BARTON MUSICAL CIRCUITS

Voltage To Rhythm Converter

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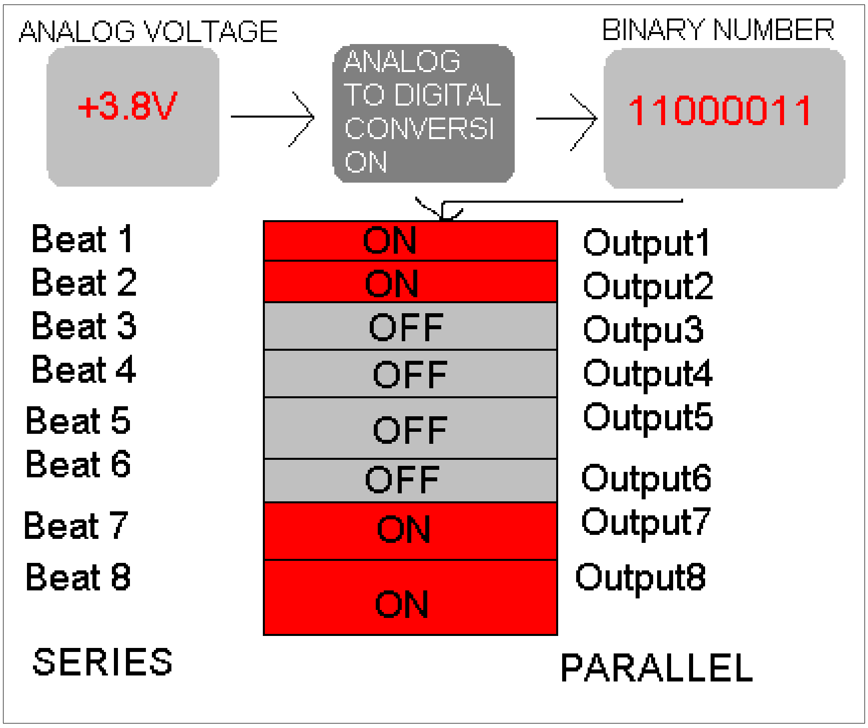
I. What is A Voltage To Rhythm Converter?



A.Voltage->Binary Number-> Rhythm.

This module turns voltages into binary numbers in a two different modes series, and parallel. Both modes utilize analog-to-digital conversion in creating rhythms from beats. In either mode, an input voltage is sampled and converted to an 8-bit binary number. A clock is then applied and on each tick of the clock, the output should change.

In series mode, the input voltage is sampled, converted to binary and then the numbers are cycled through on each clock tick with the 1's represent beats that should be played upon, and 0's represent beats that should be rested upon. An input voltage of 0v will result in all rests. An input voltage of 5v will result in all on-beats. All voltages between 0 and 5v will result in a rhythm that has both rests and on beats. Each output has it's own button and trigger input telling it when to sample the input voltage.

In parallel mode, the binary number is outputted directly to the outputs, and each clock tick triggers a resample of the input voltage. So if the input voltag is at 5v when the clock ticks, all outputs will turn on. If the input is at 0v when the clock ticks, all outputs will turn off.

B. Inputs/Outputs/Controls

<u>INPUTS</u>

1.Sample input - This is the voltage that will be converted into a binary number. This is a DC-coupled input that has it's own attenuater and manual offset, so any input voltage can be used.
2.Clock input - When using an external clock signal, input it here. This can accept trigger, gate or oscillator signals as it's input.
3.Speed cv - When using the internal clock, this is an input for speed control voltage. This voltage will be summed with the manual speed control.
4.Sample Triggers - There are 8 of these inputs, 1 for each output. Only a gate or trigger signal (a signal alternating between 0 and 5V) should be used for this input. When a rising gate or trigger is detected on this input, it will cause the module to resample the input voltage for that output.

<u>OUTPUTS</u>

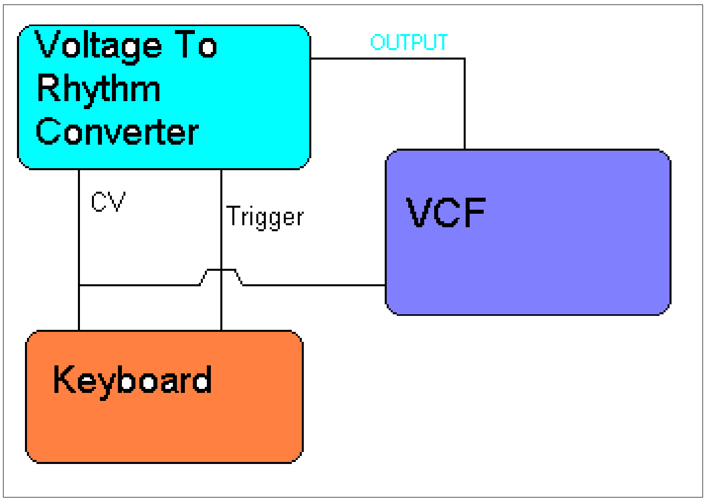
1.Trigger/Gate outputs - There are 8 of these, one for each channel. These outputs will output either

a gate or trigger corresponding to the current input voltage or sampled voltage depending on the mode of operation you are in. Each has an LED corresponding with it's output.
2.Clock output - This outputs a trigger on each new clock. It is active whether using the internal or external clock.

CONTROLS
1.Sample Attenuator and offsetter - These two control knobs condition the external sample voltage. When no external sample voltage is used, the offsetter can be used to manually select the sample voltage. To get the full range of inputs from an input in the 0 to 5v range, like a seqeuncer, turn the offset knob fully counter clockwise and the attenuater fully clockwise. To get the full range of inputs from an input in the -5V to +5v range, like an LFO, turn both knobs to be halfway up.
2.Speed - When using the internal clock, this controls it's speed.
3.Sample buttons - There are 8 of these, one for each output. Pushing one of these while in series mode will cause that output to resample the input voltage.
4.Parallel/Series switch - This switches between series and parallel modes of operation.
5.Trigger/Gate switch - This switch determines whether outputs will be triggers or gates. Gates remain on until an off-beat is presented, triggers turn on for 5ms at the start of each on-beat.
6.Divide switches - These switches cause division on the clock signal. One divides by 4 and the other divides by 16. When both are used, this causes a division of 64.

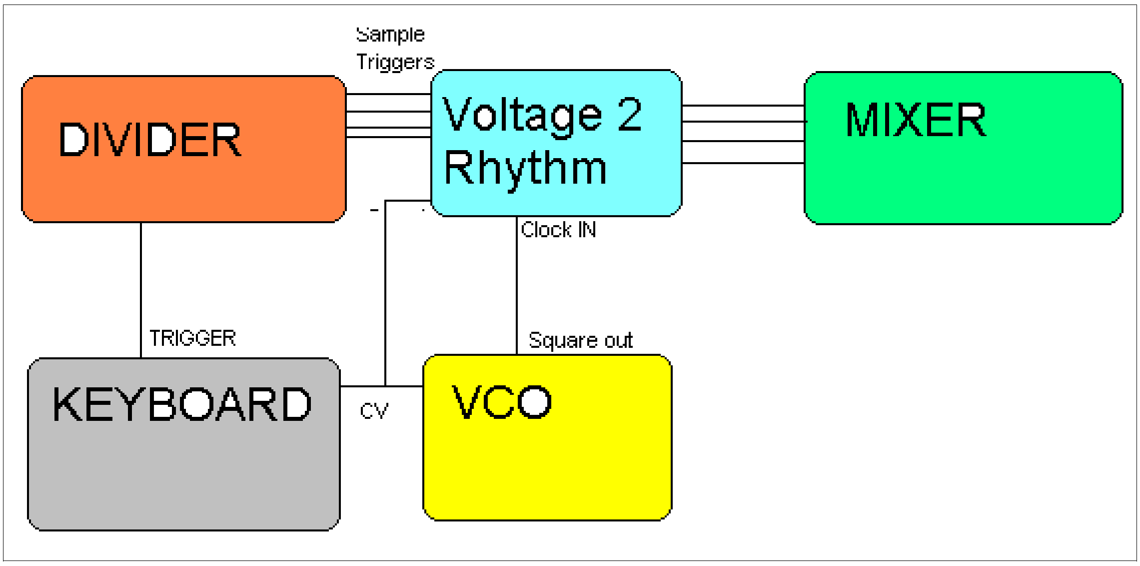
C. Sample Patches
These are just a couple of ideas for patches using the Voltage To Rhythm converter. There are plenty of other uses.

PATCH1



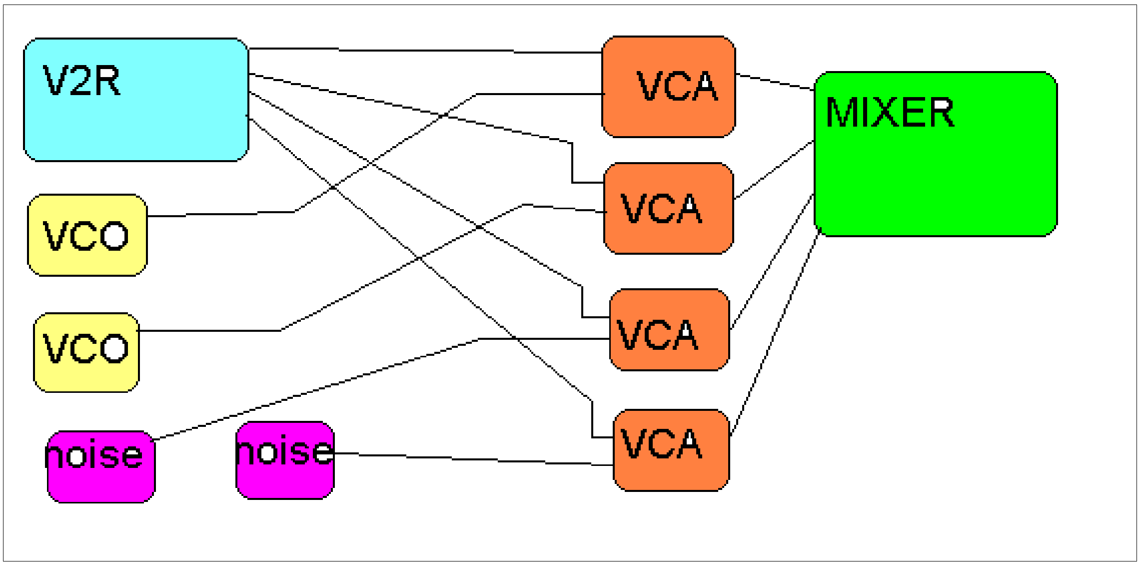
This is the first patch I ever did, when testing the original prototype. The VCF's Q should be cranked so that when the V2R's output is put into it's input, it produces a short, percussive sound. The V2R should be in trigger/series mode. With this patch, each note played will have it's own corresponding rhythm.

PATCH2



This patch gives a constantly shifting timbre. The keyboard's trigger output is sent to a divider's input, and it's outputs are sent to the V2R's sample trigger inputs. The keyboard's CV output is sent to the V2R's sample input, and a VCO's 1v/oct input. The square output of the VCO is sent to the clock input of the V2R. 4 of the outputs of the V2R are sent to a mixer. Each time a note is played on the keyboard, the V2R will resample one of it's outputs, and the clock's frequency will change.

PATCH3



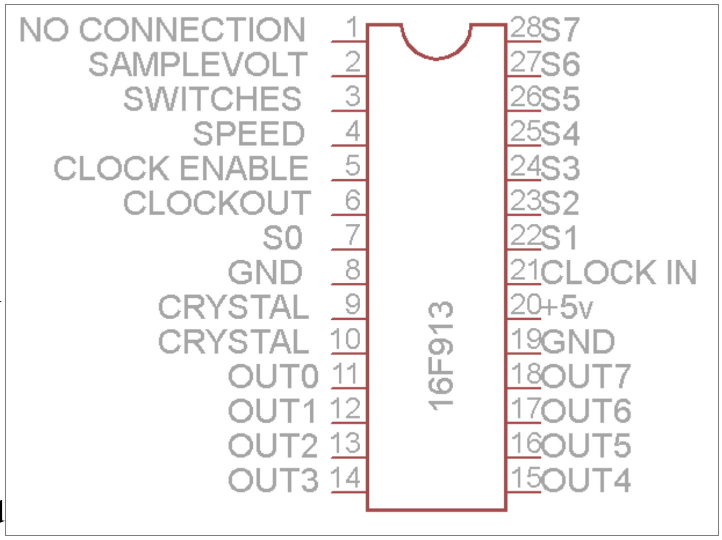
In this patch, the V2R is used as a standalone rhythm sequencer, controlling the on/offs of two VCOs and two noise sources. Very simple, but very satisfying to play with.

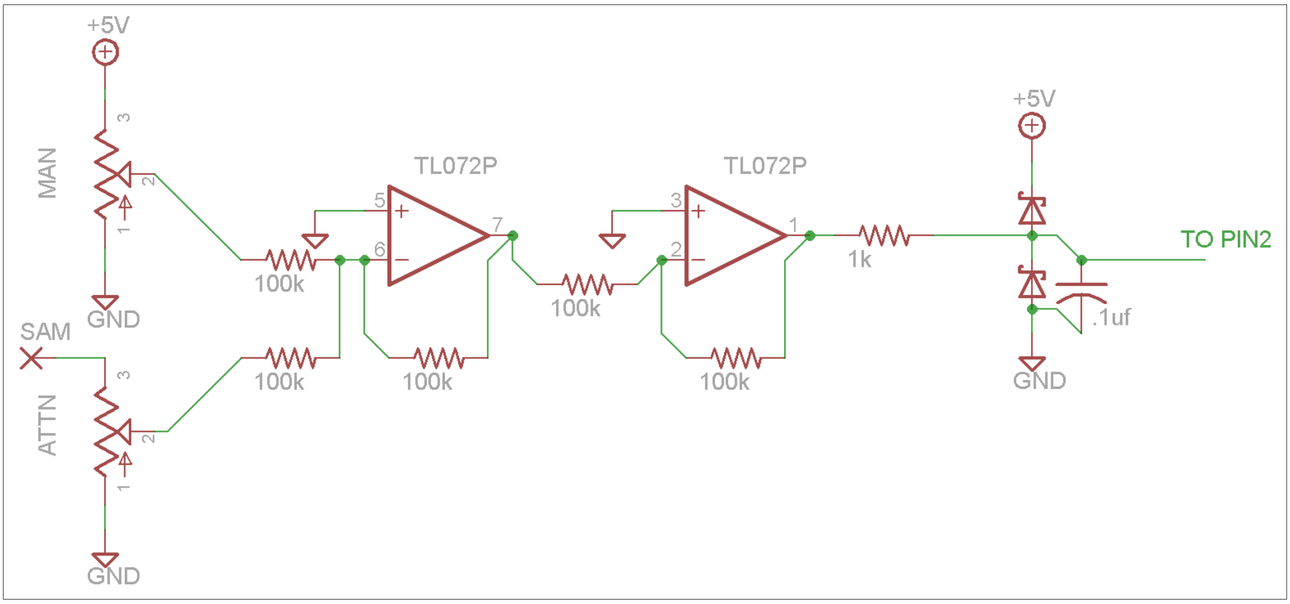
II. Circuit Description/Schematics

A. The Chip

The heart of this design is the 16F913 microcontroller. All other circuits in this section interact directly with this chip, we will look at these sub-circuits one at a time.

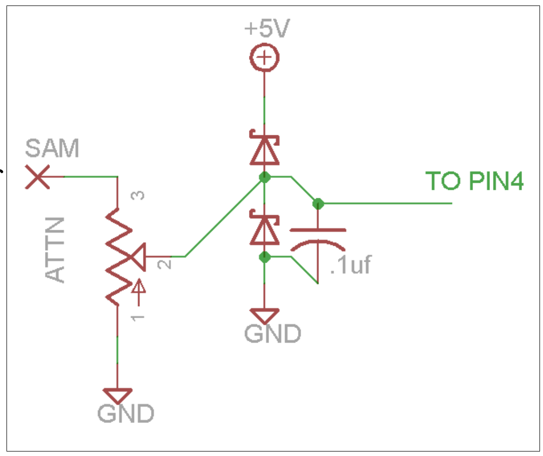
Here is the pinout for the chip. Pins 2-4 are analog inputs which read a variable voltage. Pins 5, 7 and 21-28 are all digital inputs which read either 0 or +5V signals. Pins 11 - 18 and pin 6 are all digital outputs which put out either 0v or +5V. Pins 9 and 10 are connected to a crystal oscillator which maintains the processing clock for the chip. Pins 8, 19 and 20 are all part of the power supply.





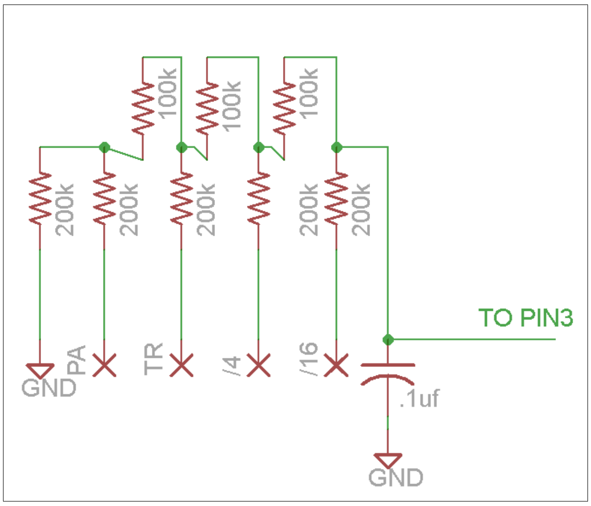
B. Analog Inputs

1. Sample Voltage Input. This subcircuit consists of two potentiometers wired as voltage dividers. The top one, creates the offset voltage for the sample voltage. The bottom one attenuates the input voltage. The 100k resistors and pair of amps form a pair of zero gain inverting op-amp gain stages. The first one is used to mix the two voltages and the second inverts it back to a positive voltage. The 1k resistor and pair of Schottky diodes protect the pin of the microcontroller from negative voltages and voltages above 5v which could damage the chip or cause erratic behavior. The .1uf cap filters high frequency noise out of the input of the chip.



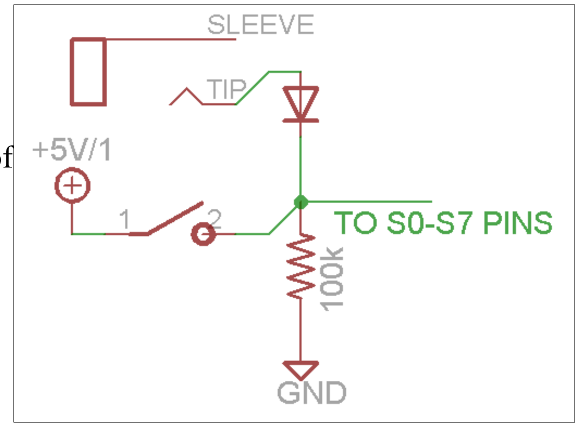
2.Speed. This circuit consists of just an attenuator and voltage protection. The speed input jack should be a switching type normalled to +5V.

3.Switches. This circuit is a text book R/2R Digital to Analog conversion circuit. At first it might seem extremely odd to convert digital inputs to an analog voltage and then send it to an analog to digital converter on the microcontroller, but it is done as an easy way to use one pin on the chip to read several switches at once. This is connected to the Parallel/Series switch, the Trigger/Gate switch and the two divider switches. Each switch should be switching between +5V and Gnd, as you'll see in the wiring diagram section.

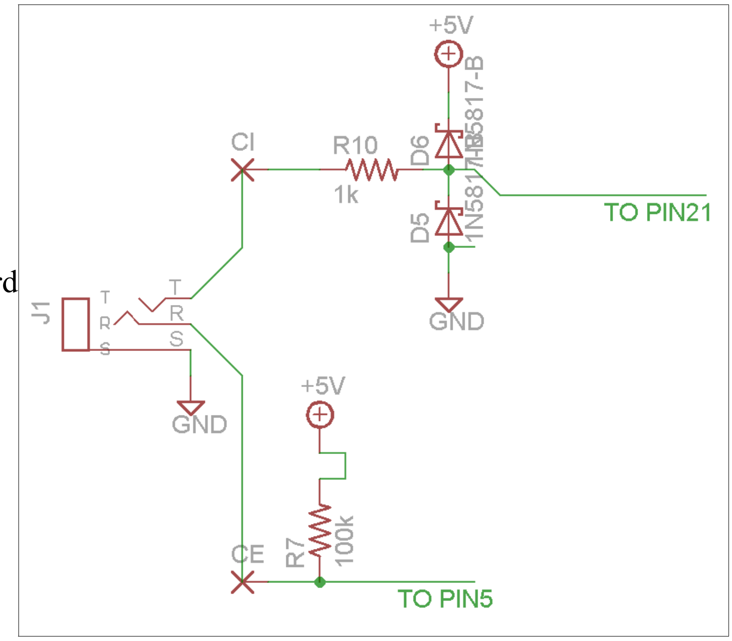


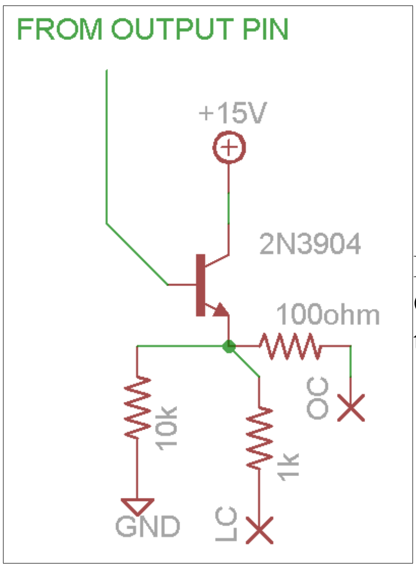
C.Digital Inputs

1.Sample Switches This circuit is repeated 8 times, once for each output. The jack and switch are both offboard components. The 100k resistor is either part of a single-in-line bussed array or it's a standalone. The 100k resistors keep the input pins of the chip at ground until a gate or trigger is applied to the input jack or the button is pressed. The diode is there to keep the button from interacting with a module connected to the input jack.



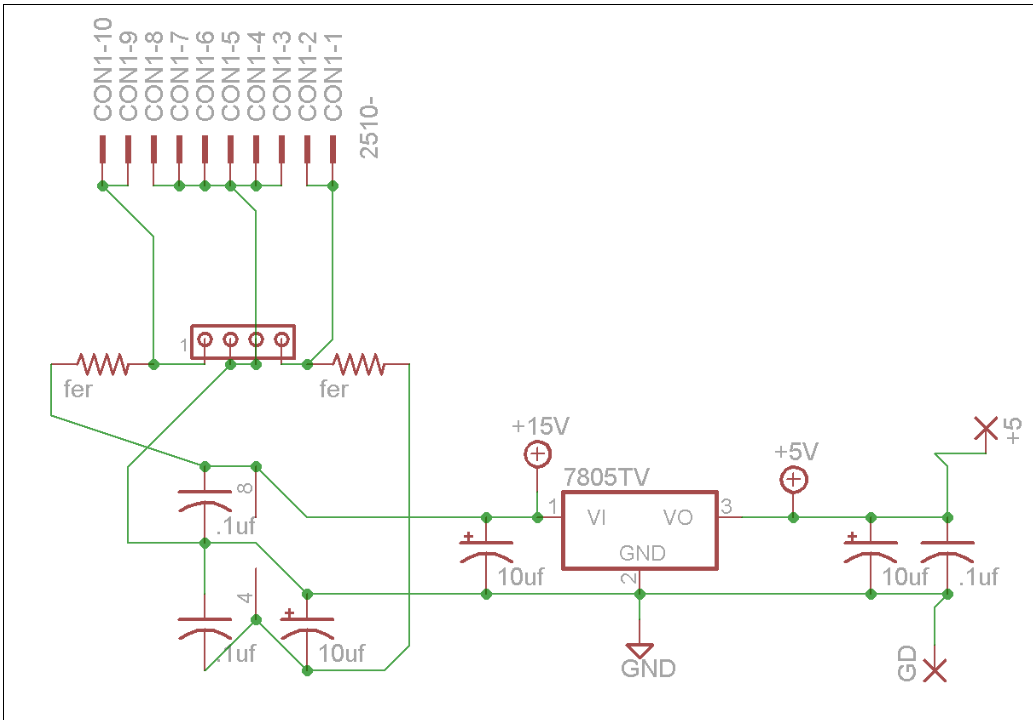
2.Clock Input. The stereo jack pictured is an offboard component. Pin5, the clock enable pin, is connected to +5V through a 100k resistor, keeping the clock enabled when no external clock jack is plugged in. When one is plugged in, the sleeve of the jack will connect Pin5 directly to ground. The tip of the jack is connected to a standard 1k and Schottky diode voltage protection arrangement and then sent to Pin21.





D. Digital Output This is a simple transistor buffer. This circuit is repeated 9 times.

E. Power Supply. Here we see two connecters, one for Eurorack and one for MOTM format synthesizer modules. The two resistors marked "FER" can either be ferrite beads or low value resistors for power supply filtering. A pair of 10uf electrolytics filter the positive and negative rails of the power supply, and a 7805 provides a +5V supply, which is then filtered with another 10uf. There are additional .1uf caps for the power supply pins of each IC.



III. Construction

A. Parts List

1.Semiconductors

Value	Quantity	Notes
16F913	1	Should come with your PCB
TL072	1	
7805	1	In To-220 packaging
2n3904	9	
1n4148	8	
SD101C	4	Or other Schottky

2.Capacitors

Value	Quantity	Notes
.1uf	3	5mm lead spacing. Cheap ceramics should work fine
10uf electrolytic	3	
22pf	2	2.5mm lead spacing. Cheap ceramics should work fine.

3.Resistors

Value	Quantity	Notes
100k 1/4W	10	5mm lead spacing. Use 3.5mm body length or stand up
1k 1/4W	12	" "

10k 1/4W	9	" "
100ohm 1/4W	9	" "
200k 1/4W	5	" "
100k bussed array	1	9 pins. 100k is non-critical value, anything over 10k should work
10 ohm	2	or ferrite bead for power supply 7.5mm lead spacing
100k Lin PC mount pot	3	Alpha RV120F-20-15F-B100K part.

4. Other

value	Quantity	Notes
20mhz Crystal	1	5mm lead spacing
28 pin Dip socket	1	
8 pin Dip socket	1	
Power connecter	1	either 4 pin MOTM or 10 pin Eurorack

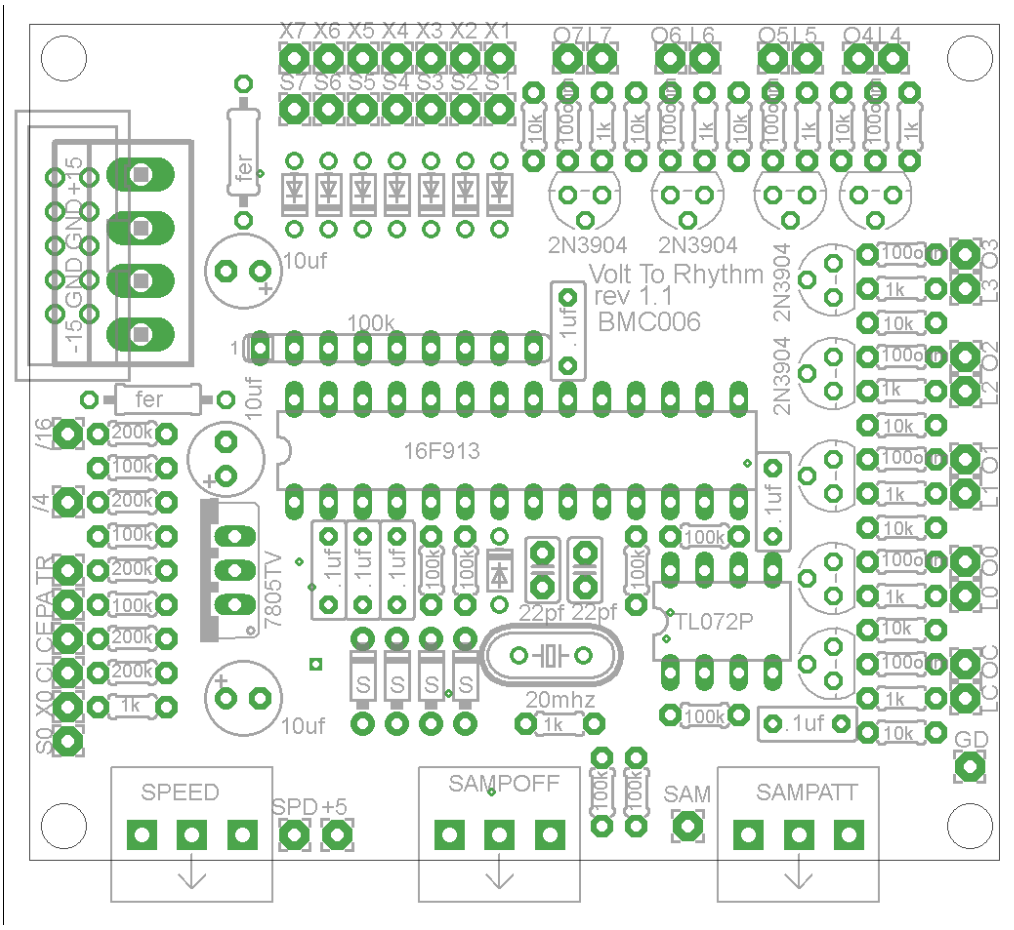
5. Off board

Value	Quantity	Notes
Mono Jack	18	
NC switching Jack	1	For speed CV.
Stereo jack	1	For Clock input
Pushbutton	8	Spst momentary off-(on) type.
Toggle switches	4	SDPT on-on type.
LED	9	

B. The Board

Here is the layout of the PCB. It's dimensions are 72mm x 62mm. The pitch of the panel mount pots is 7/8." The suggested stuffing order is:

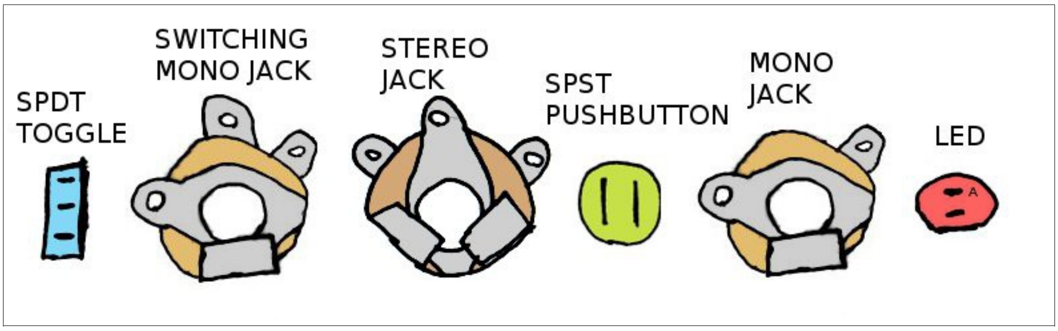
1. Resistors
2. Diodes
3. Resistor Array
4. Sockets
5. Ceramic caps.
6. Transistors
7. Electrolytics
8. Power connecter.
9. Crystal.
10. 7805
11. Pots.

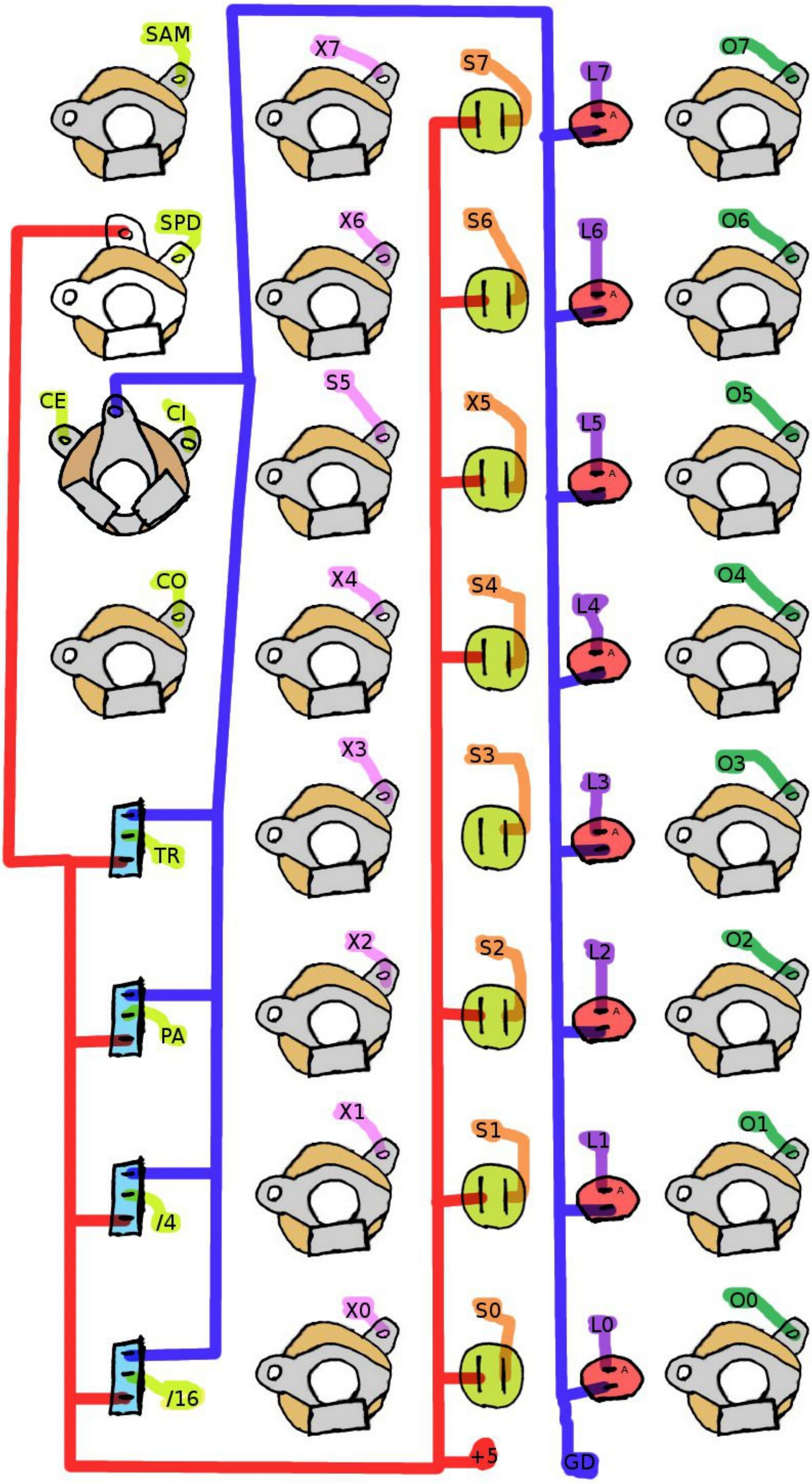


C. WIRING DIAGRAM

In the following wiring diagram, all text represents the wiring pads on the board. Here is a legend for the symbols used in the diagram.

Note that X5 and S5 are attached backwards from all the other X and S connections. This is to compensate for a board layout error.





SAM
X7
S7
L7
O7
SPD
X6
S6
L6
O6
CE
CI
S5
X5
L5
O5
CO
X4
S4
L4
O4
X3
S3
L3
O3
TR
X2
S2
L2
O2
PA
X1
S1
L1
O1
/4
X0
S0
L0
O0
/16
+5
GD

D. Calibration

Calibration is unnecesary for the V2R, but if you want to adjust the length of triggers when in trigger mode, this can be done by doing the following steps.

1.With the unit powered off, adjust the Speed knob to set length. The further counterclockwise, the longer the trigger.
2.Hold down S0 (usually the bottom pushbutton) while you turn the unit on.
3.The PIC will read the position of the knob, record it and save this as the new value for trigger length. You do not need to repeat this process on power up.