older buildings but if we build anew, let's build US. We have one of the great periods of architecture at hand. We should indeed build modern. The sound is another matter.

Yeah, I know the proper formula for avoiding the sound/sight conundrum. Build a concert hall in which "all" music sounds good. Double-yeah. Just like those new pipe organs that play everything from early Baroque to late Music-Hall. Or the all-purpose coffee grind I just bought. True, it works in any coffee brewer. And does a mediocre job in every one of them. Mediocrity is the inevitable by-product of any all-purpose operation, no matter how high minded. Good music has very rarely been all-purpose — quite the contrary.

Nor, for that matter, architecture.

Imagine an ancient pyramid complete with Pharaoh plus built-in tourist hotel and maybe a hockey rink.



flourishing architecture? Not that I can see. Mostly, it just drifts back to the same old places or the same new ones. Right along with the Tchaikovsky and the Brahms. Should it?

Box office people think so. If you don't surround it with the familiar stuff, who'll listen? True, true. But in past ages contemporary music did extremely well, wherever, whenever. Or quit. Or tried a new tack. Survival of the fittest, an old-fashioned idea if Darwinian.

What, then, should a contemporary concert hall, brand-new, *sound* like? Obvious! Like Carnegie Hall or Symphony Hall in Boston, to match the music inside it. Old fashioned. But always provided that it *look* modern, contemporary. That sort of two-wayism accounts for the sonic disasters of recent memory — nobody really knew how to make the ears contradict the eyes in such an unheard-of way. We wanted the sound of yore, but heavens, we couldn't build a visible

So now we have the successor to the all-purpose concert hall, which has so often been no-purpose, though we have tried and still do. The successor is more honest, if thoroughly two-way. Back to Square One! Here, indeed, is a hall that does *look* modern and *sound* old fashioned. This took some doing. A miracle of sorts, all right. But (sorry, Avery) I still think the idea is truly a cop-out.

What we *really* need is a whole new kind of music to go along with our new spaces minus any sort of compromise, just as in past ages. Why not? How about Music for Office Building? Symphony for Small Exxon Station? Rhapsody for Underpass in E Minor? These should do it. Might even get a Concerto for Very Modern Concert Hall.

Next time you listen to the Best Seat in the Concert Hall via your new home fi, think on these things. What an impact they have had on *our* kind of music listening!

AUDIO • July 1979



fact: viscous-damping straightens out all your records



your favorite record may be a tangle of warps

Your phono cartridge "sees" such records as twisted, heaving surfaces, jolting up and down 0.5 to 8 times a second. Even records that look flat have warps, and a warped record can change the cartridge-to-record distance, the tracking force, and the vertical tracking angle. Warps produce frequency "wow" and distortion, and can dangerously overload speakers and amplifiers.

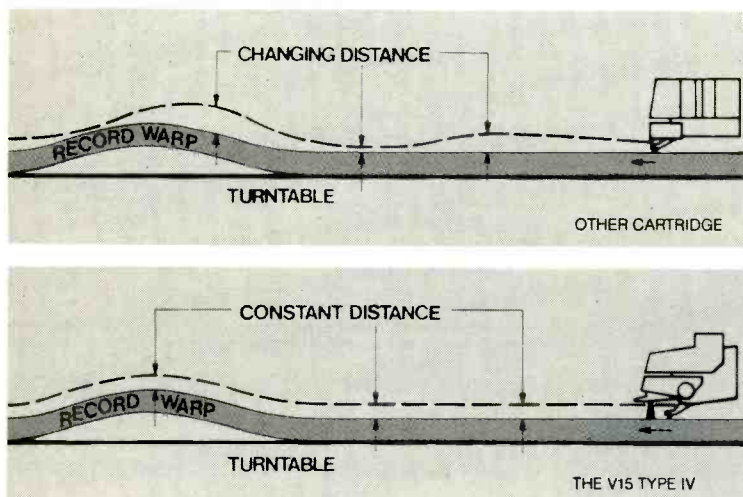
What's more, somewhere between 5 and 15 Hz, every tone arm-cartridge system has a resonance frequency—a frequency at which a warp will produce an exaggerated response that may result in mistracking and in extreme cases, cause serious damage to both the record and stylus.

The Shure V15 Type IV is the first cartridge in the world to incorporate effectively the principles of viscous damping. The Dynamic Stabilizer acts something like a "shock absorber," carrying the cartridge over surface irregularities without distortion, without bottoming out, and without risk of damage to records or stylus. It even protects the stylus should it be dropped accidentally onto the record.

the role of the Dynamic Stabilizer:

The V15 Type IV's Dynamic Stabilizer makes certain you hear the recorded information, not the warps. The viscous-damping system of the Dynamic Stabilizer resists rapid changes in the cartridge-to-record distance. This remarkable Shure innovation eases the stylus over warps without affecting the tracking force on warped or unwarped portions of the record. And the tone arm-cartridge resonance is attenuated to a subaudible level. As a further bonus, the Dynamic Stabilizer cushions the stylus from accidental impacts.

Get the straight talk today at your dealer's showroom. Ask for a free demonstration of the V15 Type IV.



V15 Type IV
the viscous-damped cartridge by...



Shure Brothers Inc., 222 Hartrey Ave., Evanston, IL 60204, In Canada: A. C. Simmonds & Sons Limited
Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

Enter No. 27 on Reader Service Card



Clean look, clean sound.

The Crown *Power Line One* amplifier and the *Straight Line One* pre-amplifier were designed for special persons who delight in accurate sound reproduction— who want to be aware of the softest notes, and to clearly identify each instrument in a bright, vibrant passage. They're designed for persons who persist in evaluating new components, trying to reproduce the ambience of a concert hall. They're designed simply for listening enjoyment.

You may already have experience with a sophisticated system, or you may just now be planning your first high-quality component system. In either case, you are aiming for sonic improvement. The Crown *Straight Line One* and *Power Line One* components can provide that improvement.

You'll be pleased at the smart, professional appearance they will add to your audio system. But your greatest enjoyment may well come from the unusual sonic accuracy of these units. The *Power Line One* and *Straight Line One* are acoustically as transparent as can be imagined.

One of the more significant innovations in the *Straight Line One* is the phono pre-amp module, a separate unit for mounting near the turntable which produces a standard input for the *Straight Line One*. This design concept, plus the advanced circuit technology in the module, eliminates troublesome RFI. Internal noise in this module is so low that the thermal noise generated by your cartridge will be the dominant noise from the phono pre-amp module.

The front panel of the *Straight Line One* is a model of simplicity, intended for owners whose principal enjoyment is in listening, and not so much in re-recording or mixing or "engineering" sound. An unusual feature of the *Straight Line One* is the overload indicator which enables the owner to determine optimum gain settings on both units to achieve minimum distortion.

The *Power Line One* amplifier, a matching unit, is a simple, practical power amplifier. It will drive up to three sets of speakers, with switching available on the front panel, and is intended for medium power systems requiring high signal reproduction quality.

The amplifier circuit design is all Crown. You will appreciate the extremely low noise and distortion and the conservative use of electronic components for high reliability.



SPECIFICATIONS

	Frequency Response, 20 Hz-20 KHz	Phase Response 20 Hz-20 KHz
Straight Line One 2-channel pre-amplifier	±0.1 dB	±10°
Phono pre-amp (RIAA)	±0.5 dB	±5°
Power-Line One 2-channel amplifier	±0.1 dB	+10° to -15°

Power rating: 50 WATTS/CH. MIN RMS INTO 8 OHMS, 20 Hz-20 KHz, THD 0.05%.

80 WATTS/CH. MIN RMS INTO 4 OHMS, 20 Hz-20 KHz, THD 0.07%.

CROWN products are available outside the U.S.A. under the brand name AMCRON.



Built-in to the *Power Line One* is the unique Crown IOC (Input-Output Comparator) system for reporting the effect of many different kinds of overload. Output distortion is detected before it becomes audible and is reported on red LED's at the top of the monitor panel. The other indicators on this panel provide information about peak output voltage for each channel. The indicators will help in determining available head room and in balancing your system.

Ease of operation and attractive appearance are not the *principal* reasons you should consider these Crown *LINE ONE* components. They are designed, and carefully built, to provide clean, pure, undistorted outputs—to enhance your listening pleasure.

For that, why not rely on the Crown reputation for sonic accuracy and reliability in all its products. More importantly, why not rely on your own ears? Try your most

demanding record or tape on a system which includes the *LINE ONE* components. You may well hear subtle overtones, nuances that just weren't obvious before.

That quality of sound happens partly because Crown is very careful in inspecting these components. We test each one individually, and furnish you with a proof-of-performance sheet which records the result of each test. Every Crown component must test equal-or-better to every published specification before it is released for shipment. And it is because of careful design, careful construction, and careful testing that we can guarantee that your Crown component will perform within published specifications in normal use for three years after original purchase. If it doesn't, we'll repair or replace it at no cost

to the owner. Crown also pays round trip shipping, if needed. We build Crown components to work as specified, and to sound as good as you hoped.

See your Crown dealer soon for a complete demonstration, or send the coupon to Crown for a free full-color brochure on both units.

Crown:

Please send the Straight Line One, Power Line One brochure.

Name _____
 Address _____
 City _____
 State _____ Zip _____
 Phone _____

Hum and Noise dB below rated output		IM Distortion at rated output, Max.	Total Harmonic Distortion at rated output 20 Hz-20 KHz, Max.
unweighted	"A" weighted		
97	101	0.00055%	0.0009%
88	94	0.0005%	0.002%
110	115	0.00095%	0.05%



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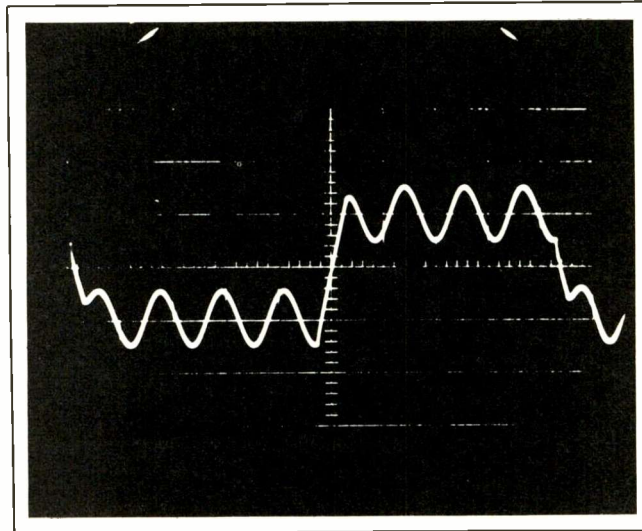
Innovation. High technology. American. That's Crown.

An Overview Of SID and TIM

Walter G. Jung, Mark L. Stephens, and Craig C. Todd

Part II—Testing

A desirable object for the study of SID is to develop a reliable and predictive test method (or methods) for the presence of this distortion. With our studies, this objective was generally met, and good correlation was observed among several different means of measurement and theoretical calculations [33, 34]. These electrical test methods also appear to correlate roughly with listening tests made on the same devices. The results of these different tests made on a wide variety of IC op amps are described in this part.



amps, but it is an excellent one for IC op amps. Reasons which can defeat its validity for some equipment are limited signal bandwidth, which masks true distortion products, and in power amps, output stage stress. For wideband, low-level stages, it can be an excellent test. However, the SID distortion mechanism cannot always be conveniently isolated and quantified, simply because one does not always have direct access and control over amplifier

configuration and/or operating condition (s).

THD Tests

It has been often reported that THD test methods are generally insensitive to the detection of TIM distortion [8, 9, 18, 49, 64]. In actuality this is only true for insufficient (or fixed) signal slopes, i.e. when $SS < SR$. This factor will be demonstrated in the discussion below. A 1-kHz *spot-frequency* THD test is an example of a test which is (typically) either too low in SS , or if fixed in level, not dynamic at all. An example of a *dynamic* test in terms of SS is one which moves the SS of the test signal *up to and through* the amplifier SR ; i.e. where the SR ratio is forced to reach and pass unity. It must do this, of course, without amplitude clipping of the output signal, which implies a swept frequency test.

In practice, a relatively straightforward means of exercising an amplifier for SID (or TIM) is to apply a low frequency (about 100 Hz) signal at full rated output voltage, and then sweep the frequency upward until a sudden rise in distortion is noted [16, 33], the 1 percent distortion level coinciding with the amplifier's full power bandwidth.

In op amps, a full output-voltage level sweep test for THD from 100 Hz to 100 kHz has been found to be a sensitive and easily applied test to detect SID, as it exercises the output signal slope-tracking fidelity to a high degree. Unfortunately, this form of test is not always directly applicable to power

configuration and/or operating condition (s). It is possible to isolate SID from other distortion sources when the test configuration can be completely controlled. For instance, when testing op amps, this can be accomplished by placing some important restrictions on the test circuit [33, 34, 35, 37, 38]. The test configuration should operate in the inverting mode, to eliminate the common-mode distortion effects which exist when an op amp is operated non-inverting [37, 38]. The magnitude of these effects in some designs can approach that of SID, therefore a non-inverting test is simply incapable of discriminating these two components. Similarly, output stage non-linearity should also be minimized by careful restriction of loading, to 10K or more. These precautions assure us that we are truly measuring *only* SID and not other additional distortions such as those produced by poor common-mode rejection or output loading. These distortion mechanisms should be evaluated separately [31, 38] and are not the subject of this study. Failure to make certain the test conditions are free from these distortions can lead to questionable results.

A test circuit which takes these points into consideration and is suitable for SID tests is shown in Fig. 9. It is a unity-gain inverter, with the device's frequency compensation adjusted for unity gain, except for special cases as noted. Input-output signal levels are full rated-voltage swings of $\pm 10V$ or $7V$ rms (except as noted), which generally maximizes the output SS . The heavy feedback condition maximizes sensitivity to slewing distortions, since it maximizes the potential error voltage.

The device under test (DUT) is operated in this circuit, and a check is made for its actual slew rate. Note that for a given device, the actual slew rate can vary from the data sheet value, therefore results can only be correlated by actual measurement. Ideally, slewing should be symmetric, so the measurement should take note of both plus and minus slew rates. After the SR test, measurements can proceed.

Portions of this article are adapted from "Slewing Induced Distortion in Audio Amplifiers" by the authors in *The Audio Amateur*, Feb., 1977 (P.O. Box 176, Peterborough, N.H. 03458), part of an article series which is available in book form. Portions were also adapted from the authors' article "Slewing Induced Distortion — Its Effect on Audio Amplifier Performance, with Correlated Listening Results," Audio Engineering Society Preprint No. 1252 from the May, 1977, convention. (See bibliography references nos. 33 and 34.) © Copyright 1979 by Walter G. Jung, Mark L. Stephens, and Craig C. Todd.

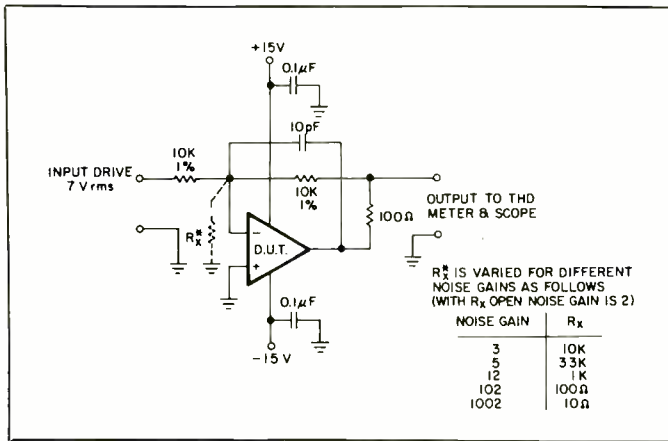


Fig. 9 — Test circuit for slew induced distortion.

Representative THD performance data on a common 741 IC op amp with a $0.5V/\mu S$ SR is shown in Fig. 10. These data indicate in the full output-level curve a characteristic sharp rise from the low frequency (LF) residual level to a 1 percent THD level at 8 kHz (fp), this occurring within only two octaves. For lower output levels, such as for 2V and 1V rms, the 1 percent THD frequency is proportionally higher, in fact by the ratio of amplitudes. In all three cases, the characteristic sharp rise in distortion can be noted as the device's SR is approached by the SS. The 1 percent THD point is reached when the SS becomes equal to the fixed device SR. This can be noted as a relatively constant SS for the three different 1 percent THD intercept points, as is evidenced by the different frequencies at which this point is reached for different levels.

SID improves considerably for higher SR devices or compensation conditions which result in higher device slew rates. In Fig. 11, THD data on a 301A amplifier is shown for various compensation/gain conditions, with all data referred to a 7V rms output level.

The first curve (left) is for unity-gain compensation, where the device SR is $0.9V/\mu S$; the behavior is similar to but slightly better than the 741 for similar conditions. For the X10 compensation curve, the resulting slew rate is $7V/\mu S$, and the performance is much better, with slew limiting not reached until 90 kHz. The improvement is largely due to the X10 improvement in SR and gain-bandwidth product, without any major penalty in LF distortion or noise.

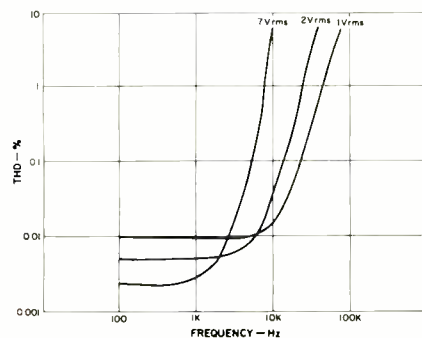


Fig. 10 — THD vs. frequency for a 741 op amp operated as a unity gain inverter at various output levels. Device slew rate is $0.5V/\mu S$.

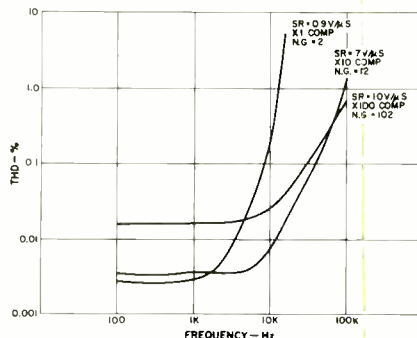


Fig. 11 — THD vs. frequency for a 301A op amp operated as a unity gain inverter at various compensation/noise gain conditions. Output is 7 V rms.

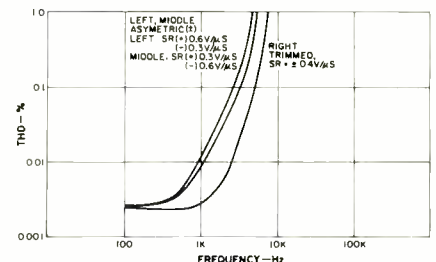


Fig. 12 — THD vs. frequency for a 301A op amp operated as a unity gain inverter with various slewing symmetries, Cc is 33 pF, output is 7 V rms. Offset adjustment is trimmed for slewing condition shown.

The third curve is for a X100 compensation/gain, and here slew limiting is not at all evident.

Slewing symmetry has a pronounced effect on SID, and SID will only be minimized when the plus and minus slew rates are equal. In some IC amplifier devices, particularly those which use current mirrors, slew symmetry can be trimmed to demonstrate this effect, as shown in Fig. 12.

Here the THD performance of a 301A op amp with an SR of $0.4V/\mu S$ (when trimmed) is plotted, and the data indicate an fp of 6.7kHz, which agrees with the theory. For asymmetric slewing, however, the distortion generated is higher, and the break point occurs lower in frequency. This sort of behavior can be noted in many amplifiers, and those in which slewing is inherently asymmetric will not yield as low a distortion as devices which are symmetric.

An aspect of SR asymmetry which illustrates why inverting mode operation is recommended for SID characterization is demonstrated in Fig. 13 and 14. Figure 13 is the full-scale (20 V p-p) slewing response of a 301A amplifier, and, as can be noted, there is a marked difference between plus and minus slopes [21, 22, 37, 38]. This same amplifier was used in the inverting-mode pattern of Fig. 4a (Part I), where it was seen to be nominally symmetric.

Slewing differences between inverting and non-inverting input operating modes show up in THD tests, as is demonstrated by Fig. 14. This data is for the same amplifier operated at unity gain, with curve A for inverting mode, curve B non-inverting. Note that the fp is lower in curve B and distortion much higher at lower frequencies than curve A. This general pattern can also be seen in other devices as well [38].

An interesting demonstration of the effectiveness of SR improvement on THD is contained in Fig. 15. This data is for the 2725, a programmable IC op amp, where the device SR can be adjusted via a bias terminal. Shown here is the resulting THD for SRs of 0.5, 1.6 and $5V/\mu S$ respectively. As can be readily noted, the resulting performance improves directly as SR is increased.

Since the previous performance examples have indicated that quality is generally directly tied to slew rate, it might seem fair to assume that a very high slew rate is sufficient in itself to achieve this quality. However, this is not completely the case, as is shown by Fig. 16. These data are THD performance for a class of op amps known as "slew enhanced" types [20]. This form of op amp uses a class B (or AB) input stage to dynamically alter (increase) the output current (I_k) and thus boost SR for high SS conditions.

In terms of THD, slew-enhanced units generally show a low SS distortion performance much like a conventional op

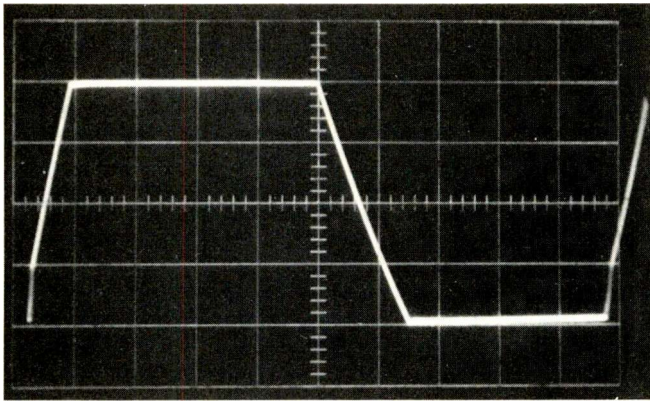


Fig. 13 — Asymmetric slewing due to common mode asymmetry in a 301A op amp operated as a unity gain follower; 20 V p-p.

amp up to a point, but complete slew limiting is prevented. The data reflects this, showing a general initial rise, then a leveling off in THD. It also shows substantial differences in the performance of the various devices tested. Highest performers are those units which show the combination of good low-level linearity concurrent with high GxBW, e.g. the x10 531, the 530A, and the 538.

As a final example of THD performance, the data of Fig. 17 indicate what effect an adjustment in SR independent of small-signal bandwidth (or feedback) has on SID. For this test, a 318 op amp is used in the circuit shown. The 318 has a

very high SR of $50V/\mu S$ with a gain bandwidth of 40MHz, and its performance is sufficiently high (curve A) that the THD measured is essentially the residual of the analyzer used [31, 33, 34, 38].

As the test circuit shows, the current sources and load C_L constitute a slew limit mechanism which can be used to experimentally alter SR, independent of both feedback and amplifier bandwidth. Curve B indicates THD for a $6.7V/\mu S$ condition, C for a $0.5V/\mu S$ condition. Note that the fp for C is 8 kHz, as equation 3 predicts.

This test indicates two things; one that SR is a good general indicator or predictor of high frequency distortion for high SS waveforms. Second, it indicates a pattern of distortion rise in curve C much more sudden than any previously noted. This indicates that the heavy feedback (for the 318, as used here) is successful in suppressing the typical two octave rate of rise noted in other patterns above [33, 53, 60].

At this point, THD performance data has been shown which reflects the key behavior patterns observed in the group of IC samples tested. From this, it can in general be noted (for these tests) that if the device slew rate is $5V/\mu S$ or more, is symmetrical, and does not use nonlinear slew enhancement, the THD performance can be superlative. This will be evidenced by a THD of 0.01 percent or less up to 20 kHz (a 20-kHz *distortion-free* bandwidth) with an fp of 80 kHz or more. For the best devices, THD can be 0.1 percent or less up to 100 kHz. Of those tested, the best devices in the above terms were: NE5534 (equivalent to TDA 1034), 536, 318, 518, the TL080 and TL070 series, 3140, 2625, 2525, 301A

Sine-Square Test

A combined sine-square wave IM test has been proposed by Leinonen, Ojala, and Curl as a method of measuring TIM [18]. For this test, the signal is a 3.18-kHz square wave, which has been filtered with a simple one-pole, low-pass R-C filter, at either 30 or 100 kHz, and combined with a 15-kHz sine wave of one quarter the peak-to-peak amplitude of the square wave. The resulting square-wave signal component has a very high slope, which is in theory actually limited only by the low-pass filter. As can be appreciated from this factor, this test has the capability of stressing an amplifier to a high degree for non-linearities related to signal slope and/or slew rate. Figure B-1 is an oscilloscope photo of a 30-kHz band-limited signal (DIM 30).

The output spectrum of the amplifier under test is analyzed for intermodulation products generated by non-linear mixing of the sine and square waves. The rms sum of these products relative to the amplitude of the 15-kHz sine wave is defined as the percentage distortion. This definition of the test does not include the residual distortion products of the square-wave source (which are not a result of the intermodulation under examination). As typically occurring in practice, these spurious products are the even-order harmonics of the square wave (which, of course, should ideally be absent).

If a very high-quality square-wave generator is used, for example with even-order harmonics 90 dB down from the fundamental, even-order distortion resulting from amplifier

asymmetry is measurable. In the tests of this study, this type of distortion was included, as sometimes it was the *only* distortion present in the output spectrum.

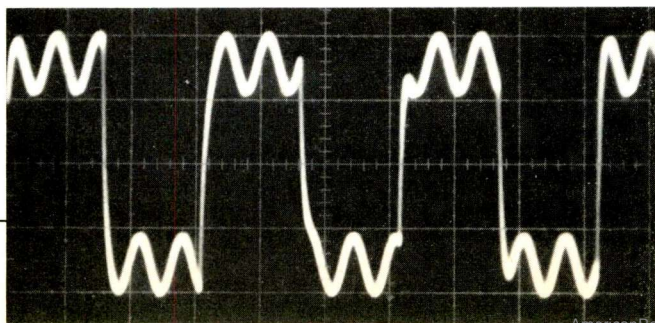
It should be noted that a test signal as defined above has a very wide spectrum. For example, even though the square wave is low-pass filtered at 30 kHz, there is still significant energy present up to several hundred kHz.

A very interesting and inherent property of an ideal square wave (with no band limit) is that every individual harmonic of the Fourier series comprising the square wave contributes the same amount to the resulting slope of the square-wave transition. This is because the amplitudes of the harmonics fall in exact proportion to their rise in frequency, which makes the slope constant for increasing harmonics. Thus, it should be intuitively appreciated that an unfiltered square wave constitutes an extreme test in terms of signal slope. In the ideal case, for a fundamental frequency/amplitude combination resulting in a slope of " x " $V/\mu S$, the composite slope will be infinite; in a practical case of " n " harmonics, the slope will be $(n + 1) (x) V/\mu S$.

This pattern of constant signal-slope contribution per harmonic is not *strongly* ameliorated by a simple 30-kHz single-pole filter, such as is used in the sine-square test. As a result, a very high percentage of the signal slope is contributed by ultrasonic energy. As a specific case in point, every odd harmonic comprising a 16V p-p, 3.18-kHz unfiltered square wave contributes $0.16V/\mu S$ to its slope. When passed through the 30-kHz filter, there will be five square wave harmonics below 30 kHz ($f_1, 3 f_1, 5 f_1, 7 f_1, 9 f_1$). These components will contribute slopes of 0.16, 0.15, 0.14, 0.13 and 0.12 $V/\mu S$, respectively, to the composite test signal slope, while the 15-kHz, 4V p-p sine-wave signal (f_2) has a slope of $0.19V/\mu S$. This sums up to a slope contribution of $0.9V/\mu S$ for those test signal components below 30 kHz.

The total composite test signal slope for these conditions has a slope of over $3 V/\mu S$. It is therefore clear that over two-thirds of the test signal slope is contributed by the square-

Fig. B-1 — Time domain representation of DIM-30 test signal.



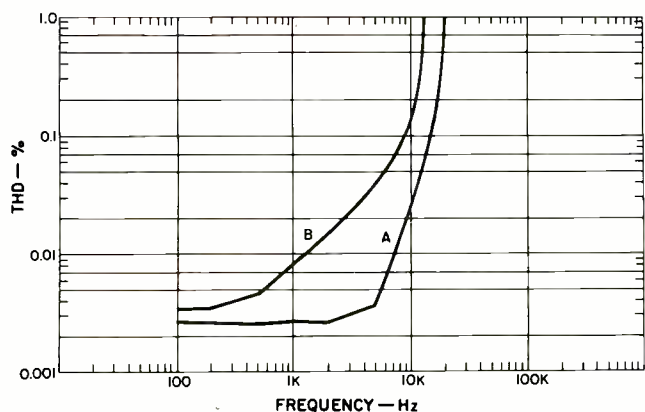


Fig. 14 — THD vs. frequency for a 301A op amp at 7 V rms output in inverting^(A) and noninverting^(B) modes.

(feed-forward), and the OP-01. Nearly as good were the AD540 and 8007. The common characteristic of all of these amplifiers is their high slew rate and input stage linearity. (No ranking is implied, and other types may be capable of such performance.)

Two-Tone HF IM Tests

A second series of tests conducted on this sample group of IC op amps was HF two-tone difference IM, hereafter called simply IM. This type of test also shows SID, as evidenced by IM, to be generally governed by amplifier slew rate. For this

wave harmonics above 30 kHz, which are not completely filtered. Obviously, this form of test cannot be construed as an "in-band" test, as the bulk of the energy distribution in terms of signal slope is concentrated in the ultrasonic region of the spectrum.

The above points are graphically illustrated in Figs. B-2 and B-3. Figure B-2 is a simple spectral distribution plot of a sine-square 30-kHz band-limit test. This shows the relative amplitude of the individual signal components as they appear at the input to an amplifier being tested. The 30-kHz filter response is also shown for reference, superimposed above the spectral lines of the signal.

The spectrum, as shown here, very closely resembles the conditions used in our sine-square tests, for the 30-kHz case. As can be noted, the non-ideal even-order products are approximately -90 dB with respect to the fundamental.

The plot of Fig. B-2 is simplistic in the sense that it gives no real appreciation for what is required of the amplifier in terms of SS capability or SR. The graph of Fig. B-3 is intended to convey this.

Fig. B-2 — Spectrum of sine-square test signal. ($f_1 = 3.18$ kHz square wave; $f_2 = 15$ kHz sine wave.)

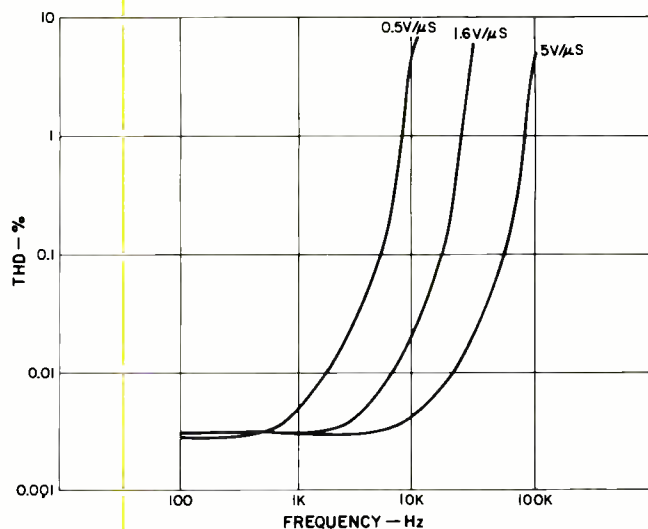
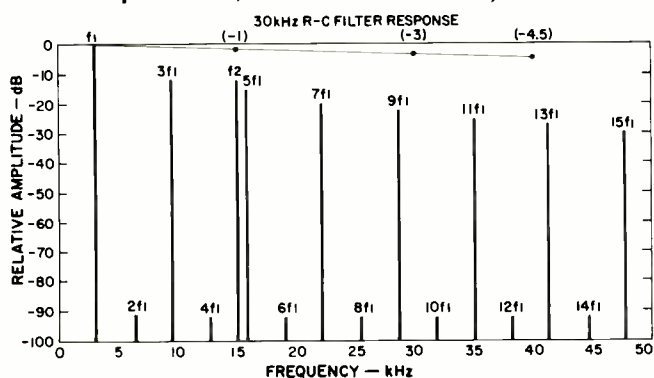


Fig. 15 — THD vs. frequency for a 2725 programmable op amp operated as a unity gain inverter at 7 V rms output at various slew rates.

test a one-to-one mixed, high-frequency tone pair at full output level is swept from 10 kHz to 50 kHz. The difference frequency is maintained at 100 Hz. All tests were performed in the test circuit of Fig. 9.

Figure 18 shows some data which indicate the general relationship of IM performance and SR. These data were taken

This figure is simply a graph (or graphs) of the signal slope which results for 30-kHz and 100-kHz band-limit conditions versus p-p operating level. For the case discussed above, the example of a 20V p-p level and 30-kHz band limit is plotted, and the resulting SS is $3.2V/\mu S$, as noted. Were the band limit 100 kHz, the SS would be over $10V/\mu S$ (for the same operating level). From the simple relationship shown, an SS can be calculated for any operating level for either case of filtering.

An important point to be noted is the fact that this relationship applies to voltage swing, and it can apply to either preamps (at lower levels) or power amps (at the higher levels). It has an indirect link to power output (since power is a function of load impedance as well as voltage).

Finally, as will be noted from the discussions of the tests in the text, a given amplifier should have an SR greater than the SS generated by a particular test condition. The $3.2V/\mu S$ SS case, for example, would require an amplifier with an SR in excess of $3.2V/\mu S$, for distortionless reproduction.

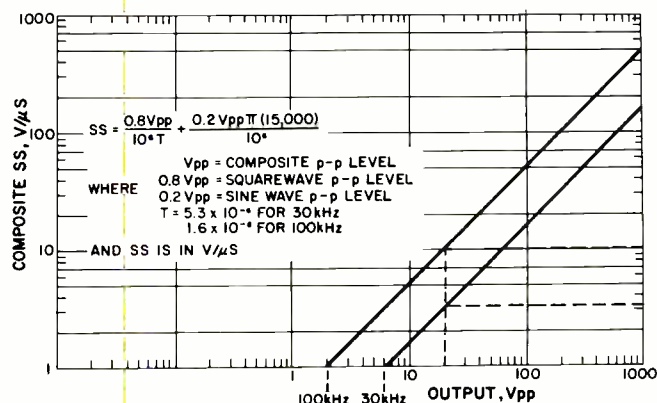


Fig. B-3 — Sine-square test signal slope.

with the 2725 programmable op amp, with slew rates of 0.5, 1.6 and 5V/μS (condition similar to Fig. 15).

The nature of the IM performance behavior with respect to increasing SS strongly resembles the data based on THD, showing a similar rise as the amplifier SR is approached. This behavior pattern is a characteristic one of IM [14, 33, 34, 51], just as it is for THD. The rise in IM (dotted) at low SS reflects the equipment residual.

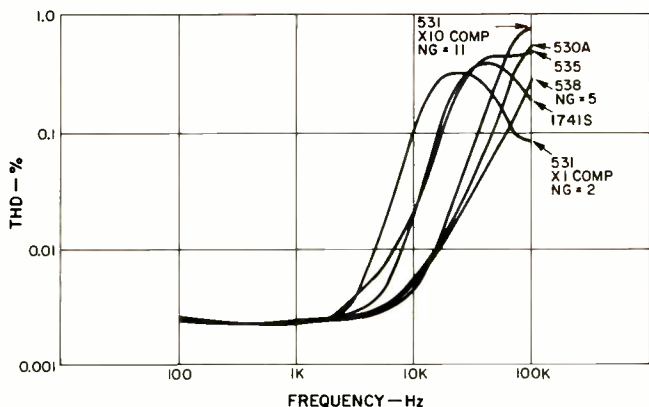


Fig. 16 — THD vs frequency for various slew-enhanced op amps operated as unity gain inverters at 7 V rms output.

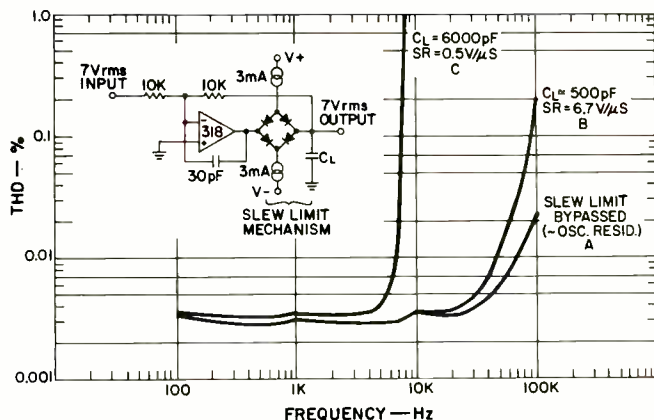


Fig. 17 — THD vs. frequency for a 318 op amp with an artificially induced signal path slew limit.

Fig. 18 — Two tone IM (mixed 1:1) vs. frequency ($\Delta f = 100$ Hz, constant) for a 2725 programmable op amp operated as a unity gain inverter at ± 10 V output for various slew rates.

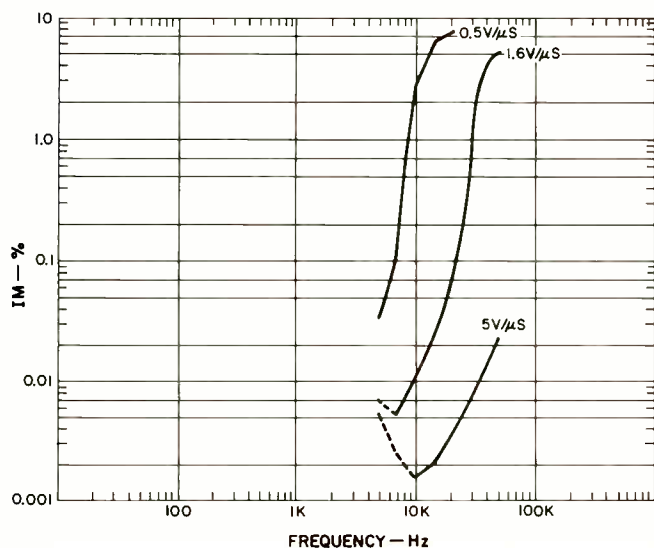


Figure 19 shows a composite plot of IM performance by this method, for a variety of different IC op amps. The highest performance devices here show IM distortion at the equipment residual level, while the others show quality generally proportional to slew rate. The notable exceptions to this pattern are the 535, a high-speed slew-enhanced type, and the 356, an asymmetric-slewing unit with appreciable second-order distortion. Each unit has a high slew rate, but the exact method of achieving it prevents optimum linearity from being realized.

The data from the IM tests follow the same general pattern as THD-based data in terms of distortion rise for SR ratios approaching unity. It is less sensitive, though, due to the fact that it measures even-order products and the amplifiers usually (if perfectly symmetrical) generate odd order. This test is quite effective in pinpointing amplifiers which have inherent transfer asymmetries (and thus even-order distortion), such as the 356 type. A two-tone IM test to measure odd-order products ($2f_1 - f_2$) would yield more useful data on the symmetrical devices.

It should be noted that an IM test such as this can be more useful for band-limited amplifiers, as it can measure IM products folded downward to lower frequencies by the HF tone pair.

Sine-Square Tests

A selected sampling of devices which had undergone the THD and IM tests were subjected to the sine-square tests as outlined in reference 18 and described in the sidebar. Like the previous THD and IM tests, the test circuit of Fig. 9 was used. Our results do not directly correlate with those of reference 18, because we are operating the amplifier with no common-mode swing (inverting mode) in order to isolate SID from common-mode distortion. Figure 20 summarizes the results of these measurements, for full output-level tests performed with a 30-kHz square-wave band limit.

The general relationship between Dynamic Intermodulation Distortion (DIM after the terminology of reference 18) and device SR capability is shown by the graph in Fig. 20. This graph shows percentage DIM versus device SR, for all types of devices under one standard test condition. The maximum SS of the input sine-square signal for this case is $3.2V/\mu S$. Thus, a given device would require an SR of at least this much to pass the waveform without gross distortion. This graph shows that distortion rises above the residual level at around a device SR of $6.5V/\mu S$, which is roughly twice the SS of the input waveform.

This is an important and useful indicator; on the average, a device must have an SR capability of twice the input signal slope to pass signals with negligible distortion. As the SR capability of the test devices falls below $6.5V/\mu S$, the graph is seen to rise linearly to very high amounts of distortion. A best straight line drawn through the data points turns out to have a slope of 3:1 on the logarithmic coordinates. This indicates that DIM varies as the third power of the ratio of the input SS to the device SR. A simple equation that expresses this relationship is

$$\%DIM = K (SS/SR)^3 \quad (18)$$

where $K = 0.16$ percent for our data.

This relationship is quite a valuable one to audio designers, as it indicates how DIM varies with SR ratio. A very interesting observation which can be made from Fig. 20 is that the DIM test is relatively insensitive to distortion detection, when the SR ratio is less than 0.5. It will, of course, measure gross IM levels for conditions of $SS > SR$, but this is hardly a practical mode of amplifier operation. Since the distortion mechanism being analyzed by a given test method is the inter-relationship of SS and amplifier SR, the point must be made that an optimum test method should show usable results over a wide range of conditions.

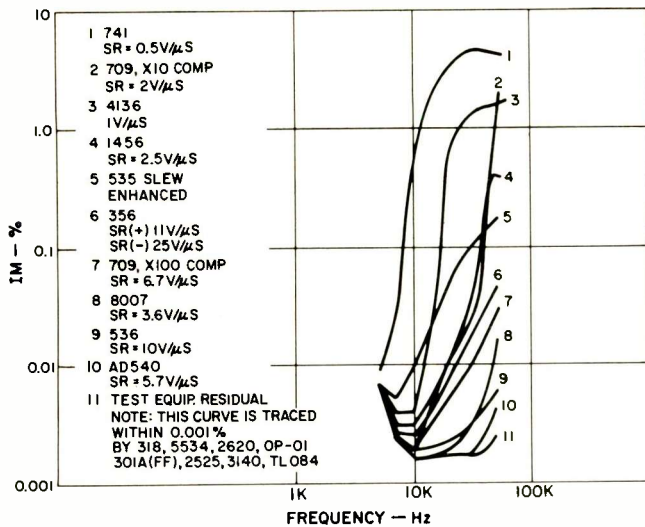


Fig. 19 — Ranking of op amps operated as unity gain inverters ±10 V output, by slew rate on basis of two tone (1:1) high frequency IM.

It should also be noted from Fig. 20 that there are devices that *do not* fit the characteristic relationship between distortion and slew rate. These devices are grouped to the right of the line and show excessive distortion for their high slew-rate capability (compared to the general trend). With the exception of the 356 and 357 devices, all of these op amps are slew-enhanced units. They feature an input-stage transconductance that varies with level to produce rapid slew rates for large signals. Unfortunately, the changing input-stage transconductance of these devices (a non-linearity), gives rise to a crossover type of distortion mechanism. Since, for small signals their SR capability is low, they begin to produce distortion for relatively low SS waveforms. As the SS of the input is increased, the slew capability of the device increases, and it is more capable of producing the required output. Thus, at high SS inputs, the distortion doesn't increase, it merely remains the same percentage as it was under low SS conditions.

We found that under varying input SS waveforms, the output spectrum of the slew-enhanced devices remained fairly constant; only the relative magnitudes of the individual distortion products varied up and down. Increasing the input SS caused some distortion terms to increase and some to decrease, but the magnitude remained fairly constant. It is interesting to compare this behavior with the leveling off of THD observed in the THD tests at high SS conditions.

The 356 and 357 devices also did not fit on the characteristic straight line, but they suffer from a different type of problem than do the slew-enhanced circuits. These units showed only even-order distortion falling on the square-wave harmonics; no other intermodulation products were produced (as did the slew-enhanced devices). The 356 and 357 devices seem to alter the symmetry of the waveform, indicating that an asymmetric nonlinearity is in action. This theory is supported by other forms of tests (for example, references 31 and 38). It should be understood that the problem experienced by these particular devices is not inherent in all Bi-FETs, or even other FET op amps, by any means. The 536, an older design, had DIM levels below the resolution of our measurement equipment. Also, the TL080 (and TL071) FET device families are capable of high performance for these tests, as is the LF351 and other devices of the same families.

Devices which are capable of differing slew rates, such as the 2725 and 301A, show DIM performance which improves as device SR is increased. In an experiment to examine the effects of open-loop bandwidth [4, 6, 7, 8, 9, 10, 14] and the degree of feedback as design criteria for low DIM, several

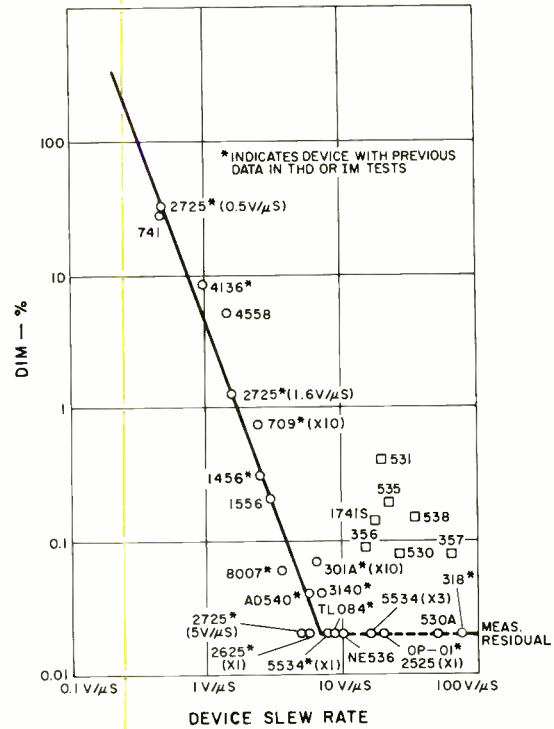


Fig. 20 — DIM vs. device slew rate. Test level is 20 V p-p, filtering is at 30 kHz, input SS is 3.2 V/μS. (*Indicates device with previous data in THD or IM tests.)

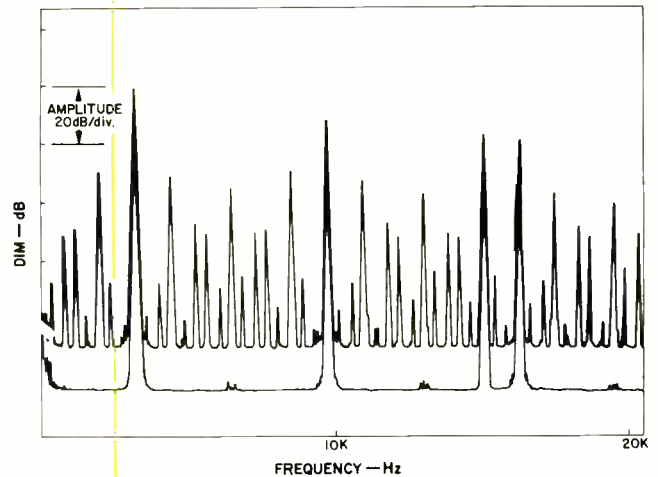


Fig. 21 — Comparison of DIM performance of two devices with different slew rates, both operated as unity gain inverters. Top curve is 741, bottom is NE536; input signal slope is 3.2 V/μS. Spectrum analyzer sweep, 0-20 kHz linear.

specific tests were performed. The results of these are the spectrum plots shown in Figs. 21 and 22.

Figure 21 shows comparative DIM performance for two different op amps for conditions of a 10V p-p output and a 30-kHz band limit (SS=1.6V/μS). The 0.8V/μS device (a 741) clearly shows strong DIM, but the 10V/μS device (a 536) shows a spectrum which is indistinguishable from the input. Open-loop bandwidth of both devices is less than 20Hz, feedback is nearly 100 dB at low frequencies, and gain-bandwidth is 1 MHz.

Figure 22 shows a performance comparison for 20V, 30 kHz (3.2 V/μS SS) band limit conditions, with slew rates adjusted to 0.5, 1.6, and 5V/μS, using the 2725 device. It is clear that DIM is reduced as the SR is increased above that of the SS (or

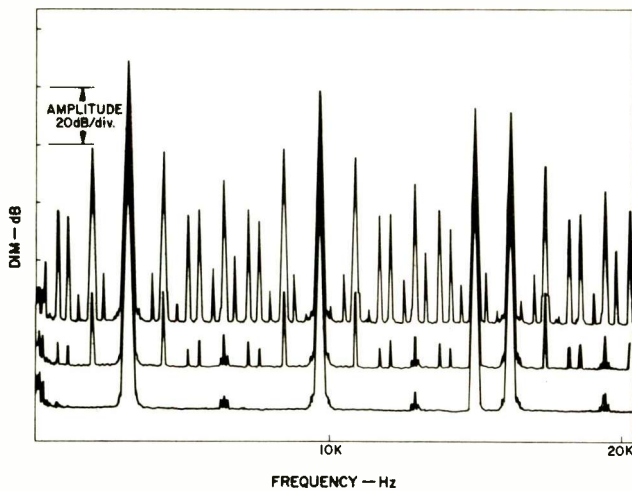


Fig. 22 — Comparison of DIM performance for a 2725 adjustable slew rate op amp operated as a unity gain inverter with input signal slope of $3.2\text{V}/\mu\text{S}$. Top curve is SR of $0.5\text{V}/\mu\text{S}$; middle is $1.6\text{V}/\mu\text{S}$; bottom is $5\text{V}/\mu\text{S}$.

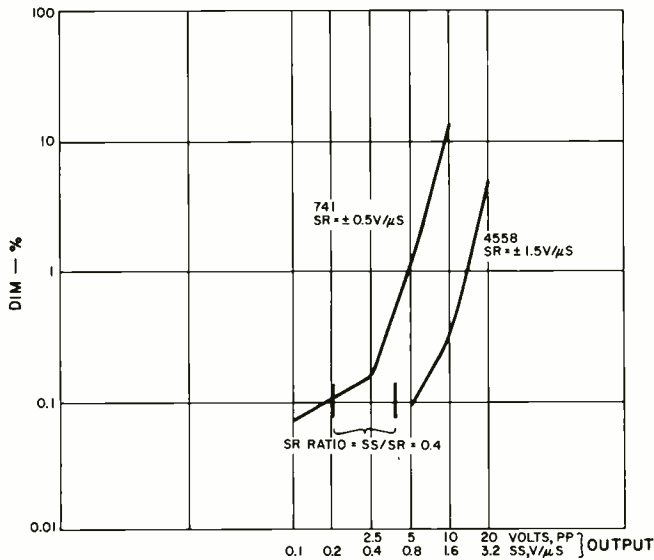


Fig. 23 — DIM vs. output level and signal slope for two devices operated as unity gain inverters with $\text{BL} = 30\text{ kHz}$.

stated another way, as SS/SR is lowered). For these conditions, device open-loop 3-dB bandwidth is for all cases less than 200 Hz, and feedback is nearly 100 dB at low frequencies.

It seems apparent from these tests and others made that the sine-square test performance is strongly affected by SR just as are THD and IM. There appears to be no directly measurable or obvious sensitivity to open-loop bandwidth. Gain-bandwidth product and loop gain affect DIM performance, as they do THD and IM, in that they affect how close to slew limit one can work before distortion rises.

A further demonstration of how DIM behaves in a manner similar to THD and IM performance is contained in Fig. 23. These data are based on the common condition of a 30-kHz band limit, but with DIM plotted versus output amplitude. To show the similarity, two different SR devices are used, 0.5 and $1.5\text{V}/\mu\text{S}$. At low signal levels DIM is at a very low level; as the output signal level is increased, DIM shows a rapid rise, similar in behavior to THD and IM, as the SR ratio approaches unity.

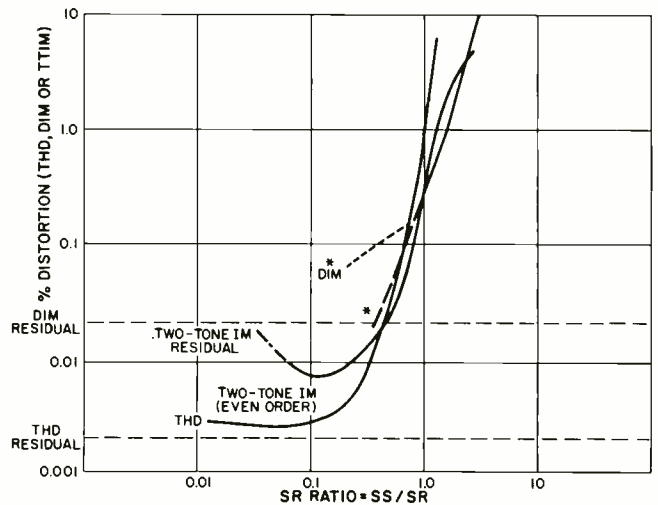


Fig. 24 — Correlation of test methods, various forms of distortion vs. signal/device SR ratio for a 741 with $\text{SR} = 0.5\text{V}/\mu\text{S}$. (*Dotted line on the DIM curve results if the even order harmonics of the square wave are counted in the distortion computation. This is very difficult to do since an extremely high quality square wave generator is required. The proponents of this test recommend ignoring these components and measuring only the distortion resulting from the intermodulation between the sine and square waves, in which case a pattern similar to the dashed line results.)

Comparison of Test Methods

If the three test methods used are compared on a common base, it is possible to see a definite common pattern in their behavior, which is done in Fig. 24, where the horizontal axis is normalized in terms of the ratio of the SS to the SR of the device. By this means, it is possible to see just how the various forms of distortion behave as the device slew capability is taxed, and also to indicate the relative sensitivity of the three test methods.

The THD method shows the widest dynamic range of the three methods and gives the highest percentage distortion at a unity slew-rate ratio, 1 percent. The anomalous low-level slope for the TIM test is due to our detection of some second-order low-level nonlinearities in the 741 tested. This produced a second harmonic of the square wave which we were able to detect in the output spectrum. Since the TIM distortion number is normalized to the 15-kHz sine-wave amplitude, and the square-wave fundamental amplitude is 12 dB larger, the distortion shows up a factor of four larger than it should. Our experiences with the equipment available for these tests was that it was very difficult to detect SID with the sine-square test at signal slopes less than $\frac{1}{2}$ that of the device SR (see Fig. 20).

Unfortunately, there is a serious problem with the sine-square test method that is not totally equipment related, one which became apparent after evaluating some of the best op-amp circuits. The problem concerns amplifier distortion products which are coincident with the even-order distortion products of the square-wave generator. Theoretically, a square wave should consist only of odd-order harmonics of the fundamental frequency. Practically, every generator will have some slight asymmetry in its square-wave output, which creates small but definitely measurable amounts of even-order distortion. Typical amounts for a general purpose lab square-wave generator are 50 to 60 dB down from the fundamental. Thus, if one were measuring a very good amplifier that had only low-level distortion products falling on the even-order square-wave harmonics, the true distortion of such a case would be masked by the generator, and therefore unmeasurable. The conclusion could then be erroneously

drawn that the amplifier was free from transient intermodulation distortion, when in fact the amplifier was producing small amounts of distortion below the threshold of measurement.

One might point out that an amplifier producing distortion products coincident with the square-wave harmonics should also produce other intermodulation products of comparable magnitude, ones that could be readily measured. This simply was not the case in our tests and can be easily demonstrated by testing an asymmetric device such as a 356 or a 530A. Both of these amplifiers show the pattern of only even-order square-wave products, even at the most severe SS TIM test (10V/μS). To accurately measure these two devices, a square-wave generator with even-order products down at least 90 dB is required. In our series of tests, this was realized by carefully monitoring and adjusting the symmetry of our square-wave generator at periodic intervals. Only when the generator's even-order distortion was reduced to these low levels did we begin to see differences between the best op-amp circuits that typically had only even-order distortion products. The magnitudes of these even-order products for the best circuits were as low as only 0 to 6 dB greater than the generator residuals, and in many cases required detailed comparison of the input and output spectrum over several runs to verify that the products were, in fact, actually there.

The two-tone difference IM test is much more sensitive to even-order distortion than the sine-square test. For example, where it was difficult to detect distortion in the 356 with the sine-square TIM test, the IM test found it easily (Fig. 19). It is possible that a two-tone IM test designed to look for odd-order products would show superiority for finding odd-order distortion products. The main attraction of the TIM test is that it allows a quick *qualitative* look at an amplifier's performance.

THD evolves as a very desirable test method, as it is not only sensitive, but equipment for it is common. However, when a limited bandwidth circuit is being evaluated, some form of IM test becomes necessary.

Listening Tests

IC op amps from the group subjected to the above electrical tests were auditioned in a listening test [33] to assess the degree of correlation between the various forms of electrical distortion and audible defects. These tests were done in mono, in an inverting test amplifier configuration similar to Fig. 9. To sensitize the test for SID, however, the test device was preceded by a preamp to drive it to near full-scale output (and so, maximum SS) with program material. The full-scale output was then scaled down and level matched with the original input to within ±0.2 dB. A-B tests were then conducted on each IC to determine audible degradation. Source material was a variety of phonograph records, using a moving-magnet cartridge.

The results of this test indicate that not only can SID be detected audibly, but also suggest that the ear is apparently sensitive to levels of distortion lower than 1 percent. The results of these tests are summarized in Table II, which also indicates the relative quality weighting.

Before discussing these results, it is highly important that the reader appreciate the basic fact that these listening tests and the quality levels they indicate for a given SR are referred to 10V peak levels. One cannot generally assume these quality levels as absolute, as operation of given (fixed SR) device at other output levels will change the working SR ratio. As a necessary result, distortion will change accordingly, i.e. improve in going to *lower* levels or degrade in going to *higher* levels (for those devices capable of higher levels).

The above effects are, of course, simply due to the level-dependent property of SID; it is worst at highest SS or highest

SR ratios. It is for this reason that the operating parameters associated with each test device are given here in several different terms, so as to avoid confusion. What the reader is most interested in, of course, is what parameters of a device are necessary to achieve a given quality level.

In terms of the reproduction observed, "A" level quality is that indistinguishable from the source on the most difficult high frequency program material. In general, devices of over 4V/μS slew rates fit into this category. Exceptions were some (but not all) slew-enhanced devices and the asymmetric devices. Quality levels B and C are degradations of a somewhat subtle nature, as noted. Quality level E and portions of D are distorted in a sense which is gross or obvious.

There appear to be two broad categories of audible SID, one which can be associated with the approach of slew limiting, Category I, and one in which slew limiting actually occurs, Category II.

Category II distortion will occur relatively infrequently on normal program material if the device slew rate is above 0.5V/μS. However, Category I distortion is possible in many instances, and adjectives used to describe it have often been seen in print.

Since the quality levels just described are for the devices and associated slew rates *operated at ±10V output levels*, some means of relating this to more general conditions is desirable. If the SR for each quality level is divided by the operating voltage level, it can be normalized to a required SR/V figure. This is simply the SR required per peak volt of output to attain a given quality level. For example, "A" quality level was observed for devices which achieved 0.4V/μS/V (or more) performance. This requires a 4V/μS device for 10V (peak) operation or a 0.4V/μS device for 1V (peak) operation.

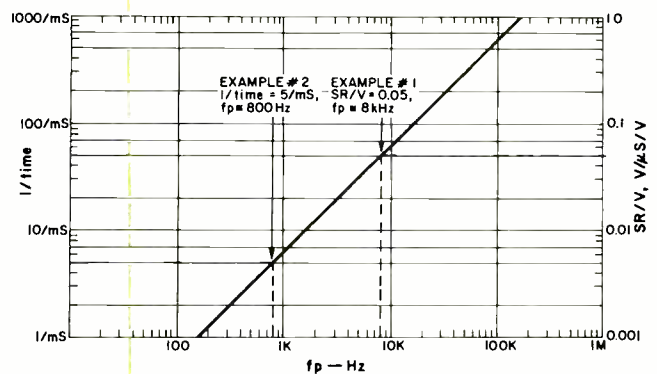
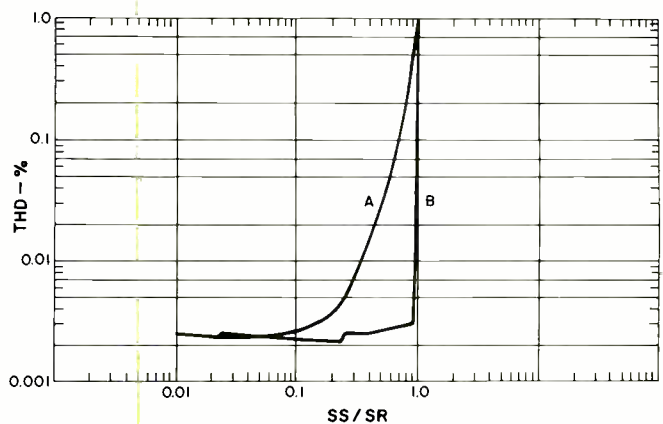


Fig. 25 — Relationship between SR/V (1/time) and fp.

Fig. 26 — Comparison of SID for low and high feedback conditions.



The parameter SR/V is related to a power bandwidth, which can be calculated as

$$f_p = (SR/V) (10^6 / 2\pi) \quad (19)$$

where f_p is in Hz, and SR/V is in $V/\mu S/V$.

As can be calculated from (19) or the table, a $0.4V/\mu S/V$ SR/V level corresponds to a 64 kHz power bandwidth.

Some authors [62] have expressed the parameter of SR/V in units of 1/time (which may or may not appear to be simplified to the reader). A power bandwidth can also be calculated from this parameter as

$$f_p = ("x"/mS) 1/(2\pi) \quad (20)$$

where f_p is in Hz, and 1/time is in 1/mS (x is the variable). These two relationships (19, 20) are graphically summarized in Fig. 25, with either parameter as an input.

The general observation which can be made from Table II is that obviously distorted reproduction begins to be noticed (level E) at an SR/V level of $0.05V/\mu S/V$, or a power bandwidth of less than 8 kHz. This is plotted as Example 1 in Fig. 24. Other researchers conducting listening tests have arrived at a corresponding distortion level threshold in terms of 1/time, at a level of 5/mS [62] (or $0.005 V/\mu S/V$), which equates to an 800-Hz power bandwidth (example #2).

The level dependence of SID has caused much confusion as to where and when a given SR is a limiting factor. The reader should understand that a $5V/\mu S$ amplifier SR (for example) will most likely not be a limitation for a preamp output, but may be critically so for a power amplifier. The difference is in the voltage swings the two types of amplifiers are called upon to produce without distortion.

As an illustrative example, if we assume a 1.5V power amp sensitivity for full output, this equates to roughly a 2V peak level from the preamp. To produce a 2V peak level in terms of the highest performance of Table II, the $0.4V/\mu S/V$ guideline implies a device SR of $0.4 \times 2 = 0.8V/\mu S$. This level of performance is met by many devices, for example the popular 4558 or 4559, at $1.5V/\mu S$.

For the power amplifier, if we assume an example of 100W into 8 ohms, this equates to a voltage of 40V peak. Applying

the highest performance level again of $0.4V/\mu S/V$, the SR required is $16V/\mu S$ or more.

Hopefully, the above discussion illustrates how SR *must* be related to operating voltage level to predict quality. It should be appreciated that an SR number quotation *by itself* is relatively meaningless, if it is not related to operating level.

Also, another point which should be made is that performance simply does not continue to dramatically increase with greater SR, once sufficient SR has been obtained. For a preamp output, for example, if an SR of $5V/\mu S$ is more than sufficient to meet any possible operating condition, $50V/\mu S$ may not improve operation in practice and may well represent a meaningless numbers race.

As pointed out in reference 33, the listening tests of this research are basically the subjective observations of one individual and should not be construed as a result applicable to all situations.

Summary of Test Results

Some sensible guidelines for amplifier selection now begin to emerge from this series of tests. The primary one is speed, which is to say that faster amplifiers are generally better. There are two basic aspects to speed, bandwidth and slew rate, and in general they tend to go up together. It can be stated that raising an amplifier's gain-bandwidth product (or unity-gain frequency) is usually desirable [27, 28, 29, 30, 31]. The reason is that at any given frequency (neglecting d.c. and very low frequencies) the loop gain of the amplifier will be higher and more feedback-related distortion reduction will take place, which lets one work closer to the device SR (and, of course, reduces other distortions as well).

It has also become apparent that higher SR is generally better, even for *equal* bandwidth, but some caution is required here. Since slew rate is determined by the dynamic range of the (usually) nonlinear input transconductance amplifier, it is important that high slew rate *not* be achieved at the expense of linearity.

The slew-enhanced devices, such as the 535 and the asymmetric 356, are examples of amplifiers which violate this

Table II—Listening test results (referred to full output of $\pm 10 V$).

Category of SID	I—Deterioration				II—Gross Distortion	
	A	B	C	D	E	
Quality Level (1) Audible Character	No differences detected for any program material.	Just discernible softening, loss of sweetness.	Further softening, somewhat dry, generally satisfactory with slight loss of dimension.	Colorations apparent, loss of dimension, "covered" sounds, dulled transients, constriction, edge begins.	Coloration and distortion obvious, more constricted covered sound, transients smeared, grit, edginess, fuzz.	
Associated Parameters (2)						
SR	$>4V/\mu S$	2-4V/ μS	1-2V/ μS	0.5-1V/ μS	$<0.5V/\mu S$	
SR/V	$>0.4V/\mu S/V$	0.2-0.4V/ $\mu S/V$	0.1-0.2V/ $\mu S/V$	0.05-0.1V/ $\mu S/V$	$<0.05V/\mu S/V$	
f_p	$>64kHz$	32-64 kHz	16-32 kHz	8-16 kHz	$<8 kHz$	
Samples Tested	318, AD518 NE5534 (TDA1034) 2625 2525 8007 NE536 AD540 3140 TL084 OP-01 NE530A NE541 (x100) NE540 (x100) NE531 (x10) 2720 (5V/ μS) 301A (x10, x100, or FF comp)	1456 NE530 NE541* (x10) NE540* (x10)	1741S 356* 4741 NE535 NE538*	741	<div style="border: 1px solid black; padding: 5px;"> <p>Notes: *Audible ranking here is possibly due to factors other than SR. 1: Listing of various devices within columns is not a ranking. Character in column "D" is generally in category I, but may at times fall into category II. 2: Some prefer expressing SR/V in units of 1/time. As point of reference, $1V/\mu S/V = 1000/mS$.</p> </div>	
		4136 (2V/ μS) 709 (x10)	4136 (1V/ μS)	2720 (0.5V/ μS) 301A (x1)	2720 (0.16V/ μS) 709 (x1)	

premise. These devices are inherently incapable of performing as well as devices with more linear overall transfer characteristics. Emitter degeneration used in an input stage is an excellent example of a technique that allows higher SR [20, 21, 24, 47], while at the same time linearizing the input stage and extending its dynamic range. The 1456 or 318 is a good example of this type of amplifier; FET differential input types, which by their very nature have low transconductance, are also excellent (provided they are symmetrical). A good example of this type of topology is the TL080, TL071, or the LF351 series.

To restate these design criteria, we primarily want an amplifier which is linear for large input signal (ΔV) levels, and importantly, one which can deliver relatively large currents to the compensation capacitance [24]. This gives us high SR and a highly linear input dynamic range, which allows large error signals. Secondly, we would like this amplifier to have as high a unity-gain bandwidth as possible, so that when we apply feedback, the HF loop gain will be as high as possible for distortion reduction. The loop gain determines how close we can operate to slew limiting before distortion begins to rise (as it inevitably will, in a practical circuit).

Some previously discussed design criteria for low TIM, such as the use of low open-loop (d.c.) gain and a high open-loop pole frequency (ω_0), do not appear to be fundamentally necessary conditions for low TIM [33, 34, 45, 47], given an $SR > SS$.

From the above considerations, it seems useful to suggest a new form of SR criteria for audio circuits. From the four series of tests (THD, IM, sine-square, and listening), this would be a criterion which specifies a minimum SR with regard to the maximum output voltage level in use. Our criterion is "The circuit, including all possible loading conditions, should possess a (symmetrical and unenhanced) slew rate of $0.5V/\mu S$ (minimum) to $1V/\mu S$ (conservative) per peak output volt." Application of this simple criterion will result in negligible

SID, either electrically or audibly, if the slew rate is symmetrical (± 20 percent) and the input stage has a linear transfer characteristic (constant transconductance, unlike slew-enhanced types).

Inasmuch as the above criterion is a stringent one, and in view of some conservative operating conditions, some qualifiers could be added. In general, this criterion specifies an fp of 80 kHz, which is four times the generally accepted audio bandwidth of 20kHz. The reasoning behind this is the rise in distortion with the onset of slewing, sometimes described in the literature as "soft TIM" [7, 8]. Figure 26 illustrates this effect in curve A, which is the THD performance of a 741 on a normalized scale of SR ratio. As can be noted, appreciable distortion exists at ratios as low as 0.25 (or two octaves below fp) [33, 60]

Curve B is for a heavily fed-back amplifier, using a high gain bandwidth IC. As can be noted, distortion is at measurement residual levels right up to the point of actual slew limit (this has been referred to as "hard TIM" in the literature).

Obviously, in the case of B, less derating is necessary, since there is virtually zero distortion until actual slew limit. However, inasmuch as most practical amplifiers will show some distortion prior to slew limit, the 80 kHz fp is intended to guarantee a 20-kHz distortion-free bandwidth (for all output levels). Of course, for less than high performance uses, the criterion can be derated as the user sees fit.

This criterion is perhaps most applicable to amplifiers where the user does not have total control over performance parameters, such as SR, bandwidth, and input dynamic range (and/or linearity). For such applications, it can be useful as a guiding selection criterion, for example with IC types.

When one has design freedom from the ground up, and can optimize *all* operating parameters, other design approaches can be more useful. These are discussed in the final part of this series, which includes a design process to guarantee non-slew-limited performance. 4

MODEL 105 COMPUTER MATCHED.



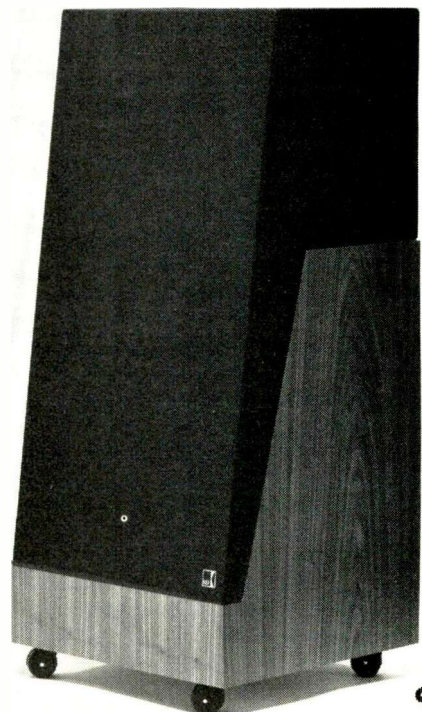
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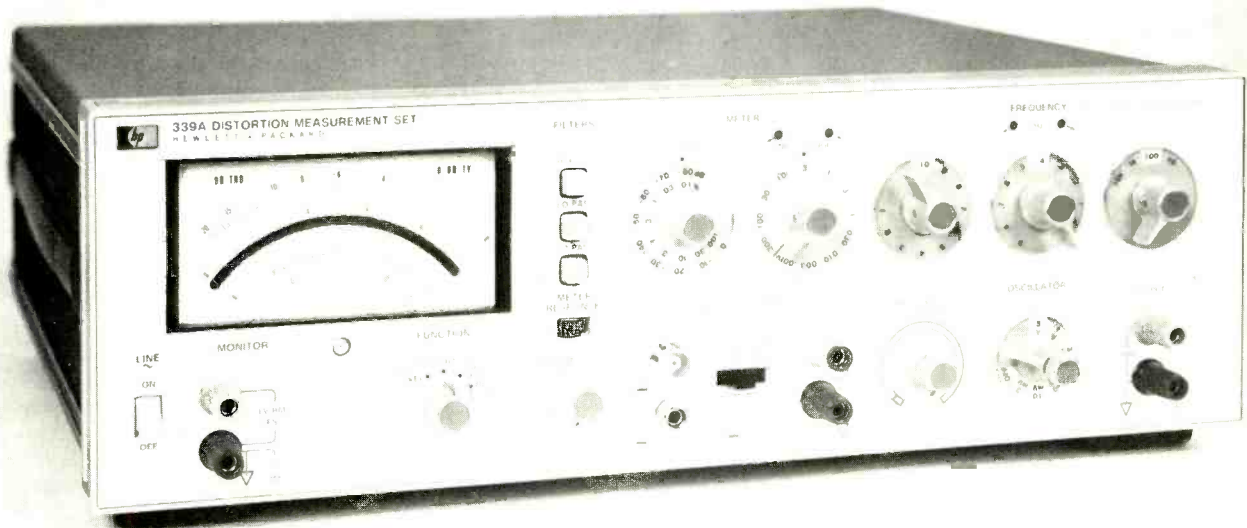
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48

MANUFACTURER'S SPECIFICATIONS

Distortion Measurement Accuracy: 20 Hz to 20 kHz, ± 1 dB; 10 Hz to 50 kHz, $+1$, -2 dB; 50 kHz to 110 kHz, $+1.5$, -4 dB.

Fundamental Rejection: 10 Hz to 20 kHz, over 100 dB; 20 kHz to 50 kHz, over 90 dB; 50 kHz to 110 kHz, over 86 dB.

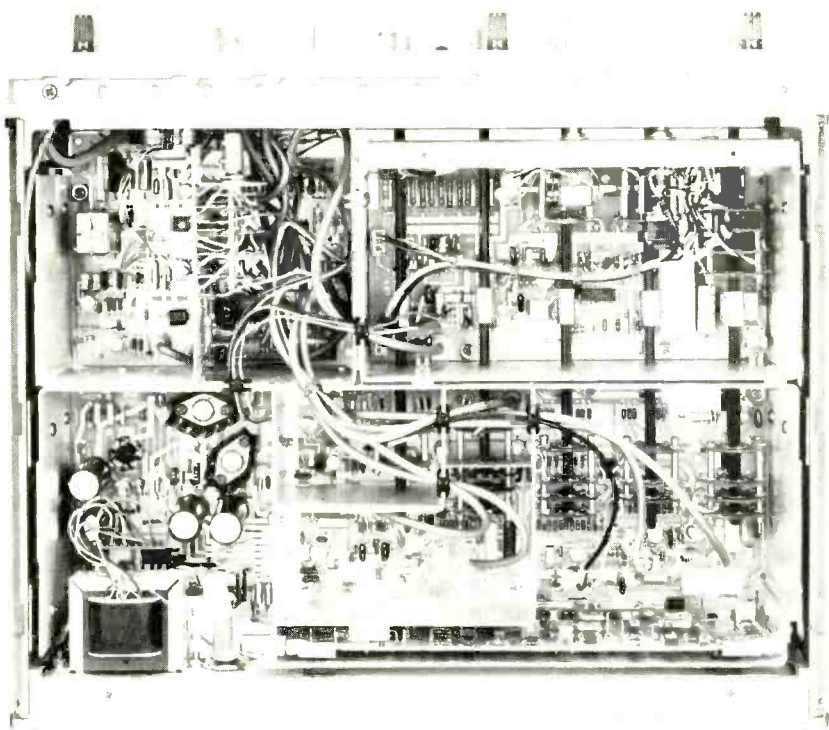
Distortion Introduced by Instrument (Inputs over 1 V rms): 10 Hz to 20 kHz, below -95 dB; 20 kHz to 30 kHz, below -90 dB; 30 kHz to 50 kHz, below -85 dB; 50 kHz to 110 kHz, below -70 dB.

Residual Noise (fundamental frequency setting below 20 kHz, 80-kHz filter in, source resistance no more than 1 kilohm): Less than -92 dB, referenced to 1 V.

Input Level for Distortion Measurements: 30 mV to 300 V rms (100-mV range minimum).

Input Impedance: 100 kilohms, ± 1.0 percent, shunted by less than 100 pF from input high to input low.

Oscillator Distortion (600-ohm load minimum, less than 3 V output): 10 Hz to 20 kHz, less than -95 dB (0.0018 percent) THD; 20 kHz to 30 kHz, less than -85 dB (0.0056 percent) THD; 30 kHz to 50 kHz, less than -80 dB (0.01 percent) THD; 50 kHz to 110 kHz, less



than -70 dB (0.032 percent) THD.

Output Resistance: 600 ohms, ± 5 percent. Oscillator output terminals re-

main terminated with 600 ohms in *Off* position of oscillator level control. **Price:** \$1900.00.

Since the earliest days of high fidelity, there has been a steady increase in technical sophistication and an improvement in all measurable parameters. One inevitable consequence of this trend has been the birth and growth of electronic equipment specially designed for audio measurements. Here is one fine new instrument from Hewlett-Packard, the Model 339A Distortion Analyzer/Oscillator.

Coming from the Loveland, Colorado, instrument division, this new machine joins a number of similar products from the same firm, such as the 4333 and the better-known 331-334 series. However, this is the first instrument from H-P that includes a low-distortion signal source. With the internal oscillator, a tracking notch filter, and a sensitive true rms responding voltmeter, the 339A has the complete capability of making the familiar THD+N measurements as defined in IHF standard A-202-1.17. Additionally, the voltmeter and oscillator may be used independently to provide various other measurement capabilities, including signal-to-noise ratio and level-flatness testing.

In the distortion analyzer mode, or more properly the distortion meter mode, the instrument can measure total harmonic distortion and noise from 0.01 percent to 100 percent full scale in nine ranges. While the fundamental frequency range is from 10 Hz to 110 kHz, the rejection and voltmeter circuits have sufficient bandwidth to provide good measurements for harmonics as high as 330 kHz.

While simultaneously tuning the notch filter, the oscillator has switch selectable frequency settings with two significant digits of resolution. A variable control is also provided to permit operation at intermediate, but uncalibrated frequencies. An output attenuator with seven 10 dB steps and a 10 dB vernier give good setability for output levels from less than one millivolt to greater than 3 volts across 600 ohms or greater than 6 volts across high impedance loads.

H-P has placed great emphasis on making this instrument fast and easy to operate. With automatic set level and the coupled oscillator/analyzer tuning, this instrument nulls without operator assistance once the desired frequency is selected. Automatic set level operates over some 10 dBV of input range. When this range is exceeded, one of two LEDs above the input level control indicates the proper action required by the operator for a valid measurement.

In similar fashion, two LEDs located above the frequency tuning dials direct the operator quickly to the appropriate setting needed when tuning to an unknown input frequency.

For convenience in making relative a.c. level measurements, the meter has a relative level adjustment that allows the user to bring any input level up to the "0" dB point on the meter. Another operating convenience is the oscillator level function. When the function selector is set to Osc level, the a.c. voltmeter circuits are connected internally across the front panel oscillator output terminals, permitting the user to see exactly what the signal level across the input of the device under test is.

A good selection of filters (400-Hz high-pass and 30- or 80-kHz low-pass) with 18 dB/octave rolloffs are selectable in any combination on all functions. Broadcasters will appreciate the self-contained AM detector and the switchable normal/VU meter ballistics.

Figure 1 shows the actual and the specified performance for distortion residual under conditions similar to those encountered in a typical preamplifier measurement. The measurement was made by tying the oscillator output to the analyzer input, setting the output level to 3 volts, and setting the dials to selected frequencies. By studying the specifications for the 339A, it can be seen that there are actually four different components to the residual distortion of the unit, 1) incomplete fundamental rejection, 2) distortion added by the instrument, called induced distortion, 3) residual noise, and

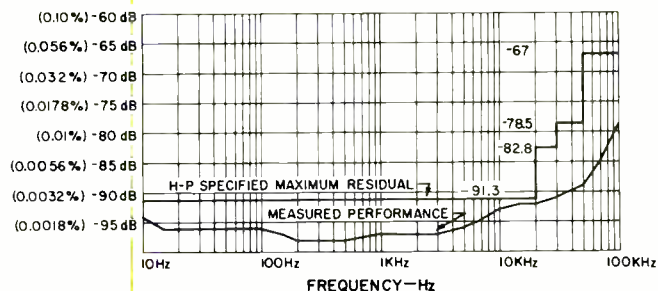


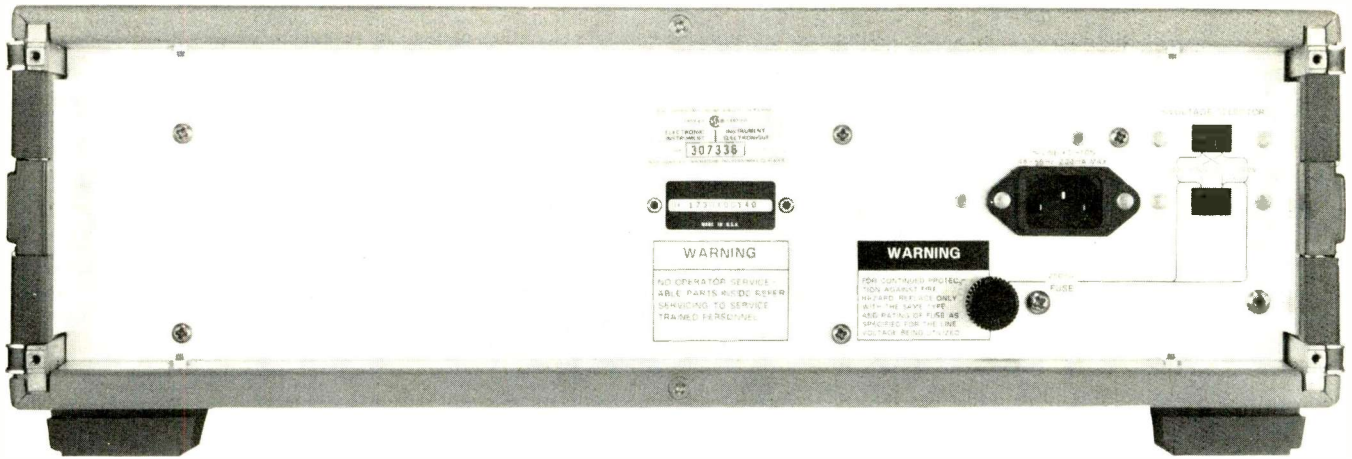
Fig. 1—Residual THD and noise vs. frequency with oscillator output unloaded, 2 V rms output; input range, 3 V full scale; all filters off.

4) oscillator distortion. In practice, the most significant contributors were the induced distortion and the residual noise of the input and analyzer circuits. Use of the low-pass filters will permit lower measurements, but the residual of the 339A is already so low that it is unlikely that many meaningful audio measurements will be limited by the instrument's capabilities.

As a signal source, the 339A oscillator section is one of the very best available. Not only is the distortion exceedingly low, but the output amplitude flatness was found to be much better than the specified +0, -2dB from 10 Hz to 100 kHz. At 100 kHz, most of the "error" is caused by simple capacitive loading on the 600-ohm output of the oscillator. From 20 Hz to 20 kHz this particular unit measured about +0, -0.01dB. Frequency setting accuracy was closer to 1 percent than the specified 2 percent, but it will still be necessary to employ a frequency counter when measurements are to be made of RIAA equalization, without the aid of an accurate pre-equalizer. One particularly noteworthy feature of the oscillator is the very fast amplitude settling at low frequencies. This desirable state of affairs is due to the use of a clever and elegant AGC circuit; it uses a sample/hold to peak detect the instantaneous output amplitude. Incidentally, the oscillator section of the 339A is available separately as the model 239A and sells for \$575.00.

The 339A is certainly to be good choice for production applications requiring a high-performance instrument. The inherently fast oscillator and notch setting, combined with the automatic set level, make this the fastest responding instrument of its type — especially when viewing the monitor output directly. The meter is large and easy to read, but the response of the voltmeter circuits is slower than that of the oscillator and notch under most conditions. This particular situation seems to be stimulated whenever one changes filters or the setting of the function switch, particularly with the analyzer set to one of the low distortion ranges. The usual effect is to send the meter pointer beyond full scale in a brisk and vigorous manner. There is one other problem related to the 400-Hz high-pass filter; it seems that this particular filter is quite susceptible to r.f.-type interference. It was occasionally found to be misbehaving when the input had significant high-frequency information, causing peculiar looking residuals on the monitor output and erroneous meter readings. Since the particular unit tested was such an early model, it is entirely possible that these details have already or will have received the proper attention before this article is published.

Grounding in the 339A is intentionally separated between the oscillator and voltmeter/analyzer circuits by the use of a different, floating power supply for the oscillator. In addition, the input and monitor ground may be floated as much as 30 volts above the chassis and power line safety ground. This



system provides good rejection of undesired low frequency hum and noise. However, the user should be aware that the 339A does still capacitively tie all grounds together. In a small number of cases, a power amplifier may oscillate when connected to the 339A in the usual manner. If this is found to be a problem with any particular amplifier, try tying the oscillator low side to chassis ground externally and not connecting the output ground to the analyzer at all. This distortion analyzer is not suitable for measuring any amplifier in which both outputs swing with respect to ground or for measuring signals on balanced lines which must remain floating. To perform well with these types of sources, the instrument should have true differential inputs. Unfortunately, a true differential input stage would add a considerable expense to the 339A and it would be difficult to maintain the same fine specifications for distortion and noise. (Editor's Note: H-P has a fix, in Service Note 339A-1, if this is a problem. — E. P.)

So far as is known to this reviewer, the 339A is one of only two analyzers to employ a true rms responding converter, as opposed to the common average responding rms calibrated detector. Although average responding meter circuits are calibrated to give the correct indication with sinusoidal inputs, they can be in considerable error with complex waveforms such as might be encountered in a noise or distortion measurement. Depending upon the actual phase and amplitude of a harmonic, the average responding meter can be as much as 20 percent in error from the true value of the waveform. Therefore, it is not surprising to see that one must use true rms detection when making measurements to comply with the IHF standard previously mentioned. Voltmeter frequency response was quite flat out to 100 kHz and then gradually dropped to about -0.8 dB at 200 kHz, and -3.0 dB at 360 kHz, worst case being at the lower input amplitudes.

George Pontis

How to improve your tonearm.

One of the most frequently-asked questions in high fidelity these days is how well a particular tonearm and cartridge work together. Because tonearm/cartridge compatibility is increasingly recognized as vital to accurate record reproduction.

At Micro-Acoustics, we have a unique solution: *the first phono cartridge specifically designed to help any tonearm work at*

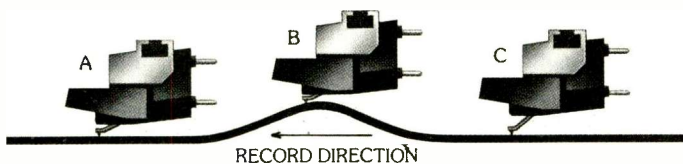


Figure 1. Record warp activates tonearm/cartridge resonance, undesirably reducing and increasing stylus force. (A) Normal position — normal tracking force. (B) Compressed position — increased tracking force. (C) Extended position — decreased tracking force. Record direction is right to left.

its best — whether that tonearm is straight or S-shaped, low- or high-mass, with low to high cable capacity. We call it the 2002-e . . . and it offers significant advantages over conventional cartridge designs.

Tonearm/cartridge resonance: a critical problem

Record warp, present to some degree on nearly every disc you play, causes the cartridge to move up and down about the stylus (see Figure 1). This low-frequency up-and-down oscillation — called *tonearm/cartridge resonance* — can be considerable, since the amplitude of record warp can actually be *twelve to fifty times* that of the loudest musical program material.

When the tonearm/cartridge combination, moves upward

relative to the stylus, the stylus tends to be pulled out of the groove, reducing tracking force to a fraction of the tonearm setting. When this lower tracking force coincides with a loud musical passage, the cartridge mistracks, causing audible distortion and sometimes, groove jumping.

There is a common misconception that tonearm/cartridge resonance can be "matched" out of existence. The fact is, it cannot: it must be *controlled* to allow the cartridge to function properly.

Compromised vs. optimized damping

The most important factor in controlling this tonearm/cartridge oscillation is *damping* — a mechanical counterforce precisely applied to suppress resonance. Because the tonearm must be absolutely free to move, virtually all tonearms are totally undamped devices. *So damping must be supplied by the cartridge.*

In conventional cartridges, damping of tonearm/cartridge resonance must be a compromise. Because it is provided by a *single*, multi-purpose elastic bearing (see Figure 2) which must trade off maximum compliance for tracking ability (less damping) with maximum suppression of high-frequency stylus resonance and tonearm/cartridge low-frequency resonance (more damping).

In contrast to this, Micro-Acoustics' 2002-e (Figure 3) has a sophisticated *multiple* damping system utilizing *eight* specialized

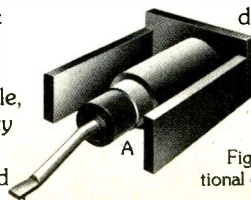


Figure 2. Single multi-purpose elastic bearing (A) on conventional cartridges compromises damping and compliance.

Benjamin B. Bauer, former Vice President and General Manager of the CBS Technology Center, Stamford, Conn., died of a heart attack in Stamford Hospital on Mar. 31 at the age of 65. Perhaps best known for his work on the SQ four-channel sound system, Bauer had been awarded some 75 U.S. patents, with foreign patents bringing the total to more than 100. His first invention, the single-transducer cardioid dynamic microphone, was awarded a patent in 1938, shortly after his graduation from college. The mike's acoustical phase-shift principle is still used almost universally in commercial broadcast and P.A. microphones.

Born in Odessa, Russia, Bauer grew up in Cuba and came to the U.S. in 1930 to study. A graduate of the Pratt Institute and the Univ. of Cincinnati, where he received a degree in electrical engineering, he then joined Shure Bros., where he developed the directional microphone. He joined CBS in 1957, taking charge of the audio tech-



Benjamin B. Bauer

nology development at CBS Laboratories, as the center was then called.

Bauer's long list of achievements included microphones for acoustical measurements, pistonphones, heartbeat measurements, hearing aids, P.A. systems, broadcast, and civilian and military communications; head-

phones and artificial voice and ear devices; loudspeakers and speaker enclosures; vibration measuring instruments; the famous STR series of test records; phonograph pickups; magnetic recording heads and transports; directional hydrophones and hydrophone calibrators, and psychoacoustic research into the measurement of loudness and directionality of hearing in air and underwater.

A Fellow of the Audio Engineering Society, Bauer was also an Honorary Member of the A.E.S. and a past president and had received the A.E.S. Gold Medal Award. He was also a Fellow of the IEEE and of the Acoustical Society of America from which he had received its Silver Medal Award, only the third scientist so honored. In March of this year, he had been made a member of the l'Ordre de Chevalerie de L'Etoile de la Paix, a Vatican-based nondenominational organization founded in 1229 and dedicated to peace.

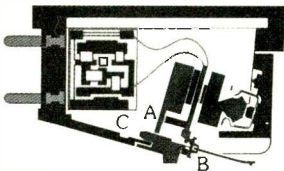


Figure 3. In Micro-Acoustics 2002-e, one pair of dampers — low-frequency warp stabilizers (A) — control tonearm/cartridge resonance. Other dampers optimize other characteristics. Dual bearings (B) provide maximum tracking ability. Microcircuit (C) optimizes cartridge output to any cable capacitance (Only one channel shown.)

dampers. One pair are low-frequency warp stabilizers, specifically designed to control tonearm/cartridge resonance. This is the first effective warp-control system because it suppresses oscillation at the cantilever pivot, rather than ahead of the stylus. The remaining six dampers are optimized for stylus high-frequency damping and other factors, while our exclusive dual-bearing system independently optimizes tracking ability. By designing separate systems for damping and compliance within the 2002-e, we can precisely control tonearm/cartridge resonance without compromising any other aspect of cartridge performance.

High vs. low cartridge body weight

Regardless of the tonearm and damping system utilized, low cartridge body weight increases the tonearm's ability to track warped records. This is because the lower tonearm/cartridge weight allows damping to more effectively counteract tonearm/cartridge resonance. At four grams, (3.3 gm with stylus guard removed) — the lightest weight possible without headshell or counter-

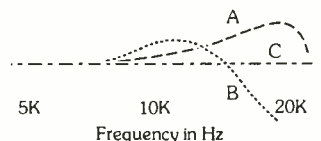


weight modification), the 2002-e yields two or more times the effective damping of many other high-quality cartridges.

Cable capacitance capability

Another important limitation of conventional cartridges is their inter-action with cable capacity, which causes a deterioration in high-frequency response and transient ability (see Figure 4). In contrast to this, the 2002-e has a passive microcircuit which automatically matches the cartridge output to any tonearm's cable capacity, providing linear high-frequency response and transient accuracy.

Figure 4. With conventional cartridges (A), low cable capacity causes response to peak; medium-to-high capacity (B) caused high-frequency response to roll off. Response of 2002-e (C) is unaffected.



Tonearm optimization made easy

If there were no such thing as tonearm/cartridge resonance or cable capacity, any cartridge would match any tonearm. But in the real world, where these problems exist, the only way to get optimum performance from your tonearm is the Micro-Acoustics 2002-e. Or our other direct-coupled cartridges: the moderately-priced 282-e and top-of-the-line 530-mp. All of them offer advantages you can hear today. Starting with less than 1/2% FIM distortion (DIN 45 542) — the best!

Micro-Acoustics Corporation, 8 Westchester Plaza, Elmsford, NY 10523. 914-592-7627. In Canada, H. Roy Gray, Ltd., Markham, Ontario.

ma
Micro-Acoustics
Because good tracking isn't enough.™

Car Speaker Installation

TIPS FROM A PRO

Installing a stereo system, particularly the radio section, in your own car is a reasonable job if you have ever built an electronic kit or a home-brew speaker system. The tricky part is installing the speakers or replacing the factory drivers with new custom units. This calls for some special tools and quite a few special techniques to do the best job.

So you can see how some of these operations are performed, we went to A-1 Auto Stereo Center, on Boston Rd. in The Bronx, where we had a custom three-driver system installed in a Datsun 230Z. The "Z" is a fairly tricky car, what with its tight quarters and console, but the techniques A-1 used made the finished job look better — not to mention sound better — than factory.

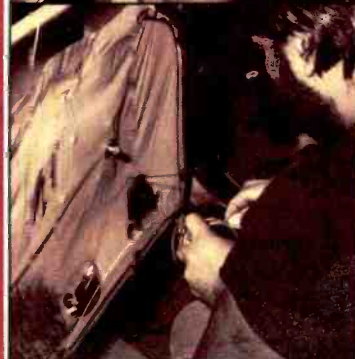
They say that one picture is worth a thousand words, so . . .



Installation in a console is much easier if the console is removed from the car. This unit is from a Datsun 230Z and also carries the super tweeters. Note the antenna switch at the left of the radio.



Removing the door panel on a U.S. car requires a special tool, sold at auto supply houses, to pull the C-clips holding door and window handles. Here the installer is using a template to mark the hole for the speaker assembly. He will later cut into the metal with a power nibbler.



The speaker leads have been fished through the hole from the front of the car using a stiff piece of wire and are now being attached to the speaker, just before mounting to the door frame.



A template for the door speaker grille is used to mark the outline of the hole over the door speaker.



A utility knife, or any good sharp cutter, is used to cut through the door material. Sharpness helps produce a smooth edge.



The grille is fastened in place using tabs.



Templates for bass speakers sometimes come with drivers, but can be made. In any case, they should be checked before any cutting is done. Note hole locations.

Here the installer is replacing a 4-in. round unit with a 6 x 9-in. oval driver. Note that the hole locations are all on the upper surface of the metal, in a single plane.

Be careful to keep the template in one position during transfer.

The nibbled hole before drilling the holes for the securing screws.

This driver is being installed from behind the panel; inside or out largely depends on clearances. This hole will need further smoothing.



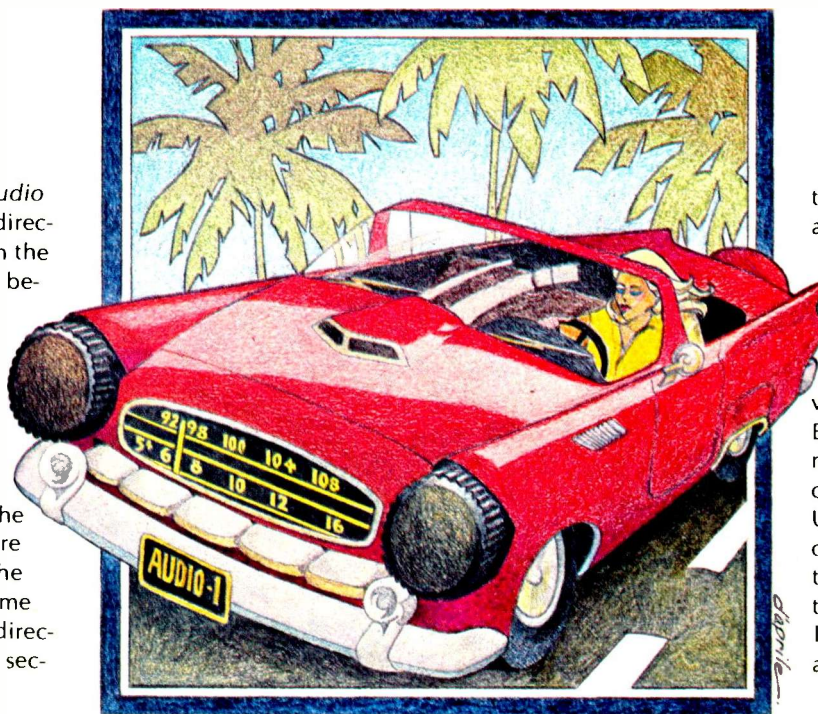
After checking clearance behind the panel of the console, the installer uses a compass to mark the proper size circle for cutting. Make too small a hole, rather than one too large, because this installation is critical.

A heavy-duty soldering gun with a line-cam-cutting tip is used to cut the soft plastic of the console. Bracing your hands or moving the console to various positions helps achieve a smooth cut.

Center the driver in the hole and confirm clearance before final installation of screws.

CAR STEREO DIRECTORY

Five years ago, *Audio* presented the first directory of car stereos in the industry. We did so because commuters, sales reps, and van people often spend more time listening to music while on the road than they do in their homes. Also, the best car systems were then approaching the quality found in home stereos. This year's directory contains a new sec-



tion on equalizers and amplifiers, reflecting further advances in the equipment available. All information, it should be noted, has been supplied by the various manufacturers. Every effort has been made to contact the companies in this field. Unfortunately, a number of firms did not return their questionnaires prior to our deadline date. Directory addenda will appear in a future issue.

MANUFACTURERS

AAL
629 West Cermak Rd.
Chicago, Ill. 60616

ADS
One Progress Way
Wilmington, Mass. 01887

AFS/Kriket
Acoustic Fiber Sound Systems
P.O. Box 50829
Indianapolis, Ind. 46250

Advent
195 Albany St.
Cambridge, Mass. 02139

Audiotex
GC Electronics
400 South Wyman St.
Rockford, Ill. 61101

Audiovox
150 Marcus Blvd.
Hauppauge, N.Y. 11787

Cobra
Dynascan Corp.
6460 West Cortland Ave.
Chicago, Ill. 60635

Dahlquist
601 Old Willett's Path
Hauppauge, N.Y. 11787

EPI
1 Charles St.
Newburyport, Mass.
01950

Electronic Industries
217 East 171st St.
P.O. Box 615
Harvey, Ill. 60426

Fosgate Electronics
2923 North 33rd Ave.
Phoenix, Ariz. 85017

Arthur Fulmer/Fultron
260 Monroe Ave.
Memphis, Tenn. 38103

Hanabashiya Ltd.
39 West 28th St.
New York, N.Y. 10001

Herald Electronics
6611 North Lincoln Ave.
Lincolnwood, Ill. 60645

Infinity Systems
7930 Deering Ave.
Canoga Park, Calif. 91304

Intervox
105 Maxess Rd.
Melville, N.Y. 11747

Jensen Sound Laboratories
4136 North United Pkwy.
Schiller Park, Ill. 60176

Jet Sound Labs
Car Tapes Inc.
1000 East Del Amo Blvd.
Carson, Calif. 90746

LTL Electronics
106 11th St., S.E.
Auburn, Wash. 98002

Linear Power
8115 Berg St.
Roseville, Calif. 95678

Mastersound
SIE
15 West 24th St.
New York, N.Y. 10010

Matrecs Industries
805 Woodman Ave.
Winslow, Ill. 61089

Misco
3806 Grand Ave. South
Minneapolis, Minn.
55409

Mitsubishi
7045 No. Ridgeway Av.
Lincolnwood, Ill. 60645

Motorola
1299 East Algonquin Rd.
Schaumburg, Ill. 60196

Muntz Hi Z, Inc.
180 Shipley St.
San Francisco, Calif.
94107

Orovox Sound
11545 Tuxford St.
Sun Valley, Calif. 91352

PSB Speakers
P.O. Box 144
St. Jacobs, Ontario
Canada N0B 2N0

Panasonic
One Panasonic Way
Secaucus, N.J. 07094

Polk Audio
1205 South Carey St.
Baltimore, Md. 21230

Polydax Speaker Corp.
2 Park Ave.
New York, N.Y. 10016

Pyramid Industries
12970 Branford St.
Arleta/Los Angeles,
Calif. 91331

Quam-Nichols Co.
Marquette & Prairie
Chicago, Ill. 60637

Radio Shack
1400 One Tandy Center
Fort Worth, Tex. 76102

Road Sounds
425 7th St., N.W.
Washington, D.C. 20004

Roadstar
5312 Production Drive
Huntington Beach, Calif.
92649

Royal Sound
248 Buffalo Ave.
Freeport, N.Y. 11520

Sharp Electronics Corp.
P.O. Box 588
10 Keystone Place
Paramus, N.J. 07652

Shmegg Electronics
8115 Berg St.
Roseville, Calif. 95678

Sparkomatic
Polydax Speaker Corp.
2 Park Ave.
New York, N.Y. 10016

Speco Components Specialties, Inc.
P.O. Box 624
1172 Route 109
Lindenhurst, N.Y. 11757

TEI Electronic Products
P.O. Box 246
Hialeah, Fla. 33011

Trusonic
10530 Lawson River Ave.
Fountain Valley, Calif.
92708

Ultralinear Loudspeakers
3228 East 50th St.
Los Angeles, Calif. 90058

Visonik
1177 65th St.
Oakland, Calif. 94608

THERE ARE FASTER WAYS TO BUILD SEPARATES, BUT THEY WOULDN'T HAVE NIKKO'S ONE-OF-A-KIND EXCELLENCE.



Once is not enough for Nikko.

That's why we go one step beyond the inspection and quality control procedures of most manufacturers. Nikko's "200% Quality Control" program takes more time. But we know that once you buy a Nikko preamp, amp or tuner you're going to enjoy it for a long time. And you can be confident you will because we continuously monitor every unit as it moves along each station of our production line. Then we thoroughly inspect each and every unit a second time before it's shipped to your Nikko dealer. It's Nikko's way to make sure you always get the accuracy, dependability and outstanding performance that we build in. And that's what you get with these new separates.

Alpha III MOS-FET DC Power Amplifier

The Alpha III uses two separate power supplies, each with its own transformer. Its direct-coupled DC amplifier lets nothing come between you and the music since there are no input or output capacitors in the circuit. By combining this design with two pairs of DC power



MOS-FETs, there's rock-solid stability. The Alpha III delivers 80 watts per channel, minimum RMS, at 8 ohms, from 20 to 20,000 Hz, with no more than 0.008% total harmonic distortion. And you can monitor power output with fast, accurate multi-LED indicators.

Beta III Stereo Preamplifier

From its direct-coupled phono input to its high-speed circuitry and top performance specifications, the slim-line Beta III is the perfect control center. Complete versatility is provided to accommodate the impedance characteristics of different phono cartridges. There's also the convenience of two-way tape dubbing and switch-selectable low and subsonic filters. The combination of high sensitivity, flat frequency response and wide dynamic range coupled with low noise and distortion makes the Beta III a professional performer you can enjoy at home.



Gamma V Synthesized FM Stereo Digital Tuner

FM stations a hairline away from each other pose no challenge for the Gamma V

Whether you tune manually or automatically, its digital synthesized tuning circuit pinpoints and locks in the signal. You can even program the unit to memorize and store up to six stations automatically by the push of a button. LED indicators show signal strength and stereo operation. With switching for high blend, IF band (wide or narrow), stereo/mono and adjustable muting, plus exceptional specifications, the Gamma V is everything you'd ever want in an FM tuner.



So if you want to get the best sound from records, tapes and FM broadcasts, you want Nikko separates. We build them as though they're one of a kind; because we refuse to compromise a standard of excellence abandoned by many for the sake of expediency.

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 Raymer St., Van Nuys, Calif. 91406 (213)
 988-0105/320 Oser Ave., Hauppauge,
 N.Y. 11787 (516) 231-8181/Canada:
 Superior Electronics, Inc.

Nikko Audio

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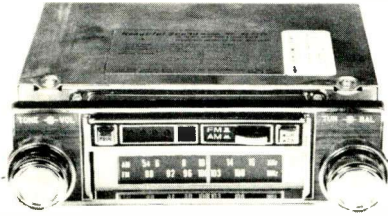
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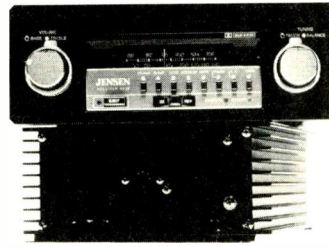
CAR STEREO DIRECTORY

RADIOS/TAPE PLAYERS

Mastersound 5300



Jensen R430



Jet Sound Labs JS-8250



Model	Price	Stores (S) Mono (M) or 4-channel (O2)	FM Sensitivity, mV (for 30-dB quieting)	Selectivity	Average Watts/channel, at rated distortion	% Distortion @ rated	Local/Distance Switch	Pushbuttons if Yes, Number AM, Number FM	Separate Bass Control	Separate Treble Control	Cassette	8-Track	Auto Reverse	Fast Forward	Tape Rewind	In-Dash (I) or Under-Dash (U)	Dimensions, inches, H x W x D	
Cobra	95GTL	139.95	S	1.9		12		Yes	5 FM, 5 AM	No	No	No	Yes	No	No	No	I	2 1/4 x 7 1/4 x 6 1/4
	97GTL	149.95	S	1.9		12		Yes	5 FM, 5 AM	No	No	Yes	No	No	Yes	No	I	2 1/4 x 7 1/4 x 6 1/4
	98GTL	189.95	S	1.9		12		Yes	5 FM, 5 AM	No	No	No	Yes	No	No	No	I	2 1/4 x 7 1/4 x 6 1/4
	99GTL	199.95	S	1.9		12		Yes	5 FM, 5 AM	No	No	Yes	No	No	Yes	No	I	2 1/4 x 7 1/4 x 6 1/4
Arthur Fulmer	16-2200	39.95	M		30	3.5	10	No	5 AM			No	No	No	No	No	I	1 1/2 x 6 1/4 x 3 3/4
	16-2400	49.95	M		30	5.0	10	No	5 AM			No	No	No	No	No	I	2 1/4 x 7 1/4 x 5
	16-3200	69.95	M	5	34	4.0	10	No	5 AM			No	No	No	No	No	I	2 x 6 1/2 x 4 1/2
	16-3400	119.95	M	5	34	5.0	10	Yes	5 AM or FM			No	No	No	No	No	I	2 1/2 x 7 3/4 x 5
	16-4200	99.95	S	5	30	4.0	10	No	5 AM or FM			No	No	No	No	No	I	2 x 6 1/2 x 4 1/2
	16-4505/15	149.95	S	5	44	5.0	10	Yes	5 AM or FM			No	No	No	No	No	I	2 1/2 x 7 3/4 x 5
	16-5000	109.95	S	5	36	5.0	10	Yes				Yes	No	No	Yes	No	I	1 1/2 x 6 1/4 x 4 3/4
	16-5100	179.95	S	5	30	5.0	10	Yes				Yes	No	Yes	Yes	Yes	I	1 1/2 x 6 1/4 x 4 3/4
	16-5300	99.95	S	5	36	5.0	10	Yes				No	Yes	No	No	No	I	1 1/2 x 6 1/4 x 4 3/4
	16-5400	129.95	S	5	36	6.0	10	Yes				No	Yes	No	No	No	I	1 1/2 x 7 x 4 3/4
	16-6100	199.95	S	5	36	5.0	10	Yes	5 AM or FM			Yes	No	No	Yes	No	I	7 x 2 1/2 x 5 1/4
	16-6300	189.95	S	5	36	5.0	10	Yes	5 AM or FM			No	Yes	No	No	No	I	7 x 2 1/2 x 5 1/2
	16-6500/15	229.95	S	5	36	5	10	Yes	5 AM or FM			No	Yes	No	No	No	I	2 1/2 x 7 x 6
	16-6600	269.95	S	5	36	5	10	Yes	5 AM or FM			Yes	No	No	Yes	Yes	I	7 1/2 x 2 1/2 x 5 1/2
	16-6800	499.95	S	5	40	14	10	Yes	7 AM, 7 FM			Yes	No	Yes	Yes	Yes	I	7 x 2 1/4 x 5 1/4
16-8400	399.95	S	5	40	3	10	Yes	5 AM or FM			No	No	No	No	No	I	2 1/2 x 7 x 6	
16-8600	499.95	S	5	40	4	10	Yes	5 AM or FM			No	Yes	No	No	No	I	2 1/2 x 7 x 7	
Hanabashiya	006		S	20	50	5		yes			yes	yes	no	yes	no	I	4 x 6 1/2 x 7 1/2	
	302AF		S	20	50	5		yes			yes	yes	no	yes	no	I	2 x 4 1/2 x 7	
	H999		S	20	50	5		yes			yes	yes	no	no	no	I	2 x 4 1/2 x 7	
	103		S	20	50	5		yes			yes	yes	no	no	no	I	2 x 6 x 7	
Jensen	R410	299.95	S	1.0	60	4	1.0	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	2.7 x 7 x 6.0
	R420	369.95	S	1.0	60	15	1.0	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	2.7 x 7 x 6.0
	R430	469.95	S	1.0	60	26	0.4	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	2.7 x 7 x 6.0
	R310	239.95	S	1.0	60	4	1.0	Yes	No	Yes	Yes	No	Yes	No	Yes	No	I	Power Amp.: 2.6 x 6.2 x 6.5
	R320	299.95	S	1.0	60	15	1.0	Yes	No	Yes	Yes	No	Yes	No	Yes	No	I	2.7 x 7 x 6.0
	R330	399.95	S	1.0	60	26	0.4	Yes	No	Yes	Yes	No	Yes	No	Yes	No	I	2.7 x 7 x 6.0
Jet Sound Labs	JS-8100	399.95	S	1.5	70	8	1.0	Yes		No	No	Yes	No	Yes	Yes	Yes	I	1 1/2 x 7 x 5
	JS-8200	499.95	S	1.5	70	15	1.0	Yes	5FM, 5AM	No	Yes	Yes	No	Yes	Yes	Yes	I	2 1/4 x 7 x 4 1/4
	JS-8580	199.95	S	4.0	65	5	1.0	Yes	5FM, 5AM, 5FM, 5AM	No	No	No	Yes	No	No	No	I	2 x 5 1/2 x 4 1/4
	JS-9380	199.95	S	4.0	65	5	1.0	Yes		No	No	Yes	No	No	Yes	No	I	2 x 5 1/2 x 4 1/4
	JS-8001	179.95	S	2.5	70	8	1.0	Yes		No	No	Yes	No	Yes	Yes	Yes	I	2 x 7 x 6 1/4
	JS-8250	109.95	S	4.0	67	8	1.0	Yes		No	No	No	Yes	No	No	No	I	1 1/2 x 7 x 4 1/4
	JS-9200	189.95	S	4.5	70	8	1.0	Yes		No	No	Yes	No	Yes	Yes	Yes	I	2 x 7 x 6
	JS-9350	109.95	S	4.0	67	8	1.0	Yes		No	No	Yes	No	No	Yes	No	I	1 1/2 x 6 1/4 x 4 3/4
	JS-9600	219.95	S	3.0	70	8	1.0	Yes	5FM, 5AM	No	No	Yes	No	Yes	Yes	Yes	I	2 1/2 x 6 1/4 x 6 1/4
Continued																		

LUX



A FUNCTION OF CONSTANT ATTENTION TO INFINITE DETAIL

For those who consider adequacy enough, there are many manufacturers able to meet that audio standard. Superiority, however, is another story.

Superiority demands imagination translated into production. It requires thorough dedication to quality without compromise. And most of all, it takes constant attention to infinite detail.

These are the factors that have made Lux audio systems recognizably superior to the select group appreciating such detail and willing to pay the price.

The Lux K-12 Stereo Cassette Deck reflects Lux's focus on perfection with a number of new and exclusive features devoted to producing the ultimate in audio fidelity and user convenience.

The first of these is "real-time processing," a standard set by computer manufacturers to eliminate the most minimal time lag in dealing with electronic signals during record or playback.

Because any meter is too slow to match real-time processing, Lux provides their Plasma Peak Indicator with peak hold function for instantaneous response to signals by means of a fluorescent tube display scaled in dB for each channel. You can see real-time processing in action.

Dual DC Amplification

As a pioneer in the development of DC amplifiers, Lux refuses to compromise and introduces the K-12, the first cassette deck with two DC amplifiers, one for recording and the other for playback.

Manufacturers—even of expensive equipment—are satisfied with mixed amplification systems, one AC amplifier and one DC amplifier. Most decks available are AC amplifiers only.

Minutes and Seconds

Still another exclusive when used with Lux's unique

cassette tape, featuring SKEW adjustment for optimum tape to head and wide pad and holding mechanism for stable frequency response, is the ultimate precision found in the Electronic Digital Tape Counter. Lux engineers designed and built an electronic counter working off a specially designed tape motion sensor. As you record or playback, this elapsed time is shown on a 4-digit LED display in terms of minutes and seconds.

Dedicated to Superiority

Lux's K-12 pure sendust alloy heads are capable of handling any tape, including the new metal particle tapes.

Dual drive motors are part of the tape transport system, with one motor driving the capstan and another the reel. Thus, torque vibration is virtually eliminated and back tension is always maintained at the optimum.

In addition, with IC logic circuitry, the slightest touch on human engineered controls fulfills your commands... instantaneously.

Additional features include Dolby* NR system, recording mute device, mike mixing circuit, separate 3-way bias and equalization and just about everything you would want or expect—on audio equipment bearing the Lux name.

Specifications are among the best available...

Frequency Response of 30-20,000Hz \pm 3dB (metal tape), S/N ratio better than 69dB (Dolby on, metal tape) and Wow & Flutter no more than 0.04% (WRMS). But, in the final analysis, your own hearing has to be the judge.

See the K-12 and test the unique cassette tape at your Lux dealer. Try it... hear it... and focus on perfection as only Lux can provide.



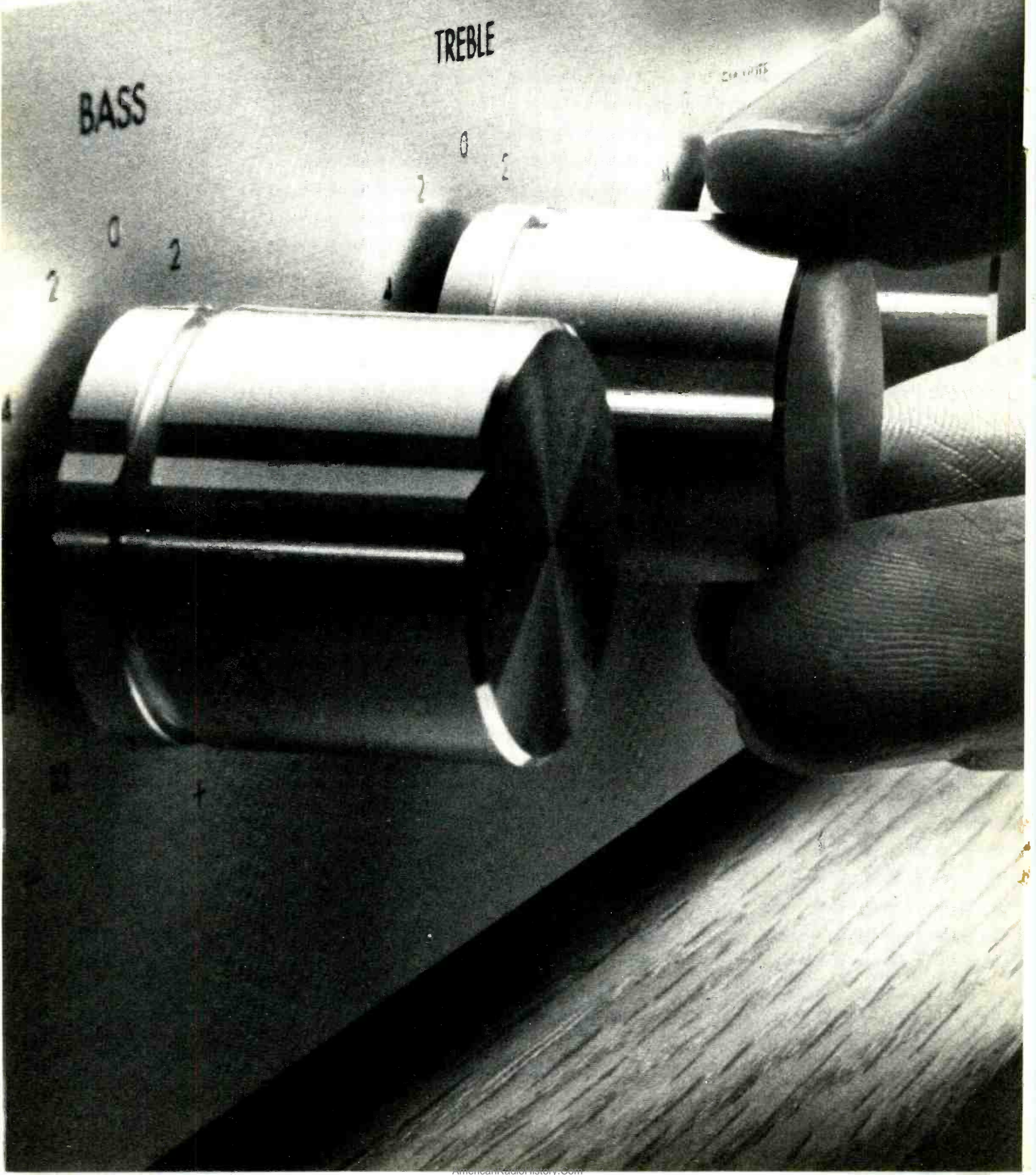
*Dolby is a trademark of Dolby Laboratories, Inc.

LUX AUDIO OF AMERICA, LTD.

160 Dupont Street Plainview, NY 11803

In Canada: LUX AUDIO OF CANADA, LTD., Scarborough, Ontario

**Bass and treble used to be
all the tone control you wanted.**



Now you're ready for S.E.A., the outboard equalization system built into our best receivers.

Controlling tone with just two knobs is like trying to play Chopin on a pair of bongo drums.

That's why we invented our S.E.A. graphic equalizer. It lets you compensate for room acoustics, differences in phono cartridges, FM frequency response, cassette tape roll-off or less-than-perfect speakers. You can bring a vocal right out into your living room, boost low bass or send a strident guitar part packing.

Now while we sell a lot of outboard S.E.A.'s, we know the best place for a good equalizer is next to a great receiver. That's why we built a 5-band S.E.A. into our JR-S201, 301, 401, and 501 integrated receivers.

All four boast DC power amp sections, phase linear ceramic IF filters, FM muting and twin tuning meters, dual tape inputs and speaker outputs, subsonic filters, LED source indicators and the unique knobless styling that makes them look as distinctive as they sound.

All put out rated power at less than 0.03% THD through a patented Triple Power Protection Circuit that guards amp and speakers from on/off shocks, shorts and DC surges.

And of course all four receivers have the S.E.A. Record circuit that lets you equalize your favorite S.E.A. settings onto a tape while

recording it, and make dynamite tapes for your car stereo, too.

Our three largest models include dual power meters; our two top receivers feature a pilot signal canceller built into their Phase-Locked FM IC circuitry that gives you 45dB stereo channel separation all the way from 50Hz to 10kHz.

So when you're out pricing receivers, ask the salesman why some status brands cost twice as much as JVC, but still have only two imprecise tone controls. And why JVC stacks up feature-for-feature and watts-per-dollar against many other receivers that don't have a built-in 5-band graphic equalizer.

For the name of your nearest JVC dealer, call 800-221-7502 toll-free (in NY State call 212-476-8300). Or write to US JVC Corp., 58-75 Queens Midtown Expressway, Maspeth, NY 11378.

JR-S501 (shown) 120 watts RMS/chan, both chan, driven into 8 ohms, 20-20kHz with no more than 0.03% THD. JR-S401 85 watts RMS/chan, both chan, driven into 8 ohms, 20-20kHz with no more than 0.03% THD. JR-S301 60watts RMS/chan, both chan, driven into 8 ohms, 20-20kHz with no more than 0.03% THD. JR-S201 (shown) 35 watts RMS/chan, both chan, driven into 8 ohms 20-20kHz with no more than 0.03% THD. Built-in S.E.A. provides ± 12 dB equalization at 40Hz, 250Hz, 1kHz, 8kHz and 15kHz. (Also shown) SEA 80 full octave outboard equalizer with ten-band realtime frequency spectrum analyzer and built-in pink noise generator.



Now you're ready for JVC.

Enter No. 11 on Reader Service Card

THE LUMBER-CORE BAFFLE BOARD: REDUCES SPEAKER DISTORTION.

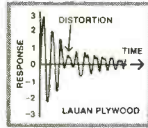
The baffle board in any speaker system is what transfers the acoustic energy (sound waves) to the air and to your ears.

In fact, it's the most critical part of cabinet construction. Like the sounding board in a grand piano, the wood used in a speaker can seriously affect the way music sounds.

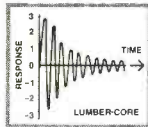
To get the music sounding best, Kenwood laminates five layers of wood around a Shina lumber-core. The result is a very rigid baffle board that produces no vibration of its own to interfere with the music. That means less speaker distortion.

You'll hear the difference as music that sounds more *accurate*. With a solid, tight bass. A midrange without coloration. And high frequencies that are crisp and clear right up to the highest violin overtones.

That's because every part of every Kenwood LS-Series B speaker is designed from scratch—from the composition of the rigid, lightweight



Typical response of damped acoustical radiation using plywood baffle board.



Typical response of damped acoustical radiation using Kenwood lumber-core baffle board.

speaker cones, to the unitized tweeter construction, to the exclusive lumber-core baffle board.

Since speaker systems are the most personal of any high fidelity component, you should really hear them for yourself. Your Kenwood dealer has a complete line of LS-Series B speakers to match your specific listening requirements.

After all, if you want your speaker's *performance* to be as good as your receiver's, choose the speaker with a *reputation* as good as your receiver's.

LUMBER-CORE BAFFLE BOARD

Hear the future of high fidelity.



KENWOOD®

For the dealer nearest you, see your Yellow Pages, or write Kenwood, P.O. Box 6213, Carson, CA 90749. In Canada: Magnasonic Canada, Ltd.



CAR STEREO DIRECTORY

RADIOS/TAPE PLAYERS



Roadstar RS-3000DU



Sparkomatic SR-3400

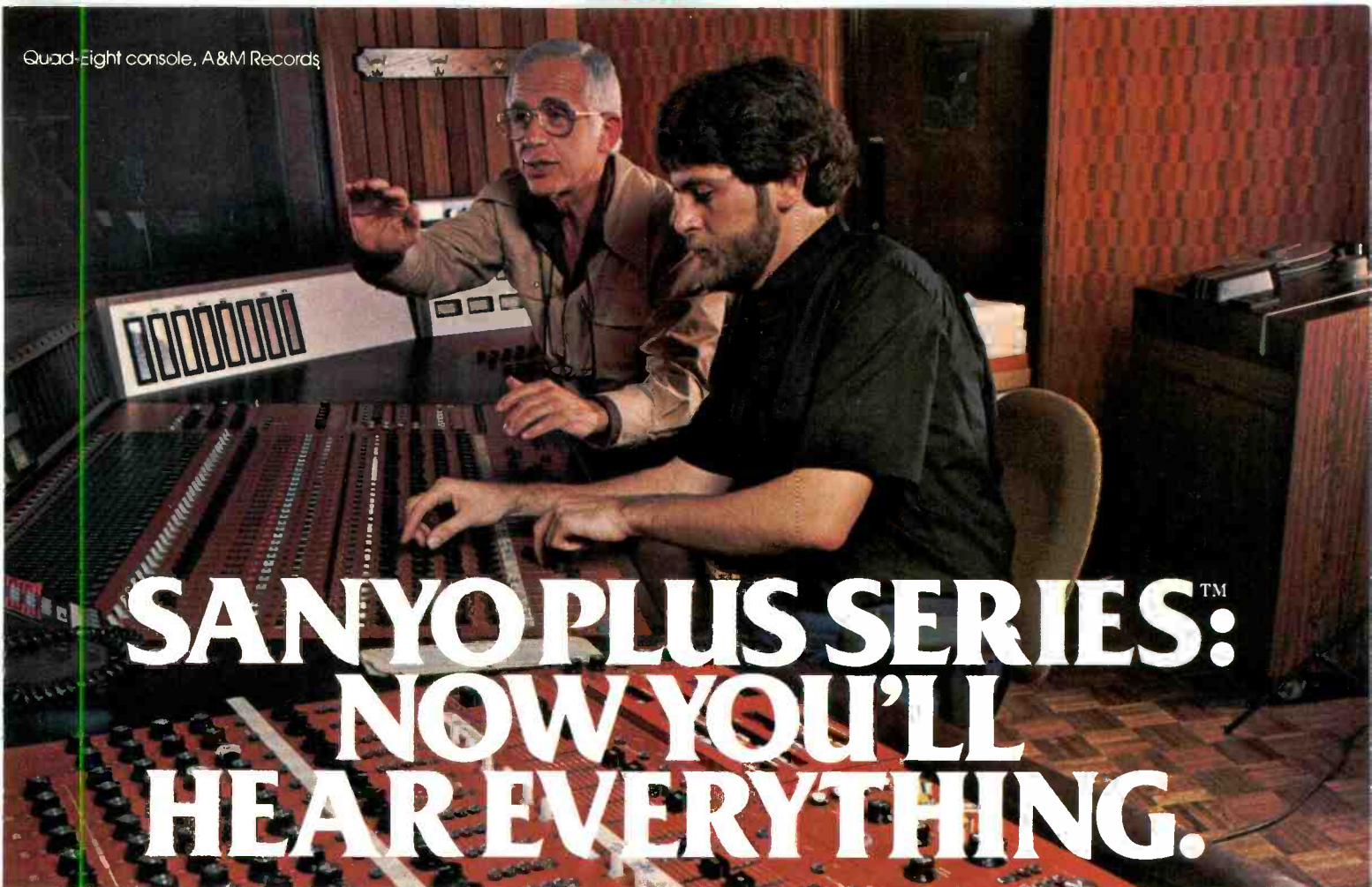


Royal Sound RS2010N



Sharp RG5252

MANUFACTURER	Model	Price	Stereo (S), Mono (M), or 2-channel (C)	FM Sensitivity, μ V (for 30dB quieting)	Selectivity	Average Watts/channel, at rated Distortion	% Distortion @ rated watts	Local/Distance Switch	Pushbuttons H Yes, N No	Separate Bass Control	Separate Treble Control	Cassette	8-Track	Auto Reverse	Fast Forward	Tape Rewind	In-Dash (I) or Under-Dash (U)	Dimensions, inches, H x W x D	
Panasonic (Continued)	CX-7200	139.95	S			4.2	5.0					Yes	No	Yes	Yes	Yes	U	1 7/8 x 7 1/2 x 5 1/2	
	CX-5200	99.95	S			4.2	5.0					No	No	Yes	Yes	Yes	U	1 7/8 x 7 1/2 x 5 1/2	
	CX-1200	79.95	S			4.2	5.0					No	No	No	No	No	U	1 7/8 x 7 1/2 x 5 1/2	
	CQ-8530	499.95	S			7	1.0		Yes	6 FM, 6 AM	Yes	Yes	Yes	No	Yes	Yes	I	2 1/4 x 7 1/2 x 6 5/8	
	Tuner								Yes	5	Yes	Yes	Yes	No	Yes	Yes	I	2 3/4 x 7 1/2 x 6 1/4	
	CQ-6520	239.95	S			7	1.0		Yes	5	Yes	Yes	No	Yes	No	No	I	2 3/4 x 7 1/2 x 6 1/4	
	CQ-2520	229.95	S		30	4	5.0		Yes	5	Yes	No	Yes	No	Yes	Yes	I	2 x 7 x 5 1/2	
	CQ-6600	239.95	S		30	4	5.0		Yes	5	No	No	No	Yes	No	No	I	2 x 7 x 5 1/2	
	CQ-4600	239.95	S		35	4	3.75	5.0	Yes		No	No	Yes	No	No	Yes	Yes	I	1 7/8 x 7 x 5 1/2
	CQ-6800	149.95	S		28	4	4.25	5.0	Yes		No	No	No	Yes	No	No	I	2 x 7 1/4 x 4 1/2	
	CQ-2800	139.95	S		20	20	4.8		Yes	3 FM, 2 AM	No	No	Yes	No	No	Yes	Yes	I	2 x 7 x 5 1/2
	CQ-5500			S															
	Radio Shack	12-1810	99.95	S			12	10.0			Yes	Yes	No	Yes	No	No	U	2 3/8 x 6 1/2 x 7 1/2	
12-1809		99.95	S			12	10.0		Yes	Yes	Yes	No	No	Yes	Yes	U	1 1/2 x 6 1/2 x 7		
12-1801		42.95	S			4	10.0		No	No	Yes	No	Yes	No	No	U	2 1/2 x 4 3/4 x 6 5/8		
12-1802		59.95	S			4	10.0		No	No	Yes	No	No	No	No	U	1 7/8 x 4 3/4 x 6 5/8		
12-1816		49.95	S			4	10.0		No	No	Yes	No	Yes	No	Yes	U	2 1/2 x 6 1/2 x 6 1/2		
12-1812		69.95	S			4	10.0		No	No	Yes	No	Yes	Yes	Yes	U	1 7/8 x 6 1/2 x 6 1/2		
12-1886		179.95	S	3	50	12	10.0		Yes	No	Yes	Yes	Yes	No	Yes	Yes	I/U	7 x 2 3/8 x 6 1/4	
12-1887		179.95	S	3	50	12	10.0		Yes	No	Yes	Yes	Yes	No	Yes	Yes	I/U	7 x 2 3/8 x 6 1/4	
12-1884	99.95	S	2	50	4	10.0		Yes	No	No	No	Yes	No	Yes	Yes	I/U	7 x 2 x 6		
12-1885	99.95	S	3	50	4	10.0		Yes	No	No	No	Yes	No	Yes	Yes	I/U	6 5/8 x 2 x 5 5/8		
Roadstar	RS-3810U	349.95	S	1.0	20	1	yes		yes	yes	yes	no	no	yes	yes	I	1 3/4 x 7 x 5		
	RS-3210U	539.95	S	1.5	5	3	yes		no	no	yes	no	yes	yes	yes	I	1 3/4 x 7 x 5		
	RS-3300U	419.95	S	1.5	5	3	yes		no	no	yes	no	yes	yes	yes	I	1 3/4 x 7 x 5		
	RS-3000DU	389.95	S	1.5	5	3	yes		no	no	yes	no	yes	yes	no	I	2 x 7 x 4 1/2		
	RS-2300U	299.95	S	2	5	3	yes		no	no	yes	no	yes	no	no	I	2 x 7 x 5		
Royal Sound	RS2010N	200.00	S	2	50	4	1.0	No	No	No	Yes	No	No	Yes	No	I	1 3/4 x 7 x 5		
	RS2510	400.00	S	1.4	60	10	0.9	No	No	Yes	Yes	No	Yes	Yes	Yes	I	1 3/4 x 7 x 5 1/2		
	RS3110	600.00	S	2	50	6	1.0	No	No	No	Yes	No	Yes	Yes	Yes	I	2 x 7 x 6 1/4		
Sharp	RG3550	219.95	S	8	8	8	10.0	yes	no	no	no	yes	no	no	yes	no	I	2 x 7 1/2 x 5 1/2	
	RG3400	189.95	S	8	8	8	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 7 1/2 x 5 1/2	
	RG3200	169.95	S	8	8	8	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 7 1/2 x 5 1/2	
	RG5252		S	8	7	7	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 6 1/2 x 6 1/4	
	RG5702		S	8	7	7	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 6 1/2 x 6 1/4	
	RG52		S	8	7	7	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 6 1/2 x 6 1/4	
				S	8	7	7	10.0	yes	no	no	no	yes	no	yes	yes	no	I	2 x 6 1/2 x 6 1/4
Sparkomatic	SS-100	29.95	S			2.5	1						Yes	Yes			U	5 1/2 x 2 1/4 x 7 3/4	
	SS-200	29.95	S			2.5	1										U	4 1/4 x 1 3/4 x 6	
	SR-100	29.95	M			2	10										I	6 1/4 x 2 x 4 3/8	
	SR-110	39.95	M			2	10										I	6 1/4 x 1 3/4 x 3 3/8	
	SR-120	79.95	S	8	50	4	1	Yes		5 AM 3 FM, 2 AM							I	7 x 1 1/4 x 3 3/8	
	SR-200	89.95	S	8	50	4	10	Yes				No	Yes				I	7 x 1 1/4 x 4	
	SR-201	119.95	S	7	55	4	1	Yes				No	Yes				I	6 1/4 x 1 3/4 x 4 1/4	
	SR-300	89.95	S	8	50	4	10	Yes				Yes	No	Yes			I	7 x 1 3/4 x 4	
	SR-301	119.95	S	7	55	4	1	Yes				Yes	No	Yes	Yes		I	6 1/4 x 1 3/4 x 4 1/4	
	SR-210	179.95	S	1	60	5	1	Yes	Yes	Yes	Yes	No	Yes				I	Separate Bass and Fader 7 x 1 3/4 x 5 1/2	
	SR-240	239.95	S	1	60	5	1	Yes	Yes	Yes	Yes	No	Yes				I	7 x 1 3/4 x 5 1/2	
	SR-310	189.95	S	1	60	5	1	Yes	Yes	Yes	Yes	No	Yes				I	7 x 1 3/4 x 5 1/2	
	SR-330	229.95	S	1	60	5	1	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes		I	7 x 1 3/4 x 5 1/2	
	SR-340	259.95	S	1	60	5	1	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes		I	7 x 1 3/4 x 5 1/2	
	SR-202	125.00	S	7	50	4	1	Yes		5 FM or AM 5 FM or AM			No	Yes			I	6 1/4 x 1 3/4 x 4 1/4	
	SR-302	125.00	S	7	50	4	1	Yes				Yes	No	Yes			I	6 1/4 x 1 3/4 x 4 1/4	
	SR-2100	219.95	S	1	60	20	1	Yes	Yes	Yes	Yes	No	Yes				I	7 x 1 3/4 x 5 1/2	
SR-2400	269.95	S	1	60	20	1	Yes	Yes	Yes	Yes	No	Yes				I	7 x 1 3/4 x 5 1/2		
SR-3100	229.95	S	1	60	20	1	Yes	Yes	Yes	Yes	No	Yes		Yes	Yes	I	7 x 1 3/4 x 5 1/2		
SR-3300	259.95	S	1	60	20	1	Yes	Yes	Yes	Yes	No	Yes		Yes	Yes	I	7 x 1 3/4 x 5 1/2		
SR-3400	299.95	S	1	60	20	1	Yes	Yes	Yes	Yes	No	Yes		Yes	Yes	I	7 x 1 3/4 x 5 1/2		



SANYO PLUS SERIES:TM NOW YOU'LL HEAR EVERYTHING.

Today's studio technology is putting sounds on record that most home stereos simply can't cope with.

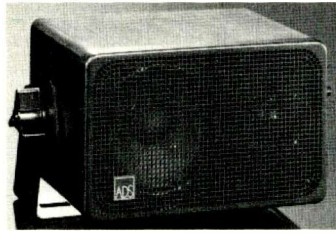
So instead of hearing everything the way it went down at the recording session, you miss the subtle nuances that make the music come to life.

The refined technology of Sanyo PLUS SERIES components lets you hear every

detail captured in your recordings — without perceptible noise, distortion, or coloration to spoil the sensation of living, breathing music.

Hear the gloriously true-to-life sound of Sanyo soon at better audio dealers.





ADS 200C/II



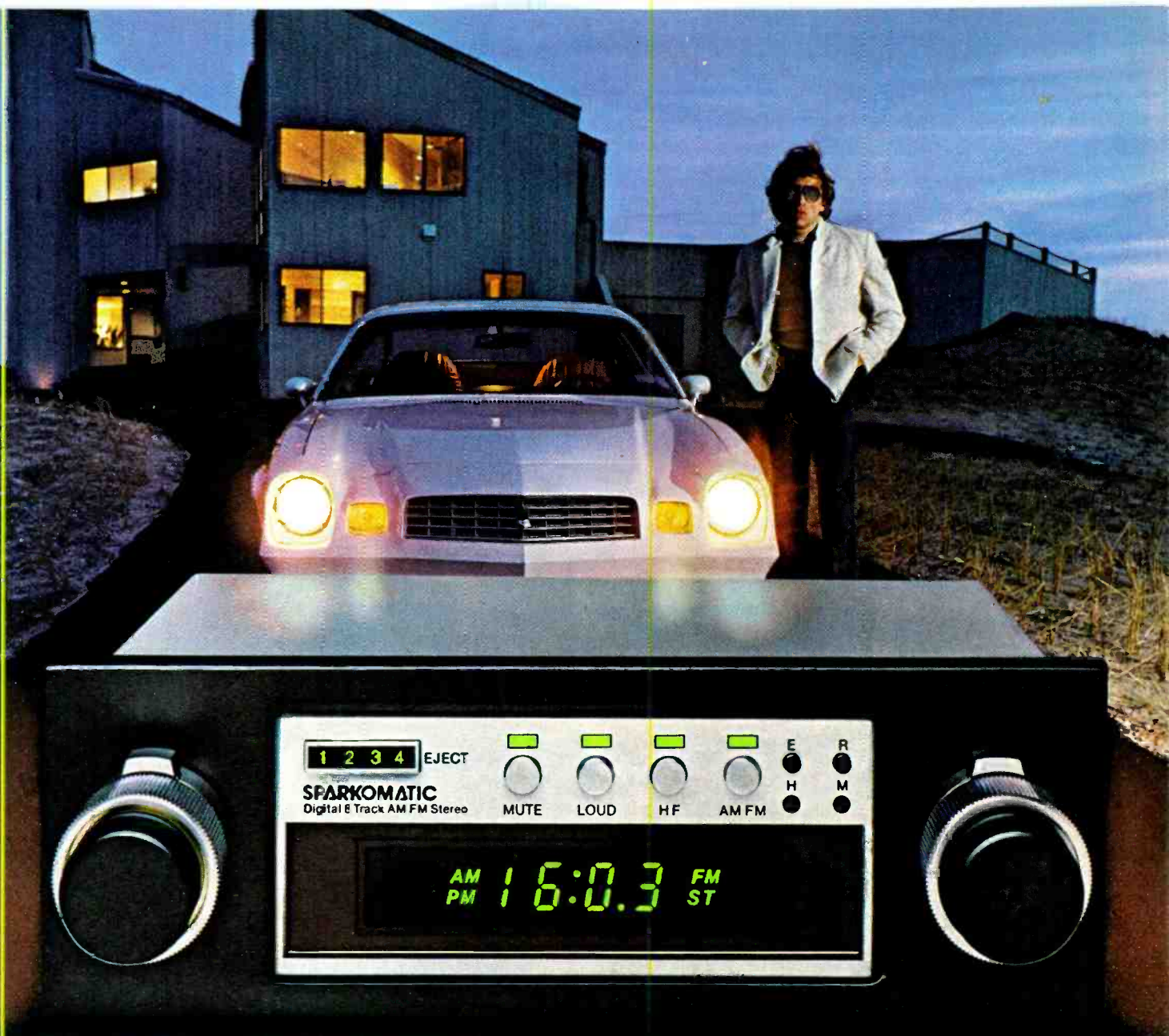
AFS/Kriket 8971



Advent EQ-1

64

MANUFACTURER	Model	Price \$ (if sold individually)	Price \$ (if sold in pairs)	Recommended Power, Watts	Driver Size, Inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
AAL	Micro 100B Studio 50	110.00 89.00		50 25	1 & 4 3 & 6	6 8	4 8	50-20k 40-25k	2 2	S S	7/8x4 1/2x4 1/4 1 1/2x9 1/2x9	With bracket & hardware.
ADS	ADS 200C/II ADS 300C/II ADS 2001 ADS 2002 ADS 300i	117.50 150.00 599.00 470.00 117.50		30 50 † † 50	1 & 4 1 & 4 1 & 4 5		4 4 47K 47K 4	55-22K ±5 40-23K ±5 50-22K ±5 55-20K ±5 30-22K ±5	2 2 2 2 2	S S S S F	4 1/4x6 1/2x4 1/4 5 1/2x 8 1/2x5 1/4 4 1/4x 6 1/2x4 1/4 4 1/4x 6 1/2x5 1/2 5 1/2x8 1/2x7 1/2	†Built-in 160 watt bi-amp. †Built-in 80 watt bi-amp.
AFS/Kriket	8974 8972 8932 8931 8272 8232 8072 8032 7311 0002 0003 0004 0005	119.95 84.95 64.95 56.95 79.95 69.95 84.95 72.95 8.95 54.95 49.95 64.95 124.95	50	50 40 35 35 30 25 30 25 15 50 30 50 50	6x9 6x9 6x9 6x9 5 1/2 5 1/2 4x10 4x10 3 1/2 1 5 6x9 6x9	20 20 10 10 20 10 20 10 3 6 10 20 20	8 8 8 8 8 8 8 8 8 8 8 8 8	40-20K ±4 40-18K 45-18K 45-17K 55-17K 55-17K 55-18K 55-18K 80-15K 5K-2K 50-5K 30-5K 30-20K	2 2 2 2 2 2 2 2 2 S/F F F 2	F F F F F F F F F F F F F	6x9x3 3/4 6x9x3 3/4 6x9x3 3/4 6x9x3 3/4 5 1/2x3 5 1/2x2 1/4 4x10x3 3/4 4x10x2 1/2 3 1/2x1 1/2 3 1/2x 1/4 5x2 1/2 6x9x3 3/4 6x9x3 3/4	
Advent	EQ-1	179.95	†	6x9	10				1	F	6x9 x4.5	†Built-in amp.
Audiotex	30-3074 30-3072 30-3071 30-3070 30-3054 30-3053 30-2648 30-2647 30-2646 30-3056 30-3066 30-3065 30-3064 30-3063 30-3047 30-5120 30-5121	39.10 38.70 31.20 27.40 22.10 18.60 91.95 80.55 53.45 17.35 31.75 22.10 17.70 16.15 17.70 61.50 99.95		30 35 25 20 25 20 25 25 25 15 25 25 20 16 15 30	6x9 6x9 6x9 6x9 6x9 6x9 4x10 4x10 4x10 4x10 5 1/2 5 1/2 5 1/2 5 1/2 5 1/2 5x7 5	20 25 20 10 20 10 20 20 20 10 20 20 20 5.5 10 10 8	4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8 4-8	40-20K 40-18K 45-18K 50-18K 40-16K 50-16K 70-20K 70-20K 70-16K 60-14K 50-20K 50-16K 55-15K 60-15K 50-14K 110-20K ±6 55-20K	3 2 2 2 2 2 3 2 2 2 3 2 2 2 2 2 2 2	F F F F F F F F F F F F F F F S S	7 1/2x4 3/8x4 1/2 7 1/2x4 3/8x4 1/4	
Audiovox	TRYVOX-20 TRYVOX-25 TRYVOX-30 TRYVOX-40 COID-69/20 COID-57/20 COID-41/20 COSC-5	81.00 70.00 87.00 81.00 54.00 58.00 62.00 53.00		15 7 15 15 10 10 10 12	6x9 6 5 1/2 4x10 6x9 5x7 4x10 5	20 20 20 20 20 20 20 5	8 8 8 8 8 8 8 8	60-17K 65-16.5K 65-18K 65-17K 60-16K 85-16.5K 85-16.5K 120-15K	3 3 3 3 2 2 2 2	F F F F F F F F	6x9x3 3/4 6x2 1/2 4x10x3 3/4 6x9x3 3/4 5x7x3 4x10x3 3/4 5x1 1/4	Separate component system w. 3-in. mid & 1-in. tweeter.
Continued												



THE SPARKOMATIC SOUND. CAR STEREO FOR THE TRAVELIN' MAN WHO IS IN TOUCH WITH THE CHANGING TIMES.

Like time, the travelin' man and his music do not stand still. Curiously, car high fidelity has failed to keep pace. The equipment in the auto was ill-equipped to reproduce any level of sophisticated sound.

Sparkomatic's new High Power Car Stereo series has changed all that. Truly machines of the times. Driving enormously spacious sound throughout the elegantly understated space they occupy. Tuners with exceptional FM sensitivity, superb separation and efficient multipath signal rejection; integrated Cassette or 8-Track that's a breakthrough in disciplined distortion and wow and flutter; separate bass/treble and balance/fader controls to command the performance.

The power: a rock slaking 45 watts.

This Sparkomatic SR 2400 High Power Digital 8-Track AM/FM Stereo with Clock (or SR 3400 Cassette alternative) is a prime example of these components-like advancements. Feather touch controls send electronic impulses to activate all major fidelity functions. And the integrated tape player performs to the highest fidelity standards.

The timepiece itself is a statement in state-of-the-art digital accuracy.

Synchronize one of 20 models to your time and space. Sparkomatic High Fidelity Speakers add yet another dimension to your car sound.

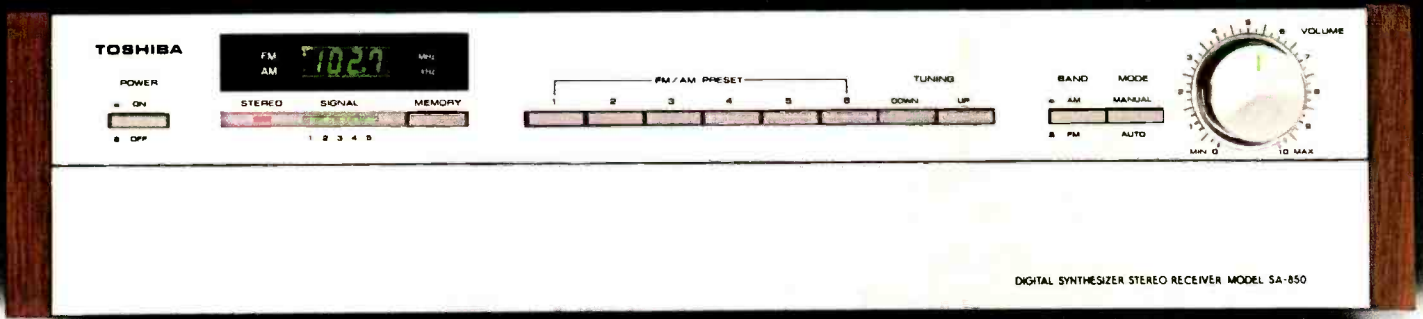
Visit a Sparkomatic dealer for a demonstration.

SPARKOMATIC

For the Travelin' Man™

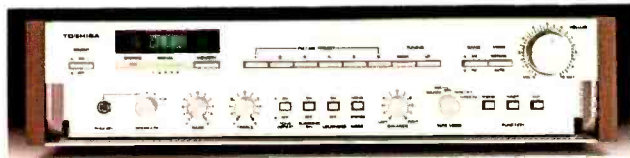
For our free catalogs on Car High Fidelity write: "For The Travelin' Man", Dept. AD, Sparkomatic Corporation, Milford, PA 18337

Enter No. 30 on Reader Service Card



TO BUILD A BETTER RECEIVER, WE LEFT OUT A FEW UNNECESSARY PARTS.

What you see here is a sophistication in high fidelity design that's never been achieved in a stereo receiver. The new Toshiba SA 850.



Look for conventional tuning devices, like a tuning knob, or an FM/AM band, or signal strength and center tuning meters.

You won't find any.

The reason is Toshiba's unique digital-synthesized tuning. The most advanced and precise system of tuning available today.

Toshiba was the first to develop digital synthesizer circuits in a receiver, and now we've utilized them again.

Choose either automatic or manual tuning.

Consider ordinary tuning systems obsolete. The Toshiba SA 850 allows you to tune automatically or manually with the ease of push-button selection.

You get LED digital read-out. And 5 LED signal strength indicators.

In the automatic FM mode, the tuner will scan until it stops at

the next listenable station. Also, 6 FM and 6 AM stations can be pre-set for instant recall tuning at the touch of a memory button. The quartz digital synthesizer locks into each station's assigned frequency with absolutely no possibility of drift. You get FM synthesizer accuracy of 0.0025%!

FM stereo S/N ratio is 68 dB. FM selectivity is a high 80 dB. Frequency response is 20 to 15,000 Hz, +0.2 - 0.8 dB.

If power is what you want, then power is what you'll get.

Full complementary direct-coupled power amplifiers provide 50 watts rms per channel into 8 ohms from 20 - 20,000 Hz. And with a THD of only 0.03%. A figure that receivers many times more powerful can't match.

This is achieved by low distortion differential amplifier technology and a triple secondary power trans-

former with twin 10,000 μ F capacitors that virtually eliminate noise and hum.

Precisely what you look for in a preamp section.

We give you provisions for attaching two tape decks. And full monitoring controls, plus duplication switching between the decks.

Our special subsonic filter switch eliminates rumble and other low frequency noise.

A great-looking body and price.

Behind our sleek, slide-away cover is a full range of controls, including tone / defeat switch and a dual speaker selector.

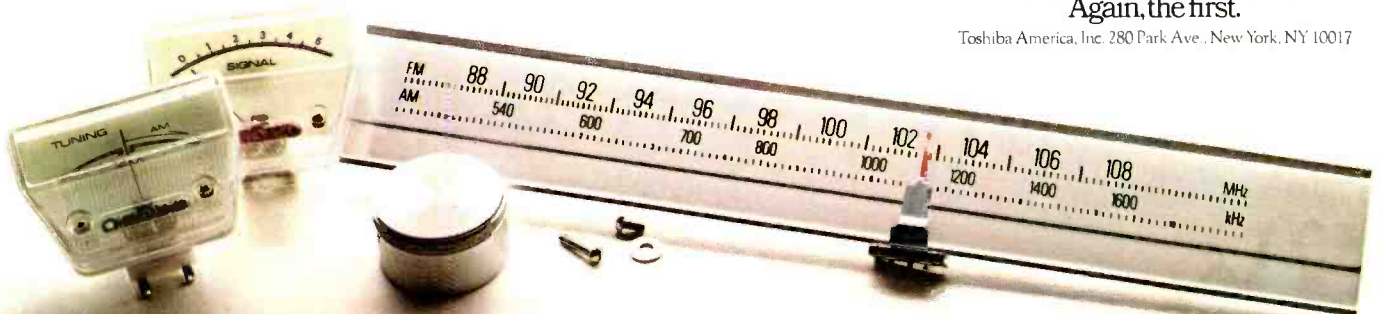
The entire unit has a clean, sophisticated look. So you can indulge your eyes as well as your ears.

But we've saved the best part for last. This digital-synthesized receiver actually costs only \$519.95* less than you'd pay for a digital-synthesized tuner alone.

Now, that's the part we thought you'd like us to leave in.

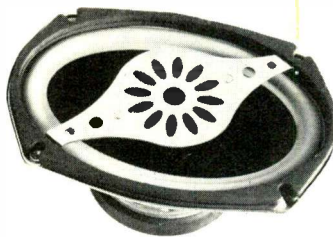
TOSHIBA
Again, the first.

Toshiba America, Inc. 280 Park Ave., New York, NY 10017

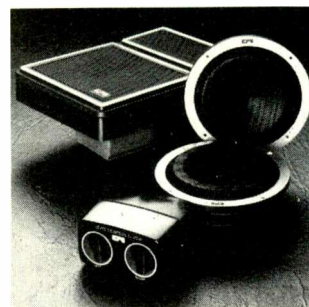


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*Suggested Retail Value Solely For Purpose of Information.



Audiotex 30-3072



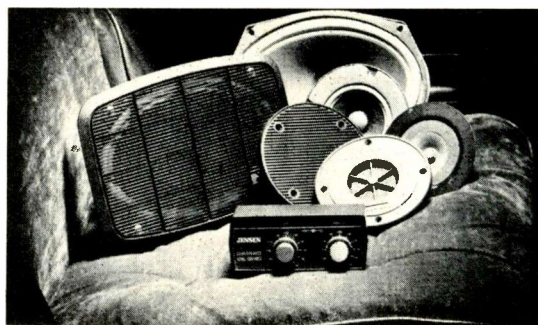
EPI

MANUFACTURER	Model	Price, \$ (if sold individually)	Price, \$ (if sold in pairs)	Recommended Power, Watts	Driver Size, inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ± db	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
Audiovox (Continued)	COSC-10	40.00	10	5 1/4	10	8	75-15K	2	F	5 1/4 x 2 1/2		
	COSC-20	45.00	15	5 1/4	20	8	70-15K	2	F	5 1/4 x 2 1/2		
	CSW-40	39.00	8	5 1/4	10	8	100-15K	2	S	5 1/4 x 2		
	DOME-20	97.00	20	6x9	20	8	60-18K	2	F	6x9x4		
Cobra	SP692-20	59.95	30	6x9	20	6	50-15K	2	F			
	SP693-20	79.95	50	6x9	20	6	50-15K	3	F			
	SP402-20	59.95	25	4x10	20	6	70-15K	2	F			
	SP403-20	79.95	25	4x10	20	6	70-18K	3	F			
	SP552-20	49.95	30	5 1/4	20	6	70-15K	2	S			
	SP553-20	69.95	30	5 1/4	20	6	65-18K	3	S			
Dahlquist	ALS-3	265.00	30	†		4		3	S	4 1/2 x 7 1/2 x 4 1/2	†3-way, 4-in. woofer, 1 1/2-in. mid, 3/4-in. dome tweeter, w. brackets.	
EPI	LS-70	75.00		1 & 6		8	60-20K	2	F			
	LS-35	40.00		3 1/2								
Electronic Industries	9D20T	79.95	50	6x9	20	4-8	50-15K	3	F			
Arthur Fulmer	15-9220	14.95	5	5	3	8	70-14K	1	S	3 1/2 x 7 1/2 x 6 1/2		
	15-9240	19.95	7	5	5	8	60-14K	1	S/F	5 x 6 1/4 x 6 1/2		
	15-9250	21.95	10	5	5	8	60-14.5K	2	S/F	3 3/4 x 9 1/2 x 6 1/2		
	15-9260	149.95	45	4	3	8	60-14.5K	2	S	3 3/4 x 9 1/2 x 6 1/2		
	15-9420	12.95	5	5 1/4	3	8	50-13K	1	F	5 1/4 x 5 1/4 x 2		
	15-9430	22.95	10	4	10	8	50-13K	1	F	5 1/2 x 2 1/2 x 4 3/4		
	15-9440	24.95	10	5 1/4	10	8	80-12K	1	F	5 1/4 x 5 1/4 x 2 1/4		
	15-9460	32.95	10	5 1/4	10	8	50-15K	2	F	5 1/4 x 5 1/4 x 2 1/4		
	15-9470	44.95	25	5 1/4	20	8	30-13K	2	F	5 1/4 x 5 1/4 x 2 1/2		
	15-9490	64.95	25	5 1/4	20	8	35-16K	3	F	5 1/4 x 5 1/4 x 2 1/2		
	15-9560	36.95	10	4x10	10	8	35-14.5k	2	F	4x10x3 1/4		
	15-9620	21.95	5	6x9	5	8	40-13k	1	F	6x9x2 3/4		
	15-9660	36.95	10	6x9	10	8	40-14k	2	F	6x9x3 3/4		
	15-9665	99.95	25	5 1/4	10	8	45-16.5k	3	F	10x6 3/4 x 2 1/2	Separate 3 way Trimount with Brilliance control.	
15-9670	49.95	25	6x9	20	8	40-15k	2	F	6x9x3 3/4			
15-9690	69.95	25	6x9	20	8	20-16k	3	F	6x9x3 3/4			
15-9696	89.95	25	6x9	30	8	20-16k	4	F	6x9x3 3/4			
Hanabashiya	1S700		20	6x9	20	8		3	F			
	CRB5		10	5 1/4	3	8			S			
	525P		10	6 1/4	3	8			F			
	525C		10	6 1/4	3	8			F			
Herald	S-016K	49.95	50	6x9	30	4-8	30-20K	2				
	S-015A	32.95	30	6x9	20	4-8	40-20K	2				
	S-994A	27.95	45	6 1/2	20	8	25-3K					
	S-983A	18.95	15	3 1/2	8	8	1000-20K					PZ add-on tweeter.
	S991A		21.90	2 1/2			3000-30K					
Infinity	RS0.1	350.00	65	1 & 5	16	4	65-32K ±2	2	S	11x6 1/4 x5 1/4		
Intervox	S500T10	77.65	15	5	10	8	70-17K	3	F			
	S525T20	83.15	25	5 1/4	20	8	75-20K	3	F			
	S5X7T20	94.35	30	5x7	20	8	65-20K	3	F			
Continued												

CAR STEREO DIRECTORY SPEAKERS



Intervox



Jensen

MANUFACTURER	Model	Price, \$ (If sold individually)	Price, \$ (If sold in pairs)	Recommended Power, Watts	Driver Size, Inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
Intervox (Continued)	S6X9T20	94.35	25	6x9	20	8	60-20K	3	F			Enclosure with control.
	S4X10T20	94.35	25	4x10	20	8	65-20K	3	F			
	S400C10	60.65	15	4	10	8	70-17K	2	F			
	S525C20	62.50	15	5 1/2	20	8	95-18K	2	F			
	S6X9C20	72.10	20	6x9	20	8	60-17K	2	F			
	S4X10C20	72.10	20	4x10	20	8	60-17K	2	F			
	B400C10	165.55	25	4	10	8	70-17K	2	S		4 1/2 x 4 1/2 x 7 1/2	
Jensen	J1033	139.95	100	6x9	20	4	38-40K	3	F			3-in. mid. & 2-in. tweeter. 3-in. tweeter. 2-in. tweeter. 2-in. mid. + 2-in. tweeter. Separate component speaker system w. 3 1/2-in. mid & 2-in. tweeter, level controls, and crossover. Component system w. 3-in. mid & 2-in. tweeter. As above w. 2-in. mid & 2-in. tweeter. As above w. 2-in. mid & 2-in. tweeter. 3-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter. 2-in. tweeter.
	J1037	99.95	90	6x9	20	4	38-20K	2	F			
	J1041	89.95	70	5 1/4	16	4	58-40K	2	F			
	J1044	69.95	35	2	3	8	1K-40K	2	S			
	J1001	159.95	35	6x9	20	8	35-20K	3	F			
	C9945	99.95	30	6x9	20	8	40-20K	3	F			
	C9991	99.95	30	4x10	20	8	45-20K	3	F			
	C9999	99.95	30	5 1/4	20	8	60-20K	3	F			
	C9740	69.95	25	6x9	20	8	40-18K	2	F			
	C9994	69.95	25	4x10	20	8	45-18K	2	F			
	C9943	69.95	25	5x7	20	8	50-15K	2	F			
	C9852	67.95	25	5 1/4	20	8	60-15K	2	F			
	C9853	59.95	25	5 1/4	10	8	60-15K	2	F			
	C9851	54.95	20	4	10	8	70-15K	2	F			
	C9729	44.95	25	6x9	20	8	40-14K	2	F			
	C9997	44.95	25	4x10	20	8	46-14K	2	F			
	C9862	43.95	25	5 1/4	20	8	60-12K	2	F			
	C9728	39.95	25	6x9	10	8	40-14K	2	F			
	C9863	38.95	25	5 1/4	10	8	60-12K	2	F			
	C9860	38.95	20	4	10	8	70-12K	2	F			
C9870	24.95	12	3 1/2	3	8	80-12K	2	F				
C9927	79.95	25	5 1/4	20	8	50-15K	2	S		7 1/2 x 5 1/4 x 4 1/2		
C9926	49.95	25	5 1/4	10	8	60-12K	2	S		7 1/2 x 5 1/4 x 4 1/2		
C9809	47.95	25	5 1/4	20	8	60-12K	2	S		7 1/2 x 7 x 4		
Jet Sound Labs	JSL-1511	99.95	50	5	20	8	55-18K	3	F		2 1/2 x 6 1/2 x 10 1/4	
	JS-5010	29.95	15	5 1/4	10	4	90-12K		F		2 1/2 x 6 1/2	
	JSW-500	12.95	8	5	5	8	100-10K		F/S		4 x 5 1/2 x 6	
	JSW-1200	25.95	20	5	10	8	100-12K		F/S		4 x 5 1/2 x 6	
	JS-25	9.95	8	3	8	8	100-10K		F		2 x 6 1/2	
	JSL-563TX	49.95	50	5 1/4	20	8	55-18K	3	F		2 1/2 x 6 1/2	
	JSL-963TX	59.95	50	6x9	20	8	50-18K	3	F		3 1/2 x 6 1/4 x 9 1/4	
	JSL-980TX	69.95	50	6x9	20	8	50-18K	3	F		3 1/2 x 6 1/4 x 9 1/4	
	JS-550CX	29.95	20	5 1/4	20	4	70-14K	2	F		2 1/2 x 6 1/2	
	JS-950CX	39.95	20	6x9	20	4	50-15K	2	F		3 1/2 x 6 1/4 x 9 1/4	
LTL Electronics	TP6953	199.50	120	6x9	20	8	40-20K ±4	3	S			5-in. mid + 3-in. tweeter.
	TP653	199.50	120	6 1/2	20	8	40-20K ±4	3	S			As above.
	CP693	159.50	100	6x9	20	4	40-20K ±6	2	S			3-in. mid.
	CP63	159.50	100	6 1/2	20	8	40-20K ±6	2	S			6x3 mid. + 3-in. tweeter.



PSB Alpha

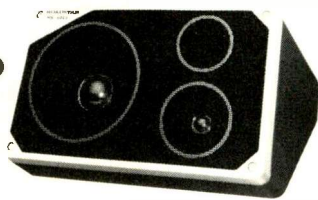


Royal Sound RS-6100

MANUFACTURER	Model	Price \$ (if sold individually)	Price \$ (if sold in pairs)	Recommended Power, Watts	Driver Size, Inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
Master-sound	504CX	39.95	25	5½	20	8	25-20K	2	F		6¼x6¼x2½	
	609CX	49.95	25	6x9	20	8	25-20K	2	F		6x9x2¾	
	410TX	59.95	20	4x10	10	8	30-20K	3	F		4x10x2¾	
	609TX	59.95	25	6x9	20	8	25-20K	3	F		6x9x2¾	
	609QX	69.95	25	6x9	20	8	25-20K	4	F		6x9x2¾	
	VTX80	159.95	30	4	4	8	50-20K	3	S		7½x4½x4½	
	CRB5	14.95	5	4½x4½	5	8	15-20K	1	S		4½x4½x2¼	
	CRB525	14.95	5	5½	5	8	15-20K	1	F		5¼x5¼x2½	
Matreacs	MA-0069-020T	43.88	30	6x9	20	4-8	40-20K	3	F			
	MA-0069-025C	44.27	35	6x9	25	4-8	40-18K	2	F			
	MA-0069-020C	36.63	25	6x9	20	4-8	45-18K	2	F			
	MA-0069-10CP		75.21†	20	6x9	10	4-8	50-18K	2	F		†Stereo speaker kit only.
	MA-0069-0020	23.40	25	6x9	20	4-8	40-16K	2	F			
	MA-0069-0010	20.90	20	6x9	10	4-8	50-16K	2	F			
	MA-0069-10DV	23.79	20	6x9	10	4-8	50-14K	2	F			
	MA-0410-20TP		109.66†	25	4x10	20	4-8	70-20K	3	F		†Stereo speaker kit only.
	MA-0410-20CP		96.04†	25	4x10	20	4-8	70-20K	2	F		†Stereo speaker kit only.
	MA-0410-020P		63.70†	25	4x10	20	4-8	70-16K	2	F		†Stereo speaker kit only.
	MA-0410-0010	20.38	15	4x10	10	4-8	60-14K	2	F			
	MA-0525-020C	36.56	25	5½	20	4-8	50-20K	2	F			
	MA-0525-0020	22.30	25	5½	20	4-8	50-16K	2	F			
	MA-0525-0010	19.18	20	5½	10	4-8	55-15K	2	F			
	MA-0525-0005	16.80	16	5½	5.5	4-8	60-15K	2	F			
MA-0057-0010	20.09	15	5x7	10	4-8	50-14K	2	F				
Misc	DC 32	5.94	4	3½	2.5	8				F		
	EC 46 CD	11.40	6	4x6	3.0	8				F		
	JC 48 CD	16.50	12	4x8	10.0	8				F		
	EC 410 CD	12.72	6	4x10	3.0	8				F		
	JC 410 CD	17.94	15	4x10	10.0	8				F		
	FC 4100	26.10	10	4x10	5.5	8		2		F		
	JC 4100	27.90	15	4x10	10.0	8		2		F		
	EC 411 CD	12.72	6	4x11	3.0	8				F		
	EC 5 CDP	10.50	6	5	3.0	8				F		
	JC 5 CDP	14.40	12	5	10.0	8				F		
	EC 54 CDP	10.95	6	5½	3.0	8				F		
	JC 54 CDP	15.00	12	5½	10.0	8				F		
	FC 57 CD	14.52	10	5x7	5.5	8				F		
	JC 57 CD	16.20	15	5x7	10.0	8				F		
	JC 570	26.58	15	5x7	10.0	8		2		F		
	FC 69 CD	15.18	10	6x9	5.5	8				F		
	JC 69 CD	17.15	15	6x9	10.0	8				F		
	FC 690	25.20	10	6x9	5.5	8		2		F		
JC 690	27.30	15	6x9	10.0	8		2		F			
Mitsubishi	SX305A	134.95	15		6.5	4	80-20K	2	S			
	SX10BA	114.95	15		5.3	4	95-15K	2	S			
	SB25A	29.95	15		4	4	5K-20K		S			
	SG40CA	59.95	15	4x10	10.0	4	50-20K	2	F			
	SG40NA	49.95	15	4x10	10.0	4	50-20K		F			
	SG20CA	89.95	15	8	6.5	4	55-20K	2	F			
	SG16CA	64.95	15	6½	6.5	4	60-20K	2	F			
	SG69QA	109.95	15	6x9	21.0	4	50-20K	2	F			
	SG69TA	89.95	15	6x9	21.0	4	50-20K	3	F			
	SG69CA	69.95	15	6x9	21	4	50-20K	2	F			
	SG69WA	44.95	15	6x9	10	4	50-20K	2	F			
	SG16EA	44.95	15	6½	3.6	4	50-20K	2	F			
	SG13WA	39.95	15	5½	6.4	4	75-15K	2	F			
SG10WA	34.95	15	4	5.3	4	100-17K	2	F				
Motorola	D3-5W	25.95	12	3½	5	8	100-12K	2	F		3½x3½x1¼	
	D5-10C	66.95	20	5½	10	6	65-14K	2	F		5¼x5¼x2¼	
	D5-20C	77.95	25	5½	20	6	65-14K	2	F		5¼x5¼x2½	
	D69-20C	89.95	25	6x9	20	6	45-15K	2	F		6x9x3¾	
	D69-20T	119.95	25	6x9	20	6	45-18K	3	F		6x9x3¾	
	M4-5W	24.95	8	4	5	6	85-10K		F		4x4x1¼	
	M4-8C	49.95	15	4	8	6	80-20K	2	F		4x4x1¼	
	M4-10C	74.95	15	4x10	10	6	80-20K	2	F		4x10x1¼	
	M5-5W	34.95	10	5½	5	6	80-10K	2	F		5¼x5¼x2	
	Continued											

CAR STEREO DIRECTORY

SPEAKERS



Roadstar RS-6043



Sparkomatic SK 525

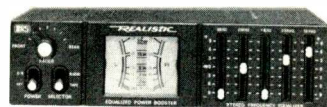


Trusonic

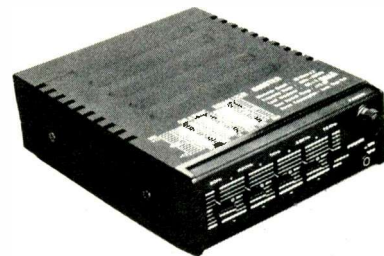
MANUFACTURER	Model	Price \$ (if sold individually)	Price \$ (if sold in pairs)	Recommended Power, Watts	Driver Size, inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
Sparkomatic	SK-4120C	47.95	25	9½x 3¼	20	8	50-15K	2	F	4¼x 9¾x 3¾		
(Continued)	SK-525	89.95	25	3¾x 3¾	10	8	80-18K	3	S	10¼x 5½ x5		
Speco	SK69CA20Q-G	103.95	60	6x9	20	8	50-20K	4	F	6x9x4	3-in. midrange & two 2-in. tweeters.	
	SK69CA20T-G	86.00	60	6x9	20	8	50-20K	3	F	6x9x3½	3-in. midrange & 2-in. tweeter.	
	SK69CA20C-G	69.35	50	6x9	20	8	50-20K	2	F	6x9x3¼		
	SK69CA10C-G	58.35	30	6x9	10	8	55-20K	2	F	6x9x3		
	SK69CA27W-G	70.20	50	6x9	27	8	50-15K		F	6x9x3		
	SK69CA20W-G	54.15	50	6x9	20	8	55-15K		F	6x9x3		
	SK69CA10W-G	44.35	30	6x9	10	8	55-15K		F	6x9x2½		
	SK410CA20C-G	69.35	40	4x10	20	8	50-20K	2	F	11¼x 12¼x3¾		
	SK410CA20W-G	56.90	35	4x10	20	8	50-18K		F	11¼x 12¼x3¾		
	SK410CA10W-G	47.10	30	4x10	10	8	50-15K		F	11¼x 12¼x3¾		
	SK410CF10W-G	41.50	20	4x10	10	8	140-18K		F	4½x11x 4¼		
	SK410CF5W-G	36.00	10	4x10	5	8	140-18K		F	4½x 11x4¼		
	SK51CA20T-G	86.00	50	5¼	20	8	80-20K	3	F	14x 7¼x3½	2-in. midrange, 1-in. tweeter.	
	SK51CA20C-G	58.15	30	5¼	20	8	130-20K	2	S	5¼		
	SK51CA10C-G	52.65	20	5¼	10	8	130-20K	2	S	5¼		
	SK51CA10W-G	41.50	30	5¼	10	8	80-15K		S	5¼		
SK51CF5W-G	30.40	10	5¼	5	8	125-20K		S	5¼			
SK51CF3W-G	27.65	10	5¼	3	8	125-20K		S	5¼			
SK4CA10C-G	51.25	4	4	10	8	30-17K	2	F	11¼x 5x3¾			
SK4CA10-G	41.50	4	4	10	8	90-18K		F	11¼x 5x3¾			
SK4CF3-G	26.25	4	4	3	8			F	6¼x 5½x4			
TEI Electronic	21-260		20	5¼	20	8	60-20K	2				
	21-270		20	6x9	20	8	40-20K ±5	3				
	21-275		25	6x9	20	8	40-20K	3				
	21-280		25	6x9	20	8	40-20K	4				
	21-420		20	4x10	20	8	40-18K	2				
	21-425		20	4x10	20	8	40-18K	3				
	21-292		25	5¼	20	8	25-20K	3	S			Separate components with 3-in. mid & 1-in. tweeter.
	21-295		30	5	20	8	60-20K					Separate components with 2-in. mid & 1-in. tweeter.
Trusonic	K6943	170.00	120	6x9	40	4	25-25K	3	S/F	6¾x 9¼x 4¼		
	K6942	130.00	120	6x9	40	4	25-25K	2	S/F	6¾x 9¼x 4¼		
	K6923	150.00	80	6x9	20	4	30-25K	3	S/F	6¾x 4		
	K6922	110.00	80	6x9	20	4	30-25K	2	S/F	6¾x 4		
	K6042	120.00	120	6	40	4	35-25K	2	S	6½x 4½		
	K6022	100.00	80	6	20	4	40-25K	2	S	6½x 3		
	K5722	100.00	80	5x7	20	4	40-25K	2	S/F	5x7¼ x3½		
	6941	90.00	120	6x9	40	4	25-500		S/F	6¾x 9¼x4	Subwoofer.	
	6921	70.00	80	6x9	20	4	30-500		S/F	6¾x 9¼x4	Subwoofer.	
	6041	90.00	120	6	40	4	35-500		S	6½x4¼	Subwoofer.	
6021	70.00	80	6	20	4	40-500		S	6½x 3	Subwoofer.		
Ultralinear	M-12	149.95	50	4½	24	8	53-18K	2	S	7¾x5¼x 4		
	M-16	199.95	50	4½	24	8	53-23K	2	S	7¾x5¼x 4		
Visonik	5000	115.00		50	4	4	50-25K +4,-8	2	S	6¾x 4½x 4½		Opt. B-5 bracket, \$10.00.
	W-600			7	4	4						Subwoofer w. cover, sold as part of AS-1 system only.



Mastersound MS540



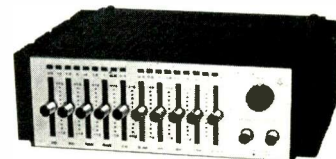
Radio Shack 12-1879



Matrecs MA-1050



Pyramid PMA-100

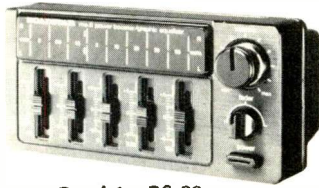


Jet Sound Labs JS-120

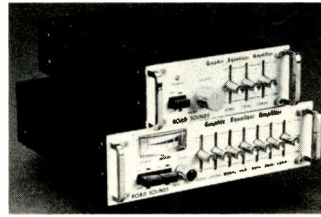
MANUFACTURER	Model	Price	Amp= Amp, EQ=Equalizer, Both=Both	Number of Bands of EQ	Separate Controls for Each Stereo Channel?	Boost/Cut Range, db	Watts into 4 ohms	% THD at Rated Output	Dimensions, inches
ADS	Power Plate 100	300.00	Both	3	Yes	4	50	0.08	12½x6½x1½
Cobra	GEA40-5	89.95	Both	5	No	±12	20	1	2 x 5½ x 6
	GEA60-7	159.95	Both	7	No	±12	30	1	2½ x 7½ x 7½
Electronic Industries	601	159.99	Both	5	Yes	±12	30	0.8	6½ x 5½ x 2
Fosgate	PR-220	119.95	Both	2	No	+ 18	40	0.05	6½x2½x4¼
	PR-250	249.95	Both	2	No	+18	100	0.05	4x1½x2½
	Preamp PR-252	315.95	Both	3	Yes	+18	100	0.05	8½x1¼x3¼
	Preamp PR-2100	459.95	Both	3	Yes	+18	200	0.05	8½x1¼x3¼
Arthur Fulmer	15-0720	49.95	Amp	2	No	±10	26	0.10	4½x5½x1½
	15-0730	99.95	Both	7	Yes	±12	20	0.10	4x2x7
Hanabaashiya	202B	69.95	Both	5	Yes		30		6x5½x1½
	PB-30	39.95	Amp		Yes		20		4x5x1
Jet Sound Labs	JS-31	39.95	Amp		No		30	0.10	2½x4x6½
	JS-40	59.95	Both	3	No	15	36	0.10	6½x5½x2½
	JS-50	79.95	Both	5	No	20	40	0.10	2½x5½x6½
	JS-70	119.95	Both	7	No	20	60	0.10	6½x7½x2½
	JS-120	179.95	Both	10	No	20	60	0.10	6½x7½x2½
Linear Power	40A	84.95	Amp				20	0.25	8x3x2
	60A	129.95	Amp				30	0.25	6x8½x3
	90	199.95	Amp				45	0.10	7x3½x6
	150	279.95	Amp				75	0.05	7x3½x9
	300	399.95	Amp				150	0.05	7x3½x13
	EQ	99.95	E. Q.	3	No	±15		0.01	7x1½x4
Mastersound	MS 540	79.95	Both	5	No	+12	40	0.025	1½x4½x6
	MS 40	39.95	Amp		No	+12	40	0.025	1½x4½x5½
Matrecs	MA-1000	77.50	Amp	5	Yes	±12	25	0.4	2½x5½x5½
	MA-1040	116.50	Both	5	Yes	±12	25	0.4	2½x5½x5½
	MA-1050	124.95	Both	5	Yes	±12	25	0.4	2x5½x7½
Mitsubishi	CV 21	129.95	Amp				20		2x5½x6½
	CV 22	89.95	Amp				20		2x5½x6½
	CV 23	159.95	Both	6		±12db	30		2x5½x6½
Motorola	PA 3000	49.95	Amp				30	1.0	
	PA 5000	89.95	Amp			±6	50	1.0	
	EQB 3000	129.95	Both	5	Yes	±12	30	1.0	25 Watts Into 3 ohms
	EQB 4000	129.95	Both	5	Yes	±24	40	1.0	10 Watts Into 4 ohms
	EQB 4001	139.95	Both	5	Yes	±24	40	1.0	15 Watts Into 4 ohms load at 14.0V DL
Muntz	Z50	149.00	Amp				50	0.01	
	Z60	134.95	Both	5	No		60	0.01	5½x6½x1½
	Z169	99.95	Both	7	No	±2	30		5½x1½x6½
	Z166	69.90	Both	5	No		30		4½x1½x6½
	Z145	295.00	Amp				150	0.3	5.2x5.8x3.2
	T-112	49.95	Both	2	No		30		4½x6x1½

CAR STEREO DIRECTORY

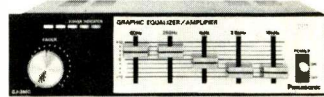
AMPS/EQUALIZERS



Roadstar RS-89



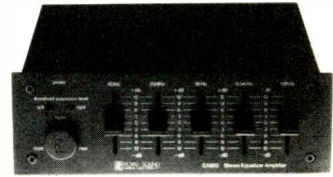
Road Sounds PB-3, PB-7



Panasonic CJ-3600



Sparkomatic GE-500



Royal Sound EA600

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MANUFACTURER	Model	Price	Amp= Amp; EQ= Equalizer; Both= Both	Number of Bands of EQ	Separate Controls for Each Stereo Channel?	Boost/Cut Range, db	Watts into 4 ohms	% THD at Rated Output	Dimensions, inches
Panasonic	CJ-5000	229.95	Amp		No		100	0.05	7"x9 1/2"x2 1/2"
	CJ-4000	189.95	Amp		No		40	0.08	5 1/2"x10 1/2"x2 1/4"
	CJ-3000	109.95	Amp		No		28	0.1	5 1/2"x8 1/2"x2 1/4"
	CJ-3600	129.95	Both	5	No	±12 dB	24	5	7 1/2"x7 1/4"x1 1/2"
	CJ-2600	59.95	Amp		No		20	5	7 1/2"x6 1/2"x2 1/4"
	CJ-255Z	79.95	Amp		No		76		16 1/2"x1 1/2"x5 1/2"
	CJ-156Z	54.95	Amp		No		20	5	4 1/2"x2 1/4"x6 1/2"
Pyramid	PMA-100	109.95	Amp		No		100	1	2 1/2"x4 1/2"x7 1/2"
	PMA-270	469.95	Amp		No		270	0.3	2 1/2"x7 1/2"x11
	X-420	144.95	Amp		No		25x4	0.5	2"x6"x8"
	X-700VL	119.95	Both	7	No	±12	44	0.5	1 1/2"x4 1/2"x6 1/2"
	X-1000XL	149.95	Both	10	No	±12	50	0.5	1 1/2"x7"x6 1/2"
X-SPEC-5	229.95	EQ	5x2	Yes	±12			1 1/2"x8"x4 1/2"	
Radio Shack	12-1879	99.95	Both	5	No	±12	21	10	2x7 1/2"x5 1/2"
	12-1878	79.95	Both	5	No	±12	15	10	2x6x5 1/2"
	12-1877	49.95	Amp				17	10	3 1/2"x5 1/2"x3 1/2"
	12-1876	29.95	Amp				8	10	1 1/2"x4x4 1/2"
Road Sounds	PB-2		Both	2	No	±10	15	0.1	
	PB-3		Both	3	No	±12	20	0.05	
	PB-7		Both	7	No	±12	20	0.05	
Roadstar	RS-50N	39.95	Amp		Yes	±12	25	0.5	1 1/2"x4 1/2"x4 1/2"
	RS-54N		Both	3	Yes	±12	25	0.5	1 1/2"x4 1/2"x4 1/2"
	RS-59N	114.95	Both	5	Yes	±12	30	0.5	1 1/2"x5 1/2"x7
	RS-69N		Both	7	Yes	±12	60	0.1	2 1/2"x7"x7 1/2"
	RS-79N		Both	5	Yes	±12	60	0.1	2x5 1/2"x8"
	RS-89	249.95	Both	5	Yes	±12	60	0.1	2 1/2"x5 1/2"x2 1/2"
Royal Sound	A600	120.00	Amp		No	±12	30	0.7	2 1/2"x5 1/2"x6 1/2"
	EA600	160.00	Both	5	No	±12	30	0.7	2 1/2"x7 1/2"x6 1/2"
	IA400	90.00	Both	2	No	±12	20	0.9	1 1/2"x4 1/2"x6 1/2"
	RC2000	400.00	EQ	7	No	±12		0.2	2 1/2"x7 1/2"x6 1/2"
	RA6000	400.00	Amp				70	0.2	2 1/2"x8x9 1/2"
Shmegg	40	79.95	Amp		No		20	0.1	
	40A	81.95	Amp		No		20	0.1	
	60A	129.95	Amp		No		30	0.05	
	120	199.95	Amp		No		60	0.05	
	250	449.95	Amp		No		125	0.01	
Sparkomatic	LC-50	29.95	Amp			±10	15	1	4x1 1/2"x5
	LC-100	89.95	Amp			±10	16	1	5 1/2"x1 1/2"x6 1/2" W. 6x9 speakers.
	LC-101	49.95	Amp			±10	16	1	5 1/2"x1 1/2"x6 1/2"
	GE-500	89.95	Both	5		±10	40	1	6 1/2"x2x6 1/2"
TEI Electronic	49-115		Amp		No	±10	10	3	1 1/2"x3 1/2"x4 1/2"
	49-130		Amp		No	±12	15	2.5	1 1/2"x4 1/2"x5 1/2"
	49-140		Both	5	No	±10	20	3	2 1/2"x5 1/2"x6 1/2"
	49-150		Amp		Yes	±12	20	4	1 1/2"x6x4 1/2"
	49-160		Both	5	Yes	±12	20	5	1 1/2"x6x6 1/2"
Visonik	A300	136.00	Amp		No		30	0.05	
	AS-1 System	400.00	†		No		35	0.025	†Add-on subwoofer system with amp, crossover, speaker, mounting kit.



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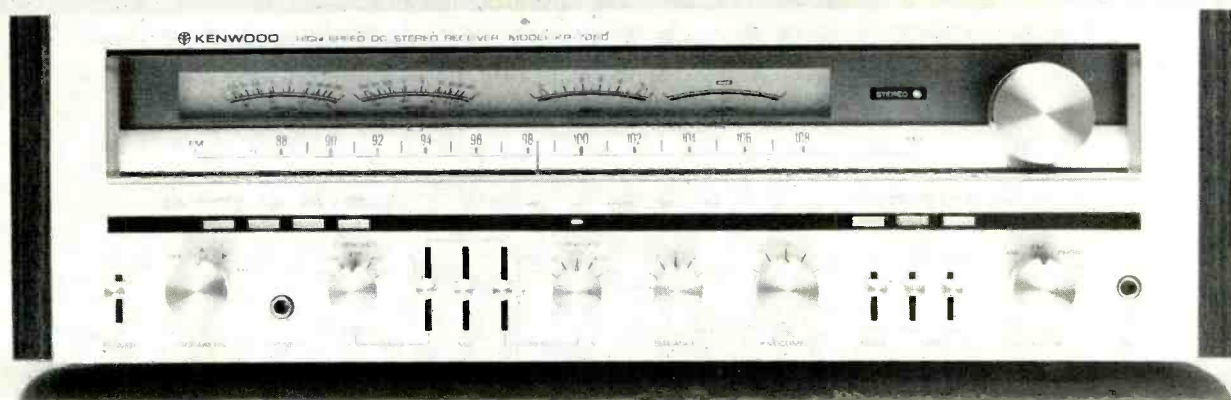
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Equipment profiles

Kenwood KR-7050 Stereo Receiver



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MANUFACTURER'S SPECIFICATIONS

FM Tuner Section

Usable Sensitivity: 10.3 dBf (1.8 μ V).
50-dB Quieting Sensitivity: Mono, 16.1 dBf (3.5 μ V); stereo, 37.9 dBf (43 μ V).
S/N @ 65 dBf: Mono, 83 dB; stereo, 75 dB.
THD: Mono, 0.08 percent; stereo, 0.09 percent.

Frequency Response: 30 Hz to 15 kHz, +0.5,-1.0 dB.

Capture Ratio: 1.0 dB.

Image Rejection: 83 dB.

I.F. Rejection: 105 dB.

Spurious Rejection: 100 dB.

Alt. Channel Selectivity (300 kHz):

Wide, 30 dB; Narrow, 60 dB.

AM Suppression: 65 dB.

Sub-Carrier Rejection: 70 dB.

Stereo Separation: 50 dB @ 1 kHz; 40 db @ 100 Hz and 10 kHz.

AM Tuner Section

Usable Sensitivity: 10 μ V (250 μ V/m with internal antenna).

S/N: 52 dB.

Image Rejection: 50 dB.

Selectivity: 50 dB.

Much of the advanced amplifier and tuner technology which Kenwood has been emphasizing in their new "high speed" amplifiers and state-of-the-art separate tuners has been incorporated in this new receiver from Kenwood. So much, in fact, that one begins to wonder whether there is any longer any reason to opt for "separates" in any medium-high powered home audio system. In terms of control features, the Kenwood KR-7050 is amply endowed. The dial area has a pair of logarithmically calibrated power-output meters which can be read accurately from 0.01 watts to 160 watts referenced to 8-ohm loads plus the usual pair of signal-strength and center-of-channel tuning meters. All four meters, plus the stereo indicator light, are mounted above a linearly calibrated FM frequency scale and the usual compressed AM scale.

The lower frame of the dial area contains two groups of pushbuttons and a series of indicator lights that denote program source selected. The pushbuttons at the left are a loudness switch, d.c.-a.c. coupling of the amplifier, a high-filter switch, and a tone defeat switch. Those at the right are for de-emphasis selection (25 or 75 microseconds), FM muting and i.f. bandwidth selection.

Controls along the bottom section of the panel include a power On-Off toggle switch, speaker selector switch, three

tone control levers (bass, mid-range and treble), a pair of five-position selector switches which determine the turnover frequencies for the bass and treble controls (80 Hz, 140 Hz, 250 Hz, 450 Hz and 800 Hz for the bass; 800 Hz, 1.4 kHz, 2.5 kHz, 4.5 kHz or 8 kHz for the treble), balance control, master volume control, selector switch, toggle switches for mode, tape monitoring and tape dubbing, a mike input jack, and the usual stereo headphone jack.

The rear panel of the KR-7050 is equipped with color-coded screw-terminals for connection of up to two pairs of speakers; the usual 300-ohm, 75-ohm (including a coaxial connector) and external AM antenna terminals; phono and high level input jacks; tape-in and tape-out jacks (enough for two tape decks); three convenience a.c. outlets (two unswitched, one switched), and the usual ferrite bar AM antenna, which can be pivoted down and away from the chassis surface for better AM reception.

Internal Construction And Circuit Highlights

The internal layout of the KR-7050 is a text-book model of thoughtful and intelligent engineering layout. Major circuit boards contain tuner circuitry, power amplifier circuitry, power supply circuitry, flat-amp/tone-control circuitry, and

Amplifier Section

Power Output: 80 watts per channel, 20 Hz to 20 kHz, 8 ohms.

Rated THD: 0.02 percent.

Rated IM (SMPT): 0.007 percent.

Slew Rate: $\pm 200V/\mu\text{Sec}$.

Rise Time: 0.9 μSec .

Damping Factor: 100 (20 Hz to 20 kHz, 8 ohms).

Input Sensitivity: Phono, 2.5 mV; high level, 200 mV; mike, 3.6 mV.

Signal-to-Noise Ratio, "A" weighted. Phono, re: 2.5 mV input, 85 dB; high level re: 200 mV input, 108 dB; Mike re: 2.2 mV input, 72 dB.

Frequency Response: Phono, RIAA ± 0.2 dB; high level, d.c. to 320 kHz, -3 dB.

Phono Overload at 1 kHz: 200 mV.

Tone Control Range: Bass (250 Hz) ± 12 dB @ 50 Hz; treble (2.5 kHz) ± 12 -dB @ 15 kHz; mid-range ± 10 dB @ 800 Hz.

Sub-Sonic Filter: 18 Hz, 6 dB/octave.

High Filter: 5 kHz, 6 dB/octave.

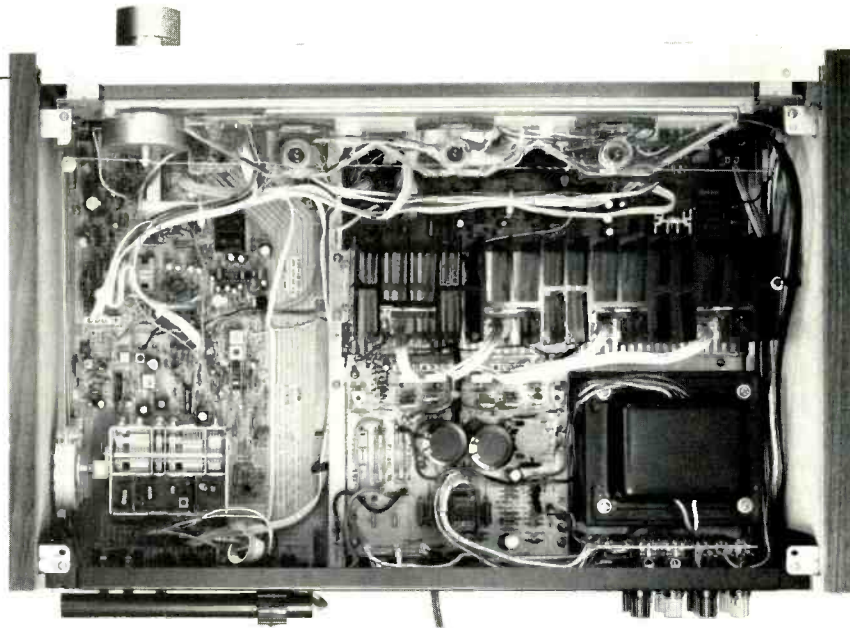
General Specifications

Power Requirements: 120 V, 60 Hz, 600 watts max.

Dimensions: 21½ in. (54.6 cm) W x 6¾ in. (17.1 cm) H x 16¼ in. (41.3 cm) D.

Net Weight: 33 lbs. (14.85 kg).

Price: \$660.00.



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the FM front end, while secondary modules are used for several of the complex switching functions. The phono preamp-equalizer circuits are contained on the major tuner-section p.c. board.

A four-gang tuning capacitor is used in the FM front end which also utilizes a dual-gate MOS-FET r.f. amplifier plus separate bi-polar local oscillator and mixer stages. Multiple ceramic filters are used in the i.f. stages, with the filter configuration electronically switched depending upon whether the user selects wide- or narrow-band i.f. operation. A multi-purpose IC serves as an additional i.f. amplifier, limiter, and quadrature-detector circuit. The multiplex decoder circuitry is of the familiar phase-lock-loop type and includes a pilot-canceller circuit that eliminates the need for steep 19-kHz filtering at the audio output stages of the stereo decoder, thereby permitting better high-end response in the FM section.

Kenwood's d.c.-coupled "high speed" amplifier eliminates all coupling capacitors in the signal path from the AUX or high level inputs to the speaker output terminals. The phono preamp-equalizer uses FET input stages and a single-ended, push-pull output configuration. The d.c. sensing circuits operate relays to disconnect speakers in the event that any d.c. appears at the output terminals because of the directly coupled amplifier configuration. When the d.c. coupling is de-

feated by means of a front panel switch, frequencies below 18 Hz are attenuated at a rate of 6 dB per octave.

FM Performance Measurements

As Kenwood rightly suggests in their literature, the tuner section of the KR-7050 is "like two tuners in one." That is, most of the major performance results differ when switching from "narrow" to "wide" i.f. modes. Signal conditions permitting, the "wide" setting offers best overall reception. As shown in Fig. 1, using this setting we measured a usable sensitivity in mono of 1.8 μV . The 50-dB quieting point required 3.0 μV (14.7 dBf) of signal strength in mono, as against 16.1 dBf claimed by Kenwood. The 50-dB quieting point in stereo was also better than claimed, with readings of only 34.7 dBf (30 μV). Signal-to-noise in mono measured 83 dB as claimed, decreasing to 74 dB for stereo. Distortion at 1 kHz in mono measured an incredibly low 0.04 percent at 1 kHz, increasing to 0.1 percent at 100 Hz and 0.077 percent at 6 kHz. In stereo, the 1-kHz THD reading was also amazingly low, 0.065 percent for 1 kHz, 0.12 percent at 100 Hz and 0.11 percent at 6 kHz. Stereo switching threshold occurs at around 7 μV (22.1 dBf).

Our lab is now one of the few anywhere presently equipped with facilities for measuring CCIF IM distortion of tuners, as specified in the IHF-IEEE Tuner Measurement

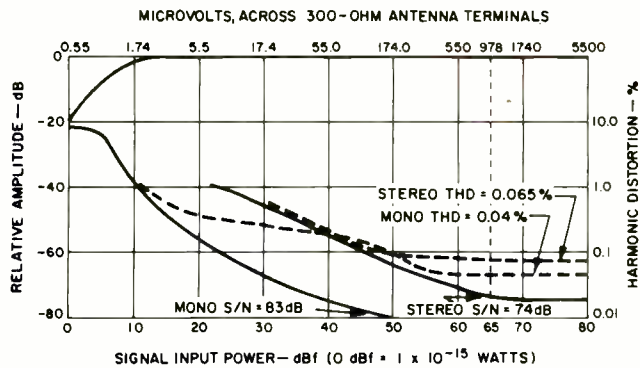
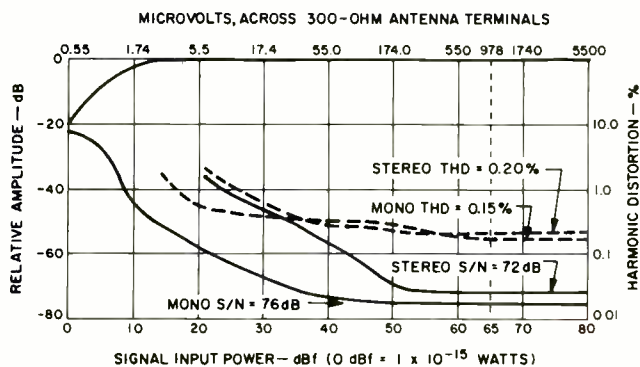


Fig. 1 — Mono and stereo quieting and distortion characteristics, wide i.f. setting.



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Fig. 2 — Mono and stereo quieting and distortion characteristics, narrow i.f. setting.

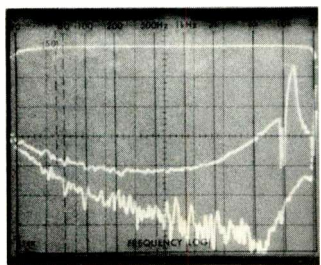


Fig. 3 — Frequency response (upper trace) and separation vs. frequency for narrow (middle trace) and wide (lower trace) i.f. bandwidth settings.

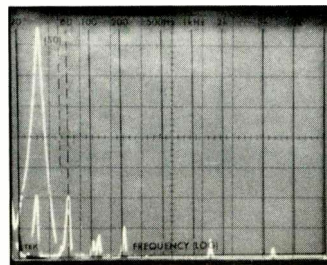


Fig. 4 — Spectrum analysis of crosstalk for 5-kHz signal in stereo FM tuner section in wide bandwidth setting. (Sweep is linear at 5 kHz per division; vertical scale is 10 dB per division.)

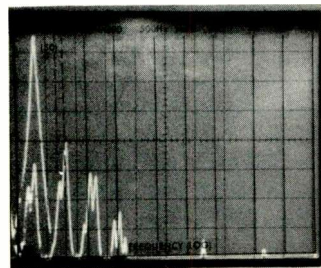


Fig. 5 — As above but with bandwidth control in narrow position.

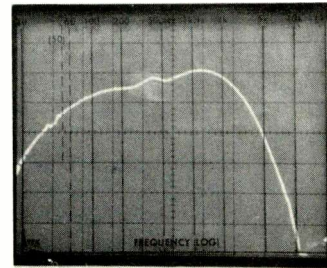


Fig. 6 — AM frequency response.

Standards. In this method, two tones (14 kHz and 15 kHz) are used as the modulating signal and the difference tone (1 kHz) which appears at the output is expressed as a percentage. For the Kenwood KR-7050, this IHF-IM reading was a mere 0.075 percent in mono and 0.12 percent in stereo, using the wideband i. f. mode. Many experts feel (and I agree) that this IHF-IM reading provides a better correlation between measurement and the sound quality that a tuner provides, and it is our intention to report results of these two-tone measurements in all future receiver and tuner test reports.

Figure 2 displays quieting and distortion characteristics of the tuner section when it is set to the narrow band position. Under these circumstances, S/N in mono drops to 76 dB and to 72 dB in stereo. Mono THD increased to 0.15 percent at 1 kHz and read 0.085 percent at 100 Hz and 0.23 percent at 6 kHz. In the stereo mode, THD was 0.2 percent for a 1-kHz signal, increasing to 0.33 percent at 100 Hz and dropping to 0.18 percent at 6 kHz. Considering the fact that the selectivity is quite high with this setting (we measured an alternate channel selectivity of 85 dB, at 400 kHz away from the tuned-to frequency, while Kenwood provided specifications for a 300-kHz separation, probably because of European channel spacings), these readings are still quite impressive. IHF-IM readings in the narrow-band setting increased to 0.17 percent for mono and 0.30 percent for stereo.

The i.f. and spurious rejection ratios both measured in excess of 100 dB (the limits of our test equipment), while image rejection was 85 dB, a bit better than claimed. Muting threshold was 9.0 μ V (24.3 dBf). Capture ratio was exactly 1.0 dB as claimed, while AM suppression measured a bit less than claimed, but a still very adequate 60 dB.

Figure 3 is a composite photo of the frequency response and separation capabilities of the stereo FM section of the KR-7050. Reponse was down 0.5 dB at 30 Hz and was within 0.6 dB of flat at 15 kHz. Vertical scale in Figure 3 is 10 dB per division. The lower trace represents the separation is somewhat degraded when the narrow i.f. setting must be used because of station crowding on the FM band in a given signal area. Key readings were 49 dB at 1 kHz, 44 dB at 100 Hz, and 45 dB for 10 kHz using the wide-band mode and 31 dB at 1 kHz, 28 dB at 100 Hz, and 30 dB at the 10 kHz using the narrow i.f. mode.

The nature and composition of the cross-talk in stereo was examined and is displayed in Figs. 4 and 5. In Fig. 4 (wide-band) the tall "spike" at the left of the sweep represents the "desired" left channel signal output, while the smaller spike observed at the right-channel output. As can be seen, the actual meter readings at the right channel output included fundamental cross-talk and second-order distortion, both of which were equal in amplitude of around 56 dB below the desired left-channel output. The test signal in this display is at 5 kHz and sweep is linear at 5 kHz per division from left to right.

In Fig. 5 we see the results of these same measurements using the narrow-band mode. In addition to observing reduced fundamental separation, we see the expected substantial increase in second-order distortion and third-order components in the right-channel output signal.

Figure 6 is a plot of the frequency response of the AM tuner section of the KR-7050. In this 'scope photo, log sweep was used (20 Hz to 20 kHz). Referenced to 1 kHz, response was down 10 dB at 60 Hz and 3.5 kHz. There is not much more that needs to be said about the AM section of this receiver.

Amplifier Measurements

While the FM tuner section of this receiver is quite impressive, the amplifier section really separates this receiver from others in its price and power class. In a word, it is superb!



MADE FOR EACH OTHER.

Earphones are made for ears. Yours. That's why the Beyer DT 440 has sound so natural and is so light and comfortable you don't even know it's there, even after many hours.

At 9.6 ounces, it is one of the lightest headphones available. And its weight is evenly distributed among the sponge-padded ear-cups and air-filled headband.

There's no great weight suspended from your head, and your ears never get squeezed.

Some people complain about the isolation of headphones that close them off from the world. So we built the DT 440 with a high velocity open design, to allow a natural mixture of recorded music and environmental sound.

How does it sound? Most

people say "spectacular." A great combination of impact and intimacy. The overall sound is wonderfully smooth and transparent. With clean, rich bass response. Powerful, lifelike midrange. Crystal-clear, undistorted highs. And perfect stereo imaging.

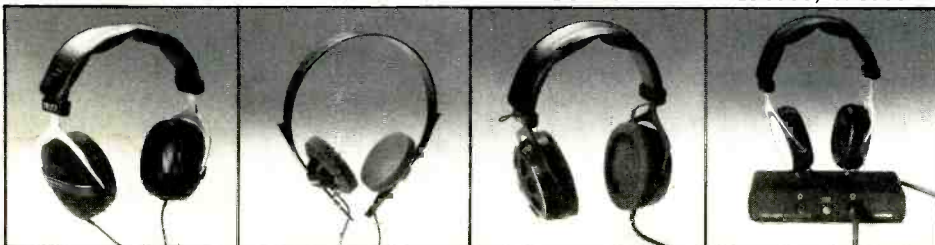
For sound — and for comfort — nothing beats a Beyer. We'd like to make one for you.

DT 220

DT 302

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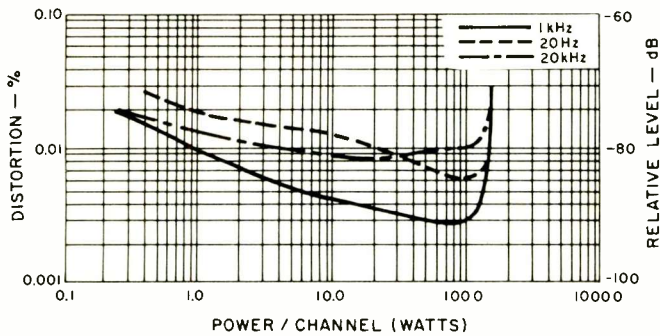


Fig. 7 — Harmonic distortion vs. power output.

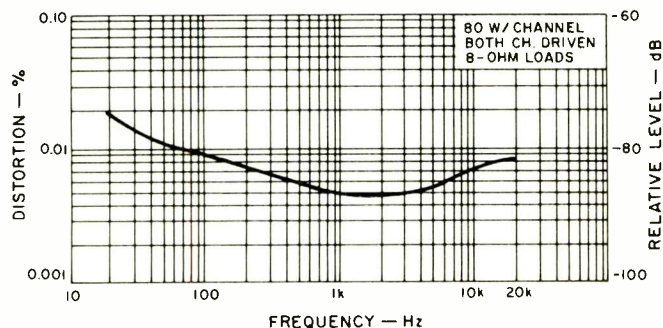


Fig. 8 — Harmonic distortion vs. frequency.

Not that the static measurements on the bench are that superior to those obtained with other receivers; they are what we would have expected from any conservatively designed unit. It's the way the unit performs.

Maximum power at mid-frequencies, using 8-ohm loads, was 91.8 watts per channel as against the FTC power rating of 80 watts per channel. Using 4-ohm loads, the amp delivered 126 watts per channel for the same rated THD. At rated output THD was a very low 0.005 percent at 1 kHz, rising to rated 0.02 percent at 20 Hz and 0.0084 percent at the high frequency extreme of the rated power band. SMPTE IM distortion was only 0.006 percent at rated output. Results of our power versus THD measurements are graphed in Fig. 7. Figure 8 is a plot of harmonic distortion at rated output versus frequency. Power bandwidth for rated output at rated distortion extended from 20 Hz to 30 kHz. CCIF IM Distortion measured 0.0028 percent using 9-kHz and 10-kHz tones, 0.0039 percent with 14-kHz and 15-kHz tones, and 0.0054 percent with 19-kHz and 20-kHz tones. Damping factor measured 75 at 50 Hz, a bit lower than claimed.

Because Kenwood emphasizes the "high speed" performance of the amplifier section of this receiver, we made additional measurements of interest to verify these claims. Figure 9 displays input (upper trace) and output square waveforms for a 20-kHz input signal frequency. Clearly, the bandwidth of this amplifier is very wide. We attempted to move up in frequency to find a point at which the rise of the output waveform and its decay might begin to show some tilt only to find that when such tilt was evidenced, it was present in our input signal display as well, indicating that the scope in use was not equal to the task (it has a useful bandwidth of 500 kHz). Slew factor, measured per the new IHF standards, was far in excess of 5.

Perhaps even more impressive was the square-wave shape at the output of the amplifier as shown in Fig. 10. The frequency, in this instance was not 100 Hz or 20 Hz, but a sub-audible 10 Hz, and yet there was absolutely no "tilt" to the flat horizontal portions of the waveshapes. To further explore the bandwidth (or "speed" to use Kenwood's term) of this amplifier, we reapplied a 20-kHz square wave signal to the amp (via the AUX input, incidentally) and magnified the scope display, superimposing input waveform above output waveform. We increased the level until the peak-to-peak voltage across the output terminals was equal to the peak-to-peak voltage of a sine-wave equivalent to rated output. As can be seen by a close examination of Fig. 11, we are only just beginning to see a slight (but equal) time delay in the rise and fall of the output waveform compared with the input signal.

RIAA equalization of the phono preamp circuitry was accurate to within ± 0.2 dB as claimed, from 20 Hz to 20 kHz. Phono input sensitivity, per the new IHF standards, was 0.25 mV for 1-watt output, and phono overload for a 1-kHz signal measured 220 millivolts. Signal to noise in phono, again using the new IHF Standard references of 5-mV input and 1-watt output was a very high 79 dB ("A" weighted). For the high-level inputs, sensitivity for 1-watt output was 22 mV, and signal to noise, referred to 0.5-volts input and 1-watt output, measured 78 dB, "A" weighted.

Figure 12 shows the multiple response traces obtained with each of the five bass and treble turnover positions with these controls set alternately at maximum boost and cut settings. The availability of so many different turnover points adds a great degree of flexibility to these tone controls, which are augmented by the additional mid-range tone control, whose maximum range of boost and cut is displayed in Fig. 13. Also shown in Fig. 13 is the response of the high-cut filter which, though sloped at a moderate 6 dB per octave, has a turnover point that is high enough in frequency so as not to interfere

Continued on page 94

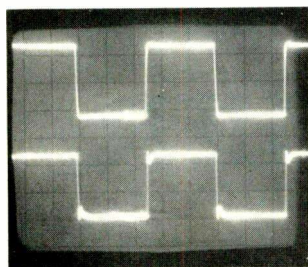


Fig. 9 — Response to 20-kHz square wave. (Upper trace is input.)

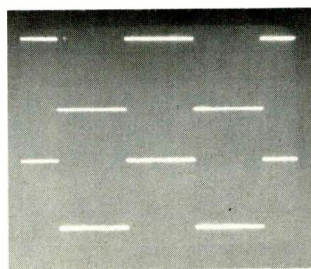


Fig. 10 — Response to 10-Hz square wave. (Upper trace is input.)

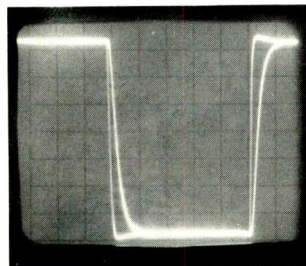


Fig. 11 — Response to 20-kHz square wave of rated output level superimposed on input wave form.

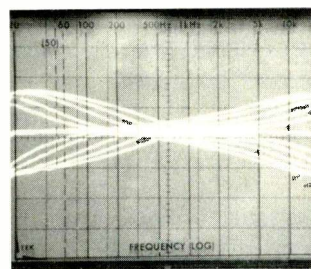


Fig. 12 — Bass and treble control response curves taken at all available turnover settings with maximum boost and cut.

SONUS Gold Series II Blue Label Phono Cartridge

MANUFACTURER'S SPECIFICATIONS

Voltage Output at 1 kHz/cm/sec:

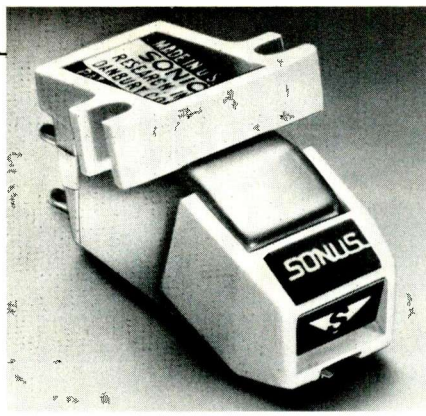
0.8mV \pm 2 dB (4 mV at 5 cm/sec).

Compliance: 50 cm/dyne \times 10⁻⁶.

Vertical Tracking Angle: 20° nominal.

Channel Balance: \pm 2 dB.

Nominal Channel Separation: 30 dB at 1 kHz; 20 dB over the range 20 Hz to 20 kHz using JVC TRS-1005.



Recommended Load Impedance per Channel: 47 kilohms resistance in parallel with no more than 400 pF. However, when intended for use with CD-4 type records (Blue Label Stylus only), capacitance should not exceed 250 pF.

Total Cartridge Weight: 5.5 grams.

Tracking Force Range: 1 to 1.5 grams.

Inductance: 150 mH/channel nominal.

Resistance: 300 ohms/channel nominal.

Price: \$154.00.

Replacement Stylus: \$81.50.

With the introduction of the Blue Label Gold Series II, SONUS has moved to further refine their excellent line of phono cartridges, based on their state-of-the-art technology. The SONUS Gold Series II contains an efficient magnetic structure that permits the use of a moving system of extremely low effective and total mass. The stylus tip is positioned on the same axis as the armature, so that little or none of the stylus motion is lost in rotation or by the generation of rotational resonances. The stylus pivot is located at the dynamic center of rotation of the moving system. It is made from material having nearly optimum elastometric properties, resulting in a highly compliant and very linear stylus suspension. Like previous SONUS cartridges, this series also has an extremely high compliance, which is specified as 50 \times 10⁻⁶ cm/dyne. The recommended tracking force is from 1.0 to 1.5 grams. Because of the very low inductance of the cartridge coils, the cartridge is less sensitive than usual to load capacitance and resistance. When mounting the cartridge, the manufacturer recommends that the arm should be adjusted so that the mounting surface of the cartridge is parallel to the record during playback.

The SONUS Gold Series II cartridge is available in three models, determined by their stylus type, but all using a common cartridge body. The Blue Label (top of the line) is fitted with a stylus of modified line contact that is suitable for the reproduction of stereo as well as discrete quadraphonic (CD-4, UD-4) records. The Red Label stylus is bi-radial (elliptical), and the Green Label stylus is spherical. Our review is restricted to the Blue Label stylus and cartridge.

Measurements

The SONUS Gold Series II Blue Label phono cartridge was mounted on an ADC LMG-1 magnesium headshell, whose total weight (including screws and nuts) was 8.5 grams, probably making it the lightest headshell currently available. The mounted cartridge was used with our reference tonearm, an

Audio-Technica AT-1009, mounted on a Technics SP-10 turntable. The cartridge was loaded with 47 kilohms in parallel with 200 pF capacitance for all measurements, except for those measurements above 20 kHz when the total capacitance in parallel with the 100-kilohm load was less than 100 pF. All measurements were made at a tracking force of 1.5 grams. During the test period, the average temperature was 70° F (21.11° C) and the relative humidity 65 percent \pm 3 percent.

Frequency response, using the Columbia STR-170 test record, is flat within 0.5 dB from 40 Hz to 12 kHz, then starts to slowly rise to +1 dB at 15 kHz and +2 dB at 20 kHz. Separation is 26 dB at 1 kHz, 17.5 dB at 10 kHz, 17 dB at 15 kHz, and 15 dB at 20 kHz. Inasmuch as this cartridge can also be used to play discrete quadraphonic records, we measured the frequency response up to 50 kHz using the JVC TRS-1005 test record. The high frequency response with this test record was +2.5 dB at 30 kHz, +4.5 dB at 40 kHz, and +6 dB at 50 kHz. Separation at these three frequencies was 14 dB, 16.5 dB, and 13.5 dB, respectively.

The response to a 1-kHz square wave shows a very large overshoot followed by ringing that decayed moderately quickly, with a stylus resonance at about 34 kHz. This type of square-wave response is common with cartridges capable of playing CD-4 records. The cartridge-arm low-frequency resonance was at 7 Hz and of 9 dB amplitude.

We understand that straight out of the box the vertical-stylus angle is 30°, which is much greater than usual. Apparently, the cartridge is deliberately made this way (due to high compliance?) because after a brief period of use the stylus settled down to about 24°. We wonder how much of this settling is due to movement in the butyl elastomer of the suspension pivot block and if, perhaps after a year of use, the angle might go further down?

The following test records were used in making the reported measurements: Micro-Acoustics TT-2002; Shure TTR-103, TTR-109, TTR-110, and TTR-115; Columbia STR-170, STR-100,

Fig. 1 — Frequency response and separation from the CBS STR-170 test disc.

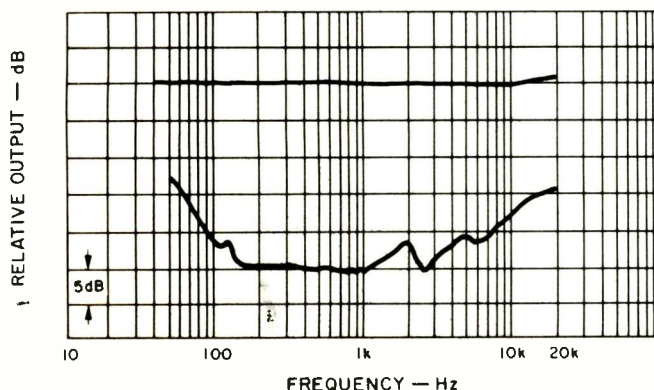


Fig. 2 — Frequency response and separation from the JVC TRS-1005 test record.

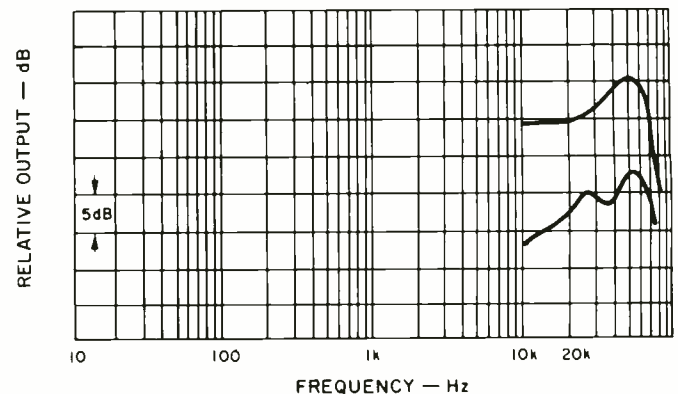
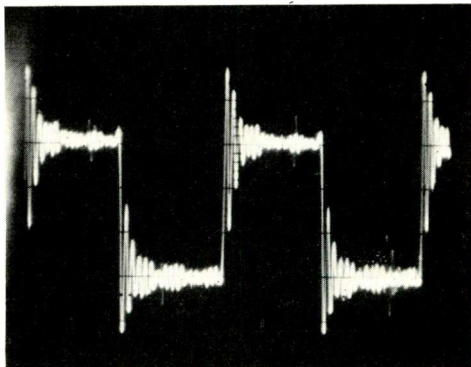


Fig. 3 — Response to 1-kHz square wave.



STR-112 and SQT-1100; JVC TRS-1005; Deutsches HiFi No. 2, and the Nippon Columbia Audio Technical Record (PCM) XL-7004.

Wt. 5.5 gm; d.c. res. 332.5 ohms; inductance 131.3 mH; opt. tracking force 1.5 gm; opt. anti-skating force 2.5 gm; output 0.72 mV/cm/sec; IM distortion (4:1) +9 dB lateral, 200/4000 2.7 percent, +6 dB vertical, 200/4000 5.8 percent; crosstalk (using Shure TTR-109) -28 dB; channel balance \pm 1.1 dB; trackability: high freq. (10.8 kHz pulsed) 24 cm/sec, mid-freq. (1000 + 1500 Hz, lat. cut) 31.5 cm/sec, low freq. (400 + 4000 Hz, lat. cut) 24 cm/sec; Deutsches HiFi No. 2 300-Hz test band was tracked cleanly to 95 microns (0.0095 cm), lateral at 17.9 cm/sec at +10.33 dB and 43.1 microns (0.00431 cm), vertical at 8.12 cm/sec at +3.64 dB. These latter measurements are extremely good and very few cartridges can track all the 300-Hz bands on this test record.

The SONUS Gold Series II Blue Label cartridge was able to play all the tracking and transient ability bands of the Micro-Acoustics TT-2002 musical test record without difficulty. Applause definition was excellent. The Shure Obstacle Course — Era III test record was played without difficulty. With the newer Shure Obstacle Course — Era IV test record, the harp and the harp and flute bands were just starting to mistrack at level 5. The flute and orchestral bells combination also started to mistrack at level 5. It is a rare cartridge, indeed, that can play all the bands of the Era IV test record without mistracking one or more high level bands.

Listening and Use Tests

As is our practice, our listening tests were performed both before and after laboratory testing of the SONUS Gold Series II Blue Label phono cartridge. While listening to the wide variety of records listed below, we became aware of the crisp

sound, excellent transient response, good sonic clarity, and lack of detectable coloration. It encountered no difficulty in cleanly reproducing the high recorded levels present on most direct-to-disc recordings.

The SONUS cartridges are well-known for their extremely high compliance. Because of this, the cartridge under test encountered some difficulty with badly warped records where the cartridge "bounce" caused the cartridge body to momentarily resonate. However, since badly warped records are seldom played, particularly by the owners of systems in which this cartridge is likely to reside, this should not be a problem of consequence.

In conclusion, we find that the SONUS Gold Series II Blue Label is an excellent cartridge and ranks among the top cartridges we have tested.

B.V. Pisha

Evaluation Equipment and Records

A rigorous listening evaluation was conducted utilizing the following equipment and the specific records listed below as well as many listed in past reports. The equipment included the Technics SP-10 and the SP-10 Mk II turntables with the Audio-Technica AT-1009 tonearm and the Technics EPA-100 tonearm, respectively, Crown IC-150A preamplifier, a pair of Crown DC-300A amplifiers used in the monophonic mode, a pair of stacked Duntech DL-15 speakers in each channel, and a Columbia SQL-400A SQ decoder. Each pair of speakers were connected to the amplifiers with Polk SoundCables using a Polk RC terminating network at the speaker end of each cable. The turntables were equipped with the Hiraoka Disk-SE22 turntable mat.

The following records were among those used to aurally evaluate the performance of the SONUS Gold Series II Blue Label phono cartridge.

Enter No. 91 on Reader Service Card

Stereo

Domingo and Ricciarelli: *Great Love Duets* — RCA ARL1-2799.

Liszt: *Piano Concerto No. 1 in E flat, Piano Concerto No. 2 in A major*, Campanella (piano), Soudant, The London Philharmonic Orchestra — PYE PCNHX 7.

Ravel: *Bolero*; Debussy: *Prelude a l'Après-midi d'un faune, La Mer*, Solti, Chicago Symphony Orchestra — London CS 7033.

Massenet: *Scenes Alsaciennes, Scenes Dramatiques*, Bonyngé, National Philharmonic Orchestra — London CS 7048.

Verdi: *Aida* (Opera for Orchestra), Camarata, National Philharmonic Orchestra — London Phase Four SPC 21171.

Haydn: *Symphony No. 51 in B flat, Symphony No. 55 in E flat (Schoolmaster)*, Dorati, The Philharmonia Hungarica — London Treasury Series STS 15443.

Rachmaninov: *Rhapsody on a Theme of Paganini*; Dohnány: *Variations on a Nursery Song*, Katchen (piano), Boult, London Philharmonic Orchestra — London Treasury Series STS 15406.

Tricia — Ark Recording Co. 2218-5.

Vivaldi: *Orlando Furioso*, Scimone, Ente Orchestra da Camera di Padova — (Erato Collection) RCA ARL3-2869.

Verdi: *La Forza del Destino*, (Price and Domingo), Levine, London Symphony Orchestra — RCA ARL4-1864.

Verdi: *Il Trovatore*, (Pavarotti and Sutherland), Bonyngé, National Philharmonic Orchestra — London OSA 13124.

Direct to Disc

Charlie Byrd — Crystal Clear Records CCS 8002.

Direct Disco — Crystal Clear Records CCS 5002.

Flamenco Fever — M & K RealTime Records RT-107.

Audio Directions presents *The Grab Bag* — JCM-R001.

Super Strings, Sugiyama, Tokyo String Ensemble — Toshiba LF-95010.

Intensive Care, Bellson, Brown, Smith — Discwasher Recordings DR 001 DD.

Pulse Code Modulation (PCM)

Janos Starker plays *Virtuoso Music for Cello* — Denon OX-7140-ND (distributed by American Audioport, Inc.).

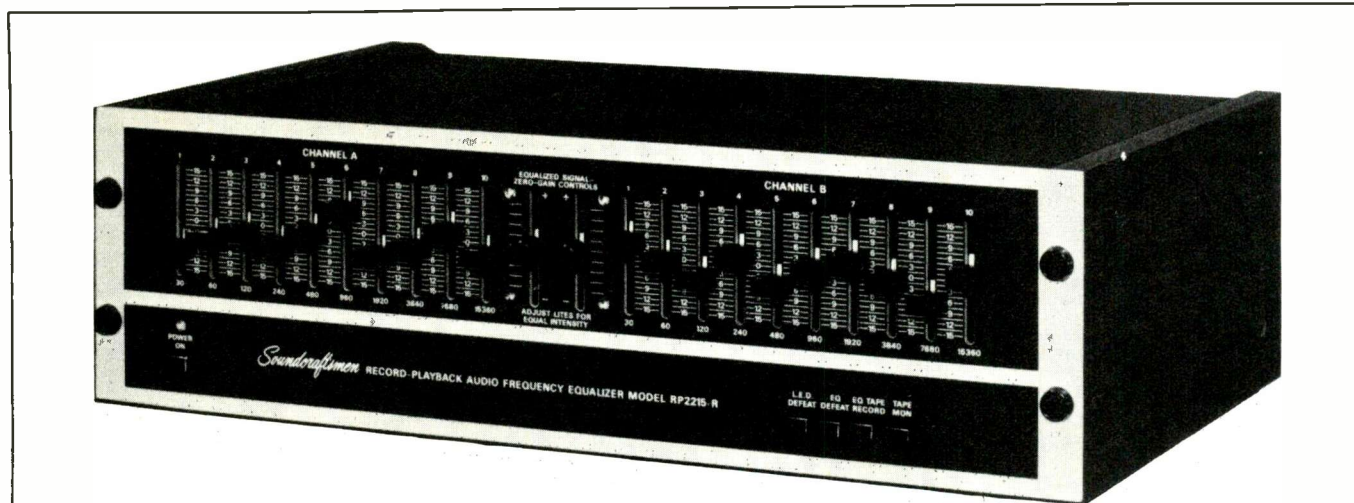
Bach: *L'Offrande Musical*, Paillard, Les Solistes de Orchestre de Chambre — Denon OX-7021-ND (distributed by American Audioport, Inc.).

Quadraphonic — SQ

Santana Festival — Columbia PCQ 34423.

Bartok: *The Wooden Prince*, Boulez, New York Philharmonic — Columbia 34514.

Soundcraftsmen Model RP2215-R Stereo Equalizer



MANUFACTURER'S SPECIFICATIONS

Harmonic Distortion: 0.01 percent at 2 V output level.

IM Distortion: 0.01 percent at 2 V output level.

Signal/Noise Ratio: 100 dB re: 2 V.

Octave Controls: Number, 10; range, ± 15 dB.

Dimensions: 19 in. (480 mm) W x 5-1/4 in. (133 mm) H x 11 in. (280 mm) D.

Weight: 21 lbs. (9.6 kg).

Price: \$370.00.

The Soundcraftsmen RP2215-R equalizer provides 10-band equalization for two channels with an excellent gain-match system. All designations and scales on the front panel are easily read, with white lettering against a black background. The bands are numbered at the tops of the vertical controls; the center frequencies are listed at the bottom, starting at 30 Hz and doubling for each band, up to 15,360 Hz at the end. (I believe I would have preferred some rounding off, just for convenience in use.) Between the two sets of boost/cut sliders with ± 15 dB ranges are the two channel "equalized-signal zero-gain controls" for matching the gain with EQ to that with it defeated (0 dB). Top and bottom LEDs with each control indicate the need for gain increase or decrease, and equal intensity of the LEDs verifies that the level with EQ matches that without. This is a very worthwhile feature, particularly if EQ will be switched in and out with speakers being driven.

Front-panel push-button switches allow switching EQ in or out, adding EQ to program back to the preamp/receiver, in-

serting EQ in the feed to a tape recorder, or adding EQ to the playback from a tape recorder (not mentioned in the instructions). There are also switches for the LED indicators *On/Off* and a.c. power *On/Off*. On the back panel, there are sets of stereo phono jacks for feeds to and from a preamp or receiver and to and from a tape recorder, a convenience outlet with a 600-watt rating, a fuseholder and a handy interconnection diagram.

The front panel of the RP2215-R has standard rack dimensions, and, with the removal of the top cover with wooden side pieces and of the chassis feet, the unit can be so installed. Removal of the chassis top cover revealed one large PCB with the great majority of components. The soldering was very good, and wirewrap was used for connection to the front-panel sliders. The three op amps were in sockets, which would facilitate making replacements, if needed.

Performance

With all of the boost/cut controls set to the zero detent, swept frequency response plots were made of both channels. There were some deviations from perfectly flat, but they were less than 0.5 dB. The detents were soft in action, and there were some minor variations when setting for flat response with EQ in. If precisely flat response is the goal, it is better to use *EQ Defeat*. There are ± 15 dB scales next to each control bar-knob, but they served just as rough indicators. For example, -15 dB actual was reached with a setting of -12 dB. The accuracy was sufficient for the intended purposes, however, and the graphic display of all the settings retains its value. Swept responses of each of the filter sections at maximum settings showed that shapes were quite consistent and that all maximum adjustments were close to 15 dB. When the 960-Hz filter was at its maximum boost, the bandwidth was 395 Hz, for a Q of 2.43 ($Q = \text{Center Frequency}/\text{Bandwidth}$). One-octave bandwidths ($Q = 1.4$) were secured with boosts of about 11 dB. With a restriction of $Q = 1$, for minimal ringing, the maximum boost was 9 dB, *not* a restriction for normal EQing.

The input impedance was 50 kilohms across most of the band, with some reduction at the highest frequencies. The

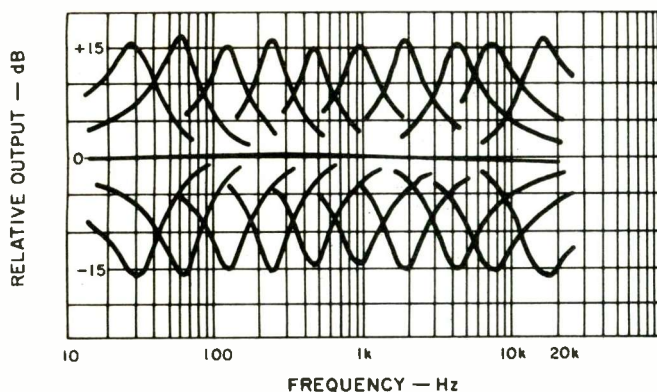
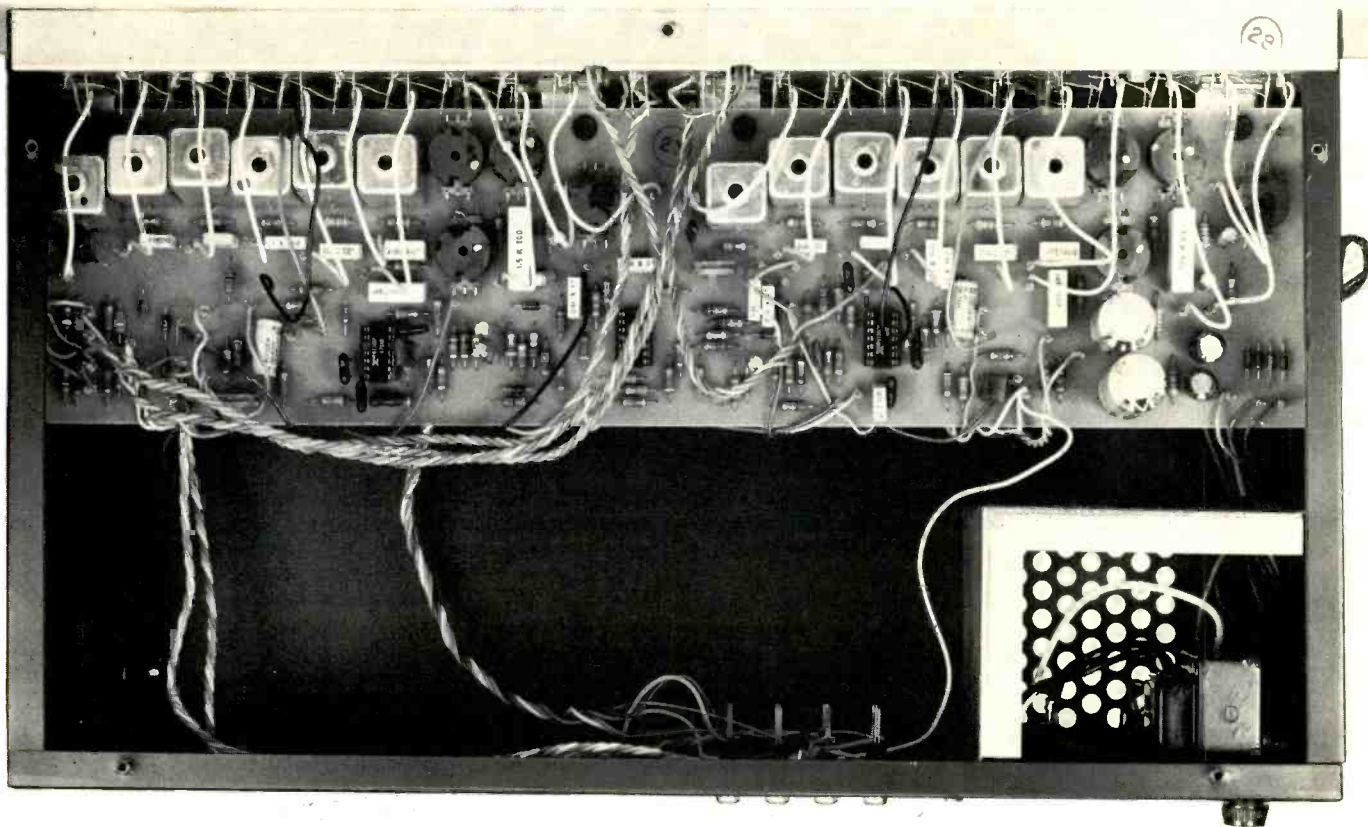


Fig. 1 — Frequency responses of individual filter sections at maximum boost and cut and of unit with all controls at zero.



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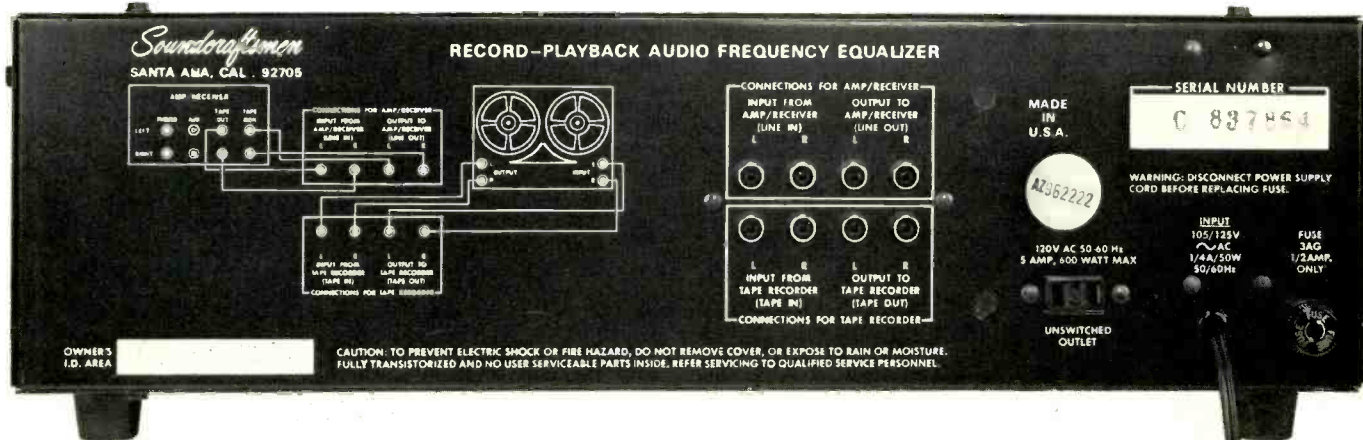
output impedance was very consistent, changing ever so slightly from 150 ohms at 20 Hz to 142 ohms at 20 kHz. With the gain-matching controls in detent, the EQ-in/EQ-out gain change was -0.2 dB for left and -1.0 for right. The gain-set LEDs indicated a need for minor adjustment, however, and when that was made for equal intensity in each set, the in/out change was 0.1 dB at most. An input of 80 mV was needed for proper operation of the indicators, with 0.3 V matching the zero position of the gain-match controls. Pink noise was fed into the unit, many combinations of EQ were inserted, and then the gain was adjusted to zero with the controls. Within the -15 dB to +6 dB range of the gain sets, they worked very well in all cases. With true rms metering, all measured in/out gain changes were less than 1.5 dB. Anyone who has switched an equalizer in/out with offset gain can testify to the value of this feature. The maximum output levels were a very consistent 8.0 V across the entire band with symmetrical clipping.

The measured slew rate was the same for positive and negative directions, very close to the 1.6 V/μs spec for the op amp used. The frequency response was 3 dB down at 80 kHz, and the THD with 2 V out was 1 percent at 72.5 kHz — both

generally compatible with the slew rate. The Soundcraftsmen had very low THD, whether the load was very high impedance or consisting of a 10-kilohm resistor shunted by 1000 pF per IHF standard. At 1 V out, distortion products were 0.0035 percent or less for most of the range, rising to 0.0062 percent at 10 kHz and 0.015 percent at 20 kHz. (These figures are true THD, they are not THD + Noise. The distortion output of a Sound Technology 1701A was analyzed with a Hewlett-Packard 3580A to get the actual levels of each distortion product.) 1M distortion was 0.0025 percent with the high Z load and 0.003 percent with the IHF load, with up to 2 V output. There was little change in the relative level of any distortion products until almost 4 V. At that point, THD was up to just 0.1 percent at the frequency extremes, and 1M distortion was up to 0.009 percent with the IHF load. These low distortion figures are superb, period.

Signal-to-noise ratios were measured using 1 V as a reference. With "A" weighting, the result was 95 dBA. This is actually 1 dB better than the specification of 100 dBA at 2 V output (95 dBA + 6-dB signal increase = 101 dBA at 2 V actual). On a CCIR/ARM basis with the 1 V reference, the ratio was 95.0 dB. The noise in a 20 Hz to 20 kHz bandwidth

Continued on page 94



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Jon Tiven

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The column



86

Rickie Lee Jones

Warner Bros. BSK 3296, stereo, \$7.98.

Rickie Lee Jones is something. Don't worry about trying to figure out who she reminds you of — the blondness of a Joni Mitchell, the timbre of a Wendy Waldman or a Laura Nyro, the worldliness of a Tom Waits. She is far too much her own assured self to make any comparisons matter. So let us go straight to what we have to call "the sounds."

Side one opens with the album's most obviously commercial shot, *Chuck E.'s in Love*. (Is Chuck E. really Waits' comrade in crime, Chuck E. Weiss?) It is a fingerpoppin' number that sounds like a left field hit. If so it'll be a nice change of pace for the airwaves. A good start, but then the side bogs down a bit with a couple numbers that just don't swing or sparkle. However, *Young Blood* does begin to pick up the pace again, and *Easy Money*, the story of a failed caper, and *The Last Chance Texaco*, close the side with some striking drama.

Side two opens fast from the gate with *Danny's All-Star Joint* which swings but furiously. Rickie's vocal is

as seductive as you could ever hope for. Hey, any song that opens with "a juke box that goes doyt-doyt" is reet with me. *Danny's* is the hot one on the album.

Then comes the cool one, *Coolsville*, wherein Rickie's voice sounds in turn like a trumpet, a tough guy, and a vamp. It is a serious piece of ambience. *Weasel and the White Boy's Cool* is about Sal of the Barrio. Rickie works in a sly tribute as she finds Sal working at Nyro's Nook. *Company* is Rickie's torch song, one that someone like Jane Olivor or even Barbra Streisand could have a field day with. The finale *After Hours (Twelve Bars Past Midnight)*, a particularly Waitsian title, is a solitary musing — "You an' me, streetlight/We'll paint the town — grey" — with lyrics as sparse and evocative as the best of Randy Newman.

With her debut, Rickie Lee Jones has burst upon the scene with an album of vivid songs populated with strongly etched characters like Sal and Chuck E., Bragger and Junior Lee. Real people in very real feeling situations, the strongest supporting cast since early Springsteen with Crazy Janie and the

rest. The album's production and musical performances in support are of obvious excellence. It sounds like one of those rare albums that the same old session cats really got into. Me, I can hardly wait to hear more. My appetite is sorely whetted. M.T.

Sound: B

Performance: A-

Contents Dislodged During Shipping: Tin Huey

Warner Bros. BSK 3297, stereo, \$7.98.

Taking that big step from Rubber City and aiming straight at your heart, here comes Tin Huey from Akron, Ohio, with their first big-label album. Making their sentiments known from the outset, they open the album with a diabolical cover of Robert Wyatt's cover of the Monkees' *I'm a Believer* (yes, written by Neil Diamond) in a bid for instant accessibility. Strong attack to catch the ear, and then right into their own stuff with their own vision.

Tin Huey is an aggressive, intelligent band of loonies. Separating them from the pack immediately is the dimension and edge that Ralph Carney's multi-

tude of woodwinds gives them. They bear traces of lots of bands, most of them English — Roxy Music for sure, Family, Soft Machine, Caravan, Robert Wyatt's work. The influence of key eccentrics like Carla Bley and Captain Beefheart is also evident.

Tin Huey's songs are satiric idea pieces that are often very funny. With *I Could Rule the World If I Could Only Get the Parts*, the title says plenty. Directly following it is the mock sequel *Coronation*. *Hump Day* captures the thoughts of the guy on the tire line. *Pink Berets* is the hilarious tale of a reverse benefit of the Equal Rights Amendment, namely the male USO girl who entertains the WAC's ("I really go for girls in army fatigues"). *Squirm You Worm* is a 2½-minute vignette right out of Ross MacDonald. And there's lots more.

They challenge. They sound nothing like either Boston or Devo. Many of their ideas are all their own. The big constant is the insistent, muscular rock beat (kudos for drummer Stuart Austin's performance). With Tin Huey the enclosed lyric sheet is a big plus because of the music's unusual thrust.

Tin Huey is a great reason to listen without labels on the music. They are new, but not New Wave, surely not punks. Their music is no buzz-saw. They may take a couple of listenings to get accustomed to, but then whoever said that everything worthwhile came easily. M.T.

Sound: B Performance: A-

Let's Have a Party: Roomful of Blues
Antilles AN 7071, stereo, \$7.98.
So Far: Downchild

Adelphi AD 4114, stereo, \$7.98.

When the Blues Brothers album broke big, ripples were sure to follow the big wave, and these two bands have both had a direct effect on the Belushi/Aykroyd production and its evolution. Roomful of Blues, originally from Boston, were the original back-up band used for the first Blues Brothers nightclub dates. Downchild, who hail from Canada, is the source for one of the Brothers' album's highlights, (*I Got Everything I Need*) *Almost* written by Downchild's chief writer and lead guitarist Don Walsh.

Roomful of Blues plays rocking rhythm and blues as if the '60s, '70s and half of the '50s never took place. They have an ideally sympathetic producer in Joel Dorn who did so many classic Atlantic Records jazz sessions. The band itself is a seven-piece unit including three saxes. Their repertoire is mostly R&B tunes from the late '40s and '50s with about 30 percent original

AUDIO • July 1979

material. Sources include Arthur Crudup, Chuck Willis, Big Joe Turner, and Fats Domino for their arrangement of Hank Williams' *Jumbalaya*. They have a real good party groove, tight but loose enough to swing. Preston Hubbard's work, alternating bass guitar and bass fiddle, adds an extra measure of authenticity. To get the sound they did, the band would almost surely have to go to New York for a place like Regent which is an old funky room.

Downchild draws from many of the same sources as Roomful of Blues, not too surprisingly, with nearly half of the album's material self-generated. Highlights include Joe Turner's *Flip, Flop and Fly*, Lloyd Price's *Stagger Lee*, Elmore James' *Madison Blues* which George Thorogood has scored big with lately, and the aforementioned *Almost* which is a slightly stronger groove than the famous cover.

I've been out there in the front of those who actively miss that big backbeat of the classic R&B in current dance music, so I'll try to put this down simple. If the the great band and the big bucks behind the Blues Brothershipped you to that sound, Roomful of Blues and Downchild are going to hit you where you live. Each band can play the stuff cold, and both are still out there playing dives, scuffling and living the music like there was no other choice. (*Amen, brother!*—E.P.) M.T.

Roomful of Blues

Sound: B - Performance: B+

Downchild

Sound: B Performance: B+

Jerry Lee Lewis

Elektra 6E-184, stereo, \$7.98.

They don't call Jerry Lee Lewis "The Killer" for nothing, and that is what his debut Elektra album is about. Lewis hasn't sounded like he's enjoyed making a record so much in ages. He's loose with the band, speaking to them, calling out during songs.

He's got some great material to rock out on, too. *Don't Let Go* has some of The Killer's patented on-record breathing, maybe the best example since all the way back to *Breathless*. Bob Dylan's *Rita May*, *Number One Lovin' Man*, *Rockin' My Life Away*, and *Rockin' Little Angel* all rock just as strong with that old Sun Records energy with no "dated" feeling at all. Lewis does up a few oldies right fine, too. There's Chris Kenner's *I Like It Like That*, Arthur Alexander's *Every Day I Have to Cry* with some added lyrics by The Killer about his parade of wives



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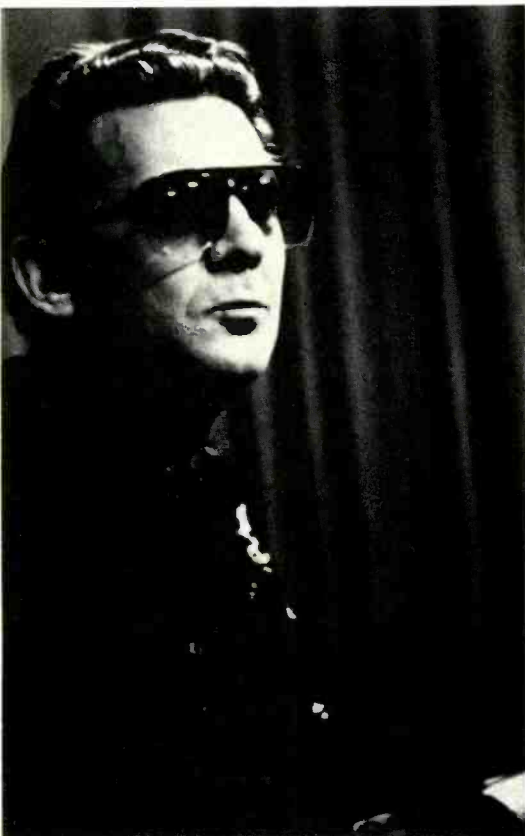
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and a romp through Lloyd Price's *Personality*. Between the latter and the version of the weeper *I Wish I Was 18 Again*, evidence is in that his fabled sense of outrageous humor is totally intact.

The man most responsible for this vinyl rejuvenation is producer Bones Howe, who also handles the equally idiosyncratic Tom Waits. Like Waits, Howe has recorded Lewis with nearly



everything live in the studio. Killer doesn't react well to a building-block overdub approach. He needs to be loose and joking to be at his best, and on *Jerry Lee Lewis* he is. This is one terrific rock & roll record that reaffirms why they call him Killer. M.T.

Sound: B+

Performance: A

Gimme Some Neck: Ron Wood
Columbia JC 35702, stereo, \$7.98.

At Budokan: Bob Dylan
Columbia PC2 36067, stereo, two discs, \$11.98.

Bob Dylan is the ultimate songwriter but, as proven time and again, lacks the ability to perform his songs in a manner aesthetically consistent with his vision. Either he's so incredibly hokey and cornball that his semitic whine is totally out of context with the musical backing, or he's placed in front of a barrage of musical confusion that apologists explain away with "there were just too many people onstage." The guy simply does not put himself across, has little or no comprehension of his audience, and just hasn't done a truly super concert in a decade and a half. He's written some good tunes, but other artists always record the superior versions — hey, that's life, Jimmy. Ron Wood, on the other hand, is strictly a performer, and if this album serves as any indication of where he is at, Mr. Wood couldn't write a song if someone handed him the words and music. His debut solo album had two decent self-penned numbers on it, but even these were simply guitar riffs with nonsense lyrics thrown upon them. Not that I mind his jamming, but to try to pass it off as a finished song is asking too much of the listener.

Fortunately, there is a tie-in between these two records, a new Bob Dylan song played and vocalized by Mr. Ronnie Wood called *Seven Days* which is very good and sung in a style which could easily be mistaken for Dylan himself. Ronnie Wood is certainly no Rod Stewart, but his pipes can be effective, provided he's got tunes to work with (as on the opening track *Worry No More*, written by Jerry Williams) as well. However, the best Ron Wood-composed song on **Gimme Some Neck** is pretty awful, save for a guitar riff that evokes memories of his days in The Faces, the song being *Buried Alive*. The rest of the album con-



sists of fine performances of non-tunes, to be filed with **Jamming With Edward** — Charlie Watts plays extremely well, Wood's guitar tones are nice although he's never been a soloist, and the contributions made by Mick and Keith never get in the way of the Ron Wood persona. They cannot turn background music into excitement, but it isn't exactly bad. It just isn't really much of anything in the way of surprises, but the two songs written by outsiders are really enjoyable once or twice. Really.

Bob Dylan's exercise/exorcism is more likely to motivate the listener to press "reject," as he has gone to great lengths to clean up his music for his notorious neo-Vegas tour, captured here before it hit America. If Dylan with flutes, background singers, and a host of other useless sweeteners appeals to your taste, you might as well not listen to me and go ahead and buy the album. Personally, I loved Dylan when he was the musical innovator in the mid-Sixties, but in the Seventies the best thing about Bob Dylan has been the people he's influenced: Tom Petty, Bruce Springsteen, Elvis Costello, and the rest. In these people the spirit of Dylan lives, but the man himself seems preoccupied with sidetrips that have little to do

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with being a great songwriter. Here he's downright silly — I'd rather listen to Ron Wood sing *Seven Days* given the choice, but fortunately, I can also listen to the older records. J.T.

Sound: B Performance: C-

Squeezing Out Sparks: Graham Parker and the Rumour

Arista AB 4223, stereo, \$7.98.

One of the songs on Graham Parker's new album, **Squeezing Out Sparks**, is called *Passion is No Ordinary Word*, an expression that explains the artist's appeal. It's his abundance of passion that constitutes Parker's front-man excellence. Despite his limited range, he takes chances vocally and the flourishes invariably work. In the opening number, *Discovering Japan*,

fluence by Elvis that's just shy of obvious due to the absence of organ.

Aside from their voices, which at times sound identical, Graham differs from Elvis by writing in a more antique R & B vein, and he sings "straight" rather than as the ironic or detached commentator that Elvis so often appears. Although it's like splitting hairs to choose a Parker ballad over one of his rockers, Graham's vocal quality of sounding hurt and defiant, hard but still warm with emotion, is best conveyed in such slow numbers as this album's *Love Gets You Twisted* and *You Can't Be Too Strong*. With a more solid band Parker would be unstoppable, but as is the flaky guitarists doodle and squeal without laying down a steady rhythm with the almost unnoticeable bass and drums.



Parker's g's come on like bullets, his a's are elongated to facilitate a whine, and his voice shivers from the feeling of foreignness and horror he's conveying. Parker takes himself as seriously as Elvis Costello and much more so than Mick Jagger: you can tell by the way he's pictured on the album cover, wearing the same shirt he did on his first two album covers and spewing sparks from his head in a halo of fury and inspiration, that he means business. Parker sings a ballad with more conviction than either the icy Elvis or self-conscious Mick could muster, and as a songwriter he ain't lacking in invention.

If you read the album's song titles and lyrics as biographical signposts, you'll agree that Parker has been through heaps of business and personal anguish since his last slick and spineless LP. On **Squeezing Out Sparks** he's emerged hurt but musically recharged — these tunes bite or clobber, and their lyrics are more lucid than before, thanks probably to an in-

Squeezing Out Sparks is a comeback from the limp and messy stuff on his previous album, and it contains more mature sentiment and observation than the childishly vengeful *Mercury Poisoning* single that was issued before the LP's release. Aside from a few numbers that aren't actually complete songs (*Don't Get Excited*), the compositions on this album rank among Parker's best. *Local Girls* is a standout "fun" tune in the vein of *Hotel Chamberlain*, *Discovering Japan* is driving and dynamic, *Passion is No Ordinary Word* hits like a sledge hammer, *Nobody Hurts You* rocks and reels, and the ballads are all gems of the injured-but-emoting hero. Not only is Parker a tough little bugger who knows how to croon, but this LP shows him still developing as a composer. Now if he could just tighten up his band, Parker & the Rumour could give Elvis a run for his money (or CBS').

Sound: B Performance: A

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In its forthcoming issue (Vol. 2, No. 1), The Audio Critic breaks new ground. For the first time, its test reports find a number of newly introduced *medium-priced* components to be just a small notch below State of the Art, a rating that would have been unimaginable as recently as a year ago.

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B0114	20	2	40	100	2	1 1/2	12.88/22.88
B0115	24	2	20	75	10	1 1/2	17.88/33.88
B0116	20	2	40	100	12	2	34.88/67.88
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Nice Guys: Art Ensemble of Chicago
ECM ECM-1-1126, stereo, \$7.98.

The Art Ensemble of Chicago has been a standard for group improvisation for over ten years; this is without the benefit of a new album since **Fanfare for the Warriors** on Atlantic in 1974. Their re-emergence on the vinyl of Manfred Eicher's ECM label is not only heartening, but could be the best thing to happen to Free Jazz since Ornette Coleman. Here is one of the greatest jazz groups ever, recording for one of the best produced and most highly respected labels of the decade, with the full advantages of Warner Bros. massive exposure and distribution. And most important of all, the music lives up to all these great expectations.

Nice Guys is not quintessential AEC, but it tells you more about the group and their unique musical perspective than any single album they've released. The AEC uses jazz as a tool of assimilation to extract the essence from various forms of black music like the blues, rock, R & B, and African music. On *Ja* they take the new folk form of Jamaican Reggae into the next step of evolution. After an introduc-

tion of suspended horn lines, Don Moye launches into a jaunty Reggae rhythm as Joseph Jarman affects a Jamaican accent. A humorous Lester Bowie trumpet solo leads to a rhythmic dissolve where the horns play sustained lines over bass and percussion turbulence. Though the Reggae rhythm is no longer being pounded out, its very absence supplies the pulse around which everyone plays.

The AEC's homage to their African roots comes out in *Folkus*, a suite that shares a similar mood with *People In Sorrow*. A quiet morning sunrise is created with small, chirping whistles and tinkling percussion instruments ("small instruments") to emulate the waking sound of a jungle. The piece becomes increasingly agitated, and the group switches to larger instruments. Another shift takes us on a midnight walk. The sounds of chimes, marimba, and vibes hang in the air, gradually increasing to a stormy crescendo and finally shifting into a fading, percussive jungle rhythm.

The album also contains two AEC "rave-ups." 597-59 begins with a punchy horn riff, then everyone flies into solos backed by the powerplant drums of Don Moye and bassist Malachi

Favor's psychic navigation. Roscoe takes a solo of funnelled energy. A bluesy vamp they've been using in concert for a while finally turns up as the foundation for *Dreaming of the Master*. Malachi walks his bass over a lazy 4/4, while Lester takes a muted solo of structural subtlety. He removes the mute and sends the band into double-time. Jarman restates the head then careens through the room on tenor.

ECM has recorded the Art Ensemble to perfection. It's especially gratifying in the ethereal sections like *Folkus* and *Cyp*, where silence is used as part of the musical fabric to surround the understated play. AEC's high-energy pieces are captured with a new clarity that only further reveals the intuitive interaction of these masters. There is a certain amount of self-editing involved in this recording. Themes are not developed as fully as they might have been, and there is the difficult attempt to create the full AEC sound on only two sides of a record. The fact that both almost completely succeed only adds a new facet to their expansive conception. *John Diliberto*

Sound: A

Performance: A

Alone and Live: John Coates, Jr.
Omnisound N1015, stereo, \$6.98.

Pianist John Coates, Jr., combines the melodic appeal of Vince Guaraldi, the harmonic resourcefulness of Keith Jarrett, and the delicacy of Bill Evans without sounding in the least like an imitator. Indeed, Coates proves that it's possible to create an entirely new and personal style while adhering closely to the melodic and conceptual expectations of the piano-jazz mainstream.

Coates' compositions — most notably the limpid *Prologue* (No. 39), the wistfully rhapsodic *Homage* and *The Prince*, with its striking interjections of dissonance — are fresh, tuneful, fluid, imaginatively voiced, gracefully stated, and developed through sensitive harmonic embellishments and an inventive, multi-directional sense of variation. On those few occasions when he flashes a few busier-than-normal runs (as on his Tatum-esque reading of *When It's Sleepy Time Down South* and the gospel-flavored *Sketch*, which brings to mind early Les McCann), he does it with the taste and restraint needed to keep them from degenerating into garish exhibitions of gratuitous virtuosity.

This solo piano recital is, with a couple exceptions, even more satisfying than **The Jazz Piano of John Coates Jr.** (Omnisound N1004), the album which reintroduced Coates to the recording scene after an absence of nearly 20 years. The bass and drums on that album, while certainly well-played, by their very presence constricted Coates' gently liquid sense of flow. He subtly slows or speeds his lines or alters their lengths, sometimes startlingly so, at other times almost imperceptibly, just enough to make a crucial interpretive difference. Listen to *Never Have Known an Esther* and *Mixed Feelings*, then try to imagine bass and drums in back of these tunes; it's obvious that solo-piano is the ideal format for Coates' personalized approach to musical mensuration.

The two exceptions alluded to above are both pleasant and listenable, but they lack the substance and originality of the rest of the album. *Something Kinda Silly* is a whimsical throwaway that sounds like the piano backgrounds that are dubbed onto silent film comedies. *The End of the Beginning* is a soft-rock ballad which could conceivably make Coates rich and famous if words were written to it.

The recording closely captures the full warmth of Coates' distinctive right-hand touch, though the lower registers have an oddly metallic sound. Moreover, some of the denser chords

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are plagued with distortion. There are also a lot of extraneous lounge noises (cash register, chitchat, etc.) which comes across with irritating fidelity. I suppose it could be considered "atmosphere," but why anyone would want to chitchat through artistry of Coates' caliber is beyond me!

Omnisound, Inc., is located in Delaware Water Gap, PA 18327, while the album is also handled by the New Music Distribution Service, 6 West 95th St., New York, NY 10025. *Tom Bingham*

Sound: C- Performance: A-

Common Ground: Paul Winter
A&M SP-4698, stereo, \$7.98.

Out of the Woods: Oregon
Elektra 6E-154, stereo, \$7.98.

Early in the '70s the Paul Winter Consort recorded several albums of pristine improvised music that you might call chamber jazz. Before long, the Consort minus Winter began a parallel recording and performing career as Oregon using the state's unspoiled, clean image as an inspiration and jumping off point for their acoustic music.

One composition has become closely identified with both bands, and that is guitarist Ralph Towner's haunting *Icarus* which is revived on the new Paul Winter album **Common Ground** and given a decidedly Brazilian flavor that hints at bossa nova from Steve Gadd's percussion. It is again a highlight of an album abounding in delights.

On **Common Ground** Winter features the recorded sounds of the

humpback whale, timber wolf, and African fish eagle as inspirations and integral parts of the music. The album was made at Winter's farm with a large number of friends including some former Consort members present as well as musicians from Brazil and Africa. Thus, the album becomes literally their common ground meeting place for some truly uplifting, beautifully recorded music.

For Oregon **Out of the Woods** is their first for a new label after seven on Vanguard. The new one is as graceful, quietly dazzling, and hypnotic as any they have done to date. For me, the highlight of highlights is their new recording of Jim Pepper's *Witchi Tai-To*, a melody based on an American Indian chant that Oregon has recorded once before. This time they stretch it out to 8½ minutes, opening with a Collin Walcott-Ralph Towner duet on sitar and 12-string guitar before the whole ensemble joins in. It is a deceptively simple and catchy melody which, as oboe player Paul McCandless notes, "doesn't have more than five notes or six chords, and yet it has such life." It is the perfect closer to an extraordinary album. Throughout, the album has a clarity of tone that allows the softest of subtleties to emerge fully.

Neither album has had a chance to get too far from my turntable since I received them. They are simply too good a balm for an overdose of urban insanity to let slip away.

Michael Tearson

Sound: A Performance: A





Black Sheep: Hammer
Asylum 6E-13, stereo, \$7.98.

Black Sheep should go a long way towards establishing Jan Hammer as the Grand Buffoon of Rock. Though he built his reputation as a flashy technician with the original Mahavishnu Orchestra, Hammer was always the soloist most prone to churning out his own terminal, note-bending cliches. It's dubious whether Hammer ever had any artistic inclinations at all. In recent years he abandoned his tenuous roots in jazz and fusion music, so he can strut across the stage with a portable synthesizer slung around his neck like a yoke.

Performing under the group name of Hammer, he plays ponderous hard rock that is overbearing and pretentious in its attack on the groin. Hammer isn't interested in making music, but in making us think he's a macho stud; instead he comes off like a flaccid idiot.

He still likes to consider himself as an electronic explorer and technician par excellence. A disclaimer on the dust jacket announces "There is no guitar on this album." But does it matter when Hammer uses the synthesizer to steal every hard-rock guitar riff in the book?

With the lyrics like "I think I just got tired of waiting/What am I waiting for," and almost cretinous arrangements, Hammer couldn't even put this past a 10-year-old Kiss fanatic. When they say you're too old to Rock and Roll, they're talking about a state of mind, not age. Hammer could never have the immediacy and conviction that inspires the best rock.

John Diliberto

Sound: B- Performance: F

Beaubourg: Vangelis
RCA AFL1-3020, stereo, \$7.98.

Beaubourg is a daring step for classical-rock keyboard wizard Vangelis to take. It abandons all the symphonic structures, rock dynamics, and

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sequencer rhythms that made **Albedo 0.39** and **Spiral** such popular successes (in their limited way). **Beaubourg** is a composition of pure electronic sound and spacial relationships; rhythms are implied, melodies are hinted at, and harmony is accidental. Instead **Beaubourg** deals with clusters, scribbles, digital plusations, and a few fanfares, which are carefully strewn back and forth, up and down, and across and through the stereo spectrum.

It's a tantalizing trip that takes you through mazes and turns you inside and outside of the sound. Occasionally you're left stranded, but the next oscillation slips in shortly. Vangelis is a romantic so that even his abstractions are emotional with moments of subtle poignancy. But if you need so much as a consistent drone to latch onto, you'd do well to step into **Beaubourg** with caution.

John Diliberto

Sound: A- Performance: B

Out of Reach: Can
Peters International PLD 9024, stereo, \$7.98.

The last 10 years have been a long strange trip for Can. Rock mutants in every sense, Can has seen a lot of changes since the free form days of **Tago Mago** and **Monster Movie**. **Out of Reach** seems to be an album of consolidation. Holger Czukay, one of the two former Stockhausen students, has dropped out for this album. Relative newcomers Rosko Gee (bass and vocals) and Reebop Kwaku Baah (percussion), both from one of the funkier editions of Traffic, have a much stronger presence. In fact, when given full reign, the rhythm section of Gee, Baah, and Jaki Liebezzeit on drums is a polyrhythmic dervish. The four instrumentals, *Serpentine*, *November*, *Seven Days Awake*, and *One More Day* are feverish energy dances of intoxicating rhythmic intensity, throbbing bass lines, and scorching sustained guitar runs from Michael Karoli. Where any holes exist, keyboardist Irmin Schmidt fills them with skewed textures.

Of the remaining cuts, the best that can be said is they are a brief respite from the absolutely exhausting intensity of the other tracks.

Though Can has always made extensive use of studio techniques in their recording, their post-production work has always been a little lax. So the pressing and the American remix (not credited on the LP) are not as bright and clean as the music calls for.

John Diliberto

Sound: B- Performance: B

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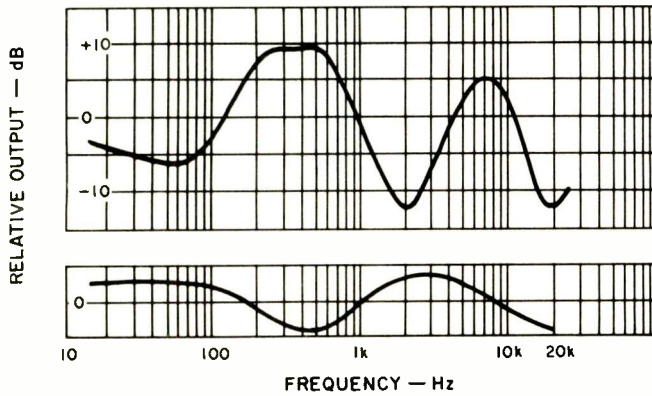


Fig. 2 — Top, swept-frequency response with 60-Hz filter at -6 dB, 240 and 480 Hz at +6 dB, 1920 Hz at -9 dB, 7680 Hz at +6 dB, and 15,300 Hz at -15 dB. Bottom, swept response of EQ used to improve system response (see text).

was at -88.6 dBV. The manufacturer makes reference to the very high ratio possible with 10 V out, but that is an unrealistic operating level. The operating signal/noise ratio will be determined by the signal level actually used in a system. A level of 1 V is quite possible, but so is 0.3 V which will have a signal/noise ratio 10 dB lower. With its low noise and low distortion, the RP2215-R will deliver excellent performance over a range of normal signal levels.

In-Use Tests

The instruction book for this equalizer is unusual in that it is part of the album cover for the test record that is supplied

with the unit. The text and illustrations are generally good, particularly for the equalized-signal zero-gain controls. A separate sheet provides a brief discussion of 10 possible equalization tasks, and comments at the end of the test record aid in the understanding of how to proceed. Each side of the record contains two series (A & B) of bands of 1/3-octave noise, centered on each of the filter sections in turn. With each of these bands, there is a reference band at 1 kHz on the other channel. The level of this band is varied for each of the test bands for level matching with EQ by ear. There is a too-small note on the album that the recording matches 75 dB SPL, and a caution should be added on the need to test at this level to minimize errors. Still, a very helpful scheme. Also supplied are what Soundcraftsmen calls Computone charts. Imprinted are scales for each of the boost/cut controls and the equal-gain sets. When a particular EQ has been set for such a task as smoothing system response, the full-size form can be cut away to match all of the settings. There are a dozen forms, so that many EQ combinations can be stored "in memory" for instant resetting.

Swept responses were made of the RP2215-R after putting in some rather unlikely (and weird sounding) settings and also after adjusting the overall system response in a small room. The latter response did not have any exaggerated boosts or cuts, and the sound was much smoother with this EQ in. Checks with a 1/3-octave RTA showed about a 7-dB spread in levels from 63 Hz to 20 kHz before EQ and a noticeably reduced 4-dB spread with the use of EQ.

The Soundcraftsmen RP2215-R offers excellent performance with very low noise and superbly low distortion, even with many combinations of boost/cut adjustments. The equalized-signal zero-gain control-and-indicator scheme is another plus feature of this equalizer. *Howard A. Roberson*

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Kenwood KR-7050 *continued from page 80*

severely with musical material being reproduced when it has to be used.

The action of the loudness compensation circuit of the Kenwood KR-7050 is shown, for various incremental settings of the master volume control, in Fig. 14. Note that Kenwood has wisely, in our opinion, refrained from incorporating treble boost in their loudness circuit. Many manufacturers mistakenly incorporate such boost in typical loudness compensation circuits because the familiar Fletcher-Munson curves suggest that human hearing falls off at the high end. Indeed it does, but the degree of roll-off in hearing is almost entirely independent of listening levels (unlike the bass fall off which increases at progressively lower listening levels) and therefore no loudness compensation needs to be added in the treble range.

Subjective Evaluations

We were so impressed with the performance of the Kenwood amplifier circuitry of the KR-7050 that we thought it might be best to invite a few additional qualified listeners to join us in our listening tests. Since, to our ears, we could not distinguish between the tight, clean, and utterly transparent sound of some of the best separates we normally use for reference listening purposes in our lab and the sound of the KR-7050, we decided to conduct the auditions with the receiver hidden from view.

A recent outstanding digitally mastered disc, Telarc's DG-10040, **Malcolm Frager Plays Chopin** (he uses a Bosendorfer Imperial concert grand piano) was played first. This recording makes unusual demands upon the entire audio reproduction system, from cartridge to speakers, with transients, percus-

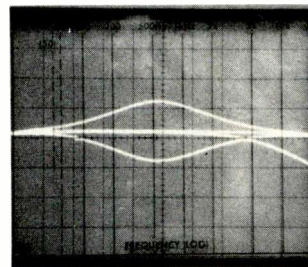


Fig. 13 — Response of mid-range control and high-cut filter.

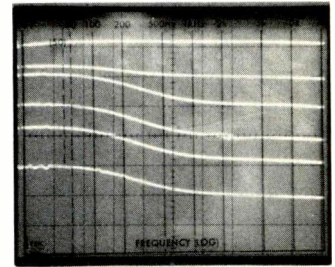


Fig. 14 — Loudness control characteristics.

sive, and bass piano sounds that must be heard to be believed. All three of my itinerant listeners guessed that we were listening to a high-end, high priced separate amplifier, a "straight wire with gain" controlless preamp, and a top-grade cartridge. They were right about the cartridge, but were all astounded when the Kenwood receiver was unveiled. Other recordings, ranging from direct-to-disc rock to orchestral works, were also auditioned, although by this time the nature of the equipment had been disclosed.

Here is one instance in which the wide-band measurements made on the bench correlated nicely with the subjective results obtained during actual listening tests. If Kenwood prefers to talk about high-speed while others talk about low TIM, high slew rate and wide bandwidth, I have no quarrel with them. Just so long as they keep on making receivers that sound this good!
Leonard Feldman

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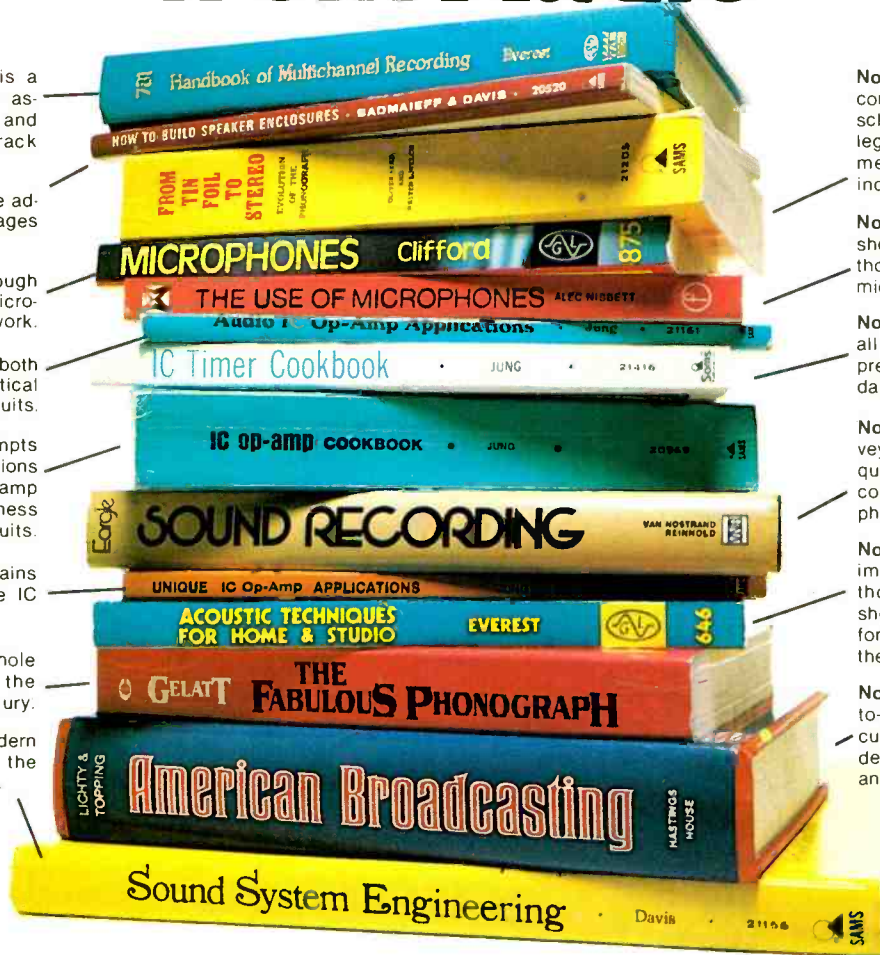
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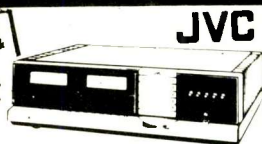
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Our third issue, now being put together, will contain PART II of our phono cartridge survey, plus a small survey of pickup arms. There will be reviews of arms from BREUER DYNAMIC, DYNAVECTOR, FIDELITY RESEARCH, GRACE, HADCOCK, INFINITY, JML, LUSTRE, MAYWARE, SERIES 20, SME, STAX, SYRINX, and ULTRACRAFT

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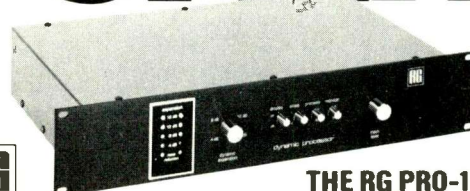
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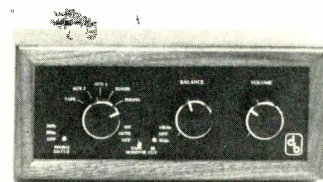
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The Art Of Record Storage

Phonograph record storage has two new facets from the technology of Discwasher Labs. Understanding the problems will make the cures very meaningful.

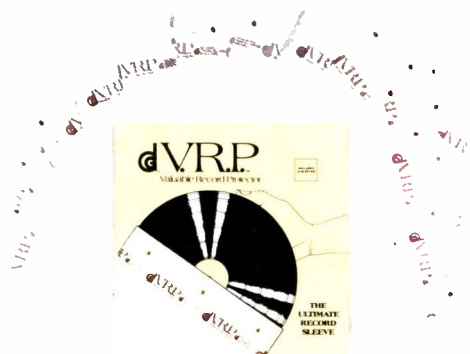
Valuable Record Protector

Cure for Record Sleeve Problems

Before VRP™, record sleeves were generally paper, or "polybags," or "poly-lined" paper. Experiments show that paper can easily scratch records, and paper textures will imprint delicate vinyl under the conditions of summer heat. Many "polysleeves" and "poly-lined" sleeves will literally "ooze" plasticizers from the plastic onto discs and leave a clogging film. The polysleeve material generates static, and often sticks to the stored records.

The new Discwasher VRP™ sleeves are totally plasticizer-stable material that is measurably anti-static and so very smooth that records effortlessly "glide" out of the sleeve without scratching.

VRP™—a refined record sleeve for recordings you value. Only \$2.75 for a pack of ten.



DiscKeeper



Cure for Storage Warp

Shelf storage at only 4° or 5° of slant will warp records even at room temperatures. And stuffing records into a tight shelf space makes album selection nearly impossible.

Enter the new DiscKeeper™—a storage system of formed aluminum and solid walnut panels. Precision compression bars hold about 50 albums perfectly flat, perfectly upright, and pull forward to permit you to "page through" your entire stored collection as you would in a record store.

The DiscKeeper™ is \$65 of excellent furniture and unparalleled record protection.

Discwasher, the leader in high technology record care, now states the new art of record storage.



discwasher®, inc.

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