M47-3-1

'180 + COLLINS F455FA40 MECHANICAL FILTER = SUPER-'180

Dallas Lankford
(c) 1982

The symmetrical bandpass, 455 khz center, Collins F455FA and FB series of mechanical filters provide a wide range of bandwidths from which to choose. The FA series of filters are identical in performance to the FB series, but do not have measured 20 db points marked on the filters. The FA (FB) series parameters are listed below.

TYPE NUMBER	COLLINS PART NO.	6/60 DB BW
F455FA-05	526-9765-020	0.5/3.0 khz
F455FA-15	526-9495-000	1.5/3.5 khz
F455FA-21	526-9427-000	2.1/5.3 khz
F455FA-27	526-9500-000	2.9/6.2 khz
F455FA-31	526-9496-000	3.1/6.5 khz
F455FA-40	526-9497-000	4.0/8.5 khz
F455FA-60	526-9498-000	6/12.6 khz

We wonder why the 27 filter should have a 2.9 khz 6 db BW, so perhaps there is a typo in the Collins catalog from which we obtained our information. The 500 cycle filter is surely too narrow to be of much use in AM DXing, but all of the others are potentially suitable for more or less narrow AM DXing. I chose the 4 khz BW filter for installation in the '180 because I wanted to retain as many of the '180's BW options as possible. In this case, all but the 6 khz and 3 khz upper and lower sideband selectivity options remain available (the 3 khz upper and lower sideband selectivities can still be had by adjusting the vernier fine tuning ± 1 khz). The 2.1 khz BW filter would, perhaps, give slightly better performance under extreme listening conditions (say, between two 50 KW locals), but then you lose a great deal of the '180's selectivity options on bands 1 - 4.

It is generally agreed that for best performance a mechanical filter should be placed immediately after the first mixer. Unfortunately, because of space and circuitry problems, installing a mechanical filter in a '180 is non-trivial. A schematic of the '180 mixer and immediately following stages is given in Fig. 1. A Collins data sheet for the FA series filters contains a suggested installation circuit which would remove the first 455 khz IF transformer, but that circuit seems difficult to use because the first 455 khz IF in the '180 is an essential part of the '180 bandswitching scheme. The suggested Collins output circuit also seems undesirable because additional AVC line would be required, thereby creating additional stray signal paths and reducing ultimate rejection of the mechanical filter. However, on the plus side there is plenty of reserve gain available by modifying the 455 khz GATE to more than overcome the insertion loss of the mechanical filter. (The GATE is a reduced gain, AVC controlled, 455 khz IF amplifier, with further signal loss due to the very low 2 pf grid coupling capacitor shunted by the 22 K resistor.)

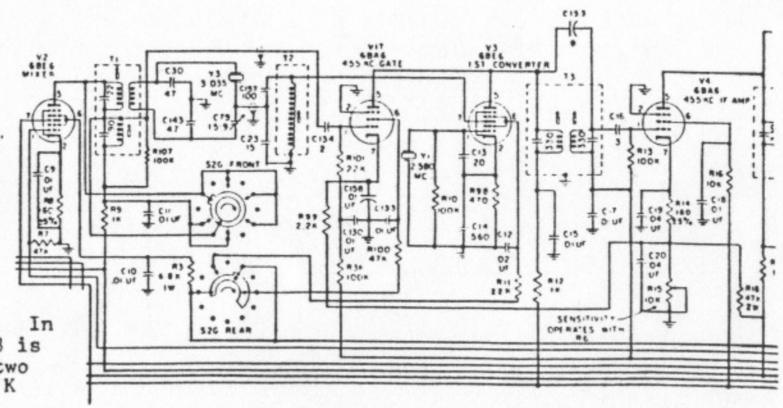

FIGURE 1

Mixer, gate, 455 khz IF amplifier schematic for 1970 model HQ-180A.

In earlier model '180's C158 may not be present, and R99 may be 1000 ohms. In addition, R18 is realized by two parallel 100 K resistors.

The circuit I used was arrived at by consultations with Dr. Tom Williams, formerly a professor of electrical engineering at Louisiana Tech University who, coincidentally, had previously worked for Collins for about 10 years. Basically, we looked at schematics of Collins receivers which used mechanical filters until we found something that looked feasible. For the input circuit, we used a standard B+ feed via a single tuned IF transformer (so that we could use the existing '180 circuitry) capacitor-coupled by Cin to the tuned filter input. In my installation, I removed the 100K R107 so that I could determine the effect of different values for R107, but observed no noticable differences for values in the 50K - 500K range and so I would leave R107 alone in future such installations (R107 is rather difficult to replace because of its position between the pins of T1). We have denoted the capacitance of the shielded cable input CCin to remind us that its capacitance adds with the 90 pf capacitor in T1, requiring that the 455 khz section of T1 be realigned for maximum signal. (In practice, the signal loss due to a misaligned T1 is generally negligible.) The output circuit allows easy filter termination and AVC feed at the GATE tube socket. A simplified schematic of the installation is shown in Fig. 2 below. The input and output coupling capacitors are shown with nominal values. Any values between .001 and .01 should do, and values as low as 100 pf do not significantly lower signal levels (though you might lose a few microvolts of sensitivity, longwire performance is uneffected, and strong signal handling performance is probably slightly improved). The filter is tuned to resonance at input and output by 130 pf capacitors Ct. The 130 pf of capacity includes stray capacity, e.g. CCout in the output Ct. For Ct I used a 100 pf silver mica paralled with a 50 pf air variable trimmer. I found that tuning of the filter is so broad that I could have just as well used 130 fixed for Ct input and 110 fixed for Ct output (I estimated about 20 pf for CCout). The output termination resistor can be anything from as high as 500K to as low as 20 K (Collins recommends against values below 50 K, but I noticed no problems). The lower values reduce the signal level somewhat, and so are useful for increasing the dynamic range of the '180. To restore the lost signal (insertion loss of these filters is not given in the Collins data sheets, but it is more than the '180 circuitry it replaces), the GATE cathode circuit was changed as shown. We originally used ½ watt power ratings for RA and RB because Hammarlund used a ½ watt power rating for R99 (which our circuit replaces). However, we measured voltage drops across RA and RB for various operating conditions, and discovered to our surprise that RB generally dissapates about 1.1 watt. A "finger test" revealed that RB was warm, but not hot, but we will still replace it with a 2 watt variable. The ground return point of C130 was changed to the same GATE tube socket ground lug as C158. In

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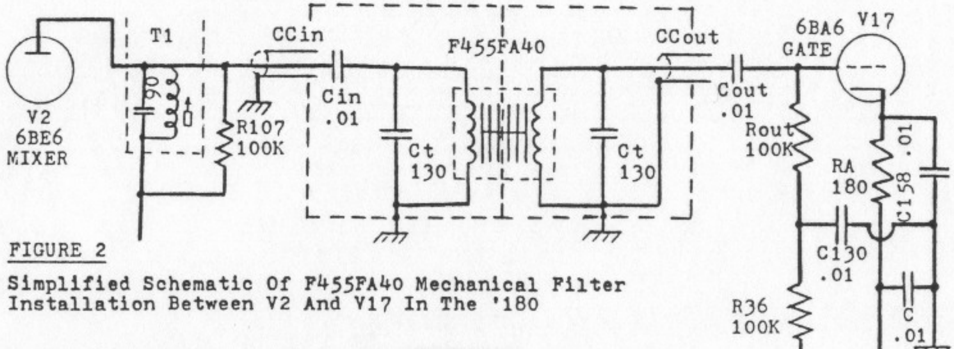
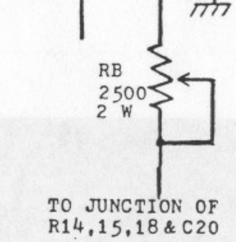


FIGURE 2

Simplified Schematic Of F455FA40 Mechanical Filter Installation Between V2 And V17 In The '180



all but very late model '180's R99 was 1000 ohms, and there was no C158. We also provided additional bypassing of the gain control line with the .01 capacitor C. Ideally, its ground return point should also be the same GATE tube socket ground lug, but we ran out of space and so used the terminal lug ground.

As can be seen, the only components removed from the '180 are (1) a short piece of coax, (2) the 2 pf capacitor C134, (3) the 22K resistor R101, and (4) the 2.2K resistor R99. The new coax shields are grounded at one end only, CCin to a ground lug near T1, and CC out to the filter output ground. CCout replaces C134, and Rout replaces R101 (I used the same tube socket pins and terminal lugs, and positioned the new components similar to the originals).

I originally intended to use a 2000 ohm variable for RB, but 2500 was the closest ½ watt variable I could find at nearby parts houses. When I replace it with a 2 watt variable, I'll try a higher value, say 5000 ohms, because a larger value will give greater gain control. In my opinion, reduction of the IF gain before the 455 - 60 khz conversion could prove useful in some extreme listening situations. In addition, there seems to be a small range of frequencies around 1200 khz where additional gain would be useful in some situations. So operator control of the sensitivity and dynamic range of the modified '180 would seem to be a useful addition. Before I start drilling holes in the front panel of my '180 I will mount the variable on a bracket bolted to the bandspread tuning capacitor so that it can be adjusted by opening the lid. And if I open the lid a lot, then I may drill a hole in the front panel. I should add that the gain of my '180 is more uniform on bands 1 and 2 than stock because I have installed a 50 pf dual variable capacitor in place of the original single section antenna trimmer which gives me dual ANT/RF & RF/MIXER tuning on band 1 (and single section tuning as before on bands 2 - 6). Spurious front end products resulting from the '180's unusual first conversion on band 6 prevented me from having dual front end fine tuning on all bands. Nevertheless, I am very pleased with my present arrangement because my stations on 1050 khz now give the same S-meter reading on both bands 1 and 2.

A good approximation of the combined selectivity of the Super-'180 can be had by subtracting the mechanical filter attenuation curve from the selectivity curves in the '180 manual, which we have done in Fig. 3 below. As can be seen the main effect of the 4 khz mechanical filter is to steepen and deepen the skirt selectivity (the 6 khz BOTH and 3 khz U and L bandwidths are also narrowed). When considering the performance of the Super-'180, one must remember that the 455 - 60 khz conversion occurs between the mechanical filter and the 60 khz IF selectivity, so that the combined selectivity curves are not as effective as they would otherwise be. Still, by judicious use of the main tuning, verniner fine tuning, and bandwidth options, the Super-'180 possesses very steep skirted, continuously variable 0 - 4 khz bandwidth, 120 + db ultimate rejection selectivity. In side-by-side listening tests with the same 100 foot long wire antenna, the Super-'180 beats the R-390A in some extreme listening conditions. For example, the Super-'180 extracts better signals on 1480 and 1500 khz beside my super-local KRUS 1490. Before the modification, the '180 never produced readable signals on 1480 or 1500 because of severe overloading. Also, the Super-'180 sometimes beats the R-390A on Once Viente 1124.8(v) khz when KMOX is strong. Moreover, the Super-'180 generally beats the R-390A in routine listening (both domestics and foreign splits) because the continuously variable selectivity can be used to minimize interference while maximizing the bandwidth for better audio quality. In severe listening conditions, the Super-'180 can present its 4 khz skirt to the QRM before its second conversion, whereas the R-390A is triple conversion (on the BCB) before any significant selectivity. The Super-'180 has significantly better dynamic range as a consequence, and you can really hear the difference in extreme listening situations. The very deep skirt selectivity of the Super-'180 is also vastly superior to either the R-390A or the stock '180, and may be responsible for a large part of the dazzling Super-'180 selectivity. Whatever the cause, much of the "slop" that used to cover and hide weak DX is now gone in many cases, so that on nights of low atmospheric noise I can follow many splits down into the background (man-made) noise, a feat seldom previously possible (either on the stock '180 or the R-390A). And strong splits, like R. Belize 834, are now received with much improved clarity.

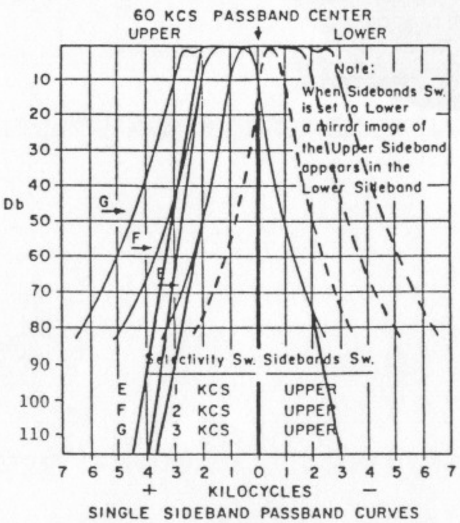


FIGURE 3A

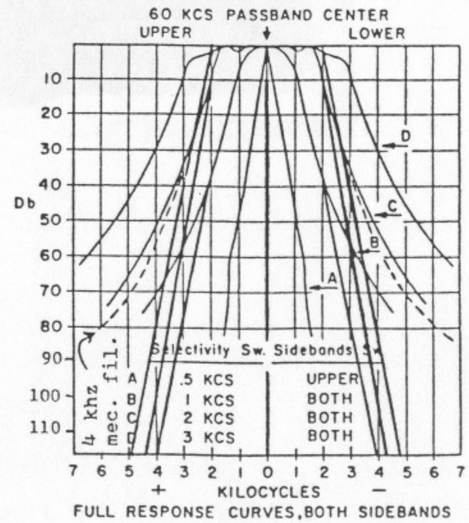


FIGURE 3B

As we have said, the curves of Figs. 3A and 3B were obtained by subtracting the mechanical filter attenuation curve from the stock '180 curves. The dashed lines in Fig. 3B denote the 4 khz BW mechanical filter, while the more or less straight lines branching off the '180 selectivity curves represent the combined selectivity. In Fig. 3A, the '180 lower sideband curves are denoted by dashed lines, and the combined upper sideband selectivity by the straight line branchings. The Db scale in both cases has been extended to 110 db, near the limit of the original Hammarlund graphs. The deep skirt structure of the 0.5 khz bandwidth is not shown in Fig. 3B because of insufficient information. It is interesting to observe that when centered on a 5 khz split, offending domestic carriers are down at least 120 db (though at the 455 - 60 khz conversion domestic carriers are down much less, say about 70 db). The graphs also show that the U and L sideband selectivity positions of the Super-'180 have better skirt selectivity than the BOTH positions. This difference can actually be heard in a few extreme listening situations. Because of their shapes, the combined U selectivity is ideal for DXing the 5 khz spectrum below a domestic carrier, while the combined L selectivity is ideal for the 5 khz above. And by setting the vernier fine tuning ± 1 khz, you have 3 khz selectivity with a <u>very</u> steep skirt on one side and a merely steep skirt on the other. In practice, none of the standard selectivity settings is usually optimal, but it is easy to find optimal settings by piddling around with the main and vernier fine tuning.

This article is not intended as a construction guide. If there is enough interest, I'll write a sequel which discusses the actual construction and debugging of the filter circuitry and enclosure. With regard to debugging the filter, let me warn the unwary that to eliminate <u>all</u> stray signal paths around the filter required, among other things, rebuilding the GATE grid and cathode circuitry, and fabricating about 8 inches of double shielded cable from RG-58/U and copper braid from RG-8/U.

Addendum 6/10/84: The "super-180" has been in operation for several years now, and I continue to be impressed with its performance. Steve Ponder visited me several weeks ago, and we got a good example of the super 180 beating the R390A on an LA split. Occasionally I wish for the wider band widths for pleasure listening, so switchable or plug in mechanical filters would be a useful addition. Due to space limitations, diode switching would seem manditory. Improvements in strong signal handling ability may not be as much as initially claimed above because I later found a "bad" 455 khz IF tube which was causing some of the overloading problems. However, this reveals an unexpected advantage of having a mechanical filter at the front of the IF strip. The steep skirt selectivity of a mechanical filter protects any weak or bad tubes in the IF strip, making the receiver more crunch proof even under adverse operating conditions. Of course, this makes detecting weak or bad IF tubes more difficult. Fortunately, there is a simple test which generally reveals weak or bad RF, IF, or mixer tubes: tune in any of your super locals, and AVC voltage (measured with a VTVM or FETVOM) should be over 6 volts (DC). On '180A's the AVC voltage is easy to measure at a screw binding post on the rear of the chassis. If a super local is not available, a strong night time BCB signal (using a 100' long wire) should drive the AVC voltage above 6 VDC. Although I haven't tried it, the R-390A mechanical filters should also perform well in the circuit given in this article. The value of capacitors Ct will be different, check your R390A manual.

<u>ACKNOWLEDGMENT</u>: I would like to express my appreciation to Dr. Tom Williams for his invaluable assistance in the preliminary theoretical studies, for doing the power transfer analysis of the final circuit, and for his help with elimination of stray signal paths around the filter.