Hints and Kinks

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IMPROVING THE HEATHKIT HW-5400 TRANSCEIVER

◊ Ever since it was new, my Heathkit HW-5400 transceiver had an unusual "peaky" quality to the receive audio. On the air tests indicated that the transmitted audio also had a peaky frequency response, as well as some distortion. One fellow described it as sounding unnatural and harsh. After several hours of tests and measurements, I determined that the cause of the poor audio was excessive passband ripple in the crystal filters and distortion in the balanced modulator circuit.

IF-Board Modifications

The HW-5400 uses two crystal filters in its IF section. The standard filter is used on both transmit and receive while the optional filter is used only on receive (in conjunction with the standard filter). In-circuit measurement of these filters revealed some rather startling characteristics. I found the optional four-pole filter to have a peak-to-peak (P-P) ripple of almost 10 dB! The standard 6-pole filter's ripple was almost 8 dB P-P. Fortunately, the ripples did not add directly (to produce a possible maximum of 18 dB P-P) because their peaks and dips did not coincide.

Assuming filters of sound design, such ripple can be caused by terminating the filters with improper sources and loads. I replaced all the components that match the filters' inputs and outputs, but the problem was still there. Rather than live with the ripple, I decided to redesign the filter matching networks. The solution was much simpler than I had anticipated:

1. Change capacitor C1112 from 0.01 µF to 10 pF.
2. Remove and discard R1154, a 51-Ω resistor.
3. Change L1101 to 4.8 µH. I wound a new coil using 36 turns of #32 enameled wire on a T-30-6 toroidal core (you can modify the original toroid to achieve the required inductance by removing turns).
4. Add a 68-pF silver-mica capacitor across the input of filter Y1101.
5. Realign the HW-5400's IF board as described in the manual.

Balanced-Modulator Modifications (Audio Board)

The HW-5400 uses the popular MC1496 IC as its balanced modulator. Because I am familiar with this device, I was surprised at the amount of distortion it produced in my transceiver. Circuit analysis and studying the MC1496 data sheet suggested that several factors contributed to the distortion: insufficient BFO/carrier drive, excessive audio input, and a missing low-frequency bypass capacitor.

Correcting these problems is relatively easy. While I was working on this board, I also modified the VOX circuit to provide a longer maximum delay time. Here are the changes:

1. Change R913 to 33 kΩ.
2. Change C906 to 300 pF. (Capacitors of this value may be hard to find. Use two 150-pF capacitors in parallel; or a 270-pF capacitor should be okay.)
3. Change R937 to 6.8 kΩ.
4. Change R938 to 3.3 kΩ.
5. Add a 22-µF, 16-V tantalum electrolytic capacitor from pin 4 of U902 to ground. (Connect the capacitor's positive lead to pin 4.)
6. Change C926 to 100 pF.
7. Change C929 to 0.01 µF.
8. Install a 15-Ω resistor between the collector of Q905 and the other circuitry as shown in Fig 1.
9. Change R927 and R993 to 100 Ω.
10. Change C921 and C932 to 1500 pF.
11. Change C947 to an 8.2-µF, 16-V tantalum electrolytic capacitor (10 µF will work well also).
12. Change C957 to 150 pF.
13. Change R987 to 8.2 kΩ.
14. With the rig in SSB mode and the mike connector's PTT contact shorted to ground, adjust R823 for a BFO level of 150 mV P-P at pin 8 of U902. If the BFO level is too low when R823 is turned all the way up, change R822 on the BFO board to 47 Ω. (This step requires an oscilloscope or RF voltmeter capable of giving readings of known accuracy at 8.83 MHz.)
15. Optional: Add a 2N2222 transistor, 0.0047-µF capacitor, 8.2-kΩ and 1-kΩ resistors, two 1N4148 diodes, and a 0.001-µF capacitor between pin 5 of U902 and the **R12** line as shown in Fig 2. These changes eliminate one side effect I noticed after modifying the balanced modulator (specifically, increasing the carrier/BFO injection level): a small amount of BFO feedthrough into the IF, noticeable with the IF shift control fully counterclockwise, when receiving in CW mode. The leakage path was through balanced modulator U902 and amplifier Q904. The added transistor shuts off U902 during receive, reducing the feedthrough by about 20 dB and making it inaudible. Finding room for these parts is rather difficult, so it may be wise not to make this change unless you need to.
16. Readjust the radio's carrier balance.

These changes smooth the HW-5400's peaky audio and eliminate transmit distortion during normal operation. (Overdriving the radio by using too much mike gain will still produce distortion, as with any other rig.) After you've made these changes, expect the radio's CW gain control to behave a bit differently than before. You'll need to turn the control farther counterclockwise than before to reduce carrier power. This is normal.

These changes made my HW-5400 seem like a different rig. Rematching the filters resulted in a passband ripple of less than 1.5 dB total for the two filters. The effect of this improvement was immediately evident on receive. The audio was much more pleasant. Because of the better filter matching, the radio's IF gain increased slightly, resulting in higher S-meter readings on all signals. Last, but certainly not least, on-the-air tests indicated that my transmitted audio had improved drastically. One old friend (Warren Ziegler Jr, NY2H) remarked that for the first time with this rig my audio sounded natural, with none of the usual harshness: "Wow, what a difference!"

If you want more information on these modifications, or would like to exchange tips on the HW-5400, please write to me. *—Paul Akimov, WA2RIA, 6418 Charnwood St, Springfield, VA 22152-1933*

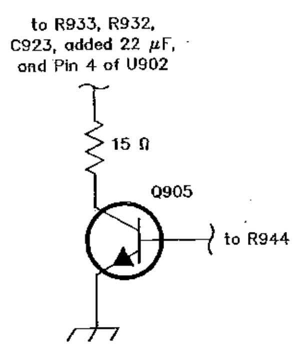

Fig 1—Adding a 15-Ω resistor between Q905 "and the other circuitry."

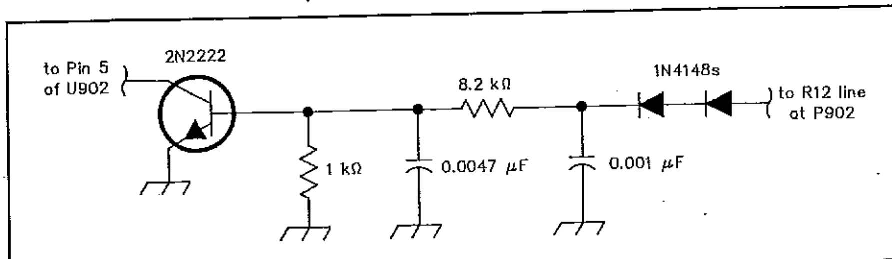

Fig 2—These optional components reduce BFO-to-IF-amplifier leakage during CW reception by turning off U902, the HW-5400's MC1496G balanced modulator IC.