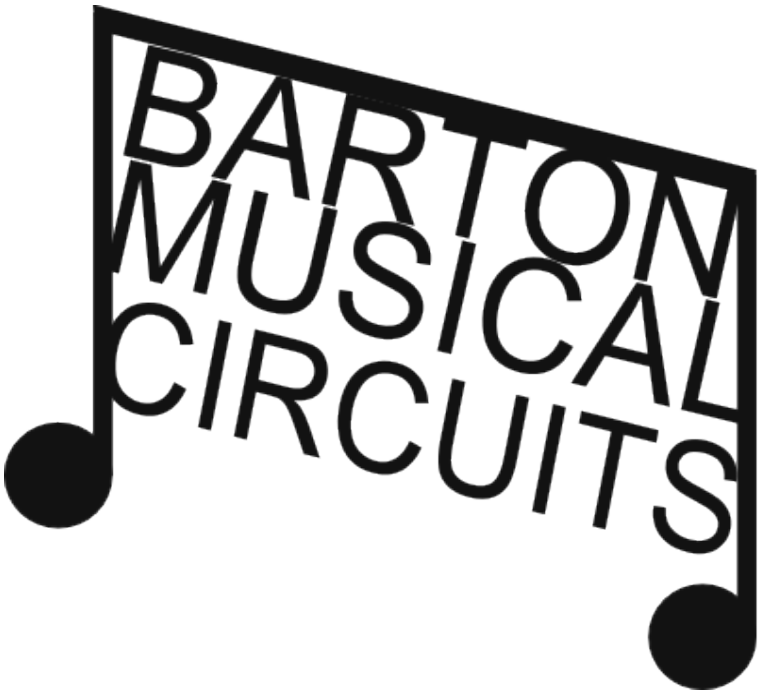


BMC110. Rhythm To Voltage Converter

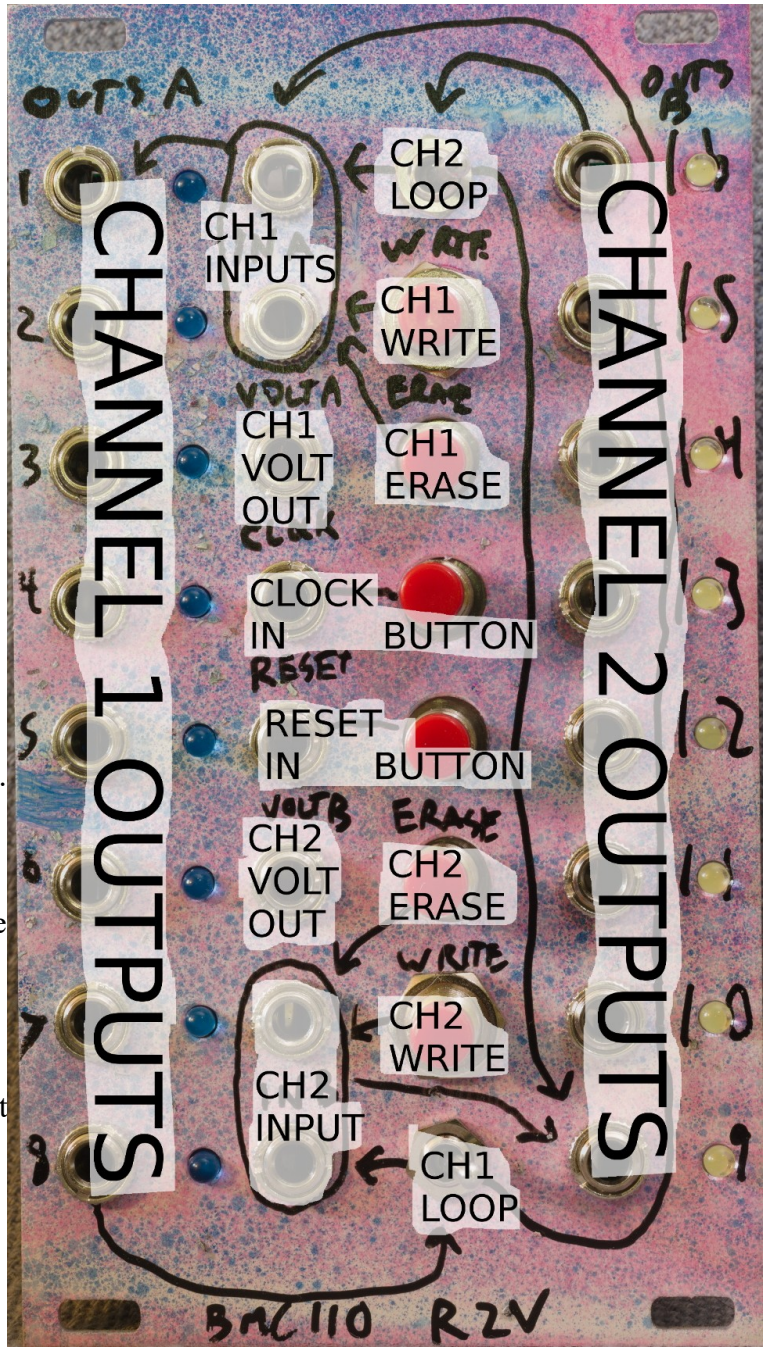
If you have any questions, or need help trouble shooting, please e-mail
Michael@Bartonmusicalcircuits.com

I. What it Does

This module is composed of a pair of 8 stage shift registers with parallel gate outputs and voltage outputs. This allows you to output a melody based on the rhythm input to the module. The shift registers can be used in series to form a 16 stage shift register or can be used individually with either looping or one shot capabilities. In addition to converting external rhythms to voltages, the module can also be used as a stand alone sequencer for short rhythmic sequences.

The panel board has board attached LEDs, 3.5mm jacks, toggles and pushbuttons making for a build with no wiring in Eurorack format. These components could be mounted off PCB and the module could be adapted to other formats, it has a footprint for MOTM style connector and no resistor value changes are needed to be used on 15V systems.

CONTROLS/INPUTS/OUTPUTS



LOOP TOGGLES – These toggles can be used to send the last output of the shift register to the input of a shift register. When the toggles are in center position they will not connect the output to anything. When set to the left they will send the output to the other channel, and when set to the right they will send the output back to that channel's input.

CLOCK BUTTON/IN – Advances the clock. Input signals will be sent to first stages and all other stages will advance by one.

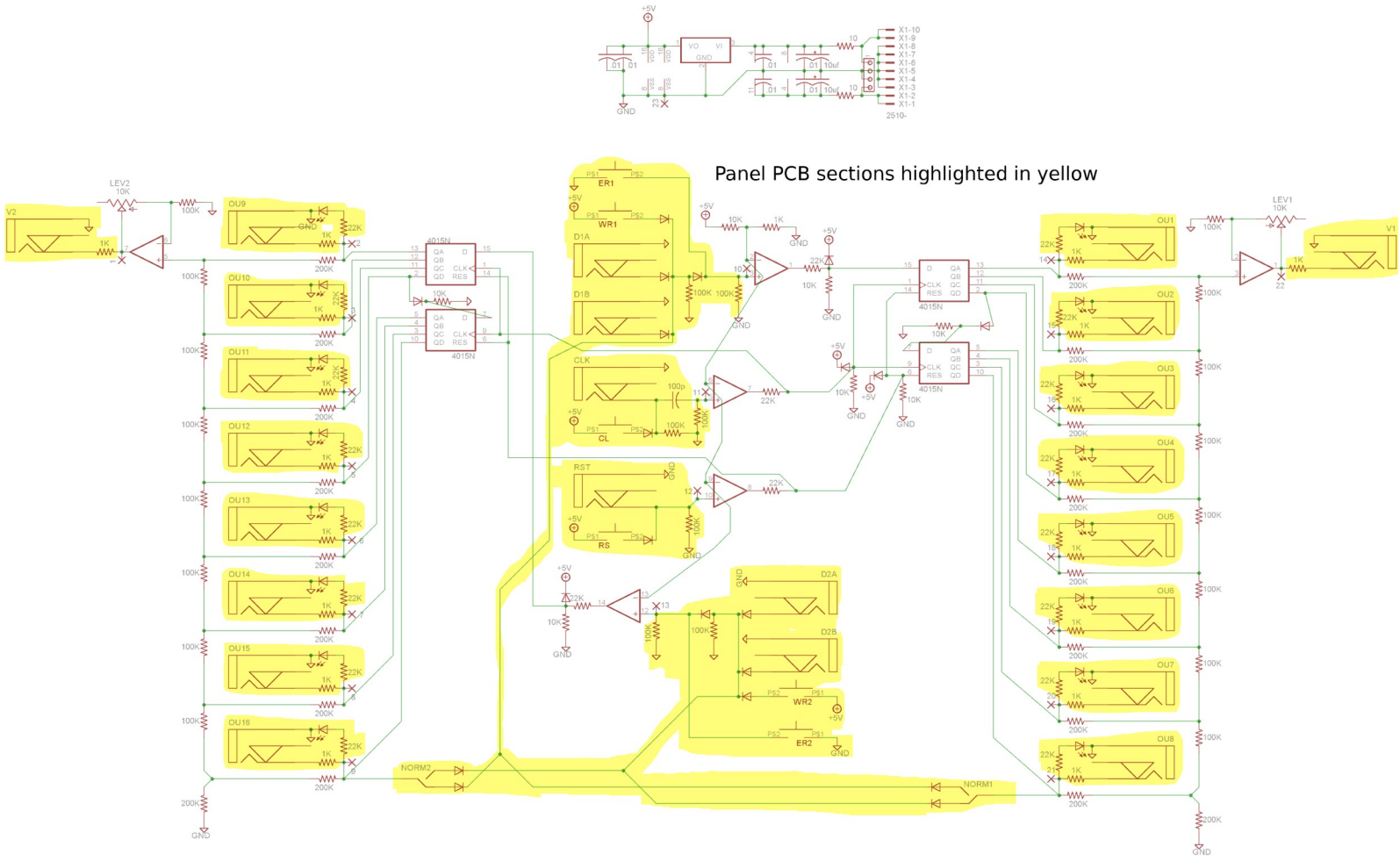
RESET BUTTON/IN – Sets the module back to it's power-on setting with all outputs high.

WRITE BUTTONS – These buttons send a gate signal to the channel's input. If the erase and write buttons are pressed at the same time, an erase will occur.

ERASE BUTTONS – These buttons will ground out the channel's input, erasing signals from a loop.

CHANNEL OUTPUTS – These are +5V gate outputs, one for each stage of the shift register.

VOLTAGE OUTPUTS – These are CV outputs that correspond to the binary number formed by the channel outputs. The conversion is weighted with the first stages as the most significant bit and the last stages as the least significant bit in the binary number. The voltage output ranges from 0V to +5.33V with 256 different voltages available in that range.


Panel PCB sections highlighted in yellow
+5V
VO
V1
GND
X1-10
X1-9
X1-8
X1-7
X1-6
X1-5
X1-4
X1-3
X1-2
X1-1
2510-
LEV2
10K
V2
1K
100K
OU9
OU10
OU11
OU12
OU13
OU14
OU15
OU16
22K
200K
4015N
QA
QB
QC
QD
D
CLK
RES
ER1
WR1
D1A
D1B
CLK
100p
CL
RST
RS
D2A
D2B
WR2
ER2
PS1
PS2
NORM2
NORM1
LEV1
V1
OU1
OU2
OU3
OU4
OU5
OU6
OU7
OU8

II. Schematic

On the previous page is the full schematic for the module. The module parts highlighted in yellow are found on the bottom PCB and the non-highlighted parts are found on the top PCB. The wirepads numbered 1 through 23 represent the interboard connectors.

Each channel uses a CD4015 shift register chip at it's heart. These are powered off of the +5V supply created by a 78L05 voltage regulator so that they can directly provide +5V gate outputs. Each CD4015 is divided into two four stage shift registers. These are set up as 8 stage registers with the 4th output of the top stage fed into the data input of the second stage through a diode and 10K pull down resistor.

Each output stage of the shift register is sent to an output jack through a 1K resistor, an LED through a 22K resistor (which also sets the brightness) and to an R/2R style DAC circuit. This circuit is composed of 100K and 200K resistors and is a classic way of converting parallel digital outputs to a single analog voltage. The output of this resistor ladder is fed to an op-amp gain stage with a trimpot in its feedback path. This trimpot sets the gain for this op-amp allowing you to match the output of the two channels.

The last output of each shift register is also sent to a Loop toggle (marked NORM1 and NORM2 for "normalization"). These toggles connect the outputs to the data inputs through switching diodes.

The CD4015's clock and reset inputs are fed from the same inputs for each shift register. The clock button and input jack go to a 100K tie down resistor and then onto a 100pf capacitor and then onto another 100K resistor to ground. The capacitor and resistor form a high pass filter making it so the clock is only active for an extremely short time. This pulse is fed into a comparator with a threshold of 0.5V, set by a 10K/1K voltage divider. The comparator's output is then attenuated by a 22K/10K voltage divider and additional overvoltage protection is provided by a diode to +5V. The reset input works the same way as the clock input, minus the high pass filter.

The data inputs for the shift registers come from the input jacks, write buttons and erase buttons. Each channel has two input jacks, signals from the Loop toggles and a write button that all connect through diodes at a single node and then share a single 100K pull down resistor. This then connects through another diode to another pull down resistor and the erase button which when activated grounds out whatever signal was being input. This then connects to a comparator set up like the clock/reset comparators.

Power headers for eurorack and MOTM style systems can be used. The votlage rails are filtered by a 10ohm/10uf passive low pass filter, and additional .01uf capacitors are placed at IC power pins for filtering. The op-amps are powered off of the +/-12V supply and the CD4015s are powered off of a 0V/+5V supply created by the 78L05 voltage regulator.

III Construction
A.PARTS LIST

SEMICONDUCTORS

Name/Value	QTY	Notes
CD4015	2	
TL072	1	Or other dual op-amp
TL064	1	Or other quad op-amp
78L05	1	TO-92 +5V voltage regulator
1N4148	25	Or other small switching diode
3mm LED	16	

RESISTORS

Name/Value	QTY	Notes
10 ohms	2	1/4W metal film
1K	19	1/8W metal film, or 1/4W stood on it's end
10K	7	1/8W metal film, or 1/4W stood on it's end
22K	20	1/8W metal film, or 1/4W stood on it's end
100K	23	1/8W metal film, or 1/4W stood on it's end
200K	18	1/8W metal film, or 1/4W stood on it's end
10K Trimpot	2	3296W package

CAPACITORS

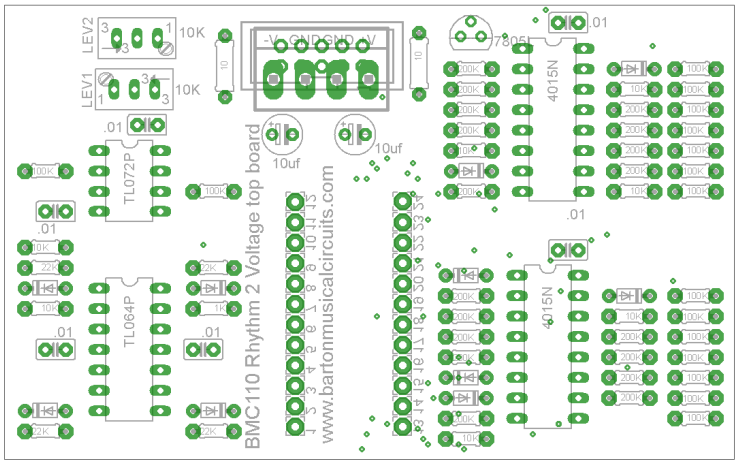
Name/Value	QTY	Notes
100pf	1	Ceramic disc
.01uf	6	Ceramic disc
10uf	2	Electrolytic

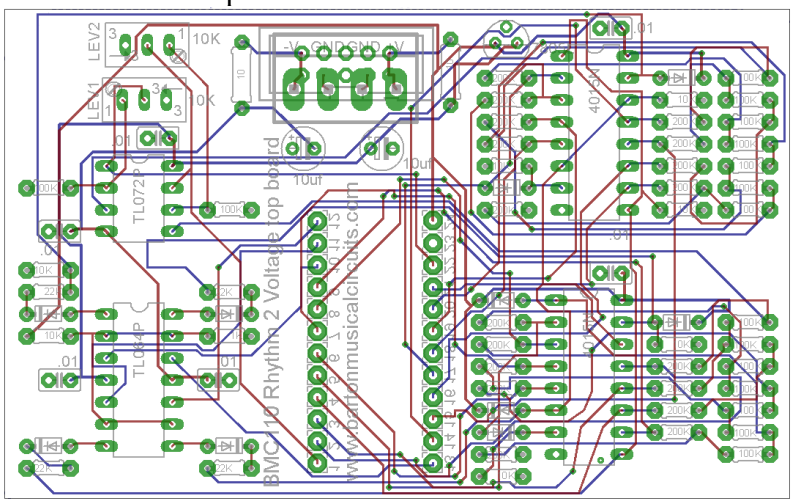
OTHER

Name/Value	QTY	Notes
SPDT on-off-on Toggle	2	Sub mini, PC mounted, like these.
Momentary Pushbutton	6	Like these.
3.5mm Jack	24	Like these.
Power connector	1	
8 pin DIP socket	1	
14 pin DIP socket	1	
16 pin DIP socket	2	
Single Pin Header Male	24	2.54mm spacing, at least 24 pins
Single Pin Header Female	24	2.54mm spacing, at least 24 pins

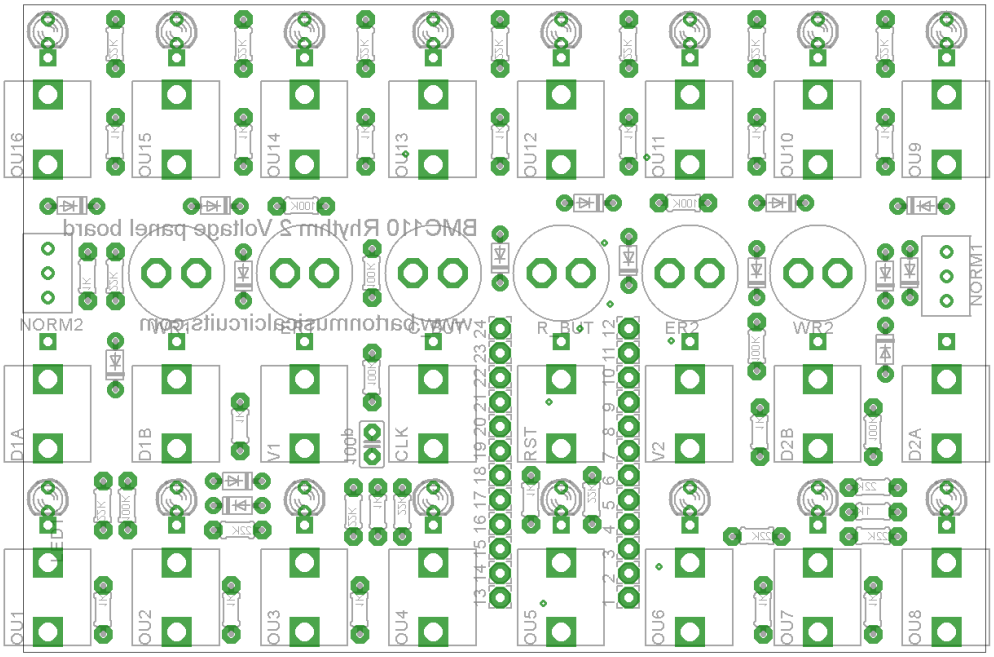
B. THE BOARDs

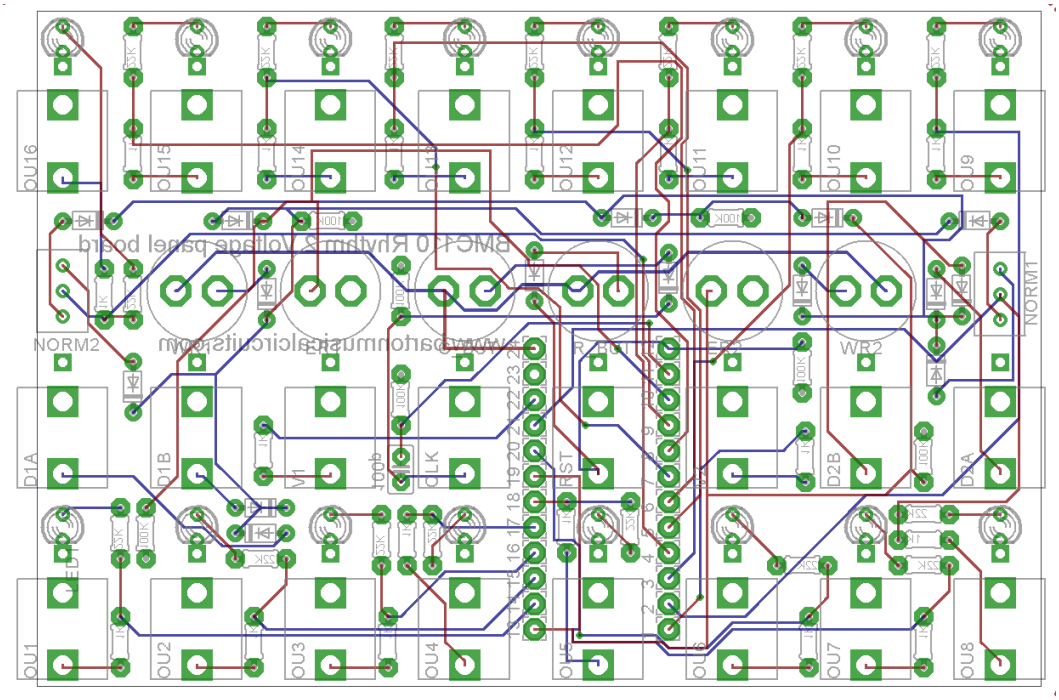
Below are renderings of the top PCB, both with and without traces present.





Below are renderings of the panel PCB with and without traces:

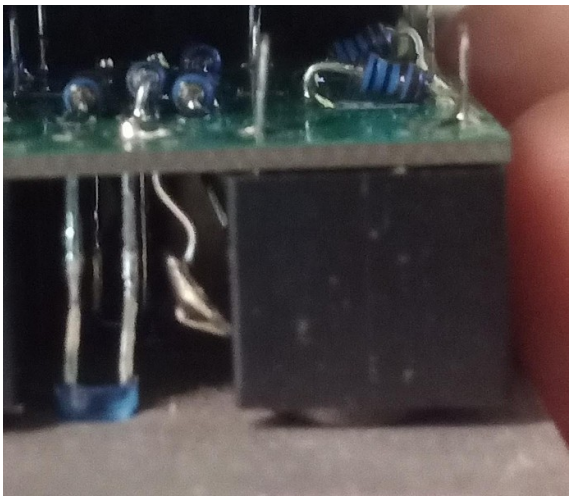




Because the PCBs have components on both sides, I suggest building in the following order.

1. Stuffing the top PCB

A. Resistors and diodes
B. DIP sockets
C. Ceramic capacitors
D. Voltage regulator
E. Power Header
F. Electrolytic capacitors
G. Male Pin Headers



2. Stuffing the Panel PCB

A. Resistors and Diodes
B. Ceramic capacitors
C. Female Pin Header
D. LEDs. Only solder one pin per LED, they'll be pushed into final placement later.
E. 3.5mm jacks.
F. Solder a snipped resistor lead from the sleeve connector of a jack to the grounding wirepad (see photo to the right)
G. Pushbuttons
H. Toggle Switches

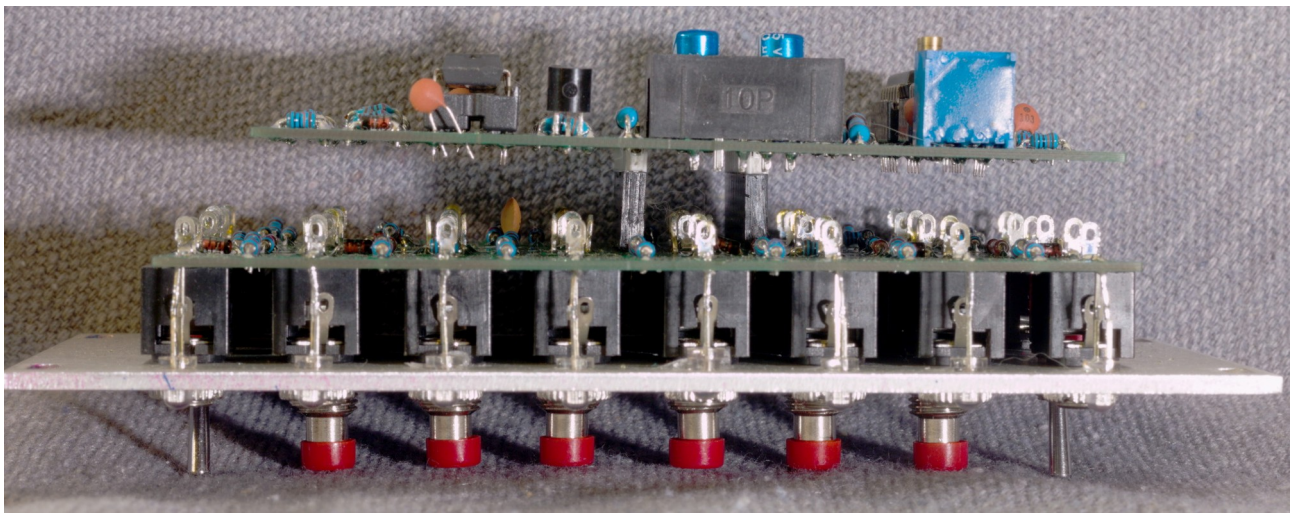
3. Putting it together

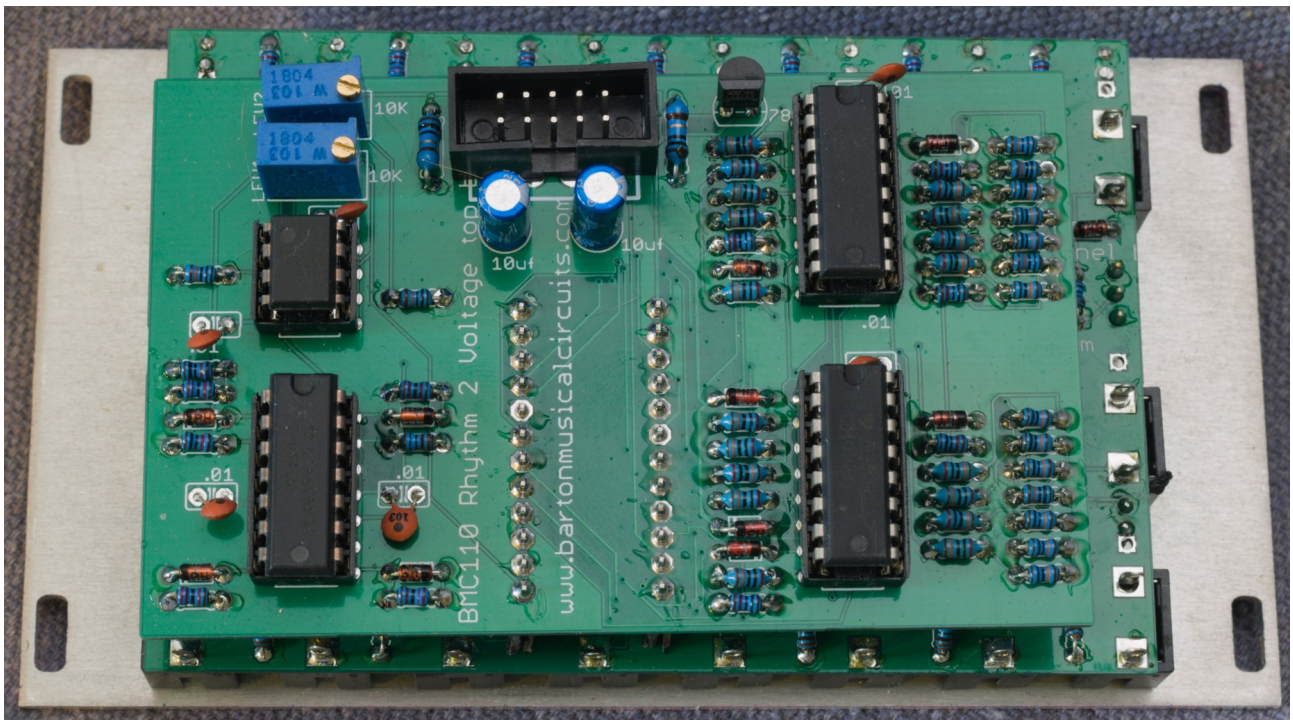
A. Remove all nuts from jacks and switches.
B. Carefully attach the panel to the jacks and switches of the panel PCB and then secure with mounting nuts.
C. Reheat solder joints of LEDS while gently pushing them toward panel to get them in place, then solder other pin of the LED.
D. Connect the headers of the top PCB and panel PCB.
E. Insert ICs to their sockets.

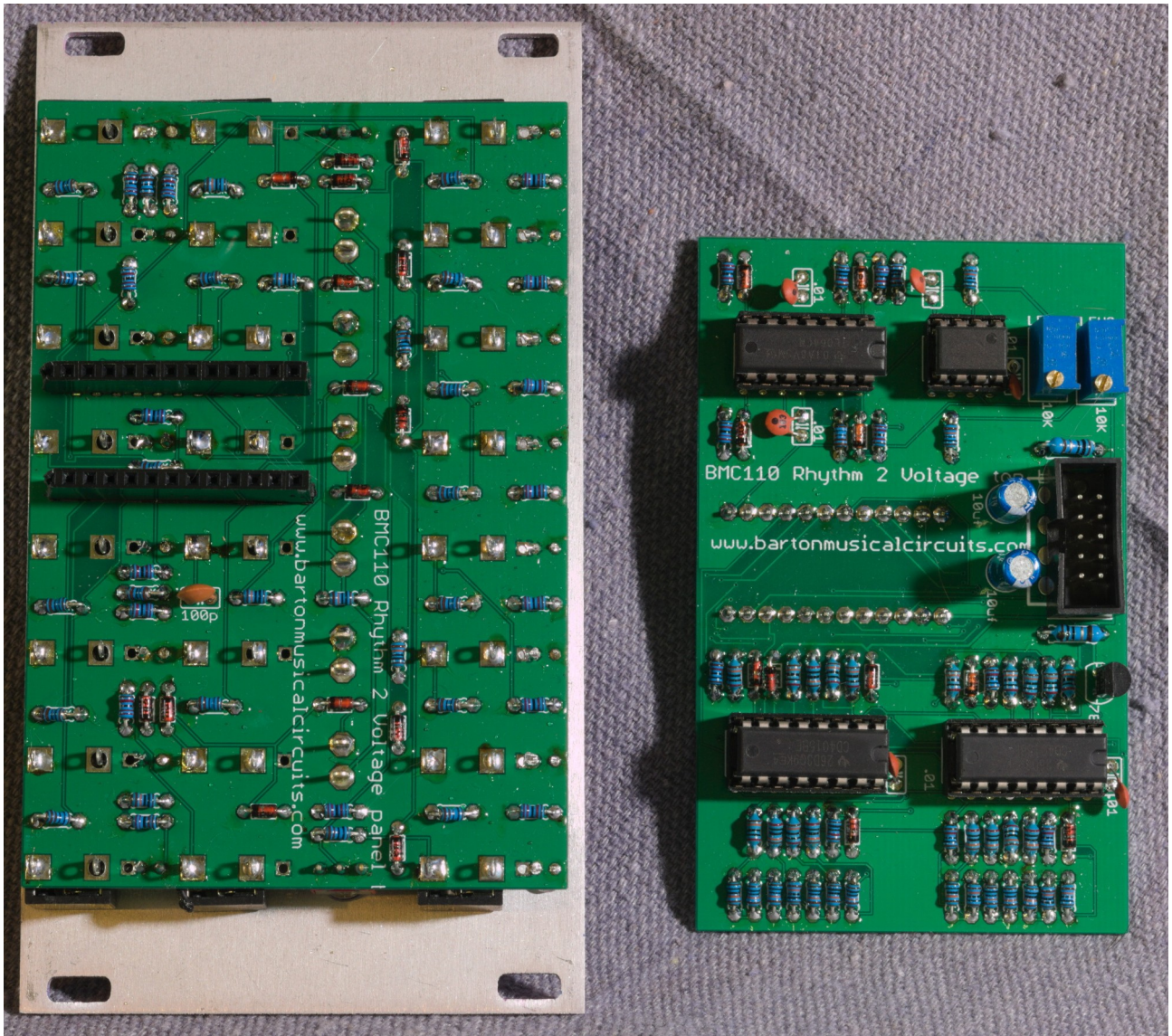
4. Calibration

A. Power on the module. All LEDs should light up.
B. Use a voltmeter to monitor the voltage from channel 1, inserting a cable and attaching meter probes to the cable is probably the easiest way to do this.
C. Adjust the LEV1 trimpot until the output voltage is 5.33V
D. Monitor the voltage from channel 2 and then adjust LEV2 until it is also 5.33V

Below are photos of a fully built module to use as a reference.




10K
10K
10uf
10uf
.01
.01
.01
BMC110 Rhythm 2 Voltage top
www.bartonmusicalcircuits.com


100p
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10K
10K
10uf
10uf
.01
BMC110 Rhythm 2 Voltage
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