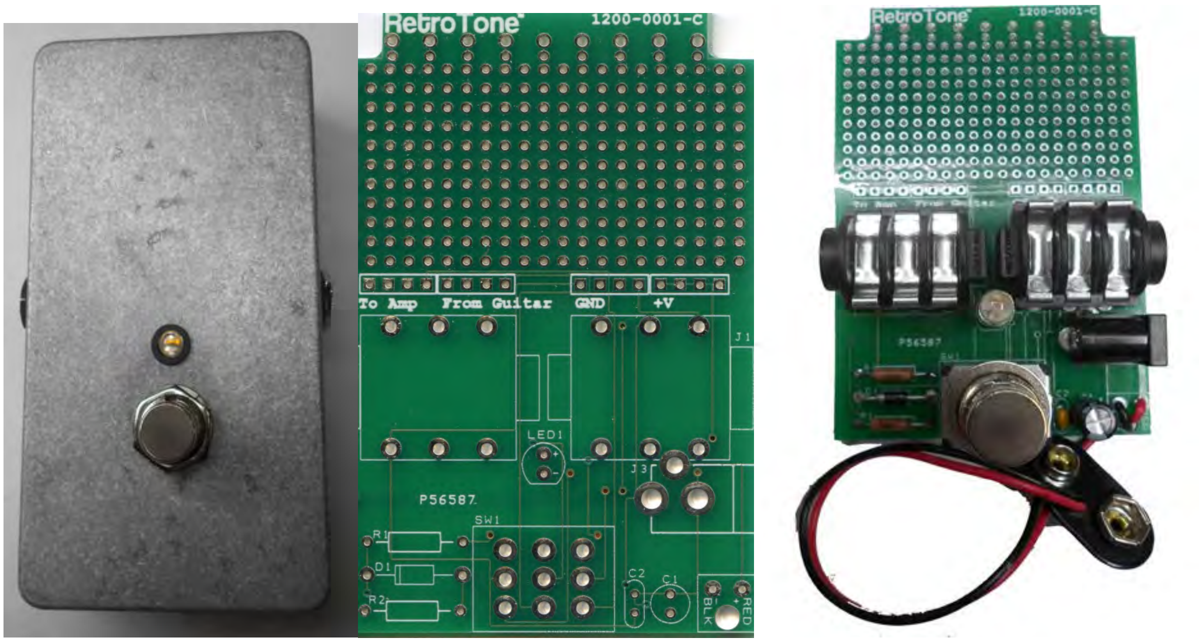
Bare Metal Prototyping Platform



A Build Em' Out™ Project

Introduction

Take your projects to the next level with the **Bare Metal 1590B** kit from **RetroTone**®. Add reliability and durability to your builds and cut down assembly time. All the heavy lifting is done for you. The Input/Output and power jacks are wired and ready to go. This virtually eliminates wiring errors and saves you time and frustration. This kit lets you focus on the important thing about every build---your design.

This project introduces component identification, soldering skills and mechanical assembly skills.

This document is designed for builders just starting out with all the essential skills to complete a successful build. **Experienced builders** can refer to the **Overview** section to find the details to gain an understanding of the connections and resources available on the **Bare Metal 1590B**.

The **Bare Metal 1590B** kit gets you to your goal of stripboard PCB builds faster with better builds that last a lifetime through tough on-the-road abuse.

Table of Contents

Table of Figures

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Specifications

21 by 11 Plated through-hole grid
10 mil traces
1 oz copper
FR4 quality printed circuit board

2.1mm Center Ground DC Input Jack
9VDC – 18VDC Input DC Supply filtering
LED indicator
Reverse polarity protection
Switched DC Power Input/Battery

Bill of Materials

Ref	Description	Qty	Value	Part Number
	PCB Power Pak			4000-0008
C1	Electrolytic Filter Capacitor	1	100uF	0200-0000
C2	MLCC Ceramic Filter Capacitor	1	10nF	0200-0100
R1, R2	Metal Film Resistor	2	1K	0100-0001
D1	Rectifier Diode	1	1N4001	1400-0001
	1590B PCB PAK			4000-0031
	FR4 Printed Circuit Board	1		1200-1001
SW1	Footswitch	1	3PDT	0600-0003
	PCB IO Pak			4000-0020
J1, J2	¼" Input/Out Jacks	2		0900-0002
J3	DC Input PCB Mount	1		0900-0007
BAT1	Battery Snap	1		0900-0001
	600-LED Pak			4000-0010
LED1	Yellow Light Emitting Diode	1	5mm LED	1500-0010
	0.6" LED Standoff	1	0.1 x 0.6	1600-0004
	LED Panel Retainer and Ring	1		1600-0003
	Enclosure PAK			4000-0001
	1590B Enclosure	1		1000-0006
	Adhesive Bumpers	1		1600-0002
	Battery Pad	1		1600-0001

Required Tools

- Needle Nose Pliers
- Soldering Iron
- Solder – No Clean Flux - 0.031"
- Wet Sponge

Parts Identification

It is important to place the correct component in the correct location on the printed circuit board (PCB). This section helps the builder just starting out visually identify the component and how it is placed and attached to the PCB.

The following photo shows you what the completed **Bare Metal 1590B** looks like when completed.

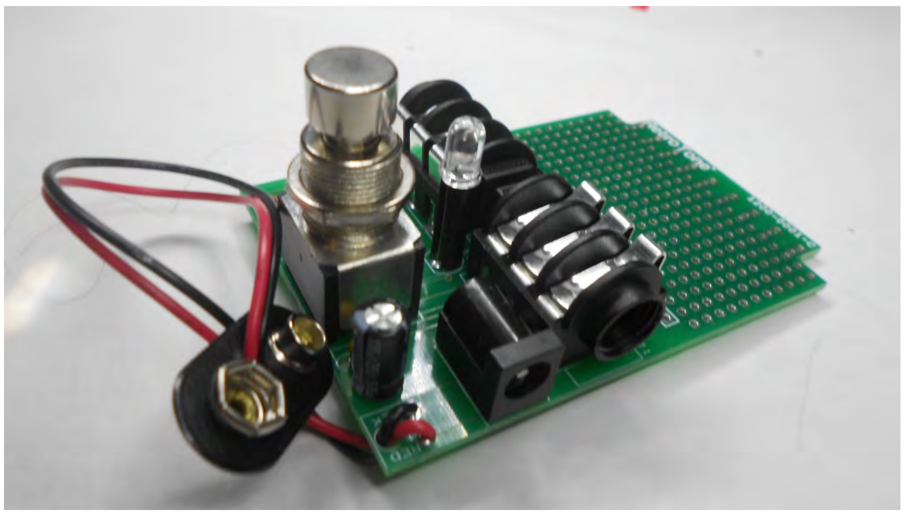

Figure 1 Completed 1590B Bare Metal

A Word on Placing Components

Place all the resistors and capacitors first. Then place the ¼" jacks then the DC input jack and finally the footswitch. Complete the build with the LED and its standoff. The battery snap can be considered optional and can be placed last. **It is a good idea to dry fit the components before you start the assembly. This clears the holes and tests for a proper fit.** Each component has a reference designator. A reference designator has one or more letters followed by a number. This scheme is standard throughout the electronics industry.

- Resistors - Rx
- Capacitors – Cx
- Diode - Dx
- Connecters - Jx
- Switches - SWx
- Battery Snap – BATx
- Light Emitting Diode – LEDx

Some components have a "polarity" and must be placed correctly for the component to work properly. LEDs, diodes, some capacitors and the battery snap on the **1590B Bare Metal PCB** have a polarity. The photos below show the LED with a clearly marked "polarity." The flat side of the LED is the "negative" terminal. The small rectangle on D1 shows the "polarity" for a diode. This terminal is called a cathode. The small plus sing on capacitor C1 shows the "positive" terminal.

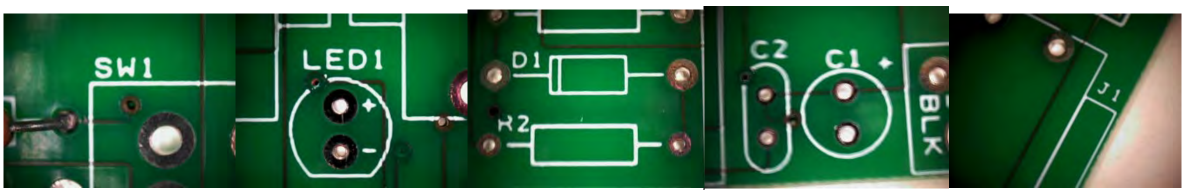

Figure 2 – Example Reference Designators on the PCB

PCB Assembly

Overview

Start with the resistors, capacitors and the diode. These components lie close to the board and can be difficult to place if there are large components in close proximity. Be aware of the polarity of the filter cap and the diode.

The footswitch is next. The only trick to this component is to make sure that it is flush with the board.

Next, place the DC Jack. This component has large holes and requires a significant amount of solder to fill the holes. It also sits very close to the ¼" input jack. It is very important to make sure that the DC jack aligns with the footprint pattern on the PCB. It also must sit flush with the PCB. Proper placement allows the DC jack to align with the holes in the enclosure in the final assembly.

Place the ¼" jacks. Make sure the open end of the connector is facing the outside edge of the board. The pattern is semetrical so it is easy to put it in backwards (yes, I've done it). This must also be flush with the board.

Put the stand off on the led and solder it into the pattern observing that the polarity is correct. The flat side of the LED is the negative terminal and it must align with the footprint on the PCB. Be sure that it is standing straight. This is essential to provide proper alignment with the hole in the enclosure.

Finally, the battery snap leads should be put into the large hole from underneath the PCB then each lead soldered into the respective hole. This provides a strain releif if the snap is acidently tugged. The PCB is clearly marked with the positive and negative terminals, as well as, lead colors.

Optional Components

The battery snap and the reverse polarity protection are optional. If you intend to always use your pedal with a power source on a pedal board you don't really need the battery snap. If your circuit is built from discrete transistors, you really don't need the reverse polarity circuit. If you think about it for a second, the transistors really act as diodes and suffer no dammage from reverse polarity. However, you can dammage the transistor with over voltage or a poor bias scheme.

Conclusion

That's It!. You are done. An experienced builder with good solder skills can assemble the **Bare Metal 1590B** in 15 or 20 minutes. A builder just starting out will take longer because it is essential to inspect the solder joints for a good bond and proper alignment. Remember, everbody makes mistakes. Don't be hard on yourself. And, don't go to the next step until you get the previous step correct.

The **Bare Metal 1590B** is the core of your dream design. If assembled well, it will provide years of flawless service.

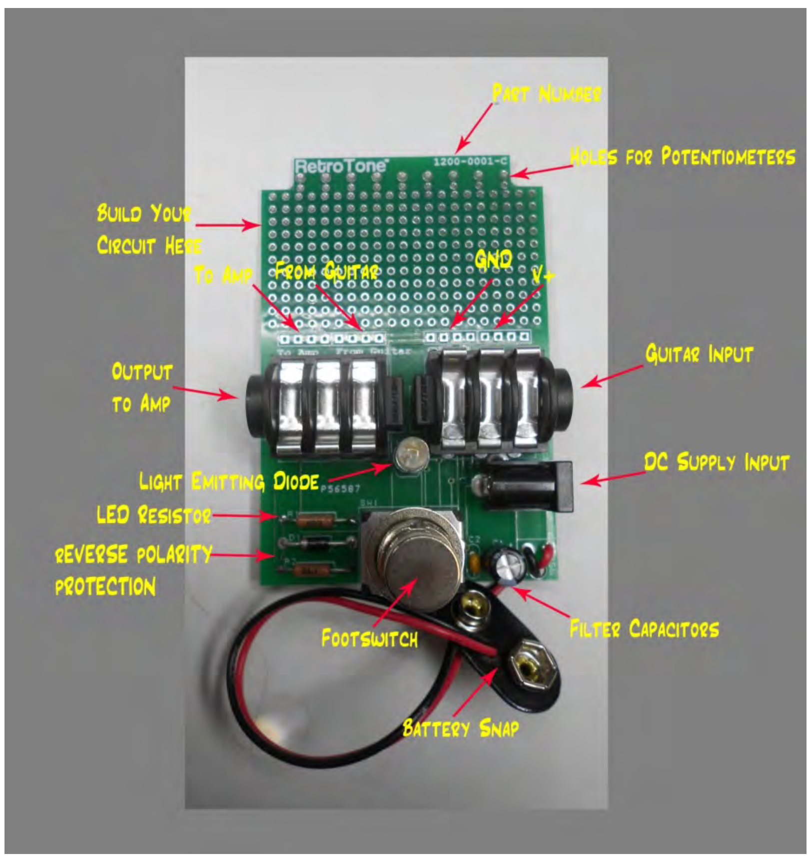

Figure 3 - Bare Metal 1590B Assembly

Component Identification

Every effort has been made to ensure that your kit arrives complete and functional. **RetroTone**® uses a two-step QA process to make sure your kit is correct. We inspect the subassembly when the components are picked and once when the kit is packed for you. The list is checked and signed by the assembler at each step. The subassembly bag has a label with an assembly name and part number for the assembly itself and the components making up the assembly. There are five plastic bags included with your kit. Each bag represents a subassembly of the **Bare Metal 1590B**.

When you unpack your kit, check the components against the bill of materials in this document to be sure everything is there **before** you start the build. There is nothing worse than getting half way through the build and find you are missing critical part. If you are missing a component, see the instructions at end of this document to remedy the situation.

It is a good idea to dry fit the components before you start the assembly. This clears the holes and tests for a proper fit.

Capacitor – C1

This cap is an electrolytic filter cap. It is designed to short undesirable low frequencies to ground. This is the low frequency hum that you may have heard before. This gives you reasonable protection against a poorly designed power supply.

This capacitor is polarized. You must place it correctly for it to work correctly and prevent damage to component itself. Electrolytic capacitors have been known to explode with reverse polarity and overvoltage.

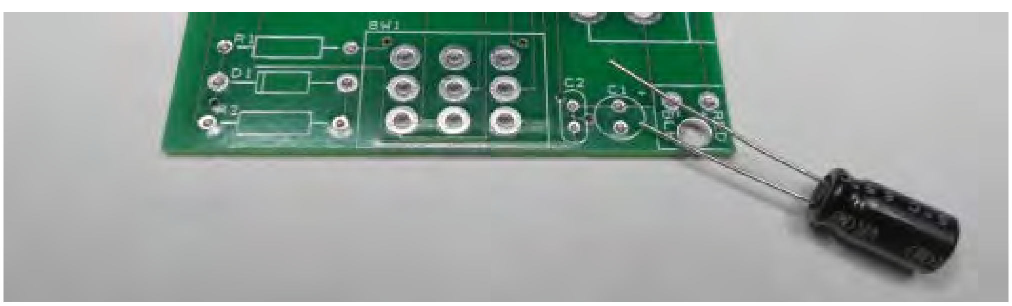

Figure 4 - Electrolytic Capacitor with Long Positive Lead

Many electrolytic capacitors have one lead longer than the other. This is usually the positive lead and must be placed in the hole with a plus sign. You can see this in the above photo. The following photo shows the characteristics of an electrolytic capacitor. These characteristics are “value”, “working voltage” and “polarity”.

The value relates to how much charge the capcitor can hold. The larger the value the larger the charge. The value for the **Bare Metal 1590B** is 100uF. This is pronounced "one hundred micro farads". The working voltage must be higher than the voltage that is applied to the circuit. Most pedals run off of 9 volts DC. This capacitor has a 25VDC limit. This allows you to apply up to 18VDC. I wouldn't go much higher than that because we always like to have a margin of error. There is much to know about capacitor materials and ratings. And, is out of the scope of this document. Check the "How To" section of our website for a paper on the capacitors **RetroTone**® uses for all the projects we produce. Beavis Audio also has an ecellent paper that covers capacitors in a more general way.

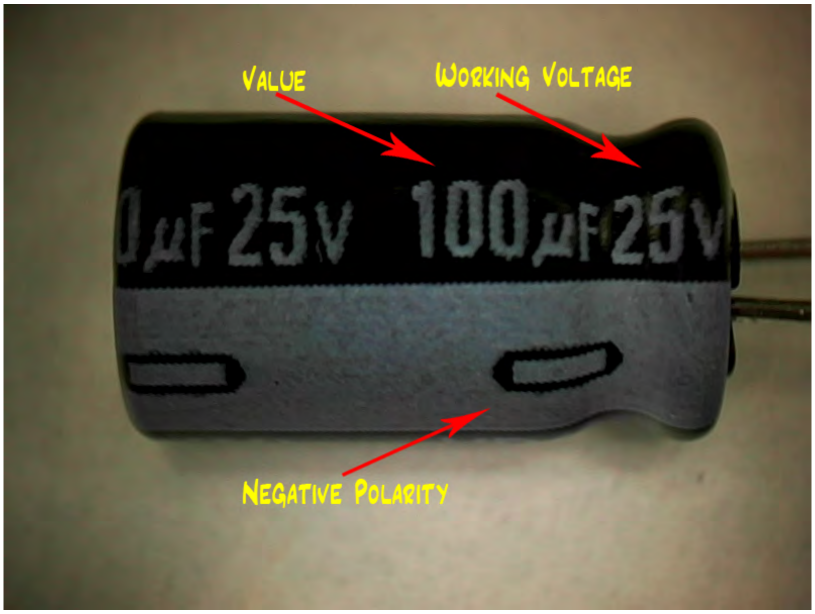

Figure 5 - Characteristics of an Electrolytic Capacitor

Hold the tip of the soldering iron **under** the component lead. Heat rises so the lead will heat evenly. Place the solder on top of the lead. Do not touch the solder with the soldering iron. The capacitor lead has to get hot enough to melt the solder so the solder will stick. The solder will melt and fill the hole. You do not want too much solder. The connection should be shiny and the solder should form sloped walls and adhere to the edges of the hole. If the solder looks like a blob, then there is too much solder. If the lead is not hot enough, the solder won't adhere and you will have a void.

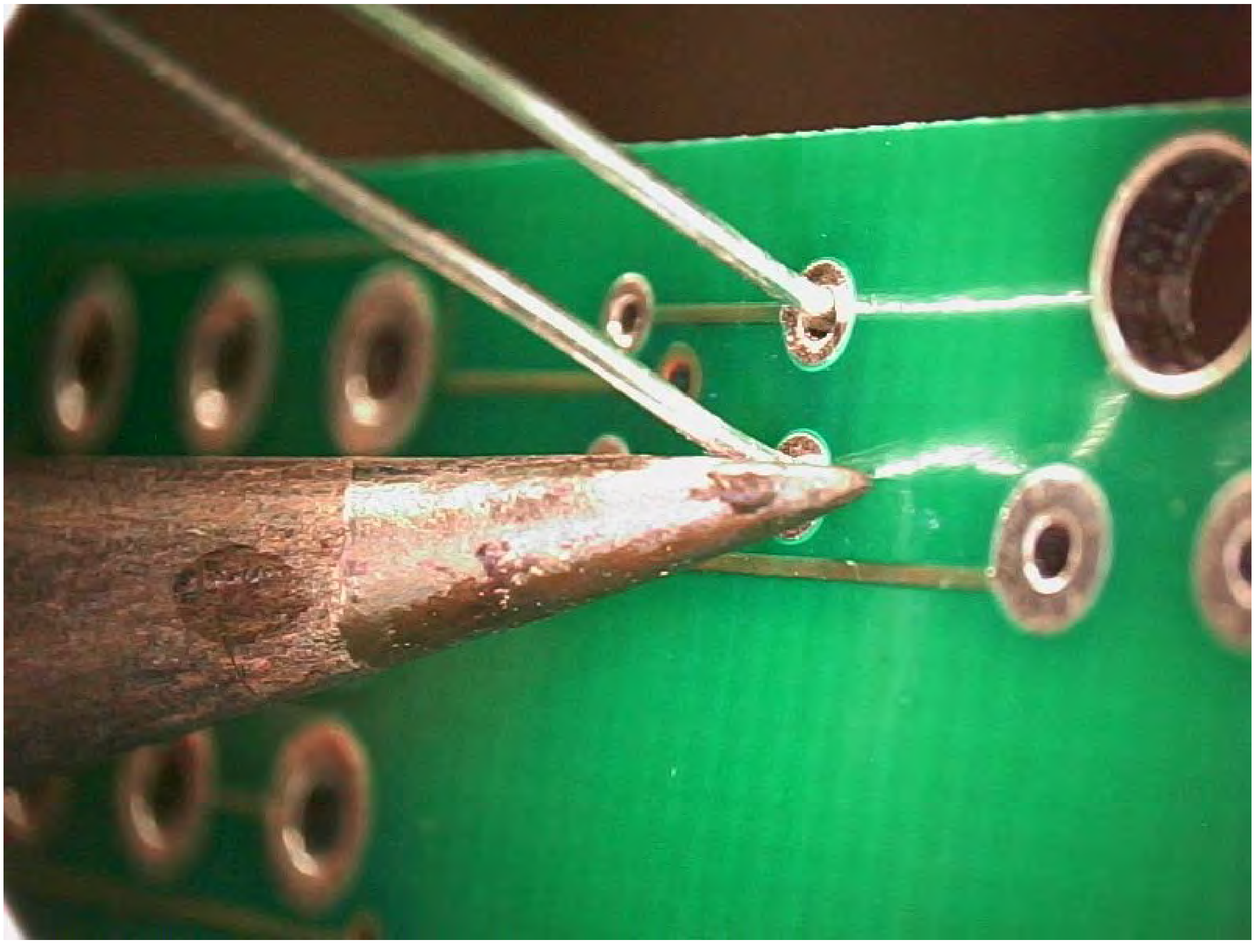

Figure 6 - Hold the Soldering Iron Tip Under the Lead

The photo above shows a good way to hold the tip under the lead. The lead will heat up after a moment or two. Touch the solder on top of the lead. Try not to touch the soldering iron tip itself. This guarantees that the lead is hot enough to take the solder. The last thing to note is that you don't need much solder. The next photo shows the two most common mistakes when first beginning to solder.

Keep the soldering iron tip clean. Your soldering iron should have come with a sponge. Wet the sponge under a faucet and wring it out so it is damp. Turn your iron on and let it come up to temperature. Start with your soldering iron temperature at 700F to 750F. Touch the tip with some solder and let the solder blob onto the tip. Wipe the tip on the sponge to remove the solder. Repeat this until the solder is evenly distributed on the tip. This is called tinning. When you are finished soldering for the day, put a blob of solder on the tip and place the iron in the holder being careful not to knock any solder off the tip. This keeps the tip tinned between uses and prevents oxidation. This also effectively increases the life of the soldering tip.

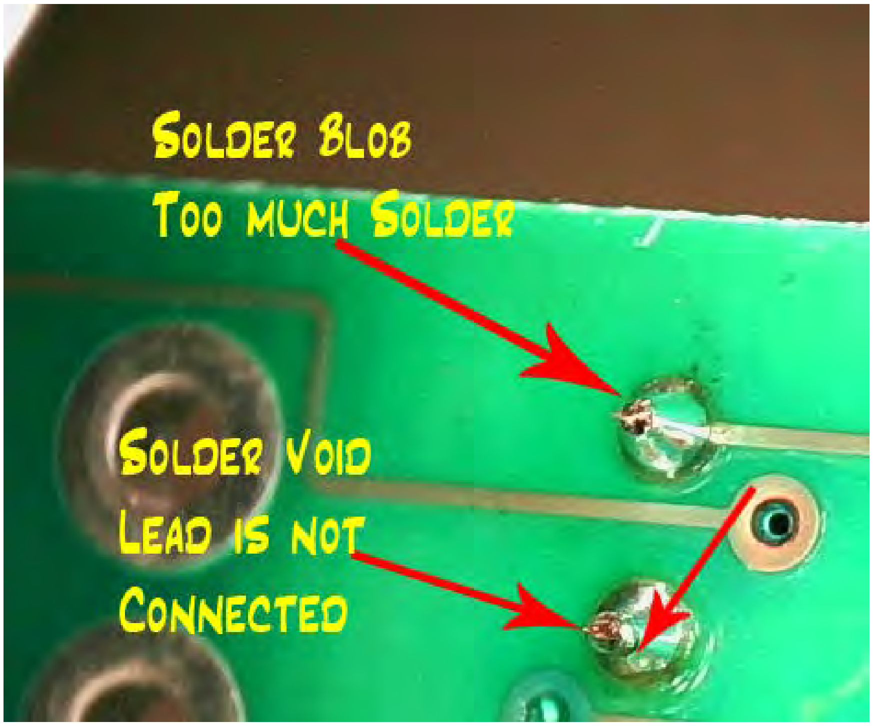

Figure 7 - Two Most Common Soldering Mistakes

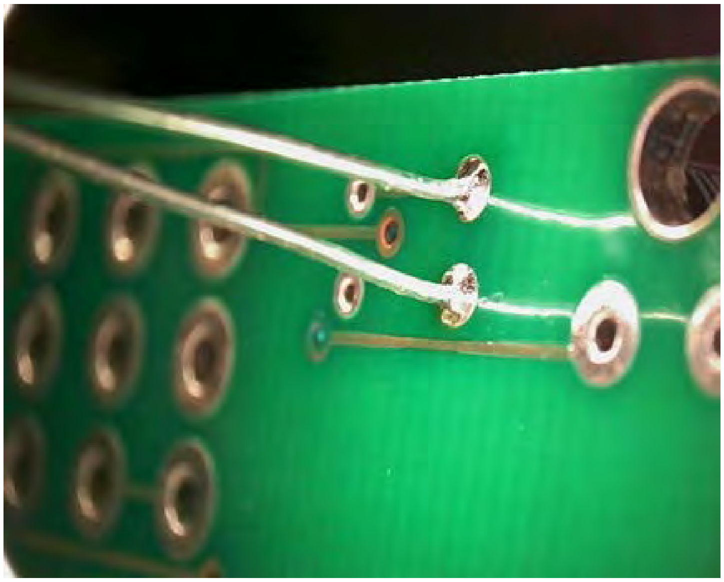

Figure 8 - Nicely Soldered Capacitor Leads

Capacitor – C2 This capacitor is multilayer ceramic capacitor (MLCC). It is designed to short undesirable high frequencies to ground. Such as higher frequency radio signals.

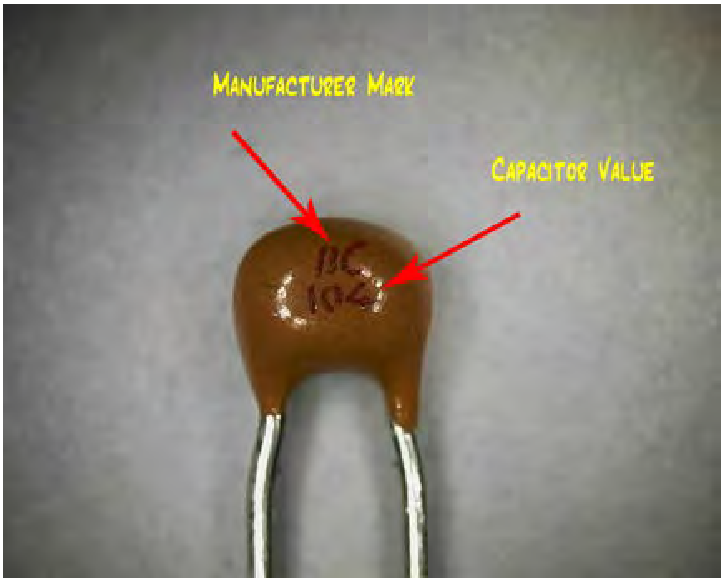

Figure 9 - Ceramic Capacitor Markings

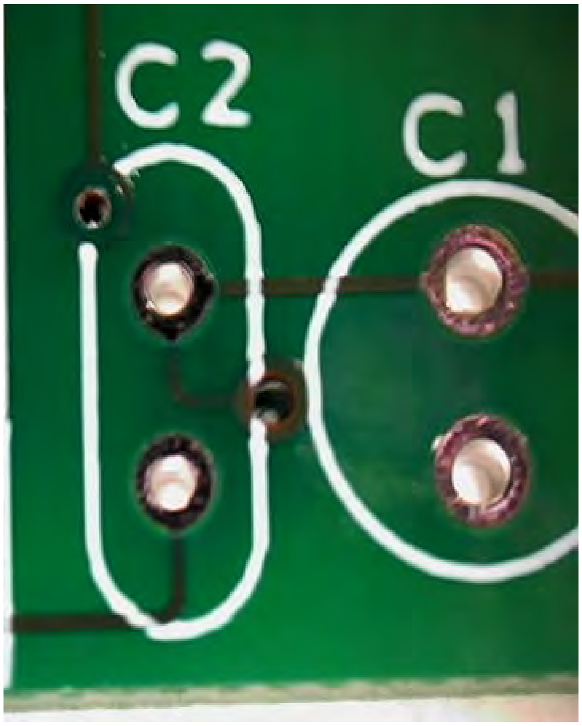

Figure 10 - No Polarity Indication for Capacitor C2

The electrolytic (C1) we placed can successfully short low frequencies but its effectiveness drops off as the frequencies get higher. Pairing C1 and C2 filters out a broad range of frequencies from the power supply.

The MLCC capacitor is marked with two items. One is the manufacturer's mark, in this case BC, for BC Components made by Vishay. The other is the value marked as 104. What this means is a 10 followed by 4 zeroes. This comes out to 100000. But 100000 what? This value is in pico farads. This is an industry standard marking. We have all agreed that the value is in pico farads for this type of capacitor. There are three value ranges commonly used in capacitors this size. "Mili" is not used for capacitors but is shown here for completeness. They are as follows.

		Engineering Notation	
Pico	p	10^{-12}	0.000000000000
Nano	n	10^{-9}	0.000000000
Micro	u	10^{-6}	0.000000
Milli	m	10^{-3}	0.000

With all those zeroes and a decimal point, it is much easier to write 0.1uF than 100000pF. This value is also equivalent to 100nF. These are all equivalent for the value on our capacitor. Some people don't like the decimal point in 0.1uF because it can get lost in the document duplication process so they will use 100nF for clarity. 100000pF just has too many zeroes.

Figure 11 - C1 and C2 Properly fastened to the PCB

Resistor - R1 This resistor controls the amount of current that flows through the LED. The photo below shows the value of the resistor supplied with your kit. This resistor is a metal film. Metal film resistors are stable over temperature and are available with tight tolerances. The photo below shows the value. The manufacturer has designed this code and is not necessarily an industry standard. The 100 is the value, the 1 is the number of zeroes and the F is the tolerance. This resistor is 1000 Ohms with a tolerance of 1%. You can also call this a 1K Ohm resistor.

Before the resistor can be placed in the footprint on the board, the leads must be bent. It is important to not bend the lead right next to the package. The lead can break off inside the package or crack the package. Use your needle noise pliers as shown in the photo below. Hold the pliers tip next to the package then bend the lead to produce a nice sharp 90 degree angle.

Figure 12 – Resistor – R1 and R2 Value

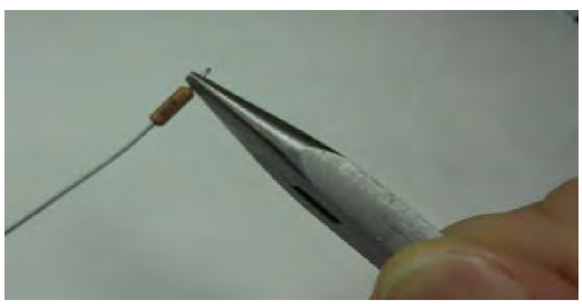

Figure 13 - Bending Axial Leads

The LED current is determined by Resistor - R1. The more current through the LED---the brighter. The LED in the **Bare Metal 1590B** has current rating of 20mA for maximum brightness. Personally, I don’t like super bright LEDs in a night club situation. Some of the LEDs are so bright; I cannot see the effect panel. The current in this LED is 7mA. This is bright enough to see it but not so bright that you can’t see anything on the pedal. The way it is calculated is as follows. $(V_+ - V_F)/ R1$. $V_+ = 9V$, V_F is the forward voltage of the LED. This is minimum voltage require to make the LED start conducting. This LED has a forward voltage of 2.1Volts. And, R1 is 1000.

(9 – 2.1)/1000 = 0.0069A or 6.9mA. The resistor to use for maximum brightness would be as follows.

(9-2.1)/0.020 = 345 ohms. This is not a standard 1% resistor value. The nearest value is 348 ohms. 0.020 is another way to write 20mA.

Diode – D1 This diode is used to protect against reverse polarity from the voltage supply. Many times when you try to connect the battery to the snap , the terminals may not line up positive to positive. This reverse voltage can damage components. This scheme is controversial in some circles. Placing a wire across the terminals of a battery causes the battery to conduct lots of current for a short duration. The wire could heat up and burn in half. The same thing can happen to the diode. When the diode burns in half, the reverse voltage is applied to your circuit and damages components any way. We have included a current limiting resistor R2 to prevent this situation. This circuit is considered as optional.

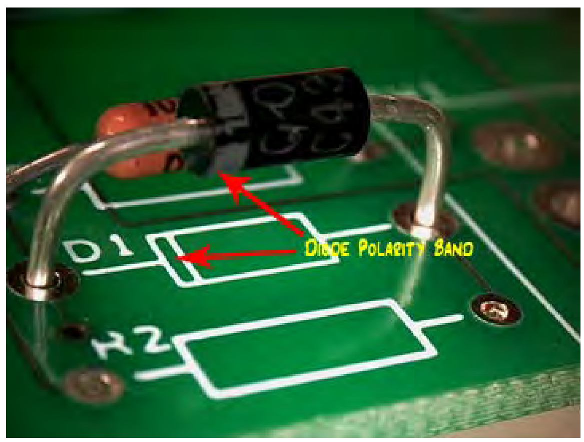

Figure 14 Diode - D1 Polarity Band

The diode has a polarity. The diode has a white band on one end. This is the cathode. The unmarked terminal is called an anode. The diode allows current to flow in one direction. Positive current flows from the anode to the cathode.

Bend the leads on D1 the same way you did for R1. Go ahead and bend the leads for R2 and put both components in the board. Solder R1, D1 and R2 at the same time as shown in the following photo. After the soldering is done, go ahead and trim the leads. Use your cutters and trim just above the solder joint. Try not to cut into the joint itself.

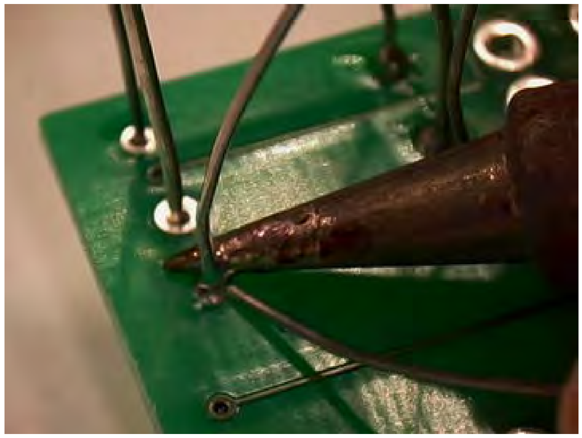

Figure 15 - Soldering Resistor and Diode Leads All At Once

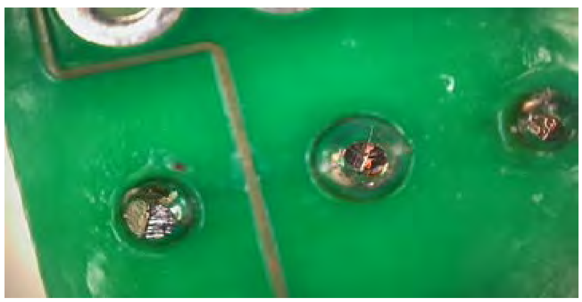

Figure 16 - Cut Leads After Soldering

Footswitch – SW1 All the soldering principles you have learned up till now apply to the footswitch as well. Hold the soldering iron on the pin of the footswitch to get it hot enough to take the solder. The main consideration for the footswitch is to make sure it is flush to the PCB. Solder one hole and make sure the footswitch is flush with the PCB. Solder the rest of the holes being sure that the footswitch remains flush to the PCB.

Figure 17 - Heat Up Footswitch Pin

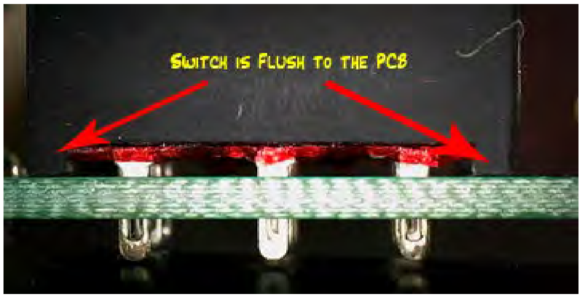

Figure 18 - Footswitch is Flush to PCB

DC Jack - J3 This jack is used to switch between the external DC voltage or a battery. The key for this component is to make sure it is aligned on the footprint of the PCB. The holes are very large and can take a lot of solder. The component has a fair amount of movement in the holes. It is also placed very close to the input jack. Proper alignment guarantees the DC Jack will have clearance with the enclosure hole. Solder one hole and make sure the jack lines up to the footprint and is flush to the PCB. Solder the other two holes in the same way.

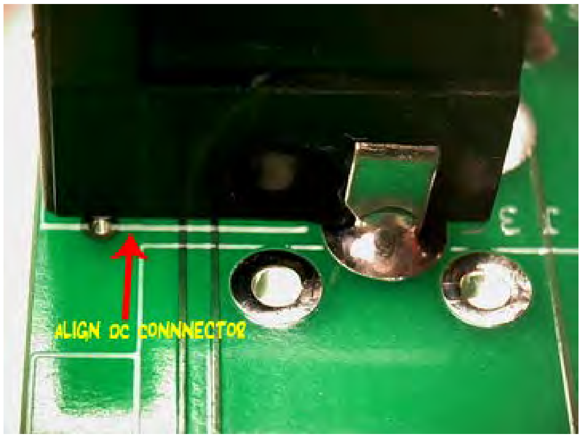

Figure 19 - DC Jack Alignment on Footprint

Figure 20 - Large Holes on DC Jack

Input/Output Jacks – J1, J2 Both of these components are identical. Either one will work in either position. Make sure you solder it in with the opening facing out from the PCB. Solder one hole then make sure the jack is flush with the PCB. Then solder another hole, and check that the jack is still flush. Then solder the other holes. Make sure that the connector is flush to the PCB. The opening needs to align with the enclosure hole.

Figure 21 - 1/4" Audio Input/Out Jack

LED and Standoff – LED1

LED1 is another component on the **Bare Metal 1590B** with a polarity. Place the standoff on the LED and solder it in observing that the flat side lines up with the "-" on the PCB. The LED should be standing as straight and perpendicular to the PCB as possible. There is a decent amount of tolerance on the enclosure it the LED alignment isn't perfect.

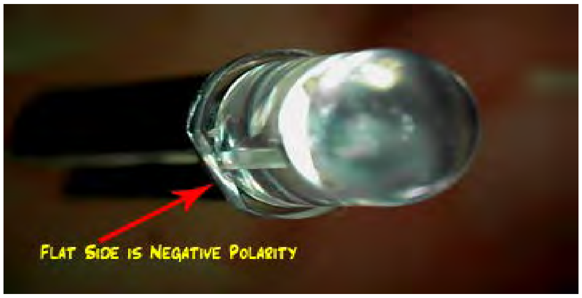

Figure 22 - LED1 Polarity

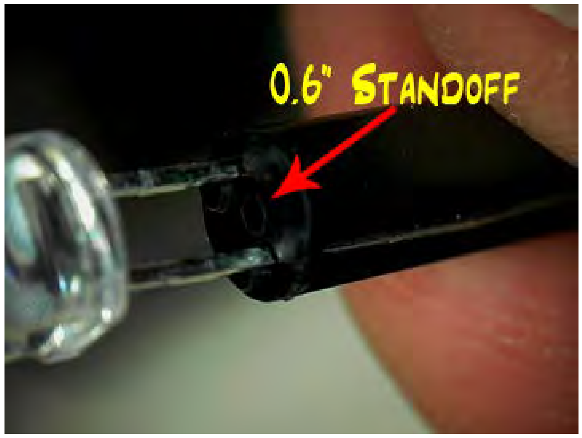

Figure 23 - LED and Standoff

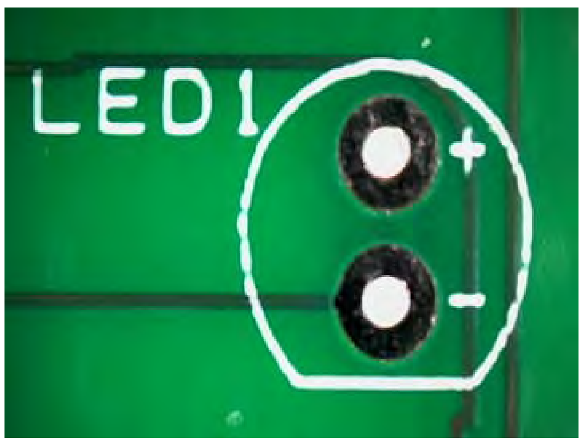

Figure 24 - LED1 PCB Footprint

Battery Snap – BATT1

The battery snap footprint provides a simple strain relief. The battery snap leads should be put into the large hole from underneath the PCB then each lead soldered into the respective hole. This provides a strain releif if the snap is acidently tugged. The PCB is clearly marked with the positive and negative terminals, as well as, lead colors.

Again, just a small amount of solder goes a long way. The battery snap leads are pre-tinned so try not to heat the leads too much as the insulation will melt.

Figure 25 - Battery Snap PCB Footprint

Figure 26 – Battery Snap Strain Relief

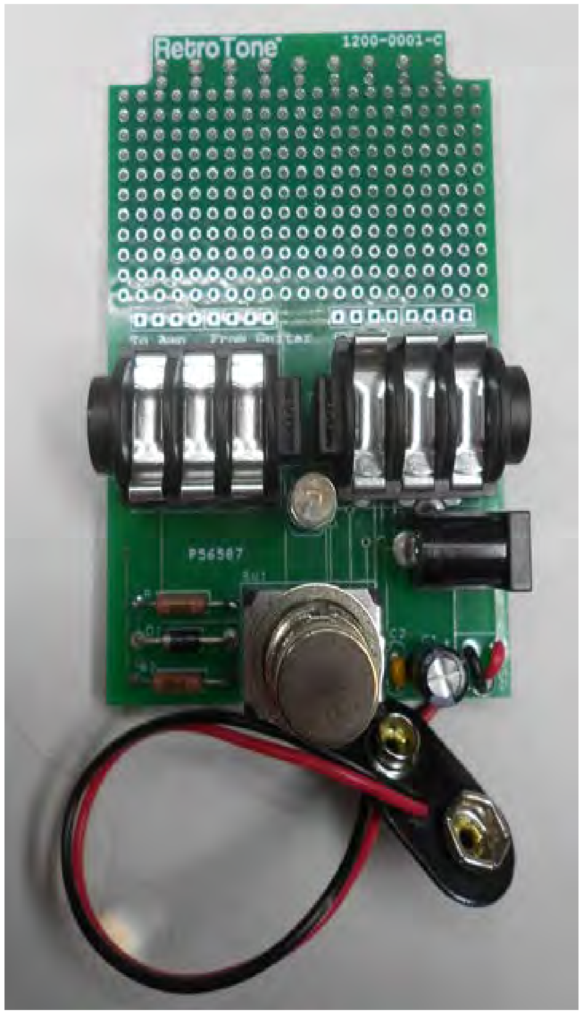

Figure 27 - Completed Bare Metal 1590B

Mechanical Assembly

The primary critical dimension when you are ready to assemble the enclosure with the completed PCB is the distance from the PCB to the top of the nut on the footswitch as shown in the following photo. The inside nut on the footswitch determines the clearance inside the enclosure and how the DC jack is centered in the hole. The height is 13/16" or 0.8".

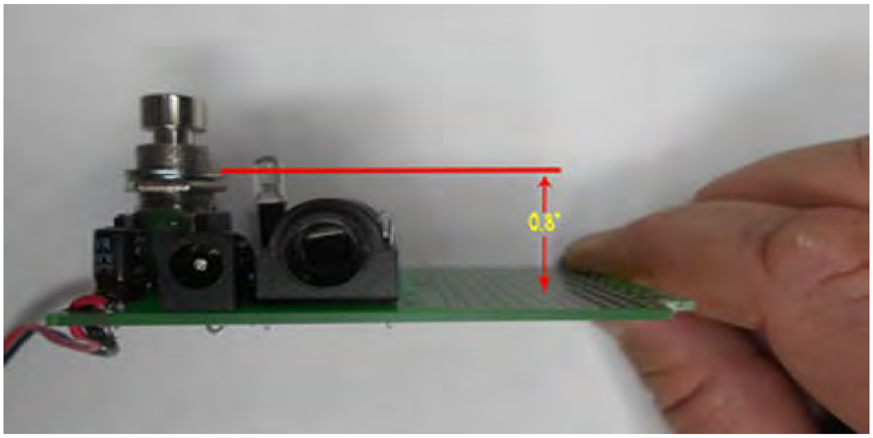

Figure 28 - Footswitch Nut Height

The diagram below shows the preferred washer/nut stackup. Place the flat washer on the outside of the enclosure and the lock washer on the inside. This provides a nice aesthetic to complement your newly painted enclosure and will minimize paint damage. The inside nut and lock washer provides maximum gripping power. There is almost nothing worse than your footswitch coming loose during a gig!

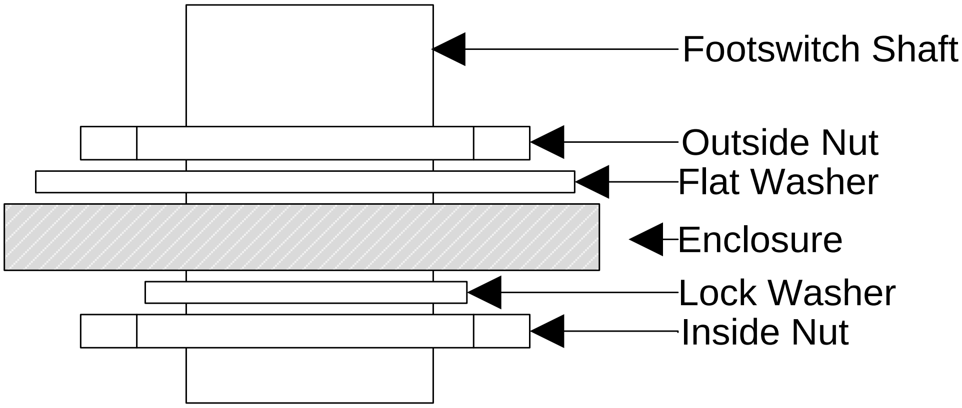

Figure 29 - Footswitch Washer Stackup

The ¼" input/output connectors provide a pivot point for the PCB. The nut position will determine how level the PCB is inside the enclosure. A couple of tries may be necessary to get the PCB level with the enclosure and square things up.

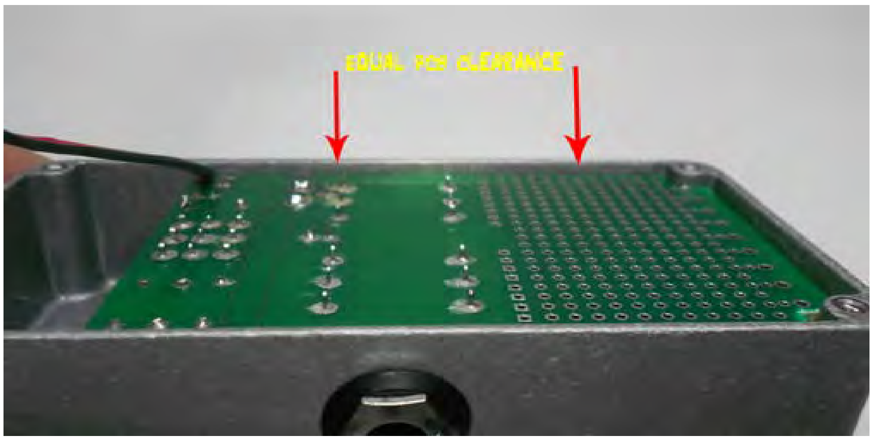

Figure 30 - Level The PCB

Figure 31 - Center DC Jack Pin In Hole

Your **Bare Metal 1590B** comes with a precision engineered enclosure. There was an option of having no holes drilled, one hole or two holes drilled when you purchased the kit. The following series of photos show the different configurations available.

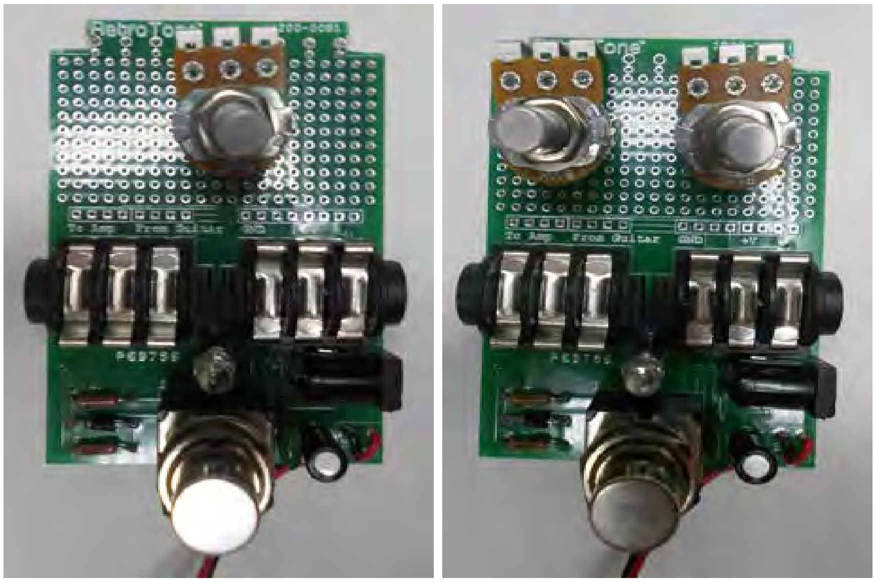

Figure 32 - Potentiometers Mounted on PCB

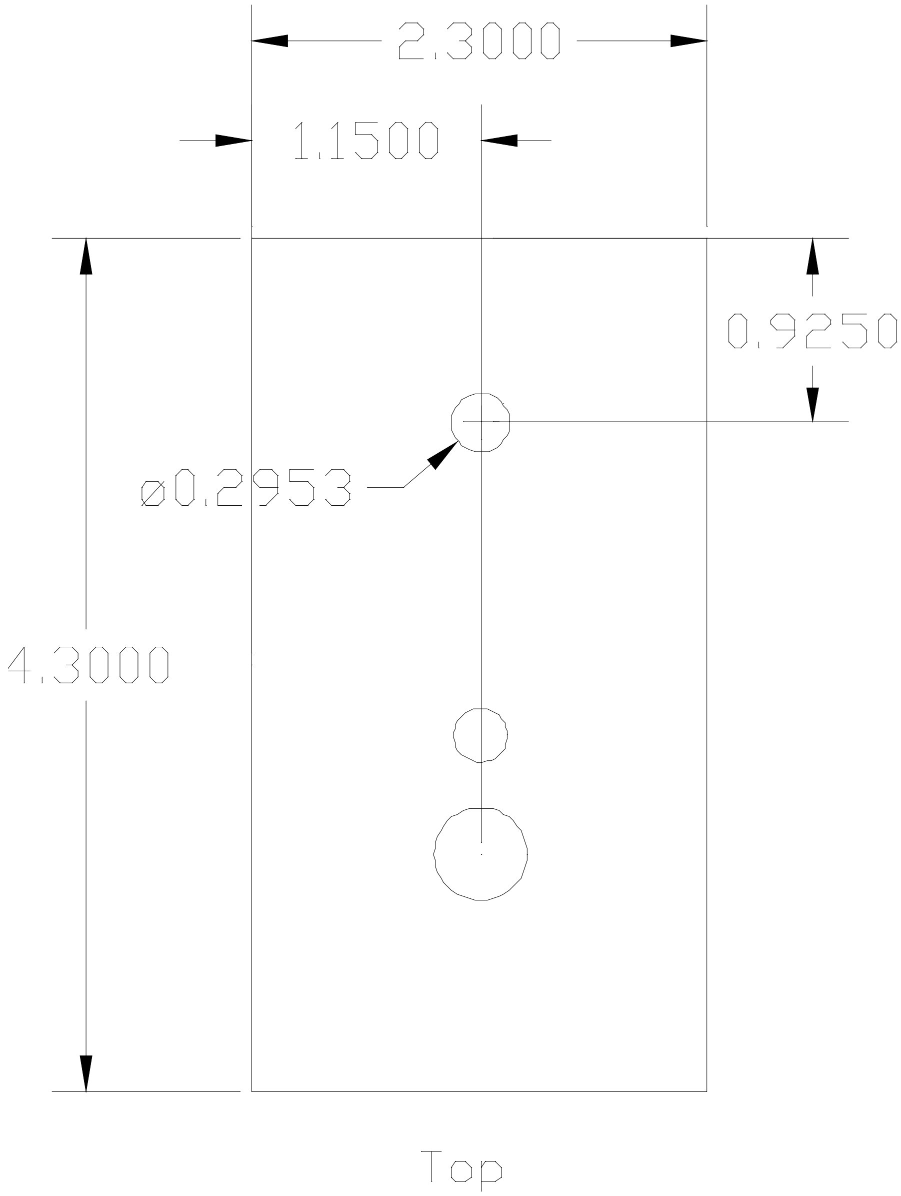

Figure 33 - Single Hole Dimensions

This drawing may not be to scale.

Potentiometer clearance hole 0.2953” = 7.5mm

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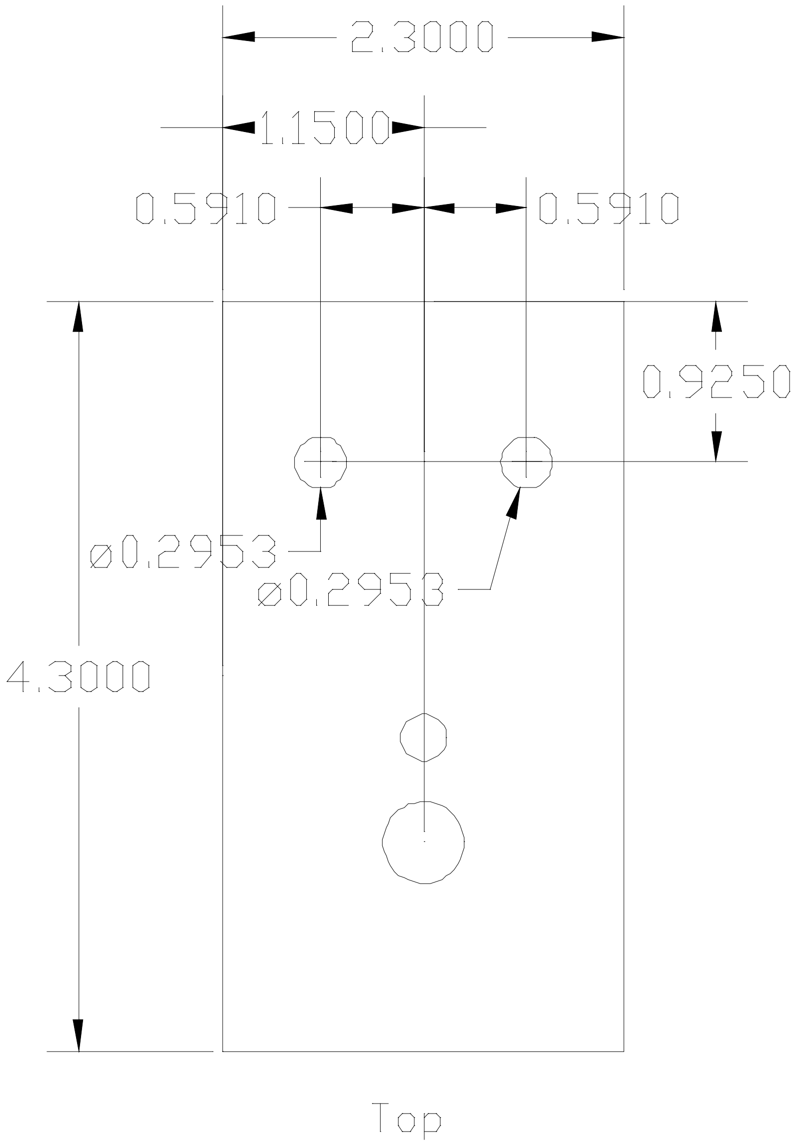

Figure 34 - 2 Hole Dimensions

This drawing may not be to scale.

Potentiometer clearance hole 0.2953" = 7.5mm

Returns and Exchanges

Log into your account, find the original order and follow the online instructions to start the RMA process.

Parts that are defective or parts that are missing from the kits will be replaced up to **30 days from the date of purchase**. Include the defective/missing part numbers in the comments field during the RMA process.

We will gladly accept the return of kits for a full refund for **15 days from the date of purchase**.

The buyer is responsible for return shipping on all returned orders.

Returned orders that do not have an RMA number will be declined.

Orders returned that are not in the original packaging will be charged a 15% restocking fee.

Orders returned that are not in the original packaging and missing parts will be declined.

Orders that have been used (the assembly process has been started) cannot be returned for any reason.

Partial refunds are not allowed.