R4-1-1

NATIONAL HRO 500 COMMUNICATIONS RECEIVER

by Paul Danlyn

INTRODUCTION

This is a completely solid state rx using a phase-locked frequency synthesizer to produce 52 crystal-stable frequencies required to convert incoming signals in the 5 kHz to 30 MHz range to the tunable i.f. of 2.75 MHz to 3.75 MHz. An up conversion mixer is used to convert frequencies below 4 MHz to 26 MHz plus signal frequency to eliminate "holes" in the rx's coverage at the various i.f. frequencies. If the synthesizer was replaced by the Drake SPR-4's conventional VFO generation, 55 crystals would be needed! The HRO 500 uses only five crystals; two for the frequency synthesizer, the rest for the BFO, 50 kHz calibrator and 26 MHz oscillator. All the transistors and crystals plug into sockets and no printed circuits are used. Power requirements are 110 volts AC, 220 volts AC, or 11 to 16 volts DC (great for DXpeditions).

USE OF CONTROLS

AF and RF gain Controls: self explanatory.

Bandwidth: selects 500 Hz, 2.5 kHz, 5 kHz and 8 kHz bandwidths

Dial lock: locks the VFO capacitor but allows main tuning dial to move for calibrating rx.

Passband Tune: operates only in 500 Hz and 2.5 kHz bandwidths. Adjusted for best readability of desired signal when there's lots of slop. This control is effective on low pitched TVI. Tuning is not critical. However, on the 500 Hz bandwidth selectivity is so sharp that it normally cuts down on an AM signal's readability too much unless this knob's tuned to the station's upper sideband. If conditions warrant, I zero beat the BFO with the station's carrier and tune in a portion of the USB or LSB for improved readability. The SPR-4 lacks passband tuning.

Rejection Tune: This control is used to reject hets from adjacent stations. Also effective on high pitched TVI. When hets are a problem use this control to reduce them to a minimum, being careful not to reject your station also. Tuning this knob is extremely sharp and takes a while getting used to.

Band MC: selects tuning ranges of preselector and synthesizer.

AGC Threshold: This selects AGC off, on and insertions of 10, 20 or 30 dB attenuation in the RF stage. This rx has minor cross modulation problems with strong locals on the BCB. When this problem occurs, using the attenuator will eliminate the problem. Also useful for extending S-meter readings to a maximum of 80 dB over S9, to make more meaningful comparisons between extremely strong stations and very weak ones. The AGC is on in all positions except "off."

Function: This is used to select rx off, standby, SSB, AM, and calibrate. In calibrate, both the 50 kHz calibrator and BFO are on. Zero beat the BFO with the calibrator marker, using the main tuning dial. If the marker is not positioned properly use the dial lock, locking the VFO capacitor, and move the dial until it indicates the marker's frequency. Release the dial lock. When using the dial lock, there are stops to prevent the dial from being set to the wrong marker.

Main Tuning: Consists of the 50 kHz per revolution dial and two concentric knobs. One knob's directly coupled to the dial; the other is a 5:1 vernier. This dial has five windows with numbers that indicate to the nearest 10 kHz. As the dial rotates the numbers change. There's also markings every 1 kHz. This dial is far easier to read than the Drake SPR-4 because the bandspread is ½ inch per kHz and 21 feet per MHz. The dial rotates ten revolutions from stop to stop.

Synthesizer Tune: This moves a cylinder behind a horizontal window indicating which 0.5 MHz tuning range the rx is at. To read the rx's frequency, simply add the frequency in MHz indicated in the horizontal window to the main tuning dial in kHz. If the synthesizer has not been tuned properly the rx's audio is muted and the red phase lock warning lamp will remain lit.

Preselect Tune: Basically, this control may be treated as a calibrated antenna trimmer. Care must be taken, particularly on the BCB, that the preselector dial roughly reads the incoming signal's frequency or you may have serious problems with images or cross modulation. This control is the most difficult to use properly. Several weeks' experience is needed to use it effectively on BCB. SW is much easier as the signals there aren't as strong. Tuning is quite sharp on the lower frequencies.

SPECIFICATIONS

The image rejection of this rx is good (minimum of 50 dB). Above 500 kHz, sensitivity is good (an optional preselector is required below 500 kHz). It always measured better than 2 uV for 10 dB S+N/N (signal generator set to 30% 400 Hz modulation connected to the rx's 50 ohm antenna input). I didn't check sensitivity using the rx's high imprdence antenna input, but LW's and loops usually worked better on this input than the 50 ohm input. Most rx's only have a low impedence input. Selectivity is excellent. The 500 Hz bandwidth (+250 Hz 3dB down) is 3 kHz wide (+1.5 kHz) 60 dB down and the 2.5 kHz bandwidth (+ 1.25 kHz 6 dB down is 6.5 kHz wide (+3.25 kHz) 60 dB down. The 5 kHz bandwidth (+ 2.5 kHz 6 dB down) is 13 kHz wide (+9 kHz) 60 dB down and the 8 kHz bandwidth (+ 4 kHz 6 dB down) is 30 kHz wide (+15 kHz) 60 dB down. The 500 Hz and 2.5 kHz filters are tunable — a great feature when slop is fierce. The rejection tune control (notch filter) with a + 10 kHz range around the 230 kHz i.f. is capable of rejecting hets with a minimum of 50 dB. Frequency stability of this rx is like the Rock of Gibraltar. National quotes a maximum drift of 100 Hz per day (including a +27% change in the AC mains voltage)! I didn't have a variable auto transformer to verify this spec but I believe it. Frequency readout accuracy is within 1 kHz over the entire 5 kHz to 30 MHz range (covered in sixty 500 kHz bands). The S meter is EXTREMELY accurate. It's calibrated with S units and dB above 1 uV. When the signal generator's output changed in 10 dB increments, the meter said so. This rx has mucho inputs and outputs for every conceivable use with any accesory equipment. To sum up, National's specs are accurate with one exception. The rx weighs 38 lbs., not 32.

BASIC THEORY OF OPERATION

The RF stage has three tuned circuits instead of the usual two for better image rejection. Frequencies below 4 MHz are converted up to 26 MHz plus receiving frequency, then fed to the "first" conversion mixer. A 26 MHz crystal oscillator signal is fed into the up-conversion mixer while the "first" mixer is injected by the frequency synthesizer in 500 kHz increments. The variable i.f. (2.75 to 3.25 MHz) from the "first" mixer is amplified by a tunable i.f. stage (four tuned circuits), then mixed in the "second conversion mixer with a VFO having a 500 kHz tuning range, giving a fixed i.f. of 230 kHz. This i.f. goes through selectable fixed or tunable passband filters and rejection filter, then amplified by three i.f. stages. AM signals go via the AM detector while CW, RTTY, and SSB signals are mixed with the crystal controlled BFO via the product detector. These detected signals are finally audio amplified. The rx has reduced sensitivity and image rejection below 500 kHz because the r.f. stage is bypassed. Frequencies above 4 MHz bypass the up-conversion mixer and go to the "first" mixer.

SUMMARY

The HRO 500 sells for $2800 in Canada. Obviously it's meant for the serious SW or BCB DXer or ham for whom price is no object. However, Mark Twain's old cliche "you get what you pay for" still rings true. I think this ruggedly built rx is one of the best and most versatile available. National has manufactured this rx since 1961 so some second hand rx's may show up in the next few years. For more info write Max J. Fuchs, National Radio Company, 18 Stone Place, Melrose, MA 02176.