

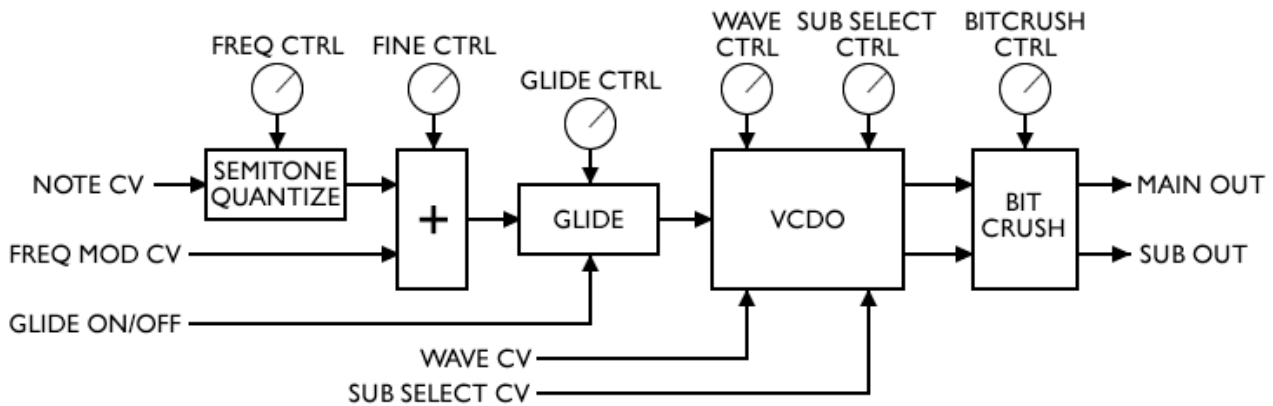
# Electric Druid VCDO



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## Introduction

The VCDO uses a PIC 16F1847 microprocessor to create a versatile and simple voltage-controlled 8-bit digital wavetable oscillator. All oscillator parameters are controlled by 0-5V control voltages. The chip has a native exponential control response, making interfacing with 1V/Oct control voltages very simple, even without an exponential convertor.



The chip contains 20 waveforms, most of which you're unlikely to have seen before. There are six controls (abbreviated to CTRL above), plus four CVs and one digital input to switch glide on and off. Final output frequency is based on the NOTE CV, the FREQ MOD CV and the FREQ CTRL and FINE CTRL, which gives plenty of scope for control.

The WAVE CTRL and WAVE CV scan through the 16 waveforms of the main oscillator's wavetable. The SUB SELECT CTRL and SUB SELECT CV switch between the 32 options for the sub oscillator, 8 waveforms over four octaves. Finally, the oscillator outputs can be modified by the BITCRUSH CTRL which reduces the output resolution from 8-bit to 1-bit.



## Features

### Exponential frequency response with no exponential convertor

The Note CV input accepts 0-5V control voltages to cover the MIDI note range 0-63. The highest note the VCDO can produce is Note 120, 8372Hz.

### 10 octave note range from 8.18Hz to 8372Hz

The basic frequency range of the VCDO is ten octaves from MIDI Note 0 to MIDI Note 120. The NOTE CV input is quantized to semitones, but the FREQ MOD CV input is not.

### Main Oscillator with 16 waveforms arranged as a wavetable

The chip can produce 16 output waveforms. Rather than switch from one to another, the oscillator is able to crossfade from one to the next, creating a wavetable which you can scan through under voltage control.

It would have been easy to include standard waveforms like ramps and triangles, but there are many oscillators that produce those. This oscillator has its own character and provides something different.

### Sub Oscillator with 8 waveforms at four octaves

As well as the main oscillator, there is also a sub oscillator with 8 waveforms. Each waveform can be selected at one of four octaves, either +1 octave (above the main osc pitch!), in unison, -1 octave, or -2 octaves.

### Bitcrushing effect

The BITCRUSH CONTROL input controls the sample bit resolution of the output. This can be reduced from 8-bit down to 1-bit in eight steps.

### Glide/Portamento

The chip also includes a glide/portamento effect, without requiring an external lag processor for the control voltage. Glide times range from 12ms/octave to 2.4secs/octave. Turning the GLIDE CTRL to minimum switches the glide effect off.

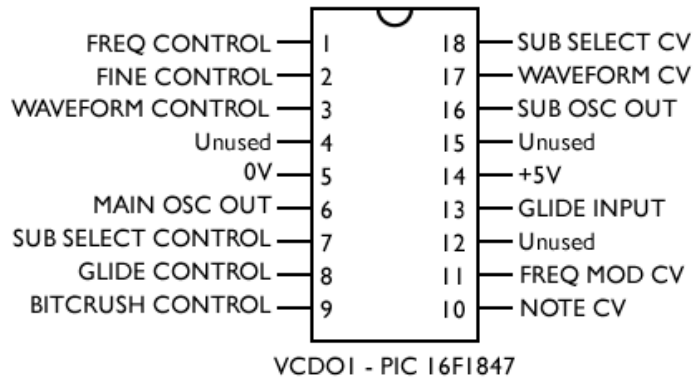
### 8-bit, 62.5KHz sample output rate

The internal waveforms and calculations are 8-bit, and new samples are output via the on-chip PWM modules at 62.5KHz. The PWM modules' outputs are at 125KHz. The fact that this is higher than the sample rate allows more effective PWM filtering to be applied. The two-stage 24dB Bessel filter provides the best-possible pulse filtering.

### Easy interfacing to control voltage mixers

The inputs intended for control voltages have an inverted response to make it simple to interface them with an inverting mixer. This is shown in the application circuits.

## Pinout Diagram



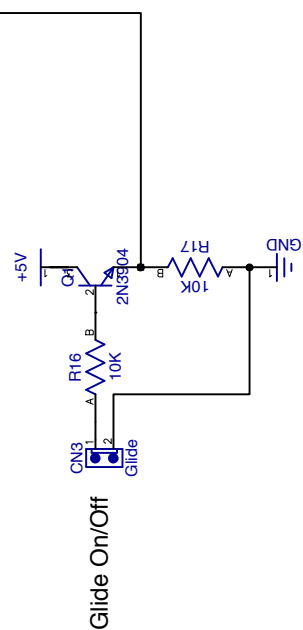
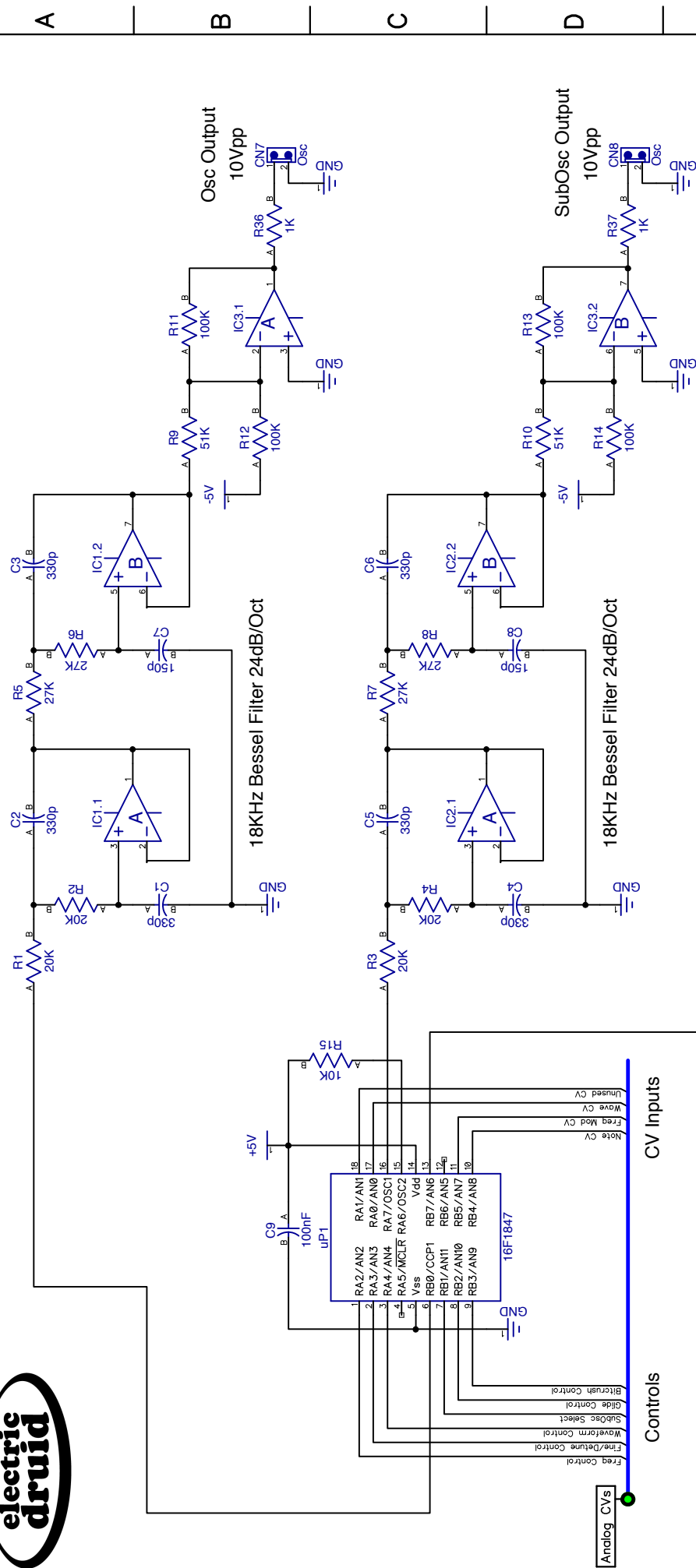
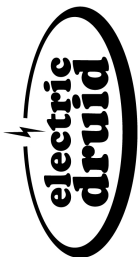
Pin	Function	Details	Notes
1	FREQ CONTROL	0-5V analogue input	Alters frequency in semitones over 4 octaves
2	FINE CONTROL	0-5V analogue input	Fine tunes frequency, +/-100 cents
3	WAVEFORM CONTROL	0-5V analogue input	Scans continuously through main oscillator waveforms
4	Unused	0-5V digital input	
5	0V	Power supply	
6	MAIN OSC OUT	0-5V digital output	Main Oscillator PWM output at 125KHz
7	SUB SELECT CONTROL	0-5V analogue input	Selects one of 32 sub oscillator waveforms. Each of 8 waveforms can be selected at four octaves.
8	GLIDE CONTROL	0-5V analogue input	Portamento times range from 12ms/octave to 2.4secs/octave. The lowest settings turn the glide off.
9	BITCRUSH CONTROL	0-5V analogue input	3 bit, values from 1 to 8 Controls bit resolution of the output
10	NOTE CV	0-5V analogue input	0-5V gives MIDI notes from 0-63
11	FREQ MOD CV	0-5V analogue input	Alters frequency +/-8 semitones
12	Unused	0-5V analogue input	
13	GLIDE INPUT	0-5V digital input	Switches glide on and off
14	+5V	Power supply	
15	Unused	0-5V digital IO	
16	SUB OSC OUT	0-5V digital output	Sub Oscillator PWM output at 125KHz
17	WAVEFORM CV	0-5V analogue input	Scans through main oscillator waveforms under CV control.
18	SUB SELECT CV	0-5V analogue input	Jumps through sub osc options under CV control



## Application Notes

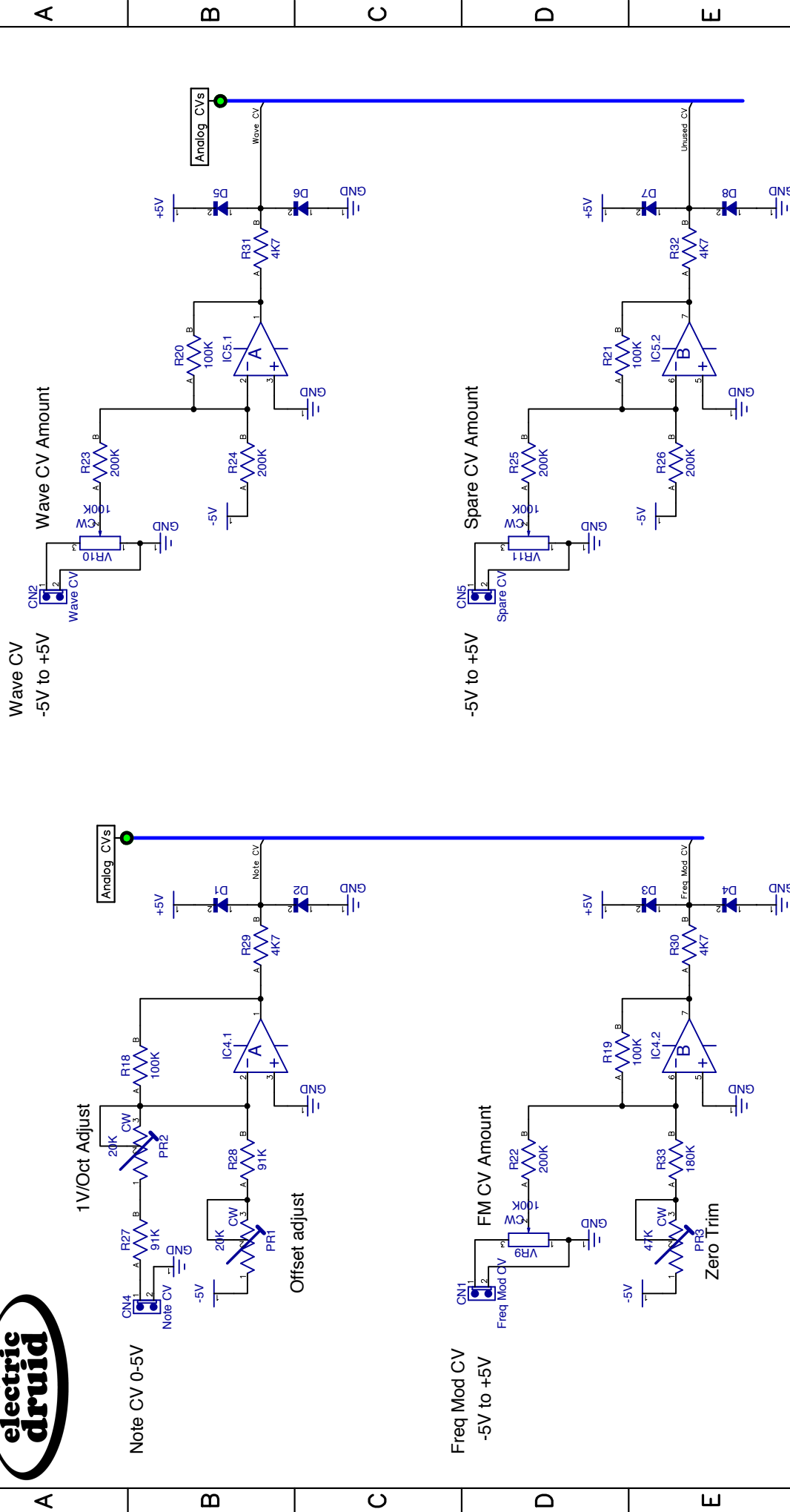
### Modular synth VCDO

A full circuit diagram for a comprehensive 1V/Oct voltage-controlled wavetable oscillator follows on the next three pages.



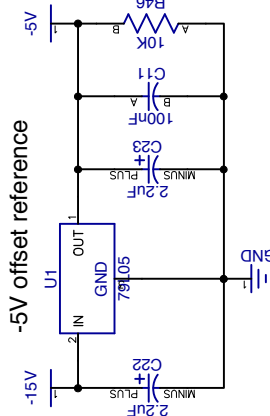
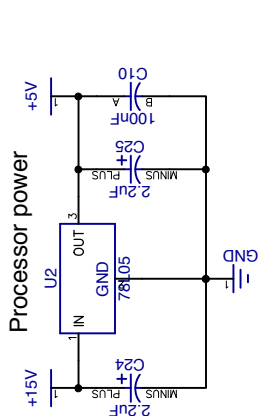
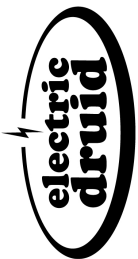
(Note that Glide On/Off socket should be normalised to +5V)

Title PIC and output filters		Rev 3
Size A4	Model 1847 VCDO	
Date 31 May 2012	Drawn by TMW	
Filename VCDO.dch	Sheet 1 of 3	

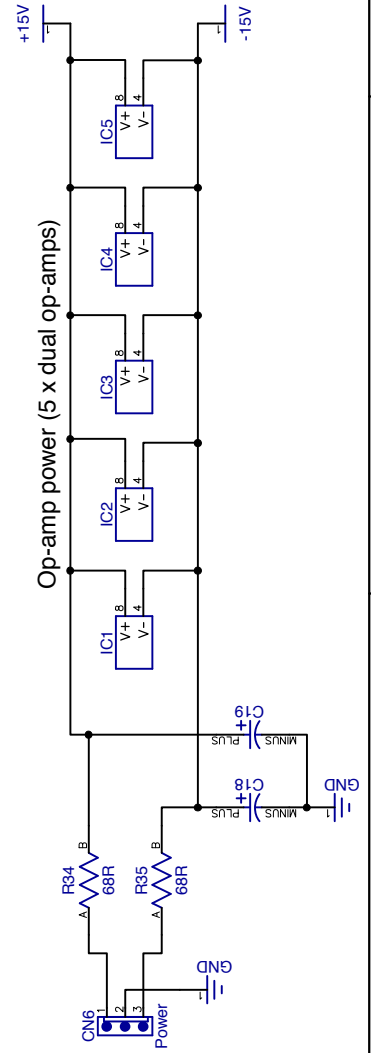


4K7s protect ADC against overvoltage  
 Optional Schottky diodes (BAT54S for SMD)

Title		CV inputs	
Size	Model	Rev	3
A4	1847 VCDO		
Date	31 May 2012	Drawn by	TMW
Filename	VCDO.dch	Sheet	2 of 3

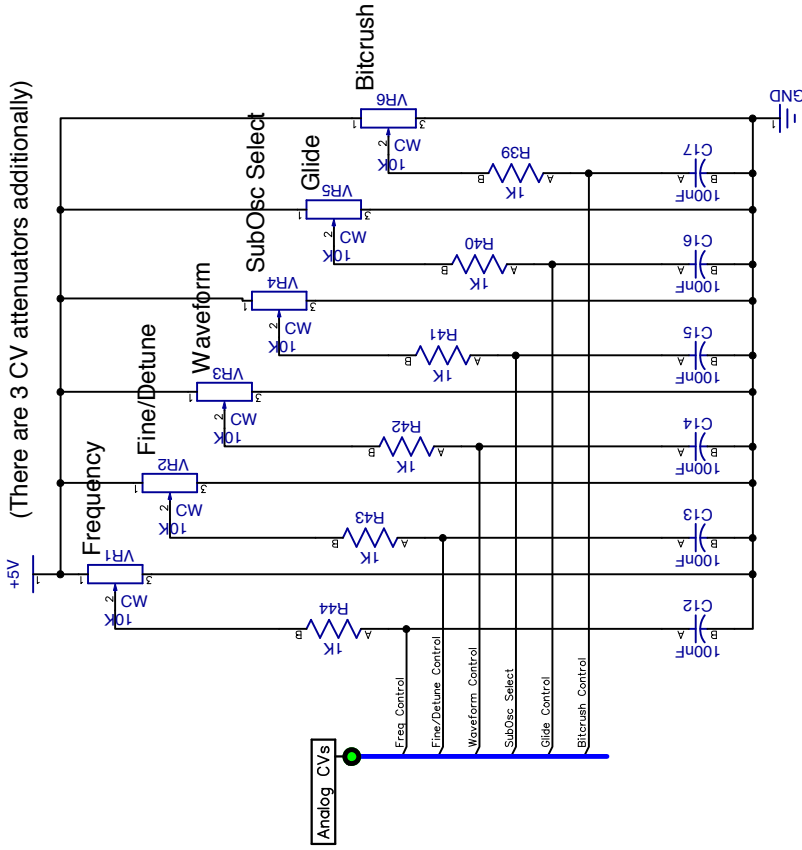


10K is Optional. Some regulators require significant load.



Main panel controls

(There are 3 CV attenuators additionally)



Title Control knobs and Power supply

Size	Model	Rev
A4	1847 VCDO	3
Date	31 May 2012	Drawn by TMW
Filename	VCDO.dch	Sheet 3 of 3



## Disabling unwanted controls or CV inputs

The table below suggests how to disable each input if it is not required

Pin	Function	Details
1	FREQ CONTROL	Any voltage between 0V and 5V will do
2	FINE CONTROL	Use two 10Ks between 5V and 0V to give 2.5V at the pin
3	WAVEFORM CONTROL	Any voltage between 0V and 5V will do
7	SUB SELECT CONTROL	Any voltage between 0V and 5V will do
8	GLIDE CONTROL	Tie input to 0V with 10K to disable glide
9	BITCRUSH CONTROL	Tie input to 5V with 10K to give 8-bit resolution.
10	NOTE CV	Any voltage between 0V and 5V will do
11	FREQ MOD CV	Use two 10Ks between 5V and 0V to give 2.5V at the pin
13	GLIDE INPUT	Tie input to 0V with 10K to disable glide, or tie input to +5V with 10K to allow Glide control to operate
17	WAVEFORM CV	Tie input to 0V with 10K for no CV
18	SUB SELECT CV	Tie input to 0V with 10K for no CV

## Calibration of the application circuit

There are three trimmers in the application circuit. They should be set up as follows:

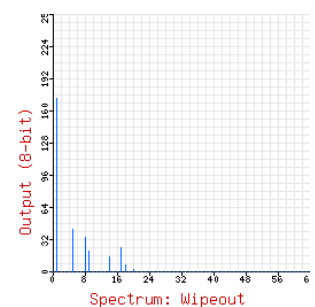
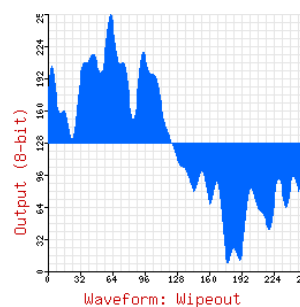
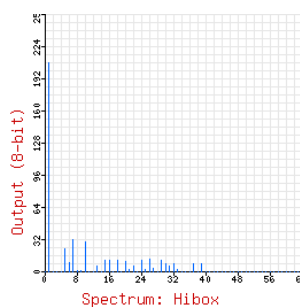
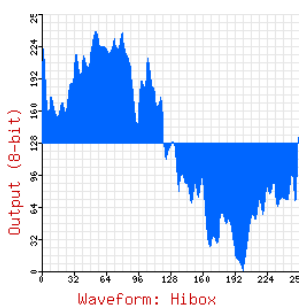
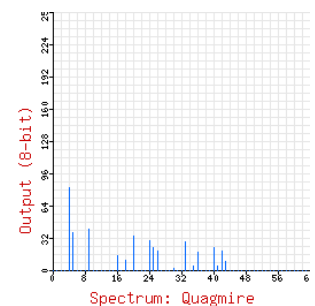
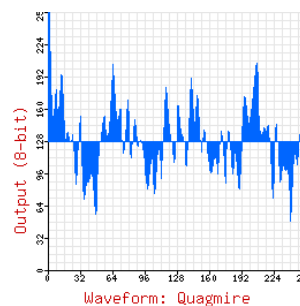
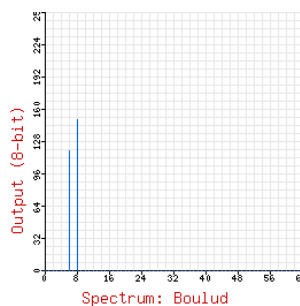
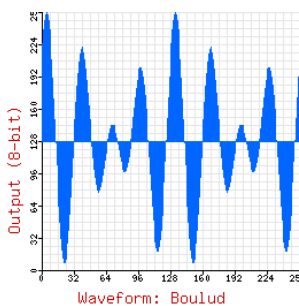
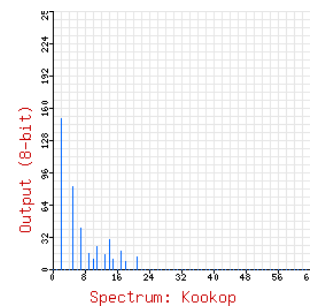
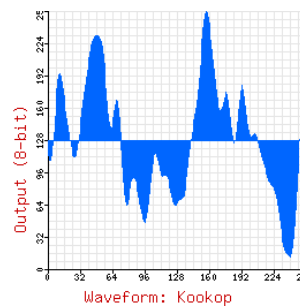
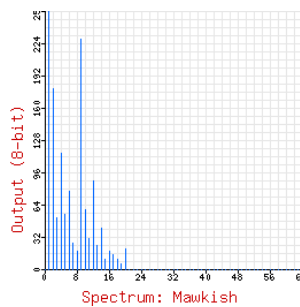
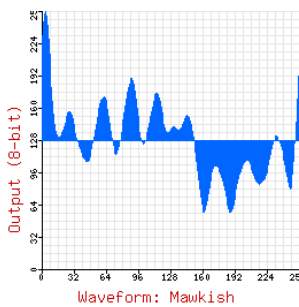
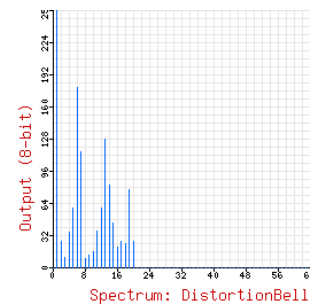
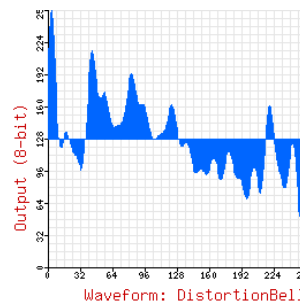
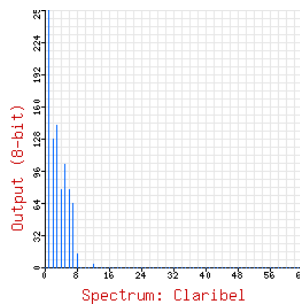
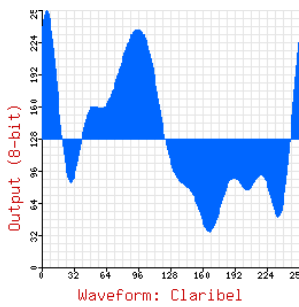
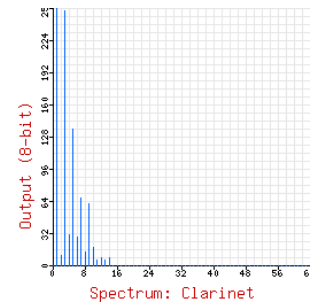
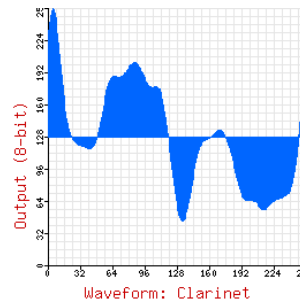
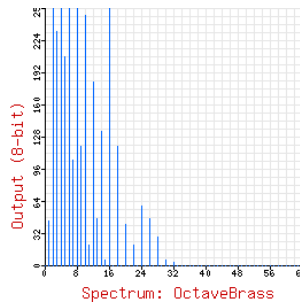
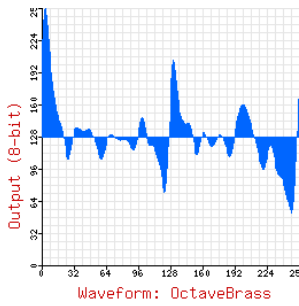
Firstly, centre the Frequency Control and the Fine Control, since these affect the tuning. The position you set now will become the “zero” position for these knobs.

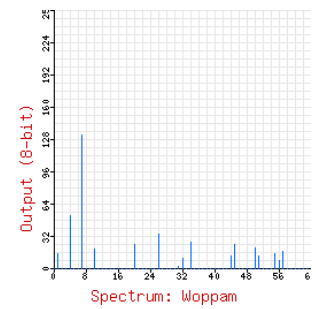
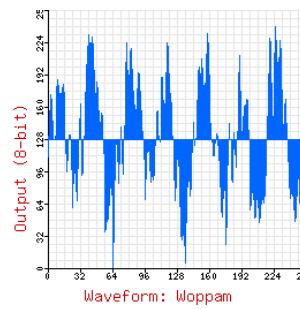
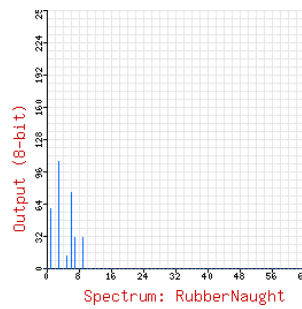
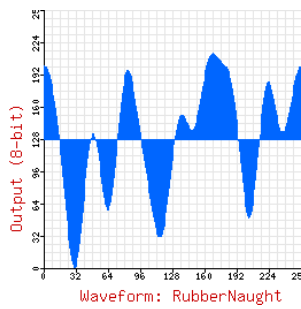
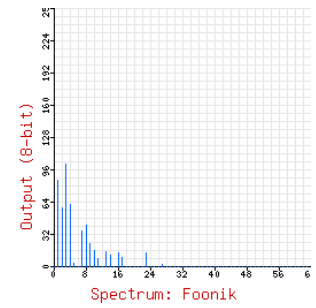
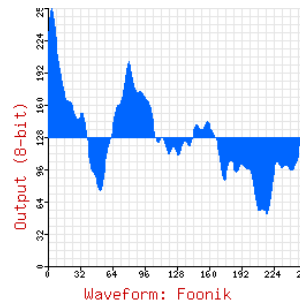
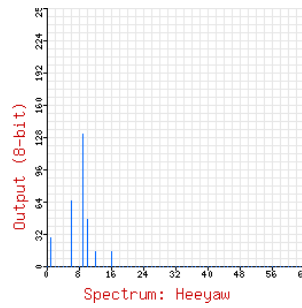
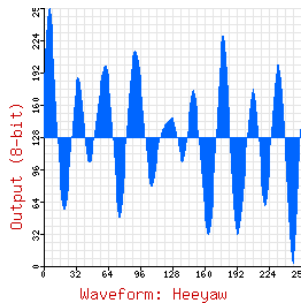
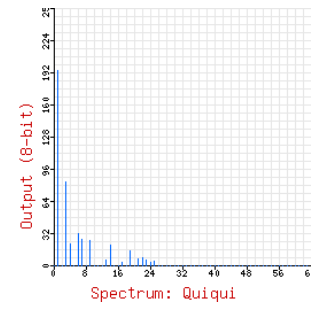
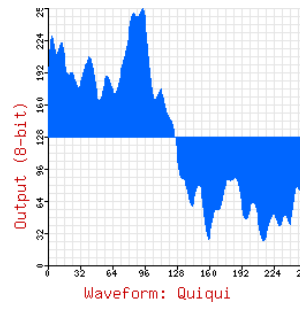
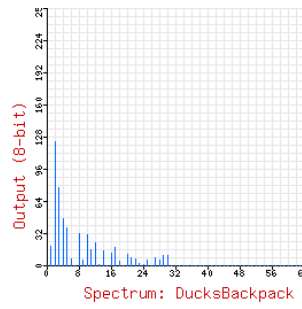
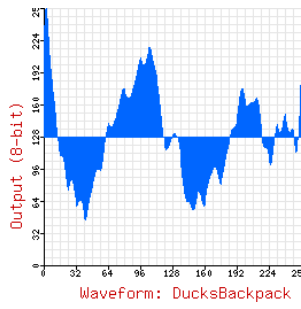
Plug a source of IV/Oct control voltages (an analogue synth or MIDI-to-CV convertor) into the NOTE CV input and adjust PR2 until an octave on the keyboard gives an octave from the oscillator. Don't worry about the pitch being wrong (C plays a D, for example). This control alters the octave range, so it's fine if pressing C0 then C1 plays D1 to D2, since both are an octave.

The offset adjust trimmer PR1 should be adjusted to give +5V at pin1 of IC4 with the NOTE CV input grounded, but the exact value is not crucial, since the voltage is quantized to semitones. If you find the oscillator is “skipping” between notes, tweak PR1 until it stops.

Next, adjust PR3, the FREQ MOD CV Zero Trim. With the FM CV Amount control turned down to zero, PR3 should be adjusted to give 2.5V at pin 7 of IC4. Alternatively, plug the oscillator output into an electronic tuner and adjust PR3 until the notes are well tuned. If the Fine control is set to the centre zero position, this *should* give 2.5V as before!

# Main oscillator waveforms





## Sub oscillator waveforms

