# C4 Synth & Spectrum Intelligent Filter Envelope / Filter Info

## Envelope Information from Bob Chidlaw

The Source Audio C4 Synth pedal has two envelope followers available. They both have the same capabilities, but their control parameters may be set differently. Input 1 or input 2 may serve as the input signal to either. An envelope follower uses its audio input signal to output a representation of how loud the audio is at the moment. Louder signals get a higher output level from the envelope follower.

Since the audio signal goes both positive and negative, we first take the absolute value of the audio; negative values are replaced by the same number, but made positive. A certain amount of smoothing is necessary, because the input signal will repeatedly go to zero, but at a rate which we don't perceive as a level change, since it is happening too fast for us to hear like that. Deliberately introducing a slower than necessary smoothing will cause the output to move more slowly than the actual audio signal changes. Different smoothing rates for attack (a rising output) and decay (a falling output) permit more control over the final response.

Whereas a typical synthesizer has a controllable release time on its envelopes (which begins when one takes their hand off a keyboard note), we have the problem that the guitar sound is over when a note is through. A synthesizer oscillator would still be running, but the pitch detector output tends to lose it as a note is dying away, so the synth oscillator is also not reliably available after note end. So our final release times are always quite short.

We also offer ADSR type envelopes (attack – decay – sustain – release). The attack segment begins when an attack threshold level is exceeded. When the envelope level gets to 1.0 (full scale ON), the decay segment takes over, dropping until the sustain level is reached. When the input gets below a release threshold, we go into a (fast, as always) release segment. These threshold levels are fixed. One more reason to do the Input Gain Calibration procedure, to make sure your guitar signal is in the proper range, for the fixed thresholds.

All of these possible envelope controls are not brought out to the user interface. This is partly due to trying to save bits in the preset data (and if you had asked me 50 years ago whether saving bits would still be a thing in 2019, I would have laughed), and also to keep the complexity down. Reasonable people may disagree that boiling down a lot of controls into only a few, with a selection of envelope types, is really simpler. But that's the way it is.
The Envelope Type definitions:

| Envelope Type | | Atk_lo | Atk_hi | Dec_lo | Dec_hi | Fast_atk | | ADSR | Sustain |
|---|---|---|---|---|---|---|---|---|---|
| 0 | **ADSR Adj A/D** | 0.2 | 1.0 | 0.2 | 0.6 | N/A | | YES | 0.0 |
| | Both A and D are controlled by the Speed control. With Speed = 0 (full counterclockwise), we use an Attack control value of 0.2. When Speed = 1.0 (full clockwise), the Attack control is 1.0. | | | | | | | | |
| 1 | **Fast A, Adj D** | 0.7 | 0.7 | 0.2 | 0.85 | 0.05 | | NO | N/A |
| | The Attack control is fixed at 0.7. | | | | | | | | |
| 2 | **Wide 1, Adj A/D** | 0.0 | 1.0 | 0.2 | 0.6 | 0.03 | | NO | N/A |
| 3 | **Swell** | 0.0 | 0.4 | 0.0 | 0.2 | 0.02 | | NO | N/A |
| | Slowest attack. | | | | | | | | |
| 4 | **Wide 2, Adj A/D** | 0.0 | 1.0 | 0.5 | 0.8 | 0.07 | | NO | N/A |
| | Same Attack range, but Decay is faster than #2. | | | | | | | | |
| 5 | **Snappy** | 0.6 | 1.0 | 0.4 | 0.75 | 0.15 | | NO | N/A |
| | Fast | | | | | | | | |
| 6 | **ADSR Fast A, Adj D** | 0.9 | 1.0 | 0.1 | 0.55 | N/A | | YES | 0.0 |
| 7 | **ADSR Adj A/D** | 0.0 | 1.0 | 0.2 | 0.5 | N/A | | YES | 0.0 |
| 8 | **ADSR 4** | 0.9 | 1.0 | 0.1 | 0.55 | N/A | | YES | 0.2 |
| | Same as #6, but with a Sustain level of .2. | | | | | | | | |
| 9 | **ADSR 5** | 0.0 | 1.0 | 0.2 | 0.5 | N/A | | YES | 0.2 |
| | Same as #7, but with a Sustain level of .2. | | | | | | | | |
| 10 | **ADSR Slow A, Fast D** | 0.0 | 0.5 | 0.6 | 0.55 | N/A | | YES | 0.0 |
| 11 | **Fastest A, Adj D** | 1.0 | 1.0 | 0.2 | 0.8 | 0.5 | | NO | N/A |

The Speed control goes from 0.0 to 1.0, for both Attack and Decay times. This is translated to the following range of what are called "time constants". (After one time constant, a decaying signal has dropped to 36.8% (or -8.7 dB) from its starting value.)

| Speed | Time Constant |
|---|---|
| 1 | .65 msec |
| 0.75 | 6.5 msec |
| 0.5 | 65 msec |
| 0.25 | 650 msec |
| 0 | 6.5 sec |

The Fast-Attack number controls exactly how fast the initial attack can rise. 1.0 is instantaneous; 0.5 is the fastest used. Most are considerably slower. The ADSR envelopes do not use this control.

Sustain is the ADSR sustain level. Most are 0.0, with two at 0.2.

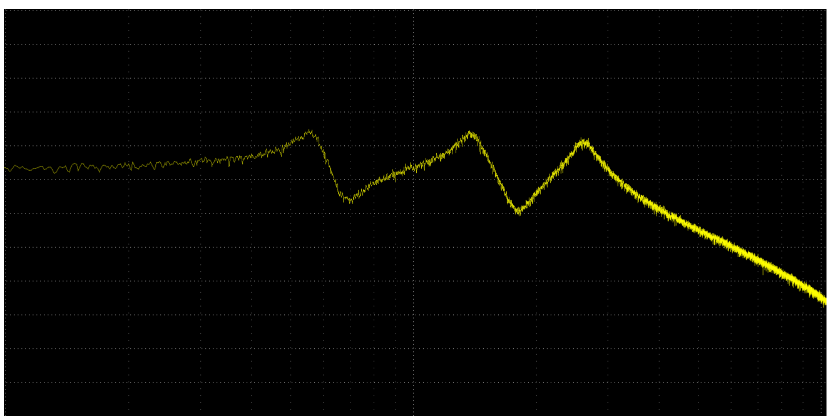
## More Information on the Filter Processors

**Theory of operation**: Internally, the Spectrum contains two independent processing blocks that perform the filtering operations. Each block has three sections, each capable of a variety of two-pole filters. These are then connected in series or parallel, with small mixers to sum as the case may be.  This gives us a large variety of frequency response shapes.  While the sound is, of course, determined from its frequency response, that doesn't mean it's easy to tell what something will sound like just from looking at the frequency response.  Not even for us.  The Frequency control for the filter moves the entire frequency response up and down in frequency, with all three filter sections moving together.  When Modulation is applied, the three sections may move together or independently, with some moving up while others move down, or they may move in the same direction, but a different amount.  Unless independent motion is specified, you may assume the entire frequency response moves as a unit when modulated, without changing shape.

Note: It is possible to combine any of the filter types in parallel with the same envelope source. This makes essentially for endless filter types.

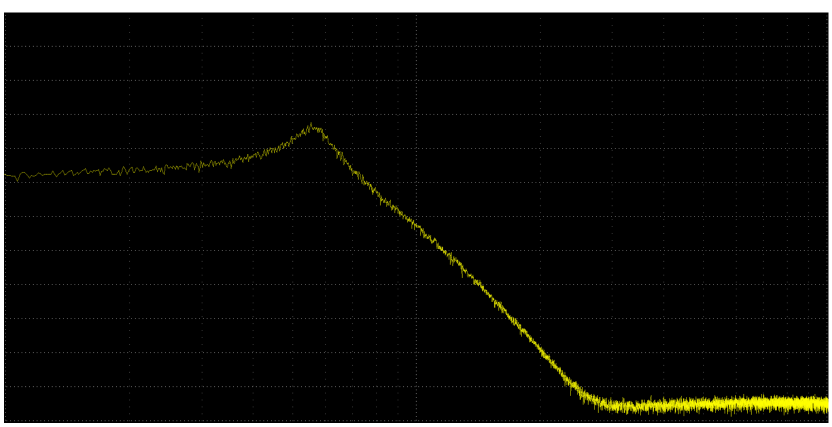
## Filter Types for C4 Synth & Spectrum Intelligent Filter

**3 Pole Parallel Low Pass**



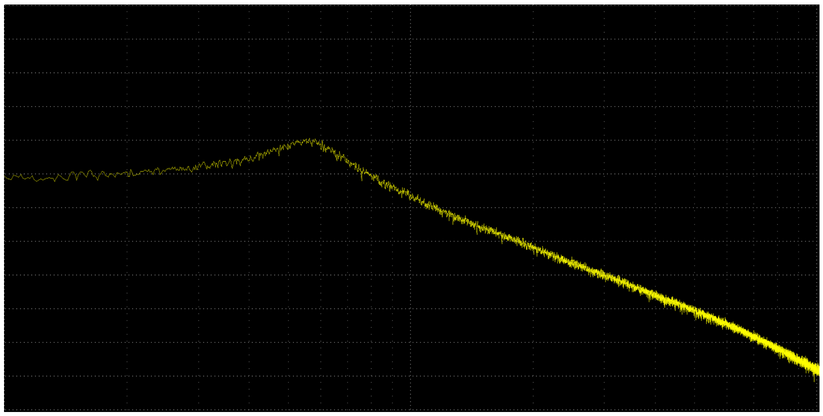
**6 Pole Low Pass**

Response drops at 36 dB/octave.

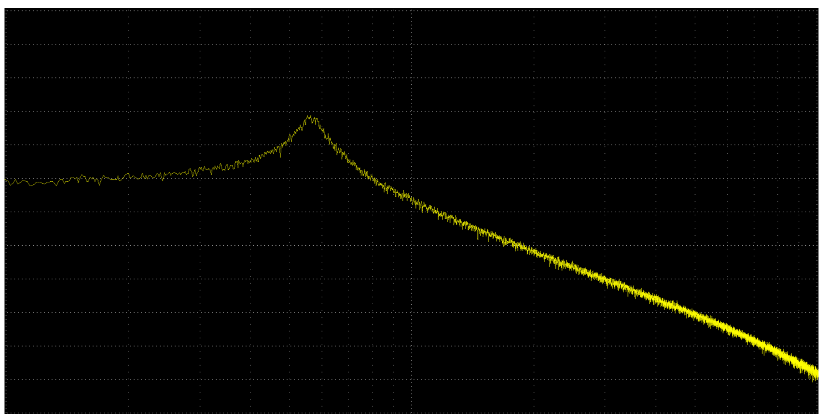


### 2 Pole Low Pass (Low Q)

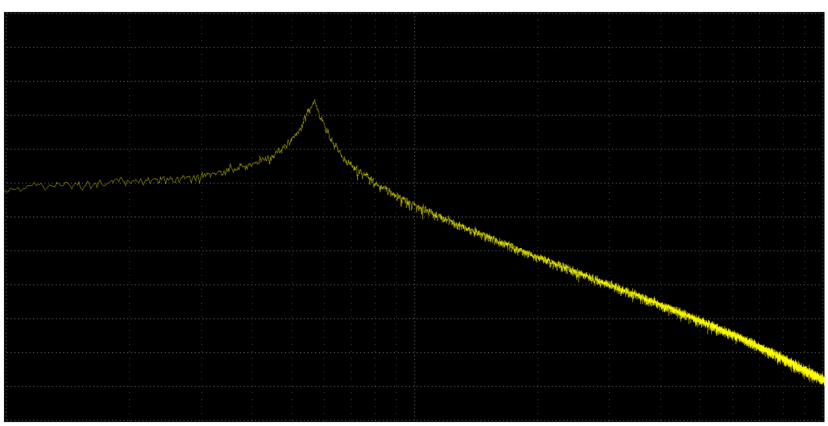
A very classic filter shape.  Above what is termed the cut-off frequency, the response drops, at 12 dB/octave.  If the Q control is turned up at least some, there will be a resonant peak at the cut-off frequency.  Higher Q's produce higher peaks.



### 2 Pole Low Mass (Mid Q)

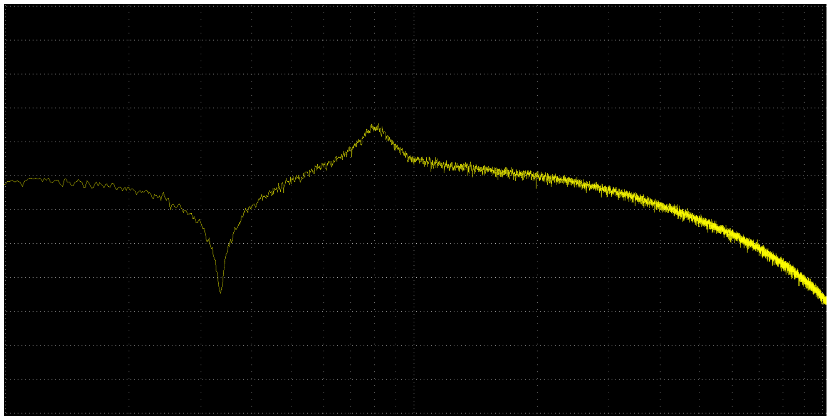


### 2 Pole Low Pass (High Q)



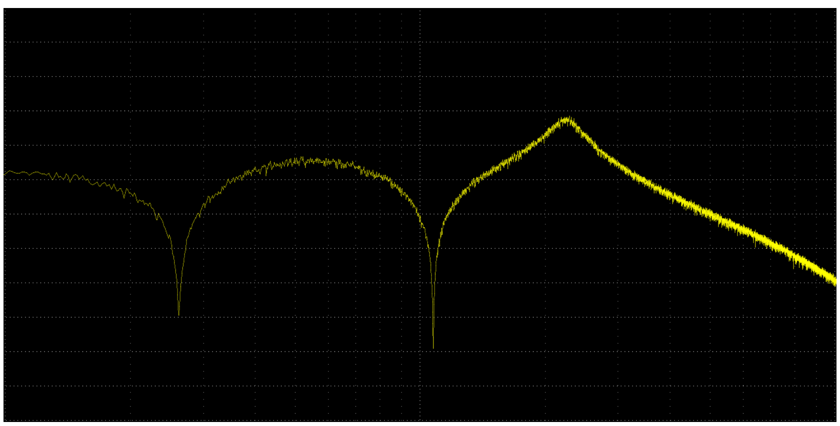
**Notch, Low Pass, Peak**

A notch, a peak, and then a Low-Pass without any resonant peak. (The name implies they are in a different order, but that is an error.) The notch is fixed at wide, and ignores the Q control. Q controls the width of the peak. There will be a little phasery-ness to any response with a notch in it.



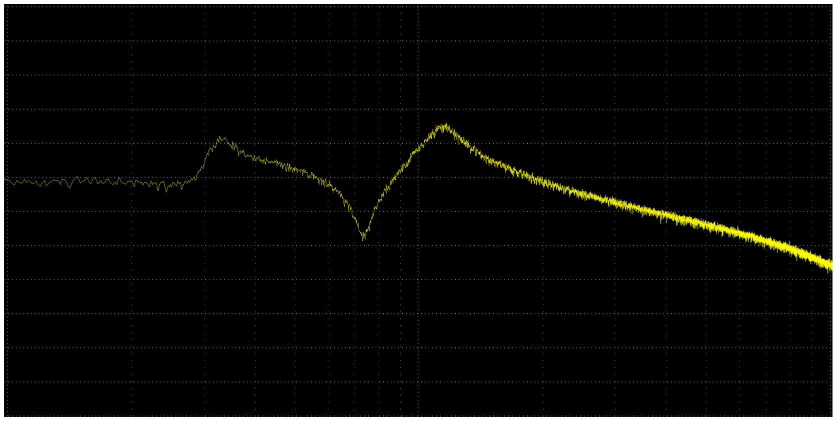
**Notch, Notch, Low Pass**

Two notches and then a Low-Pass.



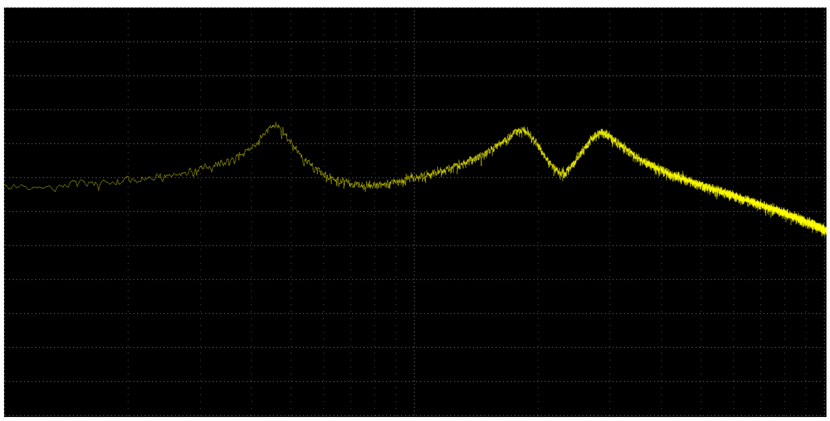
**Peak, Notch, Low Pass**

A peak, followed by a notch, and then a Low-Pass. If a peak is present in a filter, and if Q is set to the minimum, the peak becomes so wide that it tends to wash out any other structure, and will sound less interesting.

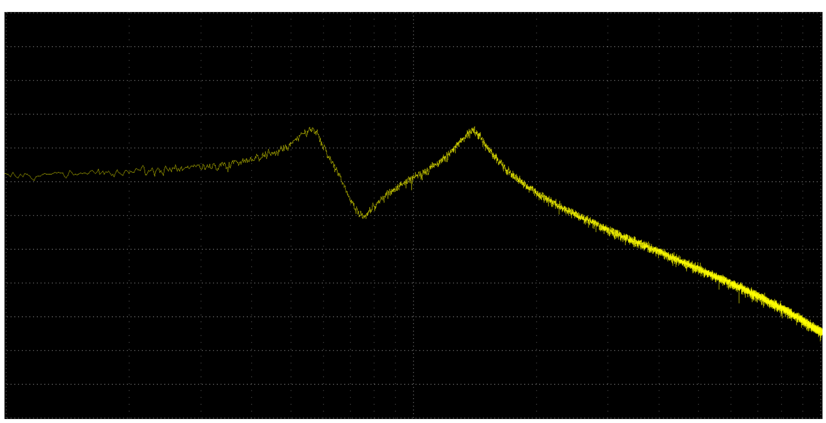


**Low Pass, Peak, Peak**

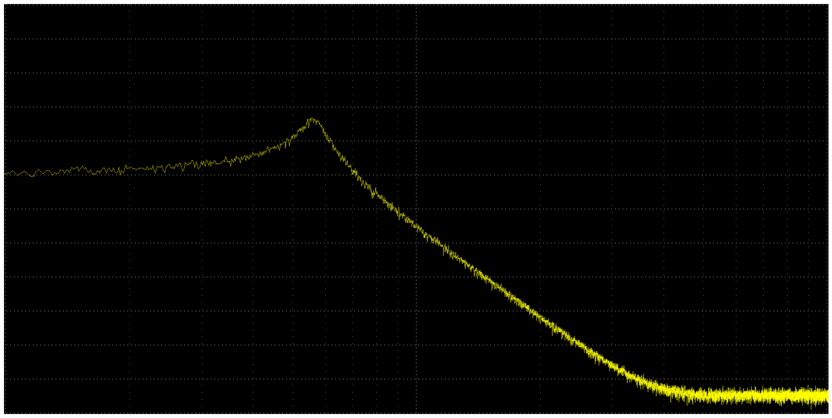
Two pole Low-Pass has two Band-Passes summed at higher frequencies.  Independent motion.



**2 Parallel Low Pass**

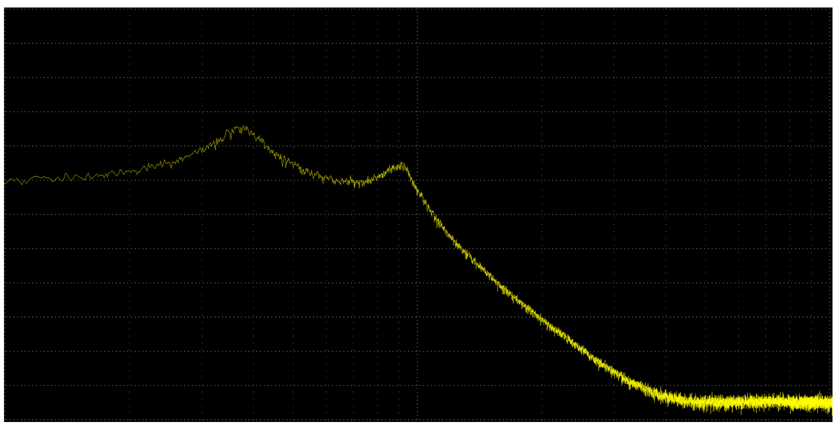


**4 Pole Low Pass**



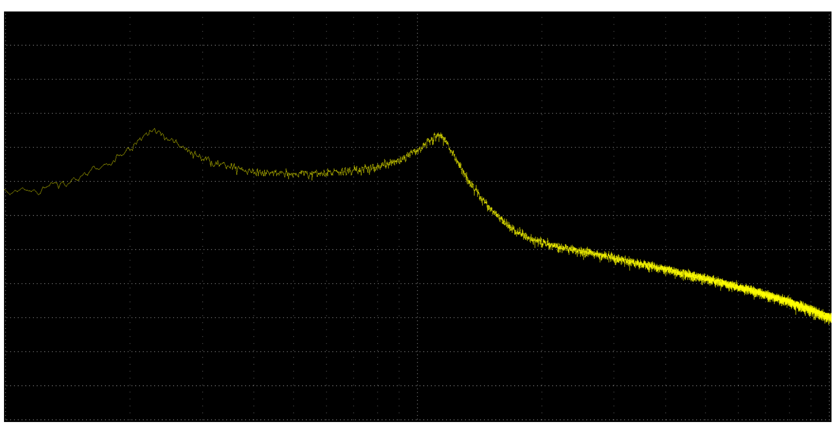
**Low Pass, Peak**

A Band-Pass is summed with a Low-Pass. The frequency of the Band-Pass is above the cut-off frequency of the Low-Pass. The Band-Pass and the Low-Pass filters move together.



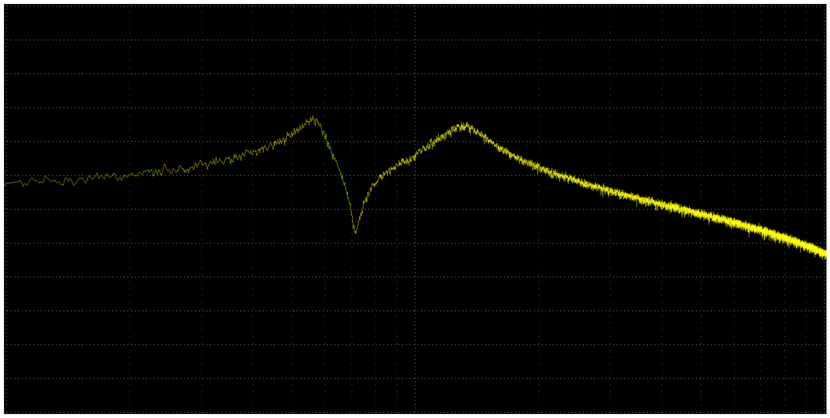
**4 Pole Low Pass, Peak**

Band-Pass summed with the 4 Pole Low-Pass. Independent motion.



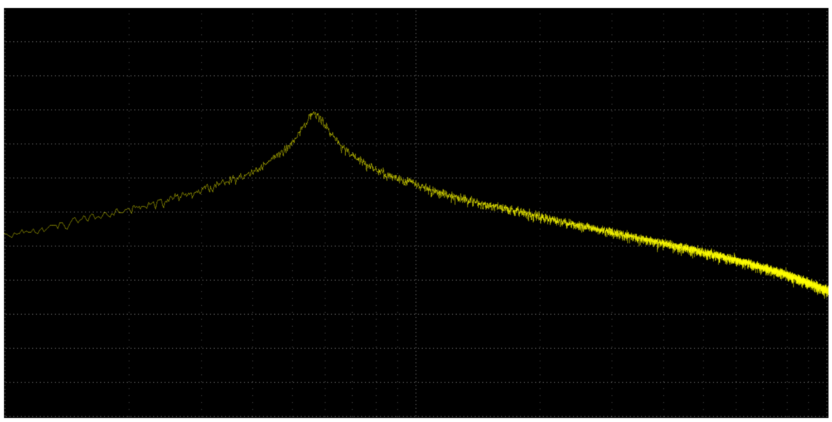
**Peak, 4 Pole Low Pass**

Another Band-Pass summed with 4 Pole Low-Pass, but here the Band-Pass frequency is below the cut-off frequency of the Low-Pass.  Independent motion.



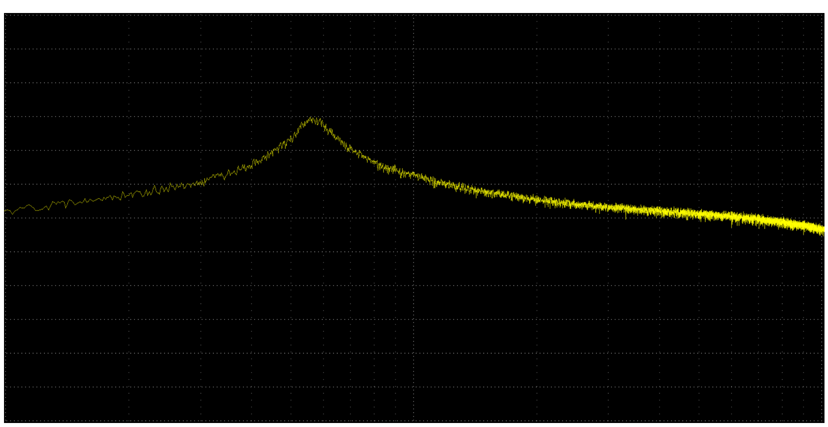
**Band Pass**

Only a range of frequencies gets through.  Higher Q's produce a narrower response.



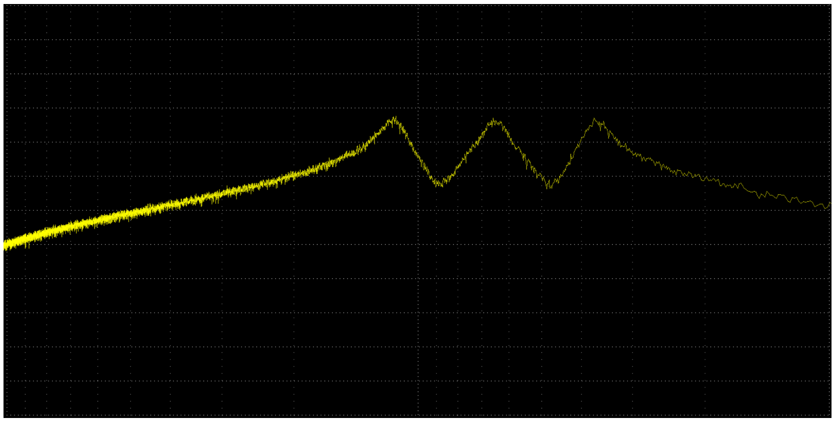
**Peak**

The original input signal is summed with a Band-Pass.  It looks something like a midrange control doing boost.



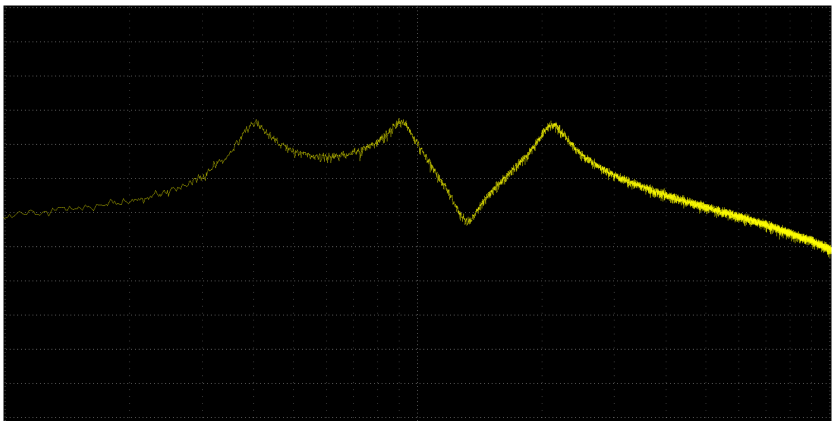
**Triple Peak 1**

Three Band-Passes summed. Independent motion. These triple Band-Passes can do some vocal sounding responses.



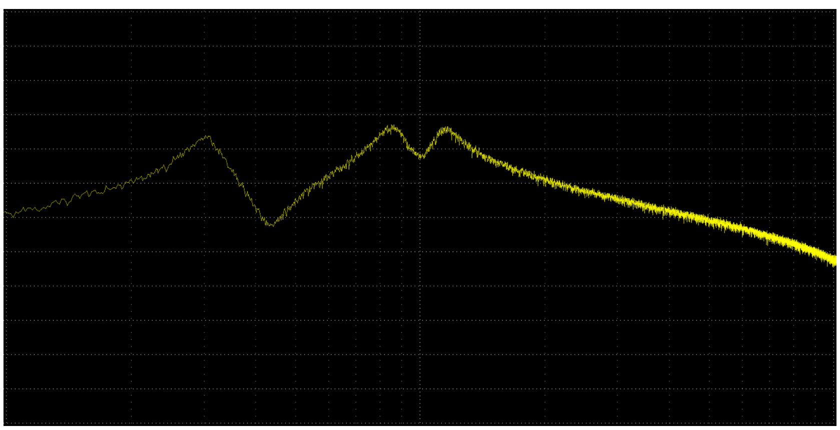
**Triple Peak 2**

Three Band-Passes summed. Independent motion.



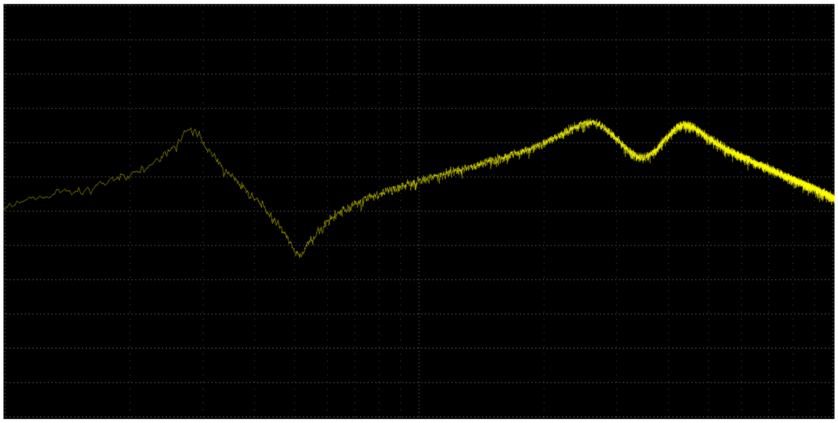
**Triple Peak 3**

Three Band-Passes summed. Independent motion.



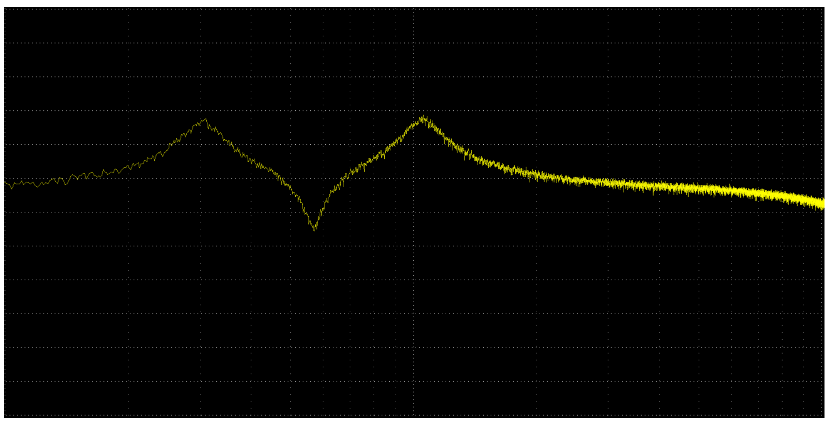
**Triple Peak 4**

Three Band-Passes summed.  Independent motion.



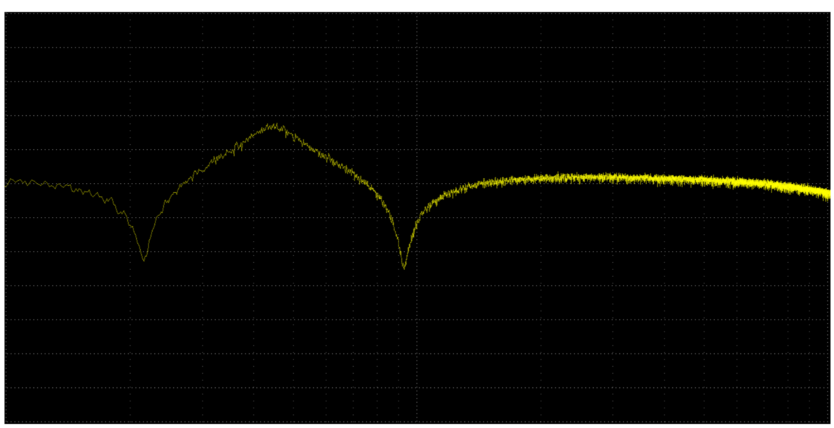
**Peak, Notch, Peak**

A flat frequency response has a peak, then a notch, and then another peak.

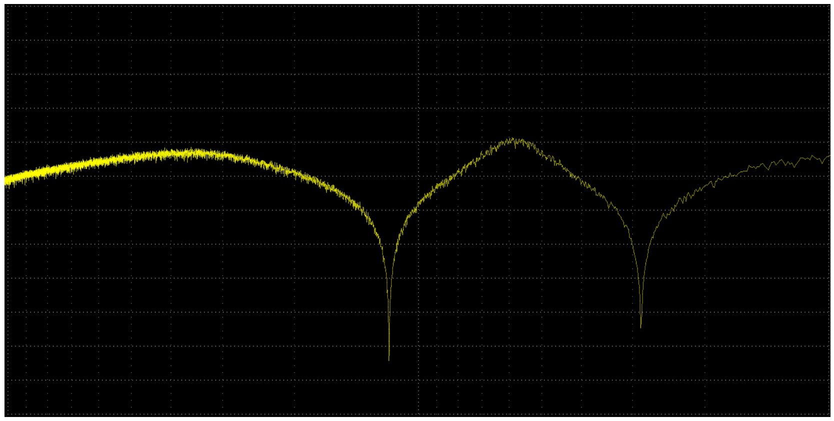


**Notch, Peak, Notch**

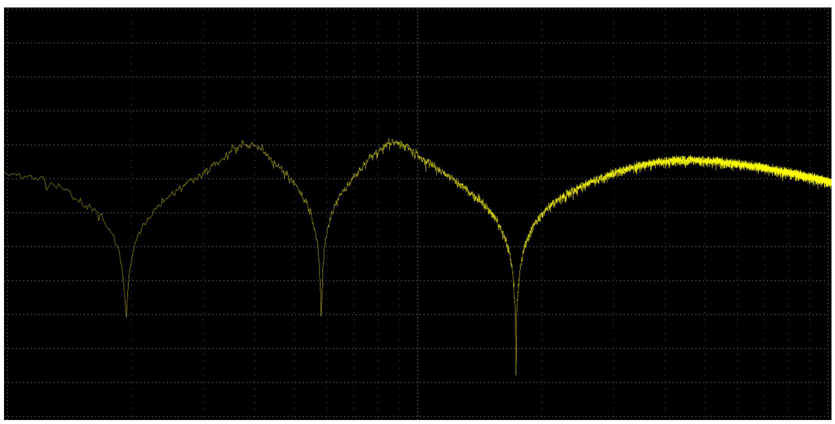
A flat frequency response has a notch, then a peak, and then another notch.



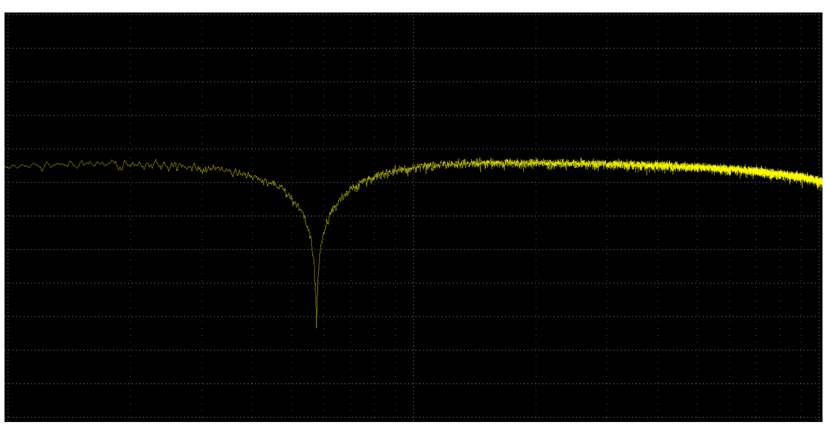
### 2-Stage Phaser



### 3-Stage Phaser

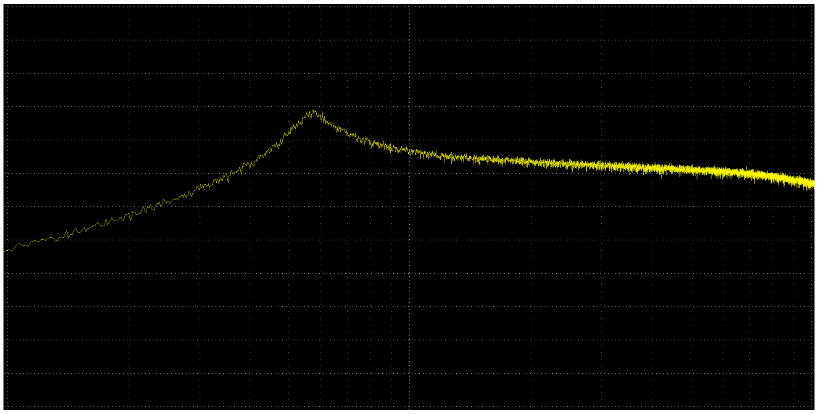


### 1-Stage Phaser



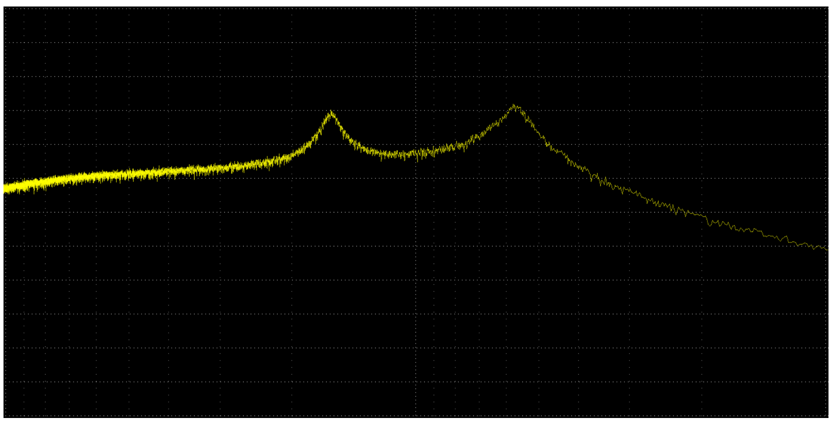
### High-Pass

Frequencies below the cut-off frequency are rolled-off, at a rate of 6 dB/octave.  There is a resonant peak at the cut-off frequency.



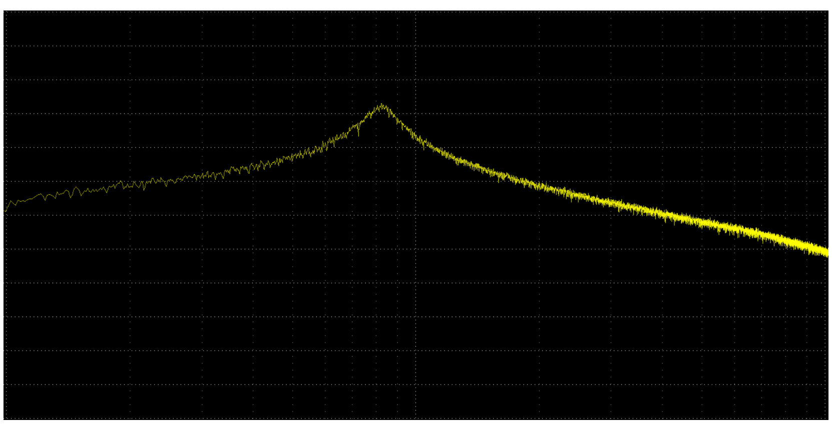
### High Pass, Peak

A Band-Pass is summed with a High-Pass, above the cut-off frequency.



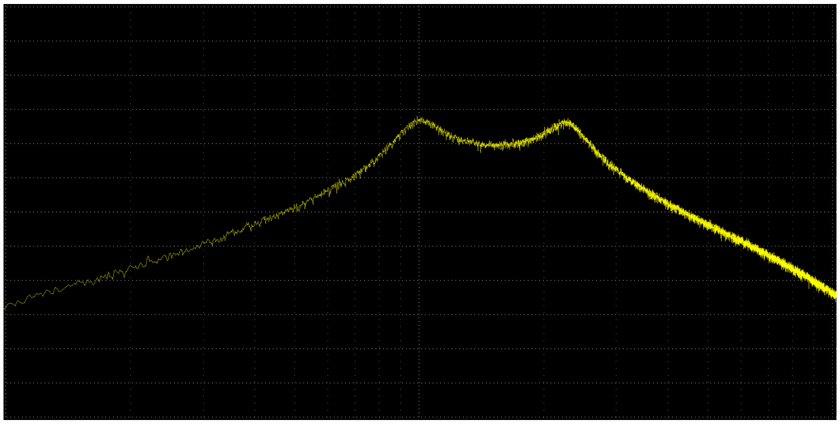
### Crybaby

An accurate model of the classic cry-baby wah pedal.  The Q control has no effect.



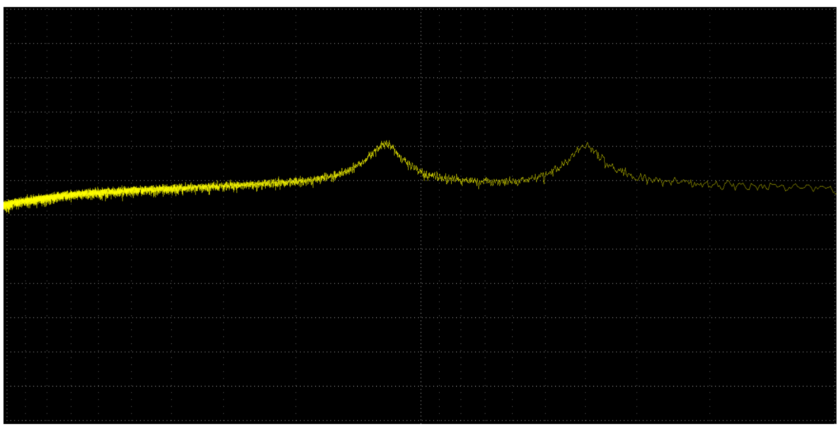
**Band pass 2**

Only a range of frequencies gets through.  Higher Q's produce a narrower response.



**Double Peak**

Input is summed with two Band-Passes.  Independent motion.



**6 Pole All Pass**

An All-Pass filter is one with a flat amplitude response, but where the phase is shifted, with higher frequencies getting more phase shift than lower frequencies.  When modulated with a sine LFO of around 6 Hz, a strange vibrato may be obtained.  This is the only way to add vibrato to the input signal.