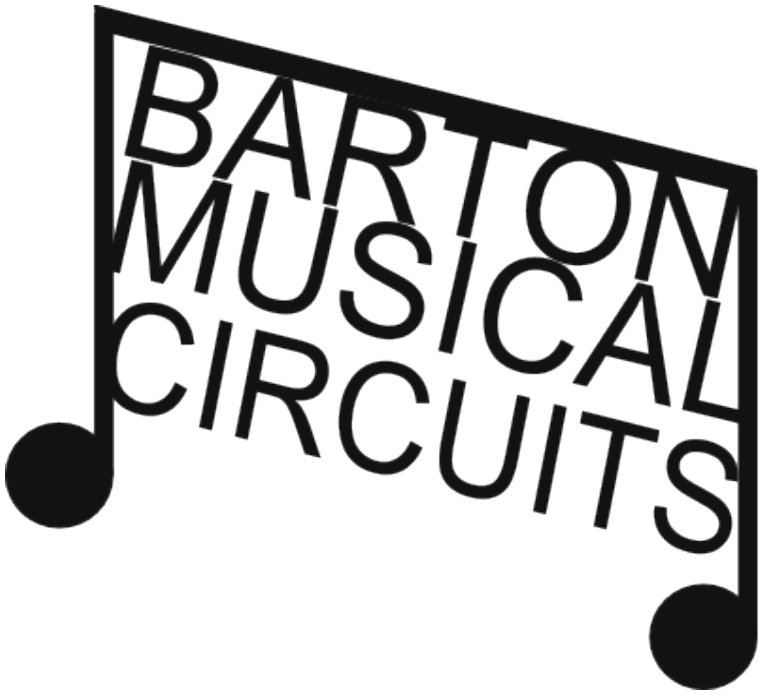

BMC052. Chordizer

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If you have any questions, or need help trouble shooting, please e-mail Michael@Bartonmusicalcircuits.com

I. Overview/Controls/Inputs/Outputs

A. Overview – The goal of the Chordizer was to use a single voltage input and output a quantized chord of voltages when used with 1v/octave VCOs. A voltage is inputted through the IN jack and can be modulated by the AUX jack and it's associated attenuator. The voltage range for the input is 0 to 5V.

Offsets to the input voltage are then applied, these offsets are controlled by three pots and can be negative or positive offsets. When the offset voltage is outside of the voltage range of the module, it will be transposed down or up an octave automatically to put it back into the voltage range.

The input voltage and the offset voltages are then quantized. The QUANT knob selects what musical scale is used to quantize. Before the voltage is finally output, a slew or portamento is applied, controlled by the SLEW knob.

The module is compatible with 12V or 15V systems without making any modifications. It also has capabilities to have voltage controllable chord selection.

B.Controls -

1.OFFSET knobs – These knobs control the offset of the voltages. They are numbered OFF1, OFF2 and OFF3. When the knob is pointed straight up, no offset is applied. When turned clockwise the offset becomes more positive and when turned counterclockwise, the offset becomes more negative. OFF1 controls the voltage outputted at the OUT2 jack, OFF2 the OUT3 jack and OFF3 the OUT4 jack.

2.AUX knob – This attenuates the voltage inputted at the CV jack which is then mixed with the voltage from the IN jack.

3.CHORD knob – This knob selects the memory bank to use in SAVE or LOAD operations. There are 8 memory banks total. The knob attenuates the input of the CHORD jack, which is normalized to +5V when nothing is plugged into it. When using a 0 to 5V range sequencer to select chords, leave this knob fully clockwise.

4.QUANT knob – This selects what scale is used in quantization. The table below outlines the scales. They are presented in order of least clockwise to most clockwise when rotating the knob.

SCALE	root	b2nd	2nd	b3rd	3rd	4th	b5th	5th	b6th	6th	b7th	7th
Chromatic	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Major	ON	off	ON	off	ON	ON	off	ON	off	ON	off	ON
Minor	ON	off	ON	ON	off	ON	off	ON	ON	off	ON	off
Harmonic Minor	ON	off	ON	ON	off	ON	off	ON	ON	off	off	ON
Major Pentatonic	ON	off	ON	off	ON	off	off	ON	off	ON	off	off
Minor Pentatonic	ON	off	off	ON	off	ON	off	ON	off	off	ON	off
Octave and 5ths	ON	off	off	off	off	off	off	ON	off	off	off	off
Octave	ON	off	off	off	off	off	off	off	off	off	off	off

5.SLEW knob – This knob controls how much the notes slew from one to another.

6.TUNE toggle – When activated this sets all outputs to 1V so oscillators can be tuned together.

7.5ths toggle – When active OUT2 will always be a 5^{th} above the input voltage.

8.Quantize-Then-Offset toggle – When active, the input voltage will be quantized before offsets are applied. This makes so that smaller changes in input voltage do not change the output.

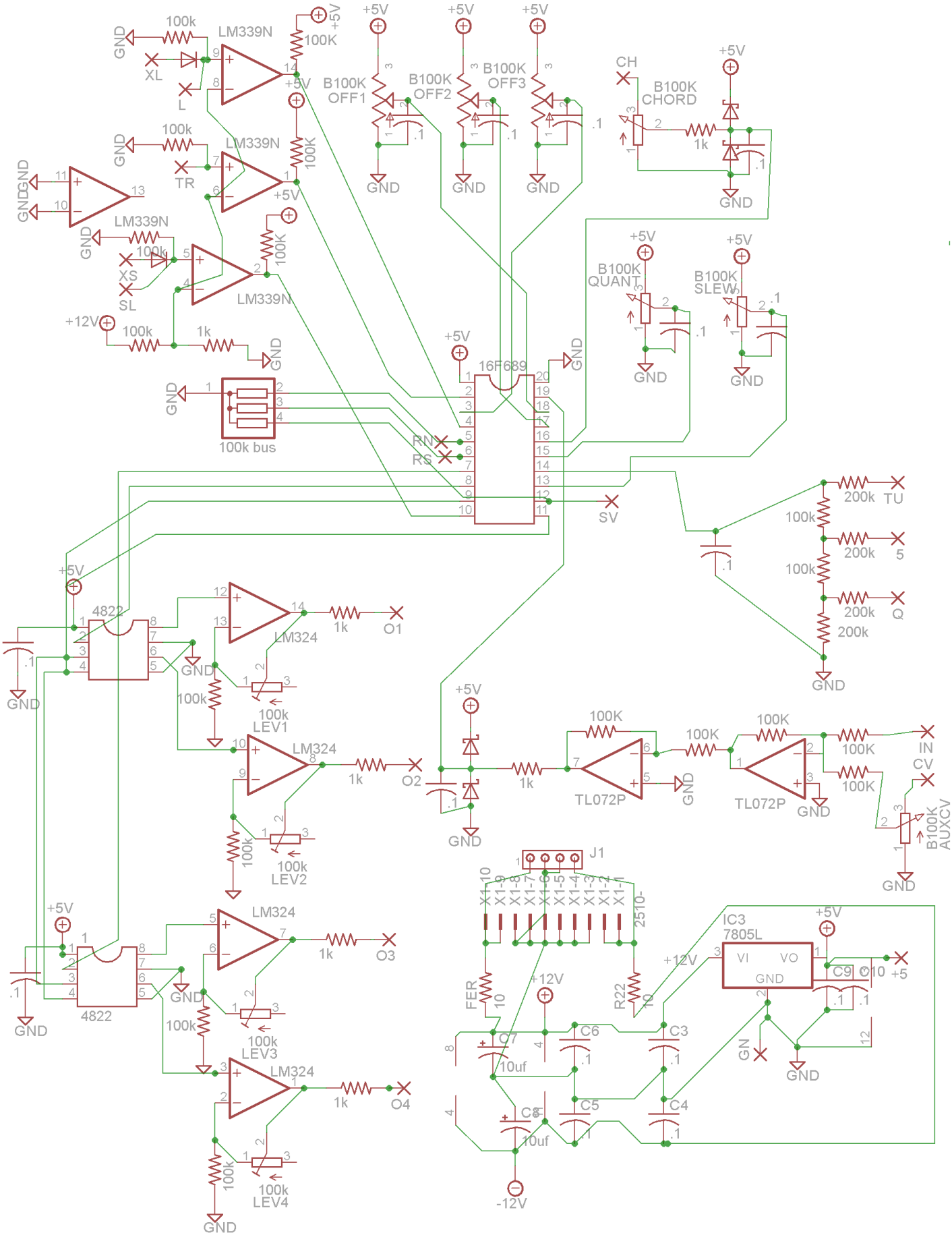
9.SELECT toggle – This toggle controls how the SELECT button and input work. When in the center position it will select a chord at random. When in the up position it will rotate through the saved chords in ascending order and in the down position will rotate in descending order.

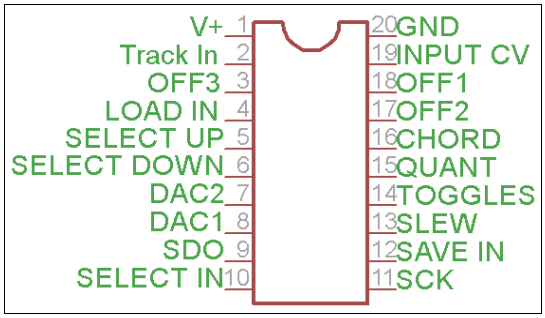
10.SAVE button – When pressed this will save the current offsets to the memory bank selected by the CHORD knob.
11.LOAD button – When pressed or when the LOAD input goes high, this will load offsets from the selected memory bank. Adjusting an OFFSET knob will override the loaded offset for that output.
12.SELECT button – When pressed or when the SELECT input goes high, this will load a saved chord using the logic determined by the SELECT toggle.

INPUTS
1. MAIN Input – This is the main input, it is mixed with the AUX input and it's quantized output appears at the OUT1 jack.
2. AUX input – This is an auxiliary input jack. The voltage is attenuated by the AUX jack and then mixed with the MAIN input.
3.TRACK input – This input is normalized to +5V when nothing is plugged in. When this input goes low (voltage is less than 0V) the module will ignore changes from the MAIN and AUX voltages.
4.LOAD input – This initiates a load like hitting the LOAD button.
5.SELECT input – This initiates a select like hitting the SELECT button.

OUTPUTS
1-4. VOLTAGE OUPUTS – The only outputs are the 4 quantized voltage outputs. OUT1 corresponds to the input, OUT2 corresponds to the input offset by OFF1, OUT3 corresponds to the input offset by OFF2 and OUT4 corresponds to the input offset by OFF3.

II. Schematic.





On the previous page is the schematic for this module's printed circuit board. At the center is the 16F689 PIC microcontroller. The pinout for the chip is presented to the right. The Select toggle and Save button wirepads are connected directly to the pins of the PIC and pull down resistors from a 100K resistor bus.

At the top left of the schematic we see the gates of an LM339 comparator chip. The comparators threshold are set by the 100K/1K voltage divider which is connected to the negative input of each comparator. This sets the threshold at .012V when using a 12V power supply. The positive inputs of the comparators are each connected to a 100K pull down resistor which brings the input to 0V when nothing is input and then the wirepads for the buttons and switching diodes connecting to the external inputs for the Load, Track and Select jacks. The outputs of the comparators are connected to 100K pull up resistors to +5V and then to the pins of the PIC.

To the right of the comparators are the potentiometers for the various control knobs other than the AUX knob. All of these are set up identically as variable voltage dividers between 0V and 5V. The wiper of each pot is connected to a capacitor to filter high frequency noise out and then to the pin of the PIC, other than the CHORD knob. The CHORD knob's wiper is connected to a 1K resistor and a pair of Schottky diodes which form a voltage limiting circuit that limit the voltage to between 0V and 5V.

To the right of the PIC in the schematic we see the wirepads of the toggle switches and some resistors. Each toggle wirepad will be at either 0V or +5V, and this resistor network (known as a R/2R ladder) converts the toggle positions to a single voltage. This allows us to read several toggles with a single pin of the PIC.

Below the toggle inputs are the main CV input and AUX input circuit. The voltages from the input and Aux CV are mixed together by an inverting op-amp and then inverted back to their original voltage by a second inverting op-amp. The output of the second op-amp goes through the same voltage limiting network as the CHORD knob and is then sent to the PIC.

In the bottom left are the output circuitry. Two MCP4822 Digital-To-Analog converter ICs are used. Each chip is connected to the serial digital output (SDO) and serial clock (SCK) pins of the PIC, and then to a chip select pin. Each chip has two analog outputs. These outputs are sent to a non-inverting op-amp gain stage with a trimpot in it's feedback path. The trimpots are adjusted during calibration to ensure accurate tuning.

In the bottom right is the power connections/filtering. Footprints for a Eurorack and MOTM style power connecter are in parallel with each other. The voltage rails are filtered by a 10ohm resistor and 10uf passive low pass filter. The LM324 quad op amp and the TL072 Dual op amp are connected to the power rails and have small capacitors next to their power pins to filter out high frequency digital noise. A 7805L voltage regulator provides the 5V power supply for the MCP4822s, the LM339 comparators and the 16F689 PIC.

III. Construction

A.Parts List

Semiconductors

Name	Quantity	Notes
16F689	1	Should be provided with your PCB
LM324	1	14 pin DIP package
TL072	1	8 pin DIP package
LM339	1	14 pin DIP package
4822 DAC	2	8 pin DIP package
Switching diode	2	1N4148 or other small signal switching diode
Schottky diode	4	BAT46 or other schottky
78L05 Regulator	1	TO 92 package

Resistors

Name/Value	Quantity	Notes
10 ohm	2	1/4w metal Film for all resistors unless otherwise noted
1K ohm	7	
100K ohm	19	
200K ohm	4	
100K ohm buss	1	4pin SIP package. Or can be made with 3 resistors*
B100K Pots PC Mounted	4	16 mm Alpha linear taper, PC Mounted. Like this.
B100K Pots Solder Lug	3	
100K Cermet trimmer	4	3296 package

* **http://www.bartonmusicalcircuits.com/makearray.html**

Capacitors

Name/Value	Quantity	Notes
.01uf	16	Ceramic disc. Value not critical
10uf	2	Electrolytic, at least 16V rating.

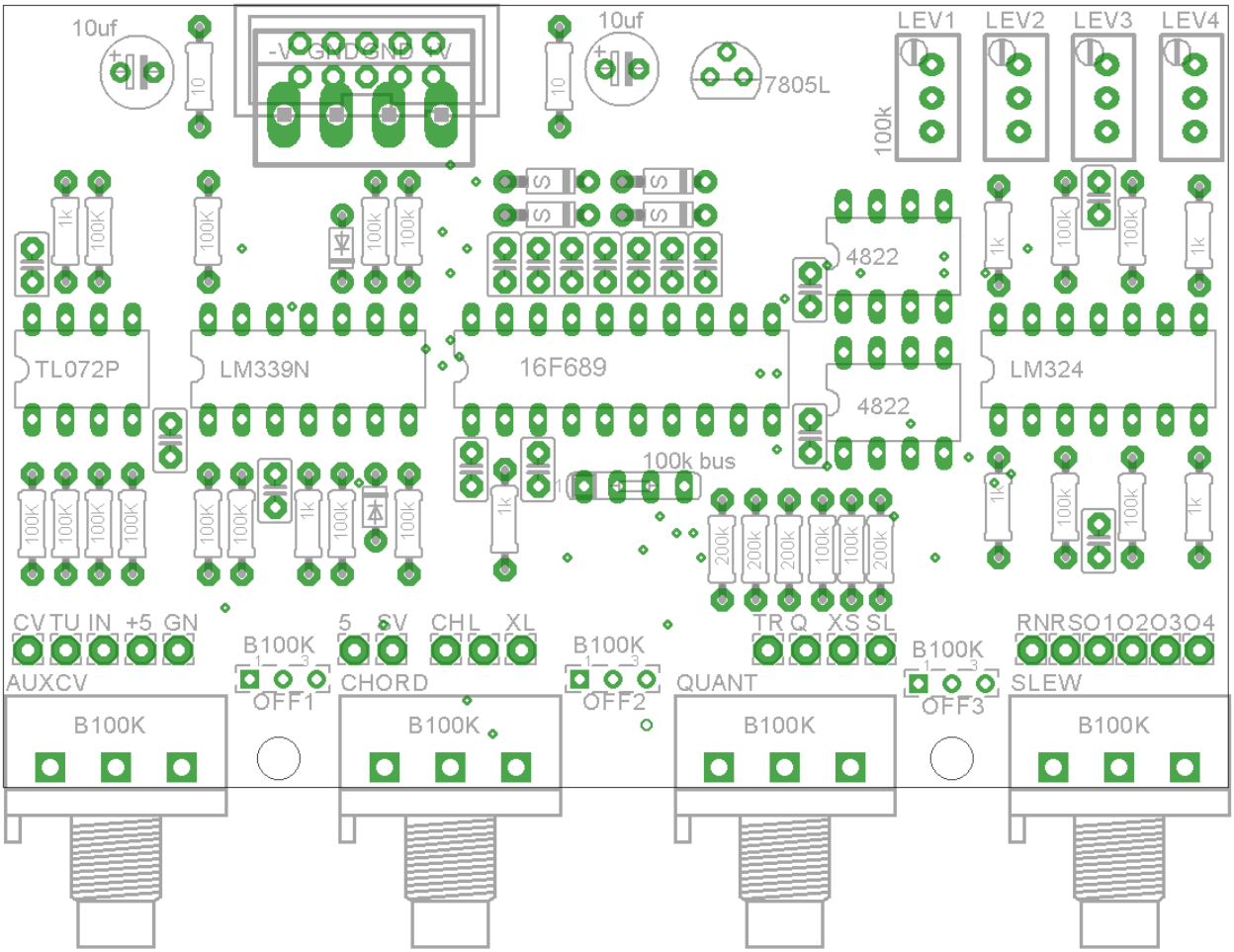
Other

Name/Value	Quantity	Notes
Power connecter	1	Eurorack or MOTM
Pushbutton	3	OFF-(ON). Like this.
Toggle switch	3	SPDT. Like this.
Switching Jack	2	
Mono Jack	8	Switching jack will work as mono jack
Knobs	7	

20 pin DIP socket	1	
14 pin DIP socket	2	
8 pin DIP socket	3	

B. The PCB

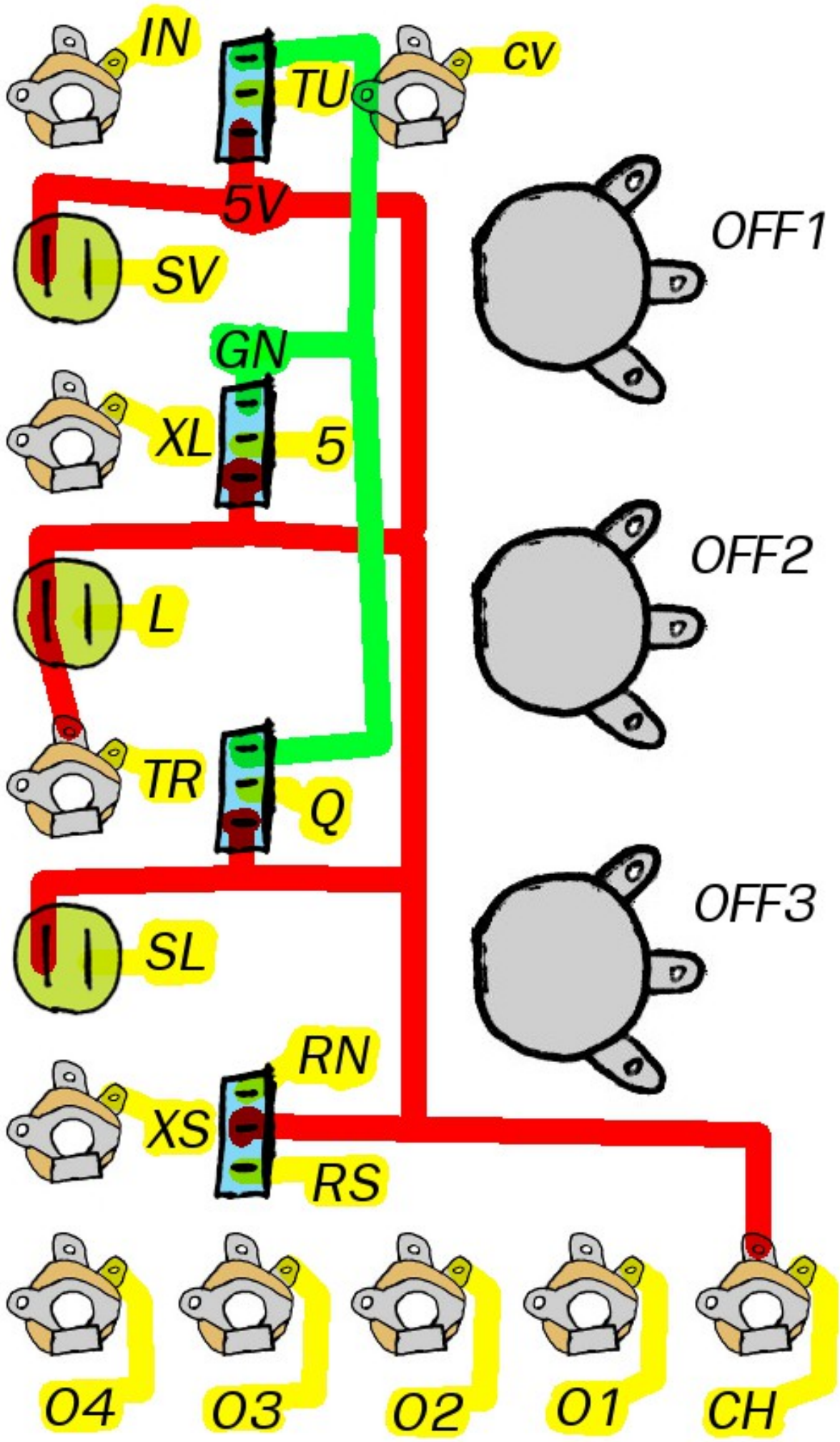
The PCB is 93x60mm. The mounting holes are spaced 51.1mm apart and pots are spaced 25.4mm apart. Below is an image of the PCB



C.Wiring

On the next page is a wiring diagram. I suggest wiring the 5V bus (in red on the diagram) between the switches and jacks first, then the ground bus (in green). If you are using a conductive front panel and jacks with conductive sleeves, you only need to wire ground to the sleeve of one jack as shown. If using a non-conductive panel or non-conductive jack sleeves, you should ground all jacks.

Next, I would wire the offset pots, and then wire the rest going from one end of the PCB to the other.


IN
TU
cv
5V
SV
OFF1
GN
XL
5
L
OFF2
TR
Q
SL
OFF3
RN
XS
RS
04
03
02
01
CH

D. Calibration

1.Activate the Tune knob.
2.Adjust the trimpot for each channel until the output voltage of that channel is exactly 1V.
3.If your meter has low resolution, turn the SCALE knob fully clockwise to OCTAVES mode.
4.Input a 5V signal and turn the offset knobs to 12 O Clock.
5.Adjust the trimpots so that each channel is at 5V.