SMOOTHIE2020

FX TYPE: Phaser
Based on the MXR® Phase45™

Enclosure Size: 1590A

"Softie" compatibility: none

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Overview

The Smoothie is based on the classic MXR Phase 45™. The Phase 45 is a two stage phaser driven by simple LFO. The input is fed through a filter network whose bias is controlled resistively by the two JFET transistors. These transistors are in turn are powered by the LFO generated by IC2B. Finally, the input signal is mixed via R15 just before the output.

To learn more about how phasers function, please refer to "The Technology of Phase Shifters and Flangers" by R.G. Keen.

NOTE: This project works best when matched transistors are used. I would not recommend building it unless you have at least 25 or more transistors on hand to do the matching or can obtain a matched pair from someone (I do not offer any matched pairs). See the NOTES section for more details.

New for the 2020 version: new layout that conforms my current style of 1590A projects. Changed all 1/8W from previous versions to 1/4W.

Controls

• **SPEED -** LFO rate from slow to fast.

Technical assistance for your build(s) is available via the madbeanpedals forum. Please go there rather than emailing me for assistance on builds. This is because (1) I'm not always available to respond via email in a timely and continuous manner, and (2) posting technical problems and solutions in the forum creates a record from which other members may benefit.

47uF

500kC

100n

250k

MBP

5817

10uF

10uF

7k5

10n

1M

150k

470k

TL072

150k

10n

150k

47n

SMOOTHIE

150k

10k

10k

3M9

470k

2n5457

2n5457

47n

10n

10k

10k

10k

10k

4.7v

10k

470k

10k

TL072

47n

10k

20k

10k

10k

10k

1M

47n

10n

4k7

150k

GND | L | + | LED | – | IN | OUT
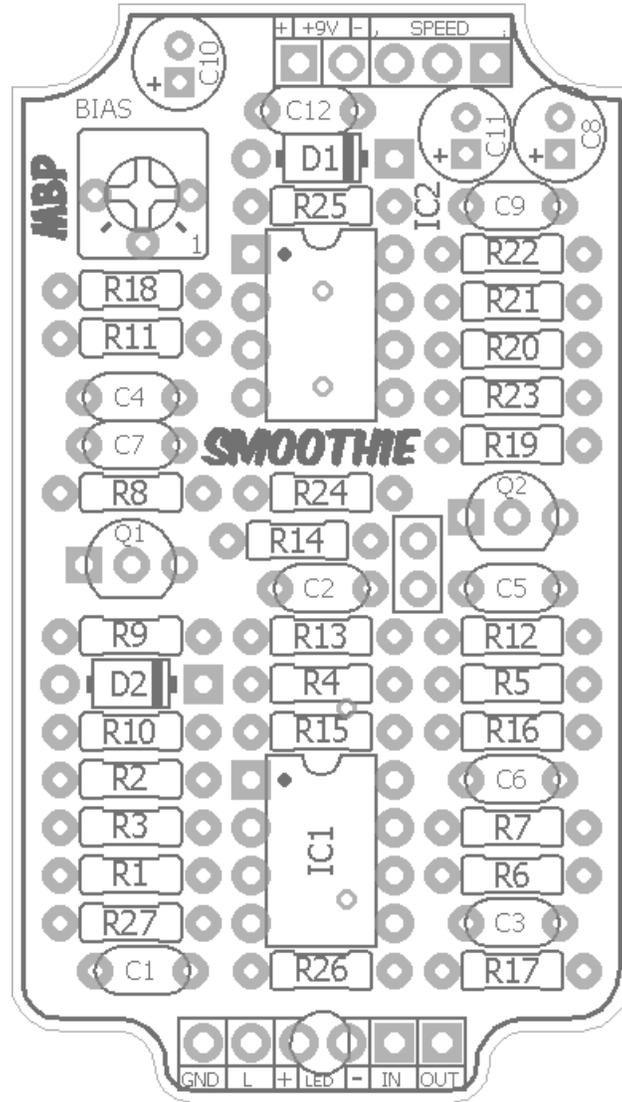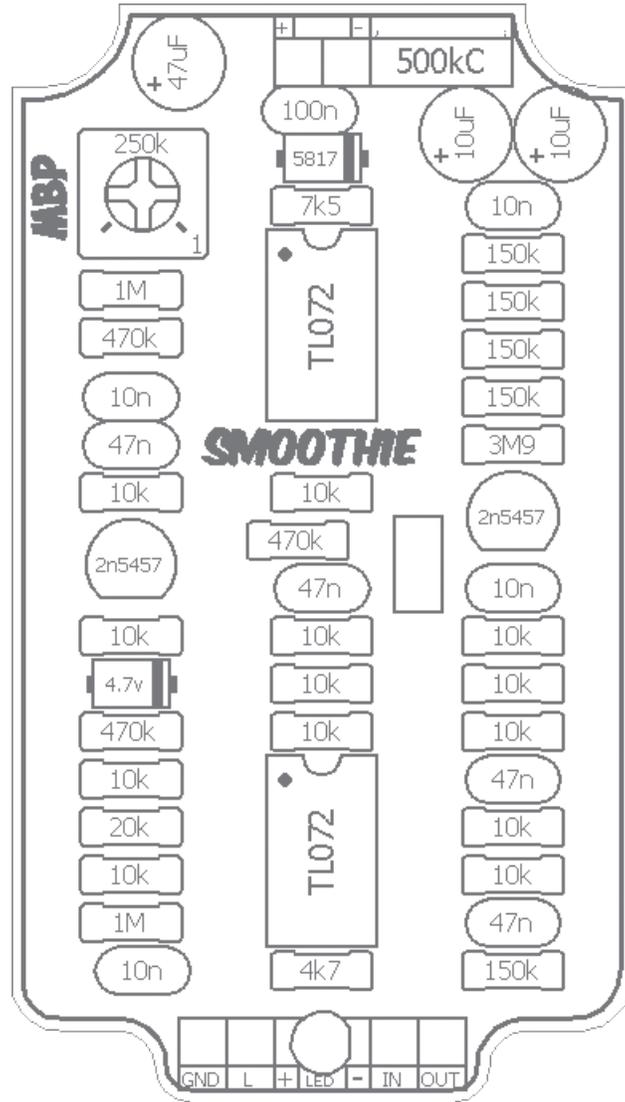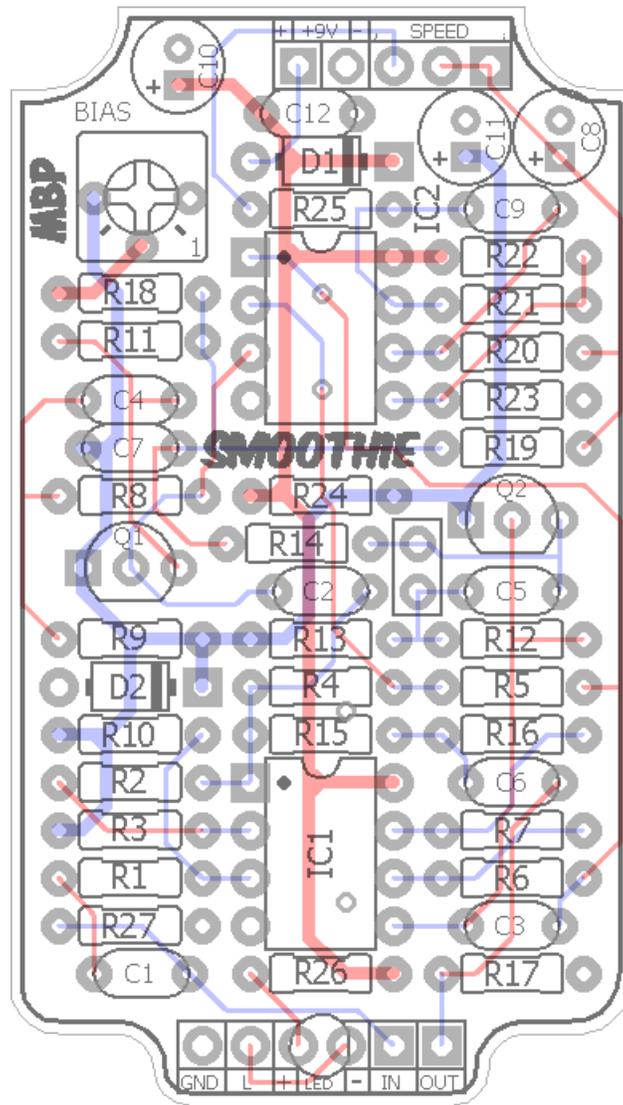
Resistors		Caps	
R1	10k	C1	10n
R2	10k	C2	47n
R3	20k	C3	47n
R4	10k	C4	10n
R5	10k	C5	10n
R6	10k	C6	47n
R7	10k	C7	47n
R8	10k	C8	10uF
R9	10k	C9	10n
R10	470k	C10	47uF
R11	470k	C11	10uF
R12	10k	C12	100n
R13	10k	Diodes	
R14	470k	D1	1N5817
R15	10k	D2	4.7v
R16	10k	Transistors	
R17	150k	Q1	2n5457
R18	1M	Q2	2n5457
R19	3M9	ICs	
R20	150k	IC1	TL072
R21	150k	IC2	TL072
R22	150k	Trimmer	
R23	150k	BIAS	250k
R24	10k	Pots	
R25	7k5	SPEED	500kC
R26	4k7		
R27	1M		

The Phase45 used 2n5952 transistors. I've used the 2n5457 package on the Smoothie PCB but either transistor (properly matched) will work fine. If you use 2n5952, flip them 180 deg. on the PCB to account for the different pinouts.

Value	QTY	Type	Rating
4k7	1	Metal / Carbon Film	1/4W
7k5	1	Metal / Carbon Film	1/4W
10k	13	Metal / Carbon Film	1/4W
20k	1	Metal / Carbon Film	1/4W
150k	5	Metal / Carbon Film	1/4W
470k	3	Metal / Carbon Film	1/4W
1M	2	Metal / Carbon Film	1/4W
3M9	1	Metal / Carbon Film	1/4W
10n	4	Film	16v min.
47n	4	Film	16v min.
100n	1	Film	16v min.
10uF	2	Low Profile Electrolytic	16v min.
47uF	1	Low Profile Electrolytic	16v min.
1N5817	1		
4.7v	1	Zener	
2n5457	2	or, 2n5952	
TL072	2		
250k	1	Bourns 3362p	
500kC	1		9 or 16mm

2n5457:

http://smallbear-electronics.mybigcommerce.com/transistor-fet-2n5457/

2n5952:

http://smallbear-electronics.mybigcommerce.com/transistor-fet-2n5952/

4.7v Zener:

http://smallbear-electronics.mybigcommerce.com/diode-zener-1n4732a/

Bourns 3362p (250k):

https://www.mouser.com/ProductDetail/652-3362P-1-254LF

Low profile Electrolytic caps:

http://smallbear-electronics.mybigcommerce.com/electrolytic-radial-low-profile-16v-1-f-100-f/

9mm (500kC):

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

16mm (500kC):

http://smallbear-electronics.mybigcommerce.com/alpha-16mm-single-gang-reverse-audio-w-solder-terms/

Thinline DC Jack:

http://smallbear-electronics.mybigcommerce.com/dc-power-jack-all-plastic-unswitched-2-1-mm/

Enclosed Mono:

http://smallbear-electronics.mybigcommerce.com/1-4-in-mono-enclosed-jack/
http://smallbear-electronics.mybigcommerce.com/1-4-in-mono-enclosed-switchcraft-111x/

Lumberg Mono:

http://smallbear-electronics.mybigcommerce.com/lumberg-1-4-compact-shrouded-mono-jack/

- There are two pads outlined next to Q2. You can ignore these. I had intended this to be a mod for a "Univibe" switch but in my haste to complete the layout I accidentally attached them to the wrong cap. D'oh!
- If you want to do the Univibe mod make C2 10n and C3 100n.
- If you don't have a 4.7v Zener, a 5.1v will work as a sub.

Transistors:

The Phase 45 originally used 2N5952 JFETS. The Smoothie lists 2N5457 for Q1 and Q2 because they are more widely available and work just as well as the 2N5952. You may use either, but keep in mind that the pinout for the 2N5952 is opposite the 2N5457. This means you will need to rotate the transistors 180° on the PCB if you use 2N5952.

The Smoothie also requires the JFET transistors to be matched. While you may be able to stick a couple of random JFETS in there and get lucky, the best result comes from matching the cutoff voltages for the two transistors as closely as possible. This is actually very easy to do, provided you have a quantity of transistors available to work with.

The process involves placing individual transistors in a test circuit on a breadboard. Each device is then measured with a multimeter to read its gate/source cutoff voltage. This is the measurement you want to match with another transistor. The goal is to find two transistors whose Vgs are within just a couple of percent of one another. The closer the match, the better response one gets in the phase circuit. This process takes all of five minutes once you have the circuit ready to test the devices, so do not be discouraged…it is actually very straight-forward. The only caveat is that you generally want to have a decent pile of transistors available to match because the Vgs values can range widely between individual transistors. 25-50 transistors should be enough to find a decently close match.

If you wish to try matching your own JFETS, please refer to this excellent project posted by Jacob Kokura the madbeanpedals forum:

http://www.madbeanpedals.com/forum/index.php?topic=3098.0

More info about matching JFETs for phase shifters:
http://www.geofex.com/article_folders/fetmatch/fetmatch.htm

Biasing the phaser section:

1. Set the Speed control about halfway up. Adjust the Bias trimmer until you hear the input signal start to sweep through the two phase stages.
2. Fine tune the Bias trimmer until the rise and fall times of the sweep are as close to identical as possible.
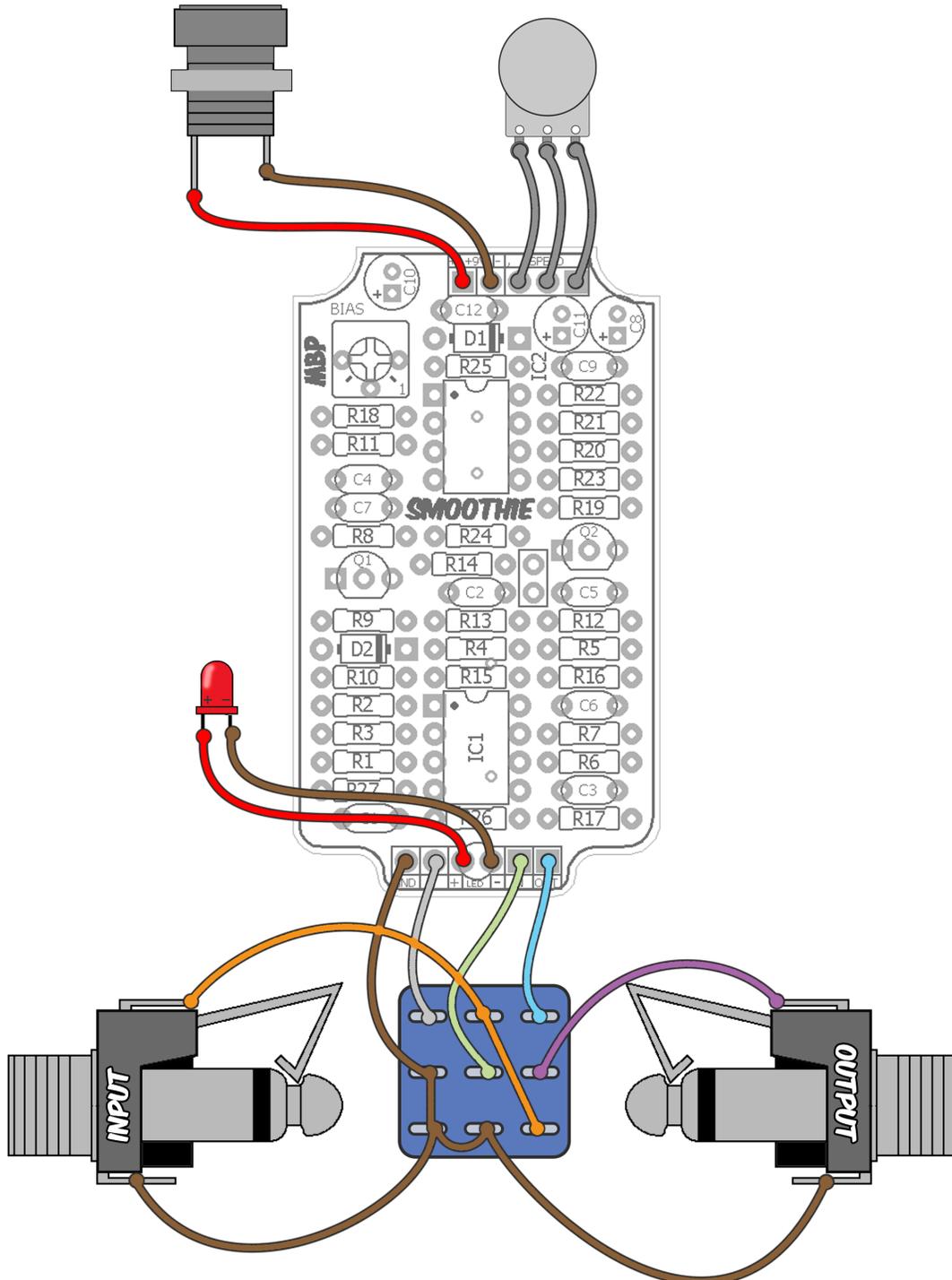
BIAS

MBP

C10

C12

D1

R25

R18

R11

C4

C7

R8

R24

R14

C2

Q1

R9

R13

R12

D2

R4

R5

R10

R15

R16

R2

C6

R3

R7

R1

R6

IC1

C3

R17

SMOOTHIE

IC2

C11

C8

C9

R22

R21

R20

R23

R19

Q2

C5

+9V

SPD

ND

+ LED –

O

INPUT

OUTPUT

5/16"

fold line

cut line

9/32"

SPEED

PCB clearance

3/8"

15/32" for annular ring

3/8"

15/32" for annular ring

PCB clearance

15/32" or 1/2"

1/8"
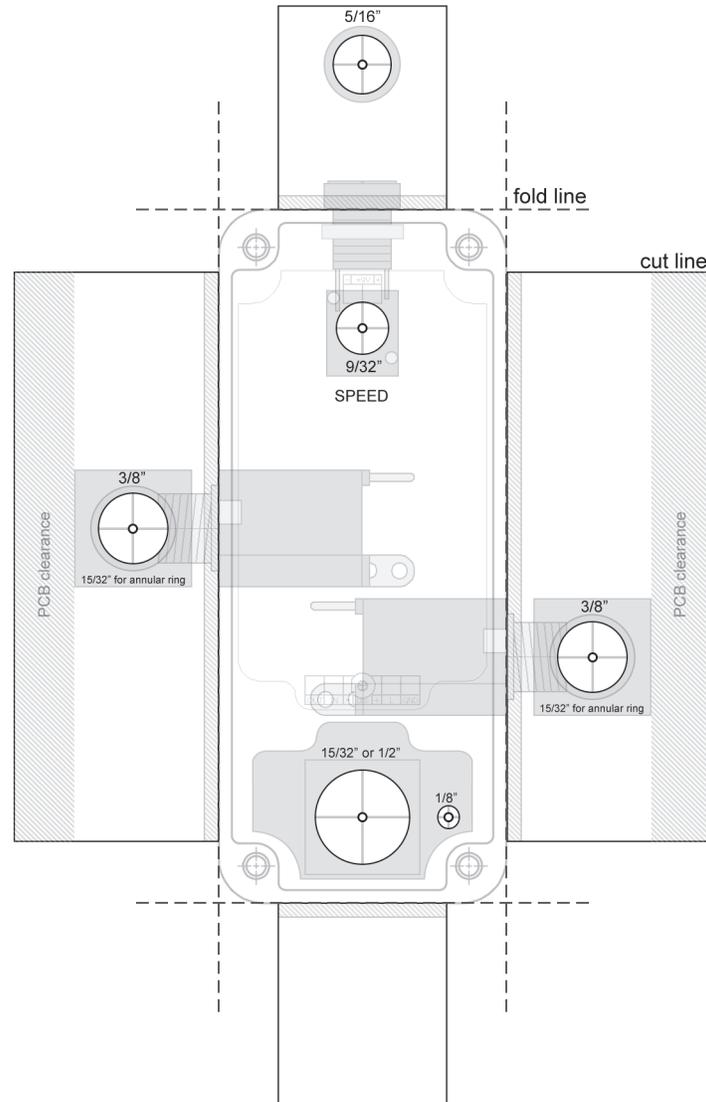
- This template will work for either mono enclosed jacks or the "Lumberg" style.
- It uses the "Thinline" style DC Jack.
- It also shows the 3PDT02 bypass PCB but this is not required. If you are wiring straight to a 3PDT you can use the same LED location on the right side or choose a different spot.

IC1	TL072		IC2	TL072		Q1	2n5457
1	3.6		1	3.6		D	3.6
2	3.6		2	3.6		S	~3.6
3	3.46		3	3.6		G	varies
4	0		4	0			
5	3.6		5	varies		Q2	2n5457
6	3.6		6	varies		D	3.6
7	3.6		7	varies		S	~3.6
8	9.16		8	9.16		G	varies

- Your voltage readings will differ somewhat depending on where your Bias trimmer is set.
- 9.42vDC One Spot
- Current Draw: ~ 8mA
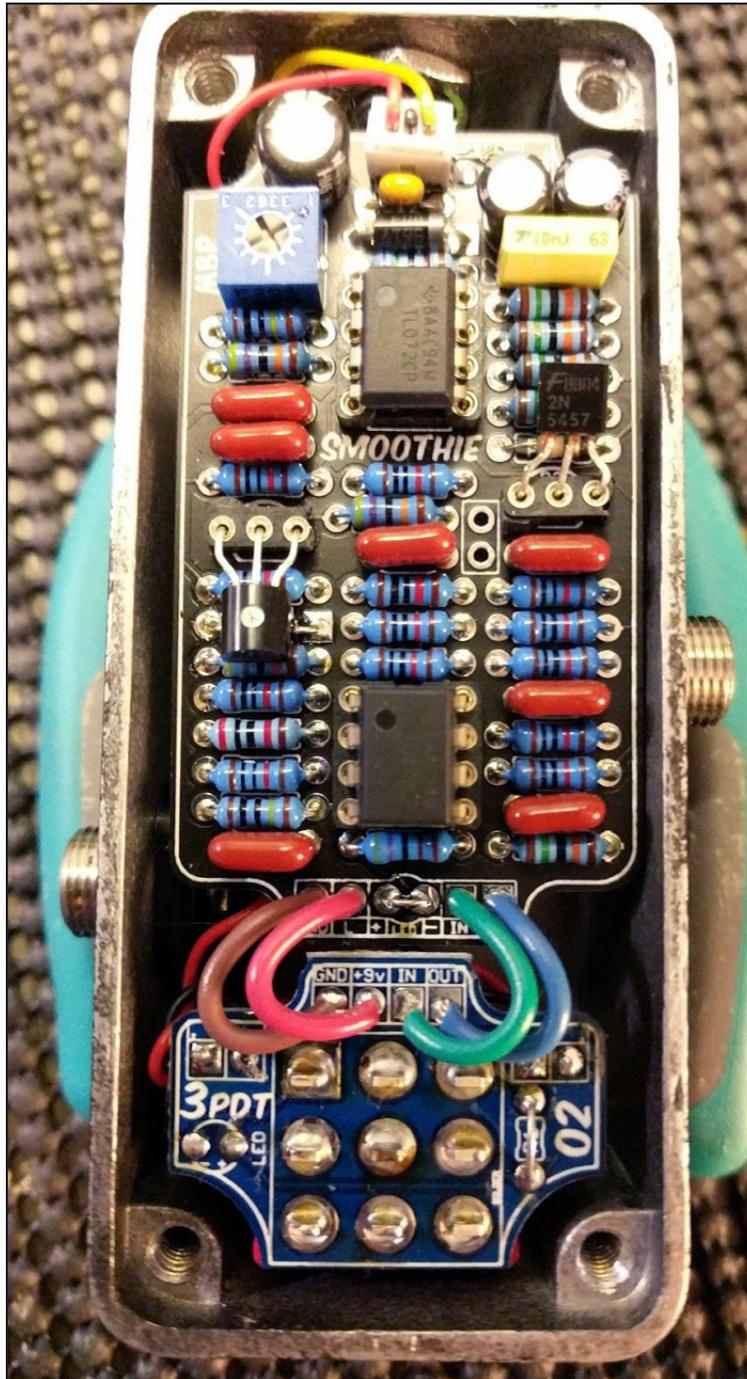
I used low profile 8-pin sockets for the two ICs. I also broke a spare apart to make two 3-pin sockets for the FETs.

https://www.mouser.com/ProductDetail/575-343308

SMOOTHIE

based on the MXR Phase 45 (tm)
v.2020 (c) madbeanpedals

VB

R24 10k

C11 10uF

D2 4.7V

4 - IC2_PWR + 8
4 - IC1_PWR + 8

C12 100n

C10 47uF

D1 5817

+9V

NEGATIVE POWER TIP

GND

BYP.1_GND

GND

R22 150k

R26 4k7

BYP.1_LED

BYP.1_L

C7 47n

R23 150k

R21 150k

TL072 IC2_B

R9 10k

R11 470k

R13 10k

R14 470k

R18 1M

R19 3M9

R20 150k

VB

C4 10n

Q1 2n5457

C5 10n

Q2 2n5457

250k BIAS

C8 10uF

GND

R10 470k

R8 10k

R12 10k

GND

GND

C9 10n

R25 7k5

BYP.1_IN

C1 10n

R1 10k

TL072 IC1_A

C2 47n

TL072 IC2_A

C3 47n

TL072 IC1_B

R16 10k

C6 47n

BYP.1_OUT

OUT

500kC SPEED

IN

R27 1M

GND

R2 10k

R4 10k

R5 10k

R6 10k

R7 10k

R15 10k

R17 150k

GND

R3 20k

VB

VB

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