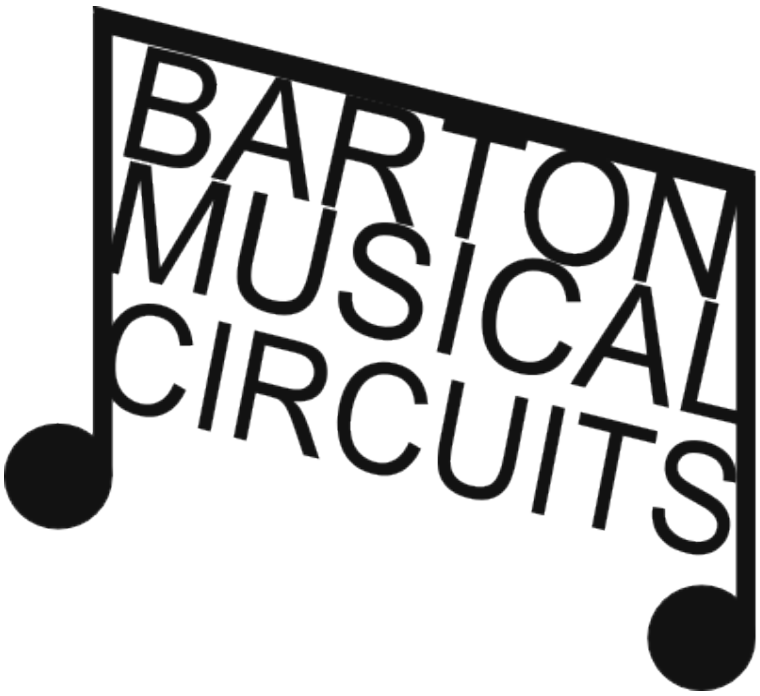

BMC108. MIDI 2 CV

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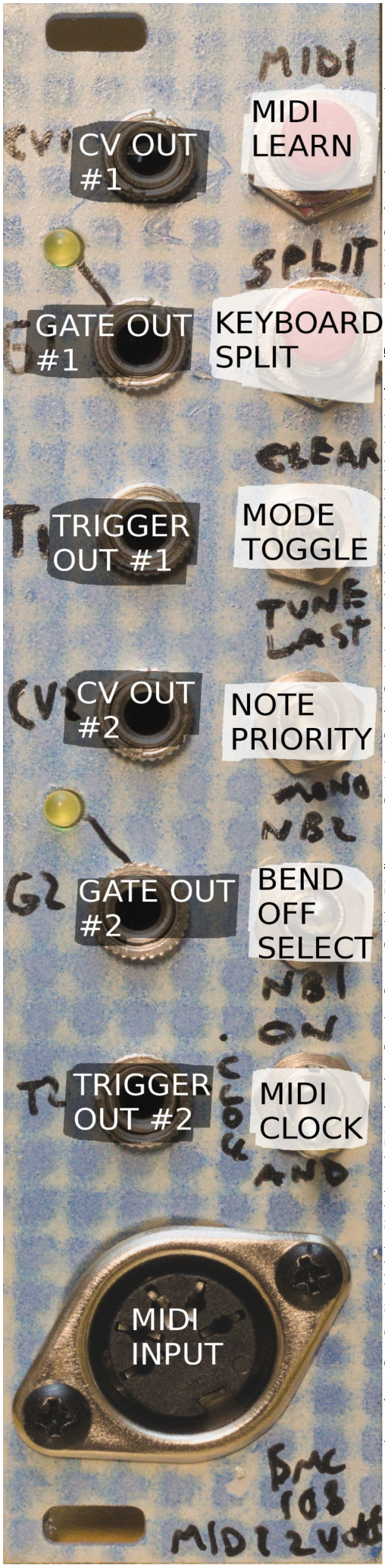
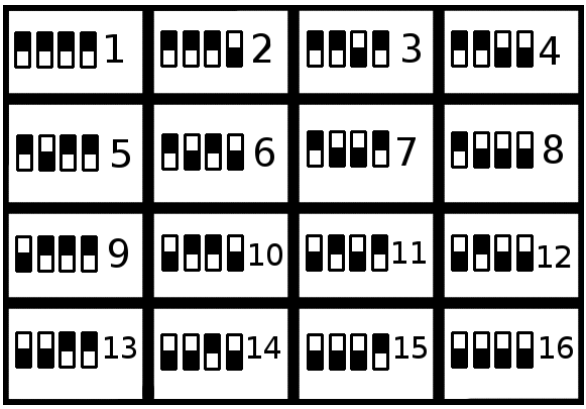
Last updated April 13, 2024



A. USING THE MODULE

The Midi 2 CV module allows a MIDI keyboard or sequencer to control two voices in a modular system with control voltage, gate and trigger outputs. It has controls for setting Midi channel, lots of options for the logic on what MIDI notes are output, output for MIDI clock and controls on ignoring bend controls. All toggles are three position toggles.

SETTING MIDI INPUT CHANNEL:



Method #1 – Press the "Midi Learn" button and then press a note on your keyboard or send a note through your sequencer. The module will then respond to all notes sent on that channel. This method is simple and foolproof, but will need to be repeated every time you use the module.

Method #2 – Use the DIP switch on the PCB to set what Midi channel the module will respond to. The diagram on the right shows what the switches should look like to correspond to each channel. This method saves time and is useful in a system where lots of MIDI channels are active, but requires taking the module out of the case to set the channel.

MODES OF OPERATION

STANDARD MODE – When first powered on with toggles in middle positions, the module will be in standard mode. Both channels will respond to notes played anywhere on the keyboard. See Note Priorities below for specifics on which notes are output. This mode can also be accessed by going into clear mode and then back out.

TUNING MODE – Pressing the mode toggle down sets the module to tuning mode. Both gate outputs will turn on and both CV outputs will output note C3 (~2V). This is useful for tuning your oscillators.

SPLIT KEY MODE – This mode is accessed by pressing the Split button and then pressing a key on your MIDI keyboard. The key pressed will determine the split point. All notes played up to the split point will output on channel 1 and all notes above the split point will output on channel 2. This is useful for separating bass and melody parts played simultaneously or allowing two people play the same keyboard at the same time.

CLEAR MODE – Pressing the mode toggle up sets the module into clear mode. This will clear the internal notes queue, turn off all gates and when leaving clear mode the module will be back into Standard mode. This is useful if you have a "stuck" Midi note or want to turn off the keyboard split function.

NOTE PRIORITY IN STANDARD MODE

PRIORITY TOGGLE UP = FIRST/LAST NOTE – Channel 1 will output the first note played and channel 2 will output the last note played. If more than 2 keys are pressed and the note currently output on channel 1 ends, channel 1 will change to the 2nd note played. Similarly if multiple notes are played and the note on channel 2 ends, channel 2 will change to the 2nd to last note played.
PRIORITY TOGGLE CENTERED = LOWEST/HIGHEST NOTE – In this priority channel 1 will always output the lowest note input and channel 2 will always output the highest note input.
PRIORITY TOGGLE DOWN = MONO LAST NOTE – Both channels will output the last note played. This is useful when playing leads and when checking your tuning across a large range of notes.

NOTE PRIORITY IN SPLIT KEY MODE

PRIORITY TOGGLE UP = LAST NOTE – Both channels will output the last note input on their side of the keyboard split.
PRIORITY TOGGLE CENTER = HIGHEST NOTE – Both channels will output the highest note on their side of the keyboard split.
PRIORITY TOGGLE DOWN = LOWEST NOTE – Both channels will output the lowest note on their side of the keyboard split

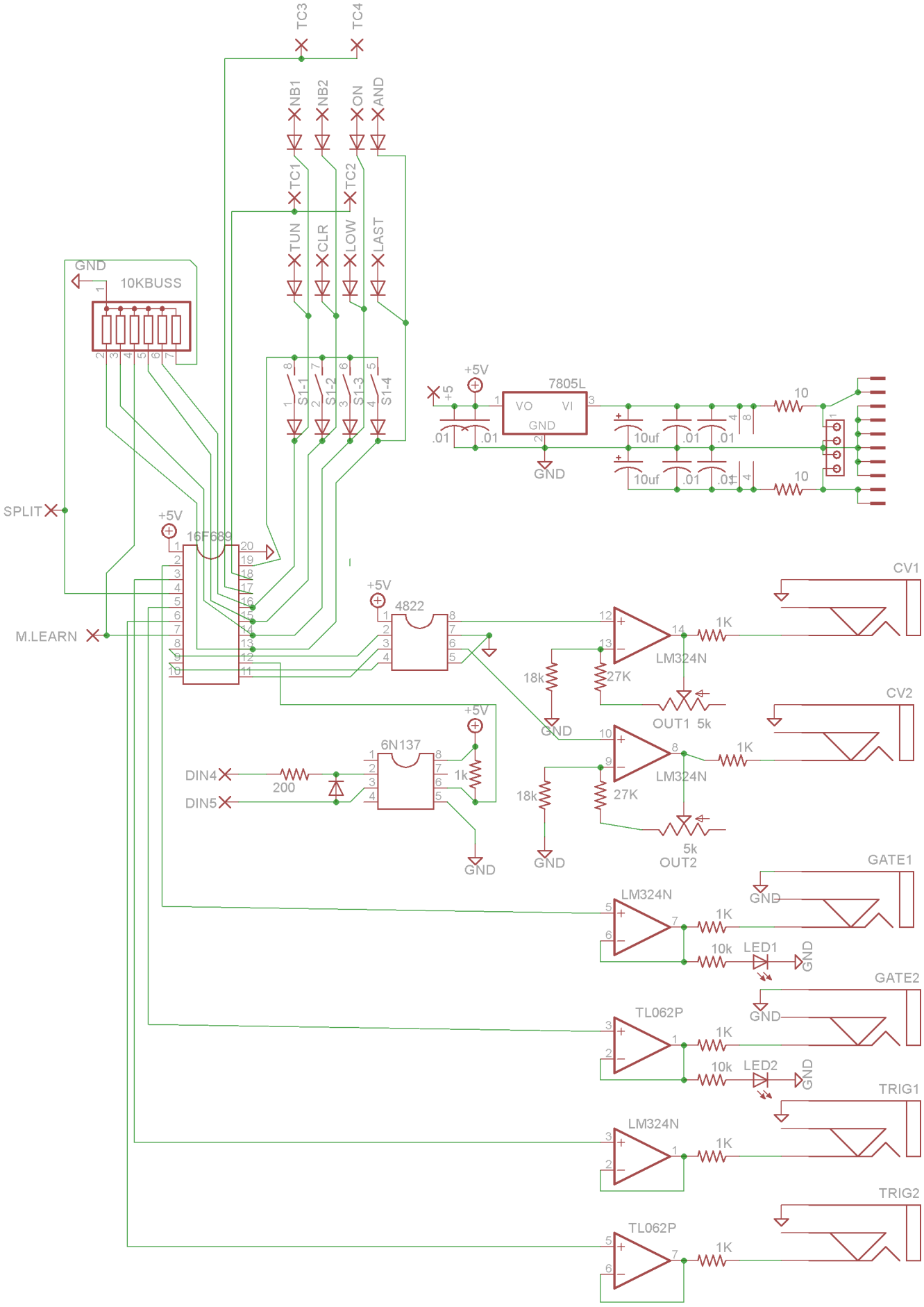
BEND OFF SELECT TOGGLE

The bend off select toggle is used to tell one of the CV outputs to ignore pitch bend controls from a MIDI controller. This is useful in split keyboard mode so you can bend a melody note without altering the bass and can also be useful for simulating the "bar bend" technique in guitar playing where only the higher note in a chord is bent.
TOGGLE UP = Channel 1 can bend, Channel 2 cannot.
TOGGLE CENTER = Both channels can bend
TOGGLE DOWN – Channel 2 can bend, Channel 1 cannot.

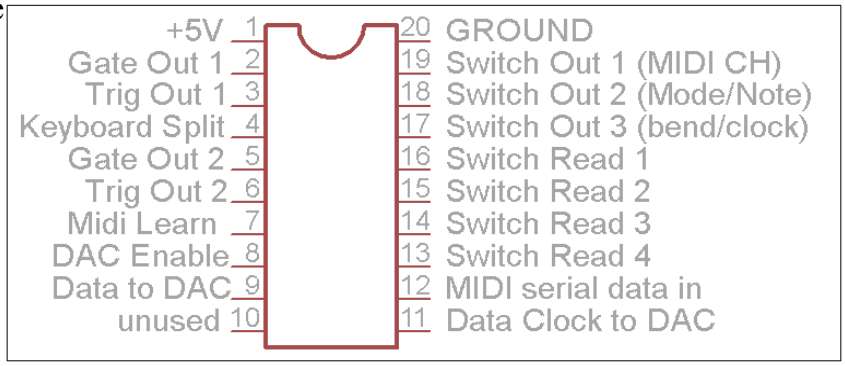
MIDI CLOCK OUTPUT TOGGLE

The Channel 2 trigger output can be set to output the midi clock instead of channel 2 triggers. It will output ¼ notes in time with the clock. When testing with a drum machine or hardware sequencers clock I've gotten great results. When using my DAW's MIDI sequencer (Reaper), I've gotten hickups in the first measure that I'm not sure if it's a bug in my software or Reaper's, but if you encounter it, just add a blank measure to the start to account for it.
TOGGLE UP = The Trigger 2 output will output triggers in time with the MIDI clock.
TOGGLE CENTER = The MIDI clock is ignored and trigger 2 out acts normally.
TOGGLE DOWN = The MIDI clock is ANDed with the Gate 1 output. So the Midi pulses will only trigger if channel 1 is playing a note.

B. SCHEMATIC


TC3
TC4
NB1
NB2
ON
AND
TC1
TC2
TUN
CLR
LOW
LAST
GND
10KBUSS
S1-1
S1-2
S1-3
S1-4
+5V
7805L
VO
VI
GND
10uf
.01
10
SPLIT
M.LEARN
16F689
4822
6N137
DIN4
DIN5
200
1k
18k
27K
OUT1 5k
OUT2
LM324N
1K
CV1
CV2
GATE1
GATE2
TRIG1
TRIG2
10k
LED1
LED2
TL062P

On the previous page is the full schematic for this module. The 16F689 PIC microcontroller is doing all the heavy lifting in this module. The pinout for this module is presented to the right. The schematic will be described by going through pin functions on the PIC in descending order.



Seven pins of the PIC are used to scan the positions of the toggles and DIP switch. Pins 17 through 19 are output pins, one at a time these pins will output +5V. The +5V is then sent to the center lug of two toggle switches or the 4 DIP switches. The outer lugs of the toggles are then connected to Pins 13-16 through diodes. Pins 13-16 are input pins that check for +5V signals letting the PIC know which toggles are an which positions. The input pins all have 10K pull-down resistors in the form a 10K bussed array that connects to ground.

Pin 12 of the PIC is the serial MIDI data input. MIDI data is received from a 6N137 opto coupler using a 1K pull-up resistor to +5V. This opto-coupler receives its data from a DIN connector using a 200 ohm current limiting resistor and a diode on it's input pins according to the MIDI standard.

Pins 8-11 are used to send data to the 4822 Digital to Analog converter chip. Pin 8 tells the DAC when to listen for signal, pin 9 sends the signal, 11 gives a reference clock to the DAC. The DAC outputs voltages on pins 8 and 6. These voltages are then amplified by op-amps wired as non-inverting amplifiers. Each of these op-amps has its gain set by a 18K resistor to ground and a 27K resistor in series with a 5K trimpot in its feedback path. Adjusting the trimpot calibrates the output of the channel to be exactly 1V/Octave. The op-amps outputs the CV to the CV jacks through 1K resistors that limit current in the case of shorting out.

PIN 7 and PIN 4 connect to the two pushbuttons to the PIC, each of these inputs has a 10K pull down resistor from the bussed array. These pins will be at ground until a +5V signal is sent from the pushbutton.

Pins 2, 3, 5 and 6 are the trigger and gate outputs. Each of these is sent to an op-amp buffer before being sent onto an output jack through a 1K current limiting resistor. The gate outputs are also sent to indicator LEDs through 10K brightness control resistors.

Power connectors for MOTM or Eurorack systems can be installed on the PCB. The voltage rails are filtered by 10ohm/10uf low pass filters and all ICs have .01uf capacitors placed next to power pins for high frequency filtering. The +5V supply is created by a 78L05 voltage regulator.

C. PARTS LIST

Semiconductors

Value	Qty	Notes
16F689	1	Comes with PCB
LM324	1	14pin DIP, other quad op-amps should work, I had good results when using these and they're cheap
TL062	1	8pin DIP, other dual op-amps should be fine
6N137	1	8pin DIP
MCP4822	1	8pin DIP
78L05	1	TO-92 +5V regulator
1N4148	13	
LED	2	3mm package.

Resistors

Value	Qty	Notes
10 ohm	2	1/4w metal film for all resistors unless otherwise noted
200 ohm	1	220 ohm should be fine as well
1K ohm	7	
10K ohm	2	Controls LED brightness, increase to 33K if using blue or white LED
18K ohm	2	
27K ohm	2	
10K Bussed Array	1	8 pin package, or can be made with 7 additional 10K resistors
5K cermet pot	2	3296 package

Capacitors

Value	Qty	Notes
10uf	2	Electrolytic
.01uf	6	Ceramic Disc

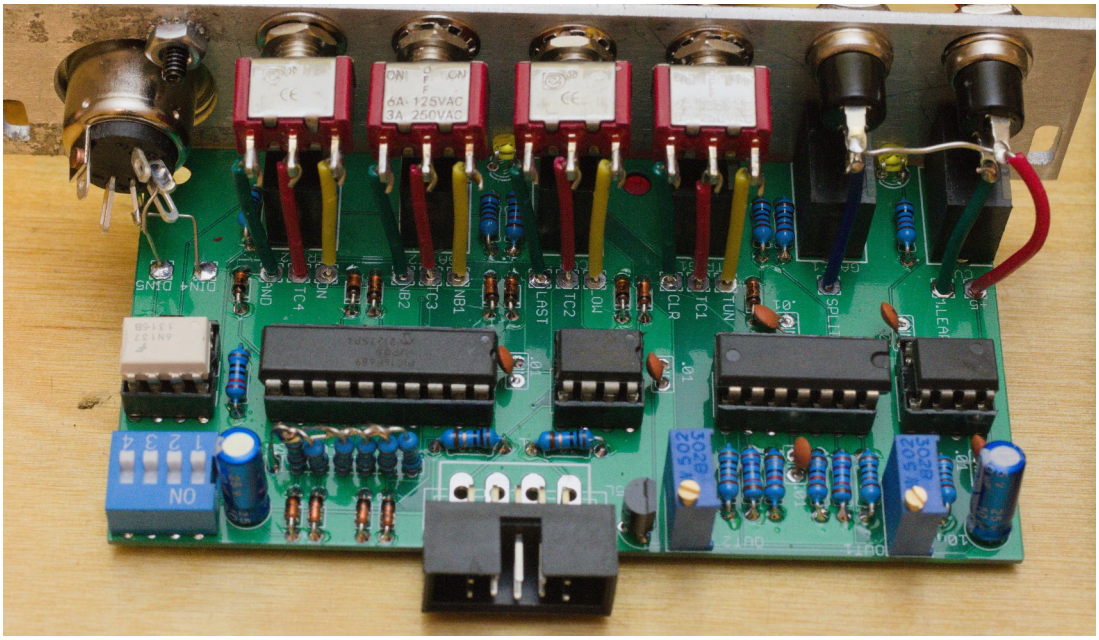
Other

Value	Qty	Notes
Power Connecter	1	
3.5mm Jack	6	The PCB is laid out to have these jacks attached to it. Other jacks can be used if attached with jumper leads.
Midi Jack	1	DIN Midi jacks will also require nuts/bolts to mount to panel.
Pushbutton	2	Panel mount, normally open
SPDT Toggle	4	On-Off-On type
DIP switch	1	8 pin, 4x switches

D.WIRING/CALLIBRATION INSTRUCTIONS

When using PCB mounted jacks, wiring is relatively simple for this module. From the bottom of the PCB to the top, wirepads should be connected as follows:
DIN5 – Pin 5 of a DIN Midi connector or the ring of a 3.5mm midi connector.
DIN4 – Pin 4 of a DIN Midi Connector or the tip of a 3.5mm midi connector.
AND – Bottom pin of clock toggle
TC4 – Center pin of clock toggle
ON – Top pin of clock toggle
NB2 – Bottom pin of note bend toggle
TC3 – Center pin of note bend toggle
NB1 – Top pin of note bend toggle
LAST – Bottom pin of priority toggle
TC2 – Center pin of priority toggle
LOW – Top pin of priority toggle
CLR – Bottom pin of mode toggle
TC1 – Middle pin of mode toggle
TUN – Top pin of mode toggle
SPLIT – To Key split push-button
M.LEARN – To Midi Learn push-button
+5 – To the two unused pins of the push-buttons
If using external jacks, the tip of each jack should connect to the center pad of the mounted jack's three solder pads and the sleeve should connect to the one closest to the edge of the PCB.

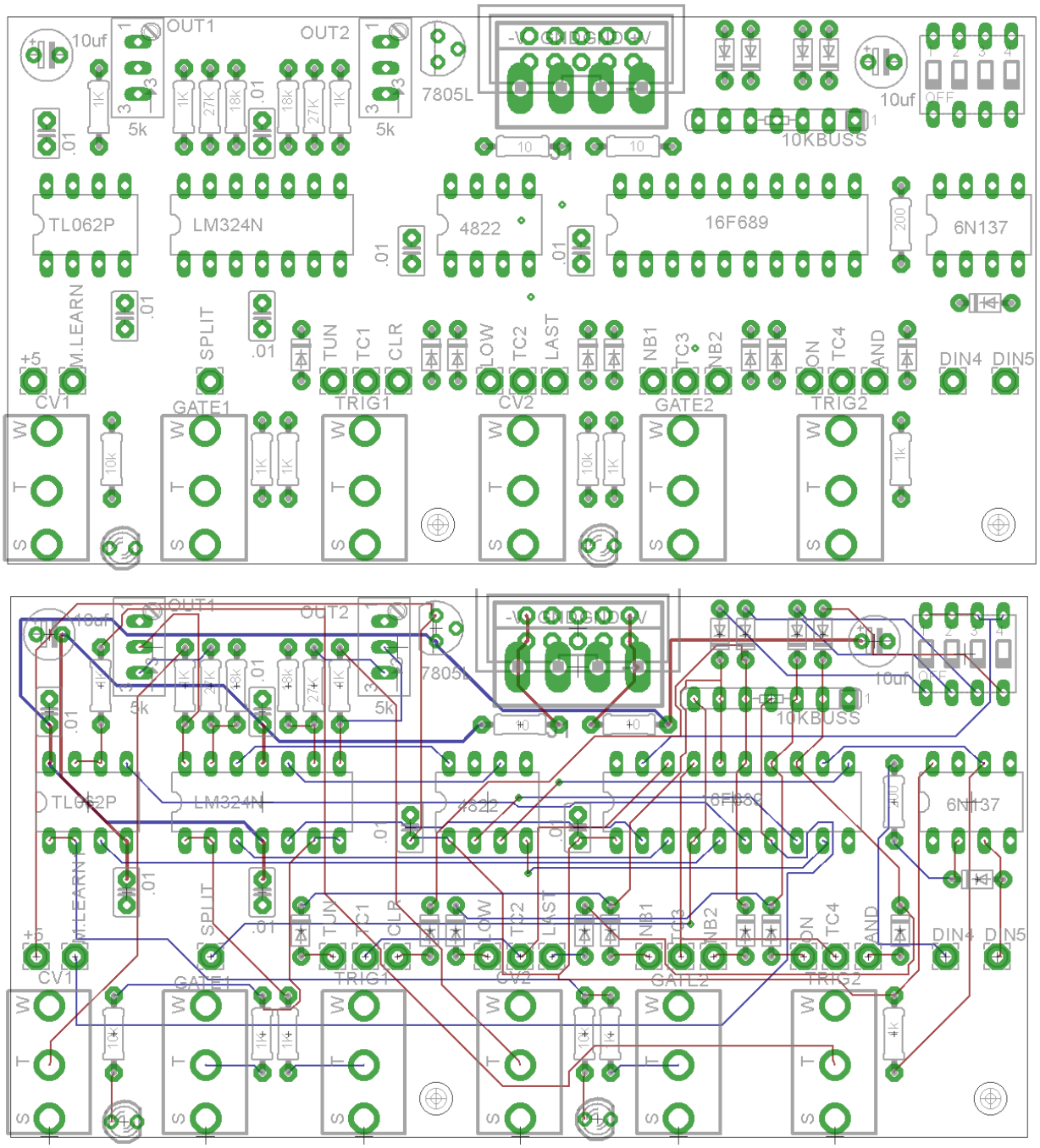
Here is a picture of a wired module:



To calibrate the module:

1.Set the module to TUNE mode.
2.Adjust each of the trimpots until the CV1 and CV2 outputs are both at 2V.
3.Set the module to Standard Mode, with MONO note priority.
4.Play a note and then play a note one octave apart and note the difference in voltage on output CV1, adjust the OUT1 trimpot until the notes are 1V apart exactly, repeat for different notes at different positions of the keyboard until you get 1V differences in octaves across the range of your keyboard.
5.Repeat step 4 monitoring CV2 and adjusting the OUT2 trimpot.

THE PCB



Above are images of the PCB with and without traces rendered. Ground connections are not shown in the image with traces.
The PCB is 100mm x 53mm with jack's spaced 15.2mm apart.