MAGNETIC UPDATE

By Taru Designs

John O'Flaherty goes on to detail his approach in *Replacement of the potentiometer in a VPC1 sustain pedal with a non-contact sensor.* I initially followed it and found a few issues:

- I wasn't able to find that same magnet, but I bought some smaller neodymium magnets that can be stacked for a similar effect.
- When mounted in the way he did, the values output by the pedal weren't as linear as one would like. This is easily explained by the way the sensor works: It will react to change in magnetic field in the direction of the main face of the IC. Since the pedal moves *vertically* you'd want to mount the sensor with the main face pointing in the same direction.
- The voltage regulator IC requires some capacitors to work properly. There was one additional issue: With my magnets and the sensor mounted vertically, the change in voltage between the "fully on" and "fully off" position was only ~0.35V. Even after using the calibration tool, the VPC1 would only output 5 or 6 different pedal values.

The Hall effect sensor idles at half the supply voltage, and will either increase or decrease its output voltage depending on the polarity of the magnetic field. For a USB supply, this would mean it idles at 2.5V (without any magnetic field). Since we want to make sure that it detects such magnetic field from the smallest movement, we actually *don't* want it to idle at half the supply voltage.

So, to summarize:

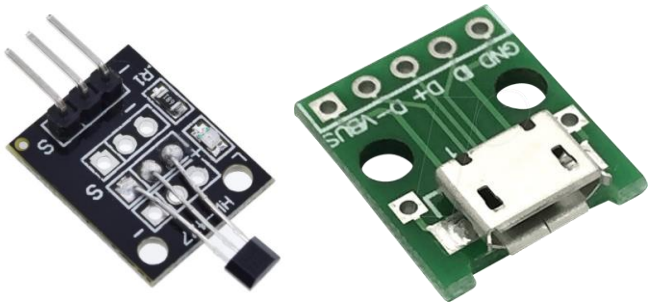
- The magnetic sensor works with any magnet, but the voltage swing might be too low for our purpose.
- The VPC1 has a minimum and maximum voltage range that it can assign to MIDI Output 0 and MIDI Output 127 for the sustain pedal: 1.07V for 0 and 2.67V for 127
- Using as much of that range as possible also means having more steps, and overall, a more *continuous* pedal

The problem then is fairly simple: We have to make it so the idle voltage, as seen by the VPC1 is 1.07, while voltage with the pedal fully depressed is 2.67V (Note: I went for slightly lower range to accommodate for slight variations in components: 1.2V to 2.4V)

The circuit is explained in more detail (including how to calculate the values for each component) in *Designing Gain and Offset in Thirty Seconds* (Positive m and Negative b). From my previous experiments I found that the idle voltage of the sensor could change depending on the mounting position (in other words, the "minimum magnetic field"), but the voltage swing would be the same (which makes sense, since the range of movement in the pedal is always the same). To accommodate for that I replaced R1 and R2 with a multiturn potentiometer so that I can precisely set the offset. In other words:

- R1 and R2 are indirectly compensating the idle voltage
- Rf and Rg amplify the voltage swing. You could also replace one of those with a small potentiometer to adjust the gain if your sensor exhibits a different voltage swing for some reason

I have attached a number of EAGLE files for a generic board. Note that some of the footprints will be unpopulated: Some of the components (USB, Hall sensor) can be easier (and cheaper!) to find in premade breakout boards, so it might make sense to simply buy one of these and plug them in rather than buying them in big quantities just to use one.



Since I added another plug, I algo had to (poorly) cut out a hole in the enclosure of the pedal.

Mounting instructions are fairly straightforward:

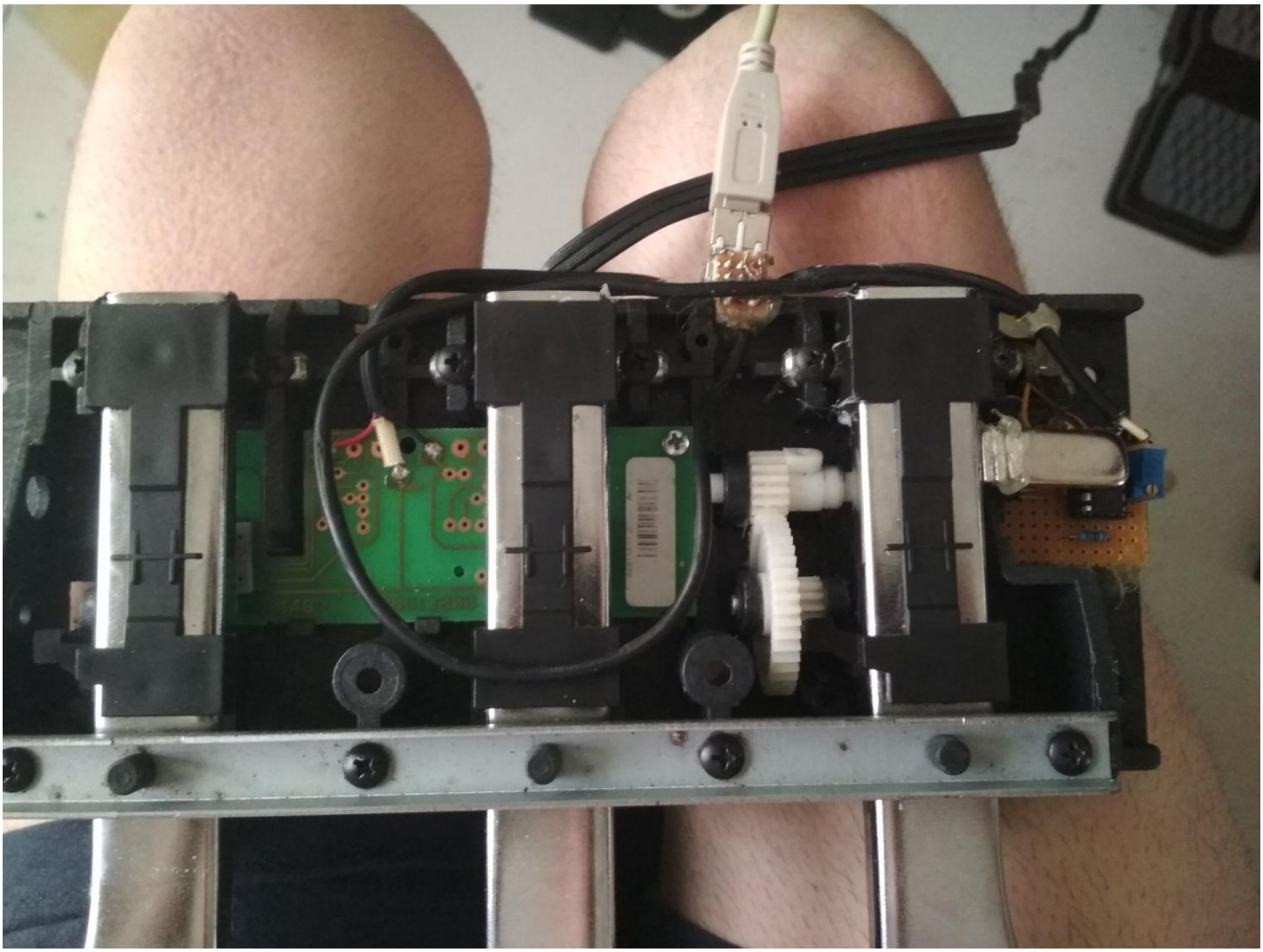
1. Disconnect the pedal and remove the enclosure
2. Remove the potentiometer and desolder the wires
3. Assemble the board in place and reconnect the two wires
4. Set the magnet into position (I used a piece of steel to offset it from the pedal, but even cardboard would work)
5. Power the board and grab a multimeter: Measure the voltage between the output jack (the tip) and ground.
6. Adjust the potentiometer until this value reads close to 1.2V
7. Depress the pedal and check the voltage when the pedal is all the way down
    a. If the voltage *decreases*, flip the magnet orientation
    b. If the voltage doesn't change or only changes a few millivolts, the magnet is not strong enough/it's too far. Use a more powerful magnet or move it closer to the sensor.
8. Once you get the desired range, assemble the pedal again and connect it to the keyboard.

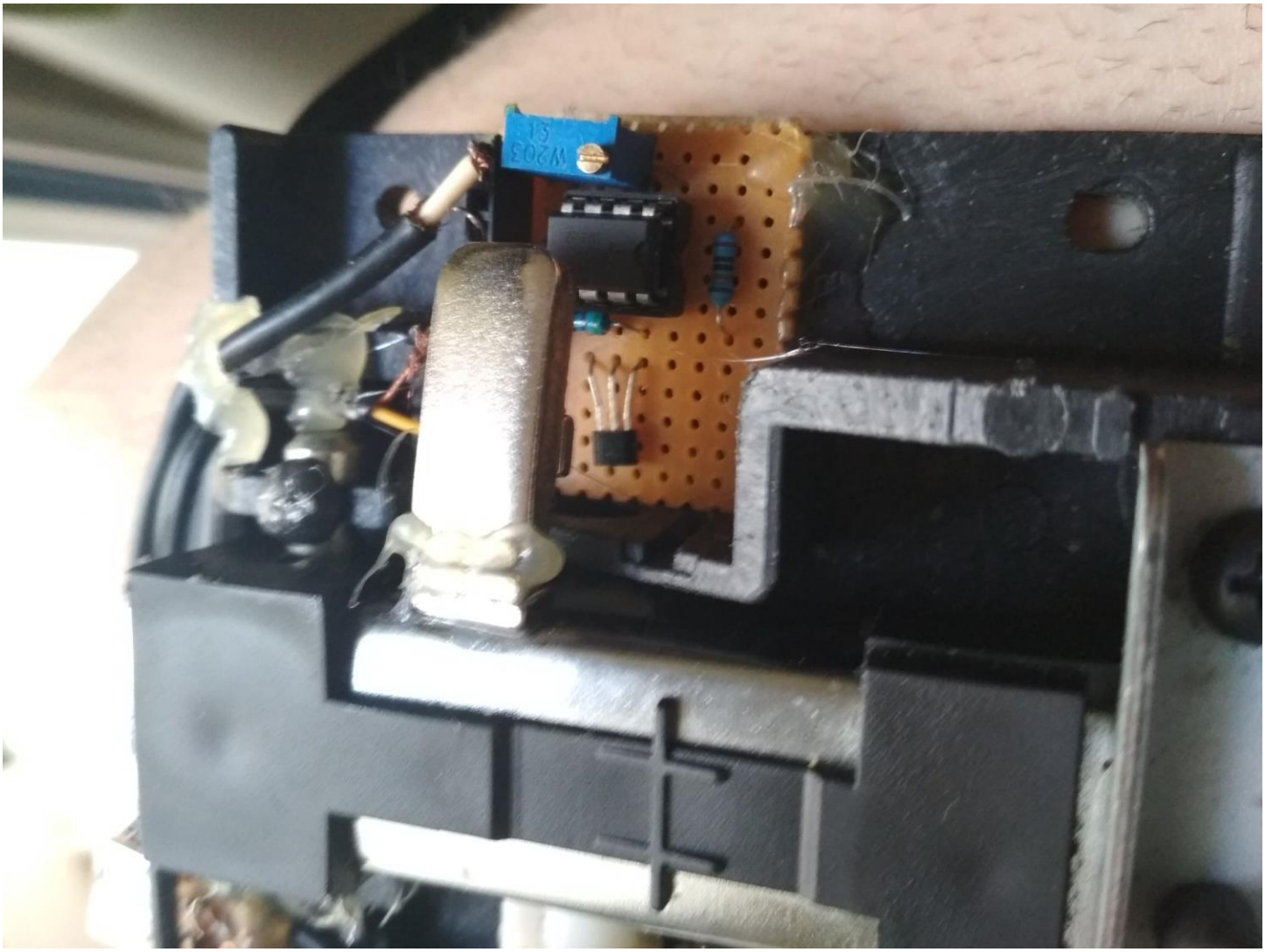
Parts List for the board:

Designation	Value	Description	Note
R1	200K	Multiturn trimmer	
R2	220K	0805 Resistor	
R3	470K	0805 Resistor	
IC1	LM358	Low Voltage Dual Opamp	
X1	USB Type B Female	PCB Mount right angle connector	Alternatives: External power on JP2
IC2	A1321	Hall Sensor	Alternatives: SS49E, A1301
JP1	3-pin header	2.54mm pitch, male	Optional: Only for external board replacing IC2
JP2	2-pin header	2.54mm pitch, male	Alternative: USB power
JP3	2-pin header	2.54mm pitch, male	Optional: Solder wires directly to board.

As for magnets, I personally bought these on amazon:

Here are some pics of the interior of the pedal with this upgrade. Since this was done very much in a hurry, it doesn't look nearly as nice as it should.




W203
S1