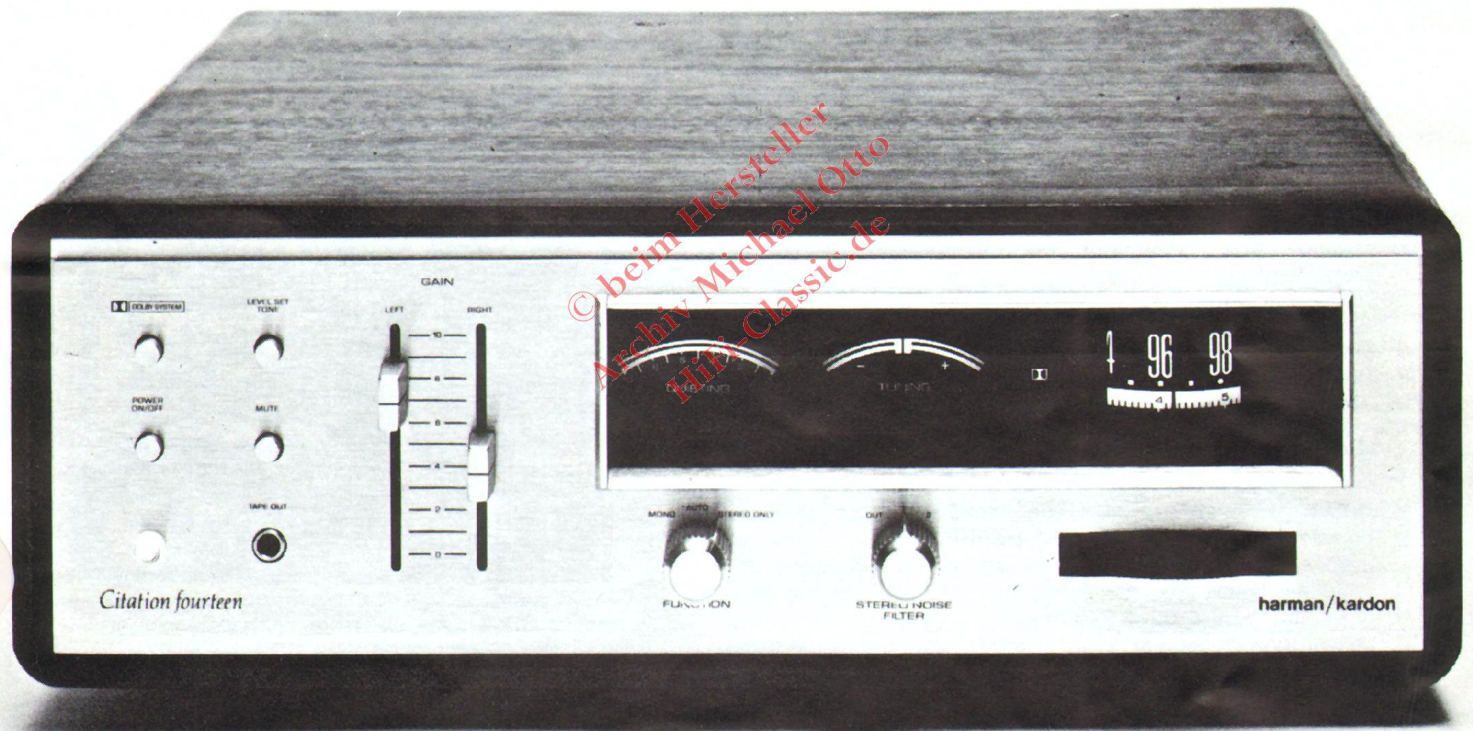


CRITICAL COMMENT



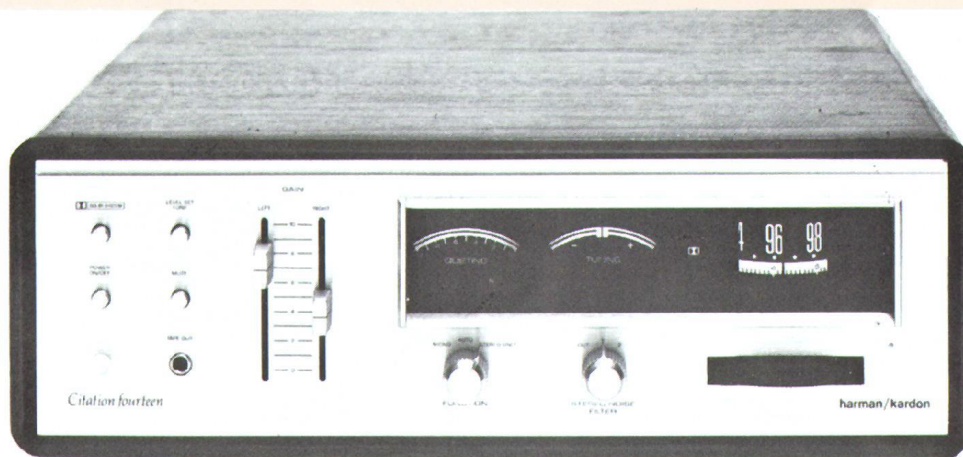
Citation Fourteen

main radio

6 Frankfurt am Main
Hauptgeschäft Kaiserstraße 40
Verkauf Verwaltung Kundendienst
Autoradio Einbaustation Parkhaus
Kaiserplatz Bethmannstraße 50
Telefon-Sammelnummer 25 10 96
Nordwest Zentrum Telefon 57 09 31
Main Taunus Einkaufszentrum
Telefon (0611) 31 94 73

harman/kardon

Harman-Kardon Citation Fourteen Stereo FM Tuner



Now Harman-Kardon's new Citation line is complete! The introduction of the Citation Fourteen tuner will enable Citation fans to put together a complete system, consisting of a Citation Twelve stereo power amplifier, a Citation Eleven control preamplifier, a Citation Thirteen speaker system, and this new Citation Fourteen tuner for a total of \$1760.00! While the product numbering system eludes us, the product performance leaves little to be desired. The new Citation Fourteen, pictured above, includes circuit and styling innovations worthy of the Citation reputation. Just below the blacked-out dial area (which is illuminated in a soft green glow when power is applied) is a massive, horizontally mounted thumb-wheel tuning knob, knurled for easy finger-spinning. The knob is vernier-coupled to a flywheel and a cylindrical dial scale which turns as the knob is turned, disclosing only a few MHz of dial spread at a time. We could swear we saw similar arrangements way back in the 1930's, but somehow, as executed by Harman-Kardon, this tuning approach is fresh, clean, and practical. The blacked-out area also contains the familiar stereo indicator light, a light which becomes illuminated when the Dolby circuit is actuated, a center-of-channel tuning meter, and best of all, a quieting meter which is quite unique and differs from the usual signal-strength meter commonly found on two-meter tuners and receivers. We'll have more to say about this innovation later.

Below the dial area are two rotary switch knobs: one a three-position stereo noise-filter selector, the other a function switch with positions for mono, automatic mono-stereo switching and stereo-only reception. The left-hand portion of the panel (which, by the way, is machined from a chunk of 1/4 inch, solid, gold-anodized aluminum) includes linear slide controls for left and right output level, four push-push buttons for power on/off, Dolby circuit on/off, muting circuit on/off and, finally, a push button with which a built in 400 Hz tone, corresponding to 50% FM modulation, can be applied to the outputs for pre-setting tape recorder levels. A tape-out jack (in

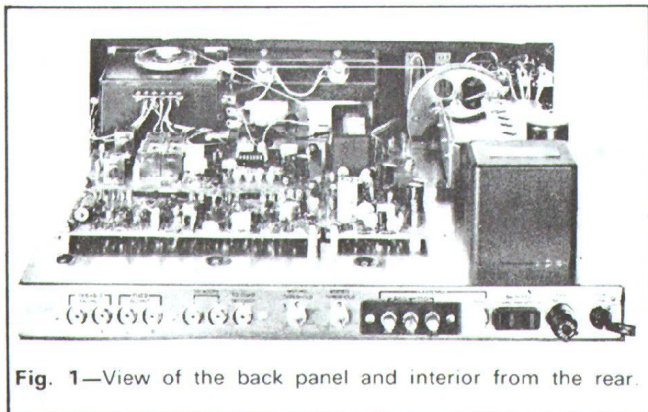


Fig. 1—View of the back panel and interior from the rear.

parallel with the fixed output jacks on the rear panel) completes the front panel layout.

The rear panel, shown in Fig. 1, includes a pair of variable outputs (level is controlled by the front panel slide controls), the fixed output jacks, horizontal and vertical, scope connection jacks (for output signal observations if you own an oscilloscope), a quad-decoder jack (for the four-channel broadcast system of the future), a muting threshold adjustment, antenna screw terminals for 300 or 75 ohms transmission lines plus a 75 ohm coaxial connector, a switched convenience a.c. receptacle, and a line fuse.

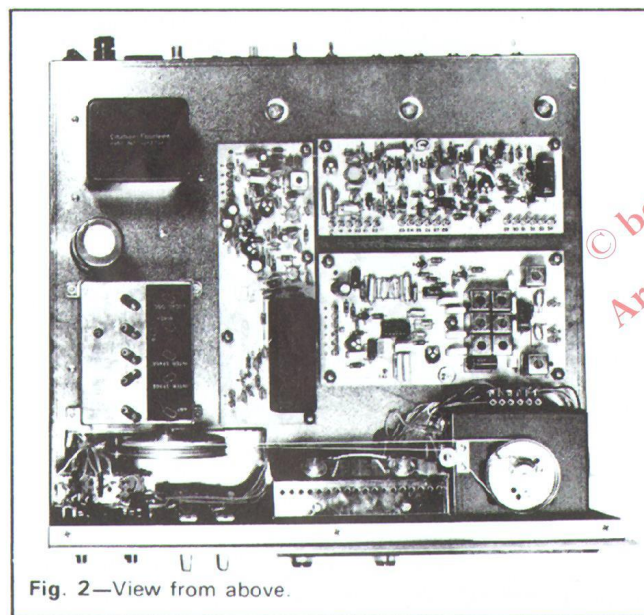


Fig. 2—View from above.

Top view of the inside of the chassis is shown in Fig. 2. In addition to the sealed front end there are six other printed circuit board modules. The front end features a five-gang tuning capacitor, three FET's and a bi-polar local oscillator. The i.f. module includes 2 high gain IC's and a sealed 9-pole phase-linear LC network plus a highly linear ratio detector circuit which is the only tunable element in this section. The quieting meter and muting circuit board contains no less than 22 NPN transistors. Rear panel muting and stereo threshold controls are associated with this PC board, as is the new type of meter mentioned earlier. This meter works just opposite to the usual strength meter. Its "zero" is at the extreme right and the numbers progress to the left, from 0 to 10. Were it simply a "backwards wired" meter, however, there'd be nothing much to discuss. As it is, this meter gives a direct indication of quieting, or signal-to-noise ratio. In tuning to a station, you are instructed to tune for the

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highest number attainable (lowest reading, if you can't help thinking from left to right). To verify this new concept, we plotted meter readings against actual measured S/N and the results are shown in Fig. 3. As you can see, the action is almost the exact inverse of the "noise" curve shown in Fig. 4, unlike most so-called signal-strength meters which generally "do their thing" almost linearly from 0 to 40 to 50 microvolts and then "hover" at maximum from that point upward in signal strength. We found, in using this tuner, that the "maximum" S/N indication is an even finer indication of correct tuning than the center-of-channel meter which is also included.

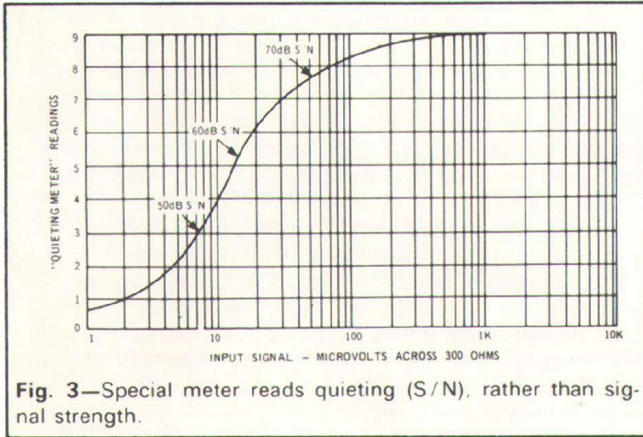


Fig. 3—Special meter reads quieting (S/N), rather than signal strength.

The heart of the multiplex PC module is a new integrated circuit which employs phase-lock-loop circuitry for "locking on" to the incoming 19 kHz pilot signal. There are no coils to adjust for best separation, just a couple of factory pre-set resistive potentiometers. An elaborate system of pi section filters accounts for the very excellent pilot, sub-carrier, and SCA rejection characteristics of the Citation Fourteen. A partial schematic of this section of the tuner is shown in Fig. 5, to give you an idea of just how many parts can be eliminated when a well-designed IC is used in a circuit of this kind.

Other PC boards include the power supply module which contains two zener diodes and five transistors in a regulating circuit which supplies stable +15 and -15 voltages to the other modules. The output module contains a pair of transistors in a direct coupled configuration for each channel output. Supply voltage is a high 50 volts to insure extremely linear characteristics with wide signal swings.

Finally, the Dolby module contains six transistors plus an FET per channel. Its action will be described shortly.

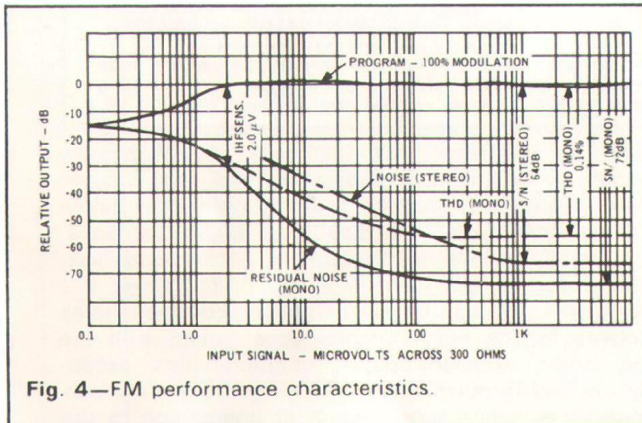


Fig. 4—FM performance characteristics.

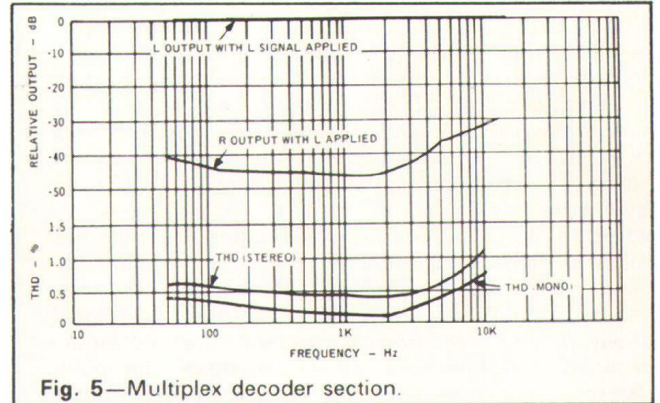


Fig. 5—Multiplex decoder section.

Electrical Measurements

Because of the quality inherent in this Citation Fourteen, we took more than the usual number of measurements to give as complete a picture of performance as possible. In Fig. 4 you can see that ultimate quieting is 72 dB, a bit better than the 70 dB claimed. Mono THD (at 1 kHz) goes below 1% for an input signal strength of 8 microvolts, reaching an incredibly low figure of 0.14% at all signal levels above about 100 microvolts. It should be noted that our new Sound Technology FM Generator only guarantees internal THD of 0.1% (lower than any other FM generator available) and, as you can see, the Citation Fourteen almost calls for another advance in measuring instrumentation! (We just finished paying off the \$1800.00 for the new generator at that!) An additional curve presented is that of residual noise in the stereo mode. This figure reaches an amazing 64 dB — amazing when you take into account the fact that included in the reading are any residual 19 kHz and 38 kHz components which, though extraneous, are not normally perceived as audible "noise." This additional curve is usually meaningless if taken on most tuners because of the presence of these components at the output at a level of -40 to -50 dB or so. IHF sensitivity proved to be 2.0, as claimed but, more important, full (-1 dB) limiting was reached at 1.5 μ V input and 50 dB of S/N was attained with 7 microvolts of input signal.

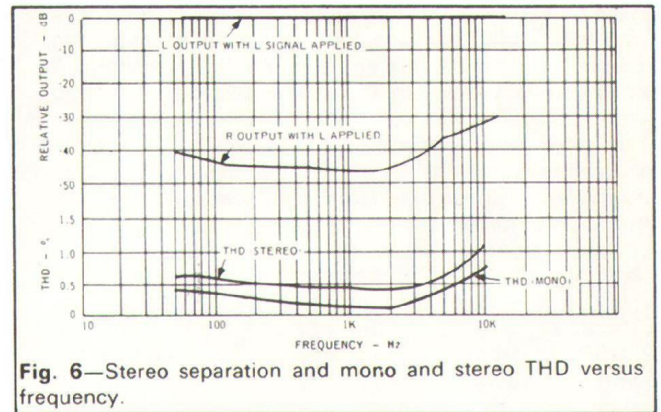


Fig. 6—Stereo separation and mono and stereo THD versus frequency.

Figure 6 depicts stereo FM separation at all significant frequencies as well as mono and stereo THD from 50 Hz to 10 kHz. It is in the area of separation, particularly, that the new phase-lock-loop circuit pays off. Separation of better than 40 dB from 50 Hz to just over 4 kHz is something you just don't run into with more conventional multiplex decoding circuits. Of course, the phase linear i.f. system helps a great deal too. Again, with a test instrument capability of 50 dB separation, this tuner is "pushing it." Even at 15 kHz, separation still measured 30 dB.

The THD characteristics for mono and stereo, also shown in Fig. 6, are outstanding. If you've been following our last few reviews, you'll recall that stereo, THD at the high end is usually quite severe (and usually not quoted by manufacturers). In the case of the H-K Citation Fourteen, stereo THD at 10 kHz is only 1.1%, with values hovering just below 0.5% over most of the useful audio range. In the case of mono, too, the 0.14% figure quoted for 1 kHz THD is not just a "best frequency" reading. Even at 50 Hz, THD was still well under 0.5% while at 10 kHz, it measured about 0.7%. All of these readings are referred to 100% modulation.

For those not familiar with Dolby noise reduction, a brief explanation is in order. The Dolby system is based upon the principle that loud music masks background noise. In other words, when the program is instantaneously loud in volume, any background hiss or noise will be "hidden" psychoacoustically. On the other hand, during quiet passages of music, our ears "home in" on the noise and it becomes annoyingly apparent. A further correct premise of Dolby is that we are most sensitive to high frequency noise. Based upon these premises, Dolby suggests that FM broadcasters employ his equipment to boost the level of high frequency programming when the level is low, but to leave it unaltered when loud passages are broadcast. To re-establish correct relative amplitudes in the tuner, it should have circuitry which plays back all frequencies uniformly when levels are loud, but progressively attenuates high frequency levels when instantaneous program levels are lowered. In the course of this attenuation, residual high frequency noise will, of course, be lowered as well, but the overall frequency response of the desired program material will be restored to "flat" if both ends of the system are reciprocals of each other.

The Dolby circuit in the Citation Fourteen, when introduced into the circuit by means of the front panel switch, provides this dynamic attenuation in accordance with the curves shown in Fig. 7. Notice that when program material is at full modulation, no such attenuation takes place. With decreasing modulation (corresponding to soft passages), attenuation becomes greater and greater, so that with only 10% modulation, attenuation at 10 kHz is of the order of 8 dB. In effect, signal-to-noise ratio has been improved by several dB at that instant of low program level. The switch on the front panel is provided, of course, since only a few stations now employ Dolby processors, and in the absence of such pre-processing, the Dolby circuit should not be used or treble will sound deficient at low program levels. (In this area, Philadelphia, I could receive several New York stations free of noise by using the Dolby mode and compensating with the amplifier treble control — or more elegantly with a Soundcraftsmen equalizer. — Ed.)

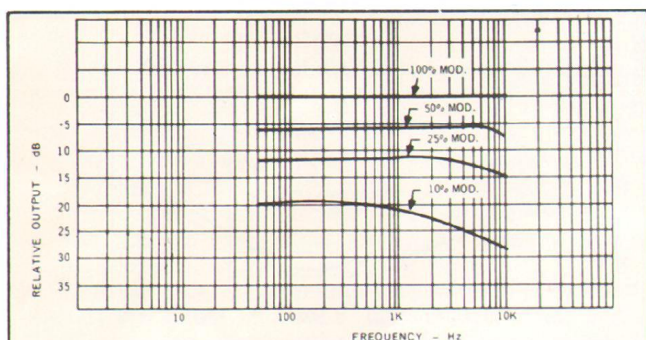


Fig. 7—Dolby action versus frequency at various levels.

We checked range of the rear panel muting control and found it to be adjustable from 30 microvolts threshold down to zero (no muting action). The stereo threshold control is variable from about 30 microvolts down to 10 microvolts. Referring again to Fig. 4, this is just about ideal, for S/N in stereo at 10 microvolts of input signal (always worse than in mono) is about 36 dB. In our opinion, you're better off listening in mono S/N is any poorer than that, and evidently Harman-Kardon feels the same way about it.

Listening Tests

We were delighted to see that the extra pains taken in the design of the stereo circuitry are audibly apparent. The stereo reception we were able to obtain was flawless (at least when tuned to those few stations in our area which put out a good stereo signal). We are convinced that it's not so much the great separation that accounted for this audible difference as it was the low, low distortion figures for that portion of circuitry. Equipped with a rotator on our outdoor Yagi antenna, we found that the quieting meter actually helped orient the antenna for best reception and least multipath. This should not come as a great surprise, since one of the effects of severe multipath is reduced S/N ratio, which is readily seen on the meter. The vernier tuning method is elegant and precise — calibration was just about perfect — as it would have to be with such an expanded scale arrangement. Maximum audio output on our unit was about 3.0 volts rms for 100% modulation and we did have to lower the two slide level controls quite a bit to match the rest of our system. Some tape recorders not equipped with input level controls might have their first stages overloaded by such a large signal.

Rather than "count stations" on this tuner, we listened at greater length to only those stations which had adequate signal strength to allow the Citation Fourteen to perform optimally by setting the mute threshold control to 10 microvolts. At that setting, 40 first-rate signals were heard and 22 of those were stereo. All were amazingly quiet (except for some "studio hum" on some) and, except for those which were loaded with — shall we politely say — poor station practice, distortion was much lower than we're used to hearing. There is one station in our area (WQXR-FM) which has Dolby equipment and so we had a chance to check that circuit in our listening tests as well. It works! We purposely lowered signal strength (by hanging on a "no-no" short piece of wire instead of an antenna) to the point where noise was just audible and threw the Dolby switch — Presto, the noise disappeared!

We understand that there is a less expensive Citation tuner available (Citation Fifteen) which omits the Dolby circuit (plus some other refinements — such as the five-gang tuning in the front end), but it seems to us that if you really want perfection in a tuner (or as near to it as the state-of-the art has come), you'd want to go "all the way" to the Citation Fourteen.

Leonard Feldman

Citation Tuner Features Built-In Dolby

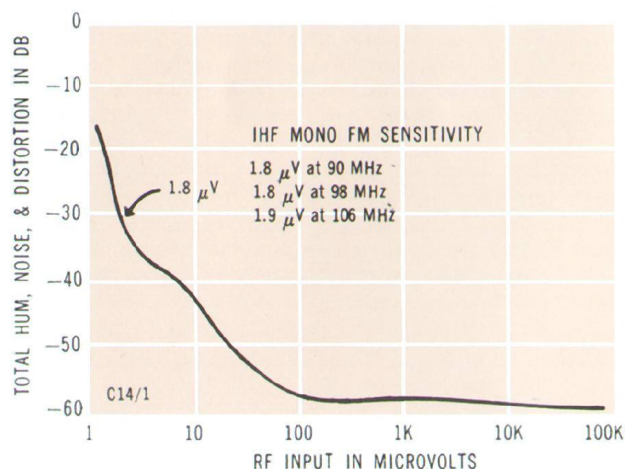
The Equipment: Harman-Kardon Citation Fourteen, a stereo-FM tuner with built-in Dolby B noise reducer (NR). Dimensions: front panel, 16 by 5 inches; chassis depth, 13¹/₂ inches. Price: \$525. Manufacturer: Harman-Kardon, Inc., 55 Ames Court, Plainview, N.Y. 11803.

Comment: The latest H-K model in the Citation series of premium stereo products, the Model Fourteen is a basic tuner (intended for connection to an amplifier and speaker or headphones) of advanced design and superb performance. Among its innovations is the inclusion of a Dolby B noise-reduction circuit that improves reception of Dolbyized FM broadcasts. (Reports indicate that more stations are adding Dolby constantly.) Another innovation is the set's quieting meter (on which patents are pending) which indicates the signal-to-noise ratio of incoming programs and which, together with the more conventional center-of-channel meter, makes for very accurate tuning. The RF section employs circuitry geared for high suppression of spurious signals, phase linearity "hard limiting" of noise, and wideband response that is designed to feed an optimum composite FM signal into an external four-channel adapter. Included too is a 400-Hz calibration reference tone (available at the push of a button) that facilitates setting recording levels on a tape recorder.

Four pushbuttons at the upper left portion of the es-cutcheon provide control for the Dolby action, the 400-Hz tone, power off/on, and interstation muting. Below the power switch is a pilot lamp; below the muting switch, a stereo phone jack output for feeding signals to a tape recorder. This receptacle is identical in function to a pair of fixed-output phono jacks at the rear. Next to this front-panel group is a pair of slide controls that regulate audio level on each channel independently when taken from another pair of variable-output jacks at the rear of the set—the jacks that normally feed your stereo amplifier.

The largest portion of the front panel is given over to a blackout section that includes the quieting meter, tuning meter, Dolby pilot lamp, station dial scale, and stereo indicator. The dial scale employs oversized numerals that resemble those used in digital tuning; the numbers themselves rotate on a drum, controlled by the large knurled knob directly beneath the dial so that the traditional pointer on a fixed dial has been eliminated. To the left of the tuning knob there's a three-position stereo noise filter; to its left, a three-position function switch (mono, automatic stereo, stereo only).

In addition to the outputs already mentioned, the rear of the Citation tuner contains outputs to feed an oscilloscope (for professional or lab applications; these are identical to the fixed-gain outputs and may be used as a second pair if desired), an output to feed an external quadra-



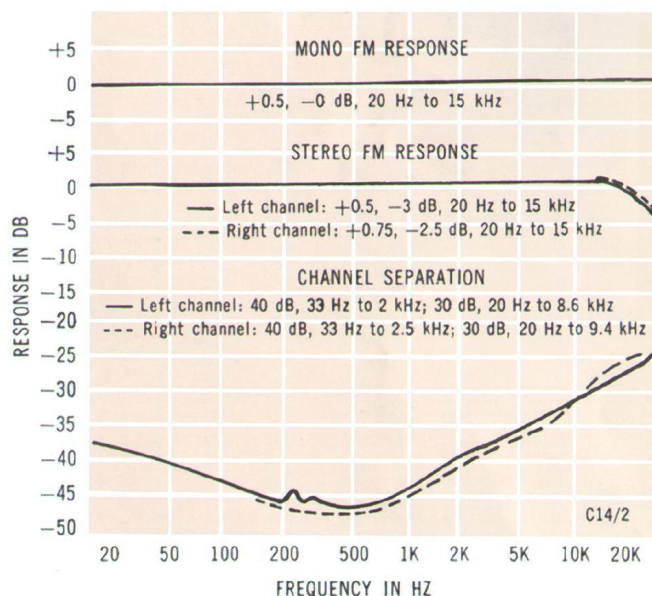
phonic-FM adapter, a muting threshold adjustment, a stereo threshold adjustment, a switched AC convenience outlet, fuse holder, and power cord. In addition to screw terminals for 300-ohm and 75-ohm antenna lead-in, there's also a separate connector for direct hookup of 75-ohm coaxial cable. This last item is a nice touch that will be especially appreciated by those who live in a cable-served area or who otherwise use 75-ohm coaxial cable.

In tests at CBS Labs the Citation Fourteen rolled up an impressive score that, together with its actual performance and sound, places it at the top of an already distinguished group of the very best FM tuners. Sensitivity is excellent; distortion figures for both mono and stereo reception are very low, even at the usually difficult frequency of 10,000 Hz. As shown on the graphs, audio response and stereo channel separation are exemplary.

To characterize the sound of the Citation Fourteen would be to repeat the hallmarks of true high fidelity reproduction. Indeed, when tuned to a good station, this tuner makes you think you're listening to high-quality discs or tapes played in the same room. In terms too of its ability to pull in stations, the Citation Fourteen is second to none. It's also a joy to use; everything works smoothly and correctly. It is very much a tuner for today, and with its Dolby feature and quadraphonic adapter output it qualifies as a tuner for tomorrow.

Citation Fourteen Tuner Additional Data

Capture ratio	1.5 dB		
Alternate-channel selectivity	70 dB		
S/N ratio	74 dB		
THD	Mono	L ch	
80 Hz	0.13%	0.15%	0.22%
1 kHz	0.11%	0.13%	0.13%
10 kHz	0.29%	0.66%	0.56%
IM distortion	0.25%		
19-kHz pilot	-66 dB		
38-kHz subcarrier	-66 dB		



Harman-Kardon Citation Fourteen Stereo FM Tuner

The latest addition to Harman-Kardon's Citation line of premium-quality components is a new FM tuner, the Citation Fourteen. Its most obvious claim to distinction is the inclusion of Dolby-B circuits to take advantage of a growing number of FM stations that broadcast their audio signal with Dolby-B equalization. The use of Dolby processing serves to extend the low-noise reception area of an FM station, and virtually to eliminate the residual hiss usually present during stereo reception from even nearby FM stations.

Aside from its Dolby circuits, the Citation Fourteen has a number of noteworthy operating and circuit features. Its front-end, which uses two FET r.f. amplifiers, an FET mixer, and a total of four tuned circuits, has exceptional selectivity. The i.f. section has a sealed nine-pole inductance-capacitance filter and two IC amplifiers. The multiplex stereo-decoder section also uses a special phase-locked-loop circuit and a single IC, with two transistor-driven low-pass filters to remove ultrasonic frequencies from the audio outputs.

Although the Citation Fourteen has a zero-center tuning meter, a novel QUIETING meter provides a very sensitive and meaningful indication of the optimum tuning point. Some eleven transistors are used in the circuits driving the quieting meter. (Another eleven operate the interstation-noise muting and mono/stereo switching circuits.) This seemingly profligate use of components for what are generally considered purely auxiliary functions is by no means frivolous. The quieting meter is a genuinely effective aid in realizing the full potential of this fine tuner. In essence, the quieting meter measures the noise in the detector output, but only in a frequency band that we estimated to be centered at about 120 kHz. When a station is tuned for a maximum meter reading (the meter scale is calibrated from right to left), both the audio noise and distortion are minimized.

The front panel is dominated by the two large illuminated meters and a horizontal drum tuning dial (the visible portion of which is about the same size as the meters), calibrated in 1-MHz intervals. Tuning is by a horizontal thumbwheel below the dial. A red STEREO light is to the right of the dial. A three-position switch provides two degrees of high-frequency channel blending for stereo noise reduction and a function switch provides mono, automatic stereo/mono switching and stereo-only reception. Two vertical sliders control the output levels of the tuner.

At the left of the panel are four pushbuttons controlling a.c. power, interstation muting, and the Dolby system. A yellow double-D symbol to the left of the dial lights up when the Dolby circuits are in use. The fourth button injects a Dolby 400-Hz standard-level reference tone, equivalent in amplitude to a 50 per cent modulated FM signal. When tape recording a Dolbyized FM broadcast, this tone is used to set the recorder's level controls for a "0-dB" level. The Dolby circuits of the tuner and recorder are normally not used during recording. Subsequent playback of the tape through a separate Dolby decoder applies the noise reduction to the tape and the FM program. If the recorder is not equipped with the Dolby system, the decoding can be done in the tuner before recording. (It should be noted that one cannot record a Dolby-encoded broadcast and simultaneously listen to it in decoded form unless one has a separate Dolby decoder or Dolby circuits in the tape machine that can be used for monitoring while recording. Nor can the Citation's Dolby decoder be used except for decoding Dolby broadcasts at the time of reception.)

In the rear of the tuner are variable and fixed audio outputs (there is also a TAPE REC output jack on the front panel), oscilloscope outputs carrying the two channel signals, an output ahead of the de-emphasis network to be used with some future FM quadrasonic decoder, stereo

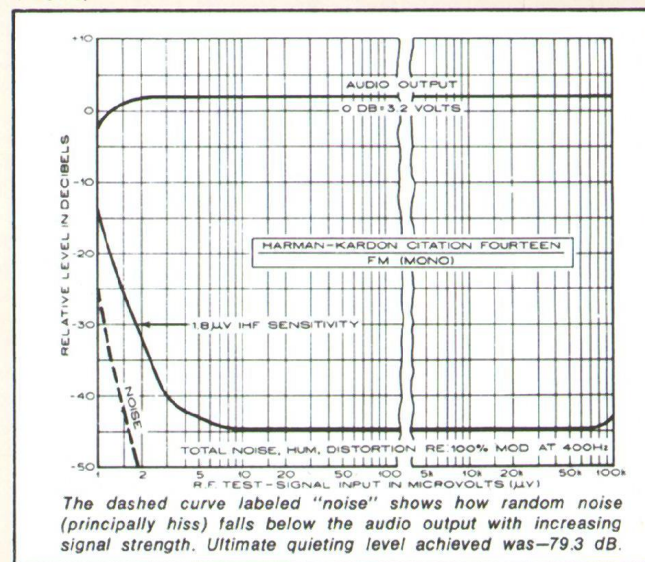
and muting-threshold adjustments, antenna terminals, and a switched a.c. outlet. The Harman-Kardon Citation Fourteen is 16 inches wide, 5 inches high, and 13½ inches deep. Its price is \$525. The very similar Citation Fifteen, which lacks the Dolby circuits, is \$395. Cabinets for either model are \$35.

Laboratory Measurements. The Citation Fourteen fully lived up to its promise. The measured IHF sensitivity was 1.8 microvolts with a remarkably steep limiting curve producing a 50-dB signal-to-noise ratio at less than 2 microvolts, and an ultimate quieting of 79.3 dB (the best we have ever measured on an FM tuner) at all inputs over 100 microvolts. The Dolby circuits were not used during these measurements.

The frequency response was almost perfectly flat from 30 to 15,000 Hz, where it was down only 0.8 dB. Stereo channel separation was excellent — over 21 dB from 30 to 15,000 Hz, and between 40 and 45 dB from 550 to 7,000 Hz. This is also the best separation we have ever measured on a tuner. The tuning-dial calibration was so accurate that the dial could be preset to the frequency of a station, and the broadcast would be there when the unit was switched on.

The capture ratio was 1 dB at 1,000 microvolts and 2.7 dB at 10 microvolts, attesting to the excellent limiting action. The AM rejection was 54 dB, and alternate-channel selectivity was about 75 dB, although the abrupt action made this measurement difficult. The image rejection was well in excess of 100 dB — at the maximum 100,000-microvolt output of our signal generator we could find no trace of an image response!

The interstation-noise muting threshold was factory set at 7.5 microvolts, and was adjustable from 2.2 to 30 microvolts. It operated smoothly and with virtually complete freedom from transients. The stereo threshold was set at 11 microvolts, and could be adjusted from 11 to 35 microvolts. The audio output reached a maximum of about 4 volts.



Comment: In the New York City area, WQXR is now transmitting with the Dolby system, and the Citation Fourteen was able to produce a totally noise-free output from these broadcasts. We also tried a poor antenna, which normally results in an audible background hiss; with the Dolby system noise was again inaudible.

Overall, the Harman-Kardon Citation Fourteen rates superlatives for its easy, unambiguous tuning with the quieting meter, excellent muting characteristics, exceptionally low background noise, and overall excellent performance. It is a fine tuner and a fit companion to the other units in the Citation line.

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