BMC026. Rando-Chordo.

*Last updated 10*23*2014*

NOTE: On Revision 1.0 PCBs, the OUT2 and OUT3 trimpots' labels are swapped. Adjust OUT2 trimpot to adjust Output 3 and vice-versa.

If you have any questions, or need help trouble shooting, please e-mail
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I. Features

The Rando-Chordo is a module which takes a single CV input and then applies multiple randomly selected offsets to this voltage, quantizes the input and the offset voltages, creating 4 notes of CV from a single input. It features the following controls/inputs/outputs.

KNOB CONTROLS:
1.MODE. This knob selects what musical mode to quantize to. The chart on the right illustrates the modes, in order of most counter clockwise knob position to most clockwise.
2.RANGE. This knob limits the range of the offsets. At it's most clockwise position offsets can be as far as 2.5volts (two and a half octaves) away from the input voltage. At it's most counter-clockwise, there is no offset.
3.AUXCV. This knob controls how much of the auxiliary CV is used to modify the main CV input. When no external CV is inputted, it will act as a manual offset to the CV input.

SWITCH/BUTTON CONTROLS:
1.NEW. This is the only pushbutton control. It causes a new set of offsets to be generated.
2.TUNE. This sets all the outputs to 1V. This allows you to tune all of your oscillators to the same note.
3.5THs. This switch sets output #2 to always play a fifth above output #1, ignoring both the normal voltage offset and what mode you are quantized to.
4.INVERSIONS. This switch allows for negative offsets to be applied, creating inverted chords where the root note is no longer the lowest note heard.
5.QUANT BEFORE OFF. This control sets it so that the input voltage is quantized before the other offsets are applied. The result of this is that all notes in a chord will change at once. This mp3 demonstrates the difference. Midway through the recording, the switch is flipped.

INPUTS
1.CV IN. This is the main CV input. It should be between 0 and 5volts, but an offset can be applied by the AUXCV knob when not using the auxiliary CV.
2.AUX CV IN. This is an input for the auxiliary CV.
3.SAMPLE IN. A trigger can be input here to get a sample-and-hold type effect on the input CV, or a gate can be input for a track-and-hold effect. This is useful when using rapidly moving CV sources. When nothing is plugged in, it continually samples the input voltage.
4.NEW IN. A trigger or gate on this input causes a new set of offsets to be generated.

OUTPUTS
1.OUT 1. This is a quantized version of the input CV.
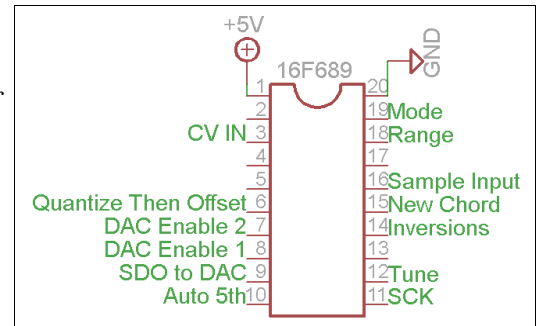2-4.OUT 2-4. These are outputs of quantized offsetted input CV.

Quantization Modes.
1.Chromatic. All 12 semitones.
2.Major. 1st, 3rd, 5th, 6th, 8th, 10th and 12th
3.Minor. 1st, 3rd, 4th, 6th, 8th, 9th and 11th
4.Whole. 1st, 3rd, 5th, 7th, 9th and 11th
5.Major 7th chord. 1st, 5th, 8th and 12th
6.Major Pentatonic. 1st, 3rd, 5th, 8th and 10th
7.Octave and 5th. 1st and 8th
8.Octave. 1st

| Mode	1	2	3	4	5	6	7	8	9	10	11	12
CHROMATC	■	■	■	■	■	■	■	■	■	■	■	■
MAJOR	■		■		■	■		■		■		■
MINOR	■		■	■		■		■	■		■	
WHOLE	■		■		■		■		■		■	
MAJOR 7TH	■				■			■				■
MAJOR PEN	■		■		■			■		■		
OCT AND 5	■							■				
OCTAVE	■											

II. Schematics

A.Pinout. *To the right is a diagram showing the pinout of the 16f689 microcontroller which is the core of this module. All of the other schematics interface with this chip.*

A pinout diagram of the 16F689 with:
- +5V (pin 1)
- pin 2
- CV IN (pin 3)
- pin 4
- pin 5
- Quantize Then Offset (pin 6)
- DAC Enable 2 (pin 7)
- DAC Enable 1 (pin 8)
- SDO to DAC (pin 9)
- Auto 5th (pin 10)
- GND (pin 20)
- Mode (pin 19)
- Range (pin 18)
- pin 17
- Sample Input (pin 16)
- New Chord (pin 15)
- Inversions (pin 14)
- pin 13
- Tune (pin 12)
- SCK (pin 11)

B.Analog Inputs. *On the right we see the three analog inputs. At the top are the Mode and Range knobs. These are wired as voltage dividers and will produce a variable voltage of between 0 and 5v. The wiper of each pot is wired to a .1uf capacitor which filters out any high frequency noise from the pot.*

    Below thsi we see the CV input schematic. On the far right are the CV Input and auxiliary input wirepads. The Auxiliary input goes through a voltage dividing potentiometer and then both inputs are mixed with 100K resistors and then sent to a pair of inverting amplifiers as part of the mixing process. The output of the two amplifiers goes to a 1K resistor in series with a pair of schottky diodes. These diodes will limit the voltage on the pin to between 0 and 5v. Then there is a .1uf capacitor filtering out noise.
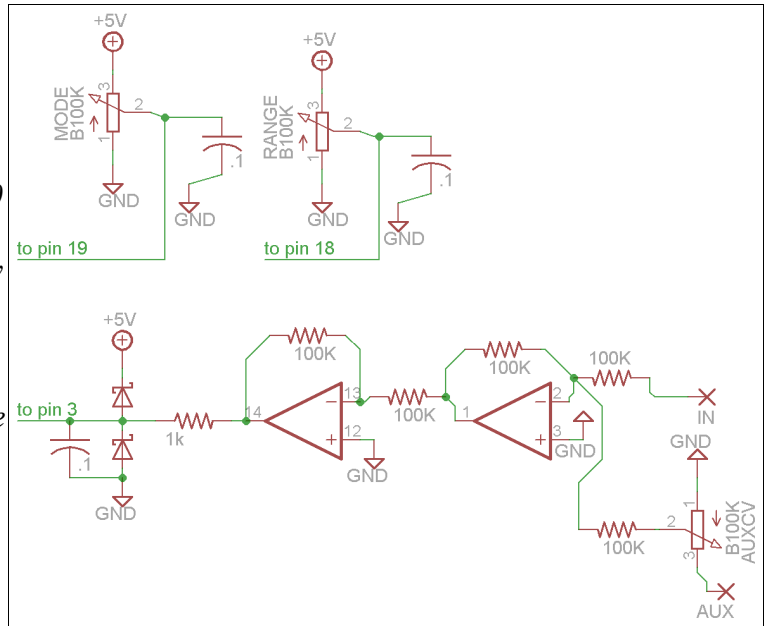
C.Digital Inputs. *At the center of the diagram on the right are the four toggle switch inputs. The switches are not pictured, but switch between 0 and 5v. Each input wirepad is connected to a 100k pulldown resistor and then goes on to the microcontroller.*

    To the right of these are the "New" and "Sample" inputs. Each of these circuits are identical. On the far right are the inputs. The "XS" input will normally not be wired to anything, but was left in from an earlier revision to allow builders to expirement if needed. The "N" and "XN" were accidentally labeled backwards, "N" should be connected to the external jack for "New" and "XN" should be wired to the pushbutton.

    These inputs go to a comparator set with a .12v threshold, so any signal should be suitable to trigger them. The output of the comparators go through a voltage divider and then to a pair of schottky diodes which limit the voltage on the input of the microcontroller.
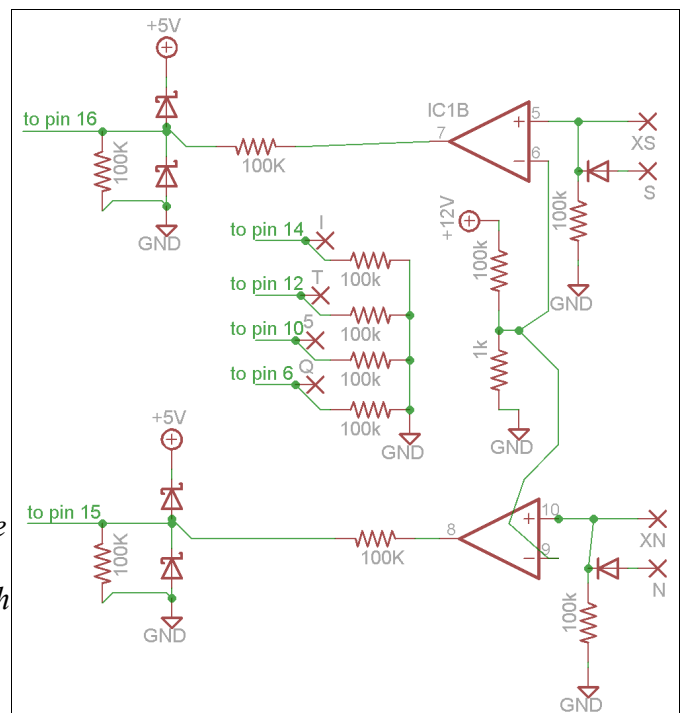
D.Analog Outputs *On the right we see the analog outputs. The 4822s are dedicated DAC chips which are connected to the micro controller receive digital information serially. Each 4822 has two outputs. All outputs from the 4822s are sent to non-inverting amplifier stages, each of which has a trimpot in it's feedback path, these trimpots are calibrated by turning the tune switch on and then adjusting each output to +1V.*

E.Power *Below we see the schematic for the power connections for the module. At the top are the footprints for the two power connecters. The positive and negative rails each go through a 10 ohm resistor and then on to 10uf capacitors to filter noise from the power supply. These rails are then connected to all the op-amps power pins. The positive rail is then connected to a 7805 voltage regulator, and it's output is sent to the microcontroller and DAC chips power pins. Near each power supply pin on each IC is a .1uf capacitor to ensure smooth power.*
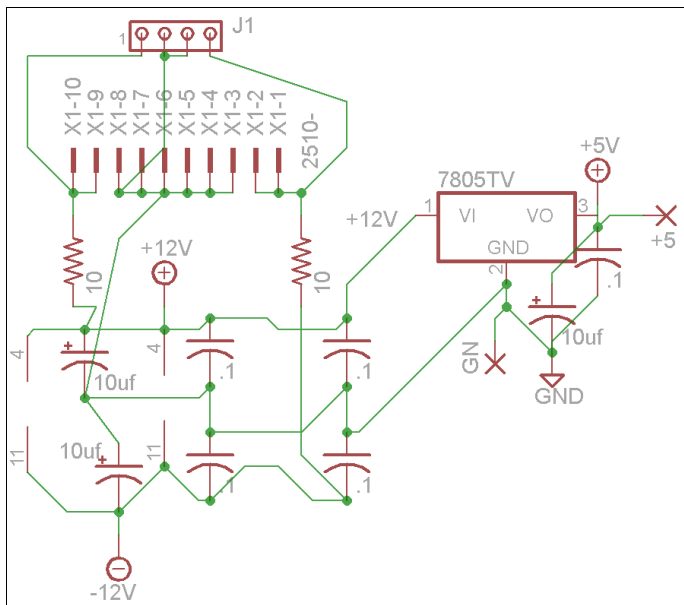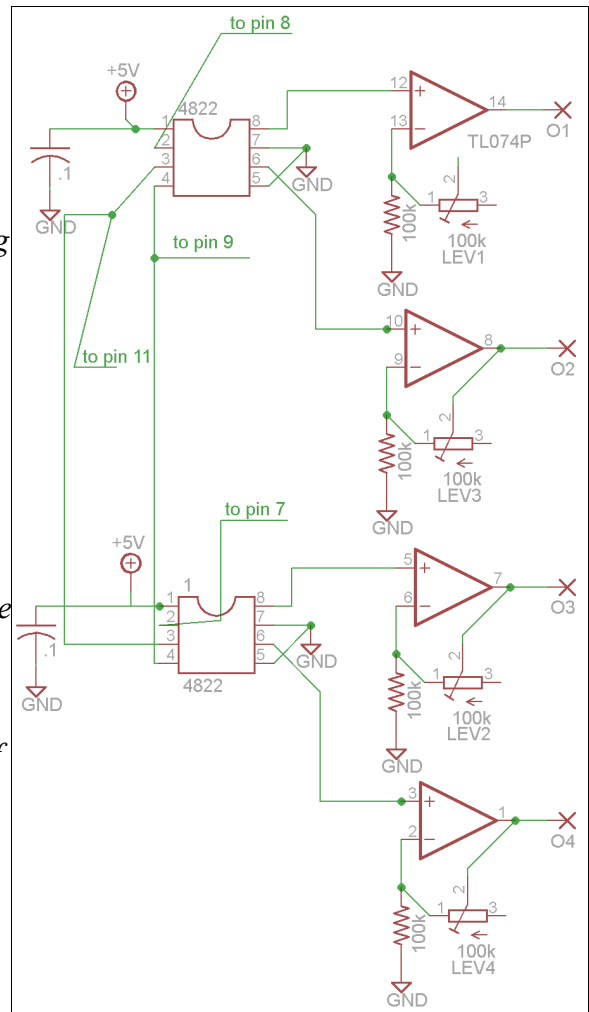
III Construction
PARTS LIST

SEMICONDUCTORS

Name/Value	QTY	Notes
16F689	1	Should have come with your PCB
MCP4822	2	DIP 8 package
TL074	2	DIP 14 Package
7805	1	TO-220 Package
Schottky Diode	6	DO-35 package. 1N60P, BAT 46, or similar
Switching Diode	2	DO-35 package. 1N4148, 1n914 or similar

RESISTORS

Name/Value	QTY	Notes
100K	12	1/4 W
1K	2	1/4 W
100K bussed array	1	9 pin SIL. Or build your own using 8 resistors.
B100K PC Mounted Pot	3	Alpha 16mm.
100K trimpot	4	3296 Packaging.

CAPACITORS

Name/Value	QTY	Notes
.1uf	10	cheap ceramic disc. Value not critical.
10uf	3	Electrolytic, 16V or higher rating.

OTHER

Name/Value	QTY	Notes
20 pin DIP socket	1	
14 pin DIP socket	2	
8 pin DIP socket	2	
Power connecter	1	MOTM or Eurorack style
Jacks	8	At least two must have switch for when nothing is plugged in. Panel mounted.
SPDT or SPST toggle	4	Panel mounted
Pushbutton	1	OFF-(ON) type.

B. THE BOARD

The PCB is 73mm x 57mm. The mounting holes are spaced 69mm apart. The pots are spaced 28mm apart.

There is a wiring diagram on the next page demonstrating connections, but here is a short summary of what each wirepad should be connected to.:
01-04 - output jacks
AUX - AuxCV input jack
+5 - switch of Sample jack and AuxCV jack and center lug of all toggle switches and one lug of the pushbutton
GND - sleeve of a single jack if using aluminum panel
IN - CV input jack
N - "New" input jack
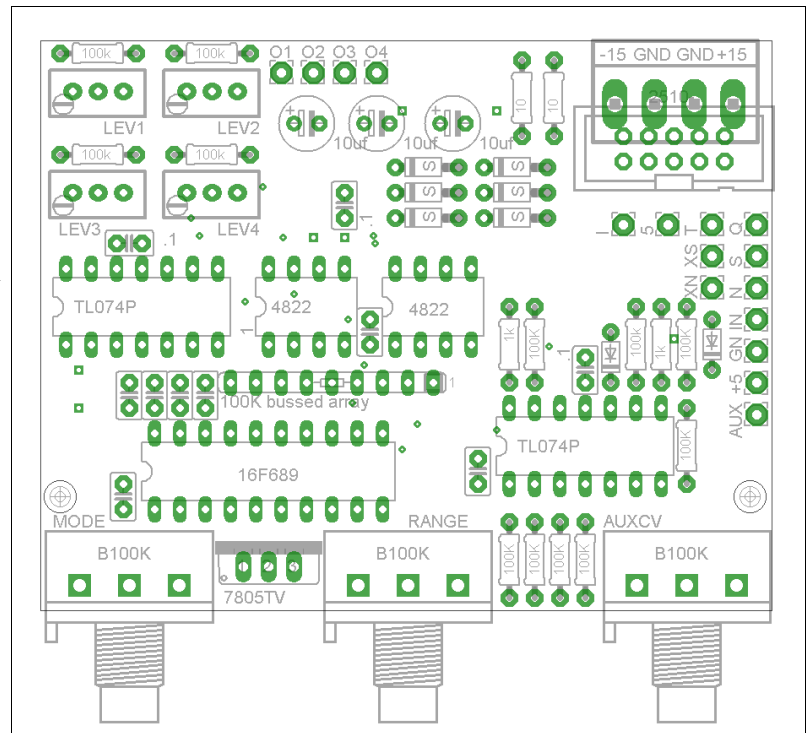*S - Sample input jack*
Q - bottom lug of quantize switch
XN - A lug of the "New" Pushbutton
XS - unused in normal wiring
T - bottom lug of Tune switch
5 - bottom lug of 5ths switch
I - bottom lug of Inversions switch

C.Calibration
Calibration is very simple. Activate the Tune switch, then adjust each trimpot until it's associated output is outputting +1V.

NOTE: On Rev 1.0 PCB the OUT2 and OUT3 trimpots' labels are swapped. Adjust the OUT3 trimpot to adjust output 2 and vice-versa.