M60-2-1

51J-4 Fast Attack - Slow Release AGC Mod

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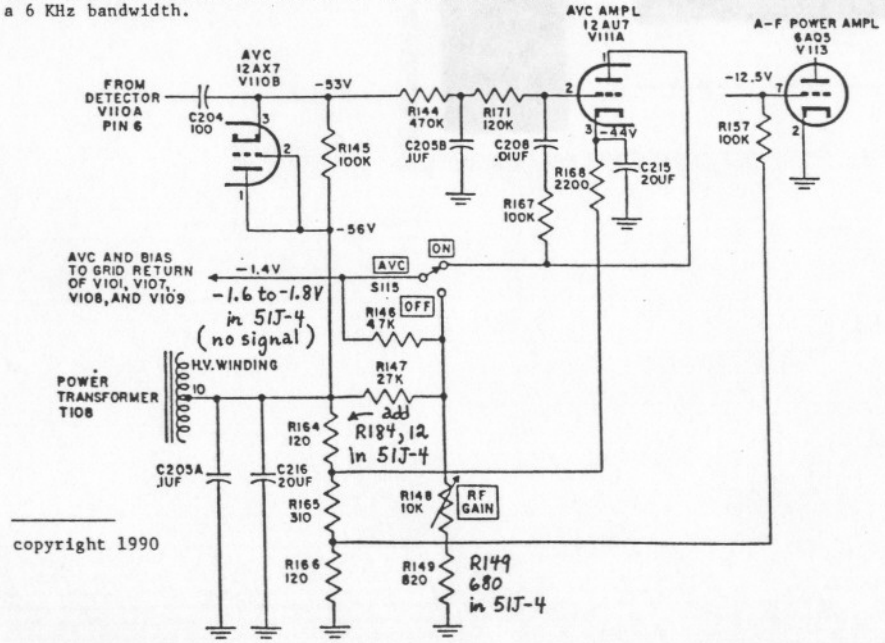
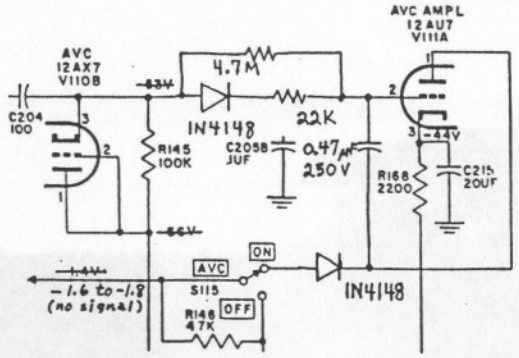
There are various approaches to modifying the 51J- series and R-388 receivers for SSB. Commander Paul Lee in his April 1961 CQ article, "The single tube product detector," pages 50-51, 118-119, described a 6BE6 product detector which is used in many of these mods. However, Lee discussed no changes to the AGC circuit, which is unsuitable for SSB. A variation of Lee's product detector was described by Wilfred Scherer in his December 1968 CQ article, "More on updated improvements for the 51J receivers," pages 64-69, 116. Scherer also presented a two part AGC mod which was supposed to provide fast attack and slow release. The first part of Scherer's mod introduced audio on the AGC line, which degraded AM audio quality. The second part cleaned up the audio on the AGC line, but slowed down attack time. In addition, Scherer's AGC mod suffers from bad overshoot, which manifests itself by a loud thump at the beginning of SSB transmissions. Yet another variation of Lee's product detector was described by William Orr in his February 1978 Ham Radio article, "Modifying the Collins 51J receiver for SSB reception," pages 66-69 (be sure to read Frisco Roberts' comments about motor-boating audio problems with the 6BE6 product detector on page 6 of the October 1978 issue of Ham Radio). Orr's AGC mod also suffers from bad overshoot and audio distortion in AM mode. Even worse, Orr recommended reducing the no-signal AGC line voltage bias to -1.4 VDC by changing R149 (820 ohms in the 51J-1,2,3 and R-388, and 680 ohms in the 51J-4) to a lower value. I did this in my 51J-4 and it reduced the dynamic range of my receiver by more than 15 dB on all bands. I presume that Orr got this idea from reading tube pin voltages in a 51J manual, or from Fig. 25 of the R-388 manual (TM 854) which I have reproduced below. Apparently the -1.4 VDC value is not correct, or else Collins discovered that the AGC line no-signal bias should be higher for improved dynamic range and changed the AGC line bias for 51J-4s. I believe the former is the case. In 51J-4s I have found that the no-signal AGC line bias voltage varies from about -1.60 to -1.80 VDC, and that with this bias range band 2-30 sensitivity is typically 0.25 microvolts for a 10 dB S+N/N ratio with a 6 KHz bandwidth.



After trying all of the AGC mods above, and finding them all unsatisfactory, I started over. I removed R144, R171, C208, and R167 and removed the wire connecting C205B to the junction of R144 and R171. Next, I added a 1N4148 diode shunted by a 4.7M resistor from the junction of C204, R145, and pin 3 of V110B to pin 2 of V111A, and a 0.47 mF 250 volt mylar capacitor from pin 2 of V111A to pin 1 of V111A; see the schematic fragment below.



My initial circuit had rather bad overshoot, so I added a resistor in series with the diode. By trial and error I determined that 22K ohms was the best compromize between overshoot and my target attack time of 2 mS. With a 47K ohm resistor there was no overshoot at all signal levels, but the attack time at lower signal levels was slower (about 10 mS at the 20 dB level). With the 22K ohm resistor there was a slight amount of overshoot at the 80 dB level and above, while the attack time at all signal levels was 3 mS or faster. After several hours of listening I discovered that at low signal levels (near 0 dB) the AGC line was driven positive relative to the no-signal bias voltage by noise pulses and very weak signals. Another 1N4148 diode was added past the junction of pin 1 of V111A and the 0.47 mF capacitor to eliminate this annoying quirk. Occasionally the meter still deflected below 0, but not nearly as often or as much as before.

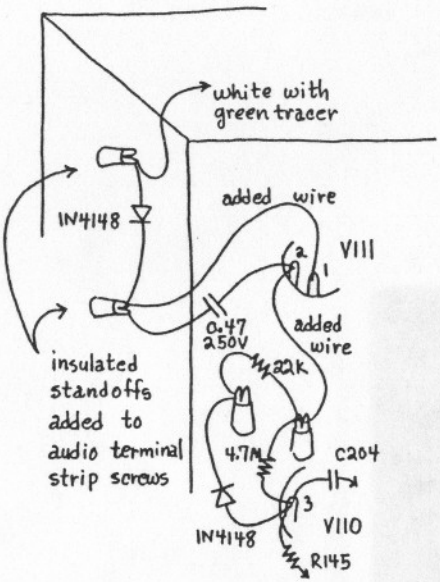
If other diode types are substituted for the 1N4148 diodes, it is essential that they have a very high back resistance. The 1N4148 diodes I used were from a Radio Shack package marked 1N914, so presumably 1N914 diodes would be suitable. The 1N914 has a reverse current rating of 0.025 microamps at the maximum voltage rating of 70 volts, which is equivalent to a back resistance of 3000M ohms.

I have already mentioned that the attack time of my AGC mod is 3 mS or better at all signal levels. An interesting feature of my AGC mod is that its release time is variable, and depends on the signal level. By definition, the release time of an AGC circuit is the time required for the AGC line voltage V to change to 37% of the difference between V and the no-signal AGC line voltage when a signal is suddenly removed from the antenna input. The release time of my mod varies from about 400 mS for 0-20 dB signal levels, to 800 mS for 40 dB signal levels, up to 1.2 seconds for 60-100 dB signal levels. It is not difficult to see why the AGC release time is variable: the AGC line voltage varies from about -1.6 VDC with no signal to about -9 VDC for a 100 dB signal, while the voltage at pin 3 of V110B varies from about -65 VDC with no signal to about -56 VDC for a 100 dB signal; thus the 0.47 mF capacitor requires more charge change for release of a strong signal.

The only complaint I have about my AGC mod is that the S-meter pins for a few seconds when the 51J-4 is first turned on. The temporary excessive voltage / current is not serious, less than twice the full scale voltage / current. Nevertheless, I turn the power switch to STAND BY for about 15 seconds to avoid pinning the S-meter.

In a sequel to this note I will describe the product detector I built for my 51J-4. Together with my AGC mod it makes a 51J-4 one of the finest all mode receivers ever made.

M60-2-2



The layout of my AGC mod is sketched here. Two existing insulated standoffs which had been used as tie points for removed components were used as tie points for one of the diodes, the 4.7M resistor, and the 22K resistor. Two new insulated standoffs were added as tie points for the other diode. The insulated wire (white with green tracer) was moved from pin 1 of V111A, and two new short lengths of insulated wire were used to complete the circuit. Because of space limitations I found it convenient to mount the 0.047 mF capacitor as shown.

I presume that this AGC mod will also work for 51J-1,2,3 and R-388 receivers. It might be necessary to change the value of the 22K resistor to some other value if overshoot is experienced or if the attack time is not 3 mS or faster. A scope should be used to measure the attack time and observe the attack trace for possible overshoot.

In the article mentioned above, Orr warned against using a resistor larger than 2M in the grid circuit of V111. As the 12AU7 ages, oxide may migrate from the cathode to the grid, causing grid emission, which can alter the operating characteristics of the 12AU7 and cause the AGC to function improperly. In my opinion, if the AGC begins to operate incorrectly, then replacement of the 12AU7 may be indicated. In fact, grid emission by any AGC controlled tube (the 6BA6 IF amp tubes, etc.) can alter the AGC line voltage and cause a receiver to function improperly. So I don't consider this is an issue unless you are such a tightwad that you want tubes to last forever.

The variable release time aspect of my AGC mod caused me some concern at first. AGCs are not supposed to function that way (at least I don't know of any that do). But after hours of listening to SSB, I can't find anything objectionable about the variable release time. When I was developing the AGC mod with an external prototype board (Radio Shack # 276-175) and test lead clips, returning the 0.47 mF capacitor to ground caused popping. The popping may have been due to the external prototype and long leads. So if you don't like the idea of a variable release time AGC, you can try returning the 0.47 mF capacitor to ground with a temporary solder joint, and move it to pin 1 of V111 if you experience popping. With the 0.47 mF capacitor returned to ground, the release time should be reasonably constant at all signal levels, about 400 mS. However, the faster release time may cause annoying pumping on stronger SSB signals.

I don't consider this to be the final or even the best 51J/R-388 AGC mod. I stopped development when I had something acceptable. Send me an SASE and I'll be glad to share my thoughts on potential variations of my AGC mod.