BMC088. PWM VCA/BLEND

Last updated August 17, 2022

I.WHAT IS IT?

-What it does

This module is a 2 channel voltage controlled (VC) amplifier and blend for audio signals. Each channel has two inputs, and the position of knobs and external control voltages determine how much of each signal is present in the output. When signal is only plugged in to one of the inputs, it will act as a VCA, and when signal is plugged into both inputs will it act as a VC Blend.

The circuit achieves this by switching back and forth between the two inputs at a high frequency. The frequency counter on my multimeter measures this as ~54Khz, but there will be variation between builds and I'm not sure how accurate the counter is. This frequency is generated by an onboard oscillator, and the clock input can be used to have an external signal control the switching.

-Limitations

1.This module only only processes audio signals, it cannot be used as VCA for DC control voltages, though can be used with LFO signals above 15hz.

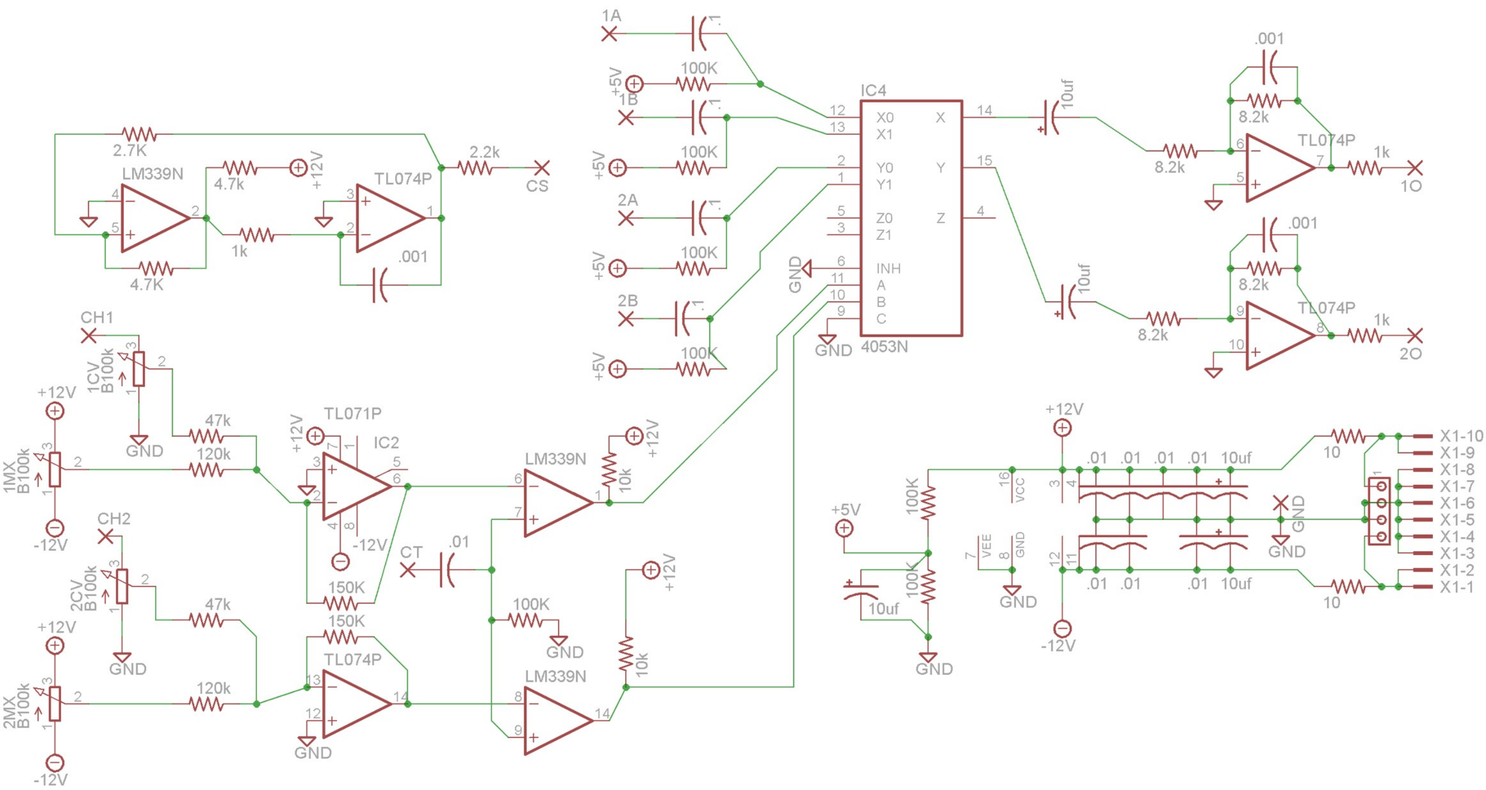
2.High frequency signals (fundamentals above 2.5khz) will have some audible heterodyning in the background. As frequency increases the heterodyning will become louder than the fundamental. So if you compose music using only notes above D7, this will not be a useful module for you.

-Controls

KNOBS (Repeated for each channel)
1. MIX – This controls how much of input A or B is present in the output.
2. MIXCV – This attenuates the control voltage signal used to modulate the MIX amount.

INPUTS/OUTPUTS
1.Clock In – Input a triangle, saw or similar waveform signal here. Square/Pulse/Gates will not provide variable switching. One clock input is used for both channels
2/3. INPUT A and INPUT B – Audio or LFO signals higher than 15hz should be input here. These inputs are repeated for each channel.
4. OUTPUT – Repeated for each channel, the blended output.

-Demos (normalized to -3db peak, you may want to turn your volume down)
DEMO 1 – Simply turning a signal off and on
DEMO 2 – Blending between two signals, first by hand and then with an LFO
DEMO 3 – Using an external VCO as a clock while blending two signals
DEMO 4 – Example of heterodyning limitations of the module.



II Schematics

Above is the schematic for the module. Starting in the upper left corner we have a fixed frequency triangle wave oscillator formed by a Schmitt trigger (the LM339) and an integrator (the TL074). The output of this circuit goes through a 2.2K resistor that attenuates this signal. If building for +/-15V you may want to increase this value to a 3.3K or 4.7K. This resistor connects to wire-pad “CS” which connects to the switch of the clock input jack.

Below this on the left we see the controls for the module. The CV pots are wired as variable attenuators of the CV coming from the “CH1” and “CH2” wirepads, while the MIX pots are wired to generate a variable voltage between +/12V. The wipers of these pots are mixed together by inverting op-amp stages (one on a TL074 and one on a TL071), with the mix resistors being mismatched so that small CV inputs can still have a great effect.

The outputs of the inverting op-amp stages are then sent to the inverting inputs comparators on the LM339 chip. The non-inverting inputs are both connected to the clock signal, input from the “CT” wire-pad that connects to the tip of the clock input jack. This signal goes through a .01uf capacitor get rid of any DC bias that might be present in external clock signals and a 100K resistor provides a ground reference.

The outputs of the comprators are connected to 10K pull up resistors and then on to the control inputs of the CD4053 multiplexer chip. When these inputs are at 0V input A is sent to the output of the chip and when they are at +12V, input B is sent to the output. When the MIX control is set in the middle, every time the clock signal goes positive, the output will switch to A and then when the signal goes negative, it will switch to B.

The other inputs of the CD4053 are connected to the 1A, 1B, 2A and 2B audio input wirepads. Each of these is AC coupled through a .1uf and then biased to ½ of V+ (marked +5V in the schematic) through a 100K resistor. This is required because the CD4053 needs to operate on a single sided power supply.

The output pins of the CD4053 are then AC coupled through 10uf capacitors before being sent to inverting op-amp stages used as output filters/buffers. The .001uf capacitor in the op-amps feedback path will attenuate frequencies higher than 19Khz, removing high frequency switching noise from the signal.

At the bottom right we see the power connections. PCB footprints for MOTM and Eurorack style connectors are provided. The +/-V supplies are filtered by a 10 ohm/10uf passive low pass filter, and .01uf capacitors are placed near the power pins of each IC to help control high frequency noise in the power rails. The ½ of V+ supply is created by a pair of 100K resistors in a voltage divider with a 10uf capacitor keeping the voltage steady.

III. Construction

Parts List

Semiconductors

Value	Qty	Notes
TL074	1	14 pin DIP package
TL071	1	8 pin DIP package
LM339	1	14 pin DIP package
CD4053	1	16 pin DIP package

Resistors for +/-12v

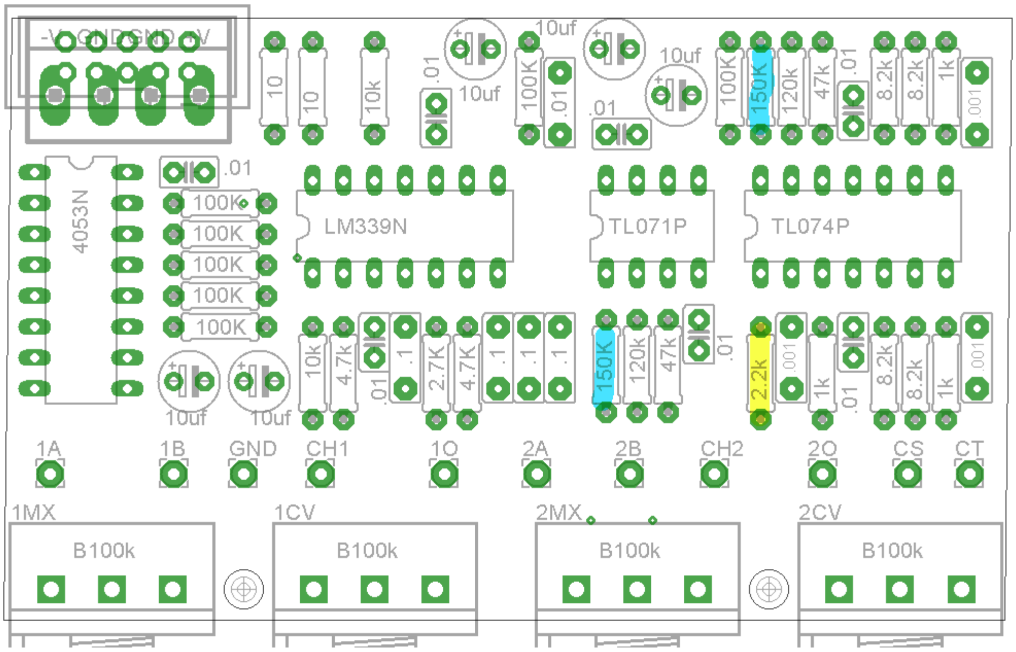
Value	Qty	Notes
10 ohm	2	All resistor 1/4W Metal Film unless otherwise noted
470 ohm	1	
1K	3	
2.2K	1	
2.7K	1	
4.7K	2	
8.2K	4	
10K	2	
47K	2	
100K	2	
120K	2	
150K	2	
B100K Pot	4	16mm PCB mounted

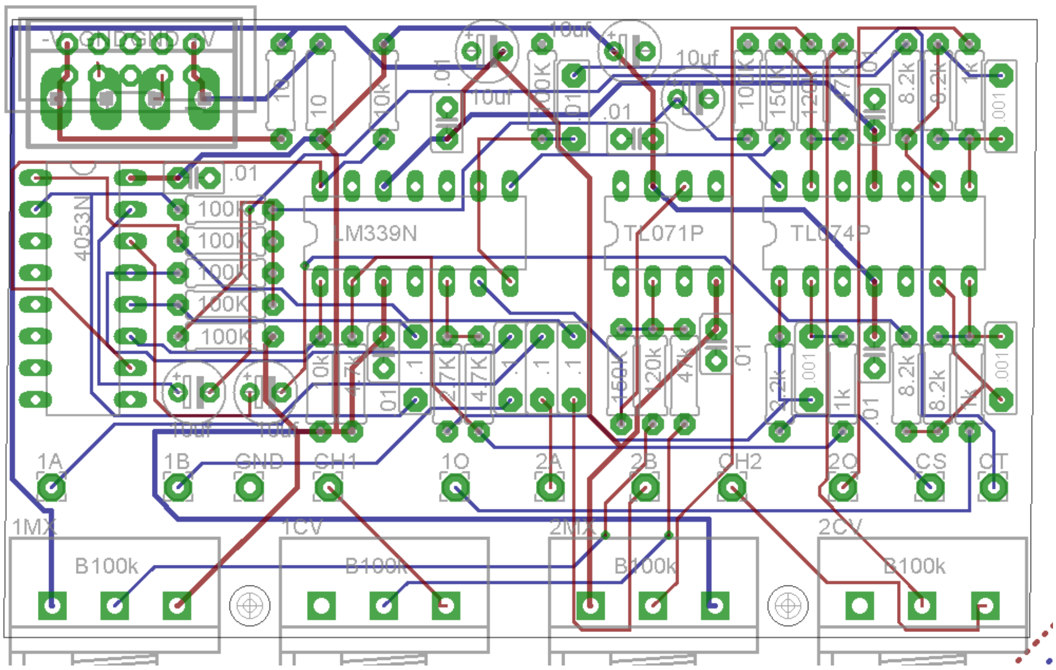
Capacitors

Value	Qty	Notes
.01uf	7	Ceramic disc, value non-critical
.001uf	3	Poly box type
0.01uf	1	Poly box type
.1uf	4	Poly box type
10uf	5	Electrolytic

Other

Value	Qty	Notes
Power Connecter	1	Eurorack or MOTM style
16 PIN	1	
14 Pin DIP Socket	2	
8 PIN DIP Socket	1	
Knob	4	
Jack	9	At least one should be a switching jack.





The Board
Above are renderings of the PCB with and without traces. On the image with traces, the ground plane is not pictured, so assume unconnected pins are connected to ground.

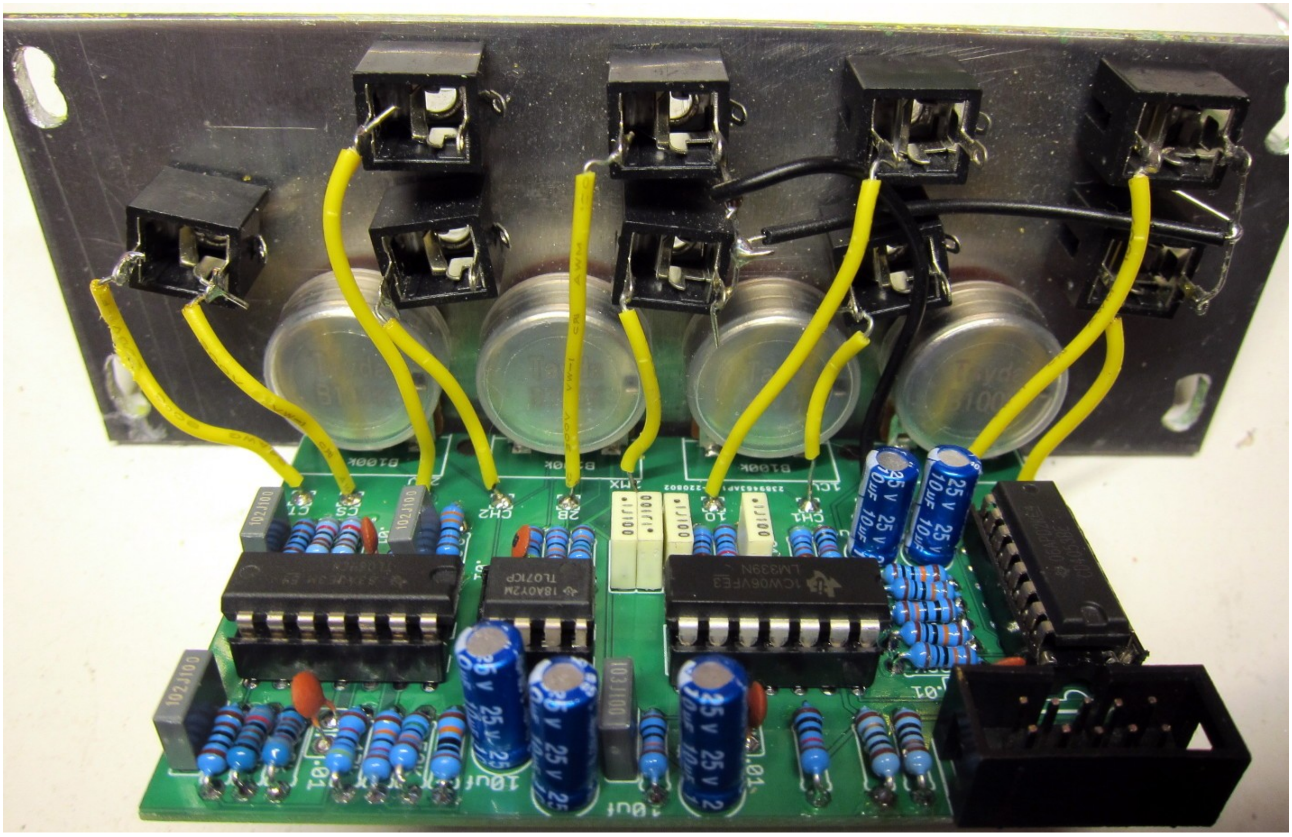
Highlighted resistors are for reference in the tweaks section below.

The board's dimensions are 82mm x 50mm. The mounting holes are spaced 43mm apart. The pots are spaced 21.59mm apart.

-WIRING

The wirepads on the board should be connected as follows.
1A – tip of 1A input jack.
1B – tip of 1B input jack.
GND – Sleeve connector of any jack and then to the switch connectors of 1A, 1B, 2A and 2B jacks. If using a non-conductive panel (wood, acrylic, etc) you should also connect the sleeves of all jacks together.
CH1 – tip of Channel 1 CV input
1O – tip of Channel 1 output jack
2A – tip of 2A input jack.
2B – tip of 2B input jack.
CH2 – tip of Channel 2 CV input
2O – tip of Channel 2 output jack
CS – Switch of clock input jack
CT – Tip of clock input jack.

Below is a photo of a wired module. I rewired these jacks to a few different iterations of the PCB, so hopefully your wiring will look better than mine.



-TWEAKS, 15V Build

If you find that you can't get the signal to fully switch to one input or the other when turning the knobs fully clockwise or counterclockwise, it probably means the amplitude of the clock signal is too large. To alleviate this, increase the value of the 2.2K resistor on the output of the clock oscillator to a 3.3K or higher if necessary. The 2.2K resistor is highlighted in yellow in the board render on the previous page.

For 15V builders, the module should work with the standard values, but you will have larger dead sections of the pots at the top and bottom when using an external clock. If you want to try and get identical response as you would on a 12V system, you’ll need to increase the value of the 2.2K resistor on the clock oscillator’s output to a 3.3K or 4.7K, and then increase the value of the 120K resistors (highlighted in blue on the board render) to 150K or 180K. I’ve not tested these values so sorry I can’t be more exact.