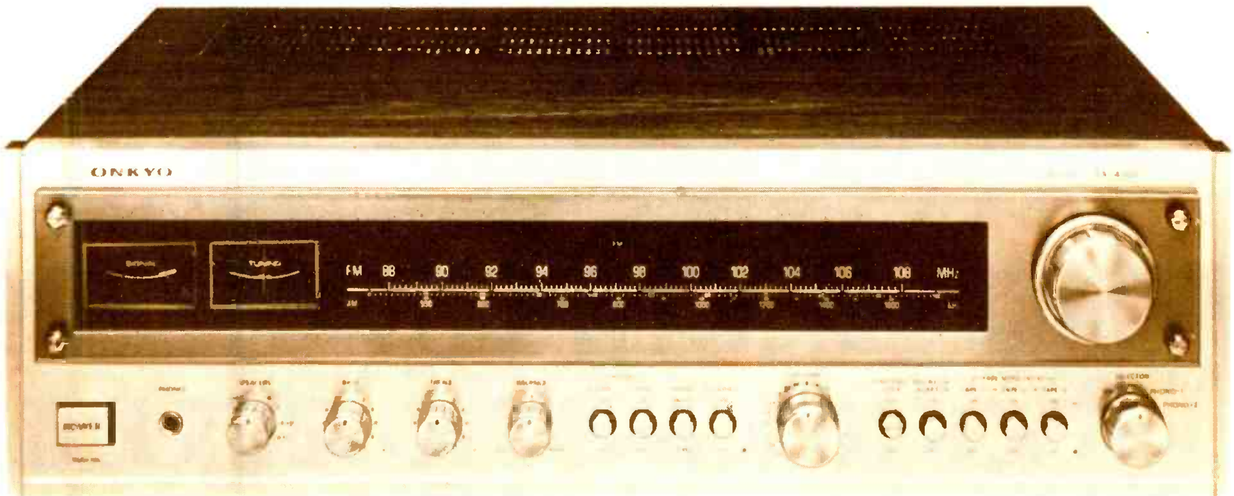
# Equipment profiles

## Onkyo Model TX-4500 Stereo Receiver






**MANUFACTURER'S SPECIFICATIONS**

*FM Tuner Section*
**Usable Sensitivity:** 1.8μV (10.3 dBf) mono; 5 μV (19.2 dBf) stereo.
**50-dB Quieting:** 4 μ V (17.2 dBf) mono; 40 μ V (37.2 dBf) stereo.
**S/N:** 70 dB mono; 65 dB stereo.
**Selectivity:** 70 dB.
**Capture Ratio:** 1.5 dB.
**AM Suppression:** 50 dB.
**THD, 1 kHz:** 0.2% mono; 0.4% stereo.
**Image Rejection:** 70 dB.
**I.F. Rejection:** 100 dB.
**Stereo Separation:** 1 kHz, 40 dB; 30 dB from 100 Hz to 10 kHz.
**Mute, Stereo & Quartz Lock Level:** 4 μ V (17.2 dBf).
**Frequency Response:** 30 Hz to 15 kHz, +0.5, −2.0 dB.

*AM Tuner Section*
**Image Rejection:** 40 dB.
**I.F. Rejection:** 40 dB.
**S/N:** 40 dB.
**THD:** 0.8%

*Amplifier Section*
**Power Output:** 55 watts per channel, 8 ohms; 65 Watts at 4 ohms, 20 Hz to 20 kHz, with no more than 0.1% THD.
**IM Distortion:** 0.3%.
**Damping Factor:** 50 at 8 ohms.
**Frequency Response:** High Level, 15-30,000 Hz ±1 dB.
**Input Sensitivity:** Phono 1 & 2, 2.5 mV; Tape 1 & 2, 150 mV.
**Phono Overload:** 200 mV.
**Tone Control Range:** Bass, ±10 dB @ 100 Hz; Treble, ±10 dB at 10 kHz.
**S/N:** Phono, 65 dB (IHF C network); high level, 80 dB (IHF C network).
**Filters:** 100 Hz and 6 kHz, 6 dB/octave.

*General Specifications*
**Dimensions:** 21 3/16 (53.82 cm) W x 16 15/16 (43.02 cm) D x 6 7/16 (16.35 cm) H.
**Weight:** 36 ½ lbs.(16.6 kg).
**Suggested Retail Price:** $449.95.

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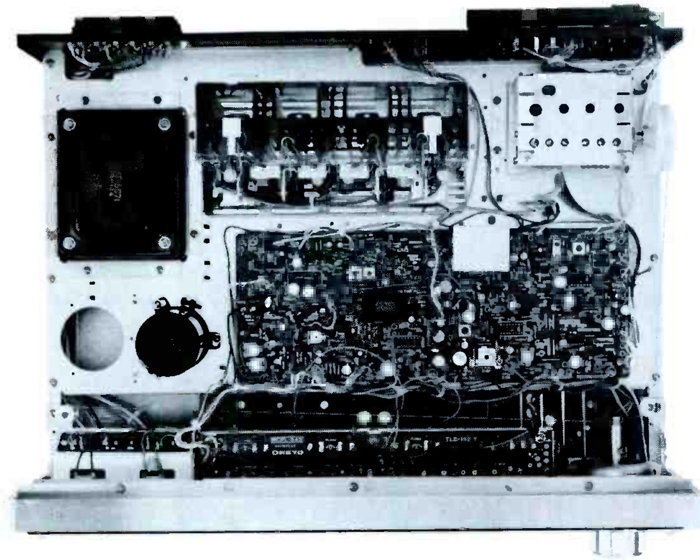
It has been quite some time since we last examined a piece of Onkyo high fidelity equipment, and our first reaction upon unpacking their new Model TX-4500 was that they have come a long way in the styling and appearance of their products. A protruding clear panel covers the upper dial area, adding to the massive overall look. Tuning and center-of-channel meters are located to the right of the linearly calibrated FM and conventional AM frequency scales, while above the scales are a series of four illuminated words to denote program source selection. Three additional lights denote stereo reception, "locked" station range (which will be explained shortly), and "tuned" condition. A large tuning knob at the right of the dial area is coupled to an effective flywheel arrangement.

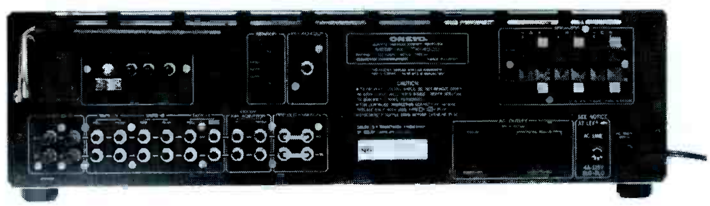
Rotary controls along the bottom of the panel include speaker selector switch, 21-click-position bass and treble controls, balance control, 41-click-position volume control, and program selector. The program selector has positions for two phono input pairs, AM, and FM, so that any other high-level program sources must be selected via the tape monitor switches. A rectangular push-button turns on power, while a series of nine smaller circular pushbuttons handle such functions as low- and high-cut filter selection, stereo–mono selection, loudness, FM muting, three tape monitor circuits, plus a fourth circuit interruption point for addition of a Dolby decoder. This fourth circuit, in addition to interposing a Dolby accessory connected at the appropriate rear panel jacks, also modifies the FM output signal from the tuner section from its standard 75 microsecond de-emphasis characteristic to the 25 microsecond de-emphasis required when listening to Dolby FM broadcasts. The usual headphone jack is located near the power on/off switch.

Antenna terminals on the rear panel, accept 300-ohm, 75-ohm, and external AM antenna connections, and a pivotable AM ferrite bar antenna and ground terminal are located in the same area. In addition to the two sets of phono input jacks and the four sets of input and output jacks associated with the tape monitor (and adaptor) circuitry, there is an output jack for future connection to a 4-channel FM adaptor, plus preamp-out/main amp-in jacks interconnected by means of wire jumpers. A three position switch, which Onkyo identifies as a "sensor" control, determines the signal level at which the automatic tuning system operates and has positions labelled *Low, Normal,* and *High.* Speaker connection terminals are of the spring-loaded type which only require that the stripped ends of speaker cables be inserted in a small hole for proper connection. Up to three pairs of speakers can be connected, but no more than two pairs can be selected for simultaneous play by means of the front panel speaker-selector switch so that sufficiently high load impedances on the amplifiers are maintained. Two unswitched and one switched a.c. convenience outlets and a line fuseholder complete the rear panel layout.

The entire AM, FM, and multiplex circuitry of the Onkyo TX-4500 is contained on a *massive* single, circuit board. Additional circuit boards are used for the preamplifier and tone amplifier sections, and vertically mounted modules with self-contained heat-sink structures are used for the power amplifier circuits. A four-section tuning capacitor is used for FM tuning, while a minimal two-sections of tuning capacitance are used for the AM tuning circuits.

Unfortunately, Onkyo did not supply a schematic diagram with this receiver, so we can only guess at how the novel tuning circuit of the unit operates. The company calls this tuning system "Quartz Locked Tuning," and we did, indeed, locate a small crystal on the tuner board which is obviously a part of a fixed frequency oscillator used as a reference frequency. Since conventional front-end tuning is used, we suspect that the crystal oscillator must be used to compare the superheterodyned 10.7 MHz i.f. frequency derived from the mixer and i.f. stages with its own generated frequency. Once the set is manually tuned close enough to center of frequency, an error voltage must be developed based upon the difference between the quartz crystal oscillator frequency and the i.f. frequency (which is close to, but not equal to 10.7 MHz at that time). This voltage is then used as a sophisticated form of a.f.c. correction while "pulls" the local oscillator over to a frequency that does result in 10.7 MHz or perfect tuning. The entire action is defeated when one touches the tuning knob, permitting "unlocked" tuning until the "locked" light tells the user that locking range has been reached. Once the tuning knob is released, the above described corrective action takes place almost immediately.

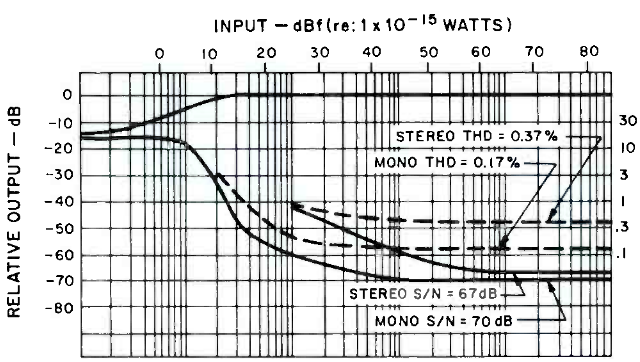






As for the amplifier section, it is entirely direct coupled, though filtering of the positive and negative supplies is accomplished by a single rather smallish, dual-section electrolytic capacitor, having a pair of 10,000 μF sections for each side of the supply voltage. The power transformer seemed a bit on the small side for the power output claimed for this receiver too. It was apparent from inspecting the chassis layout that it was designed to be used with several of Onkyo's receiver models, since unfilled mounting holes were evident.

**Fig. 1—FM quieting and distortion characteristics.**




## FM Tuner Section Measurements

Figure 1 is a graphic plot of several important FM measurements. Signal-to-noise ratio in mono exactly equalled the −70 dB claimed, while in stereo, S/N was a bit better than claimed, measuring −68 dB. Distortion in both mono and stereo were considerably lower than claimed, with 0.19% in mono and 0.2% in stereo for a 1-kHz test signal at 65 dBf input signal strength. Usable sensitivity measured 1.7 μV (9.8 dBf) in mono, 3.9 μV (17.0 dBf) in stereo. The 50-dB quieting point occurred with an input signal strength of 2.6 μV (13.5 dBf) for mono, 38 μV (36.8 dBf) for stereo. We were

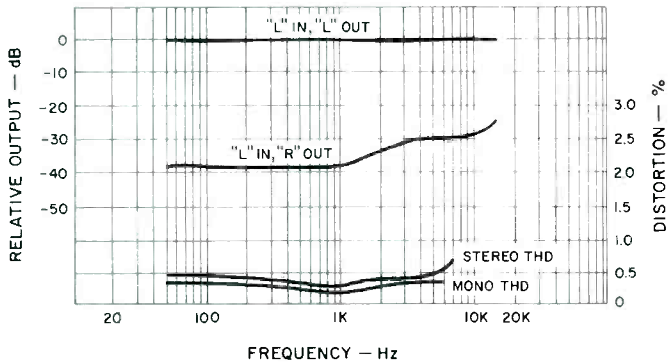



**Fig. 2—Separation and distortion vs. frequency.**

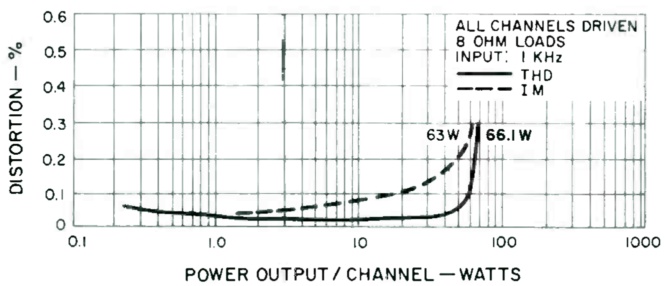



**Fig. 3—Harmonic and intermodulation distortion characteristics.**



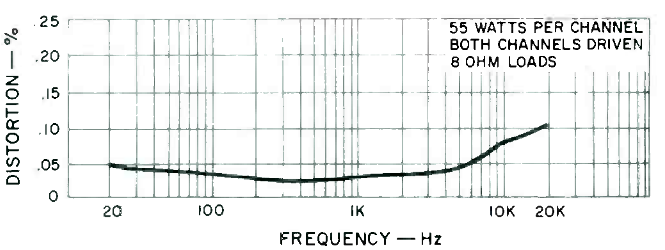
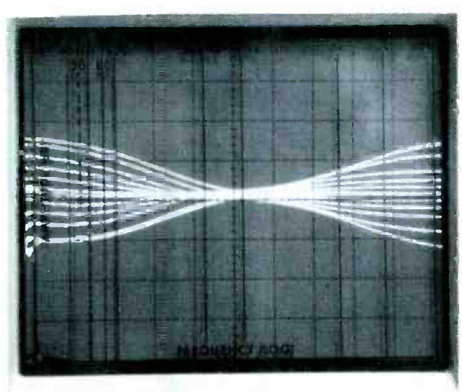



**Fig. 4—Distortion vs. frequency at 55 W per channel with both channels driven with 8 ohm loads.**

**Fig. 5—Tone control range with alternate click-stop settings shown for clarity (even finer fixed gradations are possible).**



quite pleased to note that as we tuned for minimum distortion (with our hand on the tuning knob to prevent the "lock" feature from working), releasing our fingers resulted in absolutely no change in the minimum distortion reading and center-of-channel tuning meter indication corresponded perfectly. Evidently the "Quartz Lock" tuning developed by Onkyo really works well. To confirm this, we rechecked the action at several points on the FM dial and results were just as good.

Alternate channel selectivity measured 73 dB, while capture ratio measured exactly 1.5 dB as claimed. Image rejection was a bit short of claims, with 68 dB measured, while i.f. rejection was better than 100 dB (the limit of our measurement capability). AM suppression was 51 dB, while spurious response rejection (for which Onkyo makes no claims) was a bit over 80 dB. Only the 75 microsecond de-emphasis is built into the receiver's FM section, so that the Dolby push-button on the front panel should not be misinterpreted as applying to Dolby FM reception. Both an adaptor and a change in de-emphasis would be required with this receiver to properly receive Dolby FM broadcasts.

Separation, though falling short of the claimed 40 dB at mid frequencies, did remain high (30 dB or better) all the way from 50 Hz to 10 kHz, as shown in the graphs of Fig. 2. Distortion at the 6 kHz extreme point of required measurement was also uniformly low in both mono and stereo. As many readers surely realize, proper tuning is important in maintaining good separation in FM stereo, and the novel locked-tuning feature of the Onkyo TX-4500 is definitely beneficial in this regard.

Muting threshold measured 7.0 μV (22.1 dBf), while switching to stereo occurred with an input signal strength of 4.0 μV (17.2 dBf), as claimed. Frequency response was off by only 1 dB at 15 kHz, and sub-carrier product rejection measured 63 dB.

As for the AM section, we measured a signal input of 40 μV for usable sensitivity (external antenna connection), and a S/N of 42 dB with strong signal inputs. Image rejection was 38 dB, while i.f. rejection was 40 dB as claimed. THD at 30% modulation was 1.2%, a bit higher than the 0.8% claimed. Response of the AM section was down 3 dB at 3 kHz, typical of this minimal type of circuit so often found in even some of the best receivers in the high fidelity category.

### Amplifier Measurements

Onkyo elected to quote power output ratings at both 4 and 8 ohms for this receiver. At 4 ohms, a claim of 65 watts per channel is made. In fact, at mid frequencies we were able to pump out nearly 80 watts before reaching the 0.1% rated THD using 4 ohm loads. The unit could not operate for the required one hour preconditioning time at one-third this power level without triggering its protective circuits however. While such triggering of protective circuits is allowed by the new interpretation of the FTC rule, we did not make further measurements under the 4-ohm load condition. Driving 8 ohms, the amplifier delivered 64 watts of power per channel at 0.1% THD. Rated IM (0.3%) was observed at an equivalent output of 55 watts per channel. Distortion was well below these levels for all lower power output measurements, as shown in the plots of Fig. 3. As can be seen in Fig. 4, the limiting factor as far as power rating and distortion of this receiver occurs at the high frequency end, rather than at 20 Hz, and at 20 kHz, distortion was exactly 0.1% for rated 55 watts of output per channel. Power band extended from 18 Hz to 20 kHz. Frequency response using the tape inputs was flat within 1 dB from 12 Hz to 50 kHz, and input sensitivity was 150 mV as claimed. Phono input sensitivity was exactly 2.5 mV, and a signal of 220 mV was applied to the phono inputs before any evidence of first-stage

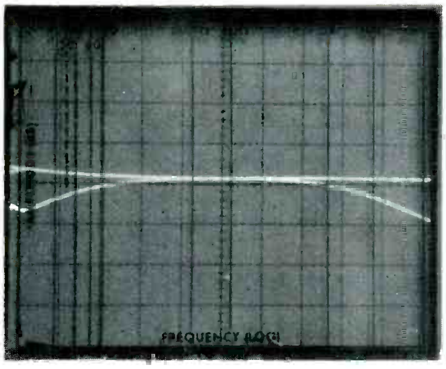


Fig. 6—Low-cut and high-cut filter response.

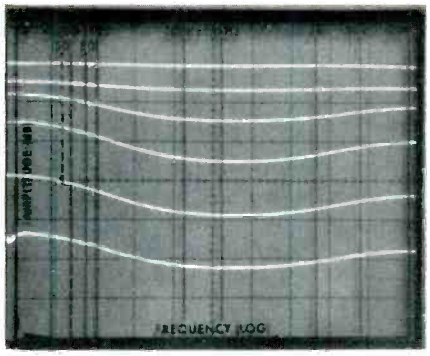


Fig. 7—Loudness compensation characteristics.

overload was noted. RIAA equalization was accurate within 1.2 dB. Unweighted hum in phono was −70 dB, while for the high level inputs it measured 91 dB; at minimum volume, a reading of −95 dB below rated output was obtained.

Tone control range was plotted by means of our spectrum analyzer/storage scope combination, and results are pictured in the scope photo of Fig. 5. High- and low-filter response, plotted in Fig. 6, is of the 6-dB-per-octave type. Loudness control action is plotted in the sequential frequency sweeps at progressively lower and lower volume control settings in Fig. 7, and Onkyo has chosen to boost both bass and treble frequencies in the loudness circuits of the TX-4500. The click-stop detents on the bass and treble control are a quite worthwhile refinement since they do permit exact repeatability of settings, as claimed.

### Use and Listening Tests

Controls on the Onkyo TX-4500 have a good feel to them and are well positioned for easy familiarity and use. Clearly, the outstanding feature of this receiver is the tuning-lock system which was as effective under actual listening conditions as it was on the test bench. We judged the power output capability of this receiver to be just about enough for reasonably loud listening with medium efficiency speakers. The abundance of tape monitoring facilities will appeal to the serious recordist who owns both an open-reel machine and a cassette deck. Even with two decks connected, there is room for additional accessories such as a noise-reduction system or even a graphic equalizer. The thermal-protection circuits, plus relay protection, offer as much of a safeguard to the equipment as anyone is ever likely to need in normal use of the receiver. Competitively speaking, the Onkyo TX-4500 offers rather good value for its price, and if some of the less important FM specifications are not quite up to state-of-the-art performance, that fact is not likely to intrude upon the pleasurable listening which can be done in most receiving areas with this unit.

*Leonard Feldman*



## JVC Model CD-1970 Cassette Deck

**MANUFACTURER'S SPECIFICATIONS**

**Frequency Response:** 30 to 16,000 Hz ±3 dB with $CrO_2$, 40-1500 Hz ±3 dB with normal tape.
**S/N:** 52 dB, 57 dB (at 1 kHz) with ANRS.
**Wow and Flutter:** 0.09 per cent W rms.
**THD:** 1.2 per cent.
**Bias:** 95 kHz.
**Motor:** D.c. servo.
**Dimensions:** 16 ½ in. (41.9 cm) W x 6 ¼ in. (15.9 cm) H x 11 in. (27.9 cm) D.
**Weight:** 18.7 lb. (8.16 kg).
**Price:** $399.95.


The JVC CD-1970 is a good example of present day cassette recorder design, with front-loading, noise reduction, and other facilities, including provision for a timer. The array of controls, in addition to the polished handle and metal case, give it a very professional appearance, and it is obviously intended to form part of a component system.

The cassette compartment is on the right just above the seven tape transport controls, which are comprised of six lever switches and a push-button for eject. On the extreme left is the power *On/Off* switch, followed by three dual-concentric controls for mike and line level inputs, plus a playback level control. Next comes a memory switch, digital counter, and a tape run indicator. The two VU meters are mounted in a black recessed panel, together with the ANRS noise reduction switch and a two-position meter switch. On the left of the two meters are two lever switches for tape bias and equalization, one of which is marked $CrO_2$ and the other normal, which means either Low Noise or High Efficiency tapes.

Standard jacks for either headphones or microphones are located just under the input controls. The rear panel contains the input and output sockets, a DIN socket, and an unswitched a.c. outlet.

One of the features of the Model 1970 is the timer facility, and it works like this. The controls are set to the record mode and the pause button is depressed. Then the recording levels are set, using the desired program source, such as a tuner. Next, both the deck and tuner power plugs are connected to a timer (many electronic parts stores carry these which plug directly into a wall socket). When the timer switches on, the deck automatically starts recording—that's all there is to it.

The heads are made of Sen-alloy, which is claimed to have the low distortion characteristics of permalloy, along with the high wear resistance characteristics of ferrite. The motor is the popular d.c. servo type. The instruction manual, written in three languages, is unusually detailed and accompanied by many photographs and diagrams.

### Measurements

The first measurement was made using a standard playback test tape, and the results are shown in Fig. 1. Next, record/replay measurements were taken with a C-60 Maxell UD tape at two levels as illustrated in Fig. 2. It will be seen that the overall response is within 2 dB from 30 Hz to 16 kHz, with the 3 dB point at 16.5 kHz. FujiChrome $CrO_2$ tape is recommended for use with this machine, and so a Fuji cassette was checked out for Fig. 3. The high frequency response was extended up to 17.5 kHz (−3 dB) with a slight reduction in headroom.

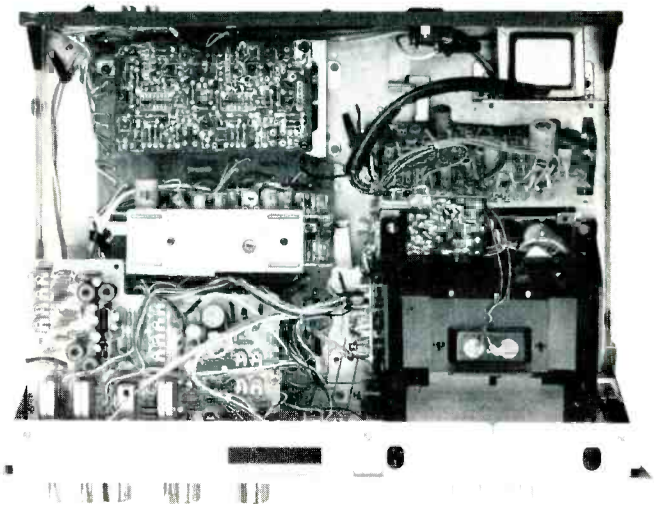
Distortion at 1 kHz can be seen in Fig. 4, with the Maxell tape being marginally superior. The differences are emphasized at the lower frequencies as can be readily seen in Fig. 5. The VU meters can be switched to read either peak or average (marked VU) values, and their response is attenuated below 100 Hz. In other words, a constant amplitude 1-kHz signal reading 0 VU would read less at low frequencies, and the graph at the top of Fig. 5 shows how much less for both meter functions. In practice, it means that care must be taken to avoid overloading when recording organ, electronic music, or any signal with a significant low frequency content—especially when using $CrO_2$ tapes.

At this stage in the tests, a number of other tapes were tried, and excellent results were obtained with the Fuji FXT-60, TDK-SA, Scotch Classic and Master, BASF-Pro, and Sony Low-Noise. Three $CrO_2$ tapes were also tested, TDK KROM, Advent, and BASF, and all had results almost identical with the FujiChrome, the latter having a dB or so lower noise.

It should be mentioned here that the playback time constants used on the Model 1970 are 3180 $\mu$S and 120 $\mu$S for the normal Low-Noise tapes, and 3180 $\mu$S and 70 $\mu$S for the $CrO_2$ tapes.

The frequency measurements were repeated with the ANRS noise reduction circuit on and the change was insignificant—less than 0.5 dB. The signal-to-noise ratio was 54 dB without ANRS and 59 dB, A weighting, with the Maxell tape. With the $CrO_2$ tape, the figures were 55 dB and 60 dB. Input required for 0 VU was 78 mV in the line, and the output was then 290 mV for Low-Noise tapes and 320 mV for the $CrO_2$. The signal required for 0 VU at the microphone input was 200 $\mu$V, and the noise increase with the level control turned to maximum was 10 dB. In practice, however, the input control would be turned down considerably, so the noise increase would be normally on the order of about 5 dB.

As the machine had been working for several hours, it seemed like a good time to test for wow and flutter, and the DIN figure was a very good 0.07 per cent. Tape speed was



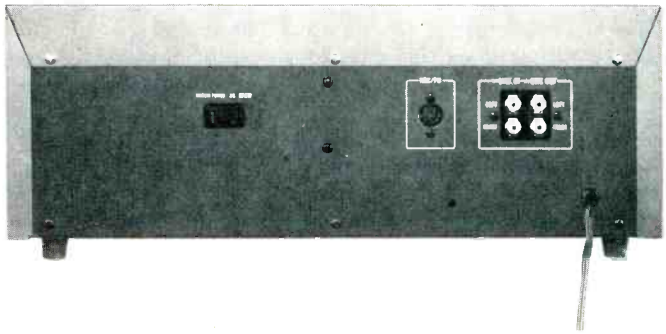


**Fig. 1—Playback response with a standard (40 Hz to 10 kHz) test tape.**

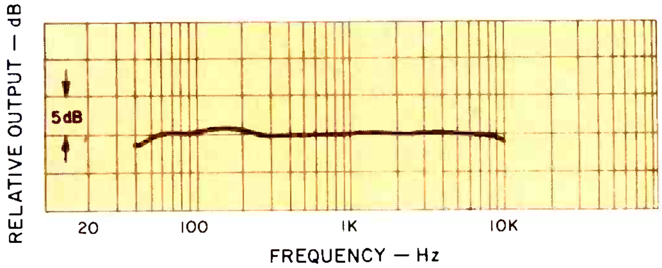
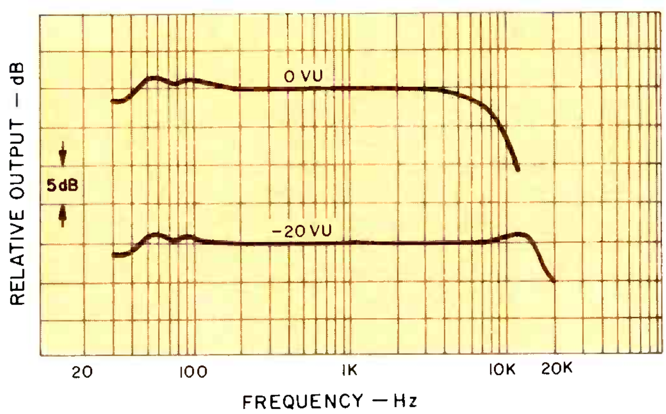



**Fig. 2—Record/replay response with Maxell UD tape.**



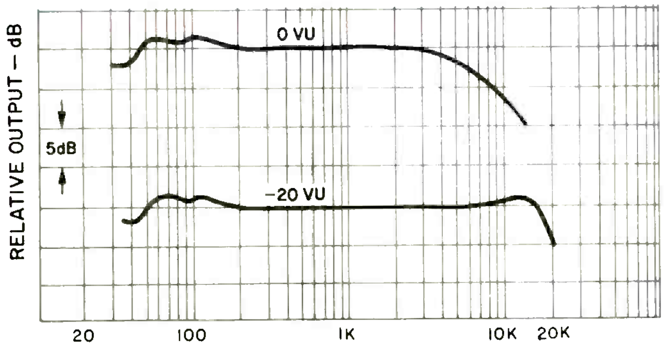
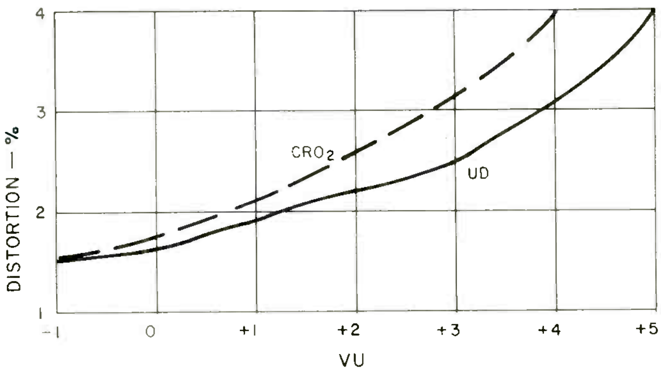



**Fig. 3—Record/replay response with FujiChrome $CrO_2$ tape.**

**Fig. 4—Distortion at 1 kHz.**



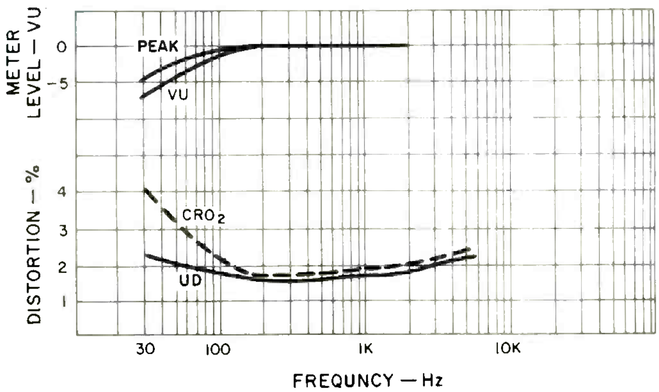




**Fig. 5—Distortion vs. frequency at 0 VU. The upper curves show meter response with switch set to peak and VU positions.**



found to be 0.4 per cent fast, and cassette rewind time for the C-60 tape was 83 seconds.

### Use and Listening Tests

The CD-1970 proved to be a very easy machine to use, and I'm sure the absolute beginner will be able to make first-class tapes with a little practice. The instruction manual recommends that the VU meter switch be set for peak reading when recording music with a high transient content, as this will give a more accurate indication of sound levels.

The manual also suggests the use of the ANRS noise reduction system when playing Dolby tapes. Both operate from 500 Hz up, with their parameters constantly changing according to frequency and amplitude of the signal. And I must say that several of the Dolby encoded tapes I tried sounded remarkably good when played via ANRS.

The microphone and line inputs are independent and, as mentioned earlier, both controls are the dual-concentric type with separate controls for each channel, so several mixing arrangements are possible.

The deck is mechanically quiet and the tape transport controls worked smoothly, without fuss—and this includes the eject button. When the eject button is depressed, the cassette does not spring out like an unguided missle—it just lays there while the door opens slowly. The reason for this is the mechanism is air-damped, and the idea is patented.

*George W. Tillett*

**Check No. 81 on Reader Service Card**

## Kenwood Model KA-3500 Integrated Stereo Amplifier

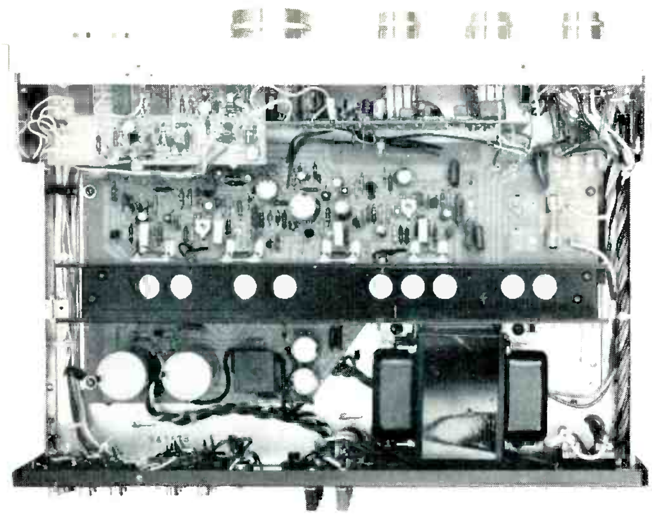

**MANUFACTURER'S SPECIFICATIONS**

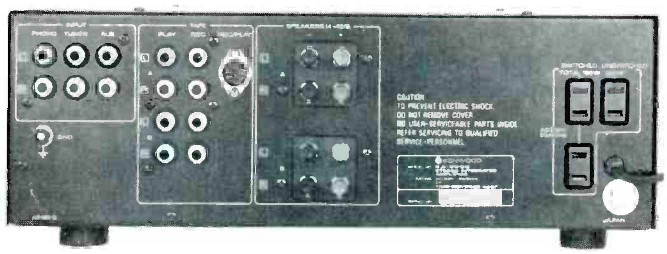
**Power Output:** 40 watts continuous power per channel, 8 ohm loads, from 20 Hz to 20 kHz.
**THD:** 0.2 per cent at all power levels from 0.25 watts to rated output.
**IM Distortion:** 0.2 per cent at rated output.
**Damping Factor:** 50.
**Input Sensitivity:** Phono, 2.5 mV; Aux and tuner, 200 mV.
**S/N:** Phono, 76 dB referred to 5 mV input; High Level Inputs, 90 dB.
**Bass & Treble Control Range:** ±8 dB @ 100 Hz and 10 kHz.
**High Filter Cut:** −6 dB @ 10 kHz.
**Dimensions:** 14½ in. (36.8 cm) W x 5½ in. (14 cm) H x 10-3/8 in. (26.35 cm) D.
**Weight:** 16½ lb. (7.48 kg).
**Price:** $159.95.

So much emphasis has been placed, of late, on those super-performance, super-powered integrated and basic amplifiers (with their 0.002 per cent distortion figures and almost-infinite slewing rates) that we tend to overlook what, to many, are products which offer a great value for their price and, in fact, represent greater value in today's hi-fi marketplace than anything that was available in their categories just a few short years ago. Such a product is Kenwood's little integrated amplifier, Model KA-3500. If you crave 100 watts plus per channel, ne-plus-ultra measured specs, and bandwidth from d.c. to channel 5, read no further and save your pennies. But if an honest 40 watts per channel with reasonably low distortion, intelligent layout, and good indications of reliable long-term performance are what you are after and you have less than $200.00 to spend on your preamp/amp components, read on.

The most prominent control on the front panel of the KA-3500 is a giant master volume control. It is a conventional potentiometer, of course, but one which is mechanically coupled to no less than 40 "click-stop" positions for easy resetability (augmented by evenly spaced calibration marks from 0 to 10). At the upper left is a rotary speaker selector switch, with *Off, A, B* and *A+B* positions, along with *Bass* and *Treble* controls, each screened with + and − dB calibration marks and fitted with 11 click-stop detent positions. Three interlocked push-buttons at the upper right select *Phono, Tuner* or *Aux* program sources, while just below them are a pair of three-position toggle switches which take care of either of two tape monitor circuits, plus A-to-B and B-to-A tape deck dubbing. Controls at the lower left include a toggle power *On/Off* switch, a balance control (with an easily defined center position) and yet another three-position toggle switch with positions for *loudness* compensation, *Off* or *High Filter*. This combined arrangement precludes the possibility of selecting both loudness circuits and high-cut filtering at the same time.

The rear panel of the KA-3500 is equipped with the usual phono-tip input jacks for all program sources, tape record output jacks for two tape decks, plus a DIN socket for one of the two tape out/in circuits. Two sets of speaker terminals are of the thumb screw type, with polarizing notations screened nearby. Two switched and one unswitched a.c. receptacles are located as far away from the input circuits as possible, while a chassis ground terminal is positioned just below the phono input jacks.





## Internal Construction and Layout

While Kenwood does not supply a schematic diagram with this amplifier, they do indicate in their literature that the power amplifier section is a direct-coupled, pure complementary circuit with an FET differential first-stage amplifier. In addition to time-delayed turn on, the amplifier is equipped with protection circuitry which Kenwood calls ASO (for Area of Safe Operation) and which the company uses in its more expensive, more powerful amplifiers and receivers.

Circuitry is essentially distributed between three p.c. modules, with the largest containing the power amplifier section. A U-shaped heat sink structure runs almost the full width of the chassis and is coupled directly to the output devices which are plugged right into the main circuit board. Preamp-equalizer parts are on the small p.c. board up front, while tone and voltage amplifier circuitry is mounted on a third, vertically oriented module also up front. Power supply parts, mounted on the main amplifier board, include a pair of 6800 $\mu$F filter capacitors for the required positive and negative voltage supplies of the direct-coupled output circuitry. Judging by size alone, the power transformer, well isolated from input circuits, seemed adequate for the power rating of the unit and, during the course of our tests, remained cool enough to be touched.

## Laboratory Measurements

At mid frequencies, the KA-3500 delivered 45.3 watts per channel before reaching its rated THD level of 0.2 per cent. At 40 watts per channel ouput into 8 ohms, THD measured a low 0.043 per cent THD and 0.075 per cent IM. Distortion versus power output into 8-ohm loads is plotted in Fig. 1 and, at all power levels below rated output, THD and IM were well below 0.1 per cent. The slight rise in the THD curve of Fig. 1 was occasioned more by the influence of wideband noise than by actual harmonic distortion com-

**Fig. 1—Harmonic and Intermodulation distortion characteristics.**

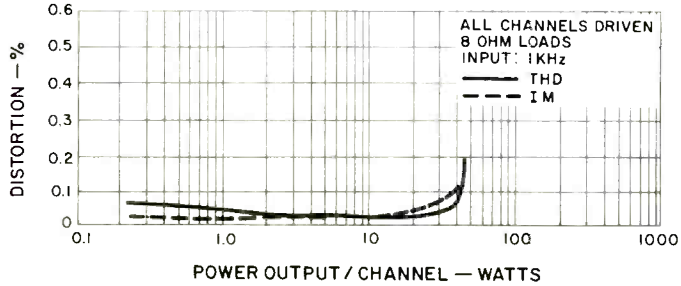
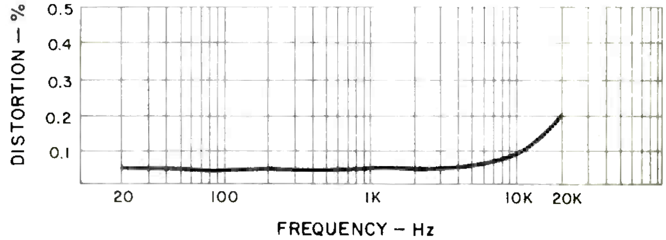



**Fig. 2—Distortion vs. frequency in the Kenwood KA-3500 amp.**



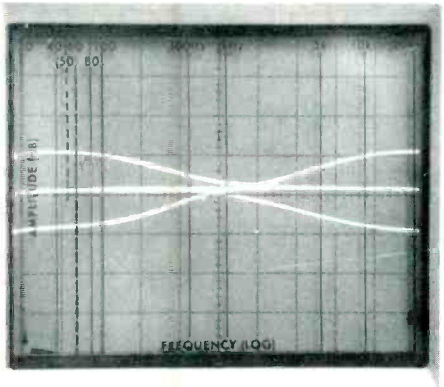



**Fig. 3—Bass and treble control range.**

**Fig. 4—High-cut filter action (upper trace) compared with response in the full treble-cut position.**

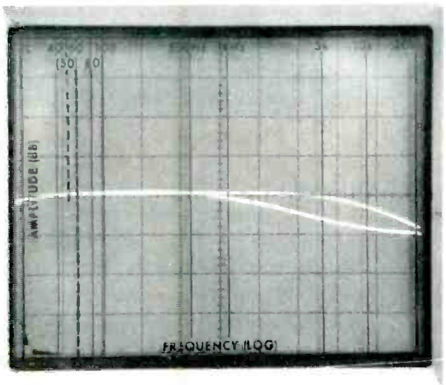
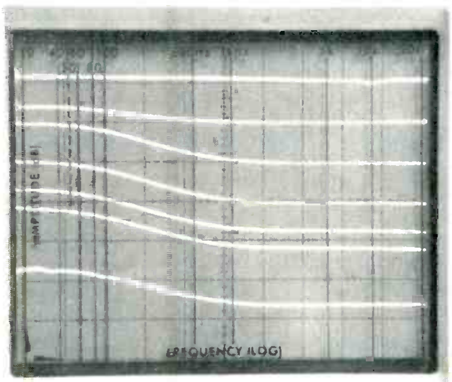



**Fig. 5—Loudness control compensation at the various volume control settings.**






ponents, good evidence that the amplifier has no cross-over or notch distortion at such low listening levels.

Were it not for high frequency power limitations, this amplifier might well have been rated at a few more watts than the 40 specified, but, as shown in the graph of Fig. 2, the unit barely delivered its rated 40 watts per channel with a test frequency of 20 kHz, and distortion climbed rapidly beyond that power level or at higher test frequencies. We measured a damping factor of 40, short of the 50 claimed by Kenwood, but certainly high enough for all practical purposes. Residual hum and noise (with the volume control at minimum) measured 92 dB below rated output, unweighted.

Frequency response measured via the Aux or tuner inputs extended from 19 Hz to 54 kHz for the −1 dB rolloff points, from 11 Hz to 65 kHz for a −3 dB dropoff. Tone control range of bass and treble controls was "graphed" using a spectrum analyzer, and the resulting scope photo is reproduced in Fig. 3. Note that Kenwood wisely "shelved" the boost characteristics of both the treble and bass controls, so that they do not increase extreme low- or high-frequency response by more than about 9 dB, even beyond the limits of the audio spectrum. Figure 4 shows the attenuation characteristic of the high-cut filter as compared with the attenuation of the treble control when the latter is set to its maximum cut position. Notice that despite the fact that the high-cut filter has a slope of only 6 dB per octave, it would be more effective in moderately reducing high-frequency scratch and noise than would the tone control, because its turnover or cut-off point is set at a higher frequency. The action of the loudness circuitry is graphed in the scope photo of Fig. 5 and involves bass boost only at progressively lower volume control settings, with no treble emphasis employed.

Phono input sensitivity measured 2.8 mV for full output and, with a signal input frequency of 1 kHz, there was no evidence of overload distortion until the amplitude of the input signal reached a high 225 millivolts. RIAA equalization was accurate to within 1 dB, with that deviation occurring at the extreme 30-Hz test frequency. At all frequencies above 50 Hz, RIAA accuracy was better than 0.5 dB. Measured S/N in phono (unweighted) was −67 dB referred to rated input sensitivity (2.5 mV). Kenwood quotes the phono S/N referred to 5.0 mV, but translated to that reference input level, we would still come up with a reading of −73 dB compared to the −76 dB claimed. Our measured figure is certainly not a poor one, but simply falls short of their claims by 3 dB.

## Use and Listening Tests

We found that the KA-3500s rather simple front panel control arrangement offered as much flexibility and adjustment capability as most hi-fi listeners might require. Control action was smooth and repeatable, rivaling that of many more costly integrated amplifiers. Kenwood was wise in sacrificing power bandwidth at the high end of the spectrum, if they had to sacrifice anything, for they have retained good tight bass all the way down to below audible frequencies, and that honest power reserve at the low end makes the amplifier suitable for use with a variety of medium-to-high efficiency speakers, some of which might be expected to require more nominal power to produce clean, loud levels. As we mentioned at the outset, all of us tend to overlook some of the inexpensive products that still abound in this rapidly expanding industry. It is nice to occasionally come back down to earth and take a good hard look at a low-priced integrated amplifier that can be counted on to form the control and amplifying center for a very respectable, yet low-cost high fidelity component system. *Leonard Feldman*

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