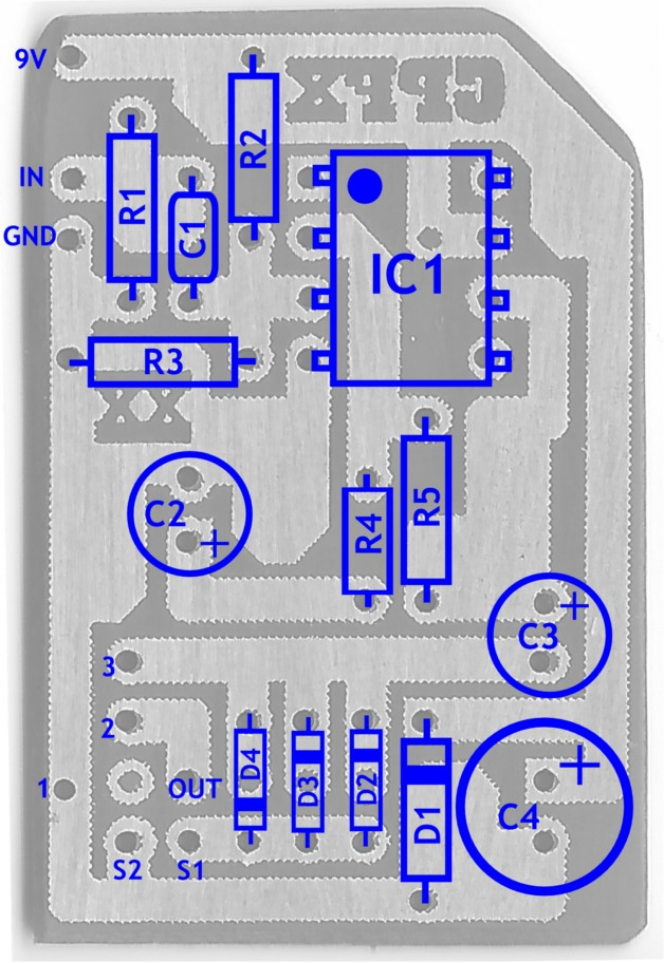
Captain P's Custom Effects presents:

The CPFX 20+ Boost!

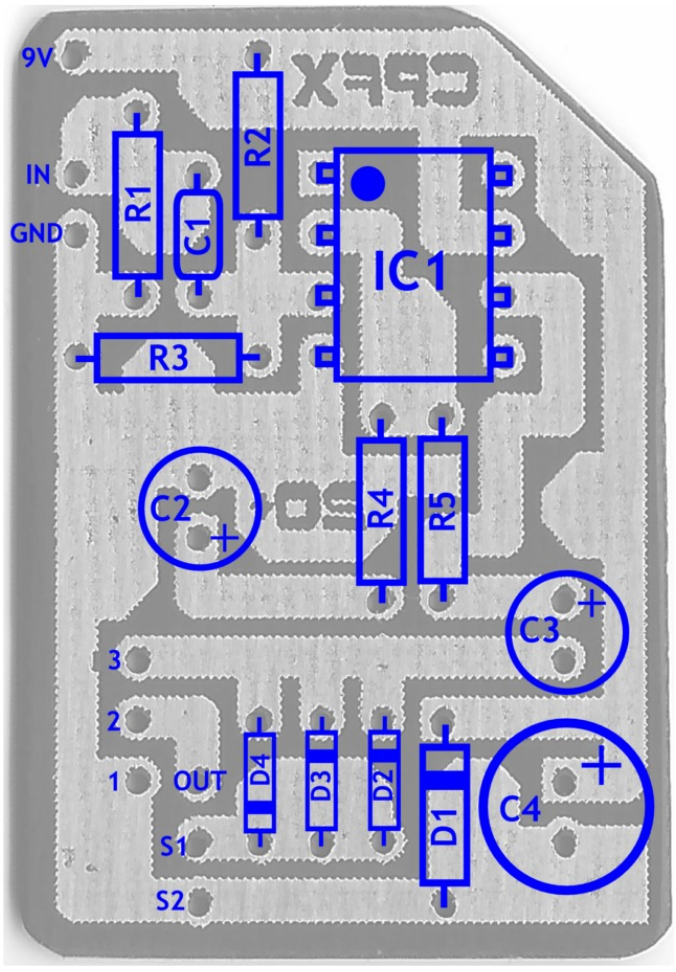
This simple, high impedance op-amp booster buffers your signal to get the most out of your pickups, and gives a totally clean boost to overdrive your tube amp's front end. This boost will work best as the last pedal in your chain, and is great for driving the cable run back to your amp. Optional clipping diodes will add just a bit of grit for when you don't want your boost totally clean. The "stock" B.O.M. will give up to a 20dB boost, but this can be easily adjusted – see mods section!

Parts layout – NOTE! Two versions of this board exist. They are very similar, but the red "XX" boards have a few minor errors. Please follow the diagram for your board as shown below. Bypass switching (including indicator LED) is not shown. Use your favorite method!

For RED circuit boards (labeled "XX"):



For BLACK circuit boards (labeled "20+")



Bill of materials:

R1 1M (optional pulldown resistor)
R2 2.2M
R3 2.2M
R4 100k (see mods section)
R5 1M (see mods section)

C1 100nF (0.1uF)
C2 10uF
C3 10uF
C4 100uF (optional power filter cap)
D1 1N4001 (optional polarity protection diode)
D2-D4 optional silicon clipping diodes (1N4148 recommended)

IC1 TL071 or similar standard JFET (single) opamp

S1-S2 SPST or SPDT toggle switch
PADS 1,2,3: B10k "LEVEL" potentiometer – wire holes to their corresponding lugs on the pot

A note on parts: pads are sized for 1/4W resistors, and C1 should be a 5mm "box" capacitor. Other parts may still fit, but might require creative bending of leads. Please note polarity of electrolytic caps C2-C4 and all diodes.

The value of the Level pot probably doesn't matter much, since it's being used as a voltage divider. I like a linear pot here, but you could easily experiment with log or reverse-log taper pots for the response you like best.

Resistors R2 and R3 are used to bias the op-amp. Any value can be used, as long as they are the same, but this will have an effect on the input impedance of the circuit. As shown, the input impedance is high enough to prevent loading your pickups, and should help bring out a little high-end sparkle. If it's too much, you could replace R2 and R3 with 1M resistors and see if you prefer the slightly darker sound. Capacitor values as shown will allow an even, full-range frequency response for use with guitar, bass, or electric didgeridoo.

MODS:

1. Optional parts: all parts listed as optional above can be omitted if desired.

2. Clipping: Diodes D2-D4 and their toggle switch are optional. However, if you want to add just a bit of dirt to this clean boost without sacrificing too much potential output level, adding two or three of these is a great option! For asymmetrical clipping, use all three diodes as shown. For symmetrical clipping, omit D2. If you want more clipping at the expense of potential output level, you could try germanium diodes, or maybe even schottky's. LED's aren't likely to do much clipping using the standard values for R4 and R5, but might have some effect if you mod the circuit for more boost as shown below.

3. Adjusting the gain: The gain of this boost is determined by the relationship between R4 and R5, and is governed by the following equation:

$$Gain\ (dB) = 20 * log\left(1 + \left(\frac{R5}{R4}\right)\right)$$

You can plug different values of resistors into the equation to find the amount of boost that's right for you… but math sucks, so here are some suggestions:

For about 10dB of boost, use a 220k for R5 and a 100k for R4
For about 15dB of boost, use a 470k for R5 and a 100k for R4
For about 20dB of boost, use a 1M for R5 and a 100k for R4
For about 25dB of boost, use a 2.2M for R5 and a 120k for R4
For a little more than 30dB, use a 10M for R5 and a 220k for R4
And so on.

Be advised that the more boost you build in, the more likely it is that you'll hit the "rails" of the opamp, leading to a kind of clipping that might sound decidedly unpleasant. You can increase headroom by increasing the supply voltage, but check the voltage rating of your caps and opamp to make sure you don't blow them up! TL071 will tolerate a 12V supply with no trouble, but 18V is almost guaranteed to let the smoke out.

A quick word on dB. The gain of the circuit, as measured in dB, does not directly relate to how much louder this boost will make your amp! The two are indirectly related in that the larger the boost, the larger the signal hitting your amp's front end… but your mileage will vary depending on your amp, its settings, and lots of other variables. The decibel in this application is used to describe the change in amplitude of your guitar's signal as it passes through the circuit. Because of the way the Level knob is configured, you can also use this to cut your volume – or set the knob to somewhere around 10 o'clock for a unity-gain signal that still has the benefits of a high-impedance buffer.

And the disclaimer:

This layout and the associated PCB artwork are my intellectual property, which I'm freely sharing with anybody who cares to look. I didn't invent the circuit, but I did tweak it a bit from a version found at http://www.jer00n.nl . Ready-to-solder circuit boards, as well as images for toner transfer etching, are available from me for a nominal fee by emailing bills.justin [at] yahoo.com. Feel free to etch your own for personal use, but if you're going to use this circuit for commercial enterprises, draw your own damn art. And also, don't blame me if you burn yourself with your soldering iron.