HARMAN/KARDON CITATION TWENTY-THREE TUNER

Manufacturer's Specifications

FM Section

Usable Sensitivity, Mono: Normal, 10.8 dBf; Hi Q, 14.7 dBf.
50-dB Quieting Sensitivity: Normal mono, 15.2 dBf; Hi Q mono, 19.1 dBf; normal stereo, 36.5 dBf; Hi Q stereo, 40.4 dBf.
S/N: Mono, 84 dB; stereo, 75 dB.
THD at 1 kHz: Normal mono, 0.06%; Hi Q mono, 0.2%; normal stereo, 0.08%; Hi Q stereo, 0.2%.
Stereo Separation at 1 kHz: Normal, 55 dB; Hi Q, 35 dB.
Capture Ratio: Normal, 0.75 dB; Hi Q, 1.75 dB.
Alternate-Channel Selectivity: Normal, 65 dB; Hi Q, 75 dB.
Adjacent-Channel Selectivity: Normal, 5 dB; Hi Q, 30 dB.
I.f. Rejection: 90 dB.
AM Rejection: 70 dB.
Image Rejection: Normal, 75 dB; Hi Q, 85 dB.
Spurious-Response Rejection: 115 dB.
SCA Rejection: 70 dB.
Output Level: 1.0 V.

AM Section

Sensitivity: 12 μV/m.
Alternate-Channel Selectivity: 60 dB.
Image Rejection: 45 dB.
I.f. Rejection: 65 dB.
S/N: 55 dB.

General Specifications

Dimensions: 17⅜ in. W × 2¾ in. H × 14⅝ in. D (44.1 cm × 7 cm × 37.2 cm).
Weight: 15 lbs. (6.8 kg).
Price: $595.
Company Address: 240 Crossways Park West, Woodbury, N.Y. 11797.
For literature, circle No. 92

Harman/Kardon does not designate a new audio component as part of their prestigious Citation series unless there is really something special about it. Their recently introduced Citation Twenty-Three AM/FM tuner merits the designation on many counts. Physically, the tuner is extremely attractive, with its softly rounded buttons, understated indicator lights, and low silhouette. But it's what lies behind the tastefully designed front panel that really impressed me.

To the best of my knowledge, the engineers at H/K worked on the Twenty-Three for the better part of two years. The result is a tuner that is ideally suited for those areas where the FM dial is populated by a great many signals—and that means just about every major city in the United States. Two innovative design features make this so: A novel type of narrow i.f. mode and an unusual fine-tuning circuit.

Many tuners offer two i.f. modes—a wide one that can be selected when there is no interference and a narrow one that uses sharp band-pass filters in an attempt to improve rejection of adjacent-channel interference. Unfortunately, such sharp filters also introduce phase and amplitude errors that often decrease separation and increase distortion. The Citation Twenty-Three provides two i.f. modes too: A conventional wide mode and another that H/K calls "Hi Q." The circuit details remain secret (H/K is waiting for patents to be granted), but I can reveal this much about it: Instead of filtering the "edges" of a desired bandwidth, the Hi Q circuit

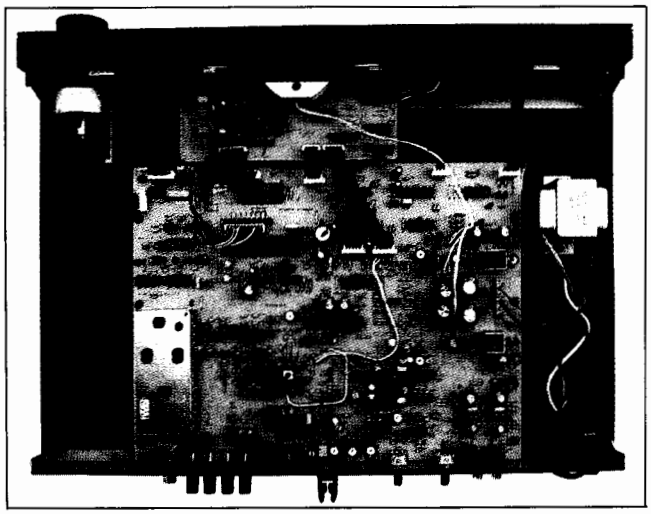
To reduce interference, an unusual feature lets you fine-tune off a station's center frequency by 25 kHz in either direction.

employs a phase-locked loop (PLL) that locks onto the FM carrier itself, isolating the center frequency of the desired listening band and then limiting the allowed bandwidth to the maximum deviation caused by the incoming modulated signal. By limiting the PLL's tracking range to just slightly more than the modulation range (approximately 80 kHz on either side of the carrier's center frequency), only the signal needed for good separation and relatively low distortion is passed through to the rest of the i.f. system and on to the quadrature detector. Because the PLL circuit does not employ resonant (tuned) elements, no phase shift is introduced; thus, stereo music signals and the 19-kHz pilot signal associated with stereo transmission retain correct relative phase.

The second innovative feature incorporated in the Twenty-Three addresses one of the disadvantages of quartz-locked, frequency-synthesized tuning—the lack of latitude in tuning to the actual center frequency of the received signal. Harman/Kardon's engineers have solved this problem with an analog fine-tuning circuit that allows you, when in Hi Q mode, to tune away from the assigned center frequency by as much as 25 kHz in either direction. This can further improve adjacent-channel rejection and eliminate interference. Such tuning flexibility is also important if you subscribe to cable FM, since cable operators are not always as careful as broadcast stations when it comes to frequency allocations and accuracy.

Control Layout

At the left end of the front panel are the "Power" button (with built-in indicator LED), a "Memory" button for setting station presets, and a button that's used, like the shift key on a typewriter, to enable you to store 16 AM and FM stations (in any combination) with only eight actual preset buttons. The preset buttons, in a horizontal row, are labelled with two sets of numbers (1 through 8 above the buttons, 9 through 16 below). When one of these preset buttons is pressed, an LED glows at its top or at its bottom, depending upon whether the "shift" key has been pressed or not. An infrared sensor above the seventh preset button responds to commands from the supplied remote control, which duplicates most of the front-panel functions.



At approximately the center of the panel is a display area that shows signal strength of a received station (graded from 1 to 5), the selected AM or FM frequency, stereo reception, and the status of the fine-tuning feature. The "Hi Q" button is just below the display area; pushing it activates the narrow-mode circuitry described above as well as the fine-tuning circuitry, controllable by means of a small rotary knob next to the "Hi Q" button. When you use the fine-tune knob, an arrow in the display shows if you have tuned above or below the frequency indicated by the numeric display. If you tune to another station, the Twenty-Three automatically cancels the fine-tune setting, since the new station might not require fine tuning. (Even if it did, the fine-tuning direction required for one station would not necessarily be optimal for another.)

Farther to the right are an interstation "Mute" button, AM and FM band selector pushbuttons, a mono/stereo button, a "Seek" button, and a large tuning knob. When "Seek" is pressed, rotating the knob in either direction causes the tuning circuits to scan across the band and stop at the next strong signal. When "Seek" is released, the knob tunes linearly, with displayed frequencies changing gradually as you turn it.

The rear panel of the Citation Twenty-Three is equipped with 300- and 75-ohm FM antenna terminals, AM antenna terminals (to which the supplied pivoting AM loop can be attached), variable and fixed output jacks, and an unswitched a.c. convenience outlet. A control near the variable output jacks is used when adjusting output level, and a second small control adjusts muting threshold (the level of signal that will overcome the interstation muting circuit if muting has been activated at the front panel).

Measurements

Usable mono sensitivity in the normal (wide) mode measured slightly more than 11.0 dBf, while maximum signal-to-noise ratio for strong mono signals reached 84 dB, exactly as claimed by Harman/Kardon. Stereo threshold was set at about 32 dBf; below this level, reception automatically switched to mono. At 65 dBf, S/N in stereo was 75 dB, as claimed, but if I increased generator output beyond that point, S/N improved still further, reaching a maximum of 79 dB at 80 dBf. Figure 1 shows how mono and stereo noise varied with increasing input signal strength. Notice, too, the excellent limiting characteristics of this tuner, as indicated by the top curve, labelled "Audio Output." Virtually full limiting is reached by the time input signal level approaches 10.8 dBf, the rated level for mono usable sensitivity. Few FM tuners deliver fully limited audio signals at such low r.f. input levels.

In the Hi Q (narrow) mode, mono usable sensitivity was around 18 dBf, a bit higher than in normal mode. However, with strong signal inputs, mono S/N readings were the same in Hi Q as they were in normal mode, so I am not presenting a separate graph for those results.

Total harmonic distortion plus noise for a 1-kHz modulating signal in the normal mode reached 0.05% in mono at 65 dBf, decreasing further to 0.043% at 80 dBf. Stereo THD in

The test result of 32 dB for adjacent-channel selectivity really made me take notice; it's the highest I have ever encountered.

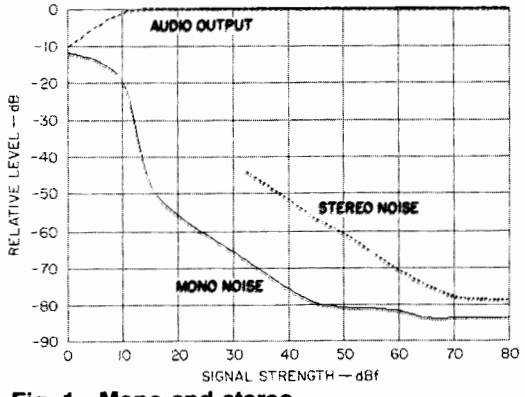


Fig. 1—Mono and stereo quieting characteristics, FM section. Note excellent limiting characteristics; see text.

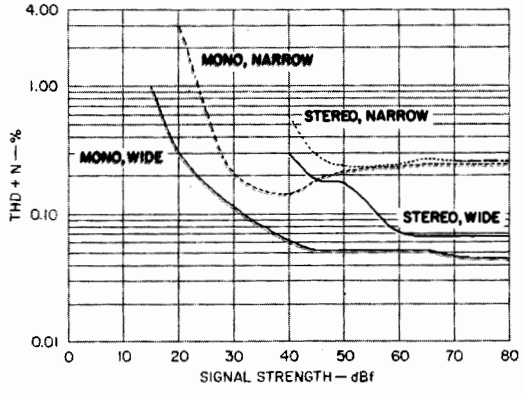


Fig. 2—THD + N vs. signal strength for normal (wide i.f.) and Hi Q (narrow i.f.) modes, FM section.

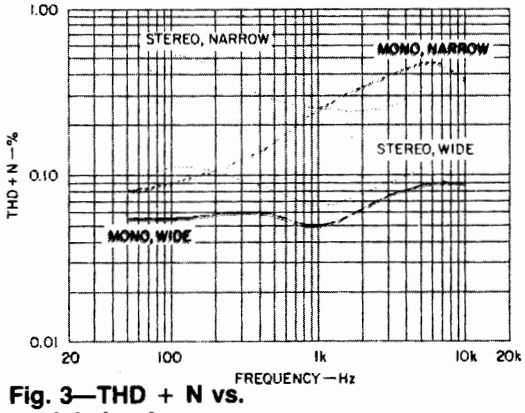


Fig. 3—THD + N vs. modulating frequency for normal (wide) and Hi Q (narrow) modes, FM section.

this mode was almost as good, with readings of 0.065%. When I switched to the Hi Q mode, distortion increased, as might be expected. That's one of the penalties of greater selectivity, no matter how it is achieved. In Hi Q mode, THD in both mono and stereo hovered around the 0.25% mark with strong signals applied. Figure 2 shows how THD varied as a function of input signal level for mono and stereo signals and for both the normal and Hi Q operating modes.

Figure 3 shows how THD + N varied as a function of modulating frequency for mono and stereo in both operating modes. Because the unit I tested exhibited a fairly high amount of unsuppressed subcarrier output, I was unable to obtain an accurate reading for THD at 10 kHz in the stereo mode. Any test setup with sufficient bandwidth to measure 20 kHz, the second harmonic of 10 kHz, would also measure the 19-kHz subcarrier components. The result would be inordinately high "distortion" readings that are not really harmonic distortion at all. This problem does not occur when measuring distortion at lower frequencies, because the IHF/EIA/IEEE Tuner Measurement Standard, which requires distortion measurements only at modulating frequencies up to 6 kHz, prescribes the use of a band-pass filter whose cutoff points are at 200 Hz and 15 kHz. (To obtain 10-kHz readings, I take this band-pass filter out of the signal path.) In any case, in the normal mode, mono THD remained well under 0.1% at all frequencies, and stereo THD rose to no more than 0.11% at 100 Hz and to 0.12% at 6 kHz. In the Hi Q mode, mono THD remained under 0.1% at low frequencies, increasing to 0.48% at 6 kHz; in stereo, THD was 0.52% at 100 Hz and 0.38% at 6 kHz.

With the tuner set to the normal mode, stereo separation (Fig. 4) measured in excess of 55 dB at mid-frequencies, dropping to 51 dB at 100 Hz and to 40 dB at 10 kHz. When the Hi Q circuit was activated, separation decreased (middle trace of Fig. 4), but it was still a very adequate 39 dB at 1 kHz, 41 dB at 100 Hz, and 29 dB at 10 kHz.

Figure 5 shows separation at 5 kHz, the difference in height between the tall spike at the left and the smaller spike contained within it. It also shows the crosstalk components produced at the output of the unmodulated stereo channel in the presence of a 100%-modulated, 5-kHz signal on the opposite channel. The two fairly large components near the right of the photo are sidebands surrounding the smaller residual 38-kHz subcarrier component. It was these unusually large out-of-band components that prevented me from getting a meaningful stereo THD reading at 10 kHz. Although these components will certainly not be audible, they shouldn't be this large, since they could affect Dolby recordings made off the air. I discussed this situation with engineers at H/K; they informed me that my sample was from a small, first-production pilot run and that the problem—which they too had discovered—has since been corrected.

Perhaps the most significant measurement which I can report is the Twenty-Three's adjacent-channel selectivity in the Hi Q mode. The 32-dB value I obtained really made me sit up and take notice; I have never measured a tuner that did as well. Most tuners, even when measured in the narrow i.f. mode, rarely achieve values of even 20 dB; those tuners that don't have a narrow mode generally do not exceed 5 to 10 dB. This unit's excellent 32-dB reading accounts for its

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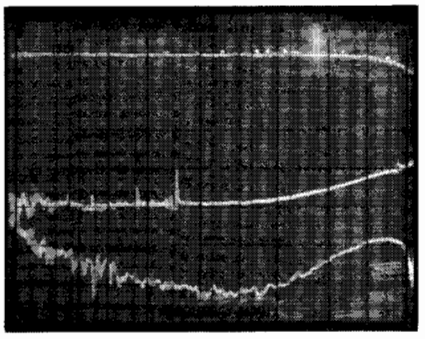

Fig. 4—FM frequency response (top trace) and separation vs. frequency for Hi Q mode (middle trace) and normal mode (bottom trace).

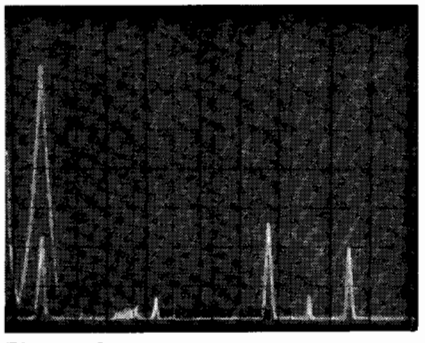

Fig. 5—Separation and crosstalk components for a 5-kHz modulating signal, plus subcarrier and sideband components. See text. (Vertical scale: 10 dB/div.)

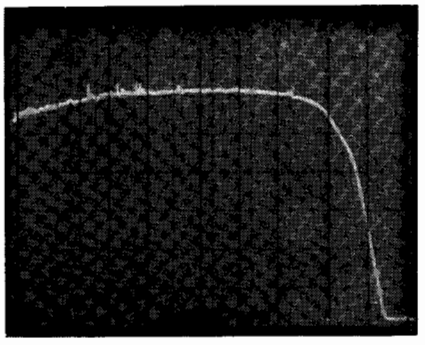

Fig. 6—AM frequency response.

ability to single out an incoming signal even when a stronger signal is only 200 kHz away.

Alternate-channel selectivity turned out to be 63 dB in the normal mode and 78 dB in Hi Q, almost exactly as specified. Other measurements, such as image, i.f., and AM rejection, also came to 1 or 2 dB above or below the manufacturer's specified value. Because of the limitations of my test equipment, I can't confirm the claimed spurious-response rejection of 115 dB, but I can attest to a figure of at least 100 dB. Equipment limitations also prevented my measuring capture ratio down as low as the Twenty-Three's rating of 0.75 dB in normal mode. The best I've ever been able to measure (again, probably owing to the test gear) is 1.0 dB, and that's what I obtained in this case. Capture ratio in the Hi Q mode was a bit poorer, closer to 2.0 dB, but that's still a very acceptable value.

Harman/Kardon obviously paid some attention to the AM circuitry in this tuner too. The AM frequency response, seen in Fig. 6, shows that the 6-dB roll-off point occurred a bit above 5 kHz. That's almost an octave higher than I usually measure on AM/FM tuners and receivers, even if it's not quite "high fidelity." Having been favorably impressed by this measurement (it's always a surprise to find a tuner with AM response above 3 kHz), I decided to devote a bit more time to the AM section. I measured AM sensitivity (via the external antenna terminals) of 15 μV, S/N ratio of exactly the 55 dB claimed, i.f. rejection of 67 dB, and distortion of under 0.5% for mid-frequency modulating signals.

Use and Listening Tests

There is a station near the bottom of the FM band in my area (near New York City) that I had always suspected was either overmodulating or simply putting out a distorted signal. With the aid of the Citation Twenty-Three, I was able to prove that the problem was overmodulation. In the Hi Q mode (which permits no more than 80 kHz deviation even if a station modulates beyond its allotted 75 kHz), I could clearly detect the kind of distortion that arises from severe overmodulation. There's also a fairly strong station in my area that has prevented me from receiving a weaker station coming from mid-Connecticut whenever I've used a frequency-synthesized tuner. With the aid of the Twenty-Three's fine-tune and Hi Q features, I was able to off-tune ever so slightly, just enough to maintain distortion-free reception of the weaker station while eliminating just about all traces of the previous interference.

Even in the absence of reception problems to address, the Citation Twenty-Three is without a doubt a very good-sounding tuner. The range of muting adjustment is very broad, from about 30 dBf to 65 dBf. I don't think anyone would ever set it at its maximum point, though, unless one wanted only the very strongest stations to come through.

I guess the highest compliment I can pay to this component is to say that it definitely deserves the Citation label, a designation that has never been awarded lightly by Harman/Kardon's management. The Twenty-Three is both great to look at and great to listen to. With tuners like this around, perhaps a few more stations in each listening area will clean up their act in an effort to match its fine performance.

Leonard Feldman