10 Min Amp, Revision B

Design By Erik Vincent

An incredibly simple pocket-sized amp, capable of up to 7 watts of power! The 10 Min Amp is the perfect first amp build, and suitable for the following types of projects:

- Cigar Box Amps
- Speaker box Amps
- Bedroom Practice Guitar Amp Head

A quick look at some of the features of the 10 Min Amp:

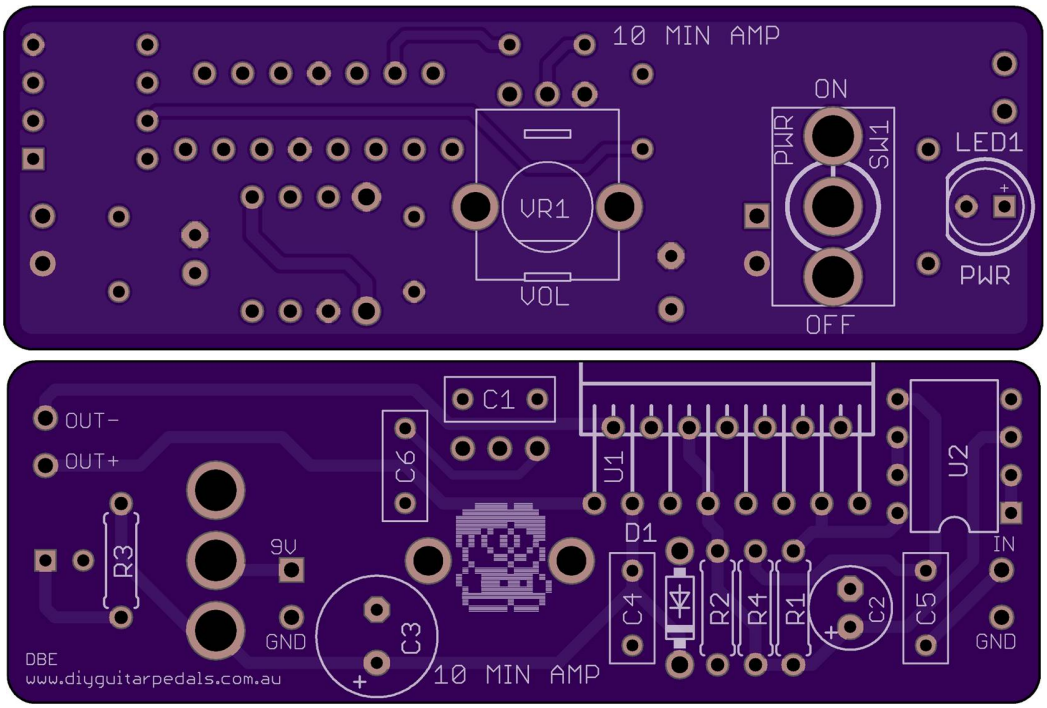
- Simple to assemble
- Incredibly Loud
- No high voltage wiring
- Good cleans and plays well with distortions
- Accepts a wide range of input voltages (battery or dc, 9v - 18v dc)
- Accepts 4 and 8 ohm speaker impedances

Adding a boost circuit and EQ / Tone Control to the front of the amp increases its versatility and volume output significantly and is a recommended addition to your amps input signal chain.

The 10 Min Amp has been designed to fit inside a 1590B enclosure (vertically). Please see the 10 Min Amp Assembly Video for more details.

Bill of Materials, 10 Minute Amp, Revision B

Capacitor		Resistor	
C1	47nF (film)	**R1**	10K
C2	47µF (Electrolytic)	**R2**	10K
C3	220µF (Electrolytic)	**R3**	3.3K
C4	10nF (film)	**R4**	2.2M
C5	100nF (film)	**(Headphone Mod)**	47-100 ohm (optional)
C6	100nF (film)		
Diode		**Switch**	
D1	1N4001	**ON/OFF**	SPDT Micro-switch (ON-ON)
LED		**Potentiometer**	
LED	5mm LED	**Volume**	10ka (9mm)
		Jacks	
ICs		**Input**	Any 6.35mm Jack
U1	TDA7266M	**Output**	Any insulated 6.35mm Jack
U2	TL072	**Power**	Any power jack to match supply



PCB Spacing
The 10 Min Amp PCB is spaced for 1590B sized enclosures or larger

Pot Spacing
The 10 Min Amp PCB mounted potentiometers are spaced for Alpha 9mm potentiometers

1. Soldering Order.

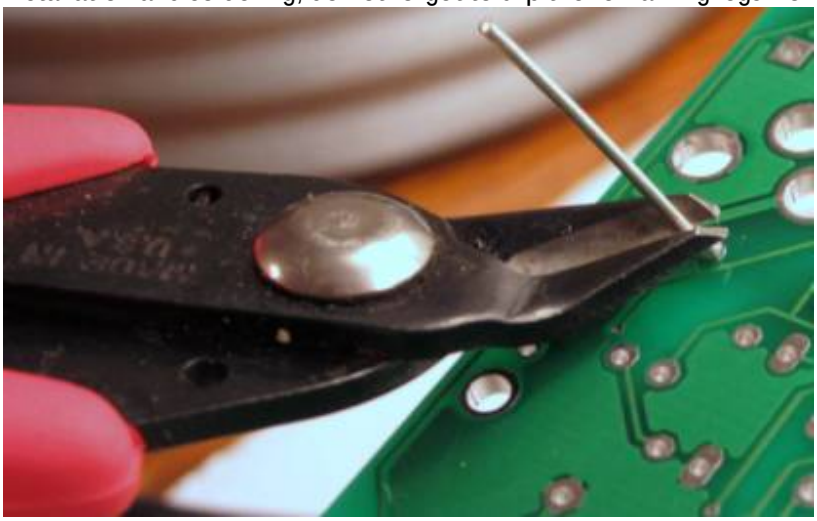
When soldering things to the PCB, the idea is to solder things on from lowest profile to tallest.

For the 10 Minute Amp, the best order would be: resistors, diodes, IC Sockets, ICs, film capacitors, electrolytic capacitors, LEDs, switches, potentiometers, and then wiring.

1.1 Resistors.

Resistors are small passive components designed to create a resistance of passage of an electric current.

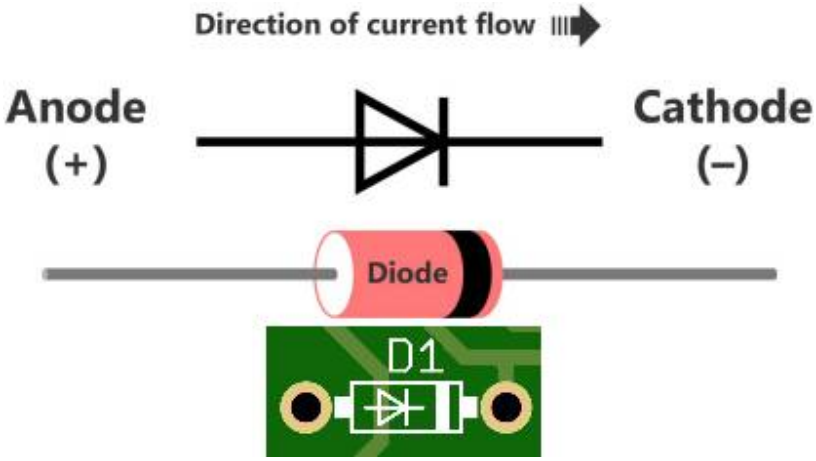
For this pedal we will be using 1/4 Watt resistors. These can either be 5% tolerance carbon resistors, or 1% tolerance metal film resistors. Orientation of “which way is up” doesn’t matter, so you can install them either way. After installation and soldering, do not forget to clip the remaining legs from the PCB.



1.2 Diodes.

Diodes are semiconductor components typically designed to allow the flow electric current to go in one direction only.

The orientation of a diode does matter based on the cathode and anode of the diode in the circuit. Make sure the stripe on the diode lines up with the stripe on the PCB's silkscreen. After installation and soldering, do not forget to clip the remaining legs from the PCB.



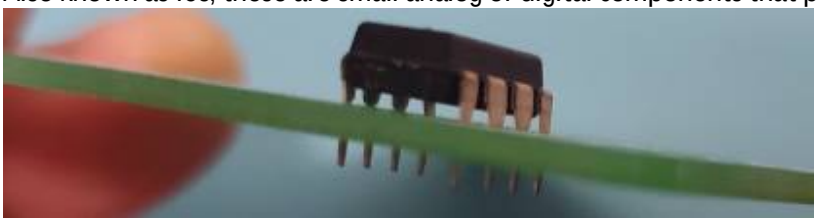
1.3 IC Sockets.

These are holders that allow easy installation and uninstallation of ICs.

These devices will have a silk screen notch to indicate an orientation with the IC or socket for the IC. Just make sure the IC notches match.

1.4 Integrated Circuits.

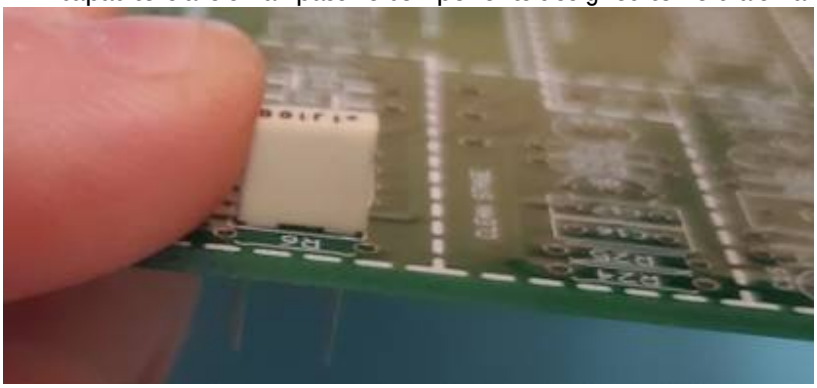
Also known as ICs, these are small analog or digital components that provide specific electrical functions.



Orientation of “which way is up” will be indicated by a notch on the silkscreen on the PCB and a dot or bar on the actual IC itself. Do make sure they match.

1.5 Capacitors (film).

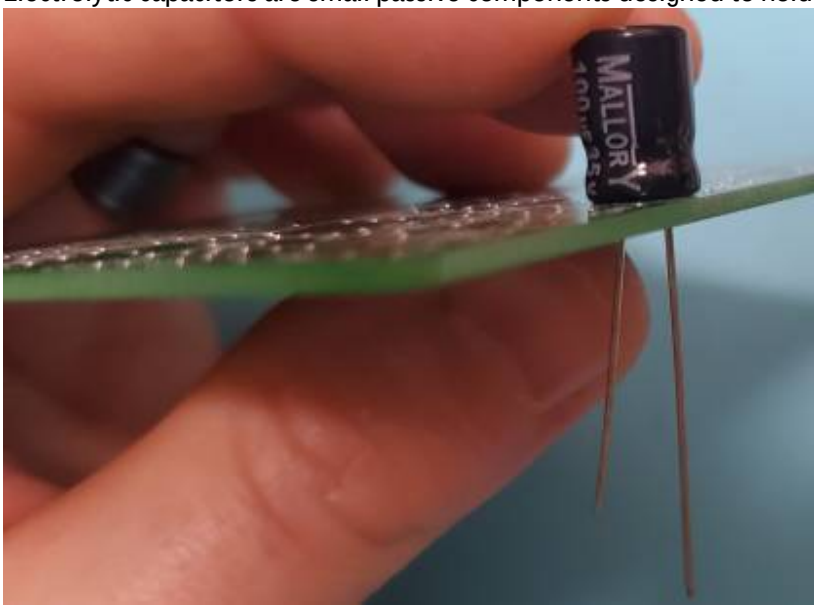
Film capacitors are small passive components designed to hold a small amount of charge in a circuit.



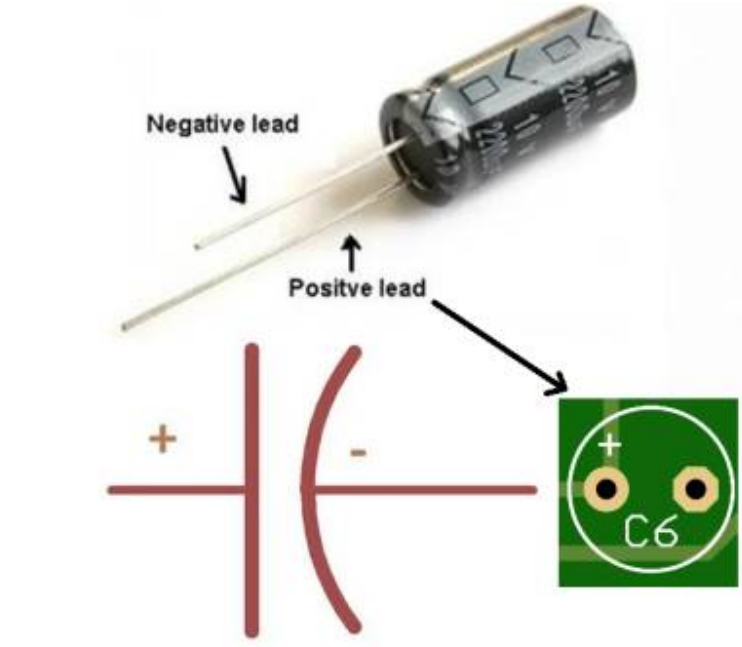
Orientation of “which way is up” doesn’t matter, so you can install them either way. After installation and soldering, do not forget to clip the remaining legs from the PCB.

1.6 Capacitors (electrolytic).

Electrolytic capacitors are small passive components designed to hold a small amount of charge in a circuit.



Electrolytic capacitors are typically polarized, so orientation will matter.

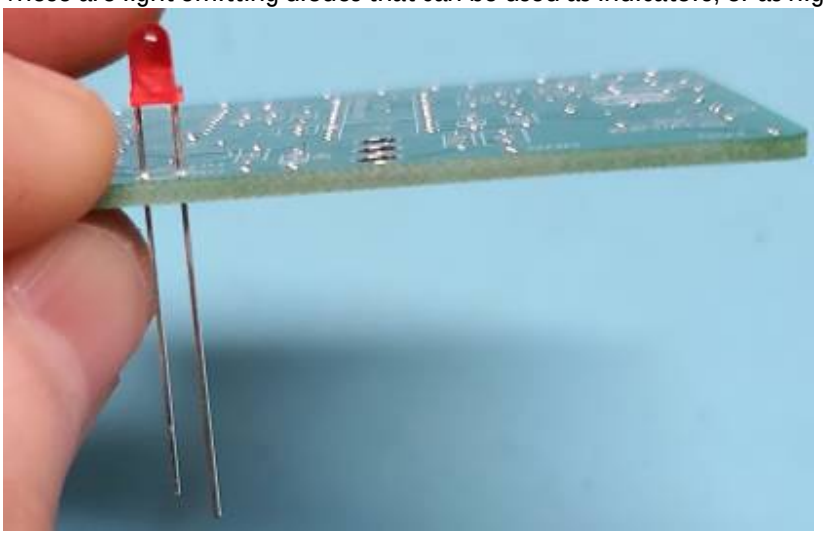


Polarized Electrolytic Capacitor and its electric Symbol

After installation and soldering, do not forget to clip the remaining legs from the PCB.

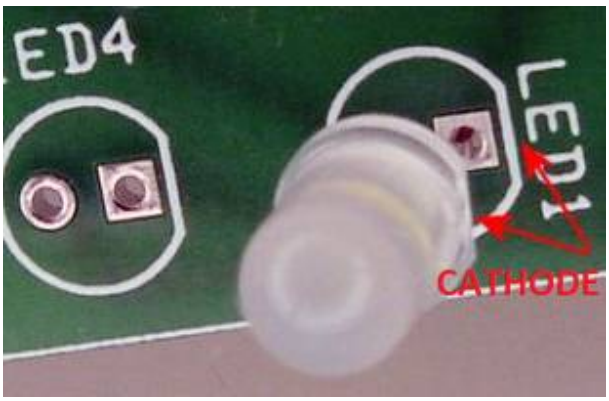
1.7 LEDs.

These are light emitting diodes that can be used as indicators, or as high-forward voltage, low signal diodes.



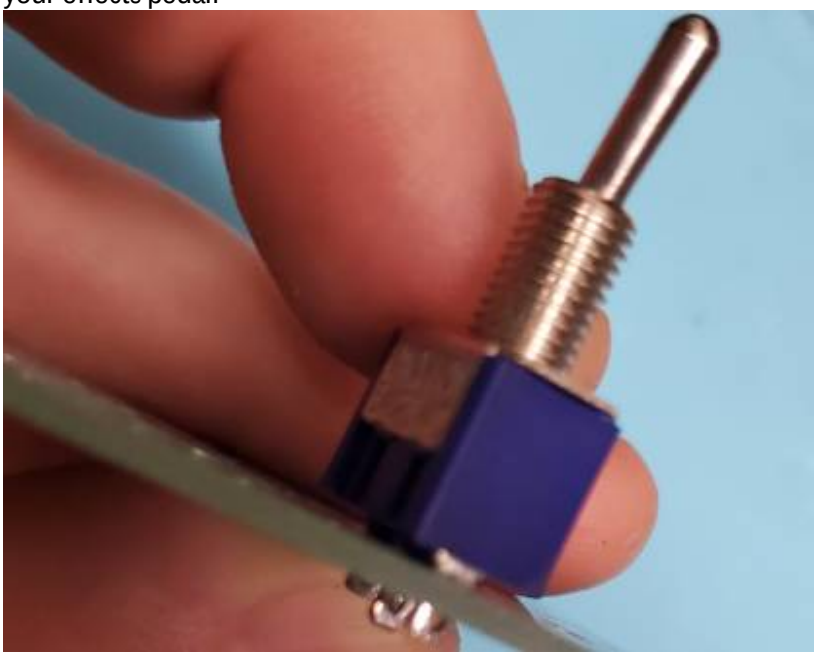
Before you solder, you will likely want to insert LED stand-offs to make sure the LED is at proper height. For the 10 Minute Amp, a 4mm standoff is recommended.

These devices will have a silk screen notch to indicate an orientation. Make sure the flat side on the PCB matches the LED's flat cathode when placing on the PCB.



1.8 Switches.

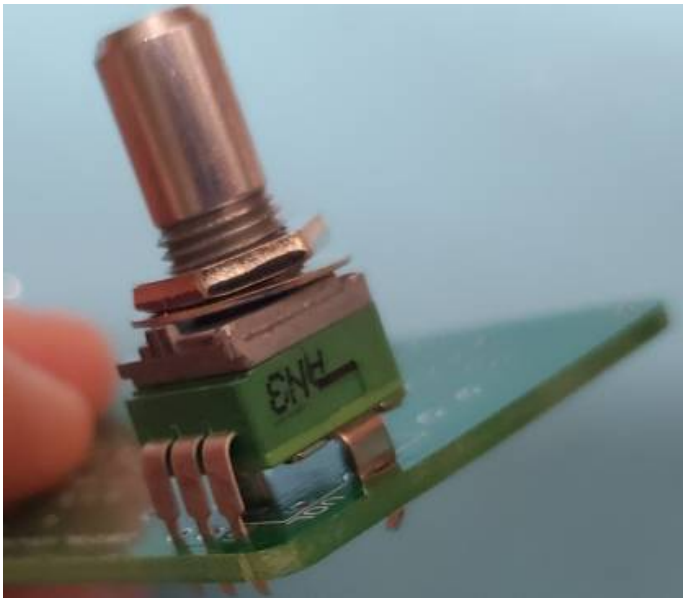
Switches are mechanical devices that change the flow of electricity on a circuit, usually to provide different options to your effects pedal.



These are typically installed on the backside of the PCB and uses jam-nuts to set the “height” of the actuator and to mechanically secure the PCB to the enclosure via a strategically drilled hole on the enclosure. Orientation should not matter with most switches.

1.9 Potentiometers.

Potentiometers are variable resistors that are used for controlling aspects of the pedal.

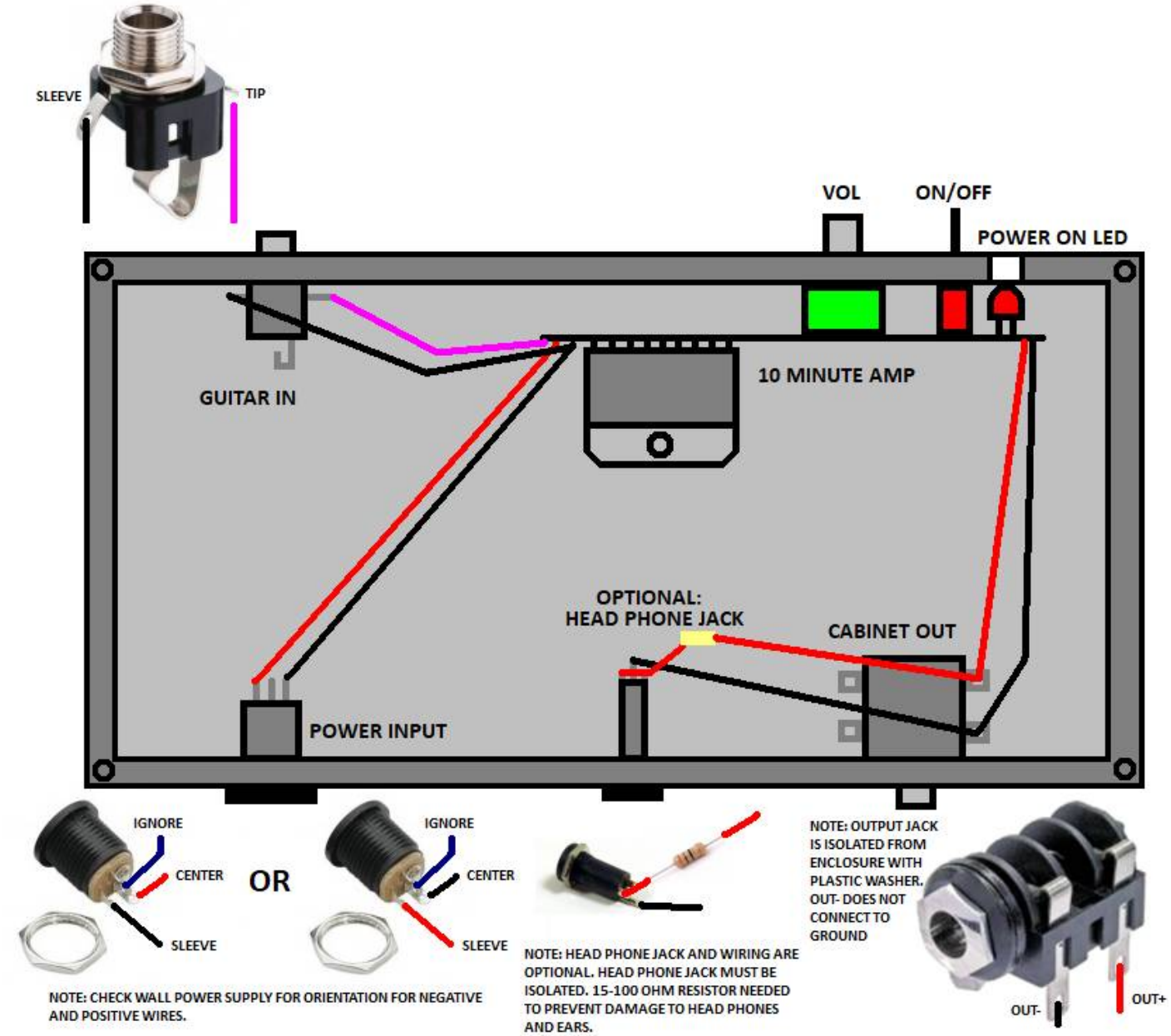


This pedal utilizes 9mm pots. These are typically installed on the backside of the PCB and uses the included washer and jam-nut to mechanically secure the PCB to the enclosure via a strategically drilled hole on the enclosure. Orientation of potentiometer is preferred to line up the knob on the silk screen with the knob of the potentiometer.

1.10 Wiring.

Wires used for the pedal are for delivering power over the hot and ground wires as well as signal for the input and output.

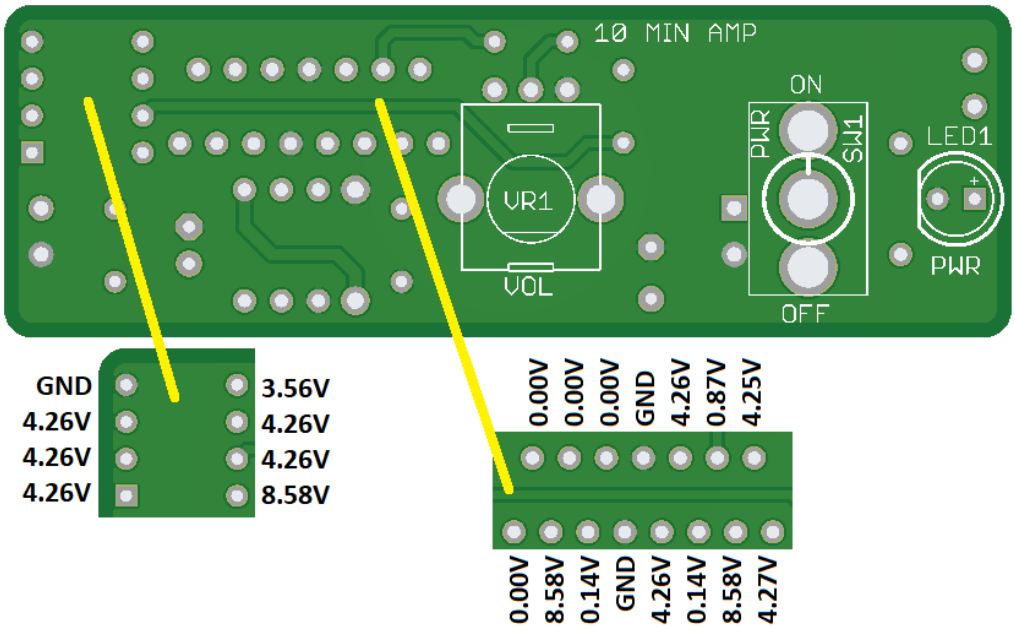
Using a DC Jack, Mono Jack, and Isolated Mono Output Jack. Optional wiring for isolated stereo headphone jack shown.



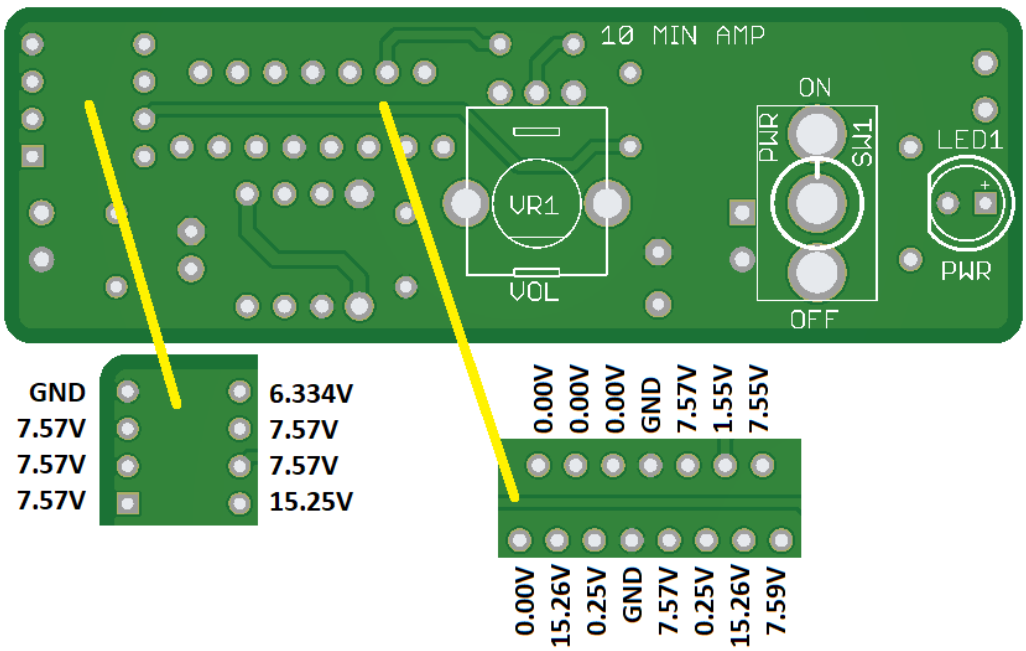
These can be installed at the very end, but in some situations, installing them before potentiometers are soldered in place can be advantageous. Colored wire doesn't change the properties, but using color codes for hot and ground wires, like red being hot, and black being ground, are common place. Typically, stranded hook-up wire, AWG 24 or 22 is used for this task. Using wire strippers, strip away about 1/8" (3mm) of the wire from either end and then using a soldering iron, tin the exposed tips with solder before installing into the PCB.

2. Voltage Readouts.

Below are the voltage readouts of the ICs onboard, assuming 9V Power Supply.



Below are the voltage readouts of the ICs onboard, assuming 16V Power Supply.



3. Enclosure Assembly for 1590B.

These steps will guide you on the mechanical assembly of the 10 Minute Amp

3.1 Print Drill Template.

Print out the PDF of the drill template and make sure it doesn't "scale down" the image. It should print a 1:1 template. Once printed, cut out and fold to cover your 1590B enclosure

3.2 Tape the Drill Template to the Enclosure.

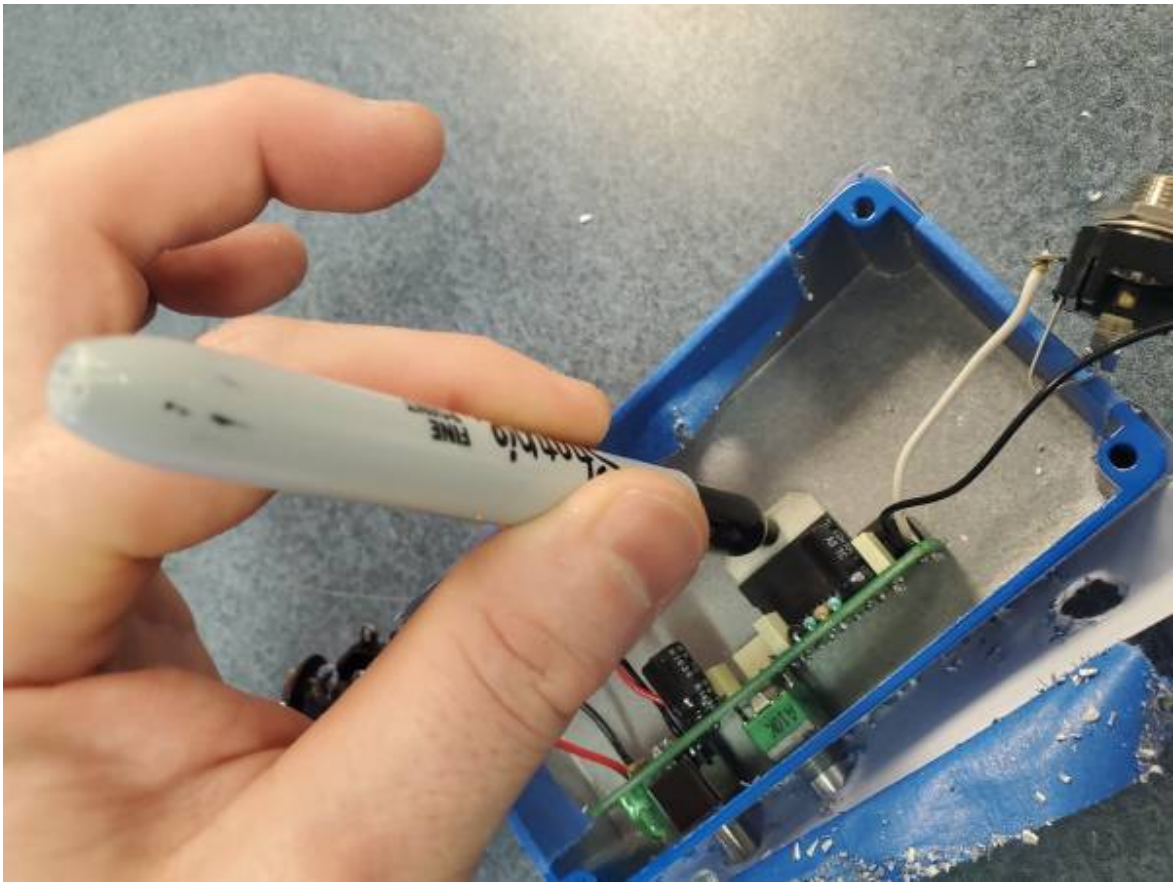
Using tape, secure the drill template around the 1590B enclosure

3.3 Drill the Enclosure.

Drill the holes for the front and back of the enclosure

3.4 Mark the Heat-Sink Hole

Mark where the hole for the power-amp will land. Remove the PCB from the enclosure and then drill out the “Heat-Sink Hole”.

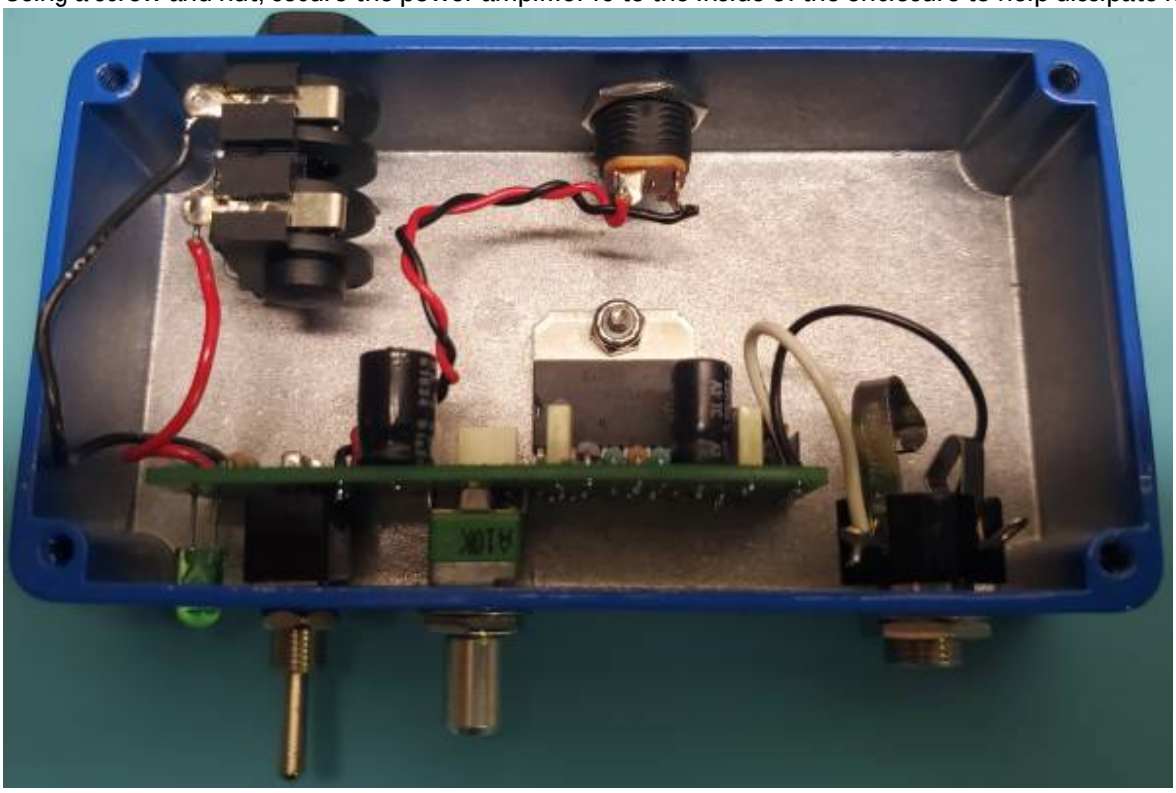


3.5 Fasten Components

Fasten all the components of the PCB to the front of the enclosure. Then solder in the power connector, noting the polarity for your power supply (center negative or center positive)

3.6 Fasten Heat-Sink Screw

Using a screw and nut, secure the power amplifier IC to the inside of the enclosure to help dissipate heat.



3.7 Attach External Parts

You should be able to attach LED bezel and front volume knob at this point.

And now you are all done.

4. Modifications

Following is a couple of worthwhile modifications that can be applied to the 10 Min Amp.

4.1 Capacitors

Changing the values of C1 effects how much bass frequencies are cut from the input signal going into the amplifier. Default value is 10nF. Decreasing the capacitance will cut more of the bass frequencies out, making the tone brighter. Increasing the capacitance will allow more bass frequencies into the input signal, making the tone darker.

4.2 Resistors

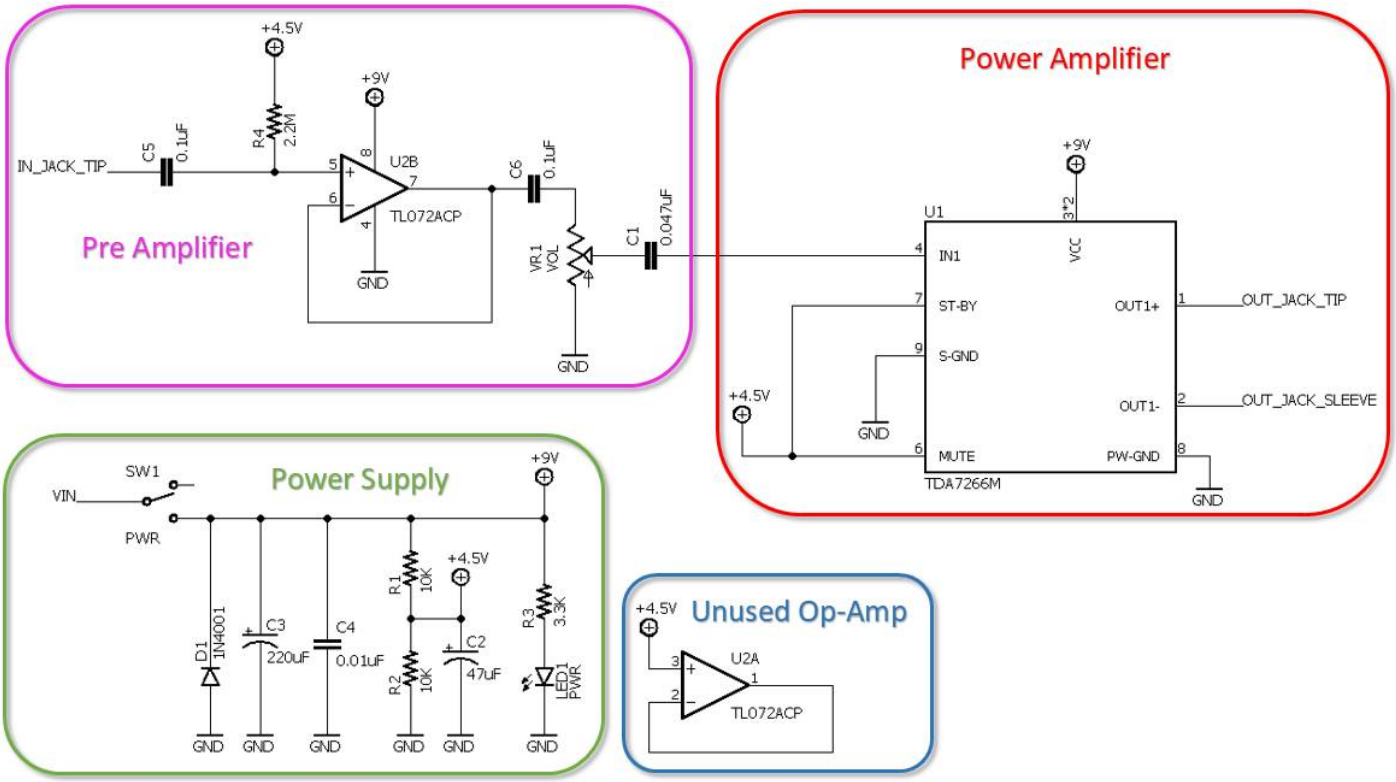
The value for R3 is by default, 3.3K as the 10 Minute Amp can use a maximum input power supply of 18V. If you are using a lower input voltage, like 12V, using a 1.5K resistor for R3 would be acceptable, and for 9V input, a 1K resistor would be sufficient.

Off-board in series resistor for optional headphone jack should be 15 ohms to 1K ohms to prevent damage to head phones and hearing. The lower the value, the louder it will be. The higher the value, the quieter it will be, as well as cutting more and more of the bass content of the sound. At 100 ohms, almost all bass content is preserved and even with a lot of gain from a high gain fuzz pedal, it shouldn't destroy the headphones (although, maybe your ears, at max volume, will still suffer). At 15 ohms, just the amp (no pedals or pre-amps), at full volume will not blow the headphones, but any lower resistance would risk damage to headphones. 47-100 ohms are the recommended values.

10 Min Amp Circuit Analysis for modifying purposes.

5. 10 Min Amp Circuit.

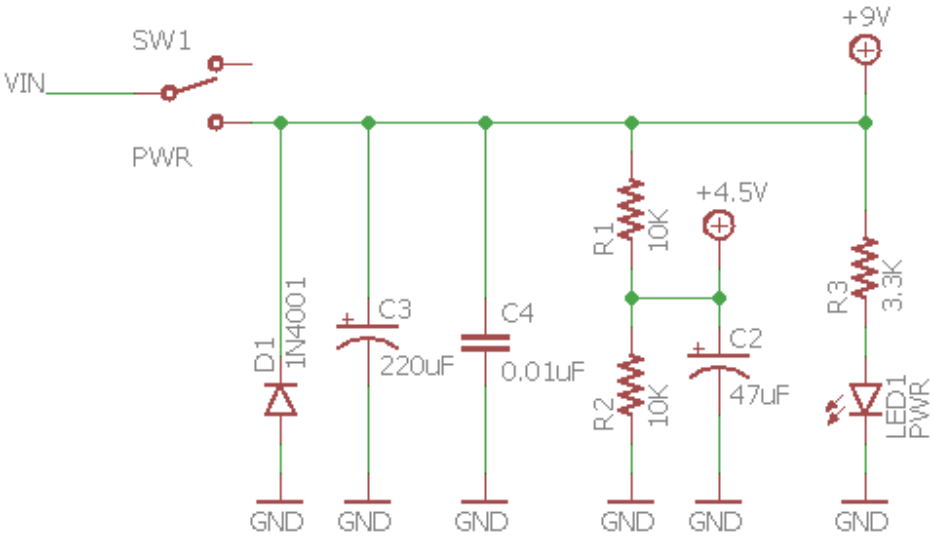
The 10 Min Amp schematic can be broken down into some simpler blocks: Power Supply, Pre-Amp, Power Amplifier and an Unused Op-Amp.



The design is based on a simple dual bridge, class AB amplifier with an Op-Amp input buffer to provide a high input impedance.

6. Power Supply.

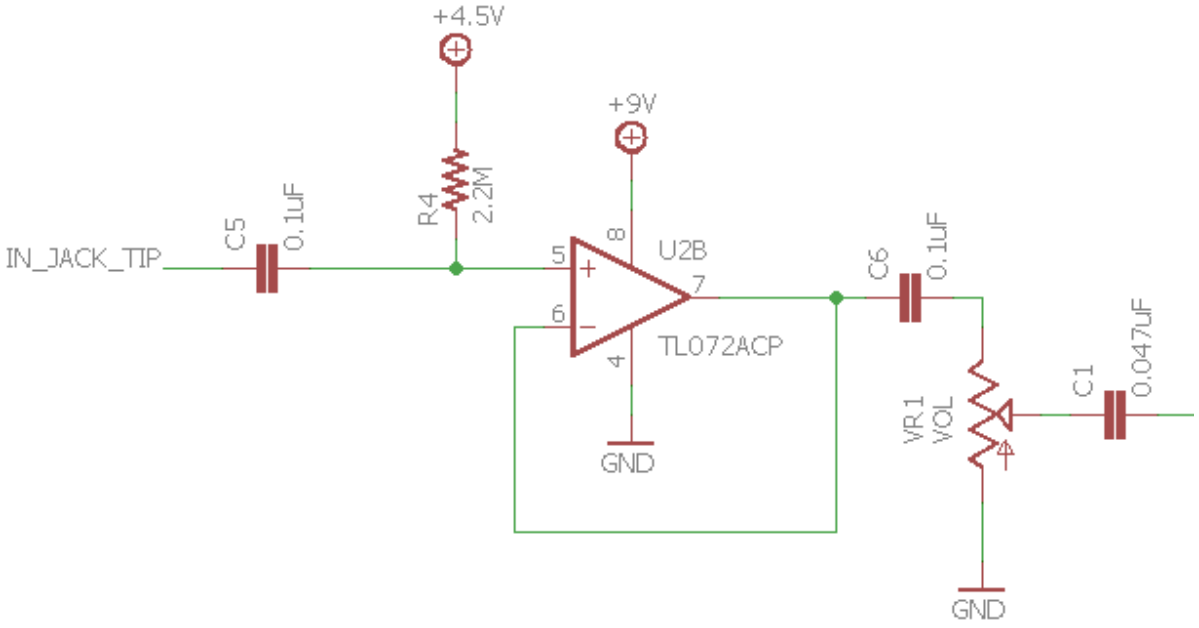
The Power Supply Stage provides the electrical power to all the circuitry.



- This amplifier can handle voltages between 3V to 18V. Typical current at 9V is 31mA. Typical current draw at 12V is 37mA. Typical current draw at 18V is 53mA. Maximum current draw is 75mA.
- The diode D1 protects the pedal against adapter reverse polarity connections.
- C2 is a large value capacitor of 47µF used to decouple the voltage divider, formed by R1 and R2, to ground.
- C3 is a large value capacitor of 220µF used to decouple to ground to help filter noise, but also helps with the bass response from within the TDA7266M, especially when driving large speakers. Values between 220uF and 470uF are recommended.
- C4 is a small value capacitor of 10nF used to decouple to ground to help filter high frequency noise that a power supply might be trying to inject.
- SW1 is a simple switch to apply power to the circuit.
- R1 and R2 form a voltage divider to provide bias voltage to the input buffer section as well as provide voltage to the mute and stand by pins on the power amp to make sure it doesn't go into a stand by or muted state.
- R3 is a current limiting resistor to drive LED1. Depending on input power voltages, R3 can range from 1K to 10K which in turn will vary the brightness.

7. Pre-Amp Stage.

The 10 Min Amp uses an op-amp to act as an input buffer to provide a high input impedance. After the buffer, a volume potentiometer is used to bleed the signal to ground before entering the power amplifier stage.



- C5 is a 100nF film capacitor used to couple the input jack to the buffer. It forms a small RC filter with R4.
- R4 is a large value resistor to set the input impedance and bias the op-amp's non inverting pin. It forms a small RC filter with C5.
- C6 is a 100nF film capacitor used to couple the output of the buffer into the volume potentiometer.
- C1 is a 47nF film capacitor used to couple the output of the volume potentiometer into the power amplifier.
- U2 is a dual op-amp, which is used as a non-inverting buffer to provide a high input impedance value.
- VR1 is a 10K potentiometer. It can either have a logarithmic taper or a linear one.

7.1 EQ Curve

There are two RC filters that essentially shape the EQ response of the pre-amp buffer section.

The 100nF C5 input capacitor blocks DC and provides simple high pass filtering. C5 and R4 create a high pass filter.

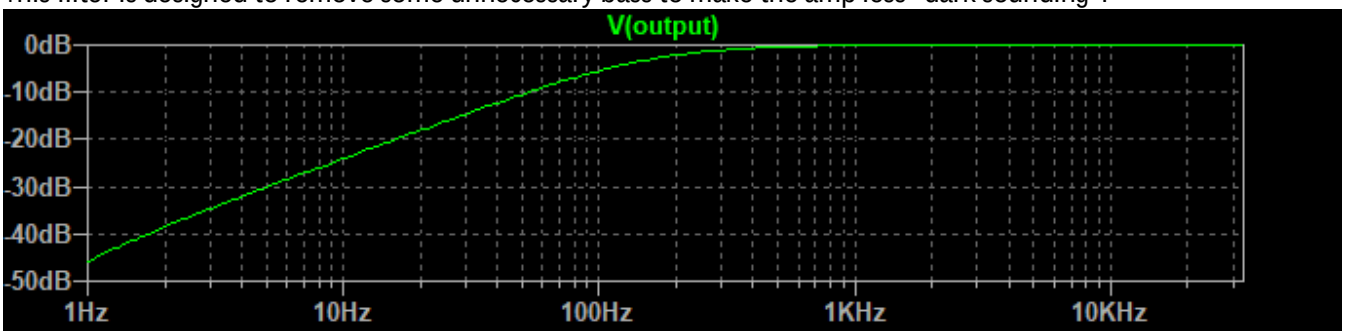
$$fc = 1 / (2\pi RC)$$
$$fc = 1 / (2\pi \cdot R_2 \cdot C_5)$$
$$fc = 1 / (2\pi \cdot 2.2M \cdot 100nF)$$
$$fc = 1 / (2\pi \cdot 2{,}200{,}000 \cdot 0.0000001)$$
$$fc = 0.7\ Hz$$

This filter is primarily there for coupling and providing bias, so it doesn't remove any noise other than low frequency oscillation.

The 100nF C6 input capacitor blocks DC and provides simple high pass filtering as well. C6 and the 10K volume pot create a high pass filter.

$$fc = 1 / (2\pi RC)$$
$$fc = 1 / (2\pi \cdot VR_1 \cdot C_6)$$
$$fc = 1 / (2\pi \cdot 10K \cdot 100nF)$$
$$fc = 1 / (2\pi \cdot 10{,}000 \cdot 0.0000001)$$
$$fc = 159\ Hz$$

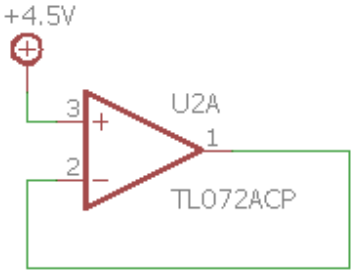
This filter is designed to remove some unnecessary bass to make the amp less "dark sounding".



Increasing the C6 capacitor to 220nF will bring the cut-off at around 72 Hz while a value of 330nF will be at a value of 48 Hz. Decreasing the C6 capacitor to 47nF will cut much of the bass frequencies from 338 Hz and lower.

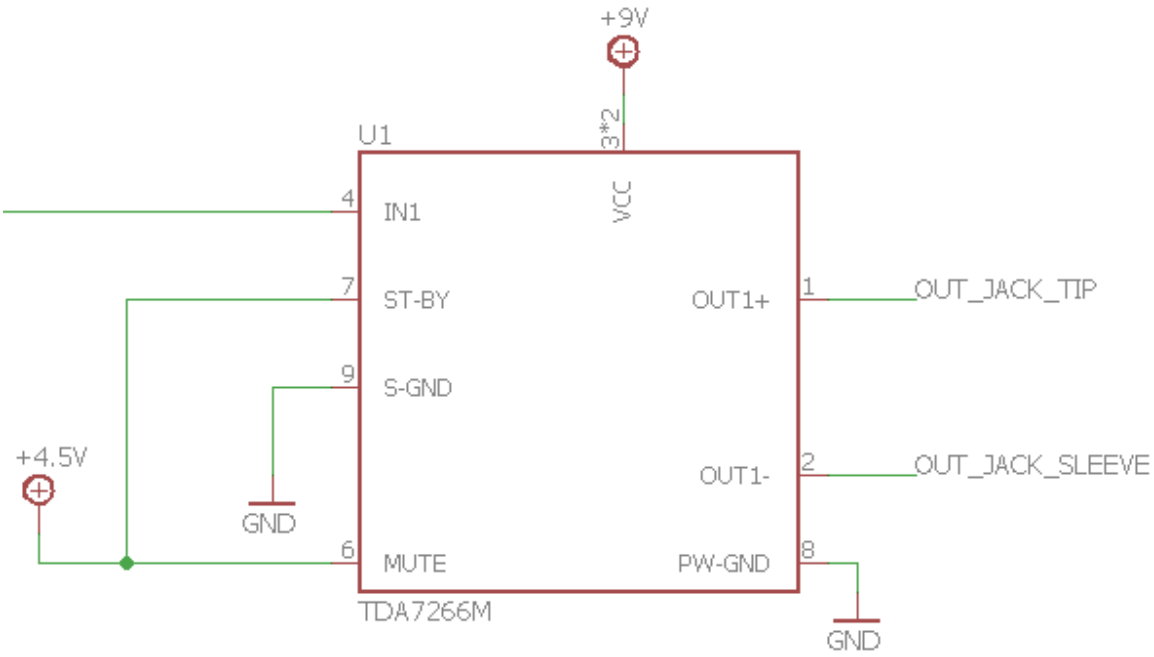
8. Unused Op-Amp.

In an effort to allow for many op-amp buffer options, but at the same time, keeping the part count low for an easy project, the 10 Minute Amp uses a dual op-amp for its buffer, but only uses one of the two op-amps. Because of the second op-amp being there, it needs to be “properly terminated” to bias so to not let it go into oscillation.



9. Class A-B Amplifier

The TDA7266M is the core of the circuit which is made of a class A-B amplifier IC.



9.1 Jacks

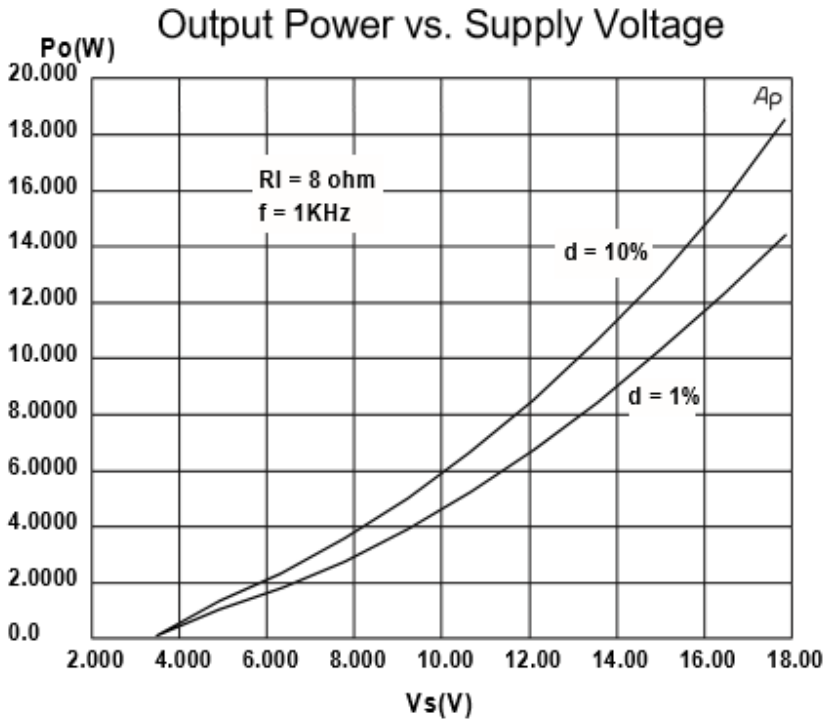
Like most guitar pedals, typical 6.35mm jacks have metal washers and sleeve jacks, connecting the ground of the jacks to the enclosure. This in turn makes the whole enclosure grounded. This becomes a problem when the output jack's sleeve, which is not ground. What this means is that the output 6.35mm jack cannot have a sleeve that is connected to ground in any way, which in turn means the jack must be insulated or plastic tipped so that it doesn't conduct on the wall of the enclosure.

9.2 Thermal Heatsink.

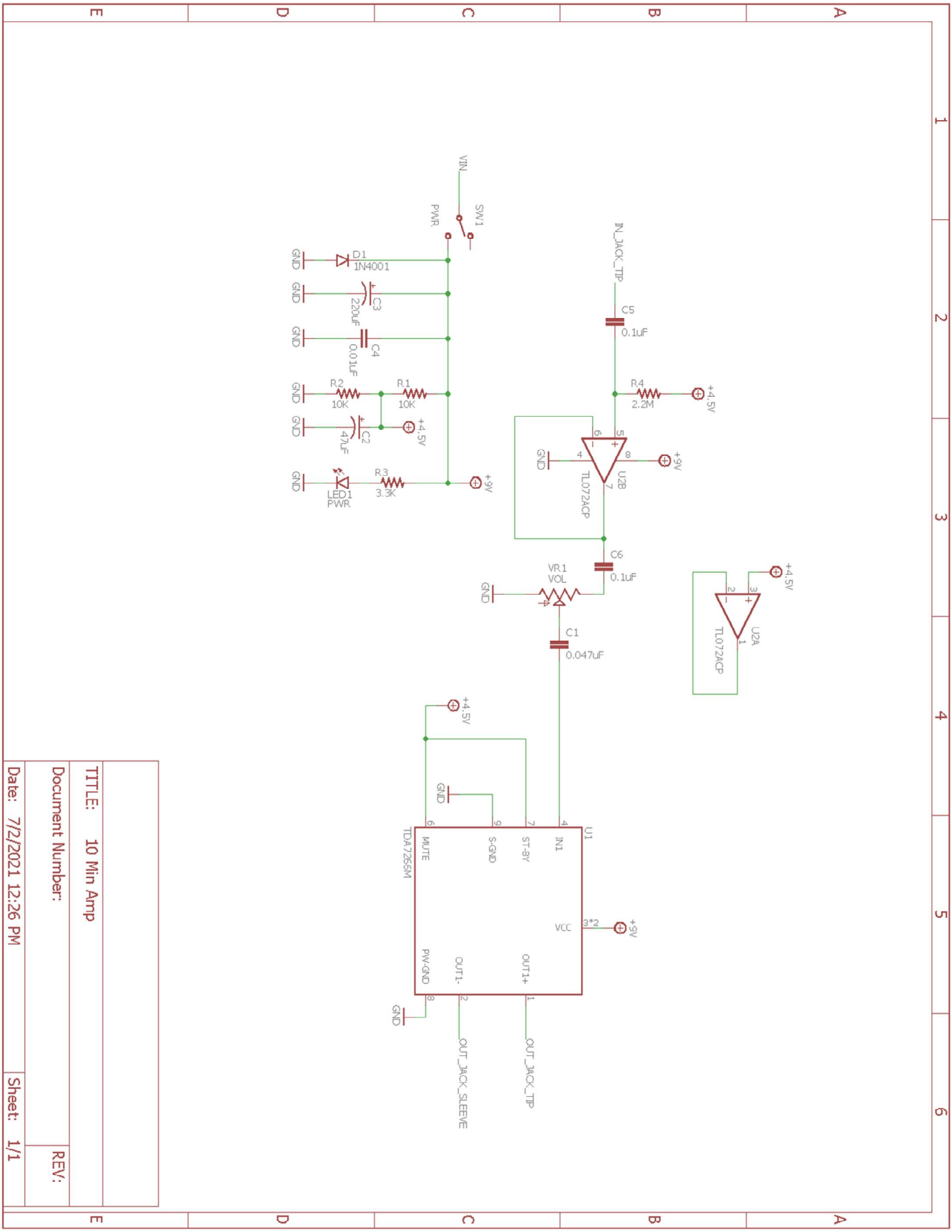
The TDA7266M has a large tab in which a heatsink can be applied. The large tab is connected to the ground pin of the TDA7266M. At 9V, at full volume, with a 2x12 Celestion Vintage 30's cabinet at 8 ohms, the tab will get warm, but probably not hot, so a heatsink may not even be necessary. However, if attempting to increase the voltage from 9V to 12V all the way up to 18V, a heatsink becomes more and more necessary. Either applying a standard heatsink via a screw and nut or even using the inside of the enclosure of the pedal and use a screw and nut to fasten the 10 Min Amp to the inside of the enclosure, will work in keeping the TDA7266M cool.

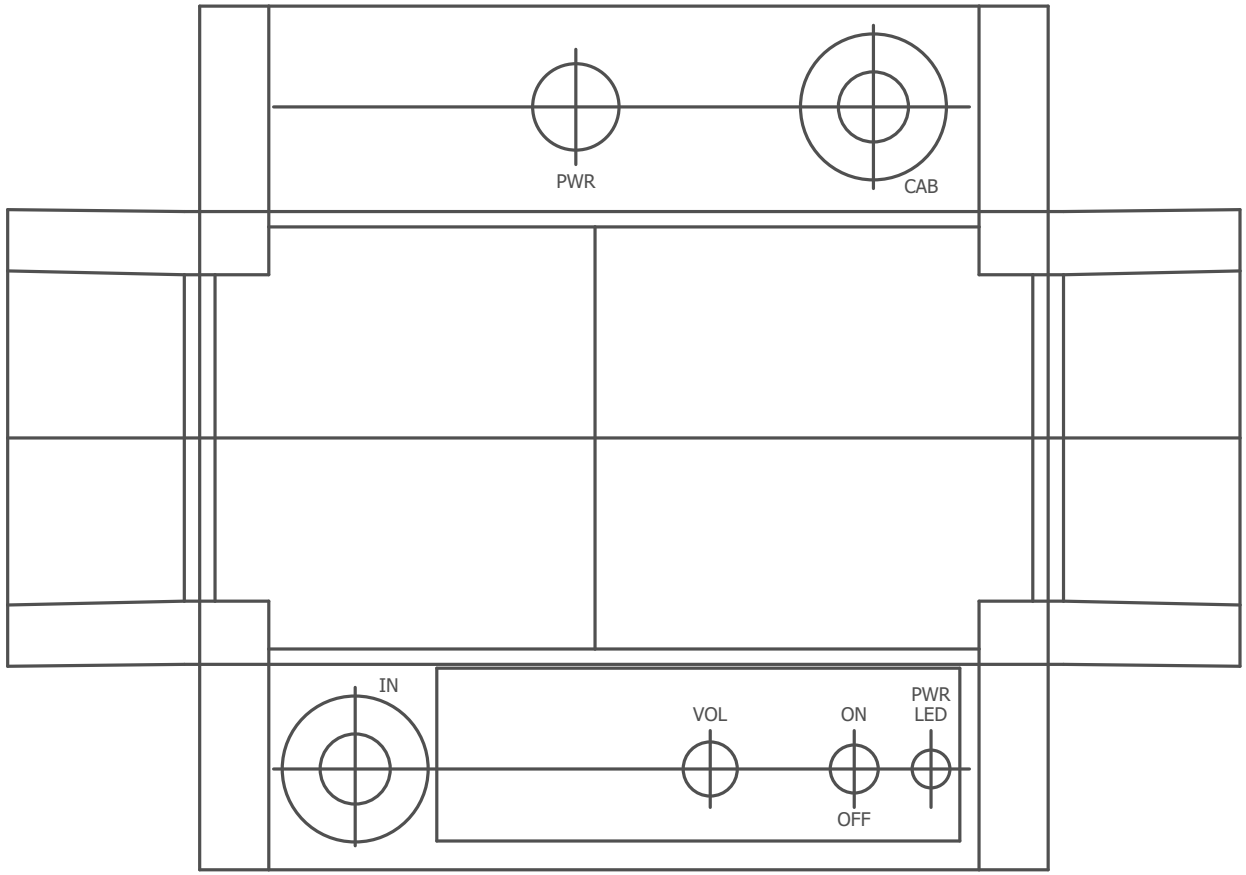
9.3 Wattage.

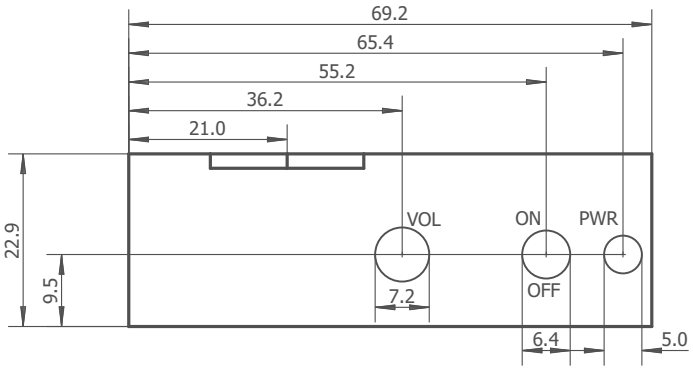
The TDA7266M is capable of doing 7W as a class A-B amplifier. However, this is dependent on several variables, such as frequency of sound, speakers, resistance of the output, and most importantly, the voltage. The below chart shows the ratio of wattage to voltage off the datasheet for the TDA7266M. At 9V, it can output a maximum of around 3W.



10. Schematic




PWR
CAB
IN
VOL
ON
OFF
PWR
LED


69.2
65.4
55.2
36.2
21.0
VOL
ON
PWR
OFF
22.9
9.5
7.2
6.4
5.0