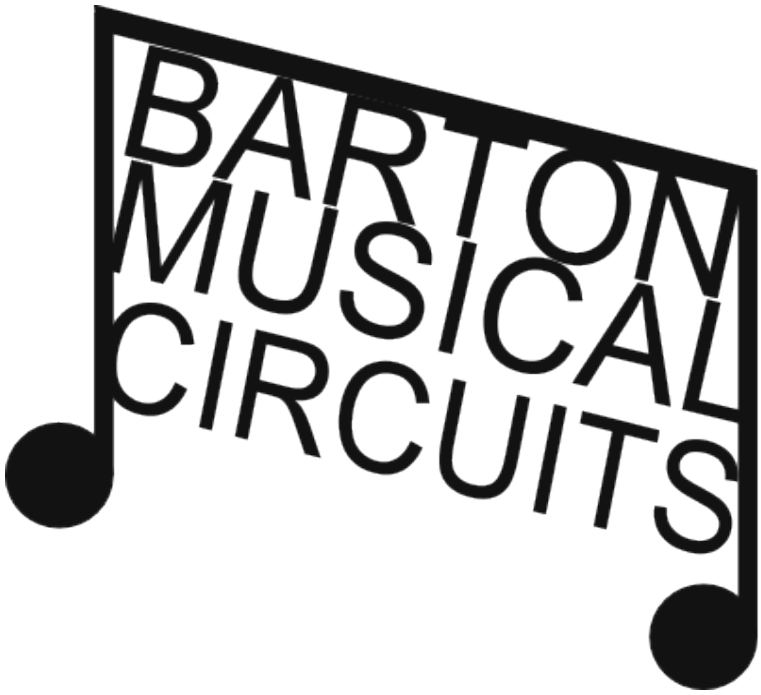


BMC046. Digital Noise.
Last updated 6-23-16

I. Features

A.How it works

This module is a microcontroller based digital noise generator. A program on the microcontroller generates semi-random numbers based on user input, and then outputs these numbers to a Digital-To-Analog converter which results in noise.

The basic program is laid out in the diagram to the right, with all numbers represented as 8-bit binary numbers. The "input number" is determined by the position of the control knob, with fully counter clockwise being "00000000" and fully clockwise being "11111111."

STARTING NUMBER	10010011
INPUT NUMBER	00011101
ROTATE LEFT	00100110
DID A 1 ROTATE OUT?	YES, IT DID
XOR ROTATED NUMBER WITH INPUT NUMBER	00111011

So, a starting number is "rotated" to the left, meaning that all of the bits move one spot to the left, so the "1" that was at the right end of the number, is now one over, and a zero has replaced it. Whenever this happens, the program checks to see if a "1" has rotated to the left out of the number, if a 1 hasn't rotated out, the rotated number becomes the new starting number. Whenever this happens, an Exclusive OR (XOR) operation is performed comparing the recently rotated number with the input number, and the result is the new starting number.

8-bit	10010110
7-bit	10010111
6-bit	10010111
5-bit	10010000
4-bit	10011111
3-bit	10000000
2-bit	10000000
1-bit	11111111

In addition to providing an input number, the control knob also determines the bit depth of the output. The diagram to the left demonstrates bit depth. The program checks a certain bit of the output number and then makes all bits less significant (the bits to the right) either a 1 or 0 depending on the state of that bit. The bit depth is decreased as the knob is moved clockwise. Having a lower bit depth will result in a louder more distorted sounding noise.

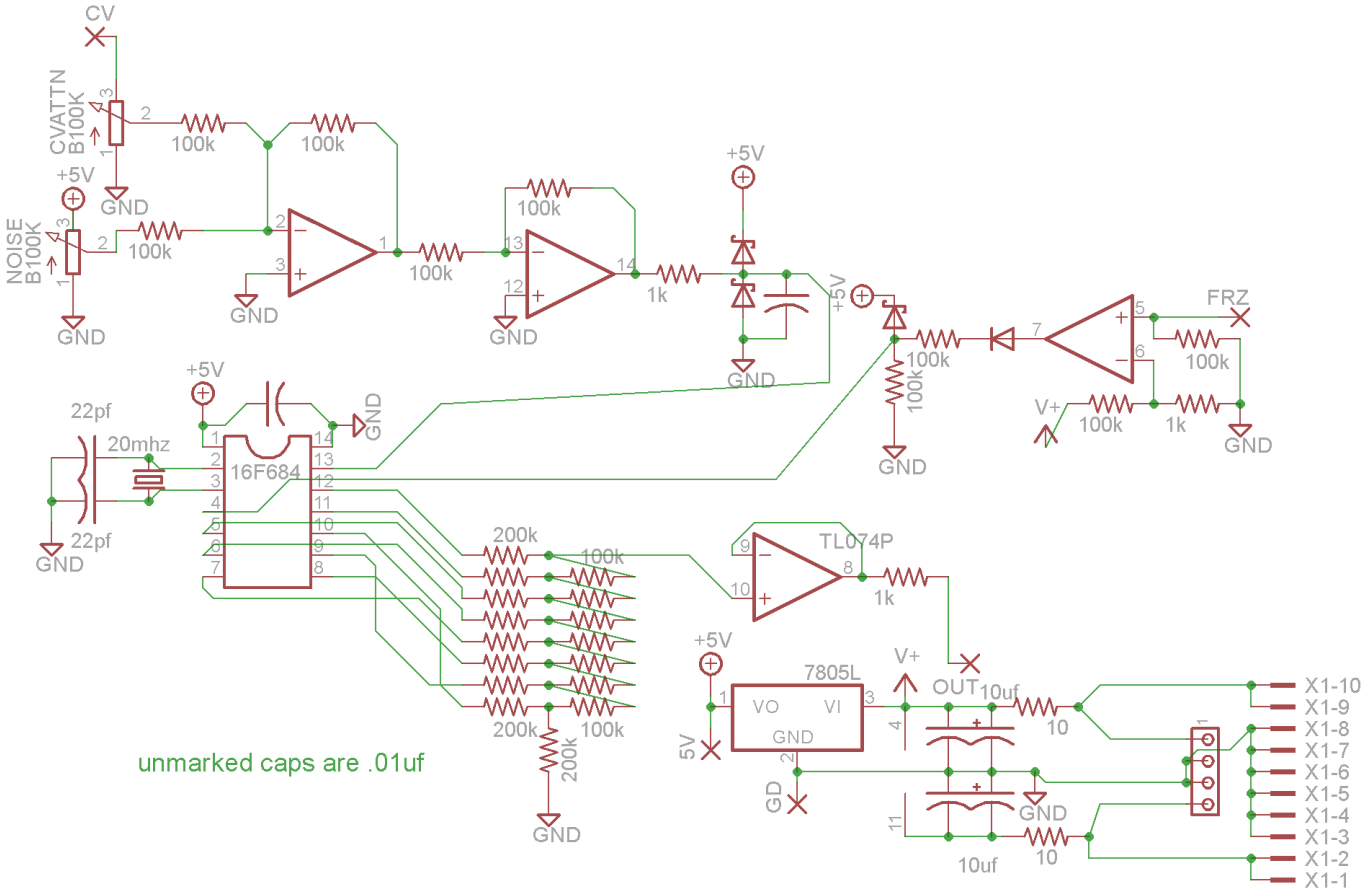
B.Controls/Inputs/Outputs

1.Control Knob – The control knob sets the input number and bit depth for the module. It is marked "Noise" on the PCB
2.CV Knob – This knob attenuates the CV input. The attenuated voltage is then mixed with the voltage from the control knob. This is marked "CVATTN" on the PCB
3.CV Input – This is the jack for external CV. The wirepad is marked "CV" on the PCB
4.Freeze Input – When a positive voltage is input to this jack the output of the module is updated with new voltages. It is normalized to +5V, so the module works when nothing is plugged into it. This can be used to either augment the sound of the noise being generated, or for extracting random steady voltages from the module. It's like the track input of a Track and Hold module. The wirepad is marked "FRZ" on the PCB.
5.Output – This is the DC voltage output. It ranges from 0 to +5V. The wirepad is marked "OUT"

C.Demo

Here is an mp3 demo of the module. At the start the noise knob is at fully counterclockwise and it's slowly turned clockwise. WARNING: loud, harsh sounds.

II. Schematic.



Above is the schematic for this project. The 16F684 is the heart of the module. It's clock is derived from a 20mhz crystal and it's power supply is +5V. I'll describe it's inputs first, then it's output, and finally the power connections. I will use terms without providing a definition, if you'd like to know more about how a comparator or an R/2R works, there are plenty of free online resources that can explain better than I can.

In the upper left corner are the Noise and CV Attn knobs. The voltages from the wipers of these knobs are mixed together by a pair of inverting gain stages with a gain of "1." The mixed voltage then goes through a resistor and pair of Schottky diodes in order to limit the voltage to a range of 0 to +5V. A capacitor filters out high frequency noise from the signal before being input to the microcontroller.

In the upper right is the input for the Freeze control. The signal goes through a comparator with a threshold set by the 100k/1k voltage divider, this lets the Freeze control usable with any signal that goes above and below zero volts. The output of the comparator is connected to a switching diode which is only allowing positive voltages through, the voltage is then attenuated by a 100K/100K voltage divider with a schottky diode to +5V to ensure that voltage remains in a 0 to +5V range.

To the lower right of the 16F684 is the Digital-To-Analog converter. This is what's referred to as a "R/2R ladder." The output pins of the 16F684 are all at either +5V or 0V, this configuration of resistors attenuates and mixes these outputs to derive a voltage somewhere between +5V and 0V. This voltage is then buffered by an op-amp and output through a 1K output resistor.

To the right of the R/2R ladder are the power connections. There are two PCB footprints for power connectors which are parallel to each other. The positive and negative voltage rails are filtered by a 10ohm/10uf low-pass filter, and there are additional .01uf capacitors at the power connections for the ICs. The +5V supply is created by a 78L05 voltage regulator. There are wirepads for +5V and Ground to be used for offboard wiring.

III.Construction

A.Parts List

Semiconductors

Value	Qty	Notes
TL074	1	14 pin DIP packaging
16F684	1	Provided with PCB
78L05	1	TO-92 packaging
1N4148	1	Or other small signal switching diode.
1N60P	3	Or other schottky.

Resistors

Value	Qty	Notes
10 ohm	2	7.5mm lead spacing, 1/4W Metal film
1K ohm	3	" "
100K	16	" "
200K	9	
B100K Potentiometer	2	16mm pot, PCB mounted, Linear taper.

Capacitors

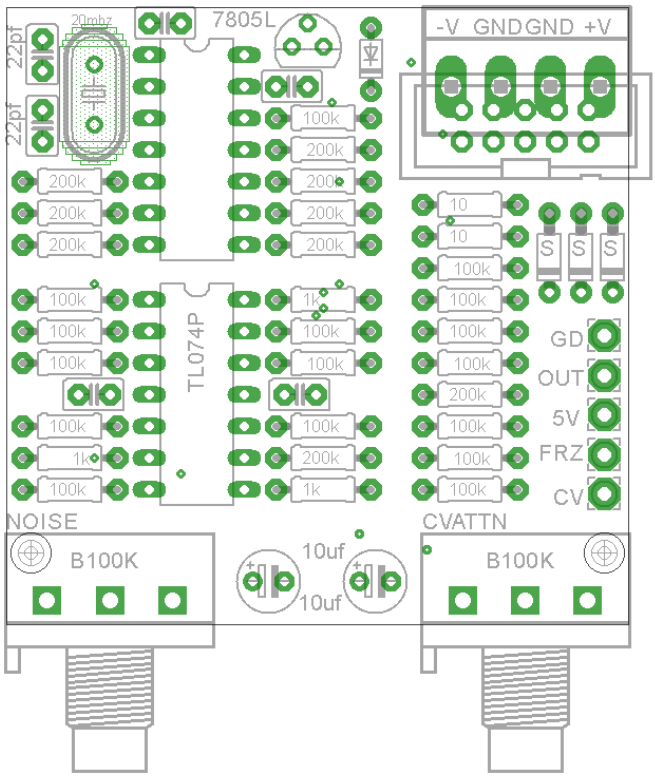
Value	Qty	Notes
22pf	2	cheap ceramic 2.54mm
.01uf	4	cheap ceramic 2.54mm
10uf	2	Electrolytic

Other

Value	Qty	Notes
Power Connecter	1	Either Eurorack or MOTM
14pin DIP Socket	2	
Jacks	3	One jack must be a switching jack.
Knobs	2	
20mhz Crystal	1	HC-49 package

B.The Board

To the right is a picture of the PCB. The PCB's dimsnsions are 49.8mm x 49.5mm. The pots are spaced 33.3mm apart. The mounting holes are spaced 46mm apart.



Below is a photo of a completed unit. The "Out" "Frz" and "CV" wirepads are all connected to the tips of the appropriate jacks. "5V" is connected to the switch of the Freeze jack. "GD" is connected to the sleeve of a jack.