BMC099. Dual Attack/Release Generator

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If you have any questions, or need help trouble shooting, please e-mail
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DOCUMENT UPDATES:
2-26-23. Added a note on improving decay to the tweaks section and BOM.

I. What The Knobs And Jacks Do.

A. Summary

This module is a 2-channel Attack/Release envelope generator. It uses “dividing” attacks meaning that while in the attack phase a new envelope cannot be triggered until attack has completed, allowing it to divide input pulses. Each channel can be set to a slow mode for very long envelopes and has inputs that ignore input gate length or wait to release until the gate is depressed.

ENVELOPE TIMES	FAST MODE	FAST MODE	SLOW MODE	SLOW MODE
	MIN	MAX	MIN	MAX
ATTACK	0.002s	0.8s	0.065s	20s
DECAY	0.05s	2s	0.25s	80s

B. CONTROLS/INPUTS/OUTPUTS

All controls, inputs and outputs are repeated for each channel.

1.ATTACK KNOB – This sets how long it takes for the output voltage to rise to its peak (a little less than 5V). During the attack phase, further inputs are ignored.
2.RELEASE KNOB – This sets how it takes for the output voltage to fall back down to 0V.
3.RANGE TOGGLE – This chooses between Fast and Slow mode. Fast mode is useful for shaping envelopes of individual notes, and Slow mode is better for shaping parameters over the course of a measure or section of music.
4.Gate Input Jack – Inputs on this jack will cause the envelope to rise, after the attack phase, it will remain at it’s peak voltage until the input signal goes to zero or below.
5.Trigger Input Jack – Inputs on this jack will be reduced to a very short pulse, so the duration of the gate will be ignored, only the rising edge will trigger a new envelope.
6.Output Jack – The output voltage comes from this jack. On my test unit, voltage ranged from 0 to +4.5V

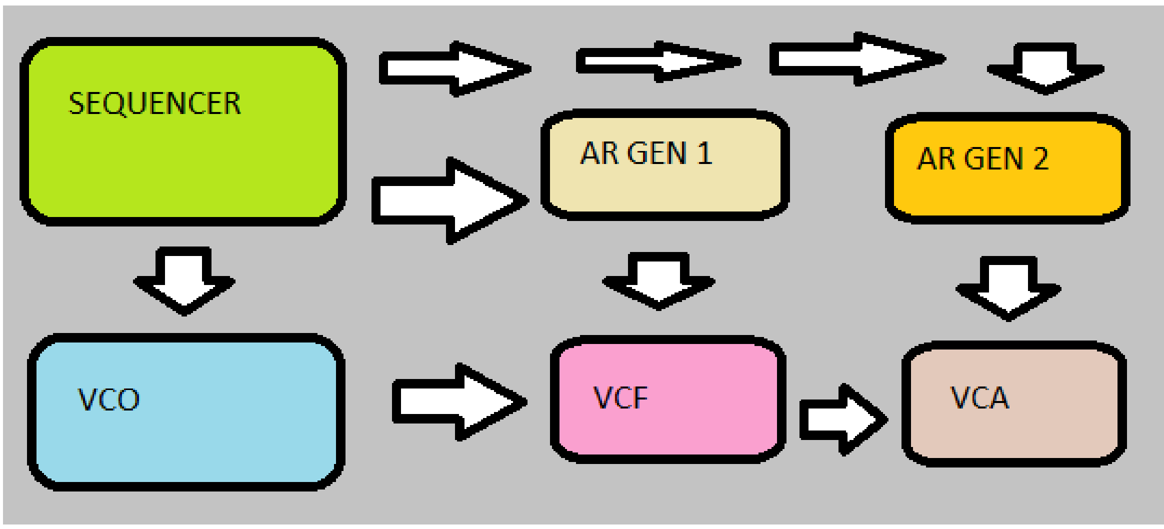
C. DEMONSTRATION RECORDINGS

Both of these recordings were made using the same setup of a sequencer controlling a VCA and sending gates/triggers to the Dual AR Gen which in turn control a VCF and VCA. In Demo 1, the VCF control is triggering every note, and in Demo 2 it’s being triggered once per loop using the slow setting.

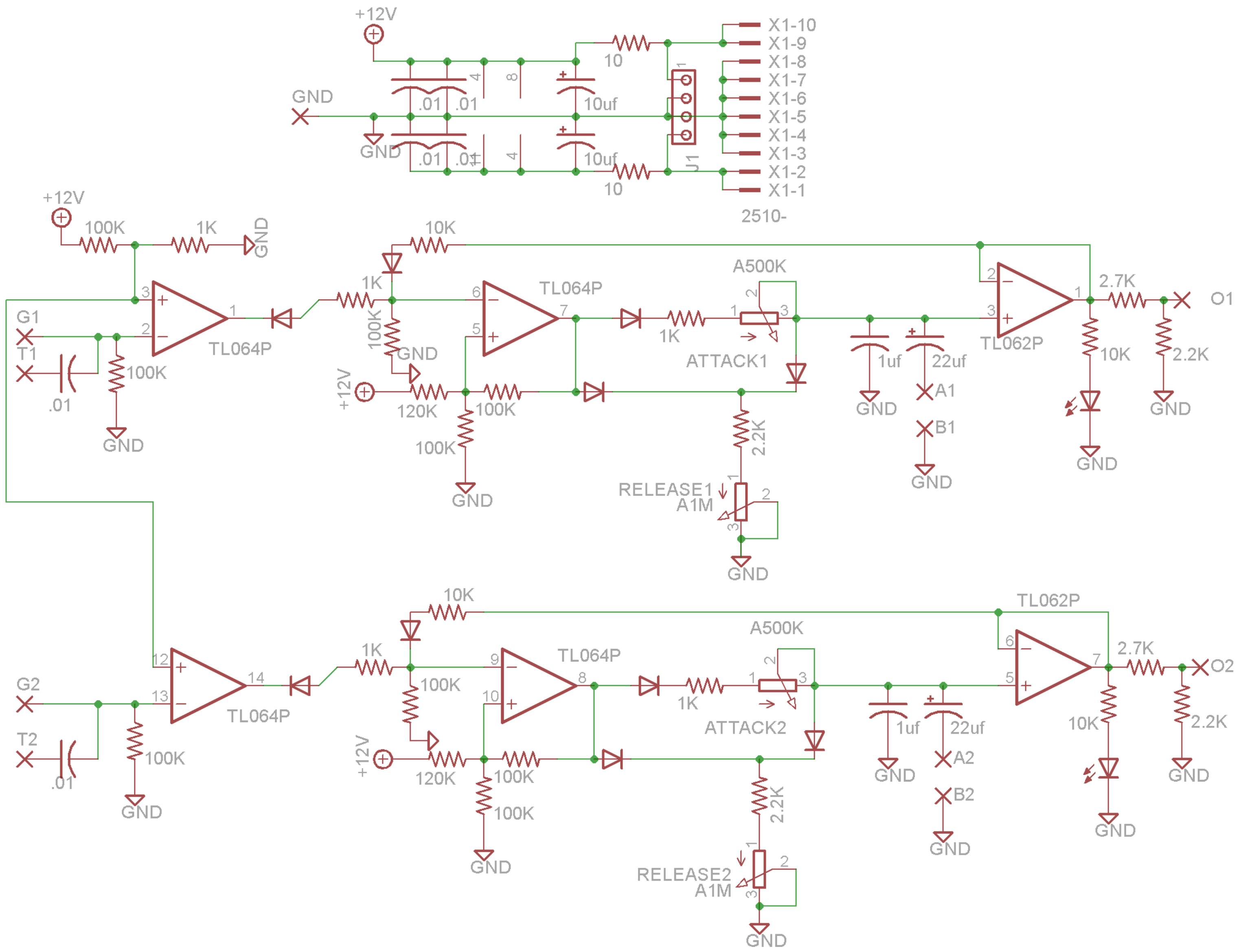
In both recordings, only knobs on the AR Generator are adjusted. Listen for when attack is increased enough to divide the input clock and create interesting rhythms.

DEMO 1. VCF Envelope triggered every note

DEMO 2. VCF triggered once per sequence



II. Schematic.



Above is the schematic for this module. Starting in the upper left, we see the Gate and trigger inputs for channel 1 (G1 and T1 wirepads). T1 is in series with a .01uf capacitor but both connect to the negative input of an op-amp with a 100K resistor to ground. This resistor is both a pull down resistor, keeping this input grounded when nothing is plugged in to avoid errant envelopes, and also forms a filter with the .01uf capacitor to form a high pass filter to reduce inputs to only a small input pulse.

This op-amp is wired as an inverting comparator, its positive input is tied to a 0.12V supply formed by the 100K/1K resistor ladder. So when no gate signal is input its output is at +12V* and when a gate goes above 0.12V it's output goes down to -12V. The output of this comparator goes to the input of another opamp through a diode and a 1K resistor in series. This makes it so the comparators negative voltage output is passed to the next stage almost completely, but none of it's positive voltage output.

The 2nd is wired an inverting schmitt trigger with two inputs. The first input is the comparator described in the last paragraph, and the other is the output buffer which is connected through a 10K resistor and a diode only passing positive voltages. Because the input comparators output is attenuated less (connects through a 1K resistor instead of 10K resistor) in a situation where both of these inputs were active, the input comparator would negate the buffer's effect on the schmitt trigger.

A network of resistors set the schmitt trigger's threshold to change between -0.5V and +7.5V. So, when its output is low meaning it's either in a release phase or no envelope has been triggered, the threshold is at -0.5V, a negative pulse from the input comparator would then set the output to high and change the threshold to +7.5V. The output going high starts the attack phase. When the attack phase has finished and the output has reached it's highest point, this positive voltage will then set the schmitt trigger's output low, but only if the negative pulse from the input comparator has concluded. When the schmitt trigger goes low, the release phase starts and continues until another input triggers a new attack.

The output of the schmitt trigger is used to control the charge/discharge of a timing capacitor. A pair of diodes connect out of the schmitt trigger, the top one passes positive current through the ATTACK potentiometer and a 1K resistor to charge timing capacitor. The bottom diode connects to the Release potentiometer in series with a 2.2K resistor and then to a backwards diode connecting to the timing capacitor. This diode effectively takes the release pot out of the circuit during the attack phase by raising the voltage at the release pot to higher than the timing cap, the cap can't discharge through the diode that connects the timing capacitor to the release pot.

The timing capacitor is a 1uf cap in parallel with a 22uf which can be switched into the circuit to engage the SLOW mode. The output buffer sends the voltage that forms on the timing capacitor back to the schmitt trigger and to an indicator LED through a 10K current limiting resistor. The output is attenuated through a 2.7K/2.2K resistor.

At the top of the schematic are power connections. Power is filtered by a 10 ohm / 10uf passive low pass filter and .01uf capacitors are placed next to the power pins of the ICs to filter out tshort spikes/dips.

*I'm describing the circuit as if these were ideal op-amps. The comparator's output will be a bit less than +/-12V

III. Construction

A.Parts List

Semiconductors

Name	Quantity	Notes
TL062	1	
TL064	1	
1N4148	10	Or 8x 1N4148 and 2x 1N60P, see note 6 in the tweaks section.
LED	2	3mm

Resistors

Name/Value	Quantity	Notes
10 ohm	2	All resistors 1/4w metal Film for all resistors unless otherwise noted
1K	5	
2.2K	4	
2.7K	2	
10K	4	

100K	9	
120K	2	
A 500K ohm potentiometer	2	16mm PCB Pins
A 1Mega ohm potentiometer	2	16mm PCB Pins

Capacitors

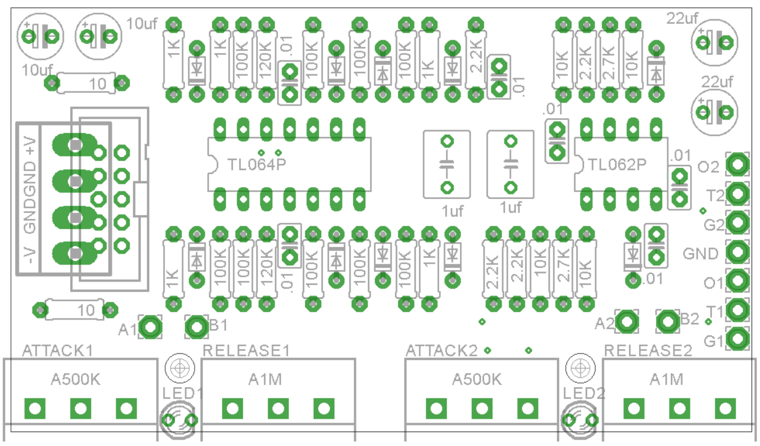
Name/Value	Quantity	Notes
.01uf	6	Ceramic disc. Value not critical
1uf	2	Film capacitor
10uf	2	Electrolytic
22uf	2	Electrolytic

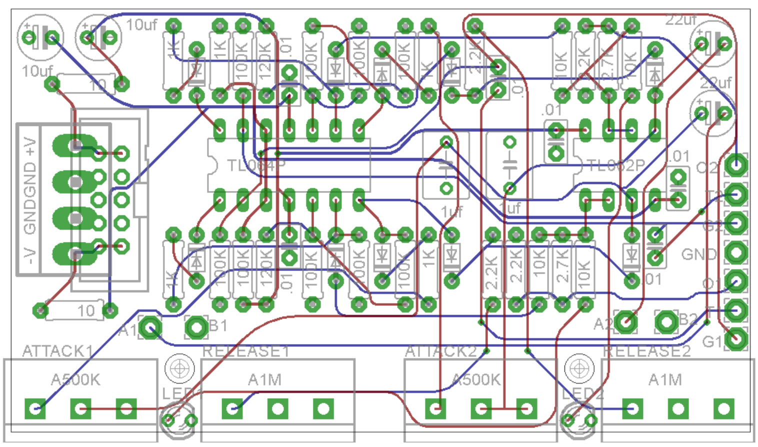
Other

Name/Value	Quantity	Notes
Power connecter	1	Eurorack or MOTM
8 pin DIP socket	1	
14 pin DIP socket	1	
Mono jack	6	Whatever standard input/output jack you use in your synth system.
SPDT Toggle	2	
Knobs	4	

B. The PCB

The PCB is 80mm x 46mm. The pots are 21.6mm apart and the mounting holes are 43.8mm apart. Below are renderings of the board with and without traces shown. The ground fill plane is not shown on the traces rendering.





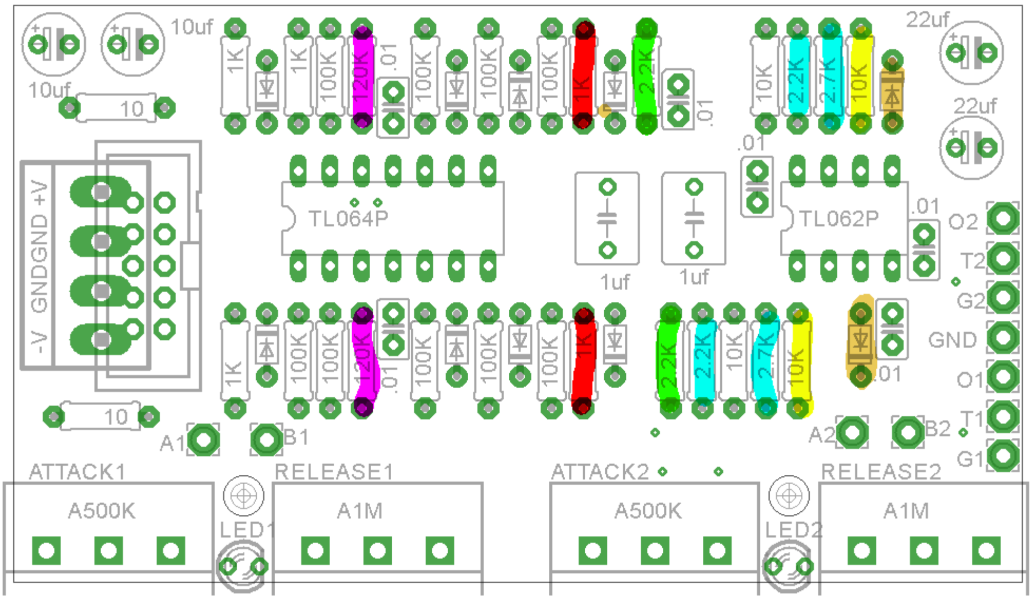
D. Wiring

Wiring is straight forward for this module, connections to each jack should go to the tip connector, except for the ground connection. Wirepads should be soldered as follows:

G1 – Gate input channel 1
T1 – Trigger input channel 1
O1 – Output channel 1
GND – Sleeve of any jack.
G2 – Gate input channel 2
T2 – Trigger input channel 2
O2 – Output channel 2

A1 – Center lug of the channel 1 Range toggle switch
B1 – Bottom lug of the channel 1 Range toggle switch
A2 – Center lug of the channel 2 Range toggle switch
B2 – Bottom lug of the channel 2 Range toggle switch

E.Tweaks/ Notes for 15V builds



1. **15V BUILDS.** This circuit is untested for +/-15V systems, but should work without modifications. If the output range is too large, the 2.7K resistor highlighted in blue can be increased to a 3.3K resistor. The only other change that might be necessary is the 120K highlighted in violet may need to be increased to a 150K or so. If you build this on a 15V system, let me know how it goes Michael@Bartonmusicalcircuits.com
2. **ADJUSTING TIMING.** The biggest change you can make would be changing the timing capacitor values. Using lower value capacitors will make attack/release phases go faster and increasing the capacitor values will slow them down. If you only want to change the minimum response times, the 1K resistors highlighted in red control the minimum attack times and the 2.2K resistors control minimum decay. Too small of a resistor may cause problems with the circuit sticking or odd interactions between the controls.
3. **ADJUSTING OUTPUT LEVEL**. The blue 2.7K resistor is half of the output voltage divider, if you'd like a higher output voltage, lower the value of this resistor and to decrease the output voltage, raise the value. To get maximum output voltage, change the 2.7K to a 1Kohm, and then remove the 2.2K resistor highlighted in blue.
4. ADJUSTING LED BRIGHTNESS. The yellow highlighted 10K resistor controls LED brightness, lower the value to get brighter LEDs and raise the value to tame LED brightness.
5. ORing INPUTS. Not really a tweak, but a non-intuitive way to patch the inputs. Patching the

gate input of channel 1 to the gate input of channel 2 means that triggers input to either channel will trigger on both channels! This works similarly to running the triggers through OR gate. Also, if you wanted to have a single gate go to the gate input of ch1 and the trigger input of ch2, you could jumper Trigger 1 to Gate 2 and accomplish this. You can also put separate inputs to the gate and trigger of the same channel, though with bi-polar signals this may not work that well.

6. IMPROVING DECAY. As-is the circuit will drain down to the last .05V and then take a very long time to lose those last volts which on sensitive VCAs can sound like a note hanging on at very low levels. By replacing the two 1N4148 diodes highlighted in orange with 1N60P or other schottky type diodes, the final few milivolts of the envelope will decay in time with the rest of the envelope.

E. Photos

Here are a couple photos of my completed build: