M65-3-1

NRD-525 AGC Mod:
Remove R104 And Jump Pins 3&4 And Jump Pins 8&9 Of IC7

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As is well-known, an unmodified NRD-525 suffers from several serious AGC problems in AM mode, namely muffled (distorted) audio due to audio on the AGC line, hanging of the AGC due to noise spikes and other strong signals of brief duration, and inappropriate release times which cause poor audio quality for strongly fading SW signals and MW graveyarders.

A number of mods for the NRD-525 AM mode AGC problems have been suggested in the past. But none of the previous AGC mods have been arrived at from an understanding of the NRD-525 circuitry, and none of the previous modifiers reported measurements of the modified AGC attack and release times. Apparently those previous mods were arrived at by tinkering with component values, and the effectiveness of those previous mods was determined by subjective evaluation rather than measurements of attack and release times using lab equipment. By contrast the AM mode AGC mod I will present in this note was arrived at by a mathematical analysis of the NRD-525 AGC circuitry, followed by a computer simulation using circuit analysis software, and the attack and release times were measured using a lab grade signal generator and a lab grade scope. The end result is the best AM mode AGC mod available at this time for the NRD-525. My mod is also much simpler than previous mods, and requires only the removal of one surface mount resistor and the addition of two jumper wires to the pins of an integrated circuit.

About 9 months ago I suggest an NRD-525 AM mode AGC mod in my article "NRD-525 AGC Mod, Preliminary Version 2, August 16, 1991." The basic idea was to disable the AM branch of the AGC circuit and to use the SSB/CW AGC circuit in all modes. The mod was untested because I had no NRD-525. Recently Russell Scotka sent me his NRD-525 to try out my ideas.

In the previous note I suggested removing R104, jumping pins 3 and 4 of IC7, and removing C78 and C79. This is what I tried first. But bad low frequency audio distortion in the FAST AGC setting was observed. The release times were measured and found to be about 25 mS for FAST and 500 mS for SLOW, much faster than my mathematical analysis and software simulation had suggested. Apparently there is a discharge path internal to IC9A equivalent to a 500K ohm resistor. In any case, this demonstrates the importance of measuring the results of any modification.

When C78 and C79 were restored and pins 8 and 9 of IC7 were jumped, the measured release times increased to 100 mS for FAST and 2 seconds for SLOW, which is about optimal. And no low frequency audio distortion was heard on received signals in either FAST or SLOW.

Consequently, the good news is that reception quality using the NRD-525 AM mode can be made much better (and much better than ECSS) by removing one surface mount resistor (R104) and adding two jumpers to pins of IC7 (pins 3&4 and pins 8&9). With these changes, AM FAST AGC is now excellent for fast bandscanning and for DXing steady or moderately fading signals, and AM SLOW AGC is now excellent for strongly fading SW signals and for nighttime MW graveyarders provided not much thunderstorm static is present. Of course, any AGC with a 2 second release will hang briefly on strong noise spikes, and this SLOW AGC is no exception.

The bad news is that the SSB/CW AGC (which is now also the AM AGC) has rather bad overshoot. This is not a problem for AM signals. And, curiously, there is no audible pop or click on initial SSB transmissions as is often the case with overshoot. The NRD-525 also has undershoot on FAST release in SSB/CW mode. No audible evidence of the FAST release undershoot was observed on AM or SSB/CW signals. Because there was no audible evidence of the overshoot or undershoot in any mode, I did not try further modification to eliminate them. Perhaps the overshoot could be reduced or eliminated by replacing R103 with a higher value resistor. But tinkering with different values for R103 is not a good idea because a PC board trace goes underneath R103.

Russell Scotka has told me that he is very pleased with the improved AM performance of his "new" NRD-525. Before I modified the AM mode AGC of his NRD-525 he used ECSS for AM reception because of the original AM mode AGC problems and related poor AM mode audio quality of received signals. Now that the AM mode AGC problems have been eliminated with my mod, Russell has found that the AM mode provides much better audio quality than the tinny sounding ECSS he used previously. Curiously, Russell said that his NRD-525 passband tuning now works much better in AM mode than before. I have no explanation for why my AM mode AGC mod should improve the performance of NRD-525 passband tuning in AM mode, but apparently it does.

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NRD-525 AM AGC Mod 2

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Recently I did my AGC mod (remove R104 and jump pins 3 & 4 and jump pins 8 & 9 of IC7) to a very late model NRD-525 and I was surprised to find that the mod in this late model NRD-525 did not perform like the mod I did to Russ' 1987 model NRD-525. In the late model NRD-525 the modified AM FAST release time was slower than for the earlier model NRD-525, and in the late model NRD-525 the modified AM FAST AGC was not as immune to static crash and noise pulse hanging as the modified earlier model NRD-525 had been. This curious situation was traced to what seem to be some production changes in late model NRD-525's. In the late model NRD-525 C77 was 0.47 mF (0.22 mF in the earlier model), and R107 was 22K ohms (10K ohms in the earlier model). The R107 change effects only SSB/CW SLOW release, but the C77 change effects FAST release in all modes; it doubles SSB/CW FAST release and lengthens AM FAST release about 60%. This explains why the mod in the late model NRD-525 was not as immune to static crash and noise pulse hanging as the mod had been in an early model NRD-525: in FAST AGC the modified late model NRD-525 was not releasing as quickly from desensitizing noise spikes. To make matters worse, more extensive listening tests revealed that my original mod has a subtle but annoying defect: in AM mode using the WIDE filter, some distortion is observed on strong AM signals when the AM carrier is tuned to about the center of the filter passband. And finally, more extensive measurements revealed that the SSB/CW AGC was not as well-defined as I had previous concluded. Both the AM and SSB/CW AGC circuits are amplified AGC circuits, and both exhibit variable release times: the release times depend on how far the signal levels drop. For these reasons, I spent several days rethinking possible AGC mods for the NRD-525 and testing my ideas.

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If you already did my original mod to your NRD-525, there is a simple change which greatly improves immunity to static crash and noise pulse hanging, and which also eliminates the distortion on strong AM signals when the AM carrier is tuned near the center of the WIDE filter passband. Remove the jumper between pins 3 and 4 of IC7, and install a 100K ohm 1/4 watt resistor between pins 3 and 4 of IC7. A 1/4 watt Radio Shack resistor is suitable for this change, although the leads seem somewhat larger than #24 solid, and so it is somewhat more difficult to attach the ends of the leads to the IC pin tips. There is a slight disadvantage to this solution. The 100K ohm resistor slows the SLOW AM AGC attack time so much that you get momentary distortion when tuning from a weaker signal to a stronge signal using SLOW AM AGC. The SSB/CW AGC performance is not changed from stock by this or the previous mod.

Because I did not like the momentary distortion in SLOW AM AGC when tuning from a weaker to a stronger signal, and because there was also momentary distortion when changing from AGC FAST to AGC SLOW in AM mode, I spent some time peering at the NRD-525 schematic and at the IF PC board, hoping to find a way to make the AM mode FAST and SLOW attack times about equal. At least for this late model NRD-525 there was a wonderfully simple and elegant was to accomplish this. In this late model NRD-525, IC8 has an unused section, pins 3, 4, and 5, and the control pin, pin 5, was joined by a PC board trace to pin 6 of IC8, which in turn was controlled by the AGC FAST control line (to P27-13); see the simplified schematic below. Thus by removing my previous mod entirely, replacing R104 (which had been removed for the previous mod) with a suitable SMD resistor for AM FAST attack, and adding a second resistor (which is switched by IC8 pins 3 and 4 via the AGC FAST control voltage at pin 5 of IC8), the AM attack times for FAST and SLOW can be made more-or-less the same. As with the previous mod, this mod requires no PC board hole drilling or trace cutting, so that you can restore your NRD-525 to original if you are ever inclined to do so.

I spent a lot of time listening with different values for R104, and finally settled on 220K ohms. With a 220K ohm resistor in place of R104 the AM FAST attack time constant is about 140 milliseconds, and the measured AM FAST attack time is about 14 milliseconds for a 10 dB increase in signal level. This puts the attack time constant within the range of values recommended by the classic radio design handbook, Radiotron Designer's Handbook, edited by F. Langford-Smith, and published in at least four editions between 1934 and 1952. According to this source, attack and release time constants between 100 and 500 milliseconds are suitable for AM signals, and the low end of that range is recommended for SW AM signals. Within the range of values I tested, 1K to 220K ohms, the steady state AGC line voltage measured at test point 3 was the same (for a given signal level, for "no signal" up to 100K microvolts input at the antenna terminal) regardless of what value was used in place of R104. In other words, my mod does not change S-meter readings or AGC line voltages from the original.

If your NRD-525 is an early model with 0.22 mF for C77, it is probably not necessary to change C77 to 0.47 mF, 25 or 35 volts, tantalum. But to be on the safe side, you should make that change anyway.

In summary, my NRD-525 AM AGC mod 2 requires that you (1) remove R104, (2) replace R104 with a 220K ohm 1/8 watt surface mount resistor (I bought a package of assorted SMD's from Radio Shack), (3) add a 22K ohm 1/4 watt resistor between pin 2 of IC7 and pin 4 of IC8, and (4) add a jumper between pin 3 of IC8 and pin 3 of IC9. If you do the mod yourself, you will need to inspect your work with a magnifying glass to be sure you have not formed any solder bridges between the IC pins and nearby traces. I strongly recommend that you use Teflon insulation on the resistor leads and on the jumper because ordinary insulation melts with soldering iron heat, and it will make a mess and perhaps allow the lead ends to short to nearby traces. To attach the lead ends to the IC pin ends you will need to form some small loops in the lead ends; see my sketch below. I used a piece of bare #24 solid wire and a small hemostat to form these small loops. The idea is to make the loops so that they will slip over the IC pin ends (using gentle finger pressure) and stay there while you solder them. Notice that the loops in the lead ends should finish on top. This minimizes the possibility of bridging to a nearby trace. In addition, the Teflon insulation should touch the loops in the ends of the leads, which also helps in preventing bridges to nearby PC board traces.

It may be possible to do a similar mod to the NRD-535. Except for some component value changes, and some minor circuit changes involving the switching IC's, the NRD-535 AM AGC circuit is fundamentally the same as the NRD-525 AM AGC circuit. One of the changes to the NRD-535 AM AGC involves increasing the value of R104 (same numbering in both) to slow the AM attack time. The AM attack time constant is about 12 milliseconds for FAST and about 84 milliseconds for SLOW. In the case of AM SLOW, that is about half the attack time constant I used above. According to the NRD-535 schematic, there is an unused section of IC5, but pins 11 and 12 of this section are shown grounded. However, if pins 11 and 12 of IC5 are not grounded, or if they can be easily ungrounded (say, by removing a zero resistance surface mount resistor), and if pin 10 of IC5 is not connected to anything, then it should be possible to adapt my mod to the NRD-535. For IC5, pins 10 and 11 are the switch, and pin 12 is the control voltage. Thus, assuming that pins 10, 11, and 12 of IC5 are isolated from the rest of the PC board, the corresponding NRD-535 AGC mod would be (1) remove R104, (2) replace R104 with a 100K ohm SMD resistor, (3) add a 15K 1/4 watt resistor between pin 1 of IC5 and pin 10 of IC5, (4) add a jumper between pin 11 of IC5 and pin 3 of IC7, and (5) add a jumper between pin 12 of IC5 and pin 12 of IC6. This would give a FAST AM attack time of about 110 milliseconds and a SLOW AM attack time of about 100 milliseconds. Depending on the PC board layout, it might be a better layout to go to pin 11 of IC5 in step (3) and to pin 10 of IC5 in step (4).

Unfortunately, my AGC mod does not eliminate the rather bad overshoot in the case of the NRD-525. Of course, not having an NRD-535, I cannot verify that my proposed NRD-535 mod will do what it is intended to do, namely eliminate AGC hanging in AM FAST due to static crashes and other noise pulses. Fortunately, as I remarked in my previous article, the AGC overshoot does not seem to cause any problems, either audible or otherwise.

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NRD-525 AM AGC Mod 2

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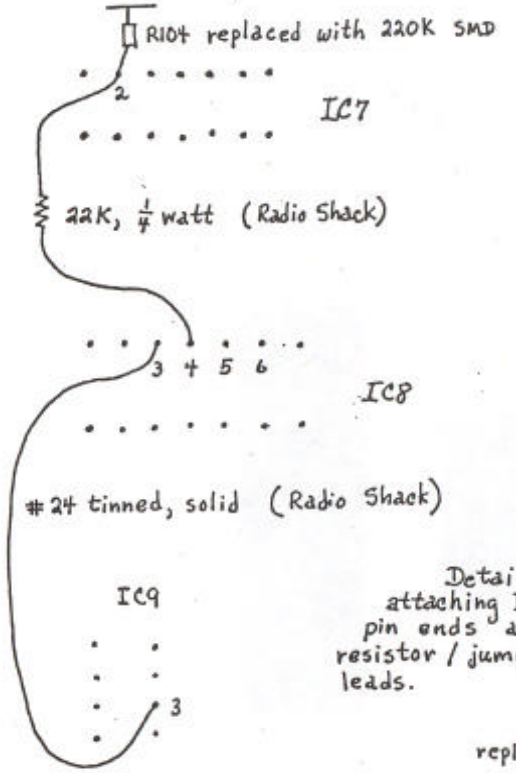
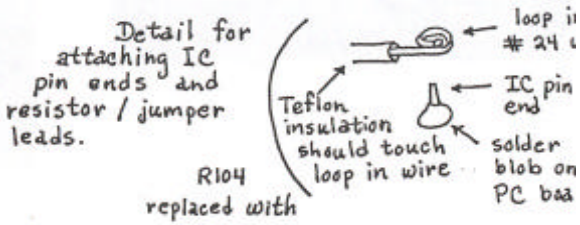
PC Board Bottom View

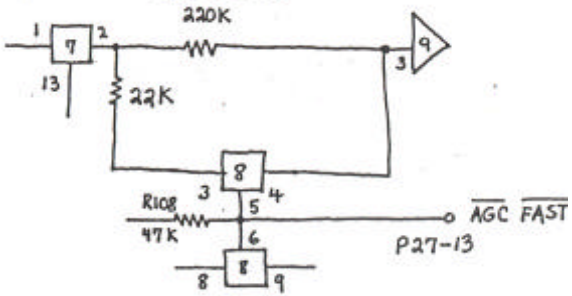


If C77 is not already 0.47 μF, change C77 (from probably 0.22 μF) to 0.47μF (tantalum, 25 or 35 volts).

Use a magnifying glass to verify that pins 5 and 6 are connected by a PC board trace. If not, and if pin 5 is isolated (no traces go to pin 5), then add a jumper between pins 5 and 6.



Insulate resistor leads and #24 jumper with Teflon insulation (stripped from #22, stranded, Teflon insulated, scrap hookup wire).



simplified schematic of mod