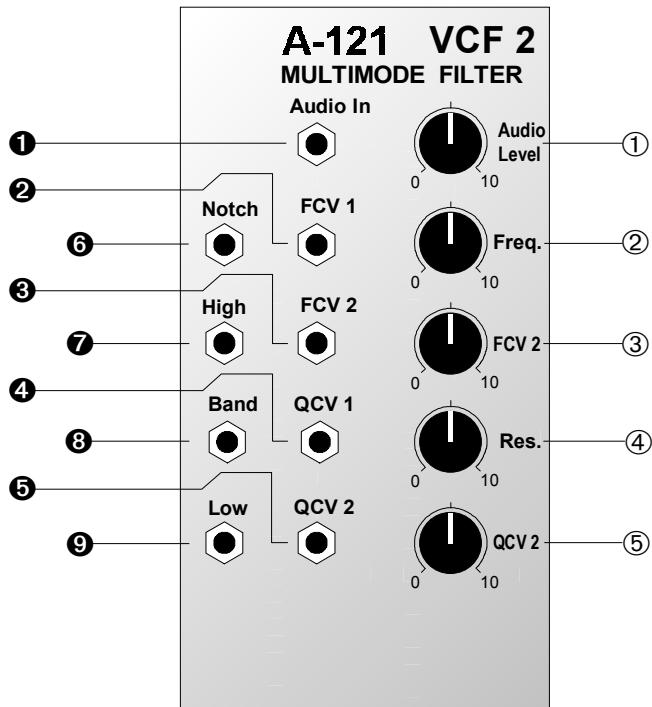## 1. Introduction

Module **A-121 (VCF 2)** is a **voltage-controlled multi-mode filter** with a **cut-off slope** of **-12 dB / octave**.

Four simultaneous outputs are available, each with different characteristics: **low-pass**, **band-pass**, **high-pass** and **notch** (or band reject).

The **cut-off frequency** determines the point at which the respective filter effects appear. The frequency can be adjusted manually, or by voltage control (**Filter modulation**, for instance by an LFO or ADSR). Two CV inputs are available, whose control voltages are summed.

Resonance (Emphasis or **Q**) can be adjusted manually, or by voltage control (**voltage-controlled resonance / VCQ**), right up to self-oscillation, in which case it will behave like a sine wave oscillator.

2. VCF 2 - Overview

A-121   VCF 2
MULTIMODE FILTER

Audio In

Notch   FCV 1

High   FCV 2

Band   QCV 1

Low   QCV 2

Audio Level   0   10

Freq.   0   10

FCV 2   0   10

Res.   0   10

QCV 2   0   10

Controls:

① **Audio Level** :   Input signal attenuator

② **Freq.** :   Cut-off frequency control

③ **FCV 2** :   Attenuator for filter CV ❸

④ **Res.** :   Resonance control

⑤ **QCV 2** :   Attenuator for resonance CV ❺

In / Outputs:

❶ **Audio In** :   Audio input to the filter

❷ **FCV 1** :   Cut-off frequency CV input

❸ **FCV 2** :   ditto, level controlled by ③

❹ **QCV 1** :   Resonance CV input

❺ **QCV 2** :   ditto, level controlled by ⑤

❻ **Low** :   Low-pass filter output

❼ **Band** :   Band-pass filter output

❽ **High** :   High-pass filter output

❾ **Notch** :   Notch filter output

3. Basics

Low Pass

The most common type of filter in analogue sound production is the low-pass, which filters out the higher parts of the sound spectrum, and lets the lower frequencies pass unchanged. **Cut-off frequency f_C** determines the frequency at which this occurs (see Fig. 1).
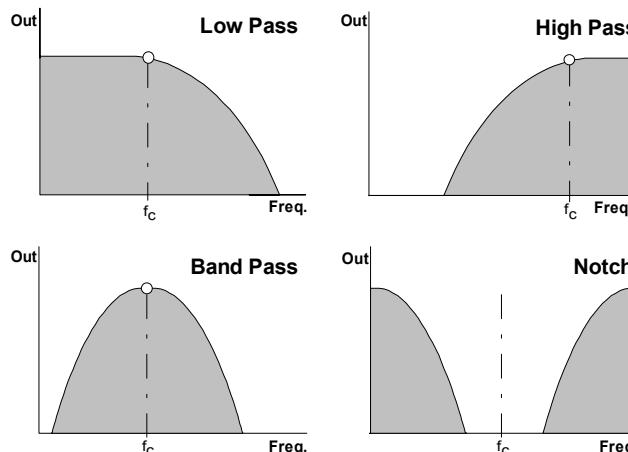
High Pass

The high-pass filter is a precise mirror-image of the low-pass filter: while it lets frequencies that are higher than the cut-off frequency f_C through, it attenuates frequencies below the cut-off point (see Fig. 1).

Band Pass

In a band-pass filter, both ends of the frequency spectrum are attenuated (see Fig. 1), and the cut-off frequency f_C becomes the **mid frequency.** It gives you the ability to highlight a particular frequency band.

Notch

A notch filter is the opposite of a band-pass filter, letting through the upper and lower end of the frequency spectrum, but rejecting a band in the middle (see Fig. 1). If the mid-frequency f_C is modulated by an LFO, the result sounds very similar to phasing.

Fig. 1: Typical response curves of the four filters.

Resonance

Another filter parameter is **resonance,** also known as emphasis or **Q**. As the value for Q gets higher, the frequencies around the cut-off frequency f_C are emphasised. Fig. 2 shows this process using a low-pass filter as an example (a high-pass filter would produce a mirror-image). This way, you can make the frequencies around the cut-off point stand out more.

In band-pass mode, an increase in Q's value makes the bandwidth narrower.

The same is true of notch mode, but of course in this case this narrower band will be rejected, instead of let through.

Setting the resonance close to maximum sends the filter into self oscillation, and makes it behave like a sine wave oscillator.
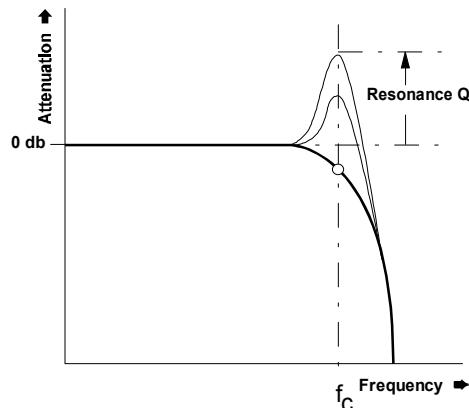
☞   The A-121's resonance is not frequency dependent to any significant degree. As long as resonance is kept below the self-oscillation level, any variation is imperceptible. The one exception to this is at high levels of resonance, coupled with a high cut-off frequency setting, when an increase in resonance can lead to a small drop in the sine-wave output's frequency. This is a characteristic of the **CEM 3320 filter IC,** and is not due to a design fault in the A-121's control system.

Fig. 2:   How resonance affects the response of a filter around the cut-off frequency.

4. Controls

① **Audio Level**

This attenuator controls the **input level** of the signal to be filtered, entering the module at input ❶ .

☞   If the filter's output signal is distorted, turn this control down, unless the distortion is wanted as a special effect.

② **Freq.**

The filter frequency is adjusted with this control.

③ **FCV 2**

If you want to control or modulate the cut-off frequency by a voltage patched into input ❸, use attenuator ③ **FCV 2** to set **the level of voltage control**.

④ **Res.**

With this control you adjust the **resonance** of the filter, which emphasises the frequencies around the cut-off frequency f_C.

Close to the maximum position, the filter goes into self-oscillation. In this mode it behaves like a sine wave oscillator, and can be used as an alternative sound source.

⑤ **QCV 2**

Attenuator ⑤ lets you control the **level of voltage control signal modulating the resonance** (Q).

5. In / Outputs

❶ Audio In

This socket is the filter's **audio input**. Patch the output of a sound source (such as a VCO, noise generator or mixer) into it.

❷ FCV 1

Socket FCV 1 is a **voltage control input for the filter frequency**. It works to the 1 V / octave standard (like a VCO).

If you patch a modulation source (eg LFO, ADSR) to this input, the cut-off frequency of the filter will be modulated by its voltage: ie., the sound color changes according to the voltage put out by the modulator.

If you use the VCF as a sine wave oscillator, connect the pitch CV into this socket. Do the same if you want the filter's cut-off frequency to track exactly with the pitch of a note.

❸ FCV 2

Socket FCV 2 is another **voltage control input for the filter.** Unlike CV 1, you can control the level of voltage - the intensity of the modulation effect on the filter - with attenuator ③.

❹ QCV 1

This socket is the **voltage control input** for the filter's **resonance**. It works to the 1 V / octave standard (like a VCO).

If you patch a modulation source (eg LFO, ADSR) to this input, the resonance of the filter will be modulated by its voltage: ie., the sound color of the frequencies around the cut-off point changes according to the voltage put out by the modulator.

❺ QCV 2

This is another **voltage control input for controlling the resonance**, but unlike QCV1 it gives you the ability to use Attenuator ⑤ to control the amount of voltage control, and therefore the intensity of its effect on the filter's resonance.

❻ Notch • ❼ High • ❽ Band • ❾ Low

Sockets ❻ to ❾ are the **filter outputs**. They simultaneously carry the input signal modified by the respective filter types (see Fig.1).

6. User examples

The A-121's cut-off frequency can be modulated in a variety of ways:

- **VCF - LFO**
  Modulation of the cut-off frequency produces cyclical changes of the **sound spectrum**. At low frequencies (c. 1 - 5 Hz), you get a **"Wah-Wah"-effect**. Modulation in the audio range produces interesting sounds; the same principles apply here as with frequency modulation of the A-110 VCO (see chapter 6).

- **VCF - ADSR**
  Modulation by an envelope results in gradual change of the **sound spectrum**. Typical uses would be the **synthesis of electric bass or drum sounds**, and **filter sweeps**, which slowly sweep through the audio spectrum, emphasising different harmonics.
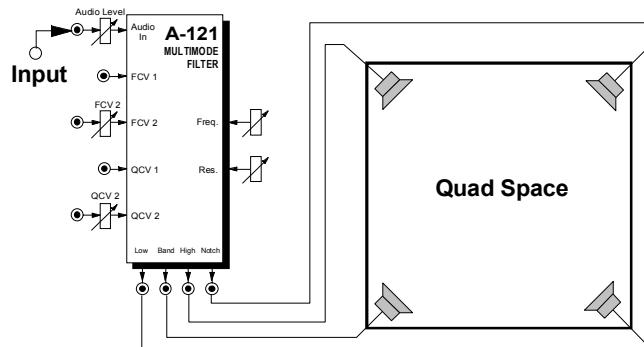
- **VCF - Keyboard CV**
  This modulation produces pitch-related filter opening and closing.

Spatial manipulation of the spectrum

Fig. 3 shows an interesting application of the multimode filter. Each of the four outputs is fed to one corner of a quadraphonic sound stage (VCAs and amplifiers, etc. have been omitted for the sake of clarity).

Each channel sends out only a part of the audio spectrum, depending on its respective filter's frequency response, and the result is interesting spatial distribution of the different spectral elements of the sound.

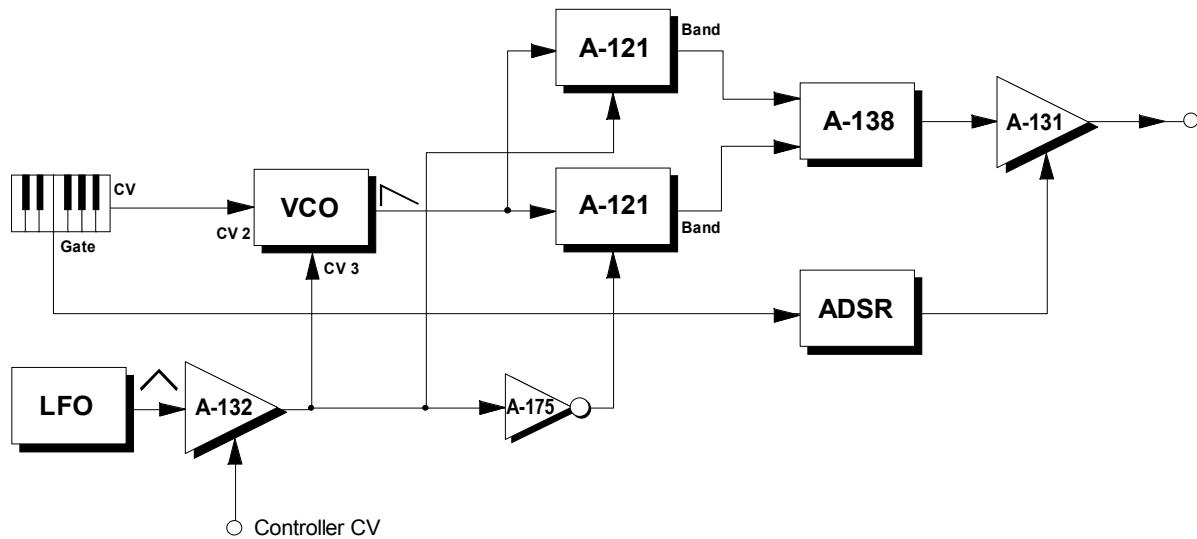**Fig. 3**: spatial manipulation of the spectrum

Generating vocal effects

With the patch in Fig. 4 (see next page) vocal effects can be produced, using two A-121 filters.

A sawtooth at around 100 Hz or less is patched into two A-121 filters. Set Q to a small or medium level, and use different mid-frequencies for each of the two filters.

Modulate the VCO and both filters with a triangle wave LFO at about 1 Hz, but with the voltage input to one of the filters inverted by an A-175 inverter. Set the modulation amount for the VCO (Attenuator CV3) and for the filter (Attenuator FCV2) to a small or medium value.

You can control the intensity of the modulation with a dynamic MIDI controller - aftertouch, mod wheel, etc..

Experiment a little with this patch (see next page). With careful setting up and tweaking, interesting vocal-like timbres can be produced.

Fig. 4: Producing vocal-like sounds

☞ Check out various different combinations of mid-frequency settings on the filters.

Experiment with different envelope settings.

☞ By turning down the pitch CV input to the VCO, more speech-like intonation can be achieved.

Patch a Slew Limiter (A-170) in before the VCO's CV input, so that the 'voice' intonation slides, rather than jumping in discrete steps.

7. Patch-Sheet

The following diagrams of the module can help you recall your own **Patches**. They're designed so that a complete 19" rack of modules will fit onto an A4 sheet of paper.

Photocopy this page, and cut out the pictures of this and your other modules. You can then stick them onto another piece of paper, and create a diagram of your own system.

Make multiple copies of your composite diagram, and use them for remembering good patches and set-ups.

- • Draw in patchleads with colored pens.
- • Draw or write control settings in the little white circles.