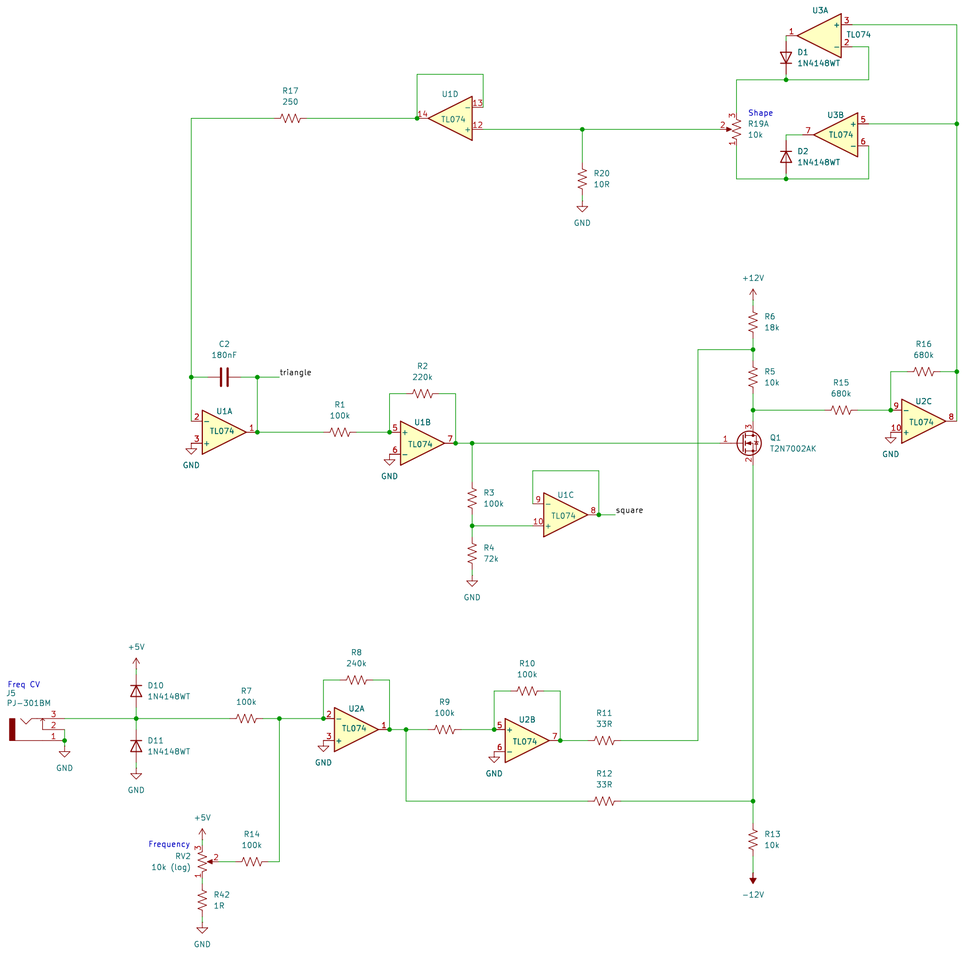
LFO (Triangle + Square Core)

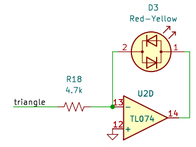


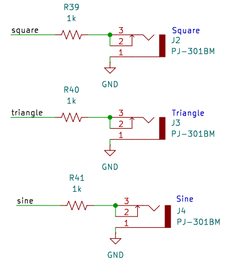
The LFO design is adapted from Kassutronic's Variable Waveshape LFO.

Kassutronic's LFO is an improvement on this Classic Triangle / Saw Oscillator Design. He improves the stability of the feedback circuit using precision-rectified buffers, which addresses the original circuit's problem of swinging to the rail when skewed too far towards a sharp sawtooth wave. I take it a step further by buffering the output of the feedback circuit (necissary to adapt it to use the 10k joystick potentiometer while maintaining the correct frequency range).

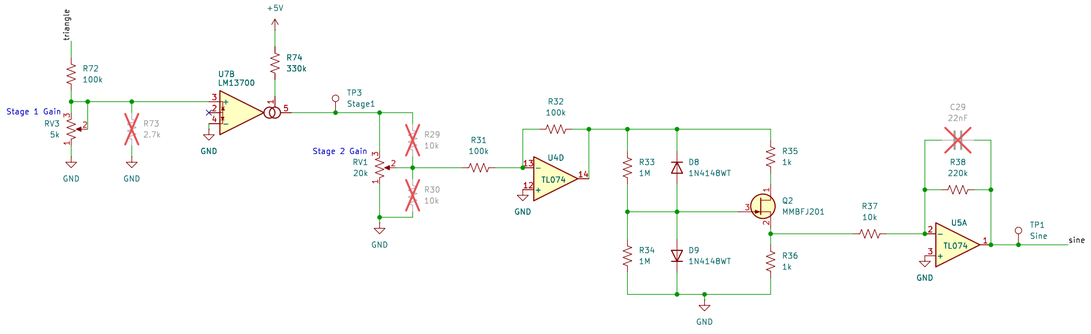
I added frequency CV by modulating the voltage rails of a MOSFET. This essentially controls the input voltage to the Schmitt Trigger. Weak pull-up and pull-down resistors and clamping diodes on the Frequency CV input are used to ensure the modulated amplitude of the square wave at the output of Q1 always stays slightly possitive. This is important for maintaining stablity.

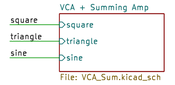
I also used my spare LM13700 OTA channel as an additional stage of waveshaping for the triangle-to-sine converter.





Triangle to Sine Waveshaper





Joystick connected with cable assembly:

Mfgr: Analog Devices Inc./Maxim Integrated
PN: CABLE-PH06
Digikey: 175-CABLE-PH06-ND

J1
CABLE-PH06

H1 MountingHole
H2 MountingHole
H3 MountingHole
H4 MountingHole

Power
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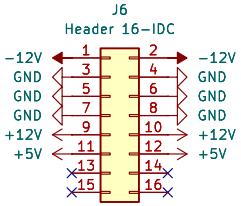
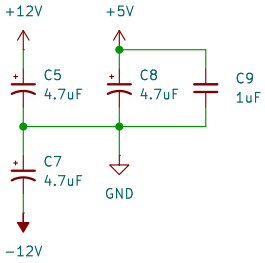
KiCad E.D.A. 9.0.3 | Id: 1/3

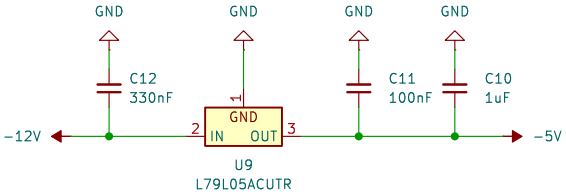
Eurorack Power



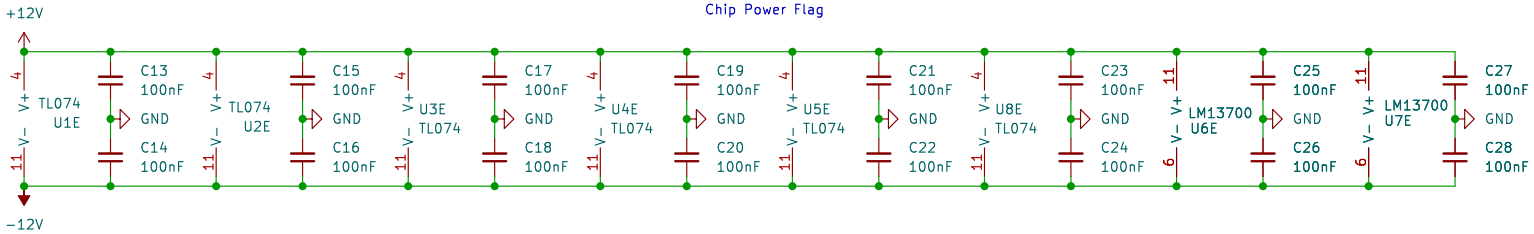
Bulk Capacitance



Negative Regulator



Chip Power Flag



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Size: A4	Date:	**Rev:**
KiCad E.D.A. 9.0.3		Id: 3/3

VCAs

Control Voltages

+5V
Wave
R19B
10k
-5V
U3C
TL074
V_cv
D4
1N4148WT
R43
330k
squareCV
U8A
TL074
Q3A
MBT3906DW1
R51
33k
D12
1N4148WT
C3
1nF
R55
1k
GND
R53
6.8k
R57
18k
U8B
TL074
R44
100k
square
U6A
LM13700
R47
620R
R49
620R
GND
R52
33k
D13
1N4148WT
C4
1nF
R56
1k
R45
330k
triangleCV
U8C
TL074
Q3B
MBT3906DW1
R54
6.8k
R58
18k
U8D
TL074
R46
100k
triangle
U6B
LM13700
R48
620R
R50
620R
R67
33k
D14
1N4148WT
C6
1nF
R69
1k
R63
330k
sineCV
U5B
TL074
Q4B
MBT3906DW1
R68
6.8k
R70
18k
U5C
TL074
R64
100k
sine
U7A
LM13700
R65
620R
R66
620R
R62
10k
R61
10k
R60
10k
R59
10k
U5D
TL074
mixed
R71
1k
TP2
Mixed
J7
PJ-301BM

Absolute Value Amplifier
R23
10k
R25
10k
D5
1N4148WT
C1
100nF
U4A
TL074
D6
1N4148WT
U4B
TL074
R24
10k
R26
10k
R27
10k
-5V
R28
10k
U4C
TL074
y = 5 - abs(x)

R21
100k
R22
100k
U3D
TL074
D7
1N4148WT

-5V -> +5V used to crossfade from sine -> triangle -> square waveforms.

Output equations:

squareCV = { 0 , V_cv < 0
V_cv , V_cv > 0 }

triangleCV = 5 - abs(V_cv)

sineCV = { -V_cv , V_cv < 0
0 , V_cv > 0 }

These control voltages are used to modulate the level of the each waveform, before being summed. This results in the following output equation:

mixed = square*squareCV + triangle*triangleCV + sine*sineCV

Falstad Simulations:

1) LFO eco (VCA and sine approximations)
2) Triangle-to-Sine Waveshaper
3) LFO + VCA (slow, not updated, not recommended)

VCA Design:

Electric Druid - Design a Eurorack "Vintage VCA" with the LM13700

Absolute Value Amplifier App-Note:

Burr-Brown / TI: PRECISION ABSOLUTE VALUE CIRCUITS - Figure 1

Summing

V+
LM13700
U6C
U6D
U7C
U7D
GND

Sheet: /VCA + Summing Amp/
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Size: A2
Date:
Rev:
KiCad E.D.A. 9.0.3
Id: 2/3