BugBrand Modular
1Frame SynthVoice

The 1Frame SynthVoice arrangement presents a combination of modules aiming roughly along the lines of traditional subtractive synthesis (VCO → VCF → VCA). The patchable, modular approach not only gives great scope and versatility around such areas, but also opens up many more esoteric arenas for exploration.

Sections:

- System Approaches
- Module Descriptions

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System Approaches

I believe that a mix of understanding and experimentation is the best way to approach this system. In many ways I design in building blocks which are quite basic when considered on their own, but when combined open up great possibilities.

Connections

4mm Banana Sockets are used for all signal connections within the system. These are colour coded to highlight functionality.

	Control	**Audio**
Input	Blue	Yellow
Output	Red	Green

Signals can be roughly grouped into two types:

- Control – signals to control processes – eg LFO, Envelope, Gate
- Audio – your sound source – eg VCO, VCF, etc

It should be noted, though, that there is a great deal of blurring between the two signal types! You should consult the individual module descriptions for detailed functionality of connections.

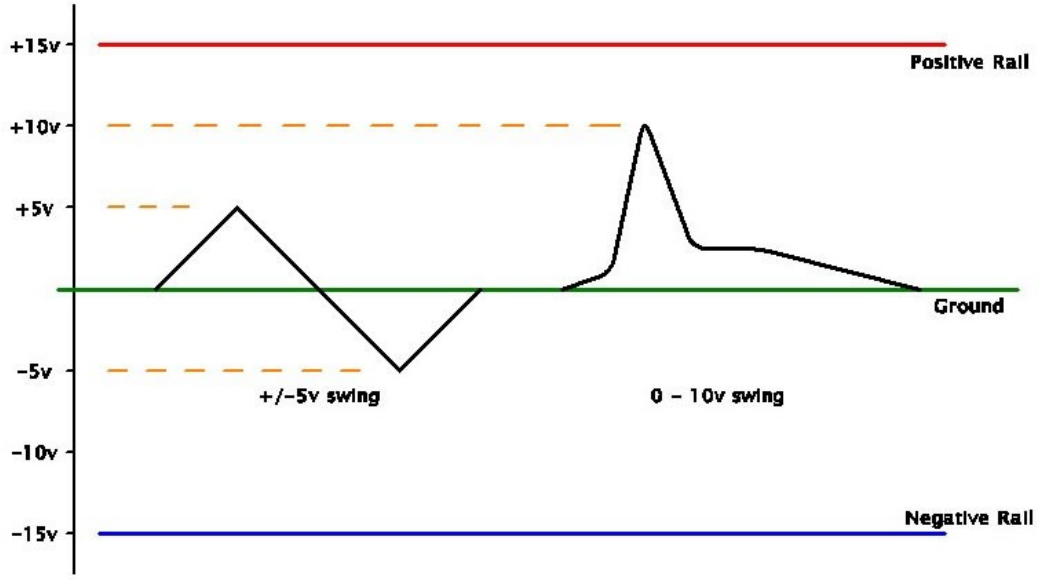
1/4” Jack Sockets are employed for Input/Output from the system – these provide the required ground connection that is not present when solely using banana plugs. Black banana sockets are also used to provide connection to System Ground.

Colours also help identify the function of dials. In general: Red/Orange are used for the main module control functions, while Yellow/Green tend to be for audio functions such as level / fade. Blue is solely used for modulation depth settings of external CV inputs.

Voltages

The Power Supply Unit (PSU) for the system provides a bipolar +/-15V supply. These voltages can be considered as 'boundaries' for signals within the system with 0v (ground) as a central point.
Signals within the system will generally have a swing of 10 volts peak to peak (10v PtoP). This 10V range is present in two forms:

- +/-5V = *BIPOLAR* swing from -5V to +5V centred around ground (0V)
  eg. VCO, LFO, VCA
- 0-10V = *UNIPOLAR* swing from 0v to +10v
  eg. Gate, Envelope



Ethos
Modules have been designed with certain approaches in mind. In particular, signals are generally output at full amplitude (10V PtoP) so they may be split and then attenuated individually at each destination, whether audio or control. Banana cables allow you to easily stack connections – this only works in splitting two signals, it does not work for mixing two signals together.

Any parameter that can be voltage controlled (VC) will have at least two controls plus one or more CV input. One control will act as the Master control, sweeping the function over its typical range (generally red/orange in colour), while the blue Modulation (Depth) control will set the level of modulation from its adjacent CV input socket. Some modules also have additional 'full-range' CV inputs without level controls – these are either for typical 1v/oct response (ie. Unattenuated) or just to offer further control possibilities. Of course, an external mixer (eg. DD2 DC Mixer) can be used before the full-range CV input both to mix input CVs and to set their levels.

It is important to consider an external waveform's behaviour when applying it as a modulation signal. The combined Master and Modulation (external CV) control settings will determine the resulting function.

- a +/-5v signal will add and subtract from the setting given by the Master control
- a 0-10v signal will add to the setting given by the Master control.

Consider a VCA(mplifier) which is swept from fully closed at one extreme to fully open at the other, covered by a range of 10V. The Master control can be manually turned to move from fully closed to fully open. If we want an external CV (10V PtoP) to sweep the VCA from fully closed to fully open we must do as follows:

- for a +/-5v signal, set the Master dial to roughly half way and dial the Modulation to full depth. If the Master is set to zero then any negative swings of the CV signal will have no effect and the positive swings will only half open the VCA.
- For a 0-10v signal, the Master is set at zero and the Modulation is again set to full. If the Master is set above zero then whenever the input CV is zero the VCA will still be open.

Of course, it is the wide scope for more subtle modulation settings that really opens up the possibilities.

Guarantee
The system is covered by a 2 year warranty – if any mechanical or electronic failure occurs within the specified period, I will repair the fault free of charge. This excludes failure from maltreatment or modification and any cosmetic degredation. Contact should first be made via email to discuss the problem. Shipping to return the device to BugBrand is paid by the user and the return shipping is paid by BugBrand. Failures that are not covered by this warranty may still be fixed at a standard rate.

Mini Power

The Mini Power has been designed specifically for 1Frame Setups and runs from an external 18V AC (not DC!) wall-wart to generate a stable +/-15v bipolar supply (max. current c.300mA per side) which is then distributed to modules within the frame via an internal power bus board. Features from top to bottom:

- On/Off Power Switch
- Power input for 18V AC external wall-wart (supplied within UK/EU) - 1100mA minimum required, 2.1mm plug
- Power indicator LEDs for V+/V-
- Common Ground connection to integrate with other systems
- Two 1/4" jack to banana converters – these are connected to the internal System Ground.

Connecting External Signals

You can connect external CV / Gate signals either via the jack-to-banana connectors on the Mini Power or via custom interface cables. Note that, due to the signal amplitudes within the system, most audio signals will require considerable amplification to reach suitable levels – this is usually achieved by the UTL1 Dual Preamp module, though this is not included in this system.

If using interface cables, the first cable should have a ground connection which plugs to the System Ground point on the Mini Power module. Once this common ground has been established, any further connections do not require further ground cables.

An external Midi-to-CV converter allows the system to be played as a traditional synthesiser. For example, the 1V/Oct CV would plug to the V/Oct input on the VCO(s) and the Gate signal would be patched to the Gate input of the Envelope.

CTL2 – Joystick / Touch

The CTL2 can be seen as a versatile modulation hub for the system. The Joystick and Touch sections of the CTL2 are independent, but complimentary and are individually explained below.

Joystick Section:
The X and Y axes behave in identical manner, both dependent on the setting of the two switches per section:
Ext(ernal) / Int(ernal) – selects whether the Joystick controls the level of an external signal or uses an internally generated voltage reference for variable DC output.
Uni(polar) / Bi(polar) – the response depends on the Ext / Int setting – examples are given below along with a response diagram.

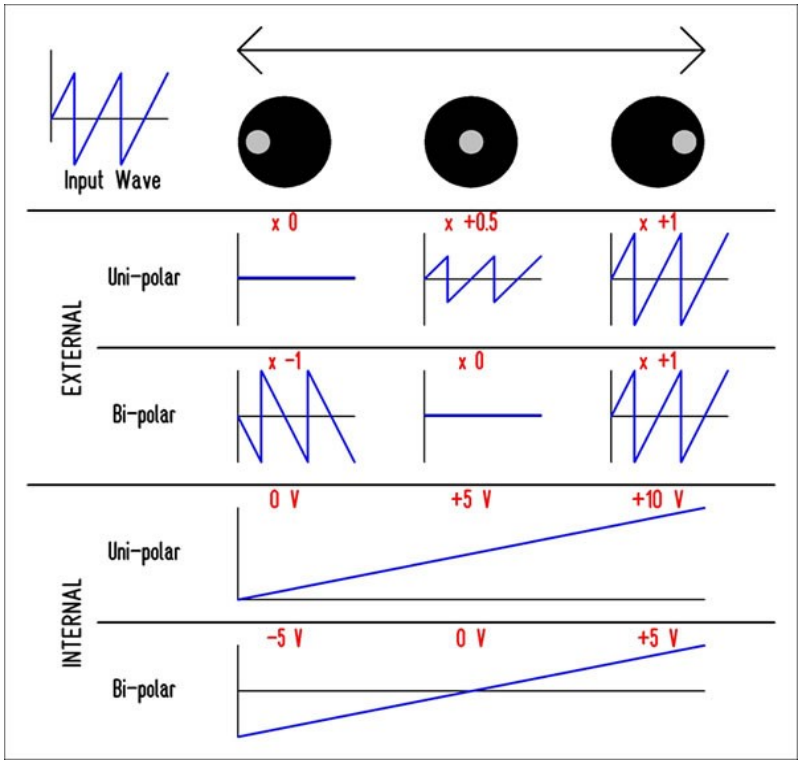
EXTERNAL – UNIPOLAR: The joystick controls the level of the external signal from zero at fully left to unity gain at fully right.
EXTERNAL – BIPOLAR: The joystick controls the phase and level of the external signal. Fully left the signal is inverted with unity gain, in the middle the signal is fully attenuated and fully right the signal passes non-inverted with unity gain.

INTERNAL – UNIPOLAR:The joystick generates a DC output voltage rising from zero volts at fully left to +10 volts at fully right.
INTERNAL – BIPOLAR: The joystick generates a DC output voltage rising from -5 volts at fully left, through zero volts at centre and +5 volts at fully right.

Each axis has a bi-colour LED with green indicating positive voltage output and red indicating negative voltage output. The control shaft of the Joystick is a custom spun aluminium piece 35mm long and removeable via a standard M3 thread at the base.

Touch Section:
The two Touch Plates generate DC output voltages dependent on physical touch with a maximum output voltage of +10 volts and an LED indicator. The Gate signal goes high to +10 volts whenever the corresponding plate is touched.

The sensitivity of response can be adjusted to suit the user by adjusting the trimmer at the top-left of the rear PCB. While the two plates are independent, pressing both at the same time can cause interaction – you should view the plates as monophonic (one at a time).



ENV1 – Attack/Decay

The ENV1 is a simple, yet extremely useful, voltage controlled Attack / Decay Envelope Generator which can also spring into work as an interesting oscillator. There are three modes of operation, plus three rate ranges:
A/S/R Mode – Gated Attack / Sustain / Release – The output ramps and holds while the input Gate is high. When the Gate signal goes low again the output decays to zero. If the Attack portion has not completed by the time the Gate goes back to low, the Envelope immediately changes to Release.
A/D Mode – Triggered Attack / Decay – The rising edge of an input Gate initiates a complete Attack/Decay cycle.
Loop Mode – Free Running - The output continually ramps up and down at rates determined by the attack and decay settings. (note that unlike usual VCOs the output signal is unipolar 0 to +10v)
3-way Rate Switch – Fast/Mid/Slow - The Fast setting is primarily for audio rate oscillations (envelopes in this mode are too fast!). The Mid setting offers 'regular' envelope lengths and is suitable for higher-rate LFOs in loop mode. The Slow setting may prove too slow for envelope use, but can give very slow oscillations in Loop mode.

Note – the controls may seem backwards! Shorter attack/decay times are set by turning UP the controls – this is based on what makes sense in Loop mode (turning up increases pitch).

The Gate Input has an internal comparator so any waveform going over c.+1v will produce a gate, so either traditional gates or other waveforms can be used. (eg. Try feeding a VCO waveform into the Gate input)

The End Out socket provides a means to chain sequential events – the output is High (+10v) when inactive and goes Low (0v) for the entire cycle of the Envelope before returning High. To achieve 'sequential triggering' take the End Out of one Env into the Gate input of the next Env – as soon as the first Env completes, the second one will fire.

The Attack and Decay times are set along with independent modulation depth controls – these are polarizing to allow positive or negative effect (centre gives no modulation - but the dials do not have a centre-detent). Independent or inverted control of the two CV inputs proves a very useful feature. In Loop Mode the Attack / Decay controls allow interesting waveshaping Oscillator effects, moving the signal from triangle to saw for example. Note that the circuit uses Vactrols which result in quite a slewed control response, especially as slower times are dialed in.

An interesting further use is to feed an audio signal into the gate input – each Mode setting giving different results:
i) *Audio SubDivision* → feed an oscillator into the Gate, set mode to AD and begin with Attack & Decay turned fully clockwise → this gives tracking of the oscillator rate. Now gradually turn down the attack and you'll hear the pitch dropping in harmonic divisions.
ii) *Audio Sync-effects* → similar setup as before, but switch to Loop mode. Now adjust the Decay rate and hear audio oscillator sync.
iii) *Filter-like effects* can be achieved in ASR mode - adjust Attack for low-pass filtering and Decay to do something that sounds more like high-pass.

SYN2B – Quadrature Sine

The SYN2B is a wide-ranging and high stability / purity Quadrature Sine-wave Voltage Controlled Oscillator module. It's main features are:

- 10-turn tuning dial covering a 10 octave range
- Osc or LFO rates
- 1V/Oct input (0.1% summing resistors) + variable depth FM input switchable between Exp(onential) DC-coupled or Lin(ear) AC-coupled
- accurate tracking (less than 0.1% error) over 8 octaves + temperature compensation
- four bipolar (-5 to +5 V) outputs at 0/90/180/270 degree phases with bipolar LEDs

The module is set up such that one rotation of the tuning dial raises the pitch by 1 octave (ie. Doubles the frequency) with the zero point of each rotation (see scale on the dial) giving tuning to approximately A (ie. 440Hz etc.) in VCO mode.

Via the tuning dial, ranges are about 13.75Hz to 14.08kHz in Osc mode and 0.014Hz to 14Hz in LFO mode. But ranges extend well beyond what is set by the tuning dial – approximately 1V above the upper range and at least 5 octaves below the low range (thus, by applying a -5V DC signal you could get the LFO mode to cycle around 30 minutes!).

Typical tuned Osc FM operation can be achieved with the pair of SYN2Bs – both receive the same 1V/Oct signal and then one is used to FM the other in Linear mode. Note that detuning can occur on the FM'd VCO when the modulation is dialed above about 1 o'clock – the input could have been attenuated to prevent this, but it was felt that the possibilities of the stronger modulation settings should be kept.

You can also achieve richer waveform timbres by Self-FM – patch an output back to the FM CV input and adjust Linear FM depth to suit. Using different phase outputs as the self-FM signal will give different end results – ramp waves or parabolas.

A quasi noise source can be achieved by cross-modulating the two modules – set both to Osc mode, connect an output from each module to the FM CV input of the other module and set the FM to Exp with the dial turned up full. Experiment with different rates on each Osc then try turning down the FM depth to bring back in pitch effects.

Note that in LFO mode it can take a long time for oscillations to get going when the system is first switched on – this is the nature of the circuit as the oscillations basically reinforce themselves to build up to full amplitude. The simplest way to get oscillations going is to apply a +10V signal to the 1V/Oct input until you can see that the LEDs are showing oscillation. Once you have got the oscillations going you can freely switch between LFO and Osc modes without having to repeat this step.

There are three trimmers on the back of the module for fine-tuning but these have been accurately adjusted at testing and should only be adjusted when you are sure that they should be.

- *tuning offset* can be used to shift the base range of the tuning dial (eg. It is currently set so that each 0 rotation point gives an A in Osc mode, but you could adjust it so that C is the zero point)
- *V/Oct Scale* adjusts for accurate tracking but please ensure that your source (eg. External keyboard or Midi-to-CV) is accurately tuned before adjusting this
- *Hi-Freq Trim* is also used for accurate tracking as the Exponential Converter section will detune at high frequencies.

An Allen Key is also supplied with each module in case adjustment of the tuning dial is required.

DD2 – LFO / DC Mixer

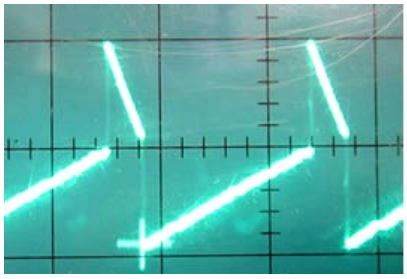
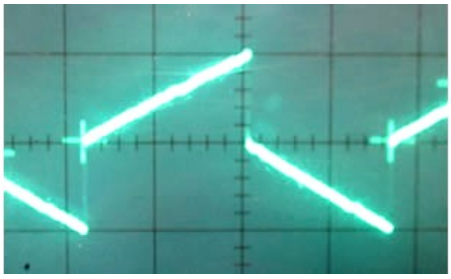
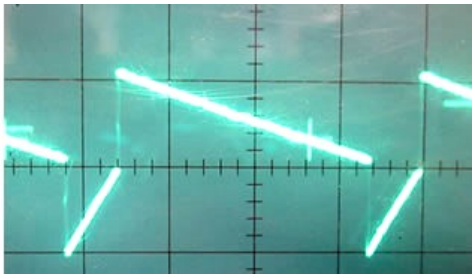
The DD2 is a dual module offering a simple Low Frequency Oscillator (LFO) and a polarizing DC Mixer in a compact form. The new Rev.2 version adds switches to couple the LFO waveforms direct into the DC Mixer so that you can achieve some interesting waveform combinations.

The LFO has two ranges for slow or fast rates (total range c. 0.04 - 20 Hz) and is switchable between Triangle or Square outputs (+/-5v buffered output signals).

The Skew control is used to shape the output – for Triangle output the signal is skewed from Ramp Down through triangle to Ramp Up, while for Square output the pulse width is changed between Narrow Pulse-On through 50/50 to Narrow Pulse-Off.

The DC Mixer provides two inputs (DC-coupled) with polarizing controls using centre-detent pots – turning a level control clockwise mixes a positive signal and turning it anti-clockwise mixes an inverted signal, while in the centre position no signal is passed. This proves an extremely useful module for mixing both audio and / or control signals. (the operation is basically the same as for the Bipolar External mode of the CTL2 Joystick section)

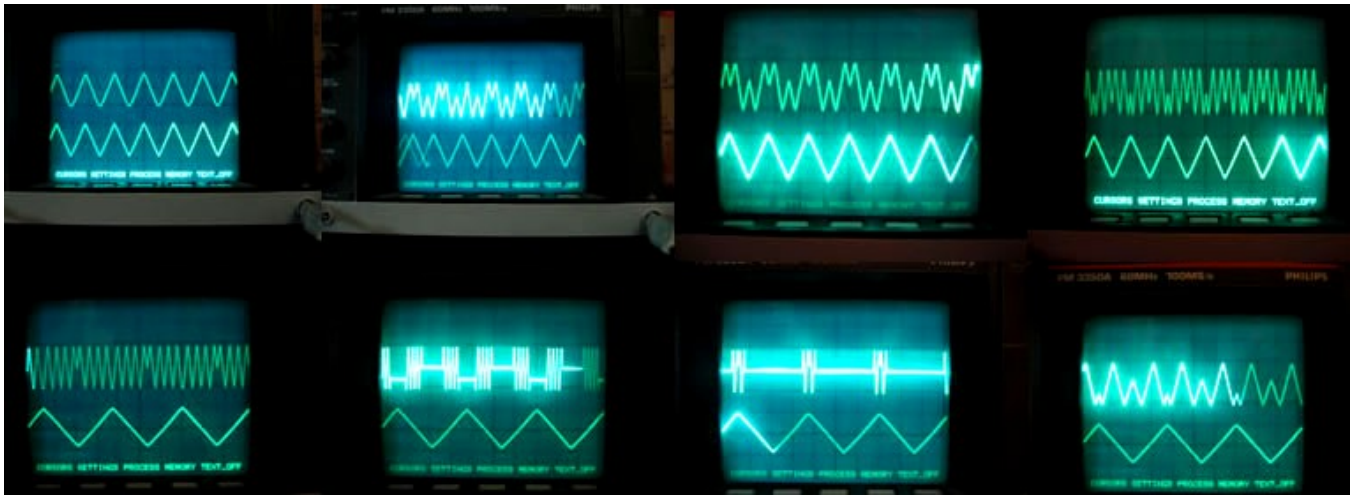
There are two Couple switches which pass the LFO waveforms into the two channels of the DC mixer. Not only does this allow you to combine, say, the LFO Tri-wave with some other modulation source, but you could also combine the Tri & Sqr waveforms to generate some interesting waveforms - see the scope shot images for some example waveforms.

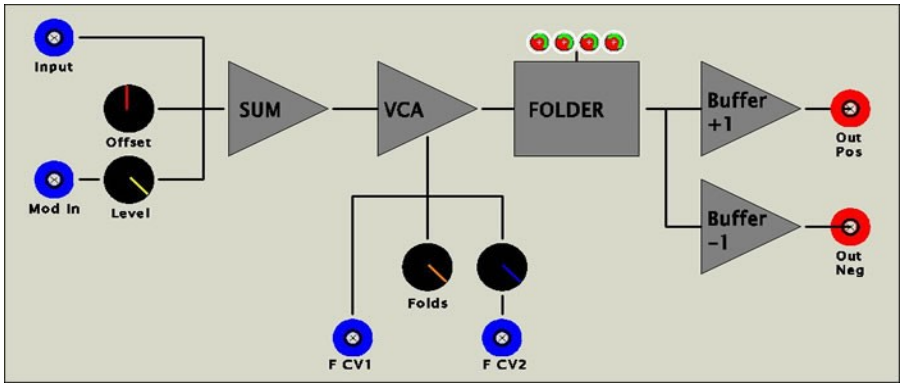




Trimmers are provided to Null the centre detent point of the two DC Mixer channels. If adjustment is needed, insert a VCO signal into one channel, turn the level control fully up and then back down to the central position - now adjust the trimmer until absolutely no sound is heard at the output. Do the same for the other input channel. There is always a little 'play' around the centre detent position but a little wiggle should always allow you to find the true centre-off.

PRC5 – Wavefolder

The Wavefolder is a powerful processor which adds overtones to input waveforms. Typical operation would begin with a simple waveform input – for example, input a sine-wave and as you increase the Folds dial the waveform folds back on itself to produce overtone frequencies. But the folding effect can also be used to process more complex input signals - think of it as a unique distortion device.





The PRC5 can be better understood with reference to the Block diagram. At the top there are two signal inputs plus an Offset control - the main input is un-attenuated, while there is a secondary input with level control. I consider the un-attenuated input to be the 'main' input because the module is set up to expect typical +/-5V bipolar signals. Both inputs are DC coupled and this is notable both for the fact that LFO waveforms can be processed and that applying DC offsets can really alter the resulting waves. A DC offset can either be applied with the Offset dial (centre equals zero offset) or I will typically apply an LFO to the 2nd input and use the level control to dial in a little of this - the result sounds somewhat similar to pulse-width modulation. (eg. Try this with DC generated from the CTL2 Joystick)

The input summer is followed by an internal VCA (linear response) which feeds the central Folder circuit. The VCA goes from zero output with the Folds dial fully counter-clockwise and with the first little turning of the Folds dial (or external CV) the response is exactly like a regular VCA. But the interest comes when the output reaches +/-5V boundary points (roughly 9 or 10 o'clock on the dial) - once pushed beyond these points, the waveform direction reverses (folds). Further amplification results in the folded waveform again reaching the boundary points, but this time going in the opposite direction - again going beyond this point results in another reversal of direction. There are a total of four folds possible - indicated by the four bi-colour LED indicators (which actually achieve the folding behaviour). Beyond the fourth fold the waveform peaks begin to flatten out. There are two CV inputs to modulate the Folds amount - the top one (FCV1) is unattenuated while the lower one (FCV2) has a level control.

The action of applying a DC offset basically pushes the waveform in one direction so that it bumps into one of the +/-5V boundaries earlier than the other. Modulating this offset achieves interesting tonal shifts. All inputs respond from DC up to high frequencies - interesting effects can be achieved i) mixing two audio signals at the two inputs & ii) modulating the Folds level with an audio rate signal.

There are two outputs, both of which give output signals ranging from -5V to +5V. The Neg output is simply an inverted copy of the Pos output. It should be noted that input waveforms should be anything except for squarewaves - these make no sense to the Wavefolder!

PRC3A – SV Filter

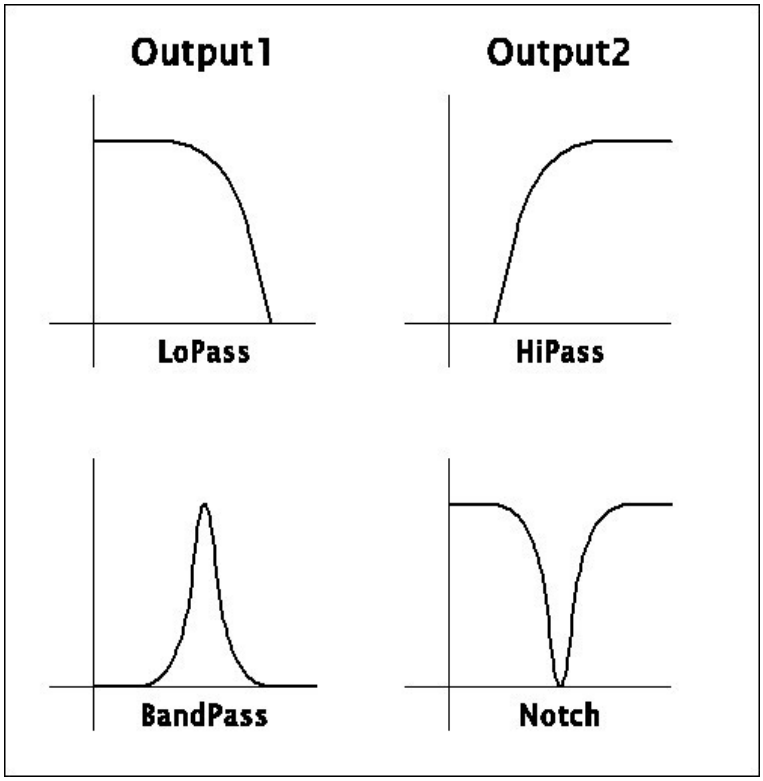
The PRC3A is a 12db/oct State Variable Filter offering Low/Band/High/Notch Outputs with voltage controlled Cutoff (Freq) and Resonance (Q).

The filter features a single audio input and two output sockets - one is switchable between Low & Band-pass while the other goes between High-pass & Notch.

Cutoff Frequency is set by a main dial plus two external CV inputs - one CV input is full range 1V/Oct while the other has a depth control. Resonance also has main dial plus CV modulation with depth control. Note that such filters do not offer self-oscillation resonance, but interesting areas can be achieved through patching – check *otoskope's Sine to Chaos* thread for further details - http://www.muffwiggler.com/forum/viewtopic.php?t=51588

You can 'Ping' the filter by applying a sub-audio signal with abrupt edges (eg. pulse wave) to the input - turn the resonance up to full and adjust the frequency to adjust the pitch of the ringing. To take this even further, try FM'ing the Cutoff with an audio-rate signal.

Note – the 1V/Oct response is only rough – there is no trimmer for fine tuning.



DD1 – Modulator / Low Pass Gate

The DD1 is a dual module providing a Modulator (BalMod) and a Low Pass Gate (LPG) in a compact form. At its most basic, it can be seen as two separate VCA sections, but each has some very different behaviours possible on top.

The Modulator section is built around the AD633 Precision Multiplier chip. The main application is Ring Modulation (RM) where two input signals are combined to generate the sum and difference frequencies. The RM is DC coupled and can also be thought of as a VCA but with the ability to invert the signal under voltage control. For example, feed a VCO signal into one side and then a DC control into the other input - raising the DC control from 0V upwards will give typical VCA response while taking the DC control below 0V will give a VCA response but with the polarity inverted. (eg. Use the CTL2 Joystick to achieve this)

The Amplitude Modulation (AM) mode can be thought of as a little bonus - it does not behave as a true VCA in that it doesn't take the signal down to zero, but gives a very different sound to the RM mode. It can be used for more subtle tremolo effects.

The Low Pass Gate was created by Don Buchla and imparts great effects on audio signals as a combined VC Filter / Amplifier. The key to the LPG is the Vactrol - a variable resistive element, driven by an LED, which changes the intensity of the audio processing. It is the slightly slow response of the Vactrol that gives the audio effects such a natural feel and is the wonderful strength of the module. The LPG can be run in three different modes - VCF, VCA or a middle mode that combines the two.

Try adjusting the depth of modulation to achieve different timbres / responses. A traditional route may be to use the ENV1 to modulate the input, but further variation can be achieved if the Env is mixed with an LFO waveform via the bottom section of the DD2 module.

UTL2 – Output Mix

The UTL2 is a simple three channel mono audio mixer designed primarily to act as the system output stage.

The input channels are DC-coupled and have independent audio-taper level controls, summing the signals before two outputs.

Out1 is a DC-coupled full-amplitude (ie. It does not pass through the Master Level control) mix of inputs on banana, switchable between positive and inverted phases - useful for feeding signals back through the system.

Out2 passes through a master level control before output on Mono 1/4” Jack.

On the rear PCB are two jumpers which affect the Out2 jack output:
The *Atten* jumper selects either full level output or attenuates by a factor of 5 for lower level output, for example when using a sensitive input on an amplifier. Set at full level as standard.
The *Coupling* jumper selects either AC or DC coupling for the Out2 output socket. Set as AC coupled as standard.