Night Shift

Harmonic and Dimension Phaser

Overview

I love designing modulation effects. You can do so many weird things with it. After doing my Aeronometron design last year, and after waffling around on harmonic tremolo circuits, I had the crazy thought of a harmonic phaser using the CD4066 chips as the variable resistors. And, while I was at it, I thought maybe it would be fun to have the option of a "dimension phaser" mode, where the dry signal is mixed with two separate phasing paths that are 180 degrees out of phase. Well, I couldn't stop there, I wanted to be able to change the relative phase of the two LFO's as well. Put all that into a single box, and you get the Night Shift.

How it Works

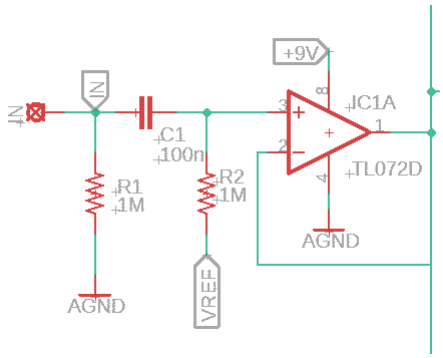
There are lots of phasers out there, and at its heart, the Night Shift is two parallel, 4-stage phaser circuits. The thing that makes it unique is that it can work as a "harmonic phaser", where the input signal for each path is filtered (one low pass, one high pass) and then phased with an LFO that is out of phase. Because of the PWM necessary to drive the CD4066 as a variable resistor array, a microcontroller was the obvious choice. The great thing about this is that it makes arbitrary relative phase shifts to the LFO's super easy. Want to have your LFO's in sync for classic phaser tones? No problem, set it to minimum. Want them 180 degrees out of phase for classic harmonic operation? Easy, it's right there. Want 67 degrees of relative phase? You can do that, too, regardless of LFO speed, something that would be impossible with analog circuitry.

Another unique feature is the ability to use it as a "dimension" phaser, where the dry signal is mixed

with the two phaser sections (input filters bypassed) and out of phase with each other, but with the ability to do the relative phase shifts as with the harmonic mode.

The digital LFO also allows for any LFO wave shape, though I programmed in sine, triangle, and rising sawtooth by default. Add in a sweepable filter frequency control, and you've got all the building blocks of the Night Shift.

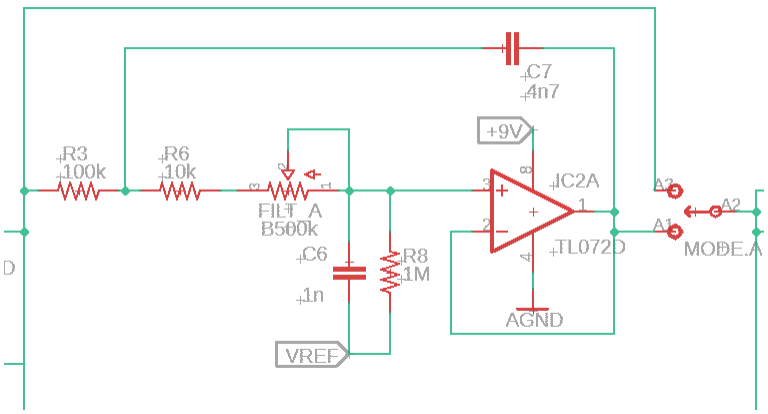
The input stage is a buffer for splitting the signal off into the various parts needed by our phasing stages. It's a simple non-inverting, unity-gain buffer as seen below.



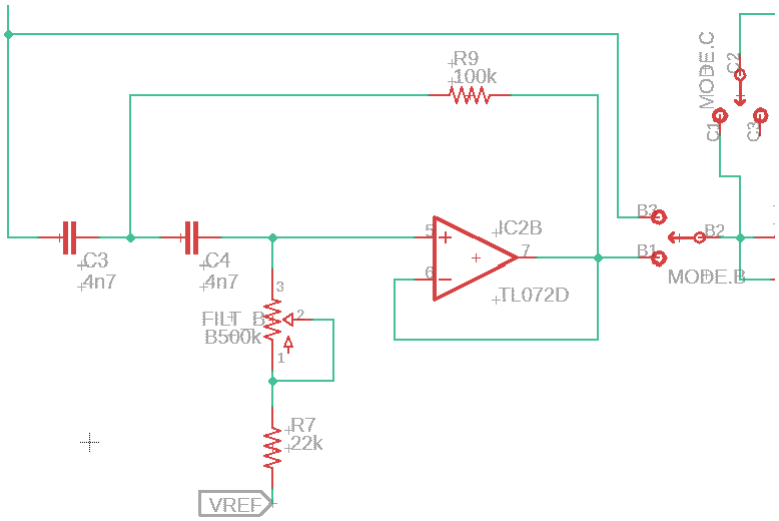
Night Shift Input Buffer

The signal from the input buffer is then filtered by two Sallen-Key filters. One is a high pass for the high frequency content and the other is a low pass for the low frequency content. The filter control is a dual gang pot that automatically adjusts the crossover frequency with one control. You will note that they are not identical. There is a small region where the two filters "overlap". This is so that the low frequency section doesn't get completely lost at some settings. Notice how the dry signal for each phasing stage is pulled after the filter and mode switch. This is so that any phase shift due to the Sallen-Key filters themselves is removed to eliminate unwanted static comb filtering.

These Sallen-Key filters are bypassable by way of a 3PDT "Mode" toggle switch. With the filters in place, the Night Shift operates in harmonic mode. With them bypassed, it's dimension mode. Because of how the dry signal is pulled, we want one of them (I arbitrarily chose the high side) needs to be disconnected during harmonic mode to eliminate a dry signal level change relative to the phased signals.

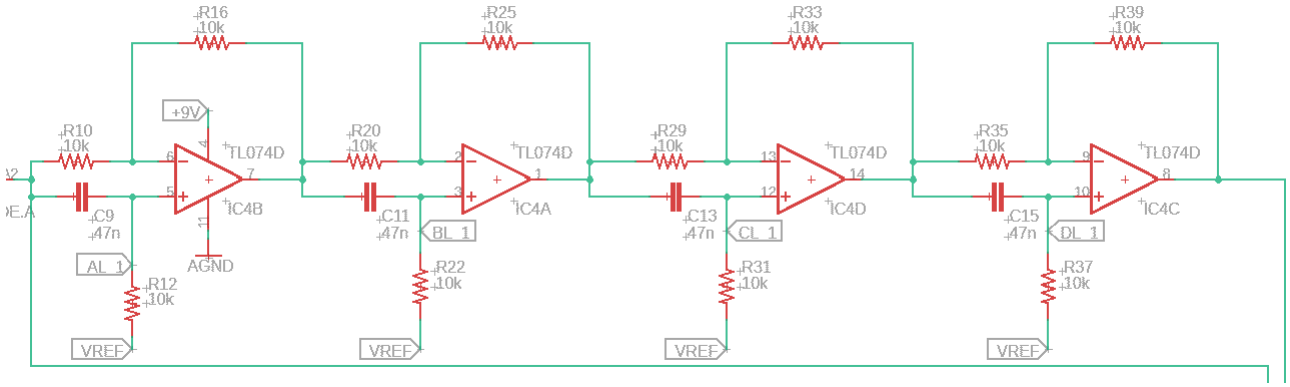


Night Shift Sallen-Key Low Pass Filter



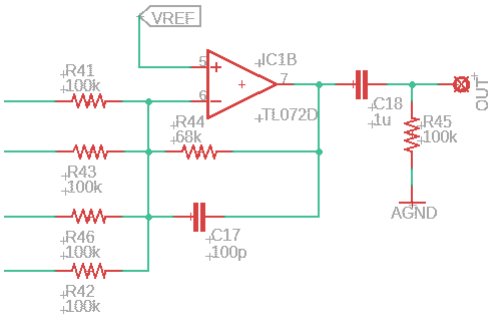
Night Shift Sallen-Key High Pass Filter

After the filtering, the two phase stages are identical. These are basically what the Phase 90 uses, except that the JFET's are replaced with the CD4066 switches for the variable resistance elements. I didn't know until after I had this mostly designed that Parasit Studios also has a CD4066/PWM phaser (though I knew about the Sentient Machine, as it was the inspiration/basis for the Aeronometron).



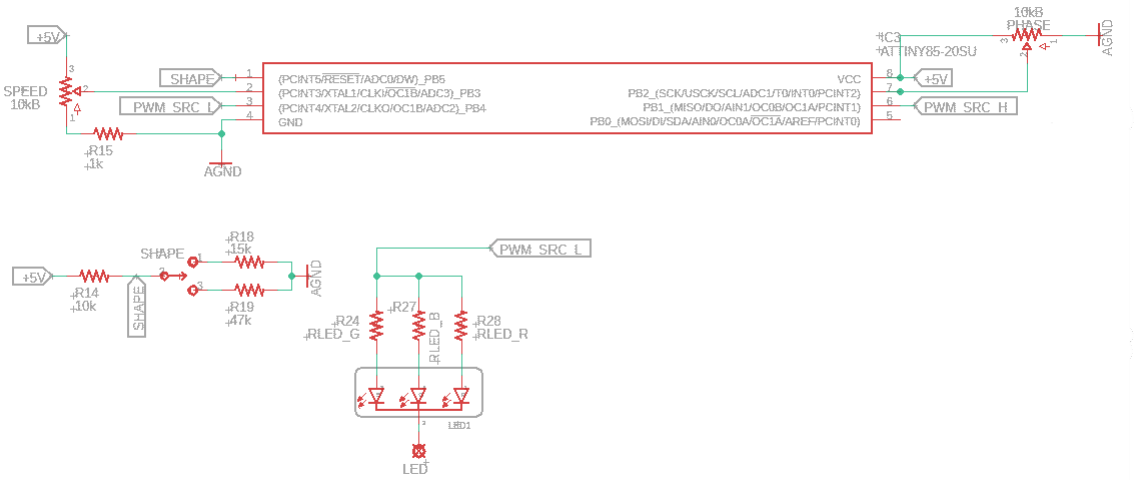
Night Shift Phase Shifting Stages

Once the phased signals are created, they are mixed into a summing amplifier with the dry signal to created the whooshy, phasey sound we love. This is a pretty standard summing amplifier/output buffer.



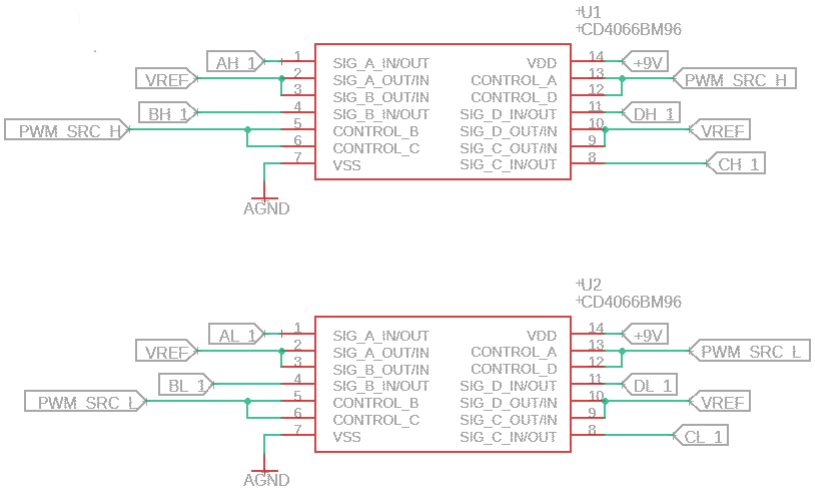
Night Shift Output Buffer

As mentioned above, the LFO is created using a microcontroller. It uses analog inputs to determine the speed and phase relationship between the two LFO PWM outputs. An analog input also serves to indicate which of the wave shapes to be used. The circuit itself is pretty simple, though the code has a little bit going on. I also opted for an RGB LED so that I can have it blink any color I want (really great idea given that I'm colorblind....).



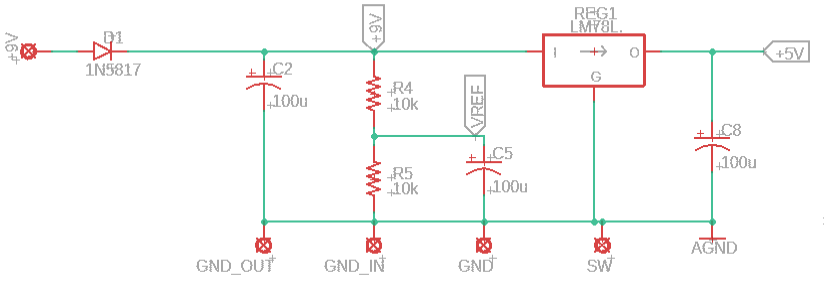
Night Shift Digital Section

The variable resistance elements in the phase stages are implemented using CD4066 CMOS switches that are opened and closed super fast. This implementation of switches with a single PWM driving them ensures that they are precisely matched and no JFET matching is necessary. There are two banks, one for the high side and the other for the low side.



Night Shift CMOS Switches

Lastly, the power section produces +9V, VREF, and +5V for all the various elements. This is my standard mixed signal (digital and analog) power section.



Night Shift Power Section

BOM

The BOM below is the list of parts I used for mine along with quantities. This is a surface mount project due to the number of IC's, but most should be easily available from Tayda and similar suppliers.

Part	Qty.	Notes
1k Resistor	1	
10k Resistor	28	
15k Resistor	1	
22k Resistor	1	
47k Resistor	1	
68k Resistor	1	
100k Resistor	7	
1M Resistor	1	
Current Limiting Resistor	3	For RGB Bypass/Speed LED
100pF Capacitor	1	
1nF Capacitor	1	
4.7nF Capacitor	3	
47nF Capacitor	8	
100nF Capacitor	1	
1uF Ceramic/Film Capacitor	1	
100uF Electrolytic Capacitor	3	
A1k Potentiometer	1	16mm PCB Mount
B10k Potentiometer	1	16mm PCB Mount
B500k Potentiometer	1	16mm PCB Mount, Dual Gang
1N5817	1	
SPDT Toggle Switch	1	
3PDT Toggle Switch	1	
LED	1	RGB, common cathode
78L05	1	
TL072	2	
TL074	2	
CD4066B	2	
ATTiny85	1	
Enclosure	1	

1/4” input jack	2	
DC power jack	1	
3PDT footswitch	1	

Schematic

The schematic for this project is provided below as well as a separate image in the project documentation folder.

Night Shift Full Schematic

Build Notes

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

Enclosure Size/Drilling

The Night Shift fits nicely into a 125B. The board is a little too wide to fit a 1590B.

Jacks

Whatever jacks you use for in/out and power in 125B are fair game; no restrictions here.

In Closing

The Night Shift will give you phasing sounds not readily available in other DIY pedals and, as far as surface mount goes, is a pretty straightforward project.