

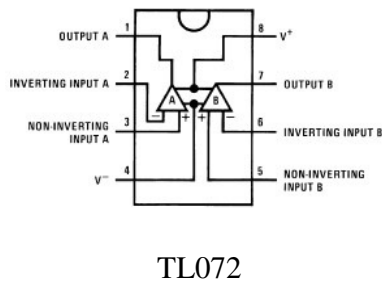
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Manual for the Tap Tremolo Rev. 3C

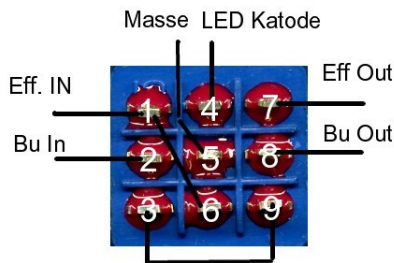
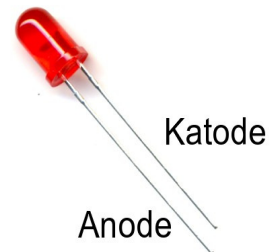
Based on TAPLFO from Tom Wiltshire (www.electricdruid.com)

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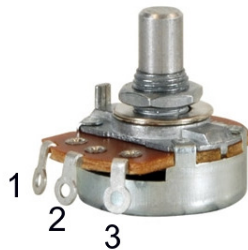
Basics of components



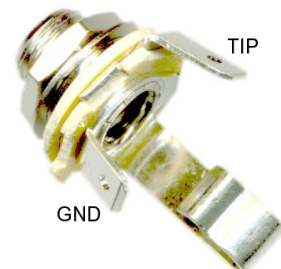
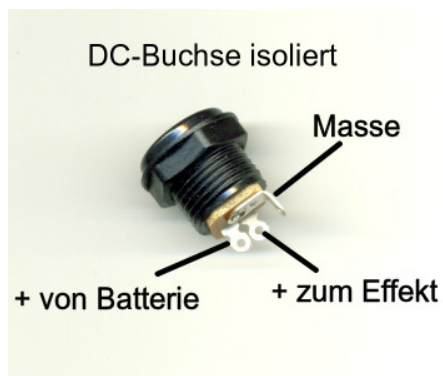
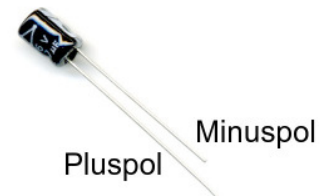
Leuchtdiode (LED)



Standard Potentiometer

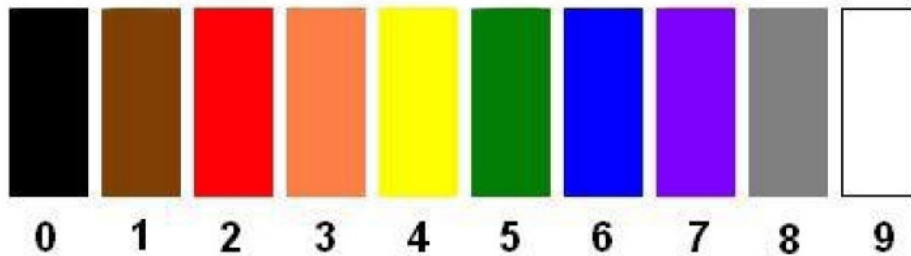


Elektrolytkondensator



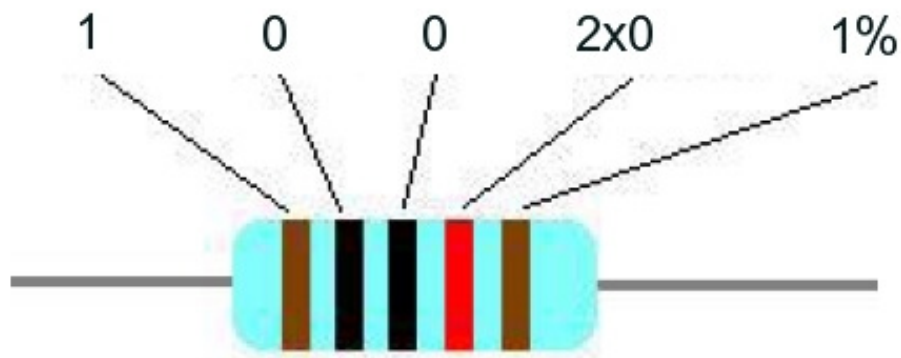
Color table for resistors MF207 FTE52 1% and a example

Resistor color code

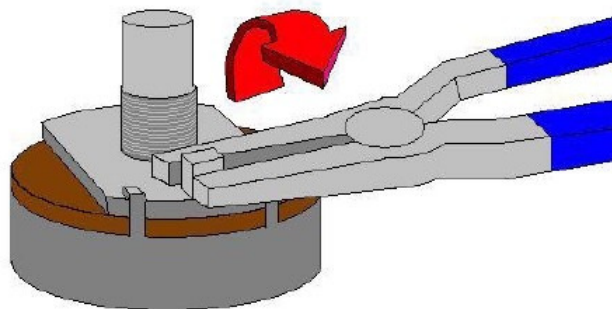


Example: Resistor MF207 10K 1%

Value: 10000 Ohm = 10KOhm



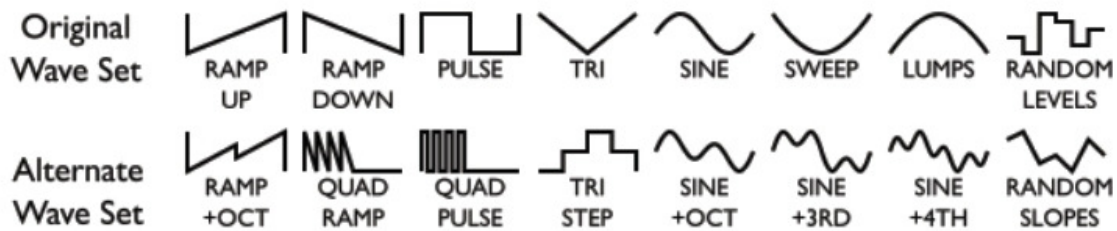
Breaking nose at the potentiometer
Nase am Poti mit einer Flachzange abbrechen



Short Circuit description

The TAP LFO Circuit makes 16 Waveforms for the modulation, which are adjusted with the control waveform and choose with the switch wave set.

1. Ramp up
2. Ramp down
3. Pulse (rectangle)
4. Triangle
5. Sine
6. Hypertriangle (the top is a triangle, the bottom a sine)
7. Inverted hypertriangle (the top is a sine, the bottom a triangle)
8. Random steps



Function of the pot:

Depth: Deep of the modulation

Tempo: Frequency of the modulation frequency approx. (0.025Hz bis 50Hz)

Mutipler: once you tap in a tempo using the tap switch, the mutipler pot selects what division of time is used for trem. For example, you can tap on a quarter notes, then use the mutipler pot to change the speed of the tremolo from half notes, quarter notes, triplet notes, eighth notes, triplet eighth notes, or sixteenth notes. Using the sixteenth note mutipler allows you to get much faster speeds than it's possible to tap, while still allowing tap tempo control.

Multiplier	Musical symbol	Note name
0.5		1/2 note, minim
1		1/4 note, crotchet
1.5		Triplet 1/4 note, triplet crotchet
2		1/8 th note, quaver
3		Triplet 1/8 th note, triplet quaver
4		1/16 th note, semiquaver

There is further information on the side of Tom Wiltshire.

<http://www.electricdruid.com/index.php?page=projects.taplfo>

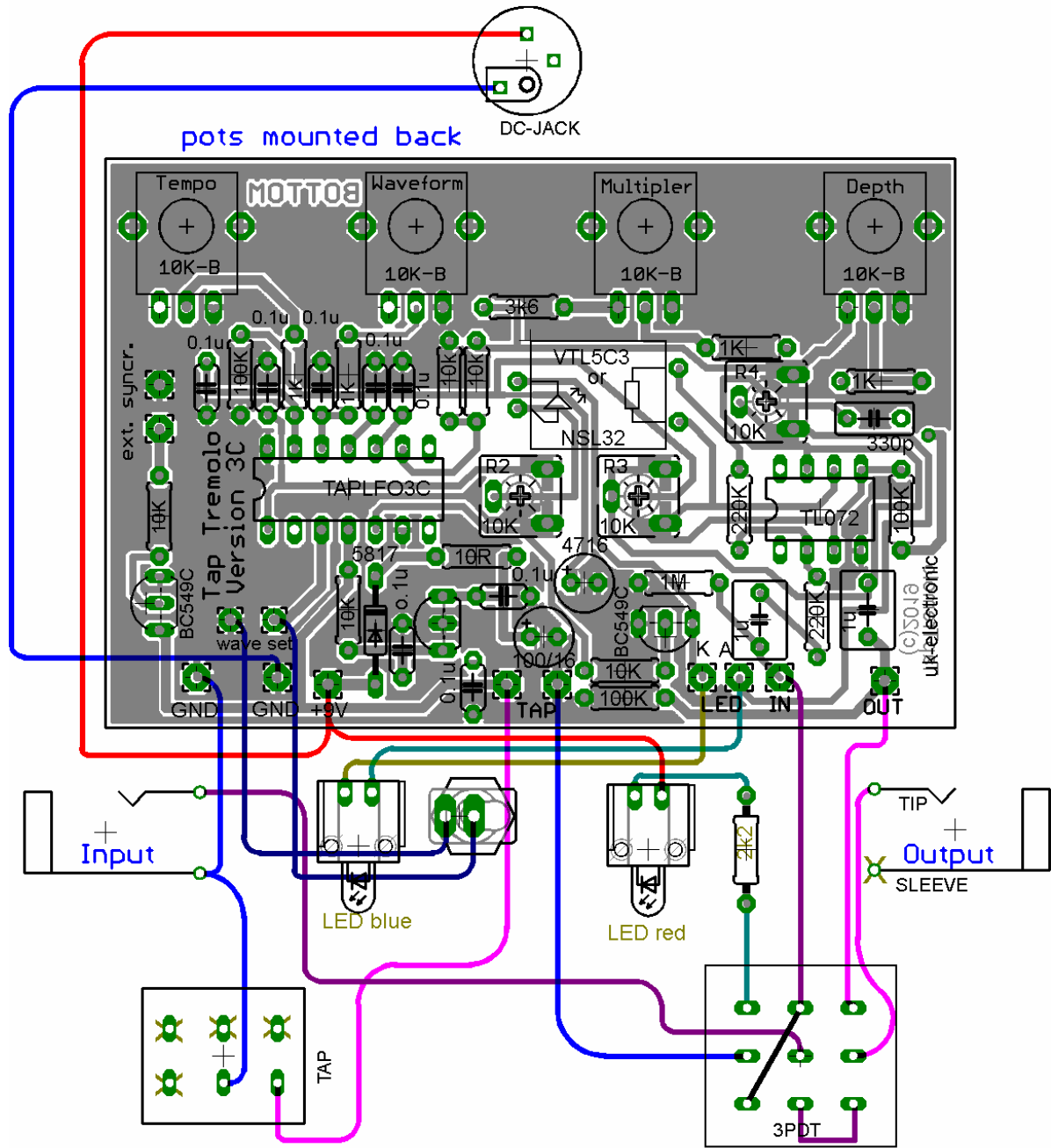
The PCB was executed to achieve as little as possible external wiring compact as a double-sided through-hole.

Bill of material

Quantity	Description
2	Mono jack ¼"
1	3PDT Switch
1	SPST momentary switch (Tap Tempo)
1	SPST Toggle switch MS243LC
2	LED bezel 3mm + LED 3mm red and blue
4	Potentiometer 10K-B, or 25K-B or 50K-B (linear)
1	DC-jack isolated
1	Pre-programmed PICTAPLFO Ver.3C
1	IC TL072
1	socket LC14
1	socket LC8
1	Optocoupler NSL32 or VTL5C3 (Depending what it availability!)
1	78L05
2	BC549C
1	1N5817
Resistors	
1	Resistor 10R (brown/black/black/gold/brown/(red))
5	Resistor 1K (brown/black/black/brown/brown)
1	Resistor 2K2 (red/red/black/brown/brown)
1	Resistor 3K6 (orange/blue/black/brown/brown)
5	Resistor 10K (brown/black/black/red/brown)
3	Resistor 100K (brown/red/black/orange/brown)
2	Resistor 220K (red/red/black/orange/brown)
1	Resistor 1M (brown/black/black/yellow/brown)
3	Trimpot 10K CA6V
Capacitors	
9	Multilayer cap 100nF= 0.1µF= 104
1	FKP2 330pF
2	MLCC 1µF
1	RASM 47µF/16V
1	RASM 100µF/16V

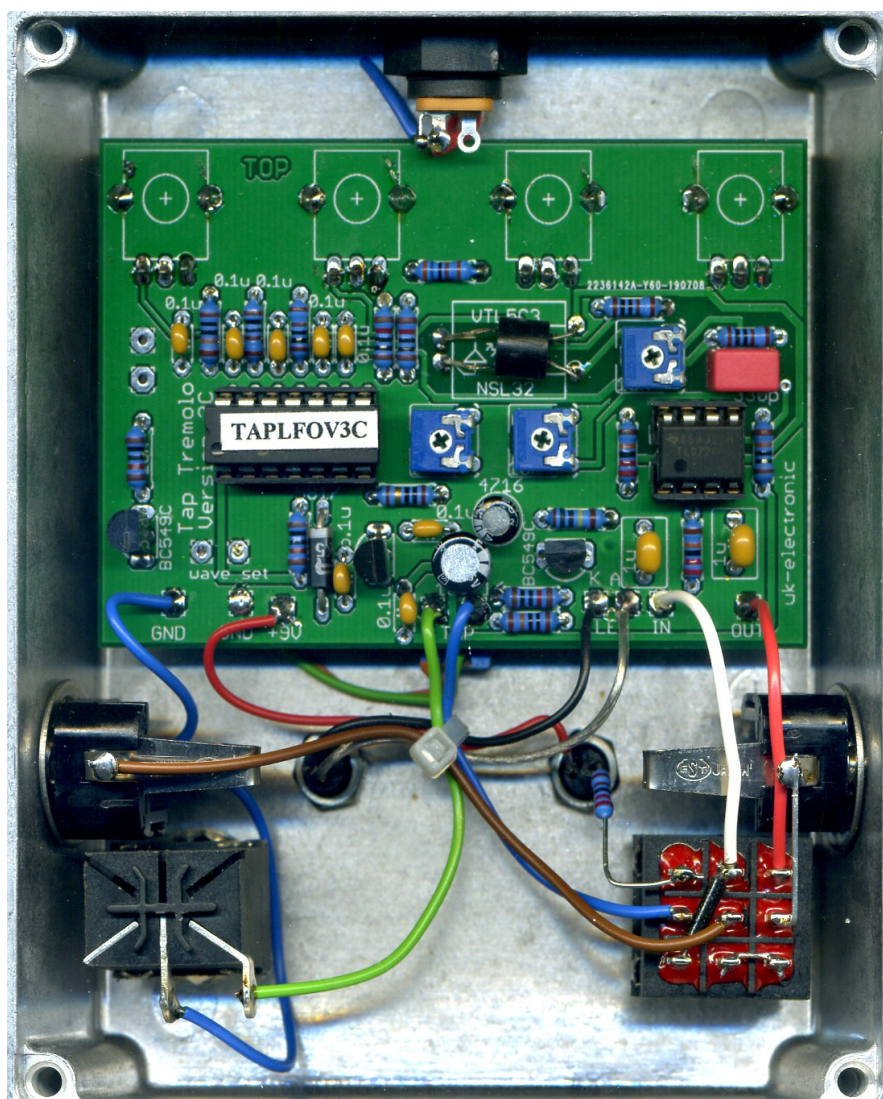
Wiring

The wiring according to the below wiring diagram after the PCB is fully soldering. You should make the wiring in the enclosure before. Thus, you need then to conclude the intended to connect the wires only points of the circuit board. The wiring is shown as it takes place in the enclosure.



Previously, however should the predrilled enclosure with all passive components (switches, jacks, sockets for the LED's be fitted. The two LED's (speed and ON) is shortened and extended with 2 wires and insulated with a little fabric hose against the metal shaft of the led bezel. It remembers which wire is the anode or cathode, or in case of doubt, you must swap the two wires to the circuit board at any function. **The DC power Jack will mounting after the PCB is installed!**

Wiring at the enclosure



The circuit board in the enclosure is fastened through the nuts of the 4 potentiometer with the enclosure.

For building an enclosure should be e.g. GEH090 (equivalent to a 1590BB) be used.

Who drilled his enclosure itself should use the following diameter.

Potentiometer : 7.5 or 8mm

Audio jacks : 9.3mm

3PDT-Switch/ SPST momentary switch: 12mm

SPSt Toggle: 5mm

DC-jack: 12mm

LED bezel: 6mm

Function of the trimpots TR1 to TR3.

TR1= Set the brightness of the led to indicated the modulation frequency

TR2= Set the gain of the circuit (Level between Original –und Effectsignal)

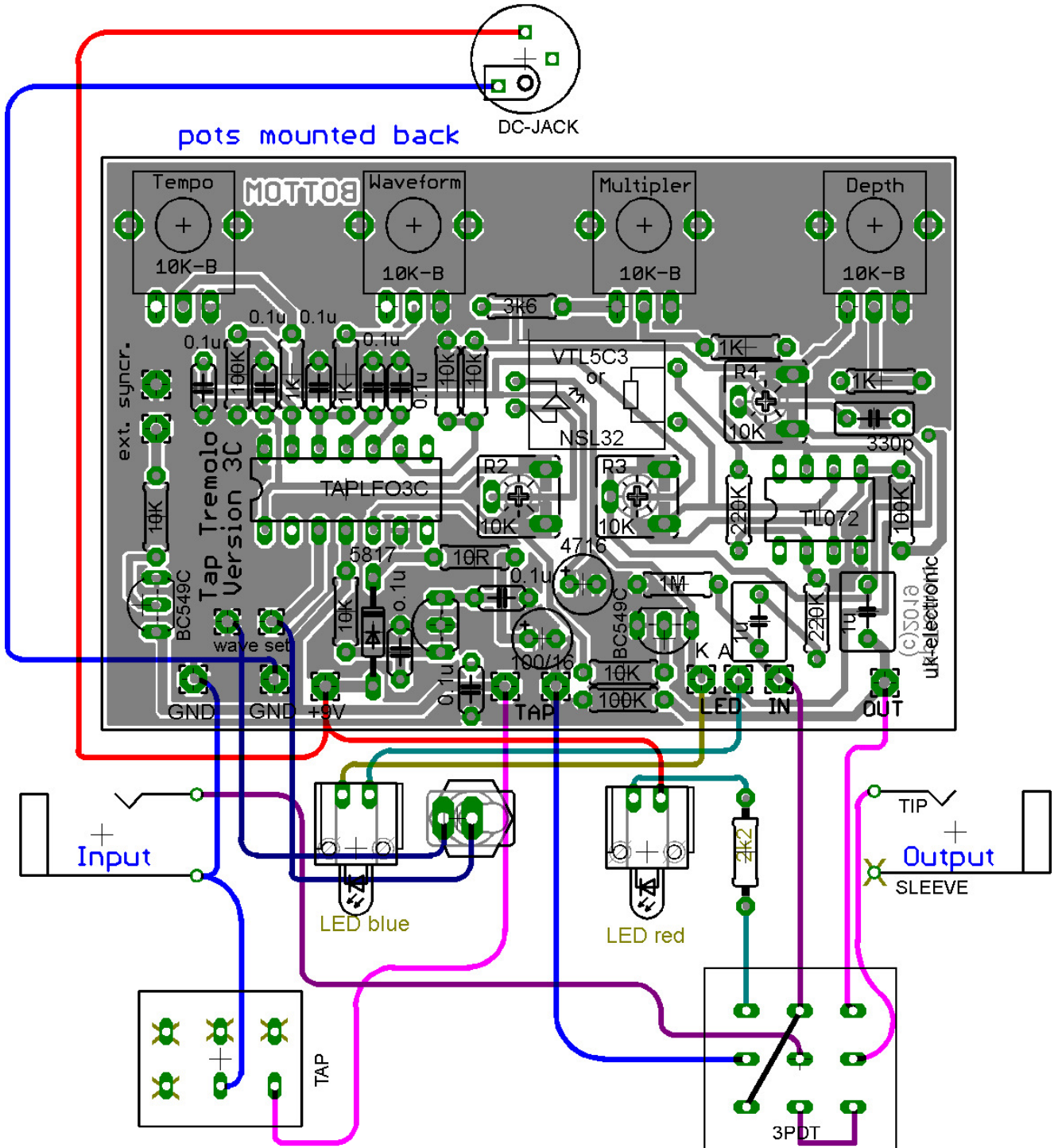
TR3= set the brightness of the led at the optocoupler. This made the deep from the modulation.

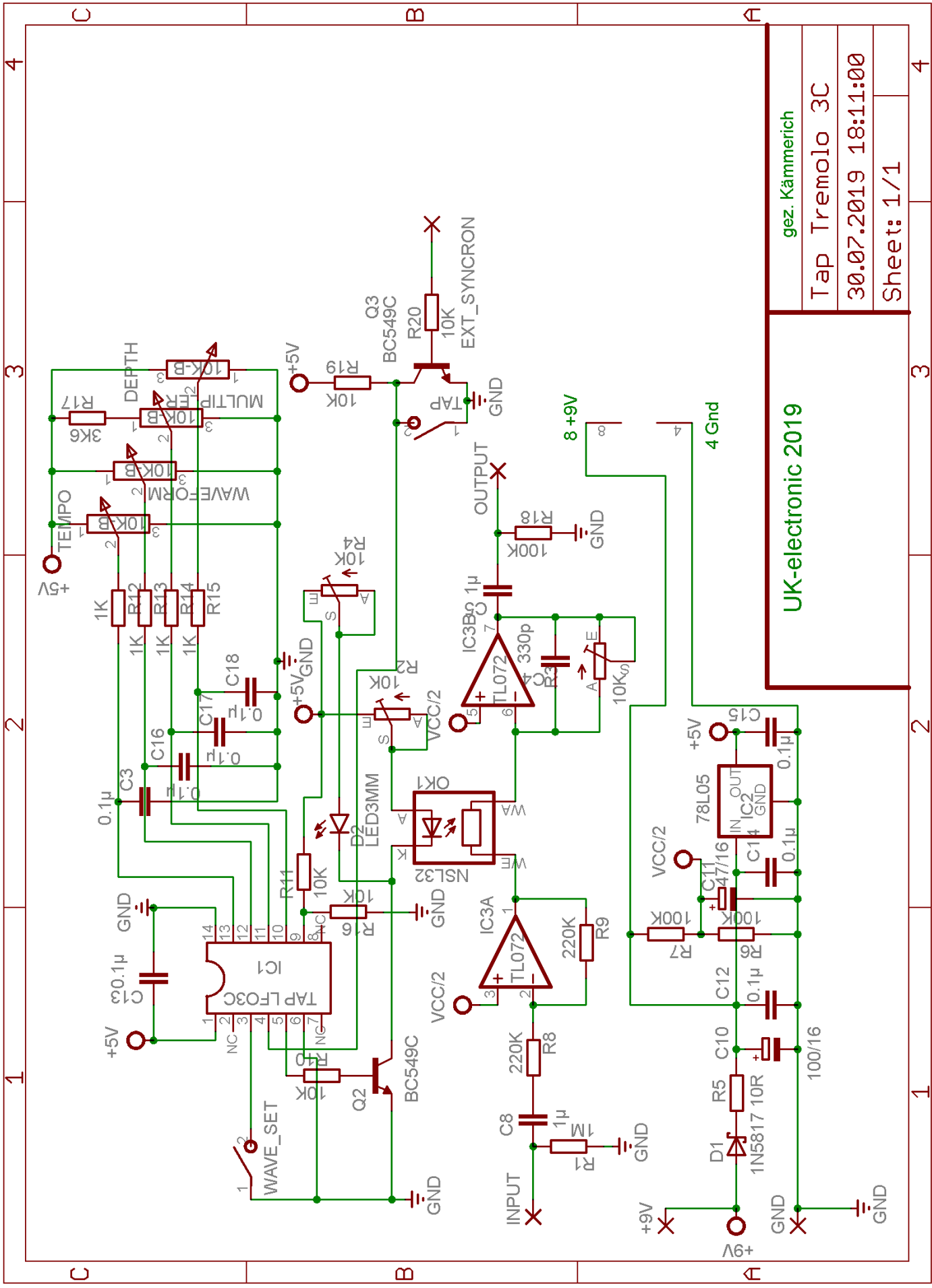
With clean design, the device should work immediately. For any questions, we are of course available.

Assembly, wiring, and wiring diagram are in the appendix to the print available!

Credits to, Tom Wiltshire (www.electricdruid.com) and Chris Safi.





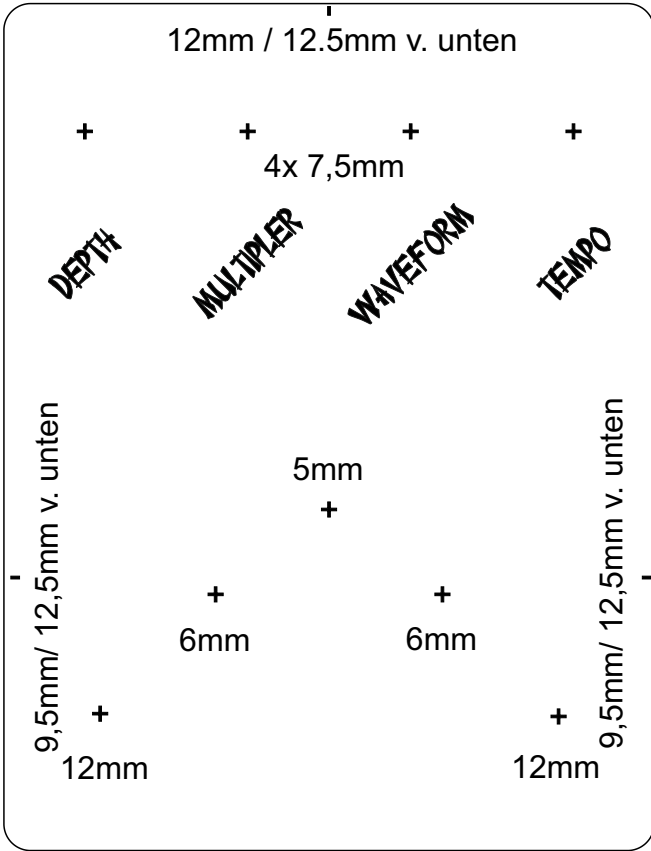


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 Tap Tremolo 3C
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 Sheet: 1/1

1 2 3 4

1 2 3 4

1 2 3 4



9V DC



DEPTH

MULTIPLIER

WAVEFORM

TEMPO

TAP TEMPO TREMOLO

OUTPUT

NORMAL



ALTERNATE

WAVEFORM



INPUT



ON/OFF

MADE IN GERMANY

TAP



Electric Druid Tap Tempo LFO

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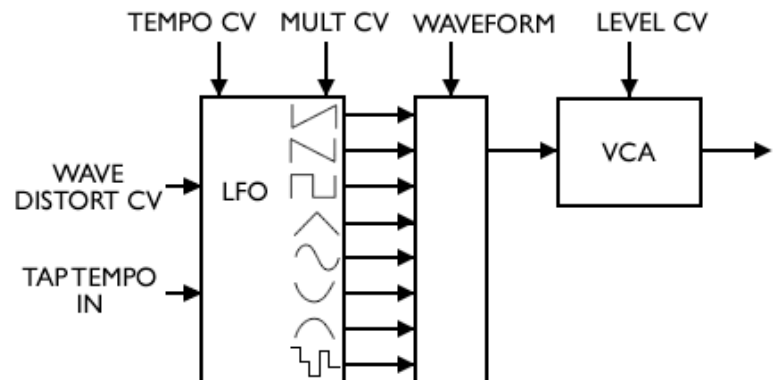
Introduction

This low frequency oscillator uses a PIC microprocessor to create a versatile tap tempo LFO. All LFO parameters are controlled by 0-5V control voltages.

The chip can produce 16 waveforms including “random levels” and “random slopes” waveforms. The basic LFO tempo is controlled by TEMPO CV or TAP TEMPO IN. The final output frequency is based on this setting and the MULTIPLIER CV, which allows you to set a basic tempo, and then produce an LFO output at a multiple of this speed.

The WAVEFORM voltage selects one of the 8 waveforms. The LFO

waveforms can be modified by the WAVE DISTORT CV. Finally, the LEVEL CV sets the output level.



Features

Simple “Tap Tempo” control

The TAP TEMPO input can measure the time between two taps of a momentary switch or button, and uses this time to set the LFO’s basic tempo.

Ability to synchronize LFO to external clocks

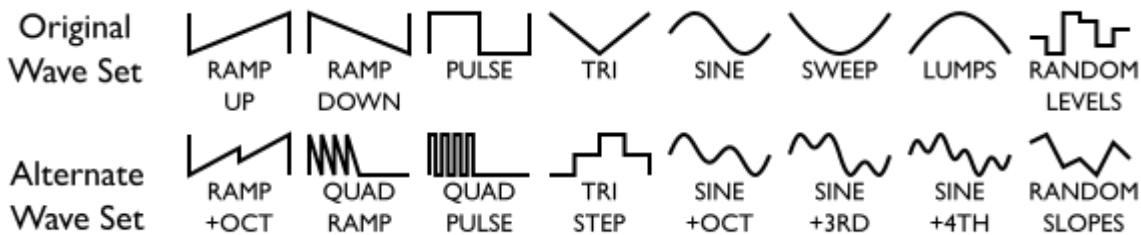
The TAP TEMPO input can also accept 0-5V pulses. This allows the LFO to be synchronized to an external clock. The chip also produces a CLOCK OUT which can synchronise other TAPLFOs.

LFO range from 0.025Hz to above 50Hz

The basic range of the TEMPO CV allows the LFO to produce frequencies between 0.05Hz (a 20 second cycle) and 12.8Hz. However, in conjunction with the MULTIPLIER CV, this range is extended to 0.025Hz (a 40-second cycle) to 50Hz.

Sixteen output waveforms, in two sets

The chip can produce 16 output waveforms, shown below. These are selected by the voltage on Pin 12 (WAVEFORM) and the digital level on Pin 6 (the WAVE SET selection input).



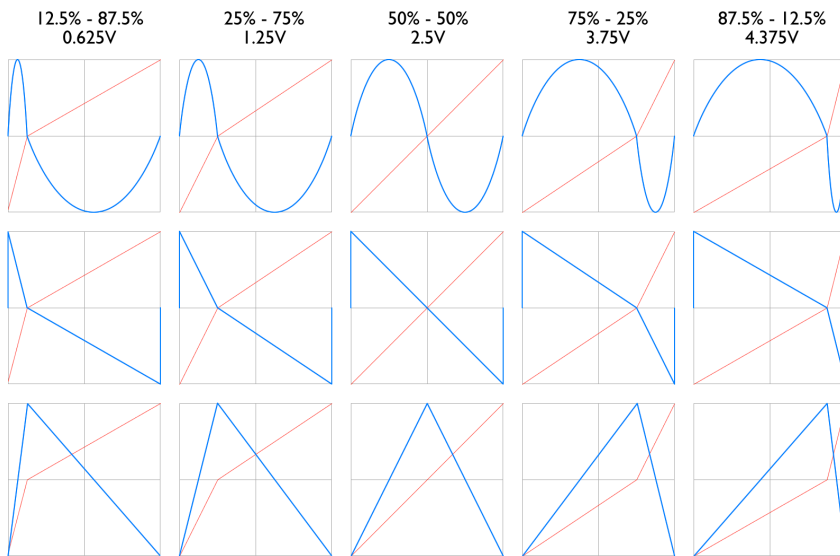
Half-speed, Double-speed, and Triplets

The MULTIPLIER CV input selects a tempo multiplier which is used to determine the final LFO frequency. This allows the LFO to produce changes at double or half-speed, or produce triplet times. The available multipliers are shown below:

Multiplier	Musical symbol	Note name
x0.5		1/2 note, minim
x1		1/4 note, crotchet
x1.5		Triplet 1/4 note, triplet crotchet
x2		1/8 th note, quaver
x3		Triplet 1/8 th note, triplet quaver
x4		1/16 th note, semiquaver

Wave Distort CV input

The selected waveform can be distorted using the WAVE DISTORT input. This modifies the duty cycle of all LFO waveforms. Examples are shown below.



The top row shows the effect of the WAVE DISTORT CV on the SINE wave, whilst the following rows show the effect on the RAMP DOWN and TRIANGLE waveforms. Other waves (excepting RANDOM LEVELS) are affected similarly.

16-bit waves and 10-bit LFO output resolution

The internal waveforms and calculations have been improved beyond the TAPLFO2D's 8-bit waves. This version uses 16-bit wave data with interpolation to give the smoothest possible result. The final PWM output is 10-bit.

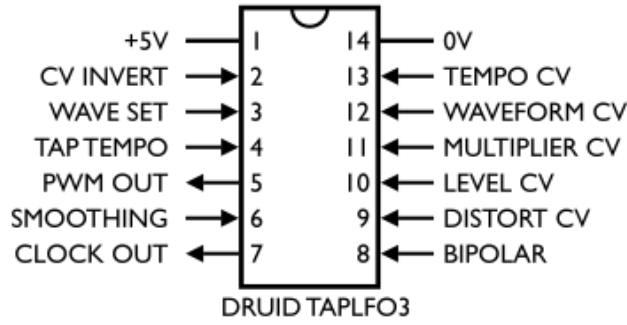
31.25KHz sample output rate

The PWM output frequency is 31.25KHz., a big increase on the 19.5KHz of the previous generation chip. This allows the PWM output to be heavily filtered for a smooth analogue output, even with just a simple RC filter.

Logarithmic control response over 1:256 range

The Tempo CV gives the full range from 0.05 Hz to 12.8 Hz in eight even octaves, eg 0.05-0.1 Hz, 0.1-0.2 Hz, 0.2-0.4 Hz, 0.4-0.8 Hz, 0.8-1.6 Hz, 1.6-3.2 Hz, 3.2-6.4 Hz, 6.4-12.8 Hz. The fact that this input is logarithmic means the TEMPO CV input can use linear pots and still have a musical feel.

Pinout Diagram



Pin	Function	Details	Notes
1	+5V	Power supply	
2	CV INVERT	0-5V digital input	Selects whether the input CVs are inverted. 0V = CVs inverted, 5V/NC = Not inverted
3	WAVE SET	0-5V digital input	Selects which set of eight waveforms is used. 0V = Alternate wave set, 5V/NC = original waveset
4	TAP TEMPO IN	5-0V digital input	Sets basic tempo of LFO. Note that this input expects negative-going pulses.
5	PWM OUTPUT	0-5V digital output	PWM LFO output at 31.25KHz
6	SMOOTHING	0-5V digital input	Selects whether the wave smoothing filter is applied. 0V = Smoothing on
7	CLOCK OUTPUT	0-5V digital output	Provides a 0-5V signal at the current LFO frequency
8	BIPOLAR	0-5V digital input	Selects Bipolar or Unipolar output
9	WAVE DISTORT CV	0-5V analogue input	8 bit, values from 0 to 255 Alters waveshape of LFO waveforms. Does not affect RANDOM LEVELS wave.
10	LEVEL CV	0-5V analogue input	8 bit, values from 0 to 255 Controls overall output level
11	MULTIPLIER CV	0-5V analogue input	3 bit, values from 0-5 Note that values 6 & 7 are not used (set to x1) so the maximum useful CV is 3.75V
12	WAVEFORM CV	0-5V analogue input	3 bit, values from 0 to 7
13	TEMPO CV	0-5V analogue input	8 bit, values from 0 to 255 0.05 Hz to 12.8 Hz for LFO
14	0V	Power supply	

NC = Not connected



Differences from TAPLFO2D

Whilst efforts have been made to ensure the TAPLFO3 is compatible with the TAPLFO2D in most application circuits, some significant changes have been made. This section details those changes and how they affect existing circuits.

Four new option selection inputs

The pins that previously were used by the clock crystal are now used for selecting CV inversion and the alternate waveform set. In addition, the little-used “Next Multiplier” input and “Tempo timing LED” output have been replaced with BIPOLAR output selection and an output smoothing filter.

All four of these inputs have internal pull-ups on the chip, so if left unconnected they default to a high state. The chip has been arranged so that this gives the same behaviour as the previous chip to maintain compatibility. If switches to select these options are required, they can be a simple SPST from the pin to ground.

CV Inversion

Pin 2 is now the CV INVERT selection input. If you’re adding inverting op-amp mixers to the CV inputs, this can save the use of an extra op-amp to re-invert the CVs. An example circuit demonstrates this.

Wave Set selection

The WAVE SET input allows the user to select a second alternate set of eight waveforms.

With the pin left unconnected (or connected to 5V), the original waves are used. With the pin connected to ground, the alternate wave set is selected.

Smoothing Filter

Pin 6 is now the SMOOTHING filter selection input. This applies the digital equivalent of a single pole RC filter to the waveform before it is output. The filtering removes the abrupt edges that tend to give clicks in some applications and gives the waveforms a softer rise and fall (about 20msecs).

With the pin left unconnected, the filter is not applied. With the pin connected to ground, the filtering is applied.

Bipolar Output

The TAPLFO2D produced a bipolar output around a bias level of 2.5V. Pin 8/BIPOLAR is now used to select this behaviour.

With the pin left unconnected, the output is bipolar around 2.5V. With the pin connected to ground, the output is unipolar from 0V up to 5V.

Tap Tempo Input has an internal pull-up

The tap tempo input now has an internal pull-up. This saves an external resistor. If you’re using a PCB designed for the TAPLFO2D that includes the external 10k pull-up, you can simply leave this resistor unpopulated.

There are no other significant changes.

Application Notes

Schematics for the example circuits are shown at the back of the datasheet.

Example circuit: Modular synth LFO with tap tempo and sync input

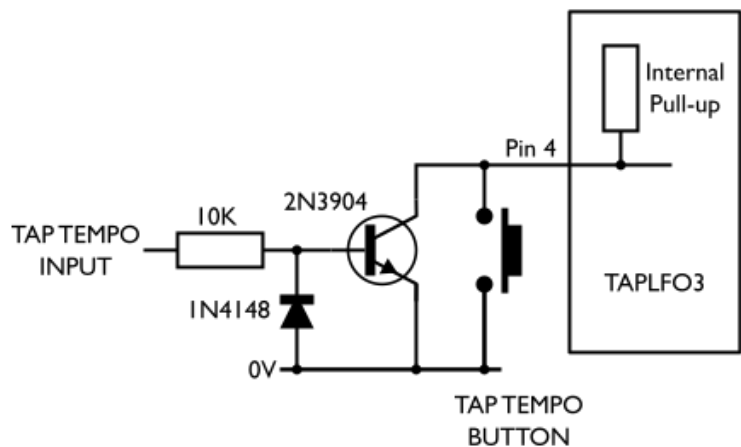
The circuit on the following two pages shows many of the features of the chip and introduces many useful circuit elements.

The chip is configured with pin 2 tied low, so all CV inputs are inverted. All the inputs except for Multiplier CV have inverting mixers attached that allow modulation of the pot setting by an external control voltage. The Multiplier input is wired simply with a pot.

The circuit uses a two-stage filter giving a 4-pole response for excellent PWM frequency suppression. The second filter stage applies a gain of two to boost the level to the typical 10V p-p used in many modular synths. It also allows the signal offset to be adjusted to ensure the waveform is centred around zero.

The TAP TEMPO input on the TAPLFO3 chip expects a “short-to-ground” signal, and times the period between the falling edges of consecutive pairs of pulses to set the frequency. If another device provides 0-5V clock signal, this can be fed to the TAP TEMPO input and the LFO will synchronize to the clock.

The circuit shown (as appears in the Modular Synth LFO schematic) can be used to provide an input that protects against negative voltages and is safe for positive-going sync pulses up to about 20V.



Example circuit: Single supply tap tempo stompbox LFO

This example circuit shows how the chip can be used with a 9V single supply, as typically found in stompbox circuits. The circuit uses a single filter stage which offsets the output to the midpoint 4.5V level. This is 2V to 7V output is what would usually be provided by a op-amp based LFO. However, it is possible to replace the op-amp filter with a simple passive filter (see "The simplest possible PWM output filter" below), in which case the output voltage will be from 0V to 5V. This may be just what is required for some circuits.

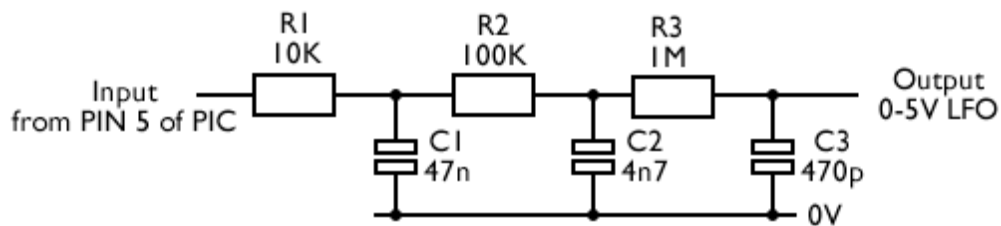
Example circuit: Tap tempo tremolo circuit

This example circuit shows a complete tremolo effect based on the tap tempo LFO. The tremolo audio path is a clean, simple design based on the classic Tremulus Lune. Thanks to Mike for his work designing this with my original PICVCLFO.

The PWM output from the chip is ideal for controlling the LED in a vactrol. LEDs don't have a linear current/brightness response, which means controlling them with a typical voltage-output LFO via a resistor gives poor results. Controlling the LEDs brightness with PWM provides much better linearity. Furthermore, an LDR's slow response means that no extra filtering is required and the PWM signal can be fed directly to the vactrol. This makes a very simple circuit for something that has so many options.

The simplest possible PWM output filter

Whilst the 2 stage filter in the Modular Synth LFO circuit above provides good filtering performance, it is fairly complicated, requiring two op-amps and associated components. Can it be done with less? Yes, it can. You can use a two or three stage passive filter like this:



You can experiment with the values a bit (The values above give 338Hz cutoff) but be sure to maintain the x1, x10, x100 relationship of R1, R2, R3 and C3, C2, C1. This helps limit loading between the stages. If you don't need three stages, simply leave off R3/C3.

Note that the output is unbuffered, so will need a high impedance input following it.

Disabling unwanted CV inputs

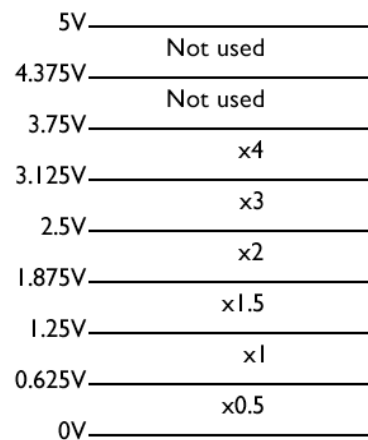
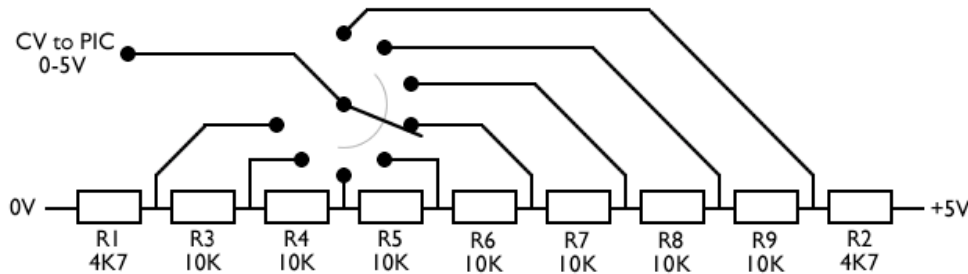
If the WAVE DISTORT CV input is not required, it can be tied to a fixed voltage. For a square wave output, this should be 2.5V. This can be produced by a pair of 10K resistors wired as a potential divider between 0V and +5V.

If the LEVEL CV input is not required, it can be disabled by tying the input to the +5V rail with a 10K resistor.

If the MULTIPLIER CV input is not required, it can be tied to a fixed voltage. Since multiplier CVs above 3.75V default to 'x1', the input can be disabled by tying it to the +5V rail with a 10K resistor.

Using rotary switches to select waveform or multiplier

Rotary switches can be used to select waveforms or multipliers by replacing the CV potentiometer with a resistor string that provides the correct voltages, as shown. Since the CV range for each option is fairly wide, exact values are not crucial, but the top and bottom resistors (R1 and R2 in the diagram) should be roughly half the other value.



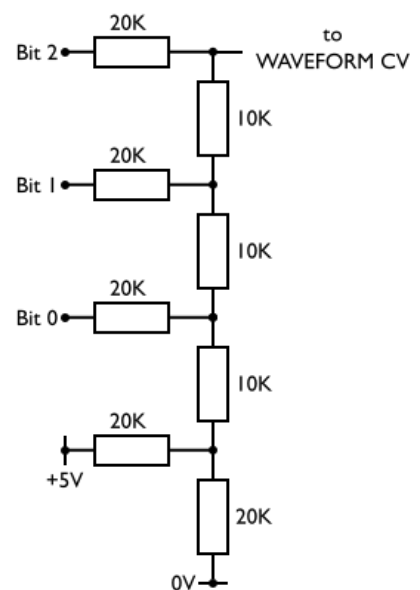
The diagram on the right shows the CV “boundary voltages” for the eight options, and the multiplier that is applied for voltages between those levels. The top two options are not used for the Multiplier (they give x1 if used). The waveform CV uses the same boundaries, but uses all eight options.

Using digital signals to select waveform or multiplier

In a programmable system, it is convenient to be able to select waveforms and multipliers using digital signals. This can be done by converting them to a CV using a simple R-2R DAC.

Although we only require eight options, we use a 4-bit R-2R DAC design with the lowest bit tied high to ensure the output falls in the middle of the voltage range for each option.

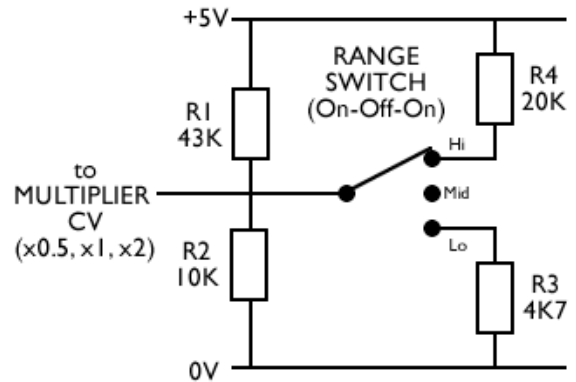
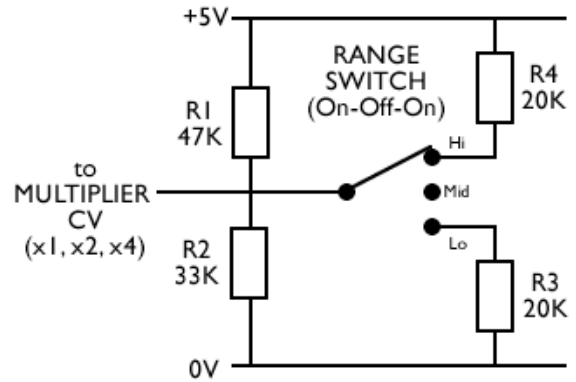
Again, for the Multiplier CV, only inputs 0-5 are used, and values 6 and 7 just give x1.



Using the Multiplier CV as a Range switch

If the Multiplier CV is not required, it can be used to increase the frequency range of the LFO.

Either of the arrangements shown provide a switchable voltage which changes the range of the LFO over three octaves.





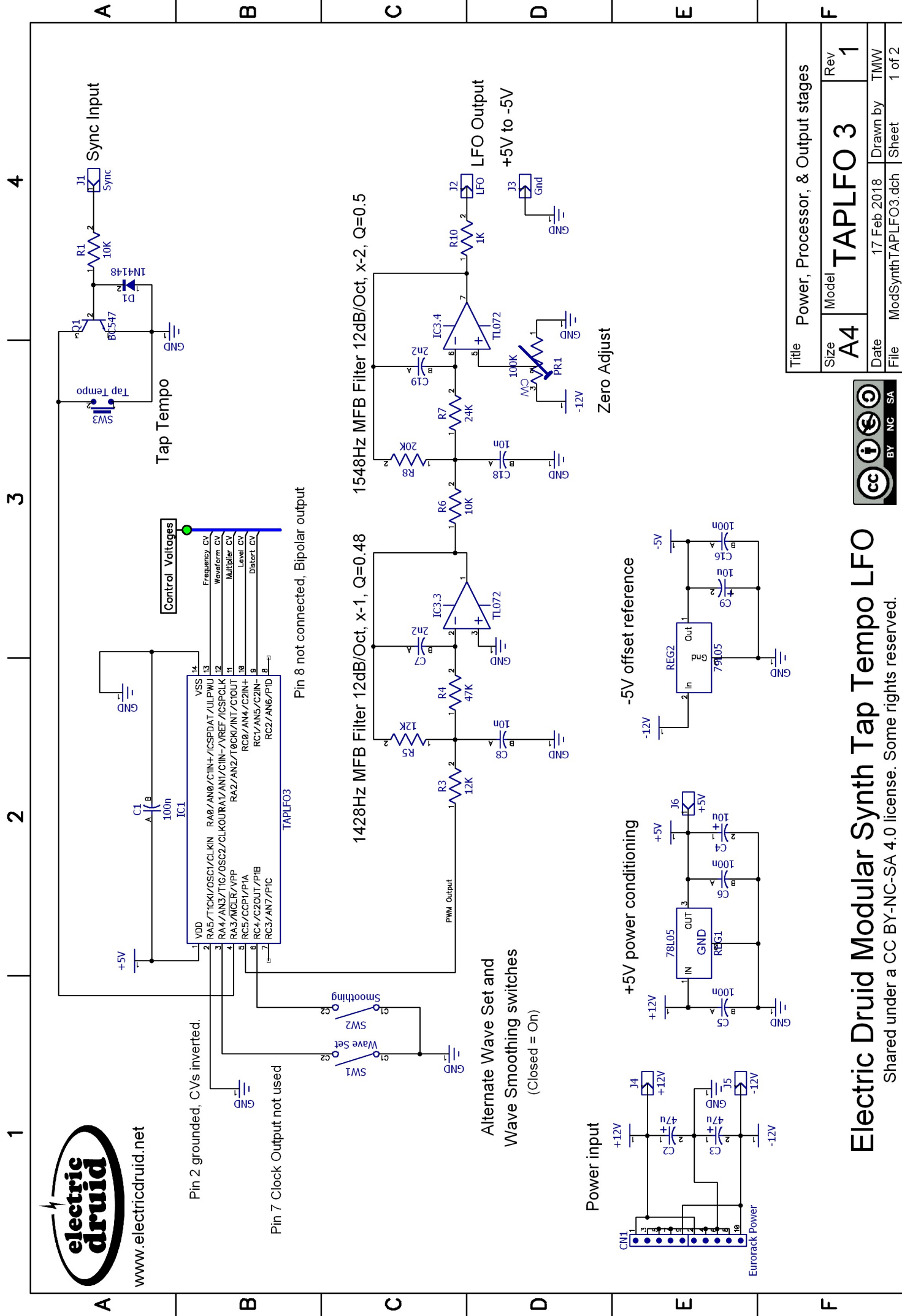
www.electricdruid.net

Pin 2 grounded, CVs inverted.

Pin 7 Clock Output not used

Pin 8 not connected, Bipolar output

Alternate Wave Set and Wave Smoothing switches (Closed = On)



Electric Druid Modular Synth Tap Tempo LFO

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Title Power, Processor, & Output stages

Size A4 Model TAPLFO 3 Rev 1

Date 17 Feb 2018 Drawn by TMW

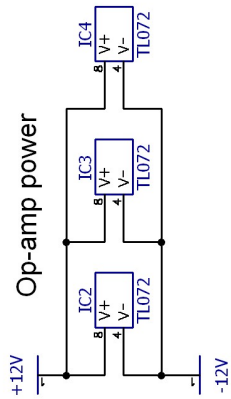
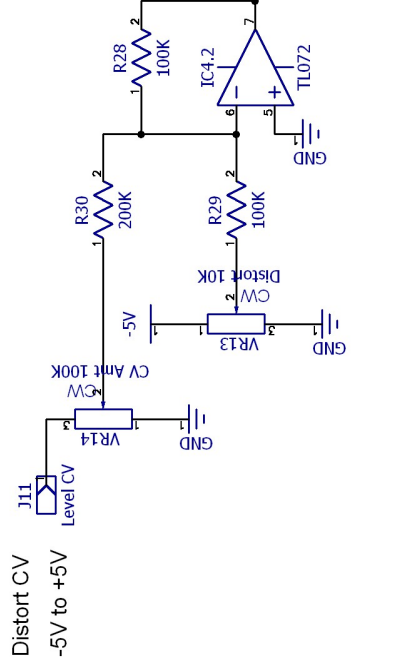
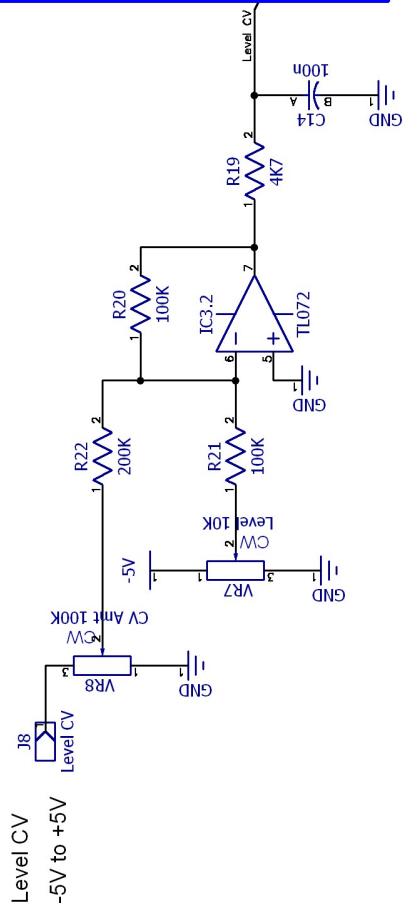
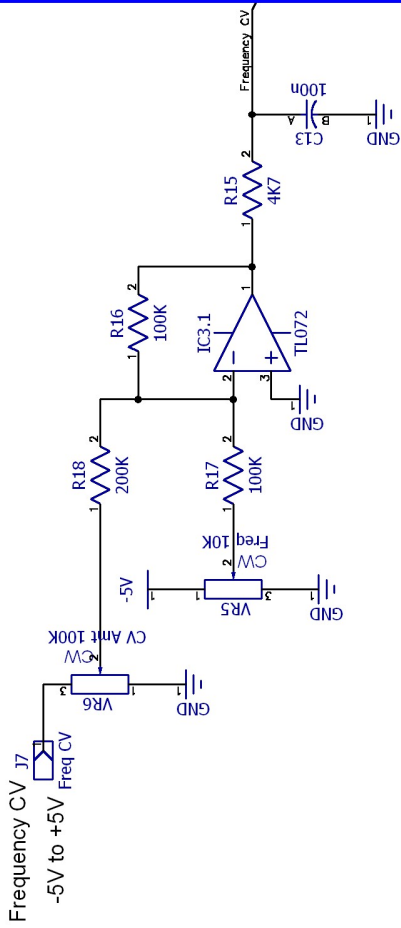
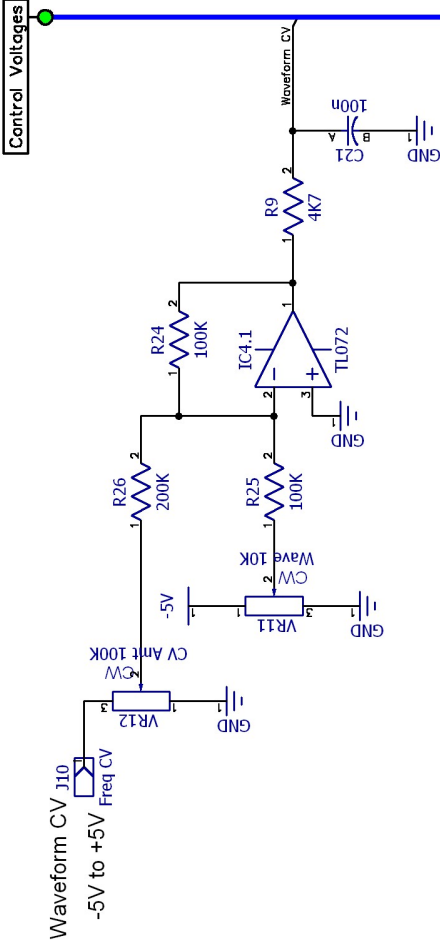
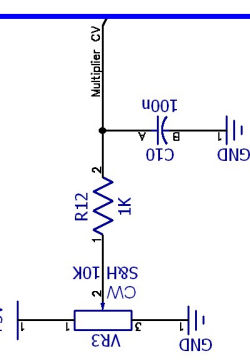
File ModSynthTAPLFO3.dch Sheet 1 of 2





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Remember all pots except CV Amt's are inverted!
"Maximum" end of the pot is *always* pin 3, marked CW.



Title		Controls and CV inputs	
Size	Model	Rev	1
A4	TAPLFO 3		
Date	17 Feb 2018		Drawn by
File	ModSynthTAPLFO3.dch		Sheet
			2 of 2

Electric Druid Modular Synth Tap Tempo LFO

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4

3

2

1

A

B

C

D

E

F

4

3

2

1

A

B

C

D

E

F

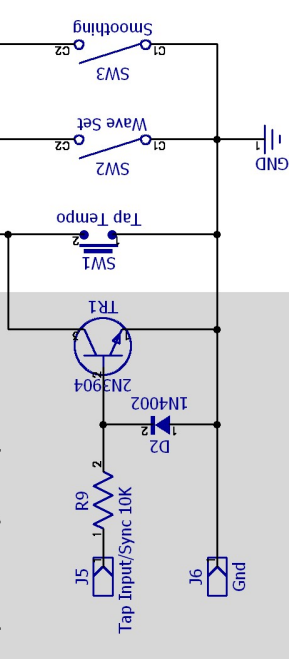


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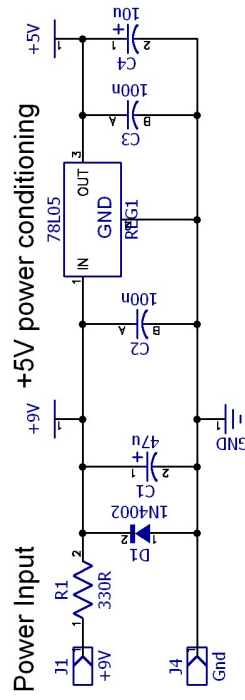
Pin 2 not connected, CVs not inverted

Pin 7 clock output not used

Optional Sync Input

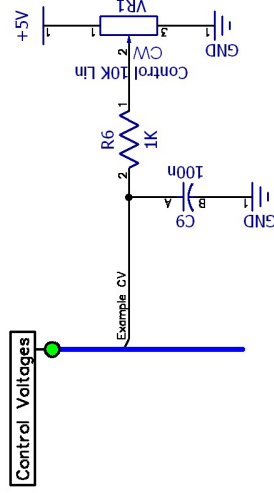


Alternate Wave Set and Wave Smoothing switches (Closed = On)



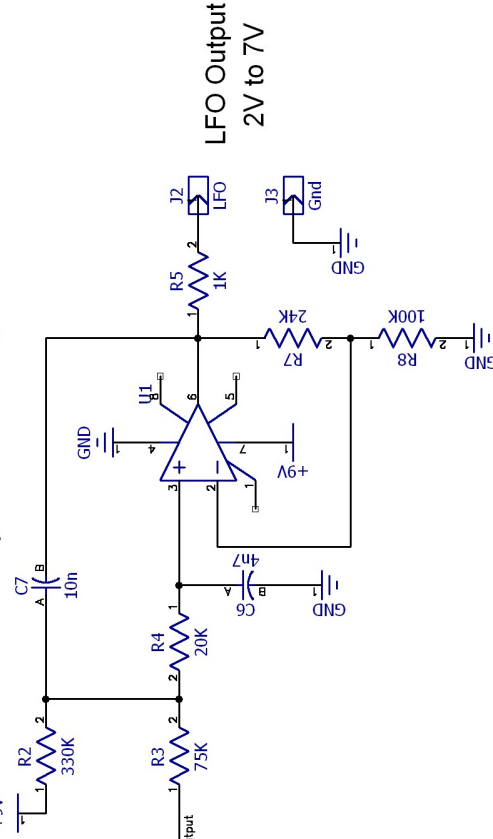
Adjust R1/C1 filter values to taste!

Example pot control circuit: repeat as required



Up to five controls available: Tempo, Waveform, Multiplier, Level, Wave Distort

664Hz Sallen-Key Filter 12dB/Oct, Q=0.63



Title		Single Supply Stompbox LFO	
Size	Model	Rev	1
A4	TAPLFO3	Date	15 Feb 2018
		Drawn by	TMW
		File	SingleSupplyTAPLFO3.dch Sheet 1 of 1



Single Supply Tap Tempo LFO for stompbox

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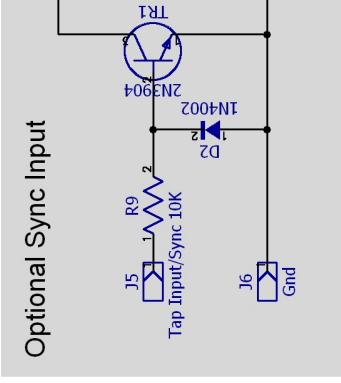
Pin 2 not connected, CVs not inverted

Pin 8 not connected, Bipolar output

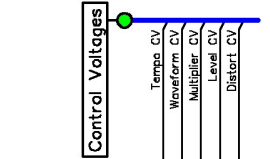
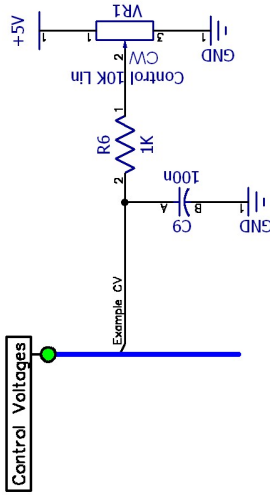
Pin 6 grounded, waves smoothed

Pin 7 clock output not used

Optional Sync Input



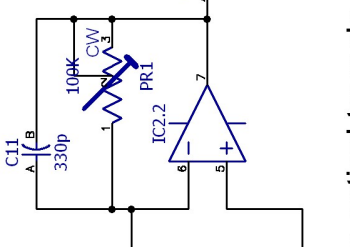
Example pot control circuit: repeat as required



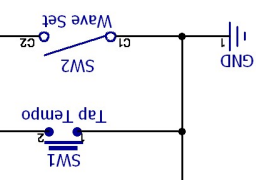
Up to five controls available:
Tempo, Waveform, Multiplier,
Level, Wave Distort



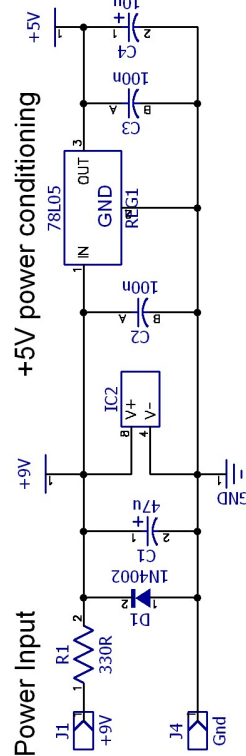
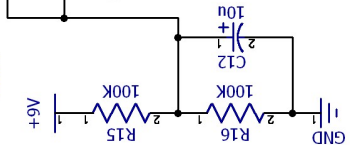
PR1 make-up gain adjust
(can be replaced
with fixed resistor)



Alternate Wave Set switch
(Closed = On)



"Tremulus Lune"-style optical tremolo



Adjust R1/C1 filter values to taste!

Title		Electric Druid Tap Tempo Tremolo	
Size	Model	TAPLFO3	
Date	Rev	15 Feb 2018	1
File	Drawn by	TremoloTAPLFO3.dch	TMW
	Sheet	1	of 1

Electric Druid Tap Tempo Tremolo

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