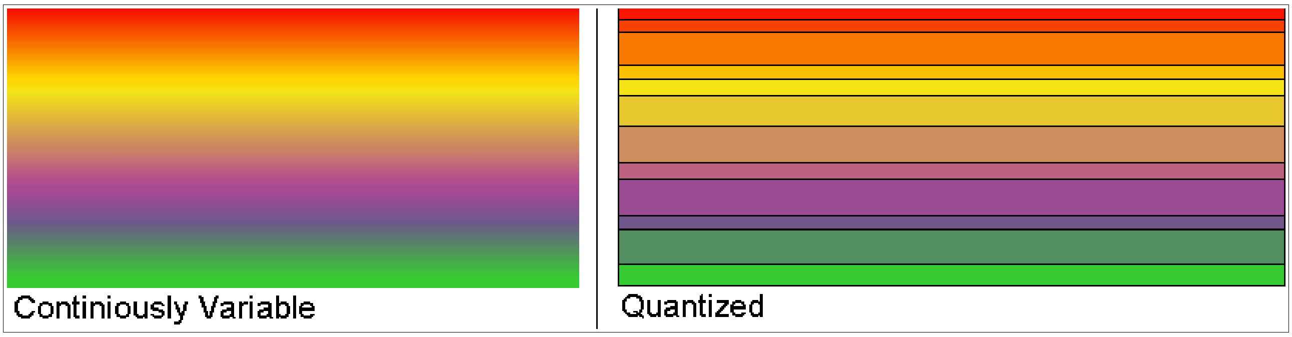
User Writable Quantizer Documentation

Document started on December 14, 2012

I. What Is The User Writable Quantizer?

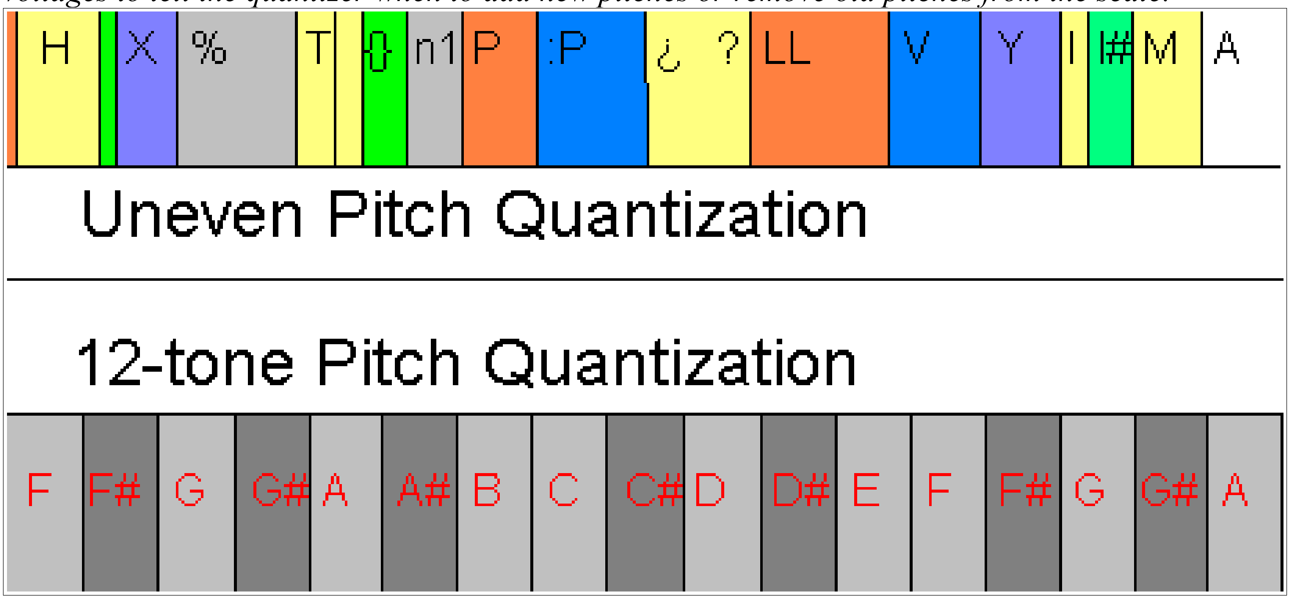
A. Quantizing is...



Quantizing is taking something continiously variable, and limiting it's possibilities. It's something that humans do all the time because it makes our world easier to understand. In baking, we quantize our flour and salt by using meausiring cups so we get a cake that we know will taste good or at least edible. In music, we quantize pitches using keys or frets to create a sense of coherence and order that we know will sound good or at least not make our heads explode.

In modular synthesis, the oscillators which create pitches are usually controlled by voltages using the 1v/oct standard, so the easiest way to quantize pitch is to quantize these control voltages. The most common voltage quantizers are ones which use divisions of 1/12th of a volt. This corresponds to the equal tempered 12-tone scale that is common in western music. There are then sometimes controls which limit the selection even further, so that only a major scale, or minor pentatonic scale can be played. If this is all you want out of a quantizer, you might want to check out the Barton Musical Circuits Simple Quantizer.

The User Writable Quantizer is a little different from most other voltage quantizers. It is not loaded with any preset musical scale or mode. Instead the user needs to manually input each pitch that they want to be quantized to. This takes a little bit of time, but it allows users to create scales that are brand new, where the distances between pitches are uneven, or change with each octave. The writing of musical scales can also be mechanized, by using external triggers and control voltages to tell the quantizer when to add new pitches or remove old pitches from the scale.



The User Writeable Quantizer also has a "softness" control which can allow the unquantized voltage to slowly shift into the quantized voltage, or act as a simple slew between quantized voltages. Quantizing can also be turned on and off, which is useful when writing scales and also allows the unit to act as a sample-hold with voltage controlled slew. The name "softness" is a tribute to a feature in an old quantizer design from Bernie Hutchins that was printed in Electronotes.

B. Inputs/Outputs/Controls

<u>*INPUTS*</u>

1.CV Input - This is the voltage that will be quantized and which will also be the guide for when writing scales.

2.Auxilarry CV Input - This is a second CV input that is summed with the main one, it has it's own attenuater.

3.Softness CV input - This is an external CV that is summed with the manual softness voltage, it has it's own attenuater.

4.Write Trigger Input - A gate or trigger input on this jack will cause the quantizer to write the current input voltage into the scale.

5. Erase Trigger Input - A gate or trigger input on this jack will cause the quantizer to erase the current output voltage from the scale.

6.Trigger Input - A trigger or gate input on this jack will cause the quantizer to sample the current input CV. This should be a switching jack normalled to +5V so that when nothing is plugged in, the unit is always sampling input.

7.Quantize Input - A gate input on this jack will cause the quantizer to output the quantized CV instead of unquantized. This should also be normalled to +5V

<u>*OUTPUTS*</u>

1.CV Output - The quantized (or unquantized) output voltage.

2.Status LEDs - Technically these aren't outputs, but they provide visual feedback. The red LED turns on when the soft control is slewing and the output has not reached it's goal yet. The green LED turns on whenever the input voltage is equal to a quantized voltage.

<u>*CONTROLS*</u>

1.Auxillary CV Attenuater - controls how much of the Aux CV gets used.

2. Softness - Controls the rate of slew between notes.

3.Aux Softness Attenuater - controls how much of the Aux soft CV gets used.

4.Write button - when pressed writes the current input CV to the scale.

5.Erase button - when pressed erases the current output CV from the scale.

6.Save button - Saves the current scale to the selected memory bank.

7.Load button - Loads a scale from the selected memory bank. When held with the erase button at the same time, clears the current scale

8.Bank select toggle - Selects which memory bank should be used in save/load operations. Should be a center-off type toggle and normally kept off to guard from accidental save/load button presses.

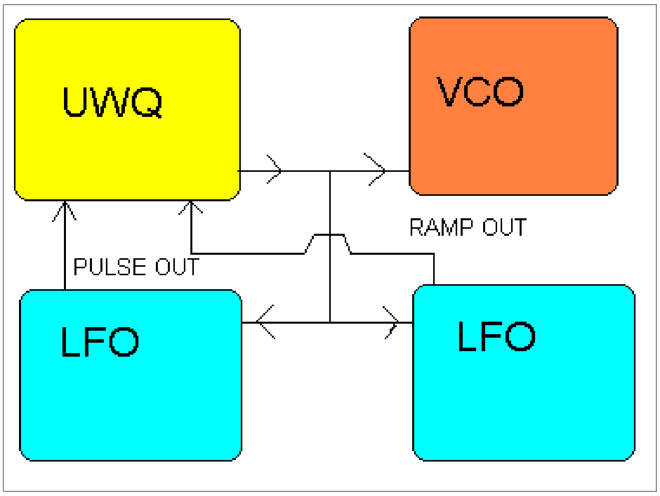
9.Up/Down/Both toggle - This selects whether the quantizer always quantizes to the note above, the note below, or whichever note is closest.

10.Quantize on/off toggle - Turns quantizing on or off.

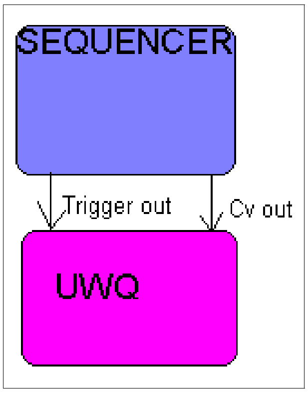
11.Bipolar toggle - Puts the unit in either unipolar (0v to +10v) or bipolar (-5v to +5v) range.

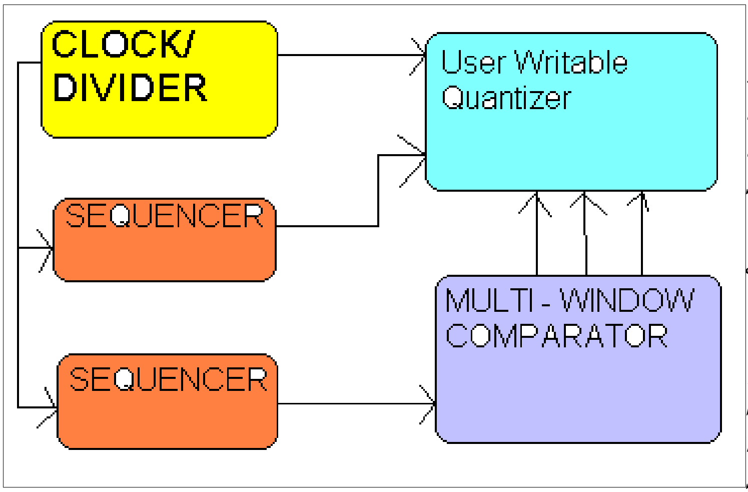
C. Sample Patch Ideas.

1. The pulse out of an LFO is inputted to the UWQ's trigger input, and the ram out of another LFO is inputted to the UWQ's CV input. The UWQ's CV output is modifying the frequencies of both LFOs and a VCO. This creates a feedback loop where the pitches will go unchanged for long stretches and then change rapidly. The pulse out could also be put into the quantize input to turn quantizing on or off.



2. First clear the UWQ's scale by pressing erase/load at the same time. Plug the sequencer's trigger out or clock out into the write trigger input on the UWQ and the sequencer's CV out into the UWQ's cv in. Turn the CV knobs on the sequencer so that no two knobs are in the same position. Play the sequence once through, then repatch the sequencer's trigger out into the trigger in of the UWQ. Then turn the softness on the UWQ up, and begin adusting the cv knobs on the sequencer. Notes will begin to glide into the their correct position, then if a step's knob is turned too closely to another steps, it will glide into it's position instead. The UWQ's output should be sent to a VCO.



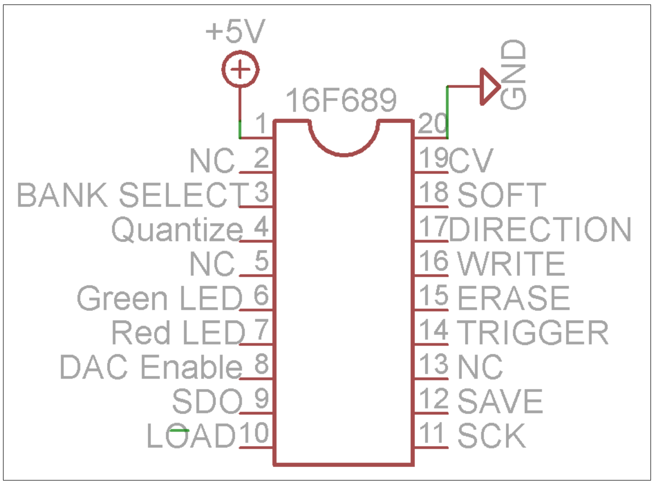


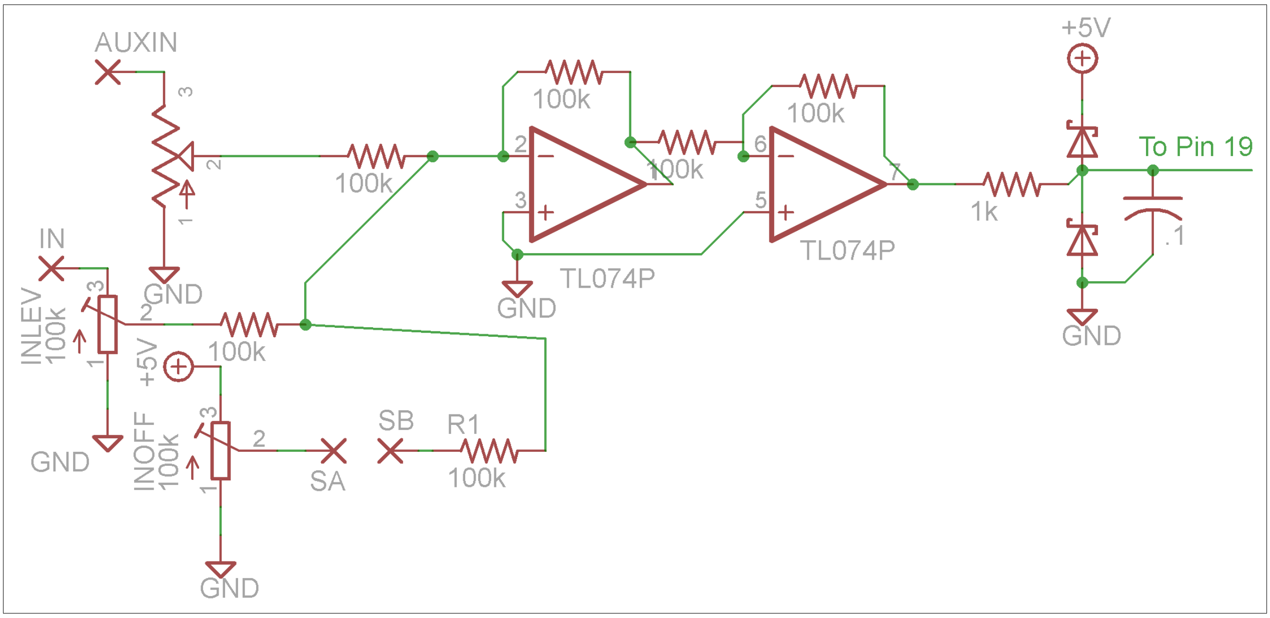
3.A Clock/Divider is sending outputs to the clock inputs of two sequencers and the trigger input of the UWQ. The first sequencer's CV out is going to the UWQ's CV in. The second sequencer's CV out is going to a Multi-Window Comparator's CV input. The gate outputs of the Multi Window Comparator are being sent to the Quantize input, the Aux CV in and the Aux Soft input. This patch will create a repeated series of notes that will sometimes be quantized, sometimes shift into place, and sometimes be a little higher in pitch. Play with the divisions and the cv settings of the sequencers. This patch can create a lot of different sounds. Try replacing one of the sequencers with a noise and Sample-Hold circuit, or replace the Multi-Window comparator with a voltage-to-rhythm converter set in parallel mode.

II. Circuit Description/Schematics

A. The Chip

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

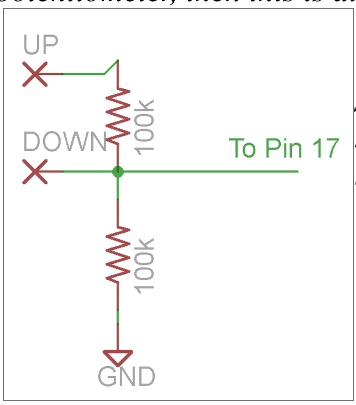




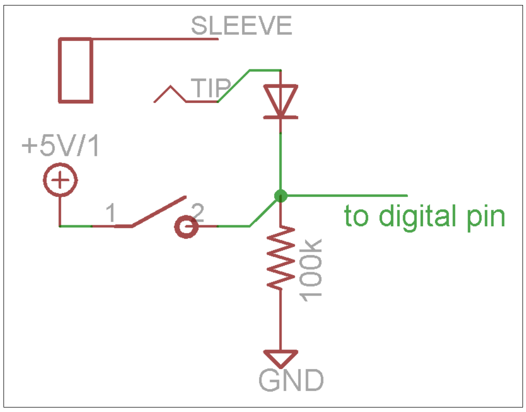
B. Analog Inputs

The diagram above is for the CV input. The main CV input is attenuated with a trim pot. This gets mixed with the attenuated auxilary input. When in bi-polar mode, point SA is connected to point SB by a switch and an offset voltage is mixed in with the input cv. These voltages are mixed together and inverted by two op amps and several 100k resistors. The 1k resistor and schottky diodes provide voltage protection, keeping negative voltages and voltages above 5V off of the chip. The .1uf cap filters out high frequency noise.

If you ignore the input offset and replace the input attenuating trim pot with a regular potentiometer, then this is also the schematic for the softness input.

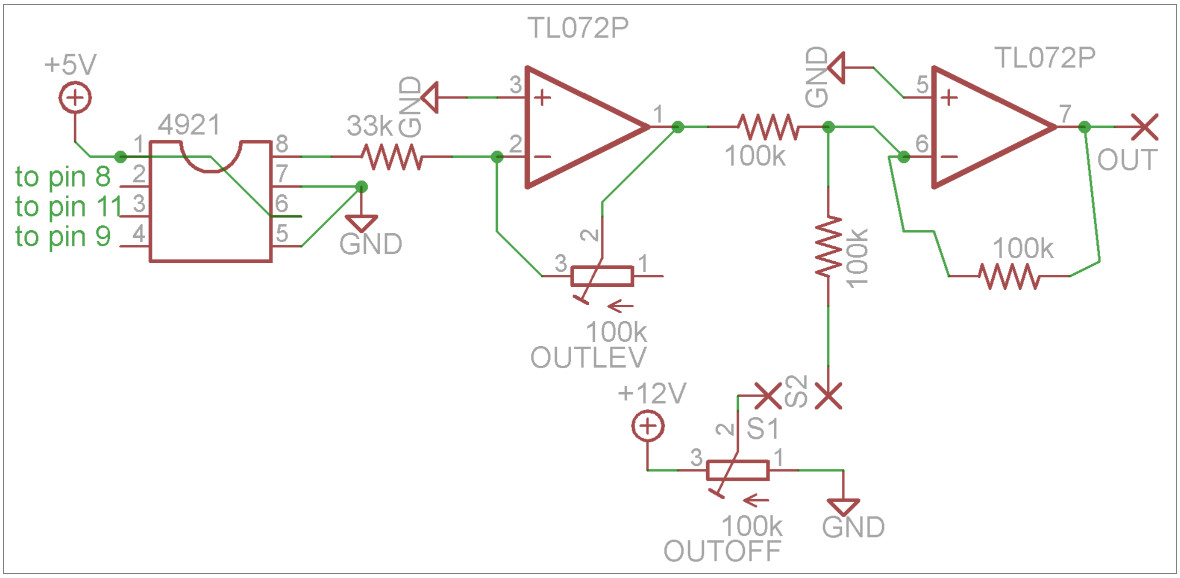


On the left, you see a schematic for the input for the UP/DOWN/BOTH switch. This is the same schematic as the Bank select switch. When 5V is applied to the UP terminal, it gets attenuated by the two 100k resistors and pin 17 sees ~2.5V. When 5v is applied to the DOWN terminal, pin 17 sees 5V.



C.Digital Inputs.

The diagram on the left describes the Write/Erase inputs/switches. Ignoring the jack and diode, it shows the Save/Load switches. Ignoring the switch and diode, it shows the trigger input. Replace the wire between the diode and resistor with an SPST and it is the Quantize input.

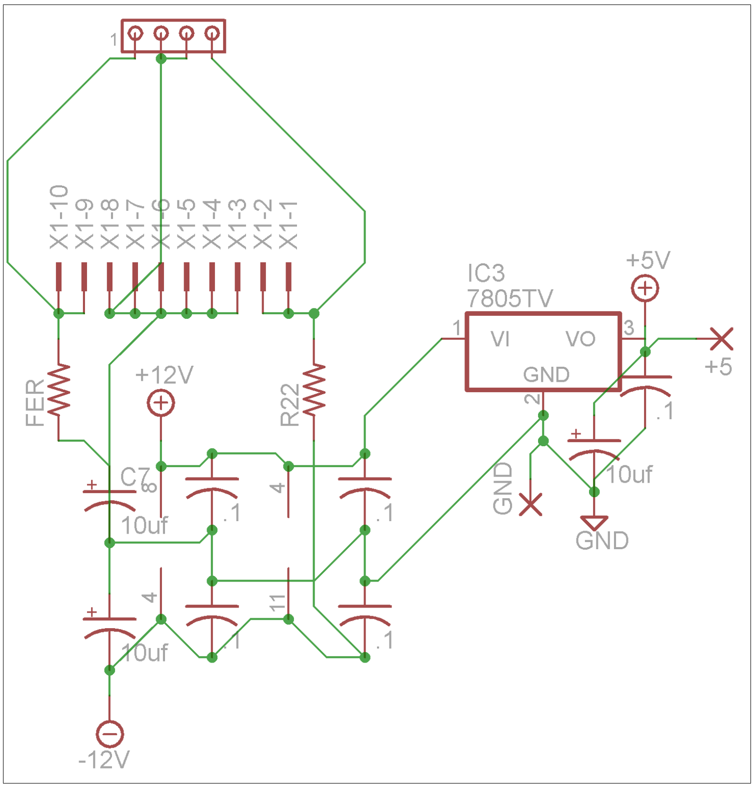


D.Analog Output

This diagram shows the analog voltage output for the unit. On the left is the 4921 Digital to Analog converter chip. This is connected to the serial-data outputs of the 16F689. The output of the DAC goes into an inverting gain stage with a trim pot in it's feedback path. This pot sets the output amplitude of the unit. The next gain stage mixes this voltage with a negative offset, when in bi-polar operation.

E. Power Supply

The two power connecters 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

Value	*Quantity*	*Notes*
16F689	*1*	*Should come with your PCB pre-loaded with software*
MCP4921	*1*	*Digital to Analog converter*
TL074	*1*	*or 064 or any other quad opamp you have on hand*
TL072	*1*	*or 062 or any other dual opamp you have on hand*
SD101C	*4*	*Schottky Diodes*
7805	*1*	*Voltage regulator*

2.Capacitors

value	*Quantity*	*Notes*
.1uf	*7*	*5mm lead spacing. Cheap ceramics are fine*
10uf @ 16v	*3*	

3.Resistors

100k 1/4W	*17*	*5mm lead spacing. Use 3.2mm length resistors or stand up.*
1k 1/4W	*4*	*" "*
33k 1/4W	*1*	*" "*
10 ohm 1/4W	*2*	*or ferrite bead 7.5mm lead spacing*
100k trim pot	*4*	*Triangle pattern pins. See board*
B100k Pots	*3*	*Alpha RV120F-20-15F-B100K part.*
100K bussed Array	*1*	*8 pin bussed array, or 7 resistors put in sideways.*

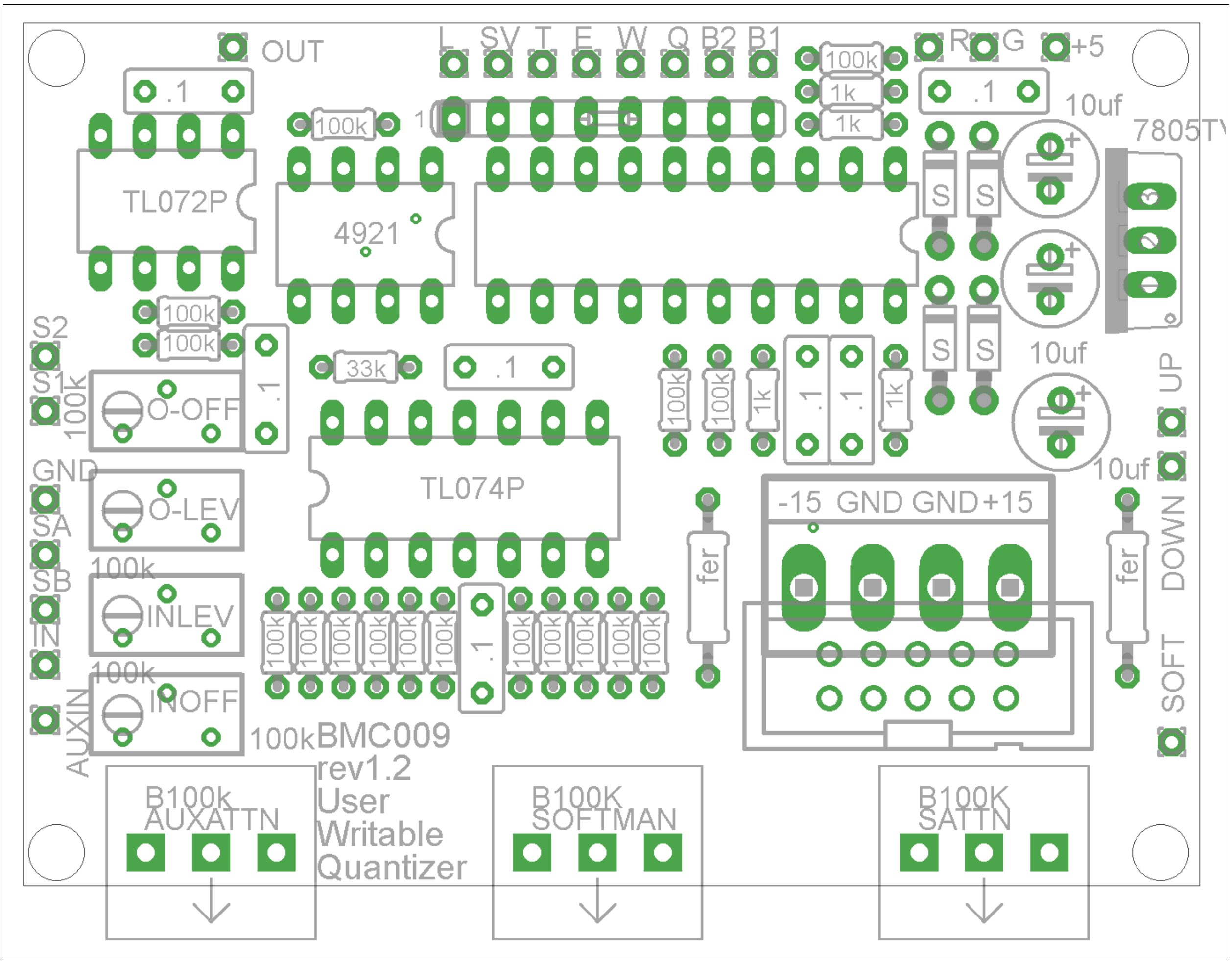
4. Other

Value	*Quantity*	*Notes*
20 Pin Dip Socket	*1*	
8 pin Dip Socket	*2*	
14 pin Dip Socket	*1*	
Power Connecter	*1*	

5.Off board Components

Value	*Quantity*	*Notes*
Mono Jack	*6*	
NC Switch Jack	*2*	
SPST pushbutton	*4*	*Off-(on) type.*
SPDT toggle center off	*2*	*On-off-On type*
SPDT toggle	*1*	*On-On type*

DPDT toggle	*1*	*On-On type*
Red Led	*1*	
Green Led	*1*	
1n4148 diodes	*2*	

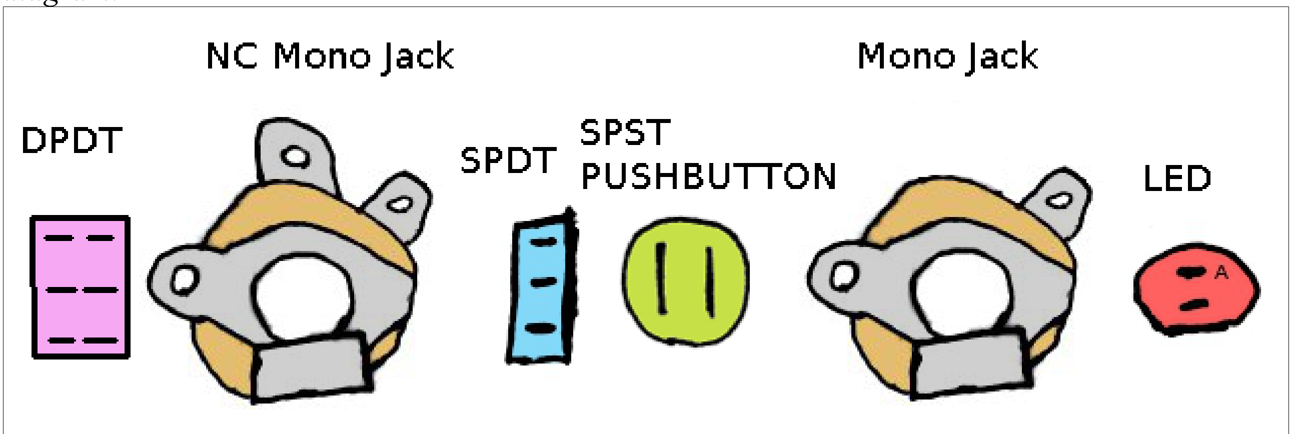


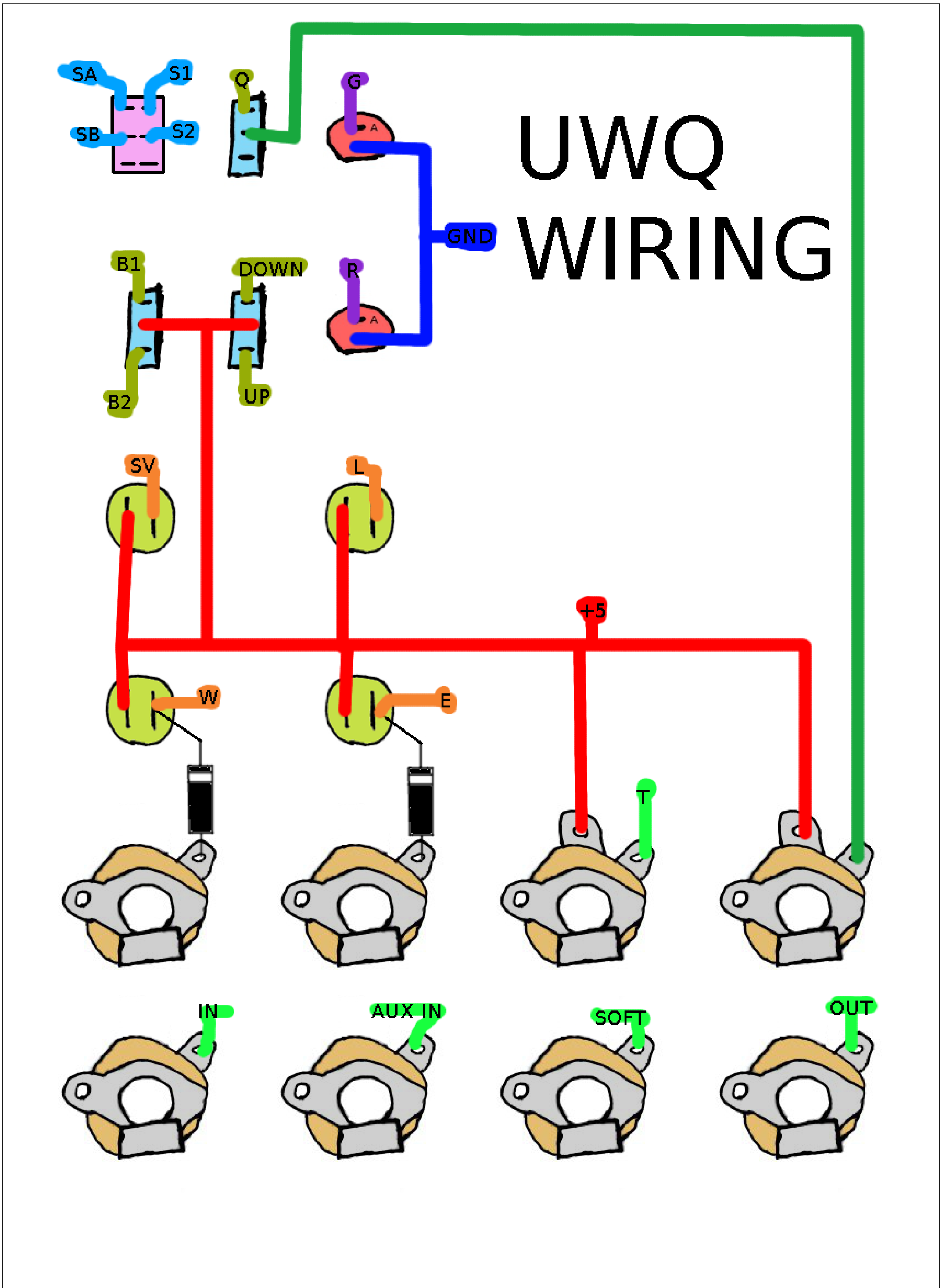
B. The Board

The pcb is 68mm x 50mm. The pitch between pots is 7/8".

C.Wiring Diagram

In the following diagram, all text refers to wiring pads on the board. The diagram is not to scale, and is not the only possible way of wiring the circuit. Here is a legend of symbols used in the diagram.




UWQ
WIRING
SA
S1
SB
S2
Q
G
GND
R
B1
DOWN
B2
UP
SV
L
+5
W
E
T
IN
AUX IN
SOFT
OUT

D. Calibration

After completing the circuit, it needs to be calibrated. You will need a voltmeter for this. These instructions are for calibrating to 10V voltage range, but smaller ranges are possible. Using a smaller range will increase the accuracy of the quantizer.

Step 1. *Adjust the toggles so that Quantization is on, Quantizing is going UP, and you are in uni-polar mode.*

Step 2. *Insert a gate signal or other 5V source into the Aux CV input, turn the Aux CV attenuater fully clockwise. Adjust the Output level trimpot until your output voltage is at 10V.*

Step 3. *Turn quantizing off. Insert the +5V source into the CV Input jack. Adjust the Input level trimpot until there is no difference between input and output voltage. Input a few different voltages and check the input, you may need to make some fine adjustments. If you do not plan on using the bi-polar operation, you can quit now.*

Step 4. *Unplug the voltage source, and flip the switch for bi-polar operation. Adjust the Input offset trimpot until you get +2.5V on pin 19 with no voltage input.*

Step5. *Adust the output offset trimpot until the output voltage is zero.*