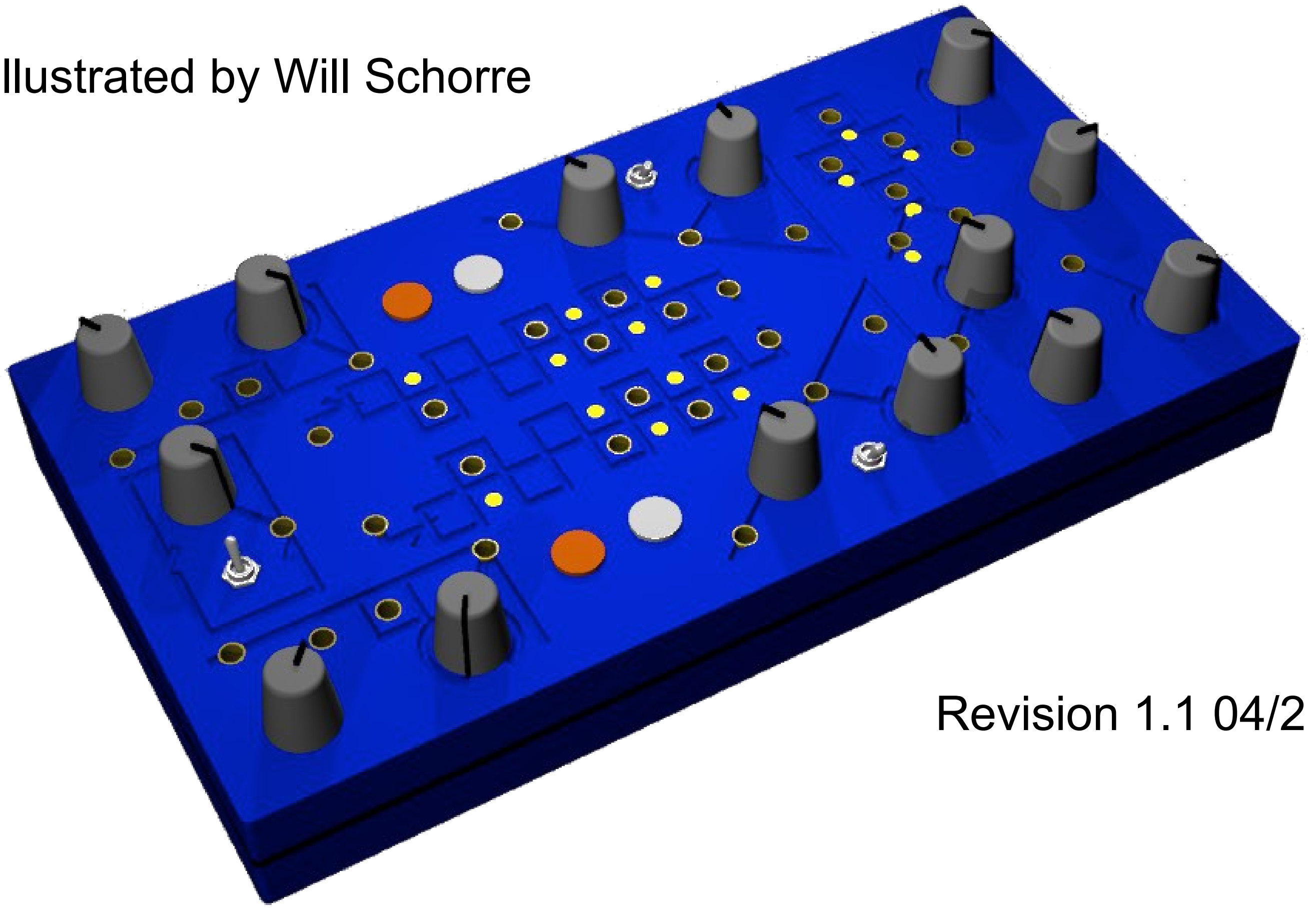
Double Knot V2 Manual

Written and illustrated by Will Schorre
09/19



Revision 1.1 04/2020

Lorre-mill.com/doubleknot

Thanks for picking up a copy of this synth, and or at least a PDF copy of the manual. Please enjoy the specs, descriptions and illustrations. If you notice some incorrect info in this doc or have some suggestion, please drop me an email to the address listed on my site.
Thank you.

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~~~~~~~~~~~~~~~~~~~~~~~~**Connection Considerations**~~~~~~~~~~~~~~~~~~~~~~~~~

- Please use the power supply which came with your synth or one with the same specs of 12v DC positive tip 2.1mm x 5.5mm with at least 500ma.
- Audio output is provided at a 3.5mm stereo line level jack on the back of the instrument, this is suitable for plugging into effects, mixer, powered speakers, or stereo receiver.
- Banana connectors are putting out signals of roughly 0 to 8v and looking for the same at inputs… please avoid using negative cv signals
- You may note looking at the front panel of the instrument, that all INPUTS are on a line and OUTPUTS are off of the lines…
- clock input on the back 3.5mm connector must cross a threshold of around 2.5V
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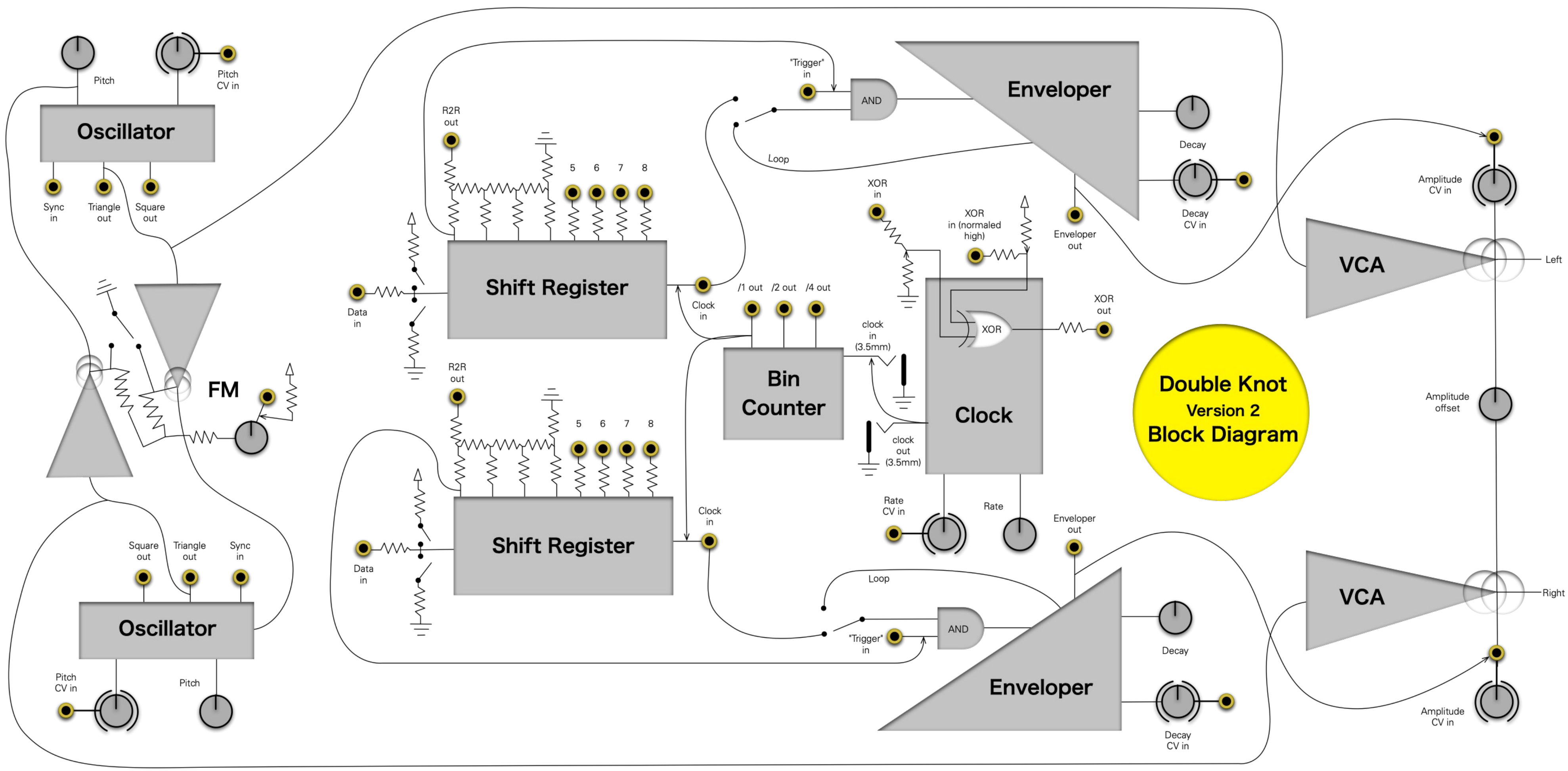
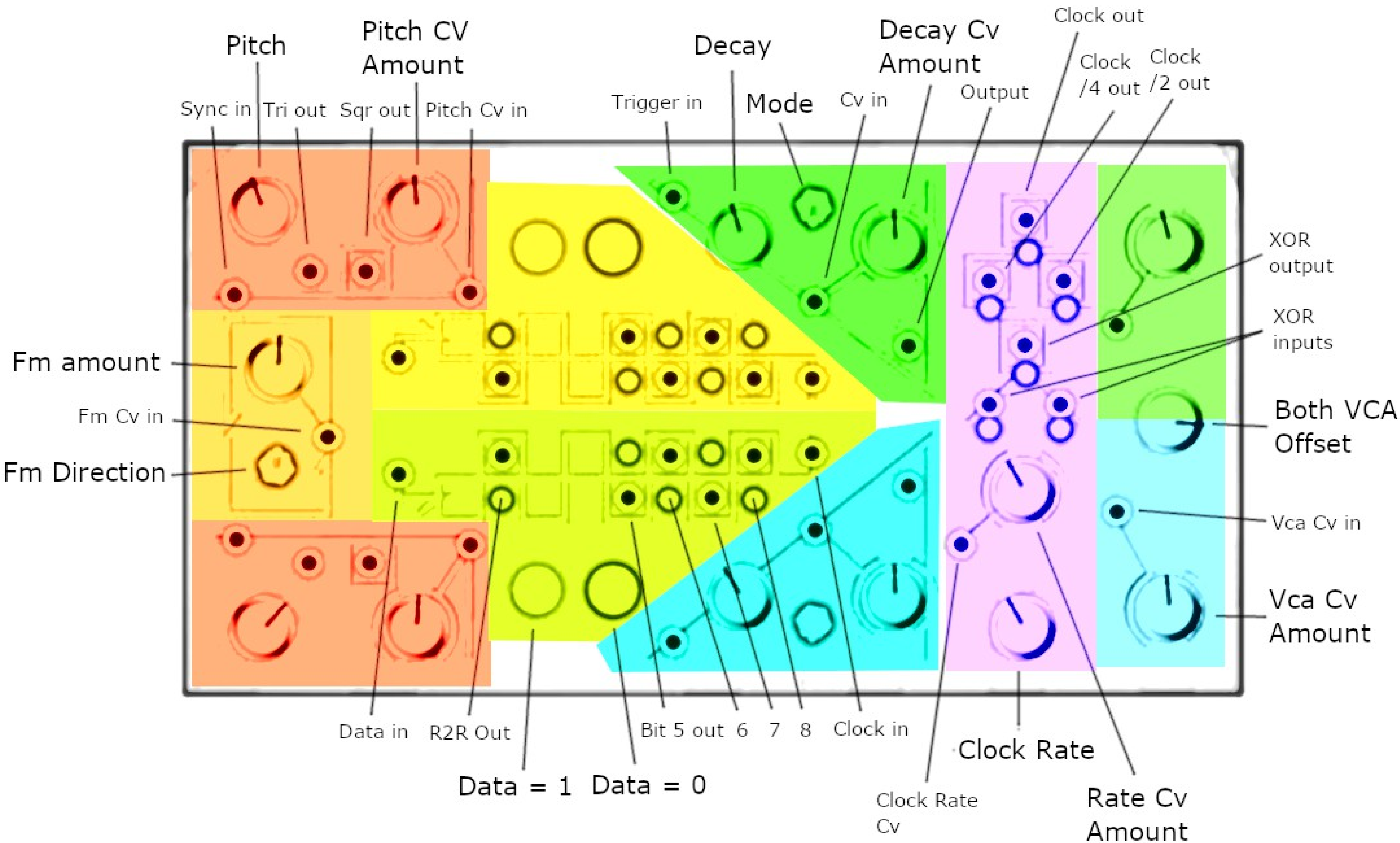


Block Diagram

Normaling Note:

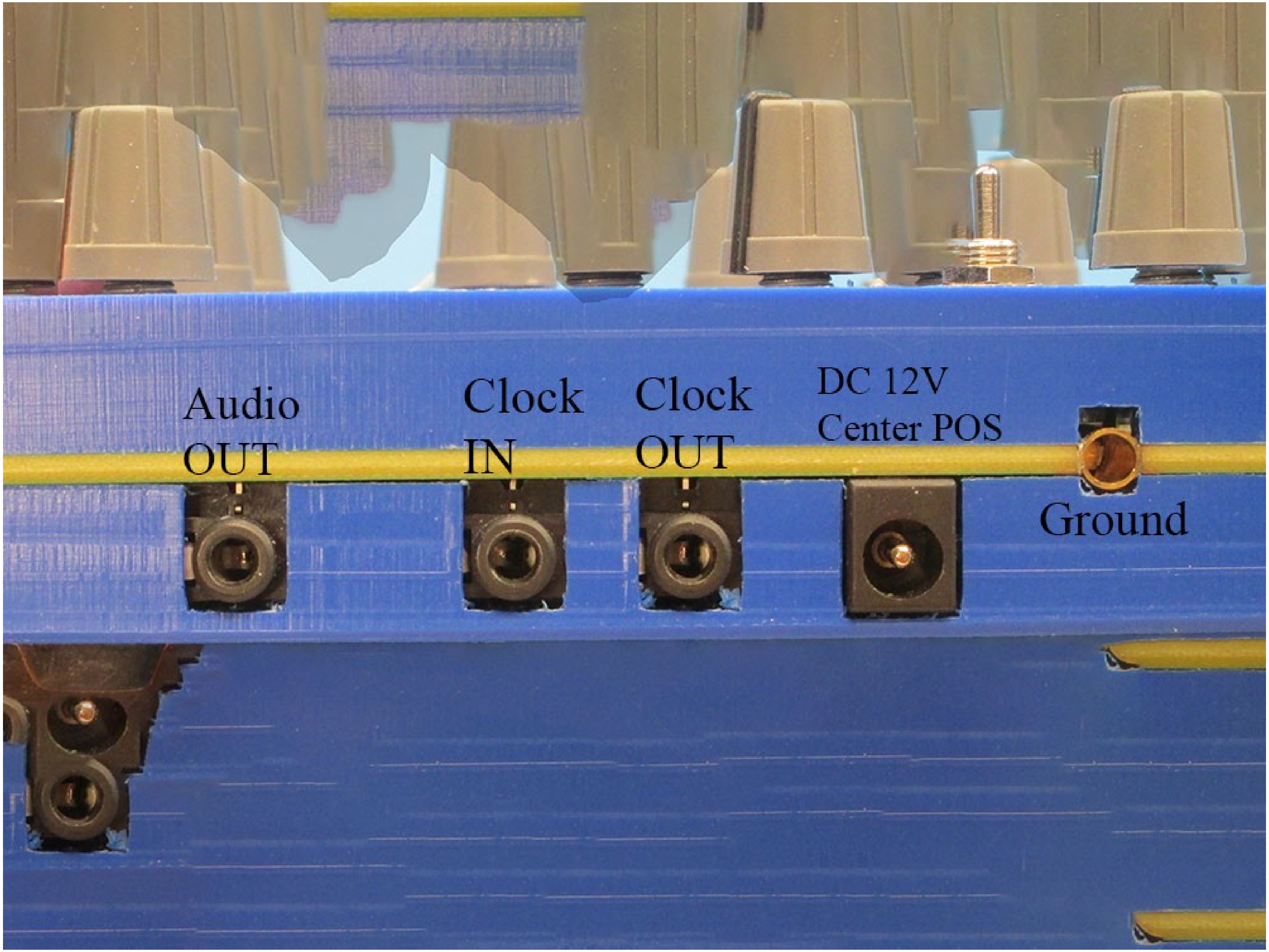
You can see in the diagram above that there are some "Normalized" connections in the Double Knot. This means there is an internal connection made between elements which is broken when a cable carrying a signal is plugged into the jack associated with that connection. These normalized connections are denoted with small arrows pointing into a line or a banana jack. For instance, look near the left side of the envelopers where there is a "trigger in" jack. Follow the line with the arrow that leads back to the first(leftmost) output from the shift register. This means that the first output of the shift register is always connected to the trigger in of that enveloper until another signal is plugged in to trigger the envelope. Some may wonder how this is done without mechanical switches and the answer is an impedance technique where the high impedance of the Jfet input opamp is used to mix the normal signal with the incoming one through resistors of two different values. Normal signal comes in through a 1M while the jack associated with that input has a series 100K. Look for this technique in the schematic section.



Please infer the function of unlabeled controls using the mirrored layout

General Description

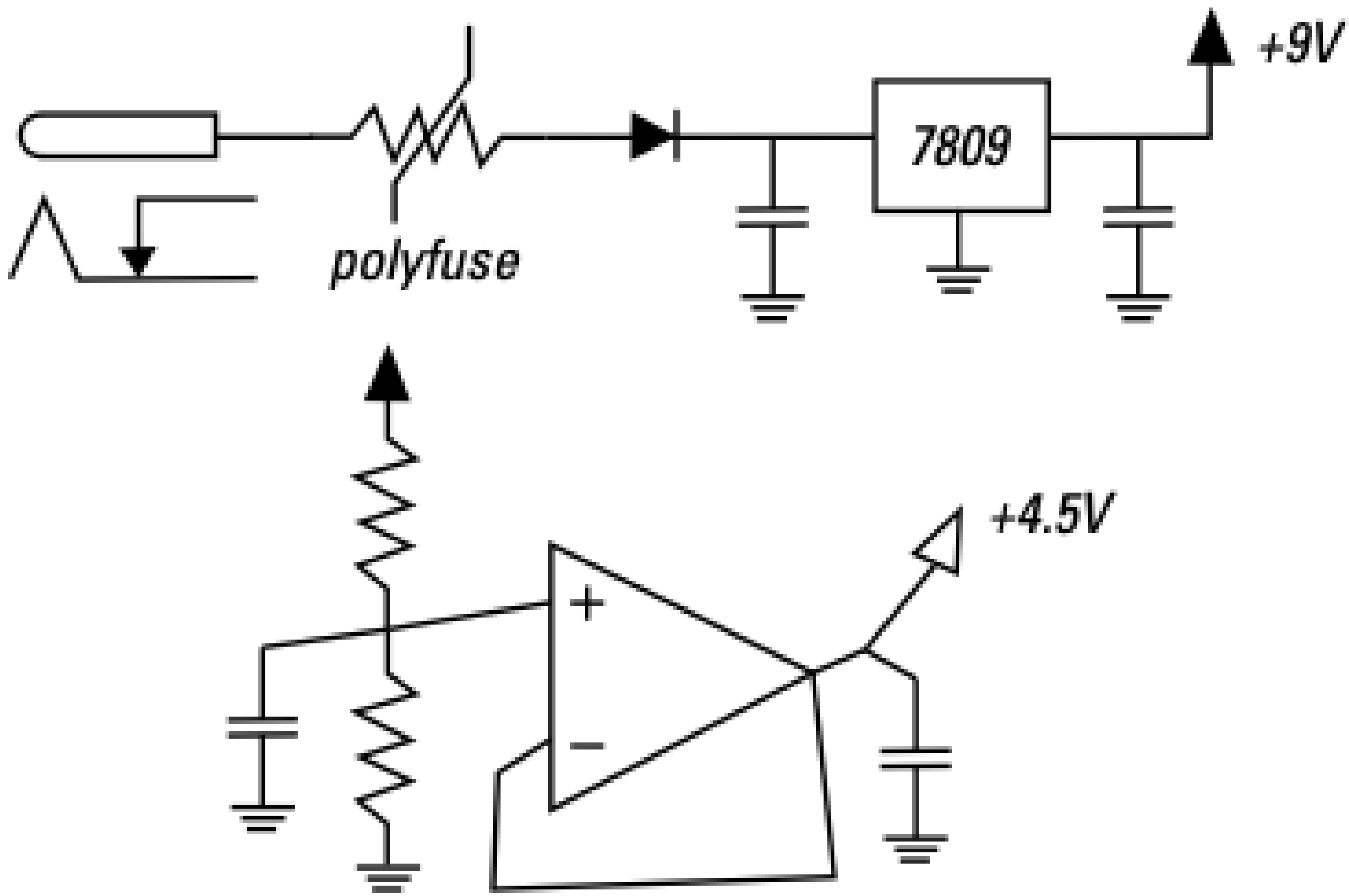
This synth is a collection of some analog blocks and simple digital logic blocks to construct electronic sound patterns. The interface is made up of knobs, switches, and banana plugs for patching. For the most part, to play this instrument means to tune and reconfigure this system as it plays itself. Inside the Double Knot synthesizer there are two voices. Each voice consists of a triangle/square wave oscillator, a shift register sequencer, an enveloper and a voltage controlled amplifier. To set the tempo of the shift registers there is a clock. Functional blocks associated with the clock are an XOR gate and a binary counter. One of the aims of this design is to provide the most flexibility while still having some shape to the piece. There are some predetermined connections in the double knot which somewhat define the roles of each block. The envelopers are triggered by the shift registers unless the trigger inputs are used. The triangle outputs of the oscillators are fed to voltage controlled amplifiers. This makes the Double Knot semi-modular. This system can be used to make complex textural sounds and fm drones, or techno drums at polyrhythmic intervals.


Audio
OUT
Clock
IN
Clock
OUT
DC 12V
Center POS
Ground

~~~~~~~~~~~~~~~~Schematics and Section Descriptions~~~~~~~~~~~~~~~~~~

Power

- The power supply is simple!!! No digital electronics in the power supply. :)
- 12V comes in through a DC barrel connector. Goes through a PTC Fuse and a series Diode then is regulated by a 7809 linear voltage regulator. Decoupled by Caps on input and output of the regulator.
- 4.5v for mid reference is made using an op-amp and resistor divider.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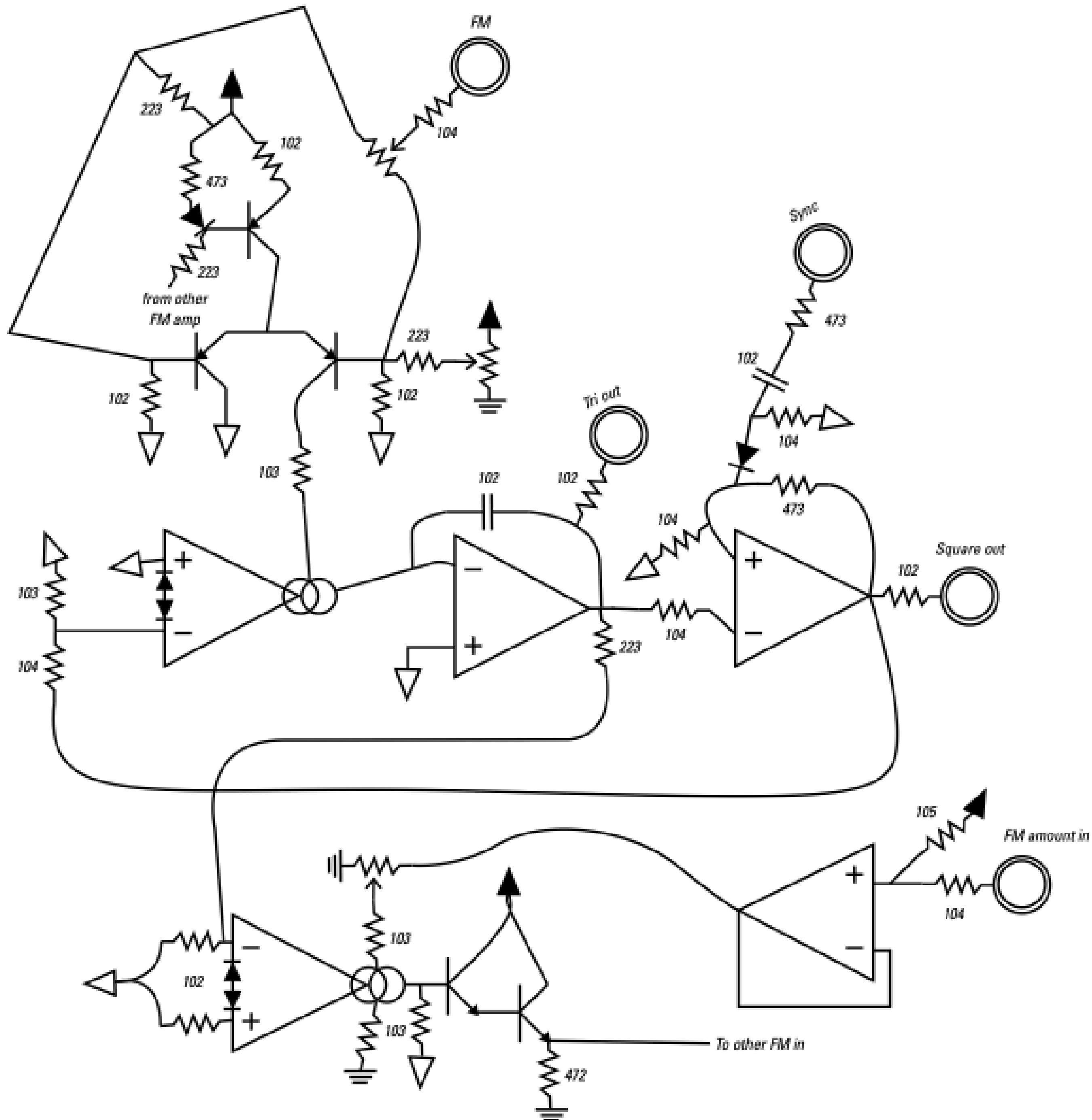
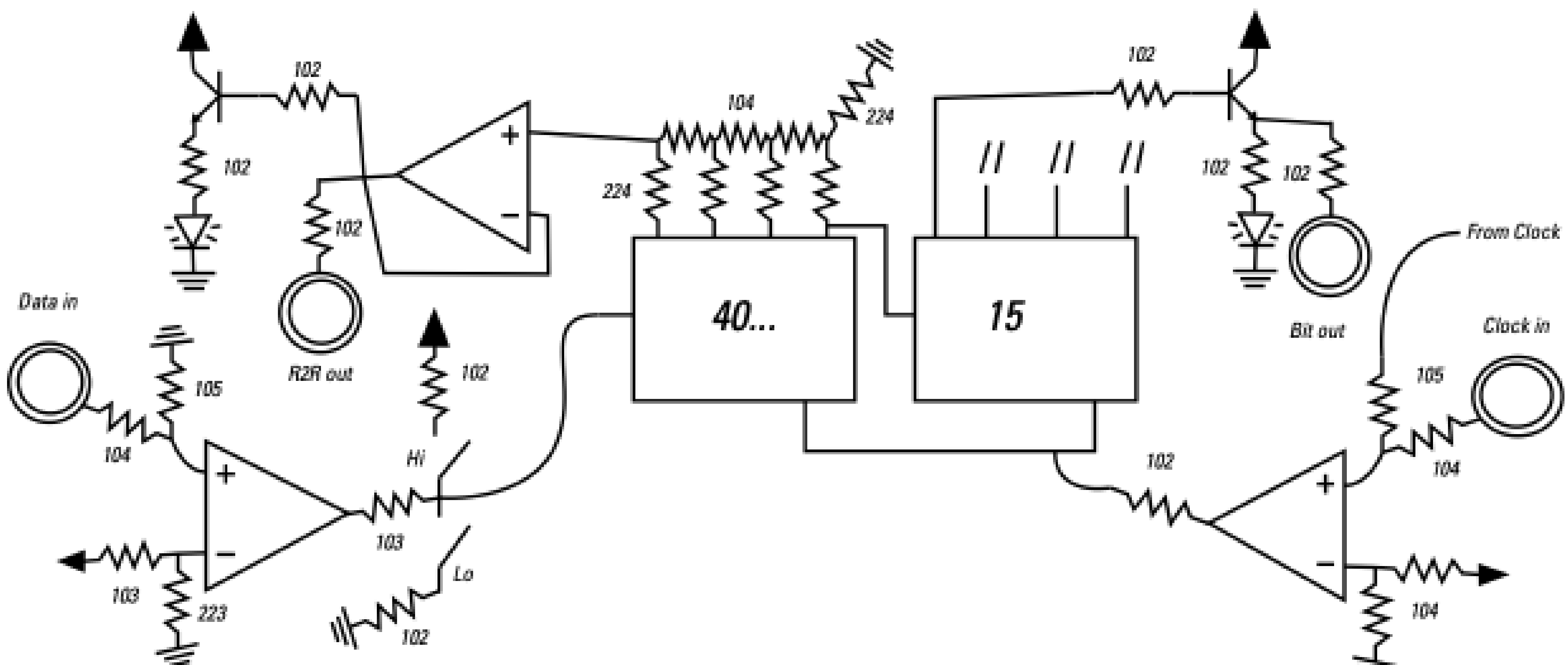
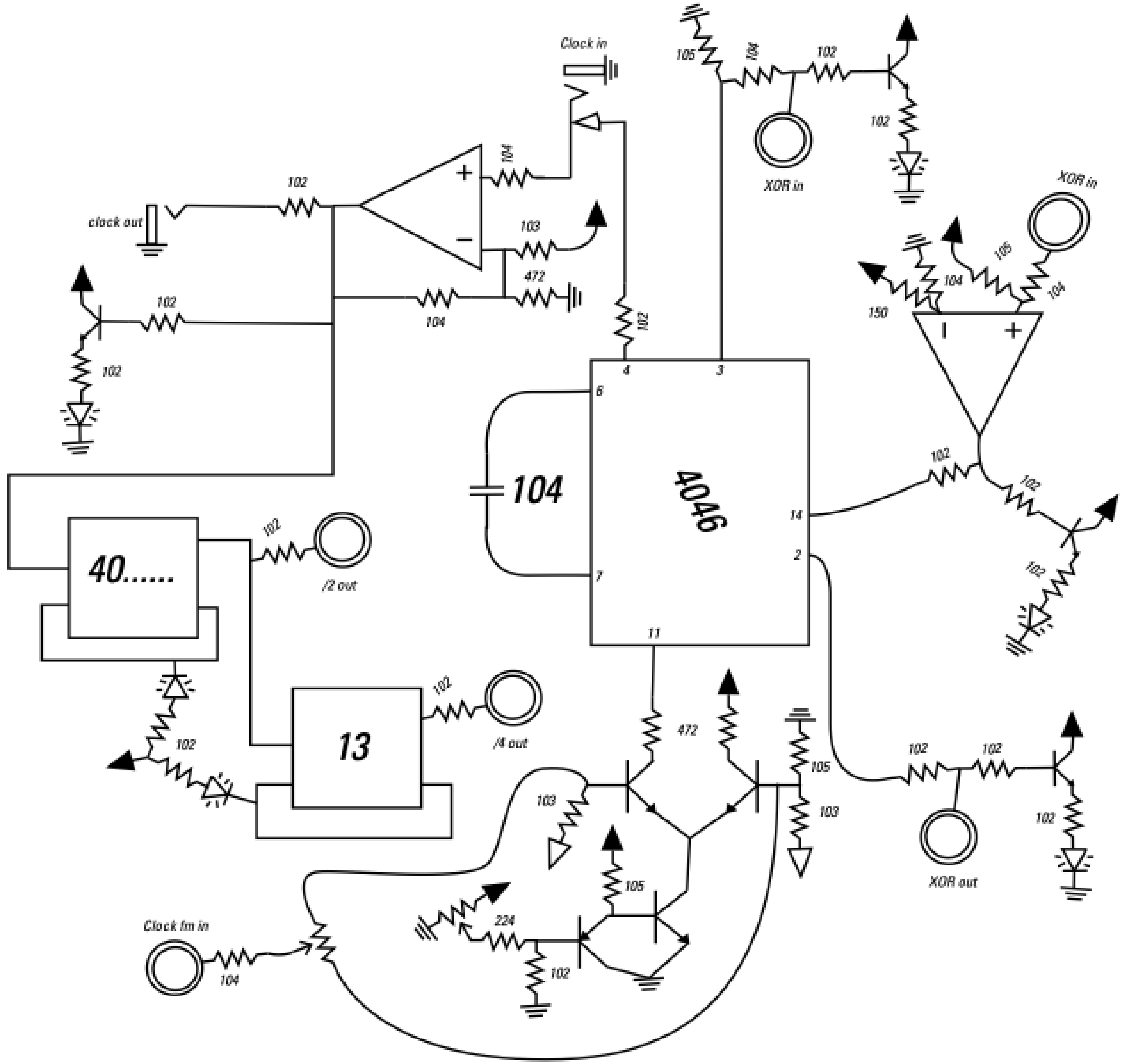


- Oscillators
  - Triangle square architecture where there is an integrator sourced and sinked by an OTA. The OTA gets its input from a Schmitt trigger which gets it's input from the integrator. And Recycles.
- FM
  - OTAs that feed triangle output of each oscillator to the opposite oscillator.

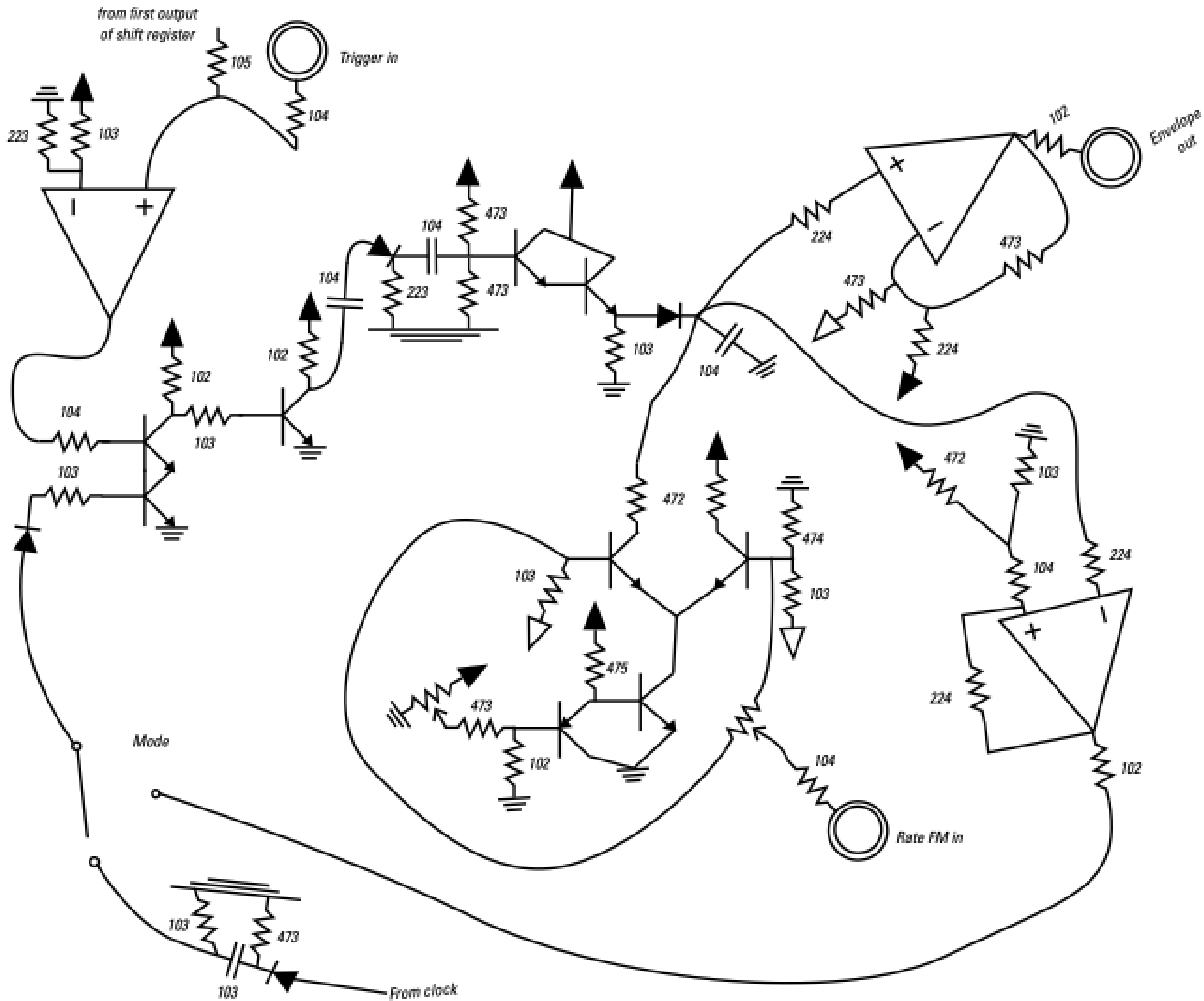
- Shift Registers
  - The shift registers are CD4015 with 4 bit R2R DAC on the first four stages and logic outputs on the last four stages. If you are at all confused about the function of this part just google the CD4015 and read the data sheet.



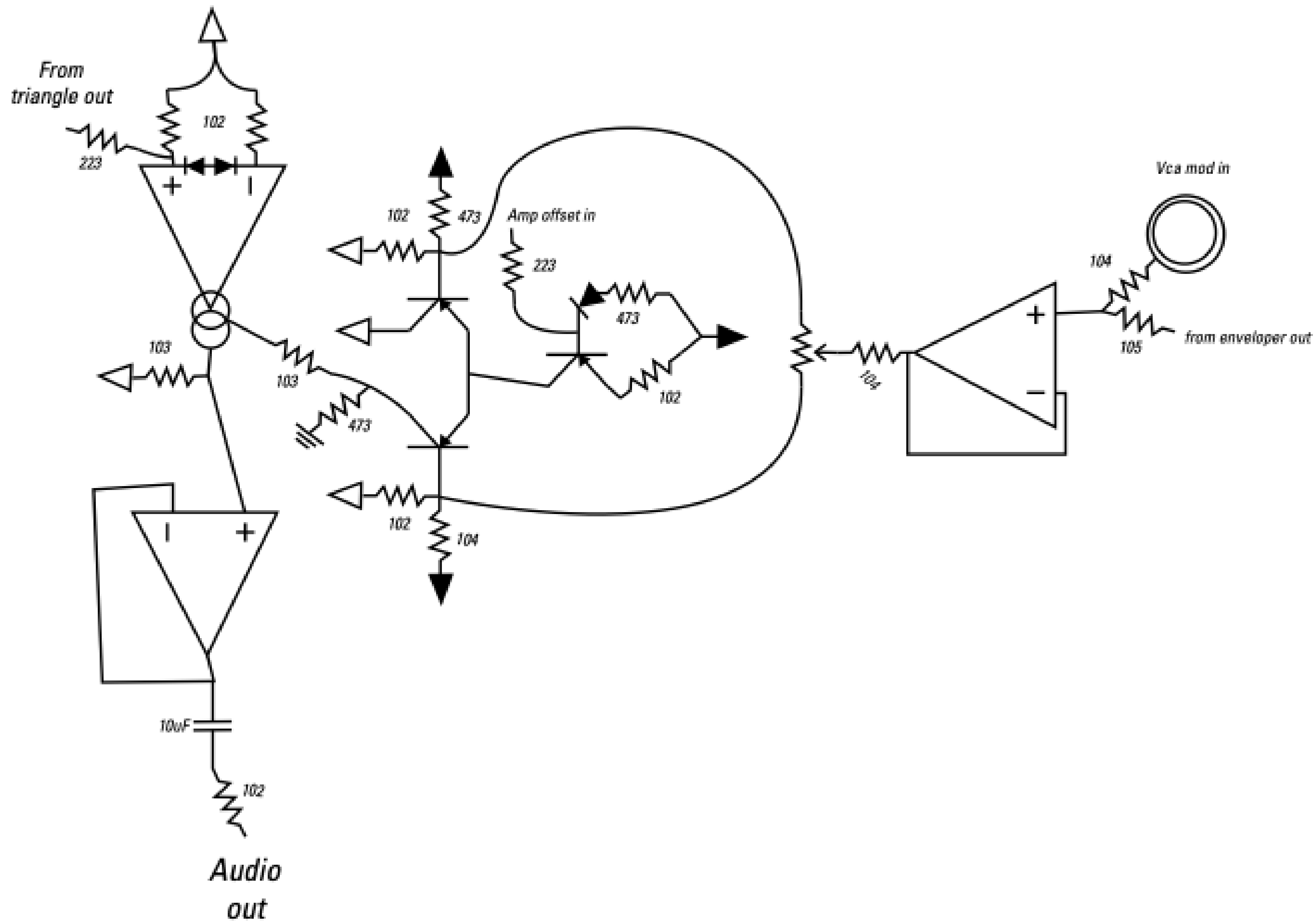


- Clock/Div/Xor
  - CD4046 VCO and XOR. CD4013 Makes a two stage binary counter for clock /2 and /4.

- Envelopers
  - And gate into high pass then darlington pair feeds a capacitor with a short spike of current. Current sink drains the cap.



- Amplitude
  - Even more OTAs and differential current sources



~~~~~~~~~~~~~~~~~~~~Example Patches~~~~~~~~~~~~~~~~~~~~

Patch #1 For Buchla Swooners (Sort-of Random FM bumps)

- Try setting the knobs and switches to the positions diagrammed in fig 1a.
- Patch the four connections shown in 1a and add some bits to the lower register by pressing the orange bit button associated with that shift register. Play with the knobs slowly to see what the effect is. Try changing the CV levels to hear the effect of the R2R output altered. Try changing the rate of decay on the envelopers and switching them to loop.
- Take this arrangement beyond four patch cords by trying the following in Fig 1b. which can produce some sort-of ping-ponging, tempo-doubling action.
  - Clock out into right XOR in
  - XOR out to clock in of one of the shift registers. You'll notice this just inverts the clock so now there is a ping-ponging effect with the clocks.
  - If we patch to the Left input of the XOR we can control if the clock is verted or inverted with another logic signal. This then gives a sometimes ping-ponged effect which can sound like the tempo is being multiplied by two.

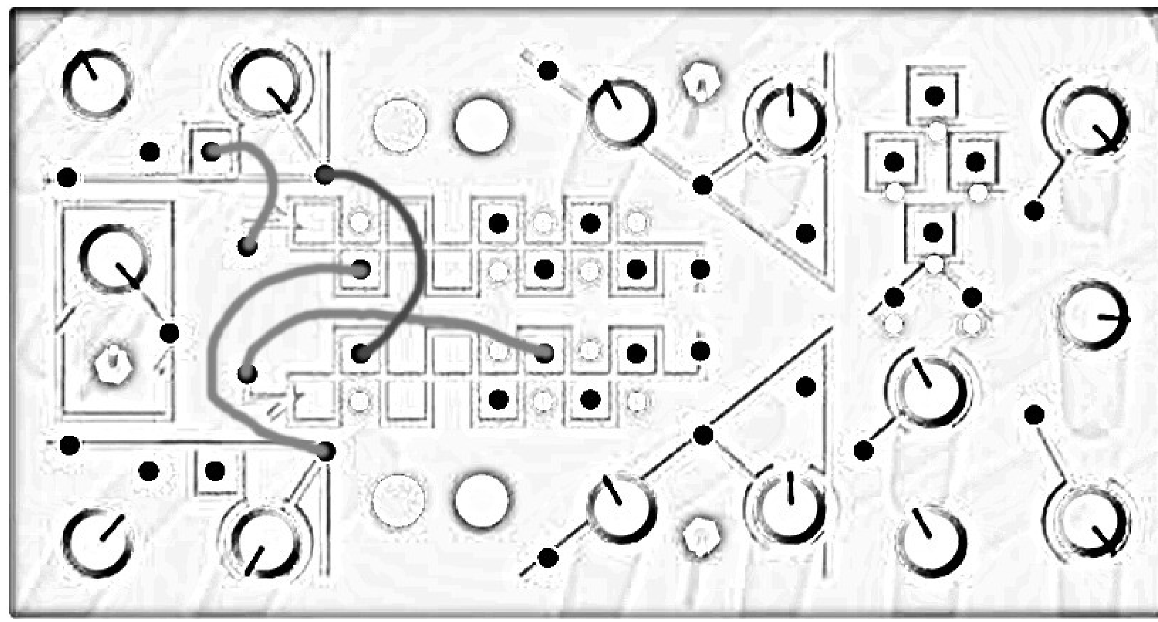


Fig 1a.

- The effect is most apparent when the Left XOR is patched to a logic out from the shift register which is not being clocked by the output of the XOR. You can see this lack of effect if you try the logic out from the same register...

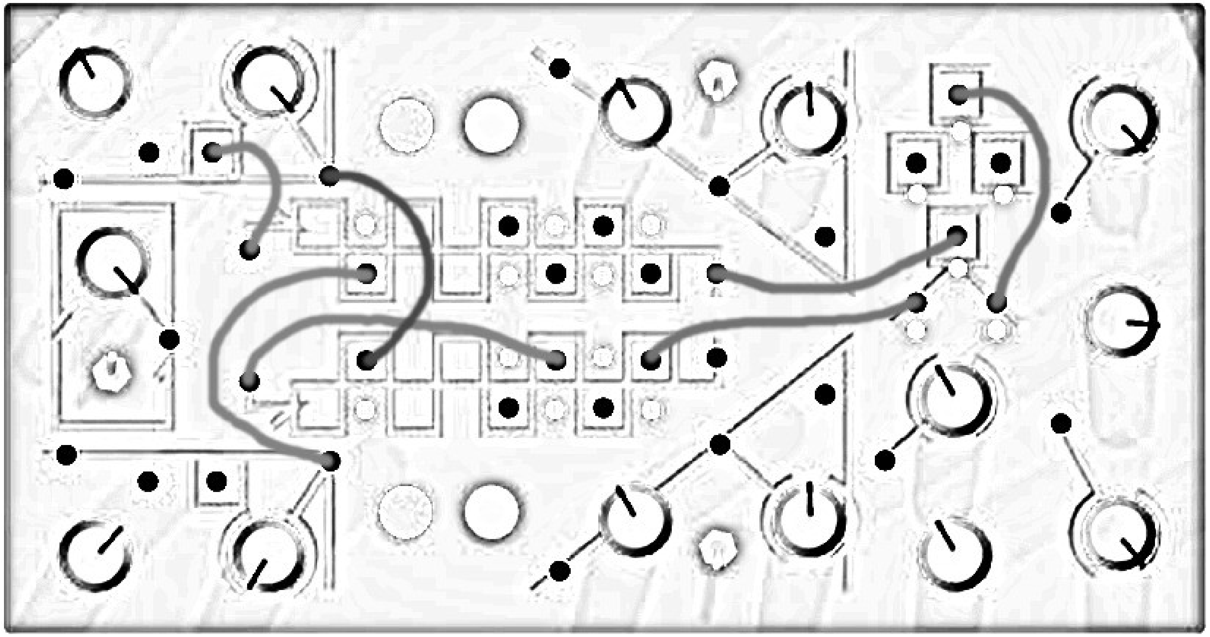


Fig 1b.

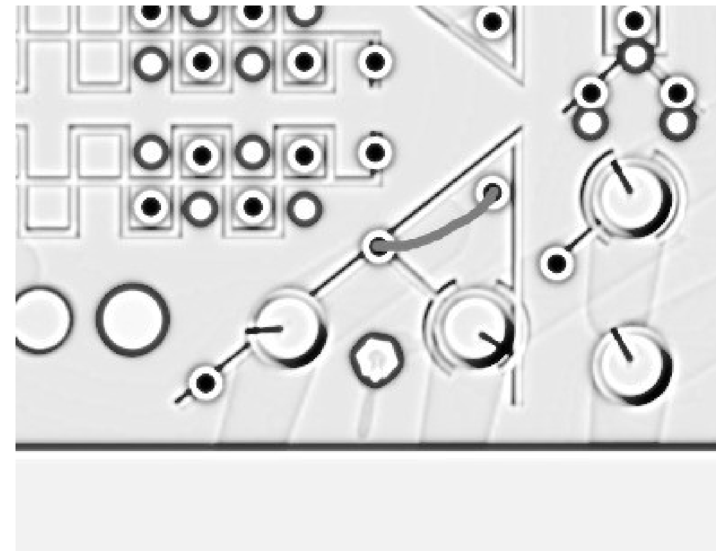


Fig 1c.

- Also to add to the percussive effect we can shape the envelopers by feeding the outputs back to the cv inputs as in Fig 1c and tweaking the knobs to get the shape to a more dramatic slope.
  - Lengthen the decay by turning the decay knob counter-clockwise and add positive modulation by turning the CV level knob clockwise. Now you are bouncing.

Also try this patch with both registers fed by the square outputs of oscillators,
And with FM switch set to the middle for FM of both oscillators at once.

Patch #2 Just Techno

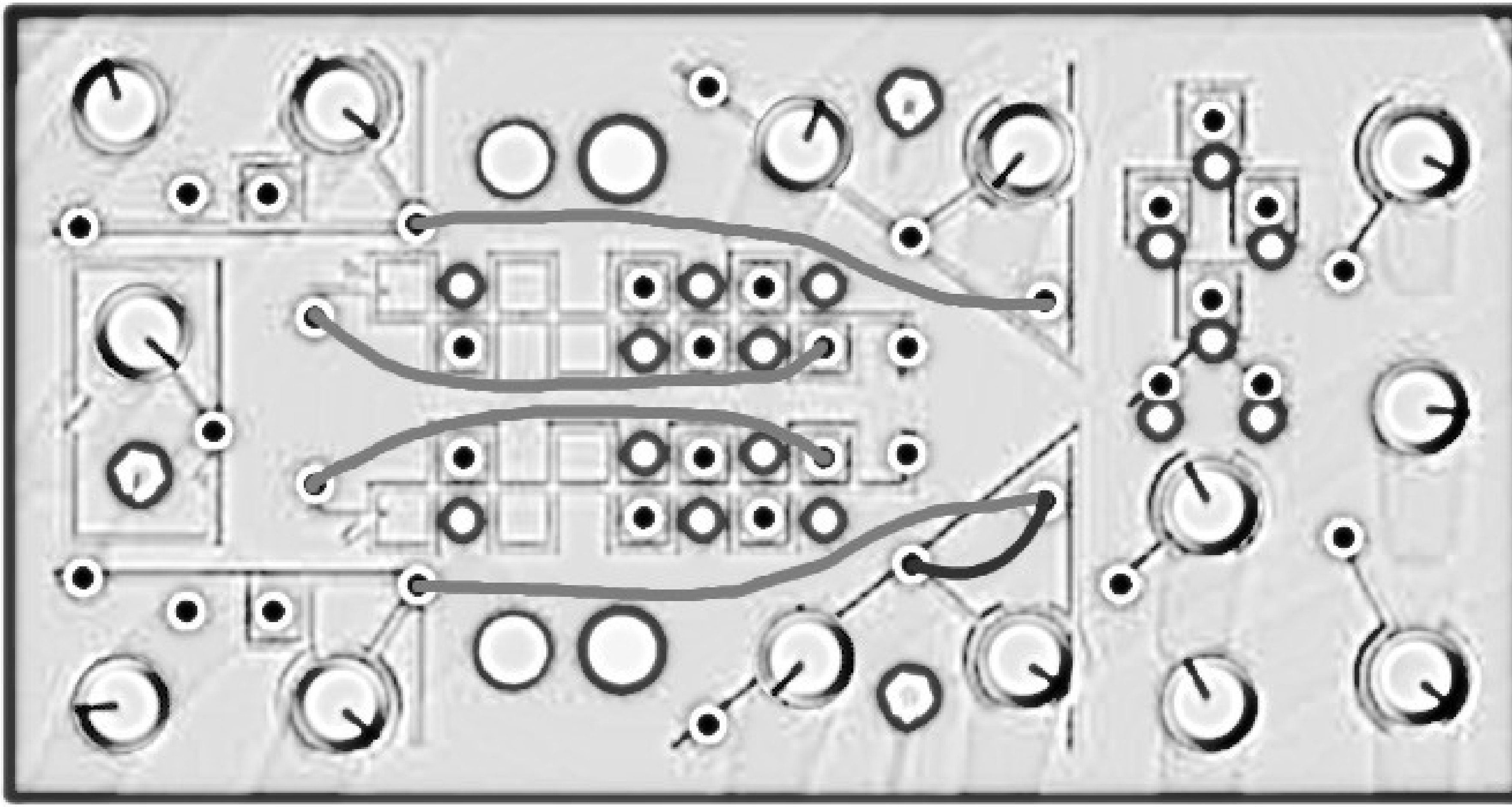
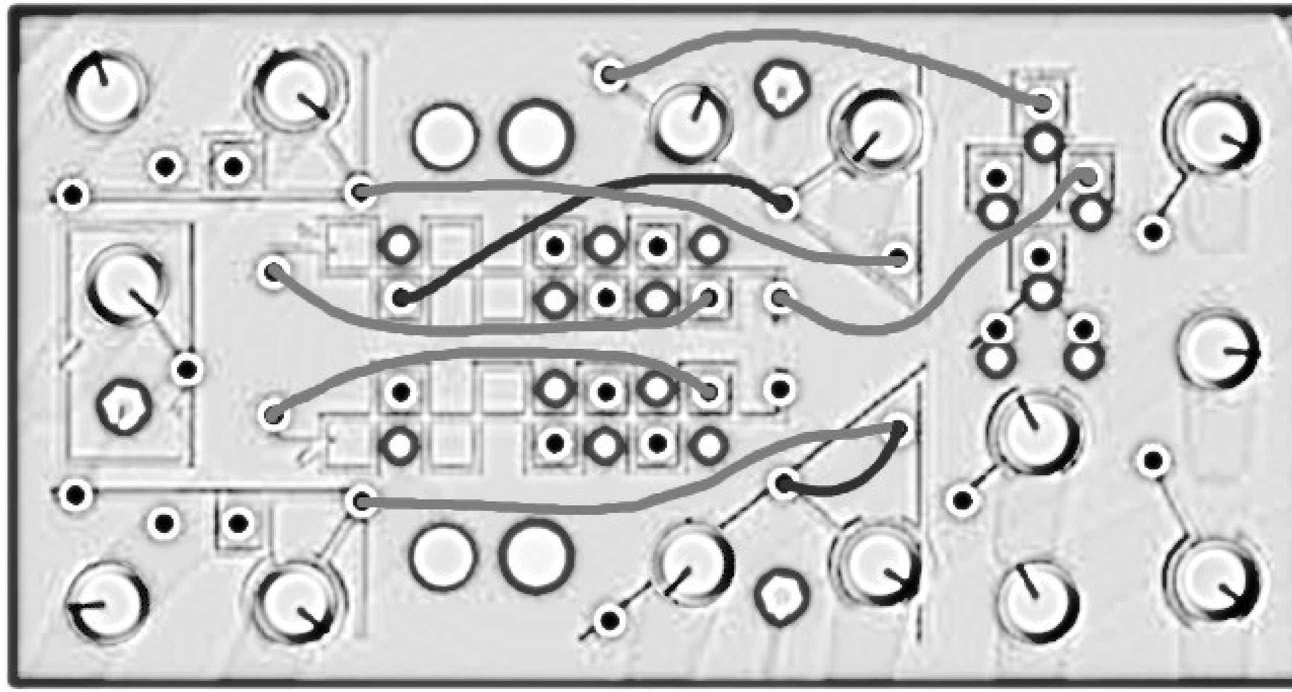


Fig 2a

- Set up the knobs and switches in the fig above (fig 2a)
- Patch the 5 connections (don't miss the bottom enveloper feedback!)
- Now watching the top clock led, type some rhythms in using the orange buttons. You need to press the buttons long enough that your pressing the button intersects the rising edge of the clock. For 4 on the 4loor press the bottom register button only when the /4 clock output is high...

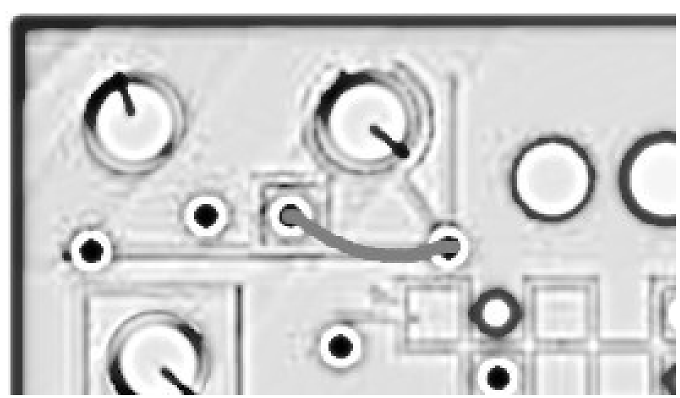
- Try patching the following connections one at a time clock out to trigger in of the top enveloper.
  - This will trigger the envelope every clock because the clock input of the shift reg and the enveloper are ANDed together...
- Now use the register that was just triggering the envelope to add some modulation by patching the R2R out to the CV in of the enveloper. (darker patch connection in diagram)
- You can also try clocking the top register with the /2 clock output to see what thats like. It will halve the time of the sequence.

Fig 2b



With the enveloper
Looping at fast speeds
It can begin to sound like
A sawtooth oscillator.
And the slower the
Source oscillator you
Will hear the saw more
Clearly.

2c



Try also feeding the
Square output back
To make the triangle a
Saw. Stack both connections
Even.

Patch #3 PRNGLFSR (Expert)

With XOR ability now available on the Double Knot we can patch a pseudo random number generator of sorts.

- Start by setting the knobs and patching one of the top register bit outputs to the bottom register data input. Try 8... This will link the registers end to end. You can test this by typing some bits into the top register and watching them flow to the bottom register.
- Patch the top data input to the output of the XOR Now both registers will fill up because the XOR out is normally high...
- Plug an output of the bottom register into the right input of the XOR. Since the left XOR input is normaled high this XOR is now an inverter. The registers should begin to cycle all high bits, then all low bits. This is sometimes called a "Walking ring counter"...
- If then a connection is made between the left XOR input and an output of the top register, the smooth cycling of the register will be altered and now we have a longer pseudorandom pattern. Try all different bit outputs to see the different patterns that you can get.

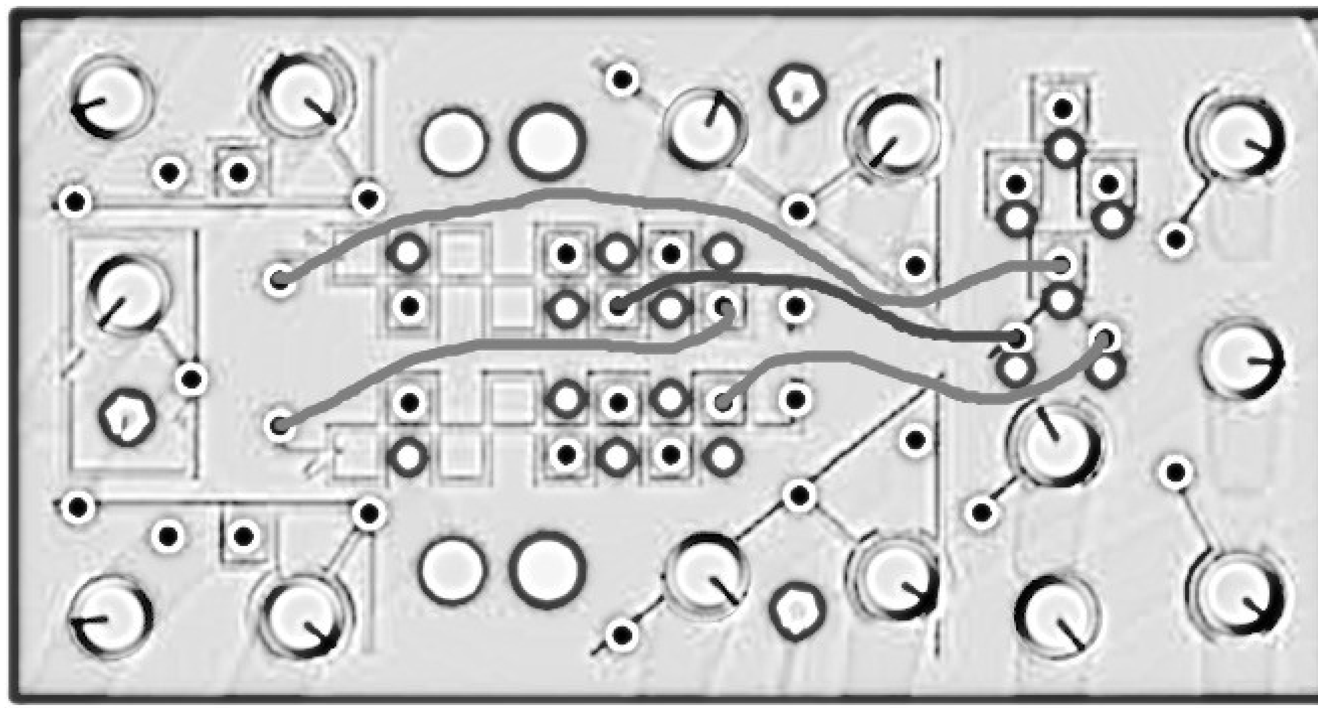
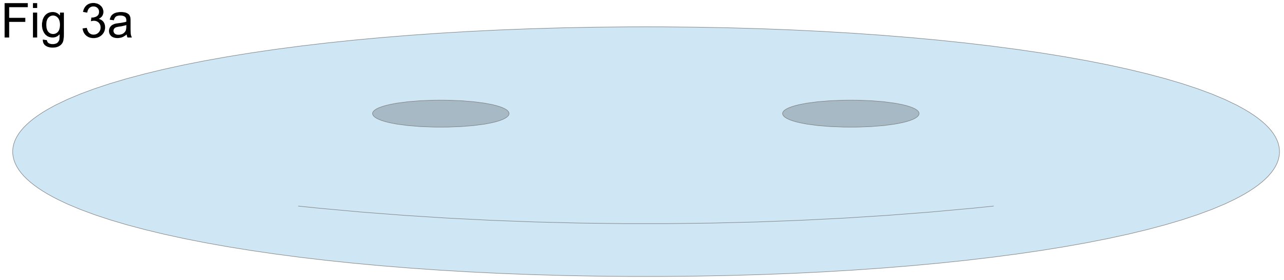


Fig 3a



- Now link both clock inputs of the registers with a short cable and stack that connection to the square output of the lower oscillator. Turn the pitch up a little bit and you will hear the shift register patterns speed up.
- Next to hear the patterns more clearly we can patch each R2R output to the VCA cv input.
- Try unplugging the cable feeding left XOR input and patch it to different register outputs. You can hear that when its unplugged the registers are just cycling what was in their short memory when you unplugged the cable.

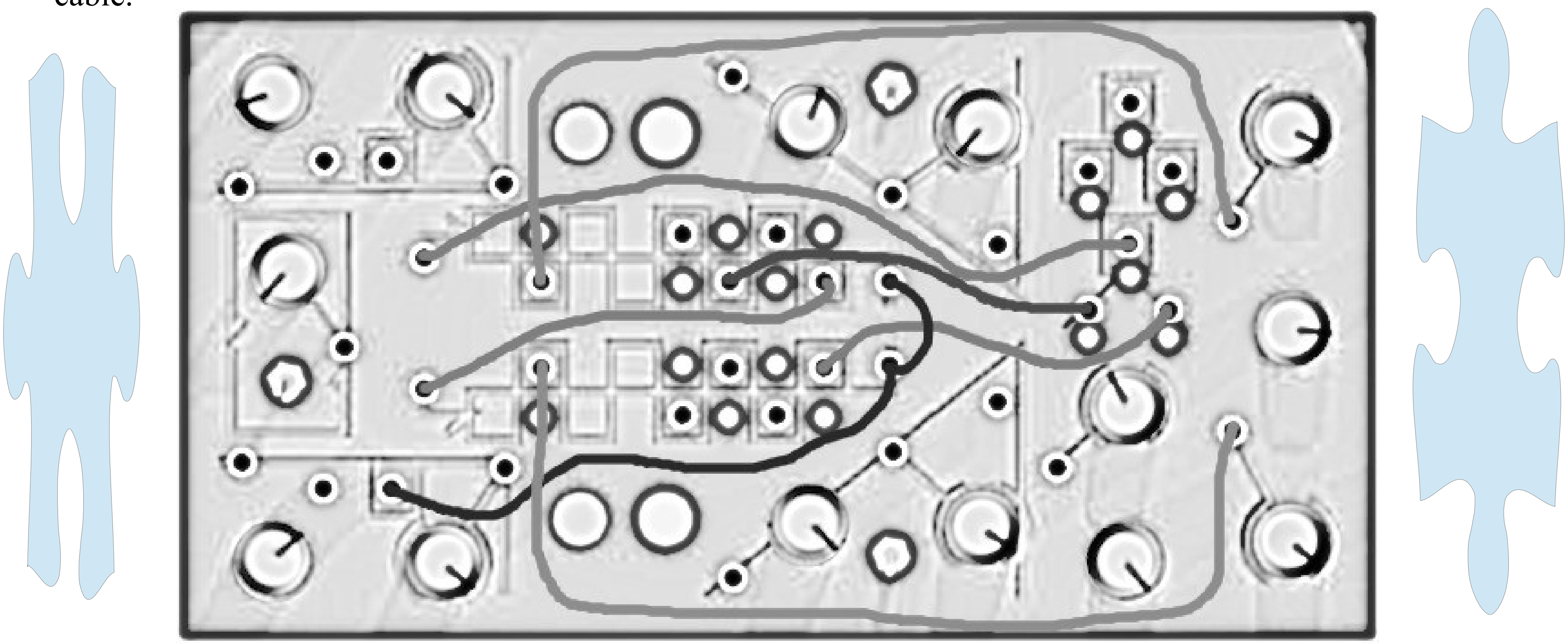


Fig 3b

Plug the left XOR input to the square output of the top oscillator with a slow pitch and you can hear the timbre of the tone change each cycle of the oscillator. This is adding a few new bits to the cycling register. It sounds a bit like a wavetable oscillator.

Patch #3.5 Wrungler

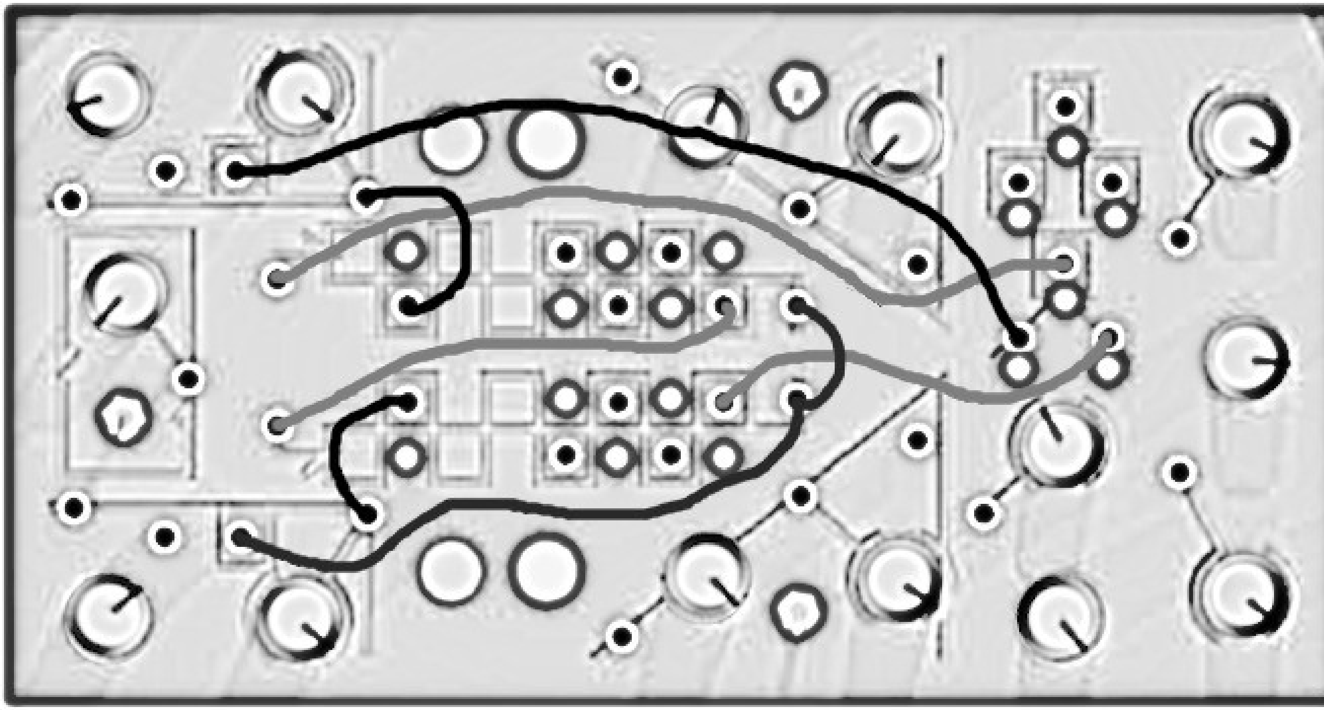
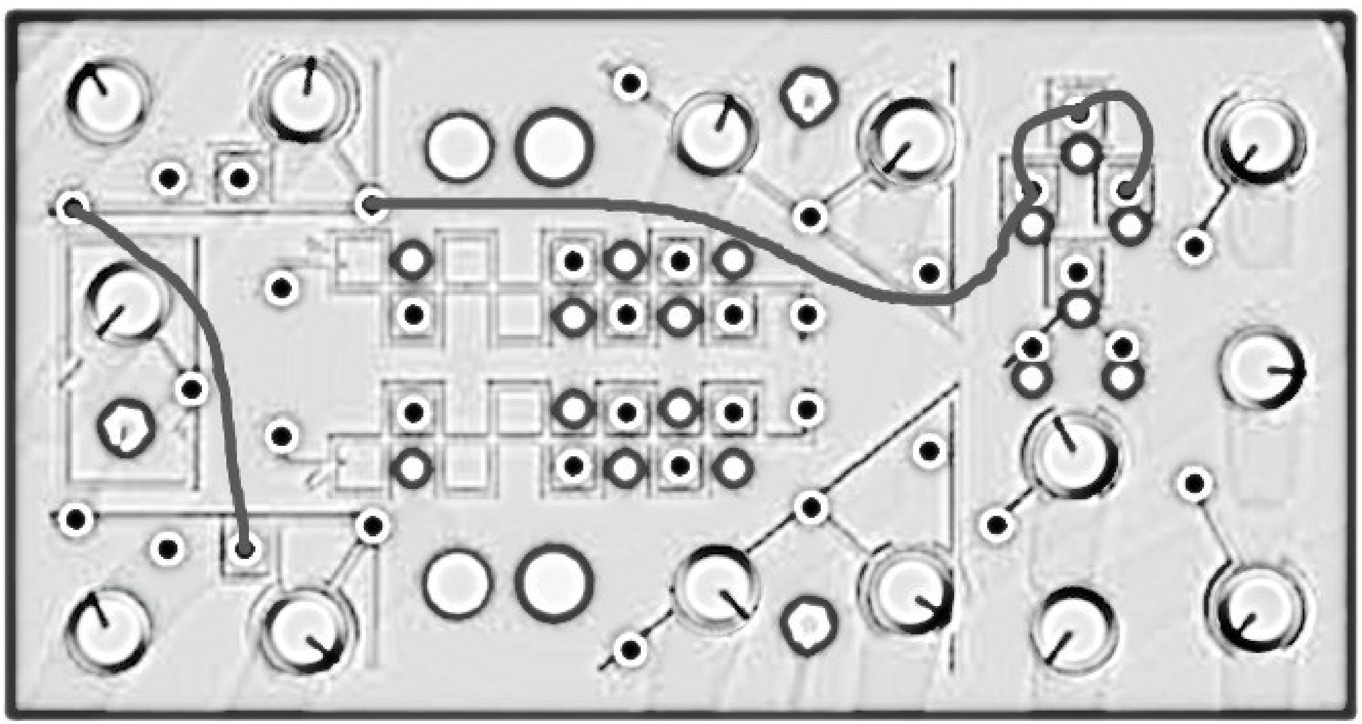


Fig 3.5a

This is a Rungler patch. Its a slight alteration of the previous example.
All that is needed is to patch the R2R outputs to the pitch inputs instead of the VCA inputs. Play with the knobs!
Also now that the envelopers are being used to control volume again, some Interesting effects can be found by looping the envelopers and modulating them With the R2R outputs or bit outputs or eachother's outputs...

Patch #4 Using Sync

- Set the knobs according to fig 4a. The VCA knobs to the right are all the way inverted opening up the VCAs so the oscillators will drone through.
- Patch the square out of the bottom oscillator to the sync in of the top oscillator.
  - Turn the pitch knobs around and see the effect of sync.
- Now connect all of the clock outputs together using stacking cables. This will make a stepped sawtooth wave at the rate of the clock.
- Patch this mixture to the Pitch CV input of the top oscillator and turn the CV amount knob just off of 12 noon in either direction.
  - You should get a rising or falling arpeggio relating to the pitch of the bottom oscillator.



Erratum and Revision notices

Rev 1 to Rev 2 changes 02/2020

04/2020 It should be noted that these are entirely housekeeping changes that mostly make it easier for me to build the knots! There are no feature changes and only very slight sonic changes if any, between revisions! Please enjoy.

- First, if you are curious which Rev you have, a quick way to check is at the left end of the device when looking at the face. There is a window to see the text "LORRE-MILL DOUBLE KNOT"
  if the text is white you have Rev 1 if the text is yellow you have Rev 2 or later.
- Power supply caps are spec'd higher on Rev 2 if there are power supply issues with Rev 1 the two 0805 size capacitors near the 7809 voltage regulator need to be replaced. They are on the rear of the PCB inside the triangle outlined by the clock divider outputs. The following part should be used and is used on Rev 2. Murata part GRM21BR61E106MA73L. If you encounter any problems with the power supply of Rev 1 boards please email me.
- FM depth and clipping is changed ever so slightly from Rev 1 to Rev 2. Resistors are swapped just above the toggle switch to set FM direction. Two right resistors are 103 and two left resistors are removed. This is just a matter of taste and can easily be changed if you wish.
- Ranging and scaling bodge resistors have been implemented on the PCB in Rev 2.
- Red bodge boards added to Rev 1 have been implemented on Rev 2 PCB. balancing levels on both envelope modes.