TSl-5■-l

Receiver Accessories

AUDIO FILTERS

Introduction by Bruce Portzer

As their name implies, audio filters take audio frequency signals from the detector and process it, sometimes feeding the signal back into the receiver's audio amplifier, sometimes sending the filtered audio into an amplifier separate from the receiver. It is possible to process tapes of DX by running them through a filter to another tape machine. It can then be run through the filter again (and again and again)--a tricky business, but sometimes rewarding. Like all filters, these can be divided into a number of subgroups:

a) "Low pass" filters let through all audio energy below a certain frequency known as the "cut-off frequency" and attenuate those frequencies above the cut-off to varying degrees.

b) "High pass" filters let through all audio above a cut-off frequency while attenu attenuating those frequencies below.

c) "Notch" filters reject a certain (usually small) range of frequencies, while letting all others pass. A notch is useful to attenuate an interfering heterodyne or test tone, thereby making the desired signal more readable.

d) "Peaking" filters reject all frequencies except for a certain (usually narrow) range.

e) A "bandpass" filter is usually a low-pass and high pass filter in series, allowing only a certain range of frequencies through. If the cut-off frequencies are close to one another, the effect will be similar to that of a peaking filter.

Some suggested uses for various types of filters:

1. A high pass filter is useful for eliminating 60 and 120 Hz hum and reducing the "rumble" which often accompanies reception of stations on graveyard channels, not to mention the low hets that go with reception of off-frequency Latins. Can clean up the muddy audio of high selectivity receivers, or one which has a low-pass audio filter set below 2000 Hz or so.

2. A low pass filter with a cutoff at about 2000 Hz will reduce the hiss which is often present when replaying DX tapes. Also cleans up some noise from sets with poor selectivity.

3. A high-Q "peaking" filter designed for amateur CW use (such as the Autek QF-1) can be used to improve reception of test tones during DX tests and f/c"s. This is especially desireable if Morse code IDs are given. The filter should have a variable center frequency, since tone frequencies can vary from one station to the next or more than one tone can be used during a test (400, 800, and 1000 Hz are fairly common tone frequencies). It might also be possible to use such a filter to enhance time pips transmitted by some foreign broadcasting stations. However, it would probably be difficult to do so, owing to the short duration of the pips and the fact that many pip sequences use two frequencies I have had good results using a bandpass filter to improve pip reception, however. A bandpass filter, with high and low cut-off frequencies set close to one another can also produce good results in enhancing test tones.

4. A bandpass filter with variable high and low cut-off frequencies can also be used to enhance some announcer's voices. The process is usually one of trial and error in which a DX tape is replayed several times while trying different cut-off frequencies until the announcer's voice is heard most clearly. On more than one occasion I've used this technique to improve a particular announcement from marginal or unreadable to where it is at least partially readable. The "optimum" passband varies depending on the announcer and reception but the range of about 600 to 1500 Hz often gives good results.

Audio filters are definitely useful, even with highly selective receivers like the HQ-180A. On more than one occasion, my Krohn-Hite 310AB variable bandpass filter has improved a DX tape's readability and in a couple of instances it's made the difference between hearing an ID and not hearing it. The main benefit, however, has been esthetic. It's improved the quality of a given reception without actually improving readability to any great extent. However, since audio filtering is usually the last stage in the receiving process it is not nearly as important as a good antenna, a receiver front end that doesn't overload easily, and selective IF stages.

The Autek QF-1 and the MFJ SBF-2BX

Initially, the Autek filter appears more impressive--it can give you a variable cut-off low-pass filter, with a variable steepness to the cut-off curve, and you can switch to an audio "notch" or "peak" facility which can reject or highlight a continuously variable range of frequencies from "narrow" to "broad".

The QF-1 model can be plugged into the headphone jack of the receiver and provides output for speaker or low impedance headphones. It has its own power supply and power audio amplifier. The cheaper QF-2 is just the basic filter guts of the QF-1, should be placed between receiver audio stages and needs 6-30 volts DC from somewhere. The MFJ filter on the other hand is simply made up of one high pass filter (375 Hz cut-off) and three low-pass filters of 1500, 2000, and 2500 Hz cut-off. The high-pass can be used on its own or combined with any of the three low pass units. For best results it should be used between audio stages of the receiver, the best place being after the first low level audio stage. It can be used between the headphone jack and headphones as well, but with inferior audio quality at high volumes.

These filters were designed for the SWL and radio amateur. How well do they work for a BCB DXer? To a certain degree, it depends on your receiver, and whether you are a SW DXer or ham as well. In spite of the Autek's versatility, you may find that it isn't much help if you already have a receiver with good IF selectivity--the Hammarlunds, Collins, modified FRG-7 etc. Such receivers already reject a lot of heterodynes and noise which the low pass filter can eliminate. My QF-2's low pass setting doesn't really clean up that much on my HRO with mechanical filters, but it makes quite a difference on the less selective DX-150A. The notch setting on the QF-2 can really knock down a het on any receiver while leaving your desired audio--it's also fine for eliminating an undesired test tone if you're looking for something underneath. The variable width "peak" setting is not that great for peaking a voice, however, but if you're a ham, it will do wonders on a CW signal at its "sharp" setting. Also very good for peaking code ID's on testers.

What is really lacking on the Autek is a high pass filter to eliminate low hets and clarify the muddy audio of high selectivity receivers. The notch set at "broad" and tuned to low frequency, approximates (but is not as good as) the MFJ filter's high pass for this purpose. The MFJ's high pass when switched in gives more bite and clarity to the bassy audio of a selective receiver. Like the QF-1, the MFJ low pass settings are not tremendously useful for a high selectivity receiver, but they'll make your cheapo receiver sound pretty good. The Autek filter with its combinations of variable selectivity and frequency requires practice to get best results. The MFJ filter is more straightforward, but more limited in its possibilities.

The QF-1 and QF-2 seem to have been superseded by the QF-1A. This has a variable high-pass filter as well as the variable low-pass, notch and peak facilities of the QF-1. Unfortunately, it can only be used instead of these functions, not in combination with one of them. An extra notch filter is provided which can be tuned from 80 Hz to 11 kHz; this can be used in addition to one of the other functions. The QF-1A has its own power supply and audio amplifier. More information from Autek Research.

The SBF-2BX was priced at $29.95 in late 1979. Its circuitry is also contained in the MFJ-721 which also includes a sharp CW filter, noise limiter and a two watt audio amplifier. This, like the SBF-2BX, runs from a 9 volt battery. An AC adapter is available. The 721 sells for $59.95--more info from MFJ.

The SL-55

The Electronic Research Corporation of Virginia offers the SL-55 Audio Active Filter. This offers a peaking filter with variable -3 dB bandwidth from 14 to 2100 Hz; the center of the passband varies from 200 to 1400 Hz. A simultaneous notch filter, variable from 300 to 1400 Hz is included with a depth of 30 dB, and has a coarse and fine tune control. Like other peaking filters, this appears to be of more use to the CW enthusiast; it doesn't really enhance voice that much. The notch is nice, particularly the fine tune; it is not variable in the width of its selectivity curve however. An audio amplifier is included along with a power supply and the device can drive a speaker. Both filter sections can be bypassed if desired.

This device would be of much more use to the ham specializing in CW work than to the BCB DXer. The notch could be most useful to the BCB'er, but $69.50 is a lot to pay for a notch.

The MFJ-752

Billed as the "Signal Enhancer II", this device consists of two tuneable audio filters in series. The primary filter has the same functions as the QF-1A--a high pass and low pass filter with variable cut-off frequencies and variable shape of cut-off curves as well as a notching and peaking facility with variable frequency and selectivity. Only one of these options can be chosen at a time. The auxiliary filter consists of a notch or peak filter with variable frequency and selectivity, and can be bypassed. Two different types of noise limiters can be switched in as well. One is marked "SSB" and is a peak clipper, while the other is marked "CW" and is a trough clipper.

The peak clipper can make some AM signals more readable by cutting down on impulse noise as well as on some splatter peaks. The trough clipper is used for cutting out background noise on a CW signal, and is not much use for AM. As with the QF-1, the low pass response can be tailored to the requirements at hand, and cuts down on tape hiss and other noise. The high pass can be tailored for, say, a woman's voice on a graveyard channel. The notch can be very effective on test tones and heterodynes, but the peak is not usually much use on voice.

On one sample of this filter, there were problems with workmanship. A knob worked loose in short time, and one of the input phono jacks on the back was bent and wouldn't accept a plug without some effort. There was also a power supply hum which was not present when an external supply was used. A problem common with these kind of filters is that they are not calibrated, so you are not always sure what audio frequency is a good position to tune to. This unit came from Gilfer Associates who supplied helpful hints on the settings for various signals using "clock" terminology, as in setting a certain knob for "2 o'clock". More info from Gilfer or MFJ; price about $80.

The Laboelectron SF-0330

This filter is very easy to operate. It is a band pass filter only and has a set of push buttons to select low end cutoffs of 300 or 500 Hz and high end cutoffs of 1500, 2200 or 3000 Hz. The filter has a volume control, internal speaker, headphone jack, and AC adapter. The price is about $90.

I found this filter to be very good for cleaning up old DX tapes. It was effective in (almost) eliminating tape hiss and low frequency "rumble". A slight increase in intelligibility was noted at times, although I heard no impressive IDs leaping out of previously hopeless tapings. The filter performed very well on 80-meter amateur SSB signals which had a very high background noise level. Some improvements were also noted on the AM broadcast band, but I doubt if using it would add many new stations to the logbook.

The volume control was very useful. Most audio filters lack one and consequently there are noticeable differences in audio level when the filter is switched in and out.

Overall, this filter performs its intended purpose very well and is extremely easy to operate. Its lack of a notch function is, in this reviewer's opinion, a major deficiency for AM DXing, where test tones and heterodynes can (and do) cause problems.

The Datong FL-2

This may well be the "ultimate" audio filter. It is designed mainly for amateur CW/RTTY/SSB use, but also works well on AM signals. It has several pushbuttons and potentiometers, permitting high and low pass filtering, notching, peaking, and combinations thereof. In addition to the usual speaker and headphone jacks, it has a low level output for a tape recorder. The price is around $300.

This filter is both the most expensive and (not surprisingly) the best performing audio filter I've ever played with. It has very steep cutoff characteristics. They are so steep, in fact, that a very slight control adjustment can make your entire signal disappear. The notch filter was excellent. In terms of overall performance, this filter always was equal to or better than the less expensive Mizuho or Laboelectron filters.

Perry Ferrell says this filter works very well on CW and RTTY signals, so I tried it out on a crowded, static-plagued portion of the 80 meter novice amateur band. The results were startling---stations almost buried in noise and interference suddenly came in as clear as the output from a code practice oscillator.

This filter is a bit complicated to operate at first due to the large number of controls and the steepness of the filter cutoffs (which necessitated very careful tweaking). However, once I became acquainted with it, I had few problems.

The Datong FL-2, in nearly all respects, outperforms all other filters I've ever used. It also costs three times more than any other filter I've ever used. The added performance is probably not worth the added expense for the BCB DXer--I'd have a hard time justifying it to myself, let alone to my wife. However, if you are also a very active amateur or utility DXer with CW/RTTY interests, and money is no object, this is probably just what you've been looking for.

There is no reason why you can't build your own active audio filters. To construct a low pass or high pass filter you can use one or two RC filter sections. They can be made variable by making the resistor(s) variable. The low pass RC configuration is seen in figure A, while the high pass configuration is seen in figure B at left.

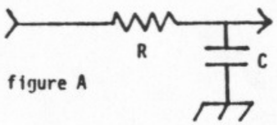


figure A

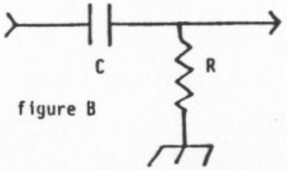


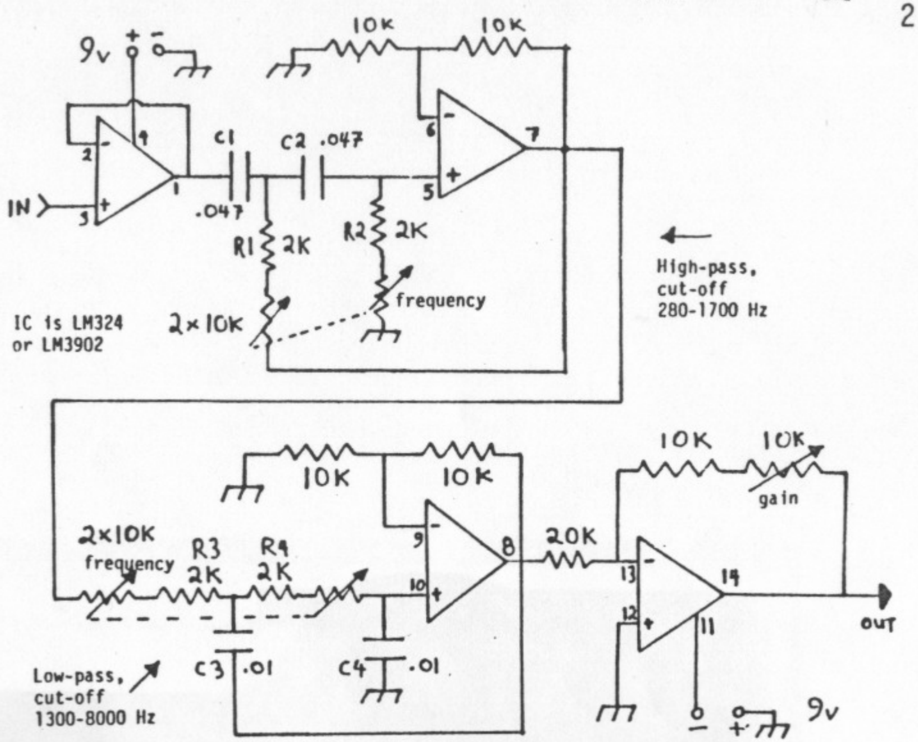
figure B

Using the formula below, you can design filters by choosing a cut-off frequency, then choosing a cut-off frequency, then choosing values of R and C to fit.

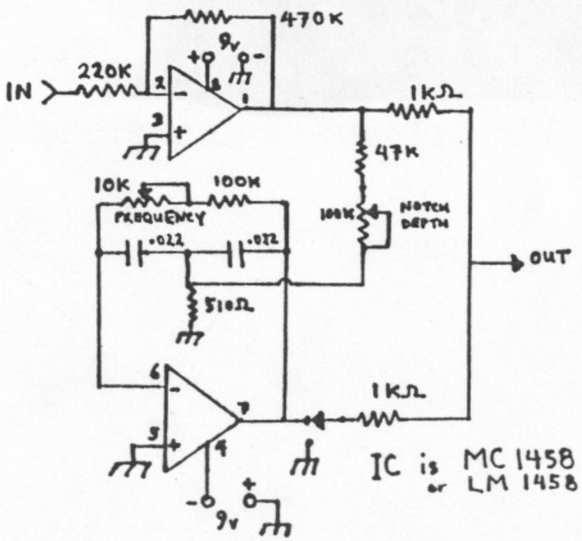
$$RC = \frac{1}{2\pi f}$$

where R is in ohms, C is in farads, and f (the cut-off frequency is in Hertz.

Gordon Cottrell designed this variable low-pass/high-pass audio filter. If the values specified for C1-C4 and R1-R4 or the potentiometers are unavailable, you can replace them with other values as long as the product of R and C remain the same in each case. 100 kilohm dual pots would result in C1, C2 values of .0047 uF and R1, R2 values of 20 kilohm. The filter's circuit is:

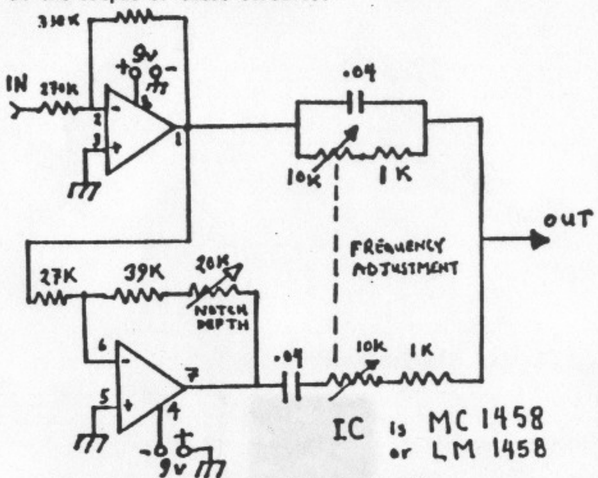


The circuit for a notch filter which can attenuate 1 kHz test tones by 40 dB:



Finally, below is a variable frequency notch filter; in this circuit, the width of the notch can be adjusted to wide enough to reject a substantial portion of an audio signal so take it easy. The frequency range is approximately 400-4000 Hz.

All of these circuits should be placed either after the detector or between audio stages in a receiver. A .01 blocking capacitor could be placed at the input and a 5 uF capacitor at the output of these circuits.



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The first contribution this month comes from Brian P. Sherwood, who announces himself as "Dr. of Transmogrification & Inventor of Other Useful Stuff"--had cards printed up yet Brian? In a more serious vein he writes:

"Here is a neat little audio filter/switcher that gives you up to 6 inputs, unlimited outputs, and the QRN/HNL-eliminating, QRM-lessening abilities of the FRG-7's audio filters.

(Brian has tried to design this circuit with parts available at Radio Shack. S1 can use a 1-pole, 12-position rotary switch (#275-1385), S2 & S3 can be a 2 pole, 6-position rotary switch (#275-1386), the input & output jacks should be 1/8" 2-conductor open circuit phone jacks (#274-251). All except the 3.3 uF capacitors are available there also. A metal box large enough to contain all components is also needed and he used a #270-265 slope-front cabinet.)

"Please note that although I only used 3 inputs, you can have up to 12, even more if you can get the right switch. And although I used only 3 outputs, you can have as many as you want, up to the point where you've split the signal so many times that no appreciable amount of current will get to each output. Two tape-recorders, two pairs of headphones, and two speakers ought to be sufficient, unless you want a third to tune WWV and get rid of your mother-in-law, hi.

Although I used the same cutoff frequencies as in the FRG-7, you can create your own filters, up to as many as the switch will handle (make sure they'll all fit in the cabinet you're using). The formula is as follows:

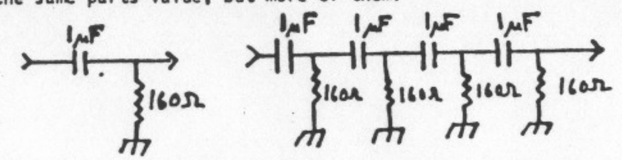
$$CR = \frac{1}{2\pi F}$$

(LOW PASS)(HIGH PASS)

where C is in Farads, R is in ohms, F (the cut-off frequency) is in Hertz, and 2π is 6.28. An example, with a cut-off frequency of 1000 Hz follows.

$$CR = \frac{1}{2\pi \times 1000\,Hz} = \frac{1}{6280} = .0001592$$

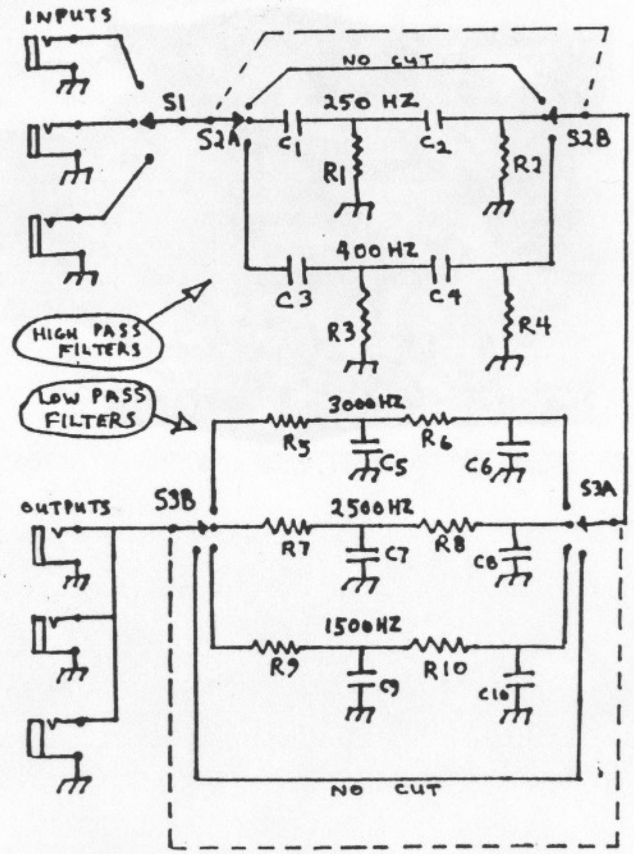
Since 1 uF equals .000001 Farad, you could effectively use a 1 uF capacitor and a 160 ohm resistor, giving you a cut-off frequency of 995 Hz. You cannot always get exact cut-offs because of the "standard parts value" problem; if you cannot have a 159 ohm resistor, settle for 160. I've noticed it's best to accept standard capacitors; it's a lot easier to juggle resistors than to fool around with multiple capacitors. You can also cascade filters; if one filter gives a 6-dB per octave attenuation, 2 filters ought to work better. Just use the same parts value, but more of them:



Well, that's it. Any questions, inquiries or comments can be addressed to: Brian P. Sherwood, 221 Larch Ave., Elmhurst, IL 60126."

Brian adds that these filters are intended to be used between the speaker output of a reciever and the speaker, or between headphone output and headphones. Like all passive audio filters, these exhibit loss even at the frequencies you want to hear. This loss can be minimized by using a very high R/C ratio in the high pass filters (i.e. use large resistors and small capacitors in the circuit) and a very high C/R ratio in the low pass filter--small resistors and large capacitors. He is willing to construct such filters for anyone who is interested--write to him at the above address.

The circuit is as follows:



C_1, C_2 — 50μF	R_1, R_2 — 33Ω
C_3, C_4, C_5, C_6, C_9, C_{10} — 1μF	R_3, R_4 — 400Ω
	R_5, R_6 — 56Ω
C_7, C_8 — 3.3μF	R_7, R_8 — 22Ω
	R_9, R_{10} — 75Ω

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The Hildreth Engineering "CommAudio Processor" by Sheldon Remington

I have been using a Hildreth Engineering "Communications Audio Processor", offered as a wired unit, in kit form, or just as circuit boards. It has a few unique features. Firstly, it has a choice of three basic bandpass shapes: Flattop, with rolloffs of 12 dB/octave below 300 Hz and above 2.5 kHz; CW, of 100 Hz width centered at 750 Hz with 9 poles; and voice, which is like the flattop, but the portion from 400 to 1500 Hz is notched out (this segment apparently contains very little speech intelligence). The CW skirts can be preset to -20, -40, or -60 dB down, depending whether one wants to hear "off frequency" stations or not. CW mode also can actuate a "Tone-Tag" a warbling modulation superimposed atop the centered CW signal. In addition, there is an internal anti-phase "pink-noise" generator which can be set to a level which barely masks line noise (or whatever) and reduces fatigue.

The final feature is a "binaural" filter, which splits the spectrum at 750 Hz, and sends the low frequencies to one ear (or speaker) and the highs to the higher. When tuning past CW signals, they progress from one ear to the other, and you end up being able to pick out a CW signal from both its pitch and from its position on the "stereo stage". The feature can be useful when listening for weak carriers on the BCB.

The unit has a 2-watt stereo amplifier built in, and runs off 12 volts DC (external). A series of articles in Ham Radio magazine described the design (Jan. 79, Nov. 76, Nov 75). I have been very impressed with the steep filter cut-off slopes. The one feature not provided is a notch filter so I will have to homebrew one and add it.

A different form of binaural system is "binaural diversity", described in NRC's Receiver Reference Manual, in which each channel is fed by a different receiver, either set to different sidebands of the same station or to a parallel. I added switching for this function to my processor, and would not be without it.

On the subject of audio filters, note that there are now some 33 different units on the market, with a very confusing variety of engineering approaches. It appears that no single unit contains all the desireable features, so one either has to stack multiple units, or do some homebrewing. The new MFJ-732 looks like a good basic unit.

ed. note: Information on the CommAudio Processor (model 210) was obtained by writing Hildreth Engineering, P.O. Box 60003, Sunnyvale, CA 94088, and enclosing a stamp. As well as the flyer, they sent a copy of the descriptive article in the January 1980 issue of Ham Radio, which was most interesting. I'd never heard of cutting out the 400-1500 Hz range for greater readability. Although the complete processor costs $150, the voice filter/binaural synthesizer/audio amp board (#1201) alone is $6.95, while parts cost $19 (matched components are needed for optimum filter operation), so one could construct a voice filter alone, if CW listening was not contemplated.

T51-5-5

A REVIEW OF TWO AUDIO FILTERS

by Bruce Portzer

In recent years, a number of audio filters have appeared on the Amateur/SWL market, some selling as low as $50. These devices perform a number of audio processing functions, including high pass, low pass, and bandpass filtering, notching (rejecting a narrow range of frequencies), and peaking (passing only a narrow band of frequencie). Details on how to use audio filters have appeared in past Technical Columns, are in A DXer's Technical Guide (get yer order in now folks!), and will be available as a reprint later this year. As a brief recap, audio filters can be used to eliminate or reduce unwanted test tones and heterodynes, to improve the intelligibility of DX tapes, to reduce the "rumble" on graveyard channel reception, and to enhance morse code IDs during DX tests and frequency checks. Although useful, an audio filter is no substitute for good selectivity in your receiver. Don't expect one to be of any help if you're plagued by a strong local wiping out adjacent channels.

Recently, through the courtesy of Gilfer Associates, I had the pleasure of trying out two audio filters. My impressions are summarized in the following paragraphs.

The MFJ-752

The MFJ is actually two filters in series. The primary filter can be used as a peak, notch, highpass, or low pass filter (selected by a front panel switch) and has potentiometers to control selectivity (steepness of the cutoff) and cutoff (for high and low pass) or center (for notch and peak) frequency. The secondary filter is similar to the primary filter, but has only notch and peak capabilities. The MFJ-752 also has a diode noise limiter, two input jacks (switch selectable), and rear panel headphone and speaker jacks. It operates from either a 12 volt AC adapter (furnished with the filter) or any 9-18 volt DC supply. It comes in a 10x2x6 inch cabinet and costs $79.95. The filter is designed for plugging into a receiver or amplifier headphone jack.

Let me assure you, this little gadget really works. I played several old DX tapes through it and discovered, thanks to this filter, that two previously unidentified loggings made in 1973 were WDEF-1370 in Tennessee and WAAO-1530 in Alabama. I had played both tapes many times in the past and had been unable to ID them, even using other filters, so needless to say, I was favorably impressed with this unit. I also found the peak and notch functions to be quite acceptable in enhancing morse code IDs and reducing heterodynes. In general, the filter improved audio quality noticeably and in some cases improved readability.

Now for a couple of negative comments. First it's a bit difficult to use. It took me several hours of fooling with it to learn how to use it and I can envision some less technically inclined DXers throwing up their hands in despair after fooling with the several controls. Second, I noticed a couple of workmanship problems: the AC adapter produced a noticeable hum which was not present when I used my own power supply. I later learned that MFJ's supplier somehow sent them 1000 AC adapters with no filter capacitor! The problem has since been corrected; however, there may still be a few defective AC adapters lying around somewhere.... In addition, one of the two input jacks was bent slightly towards the other, making it impossible to plug patch cords into both jacks at the same time.

In conclusion, this gadget is very effective. It's a bit complicated to operate, especially for the technically unsophisticated DXer. However, for the patient knob tweaker it can produce very good results.

The Mizuho AP-M1

This is really a cute little thing. It's about half the size of a World Radio TV Handbook, yet has its own built-in speaker. It can be used as a bandpass or notch filter and has controls to vary the width and center frequency of the passband or notch. It operates from either a 9 volt battery or an external 6-12 volt supply. It is designed for plugging into the headphone jack of a receiver or amplifier (a patch cord is provided). The list price is $49.95.

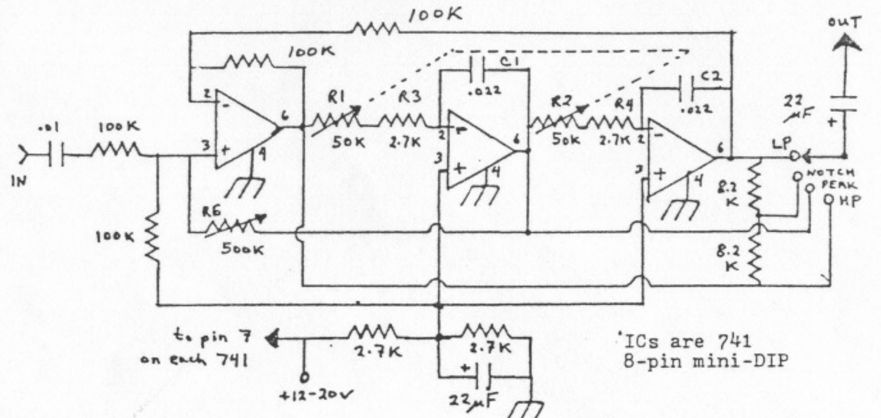
This filter did not perform quite as well as the MFJ-752, but it proved to be much easier to operate. In order to test its notching and peaking abilities, I tuned in KFI-640 and set my signal generator for 639 kHz, which of course resulted in a loud 1000 Hz tone mixing with KFI on my FRG-7. With the bandwidth control in its narrowest practical position and the center frequency set at 1000 Hz, I had only the KFI audio with the filter control in the notch position and only the tone with the control in the bandpass position. The filter was effective at enhancing a particular voice--for example by adjusting the center frequency control, it's possible to change back and forth between enhancing a woman's voice and enhancing a man's voice.

My one complaint about this filter is that the front panel is just a little too crowded. Crammed into a 1" x 5" space are two controls, 2 LEDs, input and output jacks, and a notch-bandpass-off switch. It's especially crowded when both jacks are in use; however, part of the problem could be alleviated by installing input and output jacks on the rear of the cabinet.

The filter is relatively easy to use and shouldn't befuddle anyone. Its features and small size make it ideal for taking along on DXpeditions. If you take your FRG-7 or TRF out to the coast, it would effectively eliminate many of those hets from pesty TAs and TPs!

The State Variable Audio Filter

Although the state variable filter is quite simple and versatile, and is the heart of most of the commercial variable frequency and selectivity audio filters, nobody seems to have put forward a construction project using it, so here it is:



R1/R2 frequency variation   R6 "Q" or selectivity

As you can see, this one filter offers high-pass (HP), low-pass (LP), notch and peaking possibilities, depending on the position of the output switch. The cutoff frequency for the high-pass and low-pass as well as the notch and peak frequency are determined by

$$f = \frac{1}{2\pi(R_1+R_3)C_1} \;*$$

where R1=R2, R3=R4, C1=C2, so the given values can be varied according to what dual potentiometer you have available. For best results R3 and R4 should be matched values, as should C1 and C2. A good VOM or digital multimeter will enable you to match resistors, but a capacitance meter or bridge circuit must be used for the capacitors. The values given above are for a frequency range of about 280 to 2700 Hz.

R6, the Q control, varies selectivity in the peak position, and also varies somewhat the rolloff in the LP and HP positions. Its value is not too critical, and at minimum resistance, reduces the circuit gain to zero (i.e. no signal). A 100 k resistor in series with R6 should prevent this.

The 741's specified can be replaced by a single quad op-amp such as the LM324, providing the proper pin-out is observed. The fourth section of such an IC could be used as a voltage follower if desired.

This filter could be placed in series with another filter of the same construction to allow for greater versatility, or deeper nulls, sharper peaks, and faster rolloff. Some theoretical background for the state variable filter can be found on pp.501-2 of The IC Op-Amp Cookbook by Walter Jung, published by Howard Sams, and no doubt available at Century Print Shop.

* (f is in Hz, R is in ohms, C is in farads)