

# AQUABOY

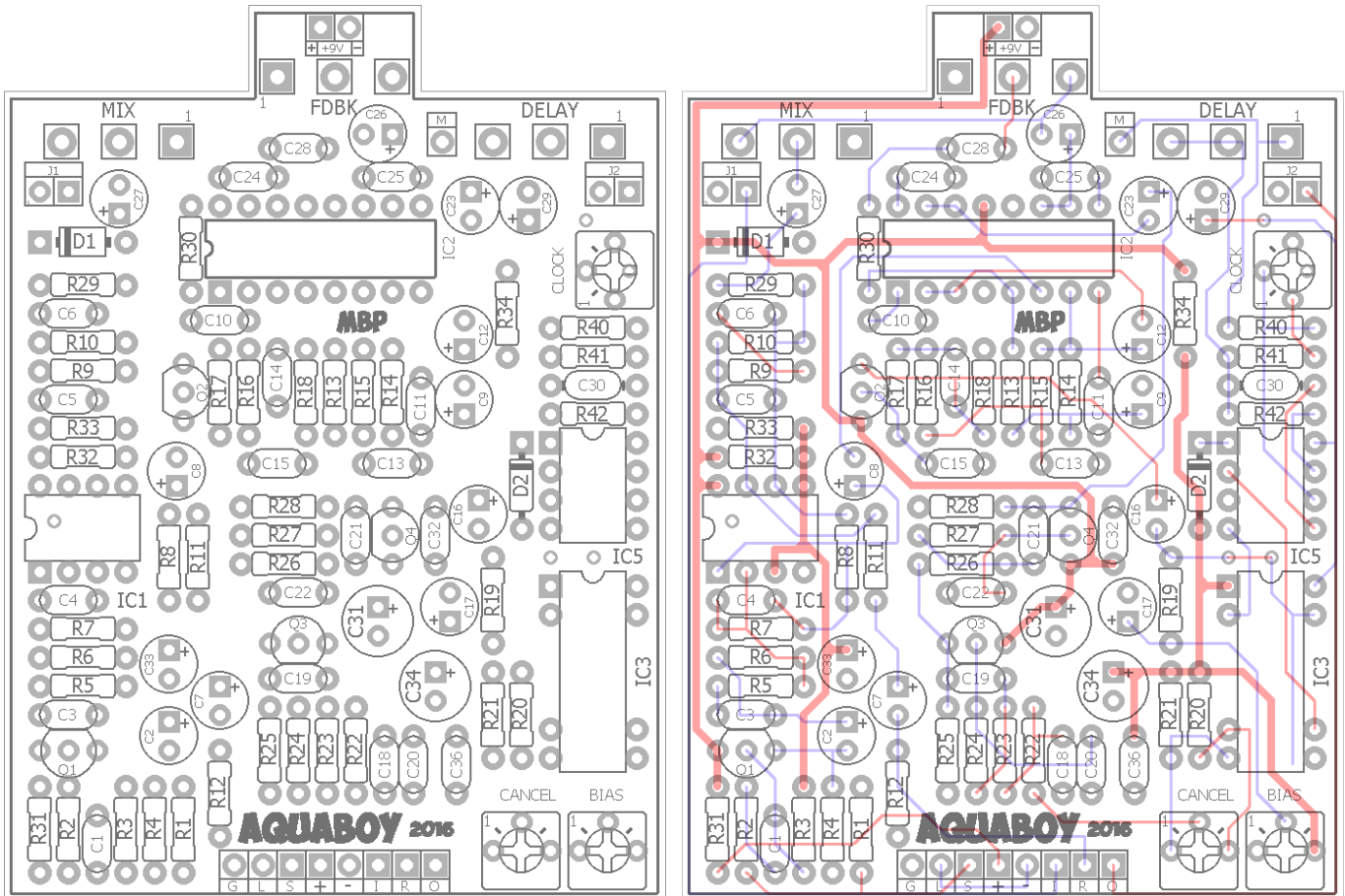
FX TYPE: Delay

Based on the Boss® DM-2™

© 2016 madbeanpedals

2.3" W x 3.125" H

1.29.17 – Correction – see page 6.



Note: the "M" pad by the Delay pot is for modulation control (see the AB\_MOD documentation for more info).

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

Resistors		Resistors		B.O.M. Caps		Caps		Diodes	
R1	1M	R22	10k	C1	47n	C22	330pF	D1	1N4001
R2	10k	R23	10k	C2	1uF	C23	1uF	D2	1n914
R3	470k	R24	10k	C3	6n8	C24	220n	<b>Transistors</b>	
R4	10k	R25	10k	C4	100pF	C25	100pF	Q1 - Q4	MPSA18
R5	10k	R26	10k	C5	100pF	C26	1uF	<b>IC's</b>	
R6	47k	R27	10k	C6	6n8	C27	1uF	IC1	4558
R7	47k	R28	10k	C7	1uF	C28	100n	IC2	NE570
R8	47k	R29	47k	C8	10uF	C29	1uF	IC3	MN3005
R9	10k	R30	22k	C9	10uF	C30	100pF	IC5	MN3101
R10	47k	R31	4k7	C10	220n	C31	100uF	<b>Trimmers</b>	
R11	470R	R32	10k	C11	100pF	C32	100n	BIAS	22k
R12	100k	R33	10k	C12	10uF	C33	10uF	CANCEL	10k
R13	10k	R34	22R	C13	6n8	C34	100uF	CLOCK	1M
R14	10k	R40	18k	C14	82n	C36	100n	<b>Pots</b>	
R15	10k	R41	10k	C15	330pF			DELAY	1MB
R16	10k	R42	22k	C16	1uF			FDBK	50kB
R17	10k			C17	1uF			MIX	50kB
R18	10k			C18	2n2				
R19	100k			C19	33n				
R20	100k			C20	1n				
R21	100k			C21	39n				

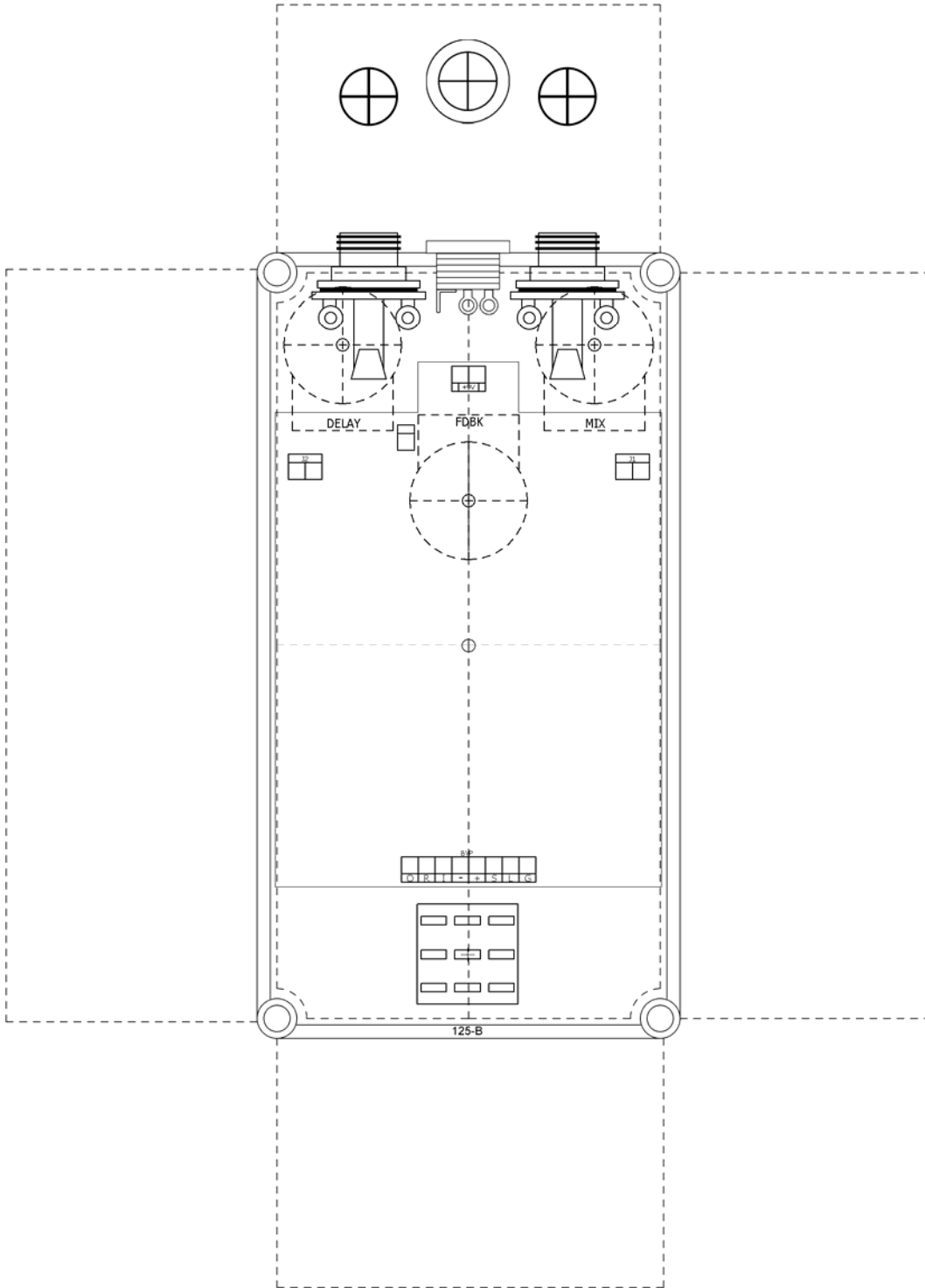
*Note: Some of the component names have gaps (ex. No R35-R39, no IC4) due to me being a dumb-ass.*

Shopping List			
Value	QTY	Type	Rating
22R	1	Metal / Carbon Film	1/4W
470R	1	Metal / Carbon Film	1/4W
4k7	1	Metal / Carbon Film	1/4W
10k	20	Metal / Carbon Film	1/4W
18k	1	Metal / Carbon Film	1/4W
22k	2	Metal / Carbon Film	1/4W
47k	5	Metal / Carbon Film	1/4W
100k	4	Metal / Carbon Film	1/4W
470k	1	Metal / Carbon Film	1/4W
1M	1	Metal / Carbon Film	1/4W
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.
33n	1	Film	25v min.
39n	1	Film	25v min.
47n	1	Film	25v min.
82n	1	Film	25v min.
100n	3	Film	25v min.
220n	2	Film	25v min.
1uF	8	Electrolytic	25v min.
10uF	4	Electrolytic	25v min.
100uF	2	Electrolytic	25v min.
1N4001	1		
1n914	1		
MPSA18	4	or, similar BJT NPN	
4558	1		
NE570	1		
MN3005	1		
MN3101	1		
22k	1	Bourns 3362P	
10k	1	Bourns 3362P	
1M	1	Bourns 3362P	
1MB	1	PCB Right Angle	16mm
50kB	2	PCB Right Angle	16mm

- You can use either 20k or 25k for the trimmer if you cannot get a 22k.
- You can use either NOS MN3005 (if you have one) or the new Xvive reproduction MN3005. No, I do not know where you can buy genuine NOS MN3005...sorry!
- Xvive MN3005: <http://smallbear-electronics.mybigcommerce.com/mn3005-re-makes-xvive-audio/>
- MN3101: <http://smallbear-electronics.mybigcommerce.com/ic-mn3101/>
- Using a silver mica or MLCC type cap for C30 (100pF) will produce optimal results.

# 125B Drill Guide

5.52"W x 7.65"H

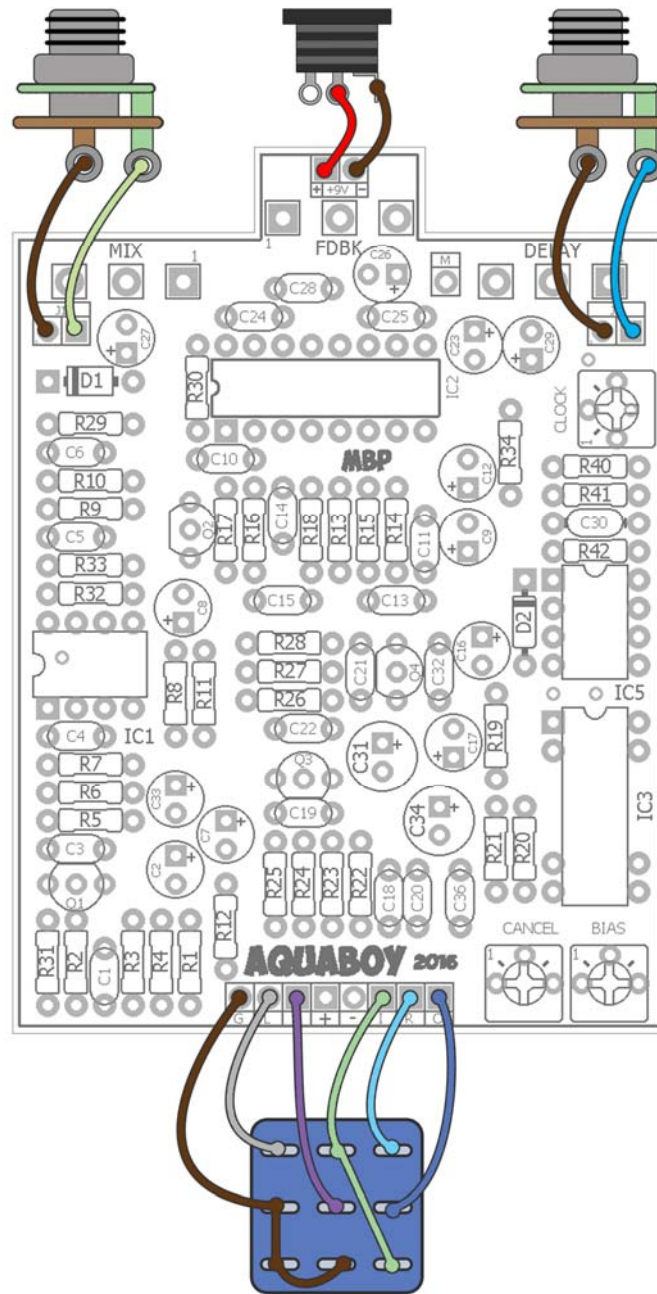


*Note: If using the add-on modulation PCB, use the template in that project doc.*

Photoshop Drill Template:

[http://www.madbeanpedals.com/projects/Aquaboy/Aquaboy\\_DRILL.zip](http://www.madbeanpedals.com/projects/Aquaboy/Aquaboy_DRILL.zip)

## Wiring



*The bypass LED can be soldered directly to the PCB*

**01.29.17** - C16 is actually backwards on the board. The "+" side should point toward IC3 pin7. **So, please reverse C16 on the Aquaboy 2016 build.** Obviously, it will work the wrong way around, but we should change that to ensure the cap doesn't fail in the long run.

## Overview

The Aquaboy was one of the first PCB projects offered commercially by madbeanpedals way back in 2009. Originally it focused on being a clone of the Way Huge® Aqua-Puss™ then later was expanded to a "deluxe" version with two BBD and on-board modulation. The 2016 version goes back to the circuit roots, which is the Boss® DM-2™. This Aquaboy is a straight-forward clone of the MN3005 version of the DM-2™ and its focus is to offer a simple and easy to build analog delay that will suit different levels of DIY'ers. However, this is not a project for the complete novice since it does require some calibration in order to work correctly. I suggest having a minimum of 5 or 6 pedal builds under your belt before attempting the Aquaboy.

## Controls

**MIX** – The ratio of delay vs. clean signal.

**FDBK** – The number of delay repeats. Maximum FDBK setting will induce self-oscillation.

**Delay** – Delay time from slap-back to about 300ms.

**Bias** – Used to set the proper bias on the input of the MN3005 for it to produce clean delay.

**Cancel** – Sets the mix of the two delay outputs on the MN3005.

**Clock** – Sets the correct clock frequency range produced by the MN3101 to drive the BBD delay lines in the MN3005

## Calibration

Make the following adjustments before beginning:

Mix control at center.

Delay at max position.

FDBK at about 1/3 up.

BIAS and Cancel trimpots to their center position.

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 (note: this is when using a 9v supply).

- Audio probe pin3 of IC3 while either strumming the guitar or send some audio through the input of the circuit. Adjust the BIAS trimmer until you get delay passing. The range over which the trimmer will result in delay is usually about 1/4 to 1/6 of its entire rotation. Continue refining the position of BIAS until you get the *smallest* amount of distortion on the delay signal. 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.
- 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 between 6 and 7 kHz.
- Unless you are using an oscilloscope to calibrate the delay, leave the Cancel trim in the center position.

## Mods

- You can add modulation control to the Aquaboy via the AB\_MOD board. Please reference that project documentation for more information.

- To build the original Way Huge® Aquapuss™ on the Aquaboy board

Add a 470pF cap in parallel with R1

Make R6, R7, R8 and R10 47.5k instead of 47k

C14 100n instead of 82n

C2, C16, C23 and C7 10uF instead of 1uF

## Voltages

One Spot: 9.42vDC  
Clock Frequency: 6.44kHz at max Delay setting

IC1	4558	IC2	NE570	IC3	MN3005	IC5	MN3101
1	4.7	1	0.92	1	9.37	1	8.76
2	4.7	2	1.84	2	4.39	2	4.39
3	4.7	3	1.84	3	4.69	3	0
4	0	4	0	4	4.68	4	4.39
5	4.7	5	1.84	5	0	5	3.88
6	4.7	6	1.83	6	4.38	6	4.72
7	4.7	7	3.03	7	4.27	7	4.25
8	9.41	8	1.84	8	0.59	8	0.59
		9	1.84				
		10	3.1				
		11	3.1				
		12	1.84				
		13	9.41				
		14	1.84				
		15	1.84				
		16	0.9				

Clock frequency depends on where the Clock trim is set.  
IC3 pin7 depends on where the Bias trim is set.

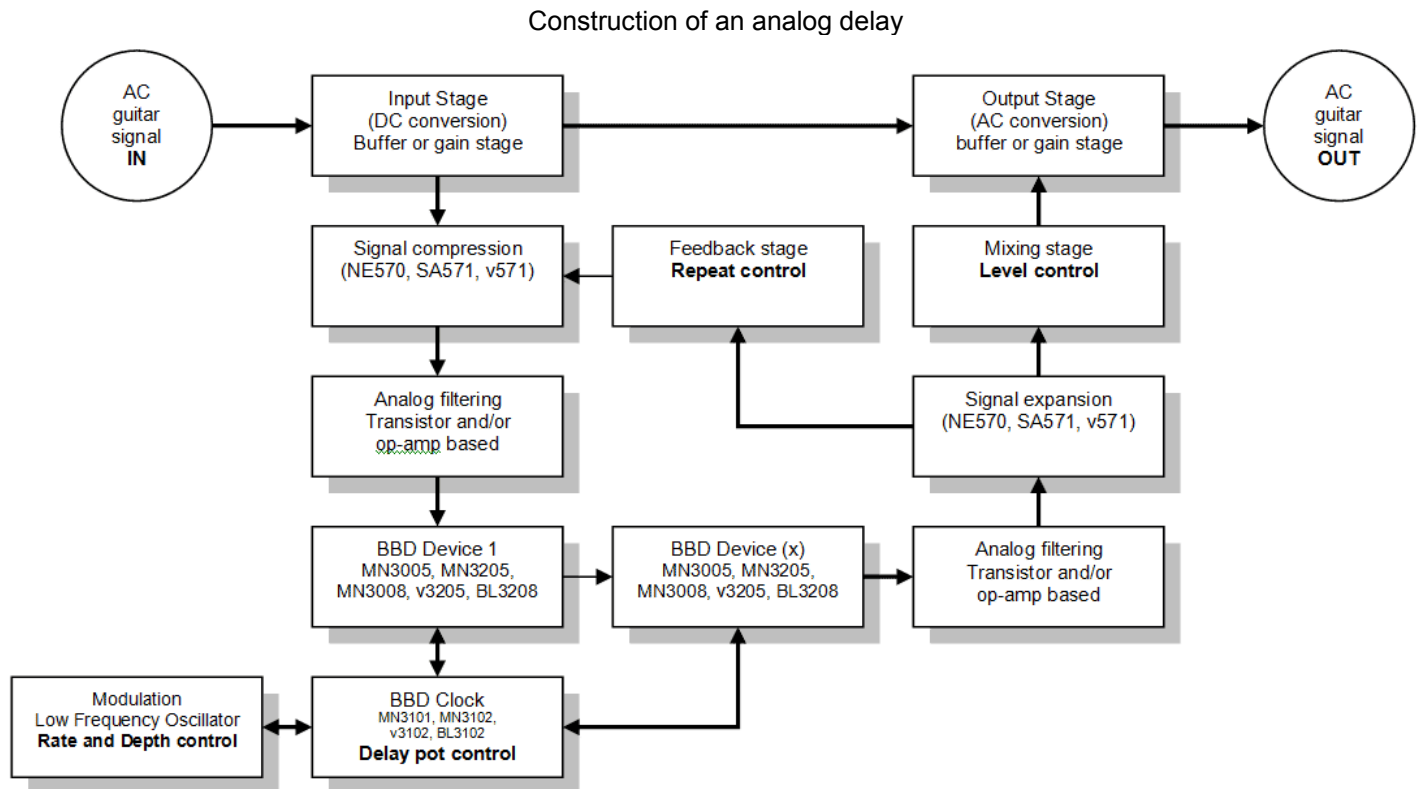
## 15v operation

Higher supply voltage means more headroom in the signal path which many guitar players like and the Aquaboy sounds very good at 15v. You will need to **change R13 and R14 to 36k** to increase the bias output from the compressor. The biasing procedure will be the same, although the clock frequency range will change a bit. The FDBK control may go into self-oscillation at an earlier point at 15v operation, so you should socket R30 and increase its value to get the response you want.

Important: **if you run the Aquaboy at 15v it needs to be regulated!** Use a Road Rage, 3PRR, or similar charge pump with a regulator. Feeding more than 15v to the MN3005 could result in damage. One important consideration here is using a charge pump introduces a second clock into the circuit and this can result in heterodyne (clock noise). If using a charge pump I suggest you test your build carefully beforehand to ensure you get a good result.

## Notes

This information is copied from the older ABDX project, but still gives a good explanation to the fundamental principles of the circuit design.



### **All analog delays have two essential ingredients: the bucket brigade device and the clock**

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.

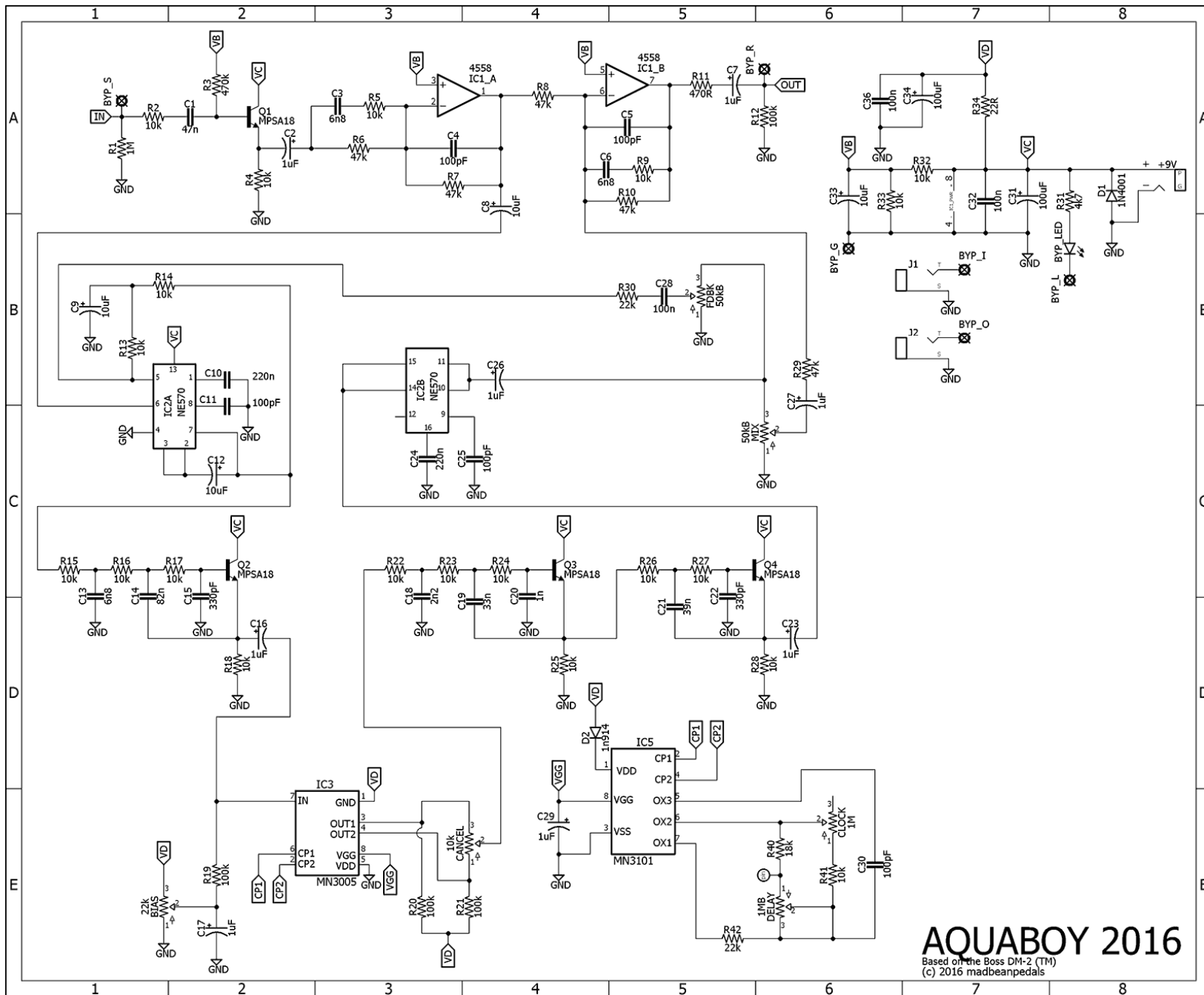
The clock outputs a continuous square wave at a specific frequency. This frequency instructs the BBD as to the rate at which its steps “catch and release” the signal. The clock (which actually outputs two frequencies 180° out of phase) can also be altered over a range to change the rate at which the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





**AQUABOY 2016**  
 Based on the Boss DM-2 (TM)  
 (c) 2016 madbeanpedals