M53-3-1

51J-4 Product Detector Mod

Dr. Dallas Lankford, Math. Dept., Louisiana Tech U., Ruston, LA 71272

As hollow state buffs know, the Collins 51J-4 is a classic tube type communications receiver. It was and still is one of the finest AM receivers ever built. Two things prevent it from being outstanding for SSB and CW - it has no product detector, and the AGC attack and release times are not suitable for SSB and CW. The purpose of this note is to describe how to convert the BFO circuit to a product detector. I have already discussed a suitable AGC circuit change in my article "51J-4 fast attack - slow release AGC mod."

Several articles have been written about the 51J and R-388 receivers which describe how to convert the BFO circuit to a product detector and modify the AGC circuit for fast attack and slow release. But none of them apply directly to the 51J-4, and all of the AGC mods, except mine, suffer from one or more serious problems, especially bad overshoot which manifests itself by a loud thump at the beginning of SSB trandmissions.

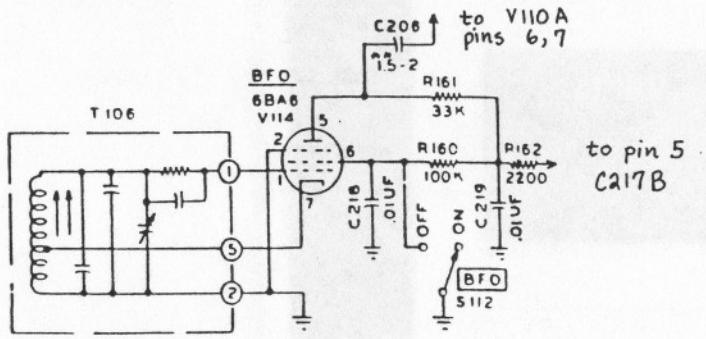

Fig. 1 - 51J-4 BFO Circuit

The 51J-4 BFO circuit is shown above in Fig. 1. I intended to convert the BFO circuit into the product detector described by William Orr in his February 1978 Ham Radio article, "Modifying the 51J receiver for SSB reception," pages 66-69, but a remark by Wilfred Scherer in his December 1968 CQ article, "More on updated improvements for the 51J receivers," pages 64-69, 116, caused me to use different component values. Scherer said that with a 56K plate and 2.2K screen resistors as recommended by Commander Paul Lee in his April 1961 CQ article, "The single tube product detector," pages 50-51, 118, 119, strong BFO harmonics were found at every 500 KHz point up to 7 MHz. The original 51J-4 screen resistor, R160, was 100K, 1 watt, so I decided not to change its value to 22K as suggested by Orr, but leave it as is because Scherer used a 330K screen resistor. The original 51J-4 palte resistor, R161, was 33K. Since I had to uncrimp and disconnect one end of R161 at pin 5 of V114 in order to access and remove C206, I decided to remove and completely replace R161 with a 47K, half watt resistor, about the same as suggested by Orr, and about half the value used by Scherer. In addition, I used an inductive pi network low pass filter instead of the resistive network used by Orr, Scherer, and Lee. The 1 mH choke and 560 pF input and output capacitors were what I had on hand. For a 2.5 mH choke you should use 22 pF capacitors, and for a 5 mH choke use 100 pF capacitors.

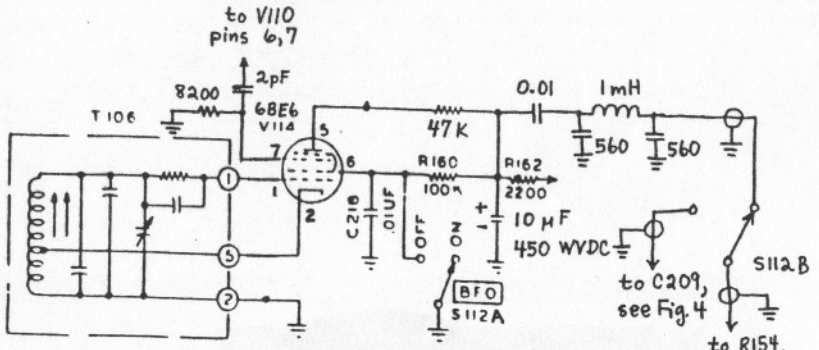

Fig. 2 - 51J-4 Product Detector

The product detector I used is shown above in Fig. 2. Orr advised that the 6BE6 oscillator voltage at pin 1 should not exceed 10 volts peak to peak. With the 100K screen resistor I used, the oscillator voltage at pin 1 is about 8 volts peak to peak. The audio output level of the 6BE6 product detector can be adjusted by varying the capacitor and resistor voltage divider at pin 7 of the 6BE6. I used a 2 pF capacitor because that is what I had on hand. Orr, Scherer, and Lee used a 5 pF capacitor. I determined the value of the 8200 ohm resistor by trial and error. I wanted the audio levels to me more or less equal when I switched between AM and CW. For a 5 pF capacitor, start with a 3300 ohm resistor, and increase it or decrease it for more or less audio output.

Notice the 10 mF 450 WVDC electrolytic capacitor which replaced C219, 0.01 mF. All of the previously mentioned articles said nothing about replacing C219 by a 10 mF electrolytic. Fortunately, I had done my homework and had found the comments by Frisco Roberts in the October 1978 issue of Ham Radio, page 6. Roberts said that after he added Orr's product detector to his 51J receiver, the audio output motor-boated at higher audio gain control settings. He determined that the motor-boating was caused by B+ hash (presumably he meant B+ ripple). So I was not surprised when my product detector motorboated. Following Roberts' suggestion, I replaced C219 by a 10 mF electrolytic and the problem went away. In my opinion, you should not even consider using a 6BE6 product detector without this 10 mF electrolytic.

According to gossip, many hams have tried one of these 6BE6 product detectors in their 51J or R-388, and were not satisfied with the result. Perhaps they experienced motor-boating and were not informed of Roberts' diagnosis and cure for that problem. Perhaps they experienced strong BFO harmonics up to 7 MHz and were not aware of Scherer's diagnosis and cure for that problem. Perhaps they got unsuitable audio output level from the product detector and did not know to vary the capacitor and/or resistor at pin 7 of the 6BE6. Perhaps my LC low pass filter avoids problems I did not encounter with the RC low pass filter used by Orr, Scherer, and Lee. Perhaps I got lucky with my component layout and did not encounter problems experienced by others. Or perhaps many hams were not satisfied with the AGC mods suggested by Orr and Scherer. (I wasn't.) The bad overshoot of the AGC mods described by Orr and Scherer is enough to turn anyone off. If you don't have a copy of my AGC mod article, send me a $1 bill and a SASE and I'll send you a copy.

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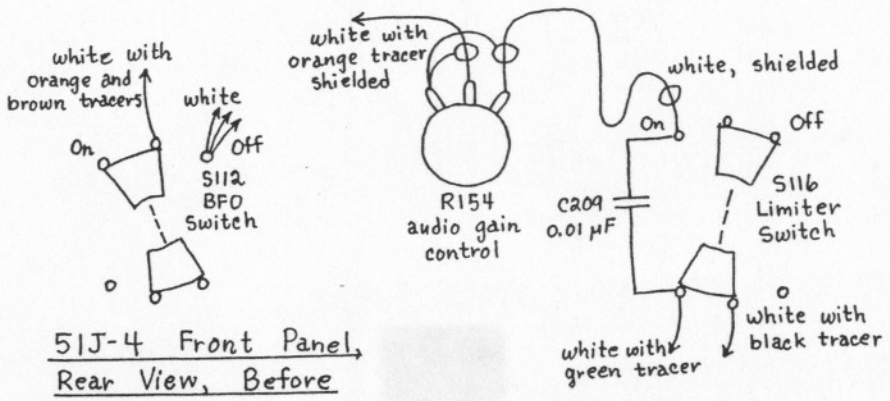
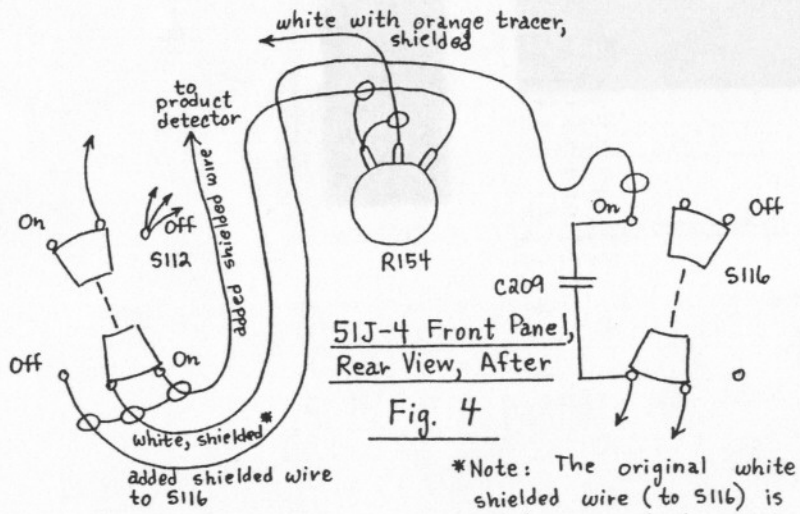


51J-4 Front Panel, Rear View, Before

Fig. 3



51J-4 Front Panel, Rear View, After

Fig. 4

*Note: The original white shielded wire (to S116) is not long enough to reach S112.

Before describing the layout of the product detector, let me explain how the switching between AM and SSB/CW is done. In all 51J-4s I have seen, the BFO switch, S112, has an unused section which I have labeled S112B in Fig. 2; see Fig. 3 for a rear view of the front panel before modification. If you will study Fig. 4 and the 51J-4 schematic, you will see that S112B is used to switch between the output of the noise limiter for AM and the output of the product detector low pass filter for SSB/CW.

To access the BFO and limiter switches and audio gain control, the 51J front panel must be removed. You should do this part of the product detector mod first in case the switches are not of the type I have drawn in Fig. 3 and Fig. 4. If the switches are not of the type I have drawn, you will need to obtain similar switches. You should observe that there is not much clearance behind the front panel, so not any switches will do. If the wire tracer colors are not as I have shown, you will have to determine how your 51J is wired. At least I have given you a starting point. When I rewired my front panel, I cut all the wiring harness lacing, ran my new wires along the existing wiring bundles, and relaced the modified bundles with new lacing. The three shielded ends at S112 were soldered together and tied down with cable lacing. The shielded wire to the product detector was run along the taped cable bundle which branches just inside the front panle and runs along the side panel to the rear compartment. I temporarily removed the filter chokes from the side panel (but did not unsolder them) to access the taped cable bundle along the side panel. I used plastic cable ties to secure the product detector shielded wire to the taped cable bundle. I made a right angle turn in the product detector shielded wire where the taped cable bundle makes a T intersection in the rear compartment, and brought the product detector wire out beside the plug-in electrolytic capacitor bracket near the BFO coil. The shielded end of the shielded wire to the product detector was grounded at the low pass filter near the 6BE6 product detector; see Fig. 5. One of the cable clamps on the front panel with have to be replaced with a larger clamp. The original clamps are #1 Tinnerman clamps, so you will need a #2 Tinnerman clamp if you want to preserve the appearance of your 51J-4. The #2 clamp is larger than necessary, and I used a small piece of rubber to make a tight fit.

The product detector layout is shown in Fig. 5. Any component or wire removed from a lug was replaced with a new component or wire. In particular, I removed the 2 pF BFO coupling capacitor, the 33K plate resistor, the 0.01 mF screen bypass capacitor, the 0.01 mF bypass capacitor from the insulated standoff to ground, all wires from the tube socket to the BFO coil, and the ground wire from the center post of XV114 to pin 2. I wired my 51J-4 slightly different than shown. I used a Teflon insulated wire from pin 5 of V114 to the insulated standoff at the low pass filter, and I ran this wire under the filament wires at pin 4 and between that tube socket ground lug and pin 3, under the wire from pin 3 to the ground lug. If you cannot obtain insulated, stranded, Teflon wire, you should run the wire from pin 5 to the insulated standoff as I have shown (in case the screen bypass capacitor ever needs to be replaced, soldering iron heat applied to the ground lug could damage the insulation). Some consideration should be given to the order in which new components are added. I installed the 47K resistor first, and then installed the 2 pF capacitor above the 47K resistor (since a 2 pF capacitor is more likely to fail than a 47K ohm resistor). The 0.01 mF screen bypass capacitor was curved away from the tube socket as shown so that the component density would be less, and so that the tube socket pins could be accessed more easily. I also found it convenient to remove the 0.01 mF capacitor from the plug-in electrolytic capacitor bracket to V113 while dressing the ends of the wire and shield of the shielded wire to the front panel.

When using the product detector for SSB, the BFO frequency will need to be offset to one side or the other of center frequency depending on whether USB or LSB is desired. You can measure the -20 dB points of the 3 KHz filter using the S-meter and a calibration signal and remember the appropriate setting of the BFO frequency control. Rough tuning of an SSB signal is done with the KCS knob, and fine tuning with the BFO PITCH knob.

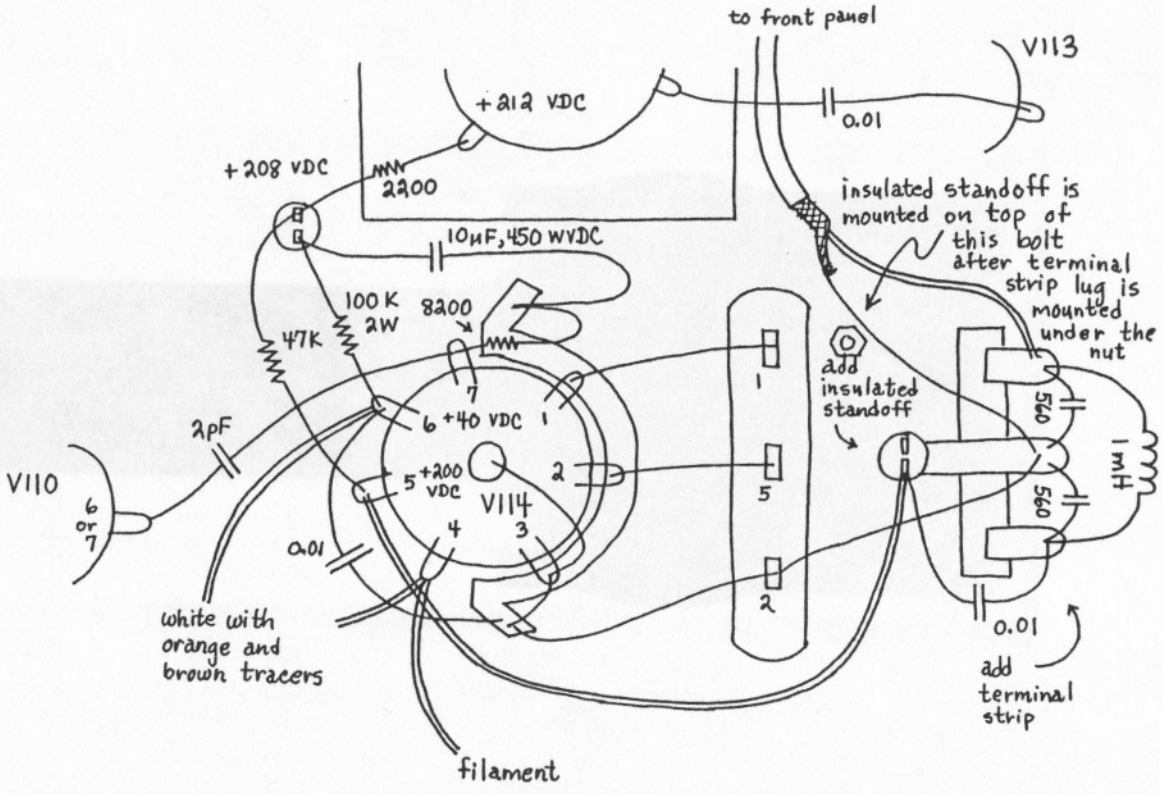


Fig. 5 — Product Detector Layout