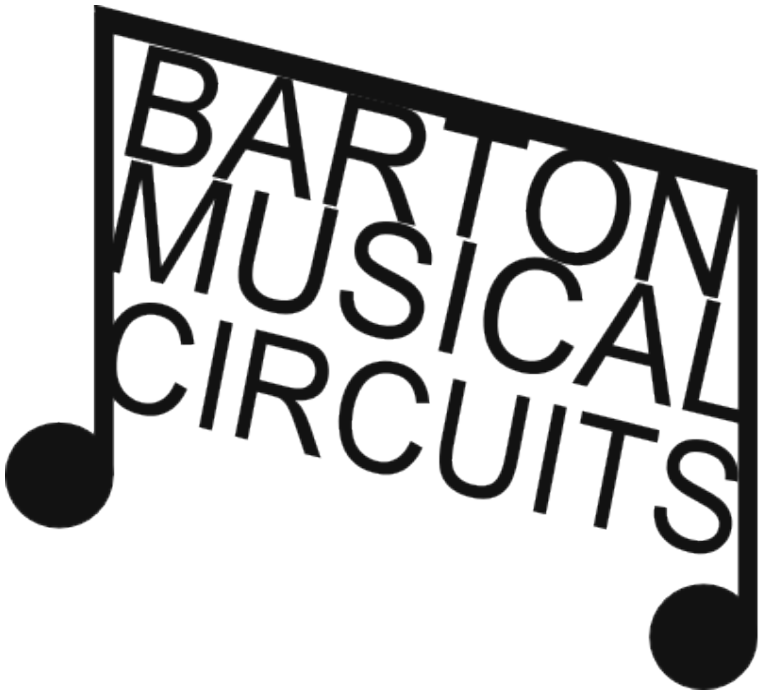


BMC083. VC Delay

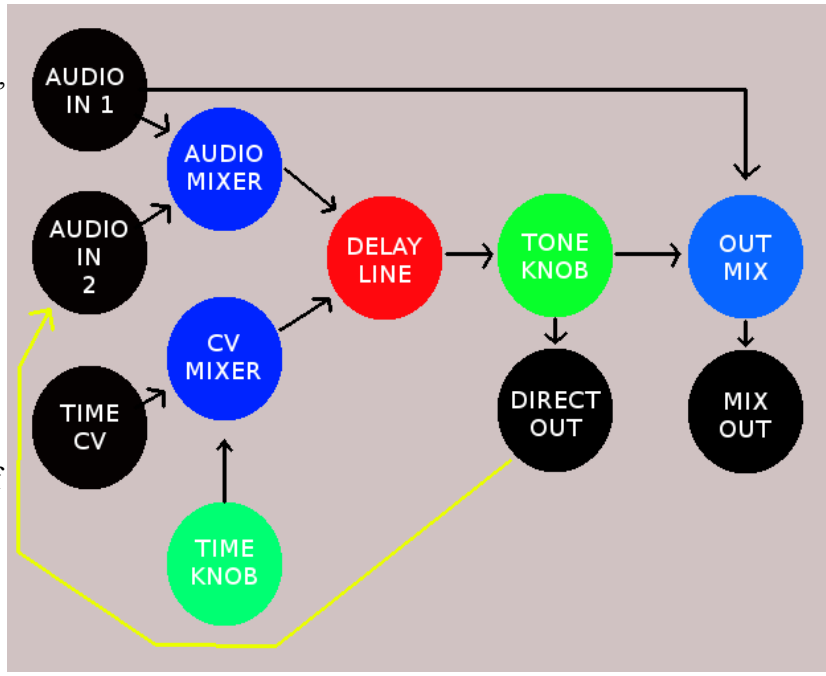
Last updated 5-18-21

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

I. Overview/Features

This module provides an audio delay line with voltage controlled delay time and an audio feedback path, making it useful for echos, reverbs and general experimentation. Delay times range from 60ms to 4 seconds, though audio fidelity drops significantly after 1 second of delay time.

On the right is a diagram of the signal path of the module. Black dots are I/O, Green dots are knobs. Here are some notes on the controls and I/O:



-Audio IN 2 is normalized to the direct out and is attenuated by the "RETURN" knob.
-The tone knob controls a filter on the output of a delay line and greatly affects the output level of the delay line in addition to the frequency. This makes the RETURN and TONE controls highly interactive.
-The MIX control is setting how much of the delay line's output is present in the MIX out, it's not a blend between the dry and wet inputs.

AUDIO DEMOS

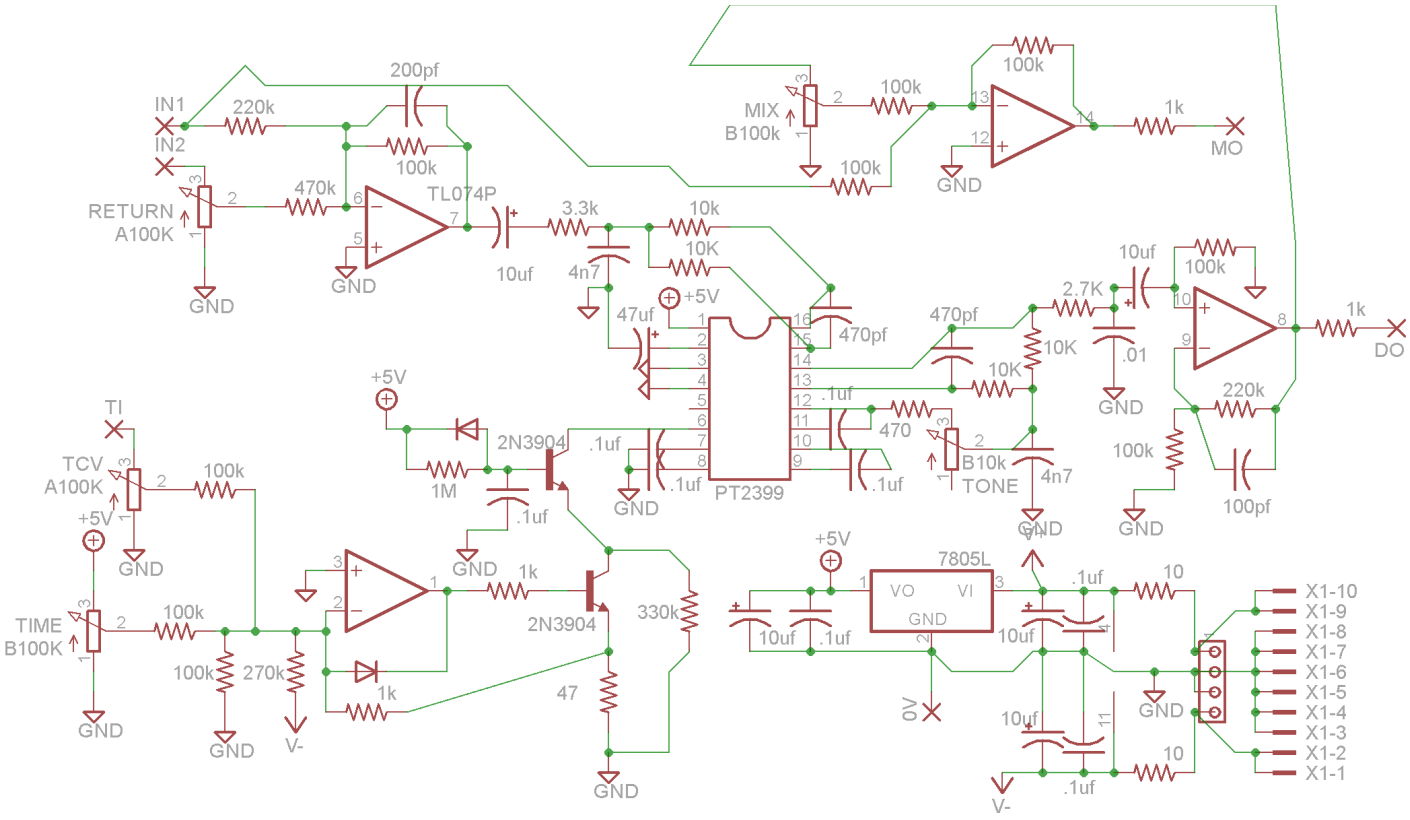
Demo 1 – Tone all the way up, Repeats off, Mix halfway up. Slowly increasing delay time. At 1:10 maximum delay is reached and you can start to hear some ticking artifacts in the background and the full distortion of the audio signal.

Demo 2 - Tone half way up, Repeats halfway up, Mix halfway up. Slowly increasing delay time and then quickly decreasing at end of sample.

Demo 3 - Delay at 75%, tone at 100%, return at 25%. Return path is patched through BMC 80. Diode LPF with it's cutoff being modulated by an LFO and resonance turned up 33%.

Demo 4 - Binary divider in delay feedback path dividing by 2. Adjusting delay time while improvising with Manual Voltage Controller.

II. Schematic.



Above is the schematic for this module. Starting in the top left corner, we see the two audio inputs coming in through wirepads IN1 and IN2. IN2 is attenuated by the return knob and the inputs are then mixed together by a TL074. Note that IN1's mixing resistor is a 220K, IN2's is a 470K and the TL074 has only a 100K in it's feedback path. Because the PT2399 chip used only accepts 5Vpp signals and most synthesizer signals are 10Vpp, this attenuates the inputs down to an acceptable level while also reducing the return knob's output to a small enough level for it to be easy to dial in. A 200pf capacitor is placed across the 100K to filter out high end frequencies that can cause runaway feedback with the return knob turned up.

The output of this mixer stage is AC coupled to the delay line stage through a 10uf capacitor, and then input to the delay line. The input has low pass filtering from a 3.3K resistor/4.7nf capacitor passive filter and then a 10K/470pf passive filter. The values for the audio inputs and outputs from the PT2399 were chosen by starting with the example schematic in the chip's datasheet and then tweaked using trial and error.

The TONE control is a variable low pass filter formed by a 10K potentiometer in series with a 470 ohm resistor and a 4.7nf capacitor. Initially this was just a 10K resistor, then a 1K and while designing I had a lot of trouble deciding on the value, which made me realize it might be more useful to have a variable control instead.

After the tone control, more filtering is applied as per the datasheet, until the output is AC coupled by a 10uf capacitor to a non-inverting TL074 set with a gain of 2.2 which should return the output signal to ~10Vpp. This feeds the direct output through a 1K resistor to the DO wirepad and then the MIX potentiomter. The output of the MIX potentiomter is mixed with input 1 by another TL074 section with a gain of 1 and sent to the Mix output jack through a 1K resistor and the MO wirepad.

In the bottom left corner is the circuitry for the delay time controls. The TIME and TCV knobs attunate a +5V signal and an external CV through the TI wirepad respectively. These signals are mixed together by 100K resistors and then attenuated and negatively offset by a 100K resistor to ground and a 270K resistor to -12V. This mixed signal is then fed into a an op-amp and 2N3904

transistor set up as a voltage controlled current sink. A 47 ohm resistor to ground at the emitter of the 2N3904 helps set the maximum current sunk (shortest delay time) while the 330K to ground in parallel sets the minimum current sunk (longest delay time).

The collector of this 2N3904 is connected directly to the emitter of another 2N3904. This second 2N3904's collector is connected to pin 6 of the PT2399. This transistor's base is connected to a .1uf capacitor connected to +5V by a 1Meg resistor. When the module is first powered on, this transistor will not allow any flow of current through it until the capacitor charges. This allows the PT2399 to warm-up before having it's internal oscillator set to a high frequency and protects the chip. I first learned of this anti-latch circuit from this article on Electrosmash and it was the key to me finally completing this design.

At the bottom of the schematic we see the power supply connections. PCB footprints for Eurorack and MOTM power connectors are connected in parallel. The positive and negative rails are filtered by a 10ohm/10uf passive low pass filter and connected to the power pins of the TL074. 0.1uf capacitors are attached at the power pins of the TL074 to keep the power supply as clean as possible. The input of the 7805L voltage regulator connects to the filtered positive voltage and it's output creates the +5V supply that's used by the PT2399.

III. Construction

A.Parts List

Semiconductors

Name	Quantity	Notes
PT2399	1	16 pin DIP Package
TL074	1	14 pin DIP package
Switching Diode	2	
7805L Regulator	1	TO 92, sometimes called 78L05
2N3904	2	TO 92 package

Resistors

Name/Value	Quantity	Notes
10 ohm	2	1/4w metal Film for all resistors unless otherwise noted
47 ohm	1	
470 ohm	1	
1K ohm	4	
2.7K ohm	1	
3.3K ohm	1	
10K ohm	4	
100K ohm	9	
220K ohm	2	
270K ohm	1	FOR 15V systems, may want to change to a 330K
330K ohm	1	
470K ohm	1	

1Meg ohm	1	

Potentiometers

Name/Value	Quantity	Notes
B100K	2	16mm PCB mount pot like THIS. Value not critical any linear taper pot above 10K should be fine.
A100K	2	16mm PCB mount package
B10K	1	16mm PCB mount package

Capacitors

Name/Value	Quantity	Notes
100pf	1	Ceramic disc.
200pf	1	Ceramic disc.
470pf	2	Ceramic disc
.1uf	3	Ceramic disc. Value not critical, can be .01uf or anythign in between
4.7nf	2	Polyester film
.01uf	1	Polyester film
.1uf	5	Polyester film
10uf	5	Electrolytic, at least 16V rating.
47uf	1	

Other

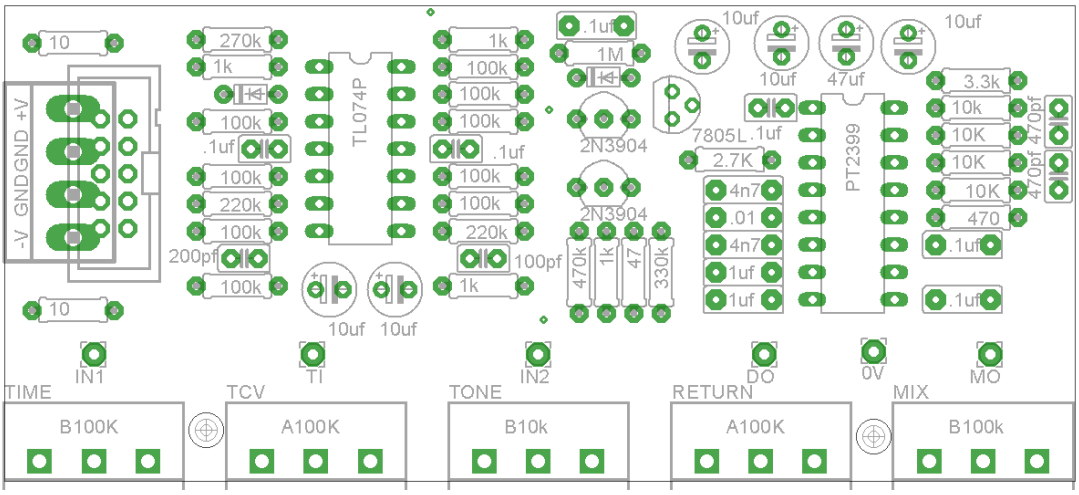
Name/Value	Quantity	Notes
Power connecter	1	Eurorack or MOTM
Jacks	5	1 should be switching type for IN2
14 pin DIP socket	1	
16 pin DIP socket	1	

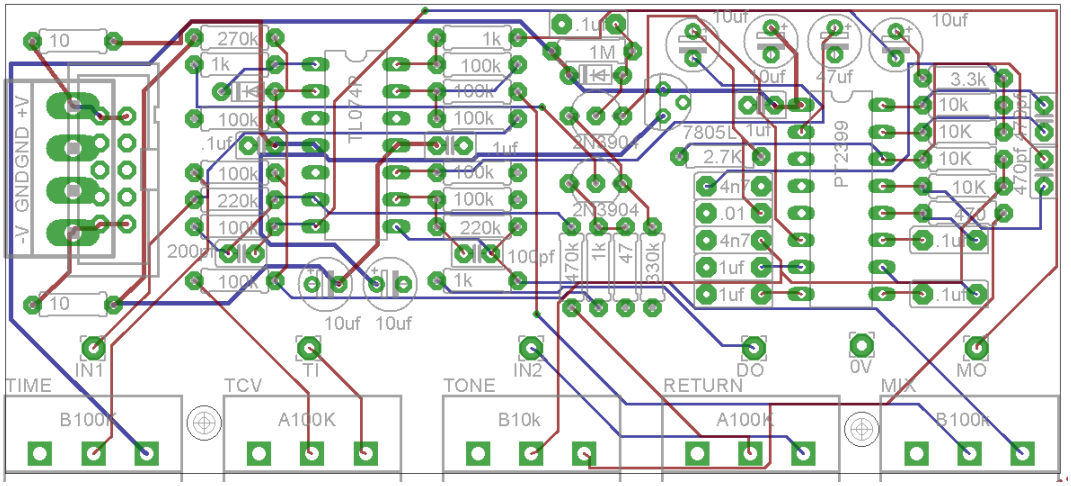
B. The PCB

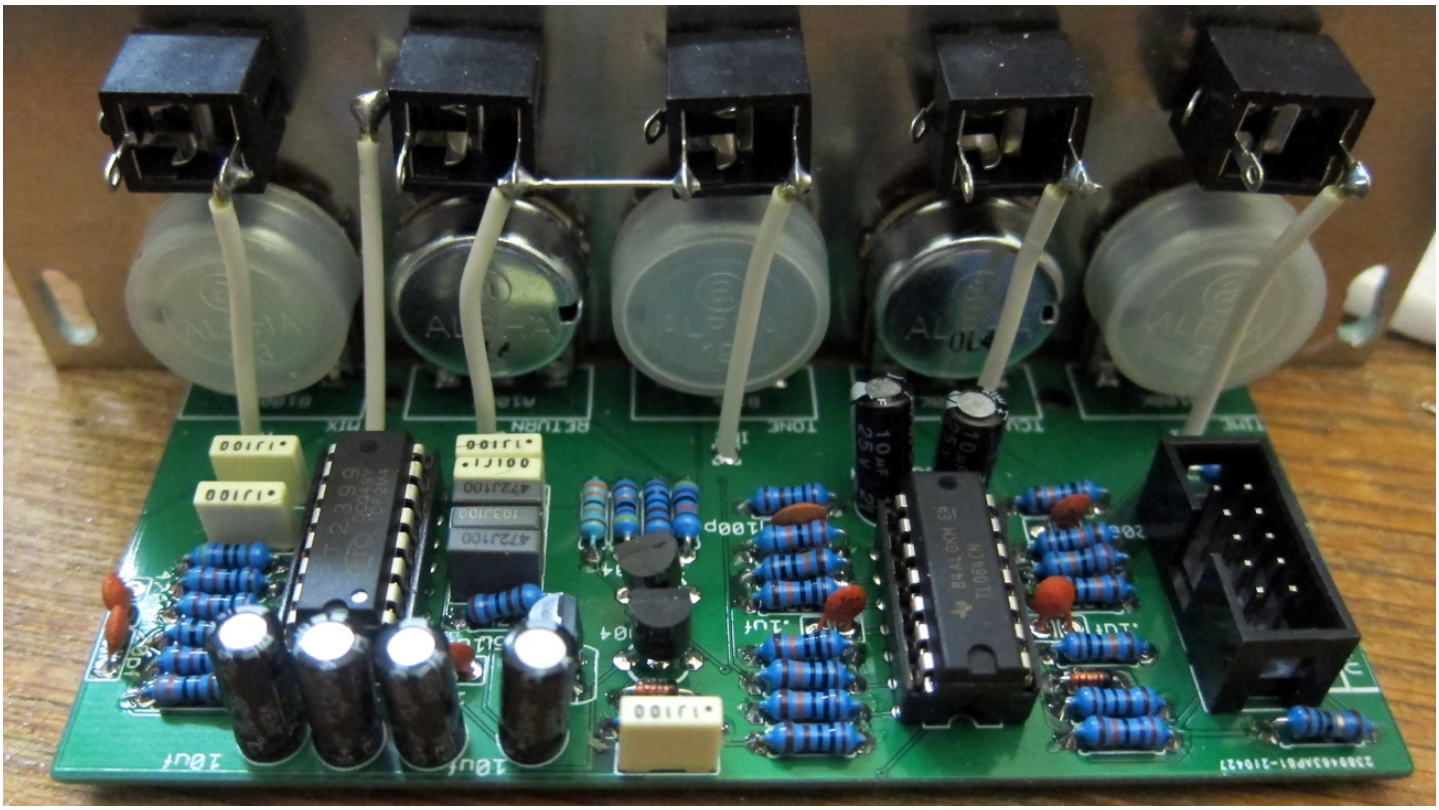
The PCB is 100mm x 45mm. The Pots are spaced 20.64mm apart (13/16th of an inch) and the mounting holes are 61.91mm apart.

The wirepads should be connected as follows:
IN1 → Tip of audio input 1
TI → Tip of Time CV input jack
IN2 → Tip of audio input 2
DO → Tip of direct output jack AND switch of audio input 2 jack
0V → Sleeve of any jack.
MO → Tip of mix output jack.

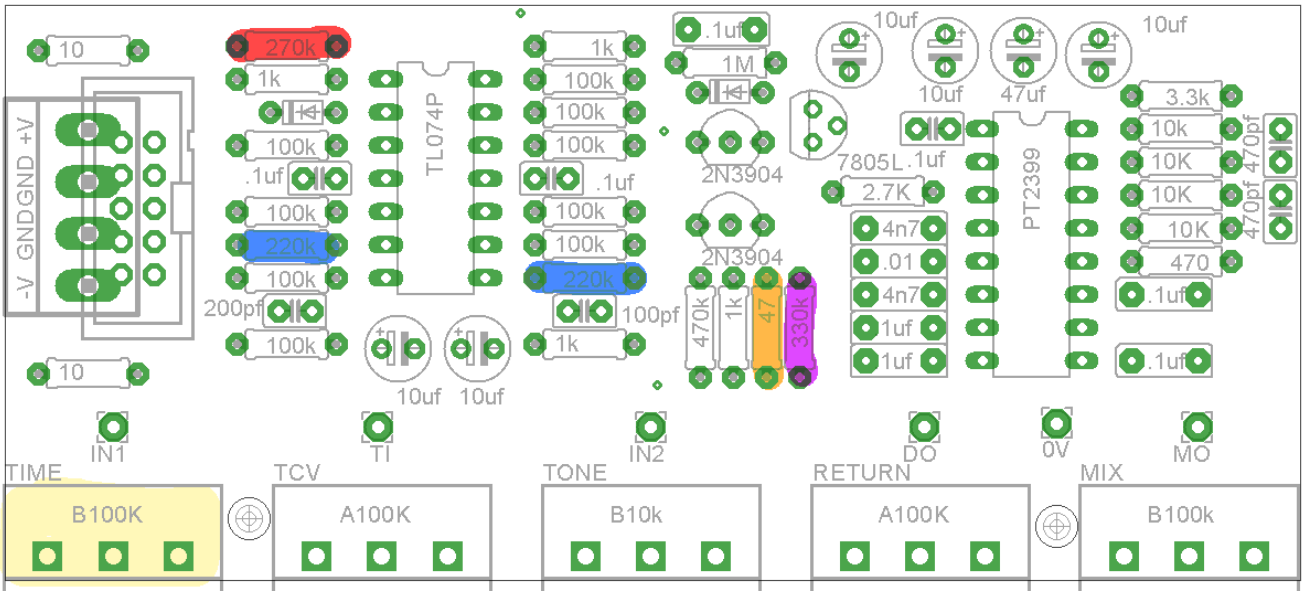
Below are images of the PCB with and without traces and a photo of a wired module. The ground plane of the PCB is not shown in the traces image for clarity







C. Tweaks / Modfications



1. The TIME pot highlighted in beige could be swapped for a C100K pot (or any value C taper pot over 10K) to get finer control over long delay times.
2. The two 220K resistors highlighted in blue could be swapped for other values to deal with larger or smaller input signals. If your input signals exceed 10Vpp and you're getting excessive distortion at short delay times, you could use 330K resistors for both of these to give the PT2399 more headroom. If your system uses 5Vpp signals or smaller, they could be swapped with 100K resistors to reduce noise from the PT2399.
3. The 330K resistor highlighted in purple can be reduced to lower the maximum delay time.
4. The 47 ohm resistor in orange can have it's value increased to raise the minimum delay time.
5. For +/-15V builders, the 270K resistor in red may need to have it's value raised to get identical performance to 12V builders, I'd try a 330K or higher if you have a large “dead spot” at the bottom of the TIME pot.