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How to get good service

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • JULY 1978 $1.25
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WHEN SOMETHING WORKS THIS SUCCESSFULLY MOST PEOPLE WOULDN'T MESS AROUND WITH IT.

BUT PIONEER COULDN'T LE
WELL ENOUGH ALONE.

WE'VE REPLACED THE WORLD'S BEST SELLING CASSETTE DECK WITH SOMETHIN

For the last two years, the CT-F2121 has satisfied more people than any other cassette deck in the world. Because the major difference between it and much more expensive front-loading cassette decks was price. Not performance.

But there remained one highly critical group of people who were never satisfied. Pioneer's engineers. Who were constantly looking for ways to make it even better.

THE DIFFERENCES YOU CAN SEE.

The most obvious improvement over the old 2121 is the new front end of the CT-F4242.

What isn't quite as obvious is the thinking behind it. The new push-button oil-damped door, for instance, doesn't tilt in like the CT-F2121's, or out like others. Instead, it slides neatly up over the lighted tape transport. So it's easier to get your cassette in and out of the deck.

This same kind of thinking went into repositioning the hard Permalloy Solid tape heads. Vertically. Right at your fingertips where you want them. So it's no hassle to keep them free of dust and in good working order.

Pioneer's engineers also put a great deal of thought into features our competitors seem to have given very little thought to. Features like a three-position bias and equalization switch, instead of the more typical two. And a six fin tape drive shaft, instead of the common three, to hold your cassettes more securely.

The point is, you'll see a lot on the new CT-F4242 that you won't see on other modestly priced cassette decks.

But there's more to this deck than meets the eye.

THE DIFFERENCES YOU CAN HEAR.

By far, the most impressive refinements in the new CT-F4242 are the ones you can't see.

Inside, for example, where many cassette decks use small flywheels that can cause wow and flutter, the flywheel in the new CT-F4242 is massive. (In fact, it's 30% bigger than the 2121's.) Our bigger flywheel reduces wow and flutter even further. So you get cleaner and crisper recordings.

Then there's our new Dolby system.

Practically every decent cassette deck today has some sort of Dolby system that adds clarity to the music by reducing tape hiss. But the Dolby in the CT-F4242 cuts tape hiss enough to produce an incredible signal-to-noise ratio of 62 decibels. A figure comparable to far more expensive equipment.

And although you'll find a multiplex filter switch on many cassette decks, you won't find one on the CT-F4242. It's built-in. Which literally means that you can't make a bad FM recording.

If you're beginning to get the idea that there are vast differences between the CT-F4242 and other decks for anywhere near the same price, you're right.

So visit your Pioneer dealer and listen to the most sophisticated cassette deck ever made for the money. Pioneer's CT-F4242.

Once you hear it, you'll be glad Pioneer couldn't leave well enough alone.

High Fidelity Components

PIONEER®

WE BRING IT BACK ALIVE.

	CT-F2121	CT-F4242
HEADS:	"Permalloy Solid" recording/playback head x1. Ferrite erasing head x1.	"Hard Permalloy Solid" recording/playback head x1. Ferrite erasing head x1.
WOW AND FLUTTER:	No more than 0.12% (WRMS)	No more than 0.08% (WRMS) No more than ± .2% (DIN)
FREQUENCY RESPONSE:	Standard LH tape: 30 to 13,000 Hz (40 to 11,000 Hz ± 3 dB), Chromium type tape: 30 to 16,000 Hz (40 to 12,000 Hz ± 3 dB)	Standard LH tape: 30 to 14,000 Hz (40 to 13,000 Hz ± 3 dB), Ferrichromium type tape: 30 to 16,000 Hz (40 to 15,000 Hz ± 3 dB), Chromium type tape: 30 to 16,000 Hz (40 to 15,000 Hz ± 3 dB)
SIGNAL-TO-NOISE RATIO:	Dolby OFF: 48 dB (Standard and LH tapes) Dolby ON: 58 dB (over 5 kHz, standard and LH tapes). When chromium type tape is used, signal-to-noise ratio is further improved by 4.5 dB over 5 kHz.	Dolby OFF: more than 52 dB Dolby ON: more than 62 dB (over 5 kHz standard and LH tape). When chromium type tape is used, signal-to-noise ratio is further improved by 4.5 dB over 5 kHz.

*Walnut veneer wood cabinet optional at extra cost.

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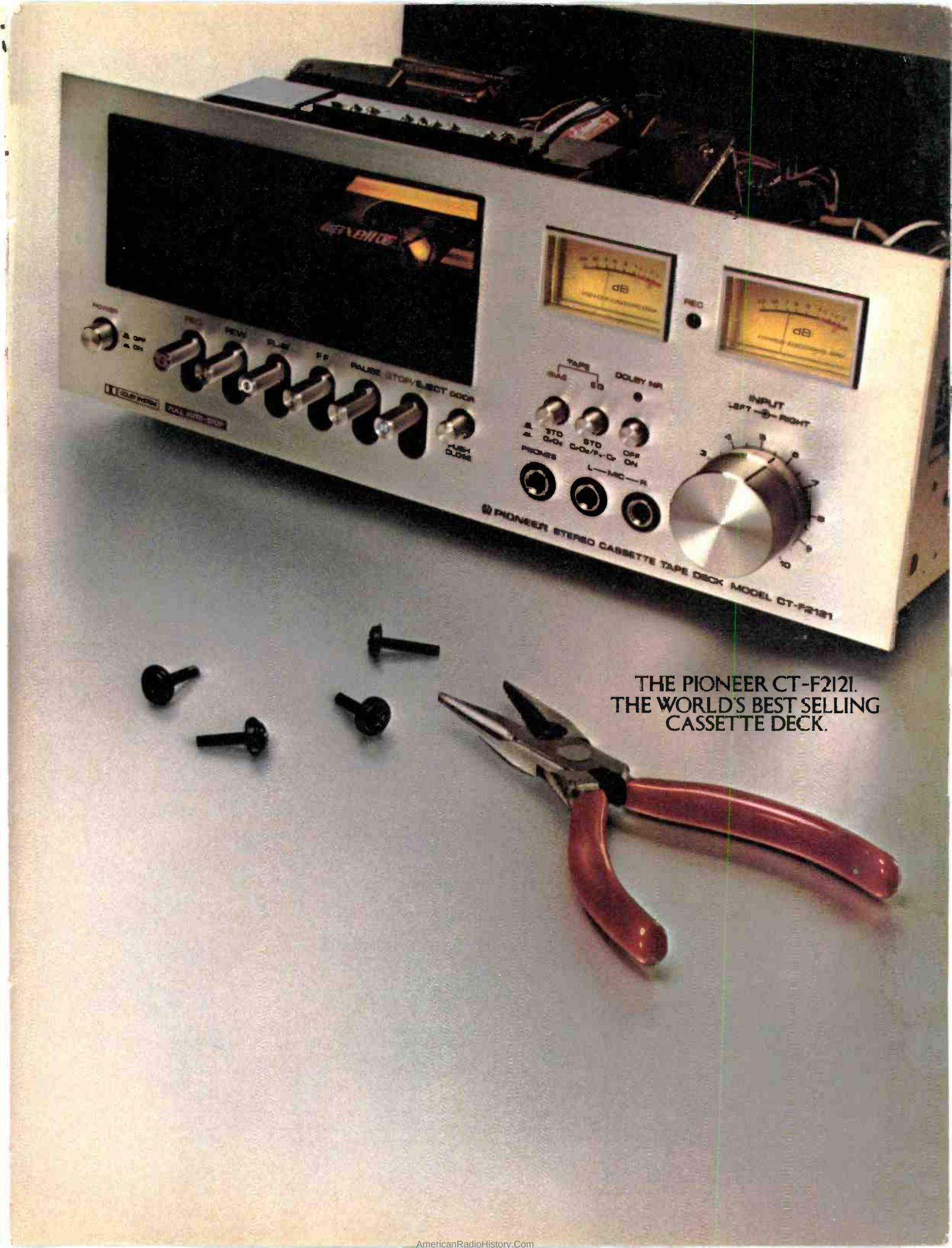

Audio

July 1978 "Successor to RADIO Est. 1917" Vol. 62, No. 7

Feature Articles

Equipment Profiles

Record Reviews

Audio in General

About the Cover: Many people listen to their car stereo more than their home system what with commuting times, vacations, and jobs where a car is needed. To find out how four car-stereo systems compare, see page 56. Photo: Photographic Illustrations

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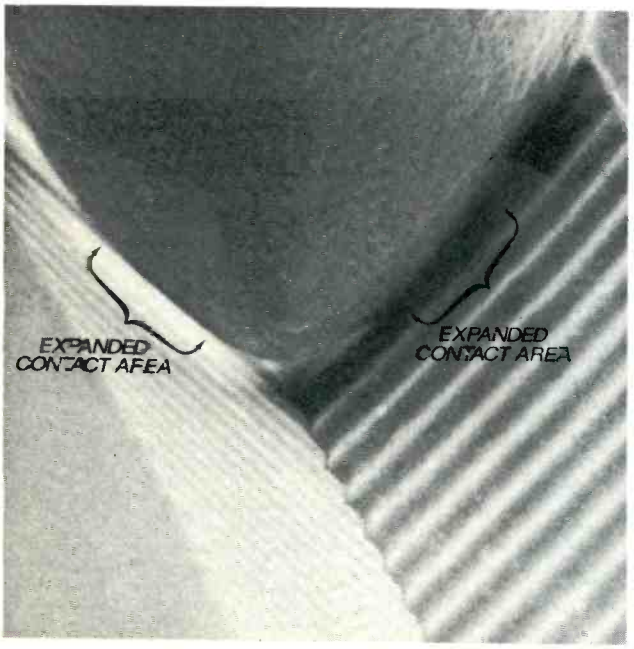
PROFESSIONAL

WUHY-FM, Philadelphia, rates Stanton's 881S superior in every aspect!

Disc Jockey, Stephen Brooks at the mike.



Scanning Electron Beam Microscope photo of Stereohedron® stylus, 2000 times magnification; brackets point out wider contact area.

The Stanton 881S cartridge has been rated, worldwide, as the outstanding stereo cartridge of its time. So, it ought to be a rather delicate pick-up. Not so, says WUHY . . . outstanding National Public Radio FM Station in Philadelphia. Mr. Ajit George, Director of Development and Awareness, quotes his Engineering Staff in this way:

1) The 881S is rugged . . . we back cue with no damage to the stylus.
2) It has excellent flat frequency response.
3) It handles high level complex music passages with complete freedom from mis-tracking.
4) The 881S has the highest output compared to average high quality magnetic cartridges, plus the fact that it gives superior signal-to-noise ratio from the phono preamp.

We are in total agreement with all of the above except, honestly, the 881S was not designed for back cueing.

Stanton guarantees each 881S to meet the specifications within exacting limits. The most meaningful warranty possible, individual calibration test results, come packed with each unit. Whether your usage involves recording, broadcasting or home entertainment, your choice should be the choice of the professionals . . . the Stanton 881S.

For further information write to: Stanton Magnetics, Terminal Drive, Plainview, N. Y. 11803

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Time and a bit of genius make the difference.

It wasn't easy to create the world's finest DC receiver. It took time. A great deal of it. For research. For development. For testing. And it also took a bit of genius – the kind of genius that Sansui engineers are world famous for. But we at Sansui were determined. And we succeeded. So now there is a patent pending on Sansui's unique new DC amplifier circuitry.

The Sansui G-6000 DC receiver, like Sansui's entire G-line of DC receivers, incorporates this unique technology. It delivers music reproduction so superb you will actually hear the difference.

With Sansui's DC amplifier circuitry you get better low frequency response. It extends all the way down to zero Hz (DC), from main-in. That's one reason it's called a DC receiver.

With Sansui's DC amplifier circuitry you get better high frequency response. It goes all the way up to 200,000Hz, from main-in. Just try to find another receiver with frequency response this wide.

With Sansui's DC amplifier circuitry you also get fuller and faster response to musical transients. This is measured in slew rate and rise time. And the slew rate and rise time figures of the Sansui G-6000 are far better than those of any competitive models.

And with Sansui's DC amplifier circuitry there is virtually no distortion. While eliminating the capacitors, we've solved the time delay problem that causes transient intermodulation distortion (TIM). And total harmonic distortion is a mere 0.03% at full rated power: 65 watts/channel, min RMS, both channels driven into 8 ohms from 20-20,000Hz.

The Sansui G-6000 DC receiver is much more than its extraordinary amplifier circuitry. It is also a superb FM section, with excellent sensitivity, selectivity and signal-to-noise ratio, virtually without distortion.

The G-6000 also gives you high-technology protection circuitry that keeps both your speakers and receiver safe, always. It offers perfectly positioned and highly accurate power, tuning and signal meters. And human engineering, for greatest ease-of-operation. The G-6000 is also elegantly styled with a beautiful simulated walnut grain finish.

Listen to the G-6000 or any of Sansui's full line of DC receivers at your franchised Sansui dealer today. You'll easily hear the difference that Sansui DC makes.

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The Sansui G-6000 DC Receiver

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Tape guide

Herman Burstein

Playback Problems

Q. Tapes played on my recorder seem to have a "fuzzy" sound and lack depth. Faulty speakers are ruled out by playing a record, which gives excellent results. However, even tapes recorded on other machines present the same problem. I regularly clean and demagnetize the heads but this does not help. What is the problem here? — James Chenault, Hampton, Va.

A. Your problem boils down to something wrong in either the playback amplifier of your tape machine or the tape input of your audio amplifier. Try connecting the output of your tape deck to a different high-level input on your amplifier. If you still get a fuzzy sound, the trouble lies in your tape deck. If the sound clears up, it would appear that you have a misconnection between the tape deck and the amplifier, or there is a fault in the tape input of your amplifier. Also, check the cable connection between the tape deck and amplifier.

If the difficulty is in the tape deck, any number of things could be wrong, faulty resistors, capacitors, transistors, dirty switches, etc. If this is the case, then you will need the services of a competent audio technician.

Recorded Buzz

Q. When I put my tape recorder in the record mode, a buzz is recorded on the tape. I have been told that this may be due to the motor. Can you help me? — Foster Overcash, Canton, Ill.

A. It may be that the unit's motor is sparking and the record amplifier is picking up this buzz, or it may be a hum somewhere in your system that is being picked up. Higher harmonics of the 60 Hz hum frequency would result in a buzz. In this case, a defective filter capacitor could be responsible.

Stereo Simulation

Q. How can I enhance mono recordings on my tape deck in order to simulate a stereo effect? — Mike Harkey, Lorain, O.

A. You can introduce a variety of differences between the right and left channels. You can emphasize the treble on one, and bass in the other. You can add presence — emphasis of your range around 3 kHz — in one channel, provided your audio amplifier has a presence control. You can also add echo or reverb to one of the channels.

Built-in Dolby

Q. While many cassette decks include the Dolby noise reduction system, why aren't there more open-reel decks with built-in Dolby units? — Mallory Harding, Denver, Colo.

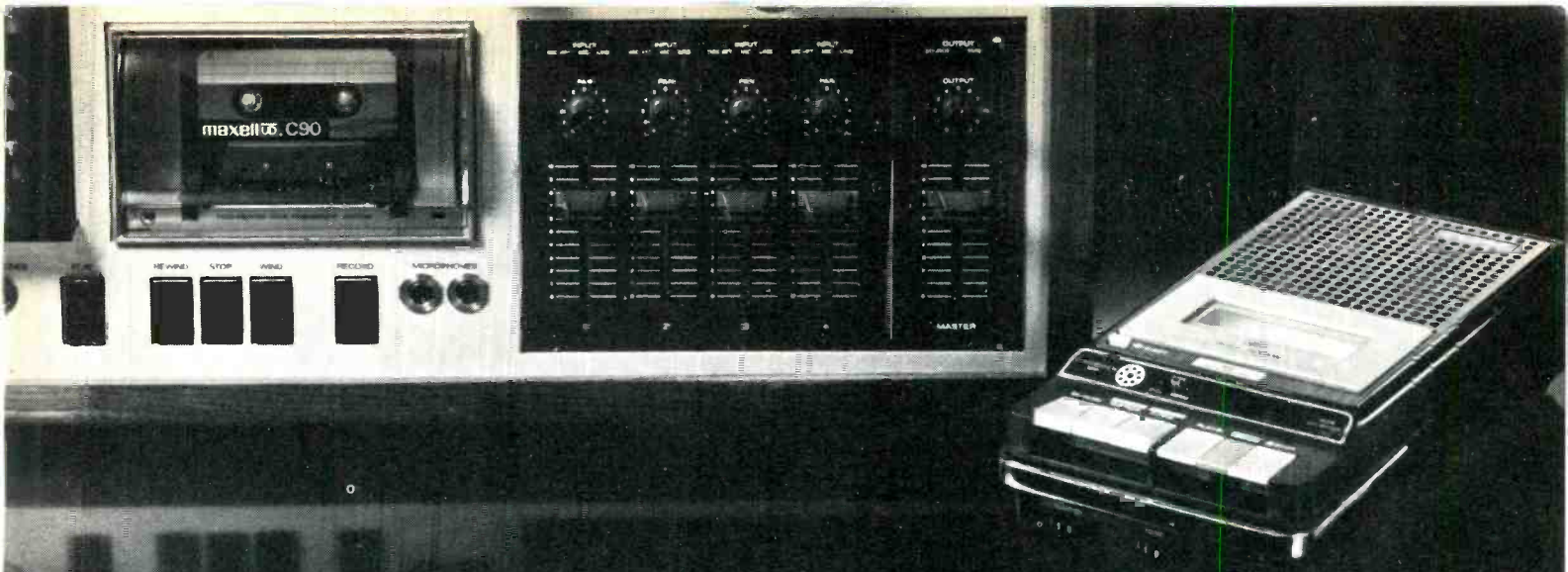
A. In terms of noise reduction, the Dolby unit is apparently most effective at the slowest speeds. Therefore, it was logical to apply it primarily to cassette decks which operate at 1⅞ ips. However, Dolby has gradually been making its appearance on open-reel machines.

Transport Troubles

Q. I've been having wow and flutter problems with my cassette deck. I attribute this problem to the motor driving the take-up reel and capstan. Could a hysteresis-synchronous motor be substituted for the one presently in my unit? — David Campbell, Brooklyn, N.Y.

A. The motor is only one of a number of possible sources of wow and flutter. Pressure pads, tape guide systems, pressure roller, capstan, tape tension, etc. may also be responsible. I suggest that you follow the lubrication and cleaning procedures suggested in the instruction manual to see how much this eliminates these possible causes of wow and flutter (such as a gummy head or guide). However, if you still have a problem, then I suggest that you consult the manufacturer as to the desirability of motor replacement.

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



It's hard to find a $1,000 tape deck that doesn't use Maxell. Or a $100 tape deck that shouldn't.

If you spent $1000 on a tape deck, you'd be concerned with hearing every bit of sound it could produce.

That's why owners of the world's best tape decks use Maxell more than any other brand.

But if you're like most people, you don't own the best tape deck in the world and you're probably not using Maxell. And chances are, you're not hearing every bit of sound your tape deck is capable of producing.

Whatever you spent for your tape deck, it's a waste not to get the most out of it. So spend a little more and buy Maxell.

Maxell. You can think of us as expensive tape. Or the cheapest way in the world to get a better sounding system.

maxell

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Maxell Corporation of America, 60 Oxford Drive, Moonachie, N.J. 07074.

Audioclinic

Joseph Giovanelli

Phono Ticks & Pops

Q. What is the reason for phonograph record "ticks" and "pops?" Is there a method for removing this noise from an already affected record? —Steve Johnson, St. Paul, Minn.

A. Records can have "ticks" and "pops" for a number of reasons. Where the air is dry, records can build up substantial static charges, and when the voltage is high enough it jumps to ground. This spark will induce a signal in the coils of the phono cartridge, and results in a "pop" in the loudspeaker. You can determine if this annoying sound is caused by static electricity by noting whether this sound is always present in the same passage or in different parts of the record. When it is random, you know that static discharge is responsible. The most positive remedy for this is the use of a room humidifier because the added moisture will help prevent the static charges from building up.

Another cause of "crackles" is dust particles being deposited on the surface of the disc. The cure for this problem is to keep the discs as clean as possible so that dust doesn't have a chance to be deposited on the surface. Always use the record sleeves inserted at right angles to the opening of the jacket as this procedure aids in preventing dust from entering the sleeve. Obtain a good cleaner from the record store and wipe each side of the disc before you play it. This will remove most of the dust particles before they become firmly lodged into the record grooves.

Try to avoid touching the grooves with your fingers. Handle the record by its edge and center only. This will prevent oil, always present on your fingers, from being deposited onto the disc, as this oil will attract and hold dust on the record surface.

Where dust has already become firmly lodged, use water under pressure to remove it, then wipe the discs with a clean, lint-free cloth. It is a tempting idea to use household detergents to make the water treatment more effective, but don't. Many of these contain perfuming agents which will attack the surface of the disc, adding more noise than was originally present. Also see the articles on cleaners by B.V. Pisha in March, 1975, and May, 1976.

Sometimes "pops" are present on a disc as the result of a production problem. A slight scratch or burr on the metal dies used to stamp out a disc can cause such a sound. An impurity in the vinyl mix can cause noise, trapped air can cause noise, and a disc pressed at too high a speed can have such noises due to lack of time for the vinyl material to fill the die properly. In these latter cases there is no remedy and replacing the disc with a new one may or may not help.

Stacking Records

Q. I recently read that it does not harm records to stack them on an automatic record changer. The article said that records have raised edges and centers so the grooves never touch. Is this true? —Alan Cargile, Adger, Ala.

A. Examine any modern phonograph record album and note that the extreme outer edge is thicker than the remainder of the disc, with the exception of the label area. If the records are stacked on an automatic turntable, the outer edges of the adjacent discs will touch thereby keeping the grooves separated.

Early LPs were not made this way. In fact present-day 45s don't have a raised edge, but they do have raised centers and the grooves can and do come into contact with one another.

This method of thickened edges has a side benefit, less material is needed to make the disc and they are lighter and stronger than their predecessors.

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

YOU SHOULD EXPECT MORE FROM THE PHASE 4000 SERIES TWO.

Even if you're made out of money, you'd be hard pressed to buy more preamp.

The Phase 4000 Series Two goes way beyond the boundaries of conventional preamps. First, the 4000 processes and amplifies your music without introducing any significant noise or distortion. Then it actually compensates for losses in dynamic range and signal-to-noise ratios that occurred way back in the recording process!

To prevent overloads, studios "peak limit" the high-level attacks common in today's music. The 4000 Series Two has highly advanced circuits to read peak limiting, and immediately restore the dynamic range. The combined overall dynamic range is increased by 17.5dB. So when Charlie Watts hits a cymbal, it sounds like a cymbal!

The 4000 Series Two also spots low level gain riding, where the recording engineer adds volume to a low signal to overcome noise on the master tape. The Downward Expander immediately expands the dynamics, so you hear the bass as the conductor called for it, not as the engineer delivered it.

The 4000 Series Two second generation Autocorrelator reduces record hiss, tape hiss, and FM broadcast noise. Weighted overall noise reduction is -10dB from 20Hz to 20kHz. So your music comes clean, and the background is silent.

The 4000 has two new RIAA phono stages which eliminate low level switching and reduce hum and CB interference to a minimum.

Tape monitor and dubbing circuits allow copying between decks, while listening to a third program source. There's a separate direct coupled (OCL) Headphone Amplifier. An infrasonic filter eliminates audible effects caused by rumble. We could go on forever, but you get the point.

AND YOU GET IT.

The Phase 4000 Series Two. It's waiting for you at your Phase Linear dealer.

Phase Linear®

THE POWERFUL DIFFERENCE

Phase Linear Corporation, 20121 48th Avenue West, Lynnwood, Washington 98036

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Audio etc.

Edward Tatnall Canby

I am just back from two days of a digital recording session, the first classical session in the U.S.A. done for regular commercial LP release. My overwhelming impression, and the most important message I can pass on to you, is that in every respect, right up to the next-to-last detail, it was precisely like any standard (i.e. analog) recording session. Though the end result has all the fabulous qualities of the digital system that we have lately been reading about.

The last detail was the digital recorder itself, the Soundstream. At the moment, it is the only digital recorder in active commercial use hereabouts though five minutes from now there'll probably be five more and in a month or so a dozen—things are moving fast. Anyhow, this was at least a fleeting "first" and an important one as such, in view of what will be the future of our recording. That's why I was there.

Ed Canby discussing the Soundstream recorder with its creator, Tom Stockham, during the Severance Hall recording session.

Along with the Soundstream machine in Cleveland's Severance Hall, there was its boss and originator, Tom Stockham, Soundstream President, and Bruce Rothaar, his digital designer, acting as a dual recording crew. Also on hand and representing the far end of the recording chain was the disc cutting man for the session, though minus his lathe, none other than Stan Ricker, who operates that ultra-quality half-speed JVC cutting service on the West coast, originally designed for CD-4 but now used for unusually fine cutting of any type original. Please note: Direct-to-disc cannot be cut at half speed! Nature won't allow it. But the results of this digital session, after editing in Utah, will indeed go on to Ricker's half-speed cutter along with the Soundstream playback unit. No reason why the sound should not match anything direct-to-disc can do. (And the same, remember, with every digital *copy*, ad infinitum.)

Stan Ricker, who is a musician as well as a cutting man, was on hand to see that, straight from the beginning, the very moment of live sound and real time, the recording accommodated itself optimally for his cutter. That's the way to do it if you want fi.

There was no representative of the press on hand (i.e. the final step, the pressing plant) but maybe this hadn't been finalized. However, everybody else in between was around, including a record company, Telarc, with its pair of executive producers and a large body of the Cleveland Orchestra. I didn't count noses but it was a good stageful. And there was a Conductor, Frederick Fennell. Remember?—those fabulous old Mercury Living Presence band recordings of his, some now being reissued ?

Also, between and around these people, was a lot of incidental but rather necessary equipment. Three mikes on tall stands, Studer/Schoepps SKM 52U omnis feeding a Studer 169 console. And for playback offstage, a couple of ADS speakers in close-order drill, about six feet apart, aimed inwards. (The favored listener took the hot seat, a few feet in front of them.) There was a yellow telephone on stage next to the Conductor, for private consultation, run by batteries, and an out-loud squawk box which, since it died at a crucial moment, will remain nameless. (JACK—CAN YOU HEAR ME? JACK! JACK!) And a red light.

The Soundstream itself has two elements. The transport is Honeywell Instrumentation Deck, a beaut, with wide tape running at 30 ips. The Digital Processor—there's only the one—does the analog-to-digital and the D-to-A conversion. It's air cooled, complex, and mighty mysterious. Probably secret, as well. It works like a charm and didn't break down even once. Uses 16-bit coding, which is plenty for all the fi you can imagine—I'll say no more. See earlier digital articles in this mag.

Finally, there were *in absentia* (deceased) three fairly eminent composers represented in Severance Hall, namely J.S. Bach, Gustav Holst and George Frideric Handel. They might well have been bemused, not to say bewildered, by the hoopla going on in their name. Recording is indeed a unique art, analog or digital.

And so, having put things in their proper order of precedence, I will let go of Telarc's leg and admit that the whole thing was Telarc's idea and Telarc's operation. Having recently been into direct-to-disc, they are now moving into digital, and I expect others will follow—as soon as there are more recorders. Our own Bert Whyte, for instance, has already been working with Soundstream. So this was a Telarc operation, but an unusual one, as per above, in its direct contact on the spot with the other important people involved in the entire chain of production. Excellent idea.

Severance Hall, built on a campus oasis in the middle of greater Cleve-

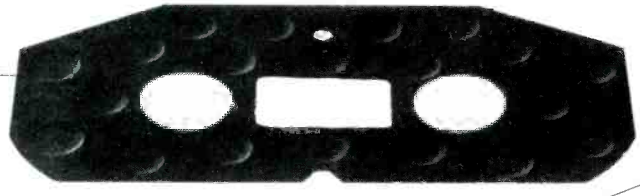
To get a superb performance, need a precision machine.

To command a great performance, a cassette shell and cassette tape must be engineered to the most rigorous standards. Which explains why we get so finicky about details. Consider:

Molded Cassettes—are made by continuously monitored injection molding that virtually assures a mirror-image parallel match. That's insurance against signal overlap or channel loss in record or playback from A to B sides. Further insurance: high impact styrene that resists temperature extremes and sudden stress.

Five-Screw Assembly—for practically guaranteed warp-free mating of the cassette halves. Then nothing—no dust or tape snags—can come between the tape and a perfect performance.

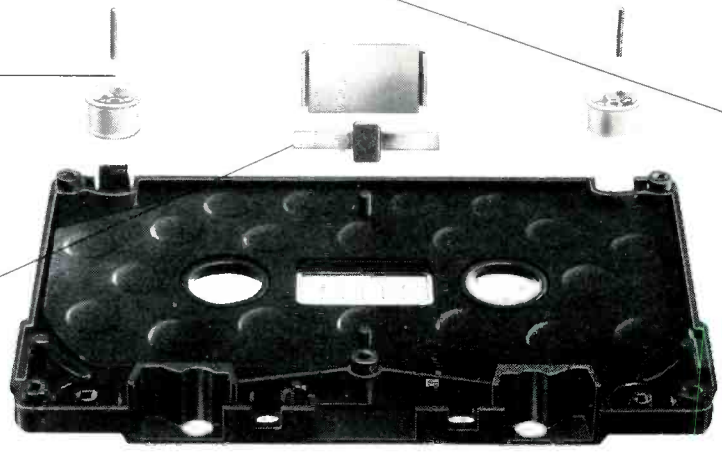
An Ingenious Bubble Surface Liner Sheet—commands the tape to follow a consistent running angle with gentle, fingertip-embossed cushions. Costly lubricants forestall drag, shedding, friction, edgewear, and annoying squeal. Checks channel loss and dropouts.



Perfectly Circular Hubs and Double Clamp System—insures there is no deviation from circularity that could result in tape tension variation producing wow and flutter and dropouts. The clamp weds the tape to the hub with a curvature impeccably matched to the hub's perimeter.

Head Cleaning Leader Tape—knocks off foreign matter that might interfere with superior tape performance, and prepares the heads for...

Tapered, Flanged Rollers—direct the tape from the hubs and program it against any up and down movement on its path towards the heads. Stainless steel pins minimize friction and avert wow and flutter, channel loss.



Resilient Pressure Pad and Holding System—spring-mounted felt helps maintain tape contact at dead center on the head gap. Elegant interlocking pins moor the spring to the shell, and resist lateral slipping.

Our famous SA and AD Tape Performance—two of the finest tapes money can procure are securely housed inside our cassette shells. SA (Super Avilyn) is the tape most deck manufacturers use as their reference for the High (CrO_2) bias position. And the new Normal bias AD, the tape with a hot high end, is perfect for any type of music, in any deck. And that extra lift is perfect for noise reduction tracking.

TDK Cassettes—despite all we put into them, we don't ask you to put out a lot for them. Visit your TDK dealer and discover how inexpensive it is to fight dropouts, level variation, channel loss, jamming, and other problems that interfere with musical enjoyment. Our full lifetime warranty* is your assurance that our machine is the machine for your machine. TDK Electronics Corp., Garden City, N.Y. 11530. Canada: Superior Electronics Ind., Ltd.

TDK®

The machine for your machine.

*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.

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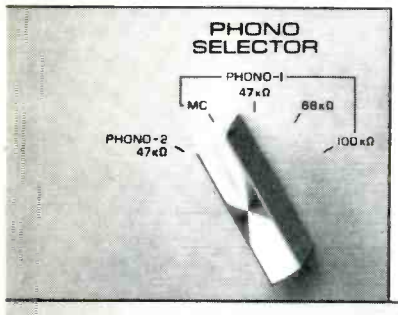
land, is a splendid auditorium for music and gave endless pleasure to my ears wherever I explored its acoustics. The place was built in the art deco period and looks it, sort of related to Radio City Music Hall, richly decked out inside with low-relief streamlined palm trees and what-not with lots of curves and curleques in the corners—the last flowering of optimum acoustical irregularity before the modern school of angles and rigid geometrics took over. There is a deep, wide stage with a more recent wood-panel shell, curiously shaped in rounded waves—did it produce the distinct *vibrato* reverb that I kept hearing? I liked it. Like, say, the vibrato in a good cello sound. You'll hear it in the recording— listen to the bass drum's vibrato die-away. Interesting effect.

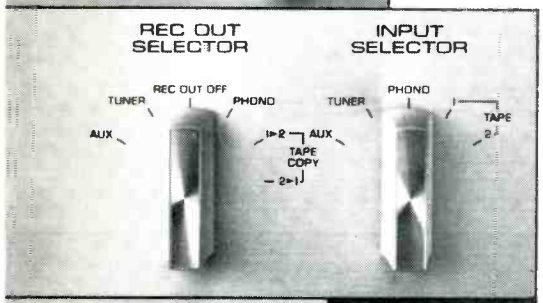
I climbed up to the very top seats in the large balcony, hundreds of feet out, and to my astonishment found that I could understand every word being said down on the stage by a few casually practicing musicians during one of the rest breaks. I even caught a whisper. Don't think that "concert hall sound" means a big blur! Not only words but music. Every bit of musical sound, as oboe, trumpet, clarinet practiced bits of their parts, came through startlingly big, round, and beautiful. In every part of that hall, the sound was virtually the same, rich, strong, warm, and absolutely clear. And balanced—you do *not* need to listen on dead center. Far from it! I had originally set myself up on stage, on a line with the mikes but far over to one side, so I could hear what the conductor had to say. Even there, the music was entirely listenable. The hall seems to impose its own over-all balance, in every part of itself; it did not matter where I wandered, up and down the side aisles, on the floor, close, distant—always that strong, warm sound. True, a slight shift of close-up mikes can make sonic changes on tape (and Telarc made minor adjustments to the mikes, as well as to the musicians themselves). But what matters for fine recording is that you have that marvelous stability of sound all around you as the basic acoustic from which you may work. That is the true concert-hall sound, and I've never heard it better.

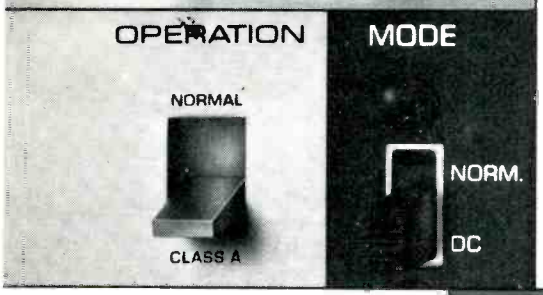
I noted some interesting spatial effects. On the floor, just out from under the balcony, the sound clearly came from the sides and *above* in a smooth blend, with very little stage directionality; that is taken care of by the eyes. Retreat under the balcony a few feet, and you can hear the difference. For "concert hall realism" you do indeed need overhead ambience, upwards space—and one of the good illusions of the four-way home system is a reasonable degree of this very thing, an overhead virtual ambience. We will need more of it.

There were two Telarc sessions, first Holst, the two *Suites Nos. 1 + 2 for Band* (plus a Bach arrangement thrown in) and, second, Handel, the *Royal Fire Works Music* in the original all-wind version, more or less. Eight oboes for that, quantities of horns, trumpet, bassoons, percussion—quite an array for the recorded fi to come. The Holst pieces are virtuoso works for large modern band, the flashiest band music I ever hope to hear, with everything from euphoniums (euphonia?) to flugel horns, an anvil, and four sizes of sax plus more percussion than you could count. It is an astonishing thing to watch a first-class band, such as this one, dig straight into such tricky music, mostly on a sight-reading basis, and play the stuff virtually note-perfect the first time. One good run-through, plus

The one alternative to separates: The Yamaha CA-2010 Integrated Amplifier.







The Head Amplifier. Discerning music lovers all over the world are discovering the transparent highs and extended frequency response of the moving coil phono cartridge. While other manufacturers require the addition of an expensive preamp or step-up transformer to boost the low output signal, Yamaha included a special head amplifier in the CA-2010. It's available with the flip of a switch on the front panel. And to help you get the most out of moving magnet cartridges, there's a 3-position phono impedance selector.

The Preamplifier. To assure exact, repeatable bass and treble settings, the controls are precision calibrated in ½dB steps. Dual turnover frequencies for both ranges double the versatility of these accurate tone controls. Completely independent Input and Output Selectors let you record one source while listening to another. And the power meters are easily switched to REC OUT readings in millivolts, so you can monitor the actual output level to your tape deck for cleaner, distortion-free recordings.

The Power Amplifier. 120 watts RMS, with no more than 0.03% THD 20Hz to 20,000Hz into eight ohms.

For tighter, cleaner bass response, the amplifier can be switched to DC operation.

Class A operation is switchable on the front panel, delivering 30 watts RMS, with no more than 0.005% THD 20Hz to 20,000Hz into eight ohms.

The twin power meters are fast-rise, peak delay—they can track even the briefest of transient bursts. Plus they can respond to levels from 1mW to 316W (into eight ohms).

Real Life Rated.™ The specifications of the individual components of the CA-2010 are superior to many separates. Individual specifications alone, however, can't possibly reflect actual in-system performance. That's why Yamaha measures overall performance from phono in to speaker out, rather than at designated points along the signal path. Furthermore, we measure noise and distortion together over a broad output range, rather than individually at the optimum output.

Our Real Life Rated measurement is called Noise-Distortion Clearance Range (NDCR). On the CA-2010, NDCR assures no more than 0.1% combined noise and distortion from 20Hz to 20kHz at any power output from 1/10th watt to full-rated power.

Superb tonality from a musical tradition of technical excellence. The tonal accuracy of our audio components is referenced to the same standards used to evaluate the tonal accuracy of our world-renowned musical instruments. The result is a rich, clear tonality that is unknown elsewhere. You really must hear it.

You really must hear the same resolutely accurate music reproduction available from all four Yamaha Integrated Amplifiers and four superb tuners. All are made to a single standard of excellence—a standard rooted in a 90-year tradition of musical perfection.

For a personal audition of the new Yamaha CA-2010, as well as the rest of our complete line of components, just visit your nearest Yamaha Audio Specialty Dealer. If he's not listed in your Yellow Pages, drop us a line.

.03%

-96dB S/N

Real Life Rated™

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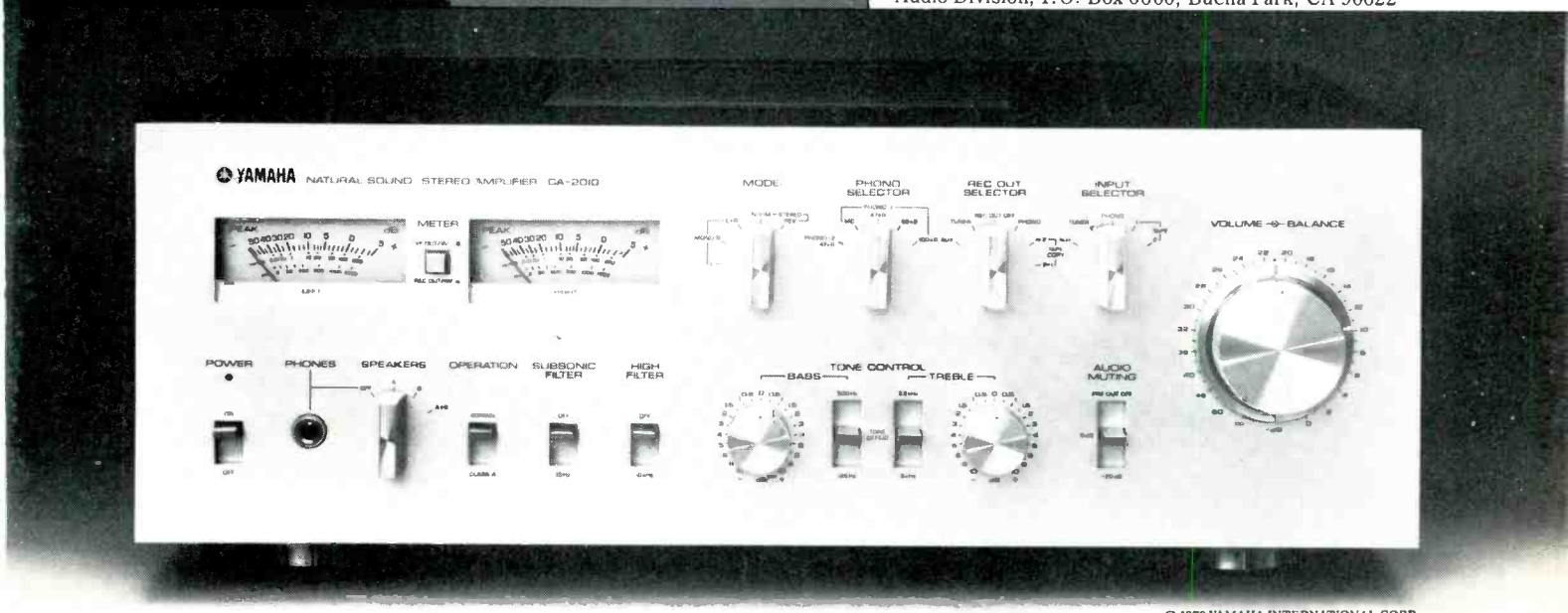

a few cogent suggestions on phrasing and balance from Fennell, and they were ready to record, two or three takes for each movement plus occasional repair patches of a minute or so for later editing. Yes, digital tape CAN BE edited, if a bit expensively.

Recording, Editing and Errors

I must say, it is an ugly thought that electronic instruments might some day put an end to this superb mastery of the older "mechanical" way of music making from printed notes. It is one of the great accomplishments of our species, *homo sapiens sapiens,* a thing to cause awe in the beholder.

To be sure, there were a few gargles in the horns (there always are) and one fine trumpet blooper. No problem! A quick re-do of a short piece, and all was repaired, and same for the horn gargles. Now just suppose that, if this were a direct-to-disc session, the same had happened. In that case we would have rehearsed the entire work, movement after movement, and then tried to record it *in toto,* complete. One trumpet bloop near the end and the entire thing has to be done all over—and surely something else will go wrong. And if the first movement is OK but the second not so good, can we do better? Unlikely. Not only a strain on the musicians, this, but extremely costly in recording time, for ever-doubtful musical results. This is *not* a concert! For recording, the flexibility of modern editing is ideal; it gets down the best of the music, all of it, selectively, with maximum efficiency and the least wear and tear. If you don't like the results, blame the producer or the editor—or the musicians. But don't blame the system. It works. It is essential for almost every type of musical recording.

A concert is a concert, and very different. It exists once and is gone forever. It has an audience, which is *there,* along with the musicians, in real time which does not repeat. NOTHING else compares to this live situation and no record can duplicate it, only suggest it by marvelous illusion. But recorded performances, too, can be incomparably good. We have a fine art ourselves, if we do it right.

I wish that more fi enthusiasts could attend a session such as this one. There is the fabulous sound of live music in a great hall, and there are the musicians. Listen to the potent BAMM of the bass drum (with that vibrato reverb)—and imagine a tall, large youth with a perfectly round face and a broad grin; who hits the drum like an athlete. He couldn't stand still, kept swinging back and forth around the back of the stage, even during takes, stopping casually now and then to deliver an enormous and unerring whack on his instrument, Don Miller, of the Orchestra. He also wallops the anvil in Holst for a sound you will not believe. Then there was the one string bass (common in wind music), a magnificent elderly gent with white stereo moustaches sprouting out 45/45, as lean as a bean and much more musical. Irv Nathenson. And the snare drum department (plus triangle, cymbal, etc.)! In the Handel you'll hear the sound loudly in the left channel—you would have seen three players, one tall and thin, one short and plump, and a third a kid who looked around 16. Fun watching them practice together; you could see the mistakes when their movements didn't match.

Instant Replay

Don't think the musicians weren't interested in the recording process. They didn't know much about digital but the younger ones flocked back to the re-

the (w)hole story

For years, SAE has been producing "state-of-the-art" separate components that offer value, quality and performance. That experience has now been applied to a line of integrated amplifiers. But what's the hole for? The answer is, ultimate performance!

Unlike others, our integrateds are identical to our separates with the same designs and component parts already proven in SAE preamps and amps. But that's not all - in each of our integrateds the preamp and amp section is entirely separated (even the power supply!). The preamp section, which is identical to our 2900 (or 3000, depending on the model) has its inputs and outputs near the front (hence the need for the hole), while the amp section (2200 or 3100) is at the rear. The only common parts are the chassis and the power switch. This unusual "U" shape design provides isolation of low and high level circuits, while retaining easy access to inputs and outputs (now only 3.5" behind the front panel).

These new units are so unique we don't consider them integrateds. Instead, we call them preamp/amps. They meet all the goals of an ideal integrated; (1) Convenience of an integrated design; (2) Excellent value due to reduced packaging costs; 3) The performance of separate components.

No matter which of SAE's preamp/amps you choose - the 2922 with parametric EQ and 100 watts* per channel, 3022 with tone controls and 100 watts* per channel or the 3031 with tone controls and 50 watts* per channel, you are assured of SAE performance, quality and value. The preamp/amps are truly integrated separates. And that's the whole story.

*Per FTC Rating @ 8 ohms

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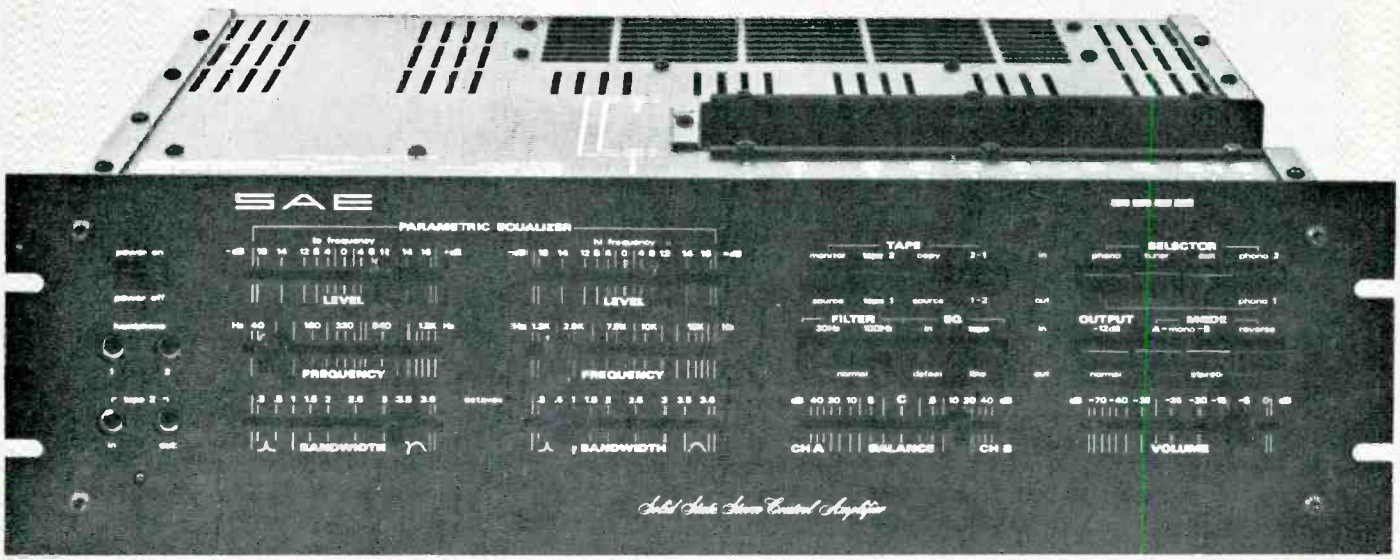

2922 Pre-amp/Amp

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cording room to hear each take—the place was jammed. (The older musicians, more conservative, stayed a bit aloof.) Things have changed. For maybe 800 years no musician ever heard the sound of his own performance, solo or in a group—now, the musical feedback is everywhere and without a doubt it has already changed the very sound of music. One clarinet, Frank Cohen, principal in the Cleveland Orchestra, even came back for an extra playback so he could hear how a new mouthpiece sounded—not to *him* but to the outside world. That's a new dimension for you.

A tuba man, Ron Bishop (curiously he had a deep bass voice) talked a half hour to Stan Ricker, the half-speed man, about the acoustics of the tuba in recording and also the bass drum, both of which I gather Stan plays himself. It was he, by the way, who was out on stage tuning up the bass drum's opposite heads for a reinforcing resonance. Ricker made an interesting audio point. It seems that normally in the orchestra the bass drum's two vibrating surfaces face sidewise while the player stands facing forward. Looks nice, but the big boom goes out sidewise to right and left from the heads—and arrives at the microphones (and even the audience) out of phase, neatly canceling the lowest frequencies. Weak bottom. Whereas if the drum is turned sidewise, so the heads face fore and aft, though it may look clumsier, the sounds now combine in one wavefront that reaches the mikes in phase, dead on center. So—BOOOM! That's what you get, and that's what we got. Thanks to Stan Ricker.

An even more important point is that a big out-of-phase low-frequency signal is sheer poison for the disc cutting head, as well as the phono playback, because it translates into vertical stylus motion. In-phase signals come out lateral and the stylus, cutting or playback, is much better able to follow big lateral excursions than the vertical powerhouses. So mono bass, in phase (there isn't much directionality anyway), is what you need for big booms.

Finally, Stan Ricker told me that in half-speed disc cutting he does not use any form of compression or limiting whatsoever. Instead he goes straight out to the recording session and sees to things ahead of time at the source. He did *this* time, anyhow. It takes that kind of musical/engineering teamwork, today, from bass drumhead to your eardrums, to produce our best fi. Especially if you are going into digital.

Yes, the new Dual 604 is direct drive. Now let's talk about something really important.

You may have noticed that most turntable stories begin and end with the drive system. The tonearm is more or less an afterthought.

But not with Dual. Because the tonearm can make a big difference in how records sound and how long they last. Which is why Dual is very serious about tonearm design and performance. And why we can be very serious about tonearms in our advertising.

Let's consider the 604 tonearm.

The straight-line tubular design provides maximum rigidity with minimum mass. The four-point gimbal centers and pivots the tonearm precisely where the vertical and horizontal axes intersect. And the counter-balance houses two specially-tuned anti-resonance filters that absorb parasitic resonances originating in the tonearm/cartridge system and chassis.

Operation is semi-automatic, with another unique Dual difference: the mechanical sensor. Switch it in and you feel when the stylus is positioned precisely over the 12" and 7" lead-in grooves. At the end of play, the tonearm lifts and returns to its post, and the motor shuts off. Automatically.

Now let's talk about the drive system. It employs a newly developed DC electronic motor with a highly sensitive CMOS regulator circuit and integral frequency generator. Platter speed is checked against rated speed 120 times per revolution. Wow and flutter are less than 0.03 percent, rumble is better than 70 dB. Well beyond the limits of audibility.

But the important story with any turntable is simply this. The drive system merely turns the record. It's the tonearm that plays it.

Dual 604, semi-automatic, less than $260. Dual 621, fully automatic plus continuous repeat, less than $300. Both with base and cover. Actual resale prices are determined individually and at the sole discretion of authorized Dual dealers.

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Behind the scenes

Bert Whyte

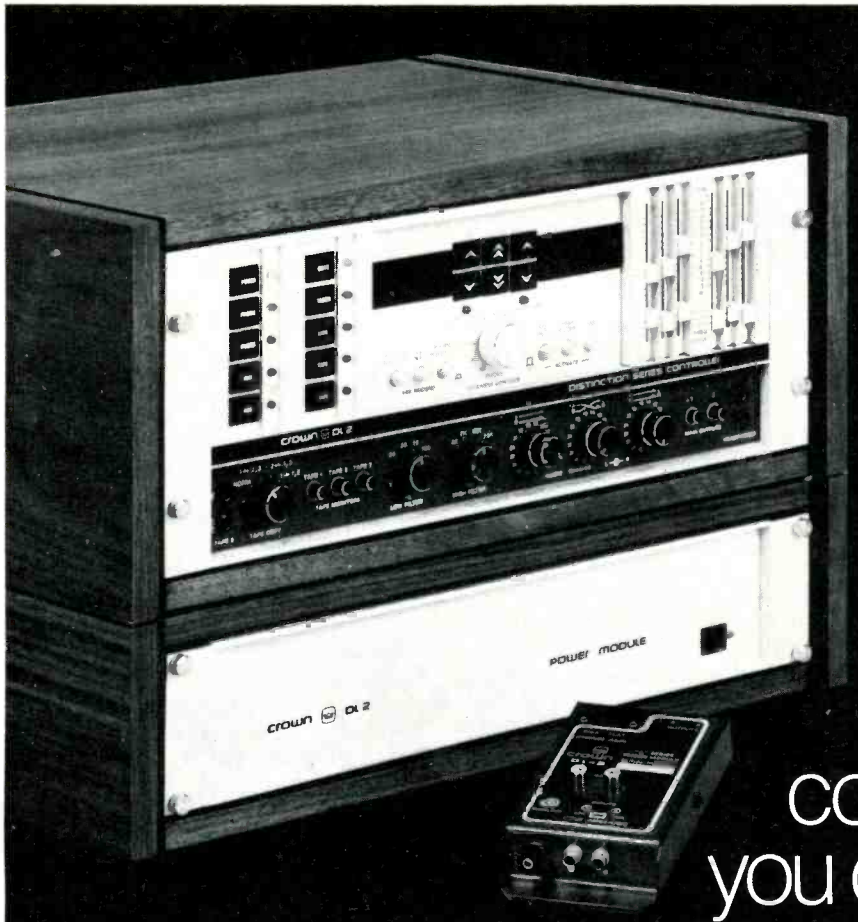
ANTHONY WEITZ

Ever since the dawn of the high-fidelity era over 30 years ago, we have been trying to record and reproduce music with that elusive quality called "concert hall realism." In all these years we have made enormous progress towards the achievement of this goal, but facsimile reproduction of live music must await some distant, future time, when, perhaps, we will be equipped with electrode implants directly into the auditory/visual sensory areas of our brains. These visual aspects are a vitally important part of the concert-hall listening experience, a stimulus to the sense of participation in the musical event and empathy with the audience. Perhaps, before we reach the stage of the implants, we will have listening rooms where the walls themselves are uniformly driven speaker diaphragms. The wall you face would display moving three-dimensional holographic images of the particular orchestra you are listening to . . . whether it be the Chicago Symphony, Vienna Philharmonic, etc., on the stages in their own concert halls. To heighten the illusion, you would be listening in the computer-simulated acoustics of their concert halls. (A foretaste of this already exists in the delay experiments of Bob Berkovitz of Acoustic Research with the simulation of the Boston Symphony Hall acoustics.) But enough of this "Star Wars" fantasy . . . the best we can hope for, at present, is a "convincing illusion" of this "concert hall realism," and I've been playing with some equipment and some new recordings which afford considerable help towards achieving this illusion.

In any attempt to create the illusion of reality of a live musical event, the preservation of dynamic range must be given a high priority. The technical exigencies of cutting phonograph records often impose the penalty of dynamic range compression. As most audiophiles are aware, there are a number of complementary expander devices on the market, that can offset quite a bit of the recording compression, but these devices must be carefully adjusted if audible "pumping and breathing" noises are to be avoided, or at least minimized. Many good recordings today have a dynamic range of about 52 dB, while some specialized direct-disc recordings can be as high as 65 dB. In spite of the way high figures for dynamic range are bandied about these days, 65 dB is very close to the present technological limits of record cutting. In fact, getting the full 65 dB of dynamic range from a recording can be a problem in the average home listening situation. If you set the gain controls so that pianissimo sections of the music are just audible above the noise floor of the recording and the ambient noise of your listening environment, when you encounter a full orchestral fortissimo of violent, high-energy, spikey, transients from the brass and percussion, it is quite likely that your amplifier will run out of steam. An oscilloscope will confirm, what your ears have already told you . . . that audible and distressing clipping of the waveforms has occurred.

Power Preference

This inevitably brings us to that most hoary of hi-fi questions . . . how much power is enough? Enough for what? If you want to listen to low-level background music, you can get away with milliwatts. The hi-fi pundits of yore used to gravely inform us that "20 watts is more than adequate for the domestic listening situation." To use the old cliche' . . . "You can't place a symphony orchestra in the average living room." This is self-evident, but you can enjoy the psycho-acoustic equivalent of a mighty orchestral fortissimo, with a fairly convincing illusion of concert hall realism . . . if you have enough watts, and speakers that can handle those watts. Then how about a thing called "living room realism?" Consider this . . . a string quartet can comfortably fit into an average living room, and you would be astonished how much power and loudness can be produced by two violins, a viola, and a cello. Similarly, millions of homes have pianos, and when they are played fortissimo, even in the average living room, their acoustic output is very high. To accurately reproduce recordings of a string quartet or a piano at the loudness levels they produce in typical living rooms, again requires lots of watts. Needless to say, the generation of high wattages is futile if it is accompanied by high levels of distortion. In the immortal words of Gene Czerwinski of Cerwin-Vega, the "high priest of high levels" . . . "Loud is beautiful . . . if it's clean." Which brings up the point of my experiences in the world of "supersound." I want to most strongly emphasize that I am not advocating loudness for loudness' sake, or overkill wattages for the production of "larger than life" sonic thrill trips. I am



Does it make sense to buy a new audio component you can't hear?

You bet it does. Especially if you care about absolutely accurate reproduction of recorded sound.

The new Crown DL-2 Distinction Series Controller is close to being the perfect pre-amplifier. It controls the signal level but changes nothing else unless you want it to.

The DL-2's sonic excellence is impeccable. New, patent-pending circuitry and no-compromise, common-sense design have resulted in outstanding specifications. Signal-to-noise ratio is better than 97dB unweighted. Frequency response ±0.2dB, 3Hz to 100KHz. THD, IMD and TIM are simply not audible.

One of the reasons you can't hear the DL-2 is that it is three components.

The revolutionary phono preamp mounts next to the turntable. That eliminates most RFI problems. But it also includes wholly new circuit concepts for unmatched sonic performance, and new convenience in hook-up.

The separate power supply keeps AC line noise completely out of the signal path.

The control module sets a new standard of control freedom. Leave all controls flat for accurate reproduction of input. Or adjust the sophisticated, equalizer-type tone controls to your taste. Select one of ten built-in ISO compensation curves. Control your choice of external processor. Unbelievably accurate digital control of level and balance. A new concept in stereo imaging.

To believe the sonic excellence of the Crown Distinction DL-2 Controller, you'll have to try to hear it. At your dealer. Soon.

Write for free brochure on the DL-2. It, too, makes sense.

crown

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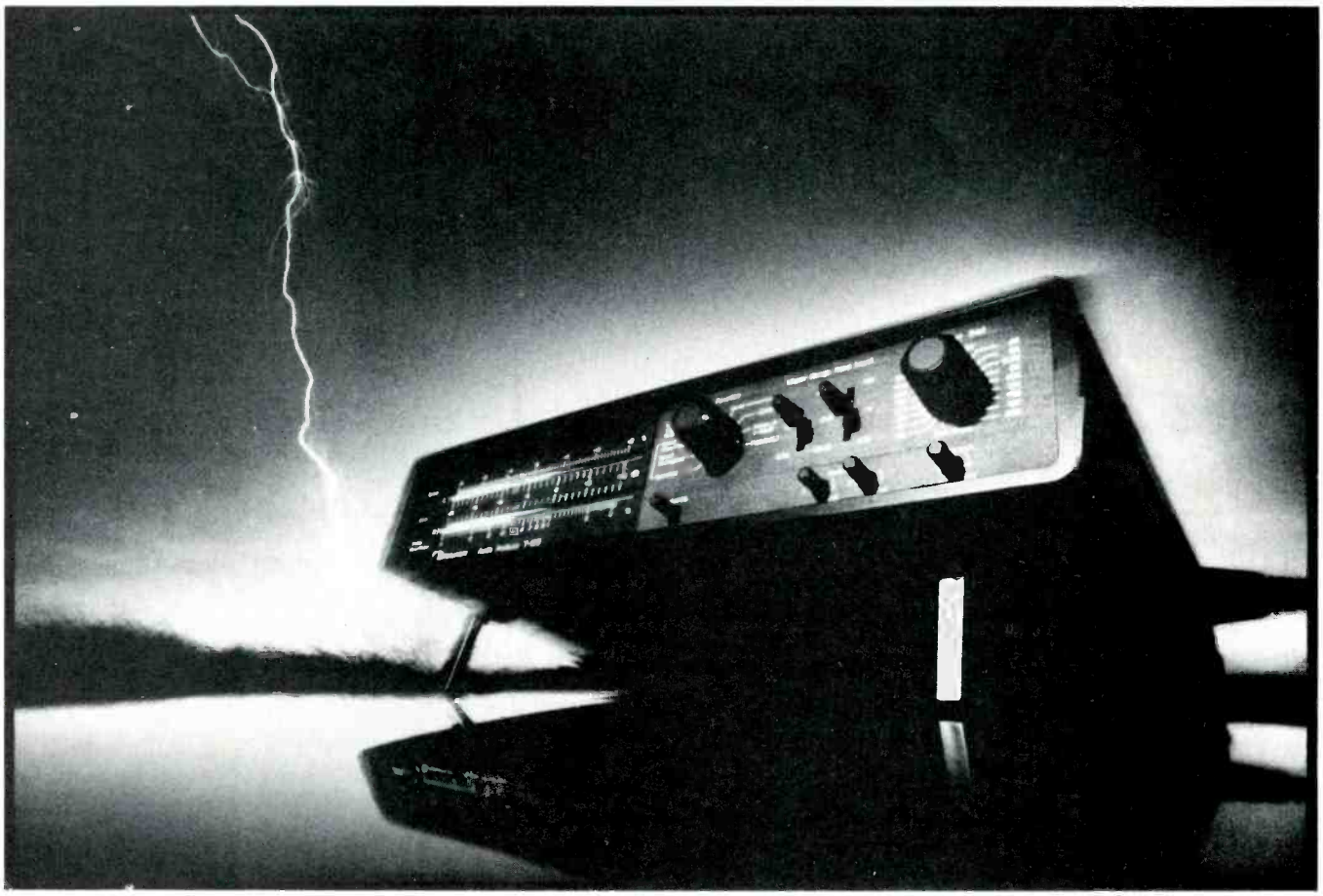
put. Thus, I wound up with 2 ultra-high powered mono amplifiers, with exceptional sonic characteristics. Their sound is smooth and effortless, very transparent, a fast amplifier with razor sharp transients, but none of the "edginess" or "graininess," which is typical of most really high-power amplifiers. HK installed special fuses in the line for me and I was ready to fly! Would HK make this modification available through their dealers? This idea is now under consideration.

Ultra-Sonorous Sound

The combination of the stacked Duntechs, and the 520 watts per channel HK amplifiers, put awesome, but exceptionally clean power in my hands. The Duntechs, which normally are flat below 30 Hz, were simply stunning in their impact on bass passages. The ability to play almost any kind of music, many times at live performance levels, without the slightest sign of clipping is a revelatory experience. Two records which certainly justified the bother of the whole project, and surely gave me a "convincing illusion" of live sound quality were the RCA RDC-4 direct disc of Beethoven's *Appassionata*, a 45 rpm disc, with Japanese pianist Ikuyo Kamiya, which was miked just a shade too close, and with the piano sounding slightly clangorous, but with an overall sound quality which is absolutely superb. Playing this recording, without a smidgen of distortion at a level which would have approximated the output of the Bosendorfer Imperial grand if it were sitting in my living room was truly awesome. The other record was London ZM1001, with Zubin Mehta and the LA Philharmonic playing the suites from *Star Wars* and *Close Encounters of the Third Kind*. *Star Wars* was bright, spritely, and exciting in its ingratiating fashion, but the real stunner here is *Close Encounters*. Recorded by top Decca engineer Jim Locke and cut at half-speed by my friend Stan Ricker at the JVC Cutting Center in Hollywood, the opening passages start off at a low level and build through one of the most tremendous crescendos ever put on a record. Then some low frequency (around 30-35 Hz) synthesizer sounds come in and with the huge power of my system, the impact leaves you limp. I might add that our Senior Editor Barney Pisha, our resident phono cartridge expert, and Ed Wodenjak of Crystal Clear Records, have the same stacked system as I have, and both are equally impressed. A lot of bother to be sure, but it opens up a whole new world of sound, and ultra-sonority.

Utterly unconventional. Shocking.



25

It is smaller and lighter than a telephone directory.
And yet, it literally replaces a pile of test instruments
many times its size and weight.

The Nakamichi T-100 is everything you've always wanted in
an audio analyzer, and maybe a bit more: a built-in oscillator
with 21 frequencies from 20 to 20,000 Hz, a pink noise
generator, a level meter featuring a lightning-fast dual
plasma display with choice of "VU" or peak ballistics,
a speed/wow-&-flutter meter with choice of unweighted or
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Rugged, versatile, accurate—the T-100 is unquestionably
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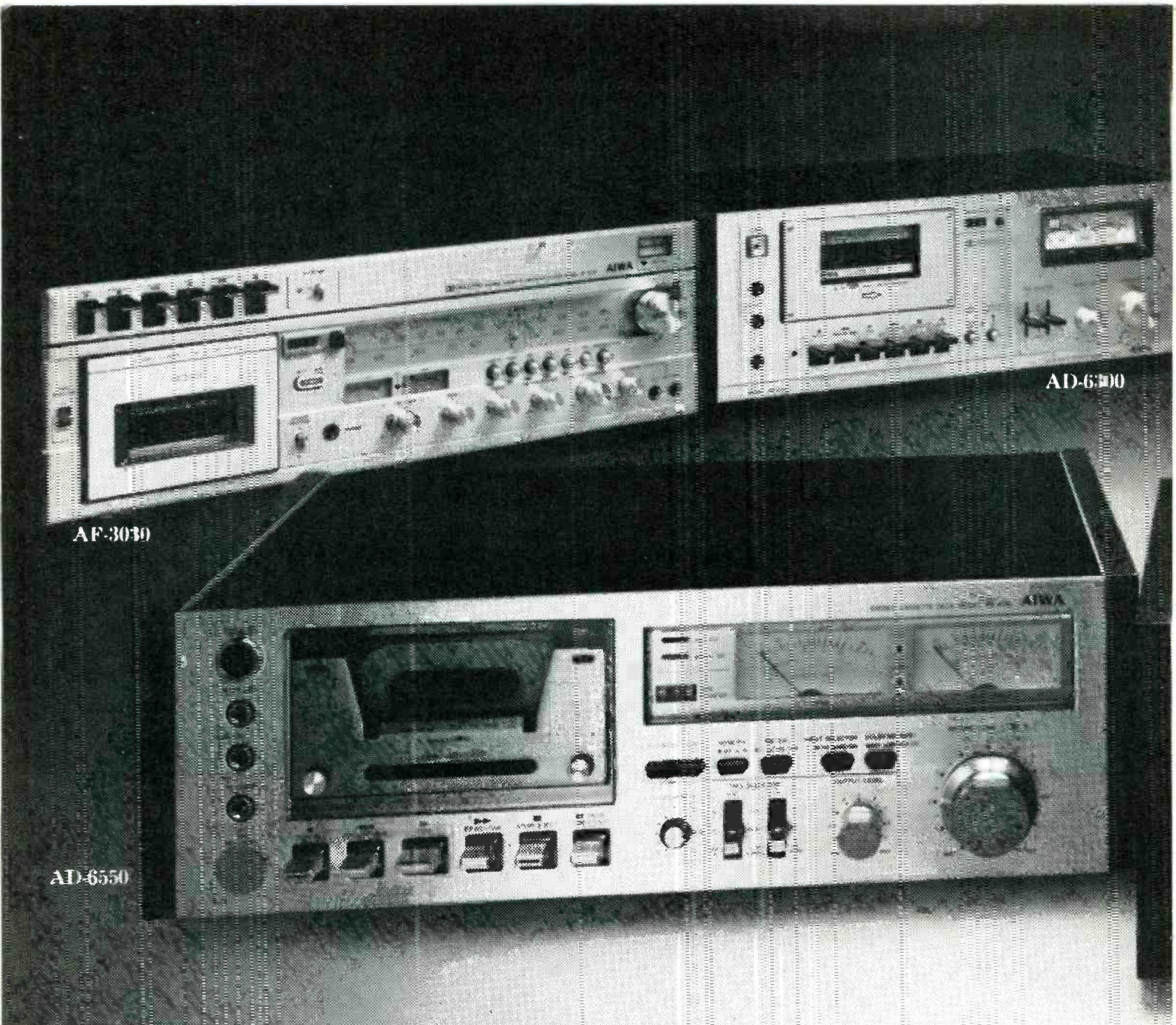
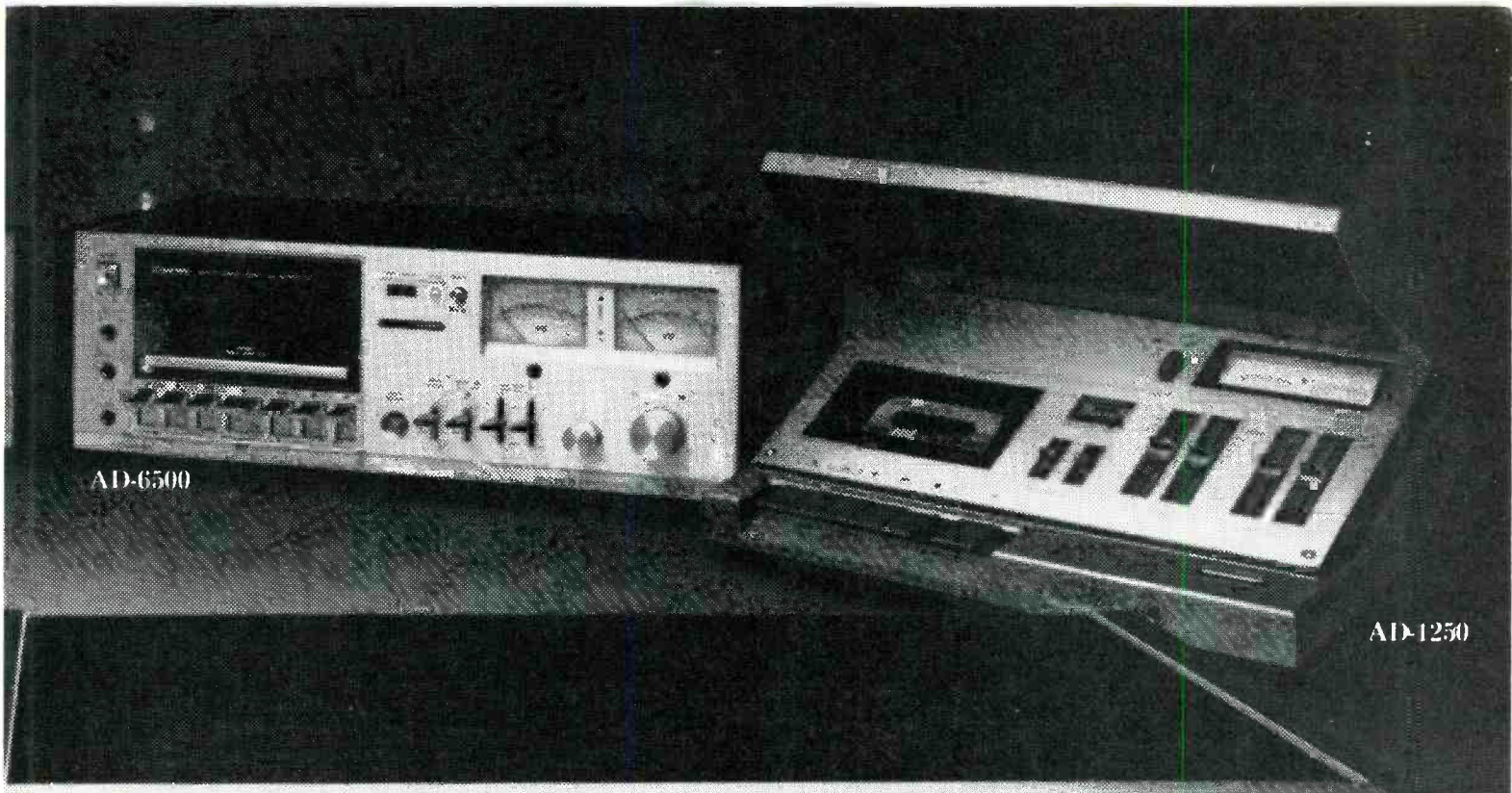
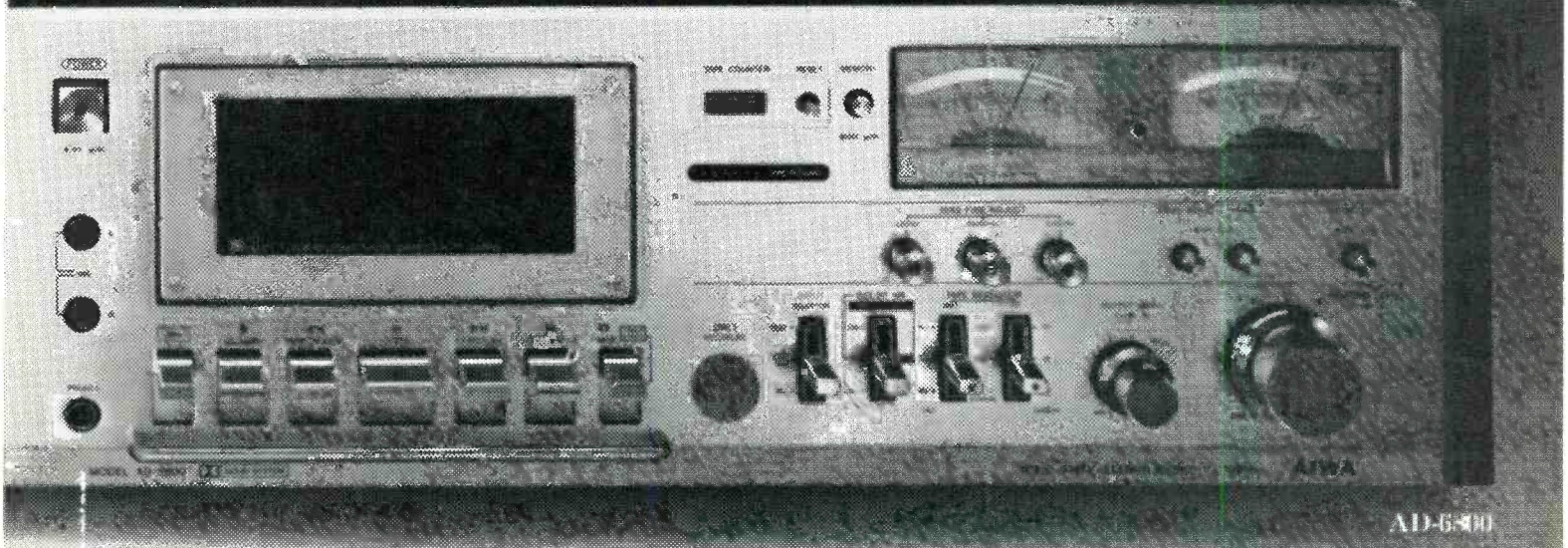


AIWA's newest response

With the new AD-6800, AIWA attains a flatter than ever frequency response with any tape on the market. For the first time, a cassette deck can use its own circuitry to measure the precise bias figure of every brand of cassette tape. Our new 3-head Flat Response Tuning System (FRTS) and built-in 400 Hz and 8kHz mixed oscillator lets you monitor a tape by watching the 400 Hz and 8kHz output levels. For optimum bias setting, you simply adjust the Bias Fine Adjustment knob to get equal output as you record. Consider too, the many other advanced features in the AD-6800: double needle metering combines the VU level and peak level into a single meter. a Peak Hold button locks the peak metering system preventing distortion-causing peak pulses, and an extraordinarily low wow and flutter of 0.05%.

The AD-6550 has a Bias Fine Adjustment knob to give optimum performance with any brand of LH tape on the market, a Remaining Tape Time Meter that shows





is a flatter response

exactly how many minutes remain on the tape when you record, and an outstandingly low wow and flutter of 0.05%.

And there's a lot more to the AIWA family.

The **AD-6500**, the first cassette deck to feature an automatic front loading system.

The **AD-6300**, a manual front loader with all the important features of top quality cassette decks.

The **AD-1250**, an ultra modern 20° slant-backed deck designed for maximum visibility and ease of use.

The versatile **AF-3030** combines all the features of the AIWA line of cassette decks with an FM-AM receiver.

So before you run out and buy a cassette deck, consider the engineering innovation that went into the AIWA family. And weigh AIWA's response carefully.

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Side panels optional with AD-6500 and AD-6300.

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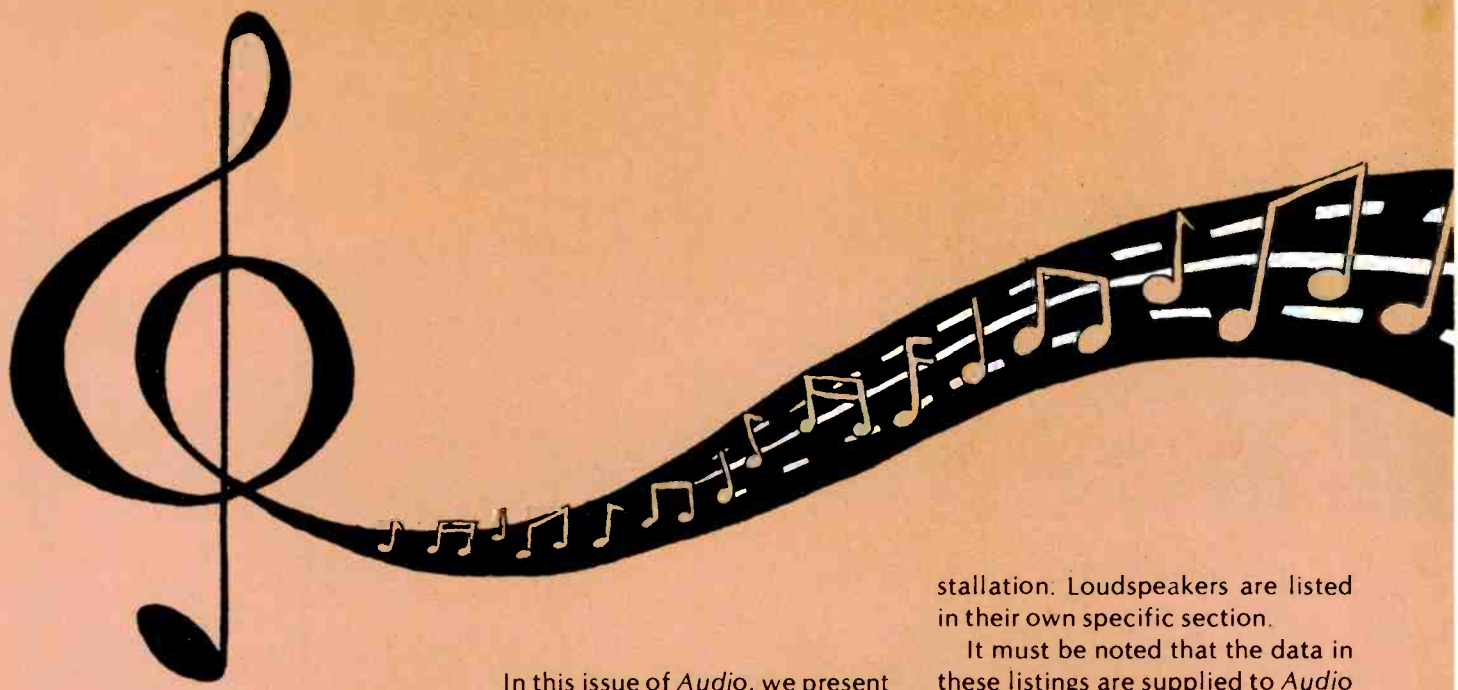
CAR STEREO



Car stereo equipment is proliferating, particularly in the wide variety of AM/FM radio, cassette, and eight-track tape gear available for post-sale and add-on installation.

In this issue of *Audio*, we present a directory of add-on equipment in many different configurations. It should be added that car manufacturers use some of these same suppliers to construct sets to fit the contours of their particular automobile for original equipment installation. Loudspeakers are listed in their own specific section.

It must be noted that the data in these listings are supplied to *Audio* by the manufacturers for this directory and are not the results of *Audio's* own laboratory tests.

This listing, unfortunately, is not complete as some manufacturers failed to return the forms sent them.

Directory of Manufacturers

Advent Corp.
195 Albany Ave.
Cambridge, Mass. 02139

Afco Electronics
471 Roland Way
Oakland, Cal. 94621

Audio Mobile
2850 E. 29th St.
Long Beach, Cal. 90806

Blaupunkt
R. Bosch Corp.
2800 S. 25th Ave.
Broadview, Ill. 60153

Car Tapes/Jet Sounds
1000 E. Del Amo Blvd.
Carson, Cal. 90746

Clarion
5500 Rosecrans Ave.
Lawndale, Cal. 90260

Comm Industries
1505 Commonwealth Ave.
Boston, Mass. 02135

Concord Electronics
20121 Ventura Blvd.
Suite 320
Woodland Hills, Cal. 91364

Craig
921 W. Artesia Blvd.
Compton, Cal. 90220

Dyusa/Marume
7110 Marcelle St.
Paramount, Cal. 90723

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

Elf Industries
8300 N.E. Underground Drive
Kansas City, Mo. 64161

EPI
One Charles St.
Newburyport, Mass. 01950

Fosgate
2935 W. Fairmount Ave.
Phoenix, Ariz. 85017

Fujitsu Ten
1135 E. Janis St.
Carson, Cal. 90746

Fulmer
260 Monroe St.
Memphis, Tenn. 38103

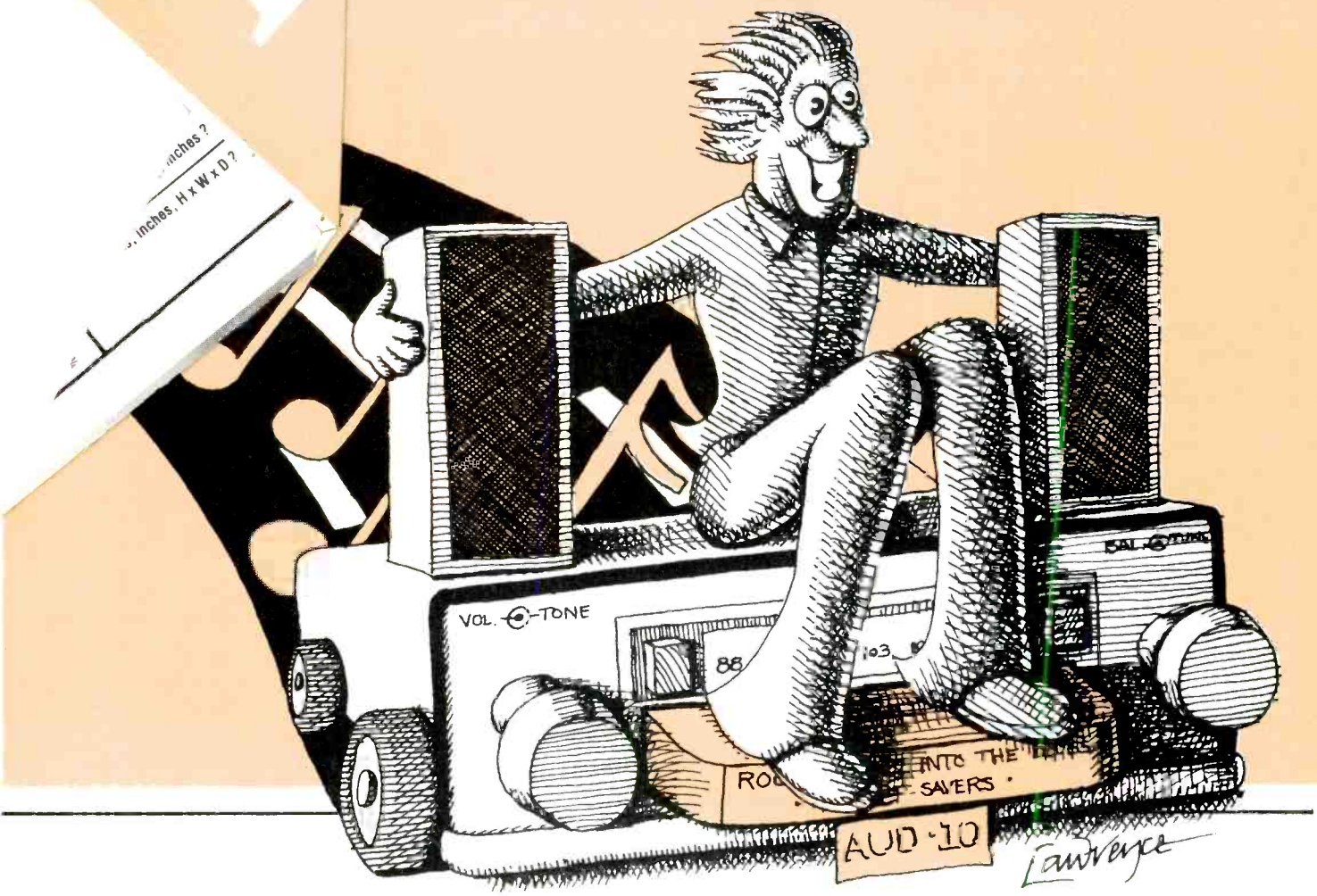
Herald Electronics
6611 Lincoln Ave.
Lincolnwood, Ill. 60645

Jandy International
152 W. Cypress Ave.
Burbank, Cal. 91502

Jensen
4136 N. United Pkwy.
Schiller Park, Ill. 60176

JVC
58-75 Queens-Midtown Pkwy.
Maspeth, N.Y. 11378

DIRECTORY



Kraco
2411 N. Santa Fe Ave.
Compton, Cal. 90224

Laser Acoustics
5663 Lankershim Blvd.
N. Hollywood, Cal. 91601

Magitran
311 E. Park Ave.
Moonachie, N.J. 07074

Marantz
20525 Nordhoff St.
Chatsworth, Cal. 91311

Minneapolis Speaker
3806 Grand Ave.
Minneapolis, Minn. 55409

Motorola
1299 E. Algonquin Rd.
Schaumburg, Ill. 60196

Panasonic
1 Panasonic Way
Secaucus, N.J. 07094

Pathcom/Pace
24049 S. Frampton Ave.
Harbor City, Cal. 90710

Pioneer
1925 E. Dominguez St.
Long Beach, Cal. 90810

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

Pyle Industries
501 Center St.
Huntington, Ind. 46750

Quam-Nichols
Marquette Rd. & Prairie Ave.
Chicago, Ill. 60637

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

Roadstar
5312 Production Drive
Huntington Beach, Cal. 92649

Sparkomatic
Milford, Pa. 18337

Speco
P.O. Box 624
1172 Rt. 109
Lindenhurst, N.Y. 11757

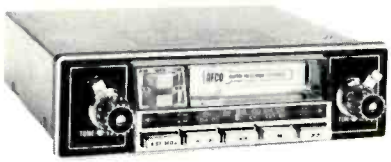
Tamon Audio
2751 Monument Blvd.
Concord, Cal. 94520

Visonik of America
1177 65th St.
Oakland, Cal. 94608

Car Radio/Tape Players

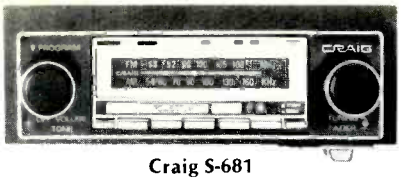
AFCO Graphic Equalizer

AFCO IDC-750AR



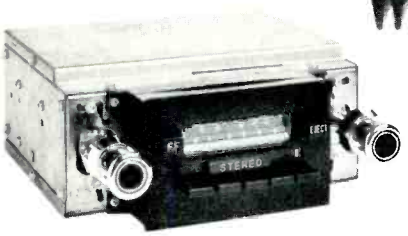
Blau

	Model ?	Price ?	Stereo (S), Mono (M), or 4-channel (Q) ?	FM Sensitivity, μV ? (for 30-dB quieting)	Selectivity ?	Average Watts/channel, 50-10 kHz, at rated Distortion	? % Distortion @ rated watts	Local/Distance Switch ?	Pushbuttons ? If Yes, Number AM, Number FM	Bass Control ?	Treble Control ?	Cassette ?	8-Track ?	Auto Reverse ?	Fast Forward ?	Tape Rewind ?	In-Dash (I) or Under-Dash (U) ?	Control Shaft Spacing	Dimensions
AFCO Electronics	IDC-750AR PB-30E Graphic Equalizer	$159.95 99.95	S S or Q	5		3 15	3 0.5	Yes	No	Yes		Yes		Yes	Yes	Yes	I	Adj.	1 3/4x6 3/4x5
Audiomobile	ST770A	299.95	S		70			Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	Adj.	2x7x5
	SA400	89.95	S		20		0.25			No	No								2x5x5 1/2
	SA800	115.95	S			40	0.5			Yes	Yes								2x5x7
	SA700A	149.95	S			35	0.08			No	No								2 1/2x6x5
	SP300A	149.95	S				0.05			Yes	Yes						U		1 1/2x4 1/2x4
	SA1500A	299.95	S			75	0.2			No	No								4x8x8
	SA460	189.95	S			20	0.5			Yes	Yes						U		2x5 1/2x5
Blaupunkt	Frankfurt U.S.	113.00	M	1.9		5			3 FM, 2 AM	No	Yes	No	No	No	No	No	I	130 mm	1 3/4x7x5
	Frankfurt U.S. Stereo	193.00	S	1.8		5		No	4 FM, 4 AM	No	Yes	No	No	No	No	No	I	130 mm	1 3/4x7x5
	CR4095	242.20	S	3.0		7		Yes	No	No	Yes	Yes	No	No	Yes	Yes	I	Adj.	1 3/4x7x6
	CR4096	231.20	S	4.0		7		Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	1 3/4x7x6
	CR4091	170.00	S	5		7		Yes	No	No	Yes	No	Yes	No	No	No	I	Adj	1 3/4x7x6
CAR TAPES/JET SOUNDS	JS8100	89.95	S	5	65	5	1.5	Yes		Yes	Yes		Yes				I	Adj	1 3/4x6 3/4x4 3/4
	CT4310	89.95	S	4.5	65	4.5	3	Yes		Yes	Yes		Yes				I	Adj.	2 1/2x7x4 1/2
	CT4355	99.95	S	4.5	65	5	1.5	Yes		Yes	Yes		Yes				I	Adj.	2 1/2x7x4 1/2
	JS8570	149.95	S	3	68	5	2	Yes	5FM, 5AM	Yes	Yes		Yes				I	Adj.	2 1/2x7x4 1/2
	7703	29.95	S			4.5	3			Yes	Yes		Yes				U		2 1/4x5x7 1/4
	M306	29.95	S			4.5	3			Yes	Yes	Yes			Yes		U		1 1/2x1 3/4x5
	JS600	79.95	S			5	1.5			Yes	Yes	Yes		Yes	Yes	Yes	U		2x7x6 1/2
	JS3500	129.95	S	2.5	70	5	1.5	Yes		Yes	Yes	Yes		Yes	Yes	Yes	U		2x7x6 1/2
	JS9100	89.95	S	5	65	5	2	Yes		Yes	Yes	Yes			Yes		I	Adj.	1 3/4x6 3/4x4 3/4
	JS9350	99.95	S	4	67	5	1.5	Yes		Yes	Yes	Yes			Yes		I	Adj.	1 3/4x6 3/4x4 3/4
	JS9370	149.95	S	3	68	5	1.5	Yes	5FM, 5AM	Yes	Yes	Yes			Yes		I	Adj.	2 1/2x7x4 1/2
	JS8001	159.95	S	2.5	70	8	1.5	Yes		Yes	Yes	Yes		Yes	Yes	Yes	I	Adj.	2x7x6 1/4
	JS9200	179.95	S	4.5	65	8	1.5	Yes		Yes	Yes	Yes		Yes	Yes	Yes	I	Adj.	2x7x6 1/4
	JS9600	199.95	S	3	67	8	1.5	Yes	5FM, 5AM	Yes	Yes	Yes		Yes	Yes	Yes	I	Adj	2 1/4x7x6 1/4
Clarion	PE-666B	239.95	S		20	4	8	Yes			Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x5 1/2x7 1/4
Concord	HP-350	249.95	S	1.8		20	0.3	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	Adj	7x4 3/4x2 1/2
	CD-12	149.95	S	2.0		5	2.0	No	No	No	Yes	Yes	No	No	Yes	Yes	I	Adj.	7x2 1/4x5 3/4
	HP-100	149.95	S	1.8		5	2.0	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	Adj	7x4 3/4x2
Craig	T607	179.95	S	1.7		4.5	5.0	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x7 1/4x5 1/4
	T609	114.95	S	1.7		4.5	5.0	Yes		Yes	Yes	Yes	No	No	Yes	Yes	I	Adj	2x7 1/4x5 1/4
	T610	129.95	S	1.9		4.0	5.0	Yes				Yes	No	No	Yes	Yes	I	Adj.	2x7 1/4x5 1/4
	T611	149.95	S	1.3		4.5	5.0	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x7 1/4x5 1/4
	3514	149.95	S			4	5.0	No	5-AM or FM			Yes	No	No	Yes	No	I	Adj	2x7x5 1/4
(continued)	T600	179.95	S			3.5	5.0	Yes				Yes	No	Yes	Yes	Yes	I	Adj.	2x7 1/4x8 1/2



Craig S-681

Elf CUS-35



Fosgate PR-220

Fujitsu Ten

	Model ?	Price ?	Stereo (S), Mono (M), or 4-channel (Q) ?	FM Sensitivity, μV ? (for 30-dB quieting)	Selectivity ?	Average Watts/channel, 50-10 kHz, at rated Distortion	? % Distortion @ rated watts	Local/Distance Switch ?	Pushbuttons ? If Yes, Number AM, Number FM	Bass Control ?	Treble Control ?	Cassette ?	8-Track ?	Auto Reverse ?	Fast Forward ?	Tape Rewind ?	In-Dash (I) or Under-Dash (U) ?	Control Shaft Spacing, inches ?	Dimensions, inches, H x W x D ?
Craig (continued)	T605	159.95	S			4	5.0	Yes				Yes	No	No	Yes	Yes	I	Adj.	2x7 1/4 x5 1/4
	T632	199.95	S			4	5.0	Yes				Yes	No	Yes	Yes	Yes	I	Adj.	2x7x5 1/4
	T633	199.95	S	1.5		4.5	5.0	Yes	5-AM or FM	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2 3/4x7 1/4x5 1/4
	T681	179.95	S	1.1		12.0	5.0	Yes		Yes	Yes	Yes	No	No	Yes	Yes	I	Adj.	2x7 1/4x5 1/4
	T683	209.95	S	1.9		12.0	5.0	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x7 1/4x6 1/4
	T685	299.95	S	1.8		12.0	5.0	Yes	5-AM or FM	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x7 1/4x5 1/4
	T201	109.95	S			4	5.0	Yes				Yes	No	No	Yes	No	U	Fixed	2 1/4x7 1/2x7
	T202	149.95	S			4	5.0	Yes				Yes	No	Yes	Yes	Yes	U	Fixed	2 1/2x7 3/4x7 1/4
	T180	129.95	S			12	5.0			Yes	Yes	Yes	No	Yes	Yes	Yes	U	Fixed	8 1/2x7x3 1/2
	T100	89.95	S			4	5.0	No				Yes	No	No	Yes	Yes	U		2 1/4x5x5
	T101	69.95	S			4	5.0	No				Yes	No	No	Yes	No	U		2 1/2x4 3/4x6 1/2
	T102	109.95	S			4	5.0	No				Yes	No	Yes	Yes	Yes	U		2 1/2x7x7
	T200	129.95	S			4	5.0	Yes				Yes	No	No	Yes	Yes	U		2 1/4x7 1/2x7
	T281	159.95	S			12	5.0	Yes				Yes	No	No	Yes	Yes	U		2 1/4x7 1/2x7
	S631	169.95	S			4	5.0	Yes	5-AM or FM			No	Yes	No	No		I	Adj.	2 3/4x7x5 1/4
	S682	179.95	S	1.9		12	5.0	Yes		Yes	Yes	No	Yes	No	Yes		I	Adj.	2 3/4x7 1/4x5 1/4
	S683	209.95	S	1.9		12	5.0	Yes		Yes	Yes	No	Yes	No	Yes		I	Adj.	2 3/4x7 1/4x5 1/4
	S685	279.95	S	1.9		12	5.0	Yes	5-FM or AM	Yes	Yes	No	Yes	No	No	No	I	Adj.	2 3/4x7 1/4x6
	V930	119.95	S			4	5.0	Yes	5-AM, 5-FM			No	Yes	No	No	No	I	Adj.	1 3/4x4 1/4x1 1/2
	S603	139.95	S			4	5.0	Yes				No	Yes	No	No	No	I	Adj.	2x7x5 1/4
	S604	129.95	S	3.1		4.5	5.0	Yes		Yes	Yes	No	Yes	No	No	No	I	Adj.	2x7 1/4x5 1/4
	S605	114.95	S	3.1		4.0	5.0	Yes				No	Yes	No	No	No	I	Adj.	2x7 1/4x5 1/4
	S608	149.95	S	1.9		4.5	5.0	Yes		Yes	Yes	No	Yes	No	No	No	I	Adj.	2x7 1/4x5 1/4
	S100	69.95	S			4	5.0					No	Yes	No	Yes	No	U		2 1/2x4 3/4x7
	S101	89.95	S			4	5.0					No	Yes	No	Yes	No	U		2 1/2x6 1/2x9
	S102	59.95	S			3.5						No	Yes	No	No	No	U		2 1/2x6 1/2x7 1/2
	S103	49.95	S			2.5						No	Yes	No	No	No	U		2 1/2x6 1/4x7 1/4
	S180	119.95	S			12				Yes	Yes	No	Yes	No	Yes	No	U		2 3/4x6 1/2x9 1/2
	S200	109.95	S			4	5.0	Yes				No	Yes	No	Yes	No	U		2 1/4x7 1/2x7
	S201	89.95	S			3.5	5.0					No	Yes	No	No	No	U		2 1/2x7 3/4x7 1/4
	S280	149.95	S			12	5.0		5-FM	Yes	Yes	No	Yes	No	Yes	No	U		3 1/2x9 1/4x10 1/4
	S281	139.95	S			12	5.0	Yes				No	Yes	No	Yes	No	U		2 1/4x7 1/2x7
	S606	219.95	S	2.5		4.5	5.0	Yes				No	Yes	No	No	No	I	Adj.	2 3/4x7 1/4x6
Elf	F-1190	Custom GM	S			5	10	Yes	5 FM, 5AM	Yes	Yes	No	Yes	No	No	No	I	Adj.	2 3/4x7x6
	F-1180	Custom Ford	S			5	10	No	5 FM, 5 AM	Yes	Yes	No	Yes	No	No	No	I	Adj.	2 3/4x7x6
	CUS-35 G&F	Custom GM & Ford	S			4	10	Yes	5 FM, 5 AM	Yes	Yes	Yes	No	No	Yes	No	I	Adj.	3x7 1/4x5 3/4
	IDC-675	159.95	S			6	10	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	1 3/4x6 3/4x5 1/2
Fosgate	PR-220	109.95	S			20	0.05			Yes	Yes						U		7 3/4x2 3/4x6 3/4
	PR-250	199.95	S			50	0.05			Yes	Yes						U		Preamp 4x1 3/4x2 1/2 Poweramp 7 3/4x2 3/4x6 3/4
	PR-2100	369.95	S			100	0.05			Yes	Yes						U		Preamp 7 3/4x1 3/4x3 1/4 Poweramp 14 1/4x2 1/2x8

Car Radio/Tape Players

Fujitsu Ten

Jet Sounds JS-9350

Kraco KID-588

	Model ?	Price ?	Stereo (S), Mono (M), or 4-channel (Q) ?	FM Sensitivity, μV ? (for 30-dB quieting)	Selectivity ?	Average Watts/channel, 50-10 kHz, at rated Distortion	? % Distortion @ rated watts	Local/Distance Switch ?	Pushbuttons ? If Yes, Number AM, Number FM	Bass Control ?	Treble Control ?	Cassette ?	8-Track ?	Auto Reverse ?	Fast Forward ?	Tape Rewind ?	In-Dash (I) or Under-Dash (U) ?	Control Shaft Spacing, inches ?	Dimensions, inches, H x W x D ?
Fujitsu Ten	DP-7871	149.95	S	18	20	5	0.3	No				Yes	No	Yes	Yes	Yes	I	Adj.	1 ½x7x5 ¼
	GP-7881	249.95	S	18	20	12	0.3	No	5-FM, 5-AM	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2 ½x7 ¼x5 ½
	Dolby																		
	GL-7851	179.95	S	18	20	5	0.3	No	5-FM, 5-AM	Yes	Yes	No	Yes	No	No	No	I	Adj.	2 ½x7 ¼x5 ½
	ETX41A	299.95	S	18	20		0.01	Yes	No	No	No	Yes	No	Yes	Yes	Yes	I	Adj.	1 ½x7x3 ¾
	AT7831	174.95	S		20		0.1	Yes	No	Yes	Yes						U		1 ¼x6x5 ¼
Fulmer	16-2200	39.95	M		30	2.4	10.0	No	5-AM			No	No	No	No	No	I		1 ¾x6 ½x4 ½
	16-2400	44.95	M		30	2.75	10.0		5-AM			No	No	No	No	No	I	Adj.	3x7 ½x6 ½
	16-3200	79.95	M	5	34	2.25	10.0		5-AM&FM			No	No	No	No	No	I		2x6 ½x5 ½
	16-3400	94.95	M	5	34	5.5	10.0	Yes	5-AM&FM			No	No	No	No	No	I	Adj.	3x7 ½x6 ½
	16-3500	114.95	M	5	34	7.25	10	Yes	5-FM, 5-AM			No	No	No	No	No	I	Adj.	3x7 ½x6 ½
	16-4200	109.95	S	5	30	2.25	10		5-AM or FM			No	No	No	No	No	I	Adj.	2x6 ½x5 ½
	16-4400	129.95	S	5	34	6.0	10	Yes	5-AM or FM			No	No	No	No	No	I	Adj.	3x7 ½x6 ½
	16-4500	149.95	S	5	44	15.0	10	Yes	5-AM, 5-FM			No	No	No	No	No	I	Adj.	3x7 ½x6 ½
	16-5100	149.95	S	5	30	6.8	10	Yes				Yes	No	No	Yes	Yes	I	Adj.	2x7x6 ¼
	16-5300	99.95	S	5	36	2.45	10	Yes				No	Yes	No	No	No	I	Adj.	2x6 ¾x6 ¼
	16-5400	129.95	S	5	32	4.6	10	Yes				No	Yes	No	No	No	I	Adj.	1 ¾x7x6 ¼
	16-6200	209.95	S	5	40	5.5	10	Yes	5-AM/FM			Yes	No	No	Yes	No	I	Adj.	3 ¼x7 ½x7 ¼
	16-6400	169.95	S	5	36	4.0	10	Yes	5-AM/FM			No	Yes	No	No	No	I	Adj.	3x7 ¼x7 ¾
	16-6500	199.95	S	5	36	4.65	10	Yes	5-AM/FM			No	Yes	No	No	No	I	Adj.	3x7x7 ½
	16-8400	349.95	S	5	40	3.6	10	Yes	5-AM/FM			No	No	No	No	No	I	Adj.	2 ¾x7x7 ½
	16-8600	399.95	S	5	40	3.6	10	Yes	4-AM/FM			No	Yes	No	No	No	I	Adj.	3x7x8 ½
Kraco	560-D	130.95	S	1.6	15	3.55	10	Yes	No	Yes	Yes	No	Yes	No	No	No	I	Adj.	2x7x5 ¼
	565-A	134.95	S	4.4	66	3.62	10	Yes	No	Yes	Yes	No	Yes	No	No	No	I	Adj.	2x7x5 ¼
	566	144.95	S	4.4	60	5	10	Yes	No	Yes	Yes	No	Yes	No	No	No	I	Adj.	2x7 ¼x5 ¼
	575	165.95	S	4	60	4.5	10	Yes	5 FM or AM	Yes	Yes	No	Yes	No	No	No	I	Adj.	2 ¾x7 ¼x6 ¼
	585	144.95	S	3.2	40	4.0	10	Yes	No	Yes	Yes	Yes	No	No	Yes	No	I	Adj.	1 ¾x7x4 ½
	588	207.95	S	3.2	45	3.8	10	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	2x7 ¼x5 ½
	1230	113.95	S	10	40	3.0	10	No	2 AM/3 FM	Yes	Yes	No	No	No	No	No	I	Adj.	2x7 ½x7
	1240	144.95	S	5.6	65	3.1	10	Yes	5 AM or FM	Yes	Yes	No	No	No	No	No	I	Adj.	1 ¾x7x5
	1220-A	92.95	S		40	5.75	10	No	2 AM/3 FM	Yes	Yes	No	No	No	No	No	I	Adj.	2x7x5
Laser Acoustics	A-100 Amp	150.00	S			65	0.25	No	No	No	No	No	No	No	No	No			2 ¾x7 ¼x7
	A-100A Amp	150.00	S			65	0.25	No	No	Yes	Yes	No	No	No	No	No			2 ¾x7 ¼x7
	A-200 Amp	225.00	S			125	0.1	No	No	No	No	No	No	No	No	No			2 ¾x7 ¼x7
	A-200A Amp	275.00	S			125	0.1	No	No	Yes	Yes	No	No	No	No	No			2 ¾x7 ¼x7
	A-350 Amp	395.00	S			250	0.1	No	No	No	No	No	No	No	No	No			5 ½x7 ¼x7
	A-350A Amp	700.00	S			250	0.1	No	No	Yes	Yes	No	No	No	No	No			5 ½x7 ¼x7
Marantz	CAR-420	389.95	S	1.1	60	10	0.8	Yes	6 FM, 6 AM	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj.	1 ¾x7 ¼x5 ½
	CAR-410	299.95	S	1.1	60	4		Yes	6 FM, 6 AM			Yes	No	No	Yes	Yes	I	Adj.	1 ¾x7 ¼x6
	CAR-350	219.95	S	1.5	60	4		Yes	No			Yes	No	Yes	Yes	Yes	I	Adj.	1 ¾x7 ¼x6
	SA-230	69.95	S			10	0.5			Yes	Yes						U		1 ¾x4 ¾x7 ¼
	SA-247	149.95	S			15	0.5			Yes	Yes						U		2 ¼x6 ¾x5 ¾
Marume	M-5	99.95	S	10	50	7	5.0	Yes	No	Yes	Yes	No	Yes	No	No	No	I	Adj.	2x6 ¾x5
	M-50	119.95	S	10	50	7	5.0	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	I	Adj	2x6 ¾x5
	M-70	179.95	S	17.8	50	7	5.0	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	I	Adj	1 ¾x6 ¾x5 ½
	M-9	79.95	S	10	50	7	5.0	Yes	5-FM	Yes	Yes	No	No	No	No	No	I	Adj.	2x6 ¾x5

Pace 8340

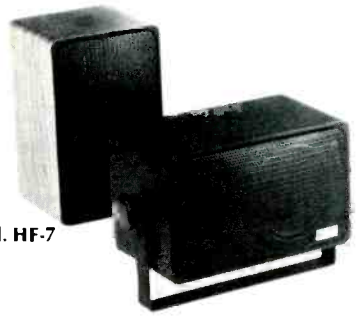
Pioneer KP-500

Sparkomatic FMX-10

Radio Shack

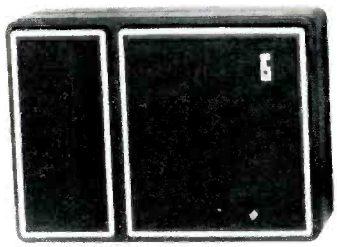
	Model ?	Price ?	Stereo (S), Mono (M), or 4-channel (Q) ?	FM Sensitivity, μV ? (for 30-dB quieting)	Selectivity ?	Average Watts/channel, 50-10 kHz, at rated Distortion	? % Distortion @ rated watts	Local/Distance Switch ?	Pushbuttons ? If Yes, Number AM, Number FM	Bass Control ?	Treble Control ?	Cassette ?	8-Track ?	Auto Reverse ?	Fast Forward ?	Tape Rewind ?	In-Dash (I) or Under-Dash (U) ?	Control Shaft Spacing, inches ?	Dimensions, inches, H x W x D ?
Motorola	TC887AX	229.95	S	2.5				Yes	5 FM or AM			Yes	No	Yes	Yes	Yes	I	Adj.	2 3/4x7x5 1/2
	TC884AX	149.95	S	2.5				Yes				Yes	No	No	Yes	Yes	I	Adj.	1 3/4x7x5 1/4
	TC883AX	161.95	S	2.5				Yes	5 FM or AM			Yes	No	No	Yes	Yes	I	Adj.	2 3/4x7x5 1/2
	TF878AX		S	2.5				Yes	4 FM or AM			No	Yes	No	No	No	I	Adj.	2 3/4x7x6
	3C4TEC8		S	2.5				No	5 FM or AM			No	Yes	No	No	No	I	5.8	3x7x6
	3F4TEC7		S	2.5				Yes	5 FM or AM			No	Yes	No	No	No	I	5.8	2 3/4x7x6 1/4
	TC876AX		S	2.5				Yes	5 FM or AM			Yes	No	No	Yes	No	I	Adj.	2 3/4x7x6
	TF853AX		S	2.5				Yes				No	Yes	No	No	No	I	Adj.	2x7x5 1/2
	TC877AX		S	2.5				Yes				Yes	No	No	Yes	No	I	Adj.	2x7x5 3/4
	TC324S	69.95										Yes	No	No	Yes	Yes	U		1 3/4x5 1/2x7 1/4
	TC334S	99.95								Yes	Yes	Yes	No	Yes	Yes	Yes	U		1 3/4x5 1/2x7 1/4
	TC344S	139.95								Yes	Yes	Yes	No	No	Yes	Yes	U		2 1/2x6 1/2x8 1/2
	FM775AX1		S	3				Yes	4 FM, 4 AM			No	No	No	No	No	I	Adj.	2x6 1/4x4 3/4
	FM676AX		M	3				Yes	4 FM, 4 AM			No	No	No	No	No	I	Adj.	2x6 1/4x4 1/2
	TF756S		S	2.5				Yes				No	Yes	No	Yes	No	U		2 1/2x7x7 1/4
	TM316S		S									No	Yes	No	Yes	No	U		2 3/4x5x7
	TM416S		S									No	Yes	No	Yes	No	U		2 1/2x7x7
	TM226S		S									No	Yes	No	No	No	U		2 3/4x5x7
	5C3RMX8		S	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	5F3RMX8		S	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	5C2RMX8		M	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	5F2RMX8		M	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	5C6DMX8		S	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	5F6DMX8		S	3				No	5 FM or AM								I	5.8	2 1/2x7 1/2x5
	PA2400 Amp	49.95	S			12	10										U		5 1/4x4 1/2x2
	PA4000 Amp	89.95	S			20	10			2 Pos. Swit.	2 Pos. Swit.						U		7 1/2x6 1/4x2 3/4
	EQB3000 EQ/Amp	119.95	S			15	10			5 Band	5 Band						U		7x5 1/2x2
Pace	8340	199.95	S			4	0.5		5 FM, 3 AM	Yes	Yes	No	No	No	No	No	I	Adj.	2 3/4x6x7
Panasonic	CQ1851	149.95	S	28		10	10.0	Yes		Yes	Yes	No	Yes	No	No	No	U		2 1/2x9 1/2x8
	CX385	54.95	S			3.5	10.0	No		No	No	No	Yes	No	No	No	U		2x4 3/4x6 1/4
	CX233	69.95	S			3.5	10.0	No		No	No	Yes	No	No	Yes	No	U		2x4 3/4x6 3/4
	CJ155Z Booster	39.95	S			10	10.0	No		No	No	No	No	No	No	No	U		1 3/4x3 1/2x5 1/2
	CQ2700	139.95	S	25		3.5	10.0									No	I/U	Adj.	2x7x6
	CQ6700	159.95	S	20		3.5	10.0	Yes		No	No	No	Yes	No	No	No	I/U	Adj	1 3/4x7x5 1/4
	CRB4700	244.95	S	28		3.5	10.0	Yes		No	No	Yes	No	No	Yes	No	I/U	Adj.	2 1/4x7 1/4x5 1/4
	CX1100	69.95	S			4.8	10.0	Yes		No	No	No	No	No	No	No	U		2 1/2x7 1/2x6 1/4
	CX5100	89.95	S			4.8	10.0			No	No	No	Yes	No	No	Yes	U		2 1/2x7 1/2x5 1/4
	CX7100	119.95	S			4.8	10.0			No	No	Yes	No	No	Yes	Yes	U		2 1/2x7 1/2x5 1/4
	CA9500	84.95	S							No	No	Yes	No	Yes	Yes	No	U		1 1/2x7 1/4x6 1/4
	CJ3510	84.95	S			10	1.0	Yes		No	No	No	No	No	No	No	U		4x2 3/4x8 1/2
	CQ8520 Elect. Tuning	399.95	S			10	10.0	No		Yes	Yes	No	No	No	No	Yes	I	Adj.	2 3/4x7 1/2x6 1/2
	CJ255Z Booster	79.95	Q			10	5.0	Yes	6 AM, 6 FM	Yes	Yes	Yes	No	Yes	Yes		U		1 3/4x6 3/4x5 3/4
	CQ6520	239.95	S			10	10.0	Yes	5 AM & FM	Yes	Yes	Yes	No	No	Yes	Yes	I	Adj.	2 3/4x7 1/2x6 1/4
	CQ2520	219.95	S			10	10.0	Yes	5 AM & FM	Yes	Yes	No	Yes	No	No	No	I	Adj	2 3/4x7 1/2x6 1/4
	CR-4520	169.95	S			10	10.0	Yes	5 AM & FM	Yes	Yes	No	No	No	No	No	I	Adj.	2 3/4x7 1/2x6 1/4

Car Speakers



Electronic Ind. HF-7

EPI LS70



Fujitsu Ten SSB-8B5

	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
Advent Corp.	EQ-1		$180.00		6x9					F		
Audiomoblie	LM50		49.95	10	5	15	4	37-6K	1	F	5	Midrange Driver
	LF65A		89.95	30	6½	15	4	37-7K	1	F	6½	Woofer
	HF1		39.95	20	1	5	4	1K-22K	1	F	3	Tweeter
Car Tapes/Jet Sounds	JSW500S		14.95	8	5	5	8	100-10k		F/S	4x5¼x6	
	JSW1200S		24.95	20	5	10	8	100-12k		F/S	4x5½x6	
	JS25		9.95	8	5¼	3	8	100-10k		F	2x6½	
	JS50-10AS		24.95	15	5¼	10	4	90-12k		F	2½x6¼	
	JS550CX		29.95	20	5¼	20	4	80-14k	2	F	2½x6¼	
	JS950CX		39.95	20	6x9	20	4	50-15k	2	F	3½x6¼x9¼	
	JSL563TX		49.95	30	5¼	20	8	70-18k	3	F	2¾x6¼	
	JSL963TX		59.95	30	6x9	20	8	50-18K	3	F	3½x6¼x9¼	
	JSL1511TX		89.95	50	5	20	8	50-18K	3	F	2¾x6½x10¼	4 Speaker
Clarion	SK-99		$126.95	8	5¼x3x1	20 2	8	100-20K ± 5	3	F	10x6¼x2	Mounts on 6x9 cutout
Craig	R731			50	5¼	11	4-8	60-17k		F		
	R730			50	5¼	20	4-8	60-17k		F		
	R770			50	6x9	20	4-8	45-17k		F		
	R780			50	5¼	11	4	80-17k		S	11¾x7x9	
	V401			25	5¼	10	8	70-13k		F		
	V440			25	6x9	10	8	55-13k		F		
	V460			25	6x9	10	8	55-16k	2	F		
	V461			25	6x9	20	8	55-16k	2	F		
	V300			15	3½	5.4	8	200-10k		*		*Dash mount
	V400			25	4	8	8	130-14k		F		
	9422			25	6x9	11.6	8	65-13k		F		
	9420A			25	5¼	14	8	70-13k		F		
	9425			25	6½	10	8	100-12k		S	9¾x5¼x9½	
	V320			25	5¼	14	8	70-15k	2	F		
	V360			25	4x10	10	8	60-15k	2	F		
	V361			25	6x9	10	8	55-15k	2	F		
	9430			25	5¼	11	8	100-12.5k		S	10¼x5¼x9	
	9426			10	4	5.4	4	130-13k		F		
	9427			10	5¼	5.4	4	100-13.5k		F		
	9428			10	5¼	2.9	4	90-16.5k		F or S	8x4x7¾	
	9429			25	6x9	30	4-8	100-15k		F		
	V240			10	4x10	10	4	60-13k		F		
	V100			8	3½	3	4	220-8k		*		*Dash mount
	9413			8	4	3.6	4	115-13k		F		
	9414			8	5¼	3.6	4	95-13.5k		F		
	9433			8	3x5	3.6	4	300-4k		S	7¾x3¼x5¾	

	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
Electronic Industries	HF-7		129.95	35	4	10	4	55-22k	2		4¼x7¼x4¼	
	9D20Q		79.65	25	6x9	20	4-8	25-22k	4	F	5½x8½x4	
	9D20T		69.95	25	6x9	20	4-8	25-20k	3	F	5½x8½x4	
	10D20T		65.95	20	4x10	20	4-8	55-20k	3	F	3½x9½x3½	
	6D20TR		57.15	20	5¼	20	4-8	55-20k	3	F	6x3	
Elf	F-2000		149.95	50	4x2	8	4	50-22k	2	S	7x4¼x4	
	111		59.95	50	6x9	20	4-8	100-10k ± 5	3	S	5½x6x4	
	3.5 SPK		5.95	10	3½	3	8			F	3½	
	4x10 GM SPK		9.95	10	4x10	3	8			F	4x10	
EPI	LS70	75.00	150.00	12	*	30	4	70-20k ± 3	2	F&S	6x9	*6-in. woofer & 1-in. tweeter.
Fosgate	PRS-500		99.95	20	5¼ & 1¾	10	4		2	F	5¼x4	
	PRS-690		119.95	20	6x9 & 1¾	20	4	35-16k ± 6	2	F	6x9x4	
Fujitsu Ten	SSB8G9		39.95	20	5x7	8	8	80-15k	2	F		
	SSB8G10		39.95	20	5¼	8	8	85-14k	2	F		
	SSB8B6		37.95	20	3	2.7	8	20-18k	1	F&S		
	SSB8B5		104.95	20	4	8	8	100-20k	2	F&S		
	SSB8B7		119.95	20	8	6.3	8	100-15k	3	S		
Fulmer	15-9220		12.95	5	5	3	4-8	70-14k	1	S	3½x7¼x6¼	
	15-9240		17.95	7	5	5	4-8	60-14k	1	S&F	5x6¼x6½	
	15-9250		19.95	10	5	5	4-8	60-14.5k	2	S&F	3¾x9½x6½	
	15-9260		129.95	45	4	3	4-8	60-14.5k	2	S	3¾x9½x6½	
	15-9420		9.95	5	5¼	3	4-8	50-13k	1	F	5¼x2	
	15-9430		14.95	10	4	10	4-8	50-13k	1	F	5½x2¼x4¾	
	15-9440		17.95	10	5¼	10	4-8	80-12k	1	F	5¼x2¼	
	15-9460		25.95	10	5¼	10	4-8	50-15k	2	F	5¼x2¼	
	15-9470		34.95	25	5¼	20	4-8	30-13k	2	F	5¼x2¾	
	15-9490		54.95	25	5¼	20	4-8	35-16k	3	F	5¼x3	
	15-9560		29.95	10	4x10	10	4-8	35-14.5k	2	F	4x10x3¼	
	15-9620		19.95	5	6x9	5	4-8	40-13k	1	F	6x9x2¾	
	15-9660		29.95	10	6x9	10	4-8	40-14k	2	F	6x9x3¼	
	15-9665		99.95	25	5¼	10	4-8	45-16.5k	3	F	10x6½x2½	
	15-9670		39.95	25	6x9	20	4-8	40-15k	2	F	6x9x3½	
	15-9680		79.95	45	6x9	10	8	45-15k	2	F	6x9x4¼	
	15-9690		59.95	25	6x9	20	4-8	20-16k	3	F	6x9x3¾	
	15-9696		89.95	25	6x9	30	4-8	20-16k	4	F	6x9x3¾	
Herald	S-833A	13.98		15	6x9	10	8					
	S-720A	19.98		30	6x9	20	8					
	S-790A	27.95		30	6x9	20	8	30-15k	2			
	S-884A	39.95		50	6x9	30	8	20-25k	2			
JVC	S-M3		159.50	25	4		8	50-20k	2	S	7¾x4½x4½	

Car Speakers

Kraco TR1-4699CF

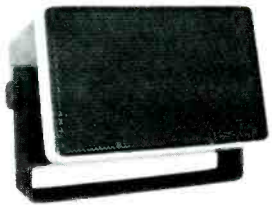
Magitran A2000

Marantz

	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
Jensen Sound Laboratories	J1001		189.95	35	6x9 3½ 2	20 3 3	8 8 8	35-1k 1k-4k 4k-20k		F		Separate component speaker system, includes mid & high frequency controls & cross-over network.
	C9945		119.95	30	6x9	20	8	40-20k	3	F		6x9 " woofer 3 " midrange 2 " tweeter
	C9991		119.95	30	4x10	20	8	45-20k	3	F		4x10 " woofer 2 " midrange 2 " tweeter
	C9999		117.95	30	5¼	20	8	60-20k	3	F		2 " midrange & 2 " tweeter in unit separate from 5¼ " woofer
	C9740		79.95	25	6x9	20	8	40-18k	2	F		6x9 " woofer 3 " tweeter
	C9994		79.95	25	4x10	20	8	45-18k	2	F		4x10 " woofer 2 " tweeter
	C9943		78.95	25	5x7	20	8	50-15k	2	F		5x7 " woofer 2 " tweeter
	C9852		77.95	25	5¼	20	8	60-15k	2	F		5¼ " woofer 2 " tweeter
	C9853		66.95	25	5¼	10	8	60-15k	2	F		5¼ " woofer 2 " tweeter
	C9851		65.95	20	4	10	8	70-15k	2	F		4 " woofer 2 " tweeter
	C9729		53.95	25	6x9	20	8	40-14k	Dual Cone	F		
	C9997		53.95	25	4x10	20	8	46-14k	Dual Cone	F		
	C9862		51.95	25	5¼	20	8	60-12k	Dual Cone	F		
	C9728		46.95	25	6x9	10	8	40-14k	Dual Cone	F		
	C9863		44.95	25	5¼	10	8	60-12k	Dual Cone	F		
	C9860		43.95	20	4	10	8	70-12k	Dual Cone	F		
	C9870		25.95	12	3½	3	8	80-12k	Dual Cone	F		
	C9927		96.95	25	5¼	20	8	50-15k	2	S	7¾x5¾x4½	5¼ " woofer 2 " tweeter
	C9926		63.95	25	5¼	10	8	60-12k	Dual Cone	S	7¾x5¾x4½	
	C9809		61.95	25	5¼	20	8	60-12k	Dual Cone	S	7½x7x4	
Kraco	TRI-469		99.95	15	6x9	20	8	70-19K ± 10	3	S/F	2¾x6x10	4-drivers
	TRI-369		99.95	20	6x9	20	8	60-17 ± 6	3	F	3¼x6½x9¼	
	PBS-90 Sound Boomers		99.95		6x9	10	8	200-4.5 ± 6		F		Built-in 45 watt/chan. amps
	CX-269-20-F		59.95	12	6x9	20	8	160-15 ± 6	2	F	3¼x6x9¼	
	CX-1-20-F		49.95	8	5¼	20	8	190-6.5 ± 6	2	F	2½x6¼diam.	
	CX-2-20-F		49.95	10	5¼	20	8	200-13 ± 6	2	S/F	4½x7x6½	
Magitran	A2000F		27.99	10		3	4-8	70-20k ± 5		F	6¼	
(continued)	A2000V		27.98	10		3	4-8	70-20k ± 5		F	6¼	

Polk Audio Mini Monitor

Sparkomatic SK6900



Visonik D-302MO

	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
Magitran (continued)	A4000S		36.39	10		3	4-8	90-20k ± 5		S	1½x5¼x9½	
	A500		28.09	10		3	4-8	80-20k ;5		S	1x6x10	
	A3000S		31.25	10		3	4-8	80-20K ± 5		S	7x2x3¼	
Marantz	SS-569		99.95	15	6x9	20	8	40-20K	5	F	6½x9½x4	
	SS-469		79.95	15	6x9	20	8	40-18K	4	F	6½x9½x3¾	
	SS-269		59.95	15	6x9	20	4	40-15K	2	F	6½x9½x3¾	
	SS-169		49.95	15	6x9	20	4	40-13K	2	F	6½x9½x3¼	
	SS-825		69.95	10	6¼	20	8	50-20K	3	S	Diameter 6¼	
	SS-725		49.95	10	6¼	20	4	50-16K	2	S	Diameter 6¼	
	SS-625		29.95	7	6¼	10	4-8	50-13K	2	S	Diameter 6¼	
Misco	D 32	5.37		8	3½	1.47	8					
	D 46	7.20		8	4x6	1.47	8					
	E 48	8.37		10	4x8	1.47	8					
	E 410	9.60		10	4x10	1.47	8					
	E 411	9.60		10	4x11	1.47	8					
	E 57	8.00		10	5x7	1.47	8					
	E 58	8.00		10	5x8	1.47	8					
	E 69	8.37		10	6x9	1.47	8					
	E 610	9.60		10	6x10	1.47	8					
	E 46 GD	10.38		10	4x6	1.47	8		2			
	E 410 GD	11.58		10	4x10	1.47	8		2			
	E 411 GD	11.58		10	4x11	1.47	8		2			
	E 5 GDP	9.51		10	5	1.47	8		2			
	F 4100	22.20		18	4x10	3.16	8		2			
	F 57 GD	13.20		18	5x7	3.16	8		2			
	F 570	21.00		18	5x7	3.16	8		3			
	F 69 GD	13.80		18	6x9	3.16	8		2			
	F 690	21.60		18	6x9	3.16	8		3			
	JC 48 CD	15.00		20	4x8	10	8		2			
	JC 410 CD	16.32		20	4x10	10	8		2			
	JC 5 CD	13.02		20	5	10	8		2			
	JC 57 CD	15.00		20	5x7	10	8		2			
	JC 69 CD	15.60		20	6x9	10	8		2			
Motorola	M3-3F		16.25	5	3	3	8			S/F	4x3¼x4½	
	M35-3F		14.95	4	3x5	3	8			S	6¼x4½x5½	
	M4-5W		20.95	8	4	5	6			F	5¼x2½	
	M5-5W		30.95	8	5¼	5	6			F	6¼x6¼x2½	
	M69-10W		37.95	15	6x9	10	6			F	10¾x7½x4	Whizzer Cone
	M4-8C		39.95	15	4	8	6		2	F	8x4½x2½	
	M5-10C		62.95	15	5¼	10	6		2	F	6¼x3	
	M5-20C		72.95	25	5¼	20	6		2	F	6½x6¼x3	
	M69-20C		79.95	25	6x9	20	6		2	F	10¾x7½x4¾	
	M69-20T		119.95	25	6x9	20	6		3	F	10¾x7½x4¾	

If this is what you are looking for.

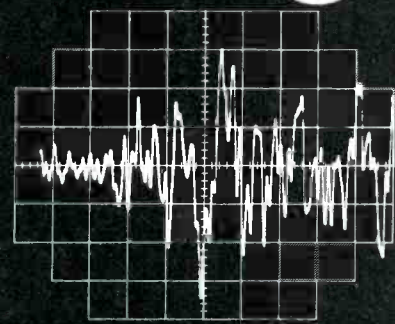
If you demand nothing less than true hi-fi performance, you'll understand the advantages and flexibility that resulted when Technics separated the basic amplifier/control/tuner functions into the five units we call the Flat Series: The automatically switchable dual IF band ST-9030 FM tuner. The SU-9070 DC preamplifier. The SH-9010 stereo parametric/graphic frequency equalizer. The SH-9020 peak/peak-hold/average metering system. And the SE-9060 stereo/mono DC power amplifier.

You'll also understand why the Flat Series challenges the performance of the most expensive professional equipment in the world. And very often surpasses it.

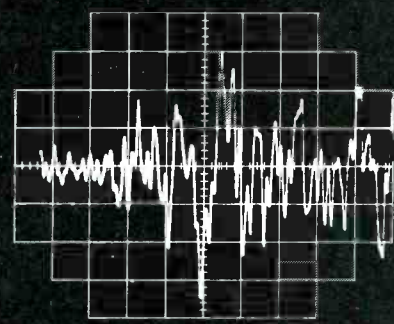
Look at the graphs. The reproduced waveform is virtually true to the original. All types of distortion—some measurable, some not—are negligible. And the linear frequency response is extremely wide.

We're confident that the truly discriminating critic will recognize the magnitude of our achievement. Especially when that achievement is offered at prices that are unprecedented for equipment of this caliber. And with the flexibility to incorporate one or more, or all five units into your system. Depending on your needs or budget.

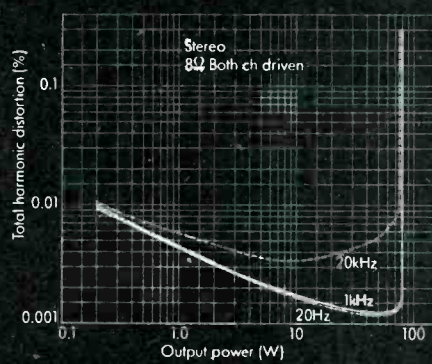
To see how Technics achieved the incredible performance shown in the graphs, you have to see and compare the incredible specifications that are typical of the Technics Flat Series on the facing page.



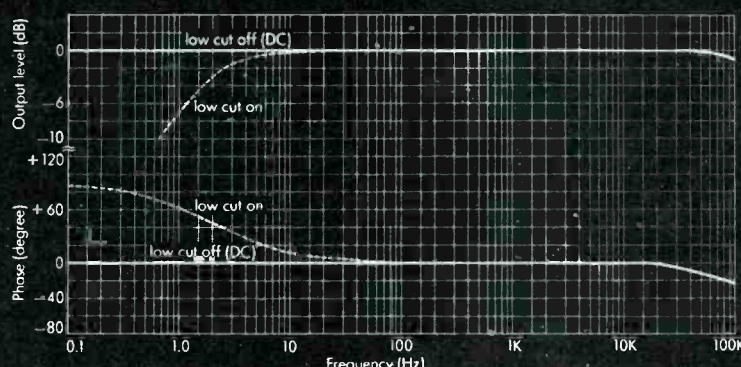
Input Waveform to ST-9030 FM Tuner.



Output Waveform from Technics Flat Series.



THD vs. Output. Power in Stereo SE-9060.



Goin, Phose vs. Frequency Response, SE-9060 Amp.

TECHNICS ST-9030. THD (stereo): Wide—0.08% (1 kHz). Narrow—0.3% (1 kHz). S/N (stereo): 73 dB. FREQ. RESPONSE: 20 Hz—18 kHz +0.1, —0.5 dB. SELECTIVITY: Wide—25 dB. Narrow—90 dB. CAPTURE RATIO: Wide —0.8 dB. Narrow—2.0 dB. IMAGE and IF REJECTION, SPURIOUS RESPONSE (98 MHz): 135 dB. AM SUPPRESSION (wide): 58 dB. STEREO SEPARATION (1 kHz): Wide—50 dB. Narrow—40 dB. (10 kHz): Wide—40dB. Narrow—30cB. CARRIER LEAK: Variable terminal—65 dB (19 kHz). Fixed—70 dB (19 kHz, 38 kHz).

TECHNICS SE-9060. POWER OUTPUT: 70 watts per channel (stereo), 180 watts (mono) min. RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% THD. INTERMODULATION DISTORTION (60 Hz: 7 kHz, 4:1): 0.02%. FREQ. RESPONSE: DC∼100 kHz, +0dB, —1 dB. POWER BANDWIDTH: 5 Hz —50 kHz, —3 dB. S/N: 120 dB (IHF A). RESIDUAL HUM & NOISE: 100 μV. INPUT SENSITIVITY & IMPEDANCE: 1V/47kΩ.

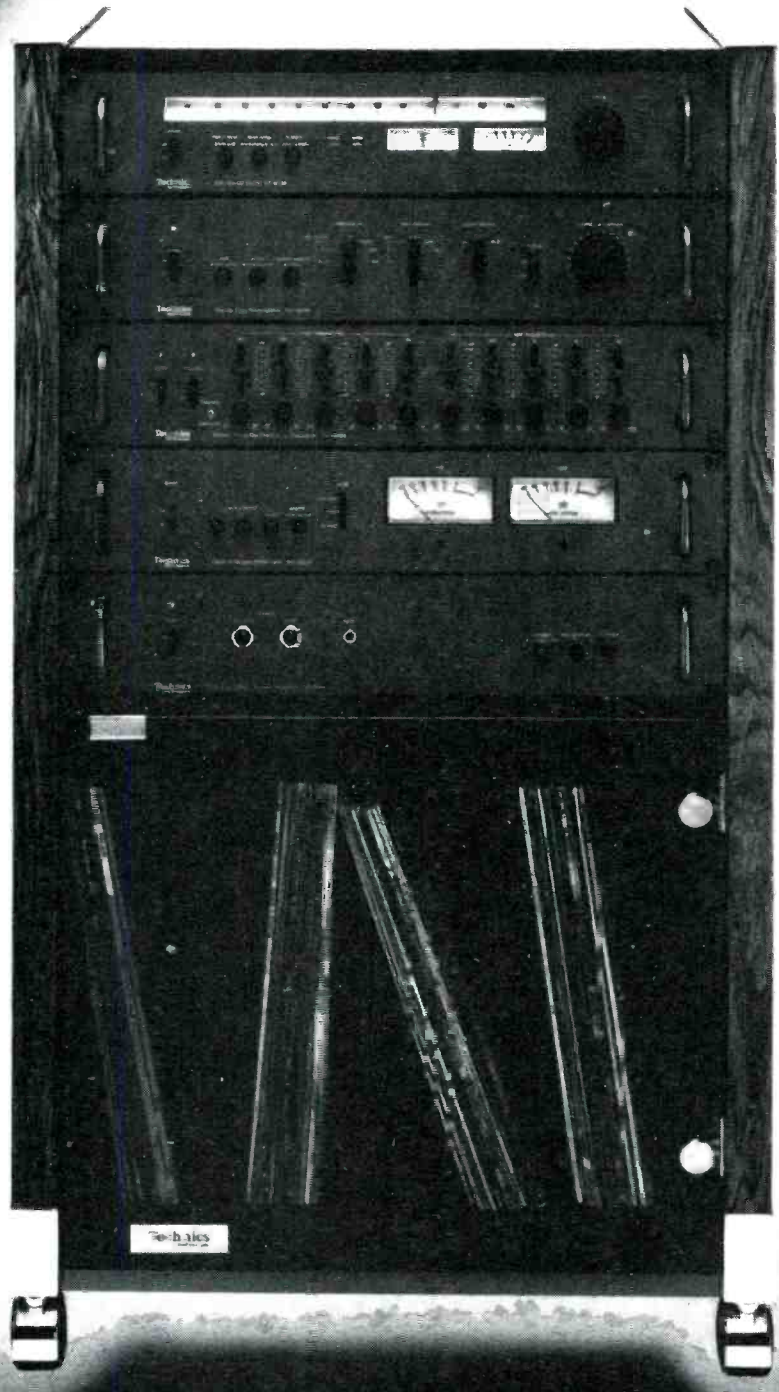
All the specifications of Technics Flat Series are too numerous and complex to list here. But their performance is too good to miss. So don't. Technics Flat Series is now available for demonstration at selected audio dealers. For very selective ears. And for very selective eyes there's Technics SH-999. A movable 19" custom rack with rosewood veneer side panels.

Technics Flat Series. A rare combination of audio technology. A new standard of audio excellence.

Technics *Professional Series*
by Panasonic

Enter No. 44 on Reader Service Card

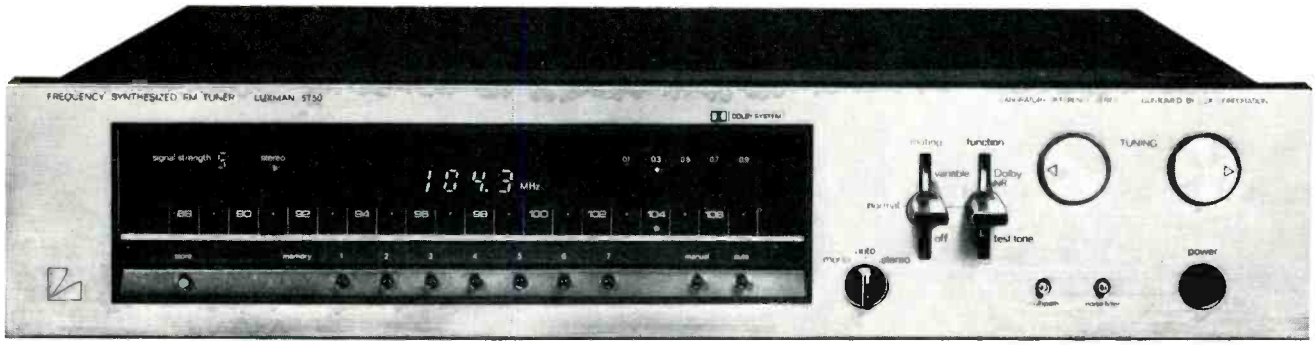
This is what you should listen to.



Car Speakers

	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
Panasonic	EAB-752	37.45		20	6x9	20	4		2	F		
	EAB-814		64.95	20	4x10		4		2	F		
	EAB-800		149.95	30	5¼ Woofer 3½ Tweeter	10W 3T	4		2	S		
	EAB-813		29.95	8	5	5	4			F/S		
	EAB-771	19.95		20	6x9	10	4			F		
	EAB-772	29.95		20	6x9	20	4			F		
	EAB-773		39.95	20	5¼	10	4			F		
	EAB-774		49.95	20	5¼	20	4			F		
	EAB-851		24.95	8	4	3	4			F		
	EAB-852		34.95	20	4	7	4			F		
	EAB-303		19.95		5		4-8			F		
	EAB-951	19.95			6x9		8		2	F	5¼" W/1"T	
	EAB-775		29.95	20	6		8			F		
	EAB-551		19.95		5		8			S		
Pioneer	TS-695		74.95	40	6x9	20		30-20k 40-20k	3	F		
	TS-681		69.95	20	6x8	10		35-20k	3	F		
	TS-168		139.95	40	6½	10		50-20k		F		
	TS-411		69.95	20	4x10	10		80-16k		F		
	TS-121		49.95	20	5½			50-16k		F		
	TS-410		49.95	20	4x10	10		30-20k	2			
	TS-167		74.95	20	6½	10	4	50-16k				
	TS-106		42.95	20	4	7	4	30-16k	2			
	TS-165		64.95	20	6½	20	4	40-16k	2			
	TS-164		54.95	20	6½	10	4	40-16k	2			
	TS-161		37.95	20	6½	10	4	40-16k	2			
	TS-160		35.95	20	6½	10	4	80-16k				
	TS-120		35.95	8	5½		4	60-14k				
	TS-100		26.95	8	4	7	4	50-10k				
	P-16L		24.95	8	6½		4	100-10k				
	P-10L		20.95	8	4		4	35-18k	2	F		
	TS-694	41.95		20	6x9	20	4	40-18k	2	F		
	TS-693	35.95		20	6x9	10	4	35-16k	2	F		
	TS-692	30.95		20	6x9	20	4	40-16k	2	F		
	TS-691	24.95		20	6x9	10	4	50-16k	2	F		
	TS-690	10.95		10	6x9		4	50-18k	2	F		
	TS-571	30.95		20	5x7	10	4	50-16k	2	F		
	TS-570	21.95		20	5x7	10	4	80-13k		S/F		
	TS-35		44.95	40	5¼		4	100-15k	2	S		
	TS-22		44.95	8	4&2½		4	45-20k		S		
	TS-M2		50.95	20			4	70-10k		S/F		
	TS-5		24.95	8	5¼		4					
Polk	Mini Monitor	99.95		5-40	1-4½ 1-4½ 1-1		4	60-20.5k ± 2	3		15x6¼x4½	
Pyle	F52C160-FC	15.95		11	5¼	16	8	90-18k ± 5	2	F	5¼x5¼x2½	
	F57C160-FC	17.95		14	5x7	16	8	85-18k ± 5	2	F	5x7¼x2½	
	F69C100-FC	17.50		15	6x9	10	8	80-18k ± 5	2	F	6¼x9¼x3	
	F69C190-FC	24.95		30	6x9	20	8	70-18k ± 5	2	F	6¼x9¼x3½	
	F69C290-FC	29.95		50	6x9	30	8	55-18k ± 5	2	F	6¼x9¼x3¾	
	F410C100-FC	17.95		15	4x10	10	8	85-18k ± 5	2	F	4¼x10x2¾	
	F5C99-WF	10.75		9	5	10	8	90-17k ± 5	2	F	5x5x2¼	
	F52C100-WF	10.95		10	5¼	10	8	90-17k ± 5	2	F	5¼x5¼x2½	
	F52C160-WF	12.95		11	5¼	16	8	85-18k ± 5	2	F	5¼x5¼x2¼	
	F57C160-WF	11.95		14	5x7	16	8	85-18k ± 5	2	F	5x7¼x2½	
	F69C100-WF	19.95		15	6x9	10	8	80-19k ± 5	2	F	6½x9¼x3	
	F69C190-WF	18.50		30	6x9	20	8	70-18k ± 5	2	F	6½x9¼x3½	
	F410C100-WF	12.75		15	4x10	10	8	85-17k ± 5	2	F	4¼x10x2¾	
Quam Nichols	69C20FEX	24.95	46.00	15	6x9	20	8	45-17k	2	F	9¼x6½x3¾	
	69C30FEX	32.00	67.75	40	6x9	28	4-8	35-14k	2	F	9¼x6½x3¾	
	69C10FECO	30.65		15	6x9	10	8	45-20k	2	F	9¼x6½x3¾	
	52C10FEX	16.05		15	5¼	10	8	75-15k	2	F	5½x5½x2½	

The Luxman 5T50



The Laboratory Reference Series tuner.

A very remarkable component—by itself or as part of a complete LRS system.

Although the LUX Laboratory Reference Series was conceived—and introduced—as a completely new concept in systems, we believe you'll find the LRS tuner alone merits special consideration.

At a glance, the 5T50 is strikingly clean and elegant. The tuning display itself is digital, supplemented by what might be considered an advanced touch of nostalgia for the dial of old. One linear dial is calibrated in 1 MHz increments, and another provides for 200 kHz indication. However, instead of a pointer, LED's traverse the dials, giving linear readout of tuned stations.

Electronic tuning and memory.

Tuning is accomplished electronically, by a touch on either of two buttons. Station selection can be switched to either manual or automatic scanning mode, and tuning speed can be adjusted from slow to rapid. A further tuning option is provided through the tuner's C-MOS IC memory system, which stores seven stations in digital code. A touch of the appropriate button provides instant reception, with the station exactly center-tuned.

Tuning accuracy within 0.003 per cent.

Tuning is always exact, no matter how you select the FM station. Using a quartz crystal frequency synthesizer instead of a tuning capacitor and coil assembly, the 5T50 gives a degree of accuracy (within 0.003 per cent) and stability that cannot be found in conventional tuners. The station is received center-tuned and it remains that way—just as accurate and as stable as the FM transmitter frequency itself—which, for reasons of precision, is also referenced to a crystal.

But the utmost in design and performance doesn't stop here. From front end to output terminals, the 5T50 utilizes the best circuitry. For example, dual-gate MOSFET's in the RF amp and mixer. And a buffer circuit—which helps achieve outstanding image, IF and spurious response rejection—follows the crystal oscillator. In the IF section, a ceramic filter plus two pairs of 4-pole block filters provide for excellent selectivity without sacrificing low distortion characteristics. A double-tuned quadrature detector also keeps distortion low, at the same time protecting against signal overload. And to assure excellent stereo separation (45 dB at 1kHz and at least 40 dB at high and low frequencies), the multiplex section employs a Phase-Locked-Loop circuit.

Special tuning refinements.

To help you take advantage of this advanced internal design—which includes a Dolby* decoding circuit for Dolbyized FM broadcasts—we've included a number of advanced external features. So tuner operation is just as precise as performance. For example, a multipath check button lets you detect multipath distortion audibly—no need for an oscilloscope. There's also an antenna attenuator for adjustment if signals are too strong in your reception area. For quick level adjustment when recording Dolbyized broadcasts, a 400-Hz test tone button is provided. The tuner output level is adjustable, along with interstation muting threshold. A digital display provides easy-to-read signal strength indication. And if incoming signals are weak, there's a high blend noise filter to assure low-noise stereo FM.

Other LRS components.

Of course, only you know if you're considering a new tuner at this time, or an entirely new system. If the latter, we'll simply advise you that the LRS system has carried the separates concept to "an extreme." That is, the preamplifiers have no tone controls—these are provided by the LRS graphic equalizer or separate tone control unit. The power amplifiers are available with or without meters—supplemented by a separate LED peak indicator. And if low distortion is important to you, the total harmonic and IM distortion of the LRS power amplifiers at rated power is no more than 0.008 per cent. That's double-0 eight.

However, if a superb tuner is really all that interests you at this time, that's fine. Chances are you'll see and hear it as part of the complete LRS system—where it will look and sound the most impressive. Suggested price: $1,495.

*Dolby is a trademark of Dolby Laboratories, Inc.

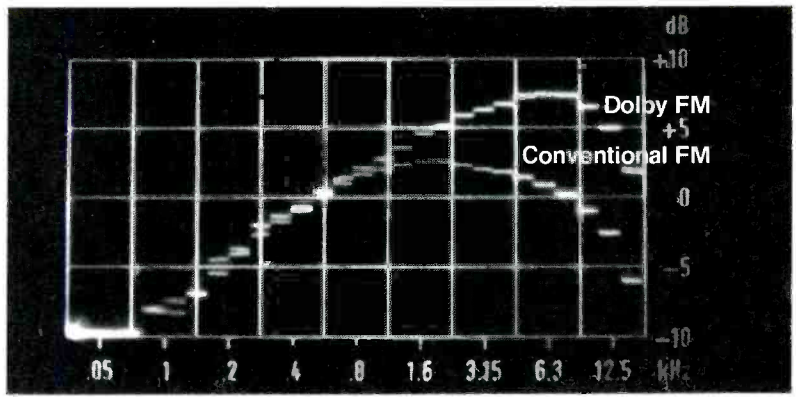
LUX Audio of America, Ltd.

160 Dupont Street, Plainview, New York 11803 • In Canada: White Electronics Development Corp., Ontario

Car Speakers

	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
Radio Shack	12-1853			20	5	7	8	5120-20k ±		S	5¾x9½x3¾	
	12-1854			20	5¼	7	8	55-15k ±	3	F	6¾x10x3	
	12-1848		29.95	15	5	10	8	5100-16k ±		F	6¾x3	
	12-1850		37.95	15	5¼	8	8	560-18k ±		S	7¾x8¼x4	
	12-1843		15.95	10	5¼	4¼	8	5130-15k ±		F	6¼x2¼	
	12-1844		15.95	10	5¼	4¼	8	5110-17k ±		S	7x7x3½	
	12-1851		9.95	10	4½	1.7	8	570-12k ±		F	5¾x2	
	12-1852		9.95	10	3	1.7	8	5200-20k ±		S	4¾x3¾x2¾	
	12-1845		24.95	10	5¼	8	8	5100-16k ±		F	6¾x2¾	
	12-1849		24.95	10	5¼	8	8	5120-16k ±		S	7¼x7¾x3¾	
Roadstar	RS-200		18.95	12	5¼	5	4	100-16k	1	S/F		
	RS-705		29.95	8	4 & 2	6 & ⅓	4	100-16k	2	S/F		
	RS-805		34.95	30	6½	10	4	50-15k	1	S/F		
	RS-505X		16.95	12	5¼	5	4	100-16k	1	S/F		
	RS-3200		38.95	12	5½ & 2¾	10 & 2	4		2	S/F		
	TR-4020		56.95	25	4x10	20	4 & 8	80-18k	3	F		
	CO-5720		44.95	25	5x7	20	4 & 8	80-16k	2	F		
	TR-5720		56.95	25	5x7	20	4 & 8	80-18k	3	F		
	RS-100		11.95	8	5¼	3	4	100-15k	1	S		
	RS-150		13.95	8	5¼	3	4	100-15k		S/F		
	CO-6920		44.95	25	6x9	20	4 & 8	80-16k	2	F		
	TR-6920		44.95	25	6x9	20	4 & 8	80-18k	3	F		
	CO-5420		41.95	25	5¼	20	4 & 8	80-16k	2	F		
	TR-5420		54.95	25	5¼	20	4 & 8	80-18k	3	F		
	CO-4020		44.95	25	4x10	20	4 & 8	80-16k	2	F		
	RS-6021		26.95	15	4 & 2¼	6 & ⅓	4	100-16k	2	F		
	RS-6031		53.95	30	6¼, 2, ¾	20, 2 & ½	4	80-20k	3	S/F		
	RS-6023		38.95	30	6¼ & 2¼	10 & ½	4	60-18k	2	S/F		
	RS-6045		109.95	30	4 & 2¼	8 & 3¾	4	50-23k	2	S		
Sparkomatic Corp.	SK-203		11.99	5	3x5	3	4-8	150-8k ± 5		S	8x6¾x4	
	SK-303		11.99	5	3	3	4-8	125-9k ± 5		S	3½x4½x2½	
	SK-313		11.99	5	3	3	4-8	100-9k ± 5		S	4½x5½x3½	
	SK-355		11.99	5	3½	5	4-8	100-10k ± 5*		F	3½x1¾	*Whizzer
	SK-690		24.99	15		10	4-8	75-12k ± 5		F	6x9x3	
	SK-610		19.99	15		10	4-8			F	6¼x6¼x2	
	SK-510		22.99	15		10	4-8			F/S	5½x5½x5	
	SK-250		14.99	5		3	4-8		2	S	6¾x10½x4	
	SK-522T		54.95	25		20	4-8	80-20k	3	F/S	5¾x8x5¾	
	SK-6920C		44.99	25		20	4-8	40-18k	2	F	6½x9¼x3¾	
	SK-620C		31.99	25		20	4-8	60-18k	2	F	6¼x6¼x2½	
	SK-520C		35.99	25		20	4-8	60-18k	2	F/S	5¾x8x5¾	
	SK-6900		79.95	25		20	4-8	40-20k	3	F	6½x10¼x3	
	SK-700V		84.95	25		10	4-8	40-18k	2	•	8x21x8	*Free standing for use in vans
	SK-6922T		63.99	25		20	4-8	40-20k	3	F	6½x9¼x3½	
	SK-622T		51.99	25		20	4-8	60-20k	3	F	6¼x6¼x2¾	
Speco	SK69CA20Q Quadraxial			60	6x9	20	8	50-20k	4	F		
	SK69CA20T Super Trio			60	6x9	20	8	50-20k	3	F		
	SK69CA20C			50	6x9	20	8	50-20k	2	F		
	SK69CA27W			50	6x9	27	8	50-20k	2	F		
	SK-3			50	6x9 4 tweeter	20 4.5	8	50-20k	3	F		
	SK51CA20C			30	5¼	20	8	130-20k	2	S		
	SK51CA10C			30	5¼	10	8	130-20k	2	S		
	SK51CA10W			30	5¼	10	8	80-15k	2	S		
	SK410CA20C			40	4x10	20	8	65-20k	2	F		
	SK410CA20W			40	4x10	20	8	65-18k	2	F		
	SK4CA10C			20	4	10	8	65-20k	2	F		
Visonik	D-302 MO	92.00		10	2 & 4		4	50-22k +4, −8	2	S	6¾x4¼x4¼	
	D-502 MO	127.00		20	¾ & 4		4	45-30k +4, −8	2	S	6¾x4¼x4¼	

Dolby FM turns the treble back up.



Real-time analysis of the output of a Dolby FM receiver tuned to interstation noise. This is equivalent to a station broadcasting "white noise," a test signal containing a great deal of high frequency energy, which is represented graphically by a rising straight line. The curves show that Dolby FM can provide much more high frequency information at high levels.

Over the years, recordings and the equipment you play them on have been improved to deliver more accurate high frequency response. FM broadcasting, however, has not kept up. FM stations have in effect been turning down the treble on the signals they transmit. As a result, your favorite recordings often sound lifeless when you hear them over the air.

It doesn't have to be that way any longer. Stations can now turn the treble back up to where it should be, thanks to a technique called Dolby FM. It uses our famous Dolby system of noise reduction in a new way, to let FM broadcasters put out a significantly clearer, higher fidelity signal.

Dolby FM is a two-step process. A station broadcasts a signal encoded very much like the recorded cassettes you buy in stores. You listen on one of the new receivers or tuners equipped with Dolby FM decoding circuitry.* The process lets a station broadcast much more high-level, high frequency information (8-9 dB at 10 kHz), an improvement particularly important on loud music rich in high frequencies, such as percussion and brass. In addition, a Dolby FM receiver provides less noise (5 dB) in weak signal areas.

Those numbers mean that FM broadcasting can now match the sound of your best records and tapes. You can listen right "through" the broadcast to the music itself. Dolby FM keeps the music intact – which is what truly high fidelity sound is all about.

If you would like more information on Dolby FM, including lists of the products and stations using it and an explanation of how it works, please write us. Thank you.

*If you still have a conventional receiver, the sound will not seem greatly changed.

Dolby®

Dolby Laboratories

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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 handle the moving coil cartridge. For a signal-to-noise ratio of −77dB. Unheard of in any other preamplifier.

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

With THD in stereo at barely 0.08% at 1kHz. Conservative, at that. With switched selectivity for uncompromising reception. With digital read-out. With LED's to determine signal strength and precise tuning. With an uncanny ability to zero in on the quietest signal.

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.

MITSUBISHI® AUDIO SYSTEMS

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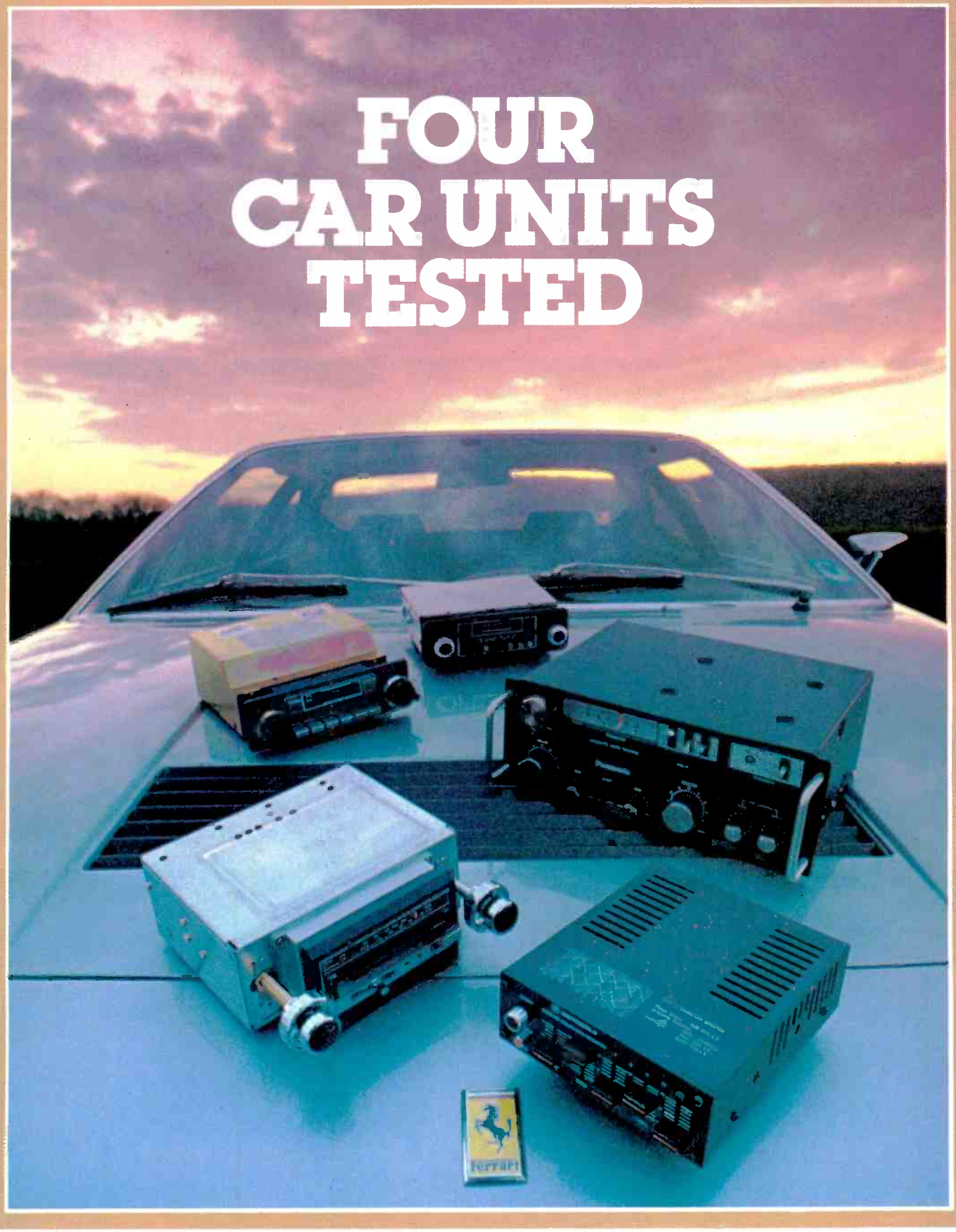
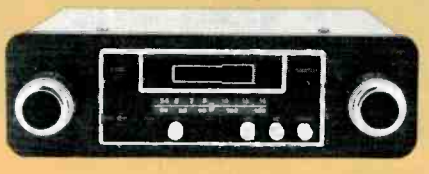
FOUR CAR UNITS TESTED



1

Sparkomatic Model SR-48 AM/FM Stereo Radio & Cassette Deck



MANUFACTURER'S SPECIFICATIONS
Audio Amplifier Section: 6 watts per channel @ 4 ohms for 10 per cent THD.
Frequency Response: 50 Hz to 10 kHz.
Loudspeaker Impedance: 4 or 8 ohms.
Cassette Wow and Flutter: Less than 0.35 per cent.
Cassette S/N: 50 dB.
Stereo FM Separation: (No frequency specified) 35 dB.
AFC Holding Range: ±350 kHz.
Price: $149.99.

2

Motorola TC887AX AM/FM Stereo Cassette Player and EQB-3000 Stereo Equalizer/Booster

MANUFACTURER'S SPECIFICATIONS
TC887AX AM/FM Radio and Cassette Deck
Power Output: 4 watts @ 400 Hz.
THD: 10 per cent at rated output.
Cassette Frequency Response: 63 to 6300 Hz, ± 3 dB.
Cassette Rewind Time: 60 seconds for a C-60 tape.
Wow and Flutter: 0.2 per cent.
Alternate Channel Selectivity: 65 dB.
Dimensions: 2¾ in. (7 cm) x 7 in. (17.8 cm) x 5½ in. (14 cm).
Price: $229.95.

EQB-3000 Equalizer/Booster
Power Output: 15 watts per channel @ 4 ohm load.
Frequency Response: 35 Hz to 20 kHz, −3 db.
Equalizer Center Frequencies: 60 Hz, 250 Hz, 1 kHz, 3.5 kHz, & 10 kHz.
Equalizer Control Range: ±12 dB at center frequencies.
Input Impedance: 25 ohms, d.c. coupled.
Minimum Load Impedance: 3 ohms.
Price: $119.95.

3

Sanyo Model FT-1490A AM/FM Cassette Player

MANUFACTURER'S SPECIFICATIONS
Power Output: 10 watts rms per channel into 8 ohms.
Frequency Response: 50 Hz to 20 kHz.
Cassette Frequency Response: 30 Hz to 16 kHz.
Tape Wow & Flutter: 0.2 per cent rms.
S/N Ratio: 50 dB w/Dolby.
Tape Speed Variation: Less than 1 per cent.
Price: $199.95.

4

Panasonic "Separates" Component Systems Model CX-7100 Cassette Deck, Model CA-9500 AM/FM Tuner, and Model CJ-3510 Power Booster

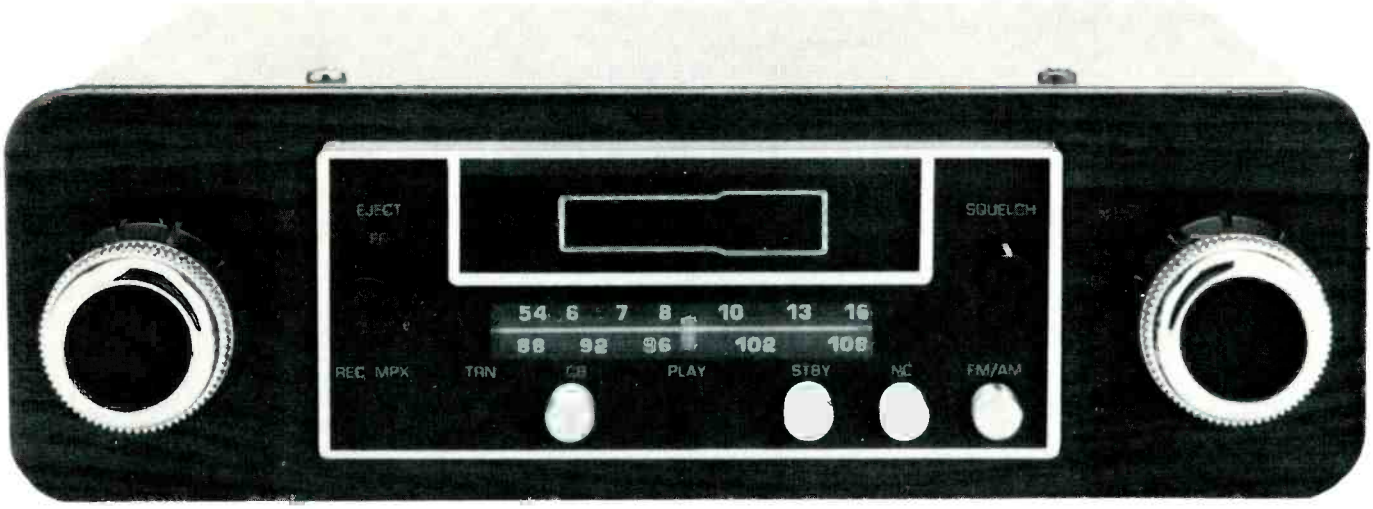
MANUFACTURER'S SPECIFICATIONS
CX-7100 Cassette Deck
Frequency Response: 50 Hz to 10 kHz.
Wow & Flutter: Less than 0.3 per cent W rms.
Signal-to-Noise Ratio: Better than 40 dB (no reference given).

CA-9500 AM/FM Tuner
Frequency Response: 50 Hz to 10 kHz.
S/N Ratio: 40 dB.

CJ-3510 Power Booster
Power Output: More than 10 watts per channel, 4 ohm loads, at less than 0.1 per cent THD.
Frequency Response: 40 Hz to 30 kHz (no tolerance given).
Impedance: 4 ohms.

General Specifications
Cassette Deck Dimensions: 7½ in. (19 cm) W x 2½ in. (6.4 cm) H x 5⁵⁄₁₆ in. (13.5 cm) D.
Weight: 3.3 lbs. (1.5 kg).
Tuner Dimensions: 7¹⁄₁₆ in. (19.4 cm) W x 1⅜ in. (3.5 cm) H x 6³⁄₃₂ in. (17.6 cm) D.
Weight: 2.2 lbs. (1 kg).
Booster Dimensions: 2¾ in. (6.5 cm) W x 4 in. (10 cm) H x 8⅝ in. (22 cm) D.
Prices: Cassette Player, $119.95; Tuner, $84.95; Booster, $84.95, and Mounting Bracket for housing all three units, $39.95.

Sparkomatic Model SR-48 AM/FM Stereo Radio & Cassette Deck



The Sparkomatic Model SR-48 is a self-contained AM/FM cassette unit intended for in-dash mounting. Many of its front panel controls are intended to interface with optionally available CB-transceiver models from the same company (Models CBM-1 or CBM-2) and are therefore inoperative when the SR-48 alone is used. Controls of interest to the radio/cassette user are conventionally arranged on the front panel, with *On/Off* volume control and tone control concentrically mounted at the left (the tone control is a "single universal" type which increases treble response when rotated to the right and increases bass response when rotated counterclockwise) and a dual concentric tuning and left-right balance control at the right. The cassette door is located above the dial scales and is arranged for sideways insertion of a cassette. An *Eject/Fast-Forward* button is at the left of the cassette compartment, while at the right is a CB squelch control. Of the controls seen below the dial scale, only the AM/FM selector button at the right and the centrally located tape play indicator light are of concern to non-CB users. The CB-related controls include a noise limiter switch, CB/radio selector, CB transmit light, and a CB receive light, which also serves as a stereo indicator light for FM.

Installation, as with most in-dash units, is fairly simple, and all the required hardware is supplied. A support strap holds the unit firmly in place in addition to the control nuts, and a sufficient quantity of spacer hardware is provided to accommodate just about any car radio cut-out in domestically produced automobiles. For some foreign cars which have a rectangular cutout for radio installation, a back-up plate is provided. An eight-pin connector and mating plug with color coded leads facilitates final connection after speaker and power wiring has been completed.

FM Section Measurements

As is true of so many car stereo products, performance specifications offered by the manufacturer are minimal. Our FM measurements are based upon a presumed 75-ohm antenna input impedance which accounts for the altered relationship between the "microvolt" and "dBf" readings quoted. (Remember, dBf readings are power readings, and 2 microvolts across 300 ohms yields the same power input as 1 microvolt across 75 ohms.)

Usable sensitivity in mono measured 7 μV (28.2 dBf), the same figure obtained for stereo sensitivity. Distortion was obviously the governing factor here, since 50-dB quieting (which does not take any distortion into account) measured 2.1 μV (17.7 dBf) in mono and 12 μV (32.8 dBf) in stereo. Ultimate quieting in mono measured 70 dB, while for stereo the best S/N at strong signals was 67 dB. THD in mono and stereo turned out to be 1.2 per cent at strong signal levels and was more a function of the amplifier section than of the tuner section. These characteristics are graphed in Fig. 1. Both in mono and stereo, THD figures at the frequency extremes rose rapidly, with readings of 2.5 per cent at 100 Hz and 2.0 per cent at 6 kHz in mono, and 6.0 per cent at 100 Hz and 6 kHz in stereo. These results are plotted in Fig. 2. Frequency response, as well as stereo FM separation, are shown in the spectrum analyzer scope photo of Fig. 3, in which each vertical division represents 10 dB of amplitude. Allowing for the 75-microsecond de-emphasis curve, response was down more than 7 dB at 10 kHz and rolled off by about 9 dB at 50 Hz, even when the tone control was set to its "best response" setting. We measured stereo separation capability of 44 dB at mid-frequencies, 30 dB at 100 Hz, and 15 dB at 10 kHz. Switchover from mono to stereo occurs at an input signal strength of 3.0

Fig. 1—The mono and stereo quieting and distortion characteristics for the FM section of the Sparkomatic SR-48.

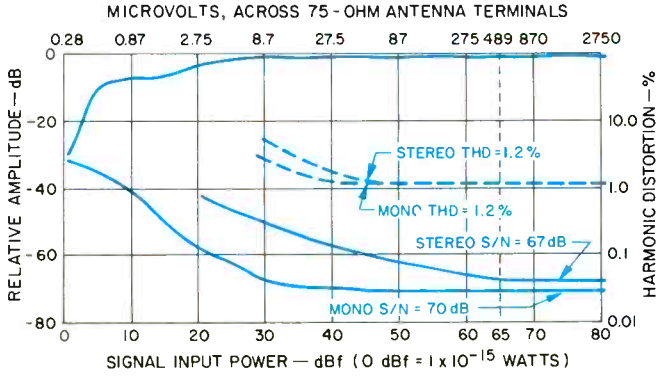
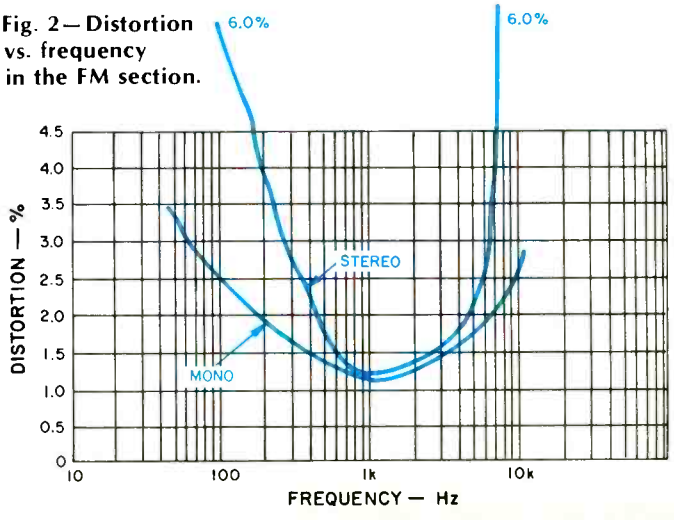


Fig. 2—Distortion vs. frequency in the FM section.



μV (20.8 dBf). Since the AFC circuitry of this tuner section is always operative, it was impossible to determine selectivity characteristics accurately, but in our listening tests we found it pretty difficult to separate closely spaced weak and strong signals, since the tuner always "homed in" on the stronger station. From the point of view of the city driver, this is a benefit rather than a negative characteristic, as it does tend to keep the signal locked in.

Cassette Section Performance

Using a previously recorded test cassette (prepared on our Nakamichi 1000 home stereo deck), we measured a wow and flutter of 0.12 per cent (W rms)—rather a good figure for a cassette mechanism of this type. Signal-to-noise ratio (using a top-quality cassette by TDK) measured 55 dB. Frequency response, however, was poor, with the 3 dB point reached at 4.5 kHz. (Played back on our Nakamichi machine, our test cassette was virtually "flat" to 20 kHz).

Power Amplifier Section

Since there was no access to the amplifier section directly, what amplifier measurements we were able to make were done via the tuner section, using a signal generator. In order to insure that the distortion was that of the amplifier and not the tuner, we decreased modulation to well below the 100 per cent point and, at 1 watt of output, read a THD figure of 0.6 per cent. Clipping occurred at a voltage output of 3.7 volts rms, which, applied to a 4-ohm speaker load (per channel) corresponds to 3.42 watts. The 10 per cent total harmonic distortion point occurred with a power output of 4.62 watts, lower than the 6 watts per channel claimed by the manufacturer.

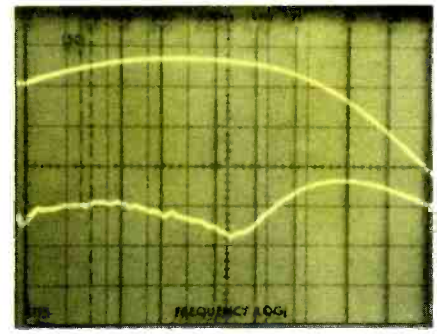


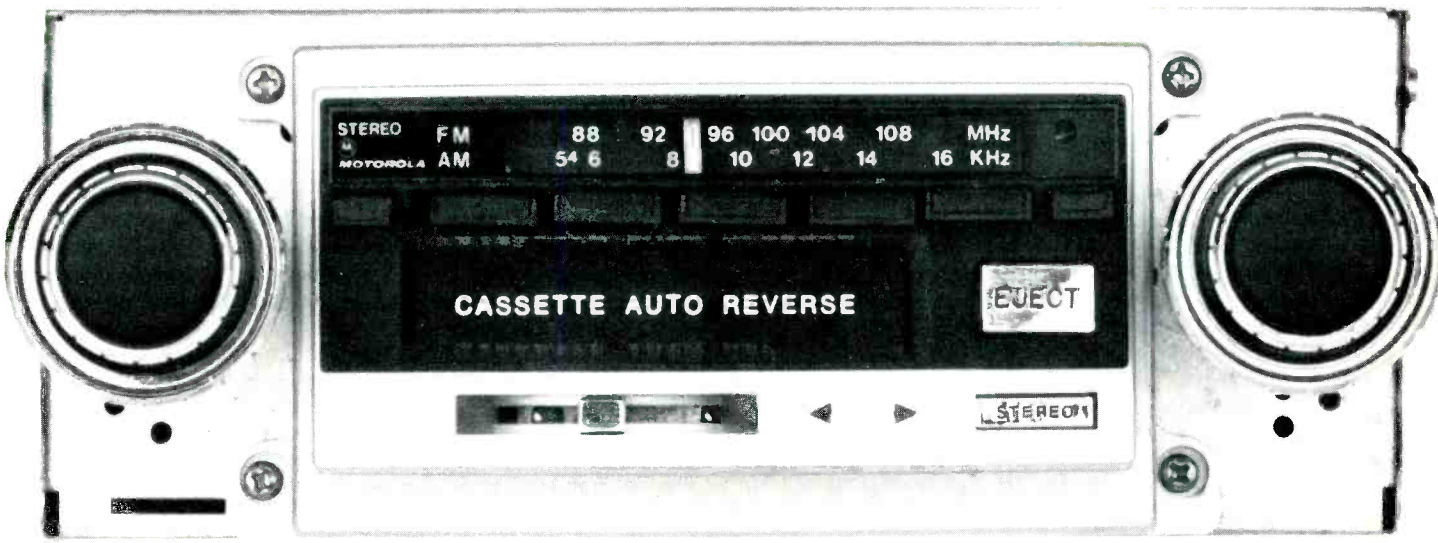
Fig.3— The frequency response (including de-emphasis) and separation for the FM section.

Listening and Use Tests

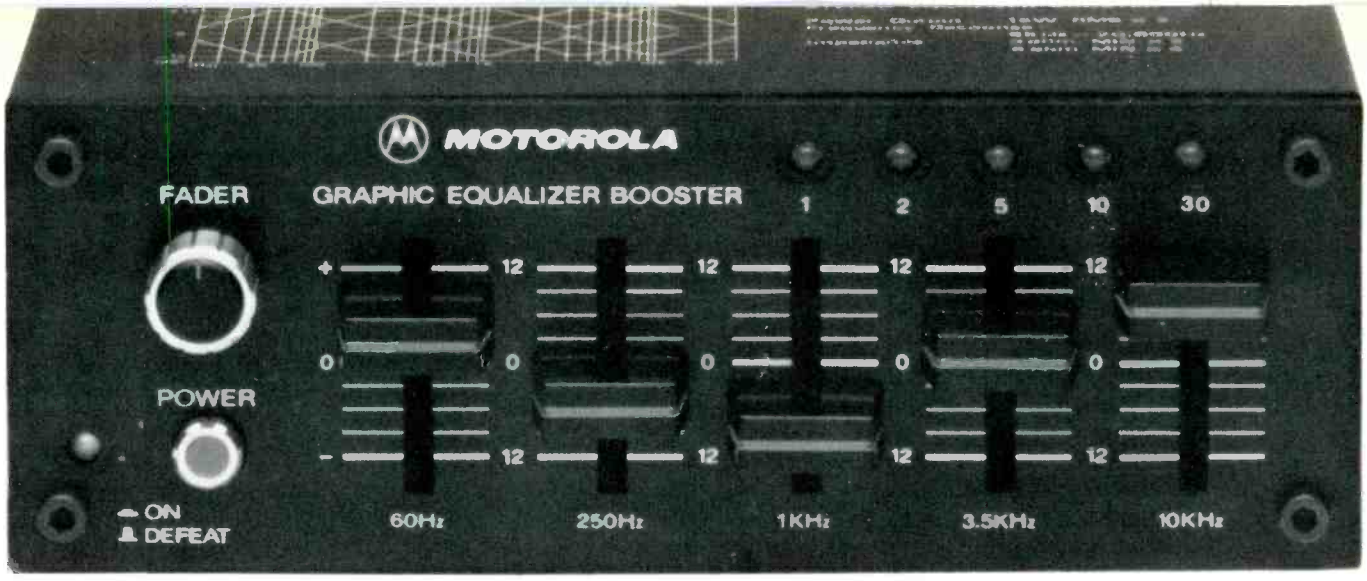
To realize best performance from the Sparkomatic SR-48, a user should naturally choose an efficient speaker system, since the power output of this unit is on the low side. From a purely operational point of view, one feature that would have been very much appreciated would have been a fast rewind button for the cassette section which, as we noted, only provides for fast forward motion of the tape—and not terribly fast at that. *Leonard Feldman*

Enter No. 85 on Reader Service Card

Motorola TC887AX AM/FM Stereo Cassette Player and EQB-3000 Stereo Equalizer/Booster



Although it is perfectly possible to operate the TC887AX radio/cassette player by itself, we chose to test this unit used in combination with Motorola's matching EQB-3000 booster/equalizer, a powerful and worthwhile unit that exceeded its published specifications by a wide margin. At the time of testing, we didn't have any specifications for the radio unit, but, as it turned out, this unit was one of the better ones we checked out for this series of reports. Motorola has managed to provide a number of useful control features in a small space (the radio is intended for in-dash mounting). Tone and volume controls are concentrically mounted at the left, and the volume control, when pulled, serves as a channel balance control. Pushing the same control in serves to change cassette program from first to second programs, since the cassette transport and electronics features auto-reverse operation. In addition to reversing tape direction at the end of play, a fast forward/fast reverse lever permits the user to reach any desired portion of the tape (in either direction) quickly. Nor is it necessary for the operator to do any one-hand driving while the fast mode is used, since the fast forward/reverse lever locks in place when actuated. Lights (in the form of illuminated arrow heads) tell the listener in which direction the tape is traveling. A *Stereo/Mono* switch is located at the lower right of the front panel and just above, in line with the cassette door, is a cassette eject button. In addition to five station pushbuttons (which can be pre-set for either AM or FM favorite stations or any combination of both), an AM/FM selector button is located to the left of the station pushbuttons, while a *Local/Distance* switch is symmetrically positioned to the right. The dual concentric knobs at the right are



for tuning and fading (front to rear speakers, if four speakers are used). The usual stereo indicator light is located to the left of the frequency scales, and to the right of the scales is a tiny hole which provides access to the AM antenna trimmer. (Why didn't anyone else ever bother to position this important adjustment so conveniently? Chalk one up for Motorola, especially if you've ever crouched under the dashboard and tried to align the antenna trimmer *after* installation has been completed and had a backache for several days thereafter.)

Installation instructions and diagrams are very clear and easy to follow, but we must mildly fault Motorola for not supplying the mating special connectors required for making speaker connections. Unless the dealer calls this to your attention, you will need to make two trips to his shop, since the connection kit is optional (Motorola kit KP-1012).

The booster unit is intended for underdash mounting and a sturdy mounting bracket, support strap, and needed hardware were all included. Input leads from the booster are stripped wires which take their signal from the speaker outputs of the associated radio (in our case, the previously described Motorola TC887AX). Circuitry of the radio/cassette makes liberal use of ICs, both in the i.f. and MPX sections as well as for the cassette, preamp, and output-amp stages. An FET is used in the r.f. front end of the FM section, while a single multi-purpose IC takes care of the entire AM tuner section. Inductorless op-amp "gyrator" circuits are used for the equalizer-control section of the booster/equalizer, whose front panel contains a power switch (when the switch is off, direct feed-through from radio to speakers takes place), the five equalizer lever controls, a fader control (when connected properly, the fader control on the main radio no longer functions when used with the booster/amplifier), and five power-output indicating LEDs calibrated to flash or light at output levels of 1, 2, 5, 10, and 30 watts (combined power of both channels).

FM Performance Measurements

Several FM performance characteristics of the Motorola TC887AX are plotted in Fig. 1. Usable sensitivity in mono measured 1.4 μV (14.2 dBf), while in stereo 4.0 μV (23.3 dBf) was required. The 50-dB quieting point in mono was obtained with an input of 1.7 μV (15.9 dBf), and in stereo, the 50-dB point was reached with an input of 28 μV (40.2 dBf). These values are not at all inconsistent with home hi-fi tuner performance. Best signal to noise in mono measured 68 dB, decreasing slightly to 67 dB for stereo. Harmonic distortion in mono and stereo measured 0.6 per cent for strong signals, and some of this amount was contributed by the power amplifier. Distortion in FM and stereo FM versus frequency is plotted in Fig. 2, while frequency response (including de-emphasis) and stereo separation are shown in the scope photo of Fig. 3.

Although we measured these units (the radio and the booster-amplifier) as a combination, we noted that the amplifier section of the radio was able to deliver a power output (before clipping) of 2.4 watts directly into 4-ohm loads, and the 10 per cent THD point was reached at an output level of 3.33 watts per channel. Of course, when feeding the booster-amplifier, the low-impedance load is removed and the output signal becomes a necessary driving voltage for the associated booster amplifier.

Cassette Section Performance

Wow and flutter for the cassette playback section measured a relatively low 0.15 per cent W rms), while signal-to-noise, as observed on our pre-recorded reference tape, measured a very good 56 dB relative to 0 dB recording level

Fig. 1—Mono and stereo quieting and distortion characteristics for the FM section of the Motorola TC887AX.

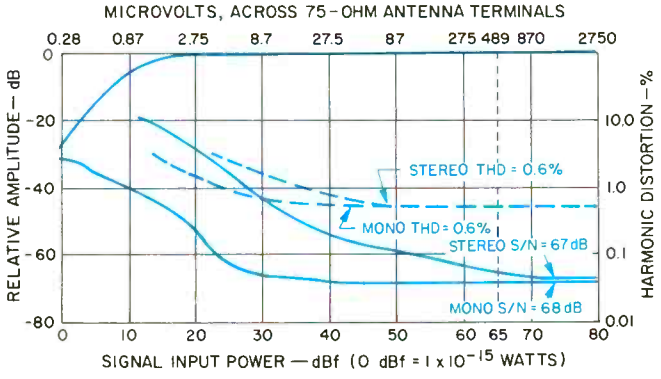
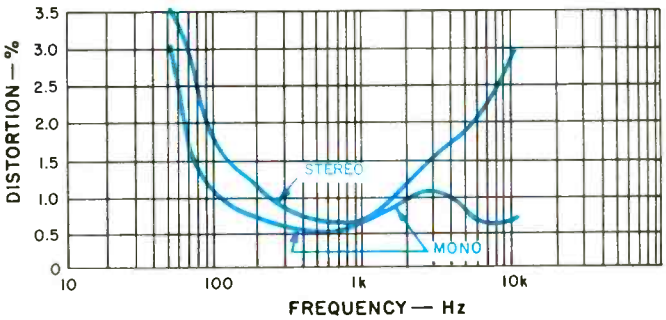


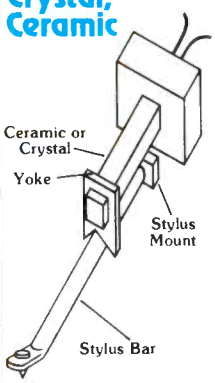
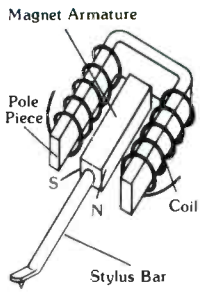
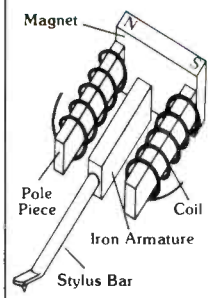
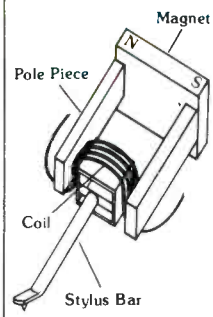
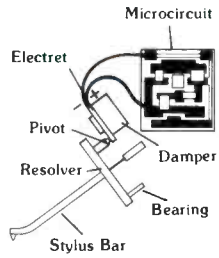
Fig. 2—Distortion vs. frequency for the FM section.



Phono Cartridges

A Buyer's Guide from Micro-Acoustics

The phonograph record is a mechanical replica of musical performance. The job of the phono cartridge is to convert complex undulations of the record groove into an electrical signal. Here's how the different kinds of phono cartridges compare in function, performance and manufacture. This chart has been prepared to help you make the appropriate choice for your budget and music system. The information encompasses the range of performance characteristics for each type of cartridge. Data* is compiled from manufacturers' literature and the results obtained at Micro-Acoustics cartridge clinics held throughout the U.S.A.

Performance Categories	Crystal, Ceramic	Moving Magnet	Moving Iron (Similar to Induced Magnet Type)	Moving Coil	Electret (Micro-Acoustics Direct-Coupled)
					
Operation Principle	Stylus bar moved by record groove under heavy tracking pressure (3-8 grams). Bar's motion bends crystal element causing output signal.	Stylus bar moved by record groove. Magnet armature vibrates between pole pieces, causing change in flux, and inducing signal in output coil.	Stylus bar moved by record groove. Iron armature vibrates between pole pieces, changing reluctance of magnetic path, and inducing signal in output coil.	Stylus bar moved by record groove. As coil vibrates through magnetic field, signal is induced in coil and fed to step-up transformer or pre-preamp.	Stylus bar moved by record groove. Stylus bar vibrates electrets through resolver and pivots, producing signal which is fed to microcircuit.
Tracking Ability	Poor to Fair	Good to Excellent	Good to Excellent	Good to Very Good	Very Good to Excellent
Transient Ability *(rise time in microseconds)*	60 to 100	30 to 60	25 to 50	20 to 30	17 to 20
Freq. Resp. Variation Due to Loading with Pre-Amp, Cables	±4dB below 1000Hz *(plugs directly into amp input)*	−10dB to +6 above 3kHz	−12dB to +4 above 3kHz	±½dB over entire range	±½dB over entire range
Ability to Perform In Variety of Tonearms	Works in low-cost units only	Good to Very Good	Fair to Very Good	Fair to Very Good	Very Good to Excellent
Ability to Track Warped Records	Poor to Good	Fair to Good	Fair to Good	Fair to Good	Very Good to Excellent
Cartridge Body Weight	5 to 10 grams	6 to 8 grams	5.5 to 7 grams	7 to 11 grams	4 to 5.25 grams
User Replaceable Stylus	Yes	Yes	Yes	Usually Not	Yes
Method of Manufacture	Mass Production	Mass Production	Mass Production	Precision Handmade	Precision Handmade
Cost Range	Least Expensive	Inexpensive to Moderate	Inexpensive to Moderate	Expensive to Very Expensive	Moderate to Expensive
Warranty	90 days *(limited)*	90 days to 1 year *(limited)*	90 days to 1 year *(limited)*	90 days to 1 year *(limited)*	2 years *(full)*

*All carmdges show single channel only

Micro-Acoustics
8 Westchester Plaza, Elmsford, N.Y. 10523
In Canada, H. Roy Gray Ltd., Markham, Ont.

THE JVC QUARTZ-LOCKED TURNTABLE.

First we invented it. Now we've made it more precise than ever.

The turntable evolution comes full-swing with the introduction of the new JVC Quartz turntable series. Since we introduced the world's first Quartz-controlled turntable in 1974, we've been constantly refining the ultra-precision oscillator circuits and improving the characteristics of our motor drive system. We've also added a host of details that offer a wide choice of features spread over eight different models. And we can now honestly state that JVC speed and accuracy are near absolute. Here's why:

SUPER SERVO FREQUENCY GENERATOR

The need to detect minute variations in platter speed and to send corrective information to the electronic circuits controlling platter rotation is inherent in a servo system. Our quartz-controlled drive mechanism provides practically perfect speed accuracy; the Super Servo additionally reduces the error in detecting even the tiniest speed variations to nearly zero. We therefore make doubly sure that the platter is "on speed," and will retain this factory-set accuracy over many long years of use.

DIRECT-DRIVE DC SERVOMOTOR

Quick-start and quick-stop, along with high-torque are combined in the DC direct-drive servomotors in all JVC Quartz-Locked turntables. The powerful motor-drive system and its companion speed-monitoring circuits reduce wow-and-flutter as well as speed drift, practically to the vanishing point. In addition, extra care has been taken to make sure that motor-related resonances have been completely damped-out.

NEW GIMBAL SUPPORT AND TRACING-HOLD (TH) TONE ARM

Our exclusive rugged unipivot gimbal support holds the tone arm's total mass in a way that is friction-free. Highly sensitive and responsive, it prevents the stylus from losing contact with the record groove walls, no matter how rough that "ride" may be. And it's included on almost all JVC Quartz turntables—even the automatics. The JVC developed Tracing-Hold tone arm provides the stability and tracing accuracy needed for the cartridge to follow even the most complex record grooves without tracking error.

All of this, plus features like digital speed read-out, quick stop and start, top quality solidly-constructed bases and electronic switching mechanisms all work together to give you more musical pleasure than ever before. There are totally manual models, as well as ones with auto-tone arm liftup/stop, auto-return and fully automatic features.

Bring the precision of QL accuracy into your music system. See all these precisely great turntables at your JVC dealer soon.

JVC America Company, Division of US JVC Corp., 58-75 Queens Midtown Expressway, Maspeth, N.Y. 11378. Canada: JVC Electronics of Canada, Ltd., Ont.

JVC

We build in what the others leave out.

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QL-F4 (featured at left). Below: QL-10, QL-A7, QL-7 (top row); QL-50, QL-5, QL-A2 (bottom row). Not shown: QL-8 (Quartz), JL-F30, JL-A20 (Belt Drive).

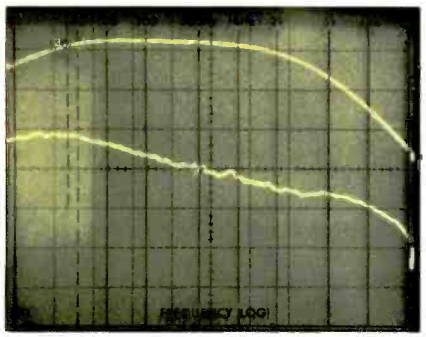


Fig.3— The FM response (including de-emphasis) and stereo separation.

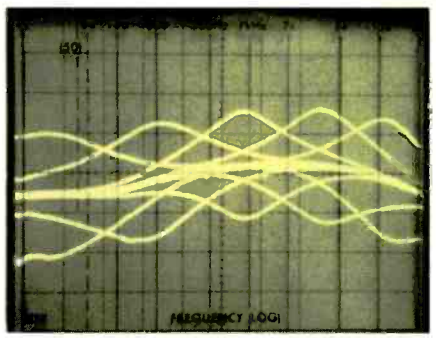


Fig. 4— The range of control for the equalizer levers on the Motorola EQB-3000 equalizer/booster. (One vertical division equals 10 db.)

as prepared on our home Nakamichi 1000 stereo cassette deck. Response was flat to within 3 dB from 60 Hz to 8 kHz—not at all bad for car cassette units.

Booster/Amplifier Measurements

With equalizer controls set in their flat position, the booster/amplifier Model EQB-3000 delivered its rated 15 watts per channel with no more than 0.3 per cent total harmonic distortion at mid-frequencies. At clipping levels (1 per cent THD), the amplifier was delivering a surprisingly high 19.18 watts per channel, while output at 10 per cent THD (measured simply because so many manufacturers still refer car-stereo power to that horrendous distortion level), was a whopping 25 watts per channel, both channels driven! What's more, the frequency response of this add-on unit was indeed flat (within 3 dB) from 25 Hz to 20 kHz—actually better than claimed. Range of boost and cut for each of the equalizer lever controls is shown in the composite storage scope photo of Fig. 4 and was measured via the tuner section (which accounts for the de-emphasis-caused roll-off of the envelope at the high end). The scale on this presentation is 10 dB per vertical division.

Listening and Use Tests

In our view, adding an equalizer/booster such as the Motorola EQB-3000 to this or any other car stereo not only provides the listener with the sort of power that is needed to overcome road and wind ambient noise in a moving vehicle, but also permits the listener to properly adjust tonal response for the rather unusual acoustic environment of the inside of a car. You would be amazed at how good this combination can sound, despite its "less than super-hi-fi" specs. All of which proves that with a little effort on the part of a manufacturer, it is possible to reproduce music with adequate fidelity in an automobile, and it is even possible to rate power output fairly for such products. Competitors, take note! *Leonard Feldman*

Sanyo Model FT-1490A AM/FM Cassette Player

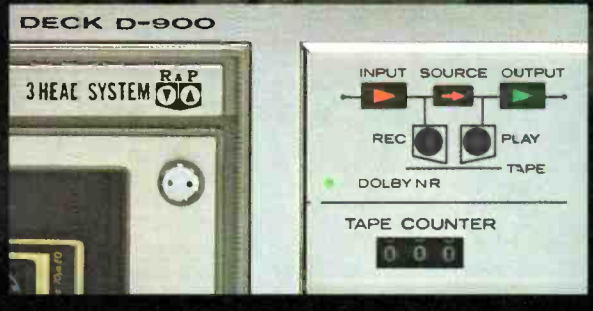
The first thing we learned about the Sanyo FT-1490A is that it is equipped with separate amplifier sections for woofers and tweeters and therefore qualifies as a "bi-amp" unit. It is also one of the few car units we have seen which is equipped with Dolby noise reduction circuitry in its cassette section. Aside from that, we were left largely on our own as far as specifications were concerned. (Sanyo's owner's manual, however, calls this unit an "Audio Spec +" model.)

A separate 23-page installation guide is supplied, in addition to the operating manual, along with a helpful guide to AM/FM and FM stereo in mobile vehicles, both of which should be considered mandatory reading by anyone embark-

HITACHI
The New Leader In Audio Technology

...introduces the unique R&P 3-head system cassette deck for no-compromise performance.

Hitachi's R&P system employs 3-heads for the same reasons professional reel-to-reel recorders do. The record and playback heads have separate and optimum gap widths which significantly extend both dynamic range and frequency. The R&P 3-head system also lets you monitor while recording. All three heads are contained in one unique housing to eliminate azimuth and height problems.



R&P 3-head system cassette decks are just one example of Hitachi's leadership in audio technology. Class G amplifiers, power MOS/FET amplifiers, Uni-torque turntable motors, and gathered-edge metal-cone speakers are just some of the others. There's a lot more. Ask your Hitachi dealer.

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Audio Component Division, Hitachi Sales Corp. of America, 401 West Artesia Boulevard, Compton, CA 90220, (213) 537-8383

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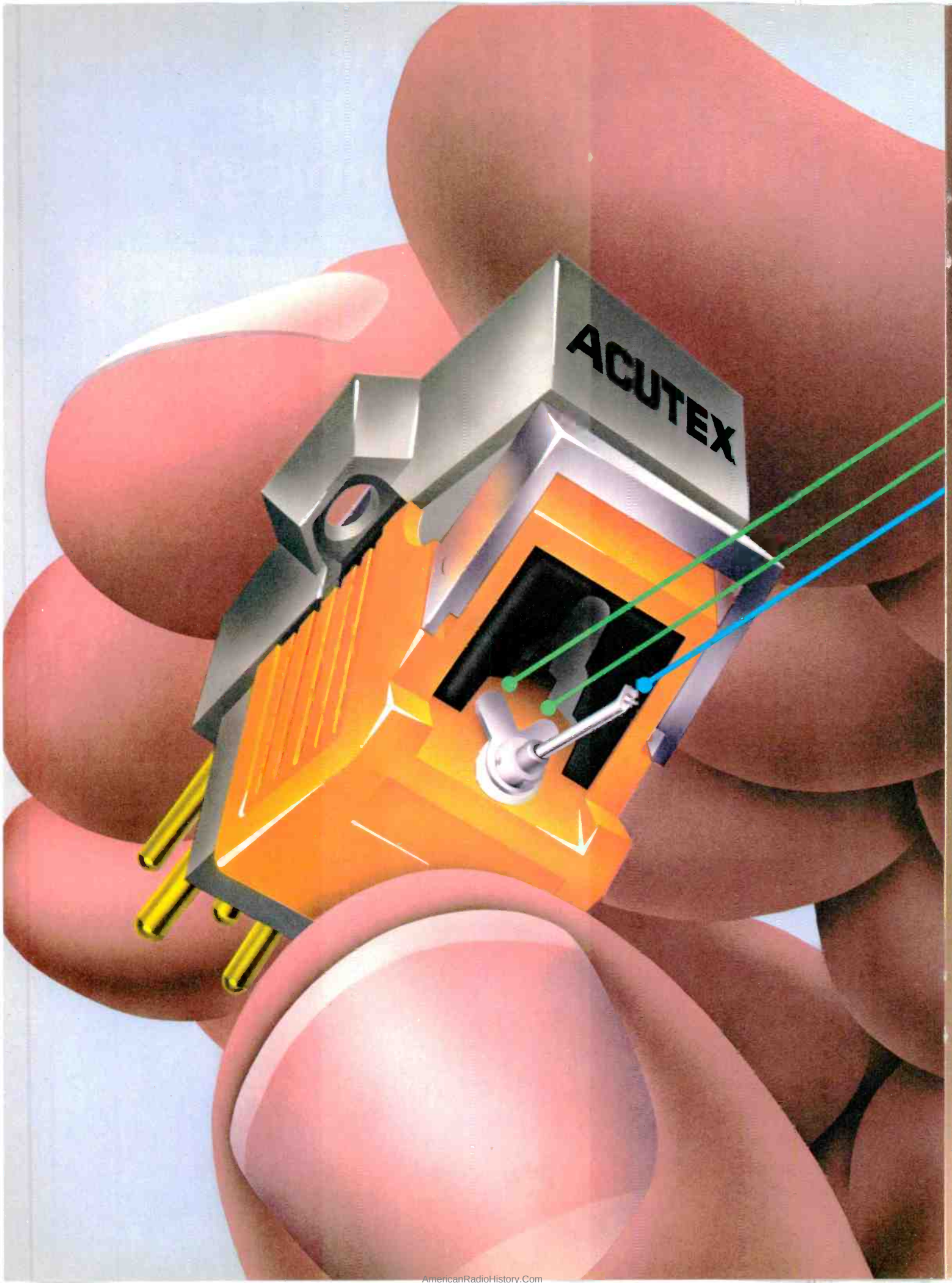

CREATING THE WORLD'S BEST STEREO SEPARATION WAS AS EASY AS X,Y,Z.

If you were asked to describe the performance of your stereo system, you'd rattle off the typical statistics.

Watts per channel. Woofer size. And of course, frequency response.

But chances are, you'd be hard pressed to say how much your cartridge separates the left channel from the right. Yet, of all stereo specifications, none is a better judge of how well your system reproduces music than stereo separation. Because the greater its separation, the more three dimensional your music sounds.

X
Y
Z

Unfortunately, while other components have improved dramatically every year, cartridges have remained basically the same for twenty. Until now.

AN ACUTEX CARTRIDGE DOESN'T GET ITS SIGNALS CROSSED.

To understand how unique an ACUTEX cartridge is, you have to know something about the common cartridge.

There are two major principles used to convert a record's grooves into electricity. Moving Iron and Moving Magnet.

With the first, the stylus arm, or "cantilever," is made of iron and wiggles near a coil and magnet inside the cartridge. In the second, a tiny magnet attached to the cantilever wiggles near those coils.

Both have drawbacks. A moving iron is a much weaker generator of electricity than a moving magnet. But a moving magnet is much heavier. Its increased weight can wear out your records faster, and might destroy certain high frequency passages at first playing.

Even worse, stereo separation is only fair in either case. Because one iron or one magnet is the source for two channels. But five years ago, some inventor had a brainstorm.

Instead of a single magnet attached to the cantilever, he used two. One for the left (X) and one for the right (Y).

Instantly, the cartridge's output rose and stereo separation improved.

It was good, but not good enough.

Since it was heavier. And when (X) wiggled it also caused (Y) to wiggle slightly; causing some left channel signals in the right channel.

There was no barrier to stop that cross talk, and stereo separation suffered.

ACUTEX created the barrier. With basic geometry.

OUR BOTTOM-OF-THE-LINE BEATS THEIR TOP-OF-THE-LINE.

First, we increased output even further by making the cantilever itself magnetic (Z). Thus we had three moving magnets at 90-degree angles to each other; each in a separate plane in relation to the coils.

So when a record played, (Z) canceled out any spurious signals created in the left channel by the right.

And vice versa.

Finally, because we placed one powerful magnet inside the cartridge—*inducing* the magnetism into our three lightweight armatures—the weight was sharply reduced.

The result was stereo separation so great that our $35 model rivals many of our competitors' $135 models.

And the two best ACUTEX cartridges *surpass* the separation specs all record companies use when cutting an album!

ACUTEX 320
Response: 20-45,000 Hz
Compliance: 42 x 10^{-6} cm/dyne
Separation: 32 db (1 kHz), 29 db (10 kHz)
Suggested List Price: $175.00

ACUTEX 315
Response: 20-31,000 Hz
Compliance: 36 x 10^{-6} cm/dyne
Separation: 30 db (1 kHz), 28 db (10 kHz)
Suggested List Price: $135.00

ACUTEX 312
Response: 20-29,000 Hz
Compliance: 24 x 10^{-6} cm/dyne
Separation: 30 db (1 kHz), 27 db (10 kHz)
Suggested List Price: $85.00

ACUTEX 310
Response: 20-25,000 Hz
Compliance: 16 x 10^{-6} cm/dyne
Separation: 28 db (1 kHz), 25 db (10 kHz)
Suggested List Price: $65.00

ACUTEX 307
Response: 20-20,000 Hz
Compliance: 14 x 10^{-6} cm/dyne
Separation: 25 db (1 kHz), 23 db (10 kHz)
Suggested List Price: $45.00

ACUTEX 306
Response: 20-20,000 Hz
Compliance: 14 x 10^{-6} cm/dyne
Separation: 25 db (1 kHz), 20 db (10 kHz)
Suggested List Price: $35.00

DIAMONDS, GOLD, AND PRECIOUS RECORDS.

Not only will ACUTEX deliver outstanding separation of your music, you'll hear more music to begin with.

Because ACUTEX's three armatures decrease record surface noise at the same moment they increase record signals. Soft notes especially sound clearer, with minimal snap, crackle, and pop.

Each ACUTEX cartridge was designed with a diamond stylus best suited for its purpose.

Our 315 model has a solid (nude) elliptical diamond with a frequency response through 31,000 Hertz.

And the 320 provides a ruler-flat response up to 45,000 Hertz, using a recently developed STR (Symmetrical Tri-Radial) diamond.

On all ACUTEX models, the terminal pins are gold-plated. This allows for maximum electrical contact to your other stereo components.

Since we applied the principle of induced magnetism, ACUTEX has a very low Effective Tip Mass. Which means our cartridges are extremely gentle on groove walls, so you can play your oldest and most precious albums without permanent damage.

But frankly, all our words and pictures won't convince you half as much as your ears. One listen, and you'll be convinced that until now, stereo sound this good was truly unheard of.

ACUTEX will be coming soon to selected hi-fi stores in your area.

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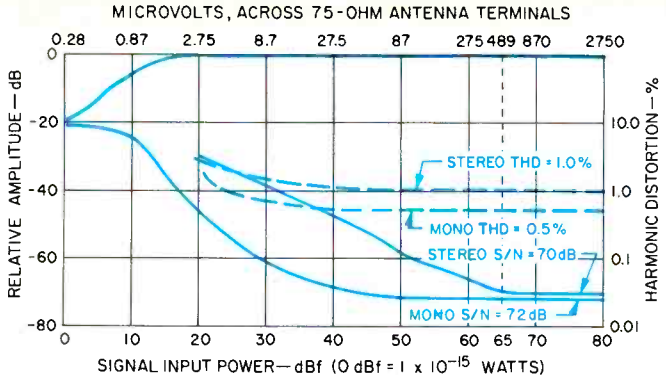


Fig. 1 — Mono and stereo quieting and distortion characteristics for the FM section of the Sanyo FT-1490A.

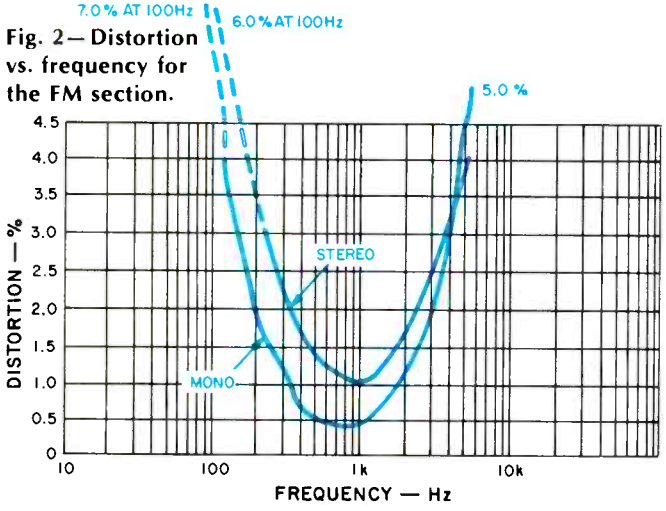


Fig. 2 — Distortion vs. frequency for the FM section.

ing upon the rather confusing course of owning a separately installed car-stereo system.

We chose the conventional two-speaker hookup (ignoring the bi-amp mode) in order to evaluate the power section of this receiver/cassette unit, since most users are likely to have wide range speakers or two- and three-way speakers with built-in crossover networks.

The front panel of the unit (which can be in-dash or under-dash mounted) sports the usual two pairs of dual-concentric knobs, the left pair of which handles power turn on and volume and (in the case of bi-amped operation) tweeter volume. Pulling out on the volume control knob makes available a treble-cut control.

The right pair of controls includes a tuning knob and a balance control. To either side of the cassette door are fast wind buttons, one for each direction of tape travel. Since this unit plays cassettes in either direction without having to invert the cassette, illuminated arrows display travel direction of tape. Just to the right of the AM and FM frequency scales are a Dolby-On light and a stereo FM indicator light, while below the scales are six pushbuttons which handle tape reverse, loudness compensation, Dolby-On, FM/AM selection, local-distant reception switching, and cassette ejection. A slide switch on the rear of the unit determines whether the amplifier section will operate as a wide range unit or as two bi-amp amplifier sections. Up to four speakers can be connected to the unit for either mode of operation. The rewind button can also be used as a repeat button by depressing its opposite button (fast forward) half way. Doing so causes the tape to begin playing once more when fully rewound.

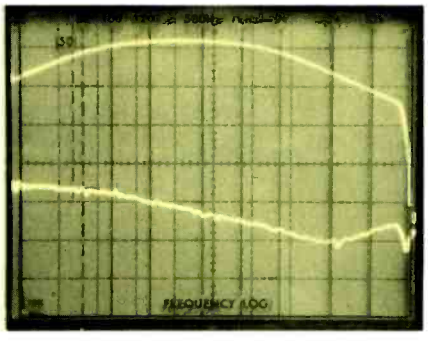


Fig. 3 — FM frequency response (including de-emphasis) and stereo separation.

FM Section Measurements

Figure 1 shows results obtained from some of the measurements of the FM section of this receiver/cassette player. Usable mono sensitivity measured 2.6 μV (19.6 dBf), while in stereo, usable sensitivity was 4.5 μV (24.3 dBf). The 50-dB quieting point was reached with input-signal strengths of 3.3 μV (21.6 dBf) in mono and 35 μV (42.1 dBf) in stereo. Best signal to noise with strong signals in mono measured a rather high 72 dB, decreasing to a still very satisfactory 70 dB in stereo. Mid-frequency THD in mono measured 0.5 per cent increasing to 1.0 per cent in the stereo mode. Figure 2 illustrates what happens to the FM distortion at other frequencies, both in mono and stereo. High-end frequency response (with the treble control set at its maximum clockwise was the best of all four products tested for this issue of *Audio*, as can be seen from Fig. 3 (which includes 75-microsecond de-emphasis) in which each vertical division on the scope photo is equal to 10 dB of amplitude variation. The same scope photo illustrates the rather excellent stereo separation capability of this tuner which measured 43 dB at 1000 Hz, 26 dB at 100 Hz, and an impressive 33 dB at 10 kHz. The otherwise excellent response in FM is slightly marred by a roll-off at the low frequency end which measured 5 dB down at 50 Hz. This low-end roll-off seems characteristic of all of the units we tested and is no doubt introduced because of the low power-output capability of car units in general, a failing which would ordinarily show up as low-frequency distortion if response were maintained flat to the lowest audible bass frequencies. Stereo threshold occurred at an input signal strength of only 3.0 μV (20.8 dBf).

Cassette Section Measurements

Even with its attractive tape transport features, playback response of the cassette section of the Sanyo FT-1490A was about that measured for the best competitive units in this test group, extending (for the 3-dB roll-off points) from 80 Hz to 8 kHz. Signal to noise was average, using a pre-recorded TDK AD tape at 0 dB record level as produced on our standard Nakamichi 1000 Stereo Cassette deck, measuring 55 dB. Wow and flutter, however, was the best of all the units measured, with readings of only 0.08 per cent W rms. Adding the Dolby noise reduction circuitry during playback improved signal to noise (from the earlier mentioned reference point) to an overall unweighted 62 dB — quite listenable even in quiet home listening situations, let alone in a moving vehicle.

In the two-speaker (non bi-amp) configuration we noted that clipping took place at an output voltage of 2.85 volts across 4-ohm loads (both channels driven) and that corresponds to a power level of 2.03 watts. Pushing the amplifier still further to obtain a nominal 10 per cent total harmonic distortion, we observed a power output level of just under 3 watts per channel, both channels driven. At nominal 1-watt power output levels, the distortion decreased to 0.6 per cent rising again at even lower, quarter-watt output levels to around 0.9 per cent total harmonic distortion.

The treble roll-off control introduces a high degree of treble attenuation when rotated fully counterclockwise, resulting in a −15 dB response at 5 kHz and −21 dB at 10 kHz.

An inside look at Jensen's Total Energy Response.

You're looking at the heart of one of the most uniformly accurate sound reproducers made today. A Jensen Lifestyle Speaker.

Unlike many speakers that require special on-axis listening positions—or others that bounce the sound all over your room—Lifestyle is engineered to deliver a wide spectrum of musical information throughout the listening area. In proper perspective. With all the depth and imaging your source material is capable of. And at real-life volume levels. That's what Total Energy Response is all about.

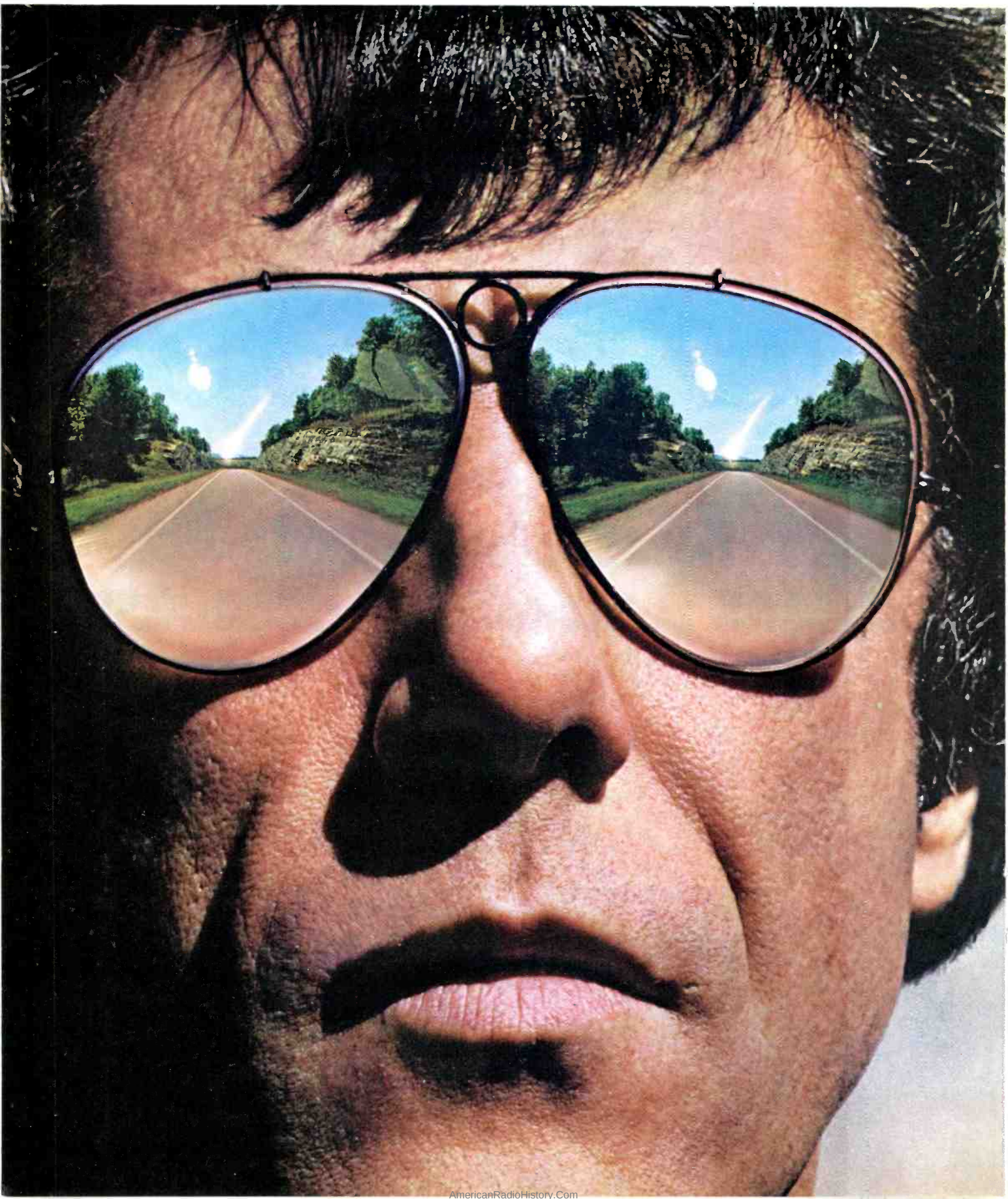
In fact, for perfectly integrated speaker systems and total quality control, we make every element that goes into the manufacture of our Lifestyle speakers. From the heavy duty magnets to our handwound, high power voice coils. Even the computer-designed crossover network. And of course, all of our precision woofers, midrange drivers and 170° dispersion dome tweeters.

But please, give a critical listen to these speakers in person. We think you'll agree, a notably superior design concept has resulted in audibly superior sound reproduction.

JENSEN
LIFESTYLE SPEAKER SYSTEMS

Division of Pemcor, Inc.
Schiller Park, Illinois 60176

THE SPARKOMATIC SOUND.
IF YOU'RE A TRAVELIN' MAN LOOKING FOR HIGHER STANDARDS IN HIGH FIDELITY.



Car speakers haven't exactly been noted for high performance or high fidelity. At best, they were a source of sound. But they were far from reproducing anything close to the original sound source.

Travelin' men seriously into sound, like yourself perhaps, were frustrated. Settling because there was no alternative. But your higher standards in high fidelity didn't keep you from sounding off. Until finally, you've made it clear that from here on in, unresponsive sound would be unheard of.

Sparkomatic, long an unchallenged leader in car sound, has been listening. And studying. And designing. And engineering. And now, Sparkomatic can proudly announce a real score in car sound. We've created speakers and amplification systems with unprecedented power band width, with exceptional frequency response and with extraordinarily low distortion. But only a live demonstration will confirm the "live" performance quality of Sparkomatic car sound equipment.

So if you're a travelin' man looking for great sound, now you can experience a new high in high fidelity. Visit a Sparkomatic dealer and see for yourself.

Van Speakers

For the man who travels by van, Sparkomatic has special Van Speakers. And these speakers don't take their van name in vain. They are designed to fit the "acrobatic" mounting requirements and acoustical imbalances created in vans. They're also engineered to handle up to 50 watt power peaks. They sound and look superb.

TriplePlay Speakers

Sparkomatic's TriplePlay speakers deliver the essence of "in person" performance. The delicate levels of high frequency are brilliant. The bass response is practically distortion free and the range is magnificent. Power is no obstacle to these speakers and 50 watt peaks come easy. The TriplePlays are available in various sizes and shapes to fit all installations.

Loud & Clear Amplification System

An amplification system to equal the power of any, but with unequaled, undistorted clarity. And for speakers to handle this power plant, Sparkomatic's Loud & Clear Amplification System is matched up with compatible 6 x 9 coaxials of impeccable credentials. The sound reproduction is indeed loud, but with an absolutely clear advantage.

The "Gutsy" Sound

The component look. It's an eyeful. And an earful. Woofer, tweeter and mid-range combine to faithfully reproduce the full sound range. These Sparkomatic speakers capture the elusive tones at high and low extremes. And they'll take plenty of power . . . up to 50 watt peaks. They're as "professional" sounding as they look.

SPARKOMATIC®
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Car Sound/CB Equipment/Auto Clocks/Shifters/Creepers

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Listening and Use Tests

Considering the rather good FM reception capability of this Sanyo unit (and its slightly above average cassette playback capability and related features, including Dolby), it would seem to us that the best way to use this system is in the bi-amp mode and in conjunction with an additional pair of boosters so that one could avail oneself of the bi-amping capabilities of this receiver, using the separate outputs as voltage sources to drive twin boosters which, in turn, could drive separate woofers and tweeters without the need for a crossover network. *Leonard Feldman*

Enter No. 87 on Reader Service Card

Panasonic "Separates" Component System Model CX-7100 Cassette Deck, Model CA-9500 AM/FM Tuner, and Model CJ-3510 Power Booster

Panasonic has come up with a clever trio of units which can be supplied separately or as a complete component system for use in car stereo systems. Pictured here separately, the units fit into a neat package in a metal cabinet which can then be mounted on the hump with the aid of an available optional bracket, Model CSMB-1. The slim tuner chassis contains a large tuning knob at the left, better-than-average frequency scale calibration for both AM and FM, designation lights for AM, FM, and stereo-FM received signals, and three toggle switches at the right, which select *AM/FM/Auto FM, Local/Distant* reception, and *power turn-On/Off*. The power booster is equipped with a power *On/Off* switch a power-on red indicator light, and separate bass and treble tone controls which have markings in 2 dB steps from −10 dB through a nominally "flat" setting to +10 dB of boost. The cassette player unit has large knobs at the left and right for volume and balance, separate left- and right-channel tone control knobs, a program selector button at the upper left (the unit is an auto-reverse type), indicator lights to tell you whether program one or program two is being played, a locking *Fast-Forward, Fast-Reverse,* and *Eject* button below the cassette door. Because of the liberal dimensions of the cassette unit, it is the only one of the four models tested which accepts a cassette oriented in its long dimension.

FM Performance Measurements

Results of our FM measurements of the CA-9500 tuner section are, in part, displayed in the graphs of Fig. 1. Usable sensitivity measured 3.0 μV in mono (14.8 dBf) and 5.5 μV (26.1 dBf) in stereo. The 50-dB quieting point required signal inputs of 5 μV (25.2 dBf) in mono and 33 μV (41.6 dBf) in stereo. Best signal to noise obtained in mono was 69 dB, while for stereo, the maximum quieting with strong signal inputs was 67 dB. Distortion measured 0.9 per cent for mid-frequency signals in both mono and stereo and was governed by limitations imposed by the amplifier section rather than the tuner section, as far as we could determine. Distortion versus frequency, in mono and stereo, is graphed in Fig. 2, while Fig. 3 represents a frequency response plot (including 75 microsecond de-emphasis) of the FM section along with the separation versus frequency characteristics of the stereo decoder section of the

WHY YOU OUGHT TO INVEST IN A FISHER SPEAKER SYSTEM RATHER THAN SOMEBODY ELSE'S.

Building a great speaker is something like building a great violin. Although there are many violin manufacturers, the design artistry and painstaking craftsmanship of the Stradivarius won it the reputation as the world's finest.

Making speakers, like making fine musical instruments, is something of an inexact science . . . even with today's computers. It still takes *artistry, craftsmanship, and most of all, experience* to produce a great sounding speaker.

Our new Studio Standard ST400 series speakers, manufactured at our modern speaker plant in Milroy, Pa., are the culmination of everything we've learned in producing hundreds of thousands of speakers. At the top of this new line is the ST461 — a speaker that critical listeners consistently rank among the two or three best they've ever heard.

The ST461 combines the staggering bass capability of the 15" Fisher model 15130 woofer, the flawless midrange of two 5" model 500 midrange drivers, and the ultra-high definition of the 3" model 350 horn tweeter. Plus a precision crossover network with adjustable midrange presence and treble brilliance, and a resettable circuit breaker overload protector. All in a beautifully finished genuine walnut cabinet, at the reasonable price of $350*. Other ST400 series speakers start at $120*.

So, if you'd like to own the "state-of-the-art" in speakers, listen to Fisher's new ST400 series.

Fisher components are available at selected audio dealers or the audio department of your favorite department store. For the name of your nearest dealer, call toll-free 1-800-528-6050, ext. 871 from anywhere in the U.S. (In Arizona, call toll-free 1-955-9710, ext. 871).

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

FISHER

The first name in high fidelity.

Fig. 1—Mono and stereo quieting and distortion characteristics for the FM section of the CA-9500 tuner section of the Panasonic combination.

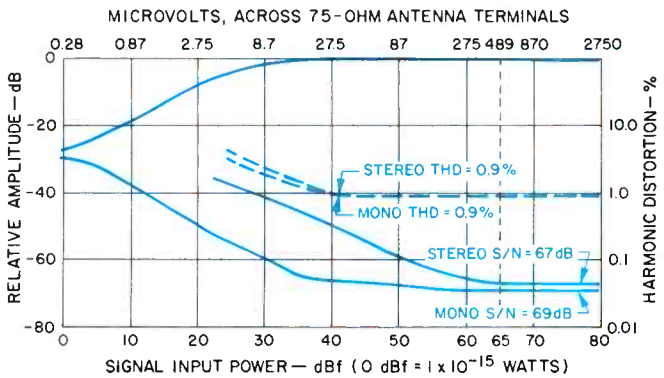
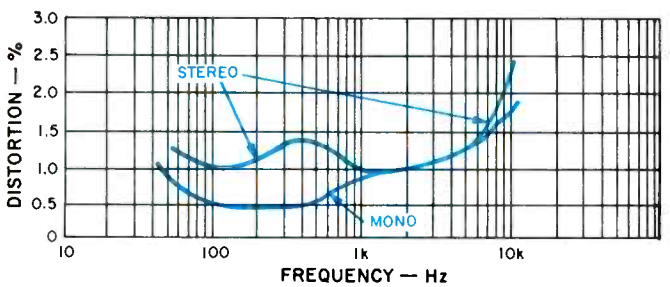


Fig. 2—Distortion vs. frequency for the FM section of the CA-9500 tuner.



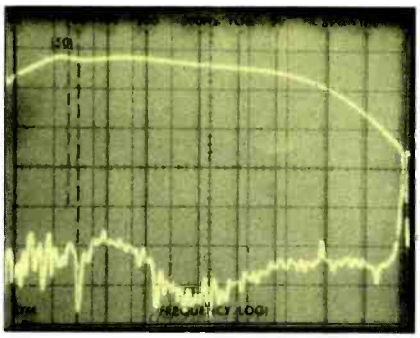


Fig. 3—Frequency response and separation.

tuner. Aside from the slight low-end roll-off between 50 Hz and 30 Hz, response was excellent—within 1 dB out to 15 kHz. Separation at 1 kHz measured an impressively high 43 dB, decreasing to 34 dB at 100 Hz and 23 dB at 10 kHz.

Cassette Section Measurements

The cassette player unit, Model CX-7100, had good low frequency response (down 3 dB at 40 Hz) but rolled off above about 7 kHz, its −3 dB point. Signal to noise, using the same reference tape used in testing the other car stereo products reviewed in this issue of *Audio*, measured 53 dB, while wow and flutter, though well within specifications, measured 0.17 per cent W rms. The signal-to-noise ratio seemed to be a function of the limitations of the tape preamp stages rather than any error in playback equalization or other tape handling parameters.

Power Booster Measurements

Like the other separate power boosters we have measured, the Panasonic CJ-3510 component of this "separates" system measured well, delivering more than 11.0 watts per channel at its rated harmonic distortion figure of 1.0 per cent. At lower power levels, however, THD did not decrease markedly from this distortion level, measuring 0.7 per cent at 1.0 watt output. This booster unit is equipped with legitimate tone controls which offer a true *Flat* response position as well as boost and cut. Range of control for the treble section is ±8 dB at 10 kHz, while the bass control provides a range of ±13 dB at 100 Hz, a sensible way to set things up, we think.

Listening and Use Tests

The tuner section of this combination exhibits reasonably good performance even when judged from the point of view of home stereo equipment. The convenience of the cassette player (its auto-reverse feature, program switching capability, and fast wind modes) is partly offset by the rather low overall response exhibited at least on the sample we tested. Purchased as a separate unit, incidentally, the CX-7100 boasts its own self-contained power output of 3.6 watts per channel for 1.0 per cent distortion and 4.8 watts per channel for 10 per cent THD.

We very much liked the concept of being able to assemble these three units so neatly into a single supplied cabinet and, of course, the mounting bracket which permits quick disassembly and retrieval of the three-piece package for safe storage when the vehicle remains unattended should go a long way towards reducing the possibility of theft. The units certainly look good enough to tempt a thief if this precaution is not observed. So, for this trio, we would rank the tuner section as number one, the booster-tone control unit second and, in third place, the cassette player. All in all, though, this was a very cleverly conceived package and does provide a complete car entertainment center for anyone who requires more than the usual couple of watts provided by most all-in-one receiver/cassette chassis. *Leonard Feldman*

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What makes this speaker better is what isn't there.

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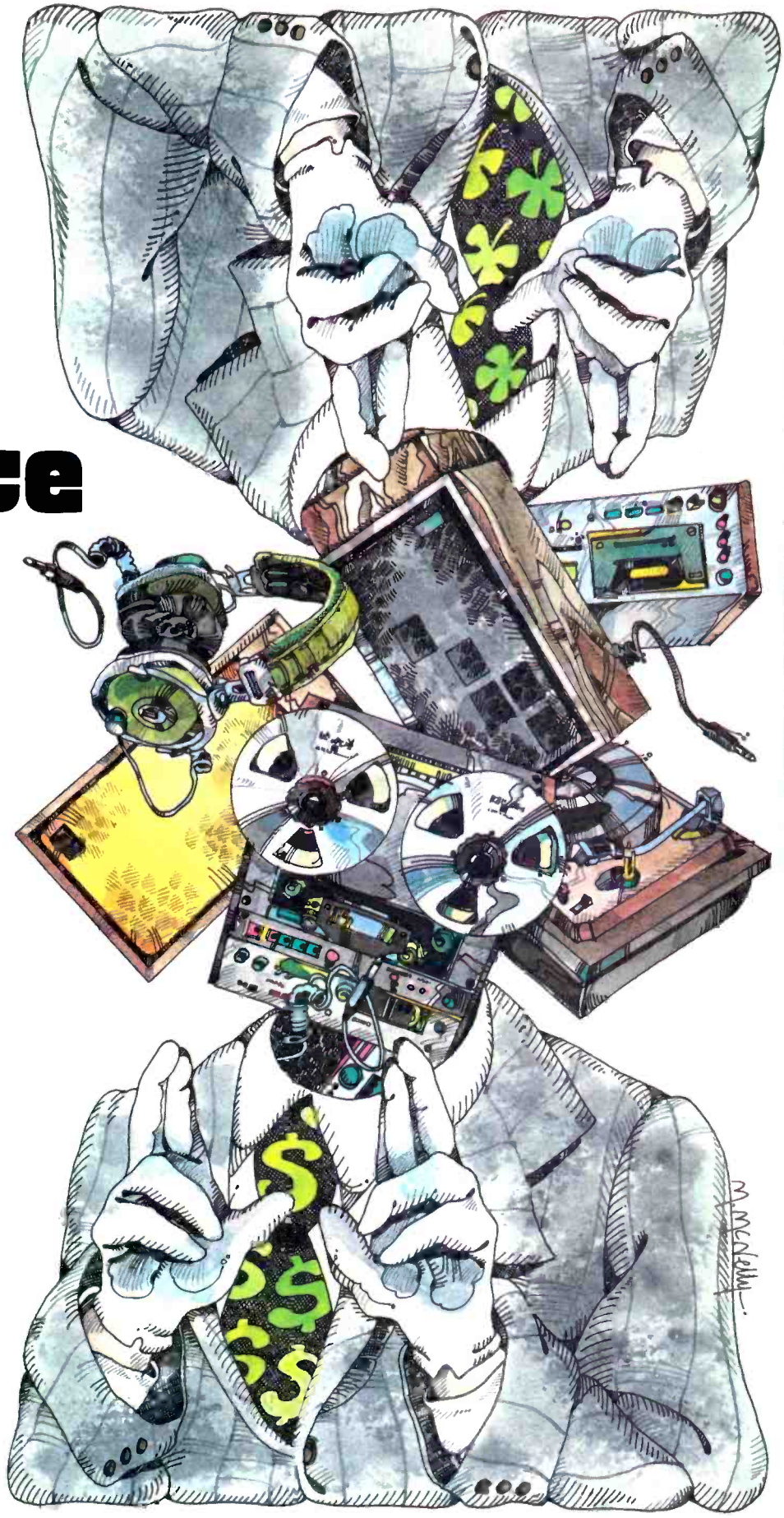
Guide to Good Service



Herman Burstein

Over the past two decades the quality of service rendered by independent service shops and by the service departments of audio manufacturers seems to have matured to the point where it generally ranges from good to excellent. Though not perfect (is anything?), it is superior to service of yesteryear. For example, I recall my first encounter with an authorized service shop some 20 years ago; my tape deck, just a few weeks old, had acquired a slight but distinct gargle in recording. A technician put the deck on the test bench, recorded a signal off FM, played it back, and said, "It works." He refused to do anything further, although I protested that the deck didn't work *well*. (Fortunately my audio dealer was willing to exchange the unit for another.)

In recent years my experience has been much the opposite. I have usually found service on the ball, ready and able to bring a unit back to specifications even though the problem might be a subtle one.

This impression of satisfactory service today is bolstered by correspondence from readers of my "Tape Guide" column. Their letters contain relatively few complaints about service. Still, some complaints do arrive. Therefore, the purpose of this article is to describe the problems faced by service facilities in giving satisfactory service, and to list a variety of steps the audiophile can take to increase his chance of getting satisfactory service.

The article relies largely on answers by nine audio firms to a questionnaire on: 1) Why is service sometimes unsatisfactory? 2) What measures can the audiophile take to insure satisfactory service? Specifically, I am indebted to: Advent Corporation, Empire Scientific Corp., Glen Oaks Service Labs, Inc., Heath Company, Mark Levinson Audio Systems Ltd., Phase Linear, Sansui Electronics Corp., Shure Brothers Inc., and Tandberg of America Inc. While I shall quote extensively from their replies, under a prior pledge of confidentiality these quotes will not be attributed to individual firms.

Nature of the Service Problem

Audiophile's complaints about service seem to divide into two categories: 1) A service facility—a manufacturer's service department or an independent shop—has failed to repair a component to the owner's satisfaction. 2) A manufacturer has failed to answer the audiophile's inquiry about a matter, such as trouble with a component, correct way of installing the component in a system, a desired modification, a replacement part, etc.

Most complaints fall into the first category, which subdivides about as follows: a) The trouble has been cured insufficiently or not at all. b) Cost of the repair is excessive. c) The repair took too long—sometimes several months. d) The "repaired" component came home with new troubles.

Why Unsatisfactory Service?

While the cause of dissatisfaction may lie with the service facility, it may also lie with the customer or elsewhere. Based on an analysis of its service performance over several years, one firm has found that while five per cent of its repair jobs were returned by dissatisfied customers, two per cent turned out to be bonafide complaints, with the other three per cent being "consumer- oriented problems, such as improper operation or difficulties in associated equipment." Another respondent points out: "A common problem is that after a unit has been serviced and reinstalled at the customer's home, the customer makes mistakes in reinstallation." The fault may also be neither that of the customer nor the service facility. For example, "Certain reception problems on FM exist only at the customer's location." These may be due to a poor antenna, hilly terrain, radio frequency interference, etc.

The problem of satisfactory service stems partly from the sophisticated nature of audio equipment, from the need to not merely restore operation but to restore it to peak performance, and from the high level of expectation by the customer.

In this vein one firm writes: "There are two problems with repair service in this industry—the generally long turnaround time for repairs and the caliber of the repair work. In contrast, repairs on television sets, the other major category of electronic home entertainment product, usually are performed in a few days, frequently in the home, and usually with a high percentage of success. Why, then, the difference? The first reason is that audio components are more sophisticated, more akin to high performance sports cars, whereas television sets are more analogous to the family sedan. . . . The second reason is that the audio component owner is more discriminating about the performance of his gear in the same way that the sports car owner is about automobile performance. Add to this the fact that no audio repair technician can possibly know all audio gear well enough to repair each of them all properly. Obviously, knowing where to go for service is essential to the audio customer. . . . We suggest that customers contact the manufacturer about where to take an ailing product."

". . . audio components are more sophisticated, more akin to high performance sports cars, whereas television sets are more analogous to the family sedan . . ."

"Attitude" of a service facility is a factor, as illustrated by the following comments of firms that enjoy a high reputation. They give a sense of what the audiophile may be justified in expecting. One firm states: "Customer service has always been important to us. As a matter of course, we try to answer letters within three days and to service units within seven, exclusive of shipping time. . . . If a unit is here for service and we cannot duplicate the problem, we call the customer for more information before simply returning the unit." Another states: "We've worked to develop a service procedure which is as thorough and efficient as possible. We maintain a two-day turnaround period, exclusive of shipping time, which includes two complete and comprehensive test and alignment procedures, both electrical and audio, with a 24- to 48-hour monitored idling period. Needless to say, this exceeds most customers' expectations, and it is to our advantage to maintain this type of high quality service." (So far as I can ascertain, a two-day turnaround is rather unusual. For high-quality service facilities, a turnaround of five working days seems more typical—*H.B.*)

A third firm states: "Everyone receives personal attention from us. Whether it is problem, complaint, comment, advice, or just plain opinion, we continually make sure that 100 per cent of all letters and calls are personally dealt with and resolved to the best of our ability. We've put special emphasis on this type of service and intend to maintain it. We therefore encourage present, would-be, and even non-customers to contact us concerning any issue in which we may be of assistance." And a fourth firm notes: "Our long-standing policy has been to answer all customer correspondence—be they application questions, general comments, or complaints—within five days of receipt. Similarly, items returned for repair receive immediate attention and are generally en route back to the customer within about eight days (weekends included)."

Although a service facility *averages* a fast turnaround on repairs, sometimes a customer has to wait a good deal longer than average. The reason may be that "an item returned for service is not accompanied by an explanation of the problem involved; or, if an explanation is included, it may not be specific enough to identify the problem. This, of course, results in a time-consuming probe on the part of the person performing the repair work to first identify the nature of the defect and then fix it. The effect is increased turnaround time."

A second reason for a longer wait than usual is a stubborn intermittent trouble, with infrequent and perhaps brief appearances that make it difficult for a technician to diagnose. True, there are ways of accelerating the appearance of an intermittent problem, such as operating a component at elevated voltage. Still, the intermittent usually takes longer to solve.

The wait may simply be due to the fact that "in his anxiousness to get an item repaired, a customer may fail to include his return address and phone number. This necessitates time-consuming work to insure that the unit is returned to the owner."

A customer may have to wait because a service shop is out of stock on a replacement part. Such an occurrence depends upon the care and money the shop is willing or can afford to devote towards maintaining an adequate supply of expensive parts . . . for example tape heads and motors. When the shop has to order a replacement part from the manufacturer, turnaround time depends a good deal on the manufacturer's response time. In this respect a manufacturer writes: "We provide a strict three-day parts turn-around time here at the factory, with same-day service on rush orders."

The out-of-stock situation may also develop at the level of the manufacturer. The respondent just quoted states: "Occasionally the factory will be back-ordered from the supplier of a certain part, so that the three-day parts turn-around policy cannot be met. If this is the case, we send out back-order notices which should keep the customer aware of the situation." In cases like this, a customer's long wait might be due not to the service shop or the manufacturer but to a supplier of parts to the factory.

Turn-around time at a service shop may depend upon the pressure exerted and the assistance given by the manufacturer who contracts to use the shop as an authorized service station. One manufacturer states: "Although the overwhelming majority of our warranty stations are top notch, occasionally we have problems with excessive shop time. . . . We monitor the turnaround times and service techniques of all our authorized service shops. . . . We provide charge-free telephone technical assistance to all of our dealers and warranty stations. Our regional representatives personally check dealers on a regular basis."

When a service shop is compensated by a manufacturer at a standard rate for repairing a component under warranty, and when the repair is especially time-consuming, a question may arise as to whether the shop has been adequately remunerated. In such cases there may be a temptation by the shop to minimize the cost of the repair by cutting corners. Whether the shop succumbs to this temptation again depends on "attitude." An enlightened point of view is that the shop will not cut corners. Instead, "by investing in proper service during the warranty period, the shop will see the customer again after the warranty expires, and the shop will then be properly compensated for service at that time."

It should be recognized that the price of a component is related to service in at least four ways: 1) Quality of design and construction (reflected in price) both govern a component's reliability—freedom from the need for service. 2) Quality of design and construction govern the ease of servicing a component. 3) Quality of service under a warranty, and the length of the warranty period, represent costs which must be recovered in the price of the component. 4) Willingness to answer questions represents a cost to be recovered in price. Thus two components of different brands may have almost identical looks and specifications but may differ appreciably in price because of the manufacturer's and dealer's intentions with respect to the service question.

Here a respondent notes that consumers may not be serving their best interests by "looking for lowest initial costs and shopping for discounts at stores where there is not enough margin left over to provide for adequate service or personal attention in a meaningful way. Consumers must accept the idea of higher initial costs for two reasons: 1) So that the equipment can be built to higher standards initially and 2) so that the dealers can make a fair profit, enabling them to offer better services. . . . In this modern age, time means money. Correct design, construction, testing, service, and so forth take time, therefore money. The consumer must accept his responsibility to pay for this, since no one really gets something for nothing."

". . . Experience shows that too often even a qualified and experienced technician does not fully understand the customer's complaint . . ."

We noted earlier that your chance of getting a reply to a question addressed to a manufacturer depends upon his attitude toward answering each and every query. However, there is another factor: The U.S. mail. A manufacturer writes: "The U.S. Postal Service is not the most reliable organization in the country. Most of the complaints that come to our attention relate to this (failure to get an answer), and our investigations invariably indicate that the initial letter was either never received or was received very late."

Measures the Audiophile Can Take

What can *you* do to maximize your chances of satisfactory service? Based on the foregoing discussion, on further comments by respondents to my questionnaire, and on other sources, the following are some suggestions:

1) *Be reasonable in your expectations.* For example, don't expect that after being repaired a component will perform better than ever before. Thus, if your tape deck has had appreciable hiss from the start, don't expect the hiss to vanish after the deck is serviced for a transport malfunction. Or, if your FM tuner has always lacked adequate sensitivity (perhaps is saddled with a poor antenna), don't expect the service facility to make it an outstanding receptor of distant stations.

A respondent supplies still another example of unwarranted expectations: "The audiophile's view of what constitutes proper service very often is at variance with the manufacturer's position. For instance, a customer will sometimes immediately demand a new product for his defective unit when the manufacturer's warranty clearly states 'repair or replace'. . . . We have had cases where the consumer writes that he is unhappy with the product and demands a refund from us. This doesn't make sense since we did not sell him the product; the proper channel for him is the dealer from whom he purchased the merchandise. We have also had cases where the consumer writes to us stating he is dis-satisfied and advising that he has already bought a new product and expects us to send him a refund for something he is not returning. . . . Finally, we run into a situation where the customer takes his defective product to the dealer, who tries to adjust it for him and winds up creating irreparable damage. The customer then tries to return the product to us for refund." (Presumably this manufacturer refers to a dealership which is not an authorized service station.—*H.B.*)

2) *Supply full, clear information about your problem.* Of course you have to put this in writing when you ship a component for service to a manufacturer. It is just as wise to put it in writing before you tote the component to a service shop. If you don't, on the way home you'll probably think of several things you wish you'd said.

Elaborating, a respondent states: "a) Give a specific description of the problem, including when it does and doesn't occur in the case of an intermittent problem. b) When inquiring about a problem, give the serial number of your unit. A manufacturer may have had a problem within a specific

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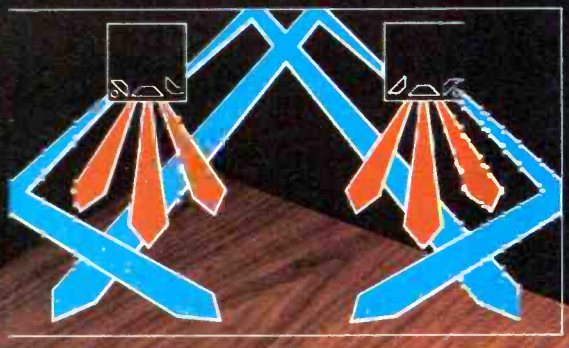

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serial group, and knowing the customer's serial number can help identify and solve the problem. c) Give a list of your related equipment, including specific model numbers. The problem may be traceable to another component in the system or to interaction between components. In the case of a tape deck, it is especially helpful to know the brand and type of tape used."

Going into detail, another respondent states: "Experience shows that too often even a qualified and experienced technician does not fully understand the customer's complaint. The customer should explain the problem as exactly as possible. In the case of a receiver, is the problem in the tuner, preamp, or power amp section? Is it in the left or right channel or both? Is it an intermittent or a constant problem? If intermittent, approximately how long must the unit be on before the problem occurs? If the problem is in the tuner or preamp, is it in mono or stereo, or both? In the case of a tuner problem, state what antenna system is used and what kind of building it's used in. If the tuner has both AM and FM, specify which mode has the problem. If the problem is in the preamp, state in which modes of operation it occurs—phono, tuner, tape, etc. If it is in phono, give the name of the cartridge and turntable used. If it is in the tape mode, give the name of the tape equipment used; this can be very important because of different input sensitivities and output levels, particularly if DIN jacks are used. If the problem is in the power amp, state what speakers are used, their impedance, how many pairs are used, and how they are connected—in series or parallel. Does the power amp work with other speakers or with headphones? In the case of trouble with a tape deck, specify whether the trouble is in the left or right channel, or both. Is the problem in record or play, or both? In the source or tape mode, or both? What kind of tape is used? If the problem tends to occur at a given point on the tape, send the tape along with the deck and state the reading on the digital counter when the problem occurs; make sure that the counter reads zero at the beginning of the tape. Has the tape path been cleaned and demagnetized? Is the deck used in the vertical or horizontal position? If the problem occurs only when using microphones, describe the microphones, their impedance, and whether the connection to the deck is balanced or unbalanced. If the problem occurs when headphones are used, state which ones they are."

3) *Send the entire unit for repair.* This applies to items such as phono cartridges, microphones, headphones, etc. To illustrate, one firm notes that sometimes a customer with a complaint about a phono pickup "might return only the stylus instead of the entire cartridge." If the pickup is in a detachable shell, as is ordinarily the case, the entire assembly should be sent for repair. Similarly, if a cartridge or microphone is used with a step-up transformer, the transformer should probably also be brought in if there is a problem with the cartridge or mike. In the case of electrostatic headphones with a power supply, this supply should accompany the phones on a trip for service. In the case of a tape deck, if is wise to send along a reel of the tape you ordinarily use.

4) *Give your return address and telephone number.* A manufacturer comments: "You'd be surprised how many customers don't provide return ad-

dresses." Giving your telephone number, both at home and at work, is a good idea in case a special problem comes up.

5) *Ask for a written estimate.* Otherwise you may have an unpleasant surprise when you pick up a repaired component that is out of warranty. You may not want to pay a service bill that you consider disproportionate to the value of the component. You may feel that the money involved is better put toward a new component. A manufacturer advises: "Asking for a written estimate can save a customer from being burned, although it usually takes as long to diagnose the problem and give the estimate as it would to repair the problem. For routine maintenance, many manufacturers recommend repair fees, and it never hurts the customer to ask the manufacturer what such a job should cost, or would cost if it were done at the factory." The consumer can compare this factory cost with a service shop's estimate before giving the shop a go-ahead.

If a service shop's charge seems excessive, there is a possibility that one can ask the manufacturer to intercede. But, as one manufacturer points out, ordinarily this is feasible "provided the consumer is complaining about a service shop authorized by the manufacturer and provided the customer has not yet paid the bill."

When you have an estimate from a service shop, ask for a pledge that the shop will not proceed without your permission if it finds that the repair cost will exceed the estimate. Some manufacturers, in their contracts with service shops, require the shop to obtain authorization from the customer before undertaking a repair costing more than the estimate.

6) *Read the instruction manual thoroughly.* To avoid actual or imagined trouble, it is desirable to read it carefully at least once and preferably twice. Some manuals are quite extensive, but they are usually written clearly and informatively, so that the time expended is worthwhile. A respondent writes: "A unit returned for service may not be defective at all. It may have been that the consumer simply did not fully read the operating instructions and overlooked a fundamental set-up step." Another states: "In almost every case of complaint after reservice (when a repaired component is returned for further service), we find the customer has not read the instruction manual or has a malfunction in an associated piece of equipment. Attention to the instruction manual can prevent incorrect use, sometimes involving other components in an audio system."

Attention to the instruction manual can also head off customer inquiries about operation of a component or its connection to other components. A manufacturer states: "Most instruction manuals supplied with today's products are very complete, and if the consumer would merely take the time to read these, most of his questions would be answered."

7) *Use authorized service stations when possible.* An authorized service shop usually has a sign listing the manufacturers which have engaged it to perform work on under-warranty components free of charge to the customer. A new component may be accompanied by a listing of authorized shops; otherwise such a listing can be obtained by writing to the manufacturer.

If your component is still within warranty, it is obviously advantageous to use an *authorized* service shop, because service will then, ordinarily,

be free (unless you have done a foolish thing such as playing with the alignment screws of a tuner or tape deck or have overlooked a consumer-correction, such as a blown fuse). Even if your component is out of warranty, it is recommended that you use an authorized shop. It is likely that they know your component well, so that the repair is efficient and effective, giving you the most for your money. Manufacturers frequently hold special training and updating sessions for technicians of their authorized stations. Usually the authorized station, in its contract with the manufacturer, pledges to conform to desirable standards of service, such as carrying an adequate supply of replacement parts, repairing equipment within a stated period of time, not making unauthorized circuit changes (which may produce new problems), etc.

8) *Make sure which component is at fault.* Manufacturers note that consumers sometimes return a properly operating component in the mistaken belief that it is defective. I have been guilty of this myself: Once I brought in for service a tape deck whose left channel intermittently dropped about 6 dB in level when recording. Embarrassingly, it turned out that the fault was in my tuner. Similarly, a fault that appears to be in a preamp, power amp, or speaker may turn out to lie elsewhere, including cable connections, pickup leads, and speaker leads. Logical sleuth-work will ordinarily identify which component has the problem. To illustrate, if the right channel of a power amplifier appears to have a defect, note what happens if the cable from the left channel of the preamp is connected to the right channel of the power amp. If the power amp's right channel now operates satisfactorily, this indicates that the problem may lie in the preamp, or in the cable used to connect the right channels of the preamp and power amp. To take another example: A speaker may seem defective because the speaker leads are partially shorting either at the amplifier terminals or at the speaker terminals.

9) *Ask for a bench check when possible.* If you personally pick up a component that has been repaired by a service facility, ask for a bench check before you pay—that is, ask for a demonstration that your component is now working properly. To illustrate the possible consequence of not doing so: A reader recently complained that he paid $35.00 for a tape deck repair by a local shop, only to find when he got home that the problem was uncured. On returning to the shop, he was told that the deck left the shop in good condition and was refused further service without further payment.

Admittedly, time is money, and it costs the service facility something to provide a bench check after repair. But a reputable firm will not refuse this. Moreover, a high-quality service facility will demonstrate that all features of your component are in proper working order, so that when you come home you don't find that one trouble has been replaced by another. Thus, a reader recently complained that he had his tape deck satisfactorily repaired with respect to the problem that led him to a service shop, but once he got home he discovered that the deck had developed new afflictions in the shop.

10) *Exercise your protest function—sensibly.* If a service facility fails to repair your component satisfactorily, or fails to answer your inquiry, or takes too long in doing either, do not hesitate to notify the proper party. To whom should you complain? In the first instance you should contact the party that caused you dissatisfaction. If this fails to resolve the matter, contact the manufacturer—either the customer relations department or the manager of the service department—by letter or telephone. Then, writes a respondent, "If all else fails and a situation has not been resolved, write a letter to the president of the company, including copies of all previous correspondence."

When even a letter to the president doesn't produce satisfaction, it is suggested that "the proper consumer agency be contacted." However, another firm advises that consumer agencies, although they exist for a good purpose, should be used only as a last resort. It explains: "Federal warranty laws require that in case of product or service dissatisfaction, the consumer is given a procedure to follow in notifying the manufacturer. Some people believe that immediately sending copies of complaint letters to various consumer agencies will speed the resolution of their problem. Nothing could be further from the truth. Direct manufacturer contact between factory and customer usually results in a fair and equitable settlement. When a third party (consumer agency) becomes involved, communications become more formal, with procedural delays."

This respondent also advises the customer to make sure he has a legitimate

grievance before seeking help from a consumer agency: "Consumer agencies will not become his advocate unless he has a valid complaint."

11) *Select your service facility with care.* Those living in or near metropolitan areas, as most of us do, usually have a choice of service shops, including a choice of *authorized* shops. Probably as much care should be exercised in selecting a shop as in choosing components for one's audio system. One respondent suggests that a telephone call to the customer relations department of a manufacturer may be the best way of finding the right shop. Or one may write for guidance. Friends and acquaintances with strong experience in the audio field, or an audio salesman with whom you have established rapport, may be helpful. The problem is not much different from that of finding a good doctor or dentist; caution and judgment should be used.

Ordinarily, unless you are dealing with an authorized shop, it does not seem to be a good idea to entrust a sophisticated and expensive piece of audio equipment to the typical TV repair shop which also takes in audio work.

Some audiophiles are not in the position of having several franchised shops available, or of having even one. Then your best bet is apt to be the service department of the manufacturer, particularly if the factory happens to be within reasonable traveling distance. Ordinarily, though, you will have to ship the component, which is not very convenient, but still usually a wiser choice than selecting a service shop of unknown quality.

If the component is to go to the factory for service, pack it with great care. Preferably, use the original carton and shock-absorbing materials, such as styrofoam braces or pellets. Select a carrier which will handle the carton gently. A number of manufacturers warn against using U.S. Parcel Post, recommending United Parcel Service instead.

12) *Save all receipts.* An authorized service shop will usually want to see your sales slip to prove that a component is under warranty. The manufacturer's service department may want the same proof. Keep your service receipt in case reservice is necessary. If your warranty has expired but you are returning a component for the same problem that was treated before the expiration date, your service receipt should entitle you to an extension of free service on this particular problem.

A New Recording System

Herman Lia*

This article describes a new recording system which has been developed by the Department of Magnetic Research & Development at Tandberg. As this system will be able to utilize the new generation of metal particle tapes, an overview of the merits of such tapes are also discussed in the context of future tape recording technology. This new recording system is called Actilinear, and patent applications have been filed and patents are pending.

The development of recording technology is being carried on in two separate and different groups: Manufacturers of magnetic tape represent one environment, and manufacturers of recording machines the other. Development in this connection is defined as the effort on the part of both parties to come up with better products for the consumers with regard to technical specifications, reliability, ease of operation, etc.

The development has traditionally been such that first the tape manufacturers bring new concepts to the market with properties that promise improvements over the existing state of the art. Then the machine manufacturers examine the nature of these improvements and how these can be used to advantage in the various types of recorders. Lately, however, a good collaboration has been established between these two groups, and this will naturally lead to better compatibility between the tape and the tape recorders. The greatest benefit of such a collaboration lies in the fact that the machine

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manufacturers will be able to include the advancement of new tape technology in an early phase of new product development.

If we look at the development of magnetic tape in the last 15 years, we find a clear trend towards higher saturation flux density, B_m, and higher coercivity, H_c. This has been a natural development based on a desire for a continuous improvement of the signal-to-noise ratio. In particular, it was an immediate requirement with the introduction of the compact cassette, since there was no opportunity to select track width and tape speed.

An increase of the B_m gives a better signal-to-noise ratio at lower and middle frequencies, whereas a higher H_c gives a better signal-to-noise ratio at higher frequencies. The first compact cassette that was introduced contained tape having H_c = 250 Oe. Then we had the so-called LH tape (low noise, high output) having H_c = 300 Oe. Later we got the CrO_2 level tapes with H_c = 550 Oe (e.g. TDK SA and Maxell UD-XL II). But these does not end the development. We know that experiments are going on today with types having H_c = 1000 Oe, and these are certain to come on the market in the near future.

In the midst of this development, a central question for the serious recorder manufacturing company is to what degree the present recorders will benefit from the new types of tape which will come on the market within a relatively short time. These are questions which gain momentum as new concepts from the magnetic tape industry are being marketed. We presently have recorders with selector arrangements which make it possible to choose between different types of tape, but only among the ones already on the market. Obviously, it is a hopeless task to design a recorder today which will give

optimum performance with any type of tape five years from now. What can be done now, however, is to prepare the ground in the best possible way to allow for the possibility of adjusting the recorders to new types as they appear on the market.

Consider a tape with H_c = 1000 Oe which today is in the experimental stage, but which quite certainly will be commercially available in a year or less. Unless we are ready to take these new tapes into account now, we will end up in the same situation we had when the CrO_2 tapes came on the market, when there were no cassette recorders to take the full advantage of them. Of course, the recorders then were not adjusted to these types, but the fact that they did not have even a 3-dB margin in bias—and recording currents such that they could have been adjusted—is a clear testimony to a lack of a progressive design philosophy at that time.

One can learn from errors, however. The tendency today is towards a far greater ability to provide headroom and adjustments, and there is a desire to bring advanced design concepts into realization. This has, in fact, been the guiding spirit in the development of the recording amplifier chain in the new Tandberg tape recorders, for compact cassette as well as open-reel recorders.

Conventional Recording Systems

The conventional method of designing a recording amplifier is well known and will not be dealt with in detail. We will just note that the summation of recording current and bias current in the recording head is done through *passive* components, and this leads to compromise solutions which have their distinct and pronounced weaknesses.

The following difficulties should be mentioned 1) small headroom margin, 2) slew rate limitations for strong signals and high frequencies which results in intermodulation, 3) poor isolation between oscillator and recording amplifier which results in interference tones, and 4) too low a margin in bias and recording currents for readjustments to adopt to the new high coercivity tapes.

The New Recording Chain

With the development of the new recording system we have left behind and abandoned any form of compromise solution. The new design philosophy is based on the optimization of modules, that is, the whole chain is divided into natural functions, and each function by itself is realized as a module. Hence, a solution is obtained which is optimum on all points at the same time as a system is realized which is more amenable to adjustment to new types of magnetic tape. The new recording amplifier chain is shown in Fig. 1.

The Particular Functions

The equalizer module: This amplifier will give the recording chain the proper frequency equalization such that the overall frequency response of the recorder becomes as linear as possible. The C_2,R_4 network gives proper equalization at low frequencies, whereas R_2, R_3, C_1, L_1 gives the desired equalization from mid-frequencies and up.

Internal adjustment of recording sensitivity: This is simply the poteniometer R_5 and provides an internal sensitivity adjustment of the recording signal.

The transconductance module: This module has two main functions. It converts a voltage from the poteniometer R_5 to

Gains Using Metal Particle Tapes

As we have presented the new recording amplifier which is especially suitable in connection with high coercivity tape, we take the opportunity to carry out calculations for such a tape as an example. The most important figures to note are the S/N ratio at low and high frequencies and the total signal capacity integrated over the entire audible frequency range.

The S/N ratio at low frequencies is proportional to the maximum remanence flux density, B_r, in the tape and the coating thickness, d. At high frequencies, the S/N ratio increases proportional to the coercivity force, H_c.

To determine the signal capacity, we use Channon's definition:

$$SB = \int_B^{log} \left(1 + \frac{S}{N}\right) \Delta f,$$

where S is the maximum obtainable signal and N is the tape noise. For further details into this matter we refer to an earlier article in the *Audio* (April, 1977), where all relevant formulas for these calculations are stated.

To get an idea of the improvement with the new tape, the results are presented realtive to the Maxell UD which is one of the most popular types of tape used today. In the following table are listed the most important physical properties and the calculated figures for S/N ratio.

The improvements have been verified by measurements on a sample received from the 3M Company a few weeks ago. The measured values agree with the calculation with an accuracy better than 1 dB.

This new tape, as seen, is certain to present another dramatic improvement in tape recording performance levels, and particularly in the compact cassette format. Tandberg has plans to introduce recorders that include provisions for the usage of metal particle tapes as soon as they become commercially available.

Tape Qualities	UD	UDXL-II	Metal Particle
Retentivity B_r (Gauss)	1430	1540	3400
Coercivity H_c (Oersted)	360	545	1030
Coating Thickness (μm)	5.0	5.5	3.8
S/N Ratio at 333 Hz * (dB)	0	+1.5	+5.7
S/N Ratio at 10 kHz * (dB)	0	+3.6	+9.1
Signal Capacity * (dB)	0	+3.0	+8.5

*With reference to the Maxell UD.

The Realistic $279.95 receiver that Peter Nero is very happy to endorse is yours for $159.95*—now to Aug. 1

On Aug. 1 the STA-78 will cost you exactly $120 more.

Pianist/conductor Peter Nero phoned us personally to applaud the FM performance of his STA-78 in comparison to other equipment he owns. A magazine recently rated its AM performance very highly. So there you have two opinions that really count in this world of hoakum and hype.

I'm Peter Nero. Everything They Say About The STA-78 is True.

What else is new? — the Radio Shack sale price that saves you $120 if you buy anytime from now through July 31.

25 or 75-Microsecond De-Emphasis for Best Sound From Dolby or Standard FM.

How many audio shops sell receivers they make themselves? Frankly, the only one we can think of is Radio Shack. Us! The Realistic® STA-78 is made in one of our 20 company-operated factories. Our design. Our engineering. Our labor. Our love. Your bargain.

The cabinet is genuine walnut veneer, not flim-flammery. The power is there: 22W/channel min. RMS at 8 ohms, 20-20,000 Hz with no more than 0.5% total harmonic distortion. Note we didn't say 40-20K or 1.0%. Another nicety: switchable 25 microsecond FM for Dolby. Its size is also a pleasure in this day of beefy brutes: 6 x 12½ x 17 inches. And the detented tone controls add a touch of class, not to forget channel reverse — a neat switch that's been neglected of late.

Precision Detented Bass and Treble Tone Controls.

Ample Audio Power for Nearly Any Speaker Pair.

Come sale with Radio Shack and save 42.8647973% (rounded to 43%) while our midsummer madness lasts. If you've looked at car prices, food prices and equipment prices lately, you'll know our return to $279.95 on the STA-78 on Aug. 1 is no idle threat. To be quite realistic (pun intended) it's just in time. Shop Shack today and save!

79

These two credit cards honored at most Radio Shack stores.

*Prices may vary at individual stores and dealers.

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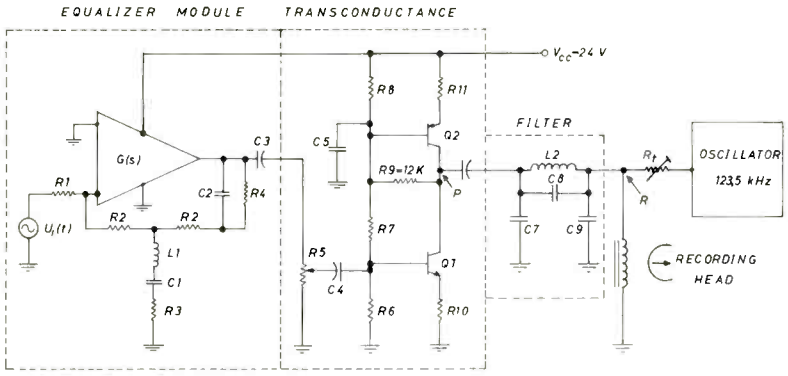


Fig. 1—Block diagram-schematic of the Actilinear recording amplifier chain.

a current i_s which is the recording current. It shall also provide an electrical isolation between the oscillator and the recording amplifier such that interference tones are avoided and completely eliminated.

The circuit consists of the two transistors Q_1 and Q_2. Q_1 is used in a common-emitter configuration, and it has R_g = 12 kilohm and Q_2 as a collector load. Advantage has been taken of a special property of transistors in that the collector can appear as a low resistance to d.c., but a high impedance to a.c. signals. The two collectors are connected at point P. This point is put at 12 V d.c. and can swing between 2 V and 22 V, and thus has a maximal dynamic range available for driving current i_s through the head. The d.c. current through Q_1 and Q_2 is about 10 mA so that each single transistor represents the equivalent of a resistance of 12 V/10 mA = 1.2 kilohm at d.c. The output impedance for a.c. signals, however, is 1/hoe = 20 kilohm for each transistor and, hence, the total output impedance seen at point P is approximately 5 kilohms. Since the recording head impedance is substantially less than 5 kilohms (200 ohm at 20 kHz), the circuit acts as a current source, that is, a constant voltage at the input gives a constant current i_s through the recording head. This is also the justification for the name *Transconductance Amplifier*.

Any residual oscillator voltage at point P is being prevented from being fed back to the input by C_5. This way the circuit provides an electrical isolation between the equalizer amplifier and the oscillator.

Filter Module: The filter module prevents oscillator signals at point R from entering into the point P and interfering with the audio signal. At point R Uosc = 20V, but is reduced to about 50 mV at point P. The filter is of the low-pass type with a trap at 123.5 kHz.

Calculation of Headroom Margin in the Recording Amplifier

Since the recording amplifier is designed as a transconductance block, the limitation in headroom is determined by the maximum available current in the output stage. This is actually the quiescent current in the two transistors Q_1 and Q_2, and is set to I_{QDC} = 10 mA.

The maximum available a.c. current is then $I_{QDC} \div 2\sqrt{2}$. The headroom margin is the ratio between this current and that which is necessary to record the tape to maximum recording level i_{sm}. Therefore, we have:

$$HRM^* = 20 \log \left(\frac{I_{QDC}}{2\sqrt{2}\, i_{sm}} \right)$$

*Where HRM is an abbreviation for headroom margin. Numerical calculations with I_{QDC} = 10 mA and i_{sm} = 0.4 mA gives HRM = 19 dB.

Calculation of the Slew Rate

The slew rate of an electrical signal is defined as the time derivative of the amplitude and is determined in Volt/μS or Volt/mS.

Let: e(t) = Em sin ωt, be a general signal with angular frequency ω and amplitude value Em.

The slew rate is given then by

$$S = \frac{\Delta}{\Delta t} e(t) = \omega \, Em \cos \omega t$$

The maximum slew rate occurs when the term cos ωt has its maximum value which is 1. That gives the usual formula S = ω Em. As an example, we will carry out the numerical calculations for the TD 20A (the new series of Tandberg reel-to-reel tape decks).

The impedance of a recording head is almost pure inductive at audio frequencies and can be expressed by Z_H = ωL where L is the inductance of the head. The maximum signal voltage across the head occurs at the maximum recording level and is given by e_{HM} (L) = ωL i_{sm}, where i_{sm} is the maximum recording current. Let i_{sm} = I_{sm} sin ωt.

The slew rate of the signal voltage across the recording head is determined by the following calculations:

$$S_H = \frac{\Delta}{\Delta t} e_{HM}(t) = W^2 \, L \, I_{sm}$$

where, fo = 20 kHz, L = 5 mH and I_{sm} = 0.5 mA, then S_H = 4 V/mS.

The maximum slew rate which the recording amplifier is able to handle is according to measurement equal to 400 V/mS. That gives a slew-rate margin of 40 dB which is a satisfactory figure.

Conclusion

A new recording amplifier chain has been designed which will be implemented in the new Tandberg cassette recorder, as well as open-reel machines. Improvements relative to conventional designs can be summarized as in the following:

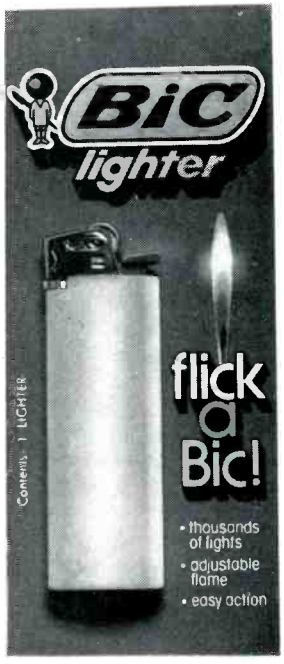
1. More headroom in the recording amplifier, greater than 18 dB.
2. The recording circuitry operates at a lower voltage level and will, therefore, give less intermodulation because of slew-rate limitations.
3. An improved electrical separation between oscillator and recording amplifier which gives less interference with the oscillator.
4. Substantially greater possibilities of adjusting the recorder to new high coercivity tapes such as the new metal particle tapes.

The lighter side of flicking your BIC

"Sir, I cannot offer you a fine cigar or a snifter of brandy. But would you accept a hearty greeting and a flick of my Bic?"

"I doubt our ability to compete in the ball-bearing business with a President who has difficulty flicking his Bic."

"I think we've come upon the earliest recorded example of 'flicking your Bic'."



Build a Dolby Noise Reducer

Part III — Encode-Decode Kit Instructions

This is the third and concluding portion of our series on building a Dolby B-type noise reducer and deals with the construction and adjustment of a pair of stereo decode channels. Paired with last month's stereo channels, the finished kit will simultaneously encode and decode a Dolby B-type program as for use with a three-head tape machine.

We should again emphasize that this is not a kit for the beginner and that a good set of tools is required, though no test gear is necessary. A kit of parts is available from Integrex, whose advertisement appears near the article.— Editor.

To convert the alternate encode-decode processor to a simultaneous stereo encode-decode unit, very few alterations are necessary.

The black legend area, covering the 200 and 300 series of parts, is used for installation of the additional components as shown in the parts list.

The jumper links, JL, next to RV8, the output level control, and R333 are cut.

On the sub PC board, behind RV4, there are six tracks to be cut. This can be done with a small pocket knife or the point of a screwdriver. In the same area, six jumper links are to be installed and soldered. Check the diagram for these locations.

Install and solder trim pots RV209, 309 on the sub PC board.

The unit has now been converted to simultaneous encode-decode circuitry.

To adjust the new processors, switch the unit on, switch the "Cal. Tone", "Aux." and "Record" pushbuttons in. Leave "Check Tape" out. Adjust RV209, 309 to obtain 0 VU level on the meters.

The "Check Tape" switch has become the "Tape/Source" switch. "Record" may now be permanently switched in.

Switch Functions

While the functions of the controls are, for the most part, self-explanatory, it is probably well to go through them in at least a brief fashion.

"Record Balance" changes the relative volume of the left and right channels of the "Aux." input.

"Record Level" changes the overall volume level of both left and right channels going to the recorder from "Aux." input.

The "fm," "rec.," and "play" trim pots change both the relative level of each of these sources and also the left and right channels, one versus another.

"Output Level" controls the volume level of both channels returning to the amplifier.

The "Cal. Tone" pushbutton, when pressed in, begins operation of the 400-Hz oscillator used for calibration of the meters.

The "Aux." pushbutton selects any external high-level source connected to the "Aux. in" terminals on the rear panel.

The "f.m." pushbutton selects standard broadcasts and does not use the Dolby processor.

PARTS LIST

Integrex simultaneous encode-decode kit

Resistors
R207, 307 3.3k 1%
R208, 308 47K
R209, 309 180
R210, 310 270K
R211, 311 560K
R212, 312 270K
R233, 333 220

Miscellaneous
IC201, 301 LM-1011A
L201, 301 30569 coil
RV209, 309 47K linear trim pot, small, surface-mount

Capacitors
C203, 303 0.33 μF, Mylar
C207, 307 2200 pF, Styrene
C208, 308 10 μF
C210, 310 5600 pF, Styrene
C211, 311 4700 pF, Styrene
C212, 312 10 μF
C213, 313 10 μF
C214, 314 27 nF, 1%
C215, 315 47 nF, Mylar
C216, 316 10 μF
C217, 317 0.1 μF, Mylar
C218, 318 0.33 μF, Mylar
C229 220 μF, 10V, Electrolytic
C231 47 nF, square red-plate ceramic
C232 47 nF, square red-plate ceramic
C233, 333 1 nF, disc

Note: It is no longer necessary that the meters be calibrated for Dolby level before these parts are installed.

Would you stake a four-figure buying decision on the equipment reviews of any audio publication you've seen?

It seems to us that everybody is reviewing audio equipment these days. There are several dozen commercial hi-fi magazines on the newsstands (only two or three of which, in our jaded opinion, have anything at all to say) and maybe six or eight highly vocal but mostly amateurish "underground" reviews sold by subscription only. The result is a whole series of credibility gaps.

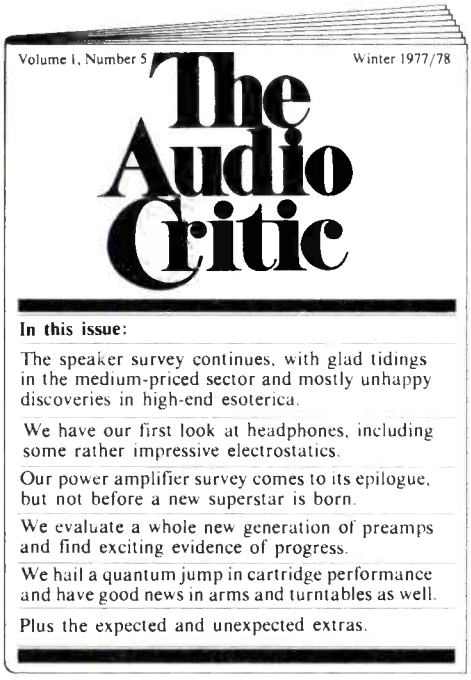
The first of these is the gap between (a) telling the whole truth and (b) not lying. Publications that carry advertising have to be content with (b) in their test reports, since (a) would put them out of business by alienating key advertisers.

Another credibility gap is in scientific and mathematical background information. The vast majority of equipment reviewers don't have enough of it, alas. Audio as a technology has entered a new era of sophistication, leaving most audio journalists well below the level of technical understanding on which the best designers operate.

"Golden-ear" listening evaluations constitute one more credibility gap. It can be verified beyond reasonable doubt that virtually all "subjective" reviews are based on reference records played with an incorrectly aligned cartridge and tone arm, or else reference tapes played on a not quite state-of-the-art tape recorder. Such listening tests are worse than invalid; they're misleading.

The Audio Critic is the first publication to address this credibility crisis in its entirety. For openers, we accept no advertising, not even from retail stores. Next, we maintain a superbly equipped testing laboratory right under our own roof. At the same time, we seek the advice of, and have a continuing dialogue with, some of the top theorists and technologists in the world, instead of surrounding ourselves with pop-tech cultists and audio-store cowboys.

In its sound room, The Audio Critic pursues the highest achievable standards of signal quality for reference purposes. (Visiting professionals are invariably astounded.) And it translates its findings into tough, no-nonsense, thoroughly detailed equipment reports that correlate the audible and measurable aspects of performance to a degree no one else even attempts.



As a result, The Audio Critic has been hailed by both audio professionals and consumerists as a uniquely original and reliable source of general information as well as of specific buying advice. For example:

- The Audio Critic was the first and only publication of the stereo era to point out the disastrously wrong cartridge/arm geometry in virtually all existing phono systems and to publish specific corrective alignment procedures.
- The Audio Critic is the only publication that has ever unequivocally condemned certain immensely costly audio components with a cult following and explained clearly, with laboratory documentation, why they are incorrectly designed.
- The Audio Critic has also been the first to point out the superiority of a number of newly available components at a relatively low price, with unhedged comparisons against costlier but less good equipment.
- The Audio Critic is the only publication to specialize in broad comparative surveys of specific component categories. (For example, the continuing preamp survey in the first, second and fifth issues covered more than 40 different models.)
- Furthermore, The Audio Critic published its first five issues within a span of approximately 14½ months, an all-time record in frequency among audio reviews without manufacturers' advertising.

This frequency will undoubtedly increase; however, The Audio Critic at this stage of its development is making no official promise as to its publishing schedule. The long-term average interval between issues is expected to be two to three months. Since the information we publish is unavailable from any other source, there's just no way of obtaining it faster than we're able to produce it.

The subscription cost of six consecutive issues (indexed as one volume) is $28, by first-class mail only. (No Canadian dollars, please!) For overseas airmail, add $5. No single copies are sold for any reason whatsoever, but the unused portion of canceled subscriptions is refundable on request.

You'll probably want to begin your subscription with Number 6, to be mailed in late June or early July. This is a special reference issue that will acquaint you with all previous findings of The Audio Critic in updated form and also bring you first-time reviews of new equipment plus other new material. Or you may want to shoot the works and start with Volume 1, Number 1, in order to own a complete set and be able to read all the original articles and surveys. (In that case you'd be better off subscribing to the first twelve consecutive issues for $56, otherwise your six-issue subscription would be up for renewal almost at once.) If you wish, however, we'll start your six-issue series with any issue you specify. The latest issue already in print is Number 5.

Send for your first six issues today! Use this convenient coupon or, if you prefer, copy the part that applies to you on any sheet of paper.

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- ☐ $28 for 6 consecutive issues starting with Volume 1, Number ____.
- ☐ $5 supplement per 6 issues for overseas airmail.
- ☐ $10 supplement per 12 issues for overseas airmail.

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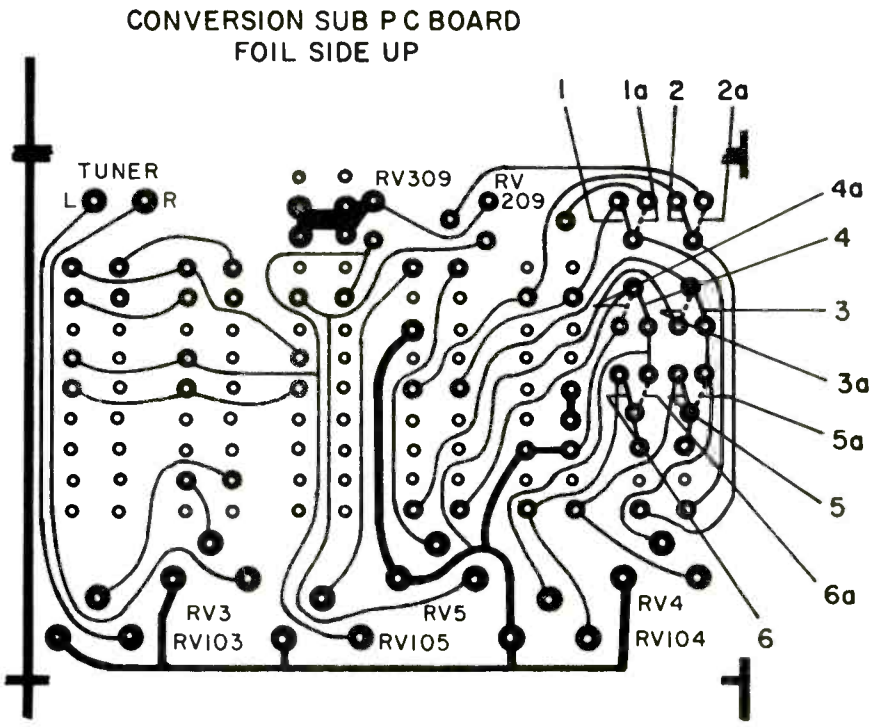


The "Dolby f.m." pushbutton is for use with Dolby B FM broadcasts which are passed straight to the recorder and may be decoded for the monitor output.

The "Record/Play" button should only be switched when the alternate encode-decode unit is used, as it switches the circuitry into the proper mode.

The "Noise Reduce" pushbutton operates encoding or decoding depending on the choice of Record or Play. In the simultaneous unit, it operates encode in the record processor and decode in the replay processor. This must be selected whenever Dolby encode/decode is required.

The "Check Tape" pushbutton allows by-passing in the switchable unit and in the simultaneous encode/decode unit functions as a tape/source switch.

The "19-kHz Filter" pushbutton switches in a filter which keeps the 19-kHz FM pilot tone from fooling the Dolby circuitry when recording and/or when monitoring Dolby FM.

The "Power" switch we'll leave for you to figure out. Hope you enjoyed this one as much as we've enjoyed bringing it to you.

85

Everything but background noise and lost dynamics in home recording with The MXR Compander.

Imagine this: You've come to that wonderful point where you can tape your favorite discs or radio programs. Now you can build up that super sound library, right? Wrong! Funny, but when you play back what you've recorded, you get that ever present background noise that drives you up the wall. And even with the best tape and a built-in noise reducer, you get chopped highs and distorted musical peaks. So what do you do?

Less than $130 will do. That's the price of the MXR Compander. It's the most effective noise reduction component you can buy. And it can double the dynamic range of most open reel and cassette tape decks.

The MXR Compander *compresses* the dynamic range of signals being recorded on your tape. This keeps the music away from tape noise. Upon playback, the Compander *expands* the music. This allows musical peaks to be reproduced without distortion. And those quiet passages aren't lost in the background noise.

The MXR Compander is part of a great family of home audio components, like our famous Stereo Graphic Equalizer and our new Dynamic Processor. We invite you to hear everything we make at your favorite audio dealer, or direct inquiries to MXR Innovations, Inc., 247 N. Goodman Street, Rochester, New York 14607. Or call us at (716) 442-5320.

Hear why, when it comes to sound, we only think of everything.

Also distributed in Canada by White Electronic Development Corporation, 6300 Northam Drive, Mississauga, Ontario.

MXR Consumer Products Group

Enter No. 22 on Reader Service Card

Equipment profiles

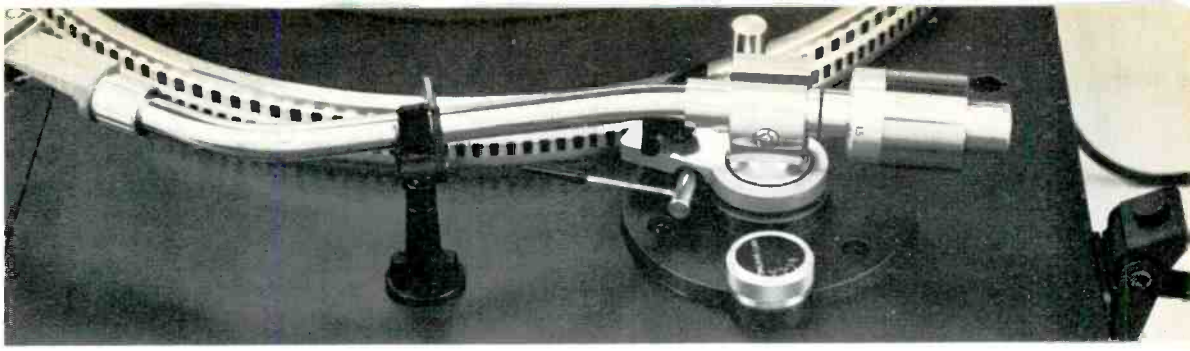
Sony Model PS-X6 Automatic Single-Play Turntable

MANUFACTURER'S SPECIFICATIONS
Speeds: 33 and 45 rpm, quartz controlled.
Motor: D.c. servo, brushless.
Wow & Flutter: ±0.045 per cent (DIN).
Rumble: 73 dB (DIN-B).
Tonearm: 8½ inch, universal pivot.
Tracking Error: +3, −1 degrees.
Dimensions: 17½ in. (44.5 cm) x 6 in. (15.2 cm) x 14¾ in. (37.5 cm).
Price: $290.00.

Sony's new PS-X6 is an automatic, single-play turntable using a direct-drive motor that is servo locked to an extremely accurate quartz-crystal oscillator. Feedback signals are obtained from a sensor head which picks up pulses recorded on a ferro-magnetic strip bonded to the platter rim. A neon strobe light is located in a neat molding at the front on the left-hand side, but there is no variable speed control. Apparently, the strobe is there to reassure the user that the quartz lock is really working, which it certainly does. Incidentally, the neon is powered from the oscillator (120 Hz) and not from the a.c. line—an important point. The turntable speed pushbuttons are located on the left-hand side of the strobe light, and on the right-hand side is an angled subpanel on which are mounted a pair of touch-contact switches, consisting of tiny metal strips with LED indicators between them, for the *Repeat* and *Start/Stop* functions. The *On/Off* switch is located next to them, and just behind it is the four-way rotary control . . . the first three positions set the correct arm dropping points while the fourth switch sets the mechanism for manual operation.

An anti-skating dial is mounted on the circular arm base with the cue lever positioned in front of it. The tonearm itself is made of polished aluminum with a lateral balance weight on the left of the pivot and the conventional kind of rotatable counterweight at the rear. The headshell is the low-mass type with a four-pin termination . . . now becoming the standard. As mentioned earlier, the drive motor is servo controlled of the d.c. brushless type. The platter is made of diecast aluminum alloy and weighs nearly four pounds, including the extra thick rubber mat.

The styling is clean and uncluttered, and the unit comes complete with a nicely made hinged dustcover. The turntable base is made of SBMC (Sony Bulk Molding Compound) which has an attractive metallic finish. This material is claimed to be acoustically inert, and further isolation is provided by the four resilient feet which, by the way, can be leveled.



Measurements

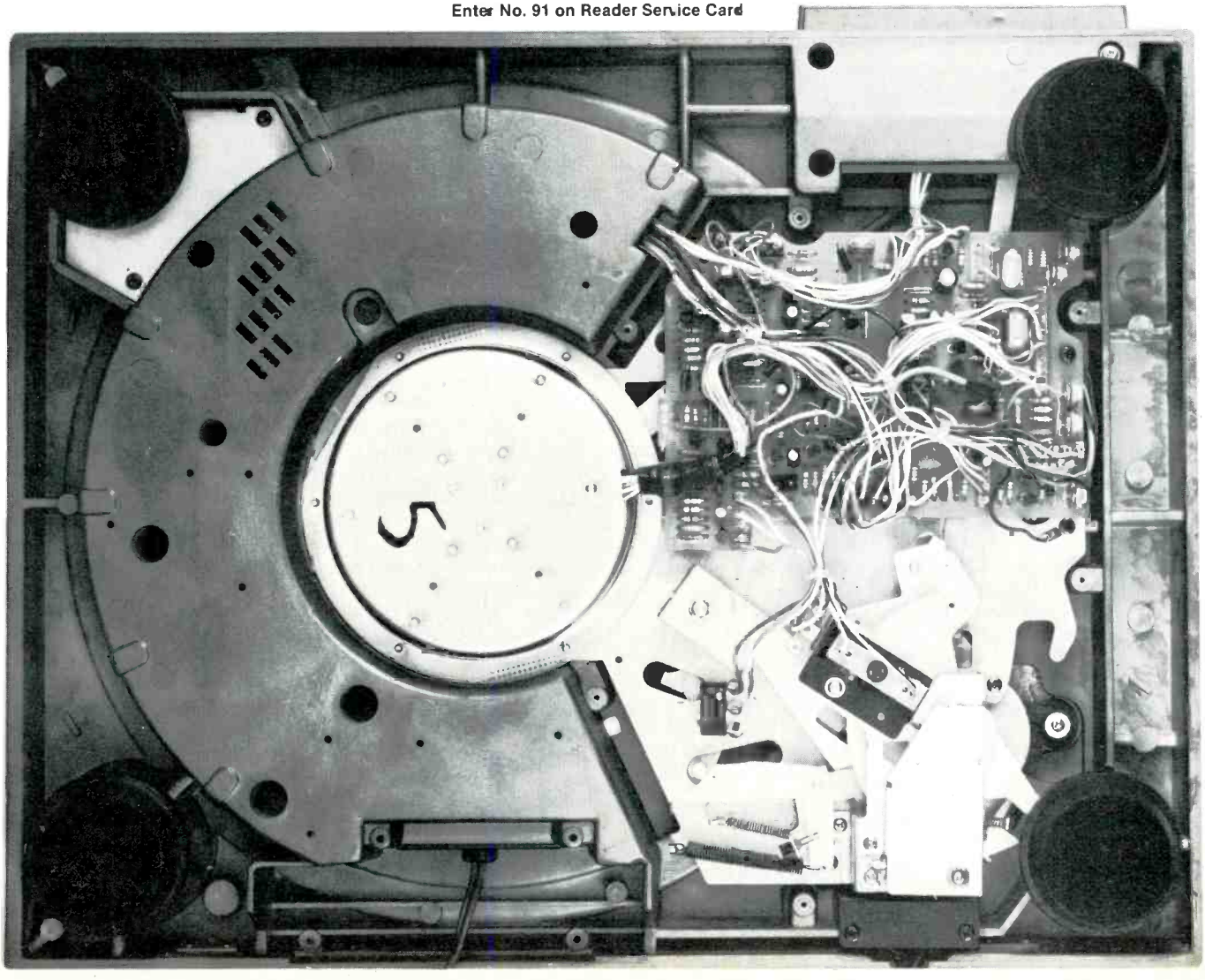
For test purposes, a Stanton 881S phono cartridge was mounted in the headshell, and it was noted that a cardboard protractor was supplied to facilitate correct alignment. (Our sample came with a preliminary instruction manual.) Tracking error measured a fraction under 0.5 degrees per inch with very low vertical and lateral arm friction. Calibration of the tracking force dial was 10 per cent light from 0.75 to 2.0 grams so I would recommend the use of a reliable external gauge if you intend to use a cartridge that requires a very low tracking force. The anti-skating dial was very accurate and, like the counterweight, it is calibrated from 0 to 3 grams. The tonearm resonance came out at 9.5 Hz with a rise of 5 dB, using the Stanton cartridge. Wow and flutter measured a low 0.05 per cent (DIN), and rumble was a very satisfactory −62 dB, using the ARLL rating.

For manual operation, the arm is moved to the required position and the *Start/Stop* switch is lightly touched, whereupon the arm is automatically lowered while the platter starts turning. At the end of the record, the arm is automatically returned to its rest position. The mechanism is triggered by a photo-cell sensor, so there is no force exerted on the cartridge stylus. The cue lift mechanism is well-damped and drift was negligible. In the completely automatic mode, the time taken before the stylus touched the record after touching the *Start* switch was just eight seconds. The turntable speed was "right on the nose" at both the 33 and 45 rpm settings, and it was not affected by power-line fluctuations.

Listening and Use Tests

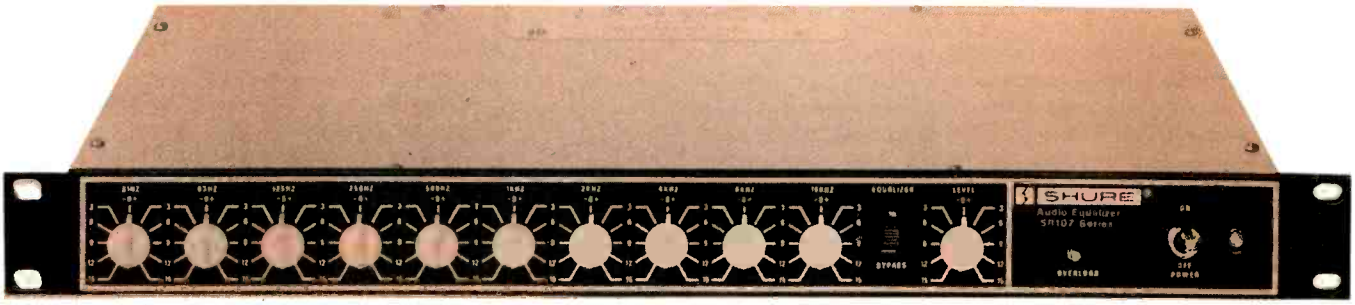
The highly-resilient feet on the PS-X6 turntable definitely help to reduce acoustic feedback, plus the individual adjustment capabilities allow you to mount the turntable on uneven surfaces while insuring stability. I'm sure that many people will appreciate the convenience of having the operating controls exposed, even when the lid is shut, although the cue lever is not accessible. Quartz-lock controlled turntables are usually quite expensive and the Sony PS-X6 is a real bargain at $290.00. Sony's Model PS-X7 is identical except that it has a fluid-filled turntable mat and a carbon-fiber tonearm; these refinements raise the cost of the "7" by $55.00.

George W. Tillett



Equipment PROfiles

Shure Model SR107 Audio Equalizer



MANUFACTURER'S SPECIFICATIONS
Frequency Response: 30 Hz to 20 kHz, ±2 dB.
Signal-to-Noise Ratio: 99 dB.
Output Noise: −84 dBV, 300 Hz to 20 kHz.
Hum & Noise: −83 dBV, 20 Hz to 20 kHz.
Clipping Level: +18 dBm.
Impedance: Input, 70 kilohms, balanced bridging; line output, 115 ohms actual, balanced.
Harmonic Distortion: 1 per cent maximum at +12.2 dBm.
Filter Center Frequencies: Accurate within ±10 per cent.
Filter Boost/Cut: ±15.5, ±2 dB maximum at center frequencies.
Dimensions: 19 in. (48.3 cm) W x 1¾ in. (4.4 cm) Hx 8$^{9}/_{16}$ in. (21.8 cm) D.
Weight: 7.8 lbs. (3.5 kg).
Price: $250.00.

The Shure SR107 octave-band audio equalizer is a single channel device designed primarily for professional applications. The unit is one of the Shure SR professional audio products, and it is made for rack mounting and requires just 1¾ inches of height. The 10 filters are centered on standard ISO frequencies from 31.5 Hz to 16 kHz, and each of the filters can be knob adjusted over a range of ±15 dB. A front-panel also has the *Equalizer In/Bypass* and power *On-Off* switches and a peak-responding LED indicator. On the back panel are the input and output connections, a gain control, and accessory power jacks. The input is at line level in a balanced, bridging configuration. Connection can be made with either a three-pin (XLR-type) or three-circuit phone plug. One side of the balanced line can be grounded in the plug, or elsewhere externally, for unbalanced operation. *Gain* has an adjustment range from unity to +20 dB voltage gain to accomodate various input/output requirements and is effective whether the equalization filters are switched in or not. There are three outputs: *AUX* on a two-circuit phone jack which is an unbalanced low-impedance output, *Line* is a balanced output on a three-circuit phone jack and also switch selectable to a 3-pin male XLR-type socket, Mike is a balanced microphone-level output on the same socket with the *Mike/Line* switch in *Mike*. There are also jacks to provide accessory power of 27 V d.c. at up to 10 milliamperes. This can be a very handy feature for use with special add-on circuits, including some of the Shure accessories.

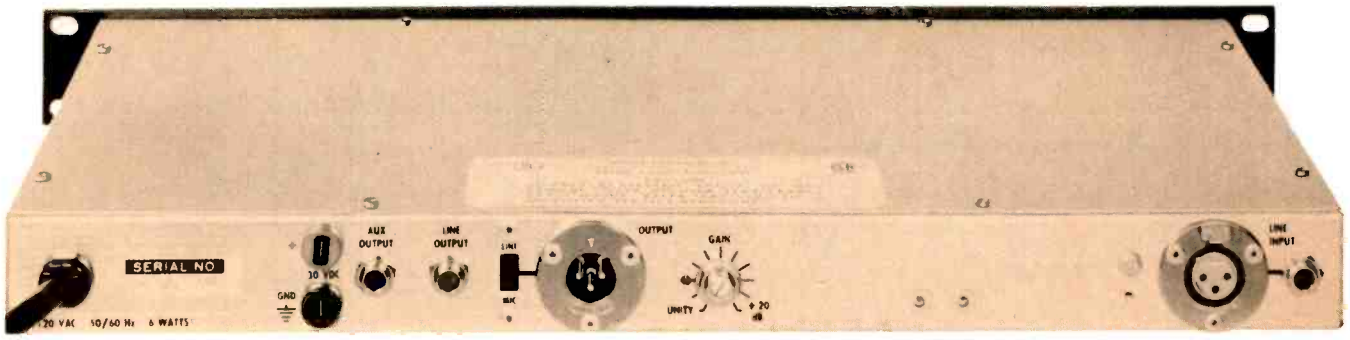
The box enclosure for the circuitry is one piece with the exception of the attached front panel and the top cover, which can be easily removed for any maintenance needs. The majority of the components are on two PCBs. The soldering was generally excellent, although some flux residue was noted.

Circuit Description

The input signal is fed through a stepdown transformer which introduces a 6-dB loss. The following attenuator provides an additional loss ranging from 11 to 26 dB, corresponding to settings of the *Level* control from zero CCW to −15 dB. The following input amplifier has a gain of anywhere from 14 to 34 dB, dependent upon the setting of *Gain* on the rear panel. Two cascaded differential amplifier stages comprise the boost and cut circuitry. Each of the amplifiers is connected to five of the 10 active gyrator resonators. These octave-spaced filters can be controlled over a ±15 dB range with front panel knobs. The configurations are minimum phase for good combining and minimum ripple. The *Level* control, referred to earlier, also provides up to ±15 dB voltage gain when turned CW from zero. This varies the gain of the output amplifier from +5 to +20 dB. By having the level control act at two different points, a total of 30 dB of gain change is obtained with minimum noise and reduced likelihood of overload. This is a good design approach, and Shure deserves credit for it. The bypass switch removes the equalizer filters from the signal path and disconnects the level control. In either mode, the output amplifier drives the output transformer which has mike and line-level taps, the *AUX* output through a fixed attenuator, and the driver for the LED overload indicator.

Performance

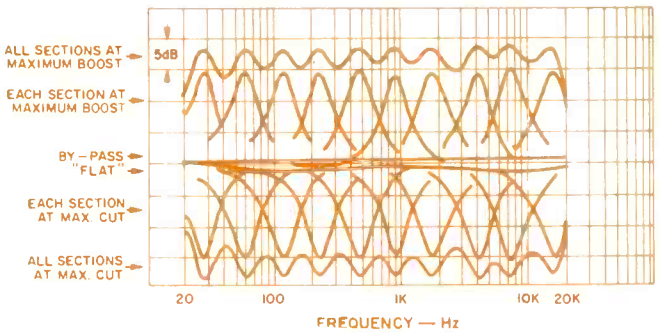
Swept-frequency responses were taken of the SR107 under various conditions. The first plot was made with the unit in *Bypass*. Then, with the equalizer switched in, all filter sections were adjusted for a zero-dial indication, and another plot was made. There were some discrepancies from the ruler-flat response of the first run, but the spread of deviations was small and not significant. The next series of sweeps were made with each filter section in turn set to maximum boost, and then to maximum cut. Finally, plots made with all filters at maximum boost and then at maximum cut. The maximum boosts and cuts for the individual sections were consistently close to ±15 dB. With all filters at the maximums, the ripple was about three dB. This was good for an octave-spaced equalizer, demonstrating the combining characteristics of the



minimum phase design. The center frequencies of all of the filters were within 8.0 per cent of the standard ISO frequencies, and the great majority within 5.8 per cent. The unit, therefore, easily met the specified 10 per cent which is adequate for such purposes. To show some of the variations possible with such an equalizer, six of the filters were adjusted in three dB steps up to the maximum. The 63 and 125 Hz and 4 kHz sections were boosted and the 500 and 1000 Hz and 16 kHz sections were cut. Note that when two adjacent filters are boosted or cut, ripple first appears at about ±9 dB. There is also somewhat greater action than with a single section because of the combining effect.

To get more of a feel of the capability of the equalizer, a "room-like" response was created. The 20 Hz to 20 kHz sweep was modified with a 1/3-octave equalizer to introduce purposeful roughness, including a crossover-like notch at 800 Hz and a peak around 6.5 kHz. It was impossible for the unit to remove all of these worst-case variations, but the spread from maximum to minimum had been reduced from close to 15 dB to less than 9 dB. The peaks in the curve had been made much more even, and the pink-noise energy in each octave band was much more equal. The sweep made of the SR107 itself with the settings used shows that extreme measures were not used. The earlier figure with variations in boost and cut settings had shown the narrowing of the filter responses with increasing amounts of boost/cut, characteristic of such equalizers. Simple calculations gave values of filter *Q* less than 1.0 at +5 dB and more than 2.5 at +15 dB. Roughly, filter *Q*= Center Frequency/3-dB Bandwidth. *Q*, therefore, increases with reductions in bandwidth for a constant center frequency. A 500-Hz square wave was fed to the equalizer with the 2- and 4-kHz filters at +6 dB. The scope photo shows the initial high overshoot with fairly fast damping, but the true value is just reached as the waveform steps to opposite polarity. The indications are that ringing is quite close. A 200-Hz square wave showed obvious ringing on the output when the 4-kHz filter was boosted to +10.5 dB. The waveform is modified when this filter is set to −10.5 dB, but there is no ringing. The results shown here are those to be expected with any equalizer that exhibits the same filter *Q*.

Fig. 1— Frequency responses of the Shure SR-107 equalizer.



The harmonic distortion was measured with the specified 3.2 V output, all filters at +15 dB, and the *Gain* and *Level* controls both at maximum. This certainly must be classified as a worst-case condition, but the SR107 easily met the specified 1 per cent anywhere from 30 Hz to 20 kHz. The 2nd harmonic was the highest level product, reaching a maximum of 0.3 per cent at 30 Hz. Typically, the 2nd harmonic was just over 0.1 per cent at this high level. The 3rd harmonic was also a maximum of 0.3 per cent at 30 Hz, but was around 0.03 per cent for the majority of the frequency range. With the input signal lowered to reduce the output voltage to 1.0 V, the relative distortion was reduced measurably with a number of readings less than 0.03 per cent. With 3.2 V out, the IM distortion was 0.145 per cent, much less than the specified 0.25 per cent. With 5-dB less drive, the IM distortion dropped to a low 0.04 per cent. The signal-to-noise ratio with a 20 Hz to 20 kHz bandwidth (unweighted) was 83 dBV (relative to 1.0 volts), and 99.8 dB relative to the measured 6.9 V clipping level. This is a bit better than the specified 99 dB, and certainly excellent performance with this unweighted measurement. Actually, the A-weighted figure was almost exactly the same as most of the noise energy was contained in the highest frequencies.

The checks on noise levels had to be made with great care because some of the specified levels were below those of the instrumentation normally used for filtering. The figures in Table I are given in both "mV" and "dBV" which is the decibel value relative to 1.0 V. Note that on a voltage basis, the dBm reference is 2.2 dB lower, being 0.775 V.

Table I— Noise levels.

	Output Noise, 300-20 kHz		Hum & Noise, 20-20 kHz	
Conditions	Spec.	Meas.	Spec.	Meas.
Controls at zero,	−84 dBV	−84.8 dBV	−83 dBV	−84.7 dBV
Unity gain	0.063 mV	0.058 mV	0.071 mV	0.058 mV
Level control at +15 &	−69 dBV	−70.7 dBV	−67 dBV	−69.2 dBV
Filter controls at −15	0.50 mV	0.29 mV	0.56 mV	0.35 mV
Equalizer switched to	−91 dBV	−89 dBV	−88 dBV	−89 dBV
bypass	0.028 mV	0.035 mV	0.040 mV	0.035 mV

Table II— Voltage gains to the three outputs.

	Gain-to-Line Output, dB		Gain-to-*AUX* Output, dB		Gain-to-Mike Output, dB	
Gain Setting	Spec.	Meas.	Spec.	Meas.	Spec.	Meas.
Zero	0	0	−27	−26.8	−50	−49.5
+20 dB	+20	+19.7	−7	−7.1	−30	−29.8

These excellent results show that the demanding specifications were exceeded in the performance tests with one minor exception. In bypass mode, the noise in a 300-Hz- to-20-kHz bandwidth was measured to be 35 microvolts instead of the specified 28 microvolts, a difference of less than 10 microvolts. The voltage gains from the line input to the three outputs were measured for *Gain* settings of zero and +20 dB; these are shown in Table II.

All input and output impedances were found to be very close to the specified values. The input impedance is a

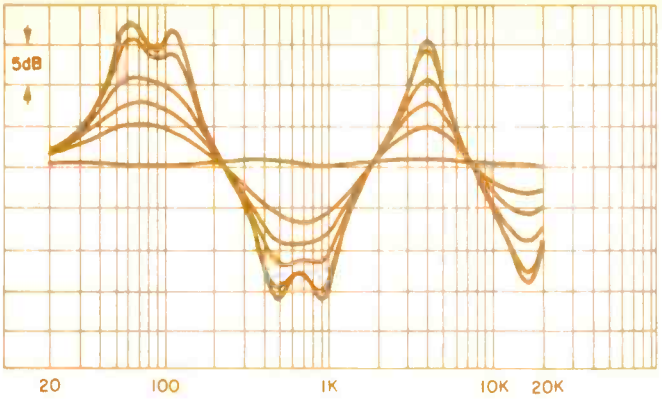


Fig. 2—"Flat" response and the settings of 3, 6, 9, 12, & 15 dB for 63 and 125 Hz (+), 500 and 1000 Hz (−), 4 kHz (+), and 16 kHz (−).

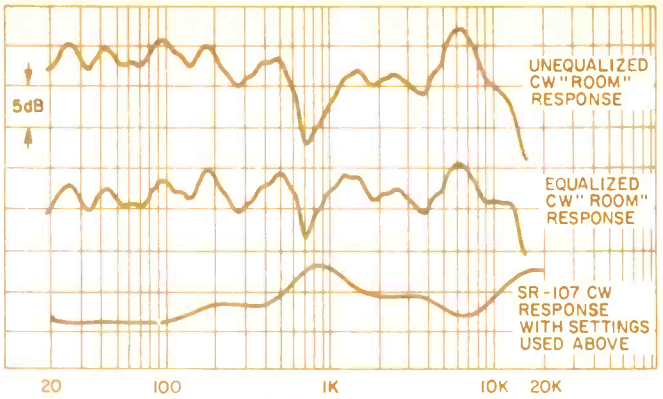


Fig. 3—Equalization of room-like response.

balanced 70 kilohms for balanced bridging from sources of 10 kilohms or less. The *Mike*, *Line* and *AUX* output impedances are 1.0, 115, and 630 ohms respectively, for use with 25- to 600-ohm mike-level inputs, for use with 600-ohm lines, and for use with unbalanced auxiliary circuits of 600 ohms or more, respectively. The *Level* control provided an additional dB of gain control at each end beyond the specified ±15 dB. Clipping first appeared at 6.9 V (+19 dBm) at the *Line* output, 0.35 V at the *AUX* output and 25.4 mV at the *Mike* output. The clipping was very symmetrical, and the measured levels were all higher than the spec. The overload indicator turned on 2.9 dB below clipping with a 1.0-kHz test tone. The response time was fast enough to show at least a flicker to a single-cycle 10-kHz tone burst just at clipping level. The overload detector was not polarity sensitive, a good feature.

In Use Tests

The Shure equalizer was mounted in a portable rack along with other sound reinforcement equipment for use in a public auditorium. The small, 1¾-inch height made it possible to carry some extra items that would have been pushed out by a

Filter Boost, Q, and Ringing

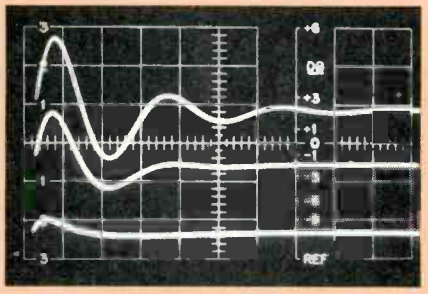


Fig. 1—Equalizer output with a 500-Hz square-wave inut, with the 3600 filter at +4 (bottom), + 8 (middle), and +12 dB (top).

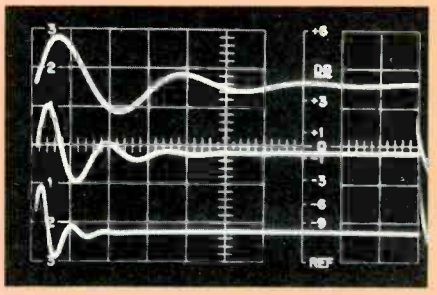


Fig.2—Equalizer output with 170-Hz square-wave input with a 12-dB boost successively in 1800- (top), 3600- (middle), and 7200-Hz filters.

It is common practice to refer to equalizers with filter center frequencies one octave apart as octave-band equalizers. The level changes, however, are not equal across the width of the octave, and the responses become more and more pointed with more boost (or cut). If the bandwidth changes as the boost (or cut) is varied, then the filter cannot be simply specified as having a certain bandwidth. On the other hand, filters used in many analyzers have flat tops out to the roll-offs at the ends of the bands, and the filter slopes are typically 24 dB/octave or greater. An analyzer's octave-band-filter half-power (−3dB) points are always one octave apart.

If we define the response of a filter as a percentage of an octave, then we can express the bandwidth thus: $BW_{oct} = BW_{Hz}/0.707 \times f_{ctr}$. For example, a true octave-band filter with a center frequency of 1000 Hz would have a 707 Hz bandwidth, i.e. from 707 to 1414 Hz. Filter bandwidth can also be stated in terms of *Q*, or Quality Factor. From the ANSI standard for acoustical terminology: "The quantity *Q* is a measure of the sharpness of resonance or frequency selectivity of a resonant vibratory system having a single degree of freedom, either mechanical or electrical." In the following notes appear two statements which will aid in the discussion below. "*Q* is approximately equal to . . . .(3) $2\pi W/\Delta W$, where 'W' is the stored energy and 'ΔW' is the energy dissipation per cycle, and (4) $f_r/\Delta f$, where 'f_r' is the resonance frequency and 'Δf' is the bandwidth between the half-power points."

From the above, we can see that $Q = f_{ctr}/BW_{-3\,dB}$. With a simple arithmetic manipulation, we can see that $Q = 1.4/BW_{octaves}$. A one-octave filter, therefore, has a *Q* of 1.4. Many filters are resonant systems, and the value of *Q* tells us what to expect. Critical damping, where there are no oscillations in the response to a step input, occurs when $Q = 0.5$. If *Q* is greater than 0.5, there will be at least some oscillation. The larger *Q* is, the less damping there is, and the longer it will take for the oscillations to die away.

Note (3) above tells us that high *Q* is associated with low energy dissipation per oscillation cycle, for it is the damping that uses up the resonating energy. It may be difficult for the reader to think that a multi-band equalizer might be a collection of resonators. Indeed it will be, however, regardless of design particulars, if and when filter responses are

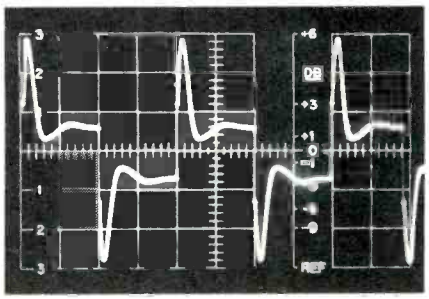


Fig. 4—Equalizer output with a 500-Hz square-wave input and the 2- and 4-kHz filters at +6 dB.

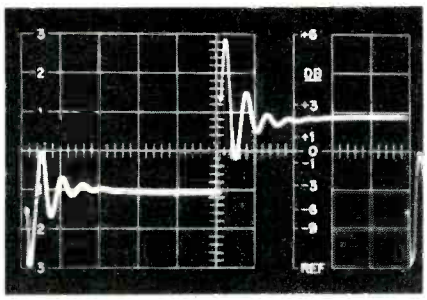


Fig. 5—Equalizer output with a 200-Hz square-wave input with the 4-kHz filter at +10.5 dB.

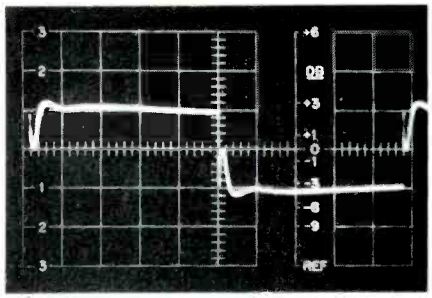


Fig. 6—Equalizer output with a 200-Hz square-wave input with the 4-kHz filter at −10.5 dB.

larger unit. With the multiple input/output options available, interconnections were easily made and changed as desired. This capability is one of the more useful features of the SR107. The equalizer gains were set to match the other equipment in the system. Initial equalization was done using pink noise. Mike gains were increased to the point of feedback, with a compressor used to keep power output at a low level. Some suppression was secured with the Shure unit with a slight increase in available gain. Greater suppression was possible, but only with an unacceptable loss in system response. During the performance, some readjustment was made to filter settings, further improving the sound. There is an appeal to the graphic-type display of many equalizers, and the first reaction to the SR107 knobs and rotary controls was negative. In practical use, however, adjustments are made to get the best sound, not to make the front panel look like a response curve. My own choice goes with Shure's design . . . rotary controls to keep rack height at a minimum.

The instruction book is completely professional in character, consistent with the equalizer itself. Specifications and operating instructions are well detailed. The coverage of applications is thorough, and the service and circuit information is excellent. The Shure SR107 10-octave filter-equalizer delivers excellent performance with professional construction and interfacing capability, all at a good price. The limitations mentioned in the text are generic in nature, not SR107 discrepancies. *Howard A. Roberson*

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peaked causing high *Q*s. These considerations tell us that even octave-band filters ($Q = 1.4$) may resonate, or ring, with step-type inputs. If a filter is boosted to where the bandwidth is 1/3-octave, the *Q* will be over 4, a good condition for sensitivity to ringing. The ringing will be at the filter center frequency, dissipating the energy stored in the filter from the input signal. On the other hand, the boosting used may correct deficiencies elsewhere in the total system with a better overall result.

A series of tests were run on a well-known "octave-band" equalizer to demonstrate the point made above. The first photo shows the output of the equalizer with a 500-Hz square-wave input. Just the top of the waveform is shown to provide more detail on ringing effects. The filter centered at 1800 Hz was boosted to +4, +8, and +12 dB, and the results are shown at the bottom, middle, and top, respectively. The start of ringing is quite apparent with +8-dB boost, and lasts most of the square-wave cycle with +12 dB. There is also an increase in the amplitude of the overshoot at the leading edge with higher boosts. In the next illustration, a 170-Hz square wave was the input signal, and +12-dB boost was set one at a time on the 1800-, 3600-, and 7200-Hz filters. The results are shown from top to bottom, with ringing obvious in all cases. Note that the ringing is shorter in time as the filter frequency is increased, but that it takes the same number of cycles for the oscillation to die away. This is consistent with the earlier discussion on the relationship between *Q* and the energy dissipation per oscillation cycle. As each of the filters has the same *Q*, the dissipation rate (per oscillation cycle) is the same. The third photo shows the entire waveform of a 270-Hz square-wave output with a +12-dB boost on the 1800-Hz section. The oscillation is being damped, but it continues to the end of each step in level. In other words, the ringing is continuous. With the boost reduced to +7 dB, the settling is quite rapid.

There are a number of conclusions to be drawn from the discussion and the test results. First of all, the typical equalizer must be used with considerable caution if boosts greater than a few dB are desired. Do not try to use a multiband equalizer to correct for room response deficiencies, crossover notches, or other holes. Trying to boost "nothing" could generate a ringing with certain input signals. Put the emphasis on reducing unwanted peaks elsewhere in the system. Then, some boost can be used judiciously for the best total system response. Use your ears to aid in getting the best overall filter settings.

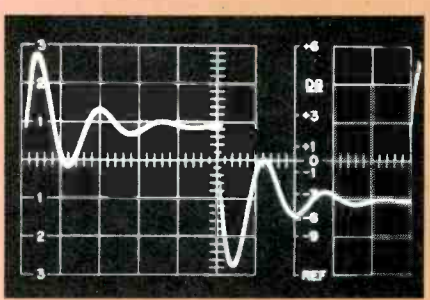


Fig. 3—Equalizer output with 270-Hz square-wave input with the 1800-Hz filter at +12 dB.

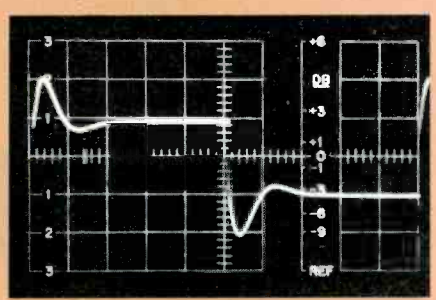


Fig. 4—Equalizer output with 270-Hz square-wave input with the 1800-Hz filter at +7 dB.

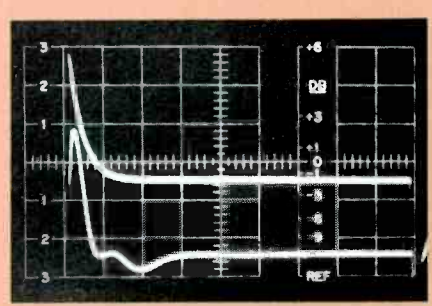


Fig. 5—Preamp output (top) with 1-kHz square-wave input and a +10-dB boost at 10 kHz with the tone control. Equalizer output (bottom) with the 1-kHz square-wave input and filters set to match the preamp frequency response.

Shure M615AS Equalization Analyzer System

MANUFACTURER'S SPECIFICATIONS

Pink Noise Generator Section

Spectrum: For constant percentage bandwidth, flat ±1 dB, 32 Hz to 16 kHz.

Output Level: AUX, 625 mV; Hi-Z mike, 33 mV; Lo-Z mike, 3.3 mV.

Output Impedance: AUX, 1.5 kilohms unbalanced; Hi-Z mike, 2.3 kilohms unbalanced; Lo-Z mike, 110 ohms balanced.

Selectable Rolloff: −3 dB/octave above 1 kHz.

Overload: AUX 56 mV; Hi-Z mike, 0.79 V; Lo-Z mike, 56 mV.

Hi/Lo Envelope: 2 to 12 dB.

AUX Output Voltage Gain: From AUX. input, −4 dB; from Hi-Z mike input, +31 dB; from Lo-Z mike input, +54 dB.

Input Impedance: Aux, 42 kilohms unbalanced; Hi-Z mike, 140 kilohms unbalanced; Lo-Z mike, 950 kilohms balanced.

Output Impedance: 4.7 kilohms unbalanced.

ES615 Analyzer Microphone

Pink Noise Frequency Response: Within 4-dB envelope from 125 Hz to 13 kHz, roll-off below 125 Hz.

Impedance: 50 ohms actual, for inputs from 25 to 200 ohms.

Power Output Level: -60.5 dB re 1 mW with 10 microbars.

General Specifications

Dimensions: 18½ in. (47 cm) W x 5 in. (12.7 cm) H x 15¼ in. (38.7 cm) D.

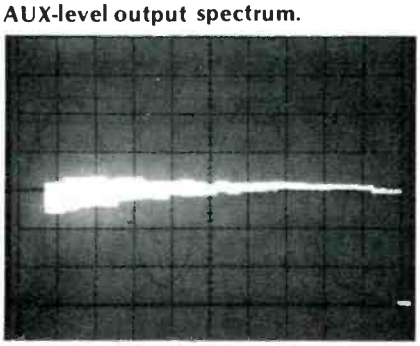
Weight: 9 lbs. (4.1 kg).

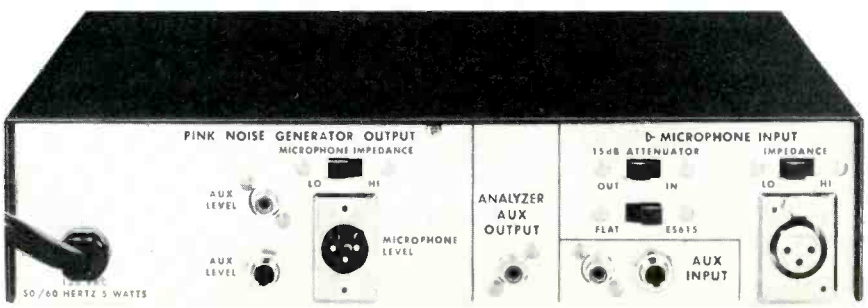
Price: $514.80; M615 Equalization Analyzer only, $421.20, and ES615 microphone only, $127.80.

The Shure M615AS Equalization Analyzer System incorporates an equalization analyzer, an analyzer microphone, and various accessories, all in a convenient carrying case. The equalization analyzer consists of two sections, a pink-noise generator and an octave-band real time analyzer (RTA). Dual concentric knobs on the front panel control the pink-noise output level and the input level to the analyzer. The RTA display consists of *LO* and *HI* LEDs for each of the standard octave bands with center frequencies from 32 Hz to 16 kHz. Any *LO* LED is illuminated whenever the incoming energy is below the detection threshold in that band. . . if the energy increases above that threshold, the *LO* LED turns off. A *HI* LED is turned on when the energy level in its band reaches a second, higher threshold, which can be set anywhere from 2 to 12 dB above the *LO* threshold by the *HI/LO Envelope Control.*

The front-panel facilities also include the power *On/Off* switch and a switch to select either a flat response or one with a 3-dB/octave boost above 1 kHz, which would be equalized as a 3-dB/octave rolloff. The pink-noise generator output connections on the back panel include an XLR-type for microphone levels, with switch selection for high or low impedance. There is also an AUX level output with both phone and phono jacks. There is an XLR-type microphone input to the RTA section, with a switch for high or low impedance. There are also switches to introduce 15 dB of attenuation for high-level conditions, or to select either a flat response or a specially tailored low-frequency boost to compensate for the low-end rolloff of the ES615 microphone. The analyzer also accepts AUX level inputs with both phone and phono jacks. There is an AUX output phono jack for monitoring purposes.

Fig. 1 — Pink noise generator at AUX-level output spectrum.





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The basic physical construction of the M615 generator/analyzer is very similar to other Shure products such as the M67. In like fashion, the M615 can use the rack-mount kit and other such accessories. Disassembly for maintenance requires the removal of a few screws holding on the top/side cover. The interior showed good, straightforward construction. The pink-noise generator was on one PCB, the preamp on another. The octave-band filters of the RTA used five cards, two filters per card. The overload detection circuitry was on a PCB which also served as the mother board for the filters and generator. One PCB contained the majority of the power-supply circuitry. All of the PCBs were of very good quality with excellent soldering and parts clearly identified.

The ES615 omnidirectional dynamic microphone has a rugged steel case, 3/4-inch diameter by 8 inches long. The system case has wells for the analyzer, microphone, and other system items, and wiggly foam in the lid of the case provides cushioning. The case is rugged plastic with a full-width hinge and a carrying handle. . . though some doubt remained about the very long-term reliability of the plastic hinge and latches.

Performance

The AUX output of the pink-noise generator was connected to a separate, 1/3-octave RTA to verify the flatness of the spectrum. The display of the RTA showed that there was equal energy in all of the bands from 40 Hz to 16 kHz. The mike level output spectrum was also flat except for a slight droop at the highest frequencies, being 1.5 dB down at 16 kHz. The spectrum was monitored while the output level control was varied. The response remained flat at all times, an important characteristic. The maximum output levels of the generator were 1.0 V at *AUX*, 48 mV at mike for *High-Z* and 3.6 mV for *Low-Z*. All of these figures exceeded those specified. Shure defines the sensitivity of the analyzer RTA as the input voltage needed to turn the *LO* LEDs off with the input level control at max CW. The first checks were made with the 15-dB attenuator in for the mike inputs. Just 0.89 mV was needed at *AUX*, and only 0.079 mV for *High-Z* mike. When switched to *Low-Z* mike, only 6.3 microvolts was needed to reach the lower threshold. All of these results were at least one dB better than the specs. With the attenuator out, it appeared that the specifications were bettered again, though there were erratic readings because of the few microvolts level required.

The generator output was patched to the analyzer input to check the matching of threshold levels from one octave to another. The *LO* LEDs turned off with a total spread of about 2 dB. With the ES615 in an equalized pink-noise sound field, turn-offs occurred at 60 dB SPL. This was only 2 dB from the specified 62 dB SPL, well within the possible spread of the various tolerances. The pink-noise output was then looped through a precision attenuator to the analyzer input. The level was then increased for three settings of the *HI/LO* envelope control. At "2 dB" the upper threshold was 1.6 dB above the *LO* off level. At "6 dB" the upper threshold was at 6.3 dB actual, and at "12 dB" it was at 11.8 dB. The deviations from the dial markings were thus very minor and well within the tolerances specified by Shure. The thresholds were also very consistent from band to band, excellent performance.

With a pink-noise source, the input level was increased until the overload lights started to flicker. For 50 per cent *On* time, the input O.L. required 50 mV at the *AUX* input. With the 15-dB attenuator in, the mike O.L. required 500 mV for *High-Z* and 63 mV for *Low-Z*. It might be noted that the level was very high, equivalent to 138 dB SPL on the ES615 mike. A check of the dynamic response of the O.L. indicators determined that there was faint flickering with single-cycle 1-kHz bursts with a CW level 3 dB above the pink-noise threshold. The analyzer was set for an equalized rolloff above 1 kHz, and the band thresholds rechecked. All thresholds out to 16 kHz were within 1.3 dB of the desired 3-dB-per-octave boost. All of the filter center frequencies were within 4.9 per cent of the standard ISO frequencies, and all of the filter crossovers were at the desired power points (3 dB down). A CW tone at the center of one band was detected as being just over 7 dB lower in the adjacent bands. This was judged to be quite adequate for most equalization purposes, but marginal in cases where actual discrete tones would exist, such as in the case of feedback. Step changes were made in the incoming level of the pink noise for rough checks on the filter response times. The lowest-frequency filters took approximately three seconds to charge and almost 10 seconds to discharge. The highest-frequency filters took less than one second to charge and less than two seconds to discharge. Other observations reinforced the conclusions from these tests that the times were well chosen, providing good stability in the display without excessive sluggishness.

In Use Tests

The M615AS system was used as an aid to equalizing a high-fidelity system. To obtain more detail on the various responses, the analyzer *AUX* output was connected to a 1/3-octave RTA. The pink-noise generator output was fed to one channel at a time, and the ES615 microphone was placed close enough to the loudspeaker to be in the direct, non-reverberant field. The 1/3-octave display showed that the response dropped off below 60 Hz, peaked at 80 Hz, dipped at 2 kHz, peaked at 6 kHz, and dropped rapidly above 8 kHz, mostly from the preamp noise filter. The 1/3-octave display was then ignored, and the M615 RTA on *Flat* was used in conjunction with a Shure SR107 octave-band equalizer. The *HI/LO* control was set to 12 dB, and the input level raised to turn off all of the *LO* LEDs except for those at 32 Hz and 8 and 16 kHz. The envelope spread was reduced until a few of

Fig. 2 — Pink noise generator at the Mike-level output spectrum.

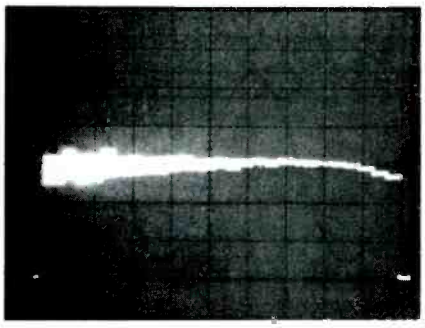


Fig. 3 — Home audio system response before equalization.

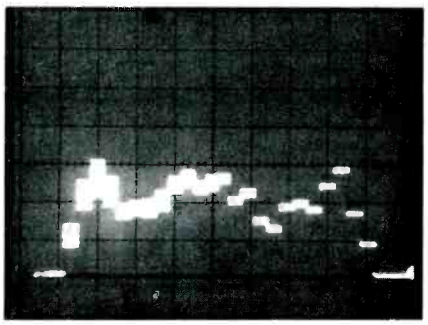
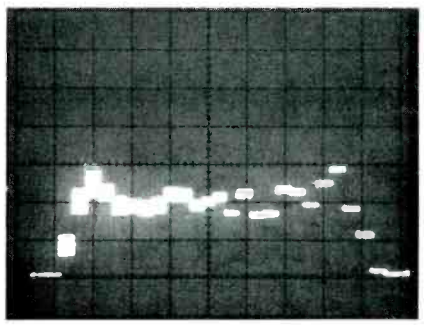
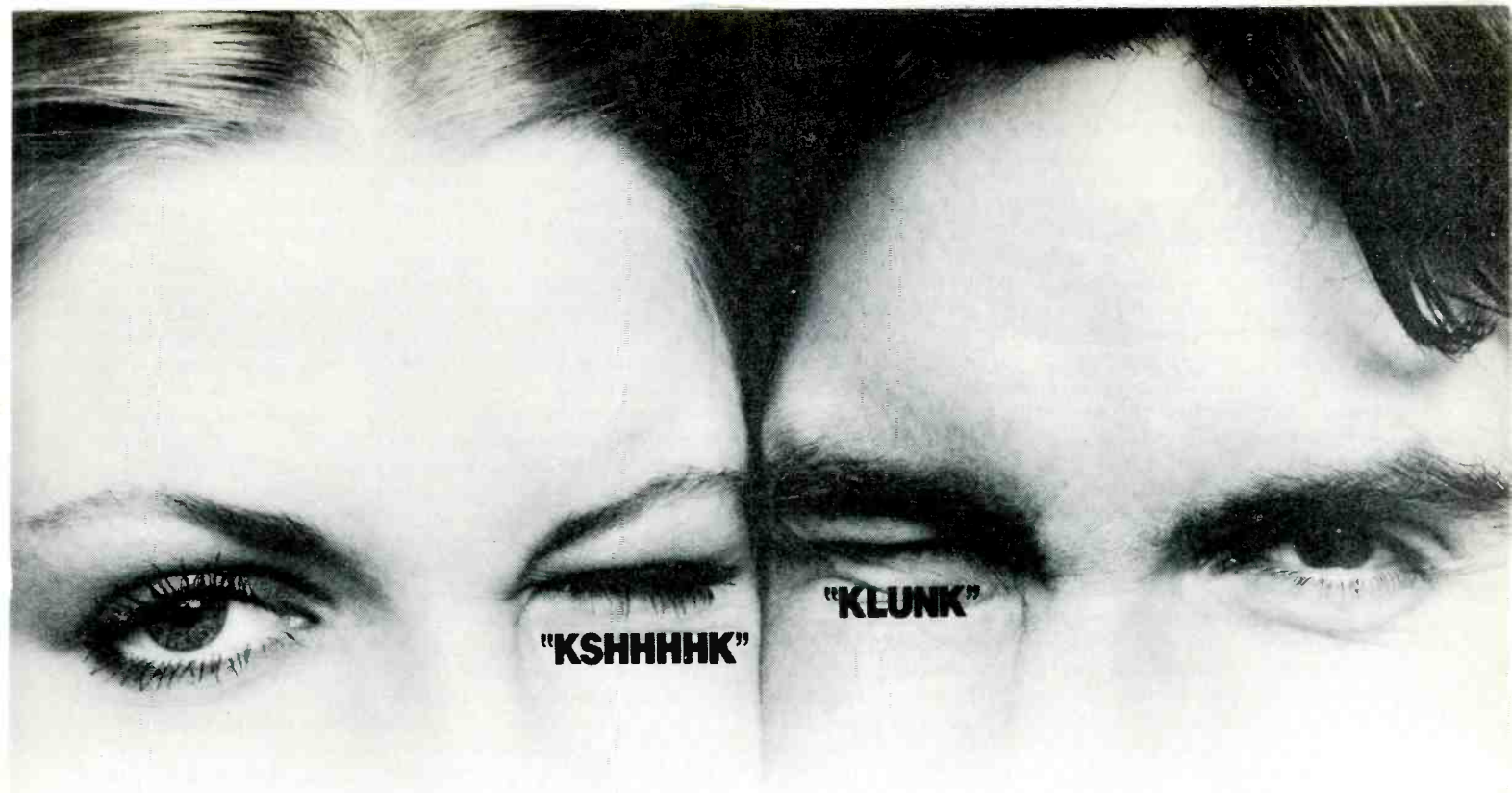


Fig. 4 — Home audio system response after equalization.





BASF'S New Professional II Cassette is so sensitive it recorded the difference between a man and a woman's wink.

New coating formulation

For a cassette to capture all the highs, all the presence, all the qualities of live music, it must be sensitive. BASF has just developed a new coating formulation that gives unheard-of sensitivity. To prove it we put a man and a woman in an anechoic chamber and with the use of excellent sound equipment actually recorded their winking on Professional II. (The sounds are like those made by a camera shutter, with the man's wink being decidedly louder and more abrupt.)

More sensitivity for more music

It's a startling demonstration of the sensitivity of our new second generation chrome formulation. Its brand new patented coating process gives it more headroom, greater dynamic range, and a better signal-to noise ratio. It gives it unheard-of sensitivity. And that's why it gives you music the way you've never heard it before on cassette.

And since Professional II is a pure chromium dioxide tape, and not a "chrome substitute," you not only get better sound performance, test results prove you get substantially less headwear.

Sounds of other worlds

Visit your BASF dealer soon and ask him about the new Professional Series, including Professional I, our new ferric formulation, Professional III, our new ferrochrome formulation that's being used in so many auto cassette players, and the Professional II demonstration cassette with the sounds of winking, an ant in distress, a butterfly in flight, and other never-before-recorded sounds. Or you can send $3.50 to BASF OTHER WORLDS, Box 18367, Boston, Mass. 02118, and we will send you a $4.99 Professional II C-90 cassette with these sounds. This offer will be available while supplies last. Please allow four weeks for delivery.

BASF

BASF

Sensitive Sound. From The People Who Invented Magnetic Tape.

Enter No. 55 on Reader Service Card

the *HI* LEDs came on, and the SR107 filters were cut to just extinguish them. The process was continued until the envelope was at a minimum, and all LEDs were off with the exception of the *LO* ones at 32 Hz and 16 kHz. Actually, the adjustments were made very rapidly with no confusion. Then, the 1/3-octave display was examined for the results. The spread of levels in the one-third octave bands had been reduced significantly, and it could be seen that the energy levels octave-by-octave were within 1.5 dB of the average level with the exception of the 32 Hz and 16 kHz bands. A listening test with the equalizers (one per channel) switched in and out provided an immediate demonstration of the advantages of a smooth response in the important middle-frequency range.

The M615 and SR107 combination were also used for sound reinforcement equalization at a performance in a school auditorium. In this case, the roll-off above 1 kHz was used. Prior to the arrival of the audience, the sound system pink-noise response was checked with the ES615 microphone at different positions among the seats. The system was quickly equalized for the best compromise for all areas. The sound system compressor was set for limiting and a low threshold. Mike gains were increased to generate feedback, limited in power by the compressor action. Mild suppression was obtained with the equalizer, purposely kept from cutting too much into the system response. The display of the M615 RTA was difficult to use for this task, and the frequency of feedback was determined much faster simply by listening. Less limiting on the feedback would probably have made for a better indication on the RTA. (*Editor's Note*: Shure Brothers has informed us of an extremely sensitive method of using the M615 in sound reinforcement equalization for improving gain before feedback. The ES615 microphone is placed in a representative listener's location and, with the reinforcement mocrophone turned off, the system is equalized to a 2-dB envelope using the roll-off above 1 kHz. With the pink noise still exciting the system, a reinforcement mike's channel gain is slowly turned up to the point at which slight regeneration is shown by a *Hi* LED turning on. This will indicate which particular equalizer control setting should be reduced until the LED goes out and this process is then repeated several times. It is not necessary to actually cause sustained feedback to use this method, since the pink noise supplies the excitation. E.P.)

Shure provides excellent guides to the use of the equipment with complete specifications, descriptions, and detailed instructions. The servicing information is excellent with board layouts, schematics, and parts lists. There is a thorough discussion of operation with sound-reinforcement, stage-monitor, and home-entertainment systems, though Shure makes an error in using the term "near field" for close-to-speaker microphone positions. It is true that the reverberant field is associated with the radiator's far field. Closer to the speaker where there is lower contribution from reflections, there is a *direct* sound field. Typically, however, it is still the far field of the radiator. The *near* field exists only *very* close to the radiator. The user must not place the microphone in such a location as it is too close to measure the amplitude vs. frequency contributions made by all of the radiating surfaces.

The M615 equalization analyzer and the ES615 microphone are each available separately for applications not requiring the total system. For octave-band equalization tasks, the Shure M615AS equalization analyzer system offers an excellent combination of performance, flexibility, convenience, and an affordable price. *Howard A. Roberson*

Enter No. 92 on Reader Service Card

VTR-ing

Michael Bucci

MIKE McNELLY

The ads certainly make it easy to understand, "Record one program while you watch another." On phrases such as this the video recording industry is pinning its fortunes on a decade old idea, home video.

In this year the home video tape recorder (VTR) manufacturers are projecting industry sale levels of 500,000 units, averaging $1000.00 each at list. RCA alone spent $4 million in a fourth quarter, 1977, advertising blitz. By 1980 optimistic estimates project sales at over one million units, representing $700,000 to $1 billion in retail revenue. Optimism spreads. So far 20 companies have announced that they will market home recorders of one format or another.

But behind the mixture and multitude of brands currently in the showrooms, department chains, television-appliance stores, and audio salons loom the two Japanese giants, Matsushita and Sony. For it is from them that almost all recorders spring and to them that all significant revenue will go. While beneath every RCA Selectavision is a Matsushita, within every Zenith is a Sony. So, too, like all disputing couples, a marriage of marketing is not without its instinctual feuds of competition. And thus, the offspring are of different format—and incompatible.

Beneath the current industry projections and feeling that "while it took 10 years for color TV to reach the $1 million level, it should take the VTR only two years," is an easy omission of true product history, a lack of concern for present marketing problems, and a disregard for cautious forecasting. The mood in the industry is ebullient—almost delusively so!

If one were to fix a date on the first home video tape recorder, or prototype of it, which could record off-air, use economical ½-in. tape, was light, compact, and sold for under $1500.00, one could go back 10 years to the Sony CV-2000. Though the unit recorded in black & white, it did include a camera and TV/monitor, which VTRs of today sell optionally. The first color "cassette" recorder was introduced in 1972. These early generations in refinement and minaturization of the heavyweight broadcast VTR captured essentially an industrial, educational, and homespun "video collective" market. But their affordability was not anymore out of line than that of VTRs today. The end-market, despite these 10 years of consumer resistance and confusion, was always the living room, preferably, in every "TV-home." It is the eye and pulse of marketing to know when great events can and cannot take place, and short of a textbook examination, suffice it to say, the time of the home video recorder is indeed upon us.

In one sense, industry-wide commitment to home video had always been aborted by insecure feelings regarding its marketability. The feeling "it would never work in the home," as Bill Paley put it, eventually killed the Columbia EVR project in 1972. In the early 70s when super 8mm was reaching its prime, introduction of yet another recording medium to the consumer, at 10 times the cost, must surely have seemed a losing proposition. The industry, however, would promise to deliver a playback video medium and vie for shelf space. High-pitched promotions and press reports circulated to the public announcing the era of a videodisc. The pitch has been heard echoing for eight years but the era has yet to arrive. The videodisc, alas, needed available software to midwife its success in the marketplace. Negotiations with Hollywood are seldom satisfactory, and though the disc player expected to retail for 50 per cent of the cost of a current VTR and software, such as full-length movies, were to cost $15.00 versus $50.00 or more for the same on tape today, the disc's future may yet be determined by the success or failure of the VTR.

Broadcasting is seriously concerned about these and a host of other developments. While Nielson, one of the large two network rating services, currently "clocks" the clocks of Selectavisions and Betamaxes in sample homes and logs the diary entry of the recorded program's replay time, noted ratings spokesman Hugh Beville of the Broadcast Rating Council feels the threat posed by the emerging VTR as a lessor evil that might well have a negative impact on the growth of greater evils, presumably cable and pay-TV. He foresees the networks adjusting their programming schedules to capitalize on the VTR machine's capability to record, off-air, a program pre-set and unattended, such as between the hours of 1 to 6 a.m. The program day could thereby expand and shows recorded be replayed at more convenient hours.

The home video hobby is an expensive one and as Paul Wilson of Videomart, a video retailer in New York City puts it, "Anyone spending over $500.00 looks into it." But so far there are only showrooms to look into. The medium is new. There exists no consumer or test reports, no product profiles of real substance or seasoned repair records, not even a publication that serves the home video consumer yet. "The biggest seller is still Sony because of advertising," says Wilson, "but we have had a big surge on JVC and RCA."

Short of a "hands-on" test of the numerous home machines available (which another column will deal with), information for this report was gathered verbally, mostly by phone to manufacturers' representatives, VPs, ad and PR departments, consumer divisions, and down the chain of command to sales reps. It was the author's experience in four days of phone calls to almost expect incomplete and, frequently, contradictory information. When data was easily secured and found reliable, it was of a promotional rather than technical nature. In half of the companies interviewed, telephone operators and often executives were

unaware of or could not find their respective VTR spokesman. In two very important areas of inquiry, compatibility and warranty terms, information was "*unavailable*." Without the assurance of total confirmation, assume that most VTRs enjoy a limited warranty of 90 days parts and labor, one year parts. Compatibility data (untested) can be found near the bottom of the chart.

General Operation

All VTR devices listed are equipped to interface with any model television receiver, color or black & white. Since the recorders already contain built-in UHF/VHF tuners, the home screen serves as a playback monitor and plays no part in the recording process.

The home antenna or coaxial must be disconnected from the television receiver and reconnected to the recorder, and the recorder's video output connects, in turn, to the TV's antenna inputs. VHF in/out terminals on the recorder are 75 ohm; UHF in/out is 300 ohm.

The "TV/VTR" switch in the front of the recorder controls the choice of signal entering the TV. The "TV" mode couples the television to the antenna bypassing the recorder. The "VTR" mode closes the TV to the antenna signal and opens the video-out signal from the recorder. The recorder's video r.f. output is a modulated channel 3 or 4, switchable to suit the requirements of other area stations. To record a program, the VTR's tuners are used. The program to be viewed on the TV does not effect the recorder's channel selected for recording. In playback, the recorder's selector mode switch is placed on "VTR" permitting viewing of the tape on channel 3 or 4.

Most VHS and BETA licensed machines feature digital clock/timers, permitting unattended recordings, counters, automatic shut-off, audio dubbing, audio input, tracking control, memory-rewind, AFT, and pause.

With the exception of the Quasar Alpha Scan model, all home video machines utilize the "rotary, two-head, helical scan" method of recording.

Unlike in audio recording, where a limited frequency range of 20 Hz to 20 kHz is handled, the video spectrum is considerably wider. Frequencies up to 4 MHz must be handled. The gap of a typical stationary audio head could read these high frequencies, but tape speed would have to approach 1,000 ips. At 7½ ips, tape head gap width would have to be 0.00125 mil. to handle, say, 3 MHz. An acceptable compromise between these two extremes was the development of a moving head. Broadcast VTRs utilize a four-head configuration, moving horizontally to the tape path. Industrial and home recorders use a two-head, vertically rotating configuration. Tape wraps around a drum containing these rotating heads which are spaced 180 degrees apart, spinning at 30 rps. One complete rotation results in one full frame of video information recorded on the tape. Also recorded is an audio track by way of a separate audio head and usually a control track which contains pulses generated at the time of recording and read back during playback. A "servo" circuit reads these recorded pulses and in turn properly positions the heads to the recorded video tracks achieving accurate playback synchronization. Azimuth head scanning is employed to minimize crosstalk.

Formats

The chart focuses on the three most popular and important home video recorders in the market today. The JVC, RCA, and Sony models are generic to practically all other models available.

The JVC and RCA are VHS format machines, Sony represents the Beta format. The VHS (Video Home System) was developed and patented by JVC (a Matsushita subsidiary); the Beta was invented and patented by Sony. Sony and Matsushita have issued licenses for the manufacture or distribution of their respective systems to all brands bearing either of those trademarks. Presently, most VHS and Beta machines are actually manufactured by their patent holders.

Sony in February of 1976 threw the first punch, bringing its single-speed (max. time: 1 hr.) Betamax into the American market; Sony had marketed Betamax in Japan since 1975. In December, 1976, Matsushita exported its Great Time Machine, capable of two hours, selling for $995.00, which was $300.00 less than the Sony. This initial Matsushita entry, through its Quasar division, did not conform to the Beta format, as Sony would have liked, and it was later outpaced by a family contender, the JVC Vidstar, also two hour, establishing a third format, VHS, which was to become the official Matsushita system. RCA in America, sensing the Eastern winds, asked Matsushita to build them a competitive machine capable of four hours play. By this time American Zenith had thrown its weight behind the two-hour Sony format, and RCA, not wanting to merely market an existing machine as Zenith was with Betamax, sought to of-

fer an added feature recorder. Matsushita took its existing two-hour unit, the Vidstar, and added half-speed, doubling maximum play time, and this was compatible, in the fast speed, with its two-hour JVC recorder awaiting American entry.

In the ring, then, were Sony-Zenith versus Matsushita-RCA. The East-West balance of power looked evenly divided. Throughout 1977 occured a rash of enlistments into the opposing armies. At last count Matsushita (JVC, Panasonic, Quasar) appears to have the strength in numbers. The VHS format, while already embraced by its own family of companies, has recruited nine other licensees, while Sony will manage with eight and no family.

VHS vs. BETA — The Big Three

MODEL	JVC VIDSTAR	RCA SELECTAVISION	SONY BETAMAX
	HR 3300U	VBT-200	SL-8200
Format	VHS Single Speed	VHS Double Speed	BETA Double Speed
MAX. TAPE TIME w/available tape	2 hrs.	4 hrs.	2 hrs. 3 hrs.
MAX. TAPE TIME w/long-play tape	3 hrs.	6 hrs.	6 hrs. w/changer
MANUFACTURER	Matsushita	Matsushita	Sony
PRICE	$1050	$995	$1095
TAPE SPEED	1.3 ips	1.3 ips & 0.65 ips	1.57 ips & 0.79 ips
VIDEO NOISE REDUCTION?	Yes	No	Yes
VIDEO S/N	43 dB	40 dB	40 dB
HORIZONTAL RESOLUTION	240 lines: color	230 lines: color 270 lines: B&W	240 lines: color 280 lines: B&W
CASSETTE SIZE	7⅞W; 4¼ H; 1D	(same as JVC)	6⅛W; 3¾ H; 1D
TIMER/CLOCK	Built-in LED	Built-in LED	*Attached clock
RECORDER SIZE	17⅞W; 5 13/16H; 13 5/16D	19 1/16W; 6 13/16H; 15½D	20⅜W; 8 1/16H; 16⅛D
WEIGHT	29.7 lbs.	38.3 lbs.	45 lbs.
POWER CONSUMPTION	26 watts	45 watts	80 watts
FEATURES IN COMMON	Built-in UHF/VHF tuners; conforms to EIA/NTSC color standards; rotary two-head helical-scan recording; Built-in r.f. modulators (ch.3 & 4); AFT; tracking control; video in/out; audio in/out; pause. *optional.		

COMPANIES LICENSED
(by format)

	Model	Manufacturer	Price
VHS Single Speed			
Panasonic (industrial)	NV-8300 (Omnivision II)	Matsushita	
MGA			$1250
Akai			
Sharp			
VHS Double Speed			
Panasonic	Omnivision IV	Matsushita	$1095
GTE Sylvania	VC 2400	Matsushita	995
Magnavox	VH 8200	Matsushita	1075
Quasar	HS 5000	Matsushita	995
Hitachi		Hitachi	
Montgomery Ward		Matsushita	995
JC Penny		Matsushita	
BETA Single Speed			*timer optional
Sony (industrial)	SLO-260	Sony	$1445*
NEC (industrial)		NEC	912*
BETA Double Speed	Model	Mfg.	Price
Zenith	JR9000W	Sony	$ 995
Toshiba	Betaformat	Toshiba	1095
Sears	Betacord	Sanyo	995
Aiwa		Sony	
Pioneer			
Quasar			
Sanyo	Betacord	Sanyo	995

COMPATIBILITY FACTOR (reported/untested)

VHS single speed — compatible w/ all other VHS sgl.sp. and w/ VHS dbl sp. in fast sp. mode.
VHS double speed — compatible w/VHS dbl sp. machines in fast speed mode.
BETA single sp. — compatible w/Sony sgl sp. and BETA dbl sp. in fast speed mode.
BETA DOUBLE sp. — compatible w/BETA dbl sp. machines in fast speed mode.
V-Cord II — compatible w/V-Cord II only.
ALPHA SCAN — compatible w/ALPHA SCAN only.

OTHER FORMATS	COMPANY	MODEL	SPEED	MFG.	VIDEO S/N	HOR. RESOL.	PRICE
V-Cord II	Sanyo	VTC-8200	2.91 ips/ 1.45 ips	Sanyo	45/ 44 dB	B&W-300 Col-250	$1214

(Rotary two-head helical scan; EIA/NTSC standard; two speed MAX TIME: 2 hrs.; 39 Watts; 37½ lbs; Audio dub; Memory/Counter; UHF/VHF tuners built-in; AFT; Pause, r.f. out-ch. 3 or 4; digital clock timer-optional; 19¾W x 6½H x 10¼D. Tape: 2 hrs. $20.)

Alpha-Scan	Quasar	VX-2000	2.05 (single speed)	Matsushita	42 dB	240/ 220 lines	$795

(Rotary single-head helical scan; EIA/NTSC standard; Max time: 2hrs.; r.f. out-ch. 3 or 4; Pause; 98 Watts; 44 lbs.; 22½W x 8½H x 16⅛D.)

The Beta versus VHS race is, pointedly, the race for ever-extended play time and number of affiliates. Both armies plan to introduce extended long-play tape and Sony promises an automatic cassette changer for $100.00 which would effectively pit the opposing formats into the next higher phase of temporal combat, six hours.

How They Compare

The chart includes two segments dealing with maximum play time, present and future. Like television itself, the VTR industry relies on quantitative time and contracted affiliates to pivot its market success. That is also why Sony has invested $50M in two tape manufacturing plants in Alabama. Sony already sells an average of 10 blank tapes for each Betamax.

Since it was impossible to secure data from all 20 VTR representatives, brand names were grouped into significant format categories: VHS/single-speed, VHS/double-speed, and the Beta/double speed. (Sony's initial single-speed Betamax has become a far distant runner in this race, as well as Quasar's Time Machine, these family first-borns are virtual drop outs.) Brand names grouped under the three competing divisions are assumed to resemble their respective parentage in specifications, though being cosmetically different.

Two additional formats are also available, Sanyo's V-Cord II and Quasar's Alpha Scan Time Machine (if still available). They are compatible with only their own model. The industry expected Sanyo to delete the V-Cord II in light of the two dominant power alliances, but Sanyo held strong to a machine which crosses into the industrial as well as consumer camps. Sanyo is introducing, however, a Beta-format recorder which it plans to manufacture for itself and Sears. Quasar's Alpha Scan Time Machine may sadly be seeing its last serials. Continual price reductions move it closer and closer to the bargain basement. Quasar, a subsidiary of Matsushita, is rumored to begin marketing another recorder, ironically a Beta-format machine, which I suspect will be called Double Agent!

In the area of compatibility, a singularly important issue, the industry, as a whole, is tight-lipped. The chart includes a compatibility guide but such information is based on hearsay. Readers best make empirical tests for themselves at large full-line dealerships by patiently pacing a tape through all machines at all speeds which bear a similar format.

Michael Tearson

Jon Tiven

The column

Pure Pop For Now People: Nick Lowe
Columbia JC 35329, stereo, $7.98.

Could Nick Lowe be this year's model of the Roy Wood? So it seems, with a self-produced album encompassing as many musical idioms as the latest by Bowie, The Bay City Rollers, Paul McC, Springsteen, Bob Marley, and Dave Edmunds put together. He is the accomplished and deft thief, plagiarizing from as many sources as he can get his ears on, but fortunately for us listeners he can put together the verse from the Jackson Five's *I Want You Back* with a chorus from **Ram** and a lyric from left field in such a way that it is pleasing to the ear. As a matter of fact, **Née Jesus of Cool** has been a staple for my stylus over the past month and will probably wear well with time, unlike Nick's work as leader of the Brinsleys.

At the time, I thought Brinsley Schwarz was allright but in retrospect the best thing to come out of that whole band was a tight unit to back the infinitely more stylistically unique Graham Parker (oft-produced by Mr. Lowe). Lowe has spent much time producing and hanging with Brit-rockabilly artist Dave Edmunds (in fact, the word is that the two of them have a band together which is touring the States), and the influence is evident on the both of them. Nick has made a record which sounds like a collection of singles, but unfortunately there aren't any *real* hits here—either they're too disjoined for AM radio, too obscene for FM, or a bit outdated in terms of the American top-40 sound. However, you can hear many of the hits of the past here, and it could be fuel for a *My Sweet Lord* style publishing litigation or two: *Chapel of Love* via *Rollershow, Reeling Through the Years* via *So It Goes, Sound & Vision* via *I Love the Sound of Breaking Glass,* ad infinitum. I trust in jurisprudence not to take the record any more seriously than Nick did and dismiss any such cases with a spin of *They Called It Rock.* *J.T.*

Sound: A Performance: A

London Town: Wings
Capitol SW-11777, stereo, $7.98.

Paul McCartney is more than just another brilliant melodist—he is the living proof that the artist does not have to endure continuous pain, loneliness, and strife in order to create greatness. With very few exceptions to the rule, he has created a legacy of being able to touch anything and instill it with a special excitement and musical magic that is undeniable and absolutely unmistakeable McCartney. The man has music literally pouring out of his fingers, and once a year he gets to let some of it out in the recording studio, bottle it up inside a twelve-by-twelve cover, and ship it out to an unsuspecting world. Lucky us.

Some quibble with his lyrics, usually the same people who resent the fact that they're singing one of his songs in their heads at least once a week even though they swear they don't like the guy. I have no argument with his lyrics—they may not always reveal the secret of the Universe in so many words, but they always carry a certain

jazz & blues

Ella and Oscar: Ella Fitzgerald & Oscar Peterson
Pablo 2310-759, stereo, $7.98.
Fitzgerald & Pass . . . Again: Ella Fitzgerald
Pablo 2310-772, stereo, $7.98.

Ella Fitzgerald is an important artist who has succeeded in making the best of two worlds, the world of popular songs and the world of jazz. At the very peak of her career, when her powers were unimpaired, Ella excelled in both. In vocal beauty, musical craftsmanship, and tonal artistry, there was simply no one in her class. Today, the musical craftsmanship is as it always was, but the vocal beauty and tonal artistry are noticeably diminished. The wearing down of Ella's vocal timbres have been painfully noticeable on her recent recordings, and the wear and tear is unfortunately evident on the **Ella and Oscar** album. Yet Ella can still make the right moves; while the vocal strain is clearly audible on numbers like *Mean To Me, How Long Has This Been Going On, When Your Lover has Gone, More Than You Know,* and *April in Paris,* the formidable technique remains as she moves through each song with the assurance of an authoritative jazzman, skillfully weaving in and out of the melodic line. Oscar Peterson's accompanyment is much more than tasteful, it is consistently brilliant. Peterson's solos on *How Long Has This Been Going On* and *There's a Lull in My Life* are worth the price of the album. Indeed, it is Peterson's contributions that make **Ella and Oscar** compare favorably with **Ella Sings Gershwin,** her fine collaboration with pianist Ellis Larkins made for Decca two decades ago.

On **Fitzgerald & Pass . . . Again,** a second pairing with jazz guitarist Joe Pass, Ella is almost like her old self, working each of these splendid songs with an intimate warmth and simplicity. The results are entrancing—Ella wisely stays in the middle register for most of this set, concentrating on the area of her greatest strength, where the natural color and timbre of her voice can still be a thing of beauty. The tunes are wonderful—splendid oldies like Isham Jones' *The One I Love Belongs To Somebody Else* and the almost forgotten *That Old Feeling.*

With superb phrasing, utter relaxation and sensitivity, plus beautiful support from Pass, the First Lady of Song floats her way through these excellent melodies. She gently rocks *I've Got The World on a String,* smoothly and vivaciously swings *You Took Advantage of Me,* and in a neat change of pace, hums her way through the refrain of *Rain,* another fine but obscure standard. She is even delightful on *Nature Boy,* a hit for Nat Cole in the late 40s which I have always detested. But I loved **Fitzgerald and Pass . . . Again.** You will too; this is a fine durable album for your collection, and it is beautifully recorded. *John Lissner*

Ella and Oscar	
Sound: A	Performance: B+
Fitzgerald & Pass	
Sound: A	Performance: A

Chico: Chico Freeman
India Navigation IN 1031, stereo, $6.98.

Chico Freeman is a jazz musician who doesn't set boundaries for himself but brings an integrity and a mature self-concept to everything he plays. His experience ranges from the present mainstream approach of Elvin Jones' group to the hard-edged fusion of Streetdancer to the *avant-garde* tradition of the Association for the Advancement of Creative Musicians. It's the experience with the AACM that informs in his solo debut, **Chico.**

Side one is a pair of sensitive duet improvisations with bassist Cecil McBee. The mood is explorative as each musician probes and pushes the other through the changes. Chico plays tenor on *Moments,* moving sensuously through McBee's pulsing lines. McBee moves to a dark arco bass on *And All the World Moved* . . . with Chico playing a contemplative flute that follows McBee's scrapings. He then switches to bass clarinet, bringing his solemn lines even more in tune to McBees' mournfulness.

Side two is one of those stunning AACM performances full of shifting colors, patterns, and density areas. Chico and McBee are joined by Muhal Richard Abrams on piano, Steve McCall on drums, and Tito Sampa on percussion. It begins with a hard-bop line played by Chico on tenor and then evolves into a series of interwoven solos that arise out of the ensemble. First it's Abrams modulating lyricism with staccato clusters, then McBee comes out of the next ensemble passage with another throbbing run. Finally it's Chico who moves from free-bop into a scathing high intensity run. Throughout McCall maintains a steady pulse of fluctuating shadings.

Chico is an exciting individual statement by Freeman which affords him room to stretch out and play in a sympathetic ensemble. On the live quintet side, things are a little muddy. This is typical of producer Bob Cummins casual, spontaneous approach to recording. None of the excitement of the performance is lost but some of the presence is missing. Tito Sampa's percussion is unnecessary the few times it surfaces in the mix. But the duet side captures Chico's clear tone and articulation on all three instruments in the studio. *John Diliberto*

Sound: C+ Performance: A

Marathon '75, Vol. 6: Andrew White
Andrew's Music AM-20, stereo, $6.00.

This album is part of a nine-record series devoted to saxophonist Andrew White's fabled 12-hour Marathon Concert of November 16, 1975. Naturally, he didn't play non-stop, but apportioned the 12 hours into 11 exhausting sets of approximately 45-50 minutes each. Vol. 6 is the only one of the nine I've heard, but if the rest of the records come anywhere near the brilliance of this one, it must have been *the* all-time monster concert!

White has a special talent for super-swift, yet totally controlled runs, in which every note is cleanly hit and perfectly placed, even though he spills them out at an incredible velocity. Rather than being merely self-indulgent displays of flashy trash, his high-acceleration lines are consistently imaginative, coalescing into an even flow, with subtle accentuations, novel rhythmic twists, and a highly inventive choice of notes. *Dock at Papaeta* (by Les Baxter who, along with John Coltrane and Wayne Shorter, is one of White's favorite sources) and *Black Diamond* include numerous illustrations of White's supremely developed brain-to-hand coordination and his in-

stantaneous inspiration, at the service of pure, naked emotion.

On *Superfly, Tippin'*, White feels his way through a chorus of descending tenor moans before jumping full-force into a creatively constructed series of facile runs and anguished cries, building to a harrowing intensity. Even more unsettling is his stunning, almost entirely unaccompanied *Giant Steps* (which only hints at the familiar Coltrane theme at the very end), built entirely of furious flurries, notes tumbling and fluttering out of his alto at such a dizzying pace they even sound wispily rapid when slowed down to 16 rpm!

Accompanying White are bassist Steve Novosel—who lasted the entire 12-hour Marathon—and two of the Blackbyrds, pianist Kevin Toney and drummer Keith Killgo. If you're expecting bumping funk from the latter two, take note that this is straightforward post-bop jazz, and very intense jazz at that. All three perform with the same forceful determination, originality, and unbridled energy as their leader.

The album closes with a lighthearted, tension-dissipating glimpse of White's signature *Theme*. This aside, **Marathon '75, Vol. 6** is an emotionally draining, yet totally satisfying introduction to the innovative genius of Andrew White.

Toney's dense acoustic piano textures are somewhat muddled, Killgo's crashing cymbals tend to obscure his skins, while Novosel (an excellent musician, judging by his past work with White) is often lost in the shuffle. On the other hand, White's tenor and alto have been captured very closely, with a precise sound that allows his most vertiginous visions to be perfectly distinguishable.

Available from Andrew's Music, 4830 South Dakota Ave., N.E., Washington, D.C. 20017. *Tom Bingham*

Sound: C— Performance: A+

Second Wind: Delbert McClinton
Capricorn CPN-0201, stereo, $7.98.

Delbert McClinton has been a star for years. Back in 1962 he played harmonica on Bruce Channel's hit *Hey Baby*, his playing inspired the Beatles to record *Love Me Do* using rock 'n' roll harmonica. In the early seventies, he recorded two albums for Clean records with his friend Glen Clark which were wildly received by the music press as brilliant innovations in country-rock. Unfortunately Clean Records didn't have much of a promotional staff, and Delbert and Glen were lost in the shuffle.

In the last three years he has recorded three albums for ABC. He has also worked as a single artist and with a large number of groups contributing his distinctive blues-based musical outlook. Recently he signed with Capricorn, and it's a perfect mating. The time is right for Delbert McClinton and the world to realize his stardom for he has recorded what he terms "the best record I've ever made." After one listen you'll agree.

Second Wind is the culmination of years of honing a style that is both sweet and nasty, lowdown and honey smooth. Stylistically it runs from blues through R&B to rock 'n' roll, all molded with a Deep South sensibility.

McClinton's songwriting talents are legend. His tunes have been recorded by, among others, Waylon Jennings, Dr. Hook, and Emmylou Harris (her latest single, *Two More Bottles Of Wine*, is by Delbert). Two tunes from this album, *B Movie* and *It Ain't What You Eat It's The Way How You Chew It*, were also on a Delbert and Glen album, but this newer performance is far superior; reflecting an impressive maturing.

It's difficult to listen to **Second Wind** and not have an emotional reaction. It's hard to sit still through most of it. *Maybe Baby* is sung with the religious fervor of a gospel chorus and makes you want to clap hands and shout halleluja. *Take It Easy* cuts with a knife dipped in pain. It's the kind of love-weary blues that can make you question every relationship you've ever had as it sends icy chills shuddering down your spine.

The excellent musician and songs are perfectly presented by Johnny Sandlin, an excellent producer and a former staff producer for Capricorn, who has worked with the Allman Brothers, Tim Weisberg, Bonnie Bramlett, Elvin Bishop, and others. His talent and experience aren't wasted here. McClinton and Sandlin are made for each other. Sandlin's production and the resulting sound quality are equal to the artist's offering.

Incidently, if you are seeking the hidden meaning in the picture of Mickey Dolenz (a former Monkee) behind Delbert on the album cover, there is none. The cover was shot in a funky West L.A. luncheonette where the owners are apparently Monkees fans. The meaning in this recording (which has nothing to do with the album cover) is inside the jacket and is only released when played. It's one of the best in a long time, so don't miss it.

J.M.

Sound: B Performance: A+

European letter

Donald Aldous

Noise-reduction systems of one kind or another seem to hold a fascination for audiophiles in general and record collectors in particular. If the record collector has some old 78s or worn LPs, any circuitry that will reduce hiss, crackles, pops, or other extraneous noises has an immediate attraction for him.

Of the many noise reduction systems on the market, the devices due to the work of Dr. Ray Dolby and his associates are the most widely known. The professional Dolby A system divides the audio band into four regions and operates on each band separately. The B version for domestic consumers operates only a single band—in the upper frequency range—as it has been found that at low listening levels the ears are most sensitive to frequencies above 1 kHz.

Another well-known "compressor" system is the dbx, which has a 2-to-1 compression ratio in dB. The replay section of the dbx method is an expander, which complements the compression and produces a change in output level that is twice, in dB, whatever level change in input is fed into the circuit.

The Dolby system is dependent upon both frequency and level and is incompatible with the dbx system which operates at all frequencies and program levels. Compression/expander circuits (so-called "companders") are not new, but the early designs were too audible in function, while the latest designs are unobtrusive in action. Dolby B encoded tapes can be listened to without decoding with usable quality, perhaps with a little adjustment of the treble control, whereas the dbx encoded signals need the correct decode unit for playback.

As I have indicated, noise reduction circuits have long intrigued hi-fi addicts seeking to clean up the background of their recording/replay systems. One of the earliest, some enthusiasts may recall, was the Scott Dynaural Noise Suppressor, dating back to about 1947, and currently available systems (incorporated in commercial products) include JVC's ANRS, the Burwen DNF 1201 dynamic noise filter, and the Phase Linear 1000 unit.

FIONE

Most of these circuits seek to tackle hiss intrusion on recordings, but with many recent releases of phonograph records, even those from the major companies, pressing quality seems to have dropped and clicks, pops, and intermittent swish noises are bothering the fastidious consumer.

If these problems are also experienced to any significant degree on the American labels, I would like to hear, as this noise problem is presently being investigated to some depth in Great Britain. (Mr. Aldous, you can't be serious, they're *worse* here. — Editor.)

SAE company has introduced the Model 5000 impulse noise reduction system which, while not reducing continuous noise (so-called "scratch") on records, does distinguish clicks and bangs from musical program material by the "peaky" rise and fall in signal levels that characterize these intrusive noises. With careful setting of the "threshold level" control, this device is useful in tackling serious clicks and pops.

A British design by Dr. Becknor, of the Garrard Engineering Laboratories at Swindon, has recently been marketed here in Britain. Known as the Garrard MRM/101 Music Recovery Module, the unit is intended to be coupled between the pickup and an auxiliary input of the main amplifier. In action, when bad clicks and pops are encountered, gaps of "silence" are inserted which are certainly less disturbing than staccato clicks.

The minute periods of "silence" are substantially inaudible, the major clicks are completely removed, and any audible residue manifests itself as a low-level "thump." The recovery specification of the fader is 0.5 mS for a return to the original input, ±25 per cent.

Examining the circuitry, very briefly, the input amplifier output separates two ways—one half feeding a delay circuit (of about 2.7 mS), which extends to the output buffer amplifier through a voltage-controlled fader circuit. The buffer amplifier includes the necessary treble-cut equalization. The second half drives the detector circuit, which detaches the "click pulse" from the program material and develops a large amplitude pulse for working the fader circuit.

The phasing is so arranged that the circuit responds to vertical (that is, L-R) groove modulation, which is substantially the type of excitation caused by a deep scratch on an LP. The pulse output from the detector also triggers the fader on the other channel. The delay is obtained by a 256-stage IC, and the fader is optically operated with an attenuation factor of 50 to 1, or 34 dB.

Circuit engineers would describe this design as an "analogue shift register," rather than a digital circuit, but operating from a digital clocking circuit. To stop spiky signals getting into the audio channel, a low-pass filter of 12 dB per octave and 28-kHz minus 3-dB turnover frequency is inserted between the fader and buffer output amplifier.

In operation, the badly scratched disc will be replayed when the MRM/101 device is in-circuit with a miniscule loss of information on each disc revolution—rather like a tape dropout. Provided this period is less than 10 mS, any listening impairment will not be badly disturbing. This Garrard unit will *not* remove the noise of bad pressings—that is hiss, noise, or the sound of dirty discs. But if you have "scored" your LP surface by a dropped pickup or the cartridge has skidded across the record, this is the device for you.

Incidentally, the SAE 5000 device also operates by sorting out the clicks and music program by the rapid peak

and decline in a signal level that reveals the presence of a "click." When detected, it is blocked from reaching the output, but a small segment of program, already stored in its memory circuit, is dropped in its place to maintain continuity. All such devices do require careful setting of the threshold level control to be able to function optimally.

Ambisonics

Quadraphony—however defined—is regarded in many hi-fi circles as being distinctly moribund, if not actually dead, although I think that some form of acceptable multi-channel domestic sound will eventually emerge.

This endless quest for sonic "realism" has been going on since the pioneer days of recording, and if the domestic recreation of concert hall or auditorium acoustics, or of bringing the artists into the intimacy of the listening room, with ambience, is the ultimate aim, then a number of channels offering sound elevation, plus azimuth information, is necessary.

The existing quadraphonic systems have failed, so far, for a number of reasons, from poor demonstrations and promotion to lack of an agreed-upon standard system, but recently I have been listening again to the Ambisonics "surround sound" technique, developed by Michael Gerzon, Peter Fellgett, and John Wright, under the auspices of NRDC (National Research Development Corporation).

This is not the first time I have heard this "surround sound" system, of course, as the group has been working on its development for years. As Gerzon has said, "the aim of a surround system is to reproduce at the listener's ears accurately, reliably, and repeatably, the directional sound field created in the studio either by a sound-field encoding-microphone array, or by artificial directionality encoding devices (pan-pots) or artificial surround-reverberation devices. In contrast, most quadraphonic systems aim at duplicating in the home the defects or limitations of a pair-wise mixed master tape."

Using associated state-of-the-art equipment (including Luxman amplifiers and four IMF Reference Standard Professional Monitor Mk IV speakers), the surround sound, via the NRDC-Ambisonic 45J decoder, heard in an optimum seating position under excellent domestic conditions was satisfyingly impressive. A worthwhile degree of realism was achieved.

The decoder was assembled from a kit, designed to decode not only 45J but virtually all other quadraphonic systems, although not the discrete CD-4, but including the BBC Matrix H. In fact, it has 10 input selections. This kit and information on it is available from Integrex Ltd. Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs., U.K. DE11 9PT.

This system offers enhanced creative possibilities to the sound producer both by ensuring that what he hears in the studio will be substantially passed on to the consumer, despite varying loudspeaker positions and seating layouts. It also gives side localization and smooth encircling effects. In addition to existing interior or in-the-head effects, new rotation or waltz and width effects are possible, plus a practical control over width-height periphonic effects, if required. And, of course, ambisonic units can cope with existing recordings and equipment, but cannot remove the faults in such material. Further trials are presently being conducted by the BBC and IBA (Independent Broadcasting Authority) with their latest matrix HJ system.

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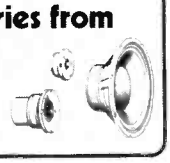

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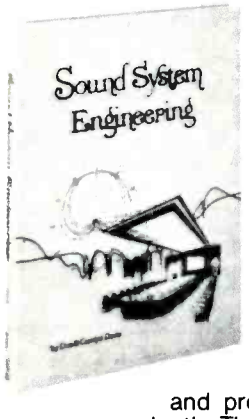

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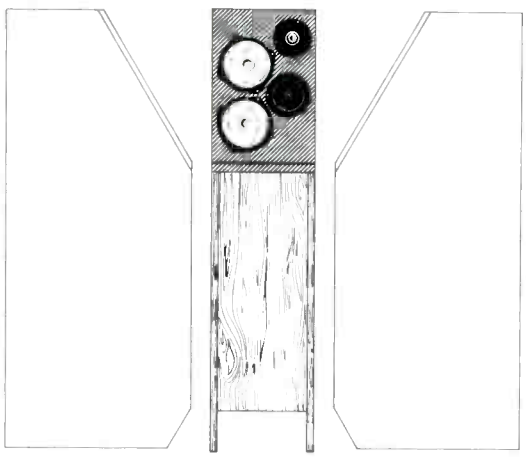

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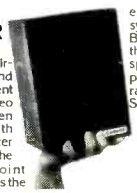

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Whether your interest is in using ambiance for a concert hall effect or as an echo chamber for studio recording use, we manufacture a broad line of sophisticated analog delay Echo and Reverberation devices at prices which only direct sales make possible. Prices range from $159 to $495.
Write for a brochure and demo record. Include $1 to cover costs (refundable with order.)
Write to: **LT Sound**, Dept AU., P.O. Box 1061, Decatur, GA 30031 (404) 284-5155

17 MARANTZ COMPONENT WHATEVER THE MIX IT'S ALWA

Now there's a Marantz component system for everyone! From our most affordable to our finest—with 223 systems priced in between—Marantz delivers the same top Marantz quality and the same stunning Marantz look. There's never a compromise! And with so many systems to choose from, you'll be able to find the exact match for your listening requirements and budget.

The RM-3700 STACK RACK contains three Marantz components on fixed-positioned shelves, an accessory shelf and divided record compartment behind its full-length smoked-glass door. The Marantz system shown includes the 6170Q Turntable, 2110 Tuner, 1180DC Integrated Amplifier, 5010B Cassette Deck and Design Series 930 Speakers.

A MARANTZ EXCLUSIVE: MIXED SYSTEMS THAT REALLY MATCH.

From the least expensive to the most expensive, all Marantz Pre-Amps, Power Amps, Console Amps, Tuners and Front-Load Cassette Decks feature the same front panel size, the same striking cosmetics, the same top quality design philosophy. So whatever component combination you choose, you'll have a perfect match. Only with Marantz.

BRINGING IT ALL TOGETHER.

Once you have selected a system, only one question remains: Where do you put it? With a Marantz STACK RACK you can bring it all together—with style. The RM-3100 "Professional" STACK RACK (at right) will accommodate up to four Marantz components equipped with optional rack handle adaptors. Or you may prefer the RM-3700 "Decorator" STACK RACK (above) which encloses three Marantz components behind its full-length smoked glass door. A perfect fit in either rack, your entire system will be at your fingertips.

BUILD NOW. ADD LATER.

Once you see and hear what Marantz components have to offer by way of more performance per dollar, striking appearance and unheard of flexibility, you'll be sold. You'll have a perfectly matched system tailored to your specific needs from as little as $650* to $2100.* And don't hesitate when you want to upgrade any part of your system. Any Marantz component you upgrade to will match what you already have.

MIX AND MATCH BY MARANTZ—IT'S ALL FOR YOU.

17 separate components from Marantz. Designed to mix and match into 225 different systems to give you unprecedented flexibility. Whoever you are, Marantz has the perfect system for you.

The three unit Marantz system shown at right includes the 2100 Tuner, 1090 Integrated Amplifier and the 5000 Cassette Deck with 6270Q Turntable. The four unit Marantz system shown at the far right includes the 2130 Tuner, 3650 Preamplifier, 5030B Cassette Deck and the 300DC Amplifier with a 6370Q Turntable.

25th Anniversary marantz®

*These prices are for informational value only (actual prices are set by Marantz retail dealers) and do not include turntables, racks, optional rack handles or speakers.

S. 225 MARANTZ SYSTEMS.
'S A MATCH – FROM $650* TO $2100.*

If Your Records Are Valuable

LOOK FOR THE RED BOTTLE

Why?

General Need: Tests by the Discwasher Labs show that fingerprints are absolutely not totally removed by "dry cleaning" in any form, either brush or adhesive rollers. Long term record care requires the complex integration of micro-dust pick-up (not spreading around), with removal of chemical contamination such as fingerprints; plus an in-process reduction of static charge so that dust particles are not immediately sucked back onto the surface. And all of this must be done without leaving a residue.

D3 fluid, used with the Discwasher System for capillary removal of fluid/contamination achieves the results required for record survival. But the hidden requirements of a record cleaner are much more complex than integrated function alone.

Chemical Integrity: The trick is not to simply clean—but to clean with vinyl safety and extremely low "solute load" or fluid content. D3 is a solution that typically has half the dry weight residue of tap water and about one-fifth the median for other "record cleaners". D3 typically has the dry weight residue of distilled water sold in drug stores—and yet D3 has an activity in surface tension reduction/fingerprint removal that is greater than any fluid with twice the solute load of D3.

D3 fluid contains a complex blend of buffered surfactants conjugated in the labs of Discwasher, Inc. These provide cleaning "activity" against real-world record contamination, like fingerprints and airborne oils. But not against artificial "test conditions" of mineral oils and sheep wax (lanolin). Because if D3 removed waxes and oils of this nature, then D3 would also begin to soften critical vinyl stabilizers which are essential for record survival under the incredible heat and pressure of a tracking audio stylus. Alcohols and many cleaners pull stabilizers and age vinyl.

Some cleaning fluids contain large molecules of fatty acids to "float" dirt—but these "molecules" positively stick to vinyl and are literally a dust trap.

D3 fluid does not dramatically reduce static charge forever. The only liquid that can is one which leaves a coating. But D3 does reduce static charge during cleaning (using 3 drops on the Discwasher brush), and actual static voltage is reduced during playback to about one-half the normal levels.

The Discwasher "Systems Approach": Any cleaning fluid, when left on the record, only spreads out contamination. With three drops of D3 on the special directional micro-fibers of the Discwasher brush, dust is lifted out of the grooves, without "follow up" or adhesive oxide removal of the vinyl.

In addition, the Discwasher System wicks up D3 fluid plus suspended contamination. The fluid is drawn deep into the absorbent backing of the Discwasher brush. No liquid, dust or contamination "dries back" when the system is properly used. The "systems approach" of Discwasher includes a hand-rubbed, milled walnut handle. Something to outlast plastic wonders and out-perform everything else. Your records can't do better than the Red Bottle inside the "system".