

THE DATONG FL-3 MULTIMODE FILTER

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INTRODUCTION

Prior to using the Datong FL3 Multi-Mode audio filter, my experience with signal improvement with an audio filter was mixed at best. The typical scenario ran like this: tuning around with the audio filter switched off, I'd find an interesting signal that was bothered by a heterodyne or slop from an adjacent channel. OK, flip on the audio filter and start playing with the controls. Bring down the highpass cutoff to get rid of the interference...and there goes the desired signal at the same time! Notch out the heterodyne...and say goodbye to the useful audio portion of the DX target. After a couple of minutes of tweaking, I'd do an "A/B" comparison between the raw signal from the receiver and the filtered signal...and at best, it was usually a coin toss as to which signal would deliver more useful copy.

I am eternally optimistic, so when I read the advertising copy for the Datong FL3 audio filter I decided to give it a try. The especially attractive thing was the automatic heterodyne killer. Advertisements said this little critter could find heterodynes and notch them out by turning the unit on and pushing a button. Jeanne Ferrell at Gilfer promised I could return it if not satisfied, so the downside risk was under control. One surprise was that the already pricey \$259.95 filter did not include an AC adapter; it requires 10-15VDC at 400mA. Gilfer will sell you the appropriate adapter for \$15.95. If you don't want the auto-notch feature, you can buy the FL2, which is an FL3 without auto-notch, for \$179.95. Check with Gilfer or Electronic Equipment Bank for current prices.

So what do you get from an audio filter that costs more than a good portable receiver? You get a unique, automatic notch filter that kills hets in under a second with NO KNOB TWIDDLING. There's a second, manual notch filter so you can kill TWO hets with one FL3. You get a pair of independent 5 pole high pass / low pass filters which can tune from 200 to 3500 Hz, providing a cut off rate of 40 db in 500 Hz at 2 kHz, and 40 db in 120 Hz at 500 Hz. These are excellent specs.

The skirts of these filters are very steep and the top of the filter response curve is quite flat, as seen in Figure 1. It's difficult and expensive to design a filter with a response curve like this. It takes multiple stages of filtration and high quality parts. This, plus the auto-notch, accounts for the premium price of the Datong FL3.

The flat top of the filter curve means that the FL3 provides linear response across the passband, or the portion of the signal that you want to hear. The steep skirts mean excellent selectivity. You have a much greater chance of eliminating the QRM without eliminating the desired signal than with a filter having less steep skirts.

In practice, if the QRM you want to eliminate is higher or lower in audio frequency than the signal you want to hear, the FL3 can probably get rid of it. If the QRM covers the same audio frequency range as your desired signal, no high pass / low pass filter arrangement, including the FL3, can help.

SETTING UP THE FL-3

Setting up the Datong FL3 is very simple. The speaker or headphone OUT jack from your receiver goes into the INPUT phono jack of the FL3. The output phono jack goes to a 4 to 16 ohm speaker, 4 ohms preferred for max output. Datong includes two cables terminated with RCA phono plugs to fit

the FL3, and tinned leads on the other end. You have to connect the tinned leads to the appropriate connector for your receiver. If you order an FL3, you may want to get the appropriate cable ahead of time from your favorite local electronics outlet.

The FL3 also has a 680 ohm TAPE OUTPUT RCA phono jack, which produces filtered, non-adjustable LINE level audio (as opposed to MIC level) for your tape deck or recorder. I prefer to record raw audio directly from the receiver; this way you get "all" of the signal, including QRM and hets. I run all my receivers through an old Dynaco stereo amplifier, and the output of the Dynaco goes into the FL3. When I'm finished taping my DX session, I can replay the tape over and over, trying different settings on the FL3 until I get the best copy. With this setup you can still use the FL3 to filter audio while you are DXing—but what you RECORD comes directly out of the receiver, ahead of the FL3 and untouched by it.

There's a 1/4" phone jack on the front panel of the FL3 for headphones. When you plug your headphones in, the speaker output is disabled.

OPERATION

Let's review the front panel of the FL3, to get a feel for the controls. From the left, you will find:

Auto notch pushbutton and LED: When engaged, the FL3's automatic notch filter "het killer" is in operation. The het killer sweeps the audio range from 200-4000 Hz, looking for a het. If it finds one, it locks on in less than one second and notches it out. The auto-notch LED lights up to tell you the filter is engaged. The auto-notch uses a voltage tuned 2 pole notch filter in a phase lock loop system. The notch is 40 db down, and it's very sharp and effective.

If there is more than one het present, the one that gets notched is simply the first one encountered in the (audio) frequency sweep search. This may or may not be the louder of the two. You can use the manual notch to eliminate the other one. If there are more than two annoying hets, try again tomorrow!

In practice there are two minor annoyances with this otherwise super feature: a quiet "whooshing", sweeping sound is heard as the het killer searches for a het to kill. This is subtle enough that you might



not notice it; if it bothers you, you can just turn it off until you encounter a heterodyne whistle. In fact, if you tune in ECSSB most of the time you will probably want to leave the auto-notch off until you need it, so you don't accidentally notch out a het that indicates the presence of a desired weak signal.

The second problem may indicate a need for adjustment of my unit. The overall volume of the signal going into the FL3, and thus into your headphones, has to be a bit high for my taste before the het killer will lock onto the het. I've never found a het that couldn't be notched out with the FL3. I do find the total volume needed before the het killer will engage to be louder than a comfortable listening level.

Low and high pass filters: The heart of the FL3 is a very versatile set of audio filters. There are two independent 5 pole filters, one low pass and one high pass, that can work in three different modes: SSB, CW, and RTTY. SSB mode really means "voice", as it works fine for AM mode signals, too. In fact, according to Datong, it's even useful for SSTV reception.

The four pushbuttons just to the right of the on/off pushbutton let you choose between the various filter modes. There are three different SSB modes: SSB alone, SSB + NOTCH, and SSB + PEAK. The notch/peak settings switch in a separate, manually tuned, 2 pole filter. This filter is 200 Hz wide at 6 db down, and tunes from 200 to 3500 Hz. If the station you want to hear is bothered by two hets, you can eliminate one with the auto-notch filter and the other with the manual notch filter. The SSB + PEAK setting is not for listening, but instead is a tuning aid for the manual notch. Select SSB + PEAK, tune for maximum strength of the het, then select SSB + NOTCH, and voila!, the het is gone.

On the righthand side of the front panel there are three knobs, calibrated from 200 to 3500 Hz. The function of these knobs depends on the configuration of the SSB/CW/RTTY mode pushbuttons.

In SSB mode, the middle knob controls the cut-off frequency of the low-pass filter. In other words, frequencies lower than the indicated frequency are suppressed. The rightmost knob controls the setting of the high-pass filter; frequencies higher than indicated are eliminated. Both of these controls are smooth and precise with minimal backlash. The knobs are on the small side, but this is not a problem.

The left-most knob controls the manual notch or peak frequency. It is calibrated from 200 Hz to 3500 kHz in 500 Hz steps except for the first step, which goes from 200 Hz to 500 Hz.

In CW mode, the low and high pass filters are combined with the peak filter to provide a 12-pole signal with a peak on the desired CW tone. Alternatively, you can choose CW(2) mode, which eliminates the peak filter and just gives you the low and high pass filters. The function of the tuning knobs changes in CW mode: the middle knob shifts the center frequency of the filter, and the righthand knob controls the width of the passband. In CW mode, the frequency range tuned is half that of SSB mode: 100 to 1750 Hz. This combination of filters is very effective at digging out a single CW tone from a pileup, as long as the interfering signals are of different audio frequencies at the input to the FL3.

RTTY mode superimposes a notch at the center of the passband. I am not set up to receive RTTY so I can't comment on the FL3's effectiveness at digging RTTY out of the QRM.

There are two ways to BYPASS the FL3 in operation; when you turn the power off, your receiver audio passes straight through to the headphone jack. The second approach is to leave the power on but press the "SSB+PEAK" and "SSB" buttons together; this leaves the FL3's electronics in line but gives you level response, i.e. no amplification or attenuation.

IN PRACTICE

I am very impressed with the effectiveness and quality of the FL3. When I ordered this filter, I knew Datong had a good reputation; now I know why. It's expensive but I think it's worth it. This audio filter gets used instead of gathering dust. It's especially good at eliminating high pitched splatter from nearby signals and is deadly on hets. It doesn't distort the desired signal and the steep selectivity skirts let you dial up the exact audio passband you want to hear. Highly recommended.

TYPICAL PERFORMANCE DATA

- Input impedance: 5000 ohms
- Nominal overall gain: unity
- Low-pass and high-pass filters
Frequency range: 200 to 3500 Hz, linear tuning
- Minimum stop band rejection: 40 db
- Rate of cut-off:
40 db in 500 Hz at 2 kHz
40 db in 120 Hz at 500 kHz
- Notch and Peak filter
Frequency range: 200 to 3500 Hz, linear tuning
Notch width at -6 db in "SSB + NOTCH" mode: 200 Hz
Notch depth: 30 db
- Bandwidth range in "CW(2)" and "RTTY" modes:
100 to 1750 Hz at -6 db
- Bandwidth range in "CW" mode:
70 to 700 Hz at -6 db

Power output:
2 watts into 8 ohms with 18 v supply
1.5 watts into 4 ohms with 10 v supply

Output protection:
The output stage (LM380) is short-circuit proof and over-dissipation proof

Supply current:
50 mA zero volume
350 mA max. output

Supply voltage:
10 to 20 volts DC. Protected against reverse polarity

Size:
184 mm wide x 153 mm deep x 44 mm high (7.2 x 6.0 x 1.7 inches)
Feet add 10 mm (0.4 inches) to height

Weight including packing:
1100 grammes (39 ounces)

Finish:
Anodised aluminium wrap-around case. Panels printed white and yellow on black

Accessories:
Supplied complete with input lead and output lead (Phono to bare end)

Optional extra:
Mains Power Unit for 220-240 volts AC. Order Model MPU or MPU1.

FREQUENCY RESPONSE CURVES

Computer generated response curves for Model FL2 are shown below to illustrate the results obtained in the various operating modes. The graphs were obtained by solving the overall filter transfer function. Actual filters may differ slightly from the curves shown due to component tolerances.

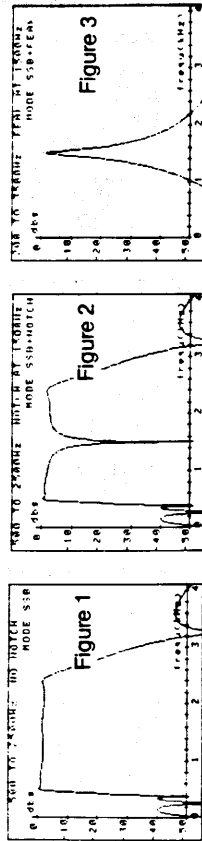


Figure 1 "SSB + NOTCH" - showing the steep skirts and the "flat-topped" response. Here only the low- and high-pass filters are in operation.



Figure 2 "SSB + NOTCH" - same conditions as figure 1 but the notch filter is also in circuit and set to 1500 Hz.

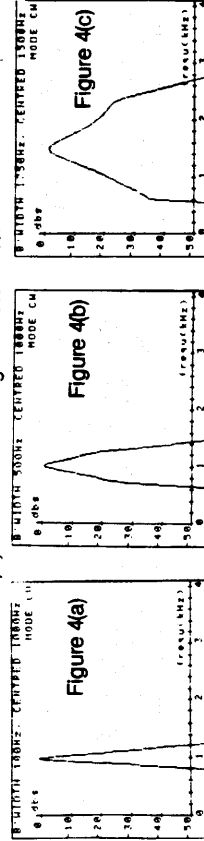


Figure 3 "SSB + PEAK" - conditions are identical to figure 2 but now the PEAK/NOTCH filter is set to PEAK instead of NOTCH. This mode is normally used simply as an aid in tuning the notch filter.

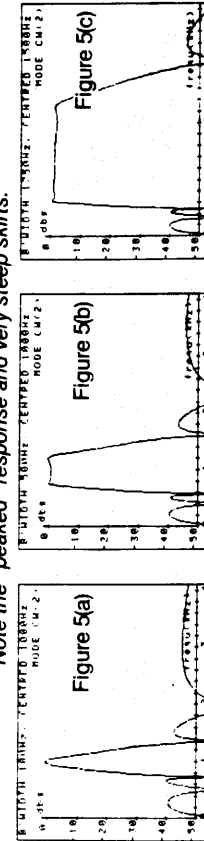


Figure 4(a), (b), (c) "CW" - showing the response in "CW" mode with a bandwidth setting of 100 Hz, 500 Hz and 1750 Hz. Note the "peaked" response and very steep skirts.

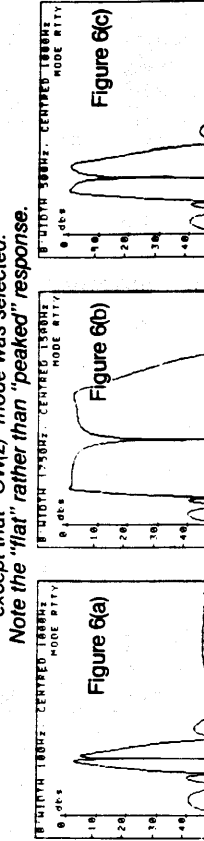


Figure 5(a), (b), (c) "CW(2)" - three graphs corresponding to those of figure 4 except that "CW(2)" mode was selected. Note the "flat" rather than "peaked" response.



Figure 6(a), (b), (c) "RTTY" - three graphs using "RTTY" mode but otherwise with same bandwidth and centre frequency settings as figures 4 and 5.



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FL3 INSTRUCTIONS FOR USE (TO BE USED
TOGETHER WITH DATA SHEET FOR MODEL FL2)

Introduction

Model FL3 contains the same filters as Model FL2 plus an automatic notch filter. Instructions for operating all the filters except the auto notch are given in the FL2 data sheet which is supplied with both Models FL2 and FL3. The following notes are intended to describe the operation of the auto notch only and are therefore applicable only to Model FL3 or to a model FL2 which has been converted to Model FL3 by installation of the model FL2/A conversion kit.

Installation

Model FL3 should be wired up and installed exactly as described for Model FL2 except that the permitted power supply range is limited to between 10 and 15 volts. It is important not to exceed 15 volts since damage could be caused to the auto notch module.

Operation

The auto notch function is intended for removing unwanted tones or whistles from speech signals. The auto notch filter is permanently connected immediately before the audio power amplifier in Model FL3, but it can be by-passed by the small black push button marked "AUTO NOTCH". When the button is out the auto notch filter is by-passed. When it is pressed in the audio signal passes through the auto notch filter and whenever the filter locks onto a tone (as shown by illumination of LED to the left of the black button) the tone will be removed.

Since the auto notch filter is affected only by the black button, it may be used together with any of the normal operating modes selected by the white push buttons. Normally however, it is best to keep the auto notch filter by-passed (button out) except in "SSB" mode. Otherwise, if for example the auto notch is selected when using the "CW" mode, it will tend to lock onto and remove the desired CW signal.

To summarise:

1. When listening to speech signals using the "SSB" mode it is convenient to leave the auto notch permanently switched into circuit (black button in). Then whenever a whistle appears the auto notch will lock onto it and remove it.

2. Whenever the auto notch has locked onto a signal, the left hand LED will illuminate. This may happen even if the auto notch filter is switched to bypass. Thus when receiving CW in "CW" mode it is normal for the LED to illuminate intermittently.
3. Remember to bypass the auto notch (button out) when receiving CW or RTTY.

Other Points

The auto notch filter has been designed to locate^e and track even quite weak signals. However, it does need a certain minimum signal (see FL3 data sheet) and if the circuit appears not to lock very successfully it may be because the volume control is turned too low on the associated receiver.

Assuming that the receiver volume control is set adequately high, the majority of annoying heterodynes will be strong enough for the filter to remain locked even despite the presence of speech. With very weak heterodynes the filter may lose lock when loud speech is present at the same time. This can be beneficial as the filter will then sweep its full range and will lock onto any other heterodyne which may be present and which may be louder and more annoying.

The auto notch filter will lock onto whichever tone it encounters first during its sweeping mode (that is whenever the lock light is off). If more than one tone is present it is possible that the auto notch will neglect the most serious whistle and remove a weaker one. In such cases it may be better to use the manual notch filter (see FL2 instructions) to remove the chosen tone. The auto notch will still be active and will be able to remove a second tone at the same time.

In some cases the filter will remove a whistle so quickly that the operator may not even realise that one has appeared. However the left hand LED will always illuminate whenever the filter is tracking a whistle. The bypass switch can then be operated if desired to check on the effectiveness of the filter.

D A T O N G
E L E C T R O N I C S
L I M I T E D

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"How to separate the signal you want from the signals you don't want?" That's one of the most difficult problems for HF bands operators today, and one which Model FL3 is uniquely able to solve.

In one stylish case Model FL3 offers the complete solution to receiver audio processing. We believe that such a powerful combination of filtering capabilities has never before been offered in one package.

FEATURES

- Fully automatic notch filter for "hands-off" removal of tune-up whistles and other steady tone interference.
- Independent low-pass and high-pass filters with very steep cut-off for removing "monkey chatter" and other off-tune interference from SSB signals. Both filters tune continuously from 200 to 3500 Hz.
- Second notch filter tunes manually from 200 to 3500 Hz.
- For speech reception all four filters work quite independently giving remarkable flexibility and performance.
- A special tuning mode for CW and RTTY combines the low-pass, high-pass and pk-notch filters into a single 12 pole filter with superb skirt selectivity and with non-interacting controls for centre frequency and bandwidth.
- All functions and controls are calibrated and designed for convenient and natural operation.
- Works with any receiver, no internal connection required. Simply connect in series with an external loudspeaker or phones.
- Protected 2W output stage built-in.
- 29 IC's including the latest switched-capacitor filter technology.

Auto-Notch filter scans continuously

Users of our pioneering Model FL1 will confirm the practical advantages of an automatic notch filter for SSB reception. With absolutely no help from the operator the automatic notch tirelessly scans the receiver's audio output until a continuous audio tone is received. When it is the notch filter locks on and removes it. If the tone changes in frequency the auto-notch follows.

Shoots down tune-up whistles and heterodynes

Imagine the benefits. A tune-up whistle no longer causes any problems; after a second or two it simply drops out of ear shot. Those tiresome whistles that frequently descend on a QSO no longer cause any problem. Only the "LOCK" lamp on the FL3's panel reminds you of what you are thankfully missing.

Plus low-pass, high-pass and manual notch

While all this is happening you still have three other independent filters at your disposal. Imagine, for example that another SSB station starts up 2 kHz high. Instead of trying to copy through all that high-pitched monkey chatter simply turn down the low-pass filter (the right hand knob) and wipe it out.

Then perhaps a teleprinter starts up 300 Hz above your carrier frequency; a touch on the high-pass filter knob (the middle one) cures that.

Finally maybe a second whistle appears. Since the auto-notch is busy, just bring in the manual notch as well and tune it out (left hand knob).

Steep skirts are vital

When an off-tune SSB station interferes with a wanted SSB station very sharp selectivity is vital if the interference is to be removed without also removing too much of the wanted signal.

It is equally vital that the overall receiver bandwidth can be smoothly adjusted to match the actual prevailing conditions.

Using modern active filter technology, Model FL3 gives upper and lower passband edges which can be placed anywhere between 200 and 3500 Hz, and which are steeper even than those of high quality crystal filters.

Not only does Model FL3 beat techniques such as "IF shift" and "Pass-band tuning" on sheer performance, it has an important extra advantage: it can easily be added to any existing receiver since all the signal processing takes place in the audio output line between the receiver and its loudspeaker. And of course, it still has its unique auto-notch and separate manual notch in reserve.

Special tuning mode for CW and RTTY

For CW and RTTY reception remarkable separation of wanted from unwanted signals is achieved by combining the low-pass, high-pass and manual notch/peak filters into a single variable filter with no less than 12 poles. Extreme skirt selectivity is achieved so that compared with lesser filters you can use a much wider bandwidth for a given interference suppression making tuning easier and reducing ringing effects.

In addition the tuning controls are re-arranged so that the centre knob controls the centre frequency of the pass-band and the right hand knob controls the width of the pass-band.

This is highly convenient for CW and RTTY reception since one can first tune the filter to the signal and then expand or contract the bandwidth symmetrically to suit varying conditions.

How it works

The auto-notch function in Model FL3 uses a voltage tuned notch filter in a phase lock loop system. The filter sweeps back and forth through

its full range until lock is detected after which it tracks the signal. Special techniques combine a short lock time with the ability to stay locked to very weak signals.

Model FL3's low and high pass filters both use 5-pole elliptic function filters to give the steepest practicable rate of cut-off. A separate 2-pole notch or peak filter is used as the manual notch or peak filter.

Each of these three filters is continuously tuneable from 200 to 3500 Hz. Tuning is by linear voltage control and precision tracking between the three filters allows them to be used ganged together or independently as determined by the various operating modes.

The advanced design techniques used in Model FL3 were developed by Datong especially for use in this application. All filter sections are based on the "state-variable" technique for optimum long term stability.

Typical performance data

Auto notch filter

Filter type: 2-pole, constant Q, switched capacitor
Tuning range: 200 - 4000 Hz
Lock time: Depends on signal strength; typically less than one second

Notch depth: 40 dbs

Filter Q: 10

Low and high pass filters

Filter type: Both filters are five-pole elliptic function
Frequency range: 200 to 3500 Hz, linear tuning
Minimum stop band rejection: 40 dbs.
Rate of cut-off: 40 dbs in 500 Hz at 2 kHz, 40 dbs in 120 Hz at 500 Hz

Manual notch/peak filter

Filter type: 2-pole state variable, constant bandwidth
Frequency range: 200 to 3500 Hz, linear tuning
Notch width in "SSB + NOTCH" mode: 200 Hz at -6 dbs
Notch depth: 30 dbs

General

Bandwidth range: 100 to 1750 Hz at -6 dbs (10 poles total)
"CW (2)" & "RTTY" modes: 70 to 700 Hz at -6 dbs (12 poles total)
"CW" mode:
Input impedance: 5000 ohms
Overall voltage gain: unity
Power output: 2 watts into 8 ohms with 15 v supply
1.5 watts into 4 ohms with 10 v supply
Output protection: The output stage (LM380) is short-circuit proof and over-dissipation proof
Supply current: 85 mA zero volume
400 mA max. output
Supply voltage: 10 to 15 volts DC. Protected against reverse polarity
Size: 184mm wide x 153mm deep x 44mm high
(7.2 x 6.0 x 1.7 inches)
Feet add 10mm (0.4 inches) to height
Weight: 860 gms (31 ounces)

Accessories supplied: Input and output leads (phono plug to bare end), jack for DC power supply.

Optional extra: Mains power unit, AC mains to nominal 12 volts DC. MPU or MPU/1 for 240V, MPU/1A for 220V.

Note

Existing Model FL2 filters can be converted to the FL3 specification using the auto-notch adapter unit Model FL2/A plus hardware conversion kit (see Datong price list).

The response curves illustrated on the FL2 data sheet also apply to Model FL3.



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