NRD-525: Filter Mods – by Dallas Lankford

Much has been written about NRD-525 filter mods, and a number of filter mods have been offered for the NRD-525, but in my opinion many of these previous mods have made little difference in the performance of a 525 despite the claims of satisfied users (I call this the emperor's new clothes phenomena), and in some cases 525 performance has actually been degraded. For example, if you merely solder a Collins FD type filter into the AUX (or NARR) position without appropriate impedance matching, the FD filter will have excessive ripple, which distorts the audio of received signals. And if you believe that putting a Collins FD455FD29 (2.9 KHz BW) filter in a 525 turns it from an overpriced scanner into an outstanding DX rig, then you are suffering from the emperor's new clothes phenomena (first of all, there is not a hill of beans difference between what you can hear with the original 525 INTER filter and a 2.9 KHz BW Collins FD filter, and secondly, unless you impedance matched the FD filter correctly, the recovered audio with the Collins FD filter is probably more distorted than the original INTER filter). Others believe that by cascading filters, such as with the ESKAB add-on filter board, you can dramatically improve the ultimate selectivity of a 525. But this is simply not so. The ultimate selectivity of a 525 is limited (to about 86 dB for a 6.0 KHz filter) by the phase noise of the 1st local oscillator, and no amount of filtering after the first mixer can improve this. There is a slight amount of filter leakage in an unmodified 525 (probably due to radiation from the filter impedance matching chokes), but this can be easily and cheaply fixed by replacing the original filter impedance matching chokes by toroid chokes as pointed out in my recent article "NRD-525: Filter Leakage" (see DX News, Vol. 60, No. 26 - May 31, 1993, pages 37-40). The ESKAB add-on filter board is sometimes justified as a means of reducing the weak-signal hiss which some 525 users complain about. However, I don't find the hiss very bothersome, and anyway, an outboard audio filter is a better and less invasive solution to the hiss problem if you find it annoying. Moreover, an easier and cheaper (free!) solution for the hiss problem was pointed out to me by Denzil Wraight: merely readjust the IF AGC level to a higher value. The 525 service manual calls for an AGC output at TP1 on the CAE-182 board of about 85 mV RMS. With a level of 160 mV RMS, the hiss is greatly reduced. If the ESKAB add-on board isn't pricey enough for you, you can contact Pühler Electronics (Dipl.-Ing. Peter Pühler, Almstrasse 3, 8019 Steinhoring, Germany, Tel. 08094/631) and replace your entire CAE-182 board. I can't quite piece together his options and prices, but it appears you can easily spend about $1000 for a CAE-182 replacement board loaded with filters (including 2.0 KHz and 4.0 KHz R-390A filters). Or if you simply must have some Collins filters in your 525 because all of you friends have Collins filters in their 525's, you can buy some of the neat little Collins torsion filters and replace your stock 2.4 KHz BW INTER filter and stock 5.7 KHz BW WIDE filter with 2.5 KHz BW and 6.0 KHz BW torsion filters. However, the 2.5 KHz torsion filter is no better and no worse than the original INTER filter, while the 6.0 torsion filter is a bit wider at the -60 dB down points (about 10.3 KHz) than the original WIDE filter (about 8.3 KHz). This is, of course, another of the many "emperor's new clothes" modifications available to you.

Having said all of the above, and knowing full well that some other filter would not enable me to hear anything that I could not already hear with the stock filters (and hear about equally as well with the stock filters), I have still wished that there was a 3.1 KHz BW filter available for the 525. My reasoning was that the 3.1 KHz BW would pass a bit more audio than the INTER filter, and thus be a bit easier on the ears than the INTER filter. Very recently Kiwa Electronics granted my wish, actually doing much better and providing me with the filter I should have wished for: an NTK CLF-D2 filter with a -6 dB BW of about 3.9 KHz, and a -60 dB BW of about 6.1 KHz, with a shape factor of about 1:1.6. I am used to thinking in terms of the old Collins FD filters with about 1:2 shape factor, which is why I had a 3.1 KHz BW in mind (for a -60 dB BW of about 6.2 KHz). In my experience, the -60 dB BW of a filter for tough DX situations should be about 6 KHz. The special-order CLF-D2 filter provided by Kiwa Electronics meets this condition, with the added bonus of a 1:1.6 (approximately) shape factor, which lets more audio through at the top for a more pleasant DXing experience. If you are interested in purchasing a similar filter (3.4 KHz to 3.9 KHz BW), contact Craig Siegenthaler at Kiwa Electronics, 612 South 14th Avenue, Yakima, WA 98902, tel. (509) 453-5492 for price and availability. It is my understanding that these filters will be priced in the neighborhood of $70, and that an adapter board for installing it in your 525 (and maybe 535) may also be available from Kiwa Electronics.

Installation of the CLF-D2 filter is actually quite simple if you don't mind losing your nominal 5.7 KHz BW WIDE filter because the CLF-D2 is identical in shape, size, and pin-out to the stock WIDE filter. This is what I did initially to evaluate the CLF-D2 filter. (It is a winner.) But I never intended to do without my nominal 5.7 KHz BW WIDE filter, and in short order developed an adapter PC board for my WIDE filter which bolted and plugged into the vacant AUX position on my CAE-182 NRD-525 filter board. The details of this modificatio are given below.

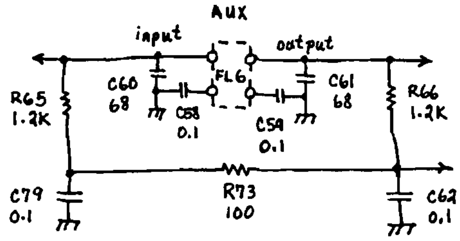


Fig. 1

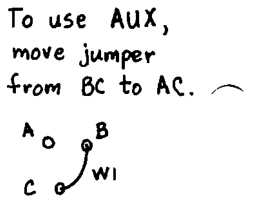


Fig. 2

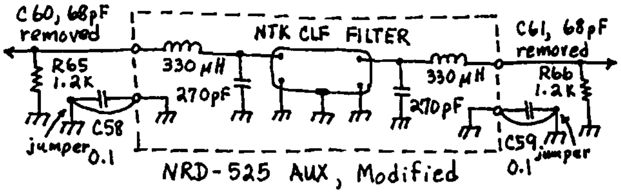


Fig. 3

Fig. 1 is a simplified schematic of the AUX filter circuit. Fig. 2 shows how to enable the AUX filter position: move the jumper W1 from BC to AC. Fig. 3 shows how to modify the AUX circuit to accept an NKT CLF type ceramic filter. The two surface mount capacitors C60 and C61 are removed, and the two surface mount capacitors C58 and C59 are jumped. (To remove C60 and C61, use some ChemWik Lite 0.100 desoldering braid to remove the excess solder from both ends of the SM caps. Then use two 23 watt soldering irons with blade tips to lift the SM caps off the 525 filter board after heating the SM cap ends for about 10 seconds. The jumpers for C58 and C59 may be short lengths of #24 tinned solid copper wire bent into a U shape, with ends flattened by applyi pressure with miniature needle nose pliers. Bend the end-flattened U shaped jumper wires so that the flattened ends act like "feet" to hold the U shaped jumpers up above the 525 PC board with the flat "feet" sitting on the SM cap PC board trace pads.) The original WIDE filter (also an NTK filter) and associated impedance matching circuitry are mounted on a PC adapter board; see Fig. 3 (the parts inside the dashed lines), and Fig. 4. If you compare Fig. 3 with the 525 schematic, you will see that what I did was modify the AUX circuit so that I could duplicate the original WIDE impedance matching circuit. The two 330 microHenry chokes should be toroid chokes like I used to eliminate filter leakage, namely 25 turns of #22 enameled copper wire on Amidon FT-50-43 ferrite toroid cores. Amidon FT-50-61 ferrite toroid cores may also be used, but more turns of smaller wire are required, namely 64 turns of #24 enameled copper wire (in two layers). The dimensions of the adapter

NTK CLF Filter Adapter Board (bottom view)

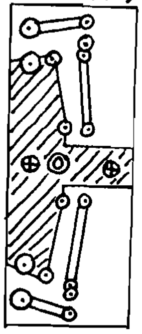


Fig. 4

NTK CLF filter pin dimensions

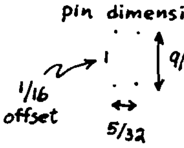


Fig. 5

CFH-36 IF Filter AUX & NARR Spaces

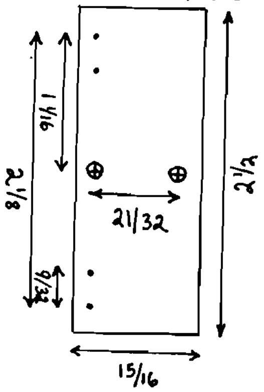


Fig. 6

PC board layout can be determined from the CLF pin dimensions in Fig. 5 and from the AUX and NARR space dimensions in Fig. 6. I used epoxy glass base PC board material (GC cat. # 22-260) and Radio Shack Direct-Etching Dry Transfers cat. # 276-1577A (made in USA, or made in Holland; avoid made in Tiwan). The shaded area in Fig. 4 was filled in with a PC Board Resist Marking Pen (RS # 276-1530A). The PC board was etched with PCB Etchant Solution (RS # 276-1535A).

You could use Radio Shack PC board material, but I don't like the Radio Shack PC board material; the GC epoxy glass base PC board material is much superior. The two large holes on the adapter board are for 4-40 mounting screws. I drilled the holes with a 1/8 inch drill to clear 4-40 screws, then enlarged the holes slightly with a small circular file to facilitate mating the adapter board with the holes on the CAE-182 filter board. I also enlarged the holes on the CAE-182 board slightly, again to facilitate mating the adapter board. Enlargement of the CAE-182 board should be done from the copper foil side. Ground pads surrounding the holes limit the amount of enlargement which should be done. "Pin-outs" from the adapter board to the CAE-182 filter board were implemented with #22 tinned solid wire, bent double on the adapter board end and "press-fitted" into 40 guage holes on the adapter board (then soldered). The 4-40 mounting hardware was implemented with 1/2 inch long 4-40 screws, with two each flat washers against both sides of the adapter board, and 4-40 nuts and lock washers to attach the 4-40 screws to the adapter board. These nots may be loosened to align the 4-40 screws with the holes in the CAE-182 filter board. After mounting the filter, 330 microHenry chokes, and 270 pF capacitors on the adapter board, the adapter board is mounted on the CAE-182 board using flat washers, lock washers, and nuts, and then soldered at the four pin positions. The end result is a "plug-in" filter adapter board which is profession in appearance and performance.

A similar "plug-in" adapter board was made for the NARR position to use a 500 Hz Collins torsion filter; see the circuit in Fig. 7 below. In the case of the narrow Collins torsion filter, a solid ground barrier between the input and output pins was made by cutting slots into the adapter board and inserting small pieces of PC board material which were then soldered to the adapter ground plane. This precaution was taken with the narrow filter because the narrow bandwidth effectively lowers the 1st LO phase noise, permitting greater close-in attenuation. The use of a ground barrier between input and output pins for AM BW filters is not necessary (considerable shielding of input and output pins from each other is already achieved by the two ground pins and one of the 4-40 mounting screws). Measured attenuation of the 500 Hz torsion filter at ±5 KHz was 92 dB, which is consistent with 1st LO phase noise.

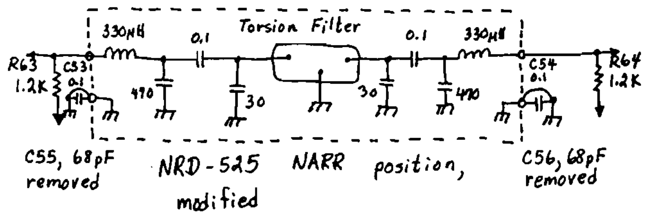
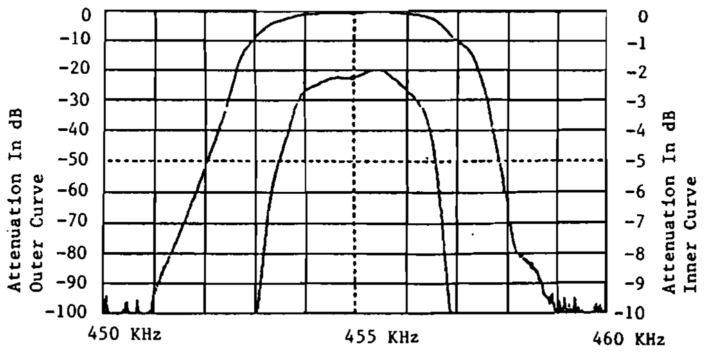


Fig. 7

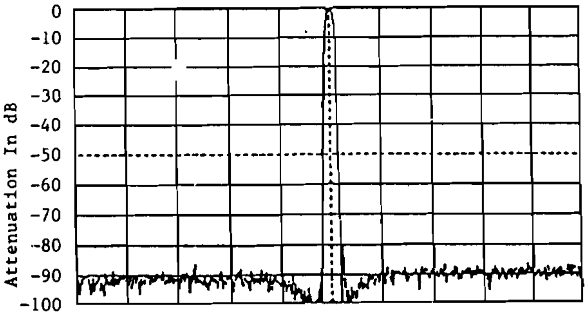
Addendum, Jan. 9, 1994

The filters which I received initially from Craig Siegenthaler at Kiwa Electronics were pre-production samples which he had received from NTK and which he generously gave to me for evaluation. Specifically, the filters discussed above were type CLF-D2 N302A. The first production run of these filters are type CLF-D2K N311A, and typical attenuation characteristics of this type of filter are given below. The "K" in the type designation denotes that the CLF-D2 filter is a special order filter which meets the specifications requested by Kiwa Electronics. You can't use any old CLF-D2 filter and get the same attenuation characteristics as a CLF-D2K filter.



Typical CLF-D2K Filter Attenuation

I dered and received four of the CLF-D2K N311A filters and measured the attenuation characteristics of three of them. The 6 dB BWs of the D2K filters I measured are running somewhat narrower than the pre-production samples, namely about 3.0 to 3.2 KHz in the three I measured. However, as you can see from the graph above (the top graph), the roll-off of these ceramic filters not fast until about -15 dB down, so they sound more like 3.3 to 3.6 KHz BW filters. Another difference between the D2K production filters and the pre-production filters is ultimate attenuation: the D2K ultimate attenuation is much better than the pre-production filters, typically greater than 86 dB for the former, and greater than 74 dB for the latter in the 400-500 KHz range. Also, the "notches" on both sides of the passband are deeper for the D2K filters than for the pre-production filters, typically greater than 90 dB for the former, and about 83 dB for the latter. These notches, which are normal for this type of filter (see the graphs above), are typically 10 dB or more deeper than the average stopband attenuation. Moreover, the notches were what made the pre-production filters barely satisfactory for a high performance receiver like the NRD-525. Were it not for the 70.455 MHz FL1 filter and 455 KHz FL2 filter ahead of the NRD-525 455 KHz filter array, and the 12 KHz nominal 6 dB



Typical CLF-D2K Filter Attenuation

BW they provided, the pre-production filters would not have been satisfactory. The point is that for a receiver like the NRD-525, the filters ahead of the pitched 455 KHz filters tend to make the attenuation of the main 455 KHz filters below 445 KHz and above 465 KHz of little concern. It is the main 455 KHz filters attenuation characterictics from about 445 KHz to the lower 60 dB filter point and from the upper 60 dB point to about 465 KHz which is crucial for overall receiver attenuation performance. To achieve all the attenuation performance the 525 is capable of, the attenuation of the main filters in these ranges should be no less than 80 dB for a 6 KHz BW filter, and no less than 86 dB for a 3 KHz BW filter. The D2K production filters meet this requirement with room to spare. The pre-production filter I have installed in my 525 doesn't quite meet the 86 dB condition, but it just isn't worth the effort to replace it for a dB or two of improvement in the close-in deep skirt attenuation of my "D2" filter. The 60 dB BWs of both the pre-production and the D2K filters are very uniform, typically about 6.0-6.2 KHz.

In addition to the NRD-525 and NRD-535, the CLF-D2K N311A filter should be suitable for use in other solid state receivers and portables which use 455 KHz IFs and which are designed for filters with about 2000 ohm source and load impedances. If the original filter pin dimensions do not match the CLF pin dimensions, it should be feasible to mount the CLF filter by attaching short wire leads to the CLF pins (the leads should be as short as possible, and should be well crimped and soldered), installing a small copper foil barrier between the input and output pins of the CLF filter, and by appropriate positioning of the short wire leads, install the CLF filter in place of the original filter. This approach is simpler and as effective as trying to devise a tiny PC board apter. Portable receivers suitable for this approach include the Sony 2010 (maybe) Radio Shack DX-400, and Uniden CR-2021. Though production ceased in 1986, the DX-400 and CR-2021 are still two of the best performing all-band portables, and well worth the expenditure of time and money to upgrade its narrow filter to a CLF-D2K N311A if you didn't already upgrade its filters many years ago when Radio+ offered its pin-for-pin compatible filter upgrades for them. And while you are at it, you should get an LF-H4S filter from Kiwa Electronics; is a 6 KHz nominal BW filter which is pin-for-pin compatible with the original "super-wide" filter in the DX-400 and CR-2021. I don't have any personal experience with the Sony 2010, but according to Gordon Darling's review, "Modifying The Sony ICF-2010/2001D," in Fine Tuning's Proceedings 1990, and according to ceramic filter data I have in my archives, the 2010 filters are pin-for-pin compatible with NTK LF-H type filters. This means that the 2010 wide filter can be changed to a nominal 6 KHz BW with a pin-for-pin compatible LF-H4S filter, available from Kiwa Electronics. Replacing the 2010 narrow filter with a CLF-D2K N311A may not be easy (Darling remarked that filter type changes for the 2010 are difficult because of limited space and because components are flow soldered on both sides of the PC board). However, it would be well worth the effort to install a CLF-D2K N311A filter in the 2010, and Kiwa Electronics may even offer an adapter module for the 2010 by the time you read this. (Contact Craig Siegenthaler at Kiwa Electronics for information on the possible availability of such a mod.)

The CLF-D2K N311A is also an admirable candidate for installation in top-of-the-line 455 KHz IF hollow state receivers, such as the R-390A, provided you do appropriate impedance matching (with attention to AGC feed if needed). That's why I bought four D2Ks. As a matter of fact, I've had a CLF-D2K operating in place of the useless 16 KHz R-390A mechanical filter for the past few days, and I am quite pleased with the result. For difficult MW splits, the CLF-D2K provides a slight but noticeable improvement in recovered audio compared to the R-390A 2 KHz and 4 KHz mechanical filters. For this application, I used the D2K with the narrowest 6 dB bandwidth, about 3.0 KHz. Also, a 6.7 KHz bandwidth LF-H4S ceramic filter was used between the last R-390A mixer and the input to the crystal filter, ahead of the first IF amplifier. This may have contributed to the improvement due to the D2K filter. The measured 60 dB bandwidth of this cascaded combination was 5.8 KHz, while the 80 dB bandwidth was 6.2 KHz. This is a substantial improvement in the nominal 60 dB bandwidth of 8 KHz for the 4 KHz mechanical filter. These complex R-390A filter mods will be the subject of a future article.