Disappearing Act

All Analog Ducking Spring Reverb

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Overview

Who doesn't love the glorious wash of a spring reverb after hitting a big chord? The only issue with it is that the wash can also turn the attack of new notes to mush, making it hard to get any real definition of the notes being played. That can be desirable at times, but other times you want that big wash of reverb on the tails of the notes but a more present, dry attack. The Disappearing Act allows for precisely this. It's an all-analog spring reverb driver circuit with an envelope follower and optical compression of the reverb signal so that you can dial in just the right amount of detail for new notes while allowing the wash of a heavy reverb to fill the space between notes.

Ducking of effects using a sidechain input is a common studio technique that allows key signals to be more forward in the mix. It gets used on vocals, snares, kick drums, and more all the time. However, this technique is not used much in a pedalboard environment, which I think is a gross oversight. So come on and let's dive in to this deceptively simple circuit!

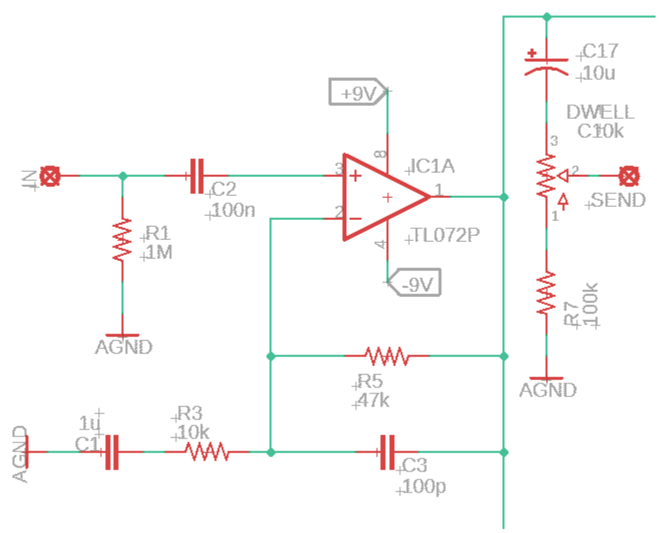
How it Works

At its most basic level, the Disappearing Act can be broken up into two parts: a spring reverb driver/recovery circuit and an envelope follower/optical compressor. There are many ways to do both of these things, but we're going to stay focused on this specific circuit.

Before we dive into the circuit itself, it is important to note that different spring reverb tanks can have different driver requirements. For example, very low impedance tanks (8-10 Ohms or similar) require a large amount of drive current to drive the tank well and are typically driven using a transformer topology. Medium impedance tanks (say 100-300 Ohms, for example) require less current and can be driven directly from an appropriately chosen opamp. Driving with tubes requires some special considerations that are outside the scope of this article. For higher impedance tanks (e.g., 800 Ohms), we have more opamp options for driving the tank and required current is reasonable. The Disappearing Act utilizes an 800 Ohm tank for the sole purpose of I picked one up locally for 10 bucks and wanted to use it. The side benefit is that there are a wide range of 800 Ohm tanks with various numbers of springs, spring sizes, and decay times, making the circuit flexible for putting into an amp, effects loop, or on a pedal board.

Since we are using an 800 Ohm tank, we are going to drive it with the ubiquitous TL072. Other opamps can be experimented with, but I didn't see the point, personally. So first off we have an input gain stage that provides a roughly 5x voltage amplification. This is so that our signal is sufficiently strong to drive the tank for a wide variety of pickups. It allows you to drive the tank strongly with weak single coils, but if you use hot humbuckers, you will have way more than enough drive.

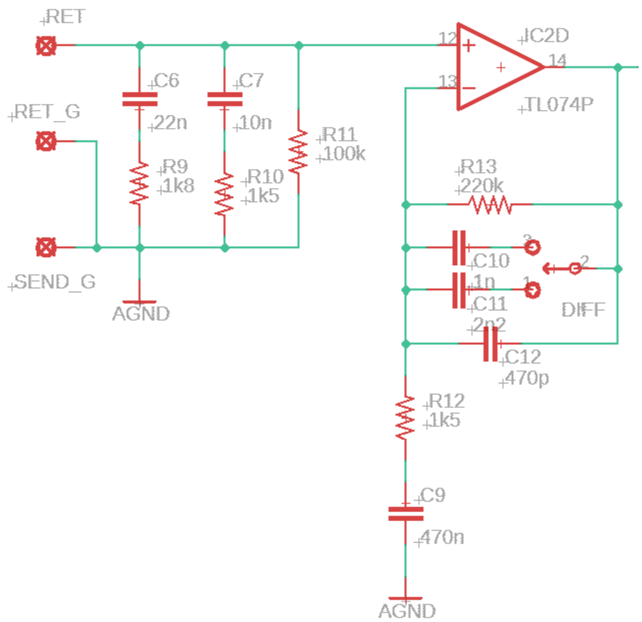
A couple of things to note. First, the opamps are driven with a bipolar power supply. This is for headroom purposes as well as simplicity in the circuit. This means we aren't having to run a Vref signal all over the board, which caused some minor issues on the breadboard. This also means that the circuit can be used as-is for synth purposes as well. Second, the Dwell control is a simple voltage divider, but because the tank impedance is only 800 Ohms, we don't need it to cover a super wide range. The values shown were chosen specifically to give just a hint of reverb at it's lowest setting and adequate drive with weak input signals at max.



Disappearing Input Stage

The signal is sent to the tank from the input stage and then is returned to a recovery stage. Note that prior to the opamp, there is a passive network. These passive components provide some mild boosting at a couple of key frequencies. The first is about 3 dB at approximately 3 kHz and the second is a smaller boost at 4.5 kHz (I think, going from memory here). This helps provide some "sheen" to the reverb signal.

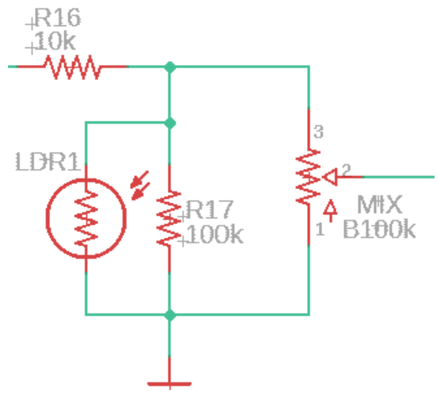
The opamp stage is a non-inverting gain stage with a fixed gain of a little over 40 dB. This is really pushing the amount of gain that a single stage should be doing, but I dialed things in by ear and liked it at this level. R13+C9 and C12+R12 set the high and low pass filter corners for the stage. I experimented with different values and found that changing the feedback cap value resulted in useful variation of high frequency content, which correlates roughly to diffusion, so I put in a three way toggle so that there are three "diffusion" settings. The center position is only the 470pF cap and is the brightest setting, but for very bright guitars, like a Tele or Strat bridge, the larger settings are rather useful.



Disappearing Act Recovery Stage

Now that we have a robust reverb signal, we are going to control how it combines with the dry signal. This is done by way of the optical compression followed by the mix control. The idea here is to set the mix control relatively high and set the compression (ducking) to taste so that there is a strong reverb wash, but only when notes aren't being actively played. This is done using a modified version of the optical compression scheme used in the Fairchild 663. Essentially, there is an LDR that forms the shunt resistor in a resistor divider network. In the case of the Fairchild, there is no fixed parallel resistor. I used the series and parallel resistors to tune the response of the circuit to the LDR that I had on hand and that I use for most of my optical stuff (KE10720).

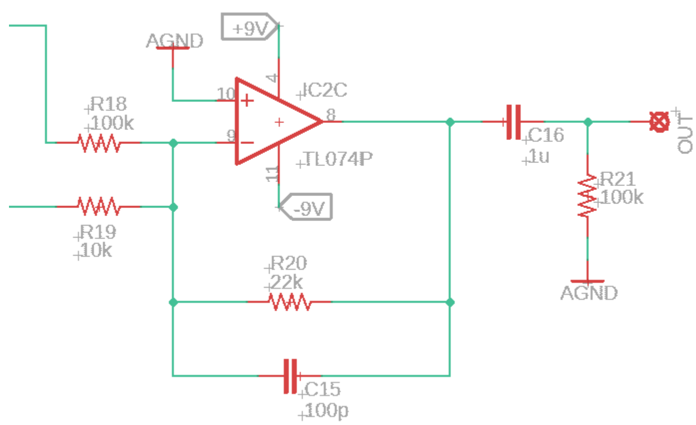
Following the optical compression of reverb signal, we have a standard Mix control, which is just another voltage divider but controlled by a standard potentiometer instead of an LDR.



Disappearing Act Optical Compression and Mix Stage

The final portion of the audio signal path is the summing amplifier/output buffer. You will notice that the input resistors for the two signals are very different. This is for two reasons. First, the dry signal comes from the input buffer, which has amplified the signal roughly 5x. We need to knock it back down so that it isn't creating a huge dry signal boost when the circuit is engaged. Thus the 100k/22k resistor ratio for this signal. Next, because I wanted to make sure that at full mix the circuit can deliver a huge reverb wash, I chose the 10k input resistor so that it will add another 6 dB of boost to the reverb signal. This allows for a final signal that is positively dripping with spring reverb goodness.

The rest of the components are bog standard and the values have some flexibility, but the values shown are a great place to be.



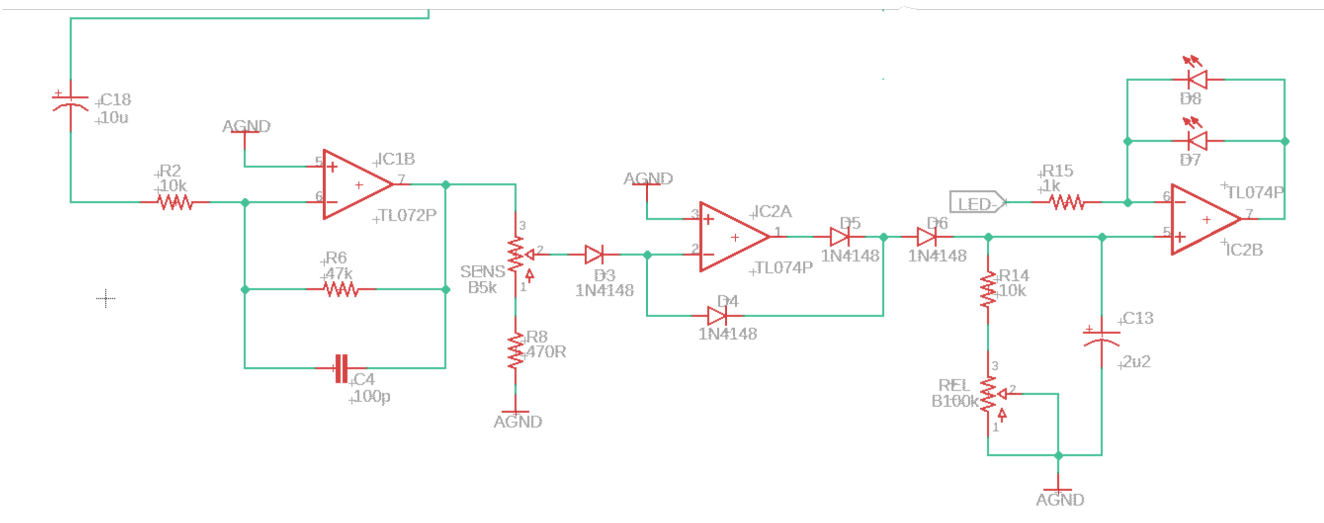
Disappearing Act Output Buffer

Even though we have discussed the audio signal path, we aren't going to have any ducking if we don't trigger the LDR with an LED. To do this, we need an envelope follower of some kind. There are many choices here, but I decided to go with an opamp-based full wave rectifier. This consists of a first amplification stage that boosts the input signal such that we can get a robust rectified voltage at full sensitivity. This is a simple inverting opamp stage with a fixed gain.

After the fixed gain stage, the Sensitivity control is a simple voltage divider before the rectification happens. With the Sensitivity control all the way up, the resulting rectified DC voltage will be strong enough to drive the LED to full or near-full brightness. With the control rolled down, the DC voltage will be low enough so that it won't drive the LED fully. In fact, with the sensitivity control rolled all the way down, there will be no ducking action at all and the Disapearing Act will act like a regular spring reverb driver. This is handy if you are trying to rock out to Miserlou or something similar.

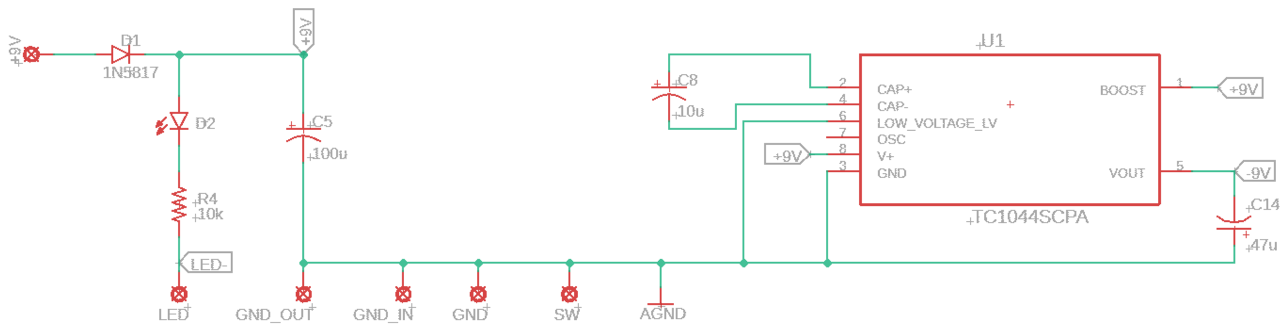
The rectification of the signal happens with the second opamp stage using diodes that make is to that voltage swings can't be negative and so that we see a DC signal with plenty of rippling on it. Cap C13 helps to smooth out these ripples, but it also works in conjunction with R14 and the Release control to determine the time constant of the envelope follower. With the Release control all the way up, R14 presents a low-ish resistance path to discharge C13, resulting in a fast time constant and the LED responds virtually instantaneously to signal level changes. With the release control all the way down, C13 discharges more slowly and it takes more time for the LED to dim, resulting in a longer time constant of the ducking action. The LED's are driven by the third opamp stage and are placed in the negative feedback loop. This is what drives the LED's brightness. The LED brightness can be tweaked some by adjusting R15, but if it goes too low, you can burn out the LED by sinking too much current and that's a bad day, trust me. If you really want to tweak the LED brightness, I suggest looking at the first opamp stage.

Note that there are two LED's in the feedback path. Only D7 is used for the optical compression of the reverb signal. I added D8 as a visual indicator of how much compression is happening, since doing it just by ear with various guitars can be a little finicky. A visual indicator means you can adjust the sensitivity and release for a given guitar quickly and accurately.



Disappearing Act Envelope Follower

The final piece to the puzzle here is the power supply section. It's pretty simple, but does use a DC-DC charge pump IC to produce the +/-9V necessary to run it. Nothing else here should be a surprise to anyone.



Disappearing Act Power Section

BOM

The BOM below is the list of parts I used for mine along with quantities. All parts are through hole with resistors being 1/4W. I got everything except for the reverb tank from Tayda.

Part	Qty.	Notes
120R Resistor	1	
470R Resistor	1	
1k Resistor	1	
1k5 Resistor	1	
1k8 Resistor	1	
4k7 Resistor	1	
10k Resistor	5	
22k Resistor	1	
47k Resistor	2	
100k Resistor	5	
1M Resistor	1	
Current Limiting Resistor	1	
100pF Capacitor	3	
1nF Capacitor	1	
2.2nF Capacitor	1	
4.7nF Capacitor	1	
10nF Capacitor	1	
22nF Capacitor	1	
100nF Capacitor	1	
1uF Ceramic/Film Capacitor	3	
2.2uF Electrolytic Capacitor	1	
10uF Electrolytic Capacitor	3	
47uF Electrolytic Capacitor	1	
100uF Electrolytic Capacitor	1	
B5k Potentiometer	1	16mm PCB Mount
B100k Potentiometer	2	16mm PCB Mount
C10 Potentiometer	1	16mm PCB Mount
SPDT Toggle Switch	1	On/Off/On
1N5817	1	

1N4148	4	
LED, Red Diffused	2	Ducking, sensitivity indicator
LED	1	Bypass indicator
KE10720 LDR	1	
TL072	1	
TL074	1	
TC1044	1	
Spring Reverb Tank	1	800 Ohm input impedance
Enclosure	1	
1/4” input jack	2	
RCA jack	2	
DC power jack	1	
3PDT footswitch	1	

Schematic

The schematic for this project is a little big to be legible on a single sheet, so it is included as a separate image in the project documentation folder.

Build Notes

Here are some things I noted from building the Disappearing Act that might be helpful to you. Please read this section to make sure you don't go through excessive frustration.

Enclosure Size/Drilling

The Disappearing Act fits nicely into a 125B mounted horizontally. This also works well to accommodate the various jacks needed.

Jacks

Whatever jacks you use for in/out and power in 125B are fair game; no restrictions here. I used box jacks because those are my standard. Note that you will need RCA jacks as well. Typically the spring reverb tank uses the sleeve of the RCA cable as a ground, but you should double check so that you don't accidentally ground out the signal that you want to send to the tank.

Reverb Tank

While the Disappearing Act is designed for 800 Ohm tanks, it may be possible to use it with higher impedance tanks. Lower impedance tanks may not work due to the increased current supply requirements. However, there are many options for 800 Ohm tanks, from tiny tanks with short reverb times to giant tanks with a very long reverb time. Any of these should work.

Sidechain

It is possible to modify the ducking of the Disappearing Act to use a sidechain input. To see how this could be accomplished, see the sidechain feature in the Escape Artist reverb I designed. This allows the Disappearing Act to sit in the effects loop while being keyed off of the input from the beginning of a pedalboard or similar.

Diffusion

The diffusion control can be changed to taste by changing the values of caps C10, C11, and C12. Note that smaller caps will make the signal brighter but noisier while larger caps will result in less noise but a warmer reverb effect.

In Closing

The Disappearing Act is sure to bring you lots of fun reverb sounds, some of which haven't been available in an outboard reverb design before. Enjoy!