

## **BMC 075. Envelope Follower Build Documentation.**

*I. Using The Module*

*II. Schematic*

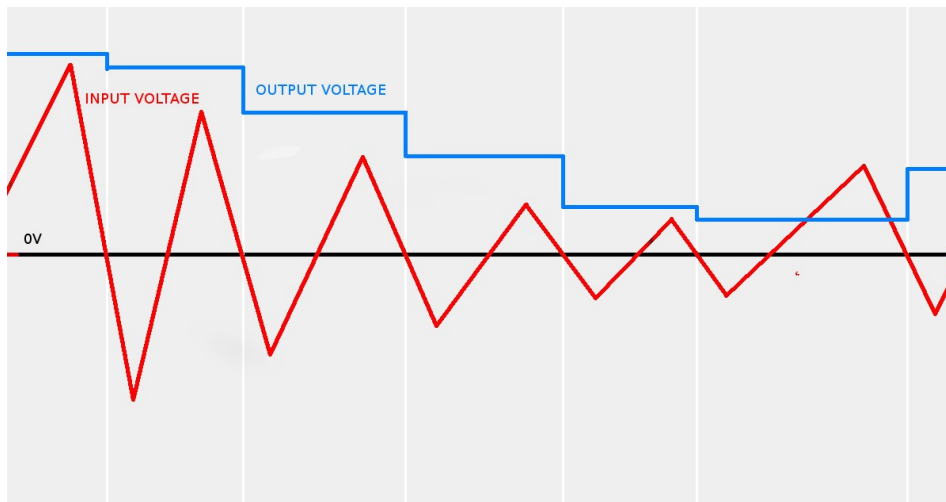
*III. Construction*

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## I. Using The Module.

This module converts an audio input to a control voltage output with the control voltage corresponding to the amplitude of the input signal known as an envelope. Most envelope follower designs use a rectifier followed by a low-pass filter, this design uses a track and hold circuit to capture the envelope quickly and accurately. Filtering of the signal can be applied by using the “Smooth” control, this is especially helpful when used with harmonically complex signals like cymbals.

The diagram below shows the relationship between input and output voltages. Each time the input voltage descends below zero volts, the output voltage is updated to the most positive input voltage in the last cycle.

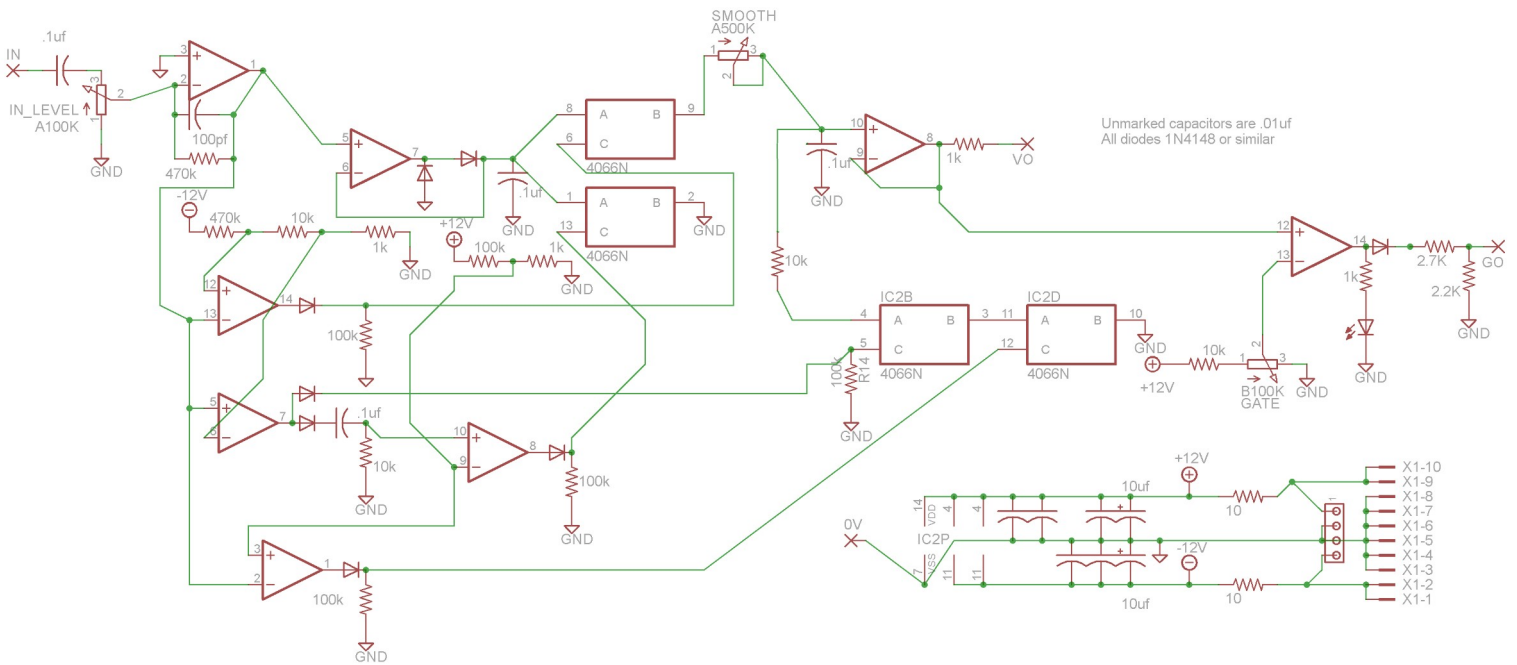


Controls:

1. Input Level – This knob attenuates the input signal before it's amplified at the input gain stage
2. Smooth Knob – This knob adjusts a filter between the output of the track and hold circuit and the output stage. Smoothing will slow the response of the envelope follower which can be useful when dealing with harmonically complex signals or with extremely slow signals so they don't have a jarring change in voltage.
3. Gate Knob – This knob controls the threshold voltage for the gate output to turn on. The more clockwise the knob is turned, the higher the threshold and the less the gate will be on.

I/O:

1. Input – An audio signal should be input here.
2. Voltage output – The Envelope voltage is output here. The voltage can be between 0 and 10V depending on how much the input level knob has been turned up.
3. Gate output – A gate output with it's threshold set by the gate knob. The gate alternates between 0 and +5V



## II. Schematic.

Above is the schematic for this module. The input is in the top left corner, which is AC coupled through a .1uF capacitor and then attenuated by the IN\_Level potentiometer. The wiper of this pot connects to an op-amp wired as an inverting amplifier. A 470pf capacitor is in the feedback path of the amplifier to filter out higher audio frequencies, this value can be lowered if capturing envelopes of very high frequency instruments. For voice and guitar I found this value increased the accuracy of the envelope follower.

The output of the first amplifier stage is split to the inputs of four other op-amps. Starting at the top, this op-amp is wired as a half-wave rectifier, which only allows the positive half of the input signal to pass through. The output of the rectifier charges a .1uF capacitor and connects to two switches on the CD4066 chip. This is the track and hold circuit. The upper of the two switches connects the track and hold to the output through the Smooth potentiometer. The lower of the two switches connects to ground, when it's activated the current from the .1uF quickly discharges, resetting the track and hold.

The control pins of all the 4066 switches are held at 0V normally by 100K resistors to ground. The timing of these switches is controlled by comparators controlled by the input voltage. The comparator controlling the switch that connects the track and hold to the output is wired to become active when the input voltage drops below  $-.275V$ . The comparator controlling the reset switch is activated when the voltage rises above  $-.025V$ . To limit the amount of time the track and hold capacitor is shorted to ground, we convert the output of this comparator to a short pulse. The output of the comparator is sent through a .1uF capacitor and 10K resistor to ground and then into a second comparator with a threshold of  $+.12V$ .

The output op-amp is wired as a unity buffer with a .1uF capacitor to ground at its positive input, like commonly found in sample and hold circuits. In addition to connecting to the track and hold circuit, the capacitor to ground also connects through a 10K resistor to a pair of 4066 switches in series with each other leading to ground. These switches are both active when the input voltage is between  $-.025V$  and  $+.12V$ . This circuit is necessary to prevent “hanging” on the output voltage when the input audio very suddenly stops, or is composed entirely of square waves. When the input voltage has settled at zero volts, the track and hold circuit will stop resetting and updating the output, so these switches become active and drain the output capacitor.

In addition to connecting to the Voltage output wirepad through a 1K current limiting resistor,

the output stage connects to a final comparator for the Gate output. The threshold of this comparator is controlled by the Gate potentiometer, it's output is sent to an LED through a current limiting resistor and to the Gate output wirepad through a switching diode to only allow positive voltages and then 2.7K/2.2K voltage divider, bringing the +12V output of the comparator down to +5V

At the bottom right of the schematic the power connections are shown. Footprints for MOTM and Eurorack style power connectors are available in parallel. The positive and negative power rails are filtered by a 10 ohm/ 10 uf low pass filter, additional filtering is done at the pins of the TL074 with .01uf capacitors.

### III. Construction

#### A. Parts List

##### Semiconductors

Value	Quantity	Notes
TL074	2	14 pin DIP
CD4066	1	14 pin DIP
1N4148	8	Or other small switching diode
LED	1	3mm through hole

##### Resistors

Value	Quantity	Notes
10 ohm	2	5mm lead spacing. Use 3.5mm body length or stand up
1Kohm	4	" "
2.2K ohm	1	" "
2.7K ohm	1	" "
10K ohm	4	" "
100 Kohm	5	" "
470 Kohm	2	" "
B100k Pot	1	16mm PCB Mount
A100K pot	1	16mm PCB Mount
A500K pot	1	16mm PCB mount

##### Capacitors

Value	Quantity	Notes
100pf	1	Small ceramic disc.
.01uf	5	Small ceramic disc. Value not critical
.1uf	4	Polyester/Polypropelene/Metal film etc
10uf	2	Electrolytic

##### Other/Off Panel

Value	Quantity	Notes
Power connector	1	
Knobs	3	
Jacks	3	
14 pin DIP Socket	3	

