THE HOLLOW STATE NEWSLETTER

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Editor's and Publisher's Corner

Hello again from hollow state land. As you can see, I'm still without a computer. So you'll have to excuse my by hand corrections. Note that on the mast head I made a mistake in the previous issue by reversing the first two digits of the post office box number. If you wrote me and had your letter returned, try again. It helps to use my name as part of the address instead of only The Hollow State Newsletter. Note also that we've reduced the price of the best of HSN nos. 1 - 4. If you want individual issues 1, 2, 3, and/or 4, please make it clear to Ralph.

This issue is mainly about the 51J-4. But we haven't forgotten about the R-390A. The lead article discusses R-390A audio impedance matching with 25 volt and 70.7 volt line transformers. If you've been suffering along with poor quality audio, run, don't walk, to the nearest Radio Shack and buy a 32-1031 70 volt line transformer, put together the impedance matching adapter described in the following pages, and sit back and enjoy the best audio you've ever heard from a communications receiver. Shortcuts like using a 120 VAC to 12 VAC transformer as described in a previous HSN are a distant second.

Excuse me, R-390A fans, but after the band 1 sensitivity fix (finally!) and fast attack - slow release AGC mods of this issue and the product detector mod of the next issue are done to a 51J-4, it is the finest all mode general coverage receiver of all time. But don't give up. I'm still trying to develop an AGC and product detector mod for the R-390A as good as these 51J-4 mods. I'm very close, but not quite there.

If you've read the 3 part R-390A article which appeared recently in Electric Radio and have been considering doing any of the mods described therein, I have one word of advice. Don't. For example, the AGC mod is not as good as the improved Cornelius AGC mod which appeared in HSN #23. And if you believe the R-390A does not work well with an 80 foot inverted L antenna connected to the unbalanced antenna input as claimed in part 1 of the ER article, then you have a defective R-390A. And if you believe the 52.7 dynamic range measurement given in part 2 of the ER article, then you'll be disbelieving the 80 to 85 dB dynamic range measurements reported by Sherwood Engineering, Ulrich Rohde, and me.

R-390A Audio Output Impedance Matching

Dallas Lankford, October 1990

Some people who use R-390As complain about hum, low audio output level, and poor frequency response. However, an R-390A has excellent audio quality and enough audio output power to drive you out of the room when used with an appropriate audio transformer which matches the 600 ohm audio output impedance to a speaker or headphones. The purpose of this note is to discuss appropriate audio impedance matching transformers for use with an R-390A.

The usual reason for hum and low audio output level with an R-390A is that low impedance headphones and a low impedance speaker, usually 8 ohms, are used without an audio transformer to match the 600 ohm audio output impedance to the low impedance load. A common cause of poor R-390A audio frequency response is the use of a military surplus LS-166 speaker. It has a built-in 600 to 8 ohm audio transformer and 8 ohm speaker, but the audio transformer has a limited frequency response of 350 to 3500 Hz. The LS-166 and similar speakers are designed for voice reception only.

The R-390A local audio output is rated as 500 milliwatts with less than 10% distortion into a 600 ohm load, and 1 milliwatt into a 600 ohm headset. The line output is rated as 10 milliwatts with less than 6% distortion into a 600 ohm balanced line. Measured maximum local audio output power before clipping is 1 watt into a 600 ohm load. Measured local audio frequency response is approximately flat from 100 to 10,000 Hz, and drops off slowly below 100 Hz and above 10,000 Hz.

One of the best ways to match the 600 ohm audio output impedance of an R-390A to low impedance headphones or a low impedance speaker is to use an audio line transformer. Line transformers come in two varieties - 25 volt line transformers, and 70.7 volt line transformers. They are designed for use with public address and audio distribution system The 25 volt line transformers are intended for use with amplifiers which have a 25 volt RMS maximum output, while the 70.7 volt line transformers are intended for use with amplifiers which have a 70.7 volt RMS maximum output. The 25 volt line transformers typically have primary taps with impedances which are multiples or fractions of 625 ohms (equivalently multiples or fractions of 1 watt). The 70.7 volt line transformers typically have primary taps with impedances which are multiples or fractions of 5000 ohms (equivalently multiples or fractions of 1 watt).

Currently I use a 25 volt line transformer, Stancor type A8089. The Stancor A8089 has primary taps marked 4, 2, 1, and 1/2 watt, and a secondary marked 8 ohms. Since the primary taps of a line transformer are often specified in watts, you will have to convert the watt ratings to ohms. For example, using the formula $R = V^2/P$, where R is the impedance in ohms, V is the voltage rating in volts RMS, and P is the power rating in watts, it follows that the 1/2 watt primary tap is $R = 625/0.5 = 1250$ ohms, and similarly that the 1, 2, and 4 watt primary taps are 625, 312, and 156 ohms respectively. For a 70.7 volt line transformer with primary taps of 10, 5, 2.5, 1.25, and 0.62 watts, the equivalent primary impedances can be calculated as 500, 1000, 2000, 4000, and 8000 ohms respectively.

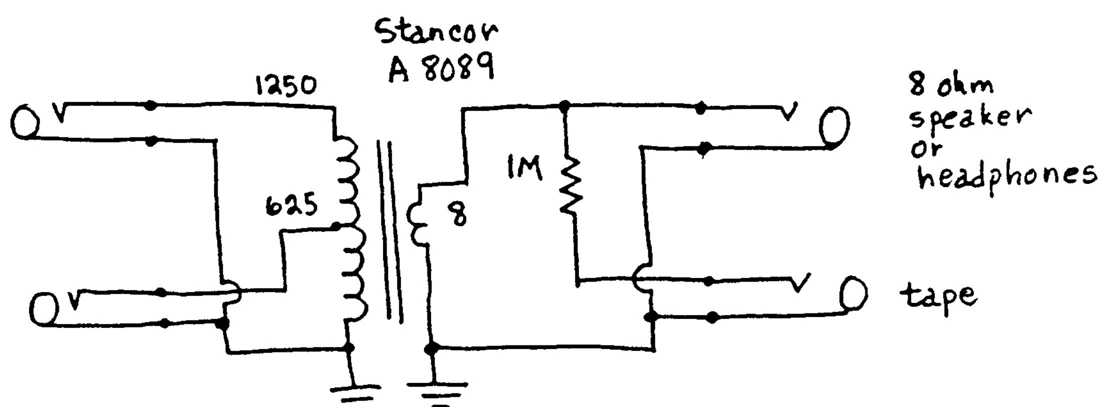
In my experience, it does not make any significant difference whether you match the R-390A 600 ohm audio output impedance with the 625 ohm primary tap of a 25 volt line transformer or the 500 ohm primary tap of a 70.7 volt line transformer. In fact, you can use a 1000 ohm or 1250 ohm primary tap of a line transformer; the only noticeable effect is a small decrease in maximum available audio output power

The Stancor A8089 transformer is no longer available from Fair Radio.for $3 plus shipping. Sin Fair Radio has a $10 minimum order, if you are not ordering other items from them, you mig prefer to use the Radio Shack 70 volt line transformer, catalog number 32-1031, for $5.95. The Radio Shack transformer has primary taps of 10/5/2.5/1.25/0.62 watts and secondary taps of 4/8/16 ohms.

My current audio impedance matching adapter is shown in the following schematic. I used both the 625 and 1250 ohm primary taps of the Stancor A8089. I cut off the two extra primary tap leads flush with the primary windings. A 1 meg ohm half watt resistor was used to provide a tape output. The transformer was mounted in a small metal box.with four standard 1/4 inch headphone jacks for input and output. Audio cables with standard 1/4 inch headphone plugs are used to connect the adapter to a speaker or to the headphone jack of the R-390A or other receiver. A homebrew audio cable with headphone plug on one end and lugs on the other end is required for connecting the adapter to the terminal strip on the R-390A rear panel. You should note that terminal 7 on the R-390A rear panel is audio ground. If you connect the mating audio cable incorrectly, you may experience a strong shock when handling the adapter box or audio plugs, or you may accidentally short circuit the R-390A audio output. For speaker use, the audio cable center conductor should go to terminal 6, and the audio cable braid should go to terminal 7 on the R-390A rear panel terminal strip.

The 625 ohm primary of my adapter is used with an R-390A. The 1250 ohm primary is used with the high impedance headphone jacks of other receivers, such as a Hammarlund HQ-180(A) or HQ-150.

Perhaps it is appropriate to mention here that I have observed unnecessary replacement of power supply electrolytics in two HQ-180A receivers, probably as a consequence of unsuccessful attempts to eliminate hum from headphone audio output. In one case, new electrolytic capacitors were dangled from the wiring which had been disconnected from the original metal can multi-section electrolytic. In another case, an intermittent loss of B+ power was traced to unsoldered connections at the multi-section electrolytic lugs; the unsoldered leads had been stuck back through the solder lugs without recrimping and resoldering them. After the careless and unnecessary tamperings had been repaired, and an audio impedance matching adapter was used, the headphone audio output of these two HQ-180As was excellent.



While I am on the subject of good audio from hollow state receivers, let me remind you of the Radio Shack Indoor/Outdoor 4" speaker in the ugly plastic case, catalog # 40-1227A, mentioned in a previous HSN. It is still the best speaker I've found for use with hollow state receivers. Has anyone tried the 6-1/2" catalog # 40-1248? For headphones it is hard to beat the Radio Shack Lightweight Monaural Headphones, catalog # 20-210A, <u>provided</u> you cut off the 1/8" plug and replace it with a standard 1/4" plug. (The 1/8" to 1/4" adapter supplied with the headphones introduces "static".)

51J-/R-388 Band 1 Mod And AGC Mod

Dallas Lankford, Summer 1990

In my article, "Collins 51J-4 Review," DX News 56, 1 (Mon., Oct. 3, 1988), pages 6-8, I mentioned that the Collins 51J- series and R-388 receivers were insensitive on band 1, and suggested a band 1 mod and AGC bias mod to improve band 1 sensitivity. However, in a subsequent article, "Collins 51J-4 Technical Notes," DX News 56, 13 (Mon., Dec. 26, 1988), pages 29-32, I recommended against those mods after I discovered they degraded dynamic range on all bands.

Recently, I took another look at the band 1 sensitivity issue. Previously I had remarked that a carefully aligned 51J-/R-388 series receiver is not seriously insensitive on band 1, but merely somewhat less sensitive than on the other bands. Specifically, typical sensitivity is 0.25 microvolts on bands 2-30 and 1.0 microvolt on band 1 (for a 10 dB S+N/N ratio and 6 KHz bandwidth). I knew that improving band 1 sensitivity slightly on band 1 would not make it possible to hear more and better DX. Nevertheless, uniform sensitivity is desirable because it simplifies optimization of antennas, which is an important factor in determining what DX you hear. Also, I was curious if band 1 sensitivity could be made about the same as for the other bands without degrading band 1 dynamic range. The solution turned out to be simple. Add a 10 pF 500 volt mica capacitor across C117; see the simplified schematic in Fig. 1.

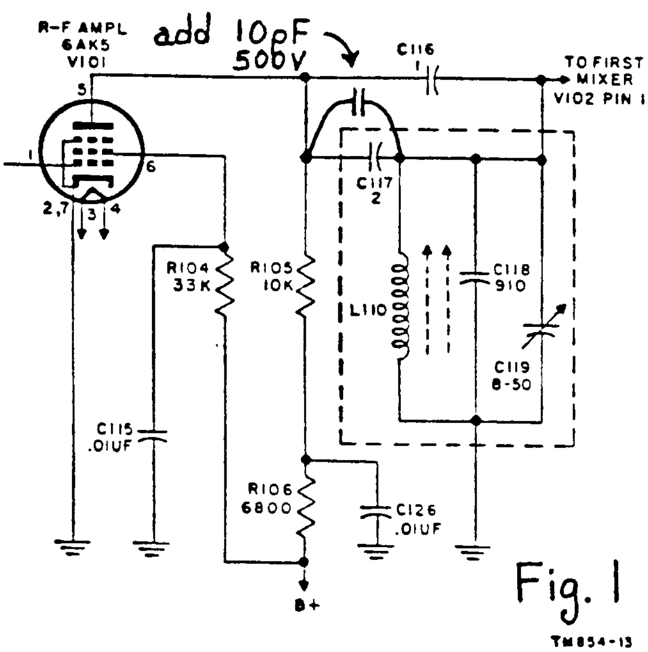


Fig. 1

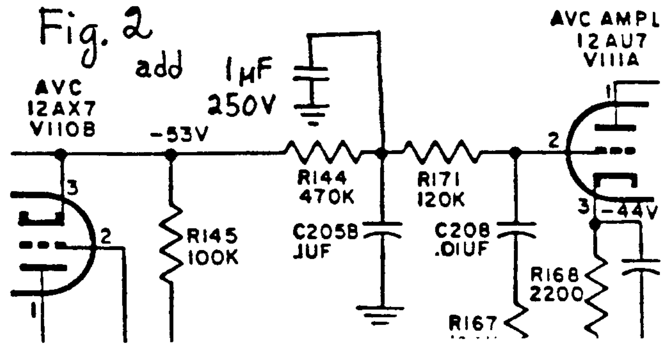
The simplified schematic in Fig. 1 is taken from an R-388 manual, but applies to all 51J- series receivers. The dashed line enclosing C117, L110, C118, and C119 is not accurate because those components are not contained in a shielded enclosure. In particular, C117 is attached to solder lugs on adjacent bandswitch wafers. It is not easy to access C117 because of its position beside an L bracket and because of two insulated wires which pass through one bandswitch wafer and are soldered to lugs on the other bandswitch wafer above one end of C117. These two wires must be unsoldered, disconnected, and pushed out of the way to access one end of C117.

The dynamic range before and after this mod was the same - 73 dB (5 KHz spacing), which is 4 dB better than an NRD-525. Sensitivity was improved to 0.35 microvolts, which is almost the same as for band 2.

After using a 51J-4 for almost 2 years I must say that it has extremely poor AGC for such an otherwise fine receiver. The AGC suffers from the worst kinds of defects one could imagine - low frequency audio on the AGC line, which causes noticable audio distortion on very low frequency audio (below 100 Hz), and attack and release times which are not suitable for MW graveyard and SW DXing. Fortunately, there is a simple cure for both of these problems (if you don't care about SSB or CW). Add a 1 mF 250 volt capacitor across C205B; see the schematic fragment in Fig. 2. In the original circuit, the release time is determined by R144 and C205B according to the formula T = RC, where R is in ohms and C is

Farads (the result T is in seconds). Thus, the original release time is about 50 illiseconds. Adding a 1 mF capacitor across C205B increases the release time to about 550 milliseconds, which is satisfactory for MW and SW AM broadcasts. This mod does slow the attack time from about 5 milliseconds to about 50 milliseconds, which makes the receiver less suitable for SSB and CW. If you want both improved AM and SSB/CW AGC performance, you will need to do my fast attack and slow release AGC mod.

Fig. 2



51J-3/R-388, 51J-4 PTO Remarks

Dallas Lankford

In my opinion, much of the value of a 51J-3,4 or R-388 depends on the linearity and end point accuracy of the PTO. That this is not an idle concern is attested to by the December 1969 Ham Radio article, "New Life For The Collins 51J Receiver VFO," by William I. Orr, pages 36-41. As Orr observed, by the late 1960's some of these 70E-15 PTOs had aged so much that the end points could no longer be brought into alignment. His article describes a method for fixing this problem which involves removing one or more turns from the end point adjustment coil. However, when a PTO has spread that much, even after you have modified the end point adjustment coil so that the end points can be adjusted, the PTO linearity is almost certain to be out of specs (+/- 750 Hz). To overhaul the PTO correctly, a corrector stack alignment should be done. But Orr does not discuss that. Take my word for it... few people have the patience and determination to do a corrector stack alignment.

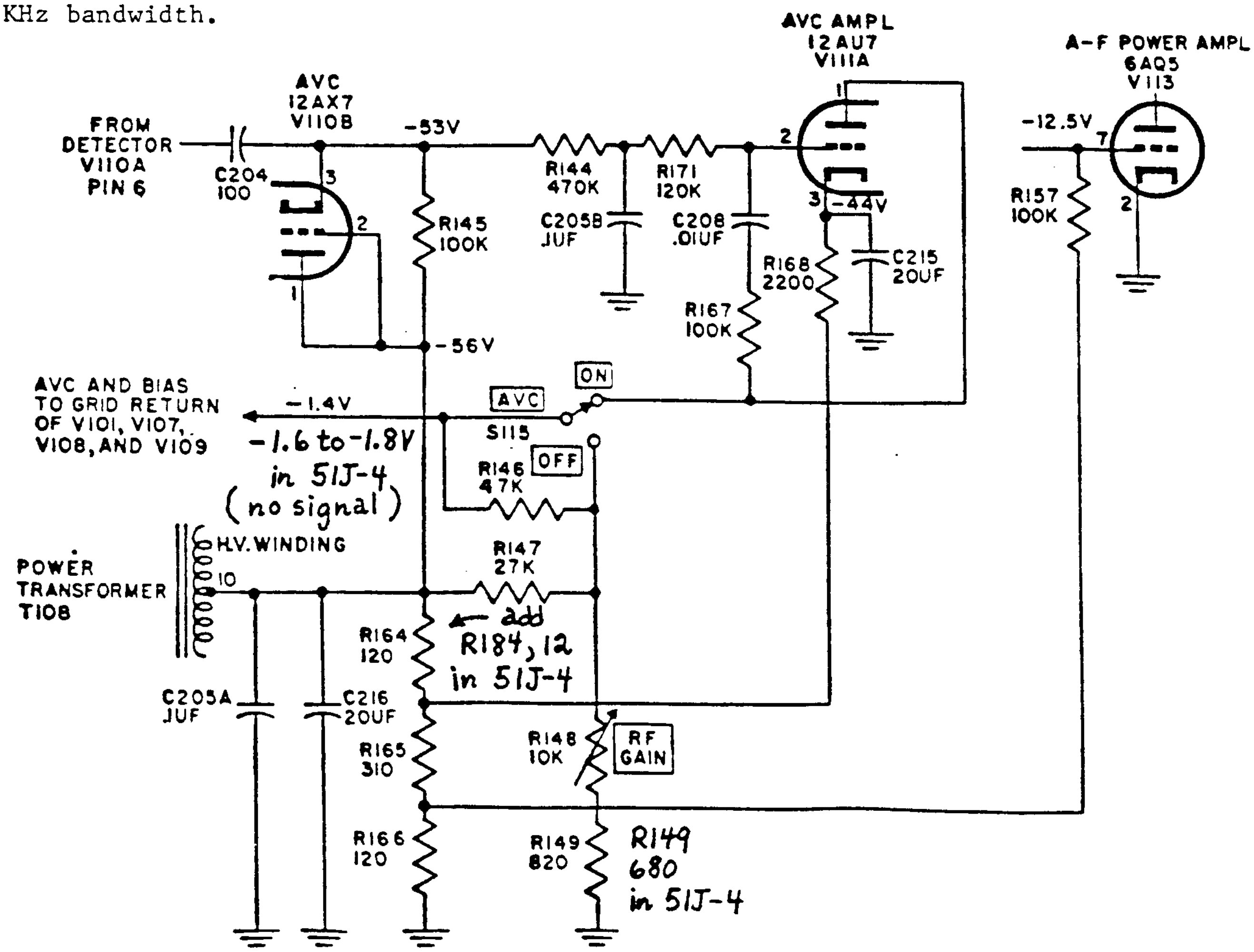
The bottom line is that if you simply must have a 51J-3,4 or R-388, you should not buy one sight unseen, but rather should personally inspect it and determine to your satisfaction that the end points are within, say, +/- 750 Hz and that all of the intermediate 100 KHz calibration points are within +/- 750 Hz. That is the only way you can be guranteed to get one with a good PTO. Of three 51J-4s which have passed through my hands, two had PTOs which were within the +/- 750 Hz spec. So there are some with "good" PTOs. If you are the gambling type, you could take a chance on a PTO which is slightly out of spec, say up to 3 or 4 KHz, and hope that an end point adjustment will bring it back into spec. (Here I mean the end points are out of spec no more than 3 or 4 KHz and the intermediate points are out of spec less than the endpoints.) If you take this approach, be forewarned that the end point adjustment slug has a lock nut which must be loosened before you adjust the slug. And if someone has been in there before you and forced the slot adjust end point shaft, it is just possible that the slotted tip of the shaft has been broken off by that someone. It is not necessary to remove the PTO to do an end point adjustment. You can fabricate two small right angle screwdrivers from 3-1/2" nails (0.148" diameter nails) and do the end point adjustment in situ with the aid of a dental mirror and a strong light.

A fascinating discussion of the 70E-15 PTO is contained in the Collins Instruction Book, Precision Tuned Oscillator 70E-15, part number 520 9887 00, 2nd Edition, 15 August 1959. If anyone has an original copy and would be willing to make me clear copies of Figures 5, 6, 7, and 8,I would greatly appreciate it. For additional information on 51J-3,4 and R-388 PTO end point alignment you may wish to send me two $1 bills (no checks please) and a SASE for my "51J-4 Technical Review" and one $1 bill and a SASE for my "More 51J-4 Technical Notes."

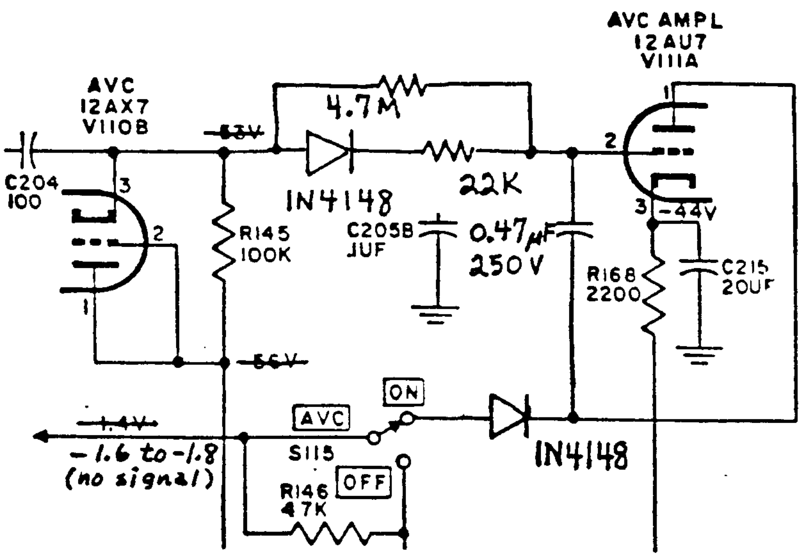
51J-4 Fast Attack - Slow Release AGC Mod

Dallas Lankford, Summer 1990

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.



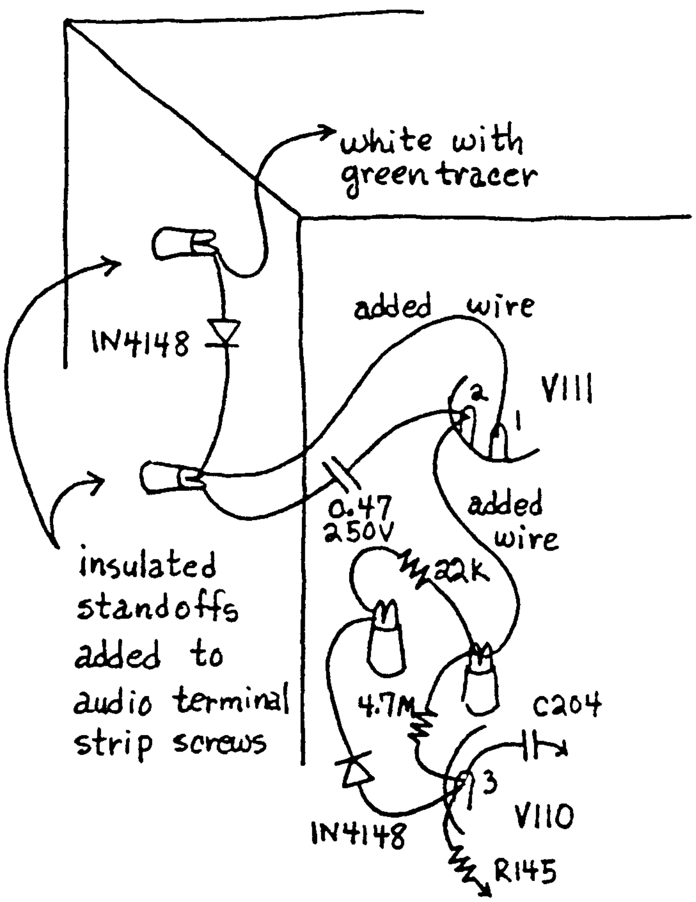
My initial circuit had rather bad overshoot, so I added a resistor in series with the diode. By trial and error I determined that 22K ohms was the best compromize between overshoot and my target attack time of 2 mS. With a 47K ohm resistor there was no overshoot at all signal levels, but the attack time 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.



The layout of my AGC mod is sketc' 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, C 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.