AQUABOYDLX_2019

FX TYPE: DELAY

Enclosure Size: 1590BB or 125BB

Based on the Boss® DM-2™

Softie compatability: none

Overview

The 2019 version of the **Aquaboy Deluxe** is a complete re-design of the 2015 project. This version incorporates many of the requested features lacking in the previous version: 15v operation, on-board charge pump, and both true bypass and tails footswitches. It keeps the same 1590BB footprint, although a 125BB is also a good choice. The ABDX has about 550ms of delay and includes modulation (triangle and squarewave).

This is complex project that should not be under-taken by novice builders. It is also a costly project to make. The BBD chips, clock and compander alone will set you back $50 or so. However, this is the type of project where money spent will go a long way toward making a unique and professional sounding delay AND still be cheaper than many commercially available analog delays with similar features.

NOTE: smallbear is currently out of the Xvive MN3005 re-makes. So, if you do not already have these you may be waiting a while to get them. I do not have any sources for the NOS MN3005 and most likely neither does anyone else. Hopefully, smallbear will be able to get more of the re-makes soon.

You will need a multimeter, audio probe and some kind of testing rig/breadboard set-up to get the ABDX properly set-up.

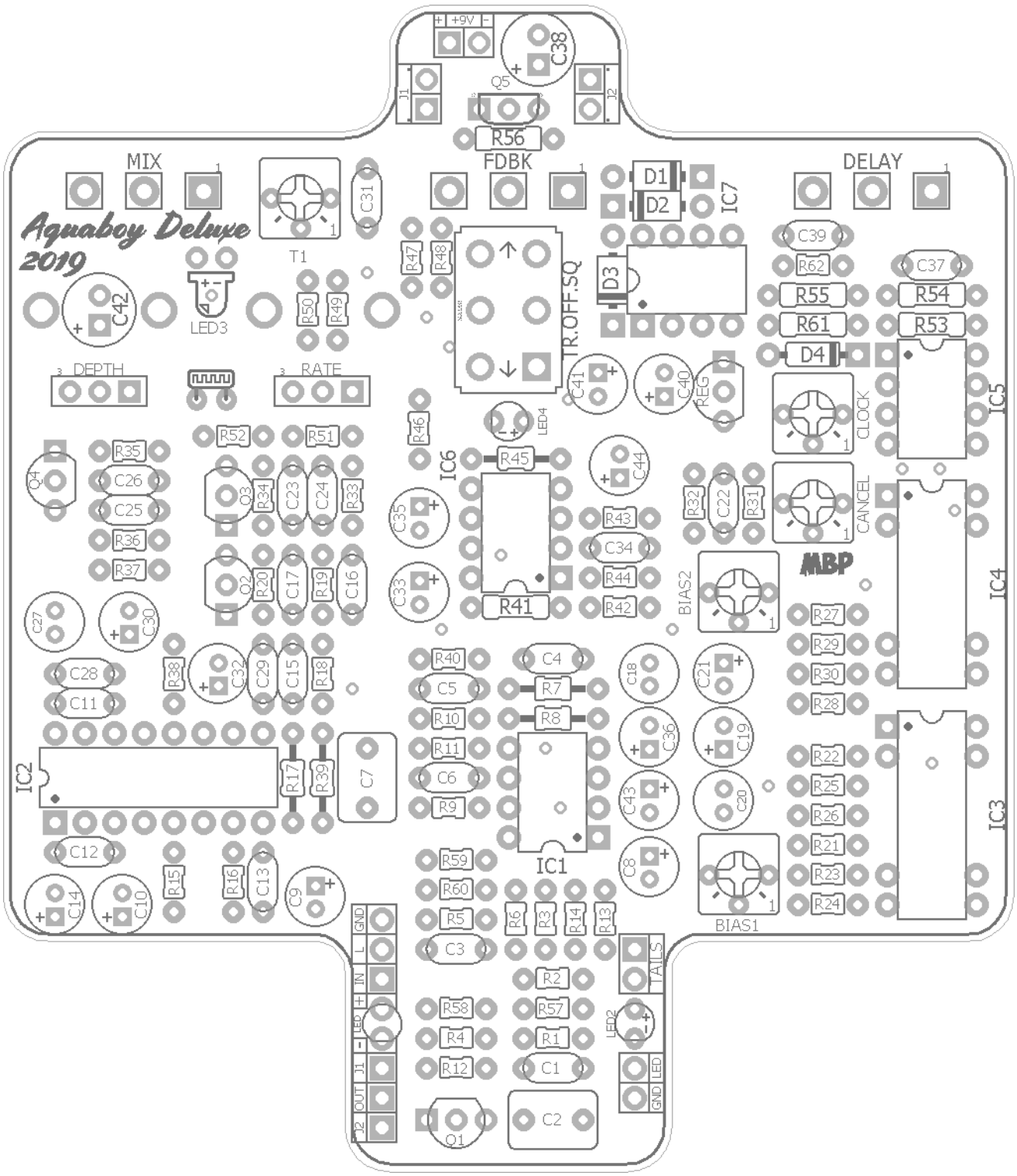
Controls

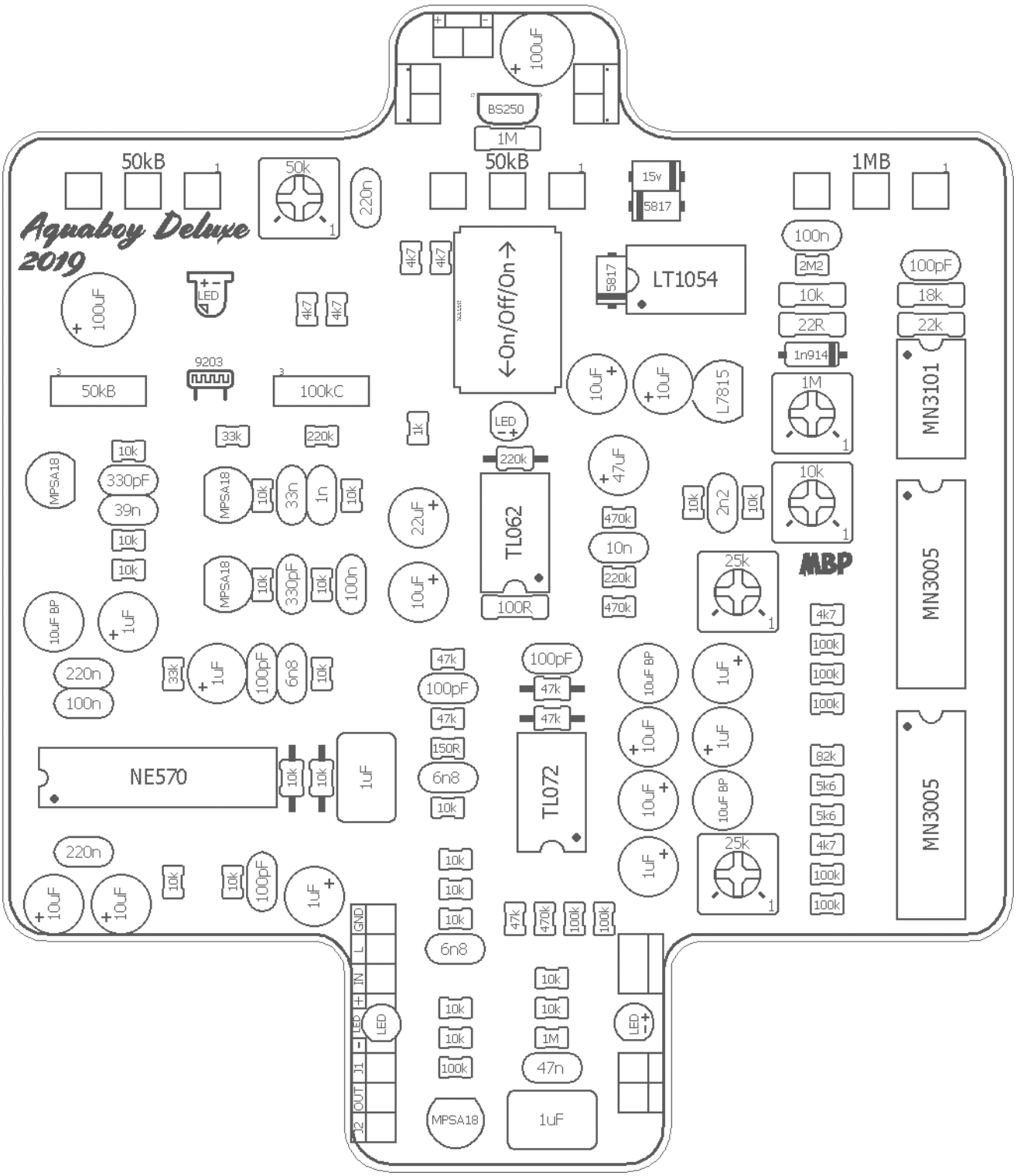
- **DELAY:** The total amount of signal delay from slapback to approximately 500ms.
- **FDBK:** The number and intensity of delay repeats from one to infinity/self oscillation.
- **MIX:** The level of delay signal relative to the dry path of the guitar signal.
- **RATE:** The speed of the delay modulation from slowest to very fast.
- **DEPTH:** The intensity of modulation from moderate to extreme.
- **MOD:** This On/Off/On DPDT allows you to choose between square, none and triangle modulation.

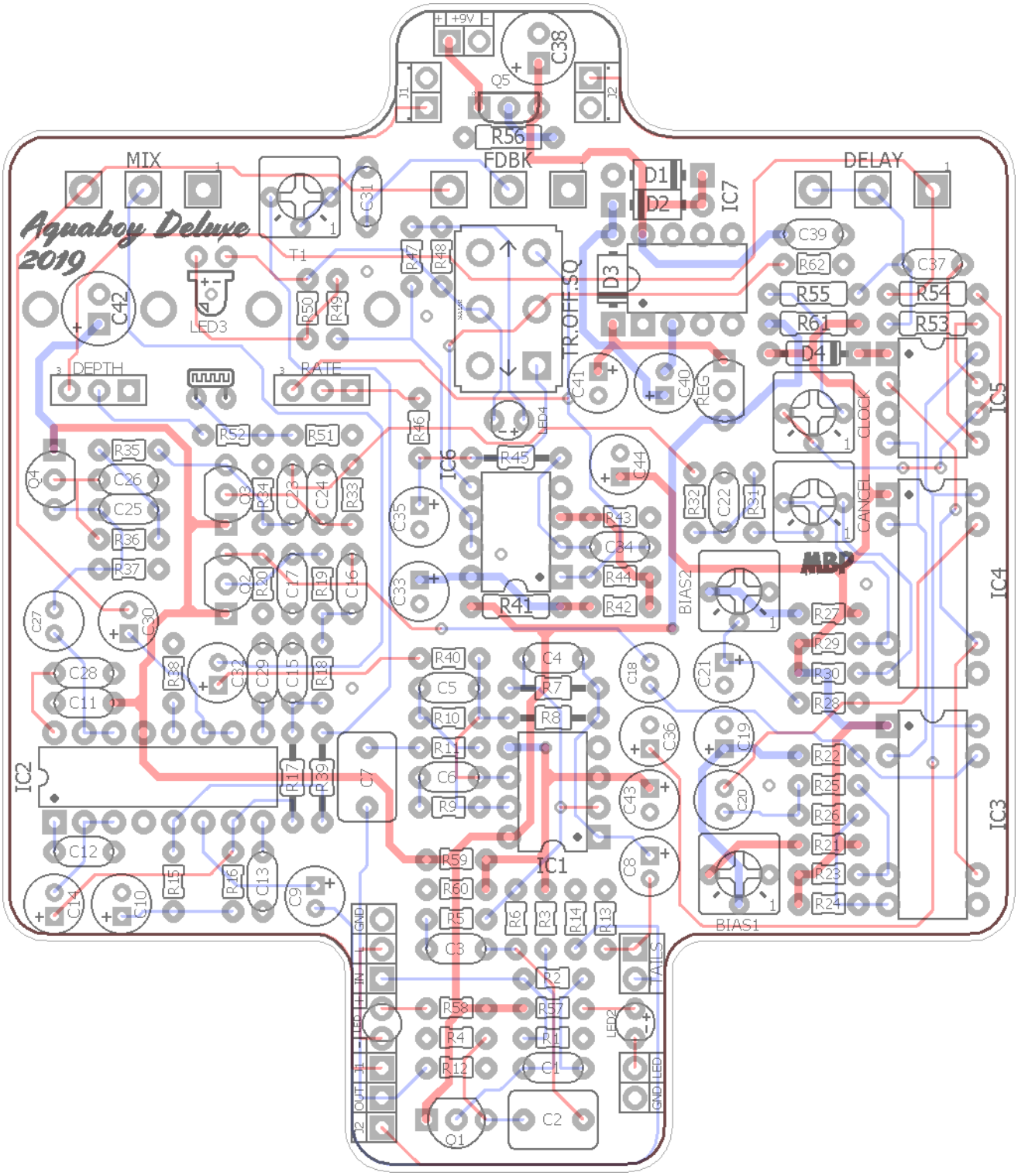
Trimmers

- **T1:** Sets the maximum amount of feedback possible in order to control the total range of the FDBK control.
- **BIAS1, BIAS2:** Used to set the biasing point on the input of each BBD.
- **CANCEL:** Sets the mix of the two outputs on BBD2.
- **CLOCK:** Sets the lower limit of the clock frequency used to drive the BBD chips.

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.


Aquaboy Deluxe
2019
MIX
FDBK
DELAY
DEPTH
RATE
TR.OFF.SQ
CLOCK
CANCEL
REG
BIAS2
BIAS1
MBP
+9V
IC1
IC2
IC3
IC4
IC5
IC6
IC7
T1
LED3
LED4
LED2
TAILS
GND
IN
OUT
LED
J1
J2
Q1
Q2
Q3
Q4
Q5
D1
D2
D3
D4
R56
C38
C42


Aquaboy Deluxe
2019
50kB
50k
220n
50kB
1M
15v
5817
1MB
100uF
BS250
LED
4k7
4k7
←On/Off/On→
5817
LT1054
100n
2M2
10k
22R
1n914
100pF
18k
22k
9203
50kB
100kC
10uF
10uF
L7815
1M
MN3101
33k
220k
1k
LED
220k
47uF
MPSA18
10k
330pF
39n
MPSA18
10k
33n
1n
10k
22uF
TL062
470k
10n
220k
470k
100R
10k
2n2
10k
10k
25k
MBP
MN3005
10uF BP
1uF
MPSA18
10k
330pF
10k
100n
10uF
4k7
100k
100k
100k
220n
100n
33k
1uF
100pF
6n8
10k
47k
100pF
47k
150R
6n8
10k
100pF
47k
47k
10uF BP
10uF
1uF
10uF BP
82k
5k6
5k6
4k7
100k
100k
NE570
10k
10k
1uF
TL072
10uF
1uF
25k
MN3005
220n
10uF
10uF
10k
10k
100pF
1uF
10k
10k
10k
6n8
47k
470k
100k
100k
GND
L
IN
+
LED
-
J1
OUT
J2
LED
10k
10k
1M
47n
10k
10k
10k
100k
MPSA18
1uF
LED


Aquaboy Deluxe
2019
MIX
FDBK
DELAY
DEPTH
RATE
TR.OFF.SQ
CLOCK
CANCEL
BIAS2
BIAS1
REG
MBP
IC1
IC2
IC3
IC4
IC5
IC6
IC7
+9V
GND
TAILS
LED1
LED2
LED3
LED4
D1
D2
D3
D4
Q1
Q2
Q3
Q4
Q5
T1

Resistors		Resistors		Caps		Caps		Regulator	
R1	1M	R32	10k	C1	47n	C32	1uF	REG	L7815
R2	10k	R33	10k	C2	1uF	C33	10uF	Photocell	
R3	470k	R34	10k	C3	6n8	C34	10n	LDR1	9203
R4	10k	R35	10k	C4	100pF	C35	22uF	Swtiches	
R5	10k	R36	10k	C5	100pF	C36	10uF	MOD	On/Off/On
R6	47k	R37	10k	C6	6n8	C37	100pF	TAILS	3PDT
R7	47k	R38	33k	C7	1uF	C38	100uF	BYP	3PDT
R8	47k	R39	10k	C8	1uF	C39	100n	Trimmers	
R9	10k	R40	47k	C9	1uF	C40	10uF	CANCEL	10k
R10	47k	R41	100R	C10	10uF	C41	10uF	BIAS1	25k
R11	150R	R42	470k	C11	100n	C42	100uF	BIAS2	25k
R12	100k	R43	470k	C12	220n	C43	10uF	T1	50k
R13	100k	R44	220k	C13	100pF	C44	47uF	CLOCK	1M
R14	100k	R45	220k	C14	10uF	Diodes		Pots	
R15	10k	R46	1k	C15	6n8	D1	15v Zener	RATE	100kC
R16	10k	R47	4k7	C16	100n	D2	1N5817	DEPTH	50kB
R17	10k	R48	4k7	C17	330pF	D3	1N5817	MIX	50kB
R18	10k	R49	4k7	C18	10uF BP	D4	1n914	FDBK	50kB
R19	10k	R50	4k7	C19	1uF	LED1, 2	any	DELAY	1MB
R20	10k	R51	220k	C20	10uF BP	LED3, 4	RED		
R21	4k7	R52	33k	C21	1uF	Transistors			
R22	82k	R53	22k	C22	2n2	Q1 - Q4	MPSA18		
R23	100k	R54	18k	C23	33n	Q5	BS250		
R24	100k	R55	10k	C24	1n	ICs			
R25	5k6	R56	1M	C25	39n	IC1	TL072		
R26	5k6	R57	10k	C26	330pF	IC2	NE570		
R27	4k7	R58	10k	C27	10uF BP	IC3	MN3005		
R28	100k	R59	10k	C28	220n	IC4	MN3005		
R29	100k	R60	10k	C29	100pF	IC5	MN3101		
R30	100k	R61	22R	C30	1uF	IC6	TL062		
R31	10k	R62	2M2	C31	220n	IC7	LT1054		

Value	QTY	Type	Rating
22R	1	Metal / Carbon Film	1/4W
100R	1	Metal / Carbon Film	1/4W
10k	1	Metal / Carbon Film	1/4W
18k	1	Metal / Carbon Film	1/4W
22k	1	Metal / Carbon Film	1/4W
150R	1	Metal / Carbon Film	1/8W
1k	1	Metal / Carbon Film	1/8W
4k7	6	Metal / Carbon Film	1/8W
5k6	2	Metal / Carbon Film	1/8W
10k	22	Metal / Carbon Film	1/8W
33k	2	Metal / Carbon Film	1/8W
47k	5	Metal / Carbon Film	1/8W
82k	1	Metal / Carbon Film	1/8W
100k	8	Metal / Carbon Film	1/8W
220k	3	Metal / Carbon Film	1/8W
470k	3	Metal / Carbon Film	1/8W
1M	2	Metal / Carbon Film	1/8W
2M2	1	Metal / Carbon Film	1/8W
100pF	5	Ceramic / MLCC	25v min.
330pF	2	Ceramic / MLCC	25v min.
1n	1	Film	25v min.
2n2	1	Film	25v min.
6n8	3	Film	25v min.
10n	1	Film	25v min.
33n	1	Film	25v min.
39n	1	Film	25v min.
47n	1	Film	25v min.
100n	3	Film	25v min.
220n	3	Film	25v min.
1uF	2	Film	25v min.

Value	QTY	Type	Rating
10uF BP	3	Electrolytic, Bi-Polar	25v min.
1uF	6	Electrolytic	25v min.
10uF	7	Electrolytic	25v min.
22uF	1	Electrolytic	25v min.
47uF	1	Electrolytic	25v min.
100uF	2	Electrolytic	25v min.
15v Zener	1		
1N5817	2		
1n914	1		
LED	2	any - for bypass switches	3 or 5mm
LED	2	Red, Diffused	3 or 5mm
MPSA18	4		
BS250p	1		
TL072	1		
NE570	1		
MN3005	2		
MN3101	1		
TL062	1		
LT1054	1		
L7815	1	15v regulator, T0-92 style	
9203	1		
DPDT	1	On/Off/On, Pin Mount	
3PDT	2	Solder Lug	
10k	1	Bourns 3362p	
25k	2	Bourns 3362p	
50k	1	Bourns 3362p	
1M	1	Bourns 3362p	
100kC	1	PCB Mount, Plastic Shaft	9mm
50kB	1	PCB Mount, Plastic Shaft	9mm
50kB	2	PCB Mount	16mm
1MB	1	PCB Mount	16mm

10uF BP:
https://www.mouser.com/ProductDetail/Panasonic/ECE-A1EN100U?qs=sGAEpiMZZMtZ1n0r9vR22ZGaUol0JcRfXPh%2FzavJdWI%3D

15v Zener:
https://www.mouser.com/Search/Refine?Keyword=512-1N4744A

MPSA18:
https://www.mouser.com/ProductDetail/Central-Semiconductor/MPSA18?qs=sGAEpiMZZMshyDBzk1%2FWiw99kSkYzPxmglTcpIOZtXI%3D

BS250p:
https://www.mouser.com/ProductDetail/Diodes-Incorporated/BS250P?qs=%2Fha2pyFaduhUNPEB3rTpwbpDH35b3gpFVXgc39Dgjmg%3D

v571 (sub for NE570):
http://smallbear-electronics.mybigcommerce.com/ic-v571d/

MN3005 (currently out of stock):
http://smallbear-electronics.mybigcommerce.com/mn3005-re-makes-xvive-audio/

MN3101:
http://smallbear-electronics.mybigcommerce.com/ic-mn3101/

LT1054:
https://www.mouser.com/ProductDetail/Texas-Instruments/LT1054IP?qs=sGAEpiMZZMtitjHzVIkrqfSWpcWTPe%252BSNc10CtLc4Cw%3D

L7815:
https://www.mouser.com/ProductDetail/STMicroelectronics/L78L15ACZ?qs=sGAEpiMZZMtUqDgmOWBjgLAmId5B%2FjmHe8yhWKd8M1Y%3D

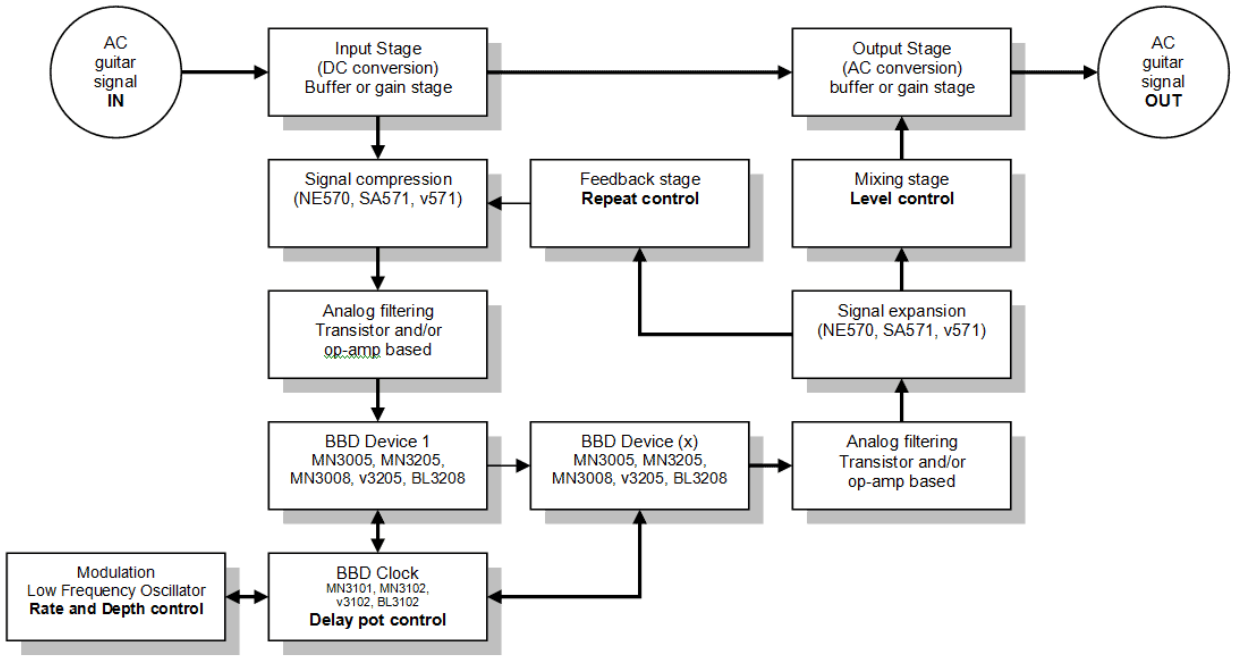
9203:
http://smallbear-electronics.mybigcommerce.com/photocells-cds-5mm-diameter/

DPDT (On/Off/On):
http://smallbear-electronics.mybigcommerce.com/dpdt-center-off-pc-mount/

Bourns 3362p (10k, 25k, 50k, 1M):
https://www.mouser.com/ProductDetail/Bourns/3362P-1-103LF?qs=sGAEpiMZZMvygUB3GLcD7k%252Bod3ZqvEIQboRRPdOKB6M%3D
https://www.mouser.com/ProductDetail/Bourns/3362P-1-253LF?qs=sGAEpiMZZMvygUB3GLcD7vRbQqL9uMLMqIpepdvyyRc%3D
https://www.mouser.com/ProductDetail/Bourns/3362P-1-503LF?qs=sGAEpiMZZMvygUB3GLcD7vRbQqL9uMLMZgtO2Ks3Q%2F4%3D
https://www.mouser.com/ProductDetail/Bourns/3362P-1-105LF?qs=sGAEpiMZZMvygUB3GLcD7kddhVJPyV2kST8Lo8Gl%252B%2F8%3D

9mm pots (100kC, 50kB):
http://smallbear-electronics.mybigcommerce.com/alpha-single-gang-9mm-right-angle-pc-mount-w-knurled-plastic-shaft/

16mm Pots (50kB, 1MB):
http://smallbear-electronics.mybigcommerce.com/alpha-single-gang-16mm-right-angle-pc-mount/



The BBD is made up of hundreds or thousands of tiny mosfet transistors (called steps) that delay the input signal via capacitive charging (each step may also be referred to as a clock cycle). The more steps in the device the longer the signal can be delayed. This delay is measured in milliseconds.

The clock outputs a continuous square wave at a specific frequency. This frequency instructs the BBD as to the rate at which its steps “catch and release” the signal. The clock (which actually outputs two frequencies 180° out of phase) can also be altered over a range to change the rate at which the BBD processes the signal. It is this range that changes the delay signal from short to long.

This type of design has two major caveats: the clock generally operates on a frequency that is within the human range of hearing and the signal processing of the delay degrades the input signal continuously. The lower the clock frequency, the more delay you get, but the further it creeps into the audio range.

Analog delays attempt to optimize the balance between signal degradation and clock bleed by a series of additional signal processing chains. These are compression, filtering and expansion. The compressor portion “beefs up” the incoming signal to minimize its degradation while traversing the BBD. The filtering removes some of the high end content so that the clock does not bleed into it (which would create a high pitch whine). Finally the expandor portion “de-compresses” the processed signal and gets it ready for the output mixer.

This entire process is also responsible for creating the “magic” and “mojo” of the analog delay. That magic is warmth. The continuous filtering of the guitar signal removes more and more high end frequencies with each repeat which the ear perceives as warmth in the resulting guitar signal. This is why people like analog delays so much---they create a very pleasing “bed of sound” that is neither too piercing nor distracting. Each analog repeat fits neatly under the preceding one to create a very natural and musical sound.

Changes to the 2019 version circuit

- 15v operation: The entire circuit now runs of 15v regulated from a standard 9v 100mA power supply. A well-regulated supply is still the preferred option for lowest noise.
- Charge Pump: The charge pump bumps up the 9v supply to 18v then regulates it to 15v for the effect. It uses a T0-92 regulator which turns out to be plenty enough for the current requirements.
- True-Bypass and Tails foot-switches: The bypass is the standard effect input ground switching used on all mbp projects. The Tails switch allows you to toggle the delay on and off when the pedal is on. So, if you like your delay repeats to spill over when you turn them off, simply leave the pedal on all the time and use the Tails switch to control the actual delays. When the pedal itself is off, the Tails switch does nothing audible.

Nerd Notes

Even though the circuit is running at 15v, I decided to leave the output voltage of the compressor portion at the standard 3v as used on the DM-2. If you built older versions of the ABDX, you may remember I suggested that if you wanted to run it at higher than 9v to change the voltage divider resistors (here R15 and R16) to a larger value to increase the voltage output (pin7) of the compressor (the idea being that a larger voltage there would increase headroom and also the bias voltage of the pre-emphasis filter that follows).

After doing some more listening tests on the 2019 version, I ended up preferring the lower headroom you get from the stock 10k resistors. To my ears, the higher voltage you get from an output voltage of 5v or more ends up making the repeats too percussive and they have a tendency to sound more “dithered” after 6 or 7 repeats. I did compensate for this in the expander portion of the compander by including the 33k resistor on pin12 (R38). This bumps the output of the compander up about one extra volt. This seemed to have no negative effect on the repeats.

If you want to tinker, then I suggest socketing R15, R16 and maybe even R38. Higher values for R15 and 16 will increase the output at pin7 of IC2. Lower values of R38 increase the voltage output at pins 10 and 11 (at low values it may stop operating).

You can use this chart I made that shows the relationship b/w compressor output and the value of R15 and R16.

Compander	
Bias Vol	R (kOhm)
3	10.0
4	18.3
5	26.7
5.5	30.8
6	35.0
6.5	39.2
7	43.3
7.5	47.5
8	51.7
8.5	55.8
9	60.0
9.5	64.2
10	68.3

Calibration

Before starting, remove IC4. This is necessary to start the biasing process. Set the controls as shown.

- DELAY, MIX controls to their center position.
- FDBK at about 1/3 up.
- RATE and DEPTH controls all the way down.
- MOD switch to the center (off) position.
- BIAS1, BIAS2 and Cancel trimpots to their center position.
- T1 full CCW.
- If you have frequency measurement on your DMM, adjust the Clock trimmer to about 6.5kHz while probing either pin2 or pin4 of IC5. If you don't have this feature set the Clock trim half-way up.

---

1. Audio probe pin7 of IC3 to confirm you have signal reaching the BBD. It is normal for this signla to be loud and even somewhat distorted. You may hear clock noise, as well. If you have no signal at pin7 you need to work your way back through the circuit to find out what went wrong (start at pin7 of IC2).

2. Audio probe pin3 or 4 of IC3 while either strumming the guitar or send some audio through the input of the effect (a looper, etc). Adjust the BIAS1 trimmer until you get delay passing. The area over which the trimmer will result in delay is usually about 1/4 of its range. Continue refining the position of BIAS1 until you get the lowest amount of distortion on the delay signal.

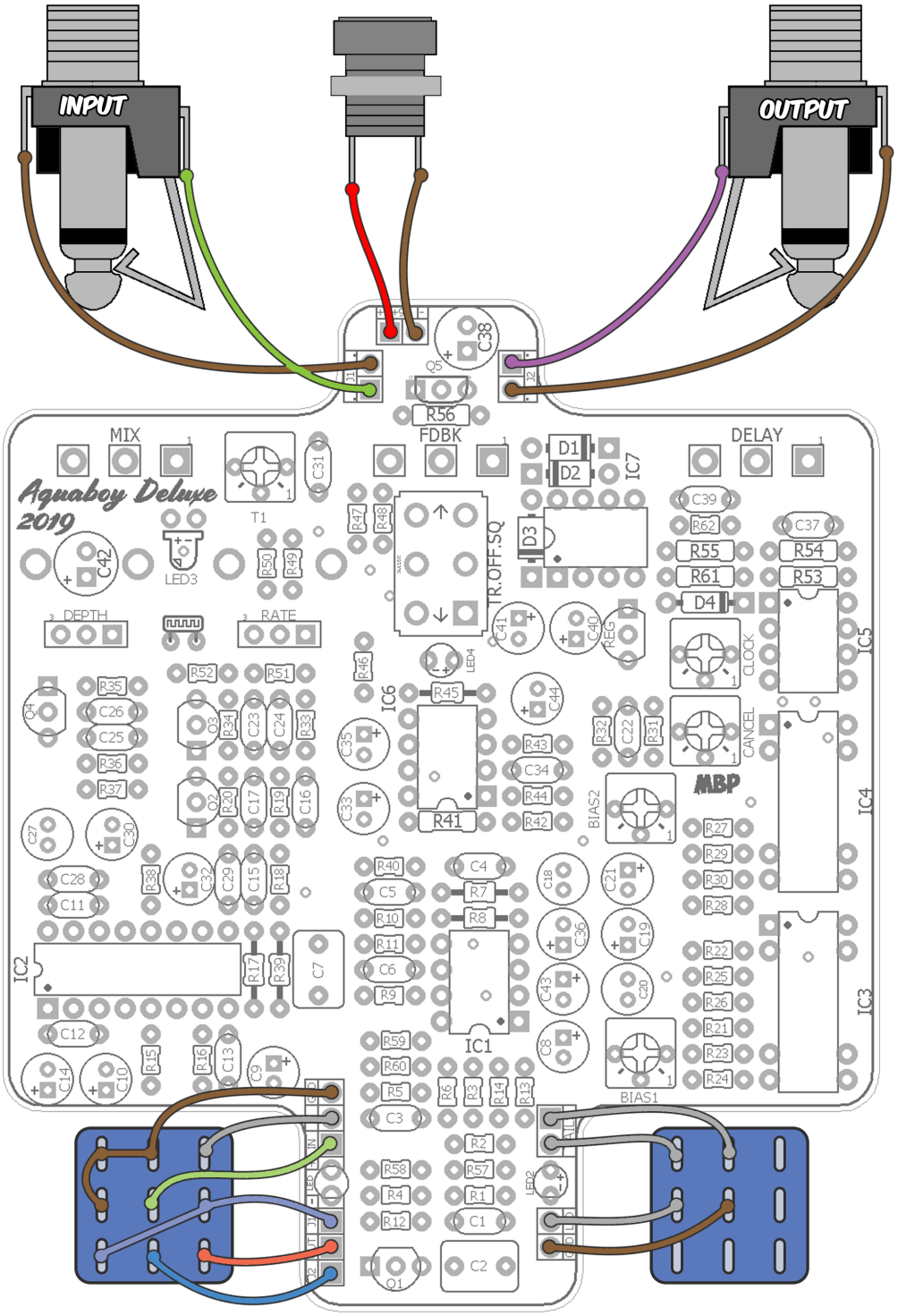
3. Now probe pin4 of IC3 to confirm it is also passing delay. If it does not, make sure that you have clock frequency on both pins 2 and 6.

4. Unplug power and replace IC4. Repeat the same procedure above by audio probing pin3 of IC4 and adjusting BIAS2 for the lowest amount of distortion on the repeats. Confirm that pin4 is also passing delay.

5. Set the Delay pot to Max. Now finely adjust the CLOCK trimmer until just before you hear any high pitch whine in the audio path. This is the maximum delay setting. The clock frequency should land somewhere around mid-6kHz. Leave the Cancel trim in the center position.

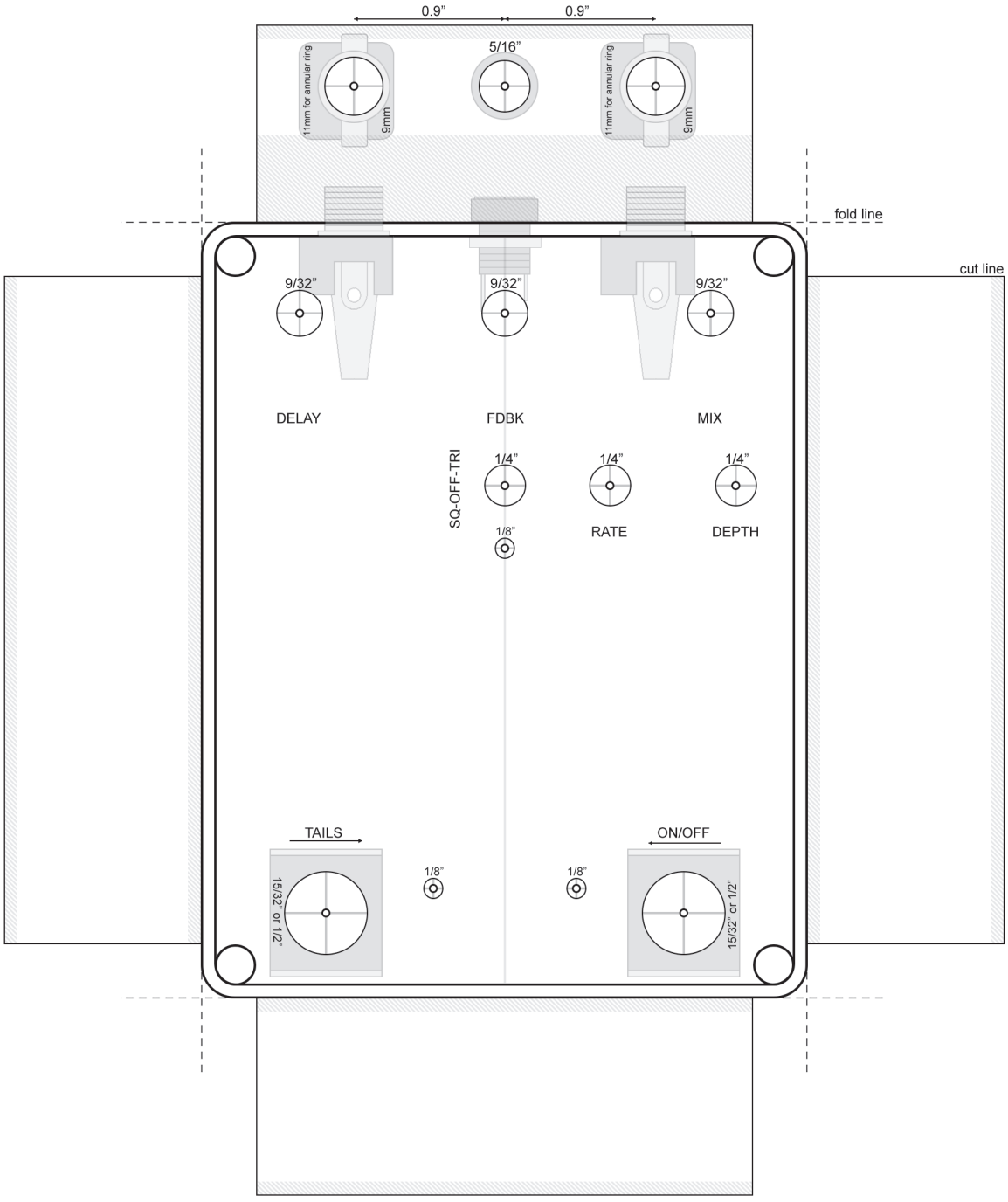
6. T1 fully CCW is the lowest volume/# of repeats you can get with FDBK fully up. At about 3/4 up, T1 is the stock setting of the DM-2. I suggest setting FDBK about 90% of the way up and then adjust T1 until it just starts to go into self-oscillation. That should give you plenty of repeats on the control with the possibility of going into oscillation if that's your thing.

If you do have a scope, you can use it instead of an audio probe to make the proper adjustments to BIAS1, BIAS2, Clock and the Cancel trimpots. When using a scope, set the Cancel trimpot so that the two output waveforms from pins 3 and 4 of IC4 converge.



The LED indicators for the two bypass switches as well as LED4 (modulation rate indicator) should be soldered directly to the PCB.

Note: *Drill Guides are approximate and may require tweaking depending on the types of jacks, switches and pots you use.*



A 125BB enclosure is the same foot-print but taller than the 1590BB shown here. If you like more room to work with, use this template with the 125BB and just move the top jacks up accordingly. It gives you the advantage of moving the input jack further away from the delay clock, too.

IC1	TL072
1	7.5
2	7.5
3	7.49
4	0
5	7.49
6	7.5
7	7.5
8	14.97

IC2	NE570
1	1.08
2	1.77
3	1.77
4	0
5	1.77
6	1.77
7	2.98
8	1.77
9	1.77
10	3.98
11	3.99
12	1.77
13	14.97
14	1.77
15	1.77
16	0.96

IC3	MN3005
1	14.88
2	7.11
3	6.38
4	6.38
5	0
6	7.04
7	6.5
8	0.97

IC4	MN3005
1	17.88
2	7.12
3	5.88
4	5.85
5	0
6	7.12
7	6.19
8	0.96

IC5	MN3101
1	14.24
2	7.12
3	0
4	7.12
5	6.64
6	7.35
7	6.88
8	0.96

IC6	TL062
1	varies
2	varies
3	varies
4	0
5	200mV
6	0.63
7	0.63
8	14.9

IC7	LT1054
1	1.63
2	5
3	0
4	0
5	0
6	2.54
7	1.39
8	9.26

Q1	MPSA18
C	17.97
B	6.9
E	6.6

Q2	MPSA18
C	14.97
B	2.97
E	2.39

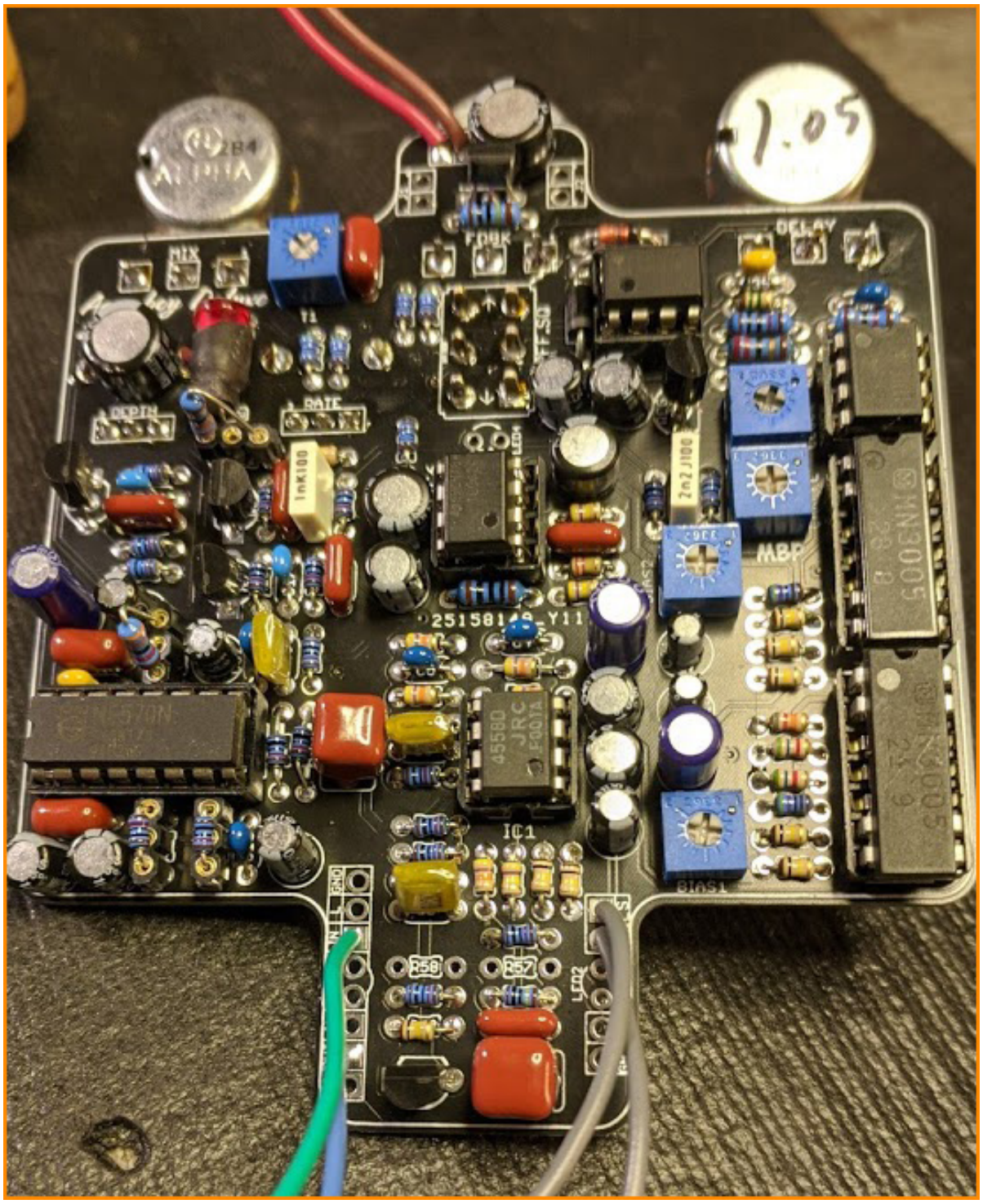
Q3	MPSA18
C	14.97
B	5.84
E	5.26

Q4	MPSA18
C	14.97
B	5.23
E	4.66

Q5	BS250p
D	9.42
G	ignore
S	9.26

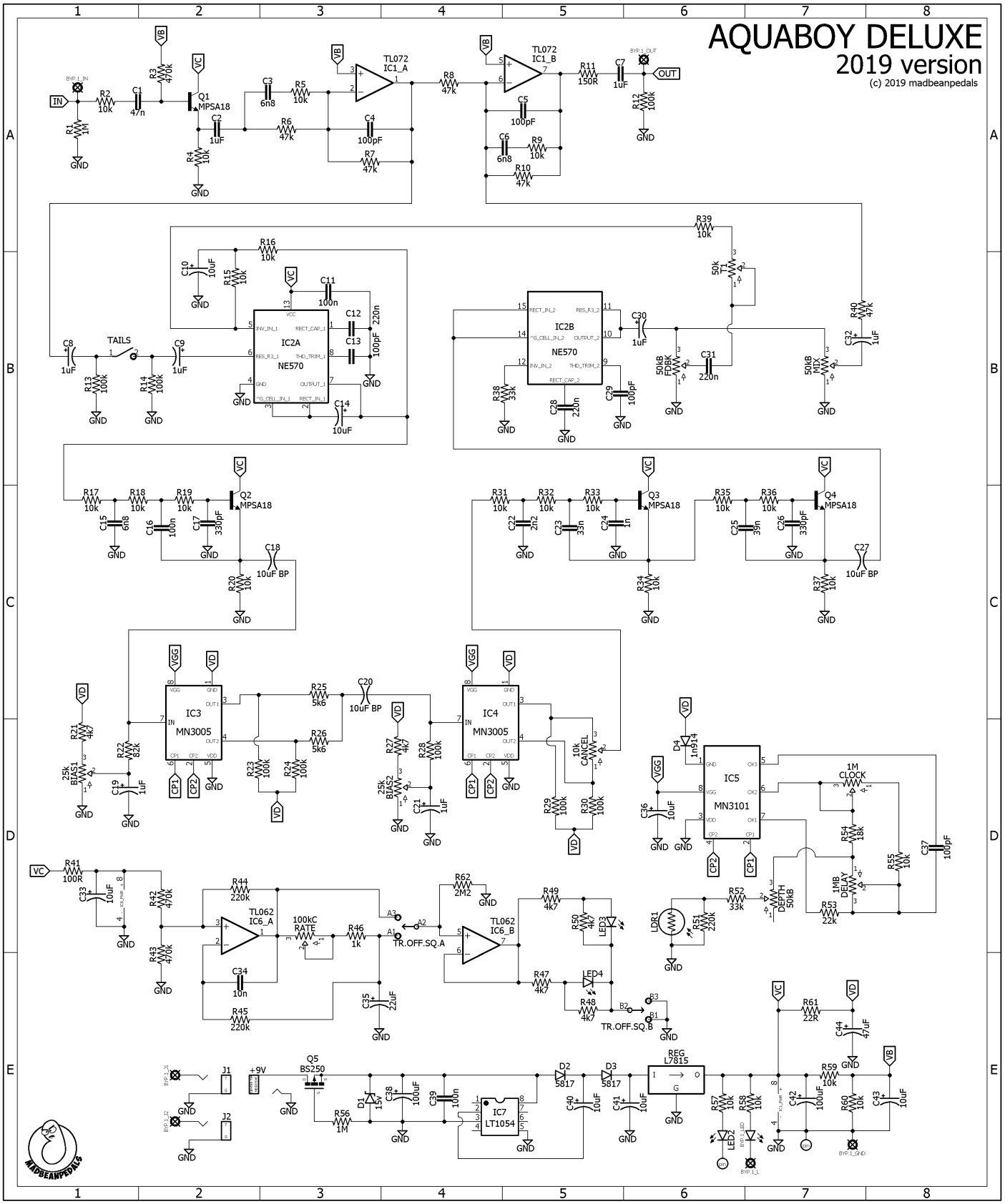
REG	L7815
I	17.55
G	0
O	14.97

- 9.42v One spot
- Current Draw: ~38mA
- Measurements taken with modulation switch set to Off.



It’s a good idea to put some heat-shrink (or other light blocking material) over your LED/LDR combo. At least while testing it before boxing!

Tip: Use an MLCC or Mica 100pF for C37 and a Delay pot that measures as close to 1M as possible. These will give you the best delay time.


AQUABOY DELUXE
2019 version
(c) 2019 madbeanpedals
IN
OUT
TL072
IC1_A
TL072
IC1_B
MPSA18
NE570
IC2A
IC2B
TAILS
MN3005
IC3
IC4
MN3101
IC5
TL062
IC6_A
IC6_B
LT1054
IC7
BS250
L7815
1n914
LED1
LED2
LED3
LED4
LDR1
TR.OFF.SQ.A
TR.OFF.SQ.B
100kC
RATE
1M
CLOCK
1MB
DELAY
50kB
DEPTH
10k
CANCEL
50kB
PDBK
50kB
MIX
+9V
GND
VC
VD
VB
VGG