

BMC012. Variable Stepped Voltage Generator

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I. What is a Variable Stepped Voltage Generator?

A. A brief explanation

B. Controls

C. Patch Demonstrations

II. Circuit Description/Schematics

A. The Chip

B. Analog Inputs

C. Digital Inputs

D. Analog Output

E. Power Supply

III. Construction

A. Parts List

B. The Printed Circuit Board

C. Wiring Diagram

I. What is a Variable Stepped Voltage Generator?

A. A Brief Explanation.

The Variable Stepped Voltage Generator is a new synth module designed to create control voltages based on gate and trigger inputs. When the voltage is used to control pitch, this acts in the opposing way of BMC006 the Voltage to Rhythm Converter and acts as a sort of rhythm to voltage converter.

B. Controls

INPUTS

1.CV Input - This external CV input is used to determine the size of a voltage step, basically, the smallest unit of pitch change created. This input has it's own attenuator and there is a manual offset for the same control.

2-7. Step Increase/Decrease Inputs - These inputs either increase or decrease the output voltage by a number of steps depending on which input. They increase by either 1, 2 or 4 steps and decrease by either 1, 2 or 4 steps. A gate or trigger input should be used.

8. Reverse - When a trigger is inputted to the Reverse input, the step increase and step decrease inputs swap functions, so a trigger to a step increase input would cause a decrease and vice versa.

9.Reset To Top - When a trigger is inputted, this causes the output voltage to go to the highest possible voltage.

10. Reset To Bottom - When a trigger is inputted, this causes the output voltage to go to zero volts.

11.Update - This control's input is normalled to a high gate signal when nothing is plugged in. When a gate or trigger signal is inputted it causes the module to read the cv input, when no gate or trigger is inputted it uses the last read cv input.

OUTPUTS

1.CV Out - This outputs a control voltage.

2. At Top - This outputs a gate signal when the output voltage reaches the maximum through increasing steps (does not turn on when using "reset to top" input)

3.At Bottom - This outputs a gate signal when the output voltage reaches zero volts through decreasing steps.

CONTROLS

1. Manual Step Size - This is a manual offset for the CV Input for step size.

2. Quantize - This is a toggle switch which controls whether or not the CV output is quantized to 12 steps per octave.

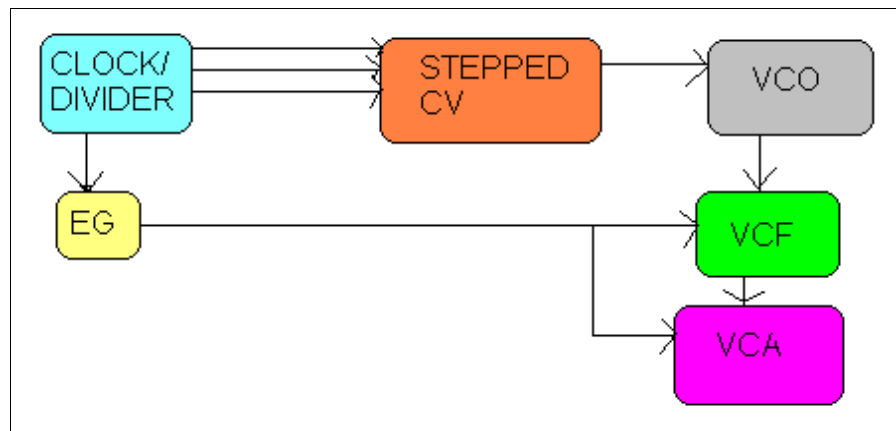
3-4.Upon Reset (optional) - These controls route the At Top and At Bottom outputs to either the Reset at Top/Bottom or Reverse directions.

5-11. Increase/Decrease Step Buttons - These pushbuttons send manual gate signals to the Increase/Decrease step controls.

C. PATCH IDEAS/DEMOS

Patch 1.

In this patch a BMC004 Clock/Divider is generating several outputs that are divisions of the same clock. Some of these divisions are plugged into the Increase/Decrease inputs of the Stepped CV Generator, and one division is going to the input of an envelope generator. The voltage generator's CV output is used

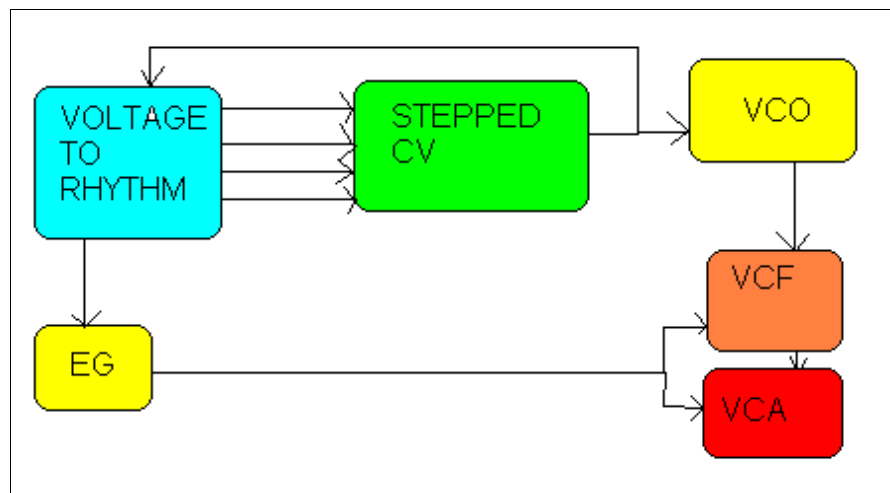


to control the pitch of a VCO whose output is being filtered by a VCF and then a VCA, which are both being controlled by the envelope generator.

[You can hear this patch by listening to this MP3.](#) In the recording the only parameter being altered is the rate of division on the outputs of the clock/divider.

Patch 2.

In this patch, a BMC006 Voltage To Rhythm Generator is being used to create trigger signals. It is in "parallel" mode, so each of its outputs is either on or off depending on the voltage inputted to it. One output is sent to an envelope generator which is in turn controlling a VCF and VCA. The other outputs are sent to the increase/decrease step inputs of a Stepped CV generator. The output of the



Stepped CV generator is then sent back to the Voltage To Rhythm converter to be used as its input voltage. This creates a feedback loop where the Stepped CV's voltage output controls what trigger outputs the V2R outputs which in turn controls the Stepped CV's voltage output, etc etc. The Stepped CV's output is also controlling the pitch of a VCO.

You can hear this patch by listening to [this MP3.](#)

Patch 3.

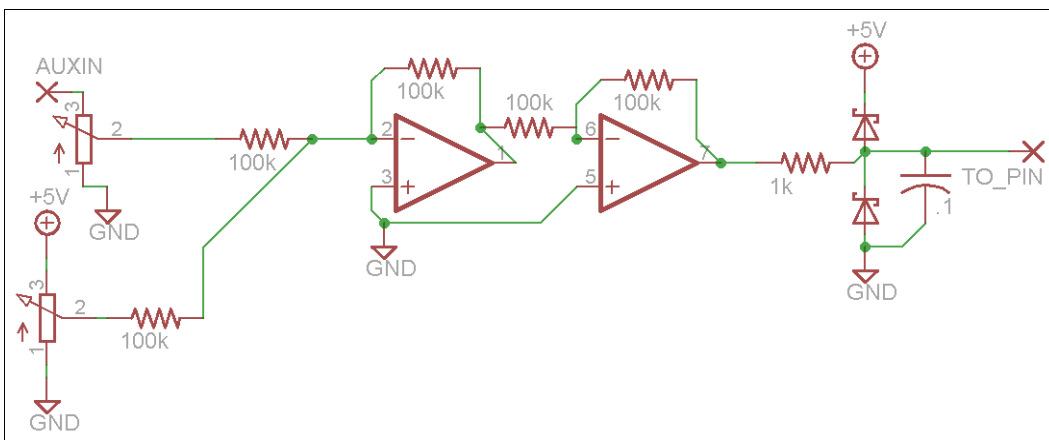
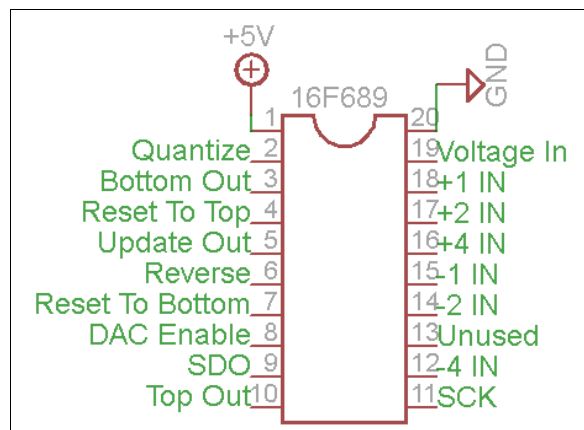
This patch is designed to demonstrate the CV input of the Stepped CV generator. It is exactly like Patch 1, except that the At Top output of the Stepped CV generator is being used as a clock input on a "Baby 10" style step sequencer. The Sequencer's CV output is then being used as the CV input of the Stepped CV generator.

You can hear [this patch here](#). The sequencer in this recording is set to be 4 steps long, with each step increasing the output CV gradually and I am adjusting the attenuation of the CV input as the recording progresses.

II. Circuit Description/Schematics

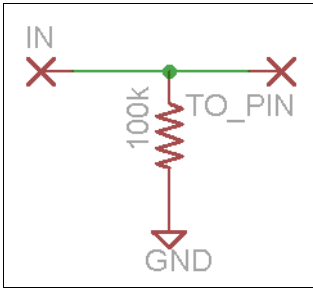
A. The Chip

The 16f689 PIC microcontroller is at the center of the design for the Stepped CV Generator. All of the sub-circuits in the design interact with this chip. The diagram on the right gives the pinout for this chip.



B. Analog Input

There is only one analog input in this module. External control voltages are inputted at the point marked "AUXIN" 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 microcontroller.

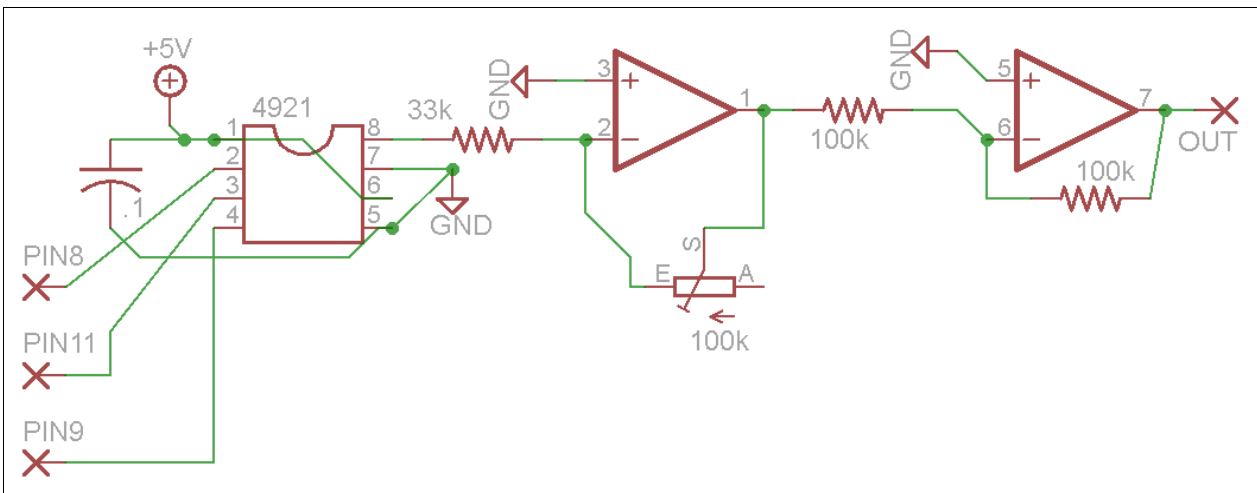
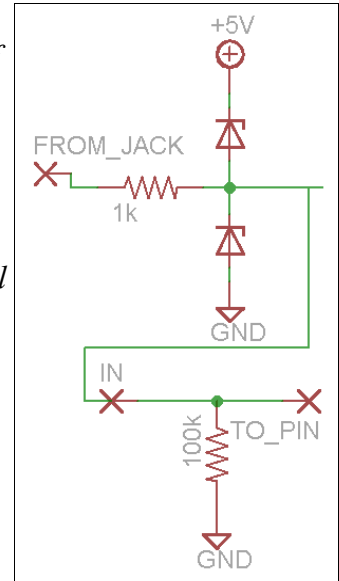


C. Digital Input

On the left you see the basic schematic for all of the digital inputs. The gate, trigger or switch signal is inserted at point "IN" which represents a wiring pad on the printed circuit board. This is attached directly to a pin on the microcontroller and a 100k resistor to ground which keeps the microcon's input at ground level

normally.

On the right we see the same circuit with an added off-board circuit added. The same 1k and schottky resistor network from the analog input is added in between the input jack and the wiring pad on the printed circuit board. This allows the user to use gate and trigger signals larger than +5v, or oscillator outputs which go down to negative voltages.

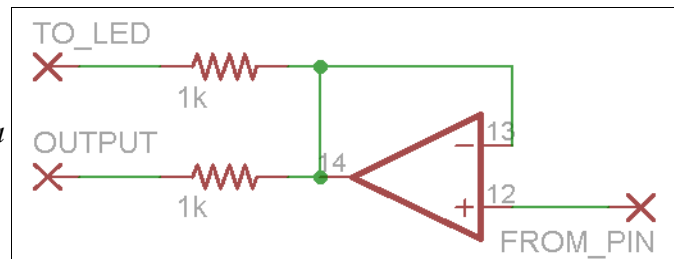


D. Analog Output

The 4921 is connected to the microcontroller and its output is connected to a pair of op-amp wired as amplifiers. In the feedback loop of the first op-amp is a trim pot, which allows the user calibrate the output of the module.

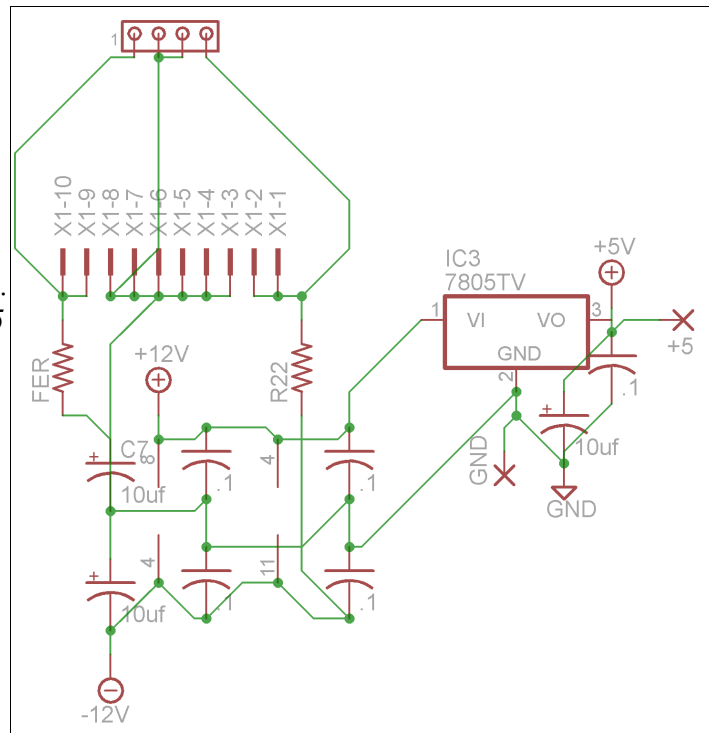
E. Digital Output

An output from the microcontroller is buffered by an op-amp. Its output is then sent through a 1k resistor to prevent shorts to ground on the buffer's output, and another 1k which acts as a current limiter for an LED.



F. Power Supply

The two power connectors 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 microcontroller and DAC.



III. Construction

A. Parts List

1.Semiconductors

<i>Name/Value</i>	<i>Quantity</i>	<i>Notes</i>
<i>16f689</i>	<i>1</i>	<i>Should have come with your PCB</i>
<i>MCP4921</i>	<i>1</i>	<i>Digital To Analog Converter</i>
<i>TL072</i>	<i>1</i>	
<i>TL074</i>	<i>1</i>	
<i>7805</i>	<i>1</i>	<i>TO220 Package</i>
<i>SD101C</i>	<i>2</i>	<i>Schottky Diodes</i>
<i>1n4148</i>	<i>11</i>	<i>Optional, see wiring diagram</i>
<i>LED</i>	<i>2</i>	<i>Optional, see wiring diagram</i>

2.Resistors

<i>Name/Value</i>	<i>Quantity</i>	<i>Notes</i>
<i>100K</i>	<i>7</i>	<i>5mm lead spacing, use 3.2mm or stand on end</i>
<i>1K</i>	<i>5</i>	<i>" "</i>
<i>33k</i>	<i>1</i>	<i>" "</i>
<i>10 ohm</i>	<i>2</i>	<i>7.5mm lead spacing or use ferrite bead</i>
<i>100K trim</i>	<i>1</i>	
<i>Array</i>	<i>1</i>	<i>12 pin bussed 100k resistor array, or 11 100k resistors.</i>
<i>B100K</i>	<i>2</i>	<i>Alpha RV120F-20-15F-B100K part.</i>

3.Capacitors

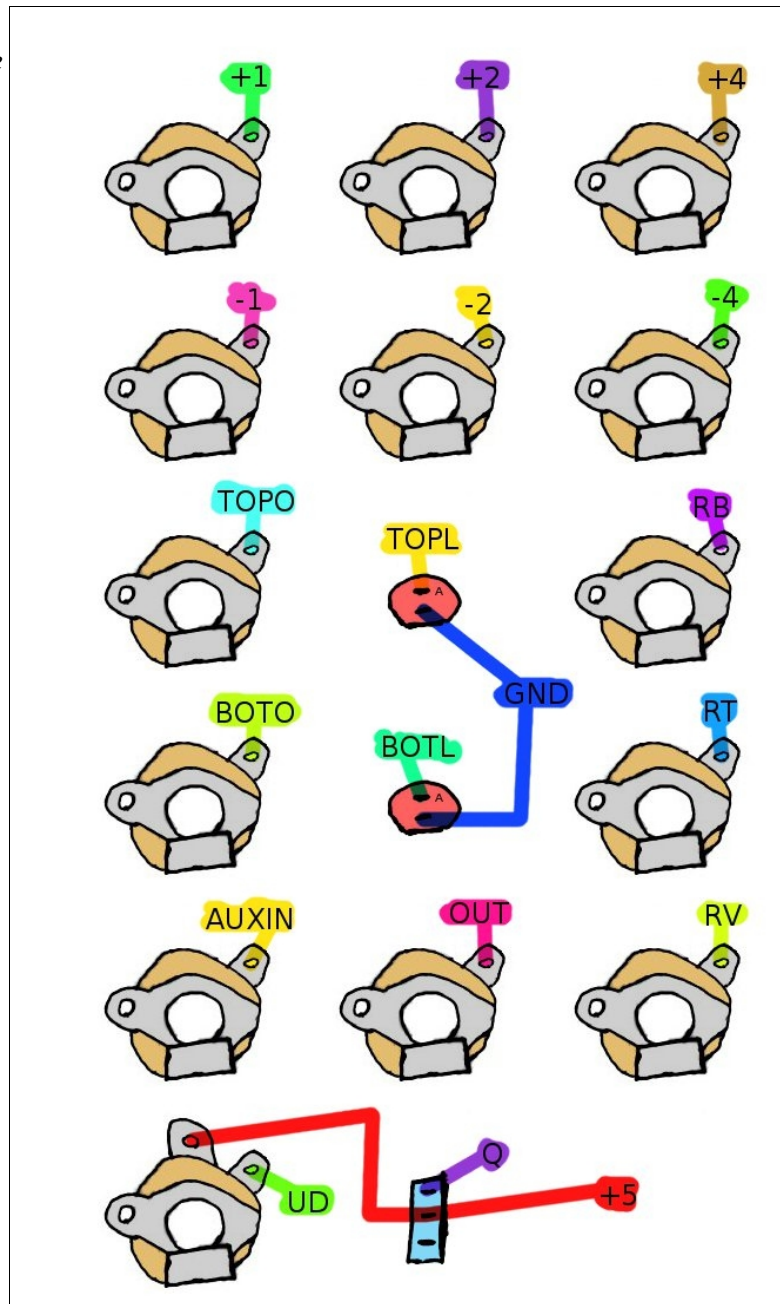
<i>.1uf</i>	<i>7</i>	<i>5mm lead spacing, used as bypass caps, value not critical</i>
<i>10uf</i>	<i>3</i>	<i>Electrolytic, 2.5mm lead spacing</i>

4.Other

<i>Name/Value</i>	<i>Quantity</i>	<i>Notes</i>
<i>Power Con</i>	<i>1</i>	<i>Either MOTM or Eurorack style</i>
<i>Jack</i>	<i>13</i>	<i>1/4" 3.5mm or banana</i>
<i>Switching Jack</i>	<i>1</i>	
<i>Toggle</i>	<i>1</i>	<i>SPST</i>
<i>Toggle</i>	<i>2</i>	<i>SPDT, Optional, see wiring diagram</i>
<i>Push Button</i>	<i>6</i>	<i>Normally off, momentarily on, optional, see wiring diagram</i>

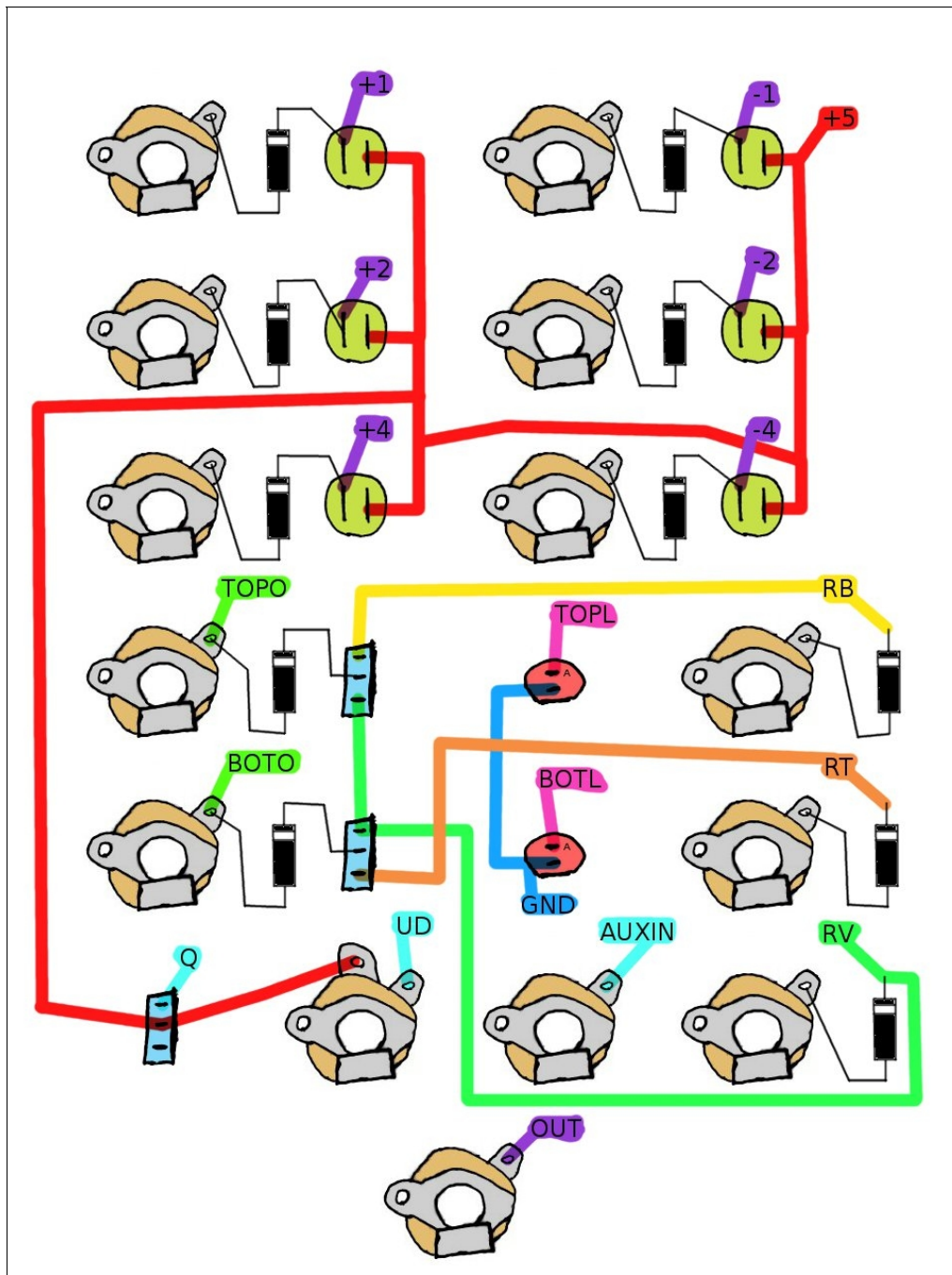
1. Simple Wiring.

This is the minimum requirement to use all of the features of the module.



2. Advanced Wiring

This version adds pushbuttons for all the increase/decrease step inputs and toggle switches which route the Reached Top and Reached Bottom outputs to the Reset and Reverse inputs. Diodes are added to act as passive OR type circuits to protect from shorts.



D. Calibration

To calibrate the circuit, hit the increase step buttons until the "reset to top" output is active. Then adjust the trim pot until the output voltage is at +5.3333V. Then turn Quantizing on and set step size to very small, connect the output of the module to a VCO with accurate 1v/oct tracking. Increase and decrease the step and adjust the trimpot until you hear half-tone intervals between notes, a tuner can be used to assist in this.