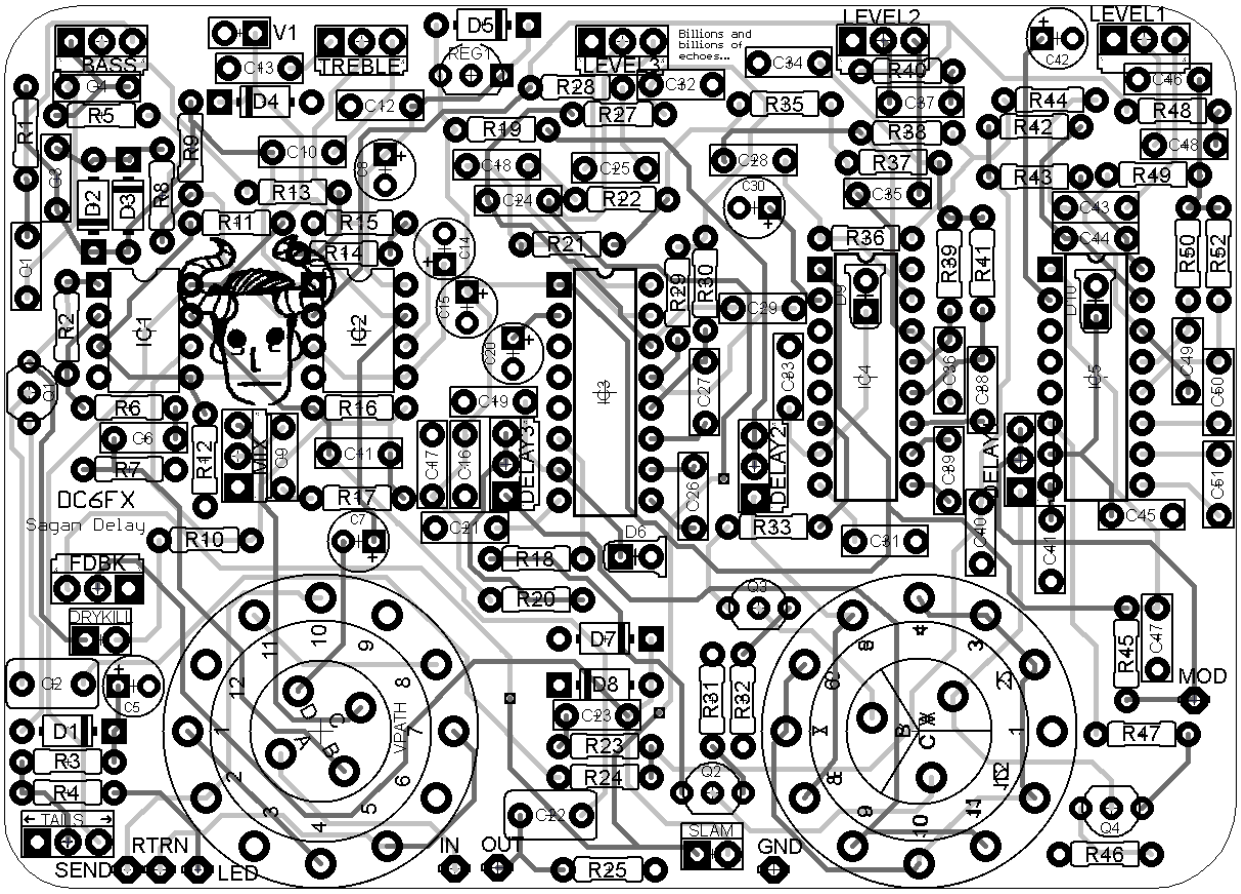
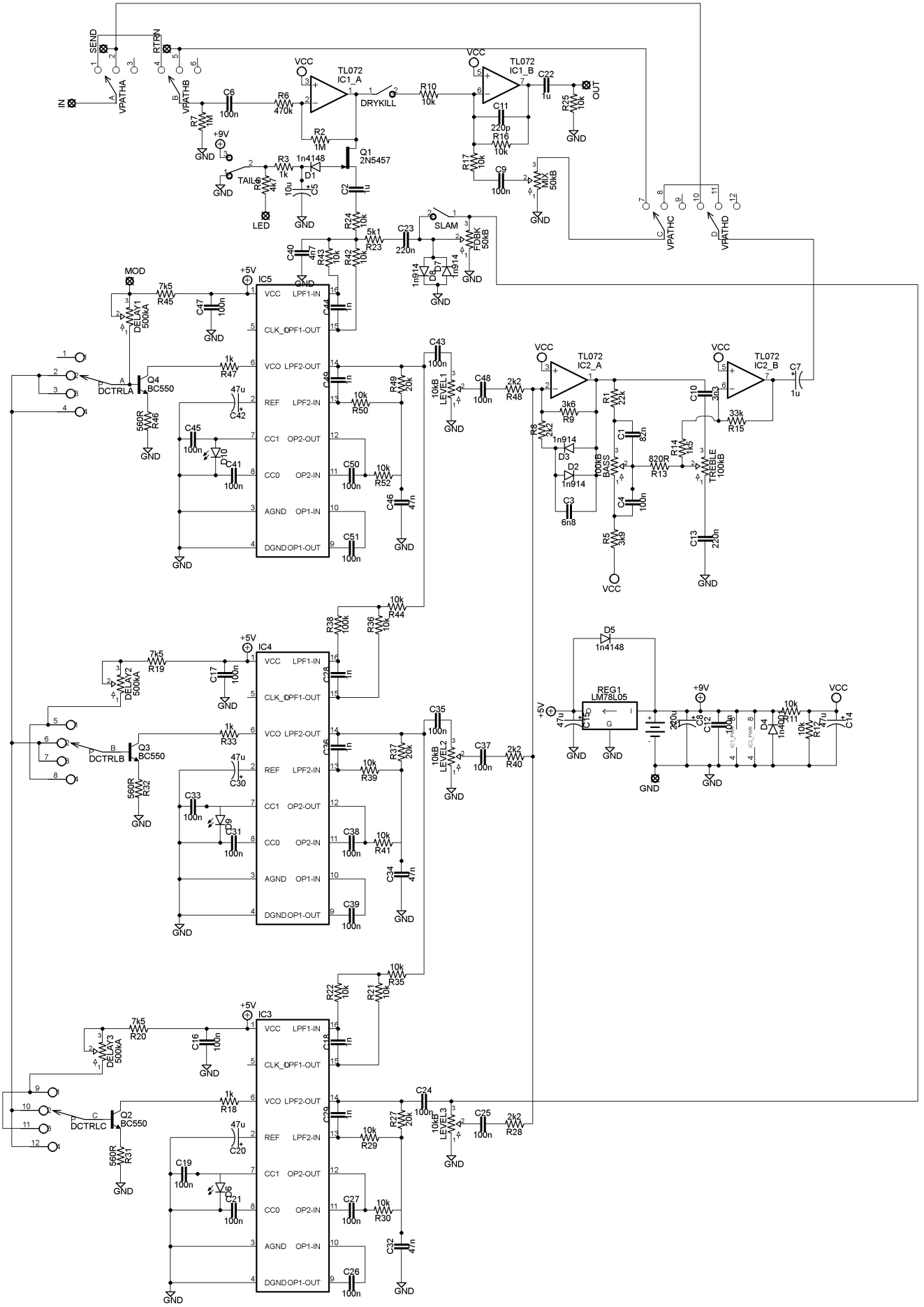
SAGAN DELAY



I've been jonesing for a Roland Space Echo for a long time. I'll never get one though. There's too much upkeep and the increasingly futile search for expensive replacement tape, and my wife would blow a gasket if I spent grocery money on a fancy tape player. Instead, I tried to design a circuit to emulate the heart and soul of a Space Echo. Three PT2399s emulate the three playback heads of the Space Echo, symmetrical clipping dirties up the delay a little, and there is a possibility to add reverb to the delay through send and return jacks. But why stop there? Let's make things weird. Instead of a rotary that selects what playback head is used, I added volume knobs for each PT2399 "playback head" for more nuanced level control than "on" and "off." I also allowed for each PT2399 to have an independent delay time with a turn of a rotary knob (maybe think of it as three Echoplexes in series, with different delay times?). Let's also add a SLAM! footswitch for instant feedback oscillation and the possibility to add modulation to the delay.

Delay times range from pseudo-reverb, to slapback echo, to galloping rhythms. To remind you of the digital roots of this beast, the maximum delay time introduces all the hiss and gurgling familiar with PT2399s. I figure these noises could be fun to fiddle around with. Also, the feedback oscillation gets a little grainy, but if the Boss RE-20 feedback can't nail the authentic sound, I won't have a problem if this can't either!


SEND
RTRN
IN
VPATHA
VPATHB
VPATHC
VPATHD
OUT
TL072
IC1_A
IC1_B
IC2_A
IC2_B
DRYKILL
TAILS
SLAM
LED
Q1
2N5457
Q2
BC550
Q3
BC550
Q4
BC550
DCTRLA
DCTRLB
DCTRLC
MOD
DELAY1
500kA
DELAY2
500kA
DELAY3
500kA
IC3
IC4
IC5
VCC
+9V
+5V
GND
REG1
LM78L05
LEVEL1
LEVEL2
LEVEL3
BASS
TREBLE
1n4148
1n914
R1 22k
R2 1M
R3 1k
R4 4k7
R5 3k9
R6 470k
R7 1M
R8 2k2
R9 3k6
R10 10k
R11 22k
R12 1k5
R13 820R
R14 1k5
R15 33k
R16 10k
R17 10k
R18 1k
R19 7k5
R20 7k5
R21 10k
R22 10k
R23 5k1
R24 10k
R25 10k
R26 10k
R27 20k
R28 2k2
R29 10k
R30 10k
R31 560R
R32 560R
R33 1k
R34 10k
R35 10k
R36 10k
R37 20k
R38 100k
R39 10k
R40 2k2
R41 10k
R42 10k
R43 10k
R44 10k
R45 7k5
R46 560R
R47 1k
R48 2k2
R49 20k
R50 10k
R51 10k
R52 10k
C1 82n
C2 1u
C3 6n8
C4 100n
C5 10u
C6 100n
C7 1u
C8 100n
C9 100n
C10 3n3
C11 220p
C12 100n
C13 220n
C14 47u
C15 47u
C16 100n
C17 100n
C18 1n
C19 100n
C20 47u
C21 100n
C22 1u
C23 220n
C24 47n
C25 100n
C26 100n
C27 100n
C28 1n
C29 1n
C30 47u
C31 100n
C32 47n
C33 100n
C34 47n
C35 100n
C36 1n
C37 100n
C38 100n
C39 100n
C40 4n7
C41 100n
C42 47u
C43 100n
C44 1n
C45 100n
C46 47n
C47 100n
C48 100n
C49 1n
C50 100n
C51 100n
D1 1n4148
D2 1n914
D3 1n914
D4 1n4148
D5 1n4148
D6 1n914
D7 1n914
D8 1n914
D9
D10
D11
D12
IC3
IC4
IC5
VCC LPF1-IN
CLK_O PF1-OUT
VCO LPF2-OUT
REF LPF2-IN
CC1 OP2-OUT
CC0 OP2-IN
AGND OP1-IN
DGND OP1-OUT
10kB LEVEL1
10kB LEVEL2
10kB LEVEL3
100kB BASS
100kB TREBLE
50kB
DELAY1 500kA
DELAY2 500kA
DELAY3 500kA

RESISTORS				CAPACITORS				ELECTRO CAPS		POTS	
R1	22k	**R27**	20k	**C1**	82n	**C33**	100n	**C5**	10u	**BASS**	100k B
R2	1M	**R28**	2k2	**C2**	1u	**C34**	47n	**C7**	1u	**DELAY1**	500k A
R3	1k	**R29**	10k	**C3**	6n8	**C35**	100n	**C8**	220u	**DELAY2**	500k A
R4	4k7	**R30**	10k	**C4**	100n	**C36**	1n	**C14**	47u	**DELAY3**	500k A
R5	3k9	**R31**	560R	**C6**	100n	**C37**	100n	**C15**	47u	**FDBK**	500k A
R6	470k	**R32**	560R	**C9**	100n	**C38**	100n	**C20**	47u	**LEVEL1**	10k B
R7	1M	**R33**	1k	**C10**	3n3	**C39**	100n	**C30**	47u	**LEVEL2**	10k B
R8	2k2	**R35**	10k	**C11**	220p	**C40**	4n7	**C42**	47u	**LEVEL3**	10k B
R9	3k6*	**R36**	10k	**C12**	100n	**C41**	100n	**DIODES**		**MIX**	50k B
R10	10k	**R37**	20k	**C13**	220n	**C43**	100n	**D1**	1N4148	**TREBLE**	100k B
R11	10k	**R38**	100k	**C16**	100n	**C44**	1n	**D2**	1N914	**SWITCHES**	
R12	10k	**R39**	10k	**C17**	100n	**C45**	100n	**D3**	1N914	**DELAY SYNC**	3P4T ROTARY
R13	820R	**R40**	2k2	**C18**	1n	**C46**	47n	**D4**	1N4001	**DRYKILL**	SPDT
R14	1k5	**R41**	10k	**C19**	100n	**C47**	100n	**D5**	1N4148	**SLAM**	SPST MOMENTARY FOOTSWITCH
R15	33k**	**R42**	10k	**C21**	100n	**C48**	100n	**D6**	GREEN LED 3MM		
R16	10k	**R43**	10k	**C22**	1u	**C49**	1n	**D7**	1N914	**TAILS**	DPDT FOOTSWITCH
R17	10k	**R44**	10k	**C23**	220n	**C50**	100n	**D8**	1N914		
R18	1k	**R45**	7k5	**C24**	100n	**C51**	100n	**D9**	GREEN LED 3MM	**VPATH**	4P3T ROTARY
R19	7k5	**R46**	560R	**C25**	100n			**D10**	GREEN LED 3MM	**REGULATOR**	
R20	7k5	**R47**	1k	**C26**	100n	**Q**		**IC**		**REG1**	LM78L05
R21	10k	**R48**	2k2	**C27**	100n	**Q1**	2N5457	**IC1**	TL072		
R22	10k	**R49**	20k	**C28**	1n	**Q2**	BC550	**IC2**	TL072		
R23	5k1	**R50**	10k	**C29**	1n	**Q3**	BC550	**IC3**	PT2399		
R24	10k	**R52**	10k	**C31**	100n	**Q4**	BC550	**IC4**	PT2399		
R25	10k			**C32**	47n			**IC5**	PT2399		

* R9's value controls how much "tape saturation" distortion affects the delay signal. This value can be played with to taste. I have played with a range of 1k5-4k7 and settled on 3k6. The higher the value, the more the gain and clipping is heard.
* * R15's value might need adjusting to boost the volume after the tone circuit. My board has a 33k, but the value might have to change if you decide to tweak R9. If you select a lower value for R9, you will need a higher value R15 to boost the signal after the tone circuit.

D6 and D9 are actually not needed and can be omitted since D10 limits the clipping at the first delay chip. D10 should be on the pot side of the PCB.
There also doesn't seem to be any difference in sound if D7 and D8 aren't there, so they can be ignored.

I originally had the idea to use the 4P3T rotary in only two positions, but a third position could be used to bypass the reverb altogether and not have a pedal plugged in to the

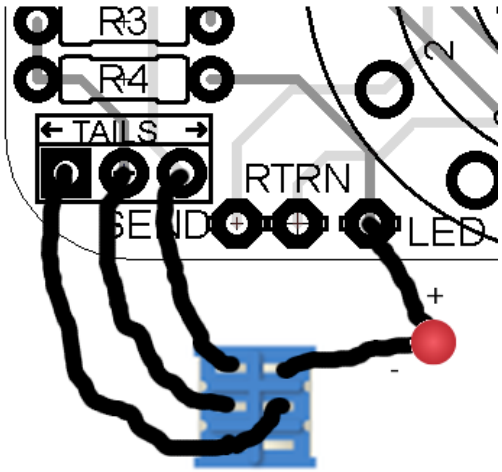
send and return jacks. To get the third position, make a jumper between pads 3 and 6 and another jumper for pads 9 and 12.

PADS

SEND= Send jack; I connected this pad to the input of a reverb pedal
RTRN= Return jack; I connected this pad to the output of a reverb pedal
IN= Connects to input jack
OUT=Connects to output jack
MOD= Connect to a modulation board of your choice. This is directly attached to the first PT2399. If all the delay chips are in sync, they will all be affected. If a PT2399 is independent of the first PT2399, its current won't be affected.
LED= connects to + leg of status LED, R4 is the current limiting resistor. The - leg of the LED can be attached to the DPDT footswitch to go to ground when activated.
GND= A courtesy ground. Can be connected to the input jack to ground all the jacks.
V1= Connects to the DC jack. The square pad connects to +9V, the round pad to ground.

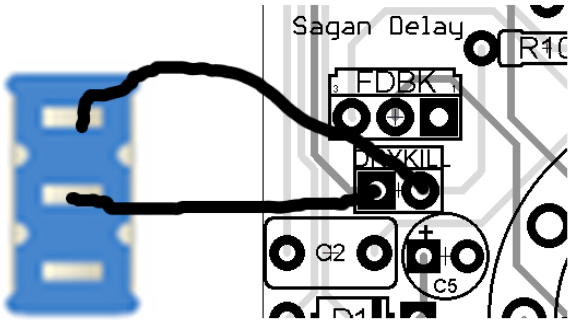
DPDT Footswitch Connections

For the TAILS switch, connect the innermost pad to lug 1 of the DPDT, the middle pad to lug 2, and the square ground pad to lug 3. Add a jumper to connect lug 3 and lug 5. The - leg of the LED connects to lug 4.

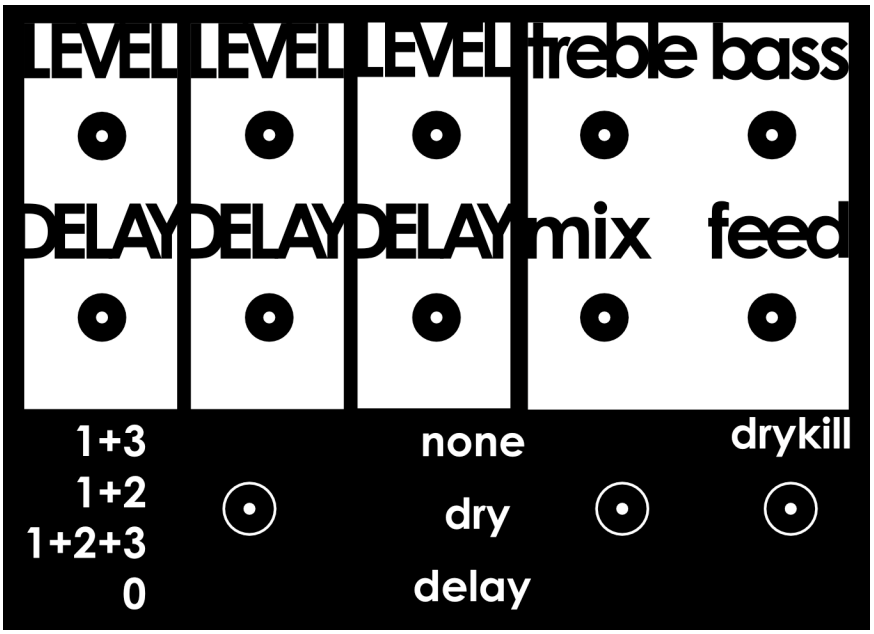


Connecting the SPDT to the DRYKILL pads

The DRYKILL switch does exactly what it sounds like; it removes the clean signal from the output so that you only hear delay sounds. If you want to omit this switch, add a jumper between the two pads.

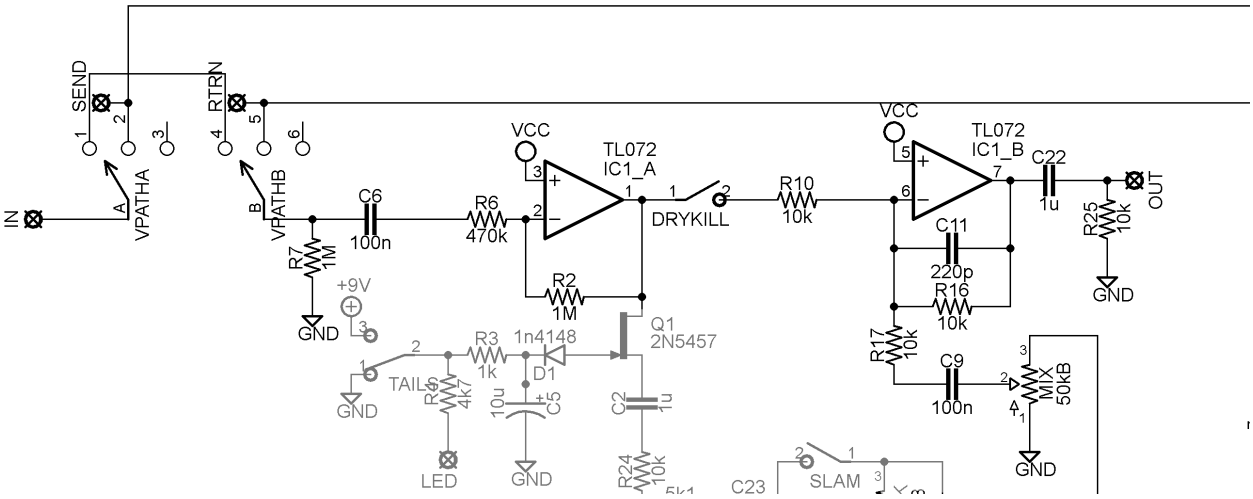


Here is an idea I have for a faceplate. It can be used as a drill template. Since the pots are solder-lug, you can do whatever you want, but it does help to give you a reference for those rotary switches.



So, how does it work?

Even though I am not an engineer and have only been dabbling in circuitry for a couple years now, I will attempt to explain what the heck is going on.



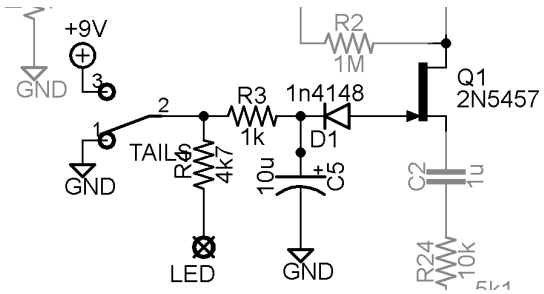
The first part of the circuit is fairly self-explanatory. The input signal goes through the SEND/RETURN rotary. Starting at the most CCW position, the signal flows as follows:

Position 1- The dry signal goes on to the op-amp unaffected, the delay signal goes through the send and return jacks before the MIX pot.

Position 2- The dry signal goes through the send and return jacks BEFORE entering the delay circuitry. If using a reverb pedal for the send/return, the reverb will be processed by the delay for some eerie atmospherics.

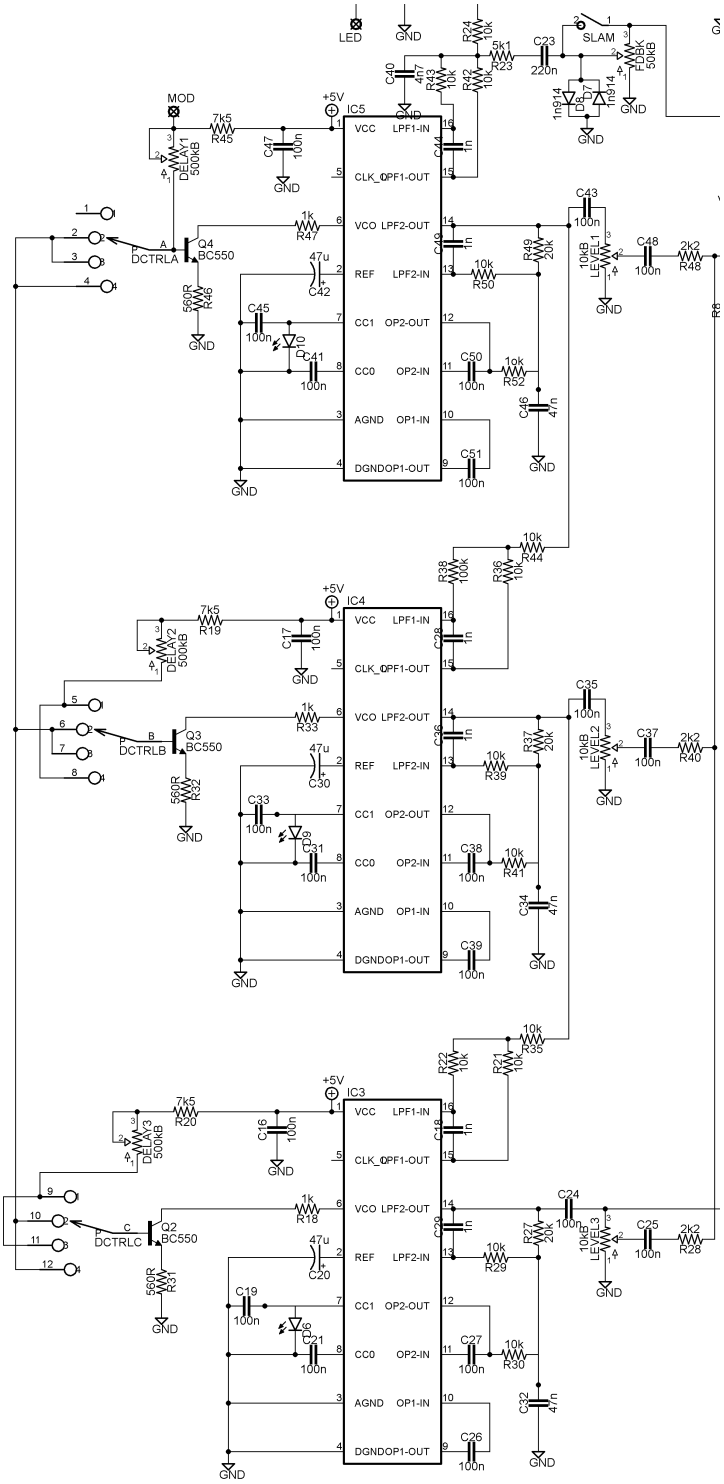
SUPER SECRET Position 3- The send and return jacks will be avoided altogether. This can only be achieved if you add a jumper from lug 3 to 6 and a jumper from lug 9 to 12 on the rotary. If you don't want this position, make sure you set the washer on the rotary to only click once.

After the rotary madness, the dry signal is split at pin 1 of IC1. The dry signal moves to the next part of the IC and down toward the delay circuit when activated. The wet signal joins back with the dry through the MIX pot and then to the output jack.



Following the signal down the delay path, we encounter the tails switching system. Without getting too technical (and exposing how little knowledge I actually have on the matter), Q1 acts as a gate for the signal from the op-amp. When the footswitch is

engaged, the 9V “opens” the gate to allow the dry signal into the delay circuitry. When the gate is closed, the remaining signal processed in the delay circuit continues to work its way out the signal path with any new dry signal unaffected by the delay.

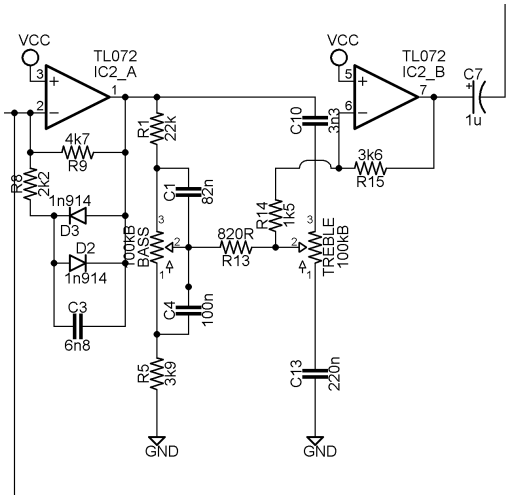


Here is where the circuit gets interesting. The PT2399 delay times are controlled through current mirroring when in sync with each other, but each successive PT2399 gets its input signal from the output of the previous PT2399, emulating the stagger of the playback heads of a Roland Space Echo. Each PT2399 output also has its own LEVEL pot. The Space Echo had a rotary to select which tape heads were used, but this design allows for more subtle delay rhythms by allowing for more volume options per delay chip than on or off.

The real fun is with the DELAY SYNC rotary. It selects what delays are synced with the first PT2399. When one or both of the subsequent PT2399s are synced to the first chip, they are controlled by the DELAY knob of the first PT2399. An unsynced PT2399 relies on its own DELAY pot. Think of it as a Space Echo where you can wiggle each tape head for funky rhythms. You can get interesting swing in the delay line.

Here are the rotary settings, starting at positon 1 and moving clockwise:

Position 1: All 3 PT2399s unsynced. Each DELAY pot works.
Position 2: All 3 PT2399s synced. Only DELAY pot 1 is used to control delay time.
Position 3: PT2399 1 & 2 synced, 3 is independent.
Position 4: PT2399 1 & 3 synched, 2 is independent.



Each output of the PT2399 ends up at the saturation/EQ stage (the output of the third PT2399 also forms the feedback loop and circles back to the first PT2399). This is a modified idea from an Ibanez DE-7 (and Madbean's Zero Point Super Deluxe) with a Baxandall-style equalization. The signal goes through symmetrical clipping to make the sound a little bit grainier then goes through the EQ before regaining any lost volume through the second half of the op-amp. The values for the EQ might be a little bizarre, but it allows for a drastic reduction of highs and a slight boost in the lows of the delay signal. The harsh cut of the TREBLE pot allows for a warm, worn tape sound while taming some of the digital noise of the PT2399s at longer delay times. After leaving this stage, the signal passes through the send/return rotary and to the MIX pot.

MISCELLANEOUS NOTES

-The transistors Q2, Q3, and Q4 need to be inserted opposite to the way the silk screen is printed (the flat side of the transistor should be on the curved side of the silk screen). I suggest you use sockets to be safe. If you insert the transistors in the way the silk screen suggests, the delay time will be extremely short.

-Due to all the pots being solder-lug (sorry!) and the tightness of the build, I would suggest soldering the wires for the DELAY pots before soldering in the capacitors.

-The slam switch is easy to install. One of the pads for the switch goes to one of the footswitch lugs, and the other pad goes to the other lug.

-While my main focus for the send and return jacks was for a reverb pedal, other pedals can theoretically be hooked up as well. I attached an Electro-Harmonix Nano Stone phaser to the send and return jacks, and it worked. Results may vary. Experiment!

-I crammed my prototype into a 1590XX enclosure; the modulation and reverb pedal are in their own enclosures. It was a tight fit with standard 1/4" jacks, but I managed to fit all 5 jacks (In, Out, Send, Return, and Modulation) in there.

ACKNOWLEDGEMENTS

Thanks to Brian at Madbean, Josh at 1776 Effects, and Rob at Dead Astronaut FX for making their ideas available for me to pick apart and tweak. Thanks to Martin (Martan) and Cody (selfdestroyer) for "beta testing" and hammering down component values. And of course, thanks to my wife for enduring my prattling about delay circuits.