BMC013. Random Resonator

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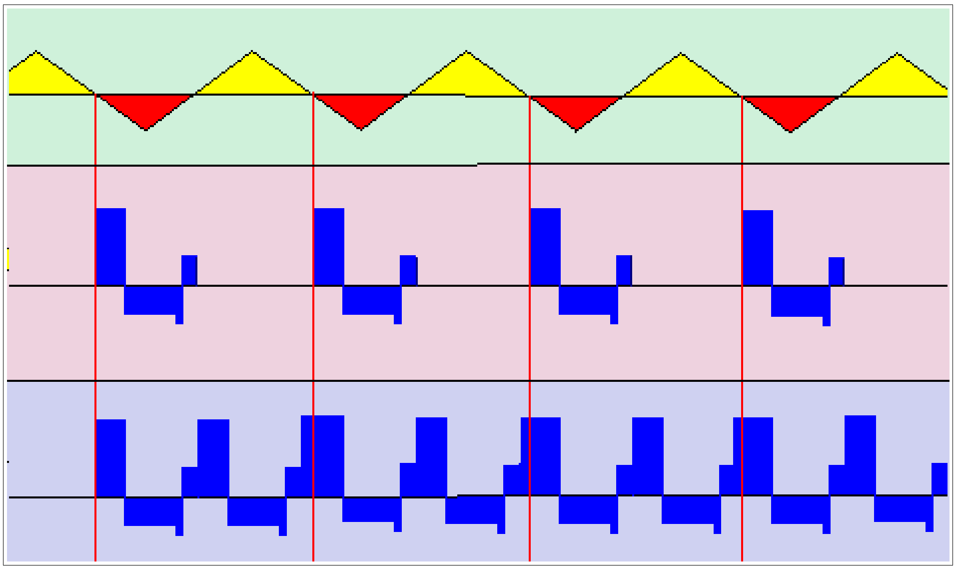
I. What is a Random Resonator?

A. Origin and Explanation

This module is inspired by Bernie Hutchins "Cascaded-Monostable Type Generalized Resonator" which he described in Electronotes #93, September 1978. This circuit took an incoming VCO signal and whenever the signal transitioned from negative to positive it triggered a series of short pulses. The Random Resonator does this as well, but with a very big difference. The CMGR had 4 pulses, each of which



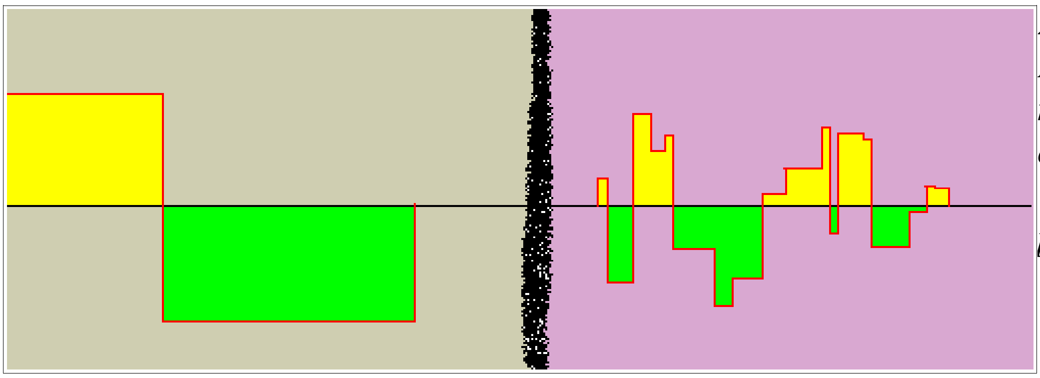
had a control for it's amplitude and it's length. The Random Resonator selects amplitudes, lengths and the number of pulses completely at random.

In the above diagram the top waveform represents the input waveform. The red line extending below it represents the transition from negative to positive that triggers the resonator. The middle waveform represents a series of random pulses being triggered by these transitions. The bottom waveform shows the same waveform repeating itself when it gets to it's end, which is possible in the Random Resonator's "loop" mode.

B. Controls, **Inputs and Output**

CONTROLS

1.Blend Knob - The blend knob is used to select what mix of the original signal and the resonating signal gets sent to the blended output.



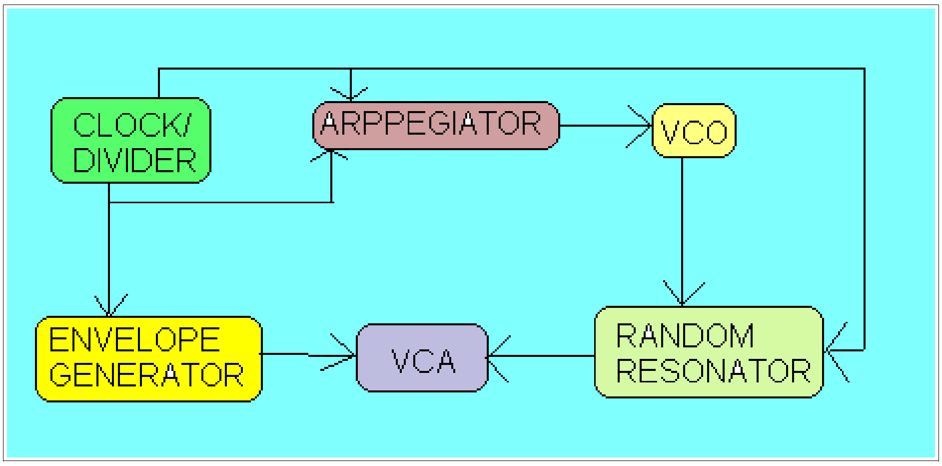
2.Complexity Knob - This manually controls the "Complexity" parameter. "Complexity" is *actually controlling three separate parameters; possible output levels, maximum number of steps and maximum length of a single step. When the complexity knob is turned counter clockwise (like the left in the above diagram) there are less possible output levels and a lower maximum number of steps, but a longer maximum length. When turned clockwise, the opposite is true (like on the right in the above diagram).*

3.Loop switch - This switch toggles whether the resonator will repeat the series of pulses at it's end or not.
4.New Button - When this button is pressed a new random series of pulses is generated. The complexity level of the new series of pulses depends on the setting of the knob when the button is pressed.

INPUTS
1.Wave Input - The output from a VCO or other part of the synthesizer should be input here.
2.New Trigger - A gate or trigger signal on this input will perform the same function as the New button.
3.Complex CV In - To use an LFO, sequencer or other CV generator to modulate the complexity level, input it to this jack. There is an attenuator associated with this input.

OUTPUTS
1.Wet Output - This is the direct output of the series of pulses
2.Blend Output - This output is a mix between the pulses and the input signal.

C. Patch **Demonstrations**



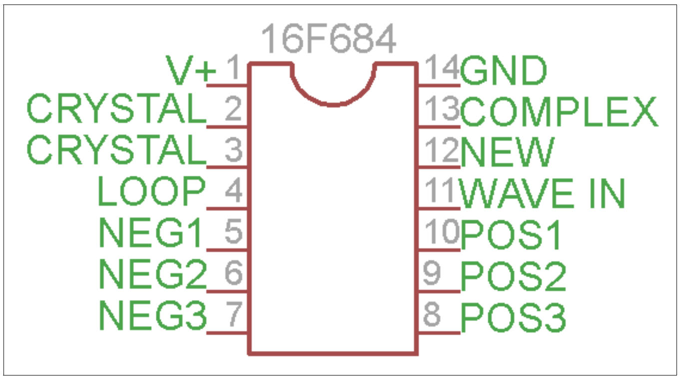
The diagram above shows the patch used for the first two sound samples. A clock/divider is sending it's undivided output to an Envelope Generator which is controlling a VCA. The undivided output is also being sent to the clock input of an arppegiator. A divided output is being sent to the reset of the arppegiator and the "NEW" input of the Random Resonator. The arppegiator is controlling the pitch of a VCO which is being processed by the Random Resonator in the diagram. The basic idea of the patch is that each new arpeggio exhibits a different timbre than the *previous one*

This MP3 demonstrates the patch with the blend knob and complexity knob both set about halfway on the resonator.
This MP3 demonstrates the patch with only the pulses being output.

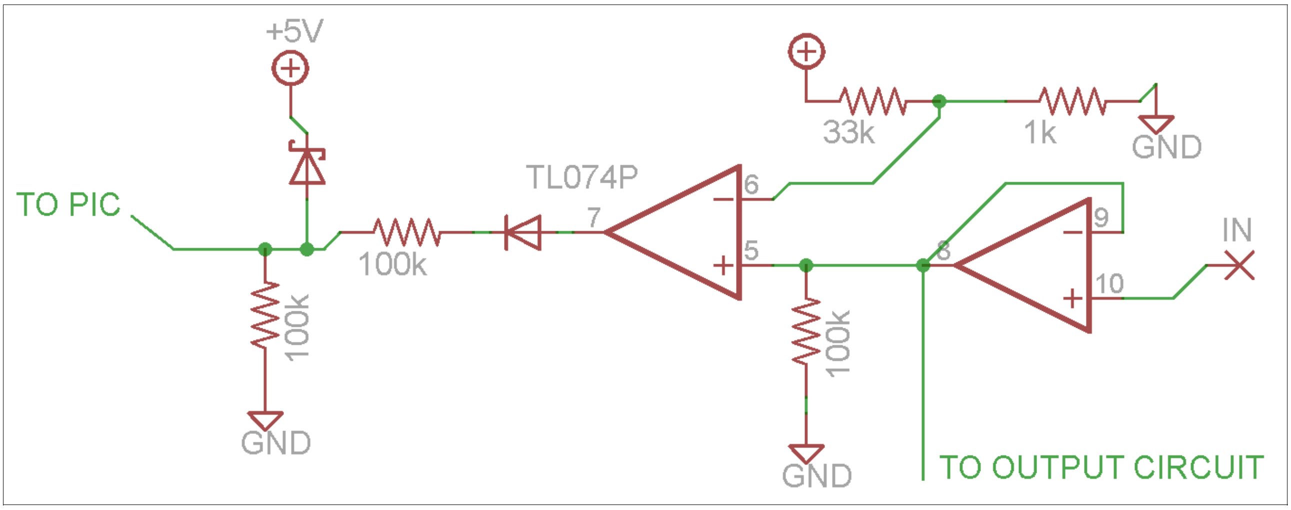
This MP3 takes the arppegiator and VCO out of the equation, and sets the Random Resonator on loop mode. Each time the "new" input receives a pulse, the resonator changes it's output tone.

II. Circuit Description

A. The **Chip**



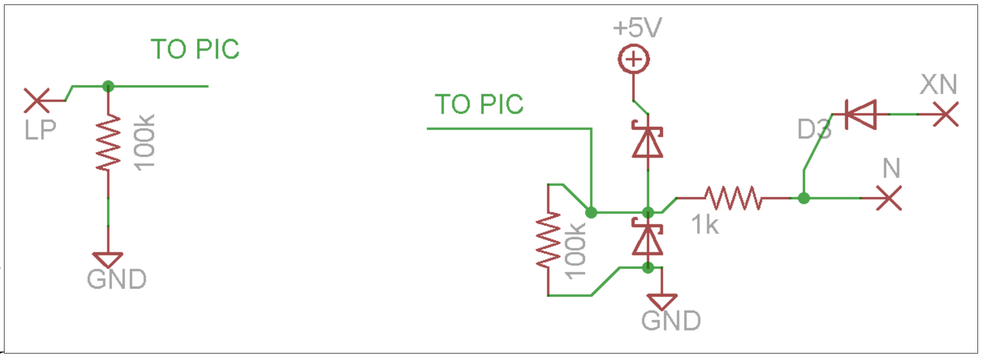
At the center of the Random Resonator's design is a PIC 16F684 Micro controller chip. The pinout of this chip is on the right. Pin 1 should be attached to a +5V supply, Pins 2 and 3 are attached to a crystal oscillator and 22pf capacitors. Pins 4, 11 and 12 are all digital inputs, meaning they only recognize changes from 0 to +5V. Pin 13 is an analog input, meaning it recognizes all different voltages between 0 and 5v. Pins 5-10 are all digital outputs which only put out either 0 or +5V.



B. Oscillator **Input**

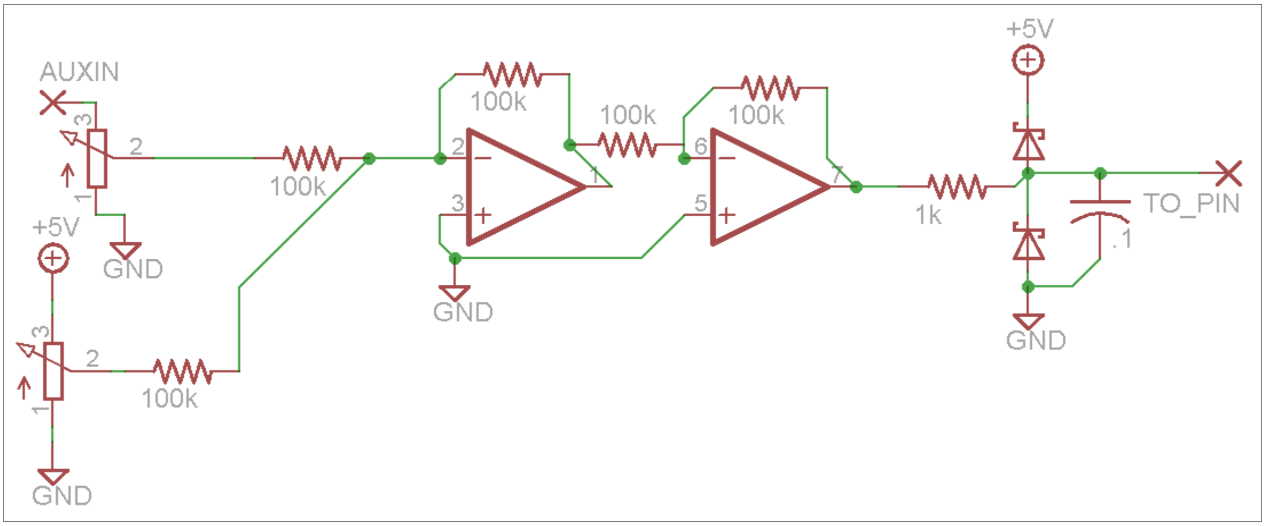
Above is the circuitry for the "WAVE INPUT" pin of the PIC. On the far right is a wirepad marked "IN" where the input waveform is inserted. This is buffered with an op-amp, and one of the op-amp's outputs is sent to the blend control in the output circuitry. It is then also sent to an op-amp wired as a comparator, set to turn on when the input voltage rises slightly above zero. On the comparator's output there is a diode, a pair of 100k resistors and a schottky diode. These components are used to limit the comparators output to 0 and +5V instead of outputting from -12V to +12V. The 100k resistor to ground also acts as a pull down resistor for the digital input, keeping the pin at 0V when there is no input.

C. Other Digital Inputs

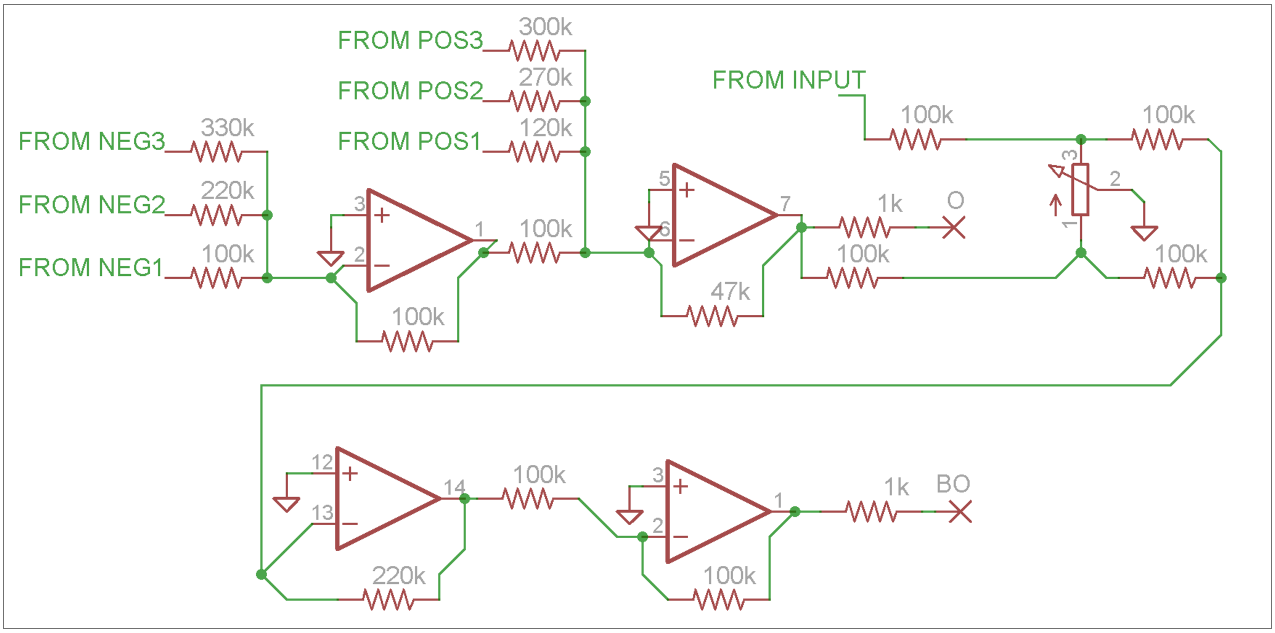


On the right we see the other two digital inputs. The input for the Loop control on the left is just a wirepad and a 100k pull down resistor. The wirepad should be attached to a switch to +5V. On the right we see the input for the "New" button. The wirepad marked "N" should be attached to a push button wired to +5V, and the wirepad marked "XN" should be wired to a jack for inputting trigger or gate signals. The diode after XN keeps the +5V produced from a button press from being sent back into the output circuitry of whatever XN is attached to. The 1k resistor and schottky diodes are used to limit the input voltage to between 0 and +5V and the 100k resistor is a pull-down resistor.

D. Analog Input



There is only one analog input in this module. External control voltages are inputted at the point marked "C" and then attenuated by a potentiometer, this voltage is then offset by the manual control voltage pot below it. These are mixed and inverted by a pair of op amps. The outputs of these op amps then go through a 1k resistor and a pair of schottky diodes which act as voltage protection of the micro controller.



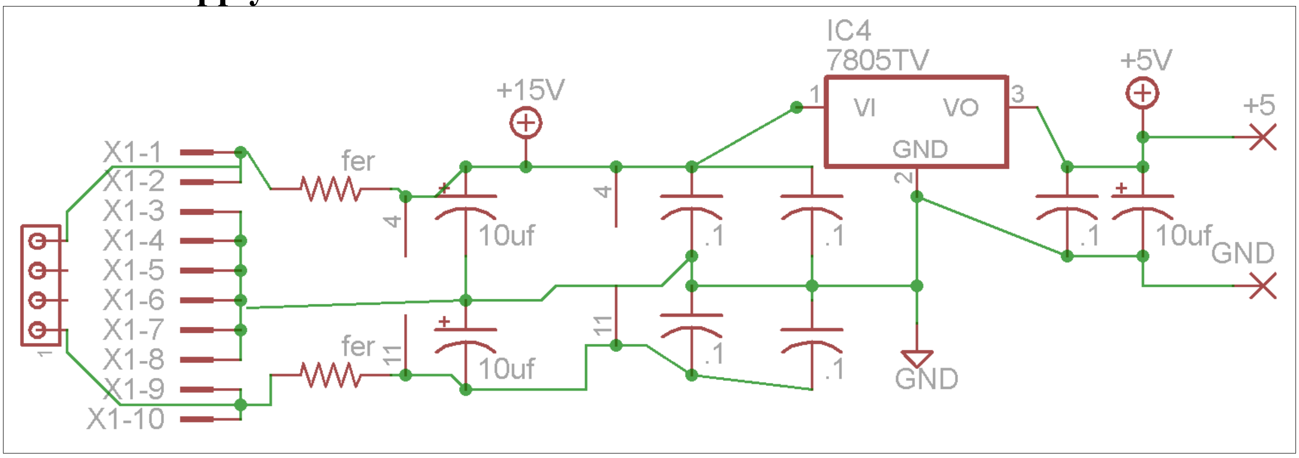
E. Output

The output circuitry is a bit different from other Digital to Analog converters I've used in past designs. On the top left we see the negative outputs from the PIC are being sent to an op-amp being used as an inverting mixer. Next the output of this mixer and the positive outputs from the PIC are mixed together. A 47K feedback resistor is chosen for the second op-amp so that the circuit has a gain of .5, keeping output to ~ +5/-5.

Note that the first set of mixing resistors have values of 100k, 220k and 330k while the second has values of 300k, 270k and 120k. The second set has different values to keep positive and negative amplitudes from completely canceling each other out when both turned on, and creating more possible amplitude levels. The values are not critical, and if you wanted to substitute near values for either of these sets, it should be fine.

The output of the second op-amp goes through a 1k resistor to the Output wiring pad and is then sent to the blend circuit. The blend knob has it's wiper tied to ground and each outside lug is being fed either the wet or original signal through a 100k load. It is then being sent to a mixing op-amp with a gain of 2 to make up for loss of gain on the blend knob, and then sent to an inverter to return the phase to normal before being sent to the blend output.

F. Power Supply



The two power connecters go through the resistors marked "FER" which can be either ferrite beads or 10ohm resistors, or bare wires, depending on your concern for power supply noise. These attach to 10uf caps for each power rail, and .1uf caps at the power pins of each chip. The positive voltage rail also goes to a 7805 voltage regulator which provides power for the micro controller.

III Construction

A. Parts List

Resistors

Value	*Quantity*	*Notes*
100K	*19*	*5mm lead spacing, use 3.2mm length resistors or stand up*
1K	*5*	*" "*
220K	*1*	*" "*
330k	*1*	*" "*
120K	*1*	*" "*
270K	*1*	*" "*
300K	*1*	*" "*
47K	*1*	*" "*
33K	*1*	*" "*
B100K	*3*	*Alpha RV120F-20-15F-B100K part.*
FER	*2*	*Ferrite Bead or 10 ohm resistor*

Capacitors

Value	*Quantity*	*Notes*
22pf	*2*	*2.5MM lead spacing. Ceramic.*

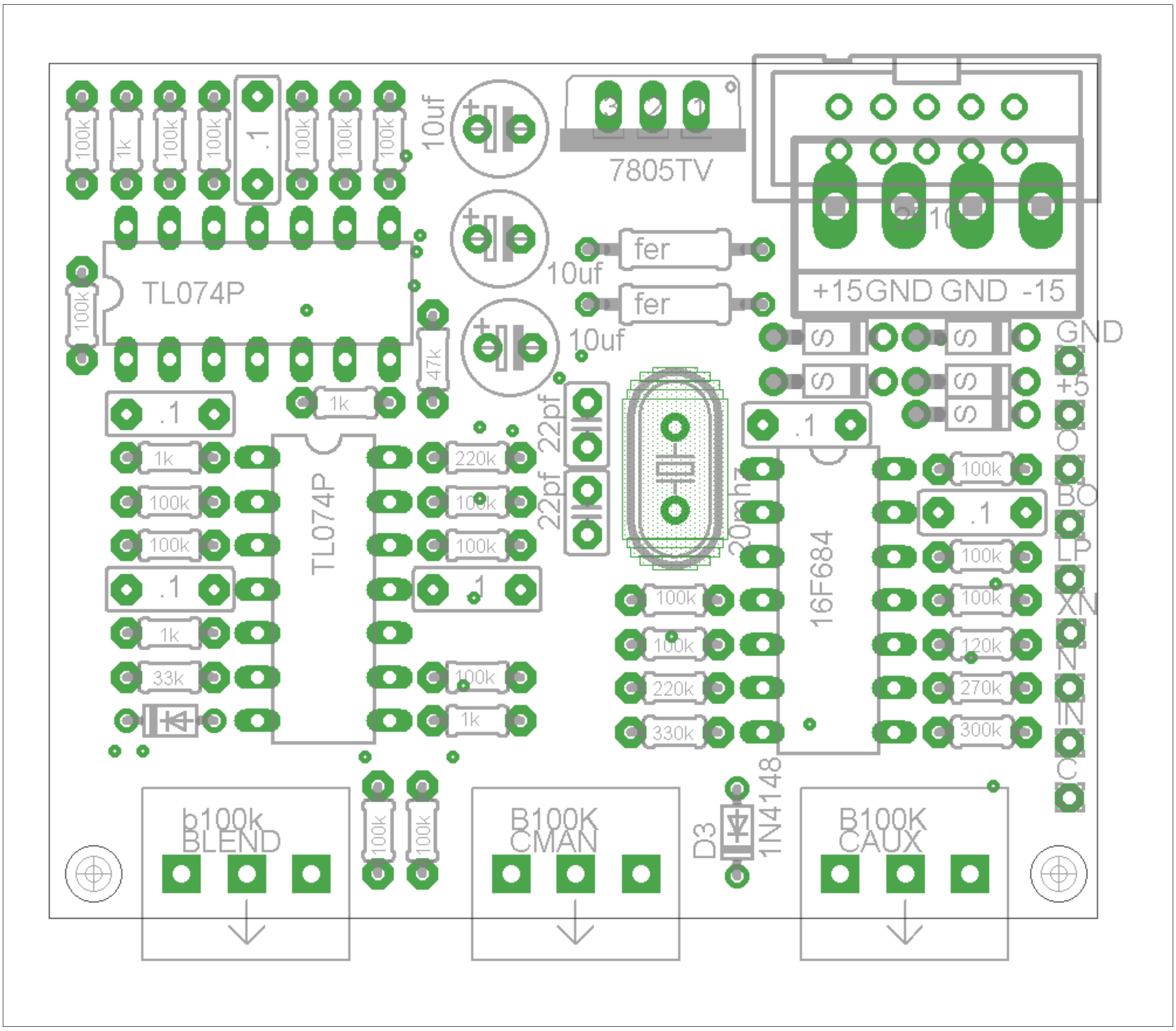
.1uf	*6*	*5mm lead spacing. Ceramic or better.*
10uf	*3*	

Semiconductors

Value	*Quant*	*Notes*
16F684	*1*	*Is included with PCB purchase*
TL074	*2*	*14 pin DIP*
7805	*1*	*TO-220 Packaging*
20 MHz Crystal Oscillator	*1*	
1n4148	*2*	*5mm lead spacing, other switching diodes should be fine*
SD101C	*5*	*5mm lead spacing, other small schottkys should be fine.*

Other

Value	*Quantity*	*Notes*
14 Pin DIP Socket	*3*	
Power Connecter	*1*	*board has footprints for Eurorack or MOTM style connecters*
SPST toggle	*1*	*or SPDT*
SPST Push button	*1*	*should be Off-(on) type*
Jacks	*5*	*either 1/4" or 3.5mm" depending on build format*



B. The Board

The board measures 60mm x 50mm. The pots are spaced 19mm (3/4") and the mounting holes are spaced 2&1/8" apart. The wiring pads are marked as follows:

GND = Ground, 0V

+5 = +5V from power supply

O = Output. This is the "wet" output of just pulses

BO = Blended Output. "wet" output blended with input signal

LP = Loop enable.

XN = External New.

N = New

IN = Input

C = Complexity external CV.

C. Wiring Diagram

This wiring diagram shows what wire pads should be connected to what panel mounted components.