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ICS64S

Assembly & Usage Manual

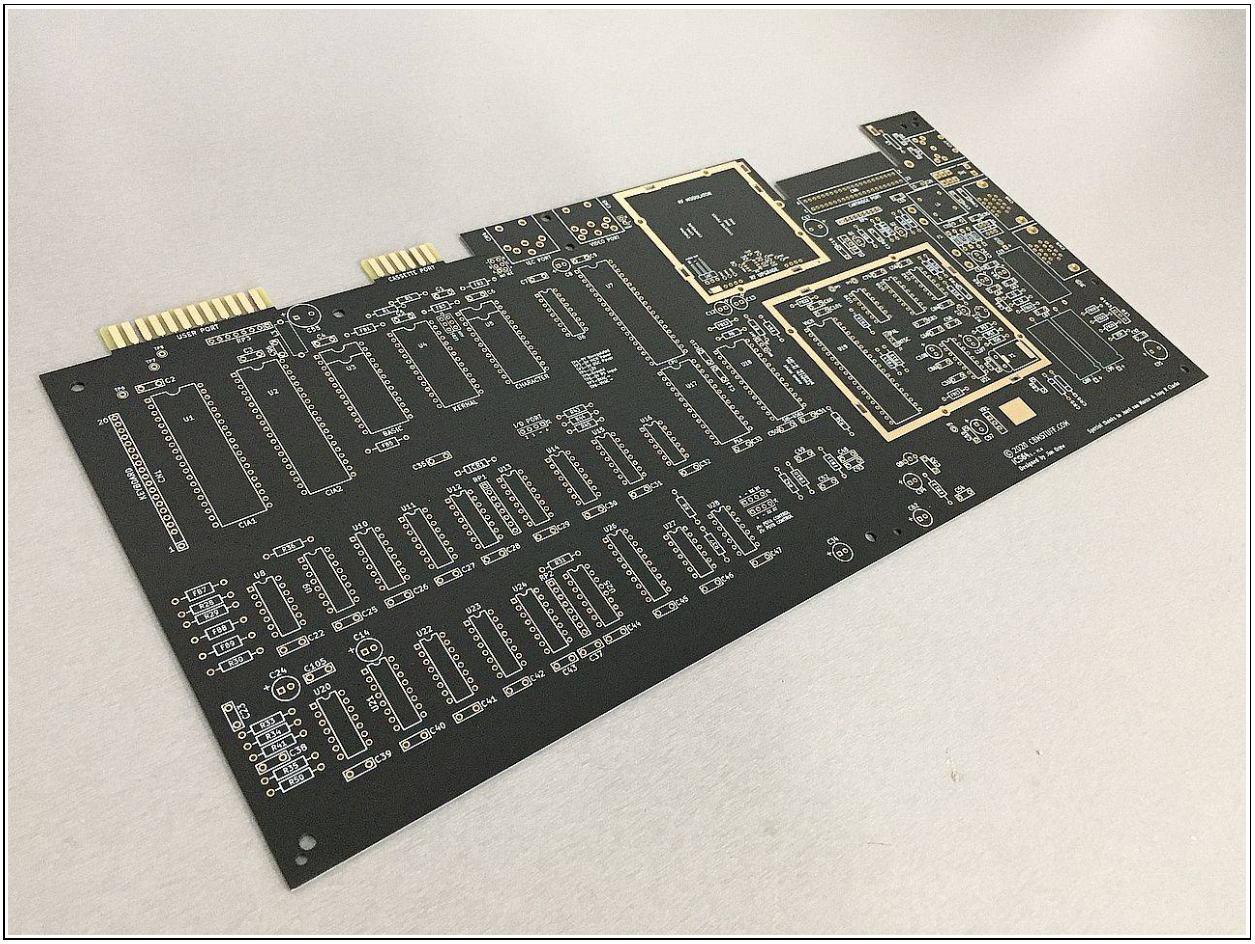
Firmware v1.0

Manual v1.2

Revision Data: October 11, 2021

DUE TO FREQUENT CHANGES IN THIS MANUAL, PLEASE DO NOT POST, UPLOAD, OR OTHERWISE PROVIDE THIS INFORMATION VIA ANY MEANS! INSTEAD, PLEASE POST A LINK TO THIS OFFICIAL MANUAL:

http://www.cbmstuff.com/ics64s/ICS64S_build_manual.pdf



ICS64S Motherboard Replacement

Introduction

Thank you for purchasing the ICS64S replacement motherboard. This DIY kit will let you to build a replacement motherboard for the Commodore 64 and Commodore C64C computer. Please read through this **entire** manual **before** you attempt the assembly of this product.

Assembly Requirements

The assembly of the ICS64S requires some basic tools for cutting and bending wires, and soldering of components. The assembly of the ICS64S is not difficult. However, if after reading through this manual you believe that you cannot perform the assembly, please seek someone who can assist you. This manual should provide ample information and clarity for the entire assembly process.

Warranty Information

This product carries a limited lifetime warranty for the SMT components that were already soldered on the board when you received it. Because this is a Do-It-Yourself assembly project, the board itself can not be warrantied after the assembly has been started. In the rare case of a defect in the SMT components we may at our discretion either repair or replace the unit covered under warranty. The customer will pay all freight charges to and from our facility. CBMSTUFF.COM must be contacted to obtain a return authorization. Any product returned without authorization will be returned without repair or replacement.

Liability

By assembling and/or using this product, you agree to hold cbmstuff.com and Jim Drew free from any type of liability either directly or indirectly.

Legal Information

The ‘look and feel’ and functionality of this product are protected by various U.S. copyright laws. Some terminology and feature names are protected under U.S. trademark laws. This product has no association with Commodore Business Machines or their entities.

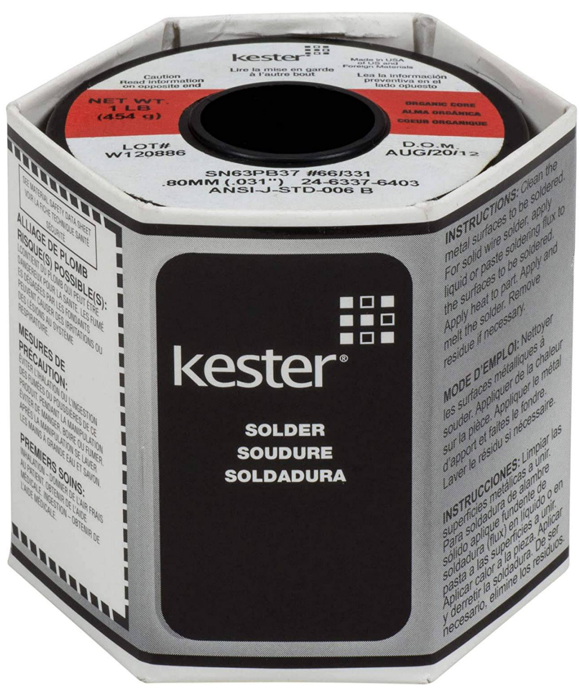
TOOLS AND SUPPLIES NEEDED FOR ASSEMBLY

Here is a list of the recommended tools (along with Amazon links) needed for assembling the ICS64S board:

Micro wire cutter: https://amzn.to/3fAjlpS

Used for cutting component leads.

Kester 331 0.031” organic solder: https://amzn.to/2PTiS7i



It is **highly** recommended that you use the recommended organic solder! This solder contains water soluble (non-toxic) flux that cleans easily with just a damp microfiber cloth, leaving the board with a perfect residue-free surface finish. The large amount of flux in the solder makes soldering a breeze! Whether you are a newbie or a seasoned pro, this solder makes your work look its best. Once you try this stuff you won't use anything else! This solder does contain a lead/tin mixture, so care should be taken to keep it stored away from children and pets. This solder may not be available in some countries due to RoHS restrictions.

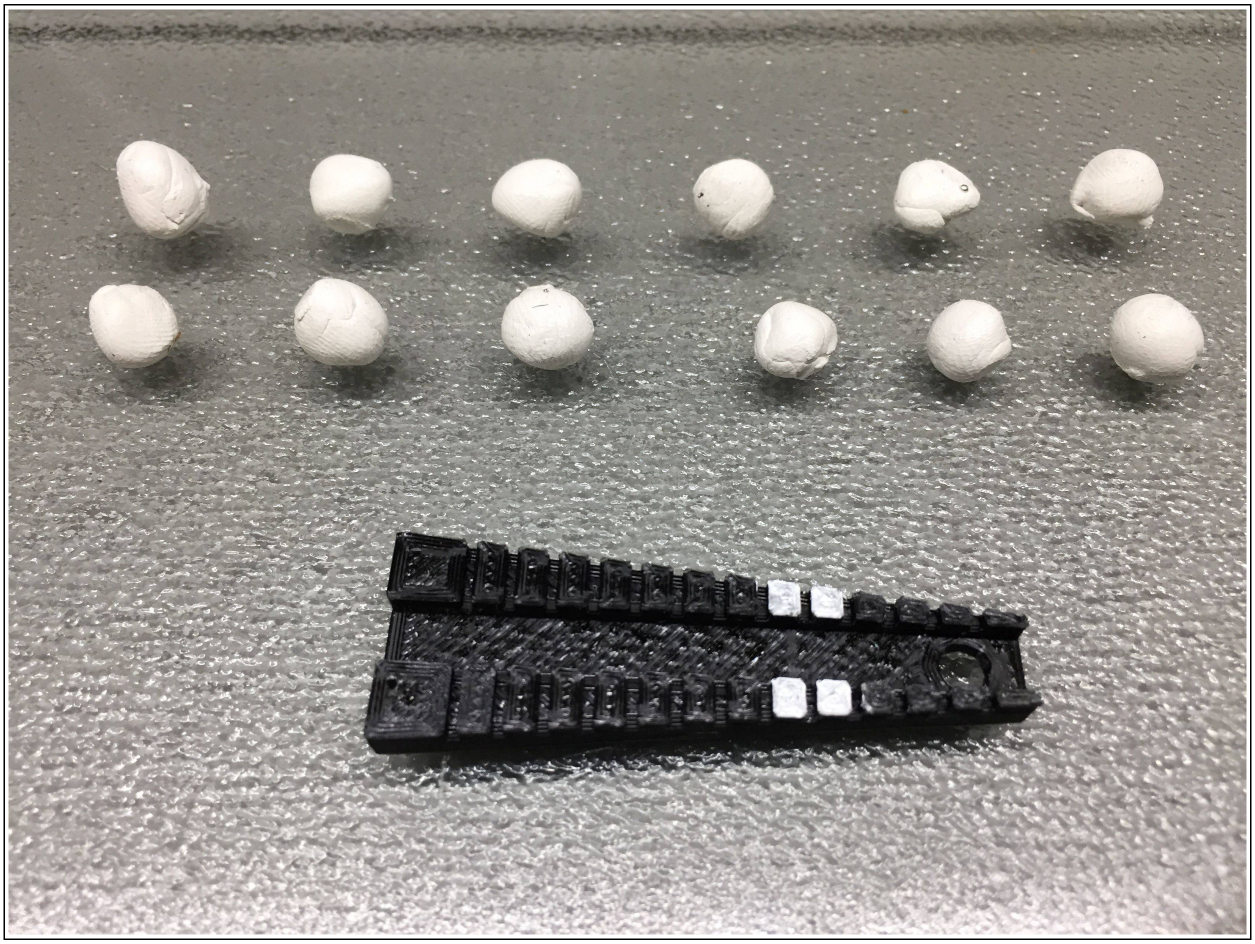
Reusable tack adhesive: https://amzn.to/3xSweSE or https://amzn.to/3dmj6Mw

Several brands of this are available, such as Plasti-Tak, Tac 'N Stick, Blu-Tak, and others. This is very handy for holding a component in place on the front side of the board while soldering leads on the back side. Do not buy a bunch of packages of this product! One package will last you a lifetime (literally)! Plasti-Tak was used during the making of ICS64S board shown in this manual.

There are convenient lead bending tools that you can purchase from Amazon and other sources. If you have a 3D printer you can find many different lead bending tool design options available on various 3D modeling/CAD websites such as www.thingiverse.com, www.grabdcad.com, and others.

This 3D printable bend tool (shown below) works very well and was used for building the ICS64S board shown in this manual:

https://www.thingiverse.com/thing:6703



Plasti-Tak rolled into balls, with bend tool marked and ready for use

Other items you will need include a microfiber cloth, inspection magnifying glass, pliers, and a large flat, well lit work area.

SECTION 1 – COMPONENTS

Brand new or borrowed components?

The ICS64S was based on the basic schematic used by most of the Commodore "breadbin" type machines. These includes assembly numbers 250407, 250425, and KU-14194HB. With the exception of a handful of components, you will be able to use nearly all of the original components from any of these "donor" motherboards to complete the ICS64S board.

Preferably, you will obtain new components. It is recommended that you use new resistors that have a 1% tolerance and new capacitors, especially the electrolytic capacitors which need replacement after so many hours of operation (and it's been 35+ years now!).

The joystick connectors can be the modern "short" type, the original size with solder tabs, or the original version with screws that hold them in place. The ICS64S supports all of these options.

The metal "cans" around the video VIC-II chip and the video modular can be re-used if you want. These are not required. The modern layout minimizes the amount of RFI/EMI that leaks into the video/audio output. If assembled per these instructions, this board will pass FCC Part 15 requirements without any shielding.

Required components

The original BASIC and CHARACTER ROMs can be used. Optionally, you can use 2764 type EPROMs for these two ROMs. **The KERNAL ROM must be an EPROM**. That EPROM can be anything from a 2764 (8K) to 27512 (64K). Having a larger capacity EPROM means more user selectable KERNAL ROMs are possible.

Optional components

The ICS64S has many options such as the joystick POT X/Y port headers, audio out header, LED/Programming port headers, internal IEC header, and the OLED screen header. These are not required for the normal operation of the computer, but these are required to use certain new features.

The SID chip can be either a 6581 or a 8580. The 6581 requires that you use a 12 volt regulator for VR1, and the 8580 requires that you use a 9 volts regulator for VR1. **Note: mistakenly using the 8580 with a 12 volt regulator will destroy the SID chip!**

The VIC-II chip can be a variety of versions, both old and new. There is a power jumper on the backside of the ICS64S board that selects the power that is provided to the VIC-II chip. **Note: using a 12 volt power selection with a 5 volt VIC-II chip can destroy the VIC-II chip!**

Sockets or not?

One word – YES! Use sockets. However, it is recommended that you **DO NOT** use fancy machine tooled sockets! Although they look nice, these type of sockets do not provide enough grip on the IC pins (in this application), especially one that is shorter than normal. Original, de-soldered components will have shorter pin lengths which provides poor contact in a machined tooled socket.

The main reason why this application is not ideal for machine tooled sockets is that any amount of flex (twist) to the circuit board can "pop" the pins out of a machine tooled socket! Machine tooled sockets are great for small boards where no flex is really possible, but that is not the case for the ICS64S board. Even though the ICS64S PCB is thick, it is long and can be easily flexed. It is recommended that you use a good quality "dual leaf" socket for all of the ICs. This will save you a bunch of money as well because quality machine tooled sockets are very expensive compared to dual leaf sockets.

You don't *need* to use sockets. If you want to solder the ICs into the ICS64S board directly that is perfectly acceptable. However, it is still recommended that you use sockets for the BASIC, CHARACTER, and KERNAL ROMs as well as the other hard to come by chips (6510, PLA, SID, and 6256 CIA chips).

SECTION 2 – ASSEMBLY

Where do components go?

There are a lot of components, and since the ICS64S follows the same component labeling as the original schematics you will find that components will need to be inserted randomly all over the board! To make it easy to determine component placement an interactive component placement reference has been created. You can see that here:

http://www.cbmstuff.com/ics64s/ICS64S_IREF.html

This will let you move the mouse over a component name and see where that component is to be placed on the graphical representation of the ICS64S board. You can also click on a component graphic and it's name will be highlighted in the BOM.

Inventory and component assembly order

After you have obtained all of the necessary components needed to build the ICS64S (either new or from a donor board), you should arrange all of the similar components together.

This assembly manual follows the same order of assembly shown in the **ICS64S BOM Guide.** This is "cheat sheet" that shows the exact component order to follow, and you can "check off" each step as you complete it. The reason for the assembly order has to do with the component height on the board. You want to have the ability to turn the board over and lay it face down on a flat surface to solder the leads on the back side. You can't use the weight of the board to apply pressure to hold a component flush with the board when the component is not touching the build surface! So, the order is from the lowest profile to the tallest profile to make it easier to assemble. **We will start the assembly with resistors**.

The ICS64S BOM Guide can be found here:

https://www.cbmstuff.com/ics64s/ICS64S_BOM_guide.pdf

You will also find a lot of high resolution assembly pictures in the ICS64S gallery located here:

https://www.cbmstuff.com/ics64s/gallery/gallery.html

Components on cut tape

Most of the new components will come as "cut tape". This is a roll (or strip) of components that is bound by paper tape at each end. It is recommended that when you need to remove a component from the roll that you simply cut the leads at each end instead of trying to pull the leads from the tape. This will insure that the leads will remain straight, making it easier to bend and insert into the board with little effort. See Figure 1 for details.

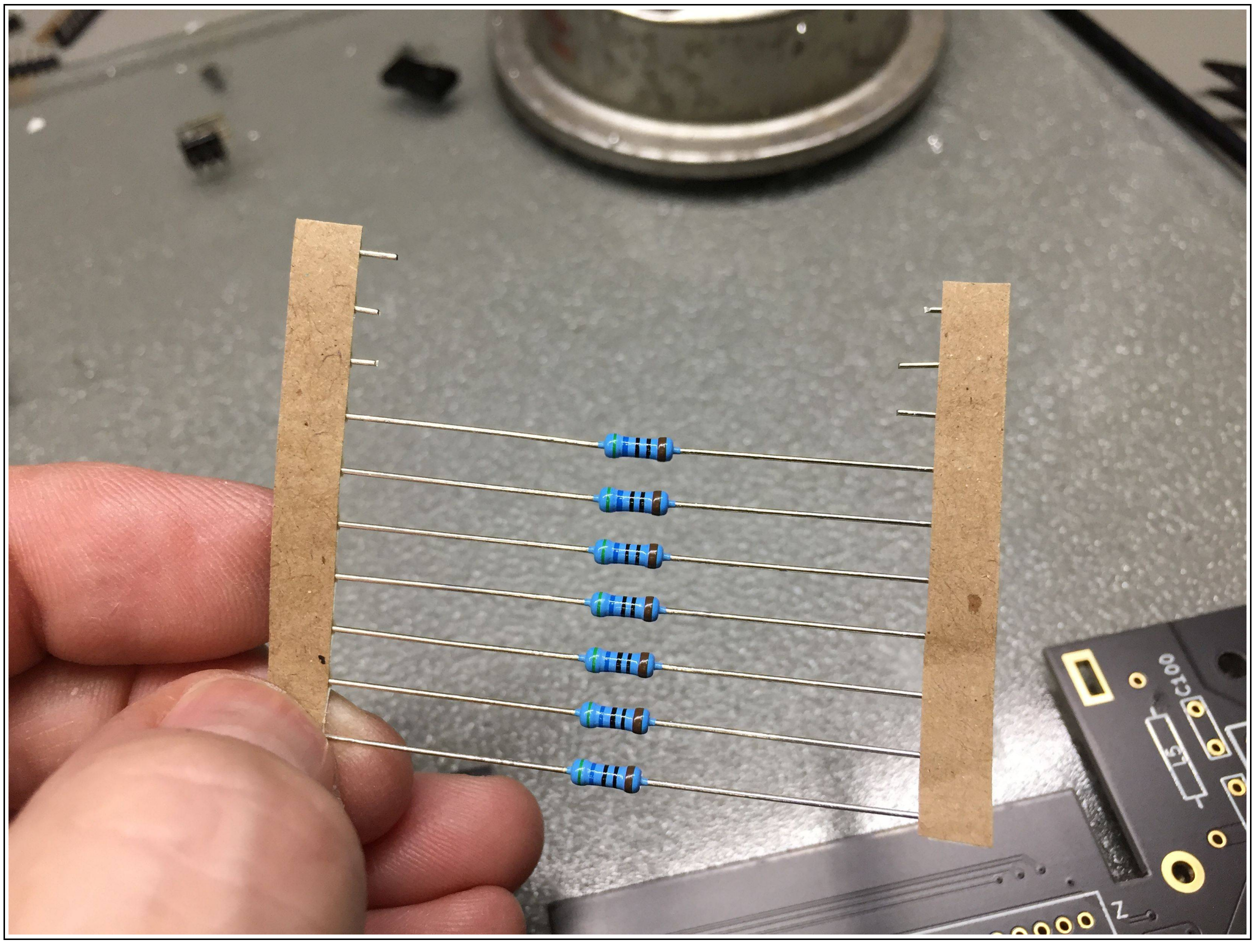


Figure 1 – Clip ends of leads to remove from cut tape roll

Bending leads

All of the resistors and ferrite beads have a hole spacing of 0.5” (12.7mm). This is the distance between the holes that each end of the component is inserted into. You will want to bend the leads of a component (like a resistor) so that there is equal lead distance on each side of the component.

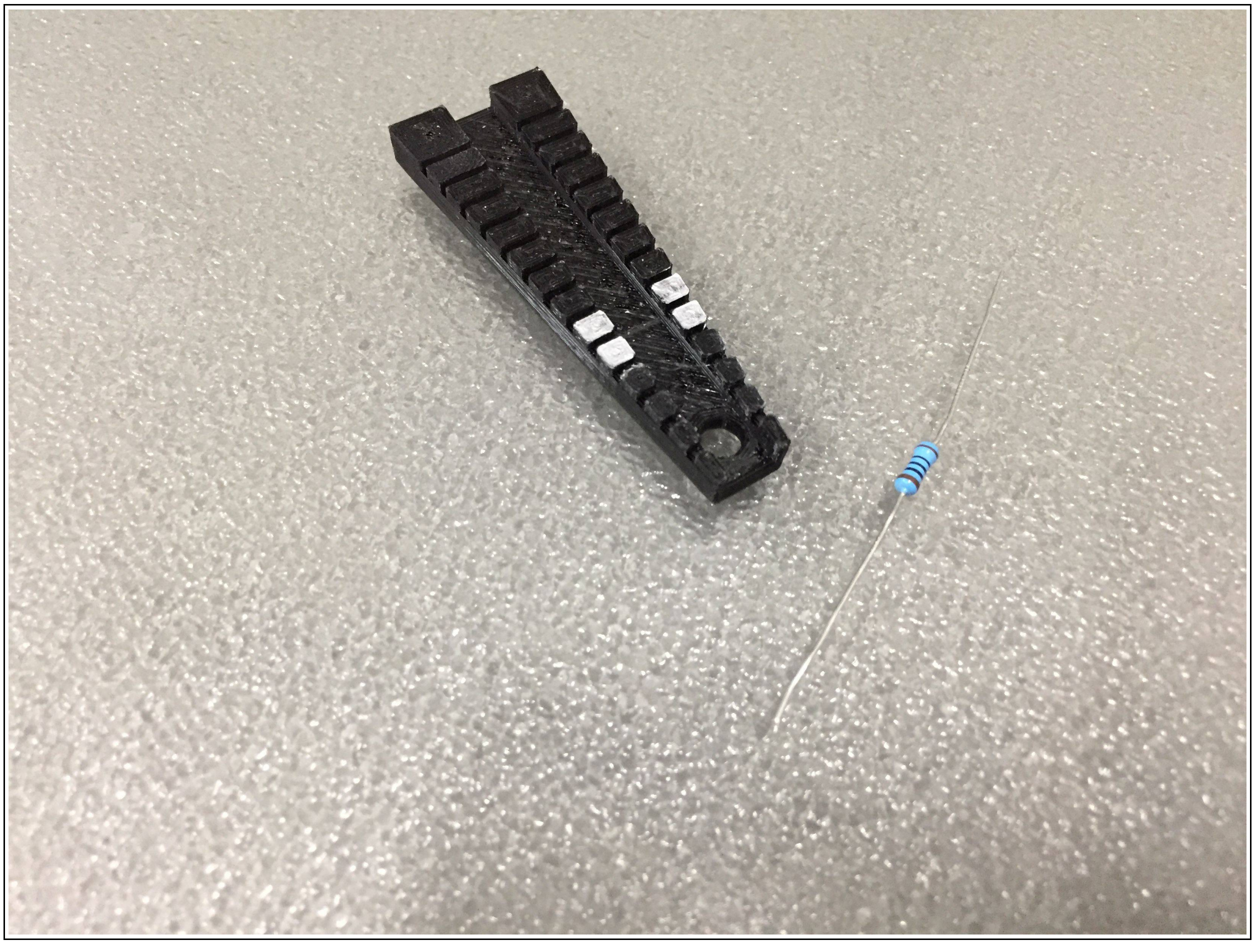


Figure 2 – Lead bender tool

After experimenting with the bend tool to determine the slot needed to get the proper lead spacing, mark the bend tool with a colored Sharpie, nail polish, or paint. This will let you quickly insert the component into the same slot each time. You can see in the image above where it has been marked. A component can be quickly placed between the two sets of slots marked in white.

Insert the component into the bend tool as shown in Figure 3. Bend the leads inwards, towards the narrower end of the bend tool. This inward bend angle will help hold the component in place in the board while you handle it. See Figure 4 for details, and Figure 5 for the finished result.

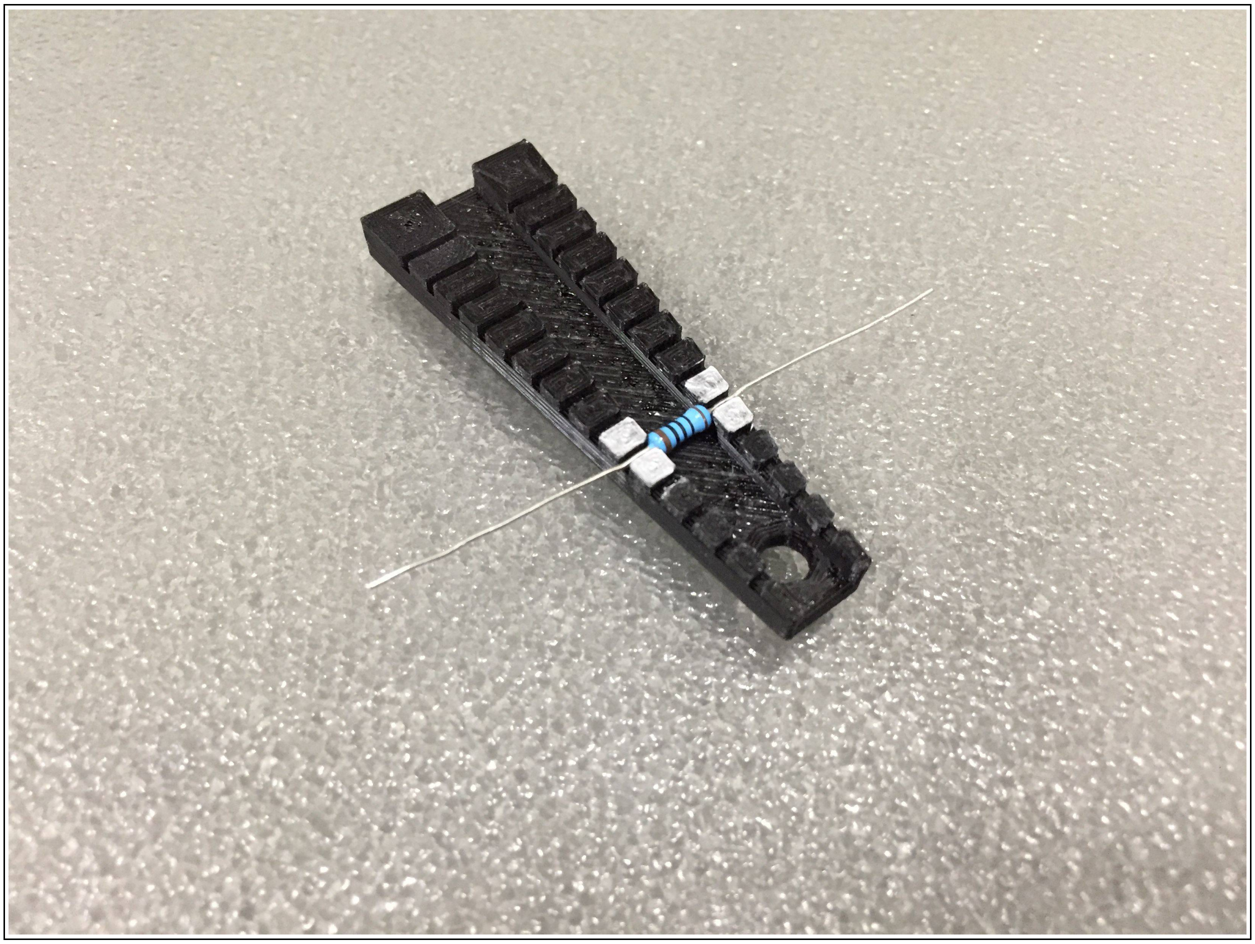


Figure 3 – Resistor inserted into bend tool (0.5" bend)

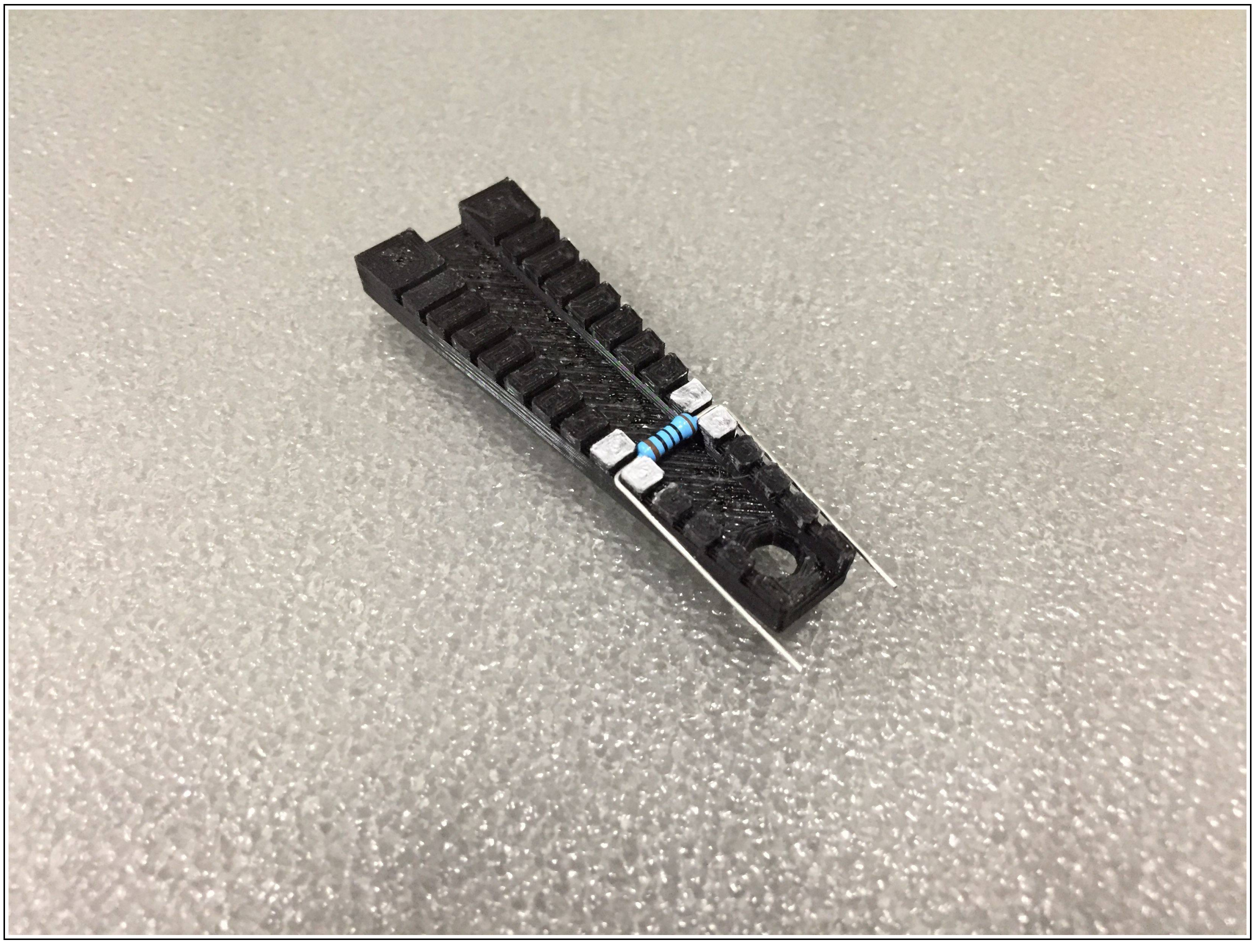


Figure 4 – Bend component leads inwards

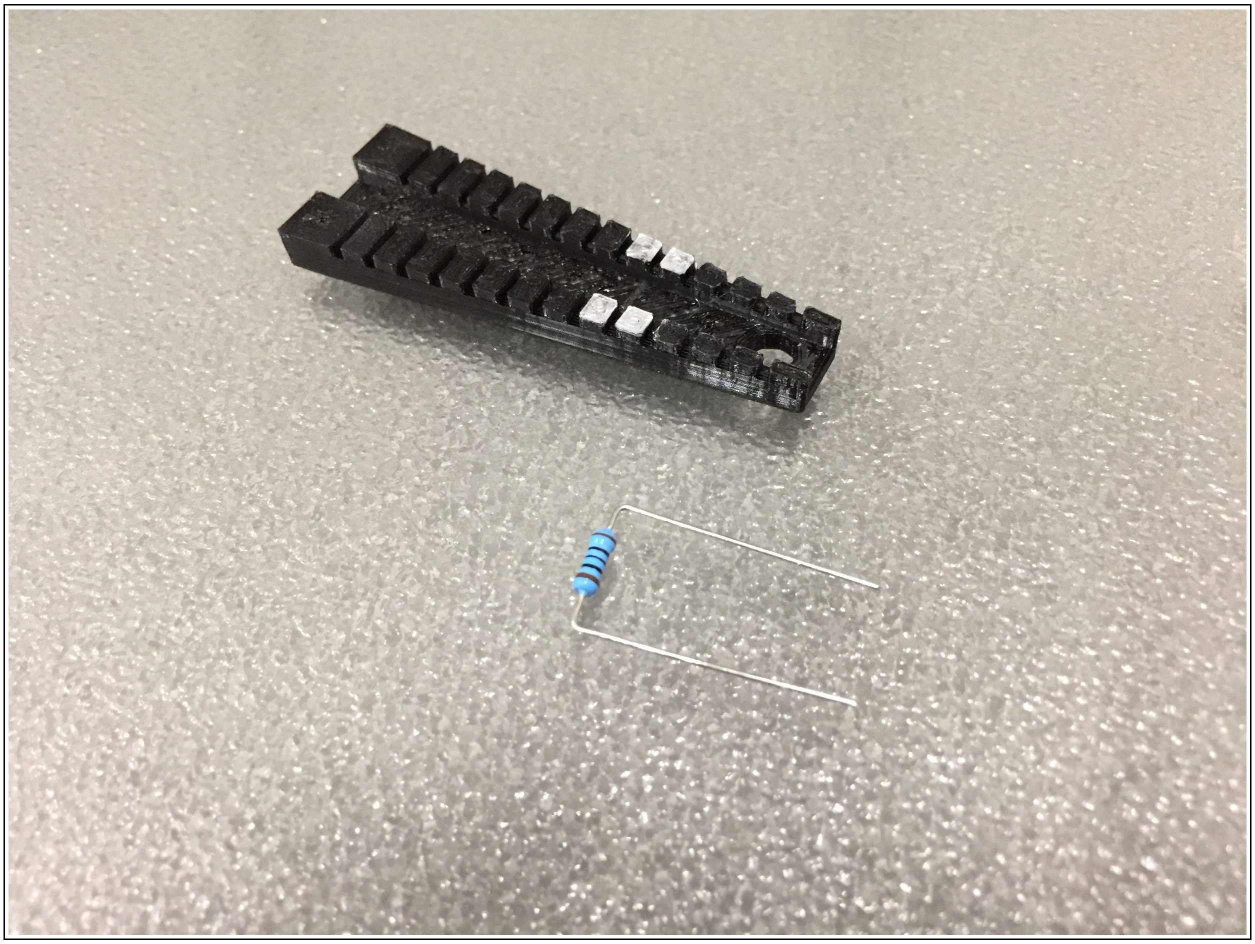


Figure 5 – Resistor ready for insertion

Which way do components go in the board?

That's an excellent question! Most components do not have a polarity (direction requirement), but there are some that must be put into the board the proper direction or damage to the component can occur. Resistors are not polarized. They can be inserted into the board in either direction. If you want a nice consistent look to your board then insert the components so the color bands are facing the the same way (one end of a resistor's colors bands is the tolerance color, usually one or two bands of brown, gold, or silver).

Holding components in place

With a component's leads properly bent, it should fit flush with the board and loosely held with the pressure of the leads in the holes, and may require nothing at all to hold it in place while you solder it. However, there will be cases (like with small capacitors) where the component will simply fall out of the holes without something to hold it in place while you flip the board over. In these cases you will want to use the reusable tack adhesive (linked to above) to hold the component in place while you solder the leads. This adhesive is much like clay, "Play-doh", or "Silly Putty". You take a small rolled up ball about 1/4" (~6mm) in diameter and place it on the component so it wraps around and over the component, and onto the surface of the circuit board, holding the component in place. See Figure 6 as an example.

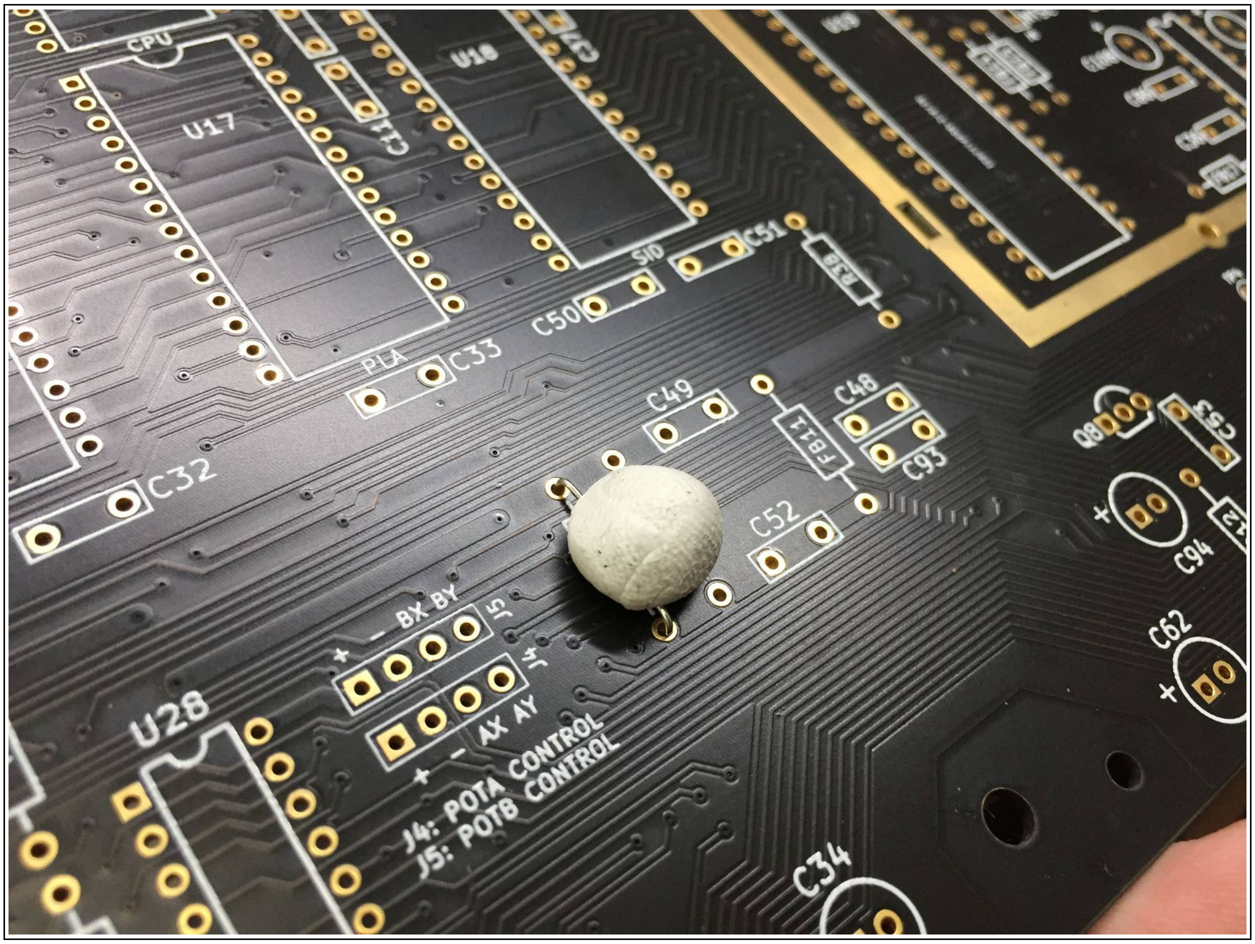


Figure 6 – Plasti-Tak place over component to hold it in place

Flipping the board over and aligning the leads

Flip the board over and lay it face down on your work surface. You will likely notice that the leads are not perfectly perpendicular (straight up) from the board. If you simply move the board back and forth you can move the Plasti-Tak ball that is holding the component and the leads will pivot. Adjust the leads so that they are straight as show in Figure 7.

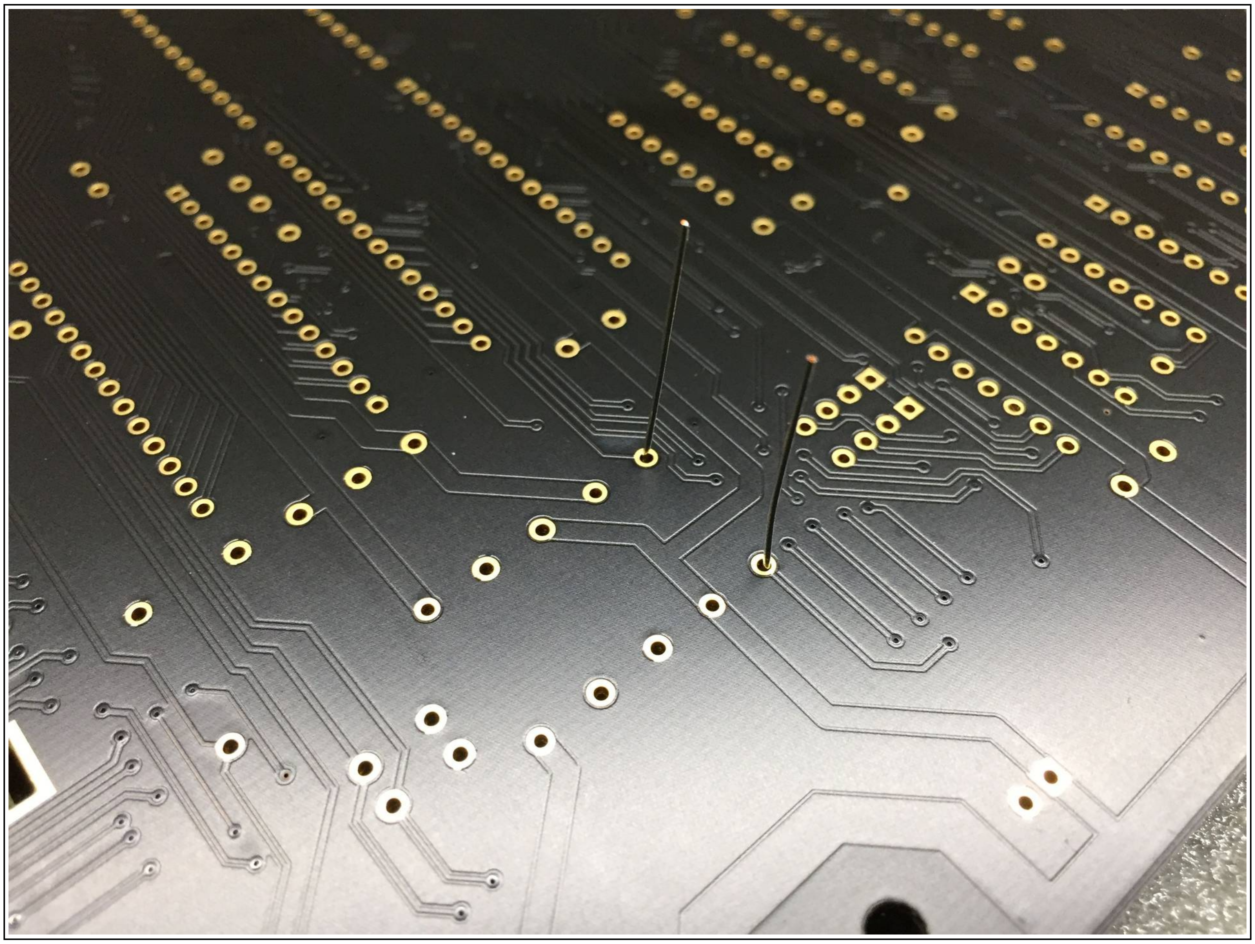


Figure 7 – Leads sticking straight out of the board

Soldering the leads

Heat the pad of the hole the lead is passed through. After the pad is heated (a few seconds), apply a small amount of solder between the tip of your iron and the lead itself. This should make the solder flow through the pad, around the lead and cover the pad. The end result should look like Figure 8.

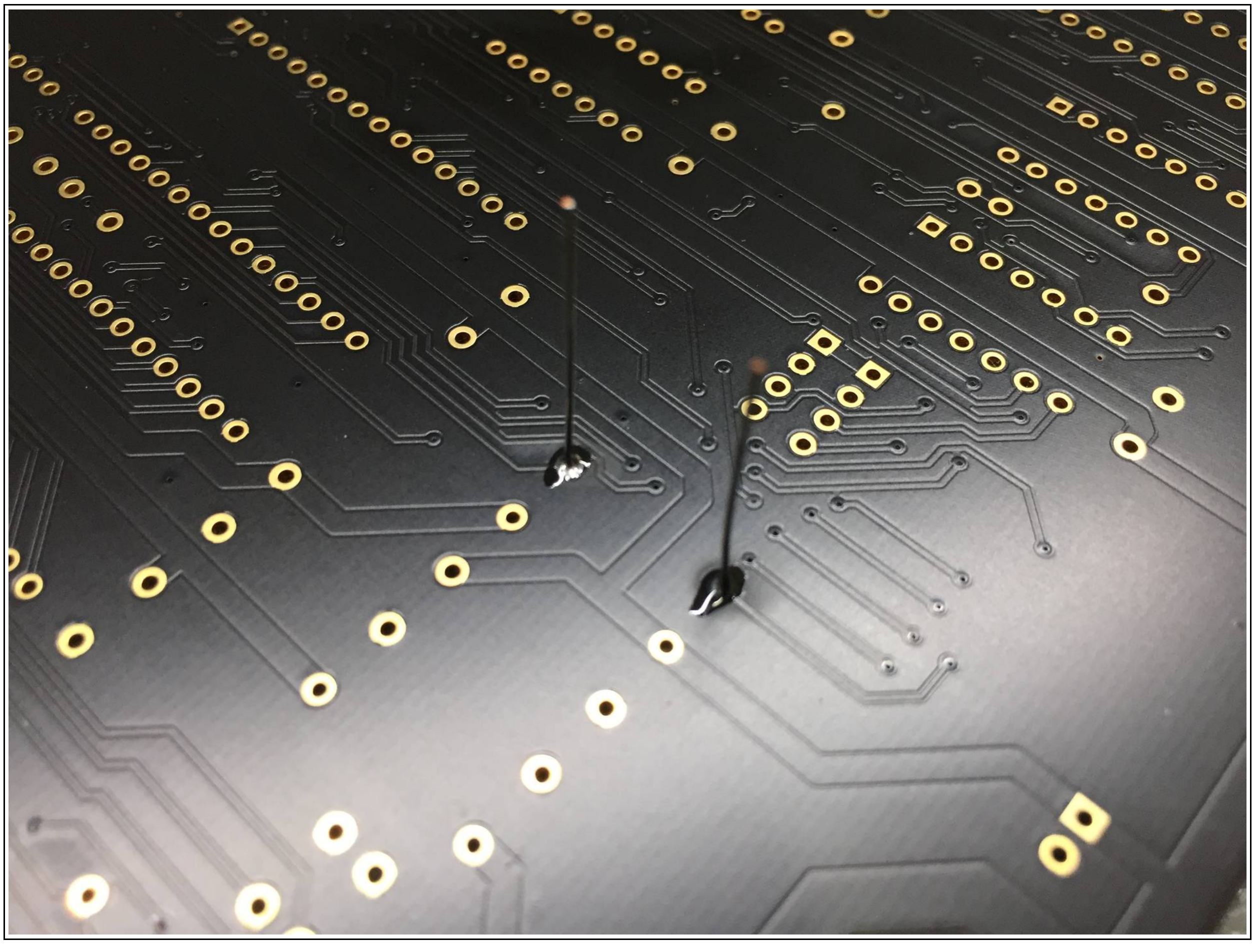


Figure 8 – Leads soldered

Trimming the leads and cleaning the board

Using the small side cutters (linked to above), clip the lead at the point of where it meets the solder. You do not need to clip deep into the solder. After the leads are clipped it is recommended that you clean the residual solder flux from the board. If you are using the recommended organic solder (linked above) you can use a damp microfiber cloth to just wipe away the flux residue. This will leave the board clean and prevent spreading the flux residue all over the board as you handle it. See Figure 9 for details.

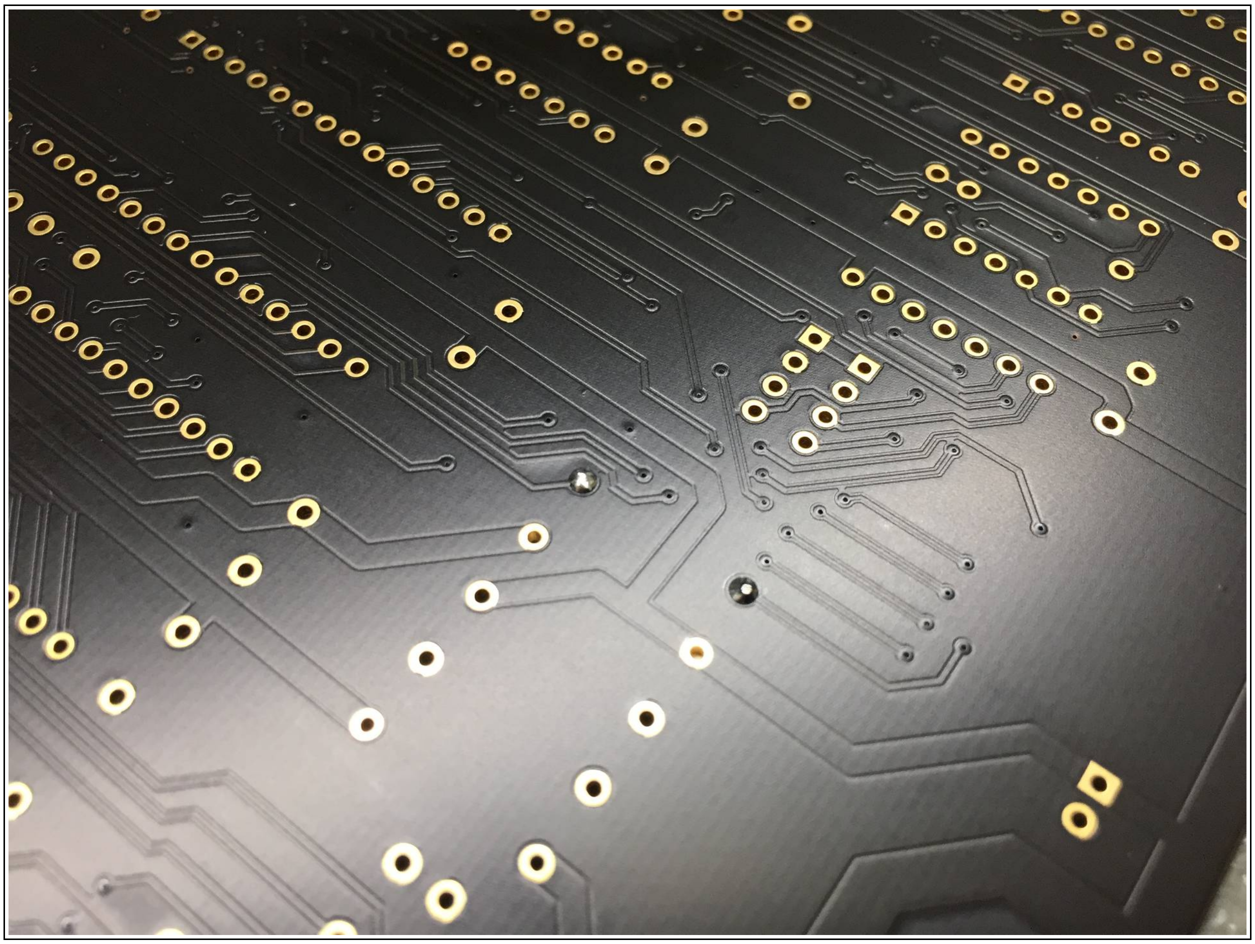


Figure 9 – Leads clipped and board cleaned

Soldering the top side of the leads

Because the ICS64S uses a real gold plating, the solder will easily flow between the bottom and top side, through the hole(s). Sometimes the top pad will be fully covered in solder, and other times there will be very little solder. The connection is solid as long the bottom pads look like the final results shown in Figure 9. It is not necessary to solder the topside of each component hole unless you want the assembly to all look the same. So, if you are particular to how your project looks, then consider soldering the top side of each pad as well. Again, this is by no means a requirement, it's completely an aesthetics thing! See Figure 10 for an example of what soldering the top side would look like.

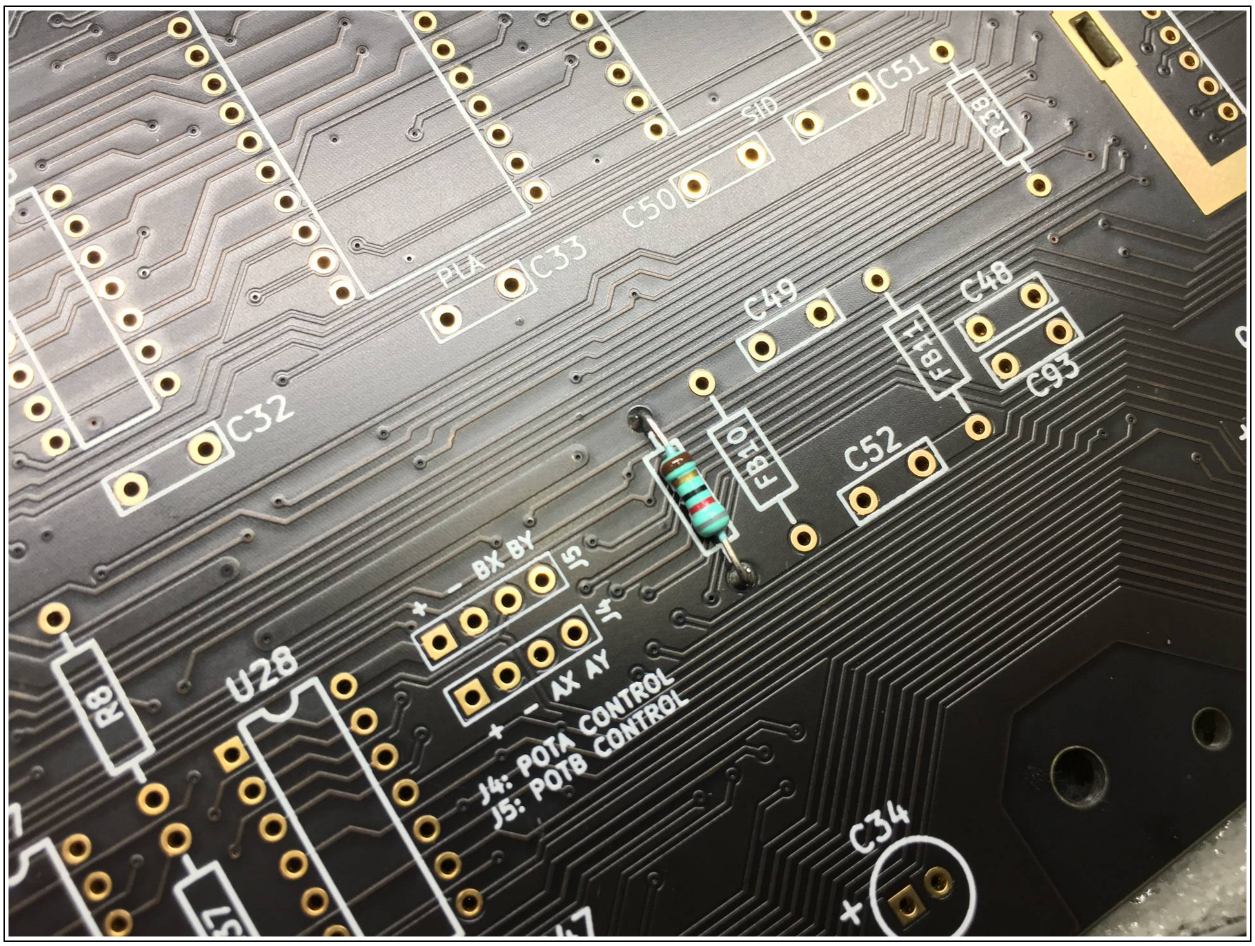
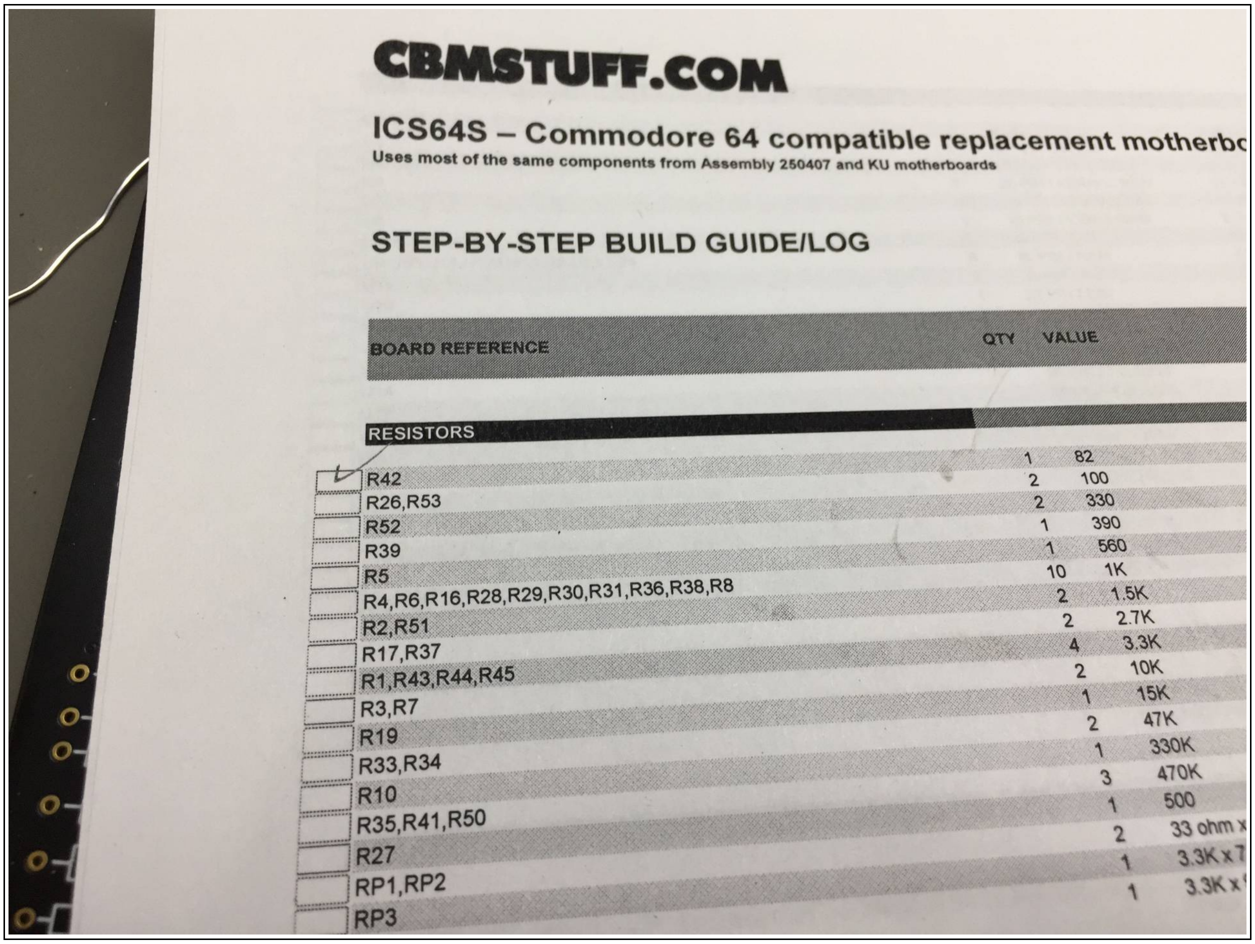


Figure 10 – Leads soldered on the top side

Following the BOM Guide

If you assemble the ICS64S following the order shown in the BOM Guide you will notice that the first component in the list is R42, a 82 ohm resistor. That is the component that is shown in the above examples.

After you have successfully inserted, soldered, clipped, and cleaned that component, you can check it off of the BOM Guide list. See Figure 11.



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ICS64S – Commodore 64 compatible replacement motherbc

Uses most of the same components from Assembly 250407 and KU motherboards

STEP-BY-STEP BUILD GUIDE/LOG

BOARD REFERENCE	QTY	VALUE
RESISTORS		
R42	1	82
R26,R53	2	100
R52	2	330
R39	1	390
R5	1	560
R4,R6,R16,R28,R29,R30,R31,R36,R38,R8	10	1K
R2,R51	2	1.5K
R17,R37	2	2.7K
R1,R43,R44,R45	4	3.3K
R3,R7	2	10K
R19	1	15K
R33,R34	2	47K
R10	1	330K
R35,R41,R50	3	470K
R27	1	500
RP1,RP2	2	33 ohm x
RP3	1	3.3K x 7
	1	3.3K x

Figure 11 – One down, and lots to go!

Continue inserting and soldering components, using the BOM Guide and interactive BOM reference as you proceed. Below are images of the several of the components in the list being located and soldered in place.

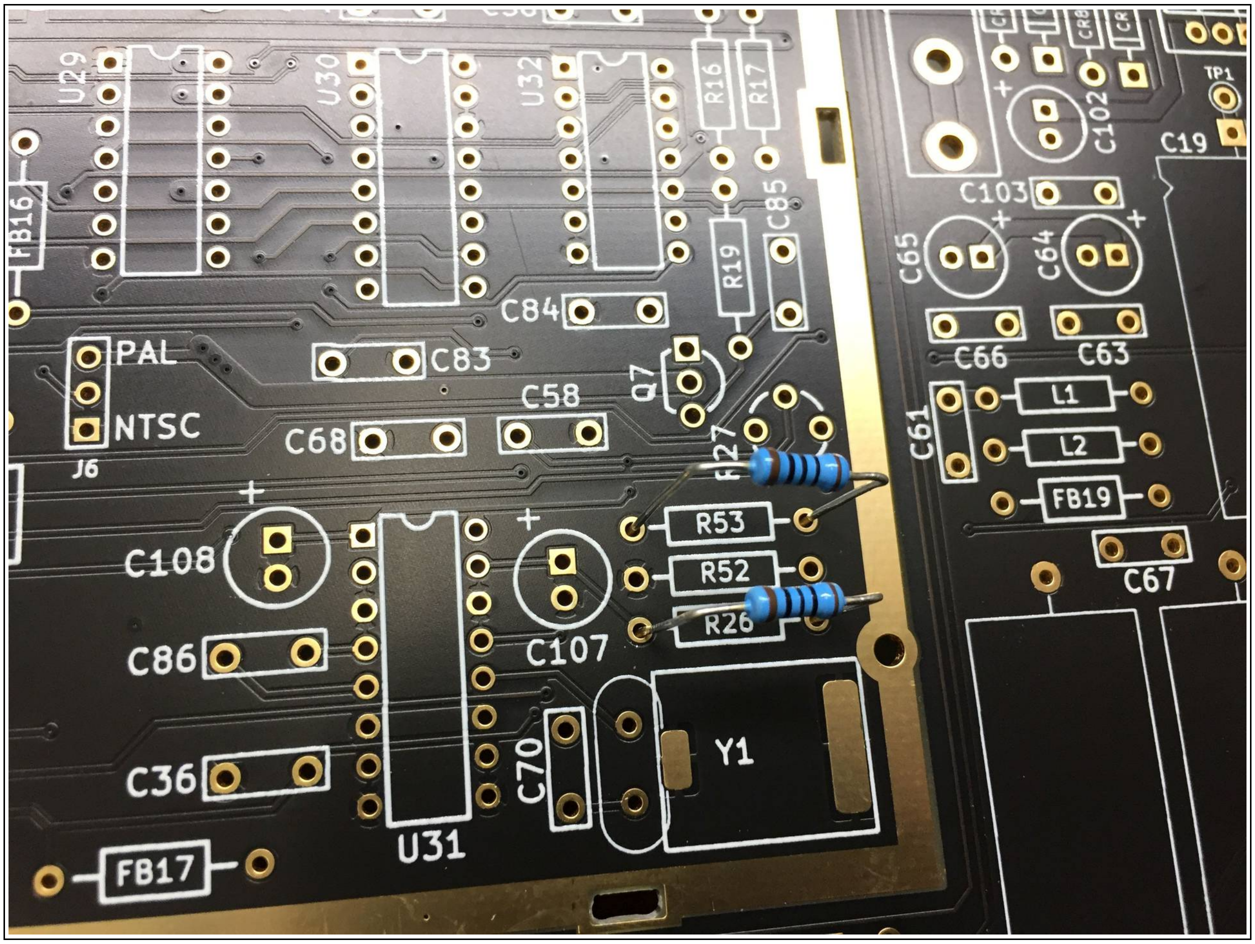

Figure 12 – R6 and R53, 100 ohms

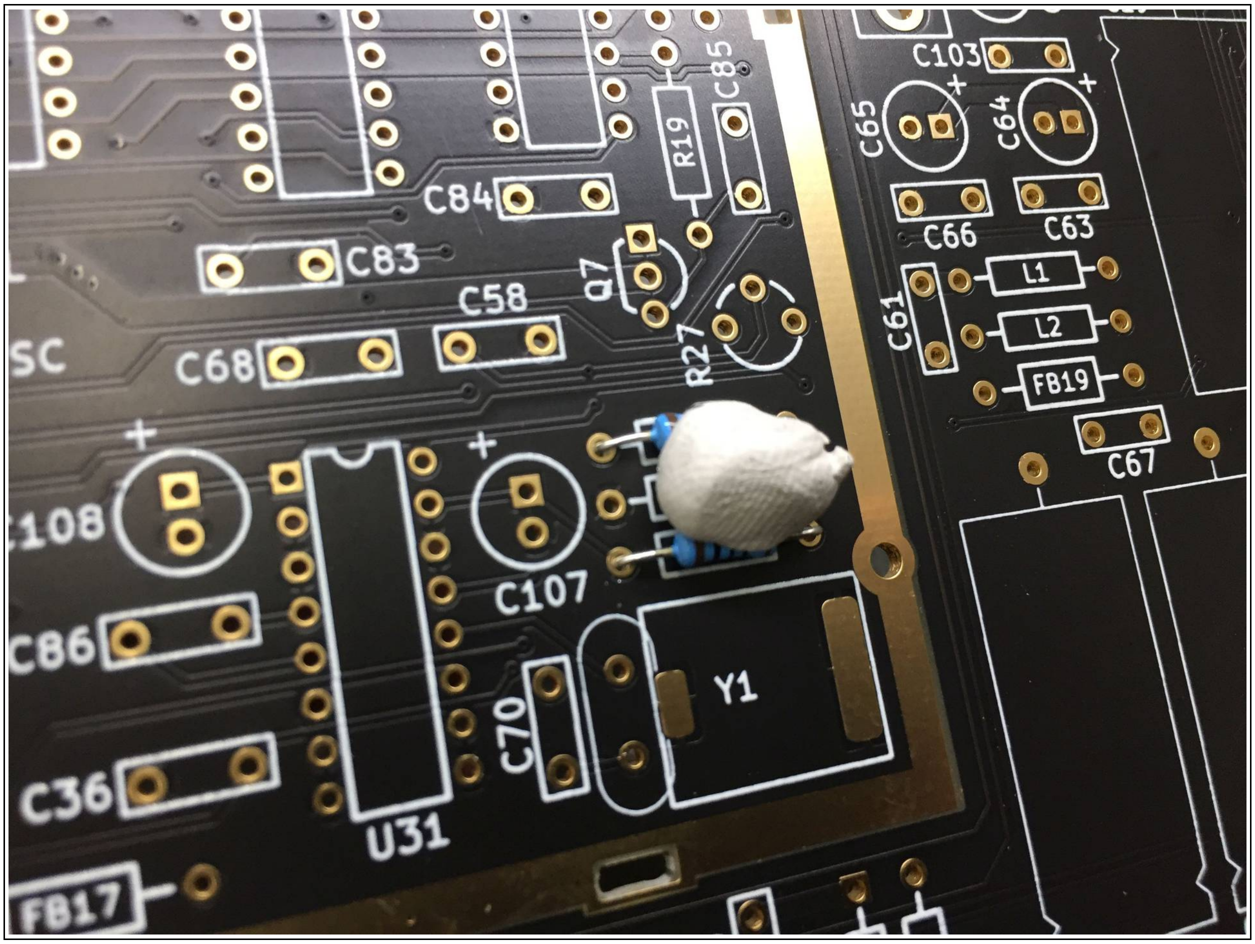

Figure 13 – R6 and R53, ready for board to be flipped

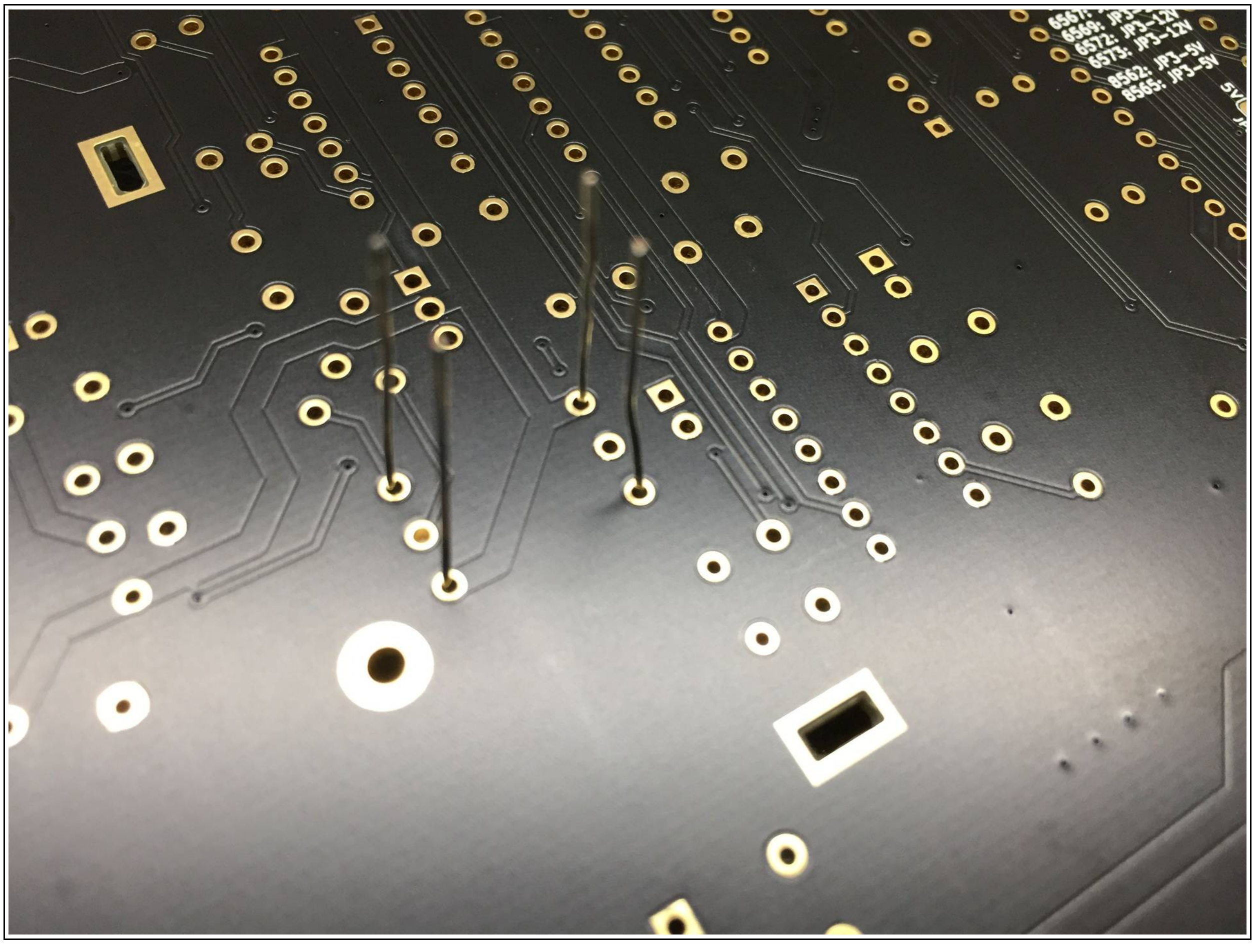

Figure 14 – R6 and R53, leads straight and ready to be soldered

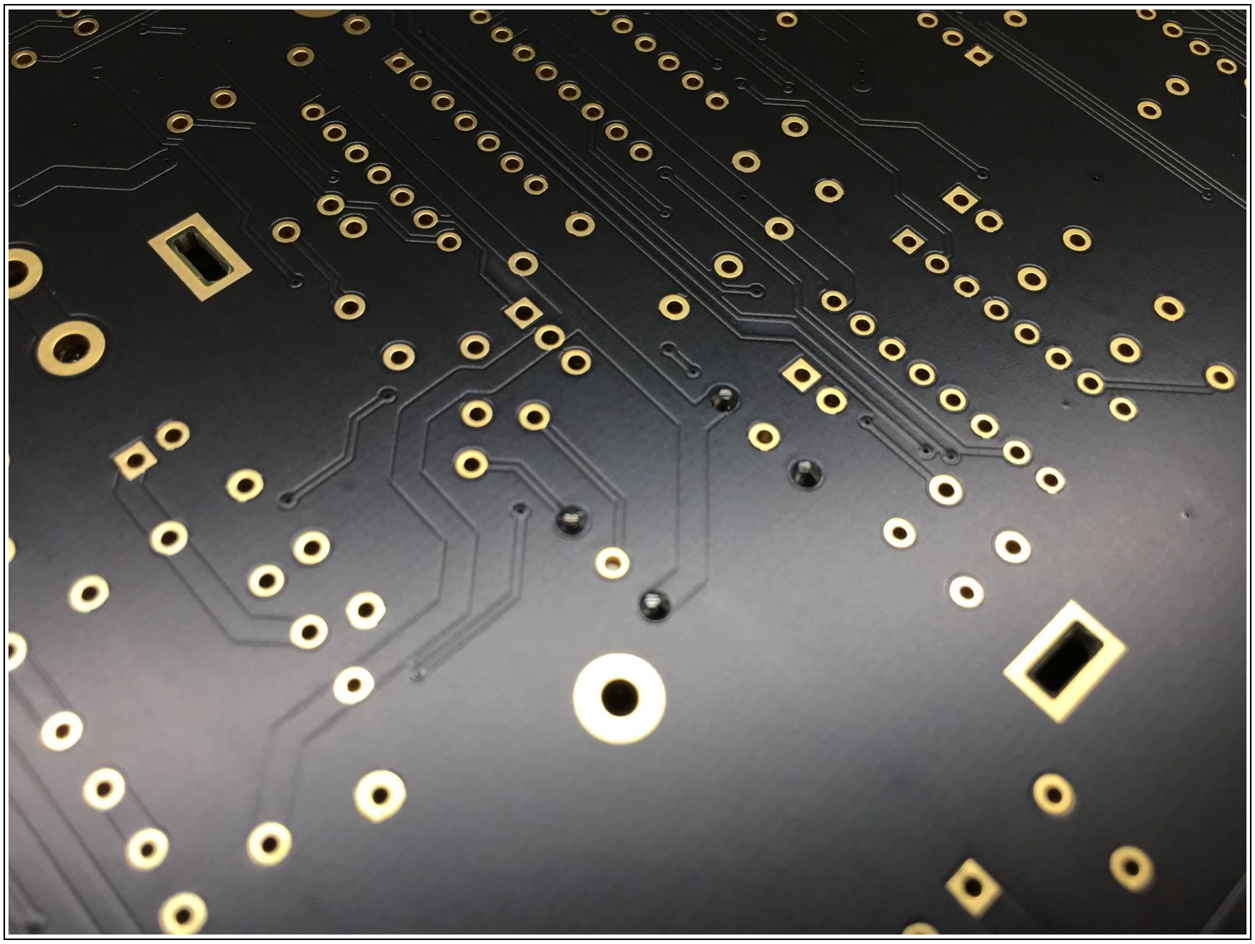

Figure 15 – R6 and R53, leads soldered & clipped, board cleaned

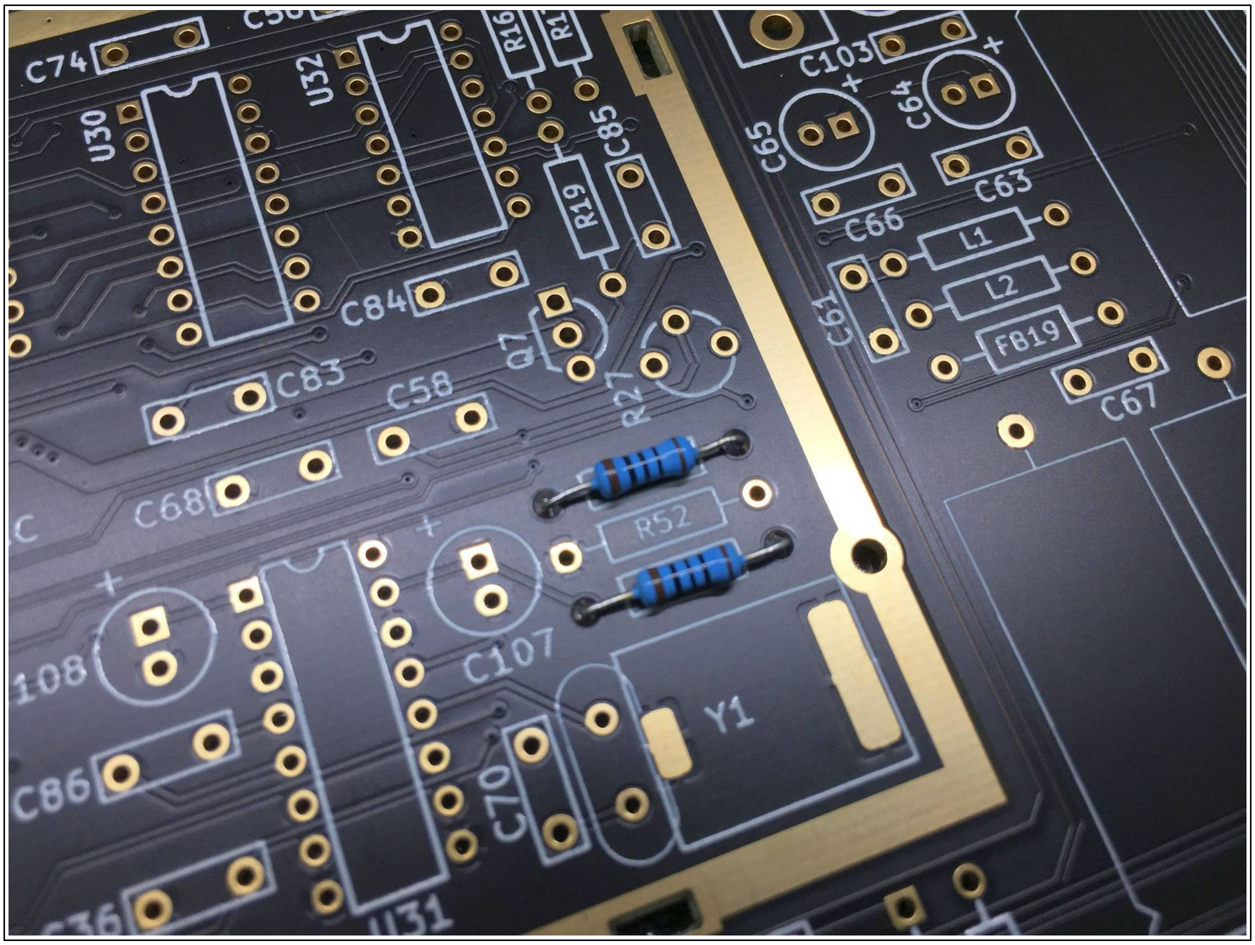

Figure 16 – R6 and R53, end result

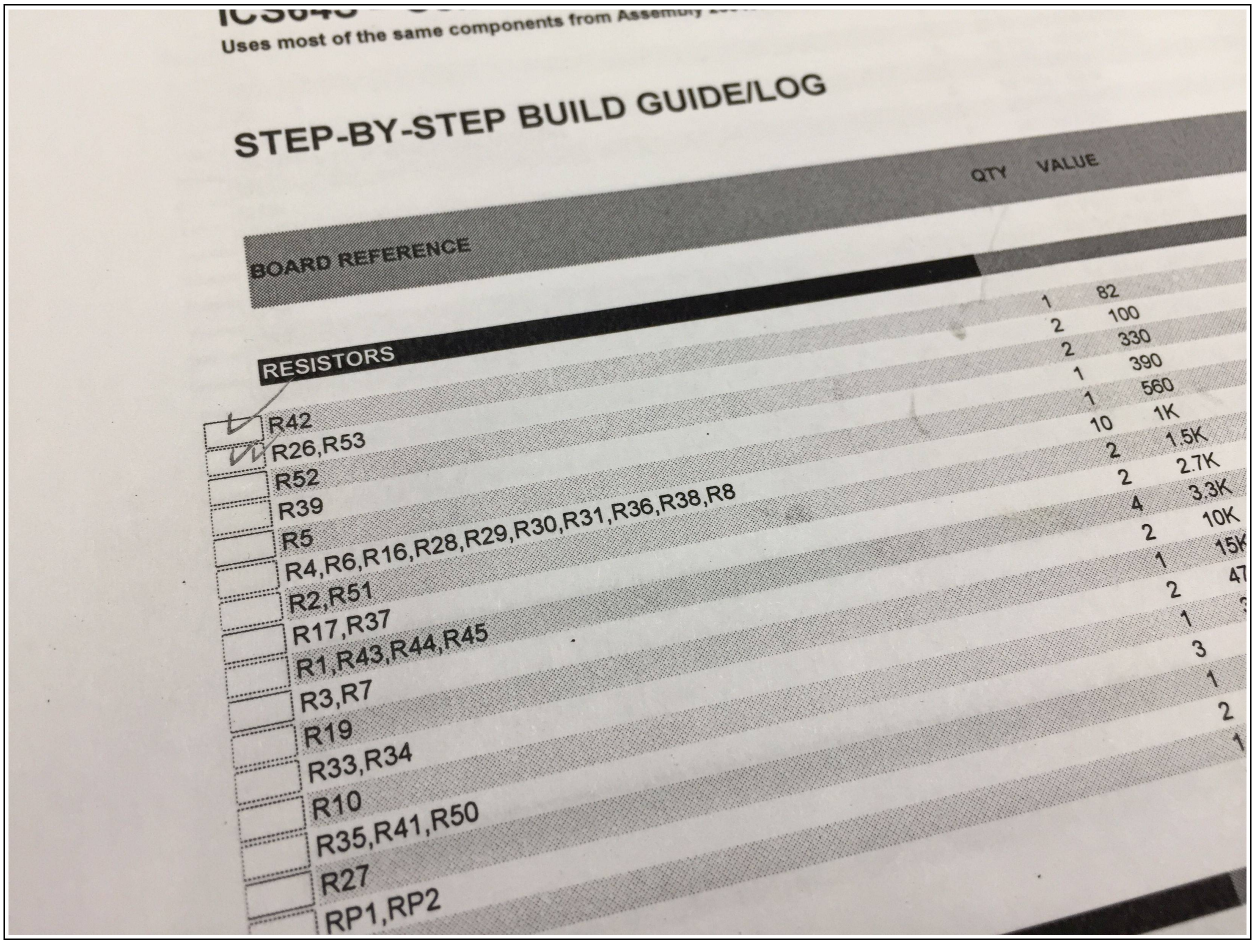

Figure 17 – Don't forget to check R26 and R53 off the list!

Continue installing all of the resistors in the list until you reach resistor arrays, RP1-RP4.

RESISTOR ARRAYS

There are four resistor arrays. Care needs to taken that you are using the correct component for each location. Also, these components require that the insertion direction is correct. Pin 1 of the resistor array is marked with a 'dot'. Pin 1 on the ICS64S board is indicated with a square around the pin. See Figure 18 for details. Use Plasti-Tak to hold these components in place while soldering. Make sure they are straight up from the board (not tilted).

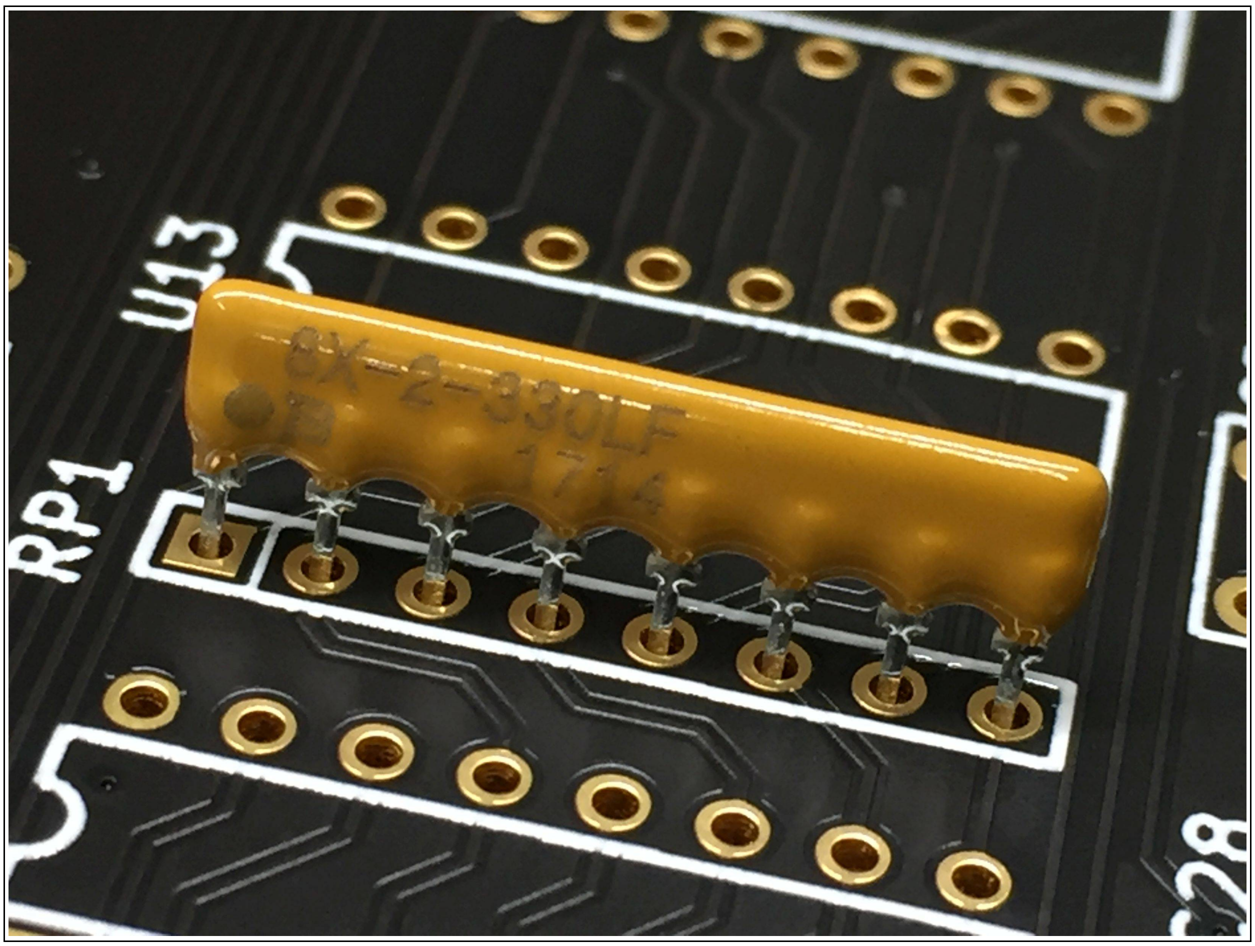

Figure 18 – Resistor array – note dot and pin 1 location

DIODES

Diodes are one of the components that are required to be inserted into the board in the correct direction. A diode has a single colored "band" around the component, at the very end or more towards one end than the other. That end is called the CATHODE, which is the negative lead. The other end is called the ANODE, which is the positive lead.

Diode CR1 is (typically) a glass type diode. Bend the leads just like you did with the resistors. Look at the location where CR1 goes on the ICS64S board. You will see an outline for the diode, along with a line that represents the band. Insert the diode in the holes with the band on the diode matching the band shown on the board. See Figures 19 and 20 for details.

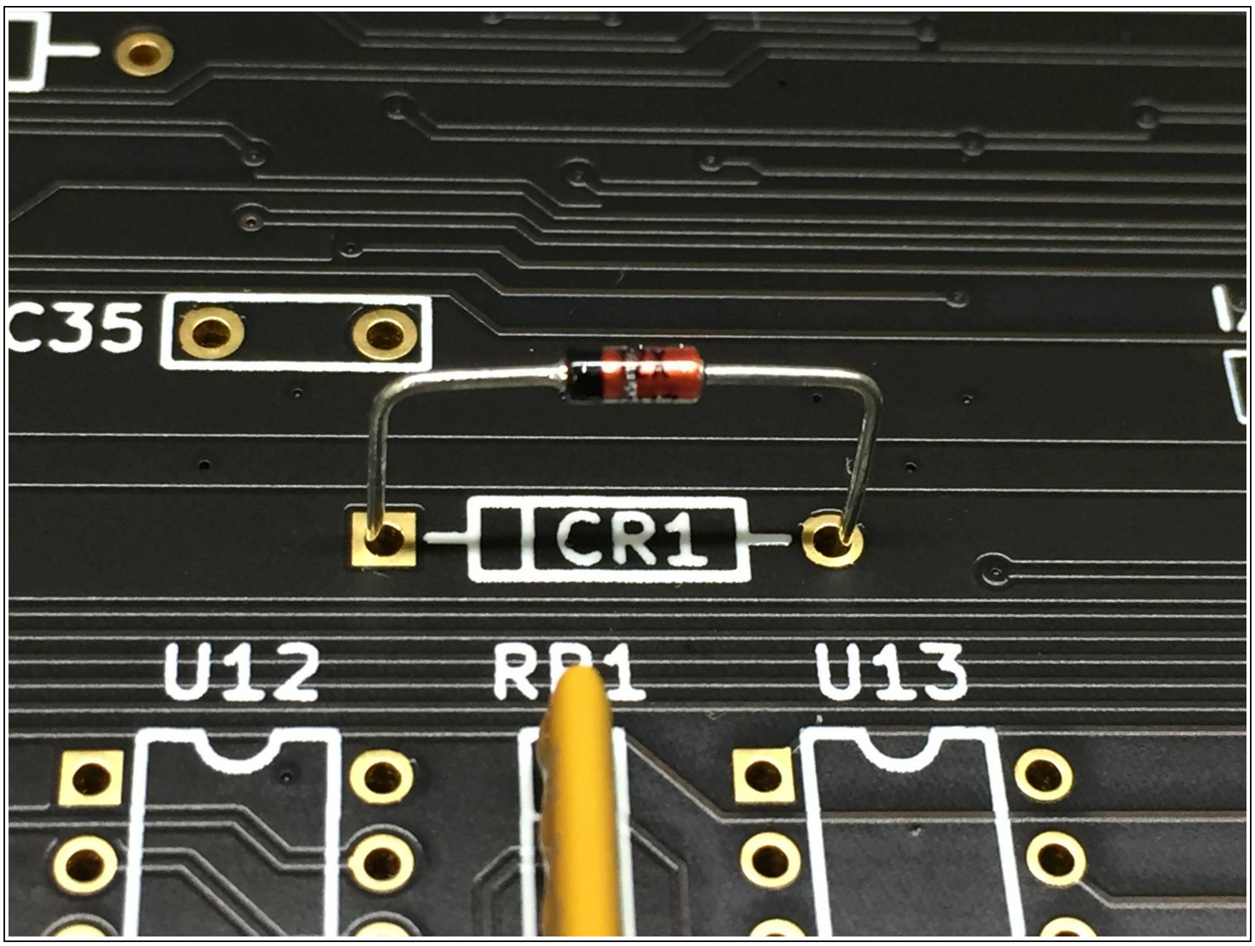

Figure 19 – Diode CR1 inserted correctly

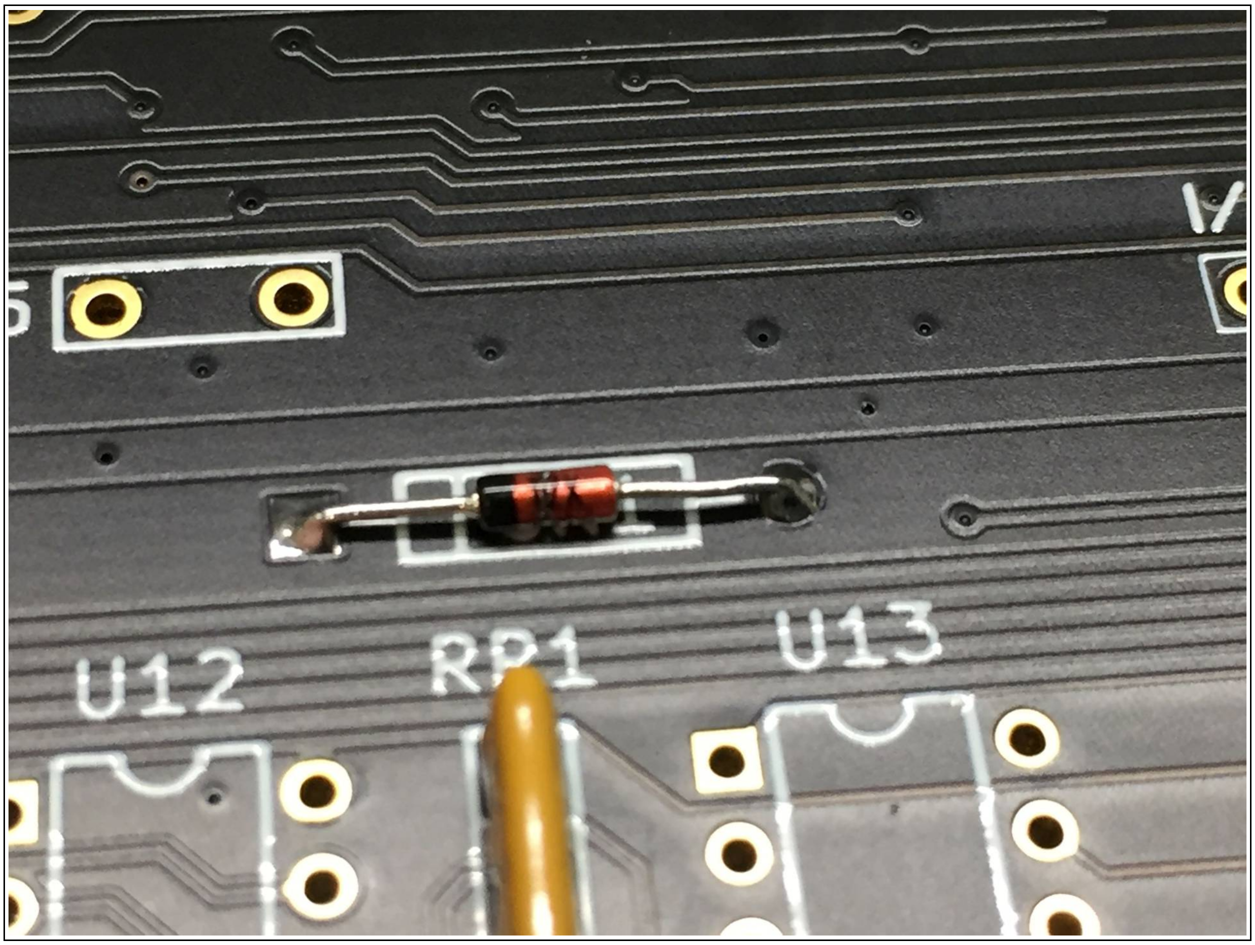

Figure 20 – Diode CR1 soldered in place

Diode CR2 is similar to CR1. Insert and solder this diode. See Figures 21 and 22 for details.

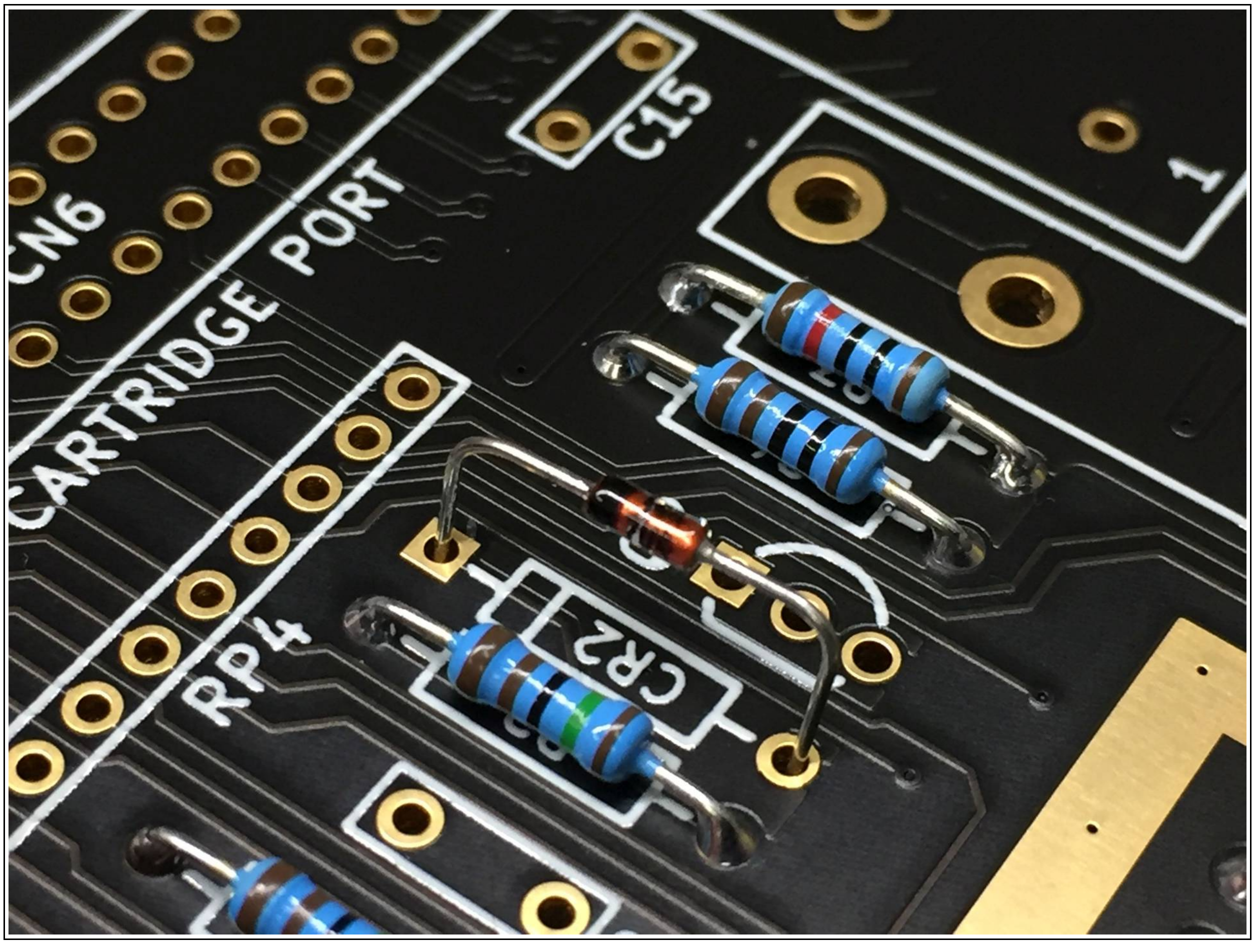

Figure 21 – Diode CR2 inserted correctly

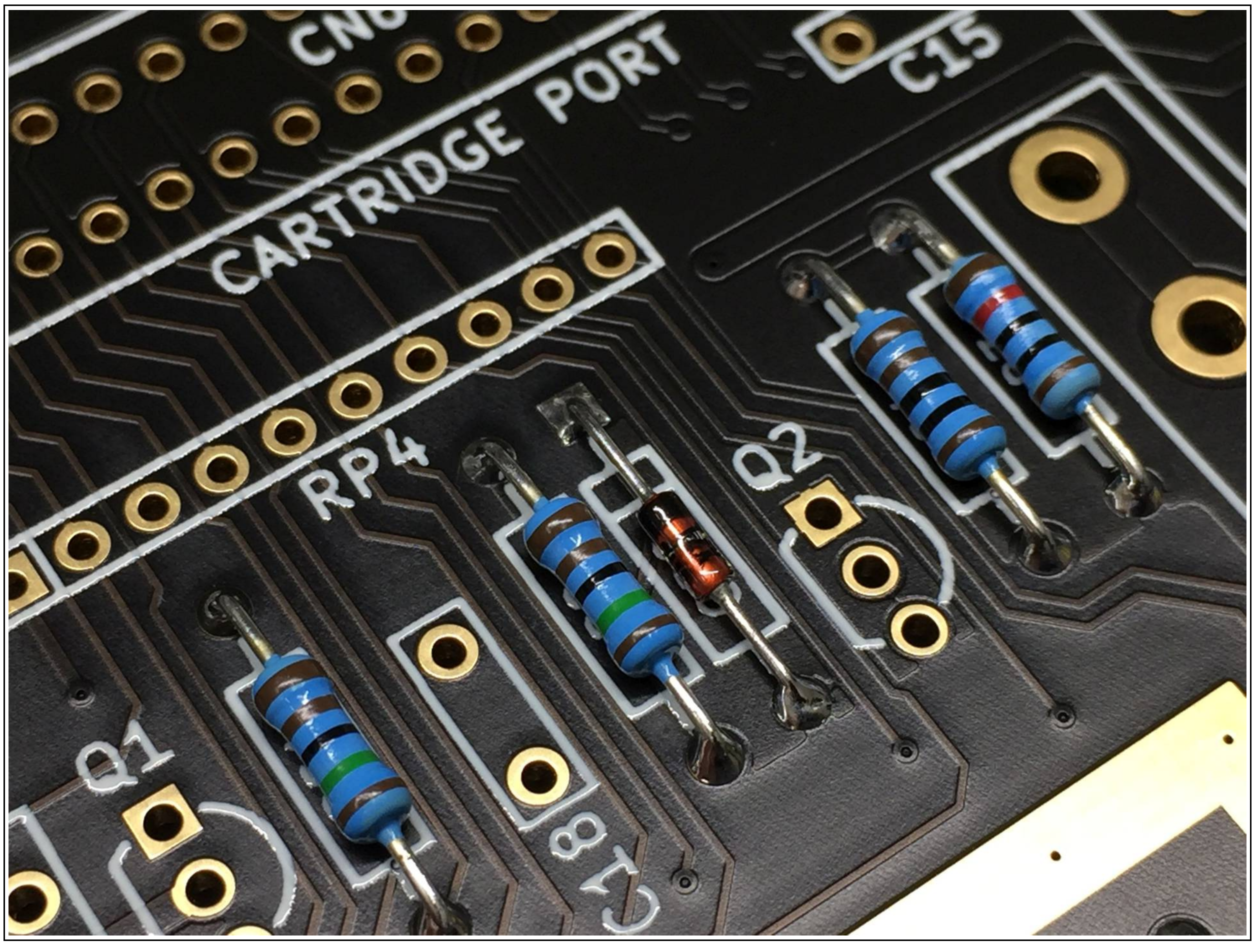

Figure 22 – Diode CR2 soldered in place

Diodes CR5 and CR6 have plastic housing (instead of glass), but their markings are similar. Note that these components are installed reversed from each other. See Figures 23 and 24 for details.

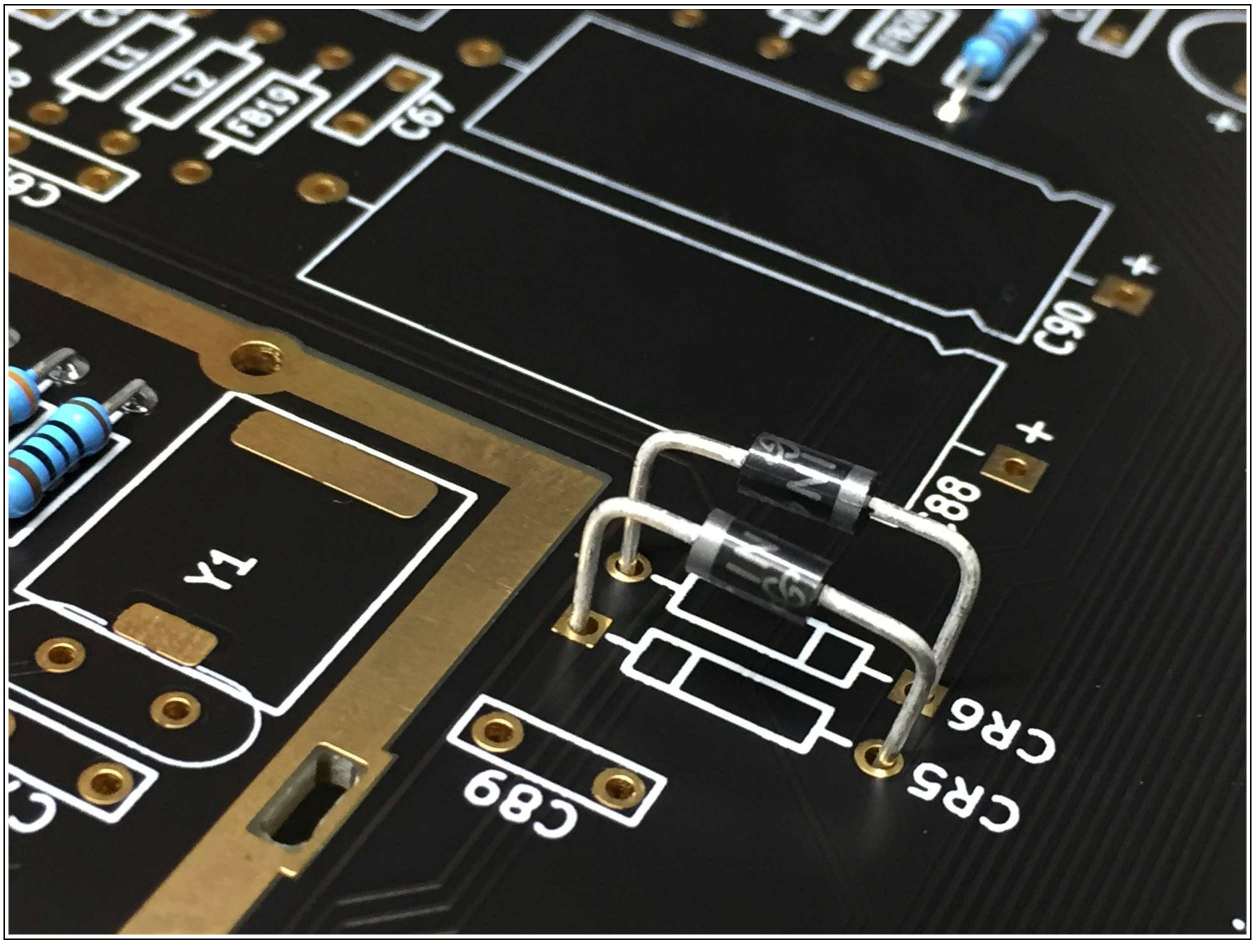

Figure 23 – Diodes CR5 and CR6 correctly inserted

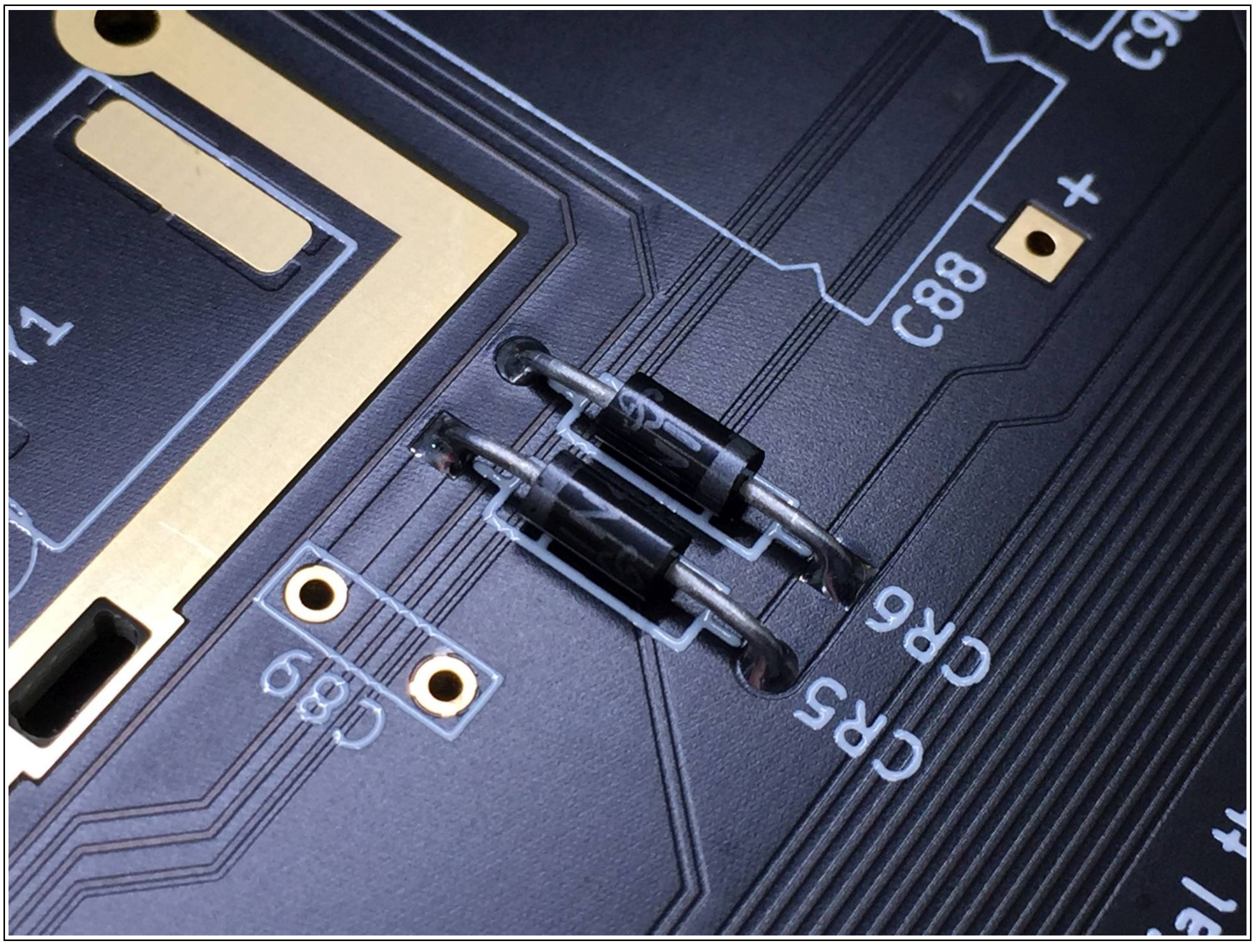

Figure 24 – Diodes CR5 and CR6 soldered in place

Diodes CR7, CR8, CR9, and CR10 have a plastic housing like CR5 and CR6, but they are larger and require a narrower spacing. These leads can be bent close to the actual body. See Figure 25 for the recommended lead bend. Note that the diodes are inserted with the bands reversed from each other. See Figures 26 and 27 for insertion and soldering details.

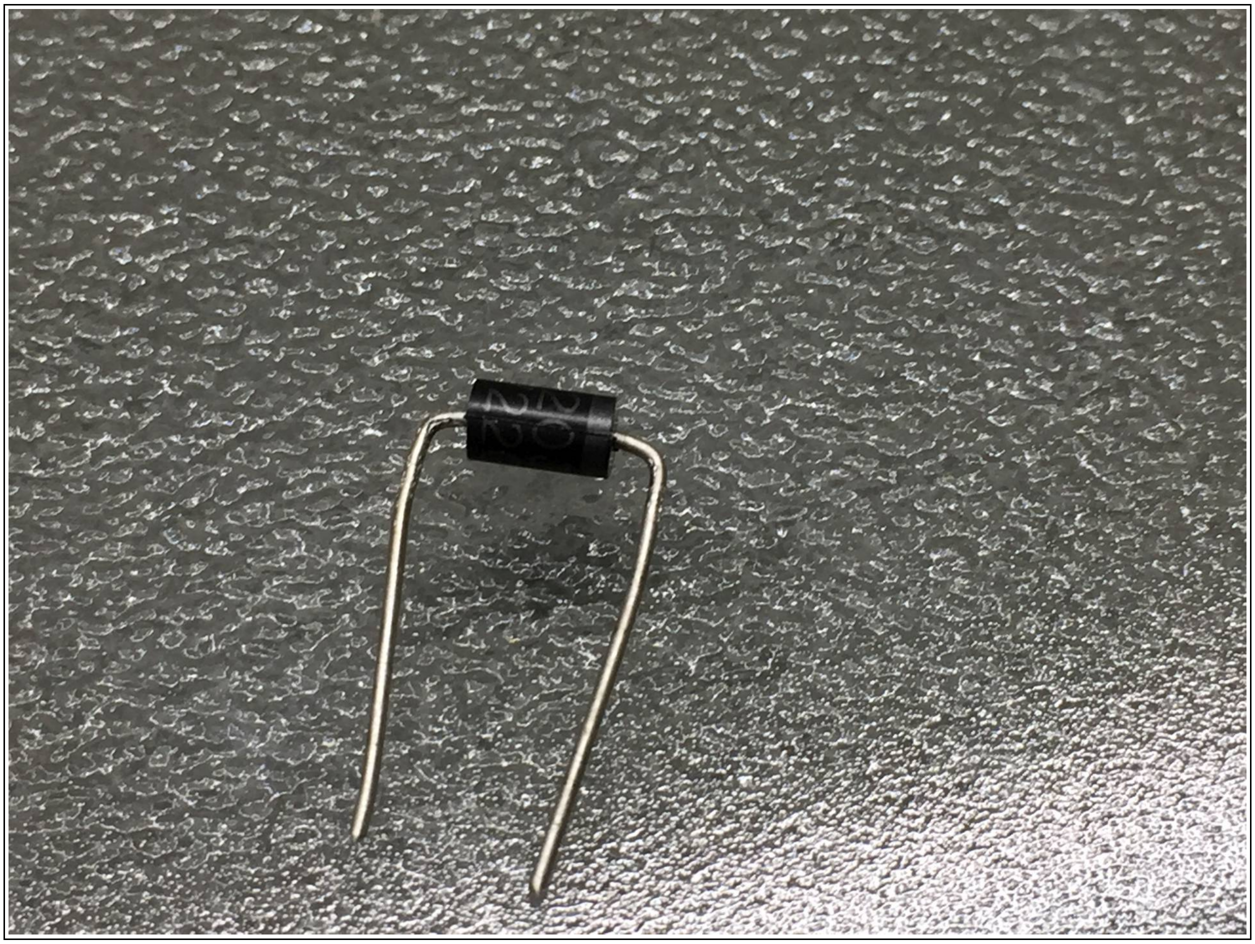

Figure 25 – Recommended lead bend for diodes CR7-CR10

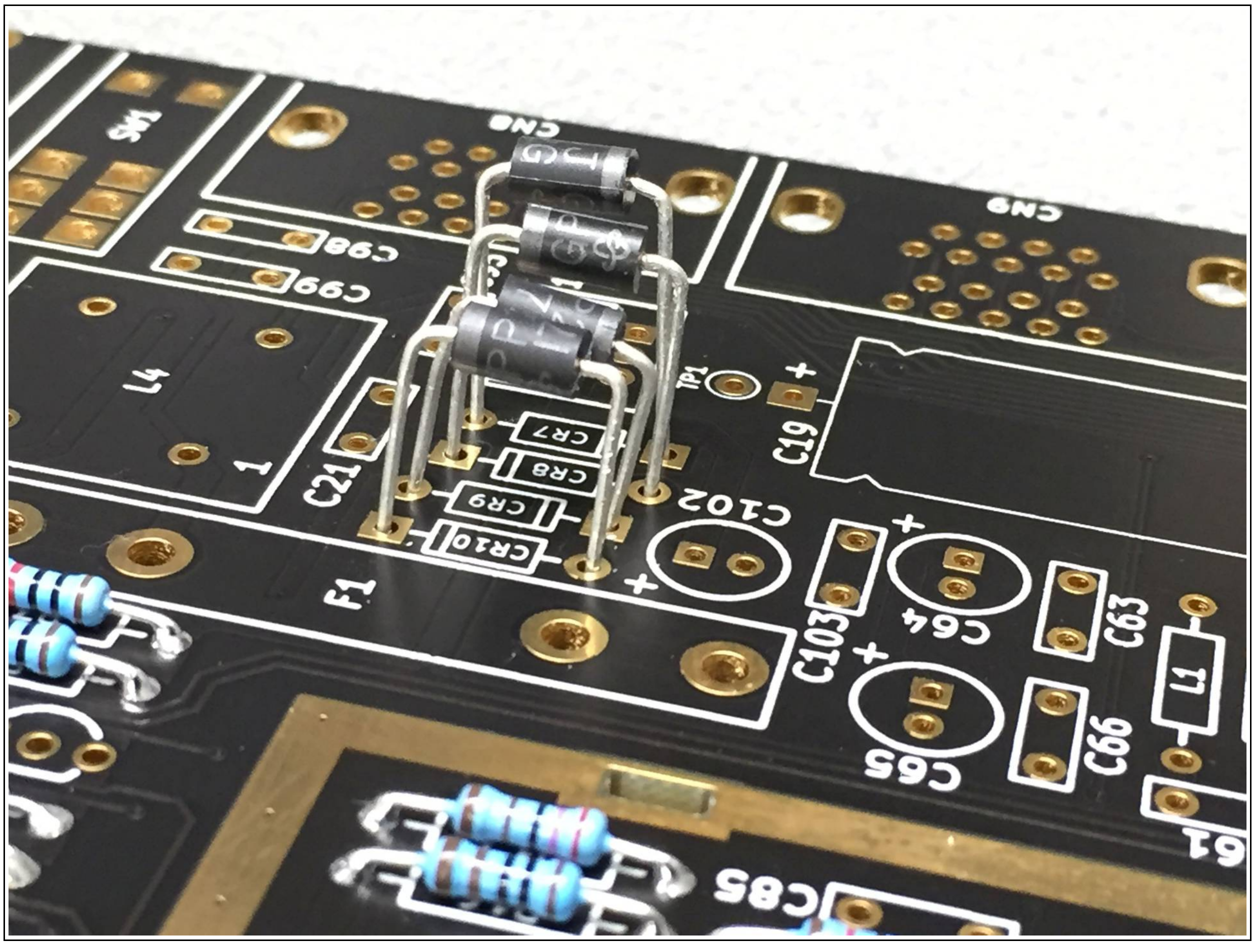

Figure 26 – Diodes CR7-CR10 inserted correctly

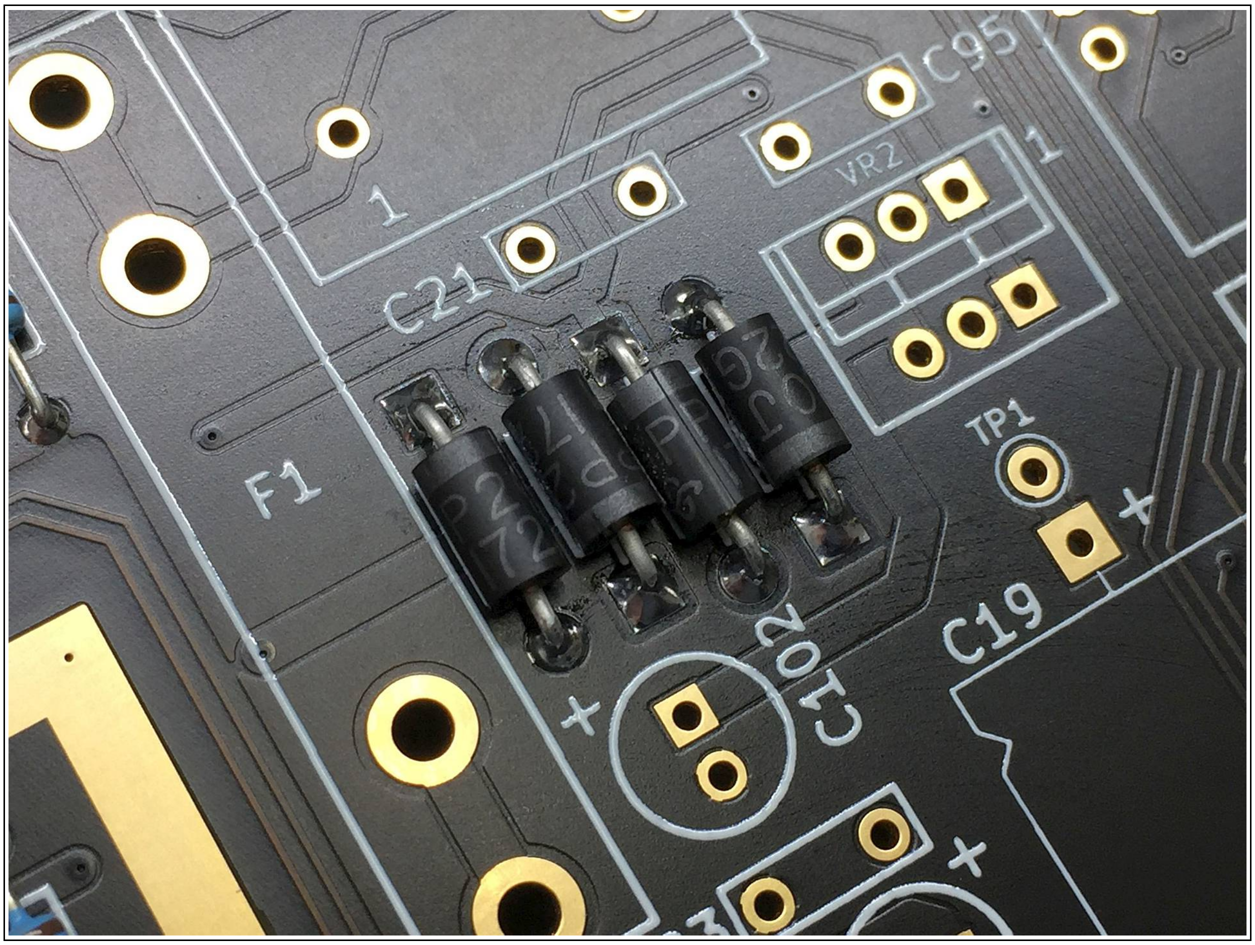

Figure 27 – Diodes CR7-CR10 soldered in place

Ferrite Beads and Small Inductors

The ferrite beads and small inductors do not have a required polarity, so they can be inserted in either direction in the board. Refer to the gallery (linked above) for detailed pictures.

Small Capacitors

The small ceramic capacitors do not have a required polarity, so they can be inserted in either direction in the board. There are a lot of these small capacitors. The small capacitors have a 0.2" lead spacing. Since the leads on these components are very thin there will be quite a bit of space in the hole, which means that the components will not stay in place on their own. Use the Plasti-Tak to hold the components in place while soldering. See the gallery for detailed pictures.

Note that there are four 0.22uf capacitors. Capacitors C20 and C21 are special "poly film" type capacitors, not the normal MLCC type. These are taller and typically square. These are located on each side of choke L4. Do not mistake these capacitors for C97 and C100.

The electrolytic capacitors (10uf) do have a polarity that needs to be followed! The capacitor is marked with a NEGATIVE (-) band on one side. The other (unmarked) side is POSITIVE. The ICS64S board has a "+" symbol to indicate where the positive lead needs to be inserted. See Figures 28 and 29 for details. See the gallery for additional pictures of the other electrolytic capacitors.

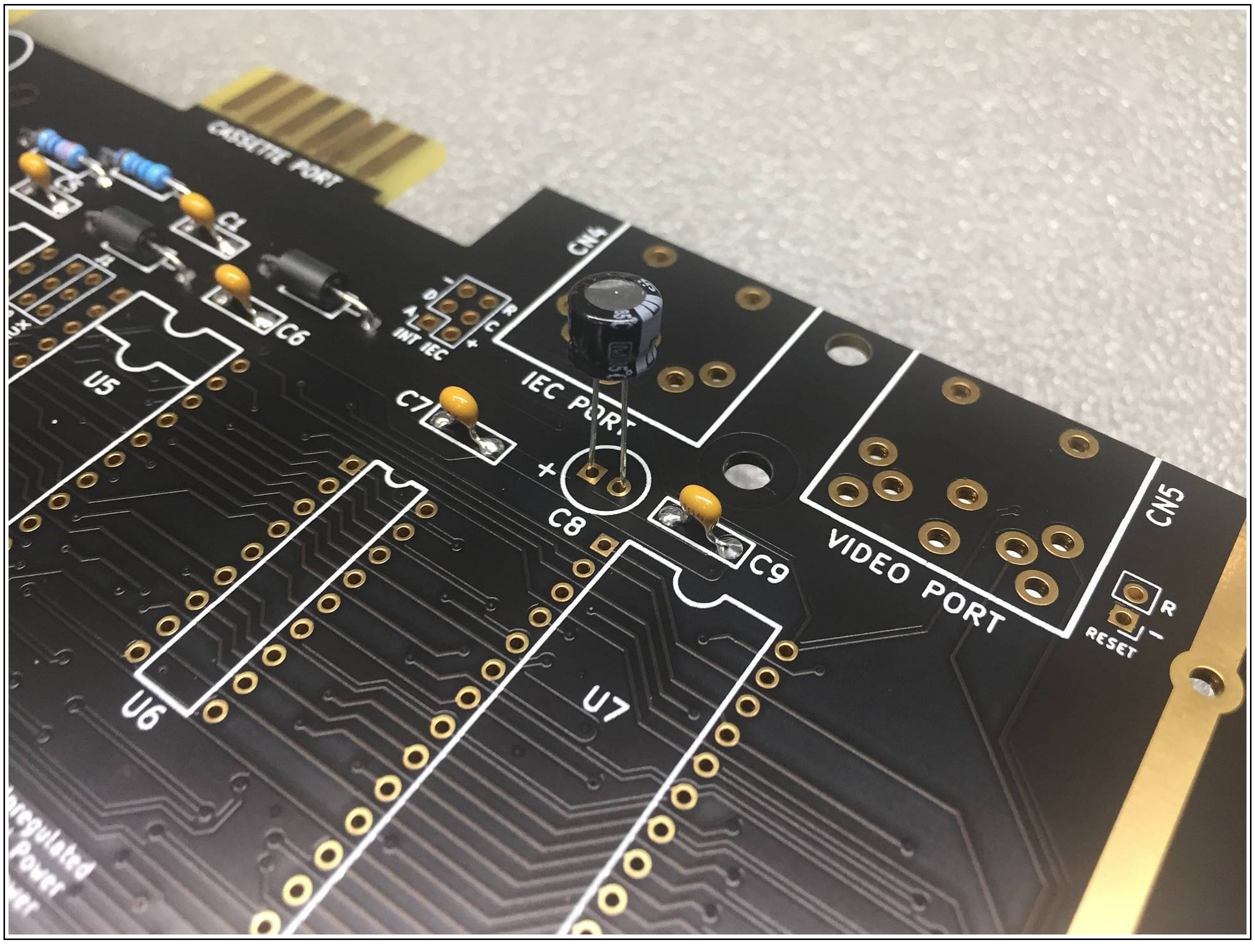

Figure 28 – Capacitor C8 inserted correctly

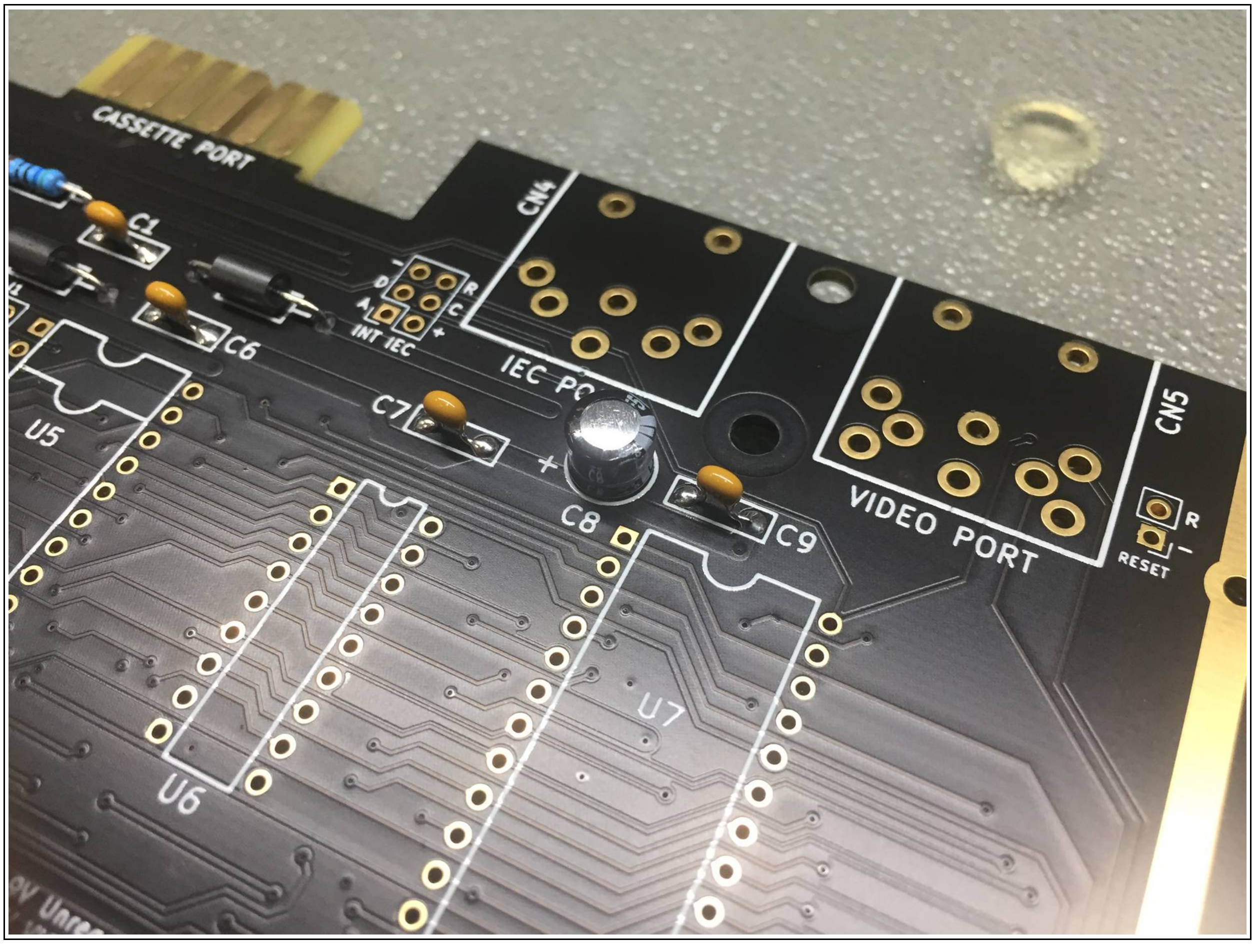

Figure 29 – Capacitor C8 soldered in place

Sockets

Insert all sockets so that the "notch" (if it exists) is facing the back of the ICS64S board. The "back" of the board is the same side that has the USER PORT, CASSETTE PORT, IEC PORT, etc. The easiest way to solder a socket in place is to insert it into the board (noting the notch orientation) and then soldering just the opposite corner pins. After this, inspect the socket to make sure that it is fully flush with the board. If one corner is slightly above the board you can heat the solder joint while applying some pressure on the socket so that it rests flat against the board. You can also make adjustments to the orientation of the socket to make it parallel with the other sockets and components. Once you confirm the socket is how you want it, solder the remaining pins.

Special care must be taken when soldering U4 & U5 (KERNAL and CHARACTER ROM sockets) due to their close proximity to the SMT components. DO NOT get solder on any of the SMT components or the ICS64S will not function!

After all of the sockets have been soldered in place, DO NOT insert any ICs into the socket yet!

Transistors

There are four small TO-92 type transistors, and one TO-220 type transistor. There is a flat side to the TO-92 transistor, and the silkscreen on the ICS64S board shows an outline of the transistor indicating the direction it must be inserted into the board. Insert the TO-92 transistors far enough into the board so they don't stick up too high. They do not need to be flush with the board. See Figures 30 and 31 for details. The TO-220 transistor is tall, so it should be inserted into the board as far as it will go. See Figure 32 for details.

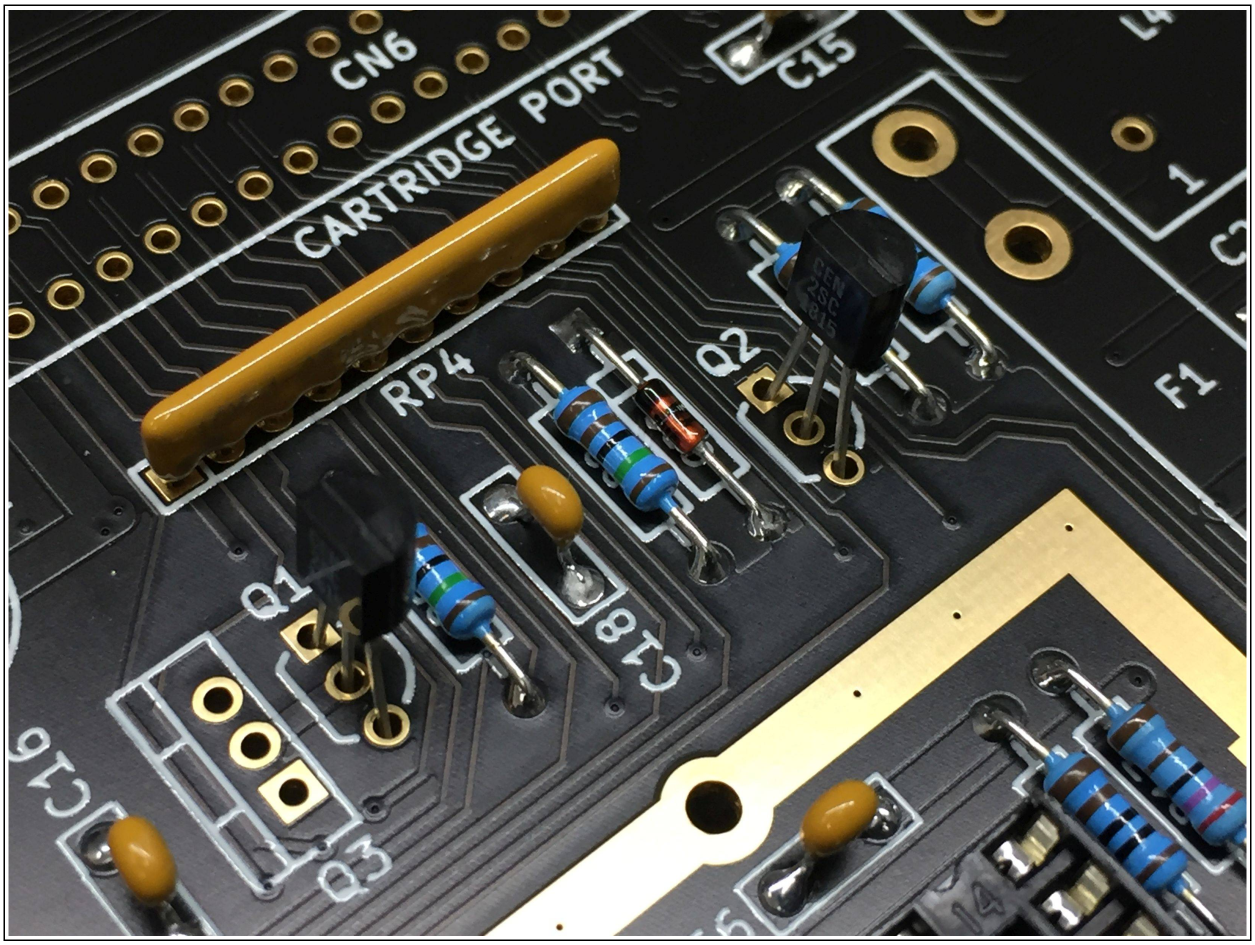

Figure 30 – TO-92 transistor locations

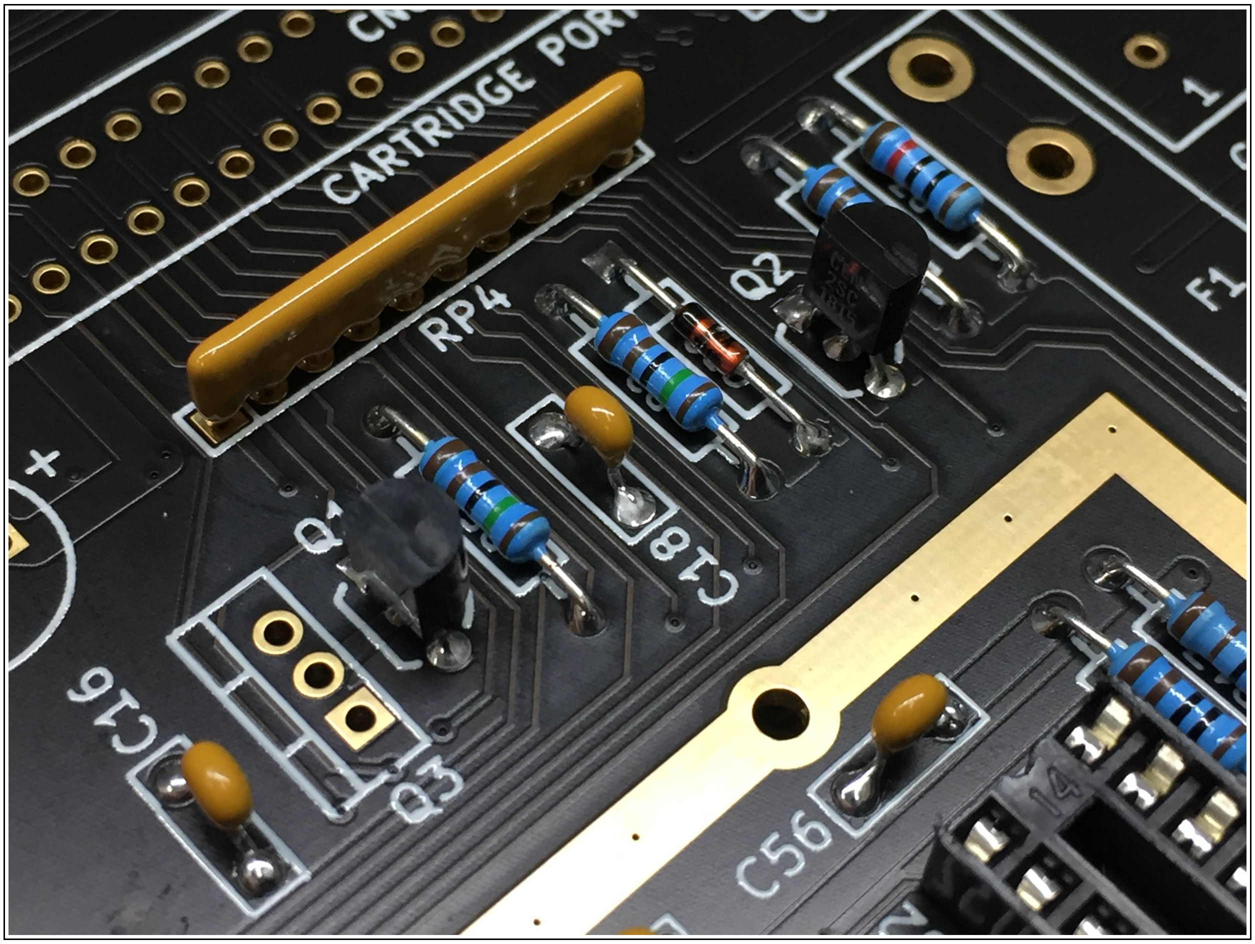

Figure 31 – TO-92 transistor height

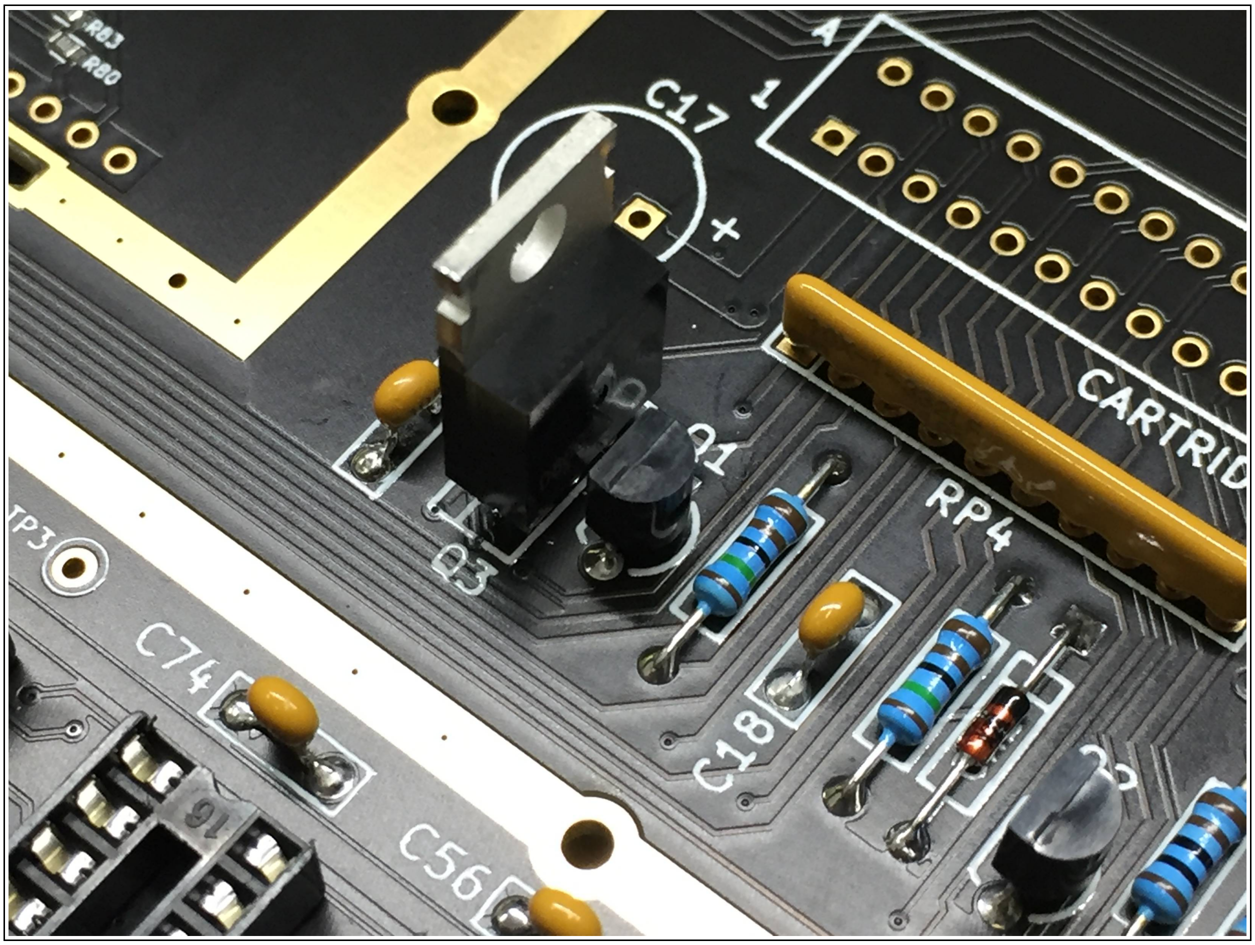

Figure 32 – TO-220 and TO-92 transistor height

Crystal

The ICS64S has the option of allowing a quick change of the crystal, VIC-II chip, and jumper to switch between NTSC and PAL configurations. To do this you will need to place a 2 pin socket in the crystal location. This socket is made from 2 pins of a machine tooled socket. See Figure 33 for details. You can optionally just solder either a short can crystal into the crystal location, or use the older style horizontal can crystal. Decide which you would like and solder in the appropriate component.

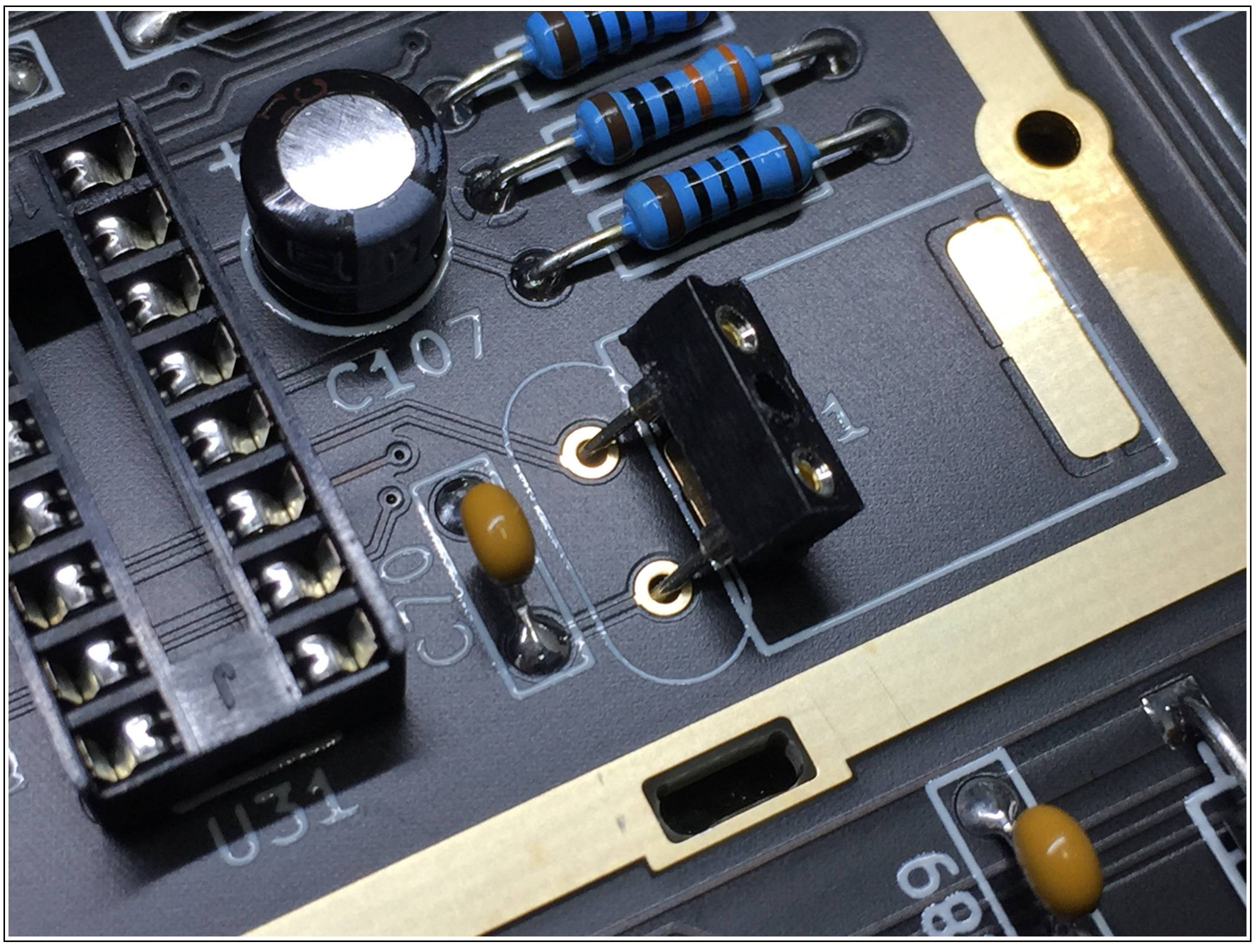

Figure 33 – Crystal socket location

Regulators

There are two voltage regulators used on ICS64S board. VR1 is normally a 12v regulator, responsible for providing power to just the 6581 SID chip. If you want to use a 8580 SID chip, **this regulator must be a 9 volt regulator (7809) instead of a 12 volt regulator (7812).**

VR1 is designed to lay flat and be soldered to the board this way. The leads must be bent at 90 degree angles and inserted into the holes. See Figure 34 for details. The best way to solder this component is to solder the 3 leads on the backside first (don't forget to clip the excess leads!), and then flip the board over and heat the regulator's metal heat sink with the soldering iron while applying just enough force to lay it flat on the board. Apply solder to the large hole while continuing to heat the heat sink. The solder will melt and flow in the hole and underneath the heat sink. Use something like a screwdriver tip to press down on the black regulator body so it is flat against the board while the solder is flowing, and leave it pressed against the board for at least 5 seconds after removing the heat from the heat sink. See Figure 35 for details.

There are several options for VR2, which is 5 volt regulator. You can use the standard 7805 type regulator with a bolted on heat sink, or you can use one of the modern type of DC-DC switching regulators. These offer a huge advantage in power stability, very low noise, and there is virtually no heat generated due to their high efficiency. Regulators from Recom, CUI, Murrata, and others can be used. Be careful about selecting a DC-DC regulator. There are many offerings from China that claim to be able to handle 1A (the minimum you need for this application), but they are unable to accomplish this and will result in everything from a non-working computer to wavy video. The proper regulator is going to be the best investment you make for this project!

See the gallery for many examples of VR2 installations.

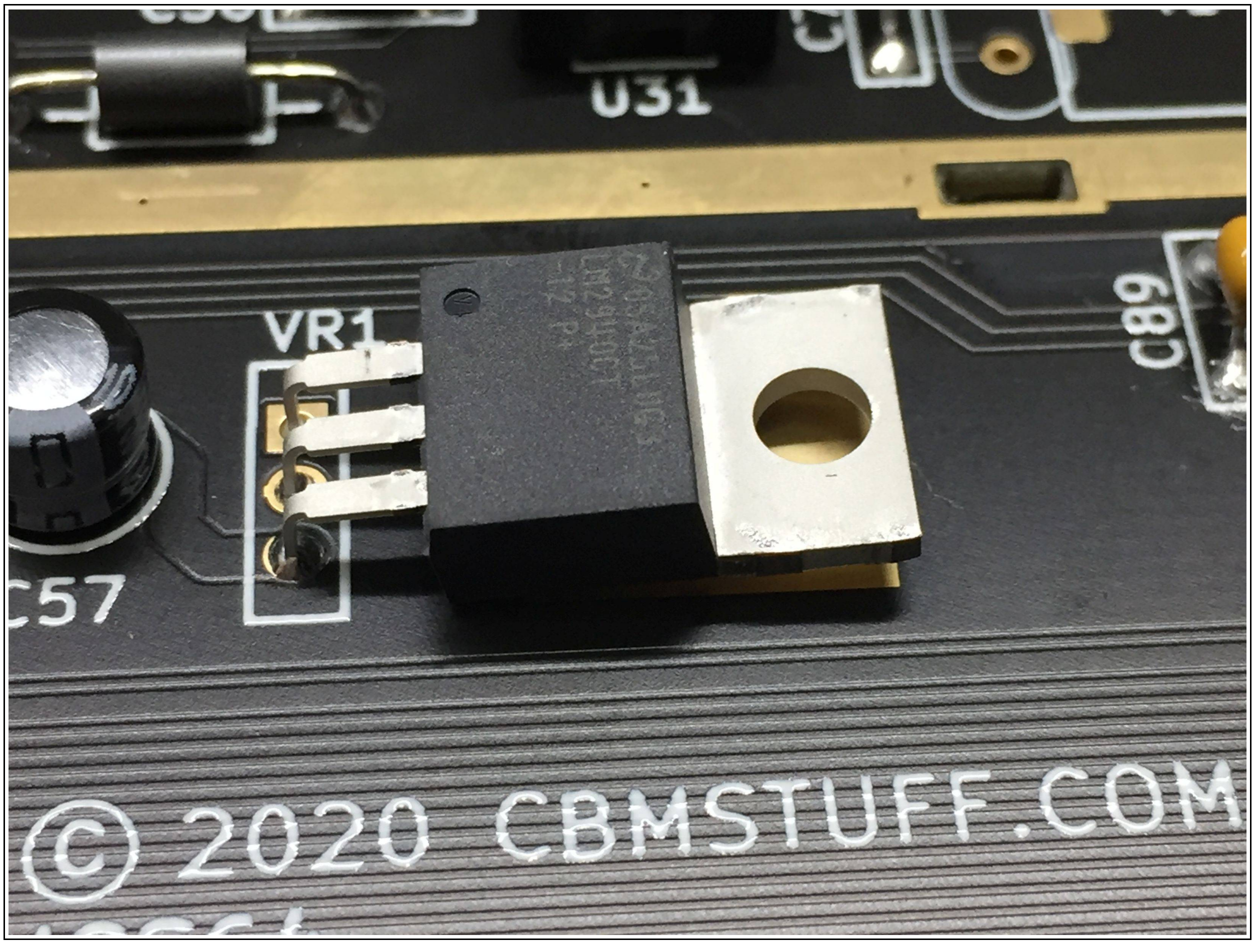

Figure 34 – VR1 placement

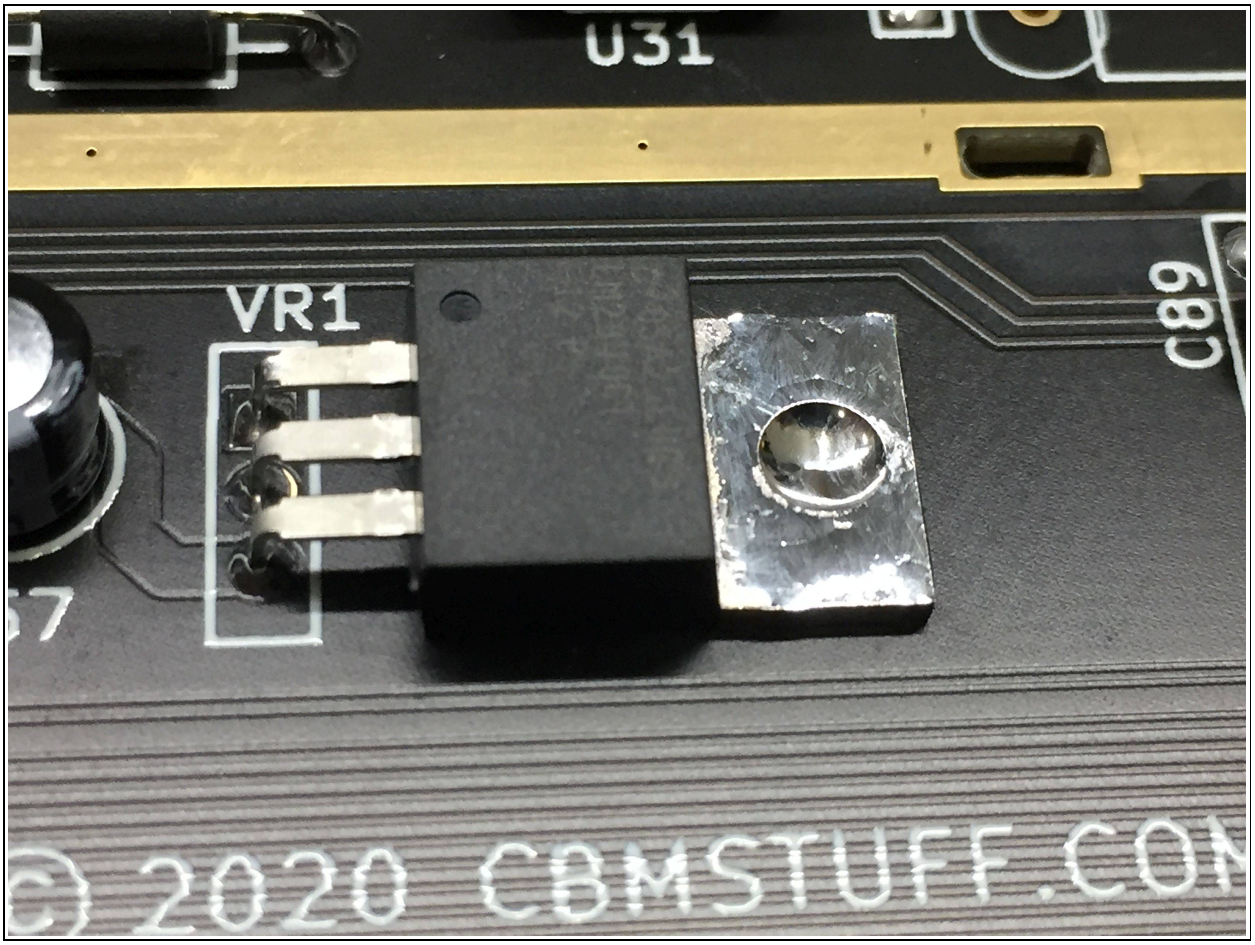

Figure 35 – VR1 soldered in place

Connectors & Headers

There are numerous headers used in the ICS64S board. These are necessary for certain features of the board. CN1 is a 20 pin header. You will need to remove one pin from the connector. That pin is the key for preventing the computer's keyboard connector from being inserted in reverse. See Figures 36 and 37 for details. CN1 will only go in the board one way, and requires the pin to be removed for it to fit. See Figure 38 for details. Install and solder the headers at CN1, CN10, J6, J1, INT IEC, J2, J3, J4, and J5. Make sure that the headers are straight out of the board, not tilted. **Special care must be taken when soldering J1 & J3 due to its close proximity to the SMT components. DO NOT get solder on any of the SMT components or the ICS64S will not function!**

The connectors can be purchased new, or you can use original connectors removed from a donor board. Insert and solder all of the connectors.

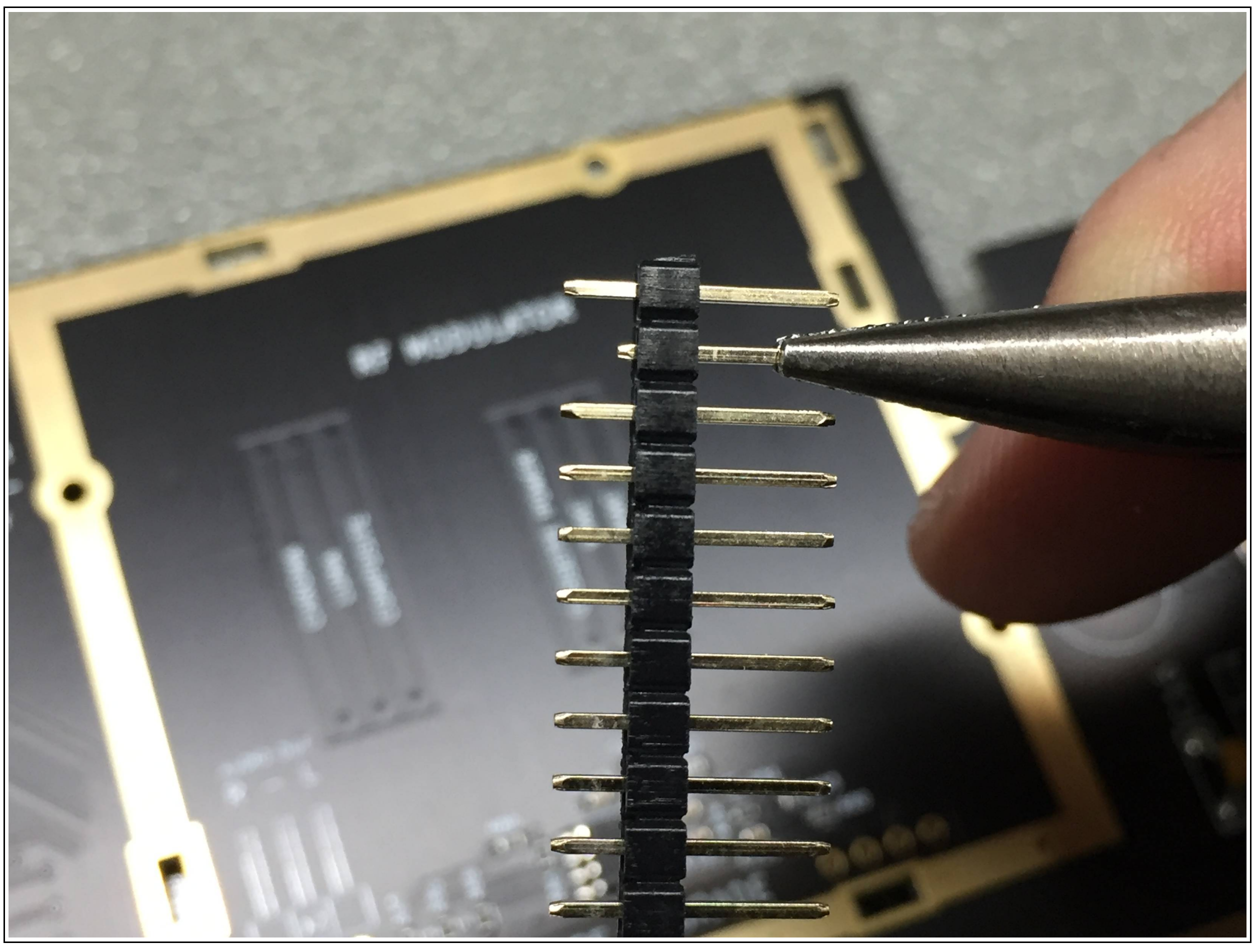

Figure 36 – Removing 2nd pin from header CN1

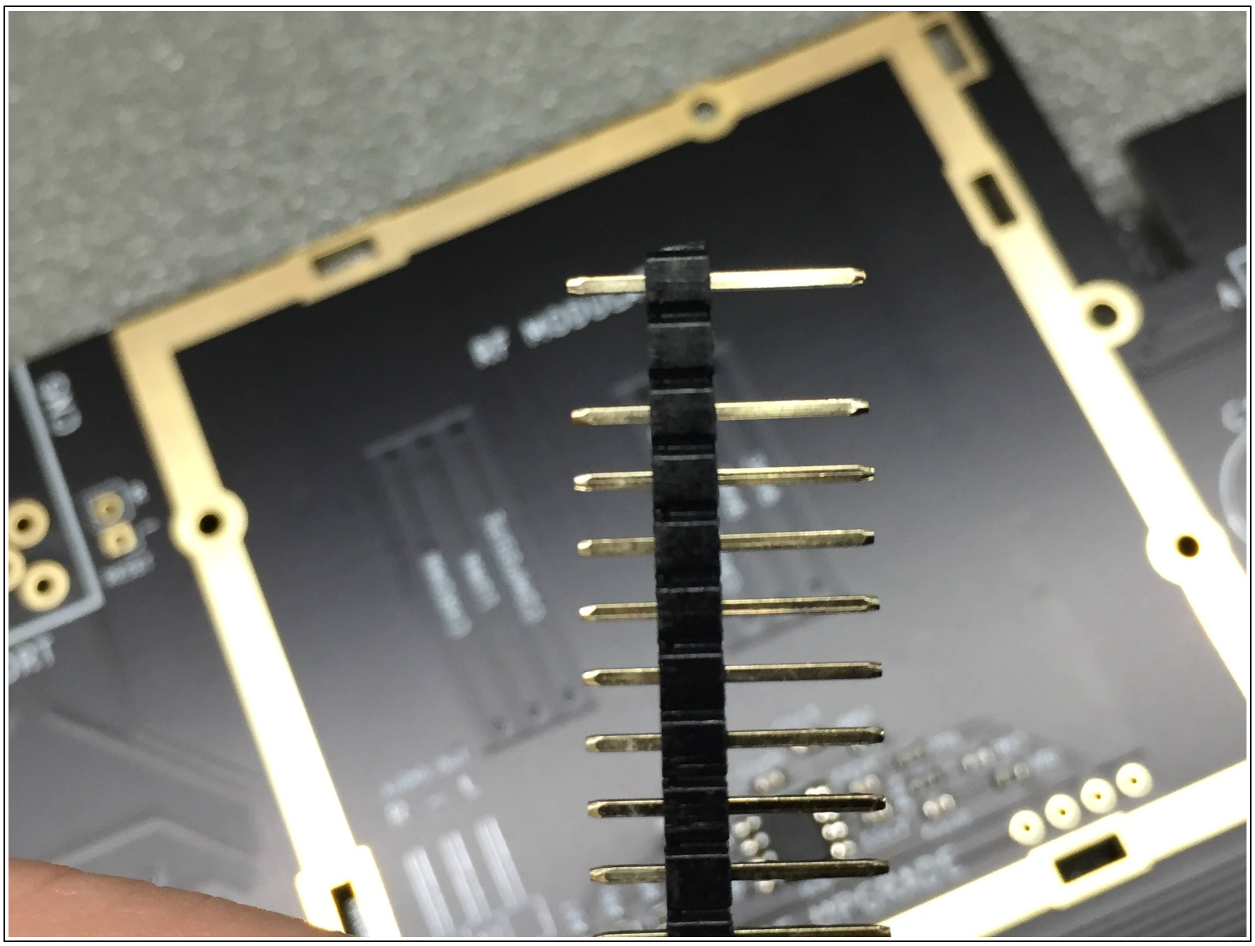

Figure 37 – 2nd pin removed from header CN1

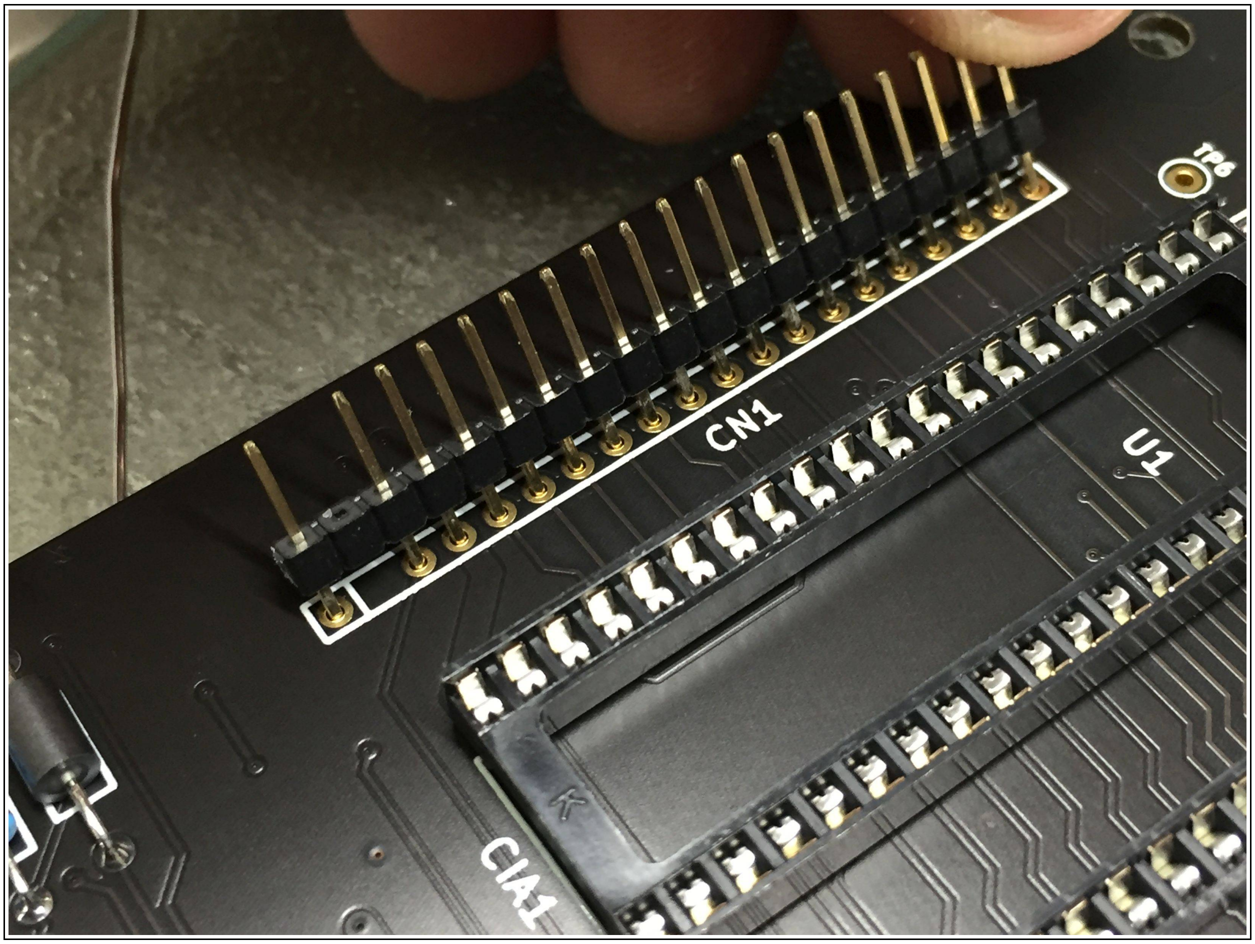

Figure 38 – Inserting header into CN1 location

Miscellaneous

Several components are unique so they are placed in the miscellaneous category. SW1 is the switch. These are relatively hard to find new, so it is not uncommon to use one from a donor board. The switch has 6 pins that need to be inserted into the holes as shown in Figures 39 and 40. Hold the switch in place with Plasti-Tak and solder the pins. See Figure 41 for details.

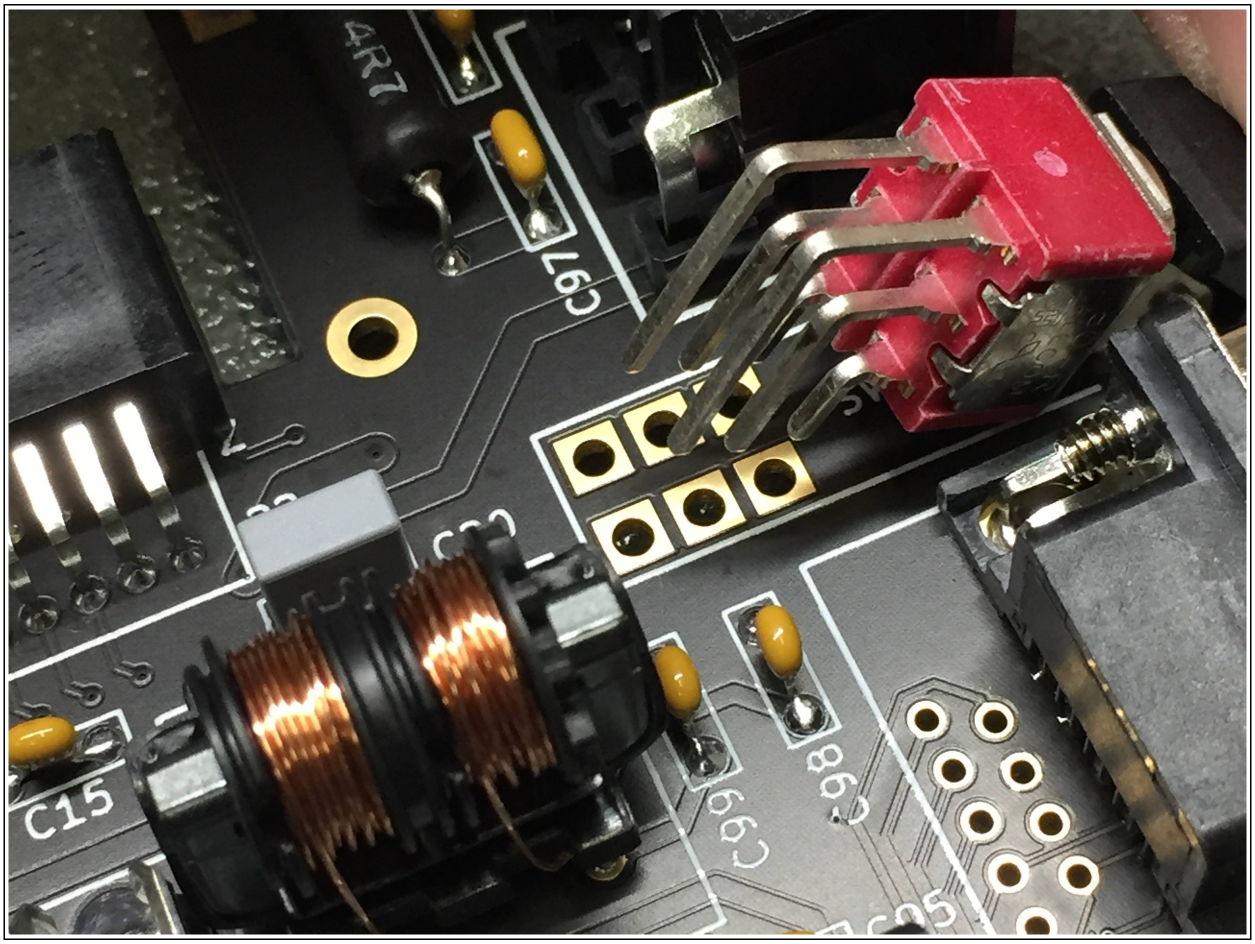

Figure 39 – Switch SW1 location

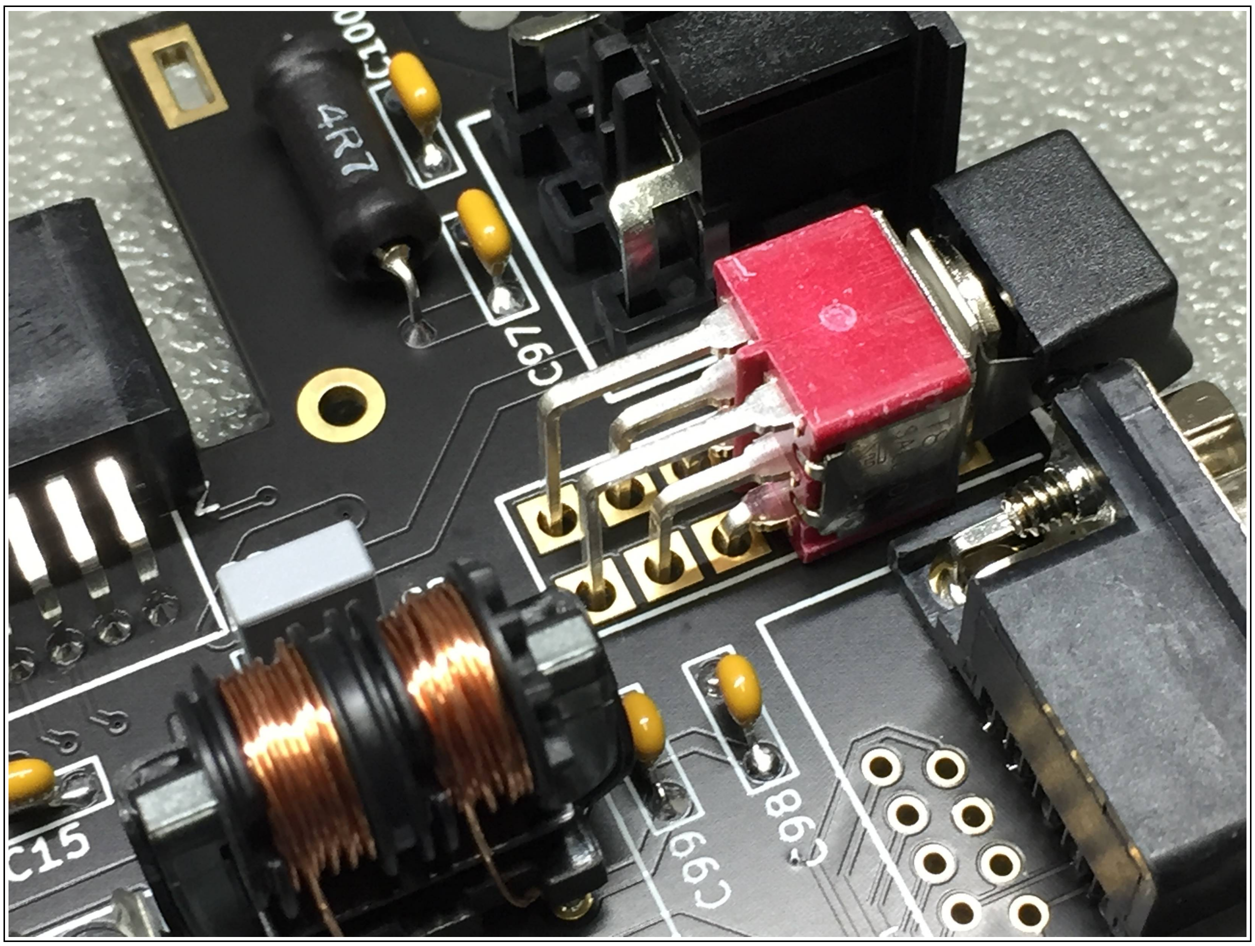

Figure 40 – Switch SW1 ready for soldering

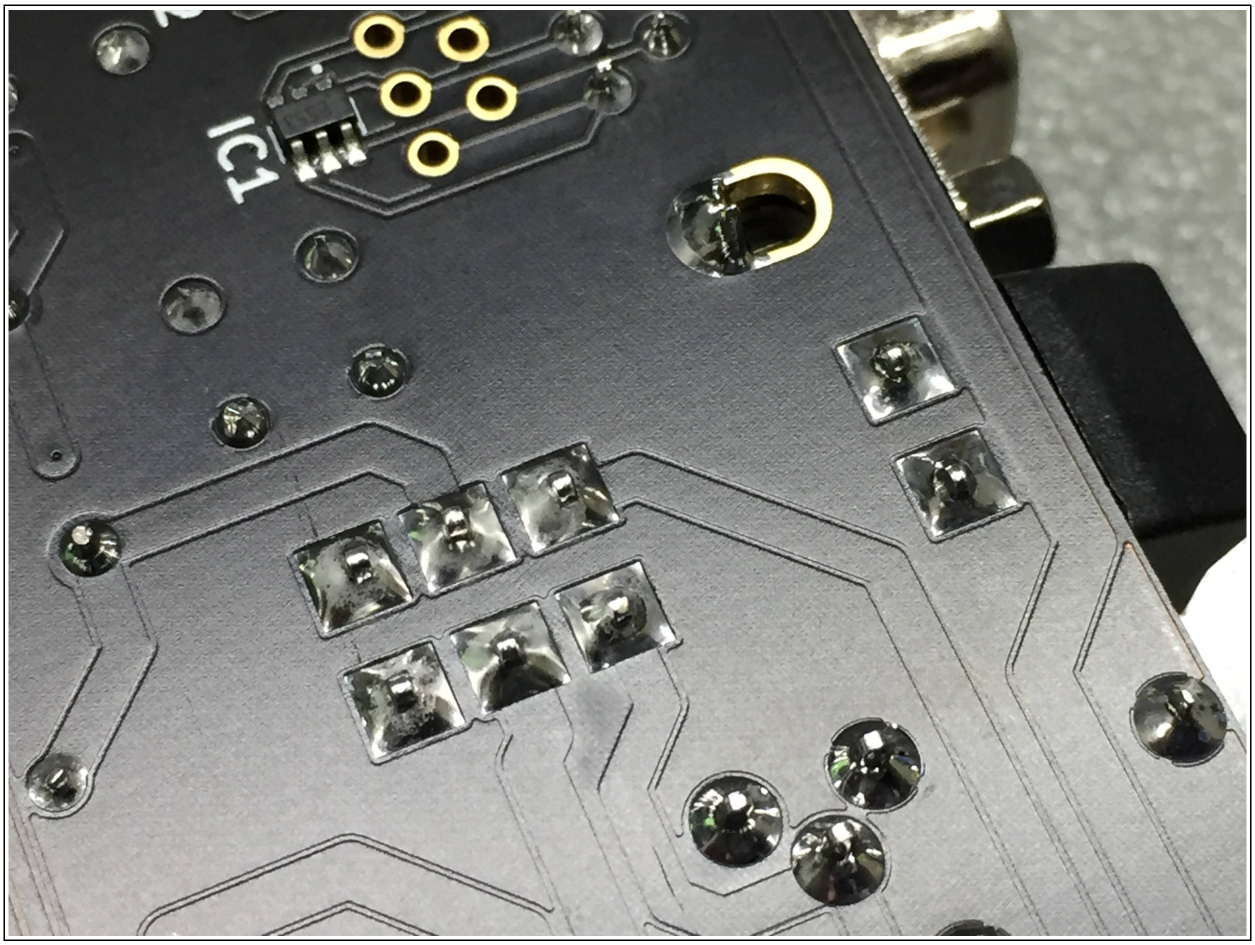

Figure 41 – Switch SW1 soldered in place

The fuse holder F1 is two pieces. Each piece has a portion with a barrier at one end to prevent the fuse from sliding out of the holder. The barrier should be placed so the furthest point is away from the fuse. The fuse holders have two tangs that pass through holes in the ICS64S board. The easiest way to solder this component is to assemble it with a fuse inserted into both halves. See Figures 42, 43, and 44 for details.

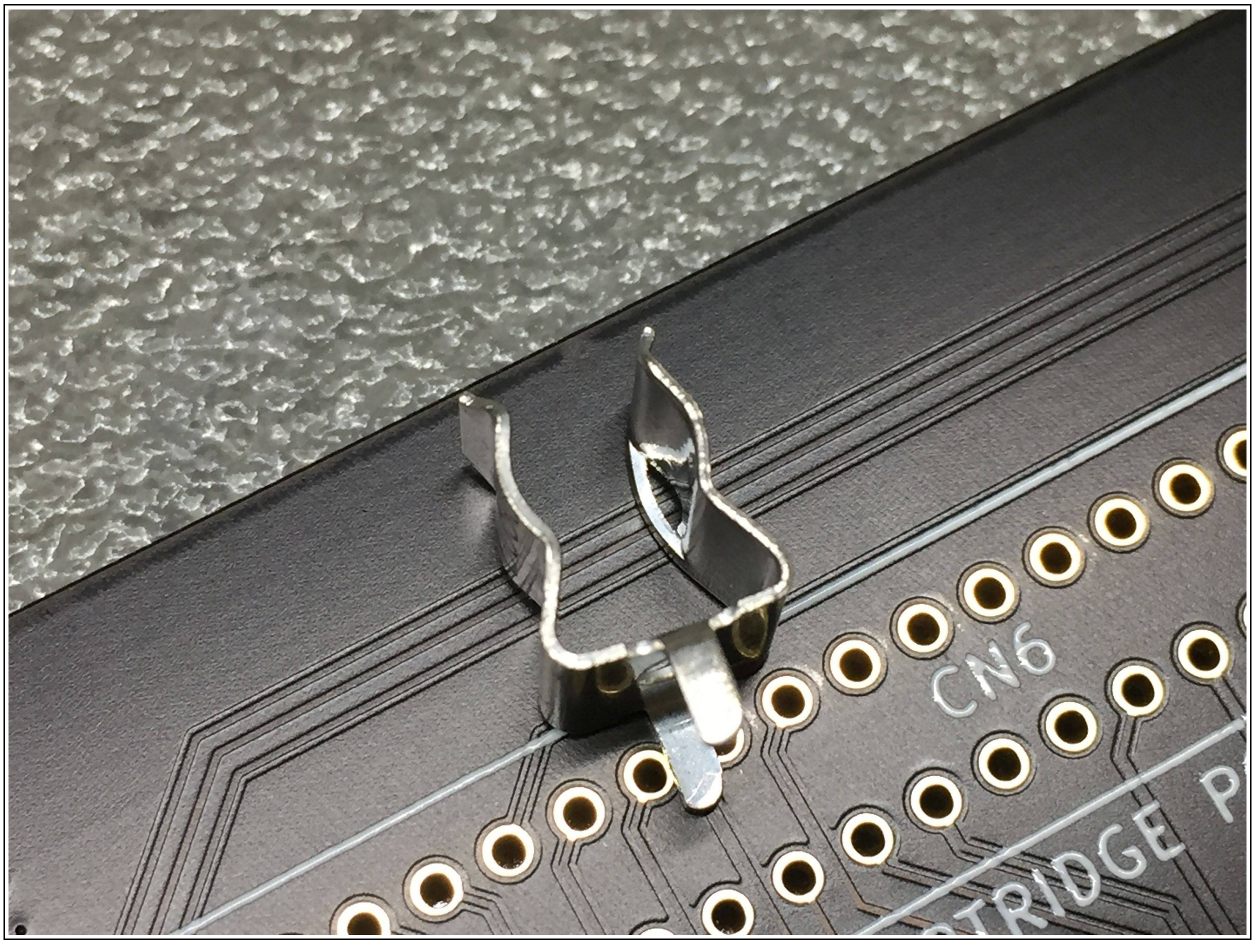

Figure 42 – One half of fuse holder F1

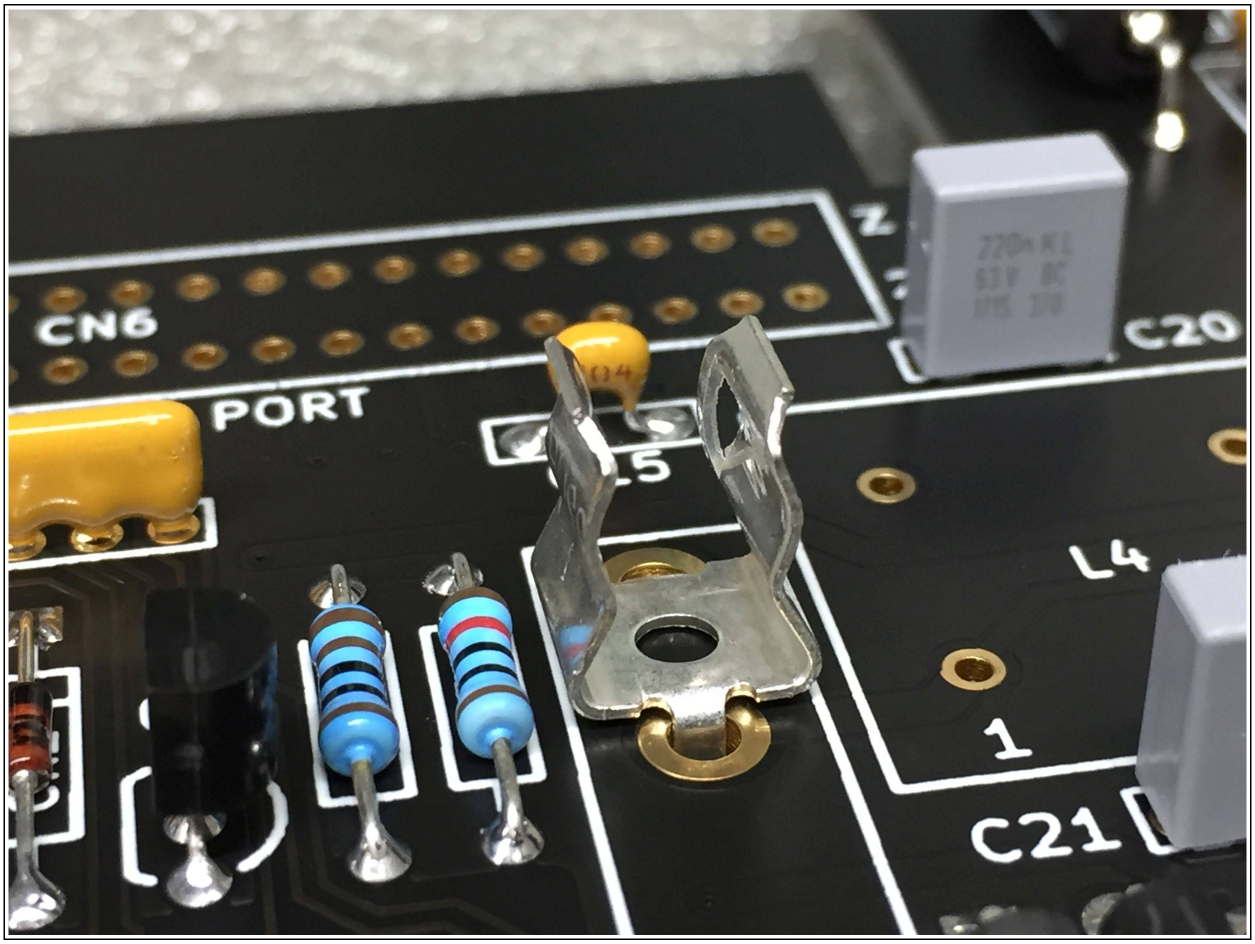

Figure 43 – Barrier of one half of F1 furthest from center of fuse

Figure 44 – F1 assembled with fuse

Insert the two F1 halves assembled with the fuse into the board. Use Plasti-Tak to hold it in place and solder the tabs. When you are done you can remove the fuse to inspect the soldering. If you need to adjust something and have to re-solder the tabs, re-insert the fuse to hold the assembly together. See Figure 45 for what the end result should look like.

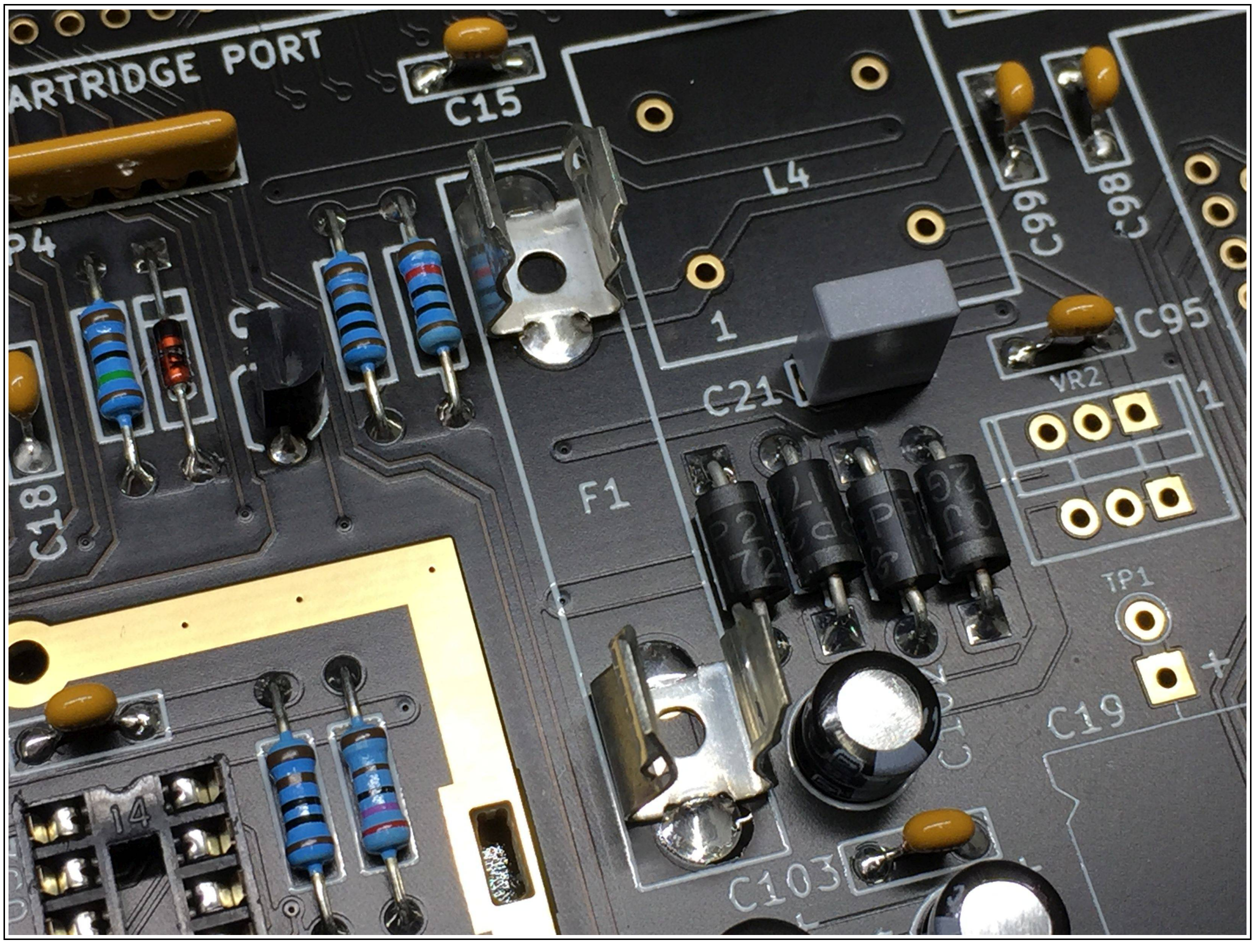

Figure 45 – Fuse holder soldered in place

The ICS64S has a special feature to greatly improved the current capability for USER PORT devices. If you plan on using any type of device plugged into the USER PORT, it is recommended that you insert a 330uH inductor into location L3. This in conjunction with C55 will provide a high current filtered 5 volt output on the USER PORT. If you do not plan on using USER PORT devices such as EPROM programmers, WiFi Modems, relay drivers, etc. then you can use a piece of 22 awg wire instead. A clipped lead from one of the ferrite beads will work well. See Figures 46 and 47 for the options you can use in location L3. You will need to use one of the two options.

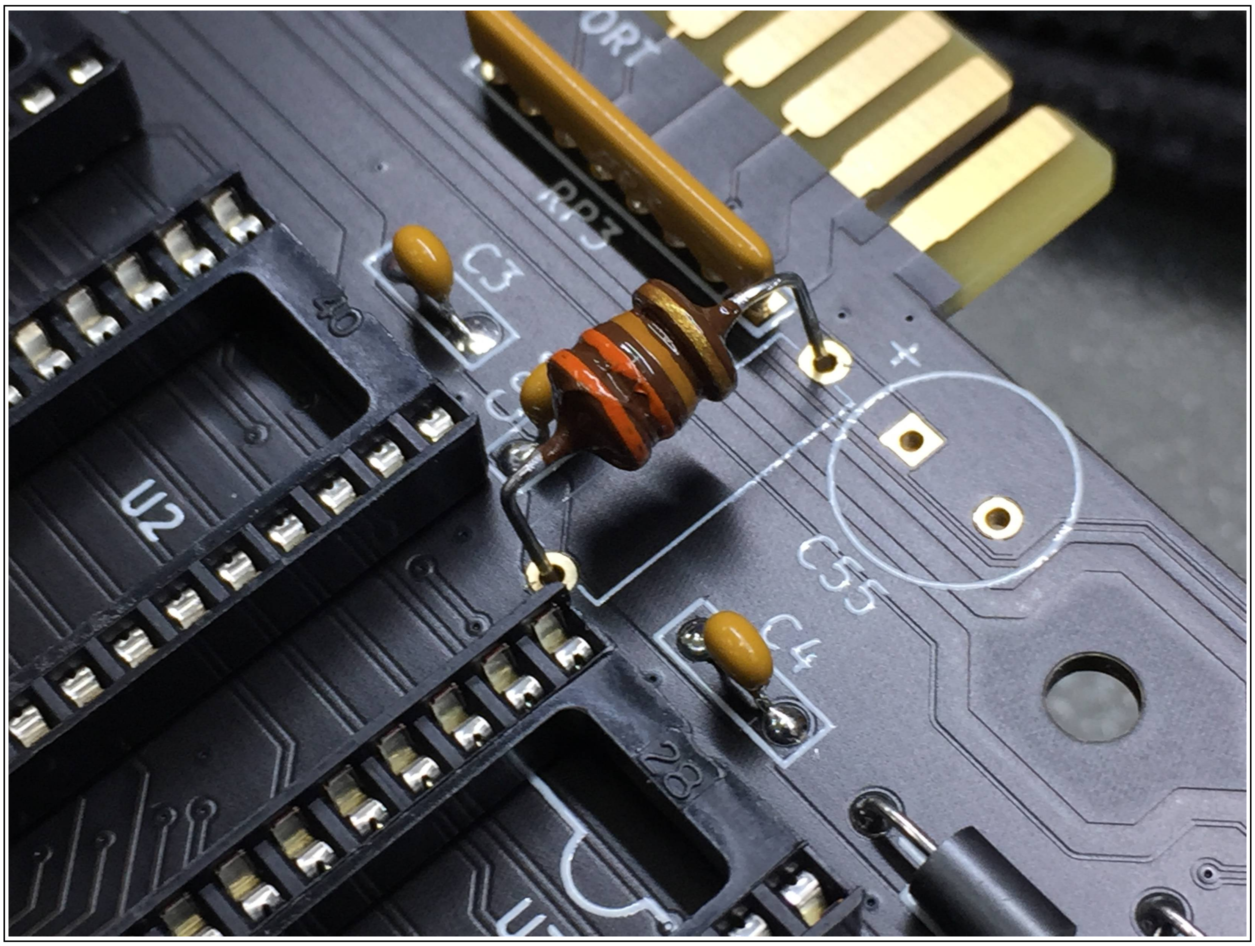

Figure 46 – 330uH inductor

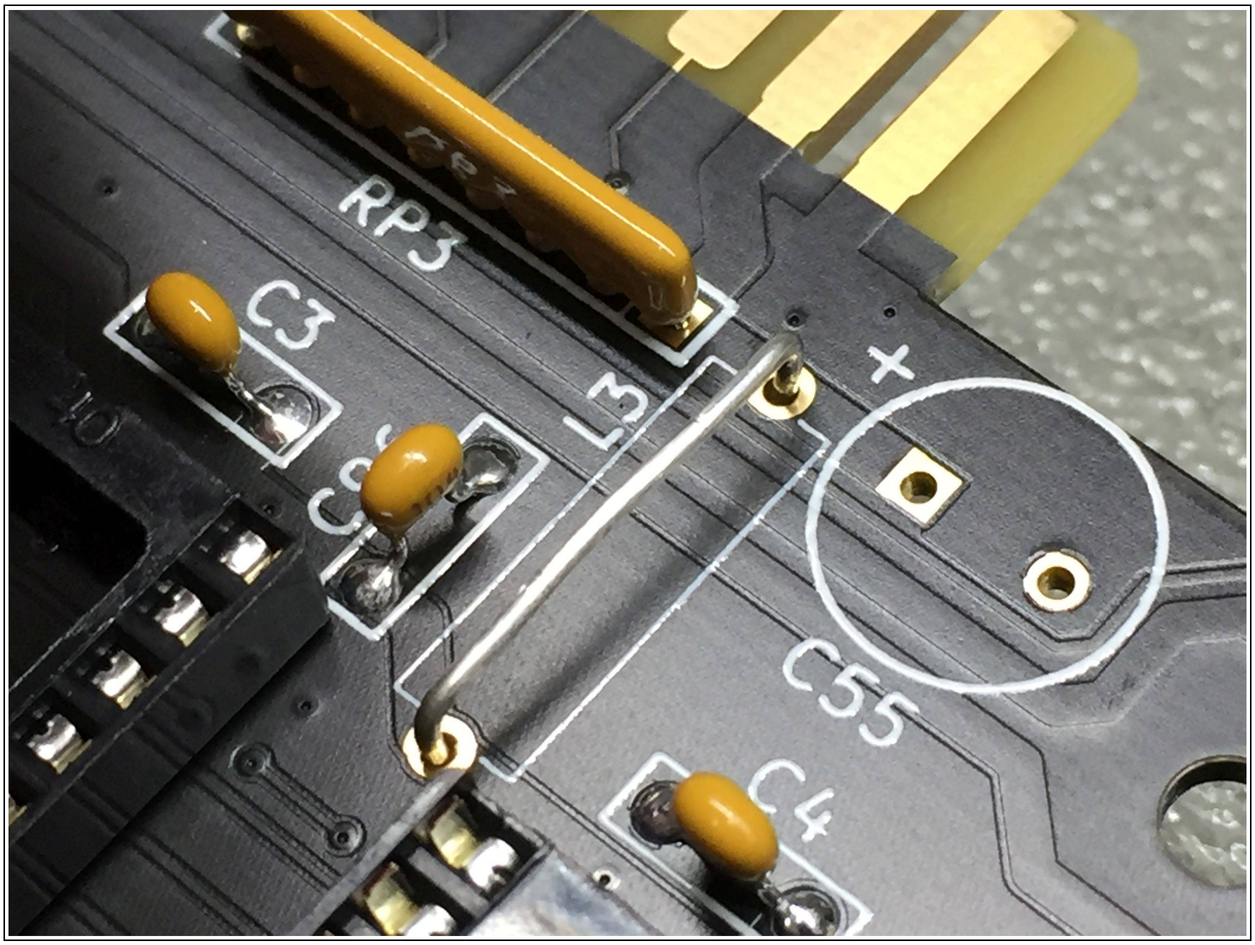

Figure 47 – Solid wire used instead of inductor

There is one large choke located at L4. These can be purchased new, but they are relatively expensive. Salvaging one from a donor board will be a good idea! See Figure 48 for what a new one looks like.

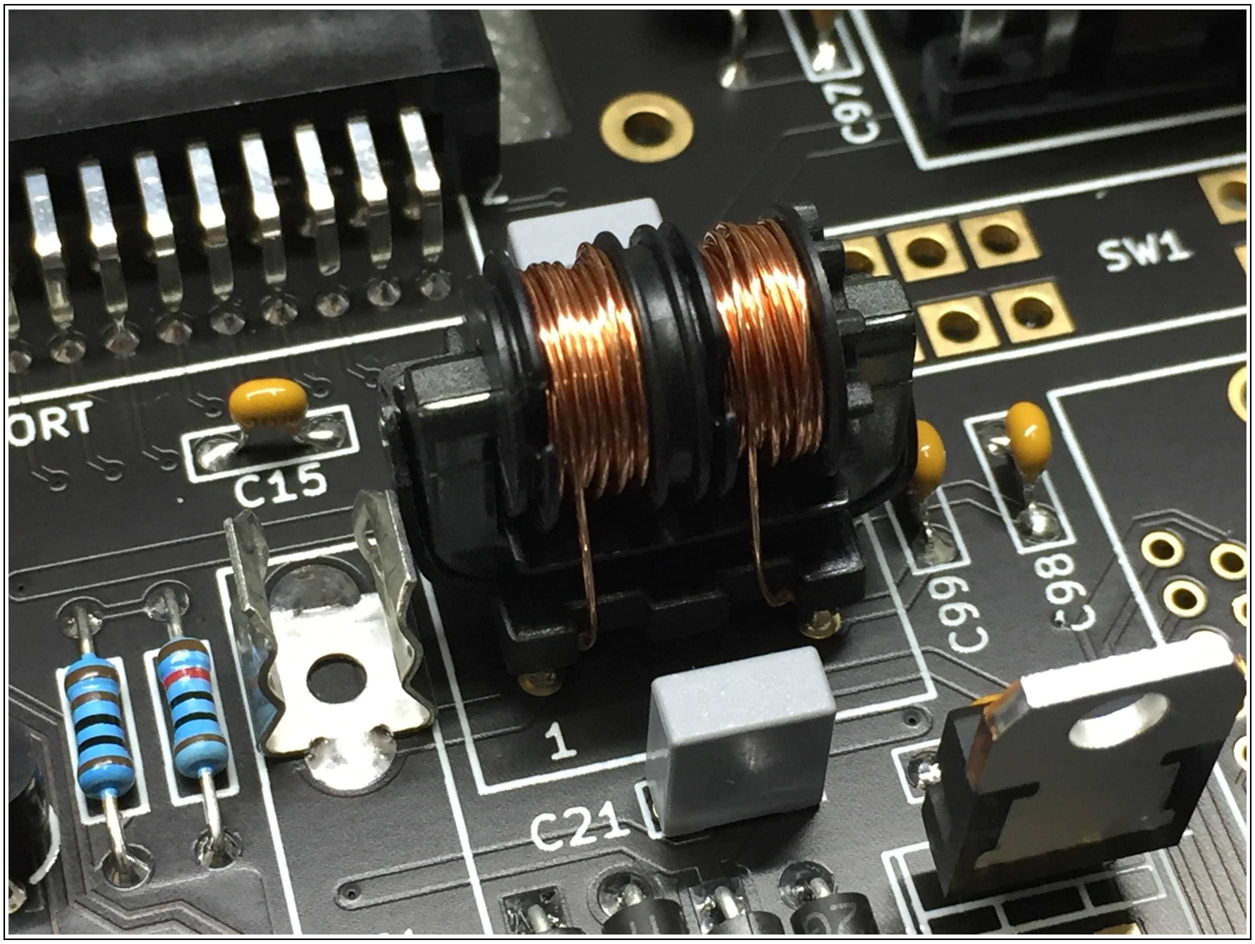

Figure 48 – New choke installed at L4

The last miscellaneous component to install is the 500 ohm potentiometer R27. This is a 3 pin package that must be oriented correctly. See Figure 49 for details.

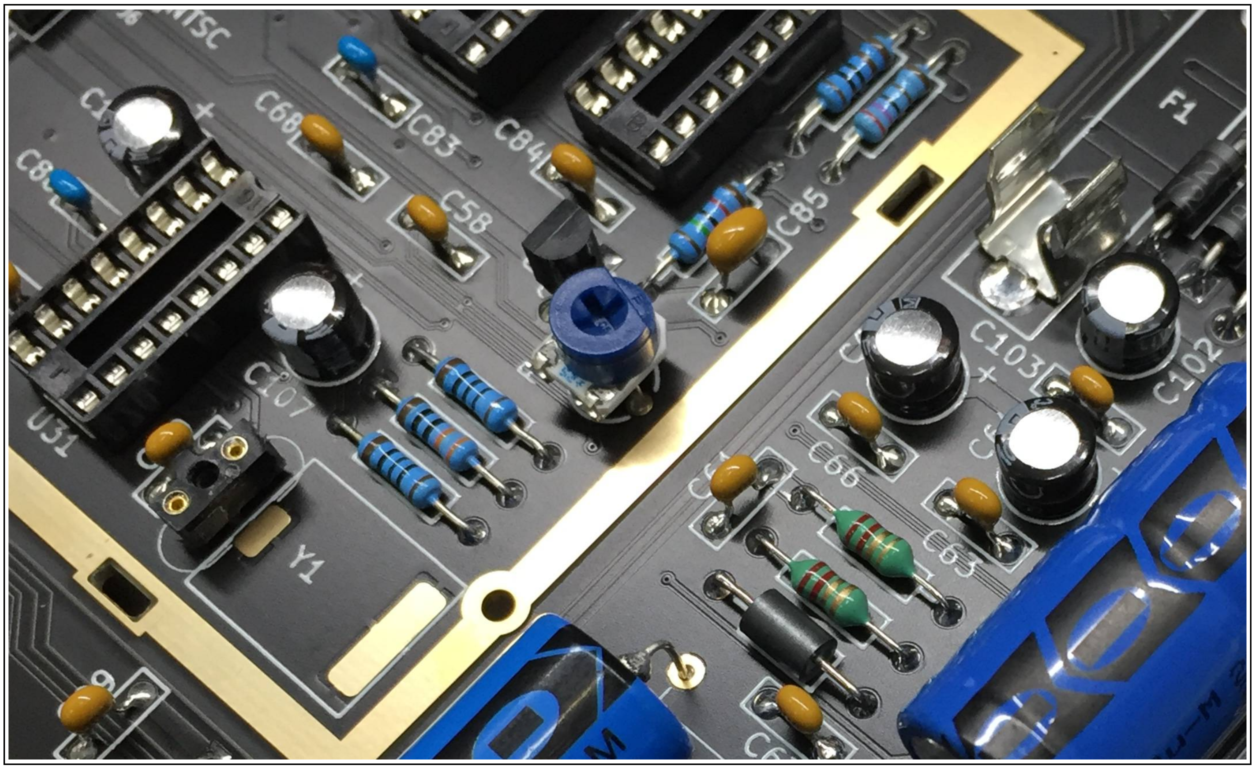

Figure 49 – R27 orientation

Large Capacitors

You're almost done with the build! This is the last bunch of components that need to be soldered! All of the remaining capacitors are electrolytics, so they have a polarity that needs to be correct. Start with the two 100uf capacitors. Place the side opposite of the negative (-) band into the hole that has the positive (+) symbol next to it. Solder these and trim the leads.

Next is the optional (but highly recommended) 330uf capacitor. The same applies for this capacitor as well. Locate the negative (-) band and place the opposite side's lead into the positive (+) hole. Solder and trim the leads.

C88 and C90 are axial capacitors. These lay flat on the board. Because they are axial they are a bit more tricky to determine which end is positive and negative. The negative (-) band is an arrow that points to which end is negative. The opposite end is positive (+). You need to place the positive side of the capacitor into the hole that is marked positive (+). In the proper orientation, the negative arrows should point to the back of the board. You should try to bend the leads 90 degrees from the capacitor to the hole. See Figure 50 and 51 for details. Solder and trim the leads.

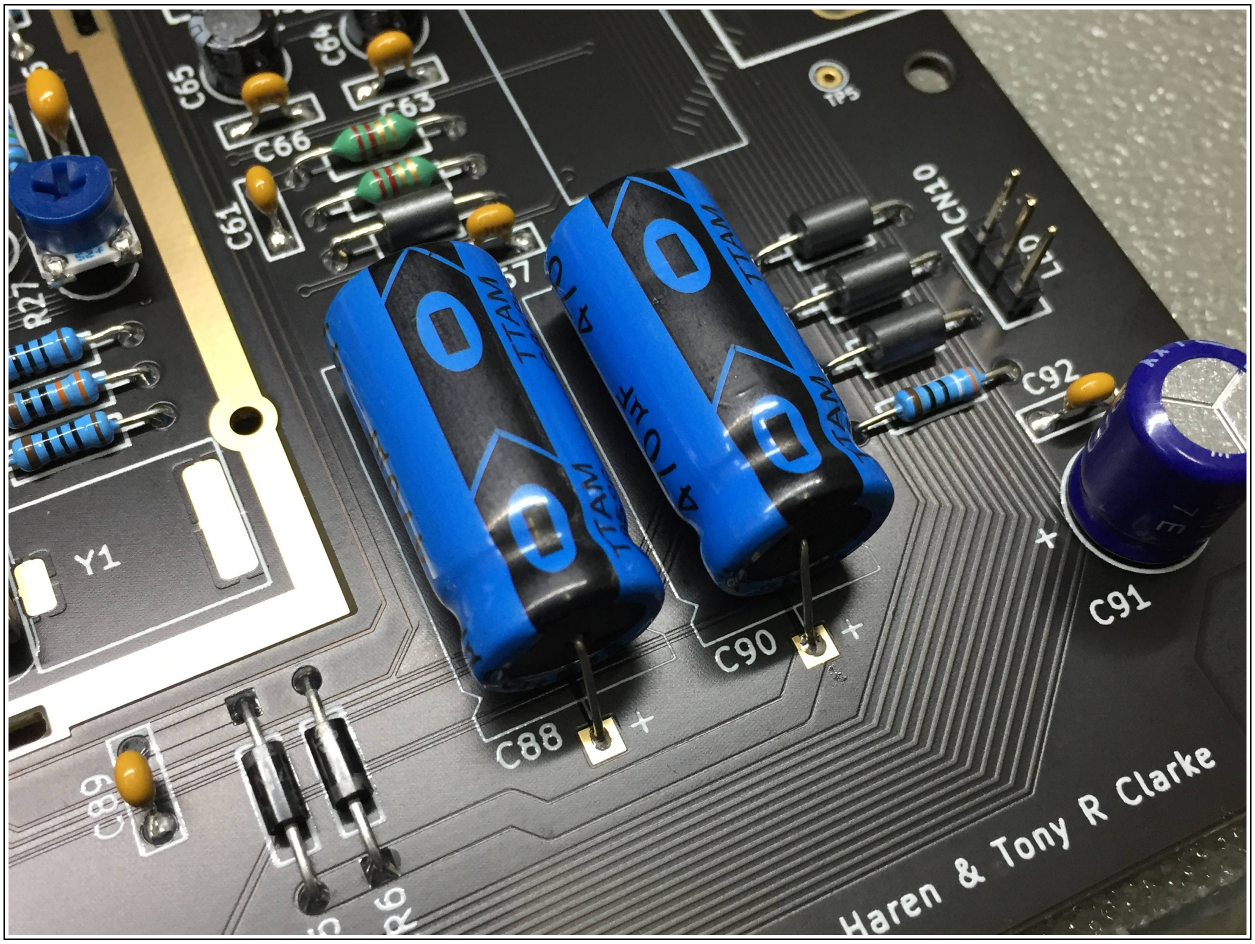

Figure 50 – C88 and C90 (-) arrows points away from (+)

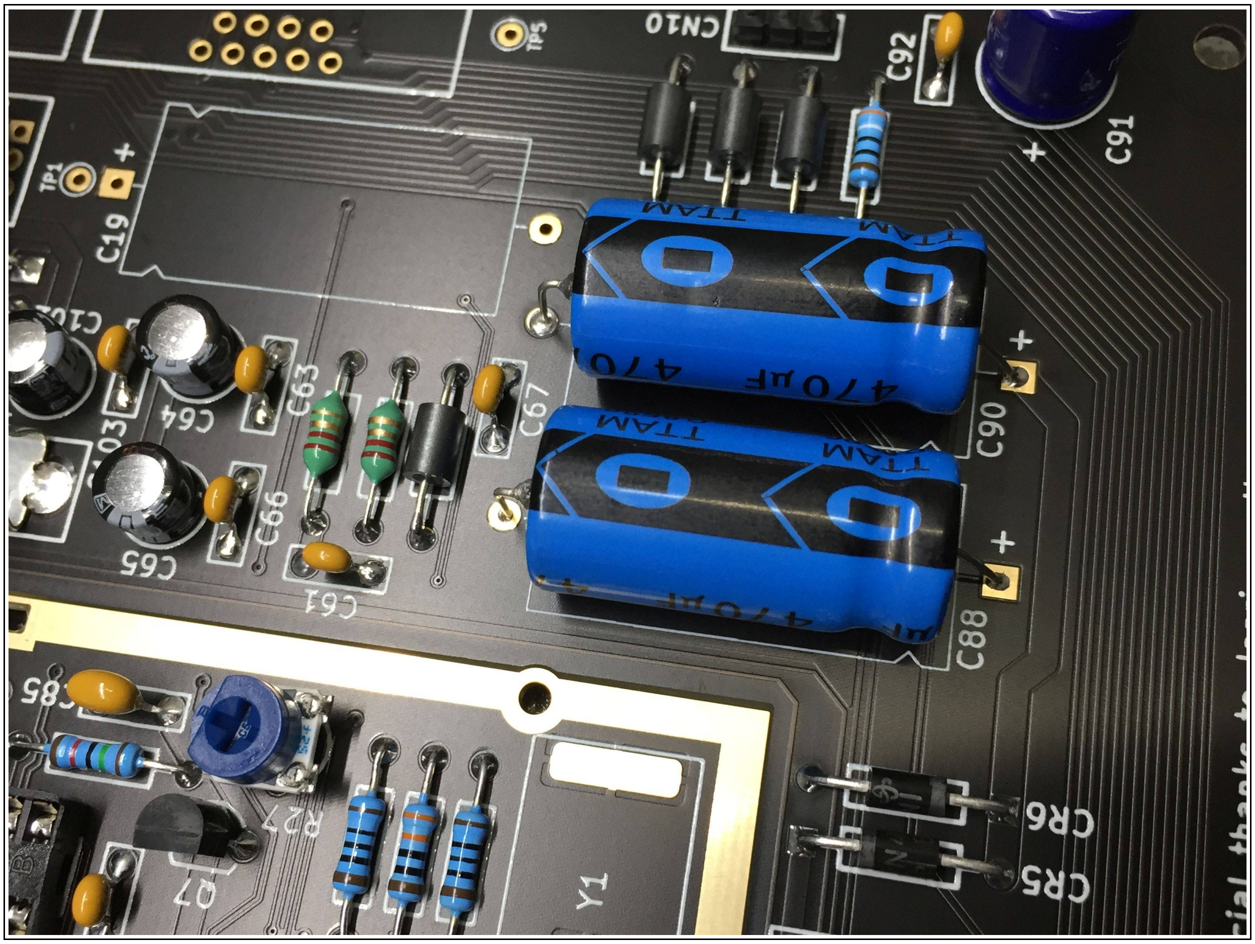

Figure 51 – C88 and C90 soldered in place

Here it is! The very last part to solder! C19 is the large 2200uf capacitor. It is also polarized like C88 and C90, with the side of the capacitor having an arrow to indicate which end is negative (-). Place the opposite end lead into the hole marked positive (+). In the proper orientation, the positive lead will be towards the back of the board. See Figure 52 for details. Solder and trim the leads.

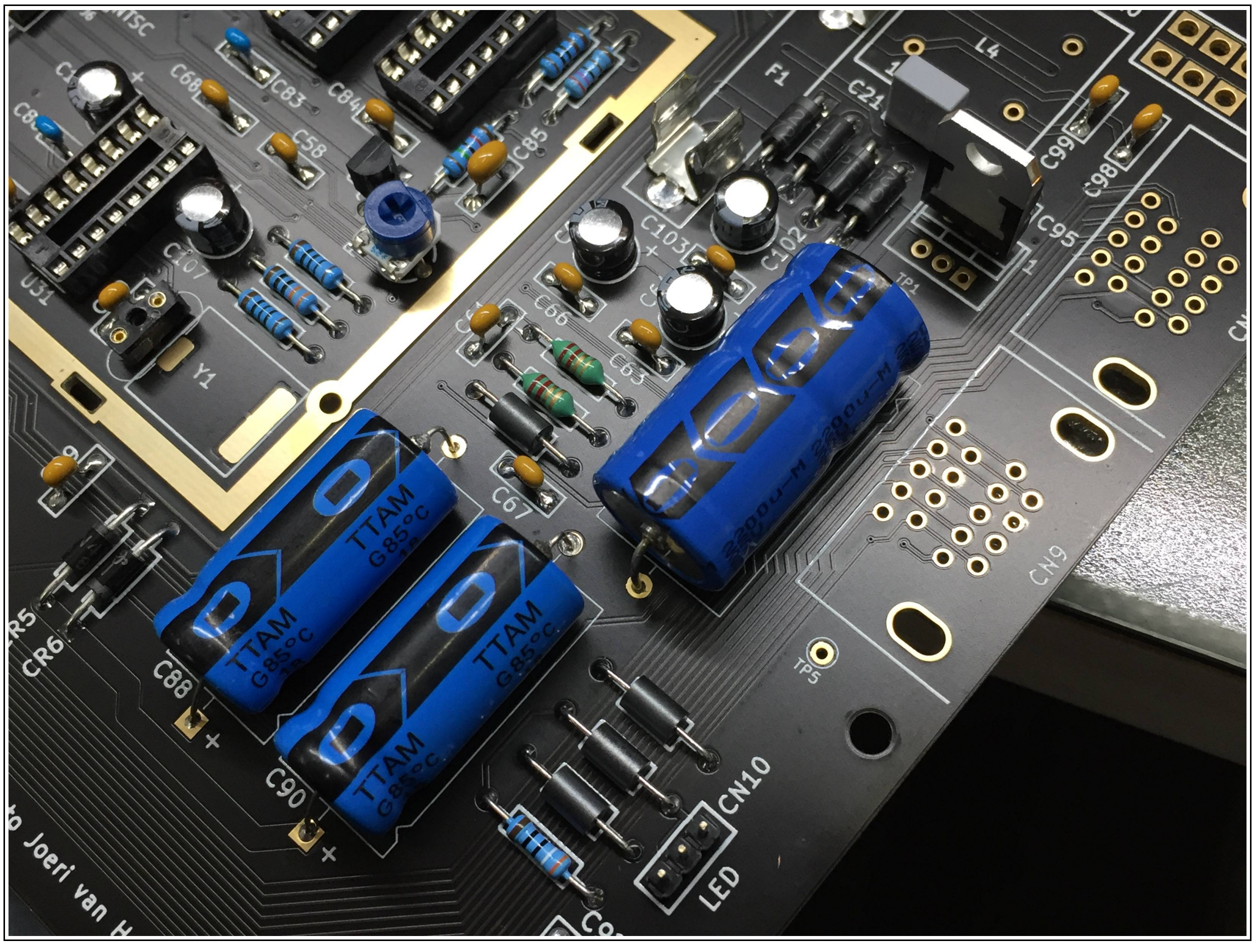

Figure 52 – C19 soldered in place

SECTION 3 – BOARD CONFIGURATION

The back of the ICS64S board has all of the solder bridge pads for the various configuration options. You can select options by bridging "solder jumpers". These are pads where solder is bridged across two points to make a connection. Bridging is a simple process. You just melt solder on to each pad and then apply a little more solder between the two pads and quickly remove the tip of your soldering iron. Solder will flow between both pads and there will be a mound of solder that connects the two pads together electrically.

Selecting the ROMs

BASIC and CHARACTER ROMs you can either the original 24 pin ROMs, or 28 pin EPROMs. In this example, we will use the stock ROMs. If you look at the back of the ICS64S board you will find CHAR, KERNAL, and BASIC labeled. Let's start with the CHARACTER ROM. As the silkscreen info states, when using a 2332 ROM (which is what the stock CHARACTER ROM is) you will need to bridge the center pad of JP10 to the "24" side (meaning a 24 pin ROM). JP11 also needs to be bridged from the center pad to the "24" side, and JP12 needs to be "CLOSED" (bridged). See Figures 53 and 54 for details.

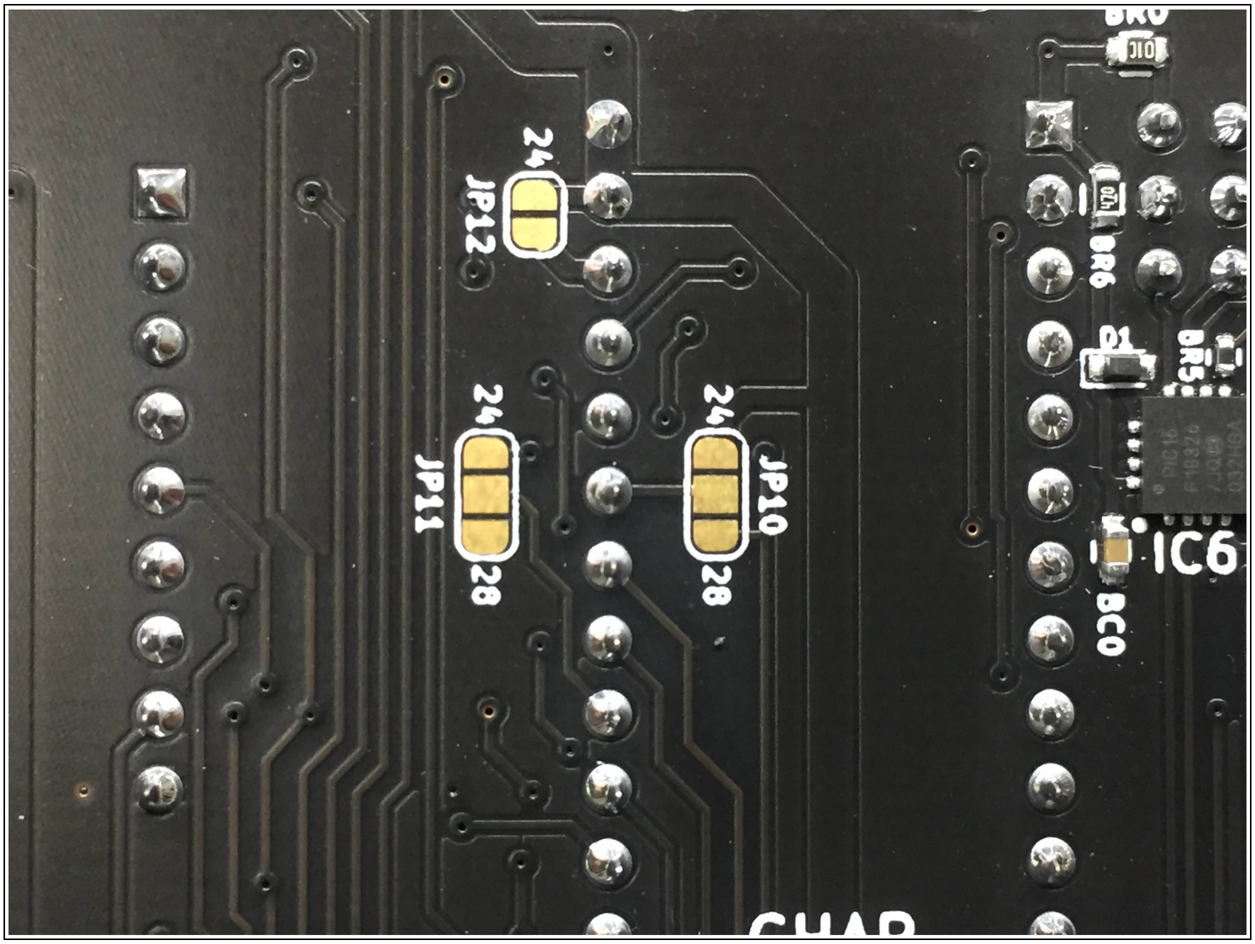

Figure 53 – CHAR ROM solder bridge locations

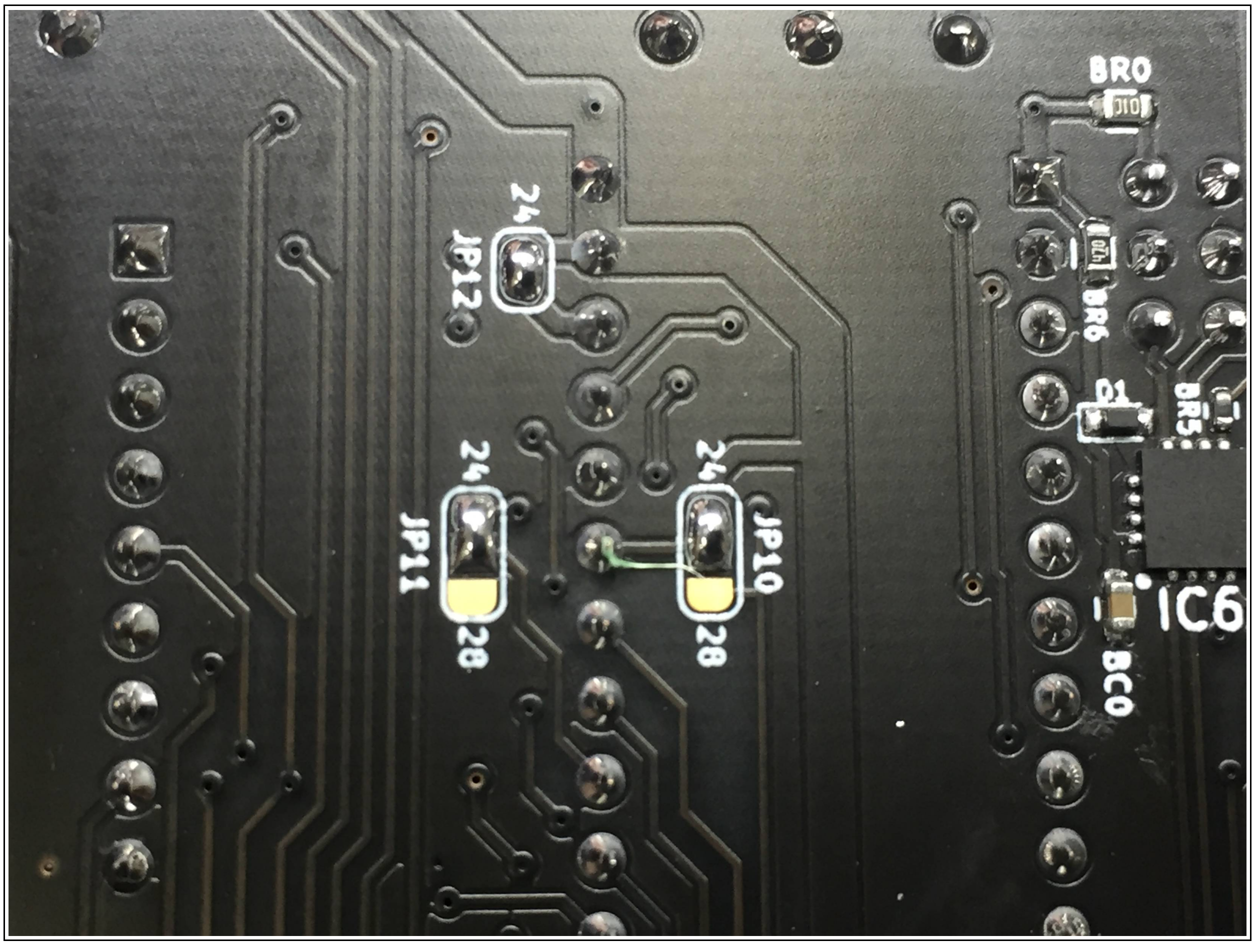

Figure 54 – CHAR ROM solder bridged for stock ROM

The BASIC ROM type is selected using the same method as the CHARACTER ROM. As the silkscreen info states, when using a 2364 ROM (which is what the stock BASIC ROM is) you will need to bridge the center pad of JP4 to the "24" side (meaning a 24 pin ROM). JP5 also needs to be bridged from the center pad to the "24" side, and JP6 needs to be "CLOSED" (bridged). See Figures 55 and 56 for details.

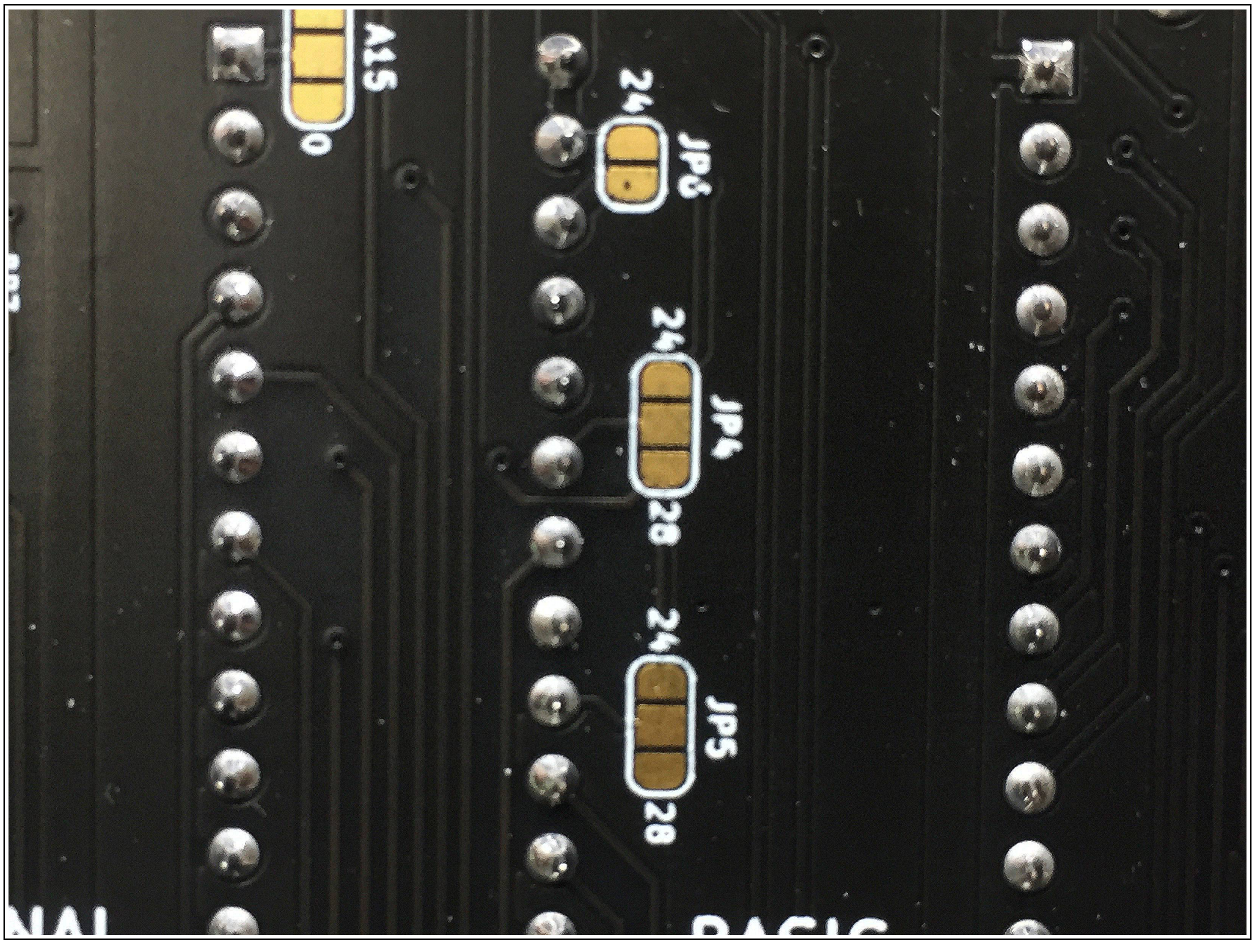

Figure 55 – BASIC ROM solder bridge locations

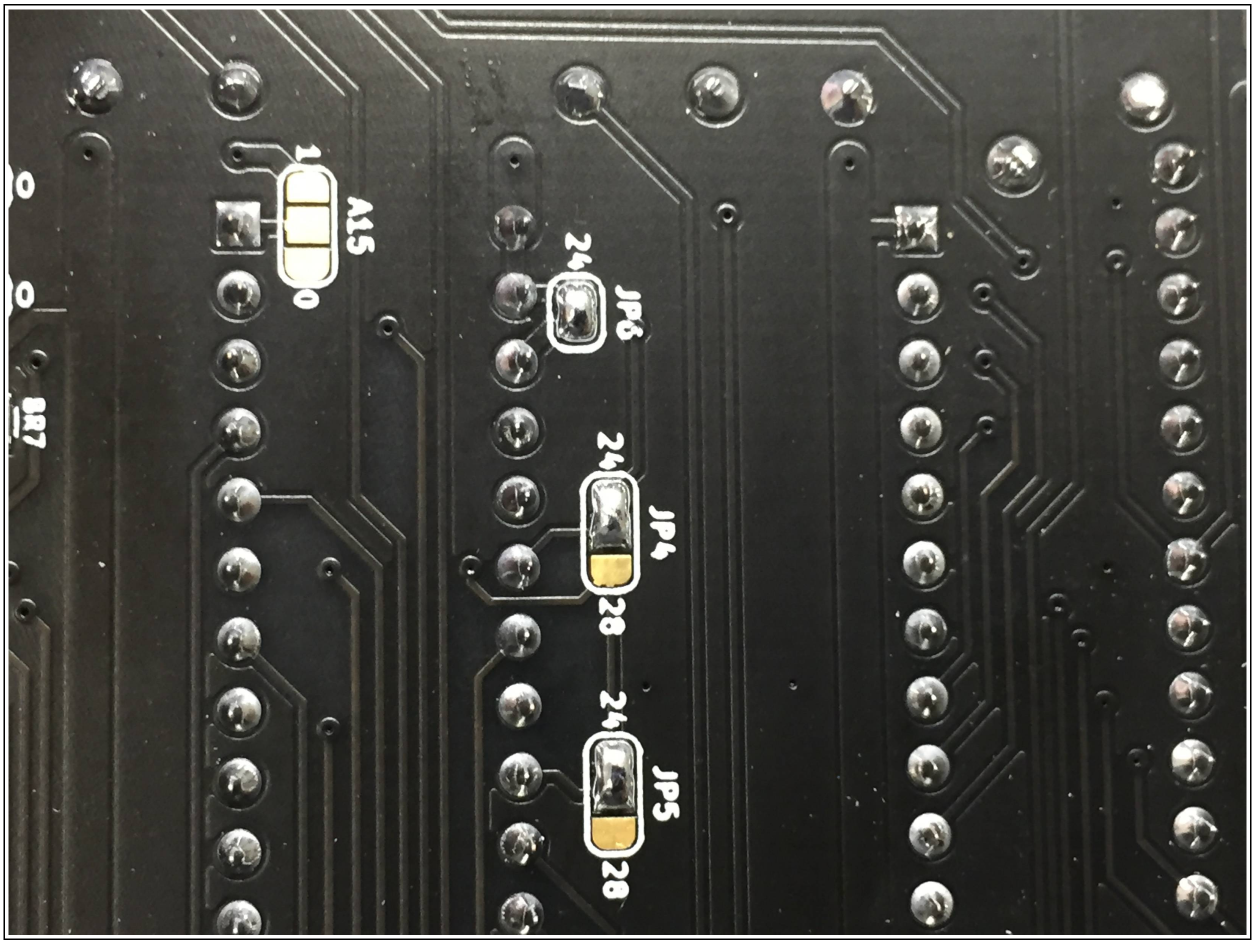

Figure 56 – BASIC ROM solder bridged for stock ROM

You can use 2764 compatible EPROMs for the CHARACTER and BASIC ROMs if you want to. In those cases, you would simply bridge the solder pads on the "28" side instead of the "24" side, and you would leave the the individual jumpers OPEN.

The KERNAL ROM must be an EPROM. **The original 2364 ROM can not be used**. You can use any size EPROM from 8K (2764) up to 512K (27512). The larger the ROM, the more KERNAL ROM images you can select from. The KERNAL ROM is 8K in size. So, with a 27512 EPROM you can have up to 8 different KERNAL ROM images to choose from. The KERNAL ROM images can be the stock ROM, the SX-64 ROM, Jiffy-DOS, Magnum Load, Turbo ROM, etc. Unless you have a reason to bypass the electronic KERNAL ROM switching capability, you should not bridge the solder pads at A13, A14, or A15. These are overrides only, and should not be used in normal conditions. See Figure 57 for details.

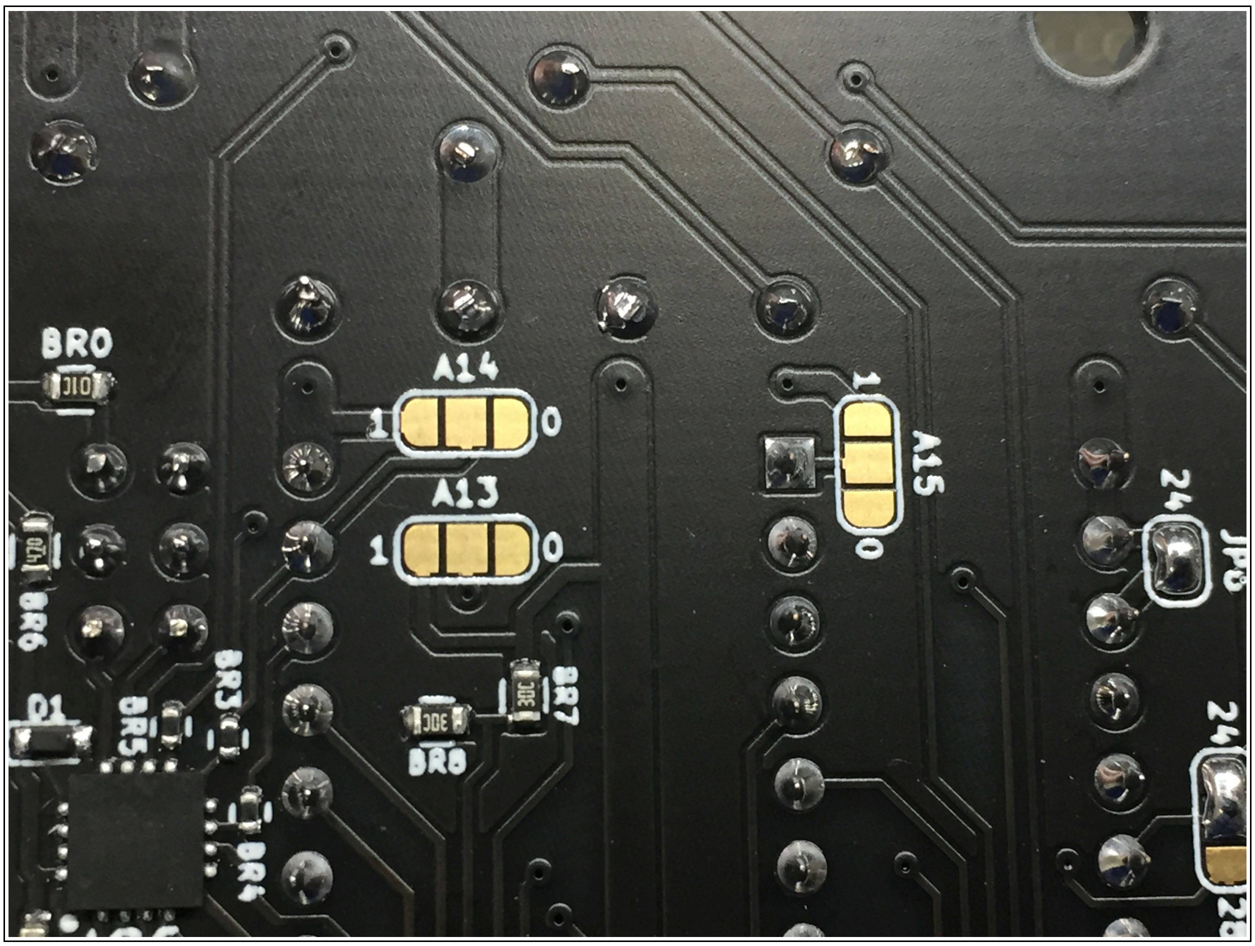

Figure 57 – Leave solder pads A13, A14, and A15 all open

Selecting VIC-II Power

You can use either the older 65xx series VIC-II chips, or the newer 85xx VIC-II chips. The 65xx series uses 12 volts for the main power. The 85xx series uses only 5 volts for the main power. **MAKE SURE YOU GET THIS RIGHT OR YOU CAN DESTROY YOUR VIC-II CHIP!**

***** NOTE *** BY DEFAULT THERE IS A CONNECTION BETWEEN THE 12V PAD AND THE CENTER PAD OF JP3! IF YOU PLAN ON USING A 856x VIC-II CHIP, YOU MUST CUT THE TRACE BETWEEN THESE TWO PADS!**

In this example we are using a NTSC 6567 VIC-II chip, so it uses 12 volts for power. Technically, it is already jumpered for the 65xx VIC-II chips so you don't really need to add a solder bridge. See Figures 58 and 59 for details.

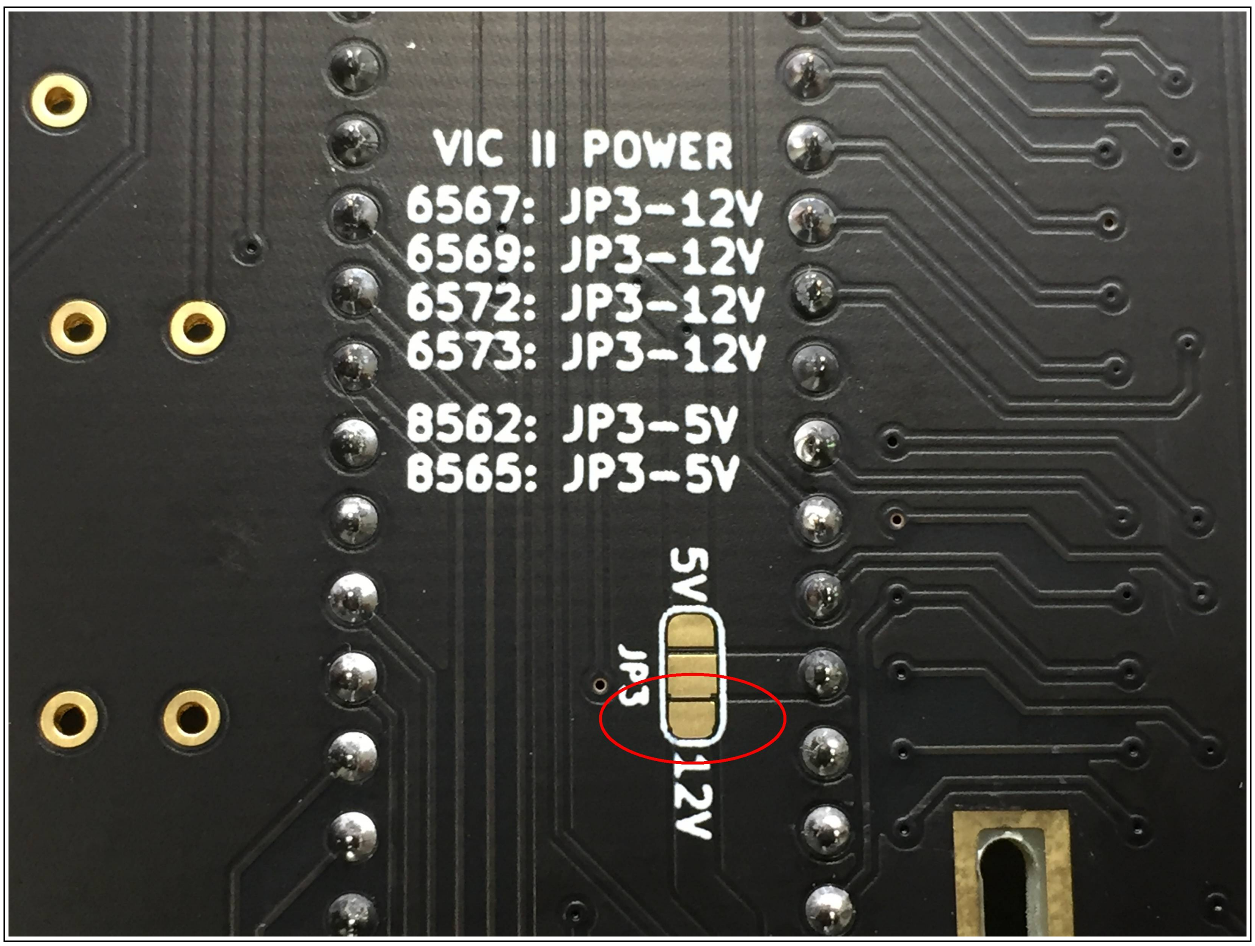

Figure 58 – VIC-II power solder bridge location (cut trace for 856x VIC-II)

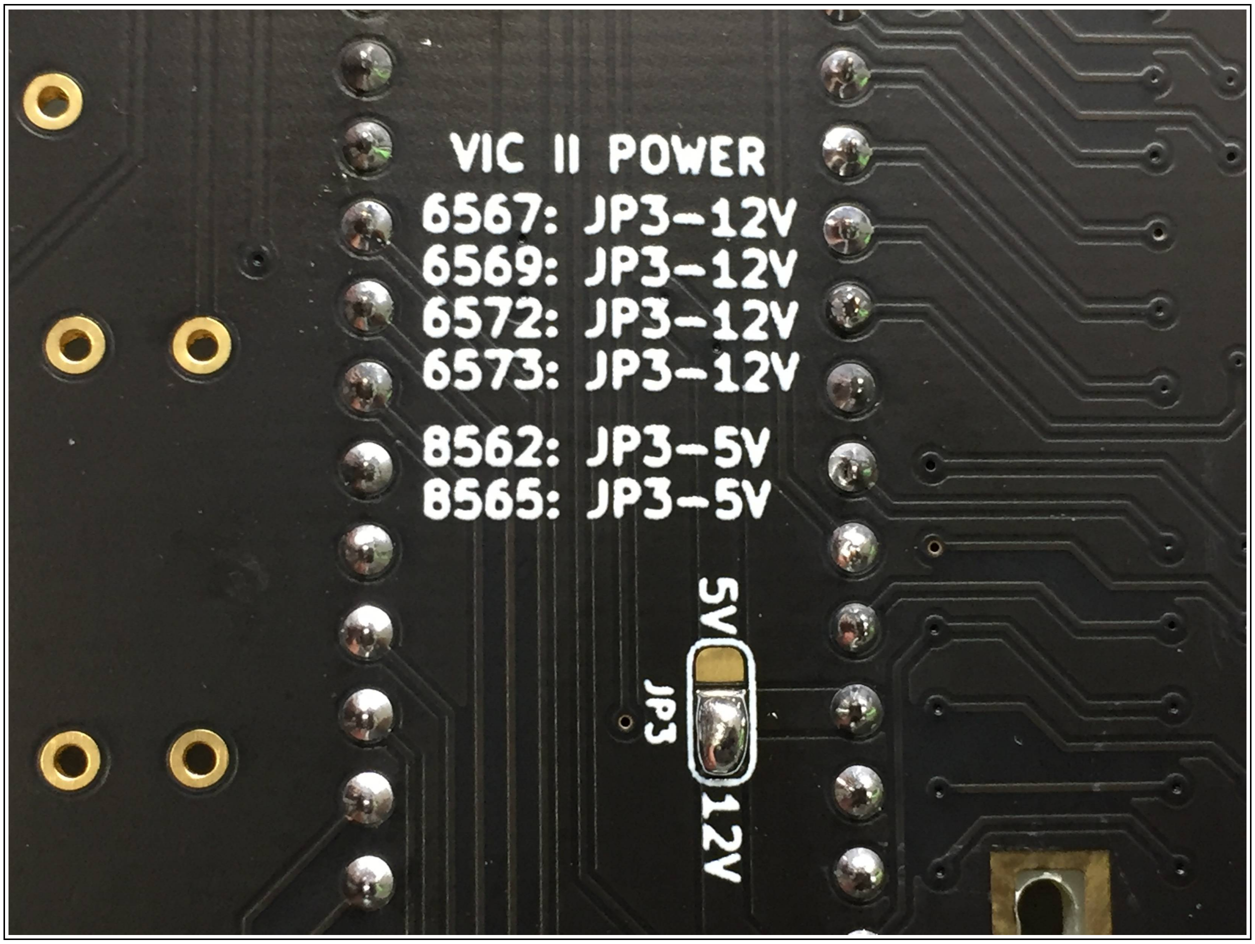

Figure 59 – VIC-II solder bridged for a 6567 (needed if you cut the trace)

CONGRATULATIONS!

The assembly of your ICS64S board is complete!

The first thing you should do is clean the board if you didn't do so while installing the parts. A board full of flux residue is not harmful, but it is messy and looks horrible. :) See Figures 60 and 61 for the before and after a good cleaning. You can clean organic solder flux based solder with just water and a microfiber cloth. If you are careful, and dry the board thoroughly with compressed air, you can actually wash the board in your kitchen sink! You can use a small amount of dish soap and large bristled scrub brush scrub the board clean. Industrial dishwashers are what is used for cleaning commercially assembled PCBs. If you did not use organic flux solder, DO NOT use water for cleaning!

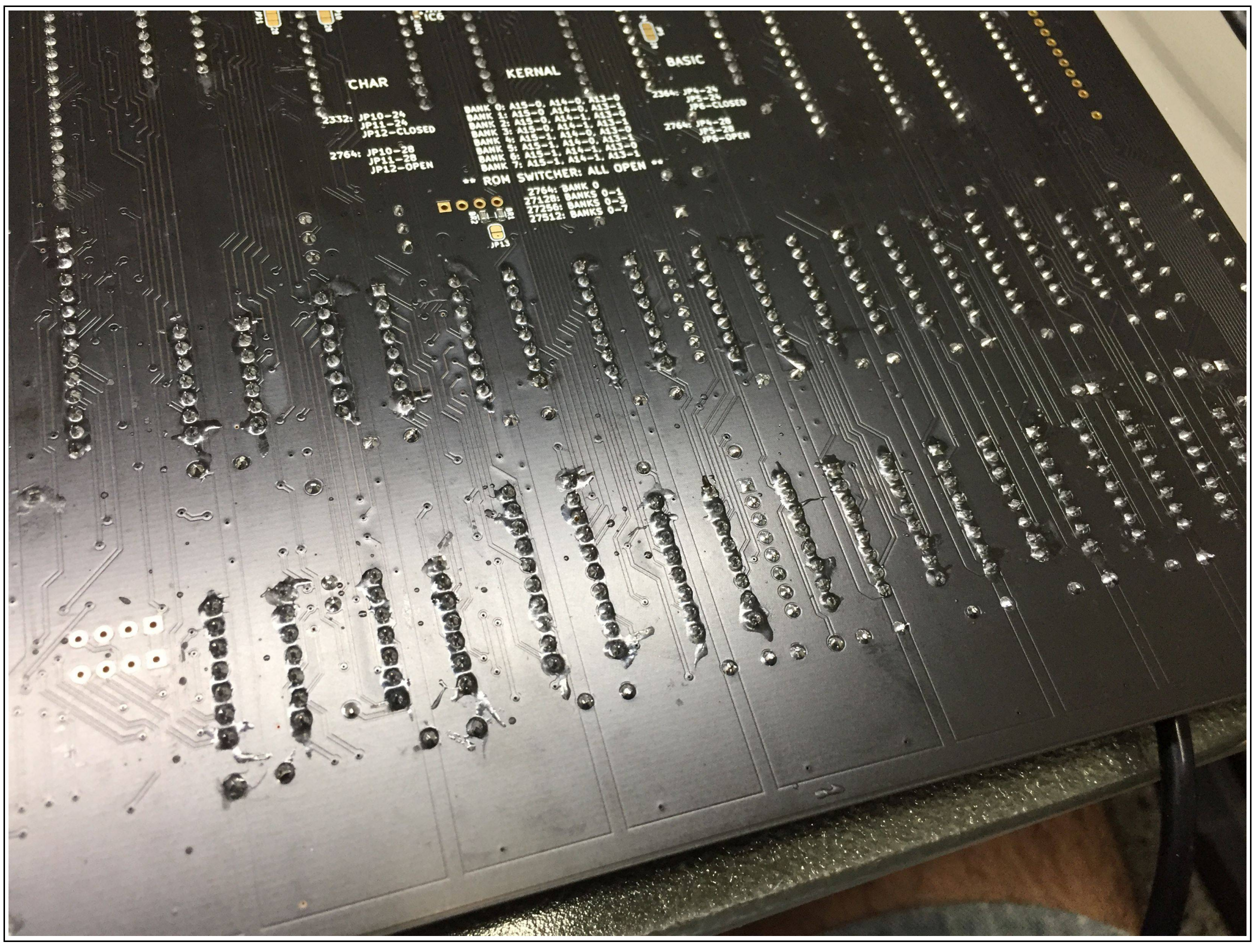

Figure 60 – Uncleaned board, soldered with organic flux solder

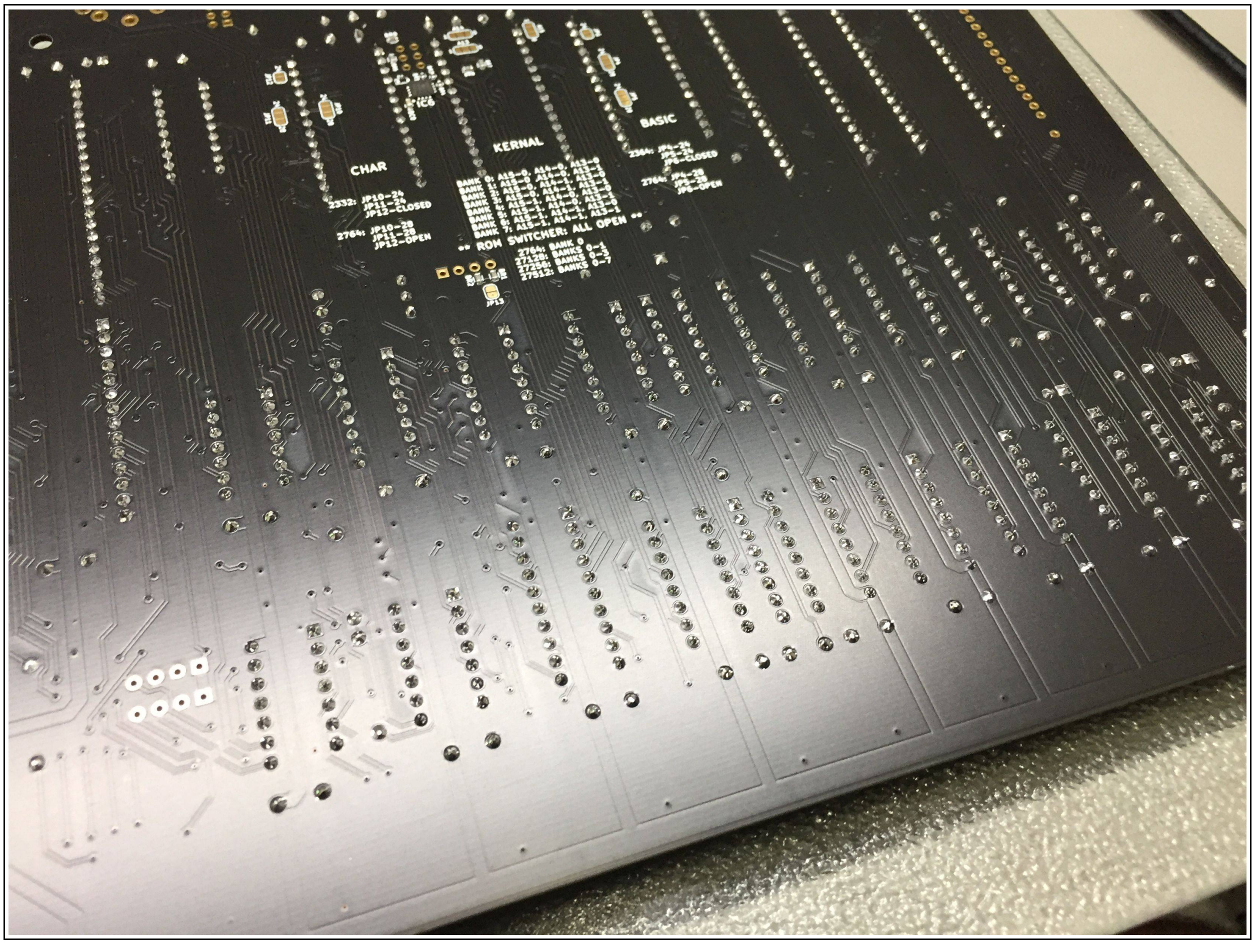

Figure 61 – Board cleaned with just water and microfiber towel

The next step is to test the ICS64S board. **DO NOT INSTALL ANY IC'S INTO SOCKETS YET!**

SECTION 4 – TESTING THE BOARD

Prior to putting any IC's in the ICS64S board, you should power it up and check each of the test points to make sure that the voltages are correct. A standard AC/DC voltmeter is necessary for testing.

There are 9 different "TP" (test points) on the ICS64S board. Most test points will use ground as the common point for your meter. Ground can be found on test point **TP5** or any of the gold ground planes around where the video modulator or video circuitry normally sits. See Figures 62 and 63 for details.

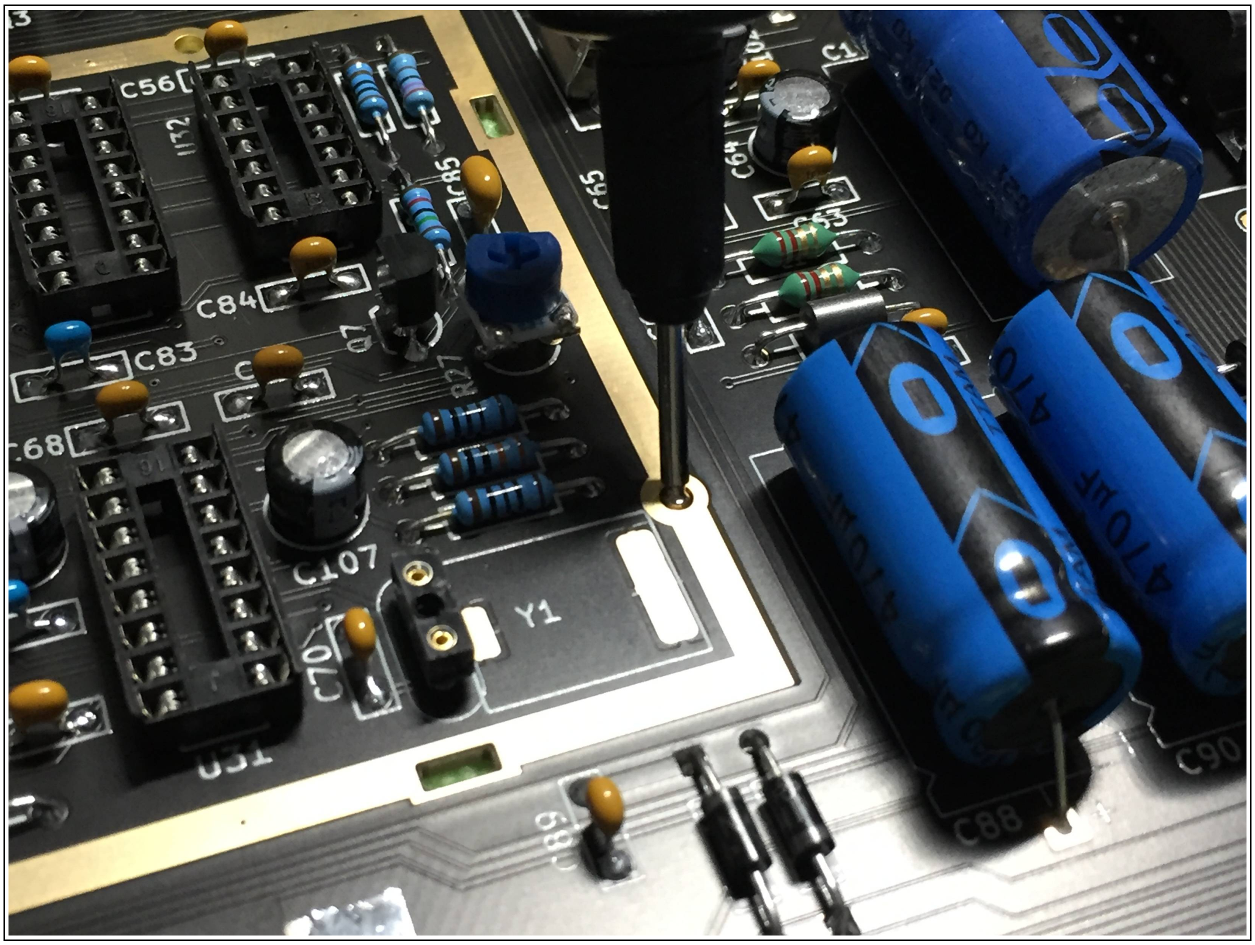

Figure 62 – Ground plane in video circuitry

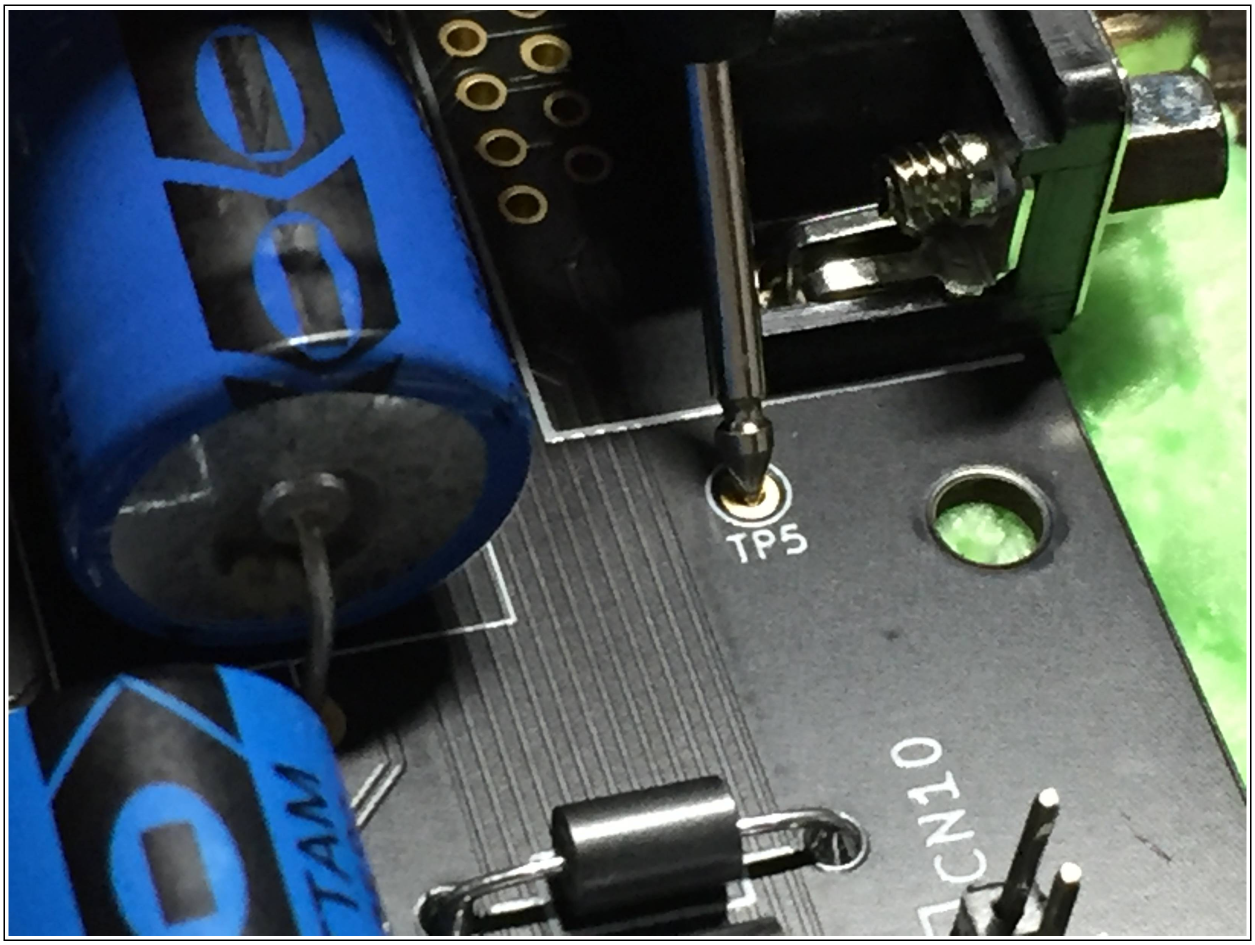

Figure 63 – TP5 is the common ground test point

The ICS64S board has a list of test points in the silkscreen on the front of the board. Use this list as a reference for the various test points. See Figure 64 for details.

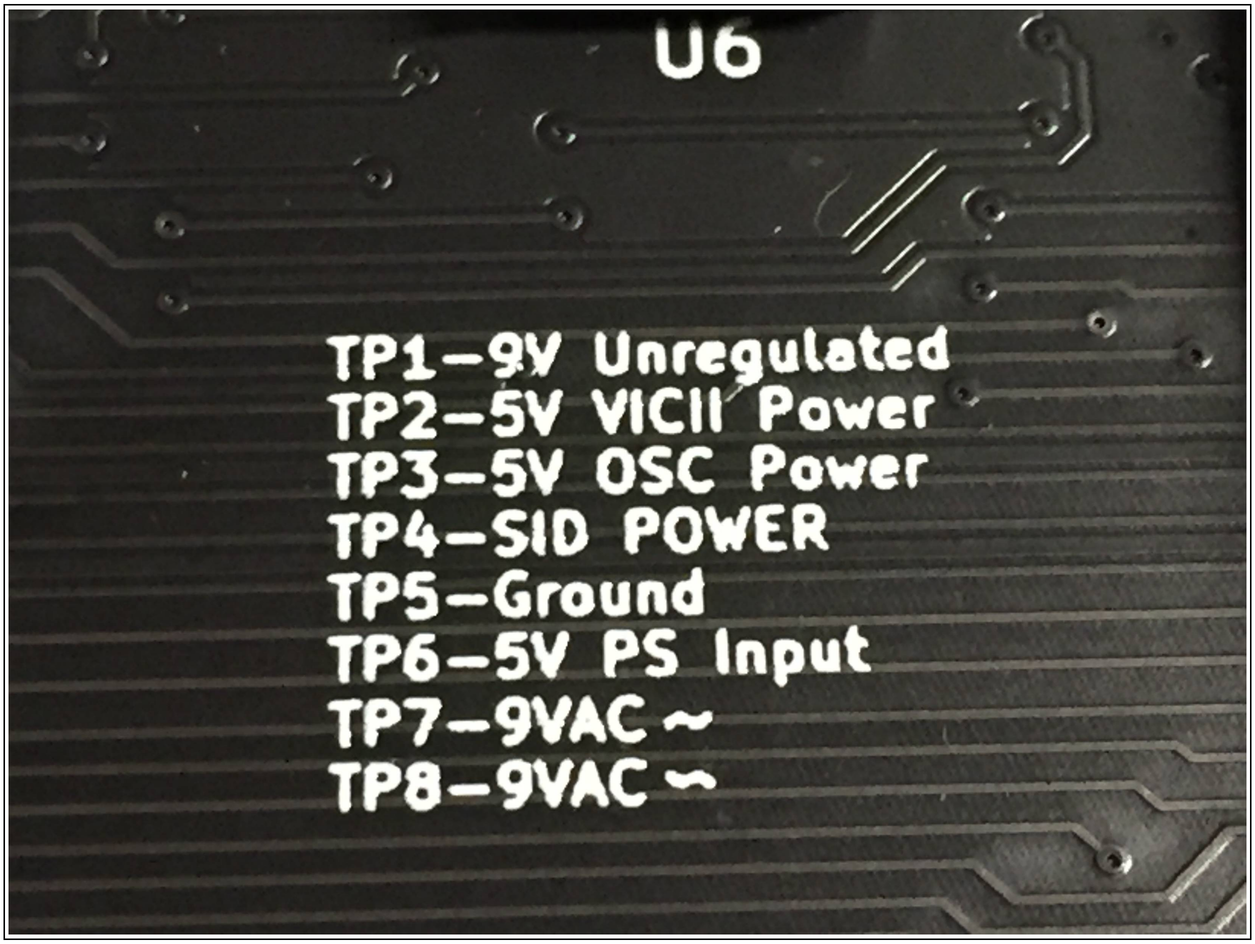

Figure 64 – Test points are listed on the front side silkscreen

Test 1 – 5 volts from power supply

Test point **TP6** is the 5 volt power from the computer's power supply. The location of this test point puts it about as far away from the power connector as possible, exposing any issues with the power supply to provide enough current to run the board.

Use the **DC** setting of your volt meter. Place the negative (-) lead of your volt meter on **TP5** (or one of the ground planes) and place the positive (+) lead on **TP6**. See Figures 65 and 66 for details. The voltage you see should be very close to 5.00 volts. If you see a voltage higher than 5.40 volts **DO NOT USE THE POWER SUPPLY – IT IS FAULTY AND WILL DAMAGE YOUR CHIPS!** If you see a voltage that is lower than 4.8 volts then the power supply also has a problem and should be replaced. See Figure 67 for what is typical.

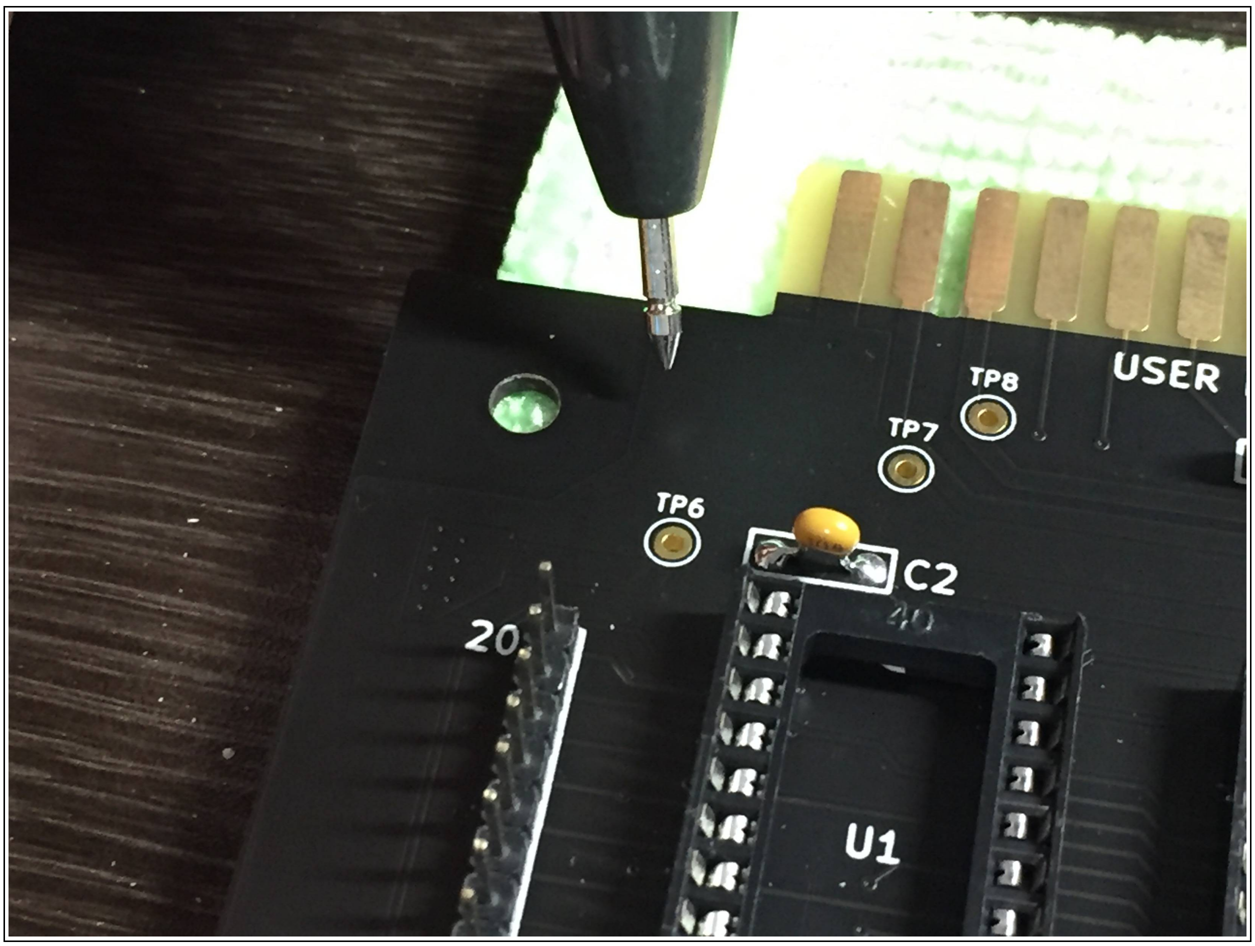

Figure 65 – Locating test point TP6

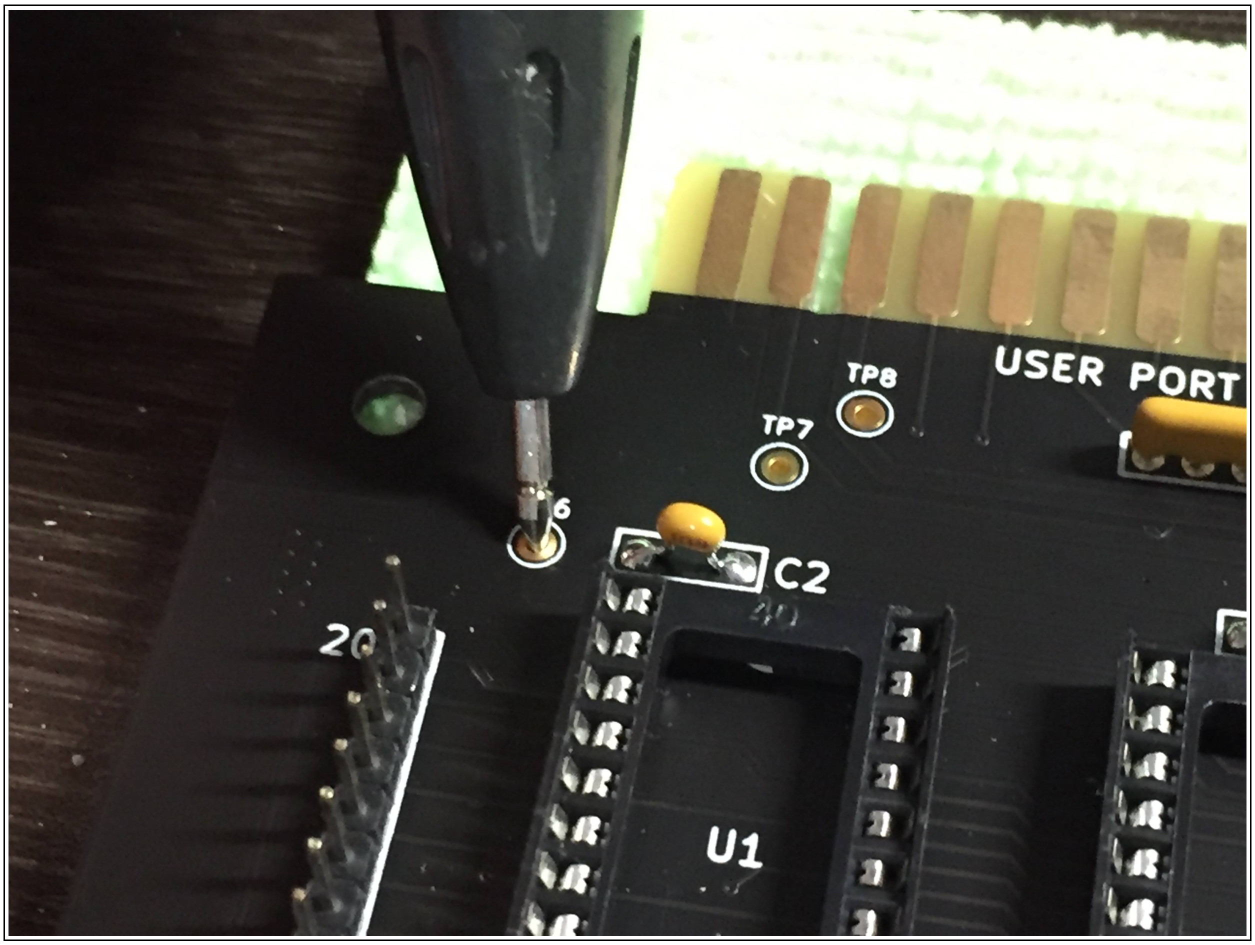

Figure 66 – Placing tip of positive volt meter lead on test point TP6

Figure 67 – Typical voltage on test point TP6

Test 2 – 5 volts for video circuitry

Test points **TP2** and **TP3** are the 5 volt power that is created from the power supply's AC voltage. This power is specifically for the video circuitry.

Use the **DC** setting of your volt meter. Place the negative (-) lead of your volt meter on **TP5** (or one of the ground planes) and place the positive (+) lead on **TP2**. See Figures 68 through 71 for details. The voltage you see should be very close to 5.00 volts. If you see a voltage higher than 5.20 volts or lower than 4.80 volts **THERE IS A PROBLEM WITH THE ASSEMBLY OF THE ICS64S BOARD - NOT USE THE BOARD WITHOUT FIXING THIS ISSUE!** See Figure 72 for what is typical. Test **TP3** next. The results should be the same as **TP2**. If the voltage is 0, it likely means that there is no AC power coming from your power supply.

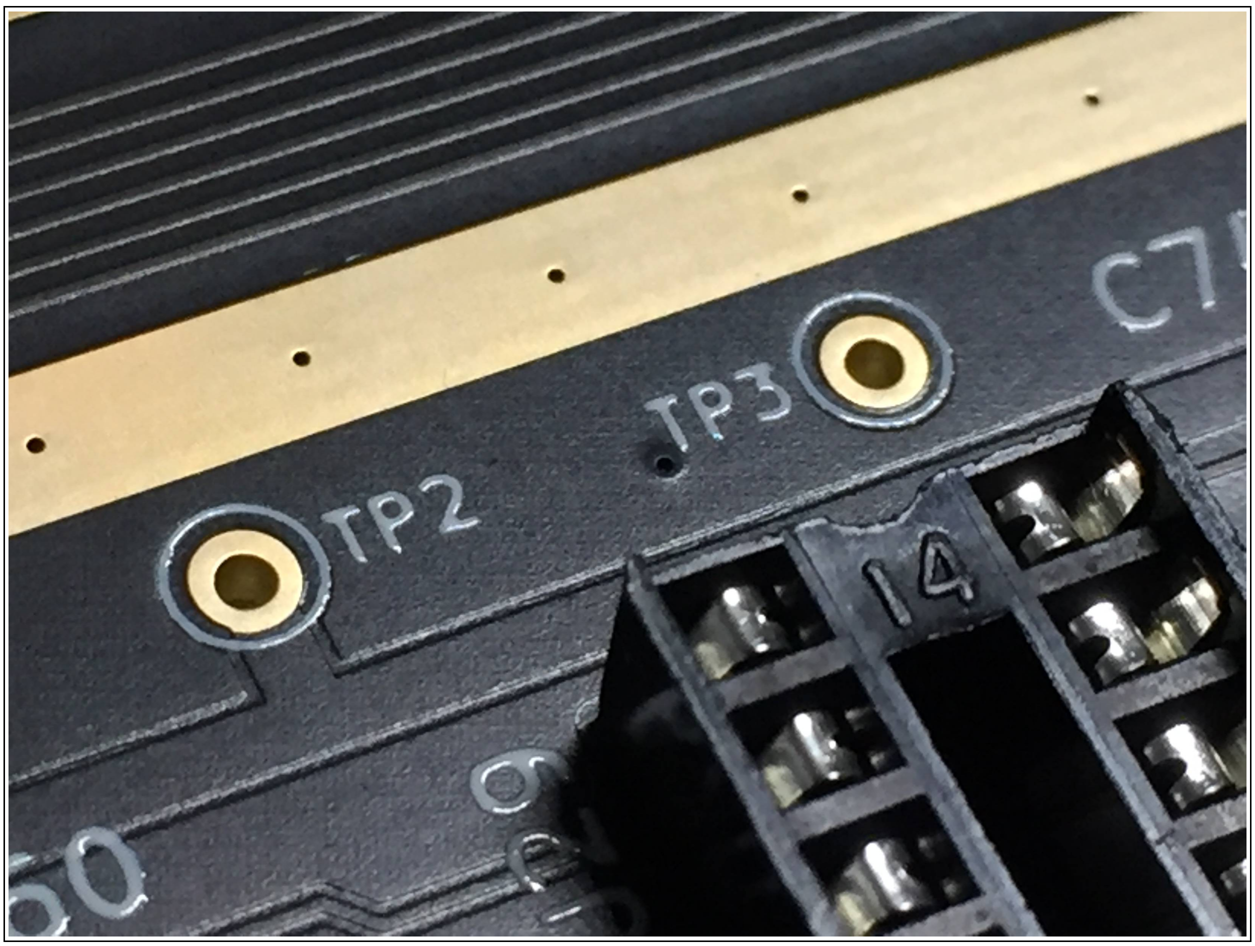

Figure 68 – Locations for test points TP2 and TP3

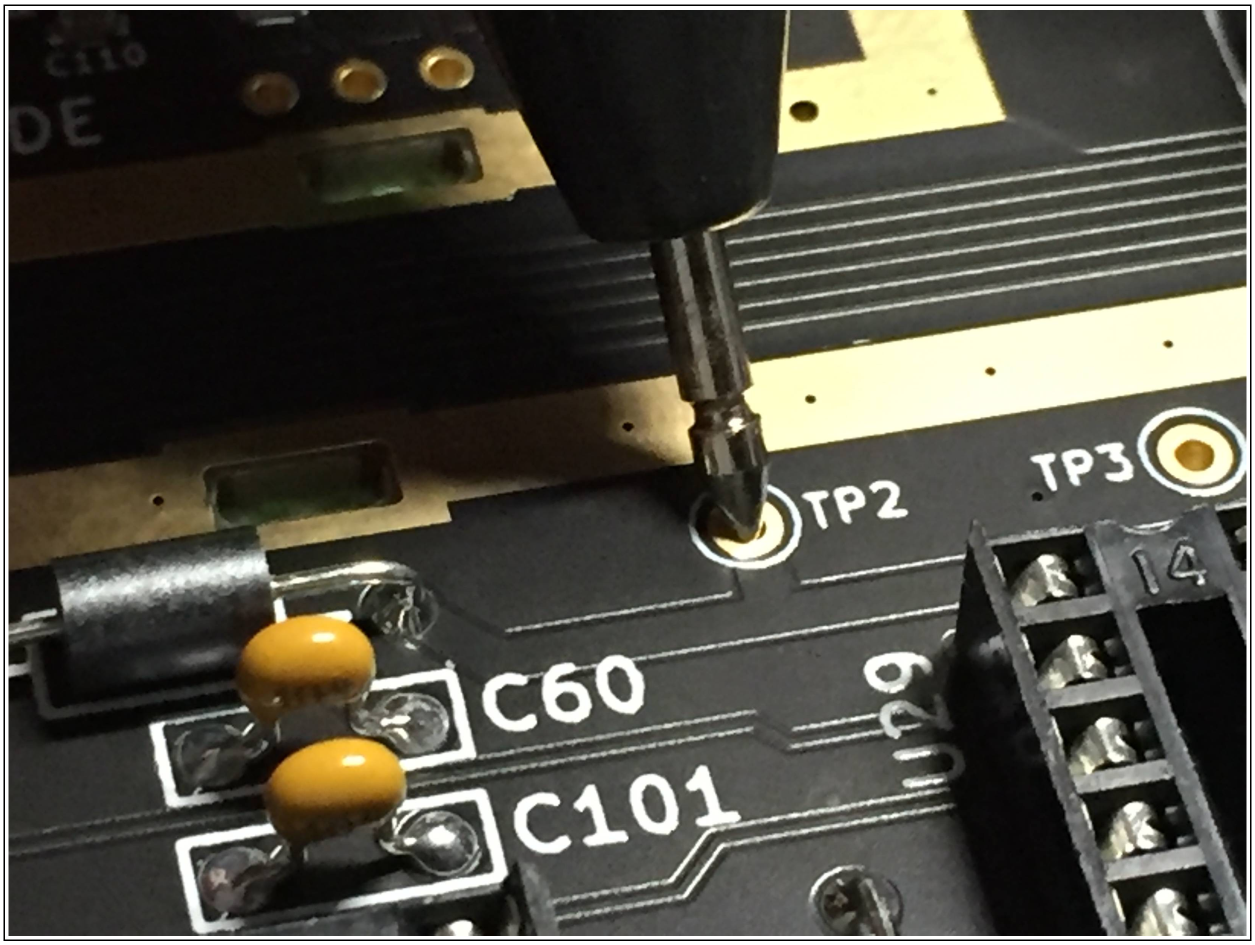

Figure 69 – Placing tip of positive volt meter lead on test point TP2

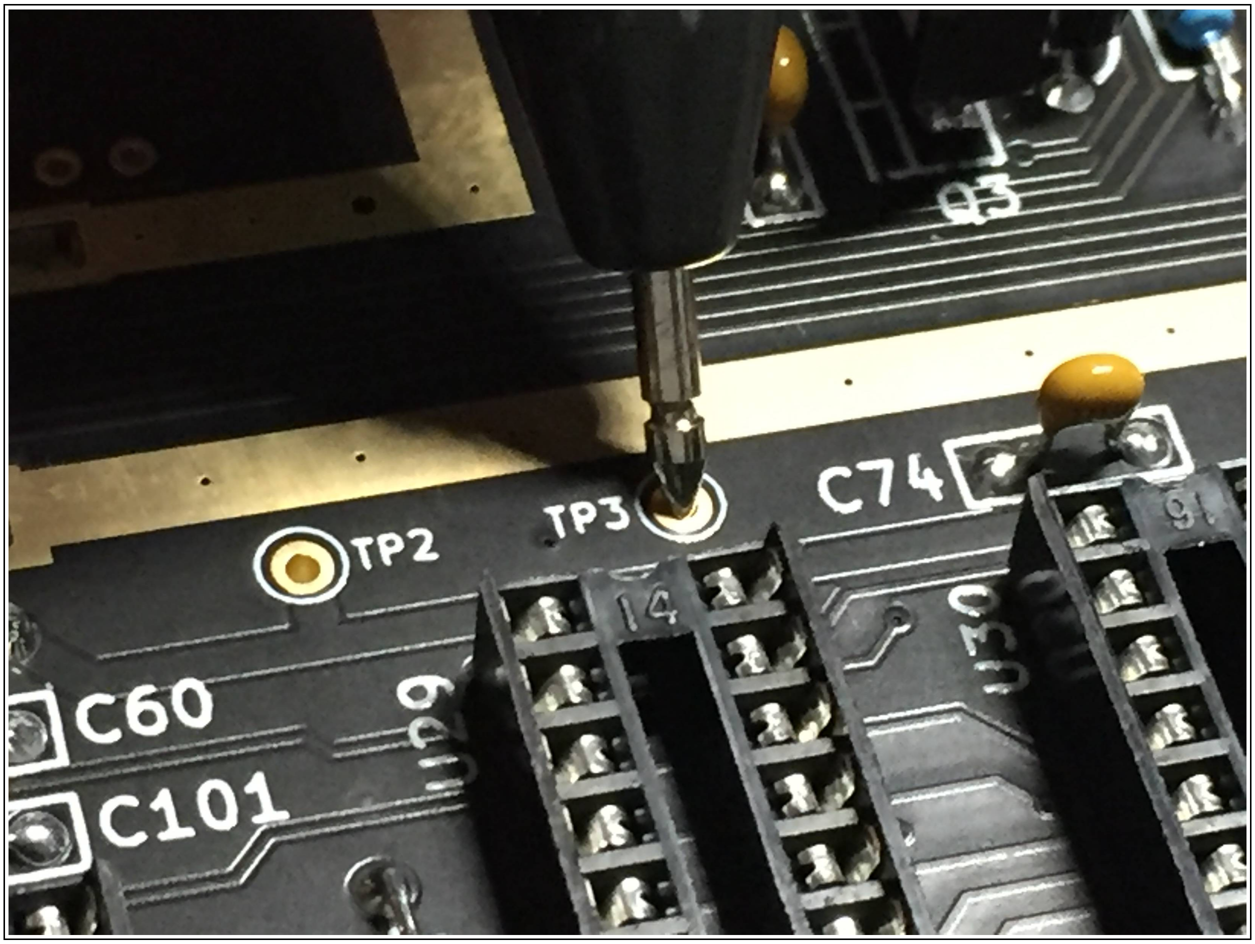

Figure 70 – Placing tip of positive volt meter lead on test point TP3

Figure 71 – Typical voltage on test points TP2 and TP3

Test 3 – 12 volts for the VICII and SID

Test point **TP4** is the 12 volt power that is created from the power supply's AC voltage. This power is for the VICII and SID power.

Use the **DC** setting of your volt meter. Place the negative (-) lead of your volt meter on **TP5** (or one of the ground planes) and place the positive (+) lead on **TP4**. See Figure 72 for details. The voltage you see should be very close to 12.00 volts. If you see a voltage higher than 12.20 volts or lower than 11.80 volts **THERE IS A PROBLEM WITH THE ASSEMBLY OF THE ICS64S BOARD - NOT USE THE BOARD WITHOUT FIXING THIS ISSUE!** See Figure 73 for what is typical. If the voltage is 0, it likely means that there is no AC power coming from your power supply.

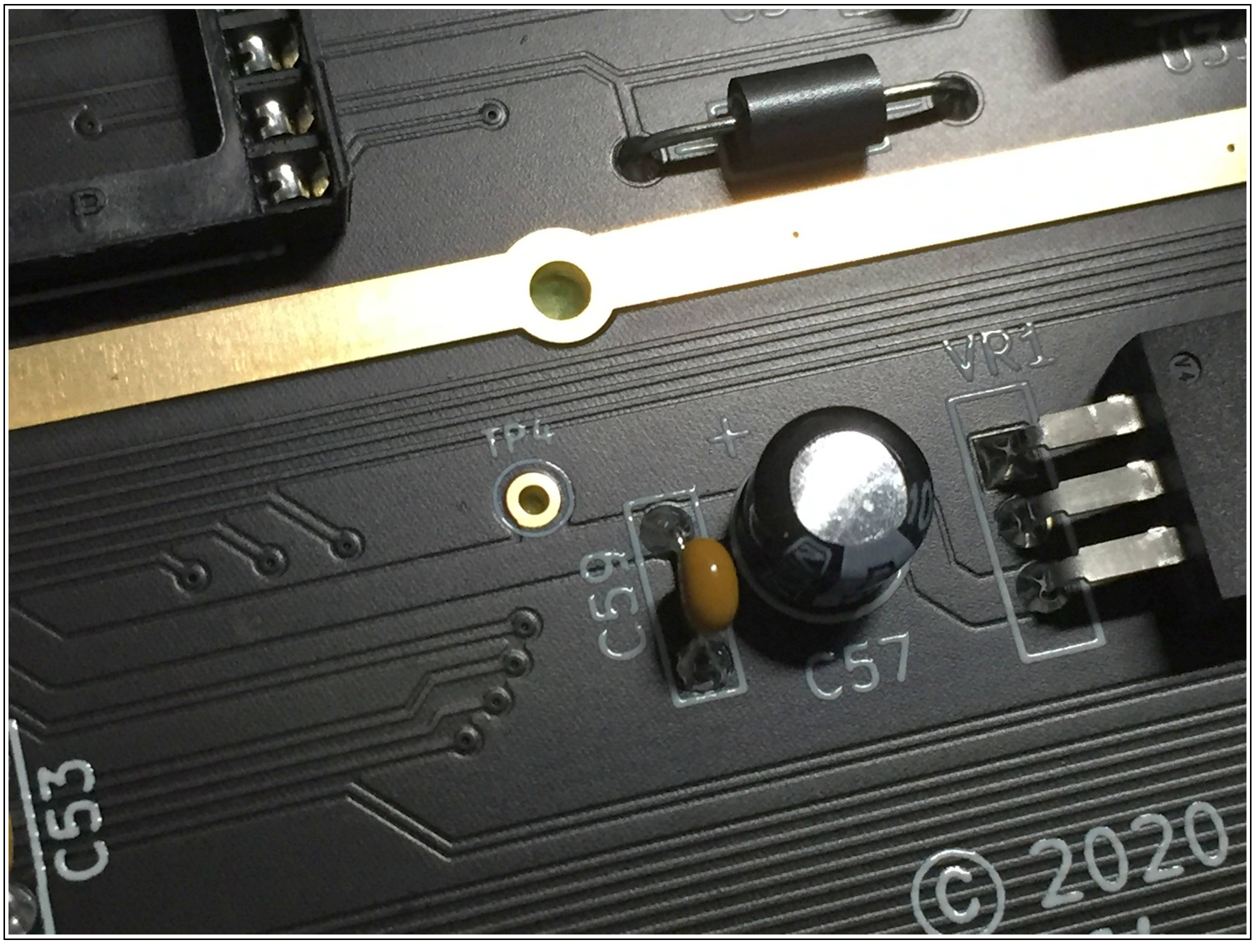

Figure 72 – Location for test point TP4

Figure 73 – Typical voltage on test point TP4

Test 4 – 5 volts for USER PORT

Pin 2 of the USER PORT should be 5.00 volts.

Use the **DC** setting of your volt meter. Place the negative (-) lead of your volt meter on **TP5** (or one of the ground planes) and place the positive (+) lead on pin 2 of the USER PORT. See Figure 74 for details. The voltage you see should be very close to 5.00 volts. If you see a voltage higher than 5.25 volts or lower than 4.80 volts **THERE IS A PROBLEM WITH THE ASSEMBLY OF THE ICS64S BOARD - NOT USE THE BOARD WITHOUT FIXING THIS ISSUE!** See Figure 75 for what is typical.

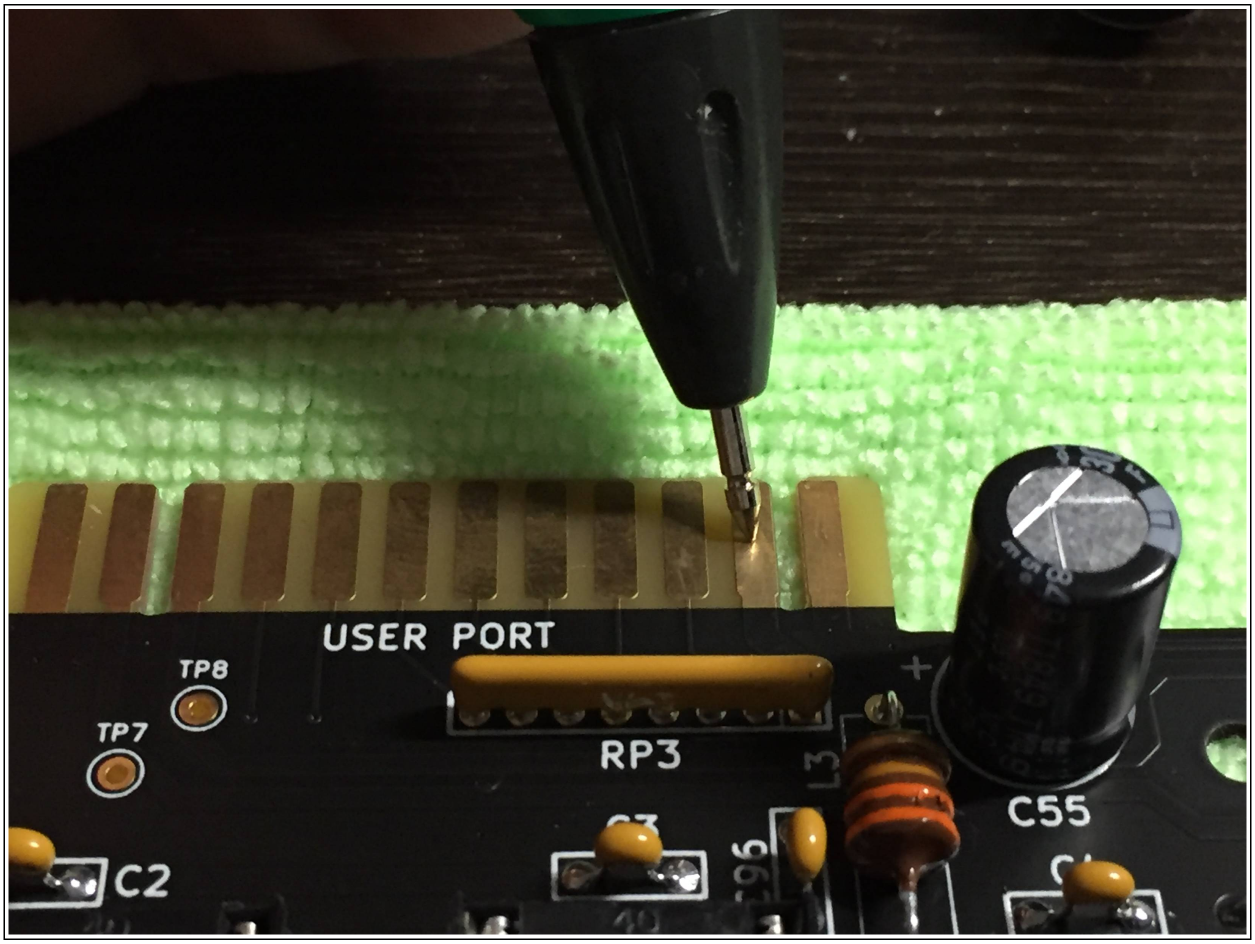

Figure 74 – Pin 2 of the USER PORT

Figure 75 – Typical voltage on the USER PORT

Test 5 – AC voltage for Video Circuitry and USER PORT

Pins 10 and 11 of the USER PORT should be about 12 volts AC. This voltage will vary quite a bit, based on the power supply and load.

Use the **AC** setting of your volt meter. Place the leads of your volt meter on **TP7** and **TP8**. See Figure 76 for details. The voltage you see should be between 9 and 15 volts AC. If you see a voltage outside of this range **THERE IS A PROBLEM WITH THE POWER SUPPLY – DO NOT USE IT!** See Figure 77 for what is typical.

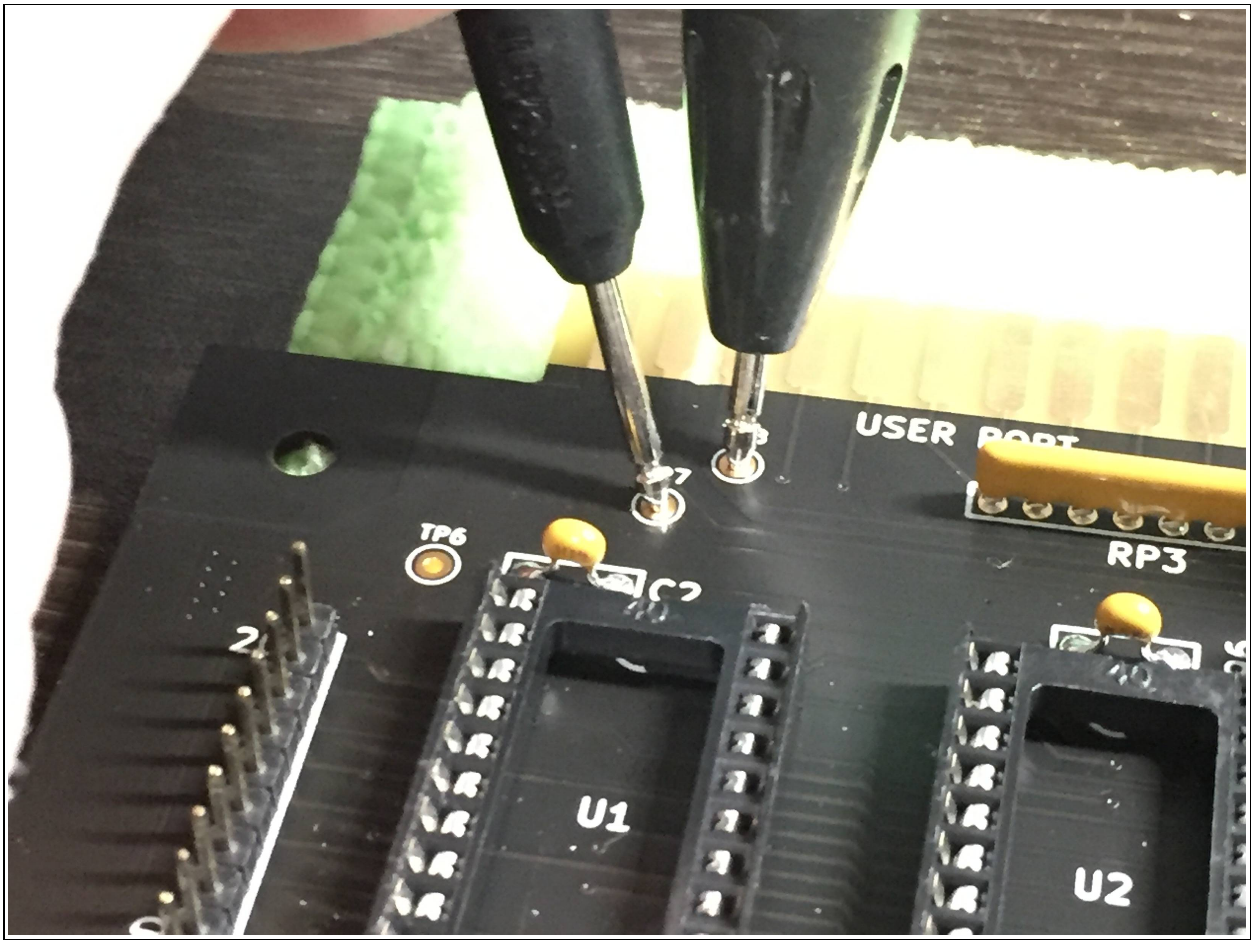

Figure 76 – Use TP7 and TP8 to test the AC voltage

Figure 77 – Typical voltage on the AC lines

Test 6 – Unregulated 9V for CASSETTE PORT

Test point **TP1** is the 9 volt pseudo-DC power that is created from the power supply's AC voltage. This power is for the CASSETTE PORT.

Use the **DC** setting of your volt meter. Place the negative (-) lead of your volt meter on **TP5** (or one of the ground planes) and place the positive (+) lead on **TP1**. See Figure 78 for details. The voltage you see should be between 9 and 15 volts AC. If you see a voltage outside of this range **THERE IS A PROBLEM WITH THE POWER SUPPLY – DO NOT USE IT!** See Figure 79 for what is typical.

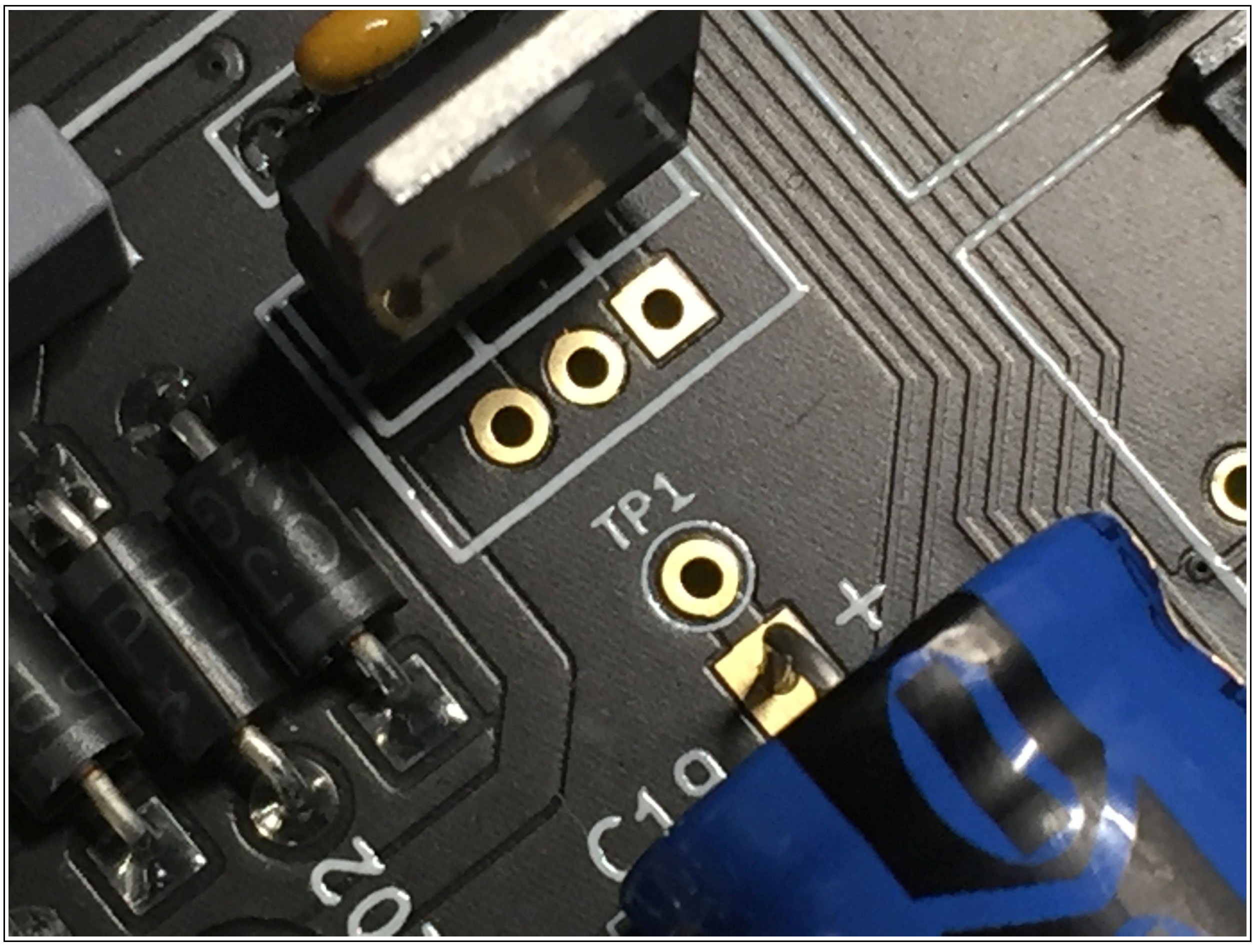

Figure 78 – Location for test point TP1

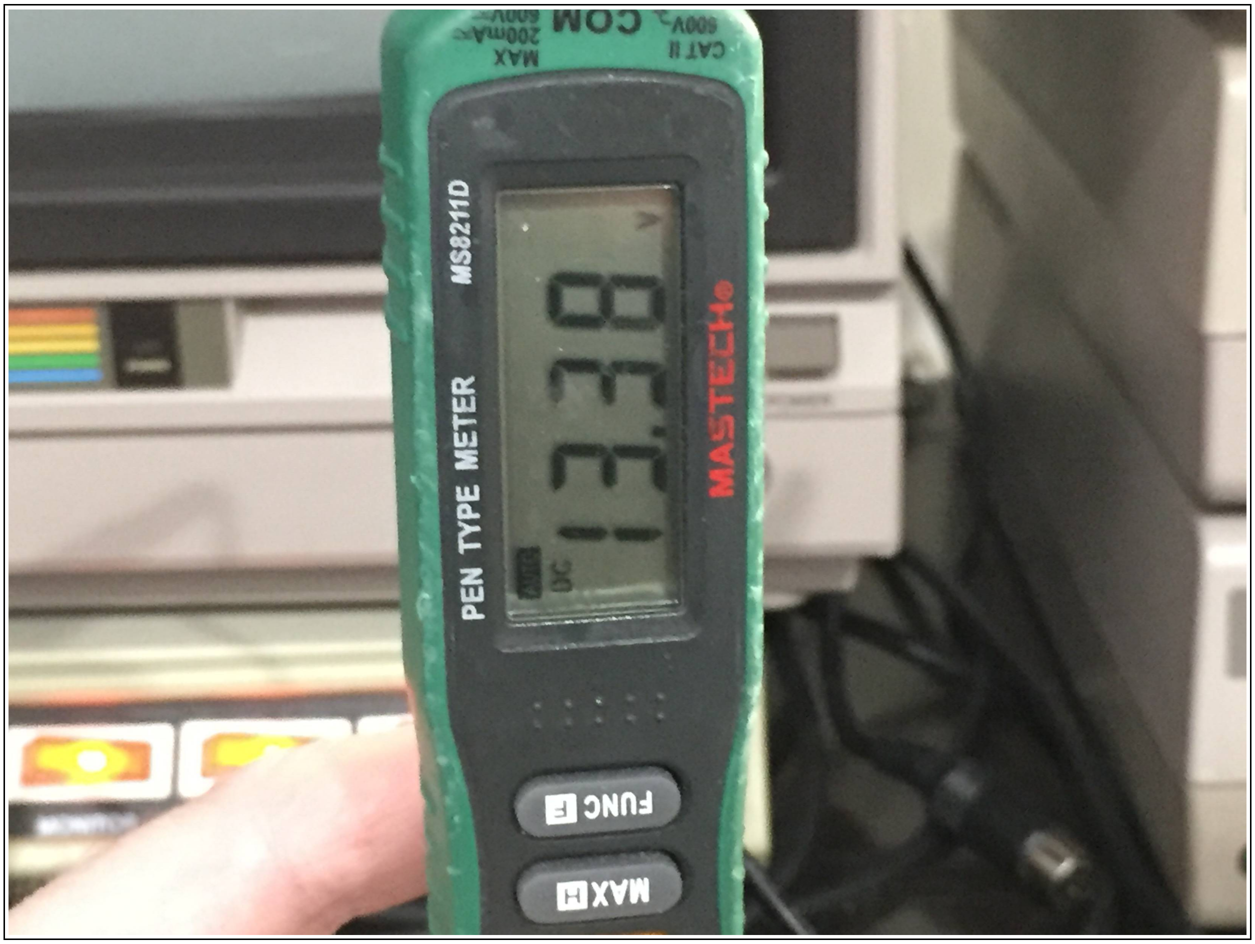

Figure 79 – Typical voltage on the test point TP1

ALL TESTS COMPLETE!

Install all of the chips into their sockets and then power it up to see if it works! If it does, congratulations! If not, re-check the test points with the chips installed. If you can't make the board work, see Section 4 for trouble-shooting tips.

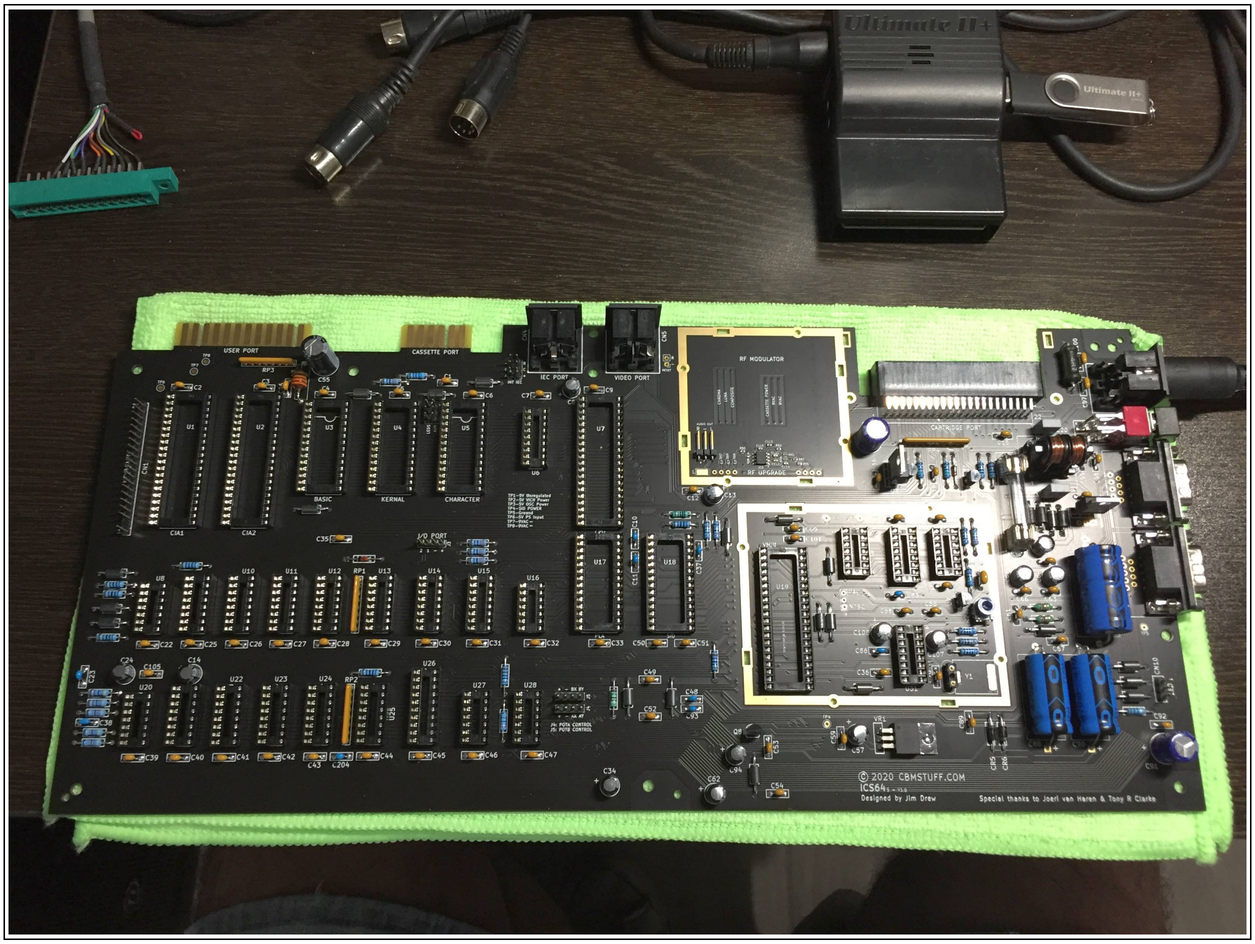

Figure 80 – ICS64S ready to have chips installed!

SECTION 3 – USAGE AND FEATURES

RESET/ROM Select with RESTORE key

The ICS64S has the ability to use the RESTORE key to reset the computer and switch the KERNAL ROM images. No external switch(es) are required for these functions. The RESTORE key is also used to access the programming mode that is used to program each of the various functions.

To reset the computer, press and the hold the RESTORE key for about 2 seconds and release the RESTORE key. The computer will reset. If you have the RGB LED strip installed, the STATUS LED will turn off when the RESTORE key pressed, and if held long enough to perform the reset it will change to teal. Releasing the RESTORE key at this point will cause the reset to occur.

To change the KERNAL ROM, press and hold the RESTORE key for about 4 seconds and release the RESTORE key. The computer will be reset with the next ROM in the bank of ROMs selected being used. If you have the RGB LED strip installed, the STATUS LED will turn off, then teal (RESET as described above), and then blue when the ROM change mode has been reached. Releasing the RESTORE key when the LED is blue will cause the reset and ROM switch to occur.

Now that you have the ICS64S powered up and working, you can start adding some of the features and learning how to use them!

The ICS64S has the ability to drive a 4 RGB LED strip and/or RGB LED matrix panel. The LEDs provide information about the system and the matrix can be used for a banner display.

The ICS64S has the ability to show information on an I^2C OLED screen. This information includes when the RESTORE key is pressed, when RESET mode is reached, when ROM Switch is reached, the KERNAL ROM currently selected, the 5 volt supply voltage, and how long the computer has been on. This display is also used for changing all of the settings for the system.

The firmware for the ICS64S can be updated using a simple FTDI based USB<>serial converter interface. The various settings can also be changed using this interface.

Let's review each of the features individually...

RGB LED Strip

The ICS64S has a 0.100" pitch 1x3 pin header labeled **LEDS** at header J1. This 3 pin header is designed for a strip and/or matrix of WS2812 RGB LEDs. The first 4 LEDs in the strip are used for the various internal states. The remaining 256 (8x32) LEDs are reserved for the RGB LED matrix. The RGB LED pinout is GROUND, +5 volts, and signal. Ground is the pin towards the back of the ICS64S board, +5 volts is the center pin, and the remaining pin is the signal. See Figure 81 for details (black is ground, orange is +5 volts, and white is signal).

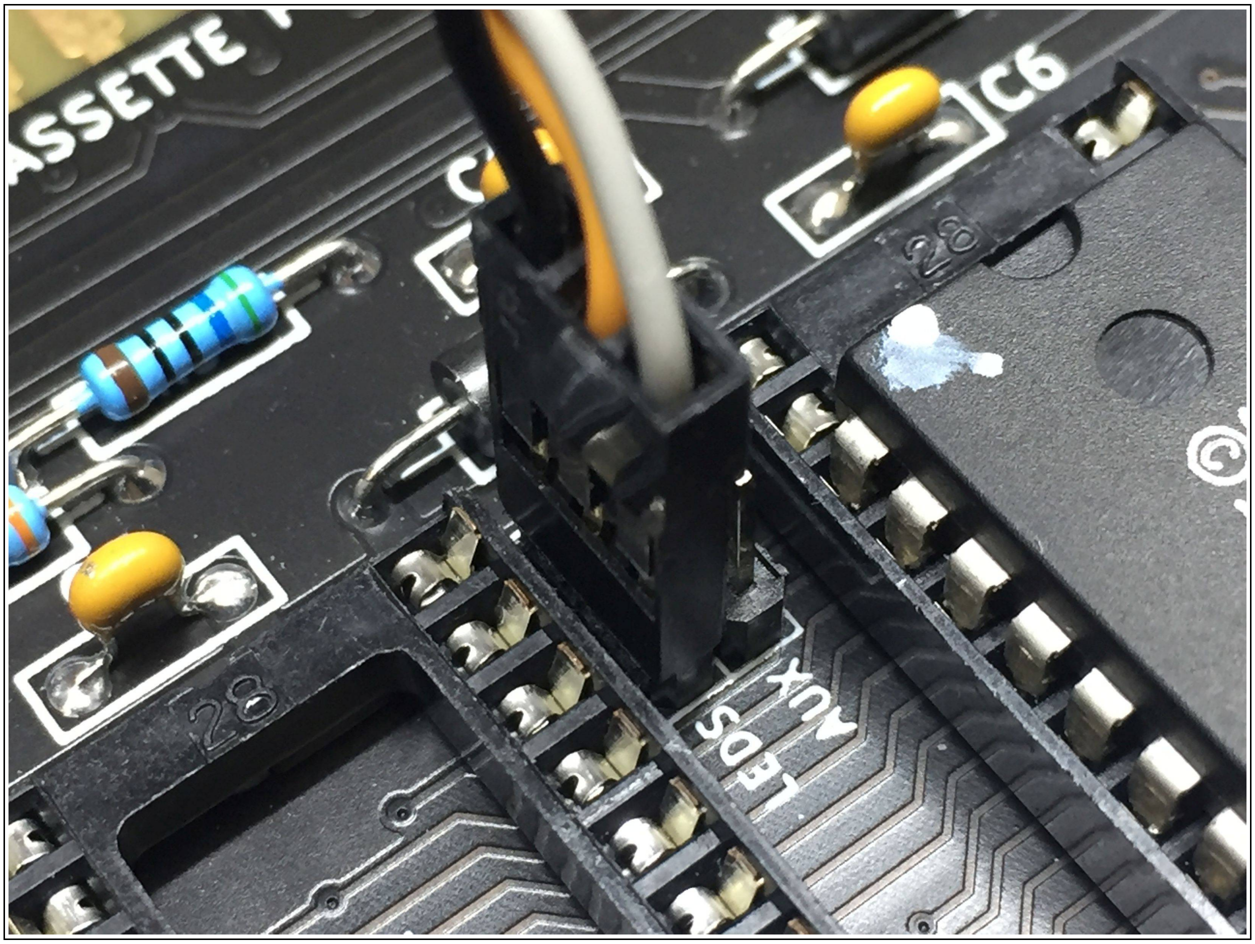

Figure 81 – RGB LED connection

The RGB LED strip is something that you can purchase from Amazon and various eBay sellers. The board used in the example and shown in Figure 82 this one: https://amzn.to/3eLfcOS

In this example a small 1.5mm connector was soldered on the DIN side and a 0.100" 3 pin header was soldered on the DOUT side. Connectors are of course not required, they just make it easy to switch between different types of LED strips and panels.

That DOUT side can be plugged into a LED Matrix display, like this one shown in Figure 83: https://amzn.to/2UA2kEg

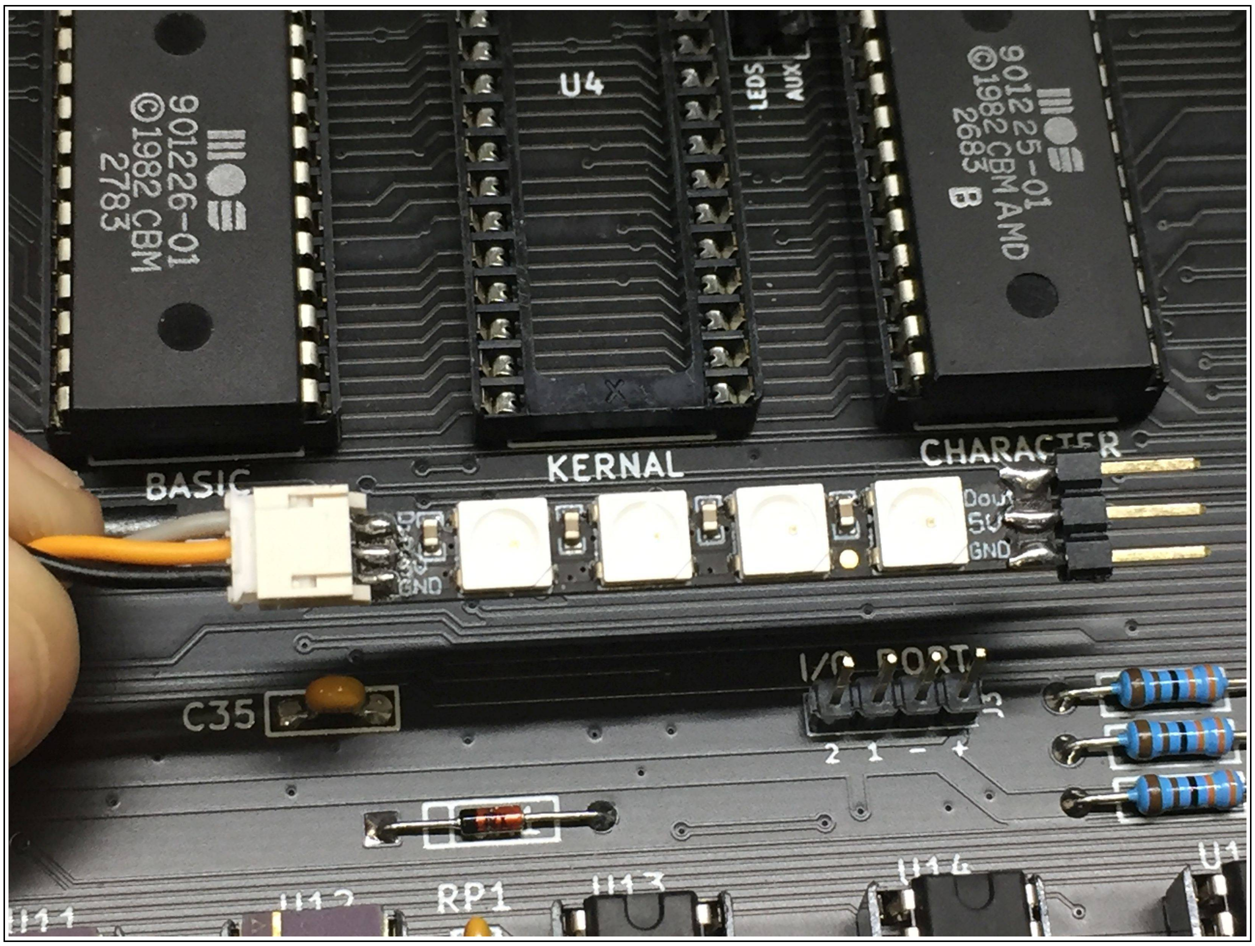

Figure 82 – RGB LED strip

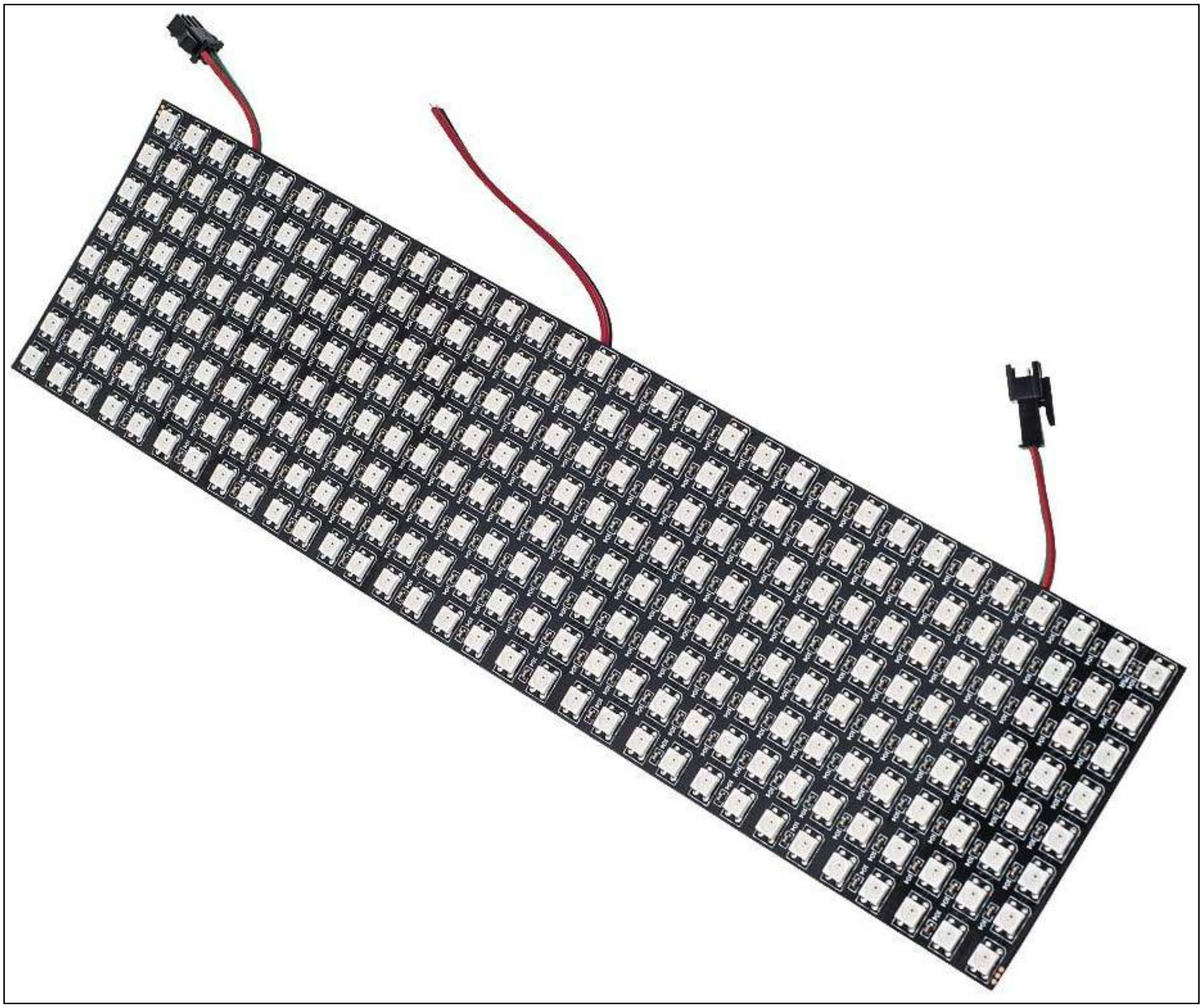

Figure 83 – RGB LED Matrix

The RGB LED strip provides 4 LEDs that represent the **STATUS**, **IRQ**, **ROM** and **EXROM** states. The description of these are below:

STATUS is current status of the system. If the main 5 volt supply ever exceeds the preset low/high thresholds this LED will flash (green for low voltage, and red for high voltage). This LED also changes colors when the RESTORE key is held down long enough to reach a RESET or ROM change modes.

IRQ is state of the IRQ line connected to the 6510 CPU. The color of the low state and high state are shown as two different colors (which can be changed in the configuration). The default is green for low and red for high.

ROM is the color assigned for which ROM bank is selected. The colors can be changed in the configuration software.

EXROM is the state of the EXROM line at the cartridge port. The color of the low state and high state are shown as two different colors (which can be changed in the configuration). The default is green for low and red for high.

Manual programming the ICS64S features

There are two different ways that you can program the various features of the ICS64S board. The first way (manual programming mode) uses the RESTORE key along with the OLED screen, and the other way (computer programming mode) uses a FTDI based USB<>serial adapter with a Windows based PC.

To get into manual programming mode, press and HOLD the RESTORE key until the programming menu appears. This will take about 7 seconds. Once the programming menu is up you can see the main options menu, shown in Figure 81.

Each time you press and release the RESTORE key, the highlighted menu option changes to the next in line (below it), and will wrap around to the top once you have reached the bottom. To select one of the highlighted options, press and HOLD the RESTORE key until the screen switches to the new option and then release the RESTORE key.

Config Menu

The config menu is the main menu level. Press and HOLD the RESTORE to enter any of the menu options.

System Options

The System Options menu contains options pertaining to the actual features of ICS64S board.

Max ROM Banks – set how many different ROM images are present in the EPROM you are using.

Reset Method – set whether the EXROM line is toggled on a reset (to allow a true reset)

LED Matrix – enable or disable the LED Matrix output on the RGB LED signal.

Flip Display – flip the display data upside down, allowing the mounting of the OLED screen inverted.

Screen Align – used to fill the entire OLED screen with pixels so you can easily align it behind a bezel.

Exit – return to the Config Menu.

LED Function

LED1-LED4 - used to select what the function of each LED is for.

Exit – return to the Config Menu.

Information

Shows copyright and firmware version information.

Exit

Exits the manual programming mode and returns to normal operation.

Computer programming the ICS64S features

To get into the computer programming mode, press and HOLD the RESTORE WHILE turning on the power to the ICS64S board.

After installing the FTDI USB drivers (if your version of Windows doesn't automatically do this for you), you can install the ICS64S programming software.

The ICS64S programming software allows you to change all of the settings mentioned above, voltage monitoring threshold points, colors for the LED strip, the messages for the LED Matrix, and other advanced options.

SECTION 4 – TROUBLE SHOOTING

This section is dedicated to helping determine the cause of a problem with the ICS64S board.

The first thing to do is to determine if all of the voltages are correct. If not, you should be able to isolate the issue by reading the section of this manual concerning the test points.

Black Screen

Having a black screen can be caused by a large variety of issues! Everything from a defective (or no) CPU, PLA, or ROM can cause this issue. You almost always need a "dead test cartridge" to determine the exact cause of this problem. Having a KERNAL ROM image with the improper data will cause this problem. If you are using a 27512 with only two images programmed (6 more banks would be available), make sure you have programmed the proper banks! All ROM images must start at the beginning of the EPROM. Bank 0 through 7 is mapped as shown below:

ROM 0 - $0000-$1FFF
ROM 1 - $2000-$3FFF
ROM 2 - $4000-$5FFF
ROM 3 - $6000-$7FFF
ROM 4 - $8000-$9FFF
ROM 5 - $A000-$BFFF
ROM 6 - $C000-$DFFF
ROM 7 - $E000-$FFFF

Corrupt Screen

If you see corrupted graphics, but can type and see the data changing then you likely do not have the CHARACTER ROM setup correctly. The 2114 RAM could also be bad or missing.

Very Bright Display

The output from the ICS64S should yield a very bright and vibrant display. You may have to turn down the brightness and/or contrast if it is too bright for your liking.

Keyboard Not Working

Check the keyboard connector to make sure you are not 1 pin (or more) off on the connection! The CIA at U1 controls the keyboard interface. Try swapping the two CIA chips to see if that makes a difference. If so, then the swapped CIA is probably bad and needs to be replaced. If not, then there is a problem with the soldering or connection to the U1 socket.

Disk Drive Not Working

The CIA at U2 controls the IEC port. Try swapping the two CIA chips to see if that makes a difference. If so, then the swapped CIA is probably bad and needs to be replaced. If not, then there is a problem with the soldering or connection to the U2 socket.

No Audio

First verify that the source you are plugging the C64's audio cable into actually works! If you can verify that then you should be able to hear "something" using a SID tester program or game with known audio output. If you get no sound at all, check to make sure that you put a SID chip into the SID socket. Several different chips are also 28 pin devices. The audio circuitry is very simple, just a voltage divider (R6/R7) and amplifier/filter (Q8/R8/C13) to check. If you do get sound but it is garbled, check to make sure that you have installed the correct capacitors for the filer caps at C10 and C11. If you are using the 8580, resistor R10 should be installed.

If you have other issues, please visit the CBMSTUFF.COM support forum!

https://www.cbmstuff.com/forum/