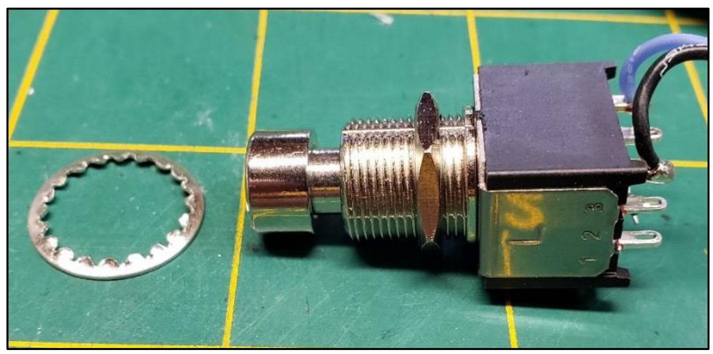
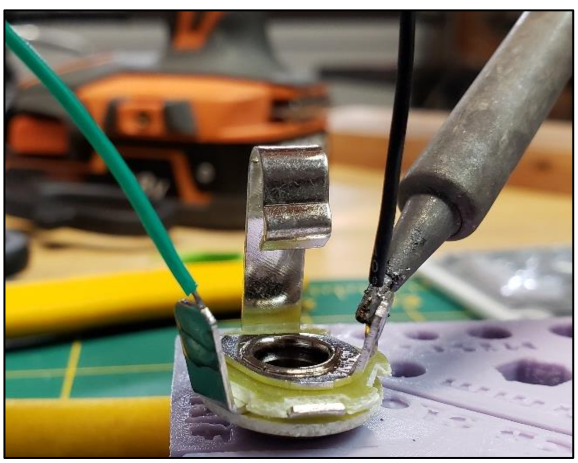
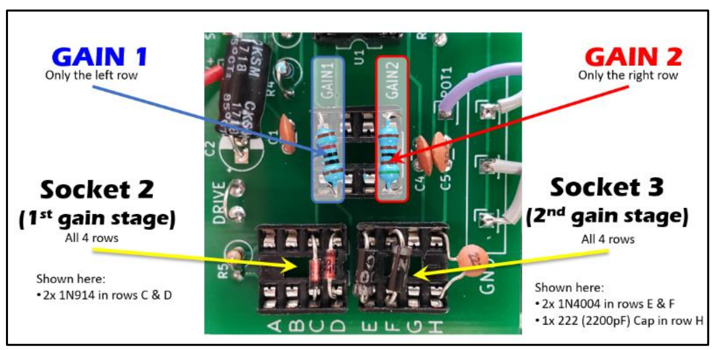
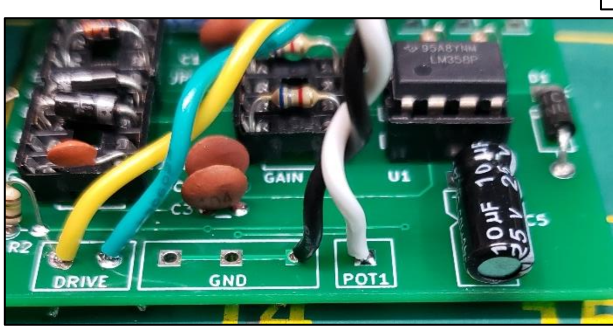
AUSTINDRIVE PEDAL

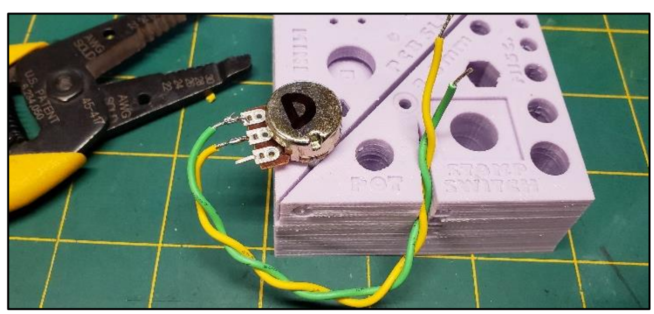
DIY PROJECTS











QUICK START GUIDE:

(These links skip-over some of the explanation, and get right to the instructions.)

This is a true DIY Pedal, designed to introduce some concepts of circuit design, and help people become curious about building their own equipment.

Release of Liability Notification - Please Read This:

You will be soldering, using a sharp razor blade, scissors, cutting and stripping wires, and in some cases, drilling the metal enclosure. There are dangers involved - based solely on the tools you are choosing to use, and your experience using them. This is not a learning manual for using these tools. Avoid breathing fumes from your solder, flux or paint, and try to use lead-free ("RoHS") solder whenever possible.

Personal Protective Equipment (PPE) is a MUST for this project.
Do not take risks that could cause injury – especially to your eyes or hands – while building this pedal.

Your fingers can be permanently damaged from heat or sharp objects, and that's not good for a guitar player. Don't "*feel if this is sharp*" by running your fingers around the drilled holes. You might also step-on metal shavings from your drill or poke yourself with tiny wire leads. Cutting-off legs of the components can shoot tiny pieces of metal across the room or into your face and eyes… or someone else's. Please use caution, wear safety glasses, and reduce the chance of injury wherever possible.

Doing this project by yourself is not required. It is optional.
Fully complete AUSTINDRIVE pedals are available for purchase at www.AustinMics.com/austindrive

The individual, common parts in this kit and the words in this document cannot hurt you. The parts you have received are not hot, there are no cutting tools or solder included in the kit. As-shipped, the parts are passive and de-energized, and pose no harm without substantial, intentional effort and energy from you. You are choosing how to handle and use these parts in ways that I cannot predict, and do not have any control over. Use of these parts and instructions is at your own risk.

By choosing to use these instructions and assemble the parts provided, you have just assumed all liability and risk, releasing Austin Microphones and Rick Wilkinson from damages and/or liability.

Please contact me for details.

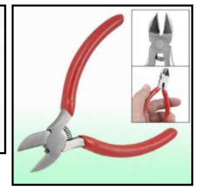
TOOLS AND PREPARING FOR YOUR BUILD

1. You should have some soldering skills.

Like our DIY Ribbon Microphone & Preamp Kits, The AUSTINDRIVE is designed to be an easy weekend project. However, some prior experience with solder and circuit boards really helps. If you've never soldered anything before, search "soldering" videos on YouTube, and read this short comic book before you start.

2. You should have a real soldering station.

You don't need a $200 pro station, but cheap $9 irons are not good enough. eBay and Amazon often have temperature-controlled stations with a sponge and stand for under $40.



3. You need a few tools and safety glasses

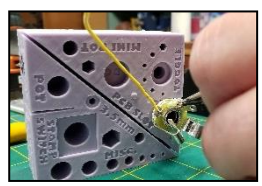
To strip the insulation off the wires, and cut the legs off components, you need a **wire stripper tool** for small wire, (22-30 AWG) and diagonal cutters (AKA "dikes")
(Each is $5 to $25 online or at hardware stores.)
Diagonal cutters can shoot the metal legs of components across the room when you cut them, so make sure you WEAR eye protection too.
You'll also need **sharp scissors** and **a Hobby Knife** (AKA: "X-Acto" knife) for the graphics label.
Not required, but helpful: **Needle-Nose Pliers**, for bending and swapping components when designing your tone.

4. Get a $10 Multi-Meter, or better.

A multimeter is required to verify resistors if you have trouble recognizing colors or reading the small print on components. Again, you don't need a $500 professional meter. Entry-level, imported multimeters can be purchased for under $20 from eBay or local hardware stores. If you cannot read component values, or need to troubleshoot your circuit, you must use a meter.

5. Find an area to work where you won't ruin your tablecloth or counter top.

Don't start your weekend with a burned tablecloth or scratched countertop. If you have no other choice, lay down some protection before you start. You can even use a kitchen cutting board or the cardboard box your kit came in.



6. Magnification and *The Pedal Port* are highly recommended

The parts are small, so a headband magnifier works well.
The Pedal Port grips parts and PCBs during soldering.

7. This project takes 3 to 6 hours, depending on your skill level.

You do not need to do it all in one evening. You can break it up over a few nights. Follow the instructions, check-off the boxes, and you can easily build the AUSTINDRIVE.

8. You need a "Center Negative" 9V DC Power Supply (made for pedals), or a 9V battery.

The kits include a 9V battery adapter clip that enables the use of a battery with the DC Jack. The pedal draws about 28mA when "ON" – mostly to light-up the LED indicator. Good batteries should last for 10 hours or more of playing time.

NOTE: A "standard" 9V power supply from another product won't work. Most supplies are usually "center positive." Get a power supply for guitar pedals. The circuit is diode protected when assembled correctly, but a large, incorrect power supply could damage that diode.

CIRCUIT DESIGN

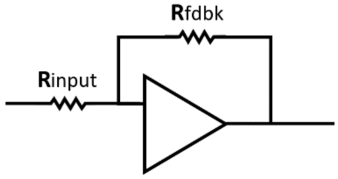
This is how this circuit works: (It's simple… really!)

<u>Short version:</u> Two amplifiers amplify and clip-off the peaks of the waveforms, resulting in distortion.

"Clipping" is literally cutting-off the tops and bottoms of a signal.

In this circuit, the gain or "drive" of each stage is defined by the builder changing the GAIN 1 and GAIN 2 resistors. The simple math for defining voltage gain in each stage of an Operational Amplifier ("Op-Amp") is:

$$\text{GAIN} = \frac{R_{fdbk}}{R_{input}}$$



Where **R***input* is the input or "GAIN" resistor, and **R***fdbk* is the "feedback" resistor.

In this circuit, the **<u>R*fdbk* is fixed at 100k</u>**, but the builder chooses the values for the **R***input*: The "GAIN" resistors.

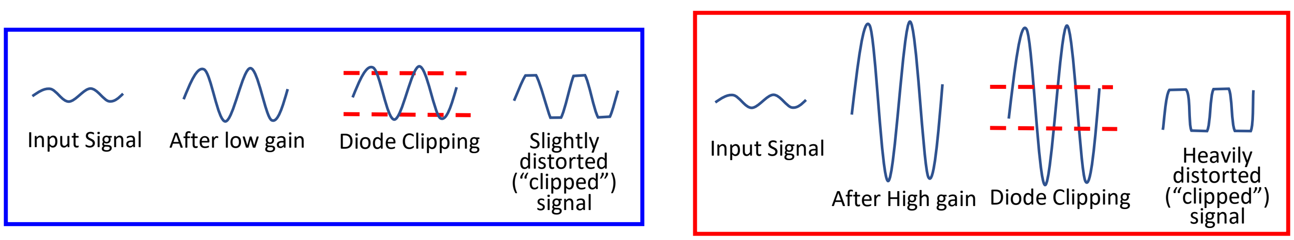
- When a 10k resistor is chosen as the GAIN resistor, the voltage gain is 100k ÷ 10k - a 10x gain (amplification)
- If a 5k resistor is chosen, the gain is 100k ÷ 5k – a 20x gain (amplifies 20x).

In other words, for every millivolt that goes in, 10mv (or 20mv) comes out. Your choice.

However, we are here to <u>*distort*</u> the signal. We don't want clean gain, we want <u>*dirty*</u> gain. That is where the "clipping diodes" come in. The amplified signal goes into the clipping diodes which distorts it like this:

A diode allows voltage to pass in one direction but blocks it in the other direction. That blocking happens at different voltages in each of the 3 types of diodes included in this kit. With 2 diodes facing the opposite direction in the feedback circuit, the voltage peaks are literally "clipped-off," resulting in distortion of the signal.

- When you amplify the signal just a little (low gain), just the very tips of the peaks are clipped-off.
- When you amplify the signal a lot (high gain), a lot of the peaks get clipped and it is more distorted.
- The more the peaks are "squared-off" the more "distorted" the signal sounds:



We are also limited by the 9-Volt power supply, or 4.5v on each side of the waveform. If the diodes do not clip-off enough signal, then the Op-Amp will clip the signal as well.

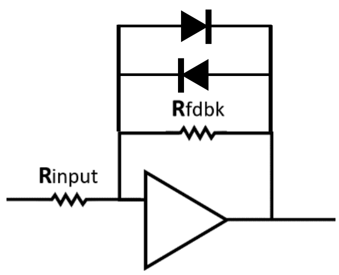
This circuit generates distortion at 4 different points in this circuit: 2 sets of clipping diodes, plus 2 Op-Amps. The distortion from Gain Stage 1 passes into Gain Stage 2, so if you clip the signal heavily in Gain stage 1, Gain stage 2 will clip it even more. Different Op-Amps can also sound different when they clip, based on their internal circuitry.

THEORY OF OPERATION (Numbered on the next page)

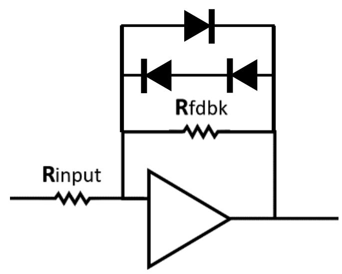
1. The 9V power circuit is completed (powered-on) when you insert a guitar cable into the input
2. The signal from the guitar goes through two poles of the 3-Pole, Double-Throw (3PDT) switch
3. The switch either jumpers the signal directly to the output (“True Bypass”), or to the drive circuit
4. Through the drive circuit, the signal passes through a DC-blocking capacitor, C1
5. If a drive knob is installed, signal is reduced by a C250k, reverse-logarithmic potentiometer
6. If a drive knob is not installed, a jumper is installed instead.
7. The signal passes through the GAIN 1 resistor, which defines the gain for Op-Amp #1 (previous page)
8. It enters Stage 1 of the op-Amp, U1 on Pin 6.
    - This is the “inverting input” of this Op-Amp, and it flips the phase 180°
9. The feedback loop contains the feedback resistor R1, and clipping diodes which clip the peaks of the signal
    - If there is high gain in the circuit, more clipping happens = more distortion in Gain Stage 1
    - Also, different diodes clip the signal differently. (“Hard” or “Soft” clipping here.)
10. The distorted signal comes out of the first Op-Amp on Pin 7
11. The signal goes to the GAIN 2 resistor, which defines the gain for Op-Amp #2 (previous page)
12. Before going into the next Op-Amp, the signal passes through another DC-blocking capacitor, C2
13. Like Gain Stage 1, the signal enters Gain Stage 2 of Op-Amp, U1 on Pin 2
    - This is also an “inverting input”- so the phase flips 180° again, restoring the correct phase
14. The Gain Stage 2 feedback loop contains a feedback Resistor R2, and clipping diodes
    - More gain here distorts the signal more, especially if it was heavily distorted by Gain Stage 1
    - Also, different diodes clip the signal differently. (“Hard” or “Soft” clipping here.)
15. The second gain stage socket also has room for a **filter capacitor**, which will reduce high-frequencies
    - With no capacitor here, all frequencies are allowed to pass through to the output
    - As this capacitor value gets larger, more high-frequencies are removed.
    - A capacitor tends to “smooth” the sound of the distortion, making it less “harsh”
16. Out of the second op-amp on Pin 1, the signal passes through a final DC-blocking capacitor, C3
17. The signal then enters a B250k linear potentiometer
    - When turned “up,” the signal passes through without any resistance, for the loudest volume.
    - When turned “down,” more and more of the signal is shorted to ground, reducing the output volume of the pedal.
    - This knob helps match the distorted volume to the clean (“True-Bypass”) volume.
    - The volume knob does not increase or decrease the distortion… only the output level.
18. The red LED is turned on/off with the pedal by passing voltage through the 3rd pole of the 3PDT switch

Notes to create a unique tone:

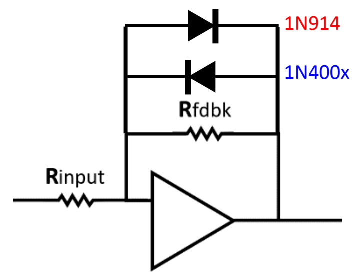
- Try a high-gain setup, then use a filter capacitor to reduce harsh high frequencies for a smoother tone
- Try different-value GAIN resistors, diodes, and capacitors with each of the 4 different Op-Amps
- You can mix/match diodes, or point 2 in one direction and one in the other, in parallel or in series.
- Two diodes in series clip the signal less than a single diode, also known as “uneven clipping”
- Some vintage pedals use these tricks. Here are some typical diode setups:



Standard, “Even” clipping with matching diodes

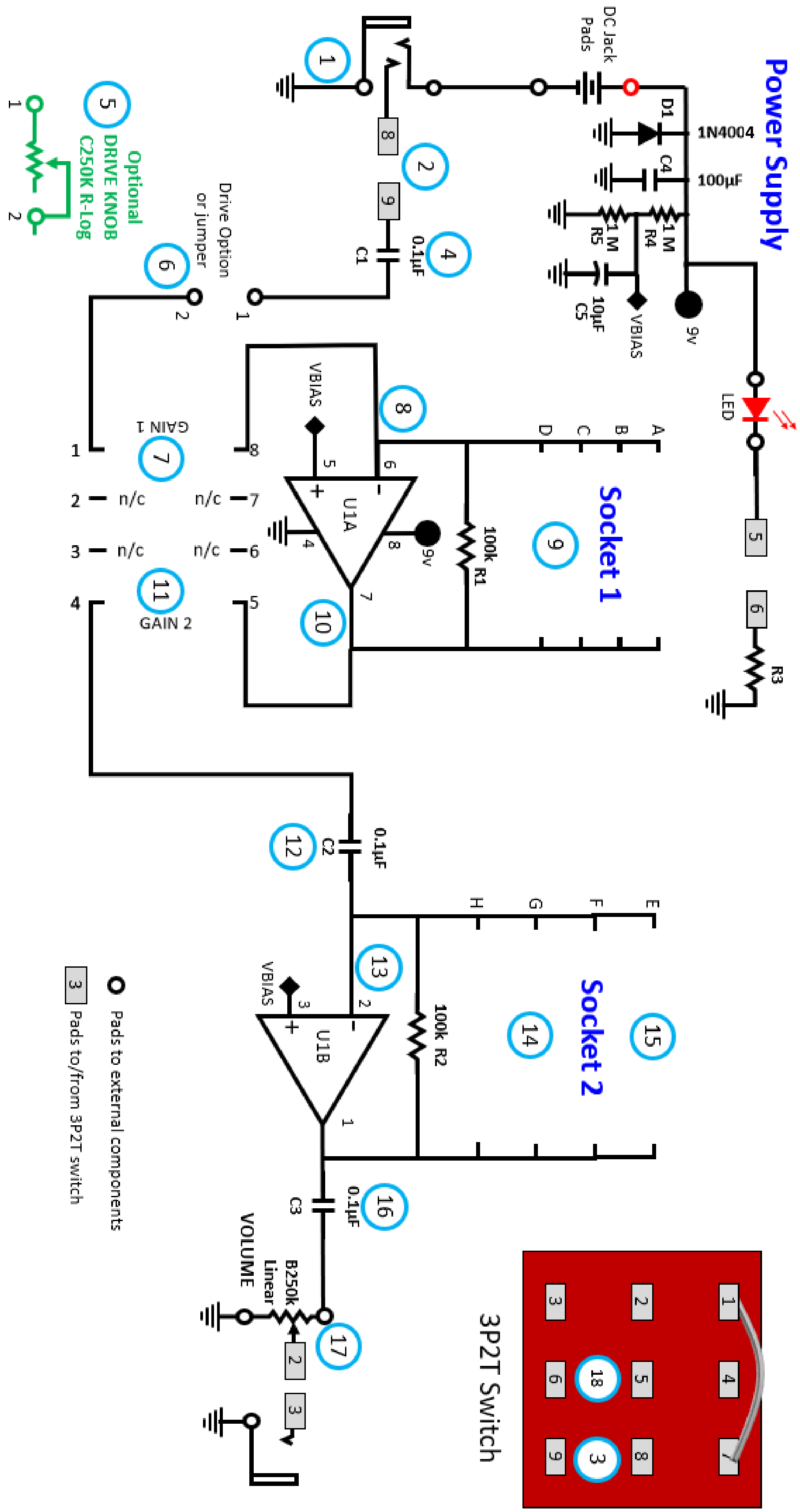


“Uneven” clipping with 2 pointing in one direction, and one pointing the other



“Uneven” clipping with 2 different diodes

Theory of Operation

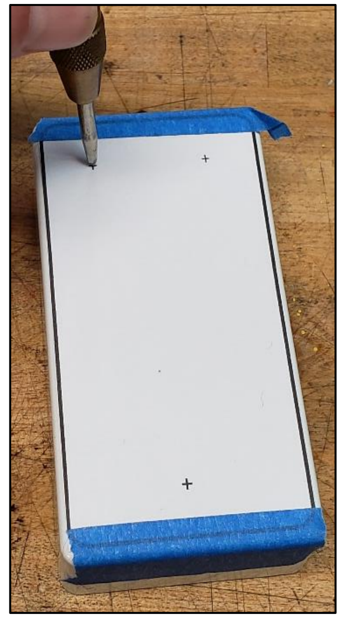


DRILL THE ENCLOSURE (Before any graphics are applied)

NOTE: Most kits come with pre-drilled enclosures, but a few "budget-friendly" kits do not.

I have drawn templates for marking the holes below. Print this page onto regular paper and cut them out around the outside edges.
I also have .stl files for 3D printing punch templates. Customers can email me for the link.

NOTE: IF YOU ARE DRILLING YOUR OWN YOUR HOLES WITH THESE PAPER TEMPLATES:
LOCATIONS MAY NOT BE *"ABSOLUTELY PERFECTLY"* ALIGNED.
There are variations between printers and programs, so if you are creating your own graphics: ***I strongly advise creating graphics that are not aligned to the holes.***



The top graphic (with 4 crosshairs) is intentionally smaller than the actual face of the enclosure, and must be centered by eyeball. Once centered, tape it down and center-punch the marks. I recommend using a spring-loaded center-punch.

Carefully remove the top template. Align the short edge near the switch crosshair (on the left below, in RED) with the end-face edge of the enclosure to mark the DC Jack

Use the INPUT/OUTPUT template to mark the input/output JACK locations, one on each side, at the correct end: *Near the switch.*

If my descriptions seem confusing, look at the photos to confirm.

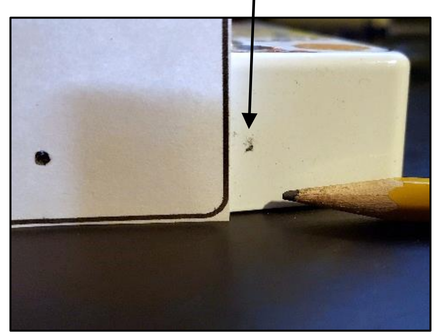
\+

\+ **Mark this center hole ONLY if you have a DRIVE knob!!** → +

TOP TEMPLATE

\+

Use the red crosshair to mark the DC jack location on this end face.



Open Side

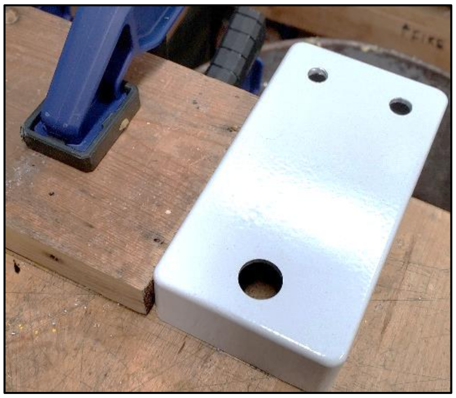
\+ +

INPUT/OUTPUT JACKS
(1 per side)

<u>While drilling the enclosure, block or clamp the enclosure so it does not spin.</u>

Keep the enclosure from spinning while drilling by pressing it against a piece of wood that is clamped to the table with clamps or heavy spring clips.

Clamped or Blocked to prevent movement while drilling.



Heavy-Duty spring clamp with rubber tips

Don't drill into your table! - The space under the enclosure must clear the table!!

Milwaukee Step Drill
P/N 48-89-9201
⅛ to ½ Inch (~$25)

<u>The hole sizes are:</u>

- LED ¼ inch (6.2mm)
- Volume/Drive Pot $^{9}/_{32}$ inch (7mm)
- Input/Output Jacks ⅜ Inch (9.5mm)
- Switch + DC Jack ½ Inch (12.7mm)

If you buy a step-drill as shown here, make sure it has all these hole sizes, or be prepared to use a round file to enlarge small holes.

APPLY THE GRAPHICS (Drill first, Label second!)

For workshops and customers designing their own graphics, use the AUSTINDRIVE Graphics Creator on Google Slides. Labels will be printed from your artwork.

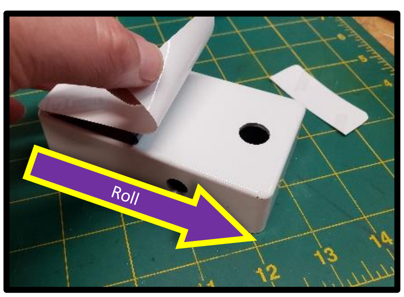
All other kits have a graphics label included, or search YouTube to learn how to make your own graphic labels without me!

Clean the face of the pedal with Isopropyl Alcohol and let it dry. However, do not wet the *label* or clean it with cleaners. The graphic may rub-off.

Use sharp scissors to carefully trim the edge of the included label around the outside, leaving the black line as the edge.

Before you remove the label backing, center the label on the enclosure and *lightly* tape it down across one side with painter's tape.

Leaving the painter's tape on one end, peel the backing on the opposite end, cut off a small section of the backing, and press that end of the label onto the enclosure.



Remove the painter's tape, then continue to peel the backing of the label, "**rolling**" the label onto the enclosure.

Spray the newly labeled enclosure with several coats of clear paint to seal the edges, and set aside to dry for at least 2 hours, preferably overnight.

Cut out the holes with an X-Acto knife or razor blade, cutting with *downward* motions to avoid peeling-up the label.

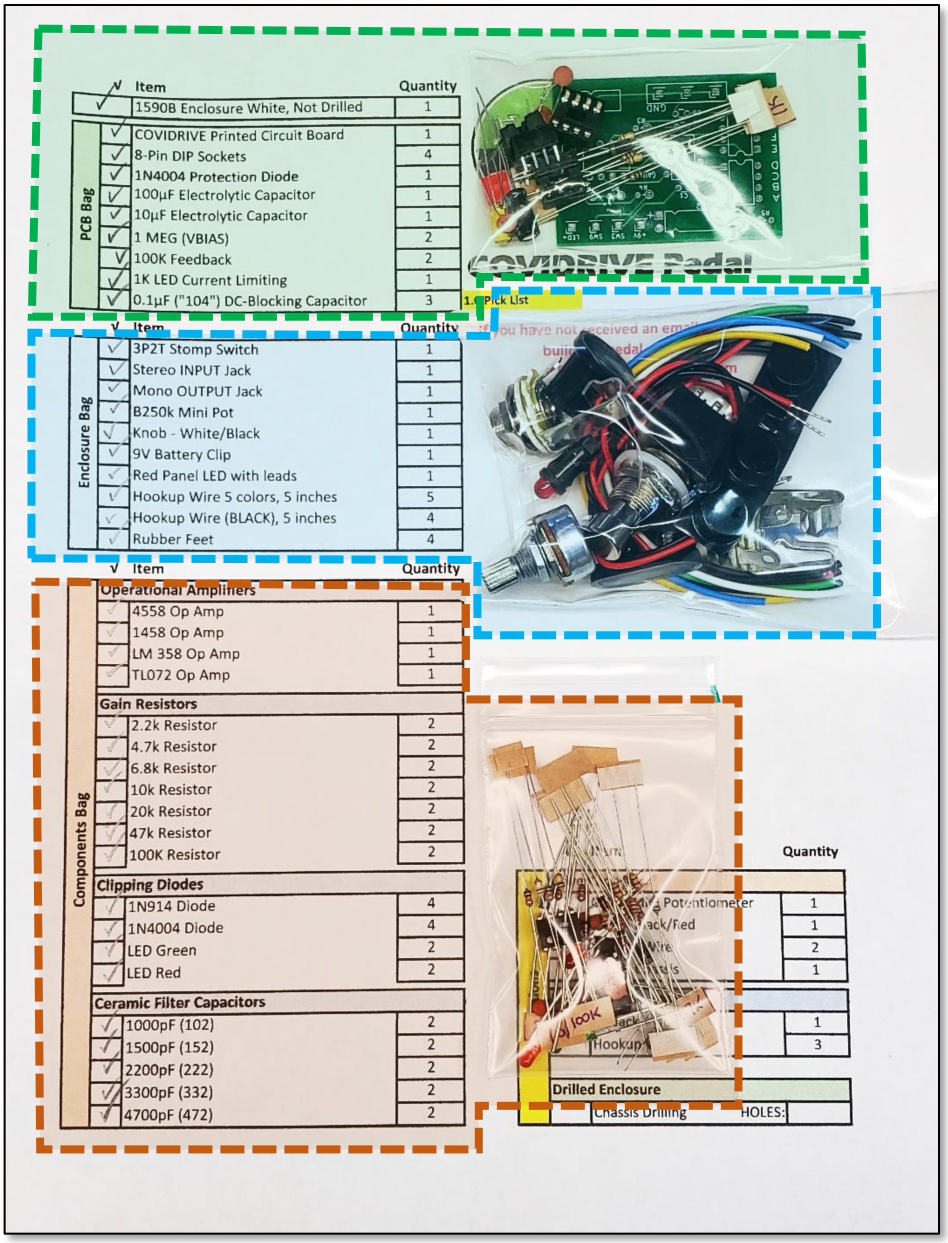
PREPARE YOUR PARTS AND WORKSPACE

Clean off your bench or prepare a nice workspace where you won't burn a kitchen tabletop or tablecloth. Having a nice area ahead of time really does help.

NOTE: There are 3 bags in this kit, plus the enclosure. (+ 1 bag if you ordered a Drive Knob)

- The PCB Bag has the green printed circuit board, sockets, and a few other parts in it.
- The Enclosure Bag has the jacks, switches, pots, and multi-colored wires in it.
- The Components Bag has ~40 resistors, capacitors, diodes, op-amps and LED's in it.

Because there are MANY different resistors included. You will need a meter to measure the resistors before soldering. I highly recommend a magnifying glass to verify your soldering, too.



STUFF THE CIRCUIT BOARD

Find the ***PCB Bag.*** It has the following components:

- 4) 8-pin Sockets
- 3) "104" (0.1µF) Caps
- 2) 1MEG resistors
- 2) 100k resistors
- 1) 1k resistor
- 1) 100µF Electrolytic cap
- 1) 10µF Electrolytic cap
- 1) 1N400*x* Diode (x= 1, 4 or 7)
- 1) Printed Circuit Board

Check-off each step in the check box at left

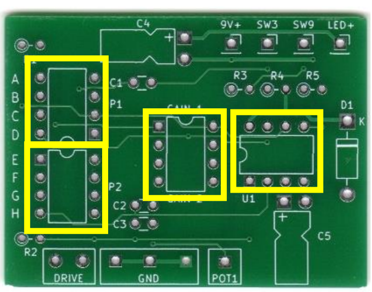
IMPORTANT:

Do not stuff *all* the components into the board, then try to solder them all at once.
Trust me on this: Too many legs make it *extremely easy* to miss soldering one!
Maybe do 2 or 3 at a time, solder, cut-off, and repeat. But not everything all-at-once.

Check-Off

☐

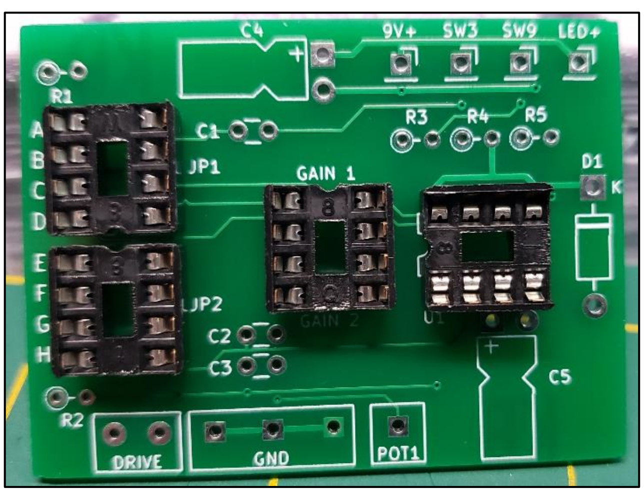
4 Sockets



8-Pin Sockets

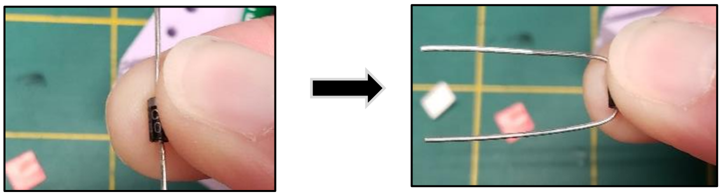
Install a socket into each location, one at a time.
NOTE: Legs can get bent during shipping. Just bend them back.
Each socket has a small "u-shaped" notch on one edge. Match that cutout with the notch printed on the board. On the back-side of the board, bend- the legs outward so that the sockets don't fall-out when you turn-over the board.

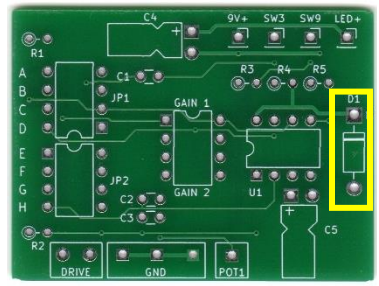
Solder all 32 legs now. It's great practice for everything else!



D1 (1N400x) Diode

Bend the 1N400x diode with your fingers so it fits in the holes.

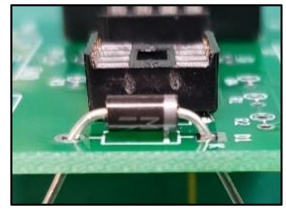




Check-Off

☐ D1

A diode is "polarized" and current only flows one way.
Put the diode through the holes so that **the stripe on the diode matches the stripe on the board**. Spread the leads slightly so that the diode stays in the board. Solder the leads from the back side, and cut-off the legs. This diode protects the circuit from reversed 9V leads or a bad Power Supply.



Save the two cut leads from this diode. Or from another component.
You will need them later.

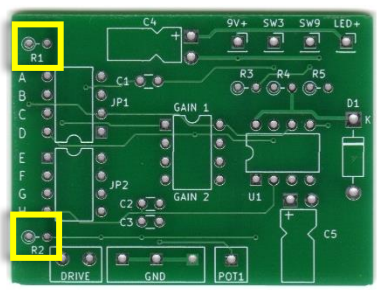
NOTE: Resistors are *NOT* "polarized." They can be installed and bent either way.

The bodies of the resistors may be tan, brown, or blue, depending on the manufacturer.

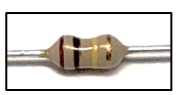
R1 & R2 (100k) Resistors

Check-Off

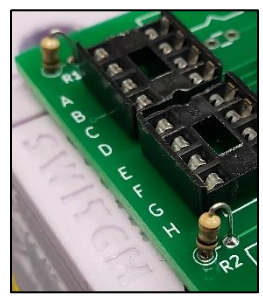
☐ R1 & R2



Bend one lead of each resistor back-over on itself, so that both legs point the same direction. Install the resistors upright.
These are fixed feedback resistors in the gain stages.



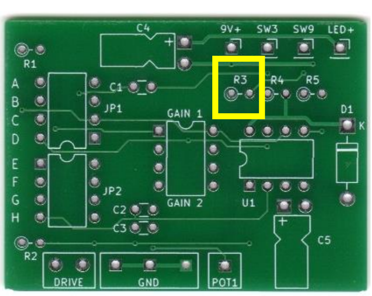
100k:
Brown Black Yellow



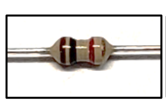
R3 (1k Ohm) Resistor

Check-Off

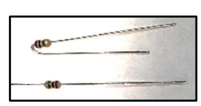
☐ R3



Bend one lead of the resistor back-over on itself, so that both legs point the same direction. Install the resistor upright.
This 1K resistor keeps the LED from burning-out.



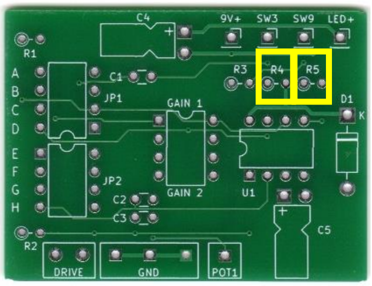
1k:
Brown Black Red



R4 & R5 (1 MEG) Resistors

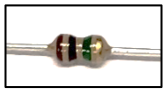
Check-Off

R4 & R5



Bend one lead of each resistor back-over on itself, so that both legs point the same direction. Install resistors upright.

These resistors divide the 9V equally into +/- 4.5v, to "center-bias" the Op-Amps.

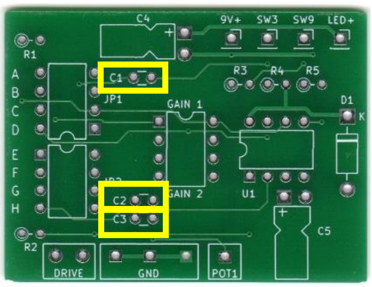


1 MEG:
Brown Black Green

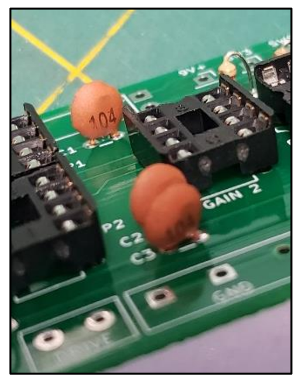
C1, C2 and C3 (0.1µF, "104") Ceramic Capacitors

Check-Off

C1, C2 & C3



Line-up the three 0.1µF (104) capacitors in the column near the center of the board. These capacitors block DC voltage from the audio stages. DC offset would alter the waveform in the next gain stage.

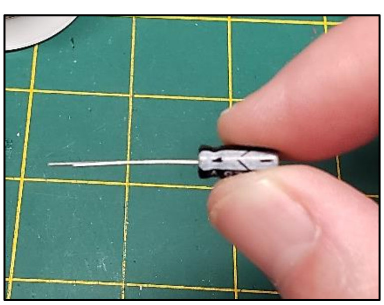


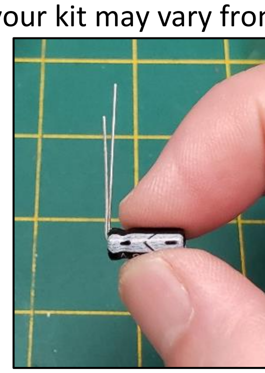
These capacitors are not polarized. They can be installed either way, but I like to have the "104" number facing the same way on all of them.

C4 & C5 (100µF and 10µF) Electrolytic capacitors

Holding each capacitor in your right hand, with the stripe towards you, bend the legs of the 100µF and 10µF capacitors 90° **UP**.

NOTE: The colors of the capacitors in your kit may vary from these images.



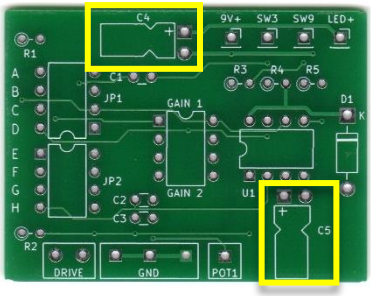


Both electrolytic capacitors lay flat on the board. They must be installed correctly.
These capacitors ARE polarized. The longer leg goes into the square "+" pad.

Check-Off

☐

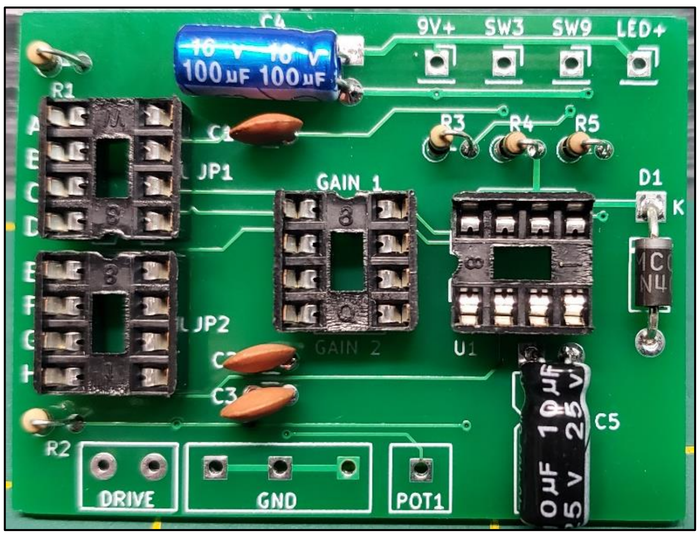
C4 & C5



C4 is the 100µF capacitor at the top, that lines-up horizontal.
C5 is the 10µF capacitor at the bottom, that lines-up vertical.

These capacitors filter-out leftover AC voltage from a power supply, and store energy for use during short, quick transient bursts when the pedal is being asked to deliver 100% of its design capability.

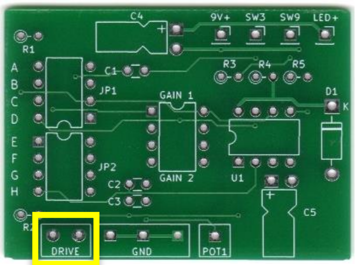
Your board should look a lot like this now:



Please double-check your components with this image.

Again, your 10 µF and 100µF capacitor colors may differ from those in this image, and the bodies of the resistors may be tan, brown, or blue, depending on the manufacturer.

DRIVE Jumper



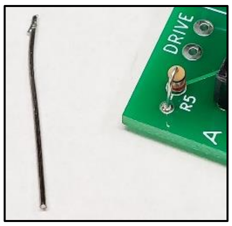
***IF YOU <u>ARE</u> INSTALLING THE OPTIONAL DRIVE KNOB*:**
Leave these pads empty for now.
We will wire them in the final step: ***Wiring the Enclosure.***

If you are ***<u>not</u>*** installing a DRIVE knob, you must place a jumper between these two pads:

Use one of the legs you previously cut-off from a resistor, diode or capacitor, and bend it into a U shape. Install that jumper into the DRIVE pads and solder it. Cut the legs off the back like the other components, leaving a small "horseshoe" or "rainbow" loop here.

If you don't have a drive knob

☐ Check-Off DRIVE Jumper



RECOMMENDATION: Leave the jumper a little higher than the board, not pressed down flat. Later, if you want to upgrade and install a drive knob, the jumper will be easier to cut, and it will provide two short "pins" to wrap the DRIVE pot wires to before soldering.

<u>Double-check your soldering with a magnifying glass.</u>

Review your check boxes from the pages above.

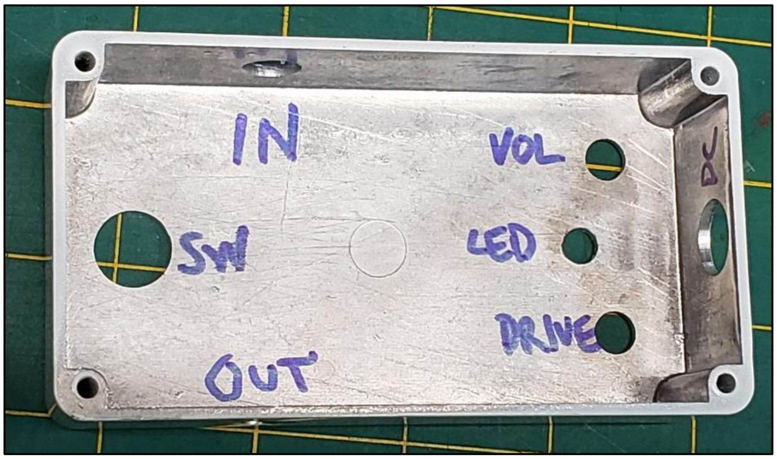
Use magnification to look for pads that you missed soldering, and solder bridges where solder has connected 2 pads, especially at the resistors. Some pads are very close together.

The two rows of pads on the top and bottom edges of the board are where the wires from the jacks and switches are soldered in the final step: ***Wire the Enclosure.***

PREPARE YOUR PARTS AND WORKSPACE

Clean off your bench or prepare a nice workspace where you won't scratch a kitchen tabletop or tablecloth. Having a nice area ahead of time really does help.

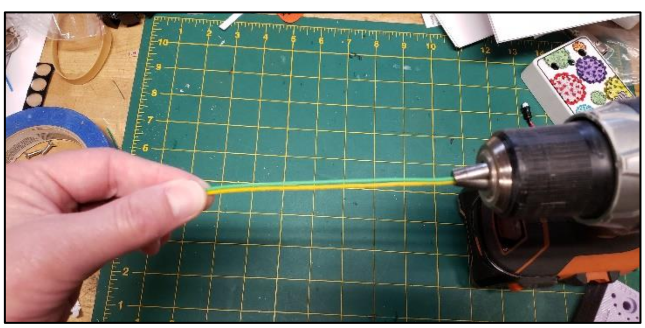
Inside your enclosure, use a sharpie to write the names of the holes from the inside.

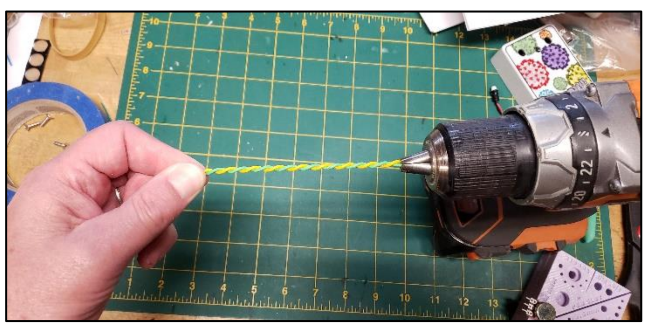


<u>MARKING THE INSIDE REALLY HELPS.</u> Trust me.

You will spend several hours building the pedal "upside-down." This can be confusing when you go to use it "right-side up." I spent many minutes wondering why my prototype pedals didn't work… because I had the guitar plugged-into the OUTPUT, or I thought my Drive knob was all the way down, when it was my Volume knob that was all the way down!

<u>Twisting Wires</u>
Some wires go to almost the same point on the board, so twisting a pair of wires helps assembly. Use a slow drill, pinch the wires with your fingers, and slowly twist wire pairs if you need to. Not more than 2 turns per inch, or about 1 turn per cm.
<u>NOTE:</u> AUSTINDRIVE Kits have pre-twisted wire pairs for certain connections.

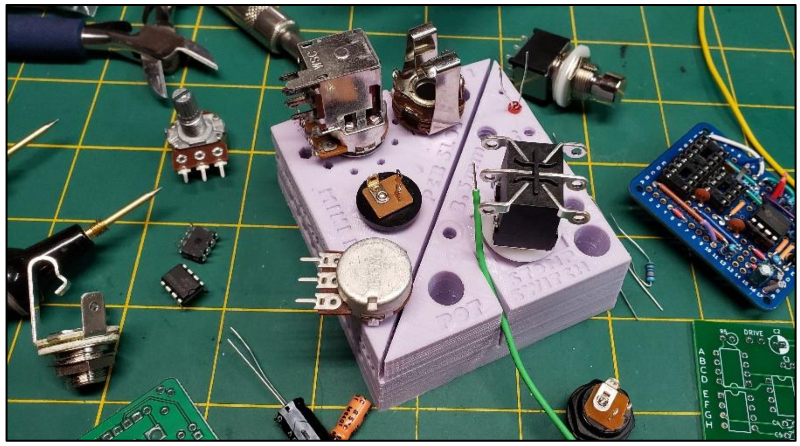




THE PEDAL PORT

Throughout this tutorial, I use **The Pedal Port**, a silicone parts holer molded exclusively for pedal-building. It grips parts tight without scratching, and it doesn't suck-out the heat of soldering.

The Pedal Port is available from www.ThePedalPort.com



Why aren't these parts soldered onto the Circuit Board?

One answer: *Reliability.*

Circuit boards, metal enclosures, solder lugs, input jacks and guitar cable plugs don't bend.

When you constantly plug & unplug rigid components into a circuit board, tweak knobs, and stomp on switches, those soldered connections on a printed circuit board ("PCB") ***will*** fail. It may take years, but when rigid components move, solder joints on PCBs crack - and electronic things stop working. This is a major reason why modern electronics and appliances only last a few years, but a 1960's Tube Amp is still running.

When rigid connections are "insulated" from the circuit board by a flexible wire, those connections to the PCB last longer. Maybe forever.

Yes. There are guitar pedal circuit boards where everything is neatly soldered to a circuit board, and it all fits nicely into an enclosure. That takes all the fun out of it for me. I like wires and colors.

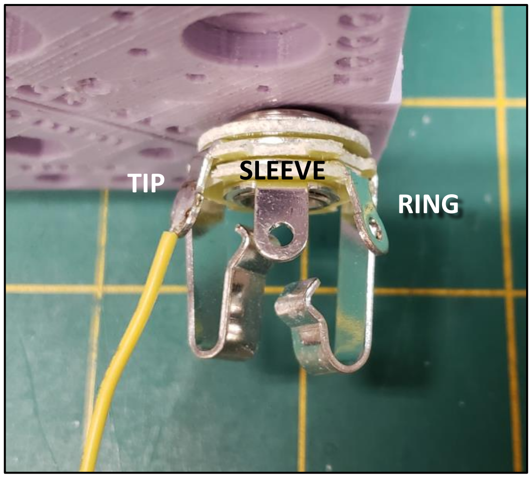
PRE-WIRE THE JACKS POTS AND SWITCHES

THE INPUT JACK has 3 connections, commonly called a "Tip/Ring/Sleeve" (TRS) or "Stereo" jack. When a guitar cable is plugged-in, the ring makes contact with ground, connecting the DC Power Jack for as long as a cable is plugged-in. Unplug to de-energize the circuit or save battery if you're using the 9V battery adapter cable.

The diagram here shows the installed position in the enclosure: Solder lugs UP.

Check-Off

- **Yellow to Tip** (Left lug)
-

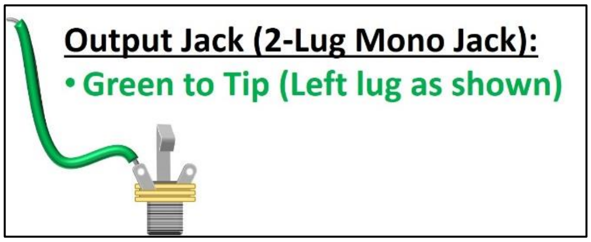


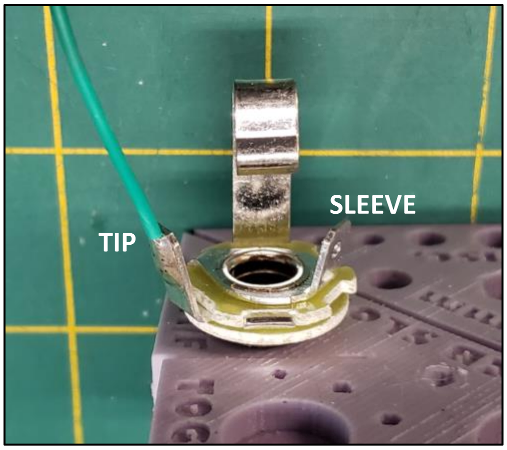
THE OUTPUT JACK has 2 connections, commonly called a "Tip/Sleeve" (TS) or "Mono" jack.

The diagram here shows the installed position in the enclosure: Solder lugs UP.

Check-Off

- **Green to Tip** (Left lug)



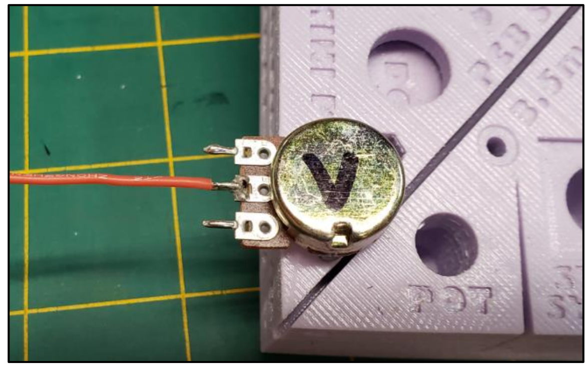


<u>THE VOLUME POT</u> is a B250k Pot with 3 connections. The outside two are the ends of a "C-shaped" resistor, and the center connection is a moveable point ("wiper") along that resistor. Turning the knob changes the resistance between the center terminal and each end. The Volume Pot literally shorts more of the signal to ground, as you turn it down.

Check-Off ☐

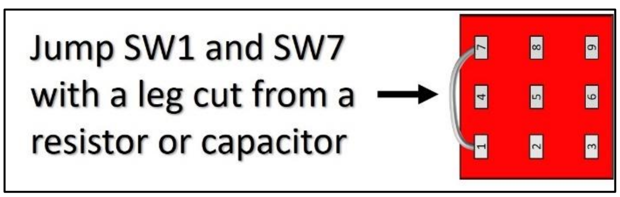
With wires pointing LEFT:

- **RED to Center**



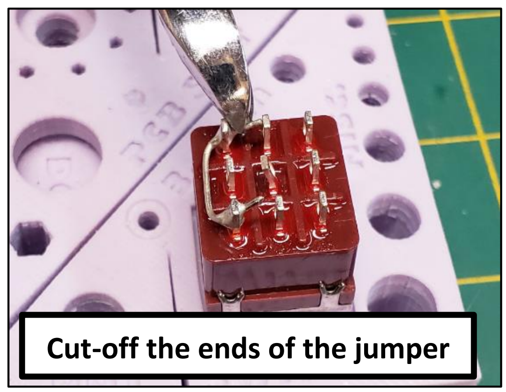
It really helps to write a "V" on this potentiometer if you have more than one knob on your pedal.

Use a leftover leg from one of the PCB components to make a jumper between Pins 1 and 7.



Check-Off ☐

Jumper between pins 1 and 7



<u>THE FOOT SWITCH</u> has 9 connections. It is a single button that controls 3 switches at one time.

- Switch 1 is on pins 1, 2, and 3 (This will be the input Switch)
- Switch 2 is on pins 4, 5, and 6 (This will be the LED on/off Switch)
- Switch 3 is on pins 7, 8, and 9 (This will be the output Switch)

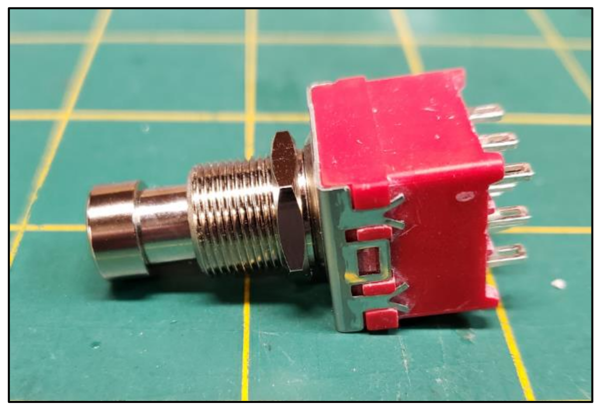
It is a "3-Pole" (*3 switches in one*), "Double-Throw" (*2-position*) switch, AKA: a "**3PDT Switch.**"
If you want more information about this type of switch (I know you do!), Google: "3PDT Switch"

Otherwise, the things you need to know to continue are:

1. **The orientation matters.** The pins are rectangles: Longer in one direction than the other. In the diagrams above and below, the pins are taller than they are wide. If the switch is oriented like this diagram in your enclosure, the pin numbers will be correct.
2. The switch can be turned 180° and still be wired correctly.
3. View the images above and see photos of the complete build if you are unsure.
4. **Don't forget to put a jumper between pins 1 and 7.** Use a cut-off leg from one of your resistors or capacitors from the PCB soldering section.

Install the Foot Switch

The foot switch has 2 lock nuts, a tooth washer and a flat metal washer. Remove everything then thread one nut on the switch so that goes all the way to the bottom of the shaft:

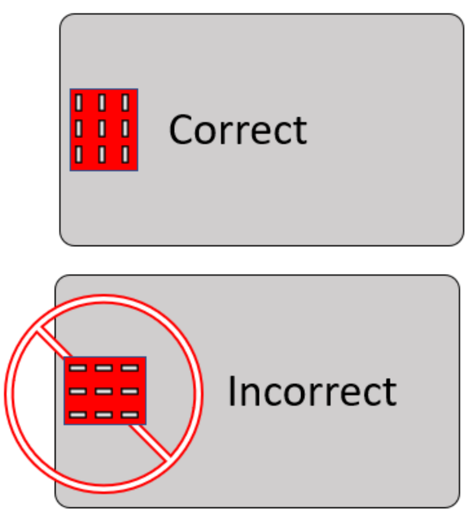


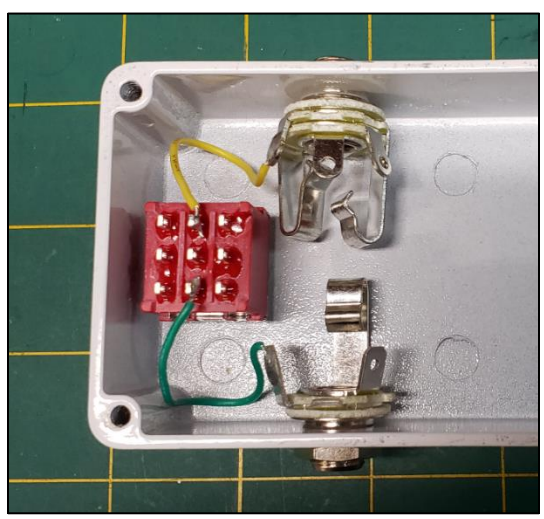
Check-Off

☐

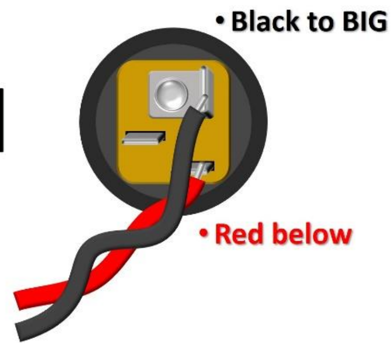
Install the tooth washer on top of that first nut, and put the switch through the enclosure from the inside. With the lock nut and the tooth washer inside the enclosure, the flat metal washer and the remaining nut are installed from the outside. Be sure the rectangle lugs are oriented vertically as shown. Your switch may vary in color from these images.

Installation in the enclosure:





Wire the DC Jack



Use the twisted **red** & **black** wire for the DC Jack.

Solder the **Black** wire to the largest lug on the jack.

Solder the **Red** wire to the lug directly below the big one.

Check-Off ☐

Install the jack from the outside, pass the nut over the wires from the inside, and tighten.

* Use a dab of Nail Polish to secure the nut to the threads. This will help prevent loosening due to use and vibration, but it can easily be removed if necessary.

With the DRIVE knob option, the LED goes in the center hole, and the C250k Drive Pot is installed into the other top hole in the enclosure. Wire the DRIVE pot to the DRIVE pads on the board.

NOTE: With the DRIVE pot option, the GAIN1 resistor in the socket should be 2.2k 4.7k, or 6.8k. Anything higher will prevent the drive knob from "turning-up" all the way…

…But maybe you don't want a massive distortion pedal, just an overdrive? Use a 6.8k or even a 10k in the GAIN 1 position to limit the drive.

The DRIVE knob actually *reduces* gain by adding resistance to the fixed amount of drive in the first gain stage.

- With the knob all the way "up" only the resistor on the board is controlling gain.
- Turning the knob "down" adds more resistance, reducing gain.

It is an "option" for basic Austindrive Pedals because:
In 25+ years of live performances, when I found "my" sound on a pedal (ex: Drive knob at 1 o'clock), I leave it set there, "fixed" at that position for years. It was always a bummer when those knobs got turned and I had to find my tone again.

Therefore, a basic AUSTINDRIVE pedal without a drive knob lets you nail-down your own "sweet spot" with fixed resistors. The sound will be exactly the same every time, unless you want to change it later.

WIRE THE ENCLOSURE

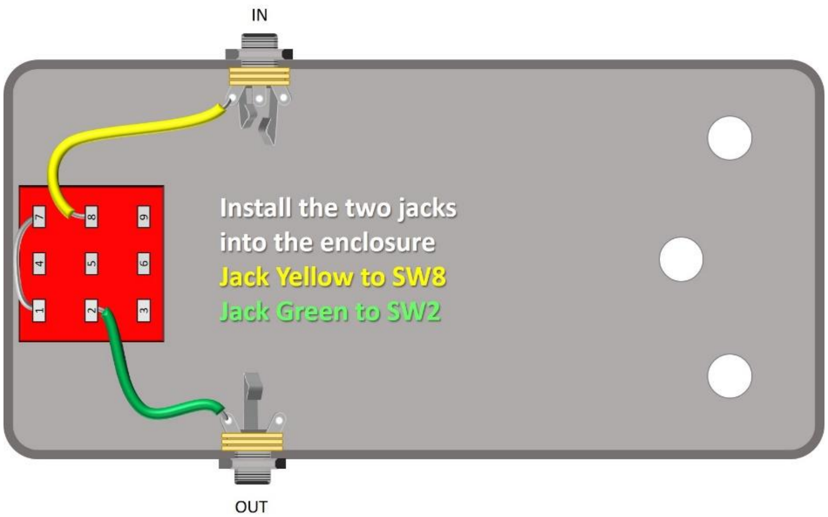
NOTE: For simplicity, not every wire is shown in these assembly diagrams, and the enclosure in the photos does not have a graphic on it.

Wires are not drawn here with the correct lengths. Keeping the wires long while you build allows you to remove the circuit board to make circuit changes easier.

Install the two input/output jacks as shown, solder lugs up.

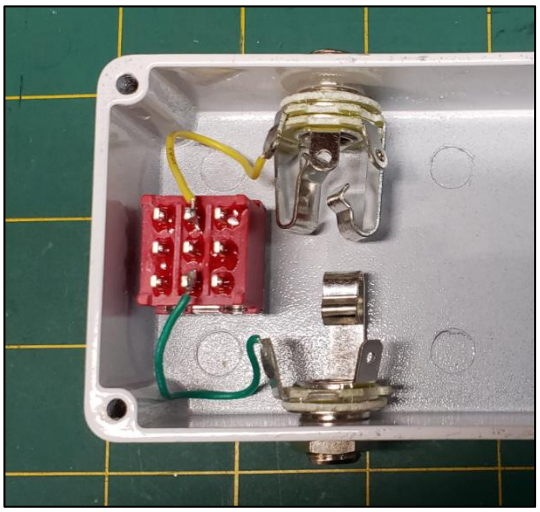
NOTE: Be careful when using pliers to tighten the nuts.

One slip, and you can scratch the enclosure. On my website, you can download and 3D print FREE plastic sockets ("TurnUps") that I designed specifically for this project.



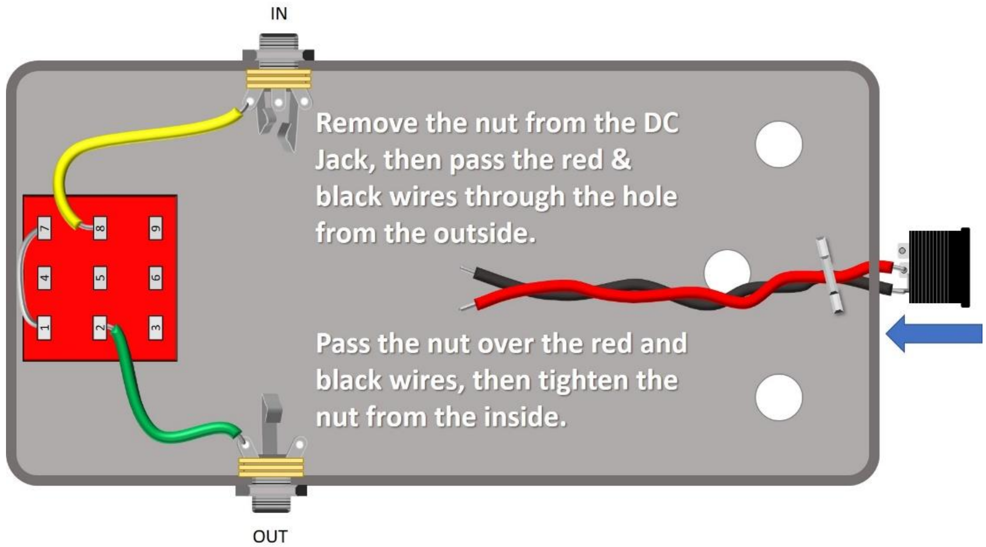
Check-Off

- Yellow wire to switch Pin 8
- Green wire to switch Pin 2



With the exterior nuts tightened, use a small dab of Nail Polish to secure the nut to the thread. Nail Polish acts like removeable glue, and reduces the chance of the nuts loosening, with vibration and use. Alternately, you can wait and do this for *all* the connectors at the very end.

Install the DC Jack



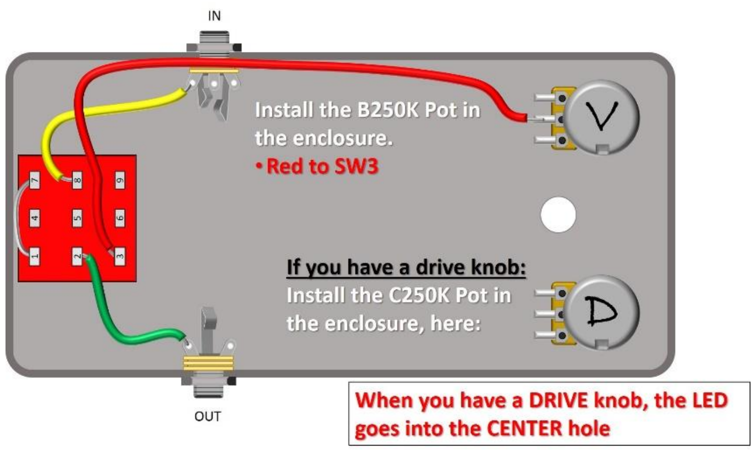
Install the Volume Pot into the enclosure. This is a B250k Pot.

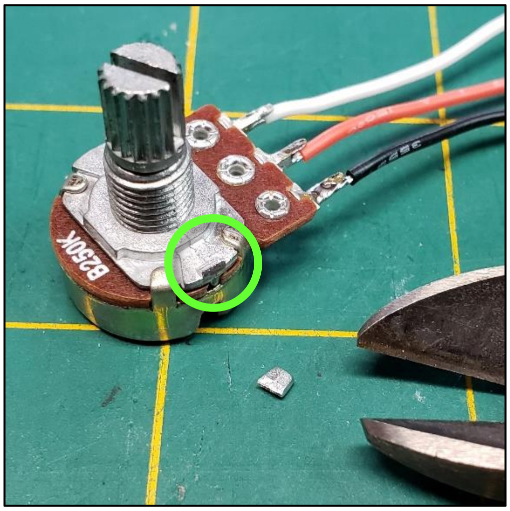
Check-Off

☐

- **Red wire to switch Pin 3 (Next to the Green wire)**

Route the red wire *over* the input jack, against the wall of the enclosure.





NOTE: The potentiometers have a small indexing tab which must be broken-off or cut-off before installation.

This tab snaps-off when bent with pliers, or use a pair of diagonal cutters (shown) to remove this small tab.

Marking each pot with "V" for volume and "D" for Drive helps with orientation.

Secure the potentiometers with a little nail polish on the threads and nut.

Avoid getting nail polish down the barrel of the potentiometer shaft!! (The part that turns.)

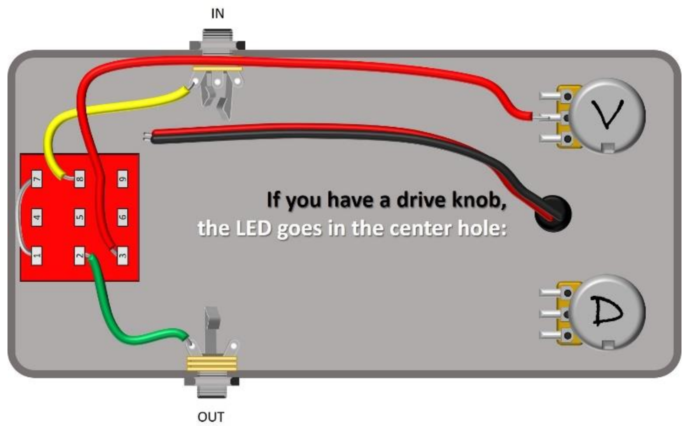
Check-Off

☐

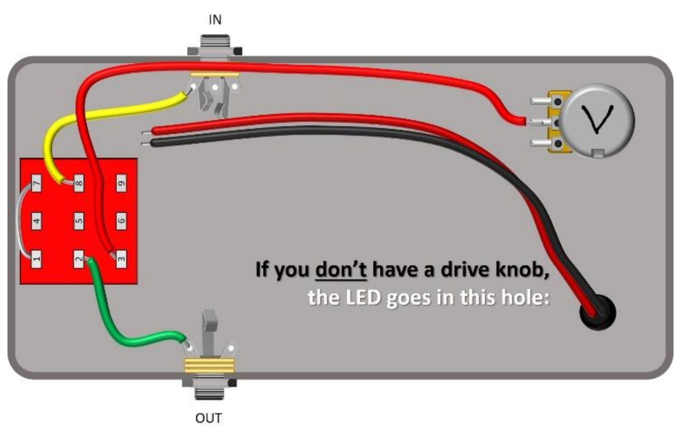
<u>Install the LED</u> into the enclosure *from the outside.* Pass the wires through the enclosure from the outside, and press in.

<u>NOTE:</u> For kits *<u>with</u>* a DRIVE knob, the LED goes in the *center* hole.

We will solder the LED wires later.



If you *<u>don't</u>* have a drive knob,
the LED goes in the other hole.



There are 4 wire pairs that get soldered to the PCB.
(Just 3 pairs if you don't have a DRIVE knob.)

Don't worry… We will check-off each pair in this section:

Wire the PCB

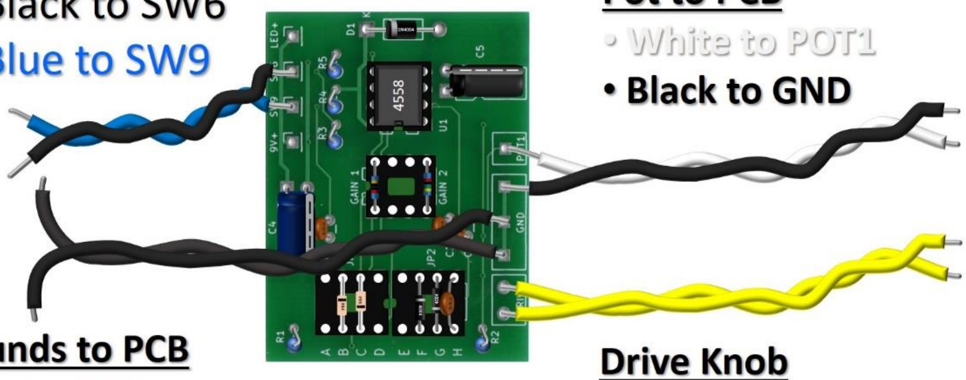
Check-Off

- Black to SW6
- Blue to SW9

Pot to PCB

- White to POT1
- Black to GND

Check-Off



Check-Off

Jack grounds to PCB

- 2X Black to GND

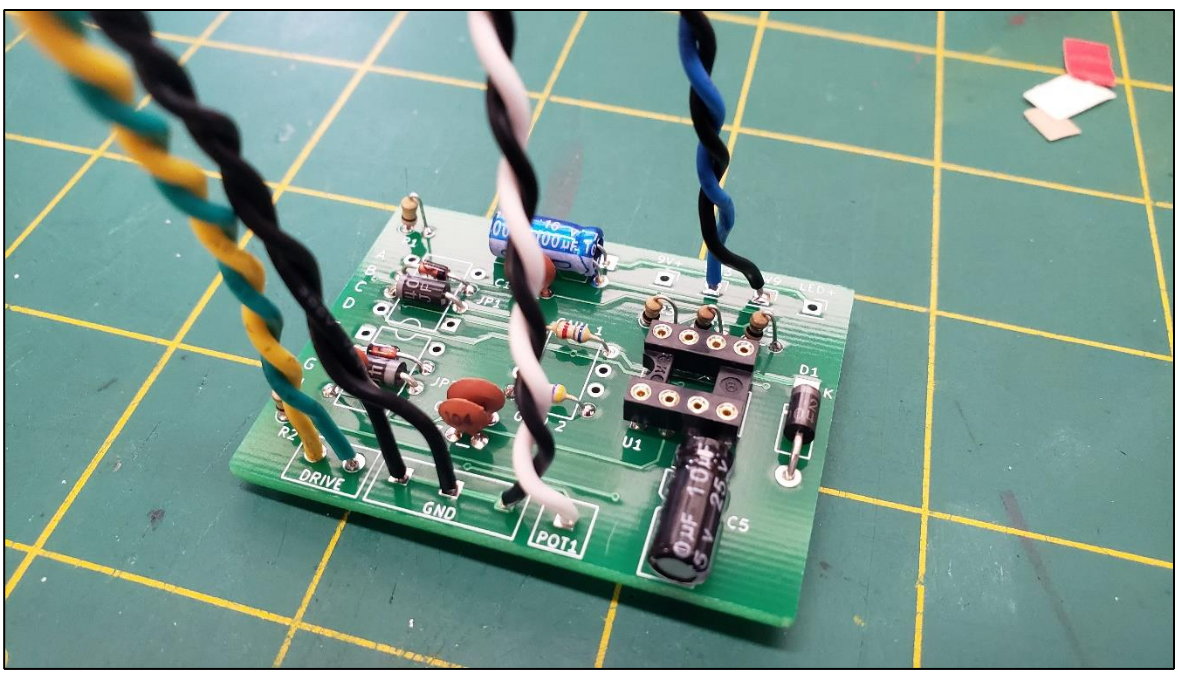
(over top of the PCB)

Drive Knob

- Yellow to DRIVE pads

Check-Off

If you don't have a drive knob, you must put a jumper in the DRIVE pads on the board.



NOTE: This board shows the older yellow & green wires for the DRIVE knob, not yellow & yellow.

Double-Checking and Routing Wires

Now is a good time to double-check your wiring against the plans and photos, while thinking about how and where to route the wires inside the enclosure.

Here are some tips:

Check-Off

☐

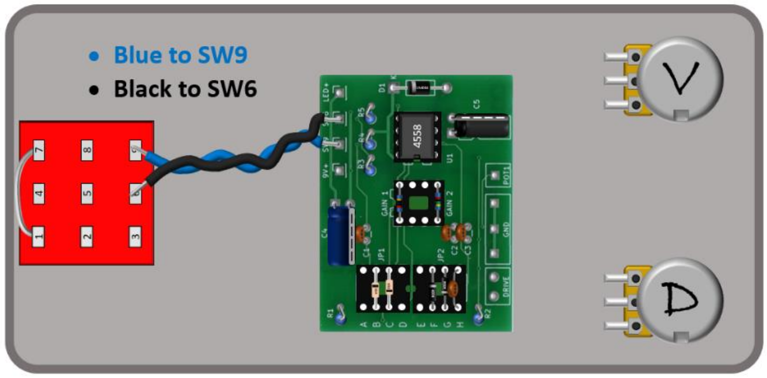
- Try and make every wire have a free path back to where it is soldered.
  If you have wire tangles now, try and separate them out individually. This is called "combing" – just like hair. Un-wrap wires that have become tangled with other wires.
- Avoid routing wires *through* or *under* the input jacks. The guitar cables go in that space, and wires can get smashed and short your signal. You can run wires "over" the jacks near the solder points, and against the wall of the enclosure to keep them out of the way. There is also a small space down the center, *between* the two jacks, that wires can fit into, if necessary.
- Any wires that will get soldered to the PCB should be left long, so that you can lift-out the PCB to swap components while creating your tone.
  - You can bend long wires down into the enclosure, following the inside edges
  - You can route wires around components
- Test-fit the enclosure lid by hand. Don't add the screws just yet… but see how the lid presses the wires down and watch how the wires move out of the way.

- **Pro Tip:** While you are testing and auditioning parts for your tone, use a rubber band to hold the pedal closed, rather than the 4 screws. It's just easier!

WIRE THE ENCLOSURE

Wire the Switch to the PCB

Even though the distance is short, I suggest keeping the wires long so that when you want to change components, the PCB moves freely.



Check-Off

☐

- Blue to switch Pin 9
- **Black to switch Pin 6**

Wire the PCB to the Volume Pot

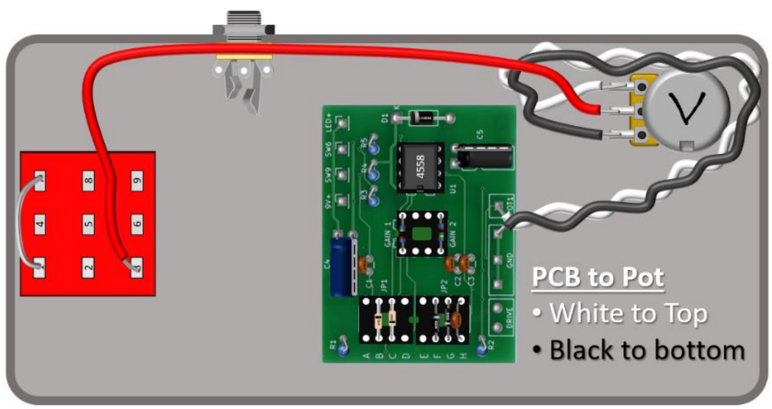
The black and white wires are long so you can move the circuit board. Loop them around the inside of the enclosure, or cut them to any length you are comfortable with.

Check-Off

☐

- White to the Top
- **Black to the Bottom**

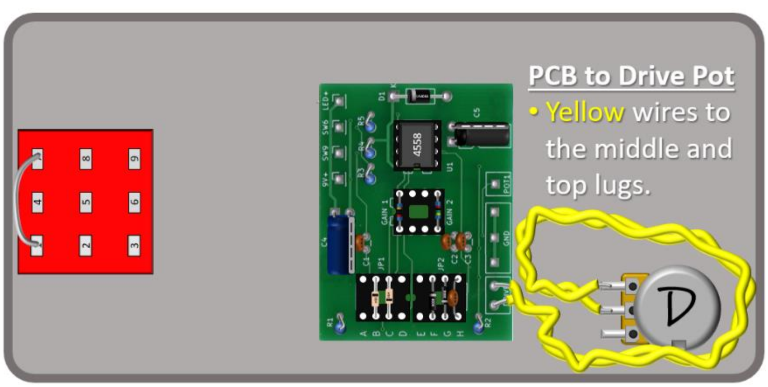
Route the red wire *over* the input jack, as shown.



Optional DRIVE Knob

Wire the yellow wires from the PCB to the top two DRIVE pins on the DRIVE pot. They are long so you can move the circuit board. Loop them around the inside of the enclosure or cut them to any length you are comfortable with.

NOTE: Nothing is soldered to the bottom pin, and either yellow wire can go to either of the two top pins.



Check-Off

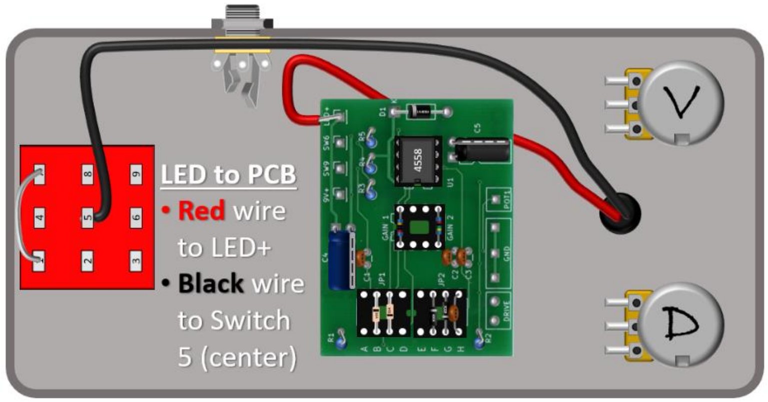
☐

Wire the LED

Check-Off

- **LED Red to PCB LED+**
- **LED Black to Switch Pin 5**

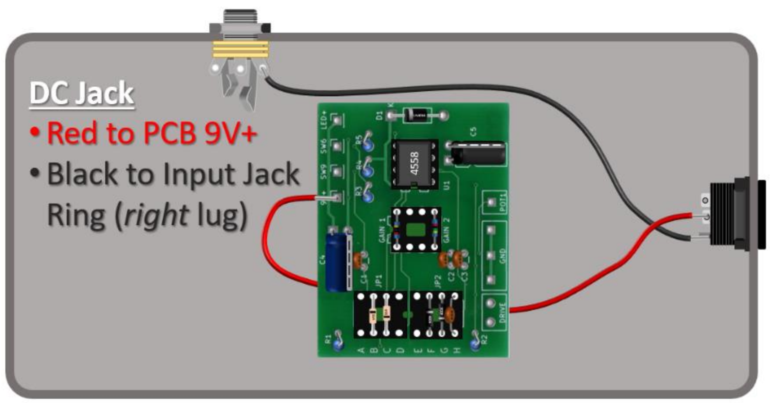
Route the black wire *over* the input jack, as shown.



DC Jack to PCB

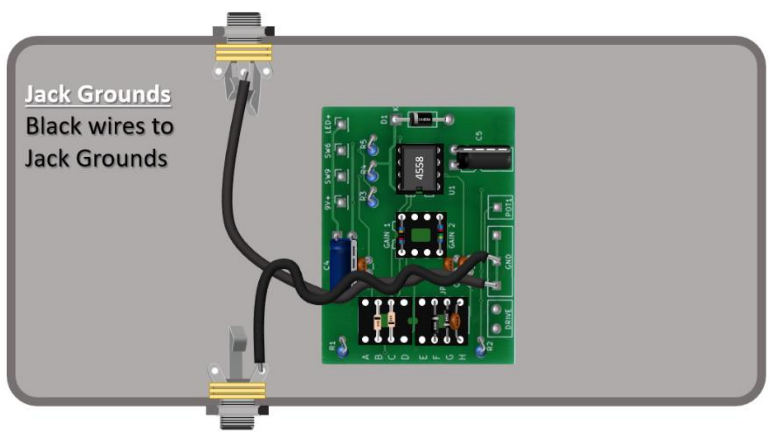
Check-Off

- **Red to PCB 9V+**
- **Black to Input Jack Ring (right lug)**



Wire the Jack Grounds to the PCB

Untwist the black wires about 1 inch and send one ground wire to each jack. The input jack goes to the center lug, and the output jack goes to the one without the green wire. It does not matter which black wire you choose.



Check-Off

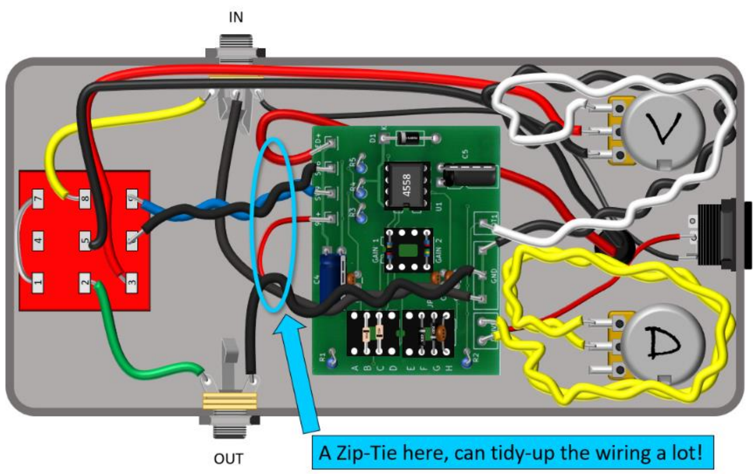
- **2x Black wire to Jack Grounds**

FINAL ASSEMBLY

Check-Off

Double-check your connections with the pictures above in this tutorial.

The Black & White, and Yellow wires are long, so you can move the PCB. Make them loop around inside the enclosure.



Check-Off

Add the adhesive foam strip to the underside of the PCB.

Check-Off

Put a business card inside the lid.
A business card fits nicely inside the metal lid to insulate it from the circuit. Secure it with some masking tape to prevent components on the PCB from touching the metal lid.

Press everything into the enclosure and add the screws – OR – wrap with a rubber band while you are testing and auditioning components.

NOTE: There is no battery inside the enclosure.

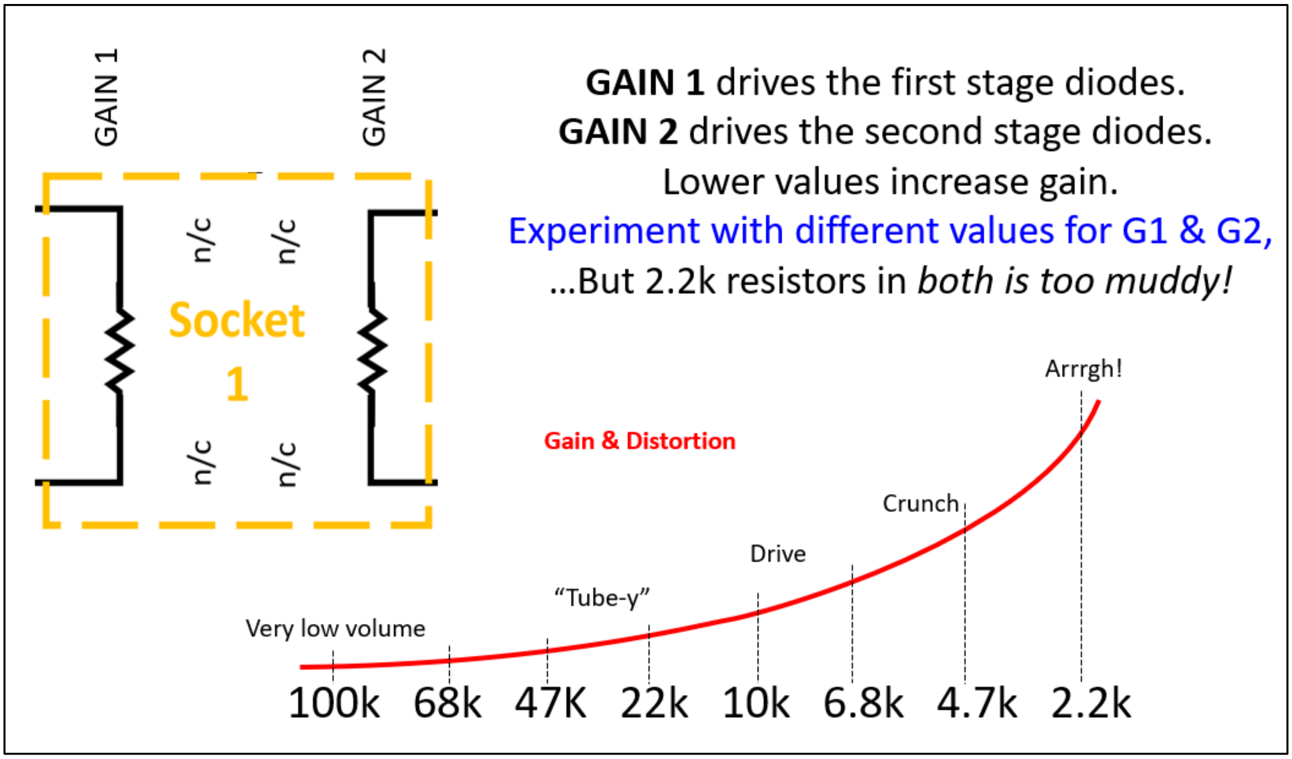
If you want to use a battery, use the 9V Battery adapter cable and plug-in to the DC Jack.

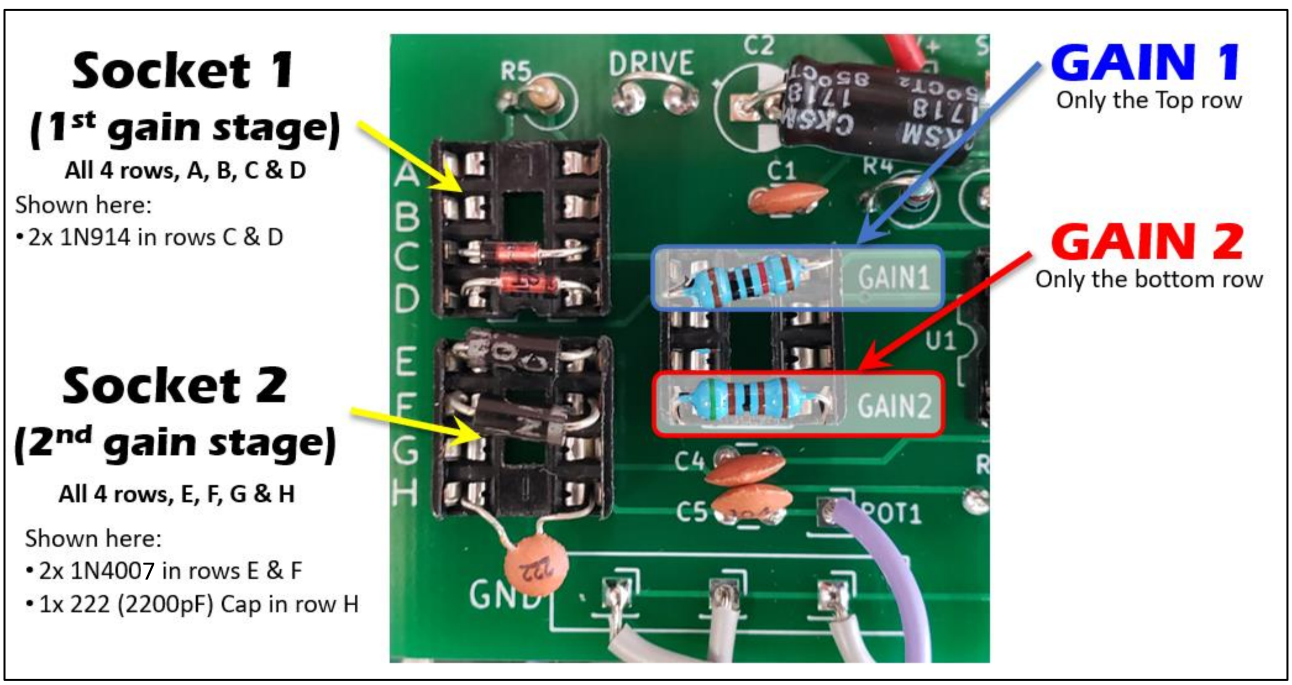
After you create your tone (on the following pages)

Install the lid with the 4 flat-head screws as the final step, making 100% sure wires are not pinched in the lid.

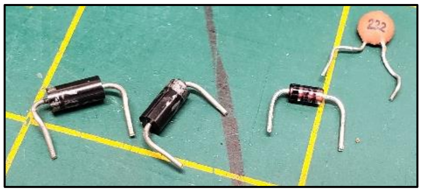
Create Your Tone

By changing resistors, capacitors, diodes and Op-Amps in this circuit, ***YOU*** define your sound. The following images will help guide you, but ***YOU*** will have the final say in your sound.





Bend all resistors and diodes so that they fit into the sockets, and cut-off the legs. Needle-nose pliers and magnification can help when installing these components into the sockets.

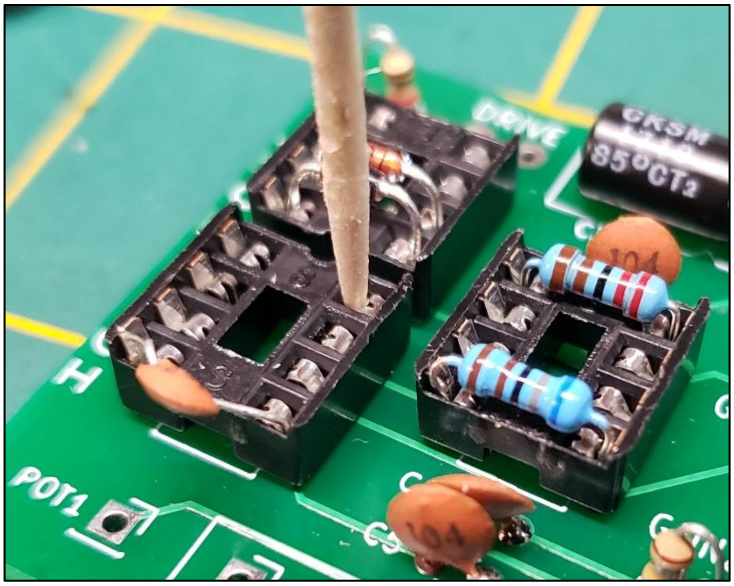


IMPORTANT NOTE:

IN400x diodes are black with a silver stripe on one end. They can be 1N4001, 1N4004, or 1N4007 diodes, and may vary between kits. The only difference is the voltage rating, which does not matter in this part of the circuit.

The 1N400x diodes have slightly larger-diameter legs than the other components.

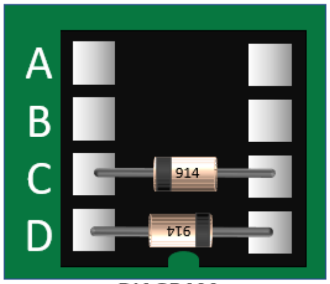
1N400x legs bend-open the socket connections in rows A, B, C, D, E, F, G & H.



When removing a 1N400x, the socket may stay bent-open. Components with smaller legs may not fit tightly into those sockets unless the sockets are bent back using a toothpick.

(I am working on a better solution than this, but a toothpick works for now.)

Gain Stage 1



DIAGRAM

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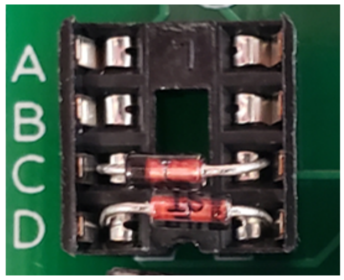

PHOTO

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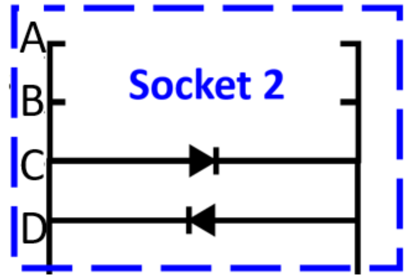


SCHEMATIC

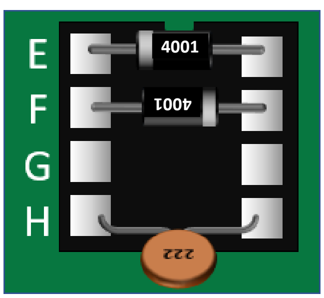
- 1N914's here provide a "smooth" overdrive
- 1N400x's deliver more "harsh" distortion
- LED's are louder, but have less distortion

NOTE:
Components can be in any row

EXPERIMENT! – Try mixed combinations of diodes across this socket, or 2 pointing one way, and just one going the other.

Remember: Distortion here, is *multiplied* in the next stage!

Gain Stage 2



DIAGRAM

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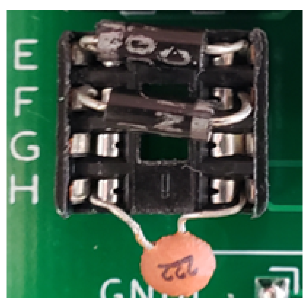

PHOTO

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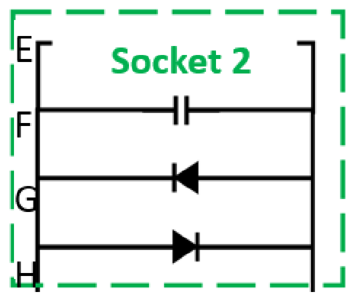


SCHEMATIC

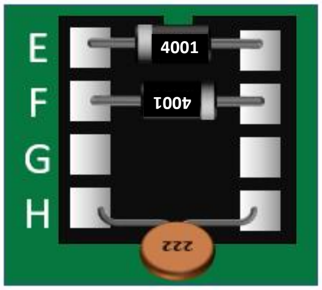
- 1N914's provide smoother distortion but lower volume
- 1N400x's deliver more distortion and higher volume
- LED's are loud, but have less distortion

NOTE:
Components can be in any row

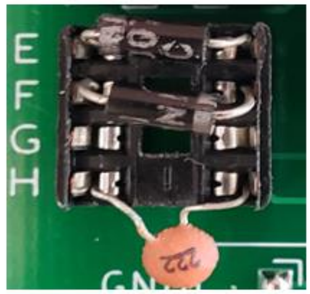
EXPERIMENT! – Remove the capacitor, Mix different diodes in this socket, try 2 diodes pointing one way, and one pointing the other.

The Optional capacitor cuts-down harsh high-frequency "squeal."
(As capacitance gets higher, more high-frequency is removed.)

Filter Capacitor



NOTE: Components can be in any row



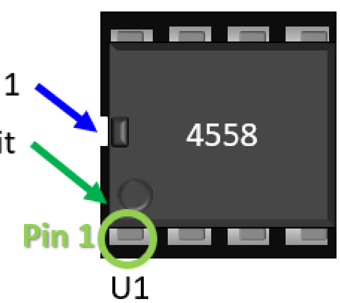
The Capacitor values in the kit are:

- 501 (500pF)
- 102 (1000pF)
- 152 (1500pF)
- 222 (2200pF)
- 332 (3300pF)
- 472 (4700pF)

The capacitor in gain stage 2 cuts-down high frequencies. It's like a tone knob.
The higher the value of the capacitor, the more high frequencies are cut. Leave the capacitor out, and no high-frequencies are cut. (Having no cap can get edgy!)
The first 2 numbers on the capacitor are the amount of Picofarads (pF) and the last number is the number of zeros to add to that number.
"102" is 1000 pF, "222" is 2200pF, "332" is 3300pF, and so-on.

A notch is on the same edge as Pin 1

Pin 1 also has a dimple next to it



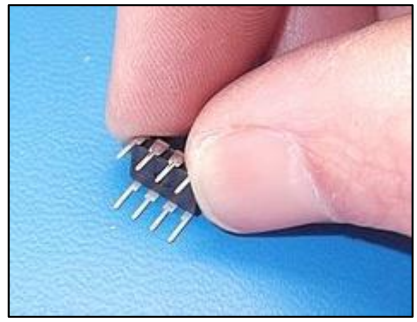
Op-Amp (U1)

FOUR different Op-Amps are included, but you only need one.
I chose vintage Op-Amps designed in the 1970's:

- The 4558 is used in lots of pedals: Tube Screamer, Boss SD-1, and HM-2, etc.
- The 1458 is an older 4558 - essentially a dual 741 (Early Fuzz pedals used 741's)
- The LM358 is a 1970's design. Not great for clean audio, but good for distortion!
- The TL072 is a "low noise" FET device popular in the Klon Centaur

Modern "clean" Op-Amps don't affect the tone as much.
Some people say they can hear differences between Op-Amps, while others cannot. Your mileage may vary.

Bend the legs to fit the socket



You must first bend the legs of the Op-Amps slightly to fit into the sockets.

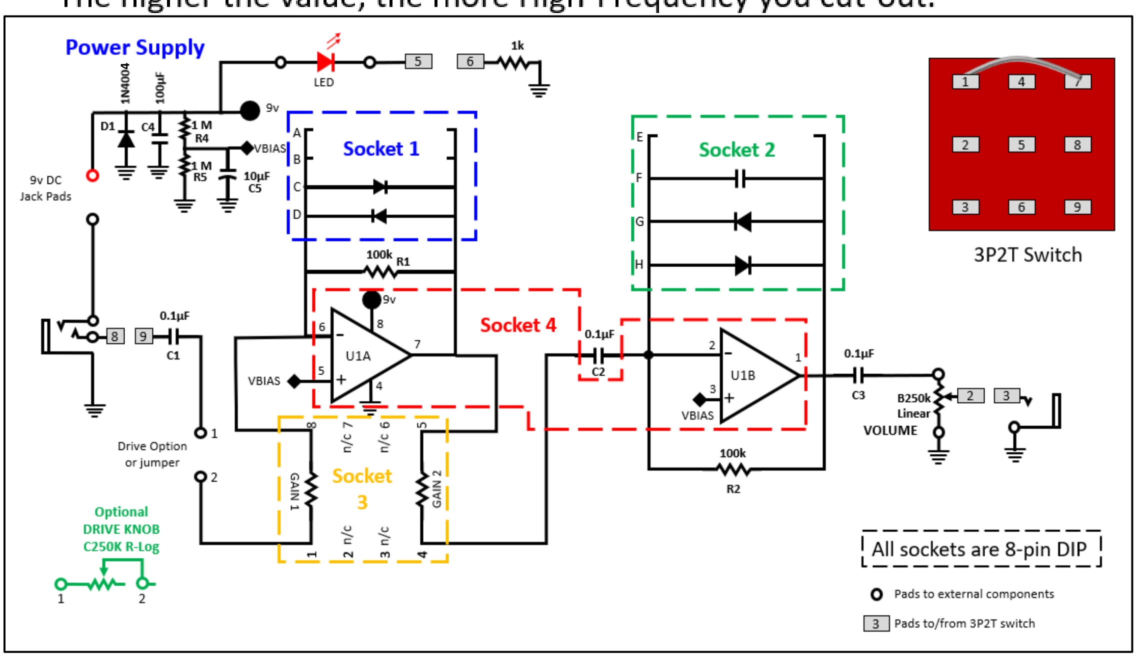
Placing the chip on its side, with 4 legs touching the work surface, lean the chip over just a little bit, bending the legs in so that they fit the socket.

Tradeoffs

- ***You might be tempted to start with the highest gain possible (low values for GAIN1 and GAIN2 resistors)*** for the most distorted pedal you can build.
- **The problem with that is:** MASSIVE GAIN from low-value GAIN1 and GAIN2 resistors overloads the low frequencies, and it gets muddy.

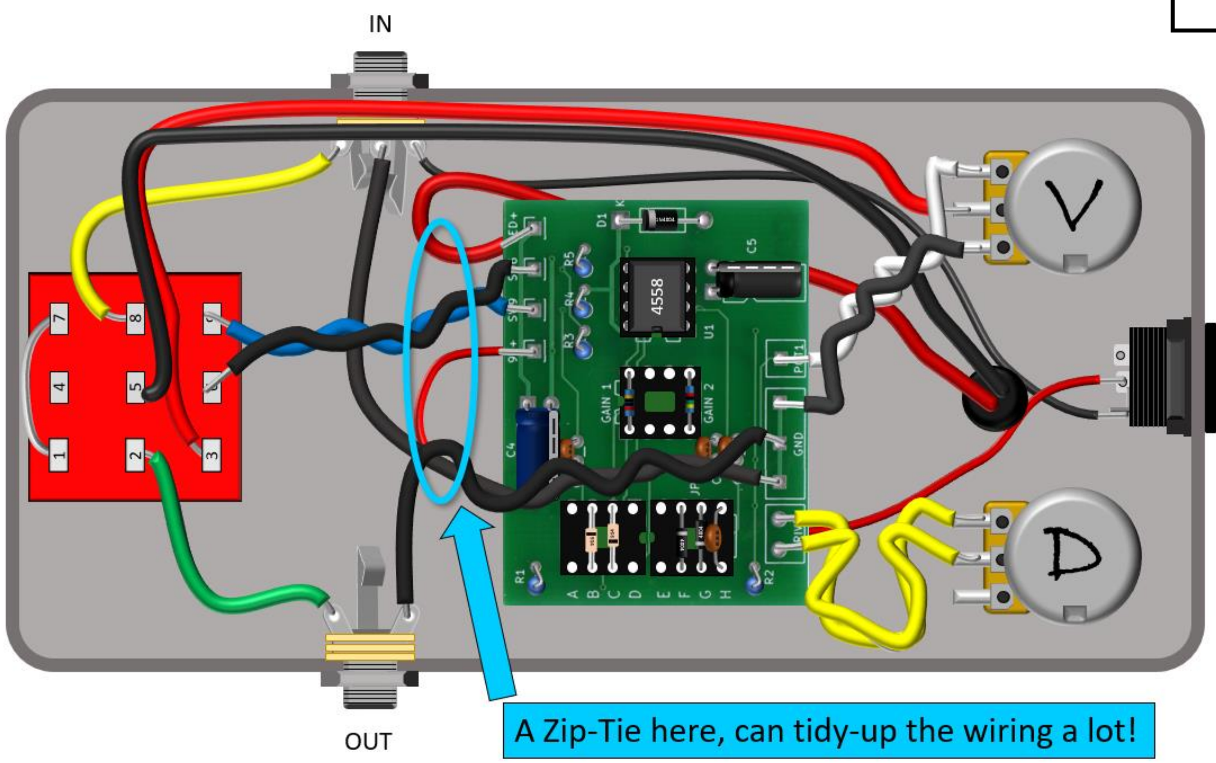
I've found my favorite tone from these combinations:

- 1N914 in the first stage and 1N400x in the second drives nicely.
- Start with 10k gain resistors, then make small changes.
  - Driving the first stage 1N914's harder, delivers a smooth "tube" drive
  - Driving the second stage 1N400X's harder increases harsh distortion
- You can reduce high frequency "distortion" with a capacitor in the 2nd gain stage. Removing it, allows those artifacts through.
  - The higher the value, the more High-Frequency you cut-out.



Check-Off

Use Silicone to "glue" the components in the sockets, so they don't fall out.



Check-Off

Silicone prevents vibrations loosening the diodes, resistors, and capacitors you've chosen, after repeated gigs and stomping. I would not recommend soldering the components into the sockets, because, you know… your "perfect" guitar tone changes over time, and you can change it over the years without getting a new pedal.

The pedal plays nice with the volume knob on your guitar, reducing drive without getting too much quieter. If you always chase your tone, or use this pedal between multiple guitars, amps, and playing styles, you can install an optional Drive Knob Kit, available from Austin Mics.
www.AustinMics.com/austindrive

If your clean sound works, but stomping on the switch doesn't turn on the overdrive, you might have a bad DC Power Supply or 9V battery, or 9V adapter cable, not a bad pedal.

See the next section for troubleshooting hints.

TROUBLESHOOTING PROBLEMS

If your pedal does not work the first time, the good news is there are only a few problems you can possibly have. Some are obvious, some take a little time to figure out. When hooked-up correctly, the circuit works every time. It only fails when there are wiring/soldering problems.

PEDAL IS COMPLETELY DEAD:

No sound, no clean/dirty switching when stomped-on, shaken, or anything.
(If you have "some" sound, skip to the next page.)

First, I've gotta ask: Does your guitar and cable work? Is your amp on? Volume up? Does the guitar and amp work when it's plugged directly in, no pedal(s)?? I never feel too smart finding an obvious problem after hours of troubleshooting something different!

Are you plugged-in to the INPUT JACK by mistake? (See photo below)
With the pedal on the floor, switch at bottom, knob(s) up-top, INPUT is *right*, OUTPUT is *left*.
I can guide you to build the pedal, but I can't guide your rig. (Tube amp in "standby?")

1. There is a switch-wiring problem. (Probably)
Because this is a true-bypass pedal, even when no power is connected you should be able to get a clean sound through the pedal when you stomp on it once. Since there is no sound when you stomp on-and-off, then your switch is wired wrong.
Did you forget the jumper between switch pins 1 and 7?

2. You missed, or mis-soldered a component or wire. (Possible)
Even if someone put random resistors in all the spaces, there should be "some" distortion sound. However, like a dead switch, a missing, un-soldered, or solder-bridged component keeps the signal from getting to the next part of the circuit. The diode on the board is important, too. Triple-check your circuit board with a magnifying glass against the photos in this manual.

3. You confused the INPUT and OUTPUT jacks. (Maybe)
This happened to me, and I'm the designer, so it might happen to someone else… Just sayin'.

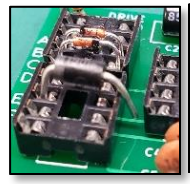
INPUT is the 3-lug "Stereo" jack, and OUTPUT is the 2-lug Mono jack. No matter what your graphic, knob(s), or LED look like, the input and output should be like this photo.

PEDAL HAS SOME SOUND, BUT IT'S BAD OR SUPER QUIET:

1. <u>Verify your power supply, guitar, and cables.</u> If you're using the 9V battery adapter, is your battery dead? A REALLY dead battery will make it sound bad. Like *REALLY* dead. Verify your DC jack wiring, and check your guitar cables and amplifier volumes.

2. <u>You put the wrong resistors in the wrong spots.</u> (Likely)
Did you *measure* the resistors, or just "eyeball" the color codes? A 100k resistor looks an awful lot like a 1k resistor. Use a meter, and start with the components you put into the sockets. Once verified, go back and check the components you soldered into the board.

3. <u>One of the components isn't actually in the socket.</u> (Possible)
Maybe a leg is out of the pin socket, or bent-over. Again, please don't ask how I know to look for that… I never make mistakes (?!?!)



4. <u>There is a problem with the colored wires.</u> (Maybe?)
If you verified your components on the board and in the sockets, and you get clean sound but no "Dirty" sound when you step on the pedal, then your input/output jacks are probably wired correctly, but there is something missing on the circuit board or colored wires.

- Look closely on the back of the board for solder points you might have missed, or solder blobs ("bridges") that accidentally connect two pads together.
- Verify your DC Jack wiring. Low/No power = bad sound or none at all.
- Re-check and verify the wire colors, resistors, capacitors, and diodes against the photos & diagrams.

CLEAN SOUND BUT NO DIRTY SOUND:

1. You're missing the "DRIVE" jumper on the board, if you don't have a drive knob.
2. You forgot to put an Op-Amp in the socket, or it's in backwards
3. You don't have the pedal plugged-in to DC Voltage
4. One of the "Gain" resistors is missing, or not firmly seated in the socket.
5. The wires to the switch are not on the correct pins

DIRTY SOUND BUT NO CLEAN SOUND:

You're missing the jumper between switch pins 1 and 7. (Almost certainly!)

FINAL NOTE: <u>This pedal is not invincible.</u>

During component testing and defining your own tone, if you open/shut the pedal enclosure many times, you might smash wires under the cover, or bend the wires so many times that they break the solder joints. Fix smashed wires and re-solder wires broken-off from the board. If there are still problems, take high-resolution, in-focus photos and Email me with the symptoms and questions: DiyRibbonMic@yahoo.com

You can always upgrade to a better stomp switch and volume/drive pots too. In this kit, these moving parts are DIY-friendly. Good volume and gain pots can cost $10 each, and great stomp-switches can cost $30 or more! Use Google to find the best parts for your budget.

THE AUSTINDRIVE STORY

This pedal was designed to springboard new DIY builders into the world of pedal-building.

Originally conceived on a long drive between California and Arizona with my friend and college professor Bob Kostlan, we wanted to create an affordable DIY pedal building workshop that the students could learn something from, not “just build.”

It is ***not*** a one-way “*Solder these parts here*” kit… or a “*We think you’ll like this sound*” pedal. Students will discover how changing resistors controls the gain of two operational amplifiers, how capacitors filter-out high frequencies, and how diodes clip the signal to produce distortion. There are more than 525,000 ways to combine the parts in this single kit. That’s 525,000 different tone combinations! Everyone gets the same parts… But no two units may ever be built exactly the same way… And that’s awesome!

This build may also dispel or ignite some myths about “magic” parts that give pedals of a certain vintage or brand a “spark” that can’t be duplicated. Yes, there are extremely unique, complex, and great-sounding overdrive pedals available, but are some worth the hype just because they have a special Op-Amp, vintage diodes, or a “Revision 1.0” circuit? You can decide.

This pedal was developed in the months of March, April and May, 2020, while I was sheltering-in-place at my home during the worldwide Coronavirus COVID-19 quarantine. “Overdrive” is a common name for a distortion pedal, so a similar-sounding “*AUSTINDRIVE*” name makes it obvious that this is an overdrive or distortion effect.

In Summer, 2020, I wrote this manual, drew the illustrations, and photographed the build. I sent beta-test units to musicians, studio owners and friends. Some of the audio samples you may have heard online are from those beta-tests. Please send me your sample sounds, too!

I also spent hundreds of hours researching different parts, looking at circuits, and trying dozens of prototype circuits in my garage, all while re-learning the basics of my college electronics degree. I created this circuit. However, I owe a lot to pedal builders that have come before me. Everything in this circuit has been done before… but maybe not in this type of way before *AUSTINDRIVE*.

Stop chasing your sound… Create it. Participate in your tone! ***Build an AUSTINDRIVE pedal.***

Rick Wilkinson
June, 2020