GOD CITY INSTRUMENTS – MURDOCK PLUS V1.0 Build guide

The God City Instruments (GCI) Murdock Plus is an expanded version of the GCI Murdock. Both are tone shaping pedals derived from the EQ section of a Boss HM-2, but the Murdock Plus adds an output volume control as well an op amp gain stage with asymmetrical hard clipping inspired by the MXR Distortion+.

The original HM-2 pedal has several gain and clipping stages followed by an EQ section. Despite having only two EQ controls, it is actually a 3 band gyrator EQ with the high and mid bands voiced fairly close together and controlled by a single pot. It is arguably this EQ, more than the gain stages, that create the classic HM-2 sound. Murdock Plus' overdrive stage is simpler and more transparent than that of an HM-2, yet it's EQ is capable of even more depth, giving the user new variations on the "old favorite" sound.

This PCB circuit has the original HM-2 "color mix" controls fixed at maximum, however, the amount of EQ can still be controlled by a single pot labeled "EQ" which controls the boost of all 3 gyrators. When the pot is full CCW, the signal is not EQ'ed, when the pot is full CW, the signal is fully EQ'ed. Adjust the pot for the desired amount of HM-2 EQ tone. This EQ can boost more than the original HM-2, so when comparing to other HM-2 circuits, try setting it at about 2 o'clock.

With this type of EQ topology, each band of EQ's frequency and bandwidth can not be adjusted independently from each other. However, if more tonal adjustability is desired, R12, R13, and R18 can be replaced by 500 ohm pots and R6, R7, and R8 can be replaced by 100k pots inline with 47k resistors. By adjusting these pots in pairs, the desired frequency response and bandwidth can be achieved. Check out the AMZ gyrator calculator to see how changing values affects frequency and bandwidth. This calculator was helpful during the design phase of this circuit because using stock values produced a tone brighter than the original HM-2. The "high" gyrator has been adjusted to darken the circuit. Stock HM-2 values are listed in the substitution column of the BOM.
http://www.muzique.com/lab/gyrator.htm

Headroom is extremely important the achieve the full depth of EQ possible with this circuit. A loud distortion or boost pedal preceding the EQ section can cause op amp clipping, reducing the apparent effectiveness of the EQ. TLE2074 is a rail to rail op amp with more headroom than a TL074, but it's also quite expensive. Alternately, more headroom can be achieved by adjusting the voltage divider formed by R15 and R16. Think of these two resistors as a single pot, with the output of the pot being the node between them. If reducing gain at this stage causes the pedal to be quiet, the gain can be made up by adjusting R17 and R11 which set the gain of the op amp boost at the output. Be wary that increasing headroom can also increase noise floor. Finally, the hard clipping diodes, D1, D2, and D3 offer a certain amount of gain protection. Removing theses diodes or replacing them with higher threshold diodes may result in less headroom. Adjust R15 and R16 accordingly.

This PCB can be build to the same spec as the original Murdock by making the following changes:

- To make the input stage a unity gain buffer, omit C1, R1, and "Drive" pot. Jump pins 1 and 3 of "Drive" pot.
- To remove hard clipping, omit D1, D2, D3 and C12, jump R9 and C11. (Note: Hard clipping may still be useful even when configuring this as strictly an EQ circuit as it will offer the EQ op amps some protection against loud signals.)
- To remove output volume control, jump pins 2 and 3 and insert a 100k resistor between pins 1 and 2.

This pedal is an easy build, but this guide is intended for people who have some experience building pedals. Component sourcing, component identification, assembly techniques, wiring stomp switches, etc. is not covered. The GCI Brutalist Jr. assembly guide has helpful information for less experienced builders. That guide can be found here:
http://www.kurtballou.com/brutalistjr/

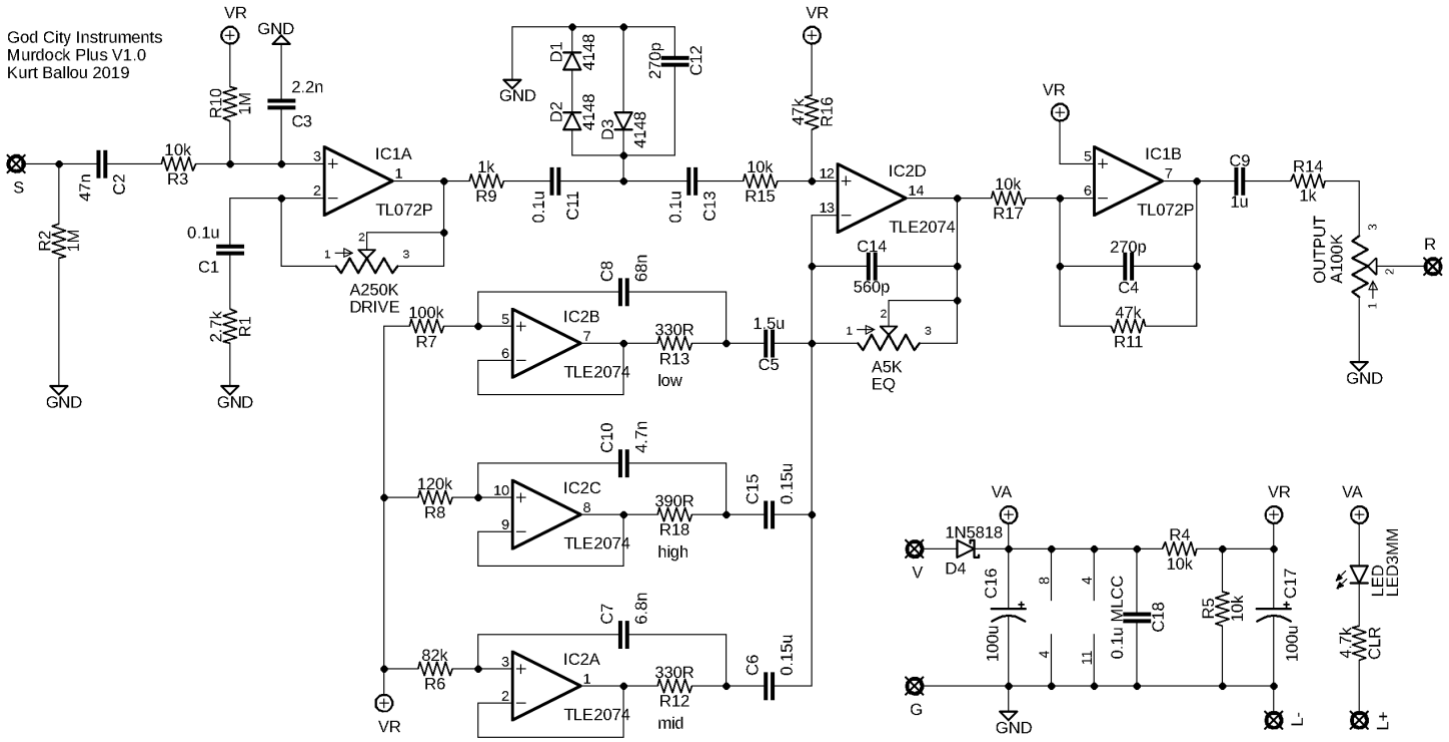
Available separately is the GCI 3PDT utility PCB for PCB pin 3PDT footswitches. This PCB makes footswitch wiring quick and easy. Not compatible with solder lug style switches.

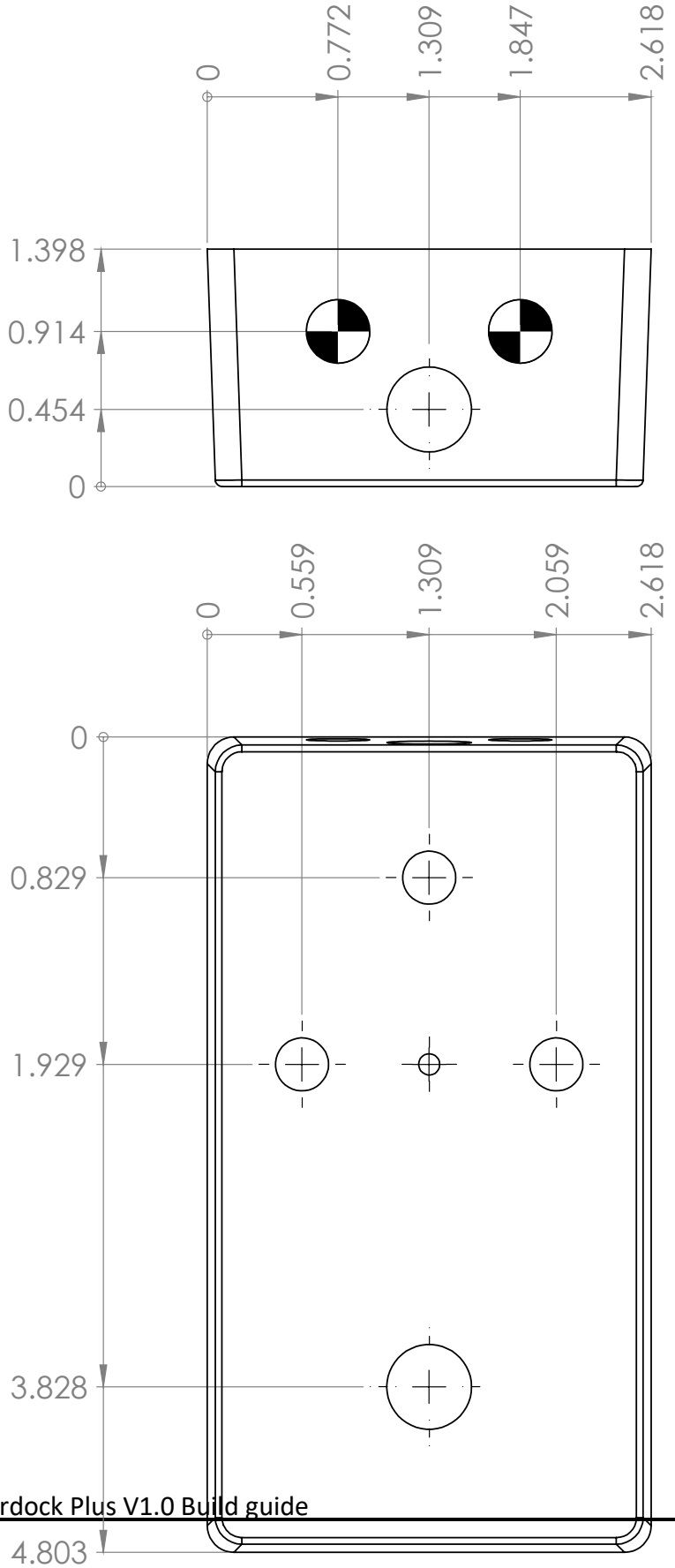
Don't forget to connect the ground pad of the PCB to the ground lug of the input, output, and DC power jacks!

Due to the scope of this project, technical support is not available. However, consider joining the GCI DIY PCB Builders group on Facebook to get advice from and share your work with other builders. We require that all group members agree to the rules before being accepted into the group.
https://www.facebook.com/groups/2454786551255317/

Component values for the PCB as well as some alternate values are listed below. This is a BOM for the PCB only. Resistors and diodes are 6.3mm leg spacing, film and ceramic capacitors are 5.08mm leg spacing, and electrolytic capacitors are 2.54mm leg spacing. I/O jacks, DC jack, switch, enclosure, and knobs are not listed. The schematic and a drill template for a 125B (1590N1) sized enclosure are also attached.

Part	Value	Description	Substitute	Substitution Notes
C1	0.1u	Film cap	0.22u	Affects overdrive low end
C2	47n	Film cap	22n-100n	Input cap
C3	2.2n	Film cap	1n-4.7n	Input LPF
C4	270p	MLCC	100p-470p	System LPF. Bigger = darker
C5	1.5u	Film cap	do not substitute	critical for EQ bass frequency
C6	0.15u	Film cap	do not substitute	critical for EQ mid frequency
C7	6.8n	Film cap		
C8	68n	Film cap		
C9	1u	Film cap		
C10	4.7n	Film cap		
C11	0.1u	Film cap		
C12	270p	MLCC	0-560p	LPF for clipping diodes. Bigger = darker
C13	0.1u	Film cap		
C14	560p	MLCC	330p-1n	LPF for EQ stage. Bigger = darker
C15	0.15u	Film cap	0.1u	Stock HM-2
C16	100u	Electrolytic cap	47u-220u	Power filtering
C17	100u	Electrolytic cap	47u-220u	Power filtering
C18	0.1u	MLCC		
LED	LED3MM	status LED		
IC1	TL072P	Dual Op Amp	LM833, RC4558, MC1458	Any pin compatible dual op amp
IC2	TLE2074	Quad Op Amp	TL074, TLC2274	Any pin compatible quad op amp
D1	1n4148	small signal diode	1n34a, 1n914, 1n456a, 1n5818	Any diode good for hard clipping
D2	1n4149	small signal diode	1n34a, 1n914, 1n456a, 1n5819	Any diode good for hard clipping
D3	1n4150	small signal diode	1n34a, 1n914, 1n456a, 1n5820	Any diode good for hard clipping
D4	1N5818	Schottky diode	1n4001, bat41	Any suitable protection diode for 9v
CLR	4.7k	1/4 watt resistor	1k-10k	Current limiting resistor for LED
R1	2.7k	1/4 watt resistor		
R2	1M	1/4 watt resistor	2.2M	Pull down resistor
R3	10k	1/4 watt resistor	1k-33k	Forms input LPF with C3
R4	10k	1/4 watt resistor		
R5	10k	1/4 watt resistor		
R6	82k	1/4 watt resistor		
R7	100k	1/4 watt resistor		
R8	120k	1/4 watt resistor	100k	Stock HM-2
R9	1k	1/4 watt resistor	1k-22k	Affects amount of hard clipping, less is more
R10	1M	1/4 watt resistor	470k-2.2M	Bias resistor
R11	47k	1/4 watt resistor	10k-100k	Affects gain of output stage. More is more
R12	330R	1/4 watt resistor		
R13	330R	1/4 watt resistor		
R14	1k	1/4 watt resistor		
R15	10k	1/4 watt resistor	1k-47k	Forms voltage divider with R16. Affects headroom
R16	47k	1/4 watt resistor	47k-100k	Forms voltage divider with R15. Affects headroom
R17	10k	1/4 watt resistor	4.7k-47k	Affects gain of output stage. Less is more
R18	390R	1/4 watt resistor	330R	Stock HM-2
DRIVE	A250K	16mm potentiometer	A100k-500k	Affects gain range of first stage. More is more.
EQ	A5K	16mm potentiometer	B5k	EQ blend pot.
OUTPUT	A100K	16mm potentiometer	A50k	Output volume
S	PAD	Send to PCB		
L+	PAD	LED+		
L-	PAD	LED-		
R	PAD	Return from PCB		
V	PAD	9v input		
G	PAD	Ground		


God City Instruments
Murdock Plus V1.0
Kurt Ballou 2019
VR
GND
R10 1M
2.2n C3
S
47n C2
10k R3
R2 1M
GND
0.1u C1
2.7k R1
GND
IC1A
TL072P
A250K DRIVE
1k R9
0.1u C11
D1 4148
D2 4148
D3 4148
270p C12
0.1u C13
10k R15
47k R16
IC2D
TLE2074
C14 560p
A5K EQ
10k R17
IC1B
TL072P
C9 1u
R14 1k
OUTPUT A100K
R
270p C4
47k R11
C8 68n
100k R7
IC2B
TLE2074
330R R13 low
1.5u C5
C10 4.7n
120k R8
IC2C
TLE2074
390R R18 high
C15 0.15u
C7 6.8n
82k R6
IC2A
TLE2074
330R R12 mid
C6 0.15u
VA
1N5818 D4
V
G
C16 100u
0.1u MLCC
C18
R4 10k
R5 10k
C17 100u
L-
L+
LED LED3MM
4.7k CLR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2.618
1.398
0.914
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0.559
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0
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1.929
3.828
4.803