HARBINGER TWO

FX TYPE: Univibe

Just how lazy and inefficient am I? I'll let you pass judgment. I first started working on what would become the "Harbinger Two" around 2013. I knew I wanted to do a Univibe in a wah configuration, and I knew more or less how it should be done (mostly less). Enter an endless parade of prototypes over the next 5 years. Mind you, I was not working on this constantly - every year I would pick it back up and try to get it right. And, with each iteration I ran into some kind of problem. It went like this: find problem, how to solve? Lemme just work on something else. The problems ranged from not understanding how to control the LFO speed properly, bad voltages, bad response to speed control, etc, etc. But, I never gave up on it and eventually I solved all the problems. And, I'm glad I did because this is a really good DIY project.

The Harbinger Two is very much a port of the Harbinger One into an expression control. If you've built the HB1, you can certainly build the HB2. If you've never built a Univibe, you can certainly build and HB2, as well. But, and I want this to be very clear: this is a time-consuming project. Expect to spend a few evenings putting it together. It's not something you can build in a single day and it requires patience and commitment. IOW, go slow and get it right the first time!

Details about the design: The Harbinger Two (like the One) does depart a little from the traditional Univibe design. It includes an JFET buffer for a louder and brighter input option (the second input option is the stock Univibe). It also runs all the audio at 18v instead of a regulated 15v. This gives the audio portion a little added headroom at the expense of a small voltage drop (see the Voltage chart below for an explanation). The LFO section runs from regulated voltage like the Univibe.

And, like the One, the HB2 only requires a 9v DC supply to operate. Lastly, the HB2 adds a new tweak: the Drag switch, which creates a ramp down effect with mod rate.

Controls

SPD: The rate of the modulation from fast (toe down) to slow (heel up).

INT: The intensity of modulation.

VOL: Output volume.

C/V: This switch selects between a chorus effect (modulation mixed with dry signal) or vibrato effect (pitch modulation only).

MOD/VIN: This slide switch selects between the traditional input and a JFET buffer input. The JFET buffer has more output volume and is brighter.

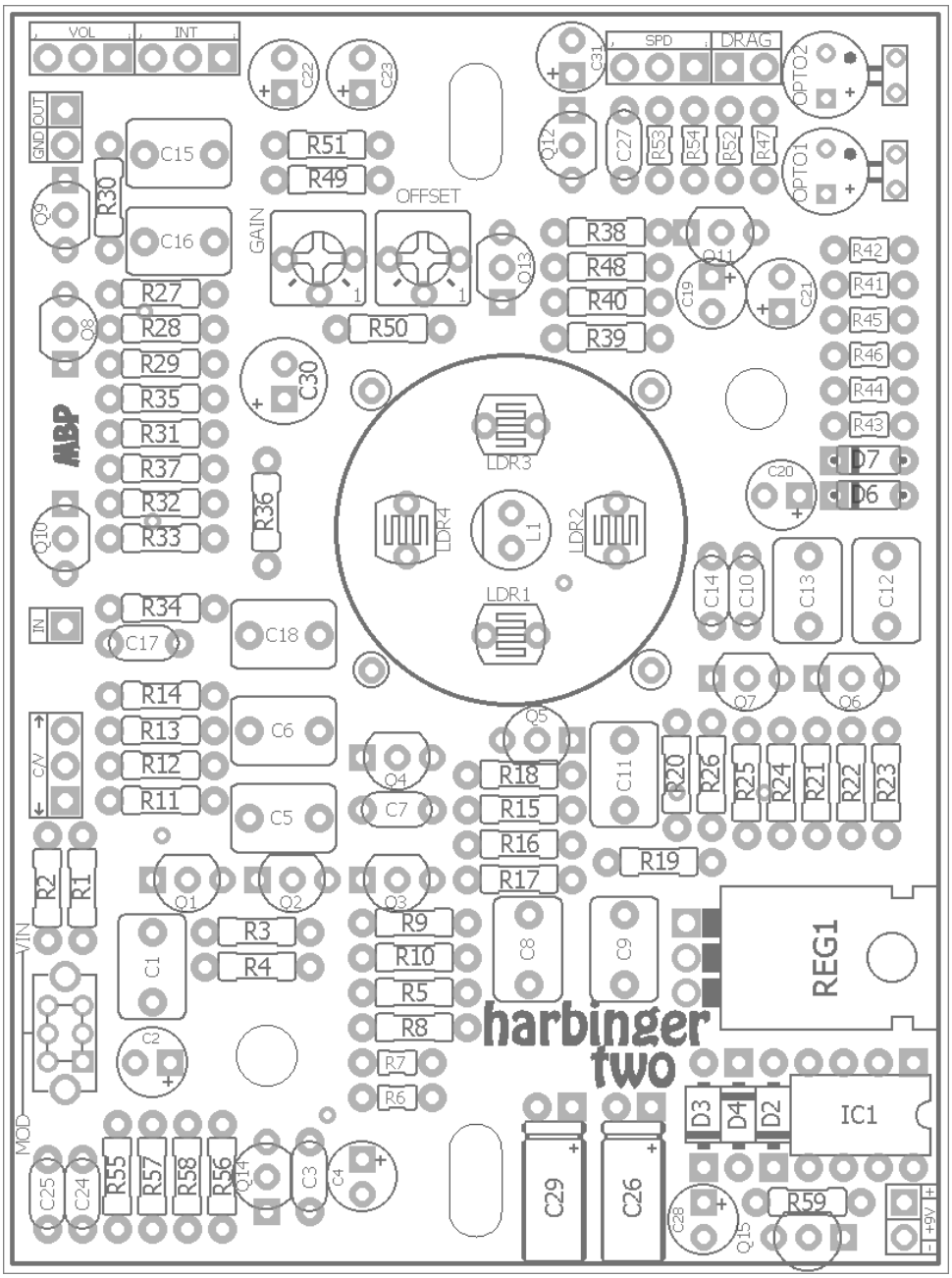
DRAG: This switch creates a slight delay and ramp-down effect of the modulation rate when going from Toe to Heel positions.

GAIN: This trimmer sets the brightness of the LFO-driven bi-pin lamp.

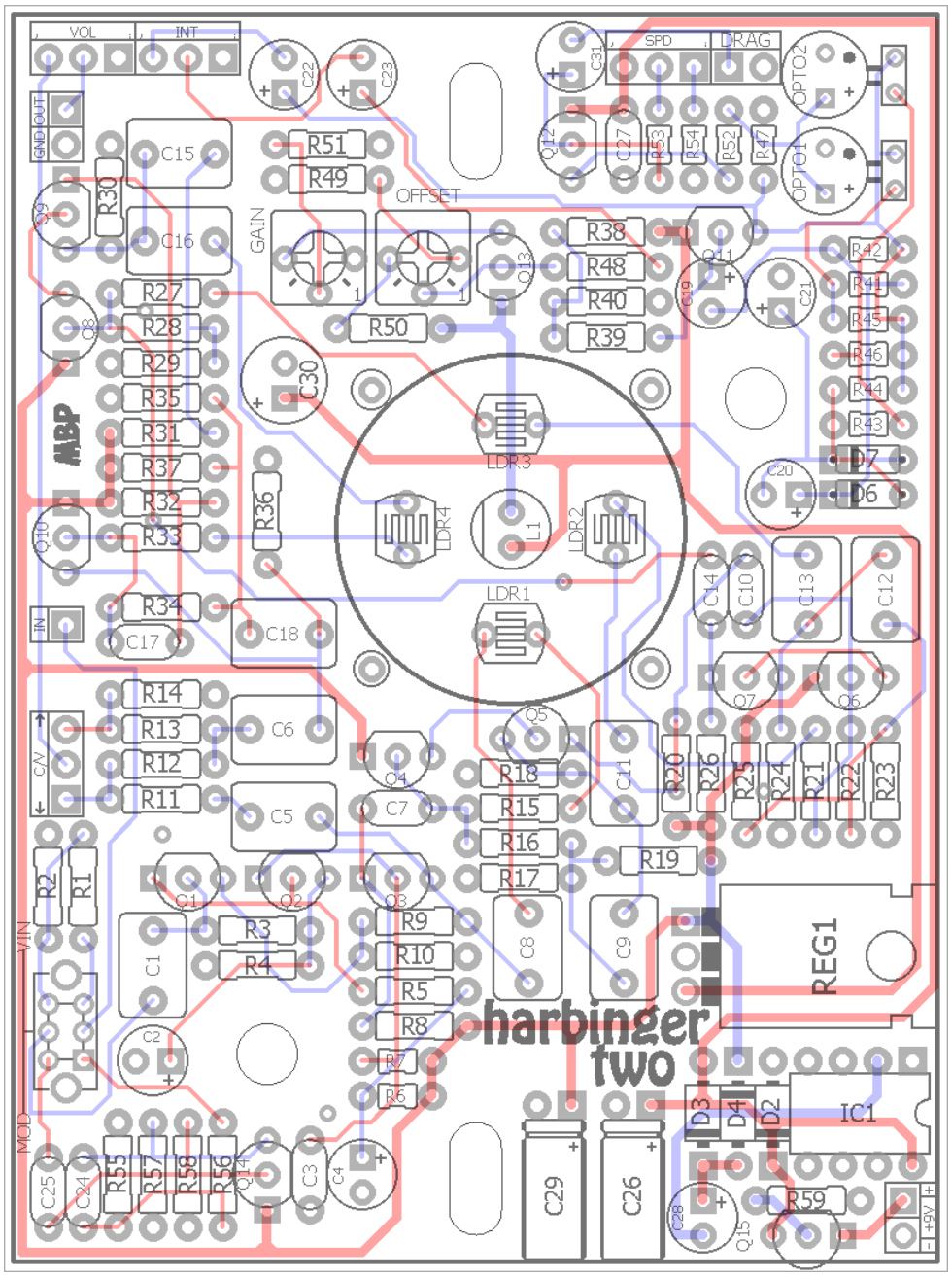
OFFSET: This trimmer lets you adjust the ramping of the lamp's brightness.

Terms of Use: *You are free to use purchased **Harbinger Two** circuit boards for both DIY and small commercial operations. You may not offer **Harbinger Two** PCBs for resale or as part of a "kit" in a commercial fashion. Peer to peer re-sale is fine, though.*

Layout


VOL
INT
SPD
DRAG
OFFSET
GAIN
harbinger
two
REG1
IC1
VIN
MOD
LDR1
LDR2
LDR3
LDR4
L1

Traces



There is a layout error regarding Q15. Please see the Notes section for the correction.

B.O.M.

Resistors		Resistors		Caps		Diodes	
R1	22K	R32	4k7	C1	1uF	D2	15v Zener
R2	47k	R33	4k7	C2	1uF	D3	1N5817
R3	1M	R34	100k	C3	330pF	D4	1N5817
R4	5k6	R35	47k	C4	1uF	D6	1n914
R5	1M	R36	22k	C5	1uF	D7	1n914
R6	100k	R37	68k	C6	1uF	**Transistors**	
R7	47k	R38	3k3	C7	15n	Q1	2N5089
R8	4k7	R39	2M2	C8	1uF	Q2 - Q10	2N5088
R9	3k3	R40	4k7	C9	1uF	Q11 - Q13	MPSA13
R10	1k2	R41	2k2	C10	220n	Q14	MPF102
R11	100k	R42	220k	C11	1uF	Q15	BS250
R12	100k	R43	2k2	C12	1uF	**Regulator**	
R13	47k	R44	220k	C13	1uF	REG1	LM7815
R14	220k	R45	100k	C14	470pF	**Optical**	
R15	4k7	R46	100k	C15	1uF	OPTO1&2	NSL-32
R16	100k	R47	4k7	C16	1uF	**Illumination**	
R17	47k	R48	4k7	C17	4n7	L1	Bi-Pin Lamp
R18	4k7	R49	47k	C18	1uF	**LDR**	
R19	100k	R50	47k	C19	1uF	LDR1 - 4	*see notes
R20	4k7	R51	22R	C20	1uF	**IC**	
R21	4k7	R52	27k	C21	1uF	IC1	LT1054
R22	100k	R53	100k	C22	10uF	**Switches**	
R23	47k	R54	27k	C23	10uF	C/V	SPDT
R24	4k7	R55	1M	C24	100n	DRAG	SPDT
R25	100k	R56	1K	C25	100n	MOD_VIN	DPDT Slide
R26	4k7	R57	1M	C26	220uF	**Trimpots**	
R27	4k7	R58	10k	C27	100n	GAIN	500R
R28	100k	R59	1M	C28	47uF	OFFSET	250k
R29	47k			C29	100uF	**Pots**	
R30	4k7			C30	100uF	INT	50kB
R31	100k			C31	4u7	VOL	100kB
						SPD	100k ICAR
						Enclosure	
						Wah Shell	

Shopping List

Value	QTY	Type	Rating
22R	1	Carbon / Metal Film	1/4W
1K	1	Carbon / Metal Film	1/4W
1k2	1	Carbon / Metal Film	1/4W
2k2	2	Carbon / Metal Film	1/4W
3k3	2	Carbon / Metal Film	1/4W
4k7	14	Carbon / Metal Film	1/4W
5k6	1	Carbon / Metal Film	1/4W
10k	1	Carbon / Metal Film	1/4W
22k	2	Carbon / Metal Film	1/4W
27k	2	Carbon / Metal Film	1/4W
47k	9	Carbon / Metal Film	1/4W
68k	1	Carbon / Metal Film	1/4W
100k	13	Carbon / Metal Film	1/4W
220k	3	Carbon / Metal Film	1/4W
1M	5	Carbon / Metal Film	1/4W
2M2	1	Carbon / Metal Film	1/4W
330pF	1	Ceramic / MLCC	25v min.
470pF	1	Ceramic / MLCC	25v min.
4n7	1	Film	25v min.
15n	1	Film	25v min.
100n	3	Film	25v min.
220n	1	Film	25v min.
1uF	11	Film	25v min.
1uF	5	Electrolytic	25v
4u7	1	Electrolytic	25v
10uF	2	Electrolytic	25v
47uF	1	Electrolytic	25v
220uF	3	Electrolytic	25v

Value	QTY	Type	Rating
Zener	1		15v
1N5817	2		
1n914	2		
2N5089	1		
2N5088	9		
MPSA13	3		
MPF102	1	or, 2n5457, J201	
BS250	1	***included with PCB**	
LM7815	1		
NSL-32	2		
Lamp	1	***included with PCB**	
LDR	4	*see notes	
LT1054	1		
SPDT	2	On/On	
DPDT	1	***included with PCB**	
500R	1	Bourns 3362p	
250k	1	Bourns 3362p	
50kB	1	Solder Lug	9mm or 12mm
100kB	1	Solder Lug	9mm or 12mm
100k ICAR	1	Wah POT	
Wah Shell	1		

TIP: You can use a 12v Zener instead of 15v (smallbear has 12v but not 15v Zeners). You can also use no Zener at all - but only if you are careful to only use a 9v supply. The LT1054 an be damaged at over 15v.

Parts Guide

15v Zener: https://www.mouser.com/ProductDetail/ON-Semiconductor-Fairchild/1N4744A?qs=sGAEpiMZZMtQ8nqTK-tFS%2fD313Kx94AdFdSPLy44WWjs%3d

2n5089: http://smallbear-electronics.mybigcommerce.com/transistor-2n5089/

2n5088: http://smallbear-electronics.mybigcommerce.com/transistor-2n5088/

MPSA13: http://smallbear-electronics.mybigcommerce.com/transistor-mpsa13/

MPF102: http://smallbear-electronics.mybigcommerce.com/transistor-fet-mpf102/

LM7815: http://smallbear-electronics.mybigcommerce.com/ic-lm7815ct/

NSL32: http://smallbear-electronics.mybigcommerce.com/photocoupler-silonex-nsl-32/

LT1054: http://smallbear-electronics.mybigcommerce.com/ic-lt1054cp/

SPDT: http://smallbear-electronics.mybigcommerce.com/spdt-on-on-short-lever/

500R 3362p: https://www.mouser.com/ProductDetail/Bourns/3362P-1-501LF?qs=sGAEpiMZZMvygUB3GLcD7iDNlz%2f-NDKompMEyhqEJhVo%3d

or, https://www.taydaelectronics.com/potentiometer-variable-resistors/cermet-potentiometers/3362p/500-ohm-trimmer-potentiometer-cermet-1-turn-3362p.html

250k 3362p: https://www.mouser.com/ProductDetail/Bourns/3362P-1-254LF?qs=sGAEpiMZZMvygUB3GLcD7p0sIDtXd-CwsKR9Dy6lj2rI%3d

or, (200k is okay): https://www.taydaelectronics.com/potentiometer-variable-resistors/cermet-potentiometers/3362p/200k-ohm-trimmer-potentiometer-cermet-1-turn-3362-3362p.html

9mm Pots: http://smallbear-electronics.mybigcommerce.com/alpha-single-gang-9mm-pc-mount/

12mm pots (50kB, 100kB): http://smallbear-electronics.mybigcommerce.com/alpha-single-gang-12mm-solder-terms/

Wah Parts:
Your best bet is to find a used Crybaby and gut it. You can often find them in the $30-50 range. The advantage is that is will cost less than purchasing an empty shell AND ICAR pot, jacks, etc. Plus, the wah pot is already mounted which is a BIG advantage. Tip: you do not need to spend a lot on a fancy Wah pot. In the Harbinger Two it only controls the brightness of the LEDs in the two NSL-32.

smallbear does offer this shell: http://smallbear-electronics.mybigcommerce.com/expression-pedal-shell/
and, this kit: http://smallbear-electronics.mybigcommerce.com/expression-pedal-shell-kit/

And, this pot: http://smallbear- electronics.mybigcommerce.com/wah-pot-the-black-bear-100k/

LDR:
smallbear does offer two versions of excellent LDRs for a Univibe:

http://smallbear-electronics.mybigcommerce.com/photocell-silonex-advanced-photonix-hi-dark-nsl-7532/
and, http://smallbear-electronics.mybigcommerce.com/photocell-silonex-advanced-photonix-hi-dark-to-5/

Both appear to be out of stock at this time. In their absence, I recommend any of these (I've used the 7532 in other builds with good success).

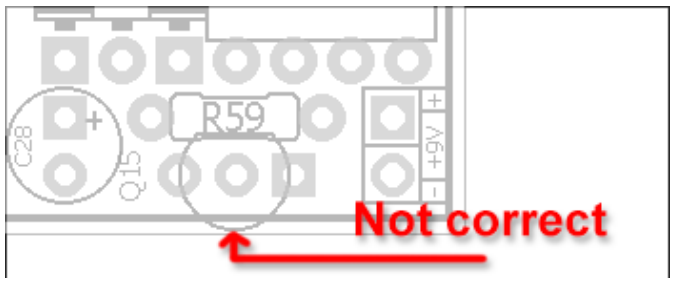
http://smallbear-electronics.mybigcommerce.com/photocell-silonex-advanced-photonix-nsl-7532/
http://smallbear-electronics.mybigcommerce.com/photocell-silonex-advanced-photonix-nsl-7530/
or, the 9203: http://smallbear-electronics.mybigcommerce.com/photocells-cds-5mm-diameter/

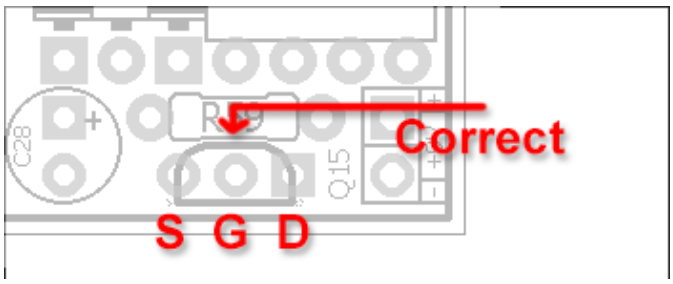
Notes

BS250p Polarity Protection and Correction

I chose this method for the HB2 to take advantage of its very low voltage drop. However, I made a mistake in the layout- the transistor orientation is shown incorrectly. Q15 must be flipped around to take full advantage of the BS250p. It will still work the incorrect way but the transistor itself can be damaged by reverse polarity if left in its incorrect orientation (I finally realized this when I fried my own transistor when I plugged the power in backwards).

Flip Q15 so that the half-rounded side faces up instead of down. The BS250p is slightly flatter than the typical T0-92 transistor casing. Use this guide:

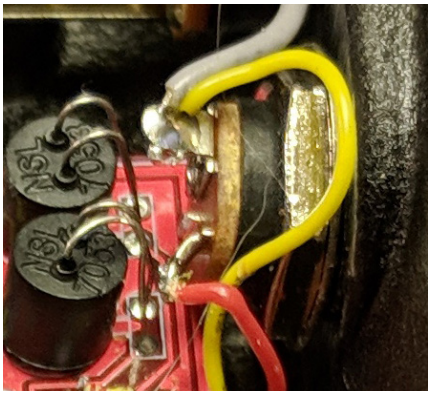




In the corrected version, the “BS250p” marking on the transistor casing faces the red arrow.

DC Jack

The placement of the two NSL-32 devices is not really optimal in terms of overall design, but it’s what worked with this PCB layout. If possible, one of the external nut jacks (http://smallbear-electronics.mybigcommerce.com/2-1-mm-plastic-round-external-nut/) would be best. But, if you are like me and don’t have those the typical jack will work fine. To make the internal nut jack work I cut the Ring tab off (it isn’t needed anyway) and gently bent the tab outward. This posed no problems.

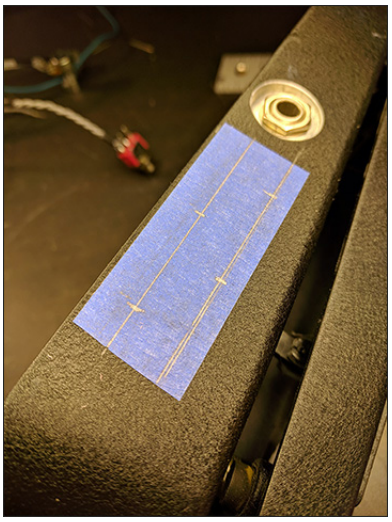


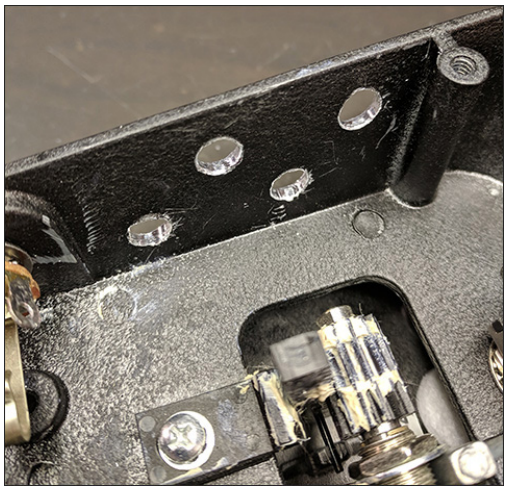
About Wah shells

Drilling Wah shells is very hard to do. They are generally made with heavy-duty die-cast and are much harder to drill than most of our plunky aluminum enclosures. However, a stepped drill bit will do the job. Just go slow when drilling and use a bit of force when needed.

Tools that will make the job go easier:
Stepped drill bit, Xacto knife, wire cutter and a deburring tool.

There is no drill diagram for the Harbinger Two. You need to work it out on you own. I used painter's tape to mark out four drill locations (two pots and two switches). I set them between the post and jack on the enclosure and spaced them about 1" apart on each row. I decided to stagger the top and bottom rows to make accessing the controls easier.



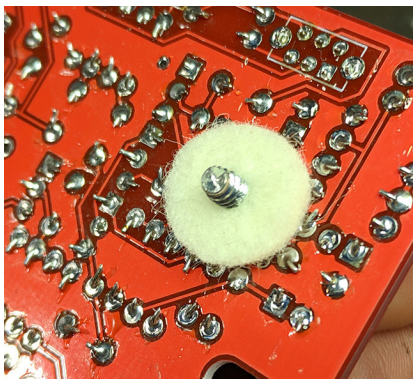


It took about 15 minutes to drill the holes (PS I also had to drill out a larger hole for the DC jack since none of my jacks fit the existing hole). I used a drill press and even with that I had to use some forceful downward pressure to punch through. After drilling, I had a lot of burrs that required clean up. Using my Xacto knife, an old pair of wire cutters I didn't care about and deburring tool I was able to get reasonably clean holes

Moral of the story: take your time and expect to do some real work here! It doesn't have to be pretty.

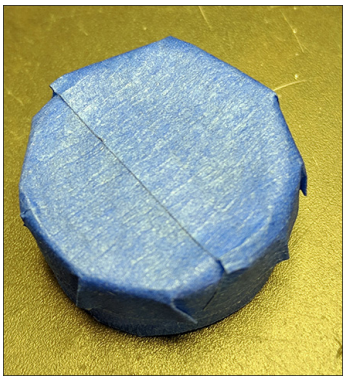
Mounting

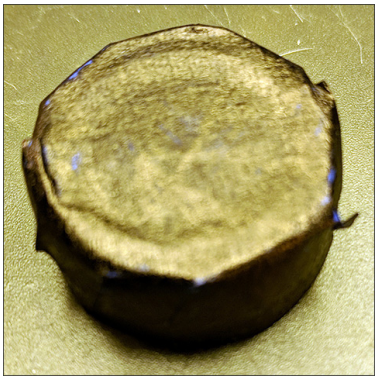
I left as much space as possible around the screw mounts to prevent any shorts from soldered pads to the enclosure. As a bit of extra insurance, I recommend adding some kind of stand-off. What you use isn't important so long as it creates a barrier between the bottom of the PCB and screw posts. Tape, wadded up paper, whatever. I used a couple felts I had that are for guitar strap buttons.



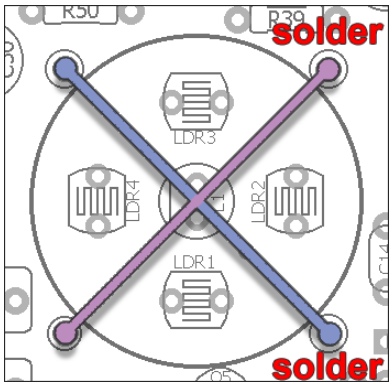
Light Shield

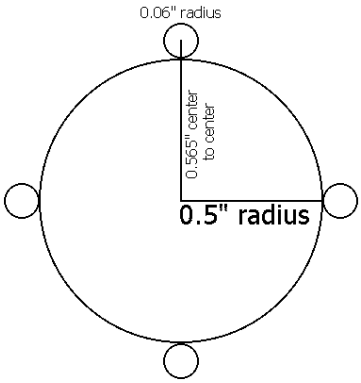
I do hope to be able to include a 3d printed light shield with this project. I may be able to do so by the time the boards start shipping. But, in case it doesn't work out here is an easy way to make one: 1) water bottle cap, 2) cover it in one layer of painter's tape, and 3) use a black Sharpie to mask out the tape.





To affix the light shield, I recommend the following: solder some buss wire the two the mounting holes on the PCB. Then just bend them over and insert in the opposite side to keep the shield in place. You don't need to solder all four positions. In fact, don't! You want to be able to remove the shield in case you need to visually inspect the lamp when making adjustments. Exact measurements of the light shield below. Alternatively, you could solder one wire in each spot and then twist them together over the top of the shield. Whatever works for you.





Lamp Calibration

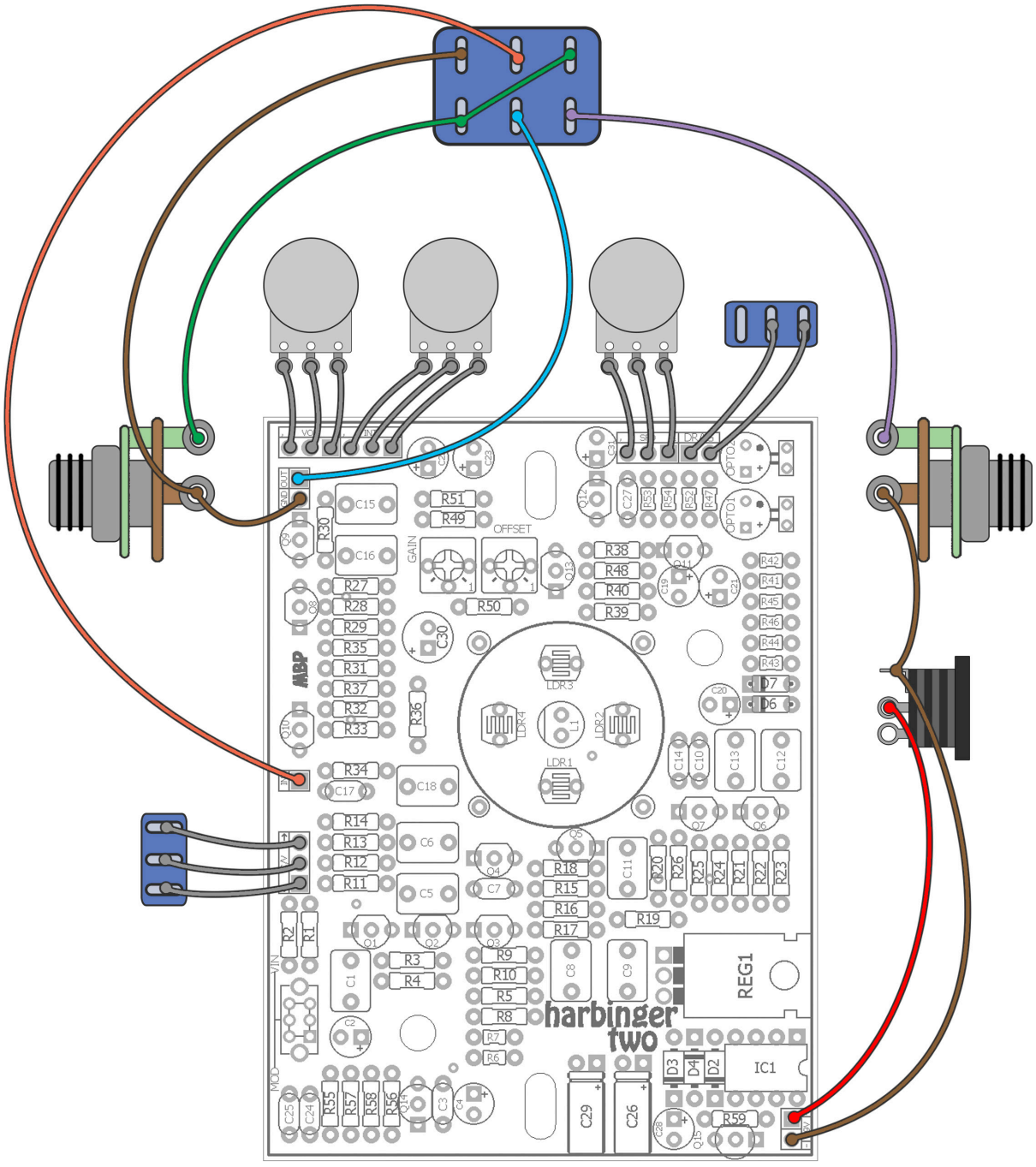
The GAIN and OFFSET controls are interactive. Use this procedure to calibrate the lamp

- Turn Intensity and Volume controls all the way up. Set the Speed control at about half-way.
- Turn the GAIN control up until you get moderate, but not overly bright lighting of the lamp.
- Now adjust the OFFSET control to find the sweet spot for the vibe where you get the most lush and swirly sounds.

The OFFSET will set the lower floor for the lamp brightness. High amounts of offset result in a lamp that goes fully off at the bottom of its sweep. Moderate and light offset means the lamp will pulse but never go fully dark. You will probably find yourself adjusting the GAIN and OFFSET a few times until you get the precise sound you want. I set my lamps to go fully dark to moderate brightness and get great results with that.

Be careful when adjusting the trimmers so that the lamp does not blow. I have yet to do this in any build no matter where I set the trimmers, but it is possible to do. Lastly, you should consider turning off your power supply or disconnecting the DC jack when not in use. This will preserve the life of the lamp considerably.

Wiring



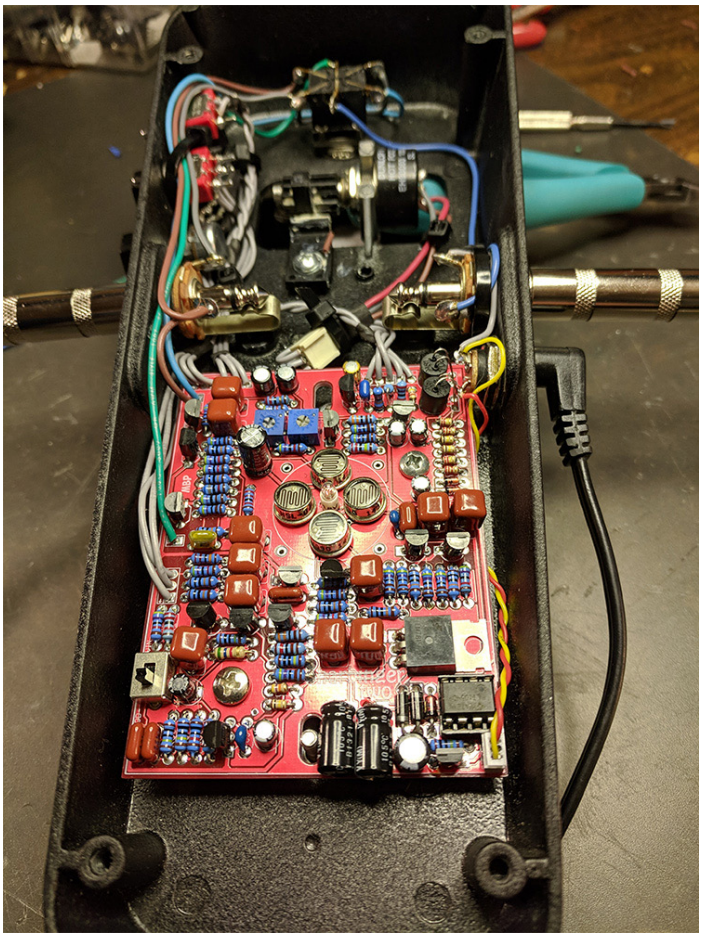
This diagram shows the HB2 wiring without an LED and is for a DPDT switch (since that is what many of the Crybaby Wahs come with). You are welcome to use an LED indicator if you want, though. Just use a 3PDT and do the same wiring, adding the LED anode and ground to the extra column. IOW, wire it exactly like the typical madbeanpedals bypass. You will also need to add a CLR wired to the positive tab of the DC jack.

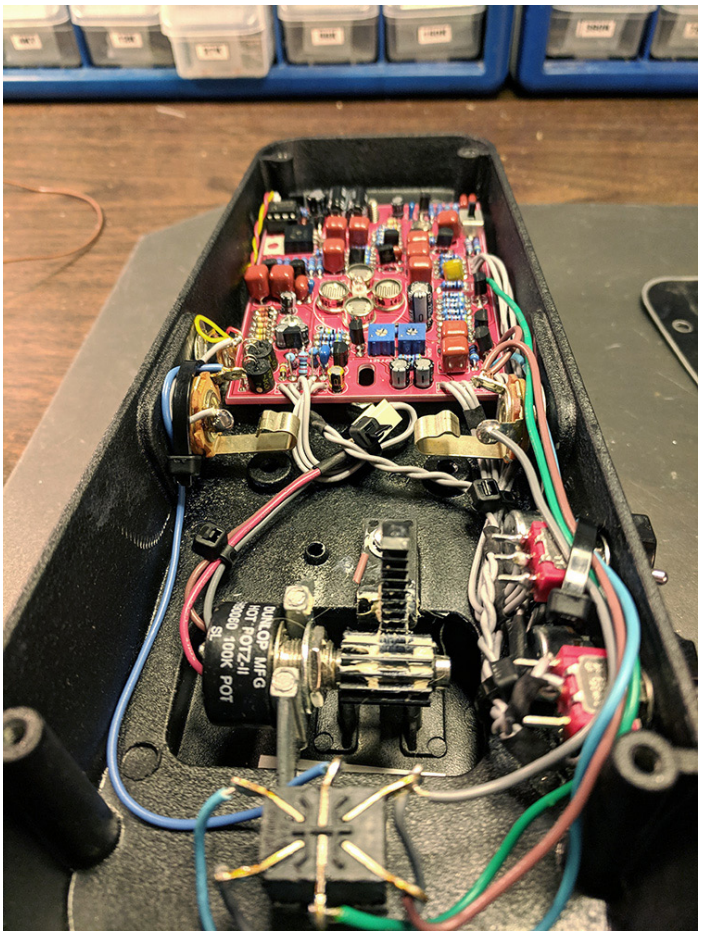
Speaking of switches: if you are buying a bypass switch for your shell try to get a long shaft one. The normal 3PDT switch is a bit too short and requires extra padding to actuate. These switches eliminate that problem.

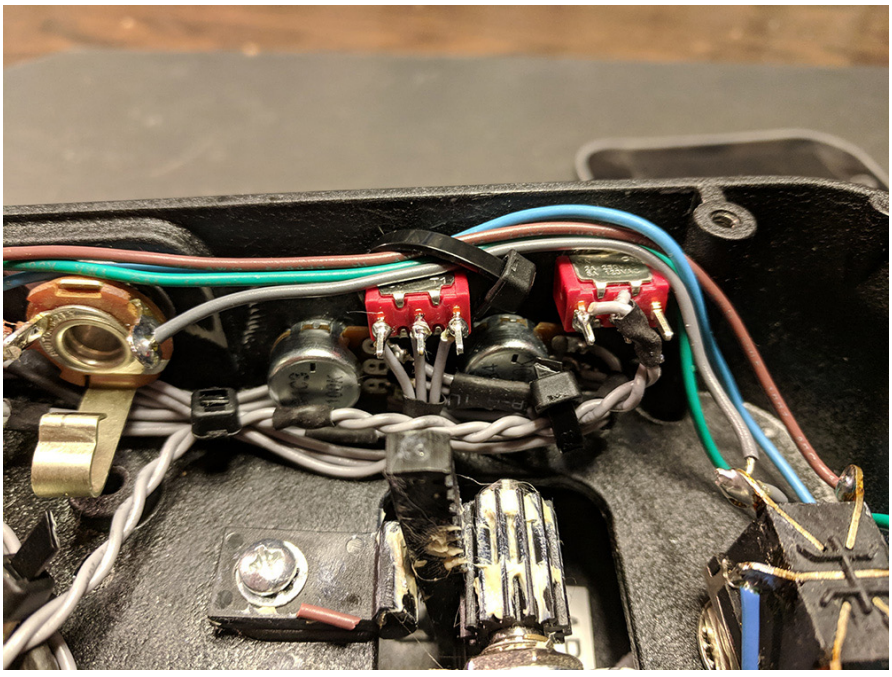
DPDT: http://smallbear-electronics.mybigcommerce.com/dpdt-316-b-pp/
3PDT: http://smallbear-electronics.mybigcommerce.com/alpha-sf17020f-0302-24r-l-3pdt-long-bushing/

Build Pics

Note: These pics were taken before I realized Q15 was wrong on the layout, so ignore it.







Voltages

Q1	2n5089
C	2.13
B	1.45
E	1.03

Q2	2n5088
C	4.42
B	2.13
E	1.57

Q3	2n5088
C	13.5
B	4.4
E	3.8

Q4	2n5088
C	17.5
B	5.53
E	5.17

Q5	2n5088
C	13.02
B	5.25
E	4.51

IC1	LT1054
1	~2.1v
2	4.94
3	0
4	0
5	0
6	2.56
7	1.38
8	9.26

Q6	2n5088
C	17.5
B	5.5
E	5.18

Q7	2n5088
C	13
B	5.16
E	4.54

Q8	2n5088
C	17.5
B	5.5
E	5.2

Q9	2n5088
C	13
B	5.2
E	4.5

Q10	2n5088
C	17.5
B	6.94
E	6.5

Q11	MPSA13
C	14.73
B	varies
E	varies

Q12	MPSA13
C	9.2
B	9.08
E	8.13

Q13	MPSA13
C	varies
B	varies
E	varies

Q14	MPF102
D	17.5
S	2.77
G	0

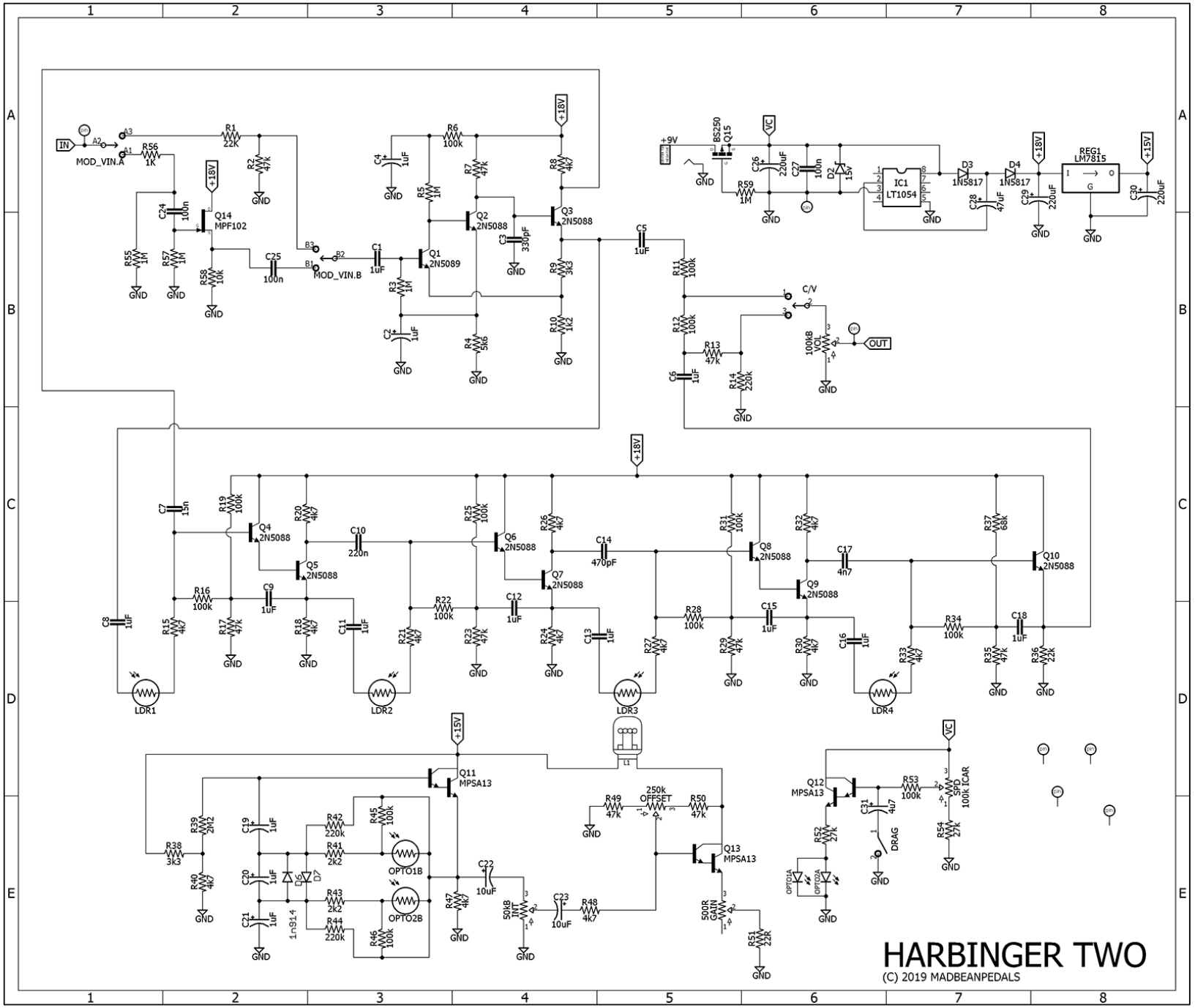
Q15	BS250p
D	9.4
G	0
S	9.26

REG1	7815
In	17.5
Gnd	0
Out	14.74

Because the audio portion of the Harbinger Two is unregulated, you may see some small fluctuations on the ~18v rail. This is from the changing current demands of the LFO, as best I can tell (the total current draw does vary some with different speeds). Do not let it concern you. These small fluctuations will not negatively impact the overall result. What's shown on the list above is the top measurement for my 18v rail.

Current Draw: Between 50-60mA

Schematic


HARBINGER TWO
(C) 2019 MADBEANPEDALS
IN
MOD_VIN.A
MOD_VIN.B
OUT
C/V
+9V
+18V
+15V
VC
GND
Q14 MPF102
Q1 2N5089
Q2 2N5088
Q3 2N5088
Q4 2N5088
Q5 2N5088
Q6 2N5088
Q7 2N5088
Q8 2N5088
Q9 2N5088
Q10 2N5088
Q11 MPSA13
Q12 MPSA13
Q13 MPSA13
IC1 LT1054
REG1 LM7815
D3 1N5817
D4 1N5817
D2 15V
D5
D6
D7
1n914
LDR1
LDR2
LDR3
LDR4
OPTO1A
OPTO1B
OPTO2A
OPTO2B
L1
250k OFFSET
50k8 INT
500R GAIN
100k SPD
DRAG