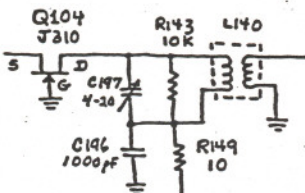
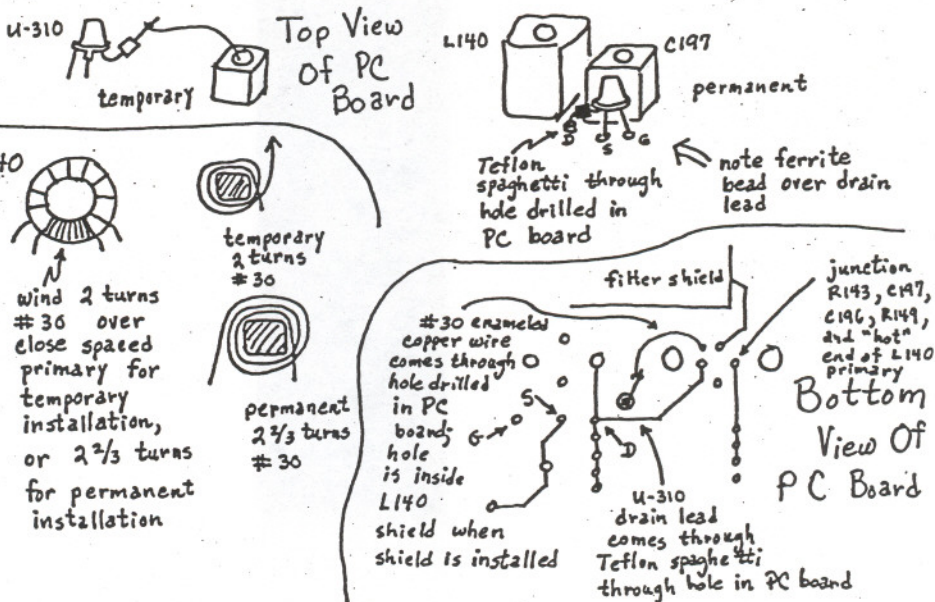
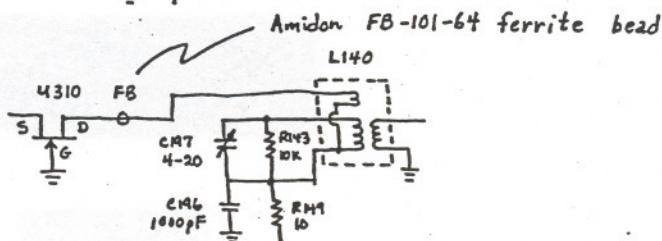


M 69-3-1

Before:



After:



As R8 owners know, just about every night you can get lots of 3rd order intermodulation distortion products (IMD3) in the 1.8-2.0 MHz range with the preamp on using rather modest antennas. And it is not uncommon to get IMD3 during the daytime in that frequency range with the preamp off. And at night in the 15.6-15.8 MHz range it is not uncommon to get 2nd order intermodulation distortion products (IMD2) from 6 and 9 MHz SW broadcaster with the preamp off or on. In a previous review of the R8 I had speculated that the cause of the IMD was the first mixer, although I did not completely rule out the 1st IF amp as a possibility. Denzil Wraight had discussed the problem with me, and he was more inclined to suspect the 1st IF amp. Because of that, and because the 1st IF amp is easier to modify than replacing the 1st mixer, I modified the 1st IF amp before trying anything else.

The basic idea was to present the J310 with a lower load impedance, which would in theory increase the 3rd order intercept (ICP3) of the J310 amp. To avoid drilling holes in the PC board, my first mod was temporary. The J310 was removed and a U-310 was installed in place of the J310 with the drain lead of the U-310 curved up (dangling). The U-310 leads are stiff enough so that there is no danger of the lead flopping around and shorting the +10 volt DC line. The L140 shield was carefully removed so as not to break the flimsy #30 enameled copper wire leads, and a two turn link was threaded around the bottom of L140 without removing L140. One end of the short length of #30 enameled copper wire was tinned in advance, and solder was removed from the PC board hole for the "bottom hot" side of the L140 primary. The tinned end of the short length of #30 was threaded through that PC board hole and soldered. The two turn link was wound, the shield can was reinstalled (with the other link lead coming out through the hole in the top of the shield), the link lead was trimmed to length, tinned, and soldered to the drain of the U-310.



M69-3-2

When I turned on my modified R8 for the first time last Saturday afternoon, I knew the mod was a winner. With preamp off, there was no sign of my usual KRUS + KWKH (2x1490 - 1130) IMD3 on 1850 KHz, and with the preamp on the IMD3 was barely there, about as strong as it had been with the unmodified R8 and preamp off.

After realigning the IF transformers (C197, C179, C174) I began making tests and observations. Signal levels were down about 12 dB, but surprisingly the sensitivity of the R8 was hardly changed, from about 1.1 uV before to 1.5 uV after the mod for a 6 KHz BW and AM mode with preamp off.

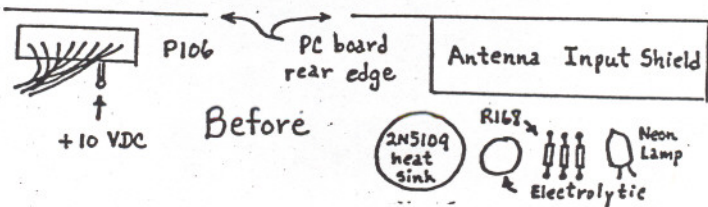
Later, for a permanent installation I used a 2 2/3 turn link, and signal levels were down only about 8 dB, but with sensitivity still down slightly at 1.5 uV for a 6 KHz BW and AM mode with preamp off.

The preamp off ICP3 is now below the local oscillator (LO) phase noise at the standard 20 KHz spacing with 6 KHz BW and AM mode. In other words, the ICP3 is LO phase noise limited. A good measure of the ICP3 can be gotten by measuring the ICP3 at wide tone spacings within one of the broadband front end filters, for example 2x1000 - 520 = 1480 KHz, 2x2000 - 1520 = 2480 KHz, and so on. With such spacings I got +16.5 dBm for AM mode and 6 KHz BW with preamp off. With preamp on the standard 20 KHz spacing ICP3 could be measured, and it was found to be about +2 dBm, about the same as for an unmodified R8 with preamp off.

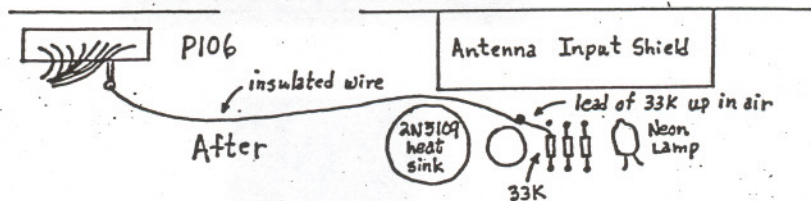
Even with the temporary mod, it was obvious to me that this mod would be a permanent part of my R8. There is not much space to bring the U-310 drain lead through the PC board. The top side is blocked by the shields for L140 and C197, and the bottom side is fenced-in by the original traces to the drain of the J310. I don't like hole drilling or trace cutting, but in my opinion hole drilling is better than trace cutting. The available space is so restricted that one side of my hole just about touched the trace from the original drain to L140. By working a small drill bit around the hole I enlarged the hole just enough so that some #20 ID Teflon spaghetti could be jammed through the hole. I trimmed one end of the Teflon tubing to a point so it could be threaded into the hole and forced through, and then used miniature needle nose pliers to pull it through further. The ends of the Teflon tubing were then cut flat with miniature diagonal cutters. About 1/8 inch of the Teflon tubing sticks up above and down below the PC board surfaces. With the L140 shield removed, a small hole was drilled through the PC board to pass through one end of the #30 link. The hole is very near one inside corner of the shield with the shield installed. When winding the 2 2/3 turn link you should be careful not to move L140 too much because #30 wire is easy to break. At some future date I'll probably rewind L140 because I moved mine around a lot while working out the mod. I may use #26 for the link because that would give a sturdier and more reliable installation.

Further testing with with several other IF amps and further alignments of the 45 MHz tuned circuits and image reject circuit at the 2nd mixer revealed that there can be considerable variation in ICP3 depending mainly, it seems, on the alignment trimmer settings and image reject trimmer settings. For best 45 MHz crystal filter shape and maximum 100 KHz image rejection, the preamp off ICP3 tends to be in the +10 - +12 dBm range, and the preamp on ICP3 tends to be in the -1 - +3 dBm range. At present I am using a pair of U-310's mounted on a small adapter PC board instead of the single U-310 mod described at the beginning of this article. It may be possible to raise the preamp off/on ICP3 to +17/+5 dBm by using a low pass filter between the diplexer and the 1st 45 MHz IF amp, but I have not finished these tests. The point is that this mod should be regarded as preliminary, and further significant improvements may be possible.

With the higher dynamic range there is no longer any reason (if there ever was one) to disable the preamp below 1.8 MHz. For the last week or two I have been running my R8 with the preamp turned on for all bands, and I have found no significant IMD3 products. The simplest way to turn the preamp on is to remove R168 (10 K), install one lead of a 33K ohm resistor in the front panel side PC board hole which formerly mounted R168, and run a short length of insulated wire from the other lead of the 33K ohm resistor to a +10 VDC plated through hole in front of P106. With this mod, the preamp is on when the R8 is on. The preamp push button on the front panel may still be used to obtain 10 dB attenuation, and the front panel light still cycles through OFF, ATTN, and PRE. However, in both OFF and PRE the preamp is on.



M69-3-3



This is, of course, not the proper way to do the preamp mod. One should fabricate some kind of tiny PC board adapter which is soldered into the R8 PC board where R168 was originally. I plan to fabricate a small adapter with a 3 prong header and movable jumper (and 10K and 33K ohm resistors) so that I can switch between the original preamp operation and preamp permanently on. This mod could be accomplished with a switch mounted on the rear panel, but then it would be more difficult to remove the RF PC board.

Unfortunately, improving the ICP3 of the 1st 45 MHz IF amp does not improve the 2nd order intercept (ICP2) of the R8. The R8 ICP2 seems to be entirely determined by the 1st mixer, which has a wideband ICP2 of about +41 dBm, plus some additional help from the broadband front end filters, which brings it up to the +45 - +50 dBm range with preamp off, and +35 - +40 dBm range with preamp on. This means you will still observe SW IMD2 products in the 15.6 - 15.8 MHz range many evenings, and perhaps at other frequencies, such as 500, 510, and 520 KHz and 3000 - 3200 KHz for MW IMD2. The only way to substantially improve the R8 2nd order performance is to replace the 1st mixer. And there is really only one MiniCircuits mixer which would, in principle, substantially improve the ICP2, namely the TUF-3H with a broadband ICP3 of about +29 dBm and broadband ICP2 of about +68 dBm. However, the TUF-3H requires +17 dBm LO drive, so additional amplification of the LO would be required. In addition, the R8 preamp would probably have to be replaced with a balanced amp to achieve a +68 dBm ICP2. Nevertheless, the advantages of such improvement may be worth pursuing.