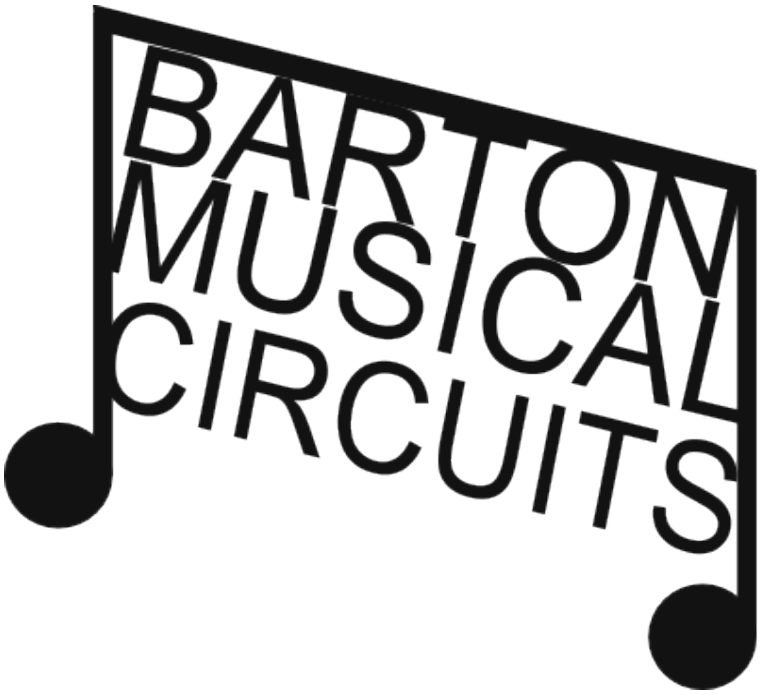

BMC119 Digital Voltage Shift Register

Last updated 9-21-2024

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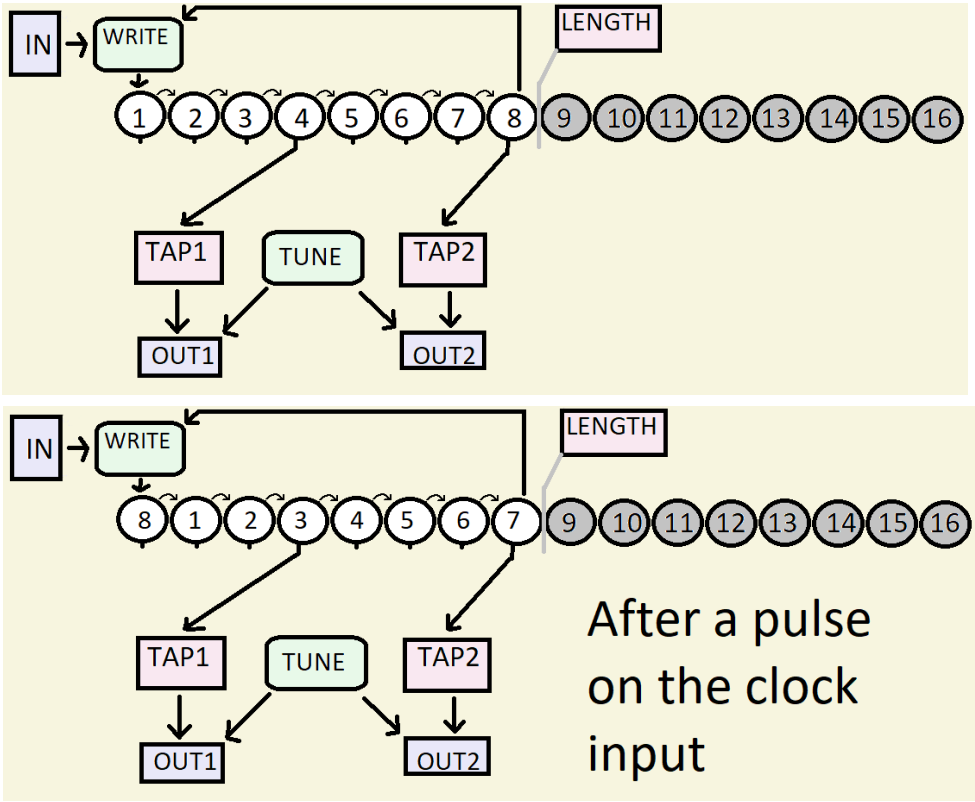
I. Overview/Features

This module is a digital implementation of an analog shift register. Every time a clock ticks, the voltage on the input is put into step one, then the voltage stored in slot one moves to step two, two to three, etc. The input can be switched to automatically connect to the final step to create a loop. It has two outputs that can output any selected step. The number of steps can be set to 4, 8, 16, 32 or 64. A voltage sequence can be saved and loaded with internal memory.



CONTROLS

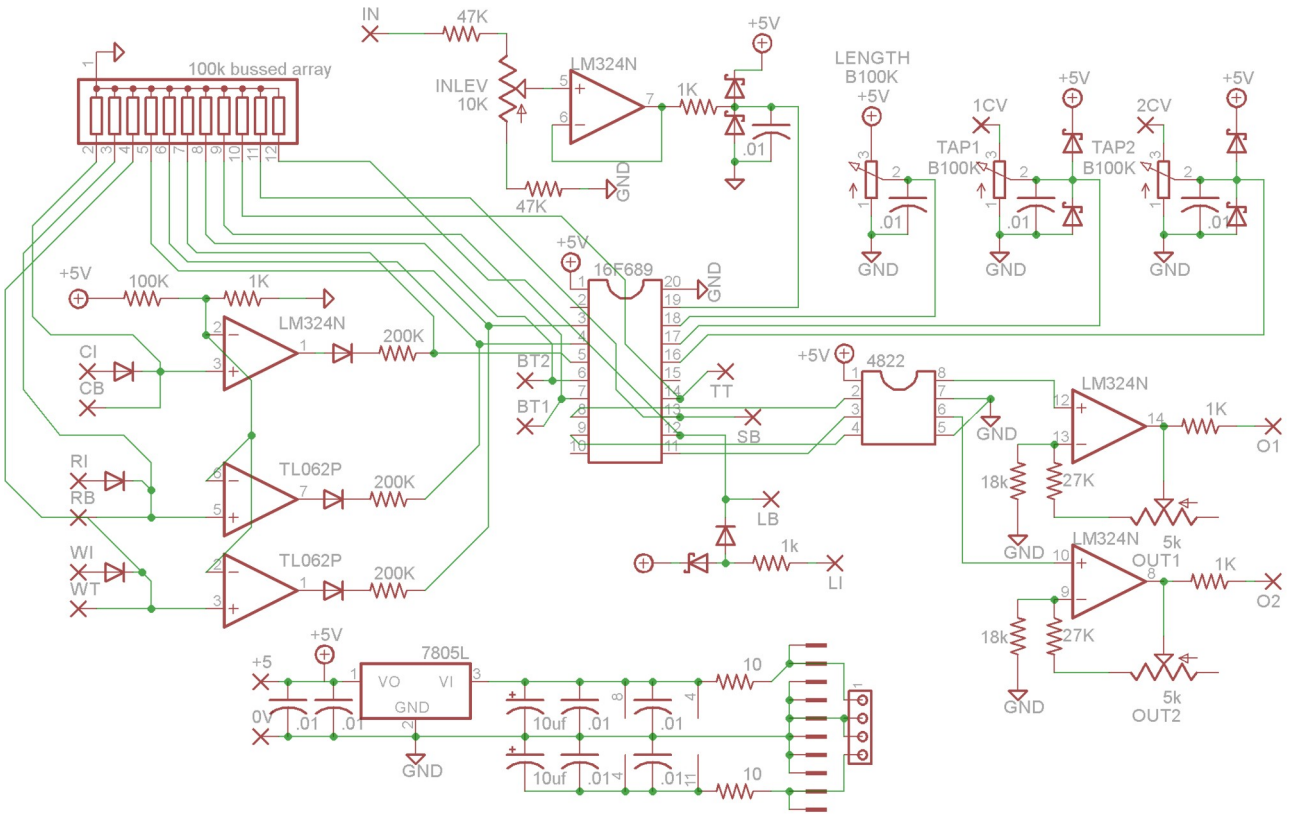
1. LENGTH KNOB – This sets the number of steps. This goes from 4 to 64.
2. TAP KNOBS – Two of these, one for each output. These choose which step of the sequence to tap for the output. The step selected is relative to the Length knob's setting, all the way to the right will always be the final step, half way will always be half the maximum number of steps.
3 .CLOCK BUTTON – This button can be used to manually clock the module.
4. RESET BUTTON – This button shifts all steps to the left to their original count. This allows you to synchronize loops with other modules.
5. LOAD BUTTON – This button loads a saved register, selected by the BANK TOGGLE.
6. SAVE BUTTON – This button saves the current sequence to memory, selected by the BANK TOGGLE.
7. WRITE TOGGLE – This toggle selects whether the first step of the sequence receives data from the last step or the external input.
8. TUNE TOGGLE – This toggle overrides the TAP KNOBS and sets both outputs to the same steady voltage to make VCO tuning easier.
9. BANK TOGGLE – This toggle selects which memory bank the SAVE and LOAD buttons will use. Two banks are available, this toggle can be an ON-OFF-ON type so that in the middle position there will be no accidental loading or saving.

INPUTS/OUTPUTS

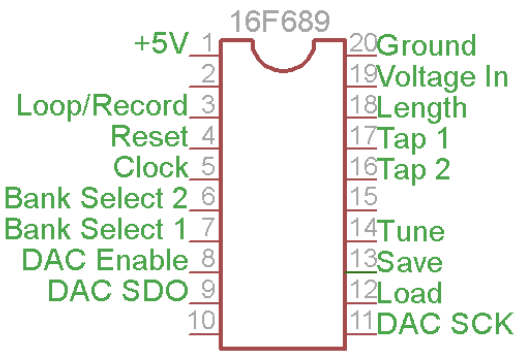
1. TAP CV INPUTS – A control voltage between 0 and +5V can be input to control what step is tapped for output. The TAP KNOBs become attenuators for this control voltage.
2. LOAD INPUT – A gate or trigger will initiate a load, like hitting the LOAD BUTTON.

3. CLOCK INPUT – A gate, trigger or LFO can be input to clock the module.
4. RESET INPUT – A gate or trigger will reset the sequence, like the RESET BUTTON.
5. WRITE INPUT – A gate can be input here to act like the WRITE TOGGLE. STEP 1 will receive input from the CV input jack while the gate is high, when the gate goes low, STEP 1 will receive input from the final step.
6. IN CV INPUT – Voltages to write to steps are input here. 0 to +10V range.
7. OUT1 and OUT 2 OUTPUTS – These jacks will output voltages on the steps selected by the TAP1/2 knobs.

II. Schematic.



Above is the full schematic for this module. At the center is the 16F689 mincrocontroller. The pinout for this chip is reproduced to the right.



A 100K bussed array provides pull down resistors for many of the pins of the microntroller and for the input comparators. The Clock, Reset and Write inputs all connect to comparators which produce a celan on/off signal from any sort of input. All have their thresholds set at 0.05V and their outputs go through a 1n4148 and 200K resistor, these combine with the 100K pull down resistor to limit the voltage going to the PIC to 0/+5V.

At the top of the schematic is the Voltage Input wirepad, this is attenuated by the INLEV trimpot, which is in series with 47K resistors on the two outside lugs. This gives very fine control over the input level. The trimpot feeds into an op-amp buffer which goes through a 1K resistor and on to two Schottky diodes referencing +5V and Ground. A .01uf capacitor filters any high frequency noise off of the input signal.

The knobs are all wired as attenuators going from +5V to ground. Length connects to +5V directly, Tap1 and Tap2 connect to it through a switching jack that's not pictured in the schematic,

when an external CV is plugged into the jack, the connection to +5V is broken and the knobs then act as attenuators of the external CV. The Tap1 and Tap2 signals go through the 1K/Schottkys arrangement to limit voltage to the 0/+5V range.

Bank toggle, tune toggle, save button all just connect directly to their pins on the PIC with 100K pull down resistors, all of these switches connect to +5V off board. The Load button is wired the same way, but also accepts an input from the Load IN jack.

In the lower right of the schematic is the voltage output circuit. The PIC connects to the 4822 digital to analog converter chip through an enable pin, a clock pin and a data pin. The 4822's output is then amplified by an op-amp with a trimpot in it's feedback path to dial in the gain.

On the bottom are the power connections, footprints for Eurorack and MOTM style connectors are available. A low pass filter for the +V and -V rails is formed by the 10 ohm resistor and 10 uf capacitor which removes noise from the power signal. 0.01uf capacitors are placed near the power pins of the ICs to help keep digital noise out of the analog signals. The +5V supply is created by a 78L05 voltage regulator.

III. Construction

A.Parts List

Semiconductors

Name	Quantity	Notes
16F689	1	Should have come with your KIt
MCP 4822	1	8 pin DIP
LM324	1	Or other 14 pin quad op-amp
TL062	1	Or other 8 pin dual op-amp
1N4148	7	
1N60P	7	Or other schottky
78L05	1	TO-92 +5V votlage regulator

Resistors

Name/Value	Quantity	Notes
10 ohm	2	1/4W Metal film for all resistors unless otherwise noted
1K ohm	5	
18K ohm	2	
27K ohm	2	
47K ohm	2	
100K ohm	1	
200K ohm	3	
100K bussed array	1	12 pin array, or make your own with 11x 100K resistors
5K Trim pot	2	3296W package
10K Trim pot	1	3296W package
B100K pot	3	Either 9mm or 16mm PCB mount pots. My panel layout is set up for 9mm pots

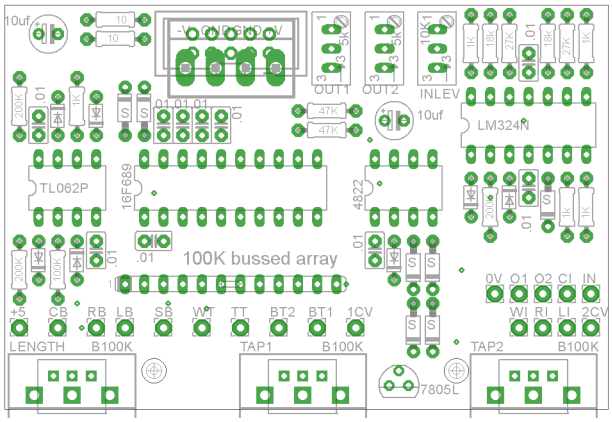
Capacitors

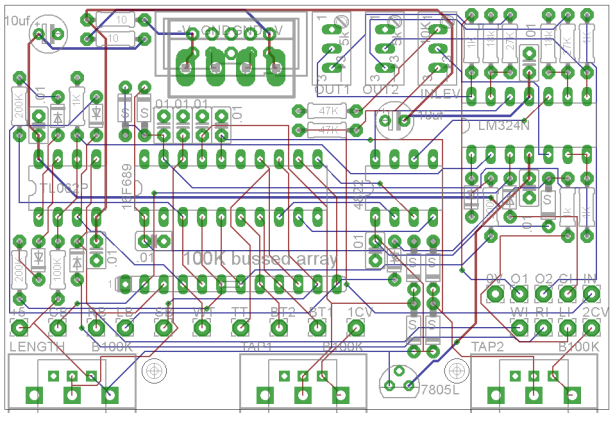
Name/Value	Quantity	Notes
.01uf	10	Ceramic disc
10uf	2	Electrolytic

Other

Name/Value	Quantity	Notes
8 pin DIP socket	2	
14 pin DIP socket	1	
20 pin DIP socket	1	
Switching Jack	9	
SPDT On-On toggle	2	Or SPST if that's easier for you
SPDT On-Off-On	1	For the Bank Toggle switch, the center position is a safety position where you can't accidentally load/save. An on-on SPDT can be used if you don't care about that.
Momentary pushbutton	4	Panel mount
Power Connector	1	4pin MOTM style or 10 Pin Eurorack style
Knobs	3	

B. The PCB





Above are renderings of the PCB, both with and without the traces shown. The pots are spaced 30.5mm apart and the mounting holes are 40mm apart.

C. Wiring

Wirepads should be connected as follows:
+5V – This should connect to one side all four momentary pushbuttons, the center lug of all toggles and switch lug of the Tap 1 and Tap 2 CV jacks.
CB – remaining lug of the Clock pushbutom
RB – remaining lug of the Reset pushbutton
LB – remaining lug of the Load pushbutton
SB – remaining lug of the Save pushbutton
WR – lower lug of the Write/Loop toggle

TT – lower lug of the Tune toggle
BT2 – upper lug of the bank toggle
BT1 – lower loug of the bank toggle
1CV – tip of Tap 1 CV jack
2CV - tip of Tap 2 CV jack
WI – tip of write jack
RI -tip of reset input jack
LI – tip of Load input jack
IN – tip of CV input jack
CI – tip of Clock input jack
O2 – tip of output 2 jack
O1 – tip of output 1 jack
0V – Ground. Connect to the sleeve connector of any jack. With a metal panel this should ground all jacks.

D. Callibration.
1.Set your multimeter to DC volts, connect the black lead to ground and connect the red lead to the tip of the Output 1 Jack.
2.Flip the Tune toggle up.
3.Adjust the OUT1 trimpot until the voltage reads as close to +2V as you can get it.
4.Move the black lead from ground to the tip of the Output 2 Jack, you're now measuring the difference in voltage between the two outputs.
5.Adjust the OUT2 trimpot until the voltage reads as close to 0V as you can get it.
6.Move the black lead from the tip of the Output 2 jack to the tip of the CV input jack. You're now measuring the difference between input and output voltage.
7.Flip the Tune toggle down, the write toggle up and patch an oscillator or fast clock to the Clock input. Turn the Tap 1 knob fully to the left.
8. Adjust the INLEV trimpot until the voltage reads as close to 0V as you can get it.