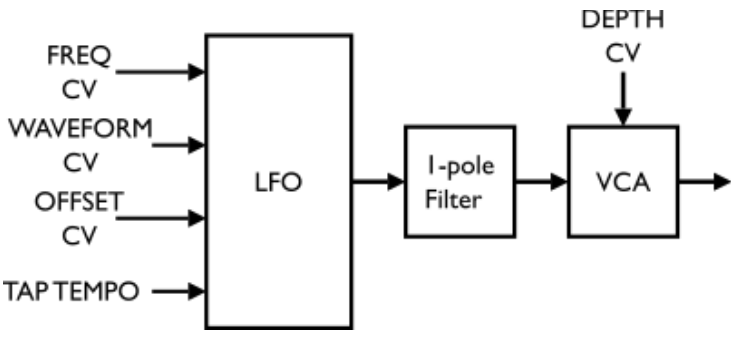
Electric Druid STOMPLFO

Introduction

This new voltage-controlled low frequency oscillator is designed for stompbox and effect pedal designs. It aims to pack many powerful features into an 8-pin chip to allow you to easily add a lot of sophistication to a simple circuit design.

The standard two op-amp stompbox LFO provides triangle and square waveforms. Often only the triangle is used. This is hardly a hugely versatile LFO! The Druid STOMPLFO is intended to replace that design with something that offers much more, without adding a lot of extra parts or complexity.



The STOMPLFO chip can produce eight waveforms, including two random waves. The basic LFO frequency is controlled by FREQ CV.

The WAVEFORM CV selects one of the 8 waveforms. The polarity of the output can be adjusted with the OFFSET CV.

The output from the LFO is fed to the wave smoothing filter, which is handy for reducing clicks if the LFO is used to modulate sensitive audio circuits like VCAs. Finally, the DEPTH CV sets the output level.

Features

Tap Tempo

The TAP TEMPO input allows you to use a 0-5V pulse signal or a simple SPST switch to set the frequency of the LFO. If the frequency has been set by the TAP TEMPO input, the Frequency CV will be ignored until it changes. The Tap Tempo feature simply times the interval between two negative edges on the input and uses the result to set the LFO frequency.

LFO frequency from 0.05Hz to 25Hz

The LFO can cover nine octaves. from 0.05Hz to 25.6Hz. This means waveforms can take anywhere from 20 seconds to 40 milliseconds to complete, and the LFO can generate tempos from 3BPM to 1500BPM!

Logarithmic control response over 1:512 range

The Frequency CV covers the full range in nine even octaves. The fact that this input is exponential means the FREQ CV input can use linear pots and still have a musical feel.

Eight output waveforms, including two random waves

The chip can produce eight output waveforms, shown below. These are selected by the voltage on Pin 6 (WAVEFORM CV).

Some of the most exciting additions are the random waveforms. The Random Levels waveform is the classic "Sample & Hold" effect from analog synthesis and can produce early Sci-fi "computer thinking" noises amongst others.

The Random Slopes waveform moves linearly between random points chosen at the LFO rate. Sometimes the points will be far apart and the output will move fairly quickly, other times they're closer together and it moves only very slowly. The waveform is great in any situation where you might have used a triangle wave, but where some more unpredictability is a benefit, such as BBD modulation for chorus and flangers, phase shifters, or filter modulation.

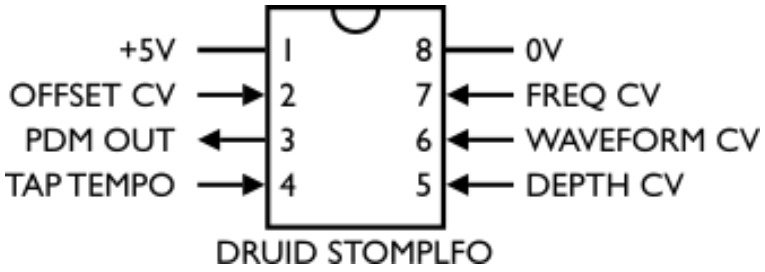
16-bit waves and 12-bit LFO output resolution

The STOMPLFO chip uses 16-bit wave data with interpolation to give the smoothest possible result. Similarly, intermediate calculations are done at 16-bit accuracy. The final PDM output is 12-bit.

31.25KHz sample output rate, with 2MHz PDM output

The sample rate is 31.25KHz, a big increase on the 19.5KHz of the previous generation Electric Druid chips. The output is produced using Pulse Density Modulation at a rate of 2MHz. This reduces noise compared with the PWM output on earlier Druid chips and allows very simple filters to produce a smooth analogue output.

Pinout Diagram



Pin	Function	Details	Notes
1	+5V	Power supply	
2	OFFSET CV	0-5V analogue input	Adds an offset to shift the whole LFO output up or down. Only effective when DEPTH CV is less than maximum.
3	PDM OUTPUT	0-5V digital output	PDM output at 2MHz, 31.25KHz sample rate
4	TAP TEMPO	0-5V digital input	Sets basic tempo of LFO. Note that this input expects to be shorted to ground. See application notes for details.
5	DEPTH CV	0-5V analogue input	Controls overall output level 0-100%
6	WAVEFORM CV	0-5V analogue input	Selects waveform 0 to 7
7	FREQ CV	0-5V analogue input	0.05 Hz to 25 Hz for LFO
8	0V	Power supply	

Application Notes

Unused pins

The chip is simple to use. However, some of the pins cannot be left floating, so if a particular function is not required, the pin should connected as shown below.

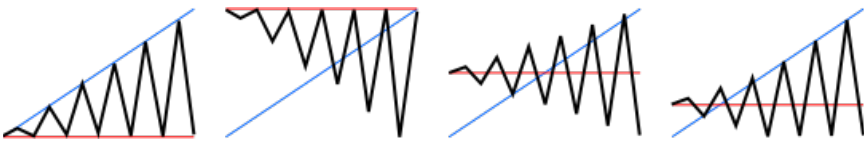
Function	Pin	If not required	Connect
Offset CV	2	Can be either max or minimum.	10K to +5V or 10K to Gnd
Tap Tempo	4	Can be left unconnected	
Level CV	5	Should be left at max level	10K to +5V
Waveform CV	6	Fix at required voltage for given waveform	Example: 10K trimmer between 0V and +5V
Frequency CV	7	Fix at required voltage for given frequency	Example: 10K trimmer between 0V and +5V

Wave smoothing

Sometimes when using the LFO output to drive a VCA or similar sensitive audio circuit, the sharp edges of some waveforms can cause clicks in processed audio due to CV feedthrough. The wave smoothing feature applies the exact digital equivalent of a simple RC lowpass before the wave leaves the chip to help prevent clicks in VCAs, VCFs, optical tremolos, and similar vactrol-controlled circuits. The filter has a cutoff frequency of around 1KHz, and this gives a rise time on sharp edges of about 10 msecs. Note that since the smoothing is a lowpass filter, the highest frequency waves produced by the chip will be affected most.

Unipolar / Bipolar output using Offset CV

The Offset CV and Depth CV interact in an interesting way to allow the chip to produce bipolar or unipolar waveforms of either polarity. Furthermore, in between these extremes, it responds sensibly to increasing depth, making it easy to set up for a given situation.



The diagram above shows the output for a Triangle wave with 0-5V Depth CV (in blue) and various Offset CVs (in red). The graphs show 0V Offset, unipolar positive "bottom up" depth control, 5V Offset unipolar negative "top down" depth control, 2.5V Offset bipolar "middle outwards" depth control,and finally 1.25V, which starts off bipolar until the output runs out of range, and then increases in a unipolar fashion. This allows full depth control without ever going beyond the lower (or upper) limit. This is really useful for filter effects or volume effects like Tremolo.

Example circuit: Single Supply LFO for effects/stompbox use

The example circuit on the next page shows an LFO that can be added to 9V effects/stompbox circuits. It can replace a simple LFO in many designs (chorus, flangers, phasers, and tremolos, for example) and will provide many more options and sounds.

There are two options presented for the output filtering - either an active filter which includes biasing to centre the LFO output around the midpoint voltage, or a super-simple passive filter which provides a 0-5V output with minimum components.

Also shown as an option is an "external sync" circuit connected to the Tap Tempo button. This allows the LFO to be synchronised to an external clock signal. The circuit provides protection against negative voltages and signals up to 20V or so.

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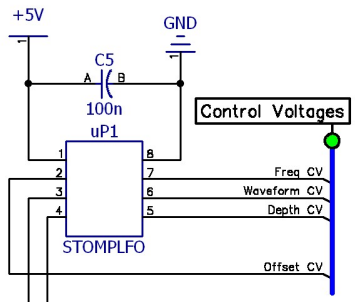
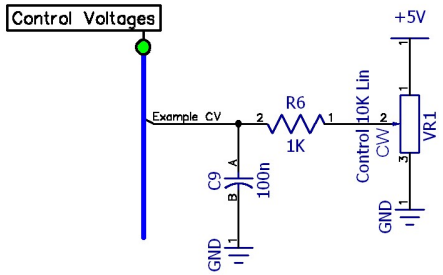
Single Supply Tap Tempo LFO for stompboxes



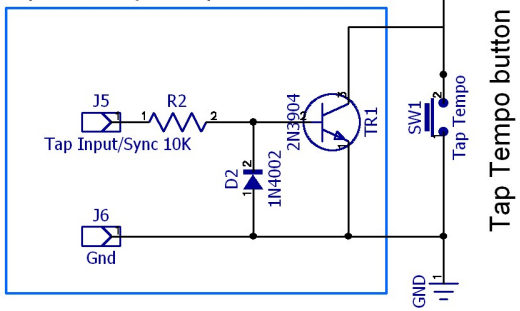
Example pot control circuit:
repeat as required



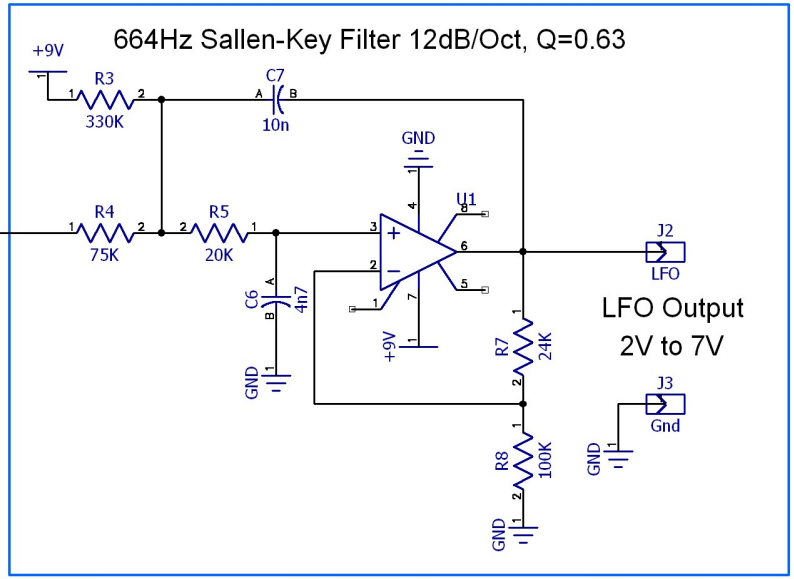
Up to four controls available:
Freq, Waveform, Depth, Offset

PDM Output

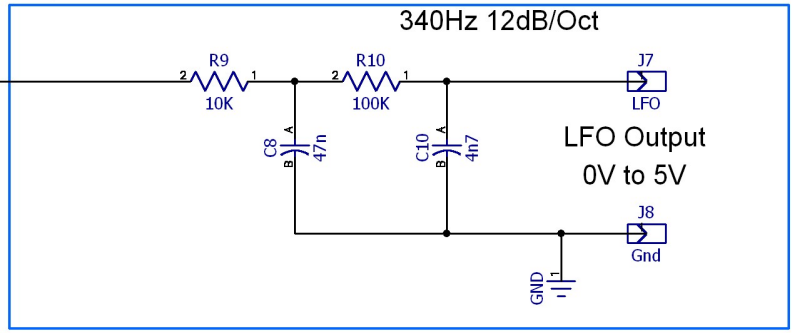
Optional Sync Input



Option One: Active filter with offset

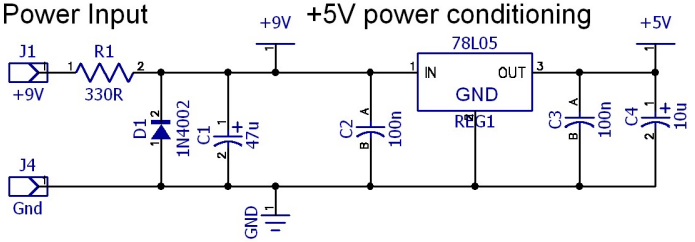


Option Two: Passive filter



Power Input

+5V power conditioning



Adjust R1/C1 filter values to taste!

Title	Single Supply Stompbox LFO		
Size A4	Model STOMPLFO		Rev 1
Date	20 Feb 2018	Drawn by	TMW
File SingleSupplySTOMPLFO.dch		Sheet	1 of 1