

Modifying the R-390/URR for SSB Reception Without External SSB Converter

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As originally designed, the R-390 HF receiver is usable, to a certain extent, for SSB reception without an external SSB converter, but it performs very poorly because the AM diode detector contributes considerable distortion. The relative levels of signal Vs BFO injection voltage are not correct for proper SSB detection. The levels can be made more optimum by reduction of the RF gain, but then the AGC action is lost and weak signals are reduced so much that they are overlooked or unheard. The R-390 was designed to feed an IF signal to an external SSB converter. However, by a simple and inexpensive modification of the internal BFO stage to a product detector, the R-390 can be made to perform as an excellent SSB receiver by itself, with no external converter being required for SSB (For ISB, however, an external converter is required, in the form of 2 CV-591s or 1 CV-157) The modification is very simple, inexpensive, and does not require any contract procurement action, nor does it involve any proprietary designs. The modification: requires less than 2 hours work by one man.

The parts required for the conversion are few and simple, and cost less than ten dollars. They are:

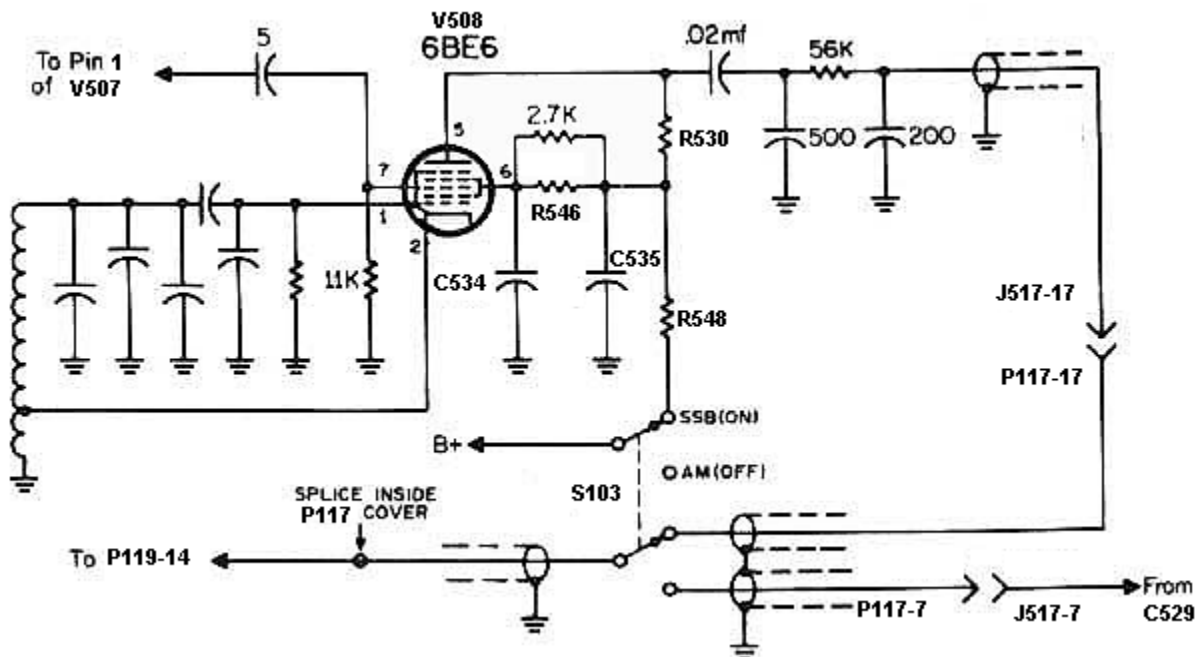
- 1 - 6BE6 / 5750 tube.
- 1 - 2700 ohms 1 watt resistor.
- 1 - 11000 ohms ½ watt resistor.
- 1 - 56000 ohms ½ watt resistor.
- 1 - 5 MMFD 1000 VDC ceramic disc capacitor.
- 1 - 0.02 MFD 1000 VDC ceramic disc capacitor.
- 1 - 200 MMFD 600 VDC mica capacitor.
- 1 - 500 MMFD 600 VDC mica capacitor.
- 1 - 1.0 MFD 400 VDC paper capacitor.
- 1 - 4" length of insulating sleeve (spaghetti), about 1/8" I.D.
- 1 - Centralab PA-2003 miniature ceramic rotary switch, 2 poles, 1 section, 2 positions. (For S-103)
- 2 - small soldering lugs.
- 1 - 72" length of shielded single conductor microphone cable, about 1/8 O.D. (RG-174/U or similar)



Conversion Procedure

The conversion is performed as follows:

1. Remove the BFO B+ wires from the BFO ON-OFF switch S₁₀₃. Remove and discard S₁₀₃, but retain the knob.
2. Cut three 20" lengths of single conductor shielded microphone cable. From one end of each of these three pieces, remove the outer plastic jacket and carefully unravel 1" of the shield braid and form a 1" pigtail lead. Twist the 3 pigtails together and solder them together, being careful not to melt the plastic insulation on the inner conductor of each piece of wire.
3. Take the new switch, a 2 pole two position unit, for S₁₀₃, and connect these three shielded leads to it to form the audio changeover circuit. See schematic below. Under the head of the machine screw holding one side of the switch wafer to the switch frame install a small soldering lug. Solder the pigtail to it, to ground (at this end only) the individual shield braids of the 3 audio wires.
4. Insert the free ends of the 3 wires through the opening at the edge of the IF shelf, pull them upward above the IF chassis, and mount the new switch in the vacant S₁₀₃ hole in the front panel. Replace the knob. Connect the BFO B+ wires to the other pole of the switch. The BFO B+ is to be on in the BFO ON position, which will become the SSB position of S₁₀₃. See the schematic below.



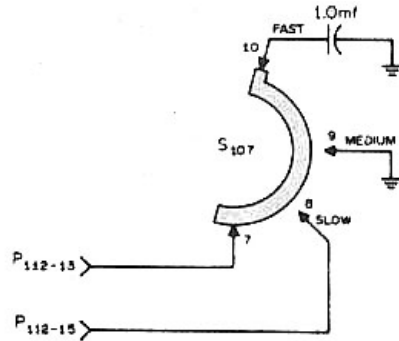
5. Unplug all plugs from the IF subchassis, mechanically disconnect the 2 control shafts, and remove the IF subchassis from the receiver.

6. Carefully remove the cable clamp and cover from multi-conductor plug P₁₁₇, slipping it back out of the way. There is no spare pin in P₁₁₇, so make a spare pin in P₁₁₇ and J₅₁₇ by disconnecting the grounding leads from P₁₁₇₋₁₇ and J₅₁₇₋₁₇. Connect these wires to pins 18 which are also ground. Remove the wire from pin P₁₁₇₋₇ and leave it hanging.
7. Twist the 3 shielded wires installed in step 2 into a 3 conductor cable, above the chassis. Wrap with plastic tape at 4" intervals. Cut this cable to the required length to reach plug P₁₁₂ leaving sufficient slack for clearance over the IF chassis and tubes. Strip back 1" of outer plastic jacket and shield braid on each of the 3 wires. Run the 3 wires through the cable clamp and plug cover.
8. Connect the shielded wire from the SSB (BFO ON) audio terminal of S₁₀₃ to pin P₁₁₇₋₁₇. Use an insulating sleeve for protection, as is done for the other wires on the plug.
9. Connect the shielded wire from the AM (BFO OFF) audio terminal of S₁₀₃ to pin P₁₁₇₋₇. Use an insulating sleeve as in step 8.
10. Slip an insulating sleeve over the free end of the remaining wire, which should be the one connected to the rotary "arm" of S₁₀₃. This is the "audio input" lead. Solder it to the free end of the wire left hanging in step 6. Slip the insulating sleeve down over the bare connection. Carefully replace the cover and cable clamp on P₁₁₇. Tape these 3 wires to the existing cable just outside the clamp.
11. Turning the IF chassis over, carefully remove the bellows coupling on the BFO PITCH control shaft. Remove the shaft by loosening the panel bearing. This step clears some working space around the socket of V₅₀₈ BFO tube.
12. Remove and discard the V₅₀₈ 6BA6, BFO tube.
13. Remove the ground (and all wires) from pin 2 of V₅₀₈. This may involve shifting several ground leads to other ground tie points on the chassis.
14. Move the existing lead from V₅₀₈ pin 7 to pin 2. (This is the cathode tap on the BFO coil Z₅₀₂).
15. In the following steps, be sure to leave room for replacing the bellows shaft coupling.
16. Connect the 11000 ohm ½ watt resistor from V₅₀₈ pin 7 to ground.
17. Remove and discard C₅₃₆.
18. Connect the 2700 ohm 1 watt resistor in parallel with the existing screen dropping resistor R₅₄₆.
19. Connect the 5 MMFD capacitor between V₅₀₈ pin 7 and V₅₀₇ pin 1. This is the IF coupling into the injection grid of the 6BE6 product detector.
20. With a pair of small metal shears cut a ¼" V-shaped notches in the lower edge of the interstage partitions near the rear of the BFO coil Z₅₀₂. Cover the edges of these slots with short pieces of plastic tape.
21. Mount the 200 MMFD and 500 MMFD capacitors on the grounded center post of the V₅₀₇ socket, by merely letting them be supported in space by their own ground leads (about ¼" long).
22. Connect the 56000 ohm ½ watt resistor between the free ends of the 200 and 500 mmf capacitors.
23. Connect the 0.02 mf capacitor from V₅₀₈ pin 5 to the 500 MMFD end of the 56,000 ohm resistor.
24. Use 12" of the shielded microphone cable for the SSB audio lead. Remove 1" of the plastic jacket from one end, and make a 1" braid pigtail on

this end: Slip a 7/8" insulating sleeve over the pigtail and ground the pigtail to the center ground post of V₅₀₇ socket. Connect the center conductor to the 200 mmf end of the 56,000 ohm resistor.

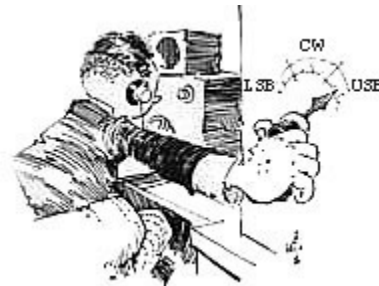
25. Lay the shielded wire in the V-shaped slot in the interstage partition, and tape it in position with a 2" length of plastic tape. Cut the wire to length to reach pin J₅₁₇₋₁₇ of the rear cable socket. This is the unused pin just created. It mates with Pin P₁₁₇₋₁₇ of the cable plug. Strip back 1/2" of the plastic jacket and braid from this end of the shielded wire. Connect the wire to pin J₅₁₇₋₁₇, using an insulating sleeve over it for protection.
26. Carefully replace the BFO shaft and bellows coupling removed in step 11. Make sure the coupling does not accidentally ground any components or wiring.
27. Replace the IF subchassis in the receiver. Insert all the plugs removed in step 5. Reconnect the 2 control shafts and replace their front panel knobs. Make sure the BANDWIDTH knob is properly positioned on the shaft.
28. Plug in the 6BE6 tube in socket V₅₀₈. Turn on the receiver. Leave the antenna disconnected.
29. With the b.f.o. switch S₁₀₃ in the ON (SSB) position, a hissing sound will be heard in the loudspeaker. With the bandwidth switch in the 1 KC position, rotate the BFO PITCH knob. The pitch of the hissing sound will vary from high to low and back to high again, as the oscillator portion of the 6BE6 is tuned through the center of the receiver IF bandpass. Set the BFO PITCH control for the lowest pitch of the hiss. Without rotating the shaft, loosen the knob set screw, and set the knob pointer to "0". The pitch of the hiss should now rise equally at the -1 and +1 positions of the control.
30. Set the BANDWIDTH knob at 2 KC, and at 4 KC. In each case, the pitch of the hiss will be lowest at the "0" position of the BFO PITCH control, rising an equal amount on each side (-1, +1 or -2, +2).
31. The original AGC action is not satisfactory for SSB voice reception. It is too fast in the FAST position and produces a "pumping" action. In the MED position it is a bit too slow for fast voice break-in operation.
32. From the unused terminal 2 of the AGC switch S₁₀₄ (FAST position) connect the 1.0 mf capacitor to ground. This may be done most conveniently by soldering one capacitor lead directly to the switch lug behind the front panel, and connecting the other lead to a ground lug placed under the RF section top cover screw just back of the center of the front panel. This places 1.0 mf in series to ground with capacitor C₅₄₆ + C₅₄₇ (2.0 mf) in the FAST position, making a total of 0.66 mf across C₅₄₅ in the grid circuit of V₅₁₁ the AGC time constant tube. The resulting time constant has been found by experimental use to be quite satisfactory, producing SSB voice signals which are pleasing to the ear to copy. For multiplex or composite waveforms of essentially constant amplitude, the MED or SLOW AGC may also be used, as desired.





* Do not do this one: remove or disconnect C_{547} instead and leave C_{546} connected. SSB operation will be superb in MED position and the SLOW position became correct also, because it was very slow originally. (VE2JFE)

33. The receiver is now ready to operate. Connect the antenna. With the AGC switch set at FAST, and BFO ON, tune in an SSB signal in the 14 MC amateur band, with the BFO PITCH control set at -2, and the BANDWIDTH control at 4 KC. It should sound very pure, clean, and undistorted (assuming the station's emission is clean and undistorted). The BANDWIDTH control may be set at 2 KC for interference reduction, with the BFO PITCH set at -1 in this case.
34. Shift frequency to the 7 or 3.9 MC amateur bands. Tune in signals here in the same way, but with the BFO PITCH set on the opposite (+) side of "0".
35. Most 14 MC amateur emissions are upper sideband, whereas those on 3.9 and 7 MC are usually lower sideband. Note that the BFO PITCH must be set to the opposite side of the carrier ("0") for reception of the desired sideband (- for USB, + for LSB). When you do this, you are in effect placing the locally injected carrier from the oscillator portion of the 6BE6 in the proper position for demodulation of the SSB signal and for positioning the signal correctly within the receiver passband. CW may also be received with the BFO switch on (SSB position), using BFO PITCH and BANDWIDTH controls as desired. For AM, the BFO switch is OFF, unless AM reception in the SSB mode is desired in which case it is ON.



The conversion is now completed, and the R-390 may now be used for SSB with no external converter. This detailed information applies only to the R-390. A similar conversion can be worked out for any other good superheterodyne receiver. It has been used with success in several Collins R-388 (51J)¹ receivers and AR-88 receivers by the writer. In the R-388, the oscillator portion of the 6BE6 has been crystal controlled, with 3 crystals (1 for USB, one for exact IF, and 1 for LSB) selected by a switch in place of the BFO PITCH control.

¹ Lee, P. H. Cdr., "The Single Tube Product Detector," CQ, April 1961, p. 50.

