Analog Guitar Overdrive Pedal

PART NO. 2176106

A solid-state overdrive/distortion effects pedal for guitar and other musical instruments. By including or leaving out optional components (included) this pedal can be "tweaked" by you, the builder, during assembly to deliver tones for blues or rock. Or try your own parts to build an effect that is uniquely your own!

Features:

- True bypass switching: won't alter your tone when switched out
- LED indicator
- Die-Cast metal case for durability
- Knobs control Drive and Level independently
- Builder-customizable design for musical flexibility
- All parts, circuit board, drill templates, and troubleshooting guides included.

Time Required: 3-4 hours depending on experience

Experience Level: Intermediate

Required tools and parts:

- Soldering Iron and Solder
- Needle-Nose Pliers or Hemostat
- Wire Cutter (side cutters)
- Wire Stripper
- Drill bits and drill for drilling metal case (drill press recommended)
- Voltmeter (optional, but recommended for troubleshooting)

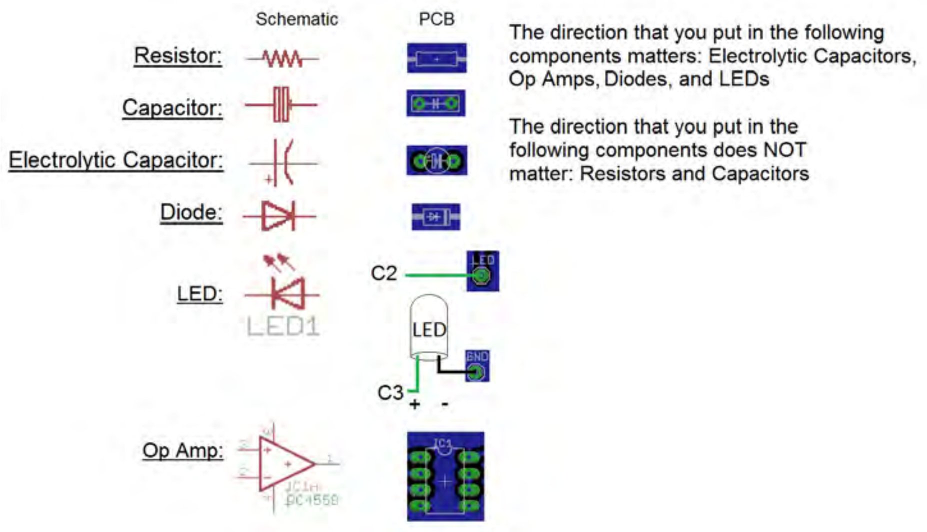
Bill of Materials:

Qty	Jameco SKU	Component Name
1	11965	Aluminum Case
1	251125	RC4558 Dual Op-Amp, 8 Pin DIP
2	286302	100K Pot, Linear
1	281738	1/4" Audio Jack (Mono)
1	281746	1/4" Audio Jack (Stereo)
1	333973	Unicolor LED
1	23077	LED Holder
1	151116	0.1uF 25V Disk Capacitor
1	330431	1uF 25V Electrolytic, Radial Pkg
1	15190	0.001uF 50V Ceramic Disk Cap
1	15405	22pF 50V Ceramic Cap
1	15229	0.01uF 50V Ceramic Disk Cap
2	691585	1.0 Meg Ohm Carbon Film 1/4Watt
1	216427	9V Battery Holder
4	126981	Rubber Feet
2	264990	Knobs
1	526299	8-Pin DIP Socket
1	691024	4.7K Ohm Resistor, Carbon Film, 1/4 Watt
1	691489	390K Ohm Resistor, Carbon Film, 1/4 Watt

2	36038	1N4148 Silicon Diode
1	690865	1K Ohm Resistor, Carbon Film, 1/4 Watt
1	151590	DC Power Jack
1	35991	1N4004 Silicon Diode
1	2181415	Stomp Switch, 3PDT

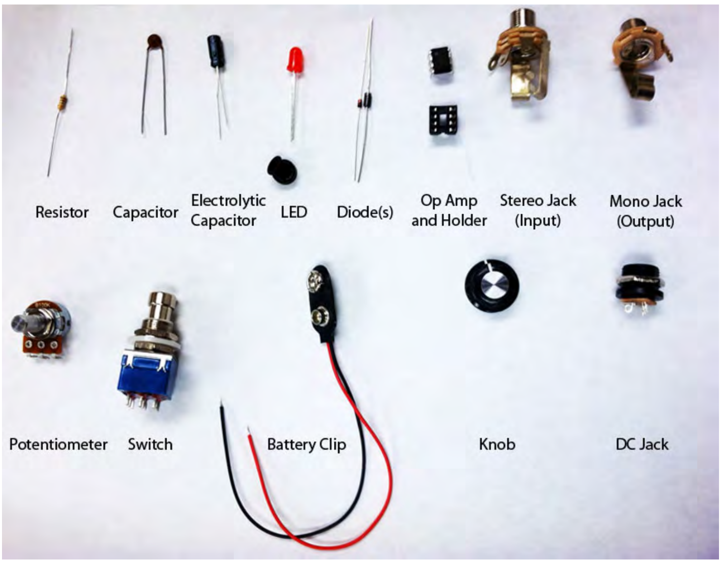
Step 1 - First Things First

1) If you're new to this kind of thing, familiarize yourself with the key.
2) Check to see if you received all your parts.
3) Some extras you'll need:
   - Soldering Iron
   - Solder
   - Wire
   - Drill and drill bits (1/2", 3/8", 5/16", 1/4")
   - Voltmeter (optional)



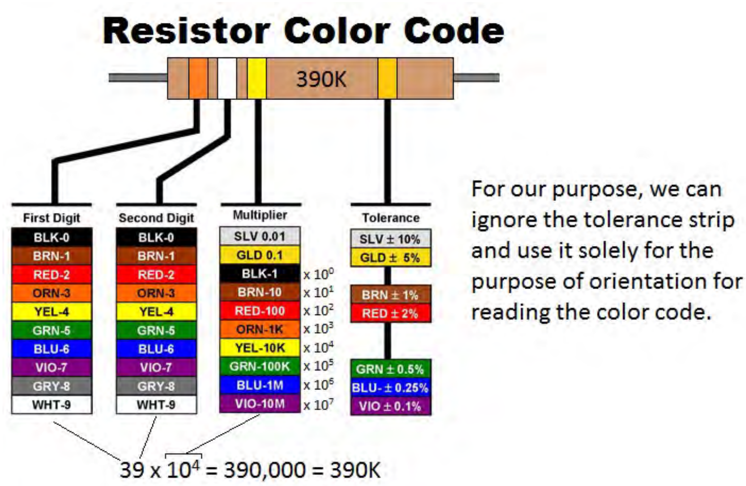
Step 2 - Getting Familiar

Familiarize yourself with the parts key.



Step 3 - Getting Familiar (Cont.)

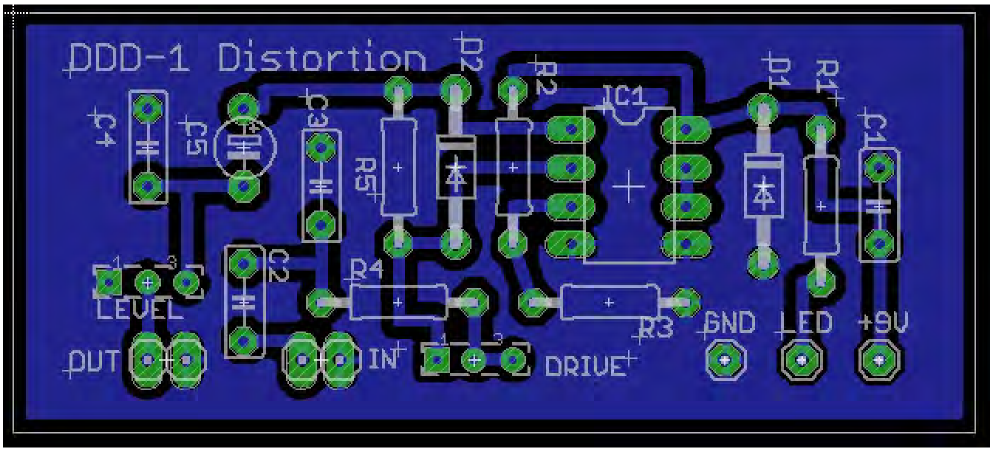
Use this color key to find resistor values



Step 4 - Assemble Circuit

Insert components in circuit board, referring to the parts list and circuit board labeling. All soldering is to be done on the copper side of the circuit board. Allow the soldering iron to warm up before starting. Once heated, proceed with soldering to the circuit board. Joints should be shiny and isolated (don't bridge connections).

Use caution installing the two diodes and the one electrolytic capacitor (C5). These parts must be oriented correctly according to the diagram.



Resistors:
R1 = 1,000 ohms = 1k
R2 = 1,000,000 ohms = 1 Meg
R3 = 1 Meg
R4 = 4.7k
R5 = 390k

Capacitors:
C1 = 0.01 uF
C2 = 0.1 uF
C3 = 22 pF
C4 = 0.001 uF
C5 = 1 uF

Diodes:
D1 = 1N4004 (the fatter, black one)
D2 = 1N4148 (the smaller, narrower one)

Chip:
IC1A = RC4558

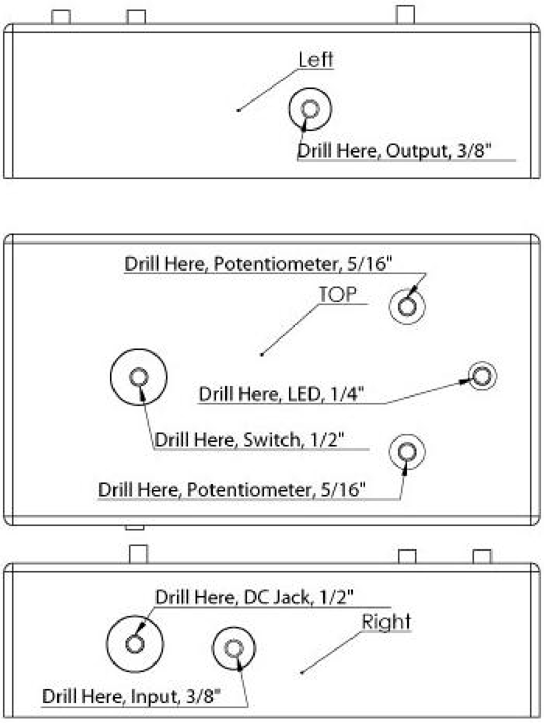
Step 5 - Drill Case

Drill bit sizes:
In/out Jacks: 3/8 inch
Both Potentiometers: 5/16 inch
LED: 1/4 inch
Switch: 1/2 inch
DC Power: 1/2 inch

First, print out the provided drill template. It should be the same size as your case so that you can cut and tape it to remain centered during the drilling process.

Then, drill pilot holes (using a 1/8" drill bit) at the indicated locations.

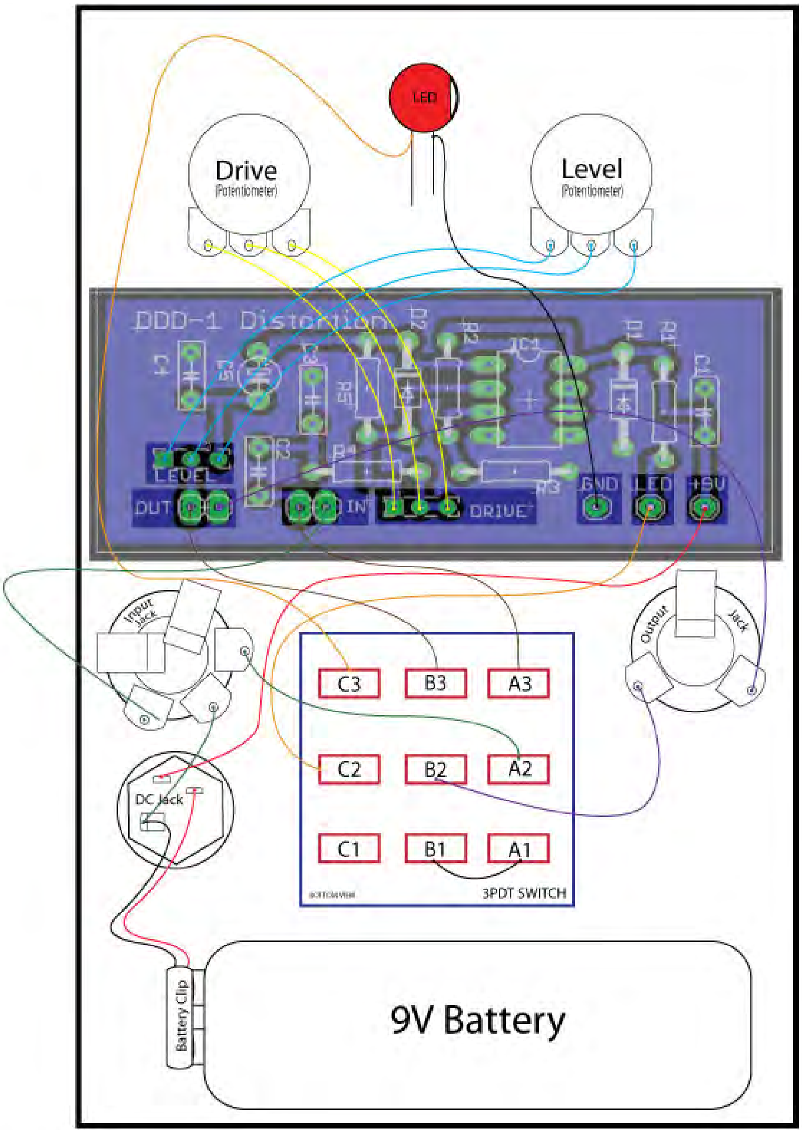
Finally, drill case as indicated in diagram, using the appropriate drill bit sizes.



Step 6 - Point to point wiring

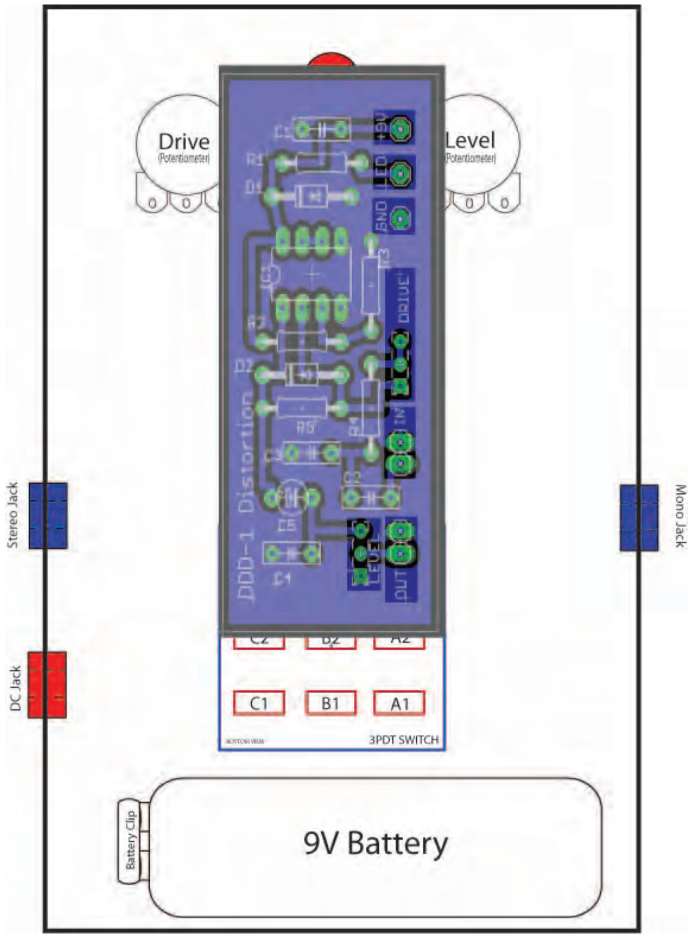
Follow the provided diagram carefully. Be sure to cut appropriate wire lengths (not too long or short). Color coding your wires is helpful, but not necessary. The color of the wire does not affect the circuit in any manner. Strip about 1/4-1/2 inch of the insulating layer off each end of the wires so that the metal is exposed. This is necessary to correctly solder. When connecting wire to the external components (i.e. jacks, switch, etc.) use "mechanical" connections before soldering. In other words, "wrap" the wire through the loop and back around so that it is physically stable. Then, proceed in soldering, so that the electrical connection is properly made.

Be careful to wire the switch with the correct orientation. In the diagram, the prongs should direct horizontally.
Correct prong orientation: --- --- ---
Incorrect prong orientation: | | |
Also, make sure that the switch rests in the case with the push-button side pointing out.



Step 7 - Placement Diagram

Shown in this picture is the spatial orientation of the fully assembled pedal, as seen from the bottom. The wires in the diagram have been removed for clarity, but will obviously be present in the pedal by this step. A piece of electrical tape covering the soldered side of the printed circuit board (PCB) will act as a good insulator against accidental grounding with the aluminum case. The PCB can be placed as shown, or in any convenient way so as to allow the bottom lid to be securely fastened. Again, the electrical tape is good practice here to prevent accidental touching of the solder joints to the enclosure. Otherwise you might get some nasty static noise and/or "popping" when hooked up to an amp.

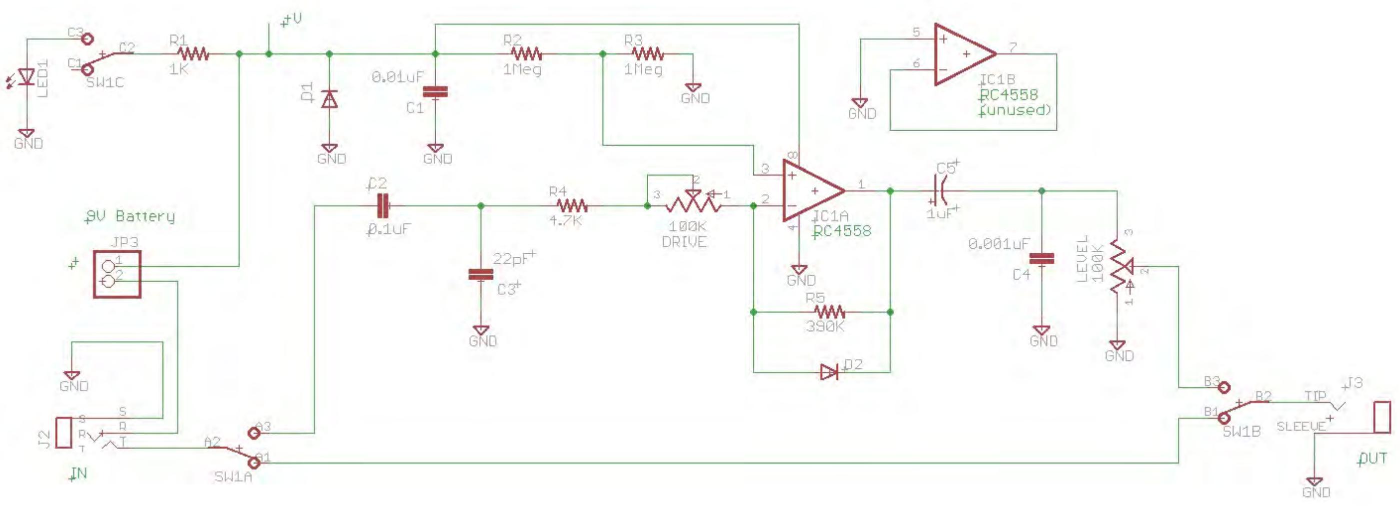


Step 8 - Troubleshooting

1) Power up the board with the IC (op amp) not in the socket. Confirm that the LED lights when the cable is inserted into the input jack. This "activates" the circuit by creating a metal to metal connection that functions as a switch. If the LED doesn't light, click the stomp switch. If it does not light after that, check all the solder connections. Make sure there are no loose solder joints or unintended bridges between connections.

NOTE: It is important to unplug your input cable when not using the pedal to preserve battery life. If left in, the circuit will stay on, and continue to use the battery.

2) Test voltage across pins 8 and 4 of the op amp socket using a voltmeter (+9V and GND). Looking from above with the circular indent at the top, pin 4 is the lower left pin and pin 8 is the upper right. It should read something close to 9V (polarity doesn't matter for measuring voltages, other than displaying positive or negative values). If all good, unplug the battery, insert the op amp into the socket, and play test. If it doesn't work, confirm that all the parts are installed correctly according to the given diagrams.



Step 9 - Circuit Explanation

So what is actually going on in this circuit? Our guitar is supplying us a sinusoidal signal, the harder you strum, the further the strings displace from their resting position, and the amplitude of the sine wave increases. This pure sine wave is what musicians label "clean", the pure signal not altered in any way (except by the limited controls on the guitar itself). This signal is transferred through the cables to the pedal, in which it goes through a variety of transformations and manipulations that, when finished, outputs a distinctly different sound. This "wave shaping" can be done in a variety of manners, hence the numerous variations of pedals on the market today.

This particular overdrive pedal uses analog components solely (as opposed to digital, programmable components combined with analog components) to distort the clean sine wave at the input into a more or less square wave at the output. The operational amplifier (op-amp for short) is the main tool in the toolbox for this type of shaping. As the name implies, the op-amp takes in an input signal (voltage) and amplifies it by a gain factor, controlled by the ratio of two important resistors, namely the input resistor and the feedback resistor. If this ratio of resistance values changes, the gain factor must also change. By fixing one resistor, but allowing the other to vary via a potentiometer (a variable resistor controlled by the user, typically using a knob), the outputted signal can change from clean to extremely distorted and everything in between.

With this background, let's discuss gain in more detail now. Gain is typically thought of and represented as a multiplier, written #X. For example, to maintain a "clean" sinusoidal signal through our circuit, we don't want any "wave shaping" to occur. Hence, we want the gain of the op-amp set to 1X, since multiplying the amplitude of the signal by one doesn't alter it any way. Conversely, if we wanted a good amount of distortion, we might set the gain to, say 300X. So far we've hinted at this dependency between gain and distortion, but why exactly is that the case? Well, the op-amp has a useable voltage range, typically symmetric about zero volts. Anything above or below these boundaries (called "rails" in circuit talk) gets clipped and turns into random unintelligible noise. In most circuits used for scientific analysis, noise is enemy number one. For musicians, it may just well be our best friend. Distortion is simply the effect of a "railed" op-amp, where the gain is set high enough such that the inputted signal gets clipped. The amount of distortion outputted from this pedal directly correlates to the amount of clipping done by the op-amp.

We mentioned that a railed op-amp clips symmetrically. This is true in the bare bones configuration, when only a resistor is found in the feedback loop. By adding certain components to the feedback loop, we can effectively change the boundaries that clipping occurs at so that they are no longer symmetric. This is called "asymmetric clipping" and is achieved in this pedal by adding a diode to the feedback loop. Diodes are directionally dependent, so two different sounds (however subtle) can be achieved with this one diode simply by switching the direction when installed. If you prefer the sound of distortion via symmetric clipping, go ahead and leave the diode (D2) out of the circuit. No harm will be done so long as the bare bones configuration is preserved (that is, there must always be a resistor in the feedback loop!).