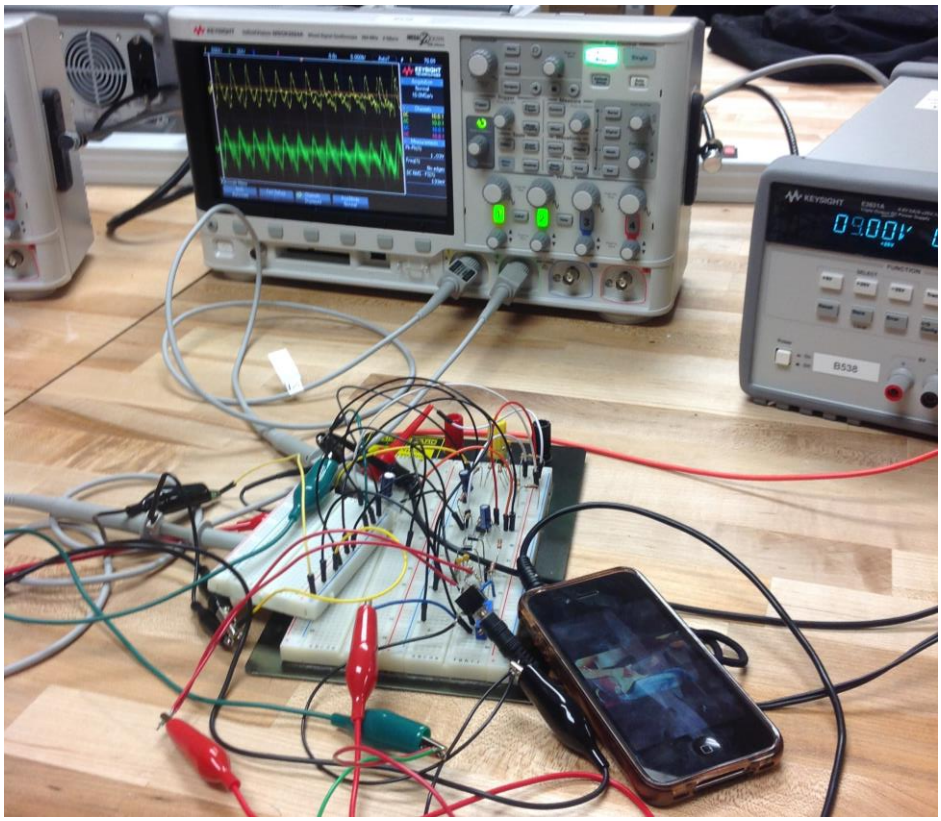
# Blue Clipper Distortion



Project in a Box

## Blue Clipper Distortion

Original Schematic Found on **Tonepad**

Modified by PiB Team:

Josh Ma, Josh Jain, Eric Ho, Julia Mou, Ella Kan, Karcher Morris, Phuong Truong

Phuong Truong | Professor Truong Nguyen

# Introduction

The end goal of this project is to build the Blue Clipper guitar effect from scratch by following a schematic. The Blue Clipper is a distortion effect pedal that boosts the gain of a clean guitar sound and creates a louder, warmer and "scuzzier" tone. The resulting pedal will have a true bypass stomp switch to turn the effect on and off. There are no other controls on the pedal as the intensity of the effect is controlled by the volume of the guitar itself.

Glance at the "Hardware & Wiring" section and the Blue Clipper Build Diagram, and you should already have a good idea on how to build this pedal. Feel free to proceed in an order that makes the most sense to you, and to connect the oscilloscope and plug in speakers at nodes in question at any point. However**, you must get the indicated steps in the "Step By Step" section checked off to receive credit**. You are not required to answer the questions in this section but they should help you think. If you are unsure what results you should get, there are some example screenshots in the "Simulation & Screenshots" sections you may find helpful.

### Learning Objectives

- Demonstration of Op Amp and diodes function in circuit
- Following Schematic and prototyping
- Soldering

### Required Materials

Hardware:

- Wires and Jumper Wires
- 1x DPDT Stomp Switch
- 2x 1⁄4" Input Jacks
- 2x 3.5mm Input Jacks
- 1x 9V Battery
- 1x 9V Snap Connector

Capacitors:

- C0 100uF
- C1 47nF
- C31 4.7uF
- C32 4.7uF
- C5 33nF

Others:

- 1x LM741
- 2x 1N194

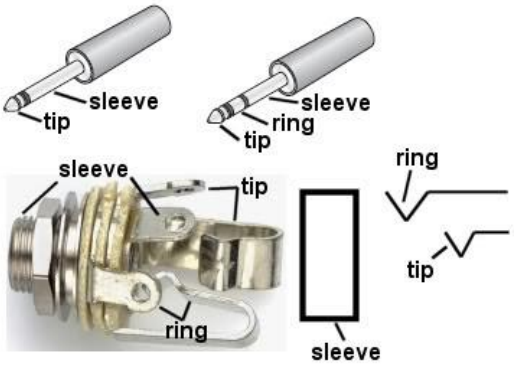
Resistors:

- R1 2.2MΩ
- R21 200kΩ
- R22 200kΩ
- R31 150kΩ
- R32 10kΩ
- R4 8.2kΩ
- R5 10kΩ
- Rout 50kΩ trim.

### Required Tools for Entire Project

- Oscilloscope
- Wire Cutter/Stripper
- Soldering Iron
- Breadboard

# Hardware & Wiring



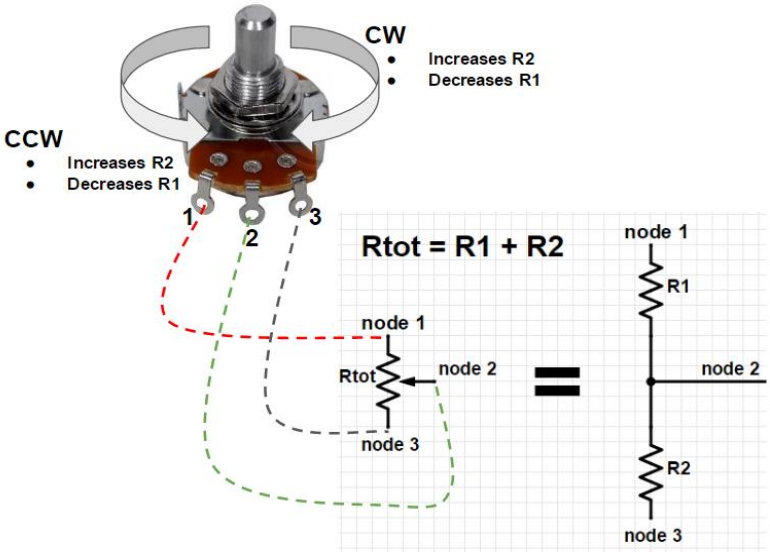

**Phone Jacks**

Almost all electric guitars and guitar amplifiers require a single channel and use two-conductor, 0.25 inch (6.35 mm) cables. Naturally, effect pedals are designed to match this interface, and we will be using TRS (tip ring sleeve) jacks as shown on the left. These jacks have three contacts and can be used with stereo cables. Since we only have a mono signal, we will be grounding both ring and sleeve and connecting tip to the input of the effect circuit.

Most of us are more familiar with 3.5mm auxiliary cords and stereo speakers. For testing convenience, 3.5mm jacks can also be used.
The wiring for these jacks are shown to the left.

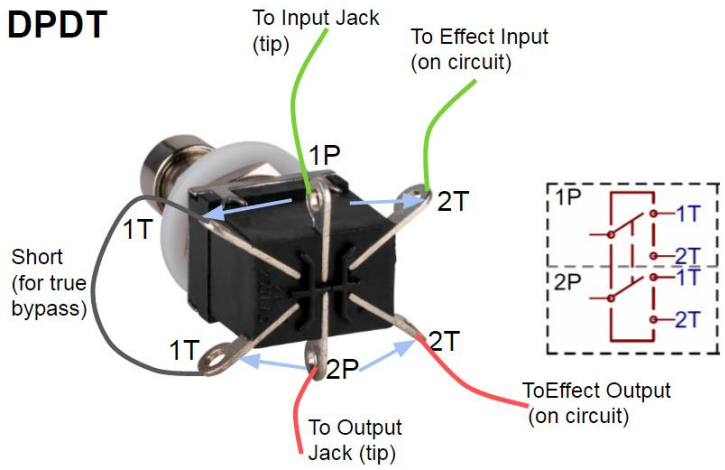

**Potentiometers**

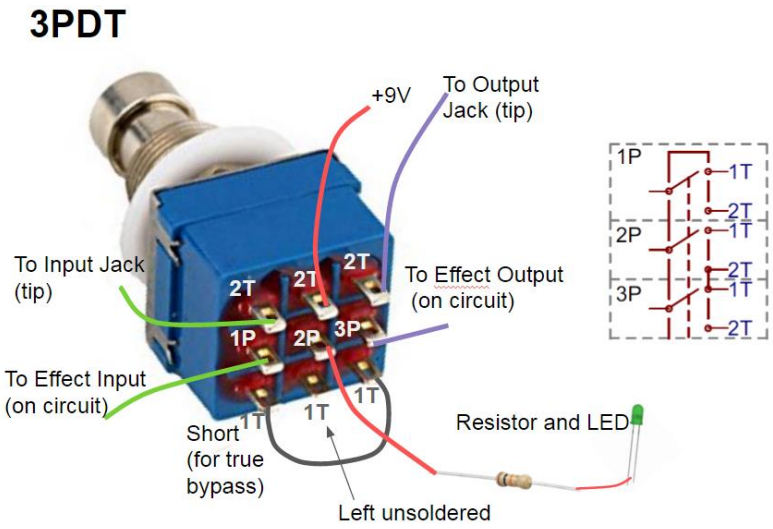
A potentiometer, pot for short, is a three terminal passive device. It acts as an adjustable voltage divider when all three terminals are used, and as a variable resistor when only two terminals are used. Pots are denoted by their maximum resistance and how resistance varies as you adjust. A zero to 100KOhm logarithmically adjusted pot would be an A100K pot, and a linearly adjusted pot with the same value would be a B100K pot. The orientation, circuit symbol, and equivalent circuit for pots are as shown to the right.



**XPYT (X Poles, Y Throws) Switches**

In switches, an incoming current is connected to a “pole”, which can be connected to different “throws” (or positions). This directs the incoming current onto different paths in a circuit. An XPYT switch controls all X poles (and therefore X incoming currents) together with a single toggle. Each pole has Y number of positions, or possible paths. For our projects, we will be using double pole double throw (DPDT) switches and 3 pole double throw (3PDT) switches. The wiring of these are as shown below.

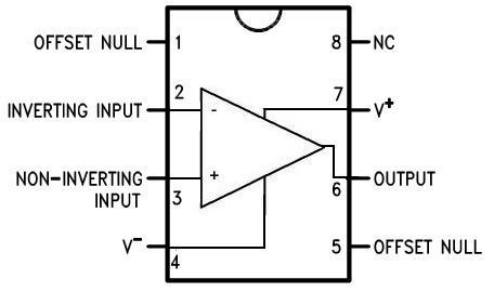


# Step By Step

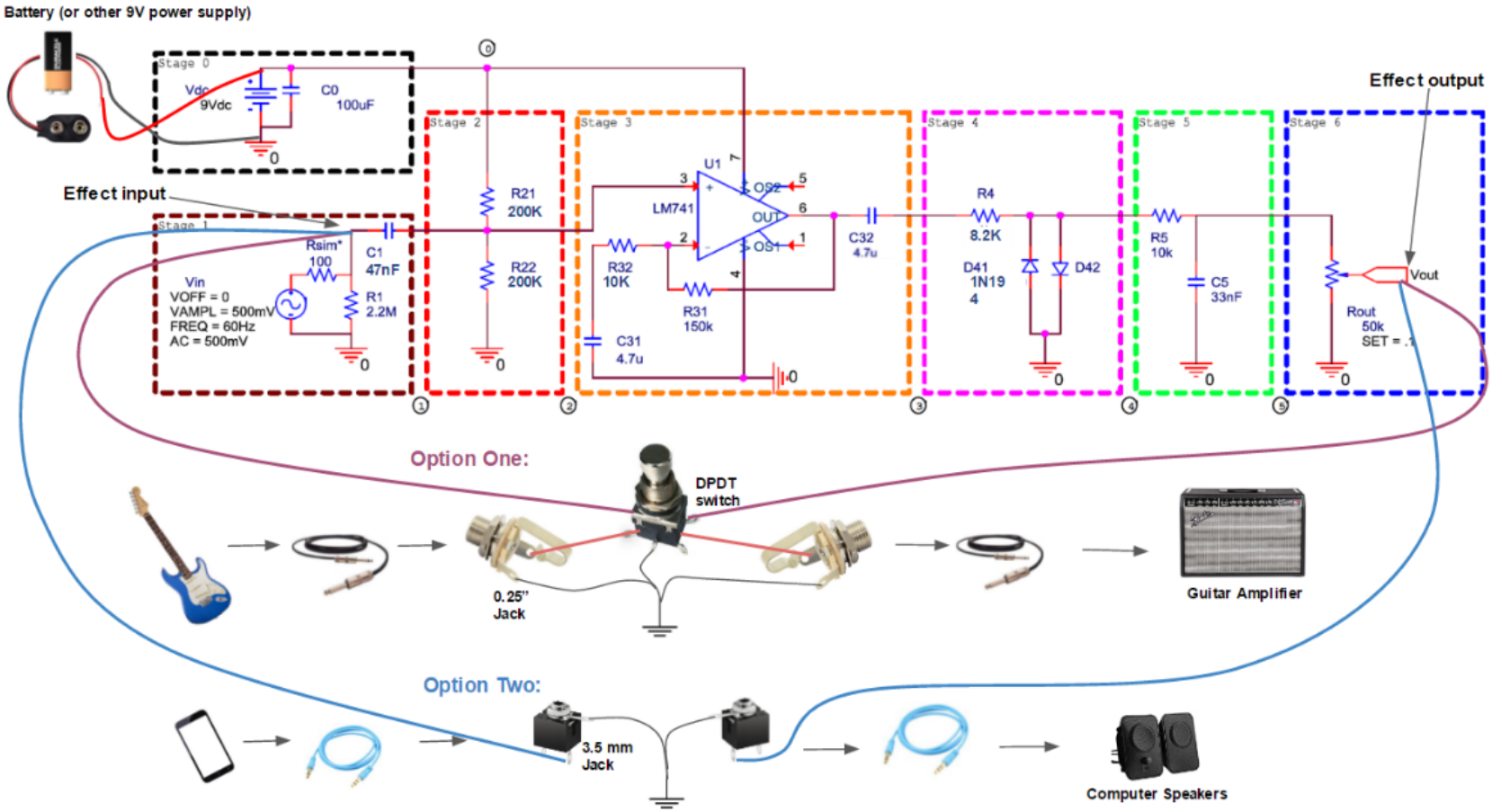
1. Follow the diagram in the next page, and solder solid core wires to the hardware components as needed. You can choose Option One if you plan on mostly testing with a guitar, or Option Two if you plan on mostly testing with an aux input and speakers.
2. Build the rest of the circuit on the breadboard using a 9V power supply. Use the function generator to send in a 150mV sine wave to model an audio signal. Any frequency within the audible (20-20kHz) range is acceptable, although frequencies at the lower and higher ends will be harder to hear when plugged into speakers.
3. Connect an o-scope probe to node 1 and take a screenshot. Now, add a +3V DC offset to the input signal and observe if there are any changes to the output at node 1. **Have this step checked off.**
   Q1: Can you guess the functions of C0 and C1?
4. Change the input signal back to one with 0V offset and build Stage 2. Connect the o-scope to node 2 and look at the output.
   Q2: What did Stage 2 do to the signal? What's the name of this structure?
5. Build Stage 3 using the pin diagram below. Using two o-scope probes, compare the signals at the immediate output of the op amp, and at node 3 (after C32). **Have this step checked off.**
   Q3: How do R31 and R32 determine the gain of this stage?
   Q4: How do R32 and C31 affect the output signal of this stage?
   Q5: What was the purpose of Stage 2 and what is the purpose of C32?

**LM741 Pinout Diagram**




6. Build Stage 4 and take a screenshot of the output at node 4.
   Q6: What is the purpose of Stage 4?
7. Build Stage 5 and take a screenshot of the output at node 5.
   Q7: What is the purpose of Stage 5?
8. Build Stage 6. This time, plug in a real audio signal for the input and plug the output of the circuit to speaker or amplifier. Play whatever you like, whether from a guitar or your phone, and adjust the 50K trimpot until the output volume corresponds reasonably to the input volume control. If the sound is too cut up or there is no output, experiment with the values for R31 and R32. **Have this step checked off.**
   Q8: What is the purpose of this last stage?
9. Listen to the effect, then take out or change the values for C5. Hear the difference. Which sounds do you like more?

**BLUE CLIPPER BUILD DIAGRAM**




*Rsim must be used for PSPICE simulation only, exclude it from the actual circuit

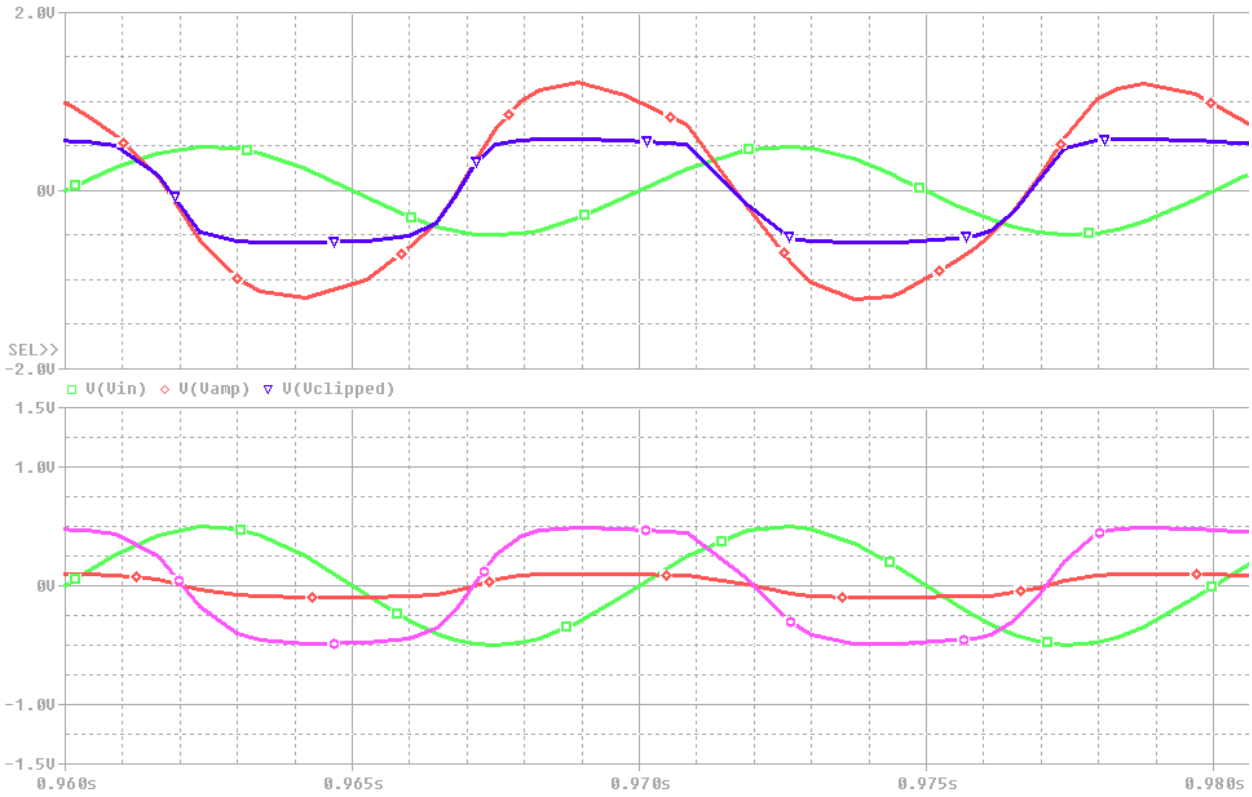
# Simulations and Screenshots

The PSpice simulations were made by Josh Ma, and the o-scope screenshots taken by the PiB team while the project was still in progress. Your results should look similar to these but most likely not exactly the same.

**PSpice Simulation**

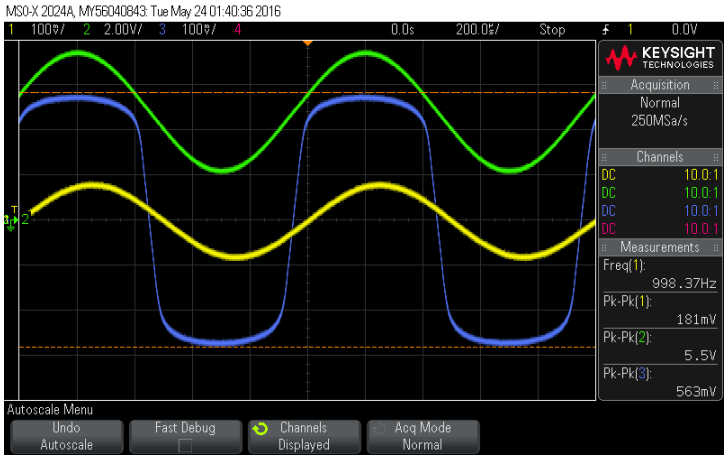
Top: Green = Input Signal, Red = Output at node 3, Blue = Output at node 4

Bottom: Green = Input Signal, Magenta = Output at node 5, Red = Final output with trimpot 0.1 position (90% CCW, 10% CW)

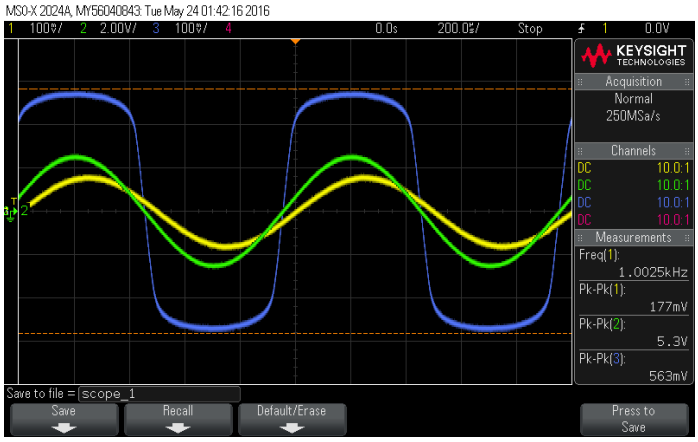


**Oscilloscope Screenshots**

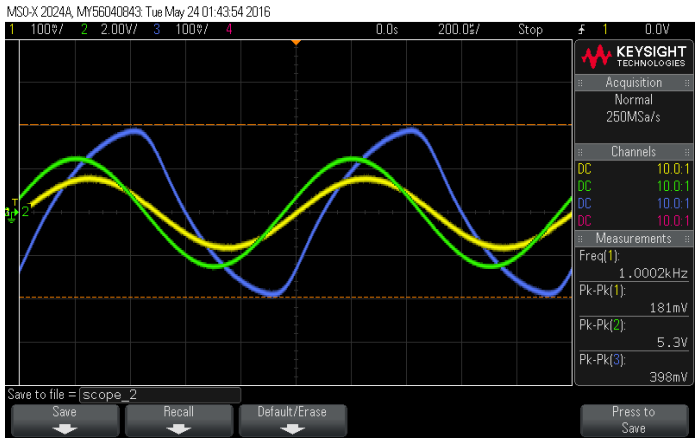
Input: 150mV at 1KHz, 0 offset Sine Wave




Yellow = Input, Green = Output Immediately after Op Amp, Blue = Node 4




Yellow = Input, Green = Node 3, Blue = Node 4




Yellow = Input, Green = Node 3, Blue = Node 5

# References

Original Schematic Found Here:
http://www.tonepad.com/project.asp?id=49

Switch Basics:
https://learn.sparkfun.com/tutorials/switch-basics/poles-and-throws-open-and-closed

If you would like to solder your effect onto a board:

- you could refer to Colin's tutorial for PCB design
- try VeeCAD Stripboard Editor:
  http://veecad.com/