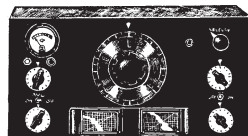


THE COMMUNICATIONS RECEIVER



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The National HRO-500 Revisited

First I want to apologize for a couple of errors in the last article. The IF output of the HRO-500 is at 230 kHz, not 262 kHz, which is a standard frequency for Miller coils for transistor radios. The inner dial on the receiver is the high speed dial, the outer dial is the slow speed dial. I mis-typed the initial series of receivers, it is 75-xxx, not 77. In addition I should have mentioned that the dial with the crank has a skirt that covers the inner dial, allowing only slow speed tuning. However the crank does make it possible to do large excursions pretty quickly.

Spending more time with the HRO-500 brought up a couple of other items I should have mentioned. The phase locked loop has a fairly slow lock-up time, making the receiver phase noise low compared to moderately priced transceivers of only a few years ago, this signal is mixed with a "real" L/C VFO, so the conversion noise is relatively low.

The phase locked loop is locked to the harmonics of a crystal oscillator. The harmonic is chosen by the band selector setting along with the synthesizer tune. The synthesizer tune control moves a drum with cutouts to show the frequency (for example 14.000 MHz) to be added to the dial reading on the great epicyclic dial system.

The audio distortion I mentioned was (according to a National Repair Technician) limited to part of the first series of receivers, the 75.xxx serial units. This distortion was caused by an error in winding the coil for BFO injection which caused the two signals fed to the detector to be quite different in level. The inequality causes distortion in the product detector. I have a late 75.xxx serial unit that has very good sound in SSB as well as AM and CW.

As I mentioned in the earlier article on

the NC-500, I do not know why National used the L/C filtering in this receiver when excellent mechanical filters had been available for quite a number of years. An option was offered to add the 455 kHz mechanical filter. Unfortunately filters for the 230 kHz IF are not readily available, so we are stuck with the cup core filter system for the narrower selectivity selections.

This filter is definitely not as bad as the 455 kHz LC filter systems offered in many receivers of this era, but doesn't compete with the mechanical or crystal filter. The filters are tunable to allow upper or lower SSB, or upper or lower sideband CW operation.

These IF filter systems allow bandwidths at 6 db. down of 500 Hz, 2.5 kHz, 5 kHz, and 8 kHz. The cup core filter system is only used for the two narrowest positions. The bandwidths at 60 db down are 3 kHz, 6 kHz, then without the cup core filter system, 16 kHz and 30 kHz. The shape factor at 2.5 kHz bandwidth is 2.5, pretty similar to that of the HRO-60 or 50T-1. One advantage of the HRO-500 over the 60/50T-1 receivers is the wider bandwidths available for AM listening.

The rear panel of the HRO-500 has nine RCA connectors, an 18 pin plug and five screw terminals as well as high (RCA Phono) and low (SO-239) impedance antenna connectors, and power input sockets for either 115/230 VAC or 11-16 VDC. This number of connections indicates the versatility that the receiver has in station integration.

The RCA connectors include VFO output, 230 kHz BFO output, HFO output and 26 MHz oscillator output (for Diversity reception when two receivers are coupled), high impedance and low impedance RF inputs and two spares. The screw terminals

provide output at 3.2 ohms for a speaker, and 600 ohm center tapped audio output connections. The low impedance antenna connector uses a phenolic insulator. The power input for 115/230 VAC is the same as that used on TV “cheater” cords. The DC input is a two pin connector using two parallel flat pins, one wider than the other for polarity control.

The 18 pin Jones type connector has a ground terminal as well as outputs for 5, 7.5, 10, 11, and 12 volts DC as well as 12 volts AC. It also has a pair of contacts for remote standby, a muting terminal, (ground for muting), NPN AGC voltage, PNP AGC

voltage, remote RF gain, detector out and audio in, along with audio output at 3.2 ohms. There are several muting circuits shown in the manual along with remote RF and AF gain control. When looking at the rear of this plug, the top six terminals are horizontal, the next two rows of six pins are both vertical in orientation.

As I mentioned before, the receiver is quite stable. After a short warm up, the change in frequency can be heard on CW, but the change is not large enough to cause you to retune a SSB QSO. Perhaps digital modes like PSK31 would be difficult to copy unless you used software that can fol-

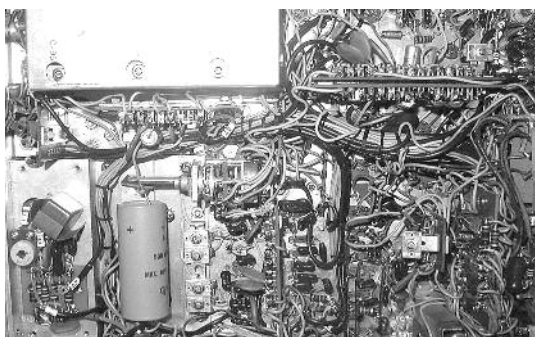
low the small drift in frequency. The sensitivity of the receiver is adequate as long as you are using a matched 50 ohm antenna connected to the SO-239 input, or have a high impedance antenna connected to the other input.

This receiver uses three tuned circuits at the signal frequency, tuned by the “Preselector Tune” control. The three tuned circuits along with the silicon type RF amplifier give higher performance than you would think for a transistor receiver of this vintage.

I am lucky in not having a large number of ham band or short wave transmitters in close proximity to my antennas. I am sure those who live in locations that cause intermodulation or overload problems with modern transceivers would not find the HRO-500 front end adequate for weak signal reception at frequencies near one of these high powered transceivers.

The “AGC” control on the front panel allows you to insert up to 30 Db of loss prior to the AVC circuit. According to the manual, “You may have found that fading of a relatively strong signal brings up a weak signal enough that it takes over the AGC lowering the gain on the signal which just faded.”

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Front, rear and wiring views of the HRO-500.

in Figure 3. Looks like the amp has a response of ± 3 dB from about 25 to 4000 Hz. I wondered whether some negative feedback might be applied to smooth out the response shown, but I believe there's not enough open-loop gain in this design to allow more than a few dB of feedback before output power would drop below useful levels. I guess most of the blame for the poor performance should fall upon the output transformers.

Finished, I added a 1.5 amp line fuse, wrote up the test results and gave the set back to my friend. But as soon as this amp was returned, back it came with a blown fuse. At first, I wondered about some fragments of cathode coating that he had noticed inside one of the 6BQ5s. Could they have gotten between tube elements and caused a short? However, a high-voltage test of the B+ chain without the tubes lighted soon uncovered a half-inch piece of wire wedged between the chassis and one lug of the filter capacitor. Clearing that stopped the problem—so far.

So what are *your* experiences with today's "audiophile" hardware? I see all sorts of homebrew amplifiers and preamps discussed in audio forums; some are prettied-up and use strange tubes in single-ended circuits. I once saw an amplifier that used a pair of 813s to give "about six watts per channel." The Antique Radio Forum¹ has a couple of categories in which the belief systems of "audiophools" are discussed, making for interesting reading.

Fifty years ago, when I was a tech for a Washington, DC Hi-Fi chain, everyone was a newbie, and our rules-of-thumb included two main pieces of advice: (1) spend half your budget on speakers, and (2) set the tone controls where the system sounds best to you. Meanwhile, please excuse me while I go out to buy some hotmelt glue... 

REFERENCES:

- 1 Internet Antique Radio Forum – <http://www.antiqueradios.com/forums/>

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National basically states that the loss introduced will precede the AGC keeping the low level signal from taking over. I was not able to see how this is different from adding an attenuator in front of the receiver. Anyway the AGC works pretty well, and has only a 5 Db change with a variation from 10 to 100,000 uv.

What can be done to improve the HRO-500? For shortwave listening I have found that using a synchronous detector improves my enjoyment. When there is selective fading, the carrier sometimes falls below the level of the sidebands, eliminating readability if you are using a diode detector. The synchronous detector synchronizes a local oscillator with the transmitted carrier. This local oscillator is then used in a product detector to produce the recovered audio.

The time constant of the local oscillator is short enough to follow drift in the receiver or the transmitted signal, but long enough to keep synchronized for an incoming carrier drop out of up to a few seconds. Sherwood Engineering offers a high per-

formance synchronous detector for IF signals near 455 kHz. Also offered are converters to take an IF signal from almost any frequency and convert it to 455 kHz.

I take the IF output from the back RCA jack on the HRO-500 to the converter and synchronous detector. This works not only for AM signals, but the synchronous detector can also act as a BFO and product detector with front panel control of the BFO frequency for CW and SSB signals.

It is tempting to run the converted 455 kHz IF signal through additional filters, but they would be outside the AGC loop. Strong signals within the passband of the internal IF filter system, but outside the external filter system would take control of the AGC system.

The HRO-500 does have AGC inputs on the back panel. The possibility exists to add 455 kHz filtering and sample the output to feed back into the AGC loop. One other possibility is to use a pair of converters, take the 230 kHz IF signal inside the AGC loop,

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paper with either gold or bronze floral designs around the outer edge and in the center. Some of them had a mechanical volume control and others didn't.

The speaker that inspired this article is the Model 7. It is a metal table model with a 14 inch cone. To my surprise my wife found it at the Kutztown show complete and in working condition. Well, almost working. It needed a new cone, which most of them do after 80 years.

When I first saw it I thought it was just another Trimm. After looking it over, however, I realized that it was a model that I didn't have. After all these years of collecting speakers it always amazes me to find something that I haven't seen before. I quickly looked at the Trimm pictures in our book* and discovered that it has the same base as the larger Model 11 but a completely different reproducer.

It is a small-diaphragm unit with a mechanical volume control. This type of reproducer has a knob that adjusts the distance between the magnetic pole pieces and the metal diaphragm, thus increasing or decreasing the speaker volume. Except for the volume adjustment it is very similar to an earphone. As shown in the photo, a brass nameplate with the Trimm logo and model number is attached just above the volume control knob.

Most of the Trimm cone speaker reproducers have a conical shaped aluminum diaphragm with a soft iron disk in the center



A closer look at the volume control and nameplate.

to allow the magnetic field to vibrate the diaphragm. This differs from the earphone drivers that are flat soft iron.

The Trimm speakers are very pretty and make a great addition to any collection. Like most of the earphones and horn speakers of that era they have a high impedance (approx. 1500 ohm DC resistance) and may be connected to any vintage battery set needing an external speaker.

**Classic Cones* By Buford and Jane Chidester. Sonoran Publishing, 2012. 122 Pages, 8½ × 11", Soft Cover, \$25.95. Available from the authors at (717) 266-4450; speakerpeople@comcastr.net. 

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convert it to 455 kHz, then convert it back to 230 kHz. There was an example of a system to do this in a late 1970s *ARRL Handbook*.

I have noticed that one of the companies offering parts for a QRP transceiver offers each module separately, so a pair of their NE-602 based converters might do the job. You would have to change the conversion crystals, though one should be adequate to drive both converters.

I have really enjoyed using the HRO-500 and after a few months of use, thought that the first fully transistorized communications/laboratory receiver deserved a revisit

in order to move more of them from collector's shelves to become part of the owner's useful receiver collection. This receiver must have cost National a huge investment in engineering and testing.

The dozen or more full page ads in *QST* and the dedication of many of their technical page ads must have also cost National a large amount of their advertising budget. These one page ads probably introduced a large number of amateurs to the operation of the phase locked loop, something that had a great future in radio communications.

73, Barry 