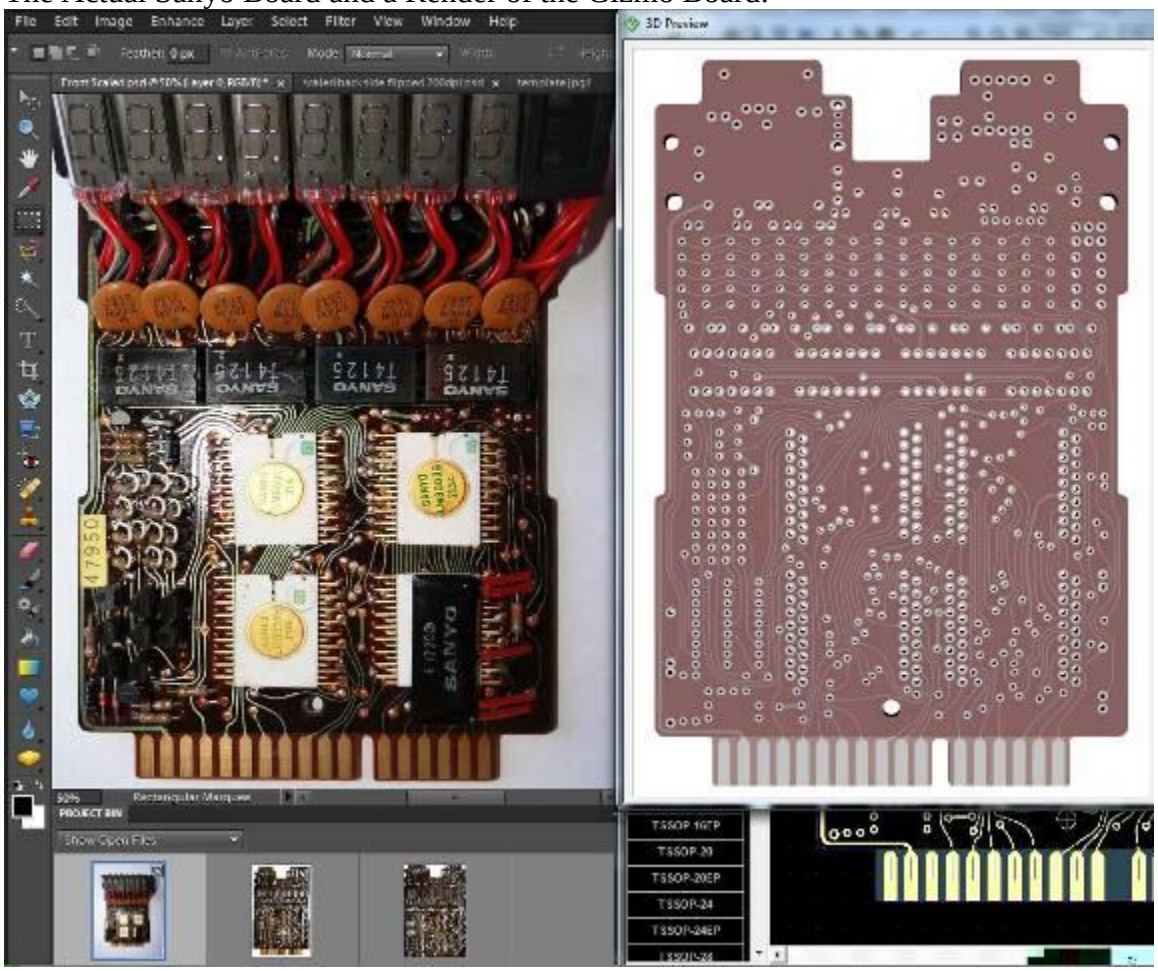
Gizmo Building Instructions

The Gizmo board is made to look very similar to the Sanyo ICC-808D calculator board with gold fingers on the card edge connector, curved traces and the plated through holes are in the same locations as the original board.

There are several variations of components used to populate this board so you can have some choices when building the board and you can also personalize your board by placing components in different places or use different values for the components.

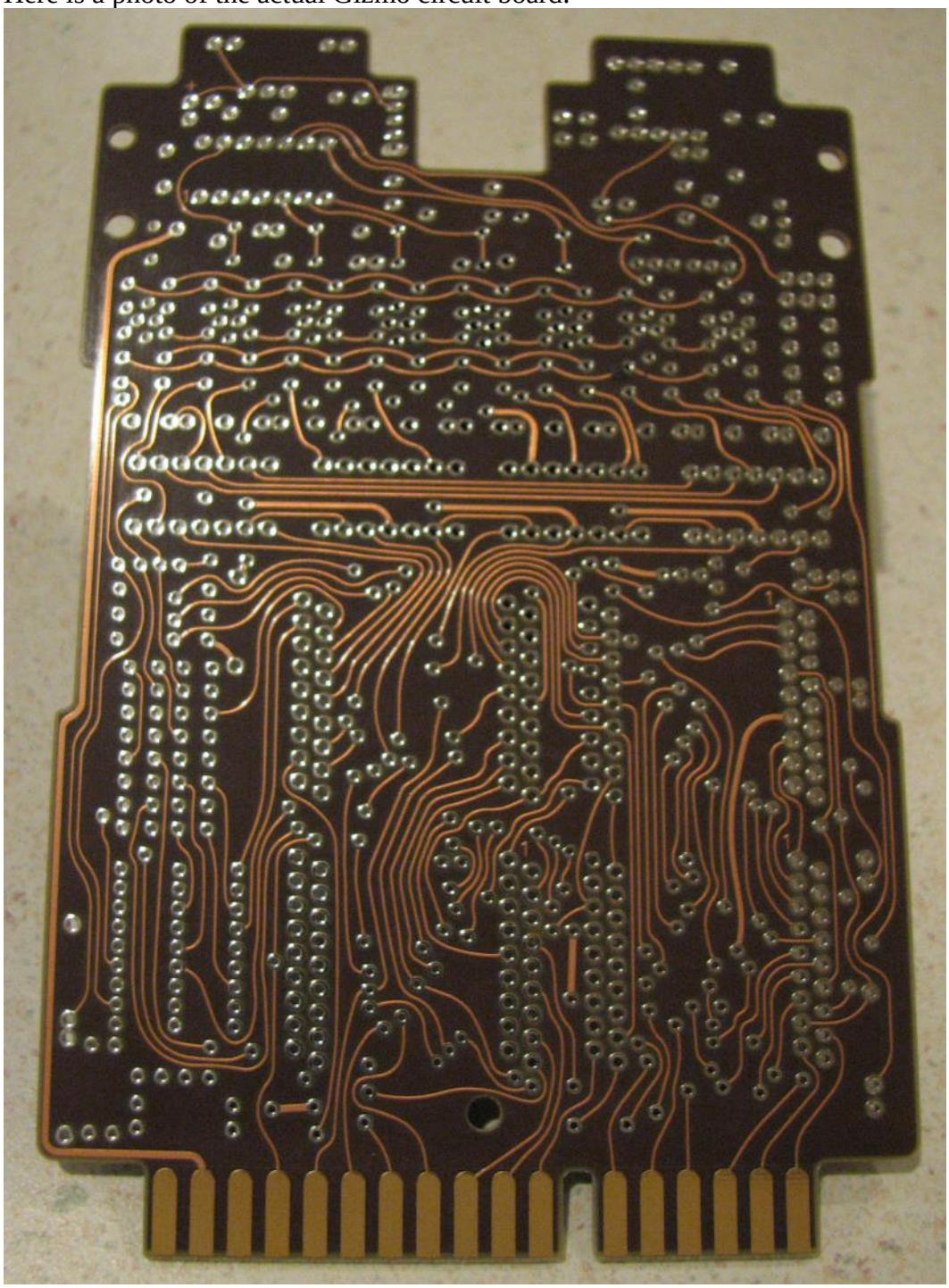
These instructions are based on a real Sanyo ICC-808D board and will try and re-create the component values and locations as close as possible to match what was used on that board.

The Actual Sanyo Board and a Render of the Gizmo Board:



Note: You may want to start with the “Detailed Daughterboard Instructions” at the end of this document if you are not a veteran electronics assembly person.

Here is a photo of the actual Gizmo circuit board:



This is the top side of the board where all of the components will be placed. The back side of the board has only a few traces (lines of copper that connect different holes together) and is where you will solder the part leads to the holes.

“BP” Basic Parts kit assembly

If you have the basic parts kit, it will contain all the parts that are shown in this portion of the build.

1/4W Resistors:

Laying flat on the board:

2x 2.7K (Red Violet Red Gold)
3.3K (Orange Orange Red Gold)
10K (Brown Black Orange Gold)
15K (Brown Green Orange Gold)
33K (Orange Orange Orange Gold)
39K (Orange White Orange Gold)
100K (Brown Black Yellow Gold)

Standing up on the board with white or red sleeves covering one lead:

7x 220K (Red Red Yellow Gold)
7x 560K (Green Blue Yellow Gold)

Transistors (Black device with 3 legs) quantity 10

Diodes

2x Black Diodes (2 leads)
2x Red/Clear Diodes (2 leads)

Capacitors

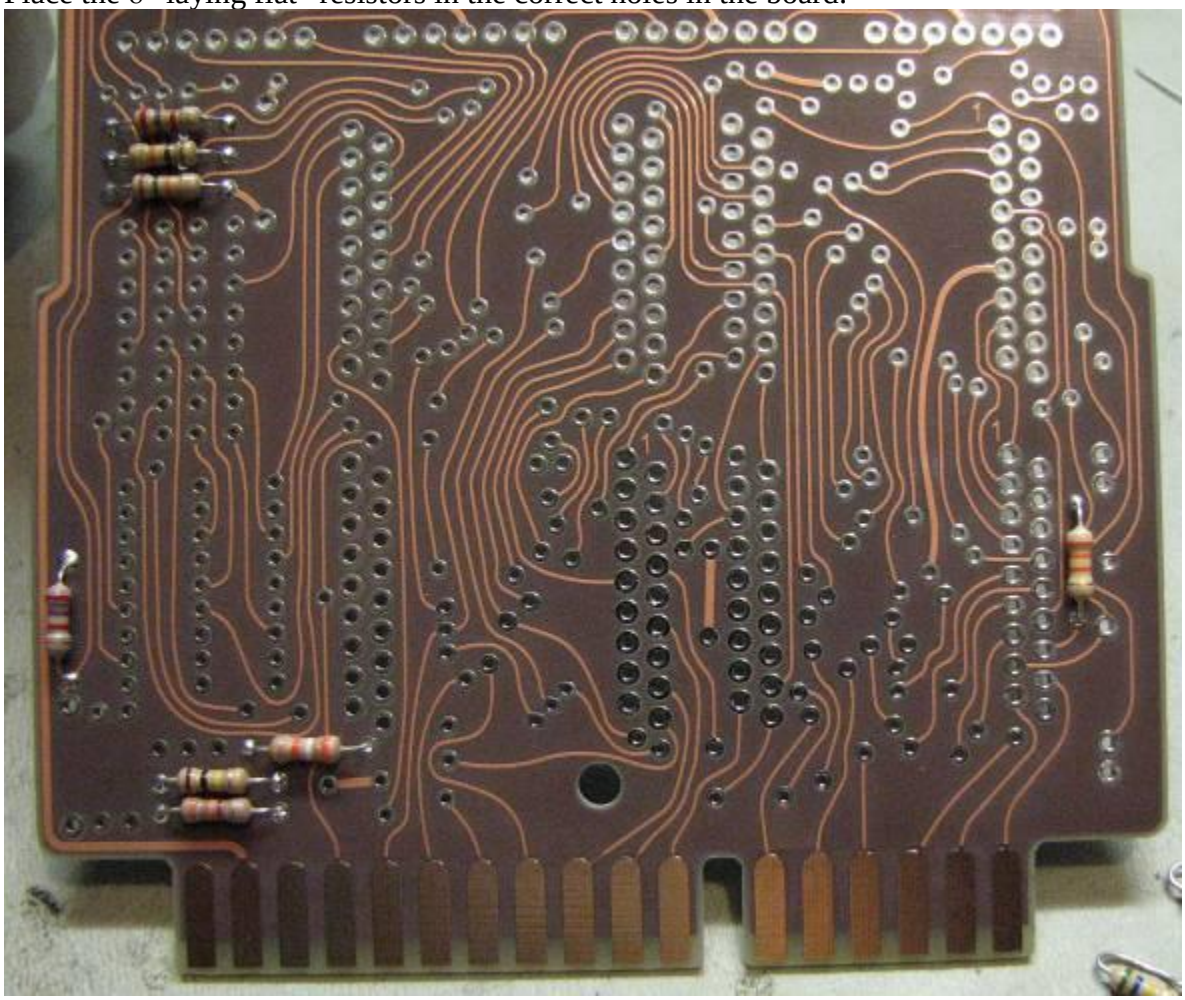
1x White capacitor
8x Brown Ceramic Disk Capacitors, approximately 12mm in Diameter

White and Red Heat Shrink tubing

Enough to cover the leads of the 14 resistors that are standing up on the board

It is best to build up the board with the shortest parts first. This allows you to place the parts on the board and then flip the board over, resting on the parts, when you go to solder the parts on the board. The order is not necessary, and I didn’t do this because I was too excited and wanted to see how the standup resistors with white tubing on them would look. At least I started out the right way.

Place the 8 “laying flat” resistors in the correct holes in the board:



You can match the color codes with the parts as seen in this photo or you can just randomly select a resistor if you want it to be different. The two sets of 7 resistors will be used for the stand-up section of parts. In the actual board each group of standing resistors had the same value (same colors). You can choose to do this or not – it is your board!

Resistors in real circuits can be placed in either direction. The gold band can go to the left or the right, so each real board may have them in either direction and there is no right or wrong way.

To place the resistor in the board, bend the wires up to form a “U” shape and then insert the wires into the holes as seen above. (They are shown above after I soldered them in). Be careful about finding the correct holes. The ICs do need access to the larger holes nearby, so we don’t want to mount a resistor in one of those holes.

After a resistor has its two leads placed in the holes, the resistor should be lying flat on the circuit board and the leads should be sticking way out on the back side of the board. You can bend the leads on the back of the board at a 45 degree angle or so to help keep

the part from falling out when you flip the board over to solder the leads to the circuit board pads.

You can do this one at a time or you can place all 8 resistors before you solder them.

Flip the board over and solder the leads to the pads on the back side of the circuit board. For these parts, the solder is only used to make the part stay in place and look correct. No actual functioning circuitry is being added so shorts or bad solder joints aren't much of an issue. If you end up also putting in the LED parts, those are actual electrical circuits, so the soldering is much more important.

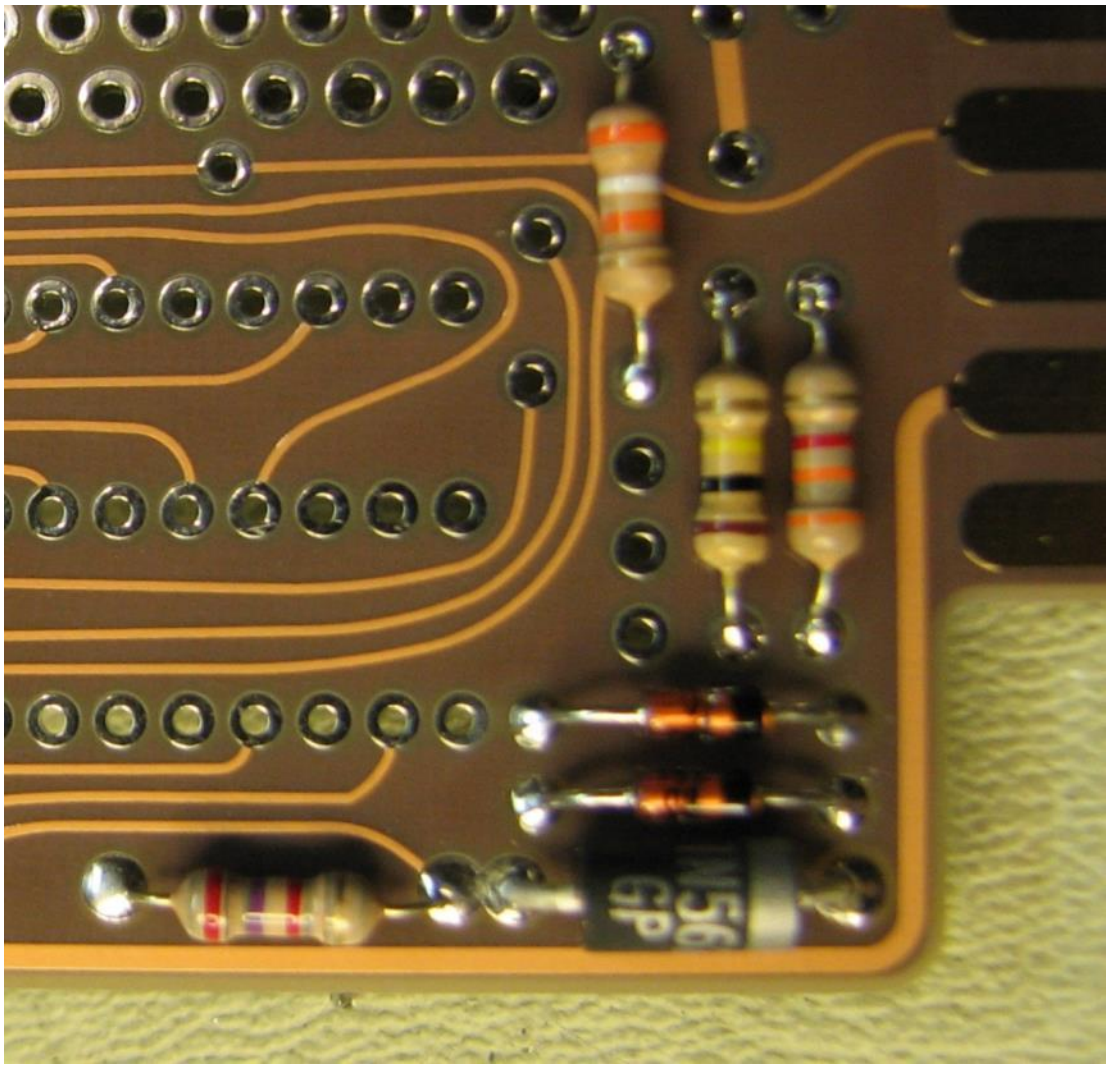
If needed, you could glue the parts in, but soldering is more accurate.

*** WARNING ***
Solder can contain lead and that is a poisonous substance, so be sure to keep the solder out of kids reach and wash your hands after handling the solder and before you eat or prepare food. It is best not to directly breath in the smoke when soldering, so a ventilated area is best and a light breeze from a fan can be very beneficial if you do not solder equipment designed to remove the fumes (much more expensive than the typical soldering tools most people have or purchase).
*** END OF WARNING ***

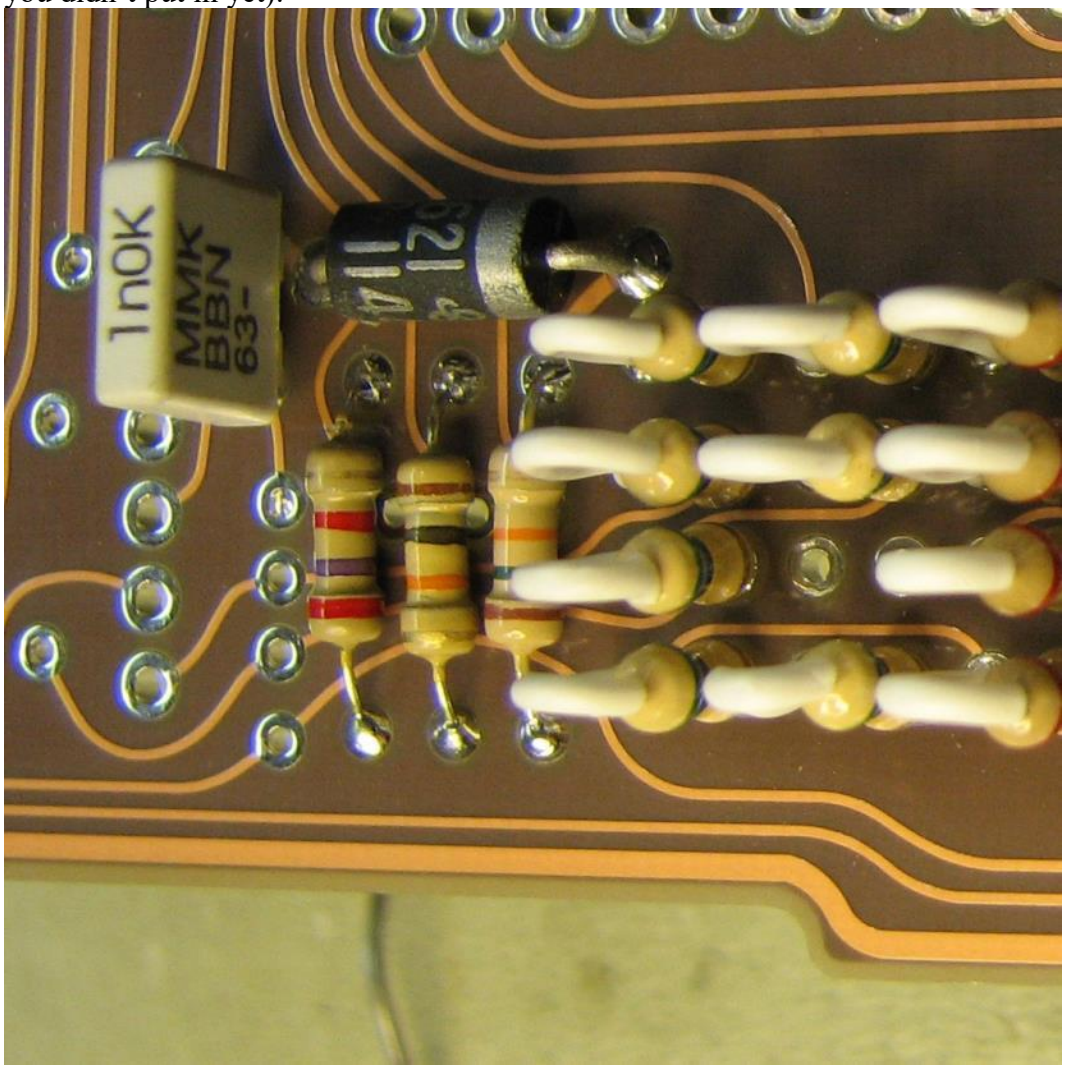
After the part or parts are soldered, cut off the excess part of the leads on the back side of the board. I use small diagonal cutters and cut the lead as close to the board as possible. The small stubs that are left can be fairly sharp, so be careful. Depending on how this is mounted to your belt, you may want to file them down a bit to remove any sharp edges. This is not normally done, but this won't hurt anything and since it is not a working circuit this should not cause any issues. When all done be sure and clean off any filings from the filing/sanding especially if you plan on building the operational LED circuit later on.

Add the 4 diodes, in the same way as you did the resistors. The parts should be flat on the board and the leads should stick out the back side and be bent to hold the part in place. Flip the board over, solder the leads to the board and then trim the excess leads from the backside of the board.

Here are the two red/clear diodes and one black diode mounted and soldered to the board:



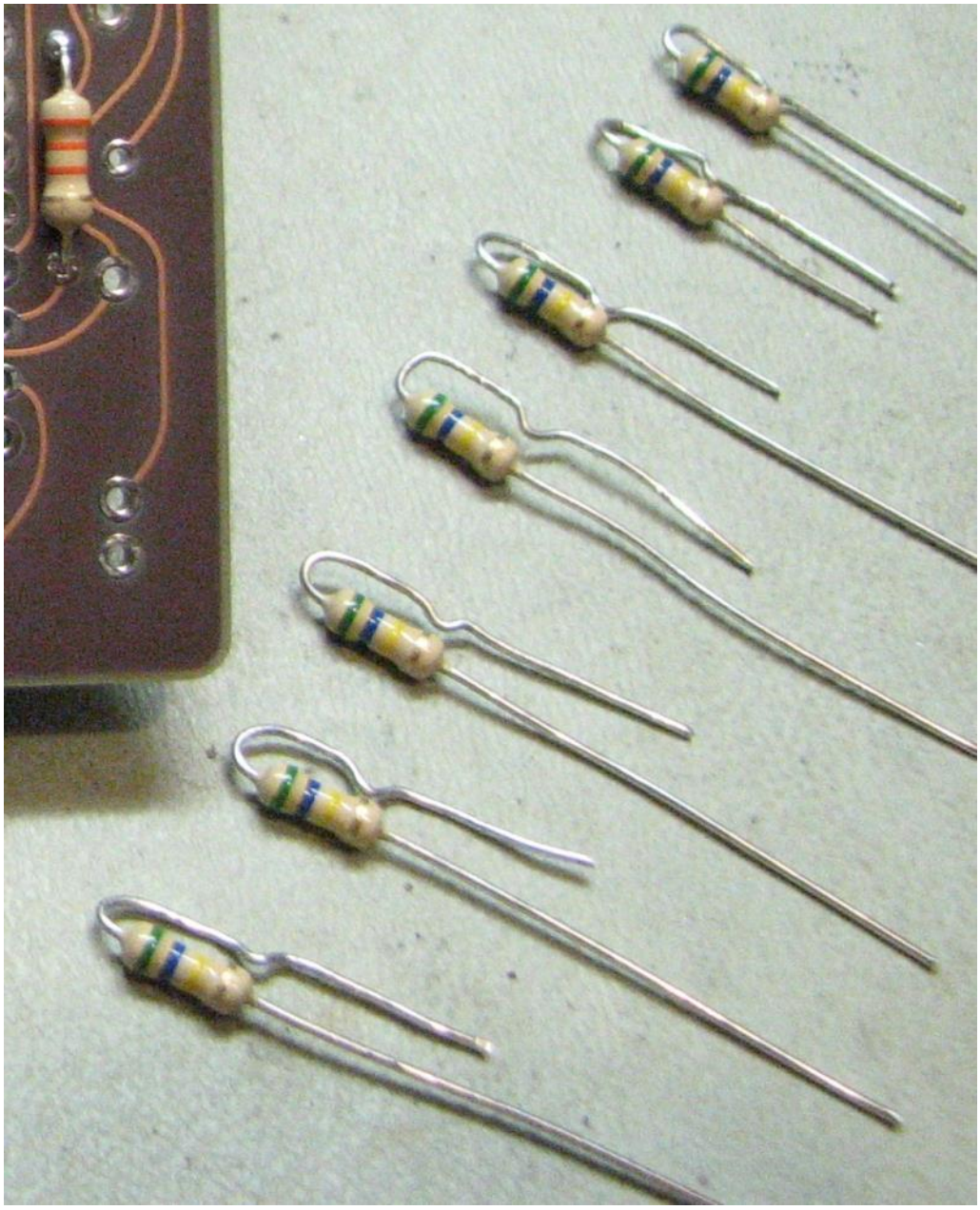
And here is the other Black diode (yes there are other parts mounted in this picture that you didn't put in yet):



Real diodes have polarity indicators and must go in the correct direction. They have a silver or black band to indicate a particular side of the diode for you to care about. Since this is non-functional, you can put them in "backwards" here and it is fine. In the real Calculator board they would always be placed with the same orientation, unlike the resistors that can be loaded in either orientation.

The standing resistors and the transistors are about the same height so you can place whichever one you want first. I chose to place the resistors first because I really wanted to see how they looked and they turned out great!

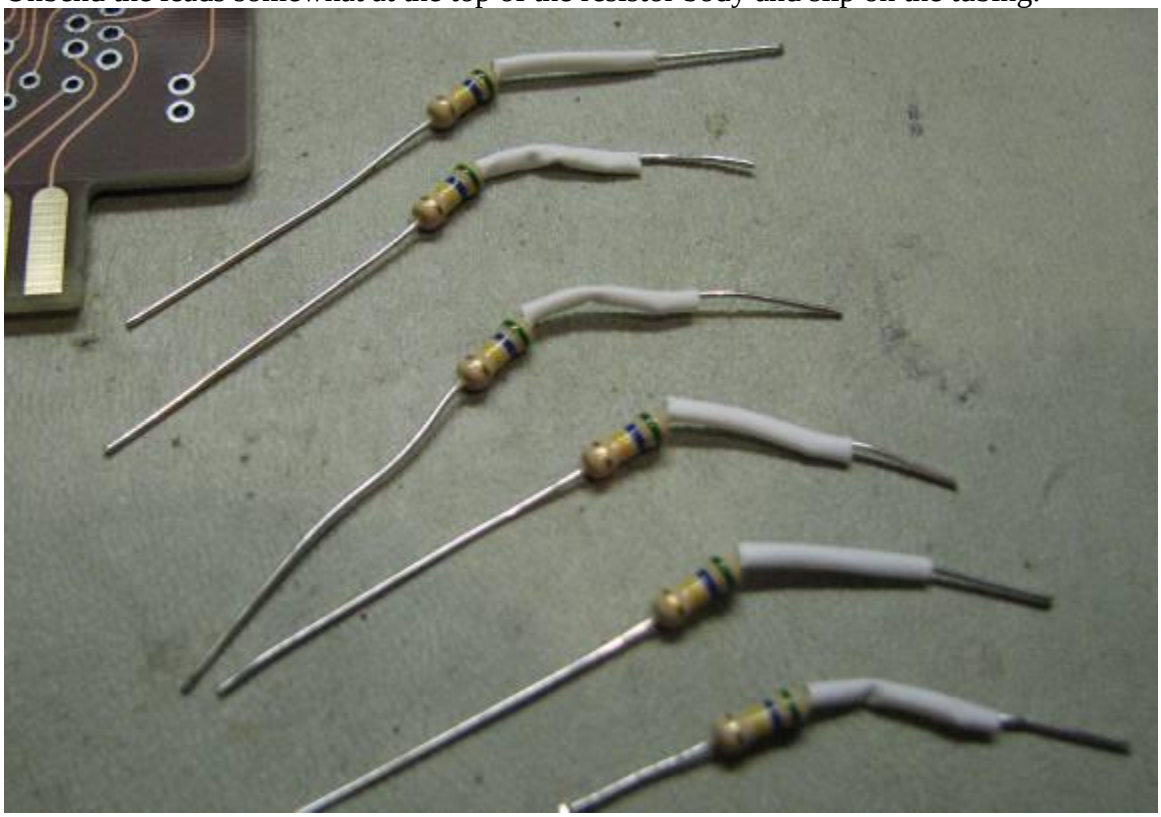
In the Sanyo board, the resistors stand up and one leg is folded over and gets a kink in it and then goes into the board. You can just make the lead form a very narrow “n” or you can add the kink if you want to have the resistors look more accurate. The parts can be oriented either way, but I like to have the Gold band on the bottom for all of the parts to make them look more uniform. I just bent the leads over by hand by making a nice arch at the top of the resistor with the lead. Then I used needle nose pliers to make a kink in the wire near the base of the resistor body.



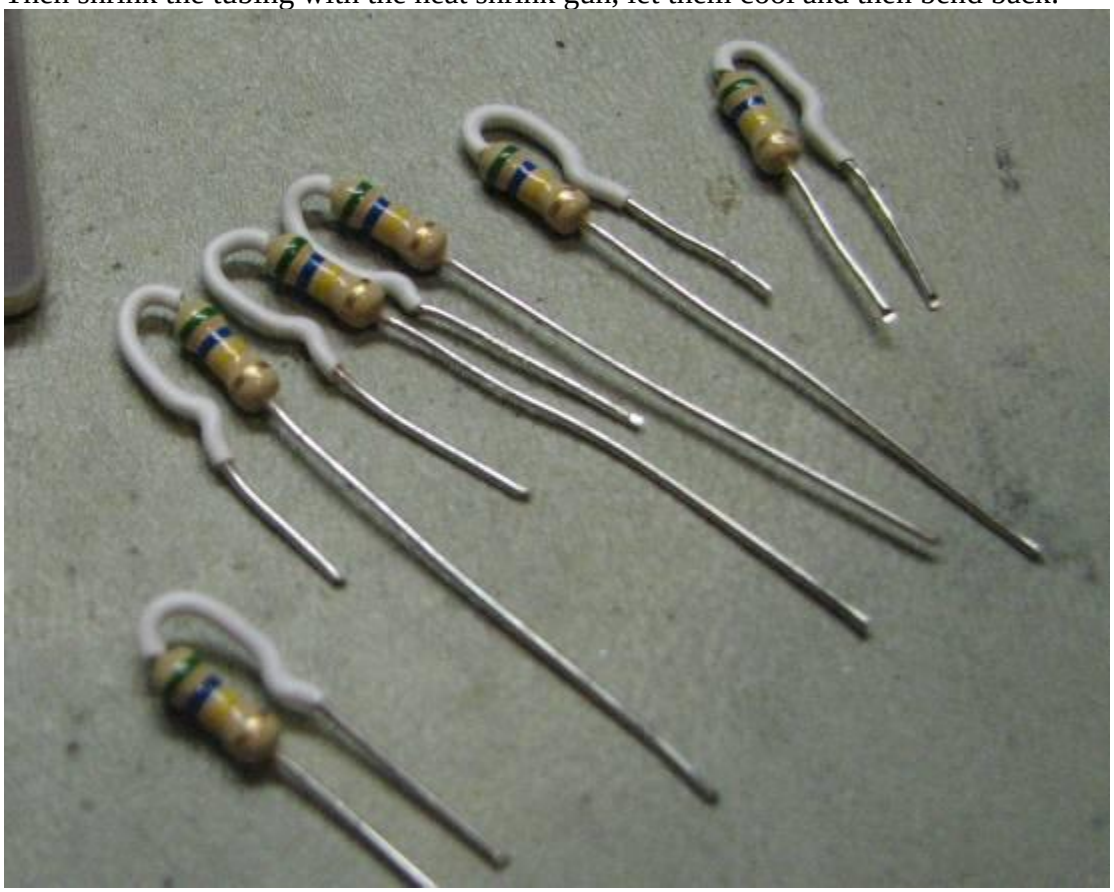
Then cut up the white tubing (white was used on all 14 resistors in the board that I used for reference but there are boards that have some or all of the resistors with red tubing) About a ½" of tubing for each resistor is needed, but depends on how you bend your leads. The tubing should go over the leads and extend from the top of the resistor to the bottom of the body of the resistor.

The tubing is a bit larger than ideal and if you use a heat gun (designed to shrink heat shrink tubing – hotter than a hair dryer) it will shrink down to a very snug fit and look even better. I found that the top bend would not be covered as well if you shrink the wire in this bent position, so I measured and cut a piece of tubing and bent the lead out to make the bend much less sharp, used the heat gun and then waited a few minutes for the heated tubing to cool before I bent the lead back to the tight angle shown above.

Unbend the leads somewhat at the top of the resistor body and slip on the tubing:



Then shrink the tubing with the heat shrink gun, let them cool and then bend back:



There should be seven same color resistors, even though only six were captured in the above photo.

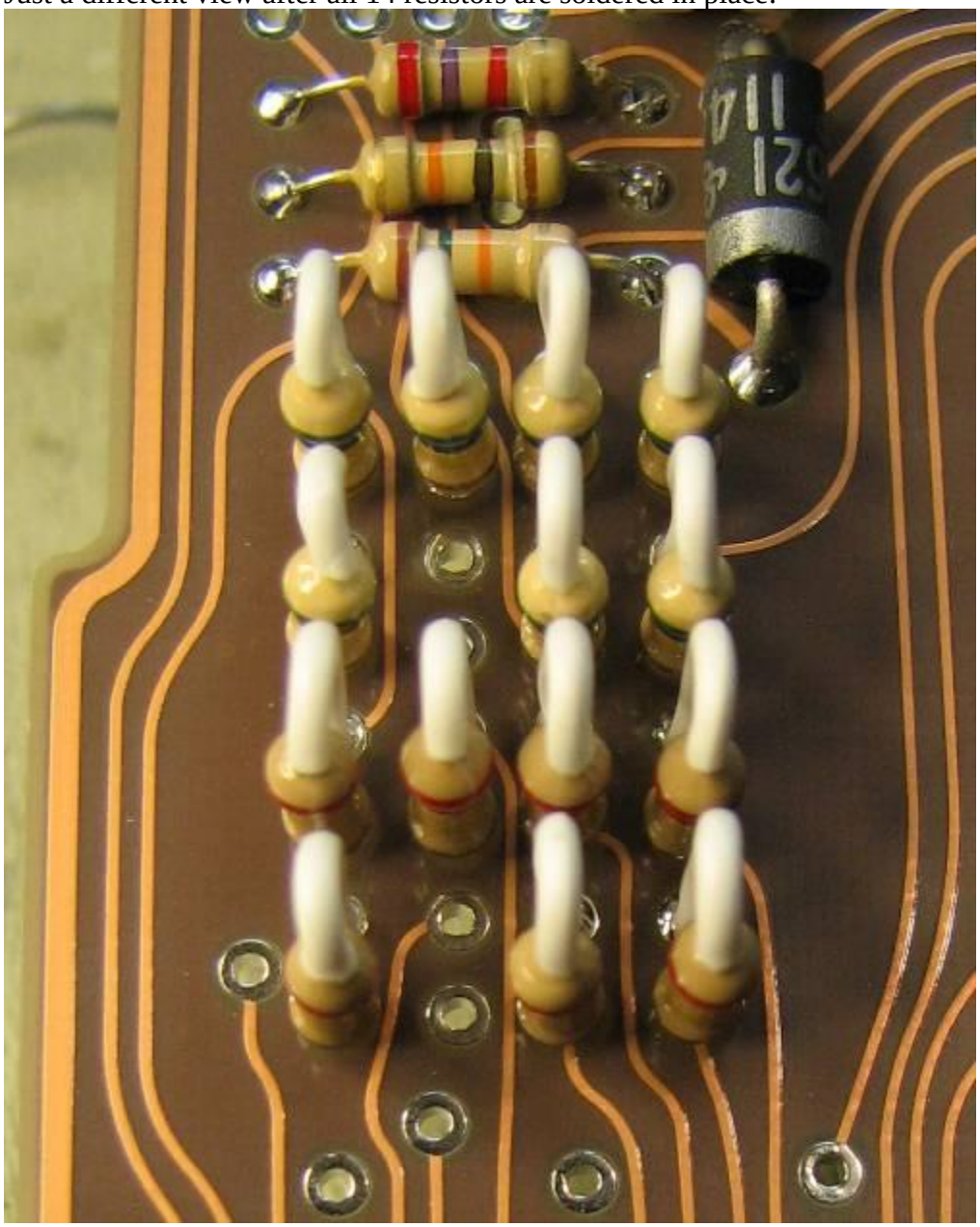
You can test place each resistor and use a standard wire stripper to cut off the excess tubing if it will hold the resistor up off the board. You want the part to stand fairly straight up and one side of the resistor should be very close to the board. See the reference photos on the next page.

Like before, place the leads through the board, you can bend the leads on the backside to hold them in place and then flip the board over, solder and then trim off the excess lead. I did use a trick to get them better aligned: Just solder the longest lead (the lead that does not have any tubing on it). Then you can position the part and adjust the tubing covered lead a bit before it gets soldered. Use your fingers or wider blade flat tweezers if you are adjusting the tubing covered lead. Pliers (and even your fingernails) can leave noticeable marks in the tubing if they are aggressively handled.

Now mount them all facing the same way with 4 across in one row and one missing in the second row.

Do the same with the other group of seven resistors. You can use either color of tubing, but on this board they are all using white to match the reference board photos.

Just a different view after all 14 resistors are soldered in place:



Next mount the transistors, the black devices with three wires coming out all on the same side.

The three wire leads should go in adjacent holes. Since the board spacing is a bit different than the spacing of the wires on the part, the exact height of the part depends on how the leads are bent and also how hard you push the part into the board. Try and get all 10 parts at about the same height. You can use the same trick as with the resistors: just solder one lead (the center) and then adjust the part to be vertical (no slanting!). If the part is higher or lower then the others, apply the soldering iron to the one soldered pad on the back side and pull or push the part from the other side of the board with tweezers or pliers. When the part is the correct height remove the soldering iron, let the joint cool (just a few seconds) and then let go of the part. Adjust the position of the part and then do the same for all 10. When they are looking very symmetric, flip the board over and solder the other two leads on each of the parts.

After soldering (and making sure they look about right from the top side of the board), trim off the excess portion of the leads.

Transistors also must be oriented properly in a real board so all boards should have the parts facing in a particular direction.

Here are the soldered transistors with the group of nine on the lower left portion of the board.

And the tenth transistor is mounted above those nine. The white cap is already loaded in this picture, even though you haven't put that part on yet.

OK, now you can locate the white capacitor and mount it in the position shown above on the far right of the photo.

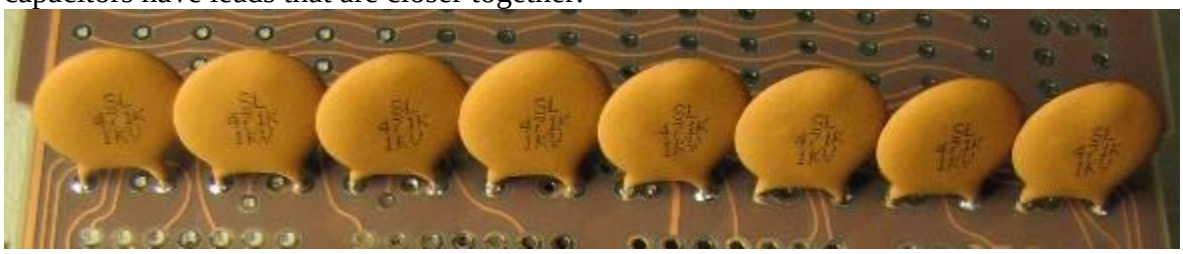
This cap can go in either way and you can decide which side you would like facing which way. The leads are a bit wider than would be ideal for this board, so it will sit a bit above the board and the wires will be bent to be able to get the part near the board. Make sure it is fairly straight, flip over and solder the wires then trim off the excess portion of the leads.

Now you can place the 8 larger brown ceramic disk capacitors across the board. Bend leads on the back side to hold them in place, flip the board over and solder then in. You may want to solder just one lead, make sure the part is positioned well, and then solder the other lead.

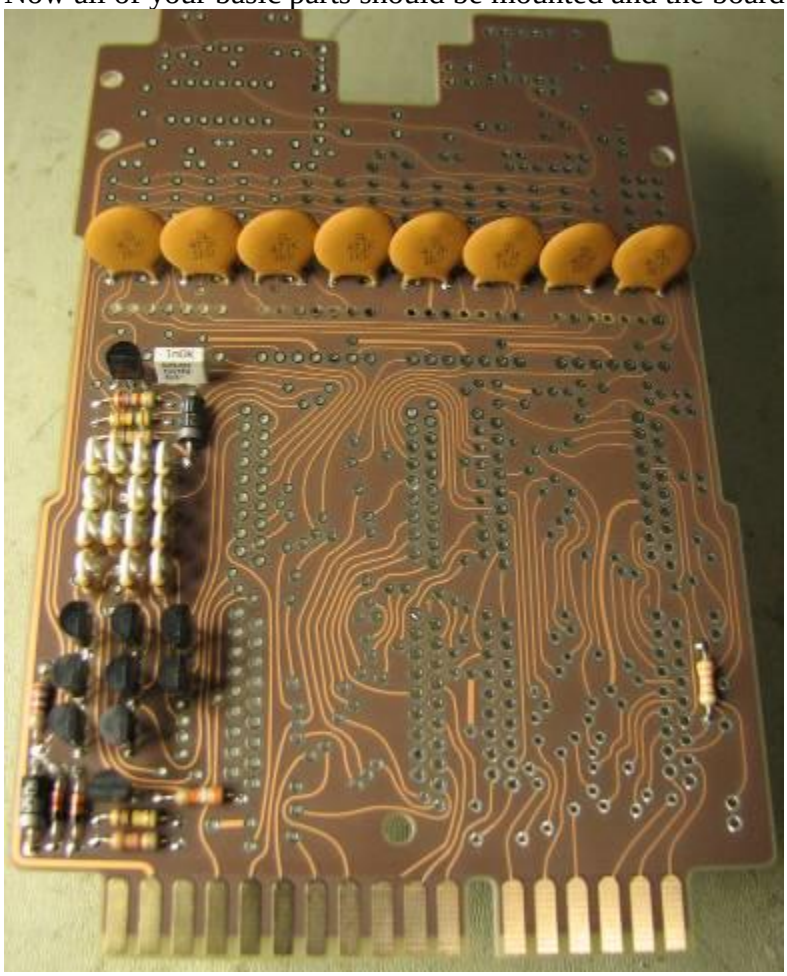
Some vintage caps may look like they have large indents where leads were pressed into them. These caps are covered in wax that may melt enough to reflow and the lines in

them will disappear when soldering them in place. You can also use a heat gun to warm up the part enough to melt the wax covering and have a nice uniform surface.

Some Capacitors have kinks in the leads. Just straighten those out with needle nose pliers and insert the leads into the holes. Some capacitors that you already have may have leads that are closer together. The board has extra holes that make this easier to mount. The capacitors here are shown with the wider lead spacing. Look between the two leads and you will see an extra hole near the right lead on the first four caps (on the left side of the board) and near the left lead for the other four caps. Use these other closer holes if your capacitors have leads that are closer together.



Now all of your basic parts should be mounted and the board should look like this:



“IC” Integrated Circuit parts kit assembly

There are 4 40 pin angled gold connectors included in this kit. Each connector has enough pins (and a few spares) for the 36 pins that are needed for each of the four white “Integrated Circuits” that sit on the bottom half of the board.

The procedure described for each of the four ICs will be identical.

The angled gold portion of the connector will end up being the visible part of the lead for the IC. The problem is that the black plastic portion of the connector is too close to the bend and would not look right. We want to keep the black portion of the part around for a while since it can hold the pins in place and at a great angle while we are soldering the pins in place. If you had to solder each bent pin in place individually it would be very difficult to make them look uniform.

So… use the heat shrink gun to heat the straight portion of the connector. If you get the black portion too hot it will melt and deform, messing up the alignment of the pins a bit, so try not to melt that. You can cut the 40s in half and work on each section of 20 separately if it is easier.

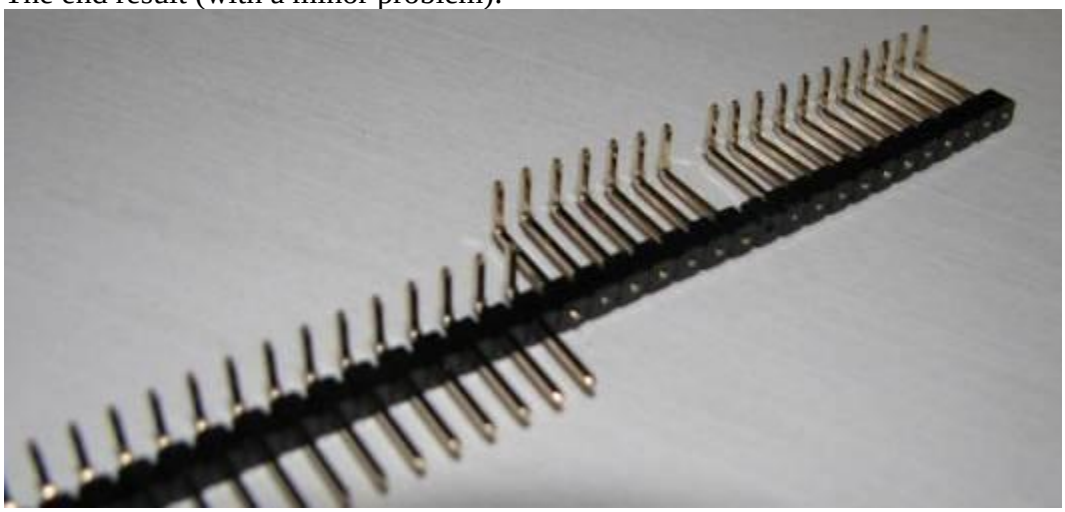
Heat up a bit more than half of the pins since you are holding on to some of the others and you don’t want to burn your fingers. I heated them with my heat gun for about 8 seconds. The pins should be hot enough to loosen the connection between the pins and the black plastic. On a hard surface that will probably get marked up a bit, put the heated pins against the surface (only the half that were heated) and use something like very narrow pliers or heavy duty tweezers and push down on the top of the black portion and slide it down to the hard surface.

All of the pins may not move at the same time, you may have to work from side to side pressing on the black portion and having it slide just a little. Once you get all of them started, the black portion will slide down much more easily.

Here are photos of one of the first pieces I was playing around with. Heating up the leads directly (and not the black plastic very directly):

Pressing down on the black plastic while the leads are still hot (against a hard surface):

The end result (with a minor problem):

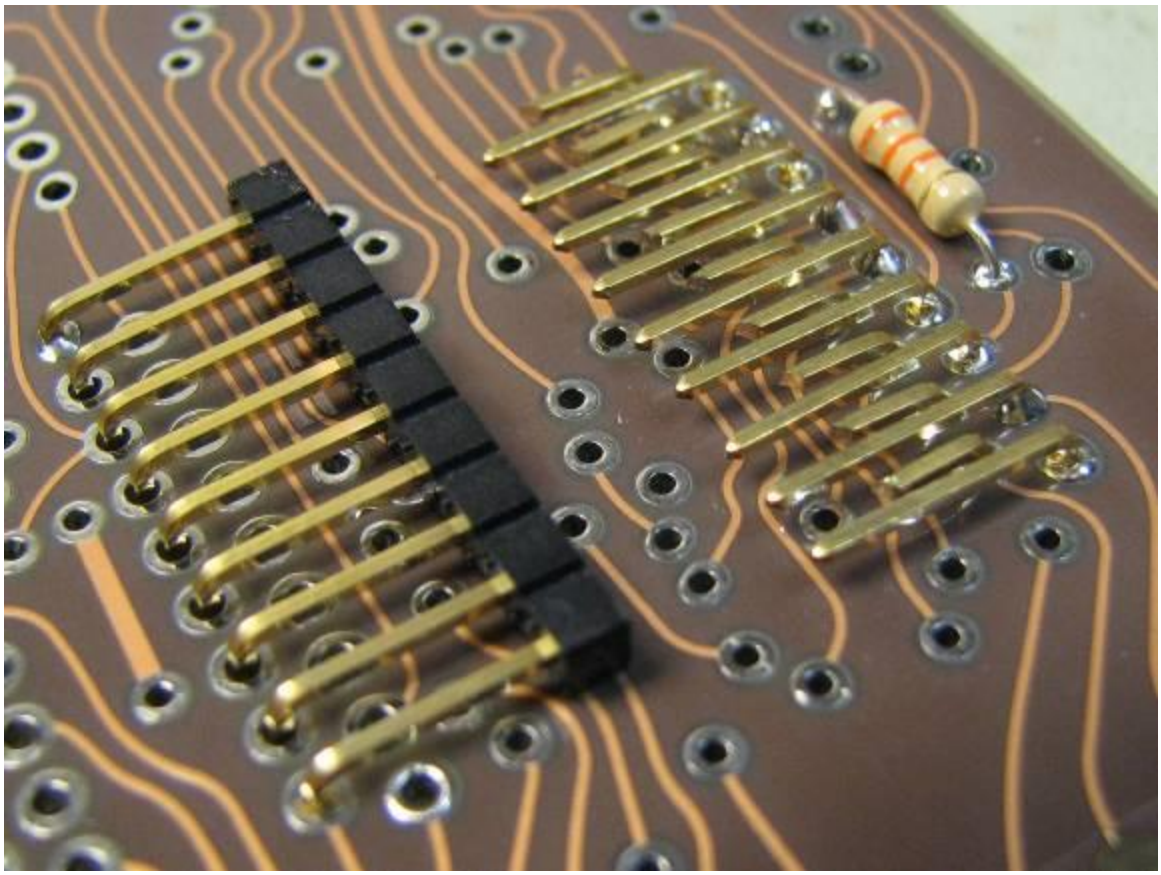


Notice that one of the pins fell out in the middle of the section I was heating up. You can just put the pin back in, but they can be lose enough that you must be careful when handling the parts after you pressed the pins up to the edge of the black portion like in the upper right hand portion in the photo above.

I also tried cutting the 40 pin parts into the 9 pin sections first and just applying pressure like shown above and the black plastic was able to be moved down to the end without any heating of the part.

Once you have the 40 pins positioned like the upper right hand portion of the photo above, you need to cut the black part into 4 sections of 9 pins each. The extra pins are left as spares in case you lose some from your main sets of 9 pins.

Now you get to place them on the board and solder them down. A single IC has 4 sets of interleaved pins. The holes on the board are the in two sets of 9 holes that are staggered. Work from the outside in (it works better! I had a problem working from the inside out and had to trim the leads on the top of the board after they were soldered in just to be able to slide the black part off).

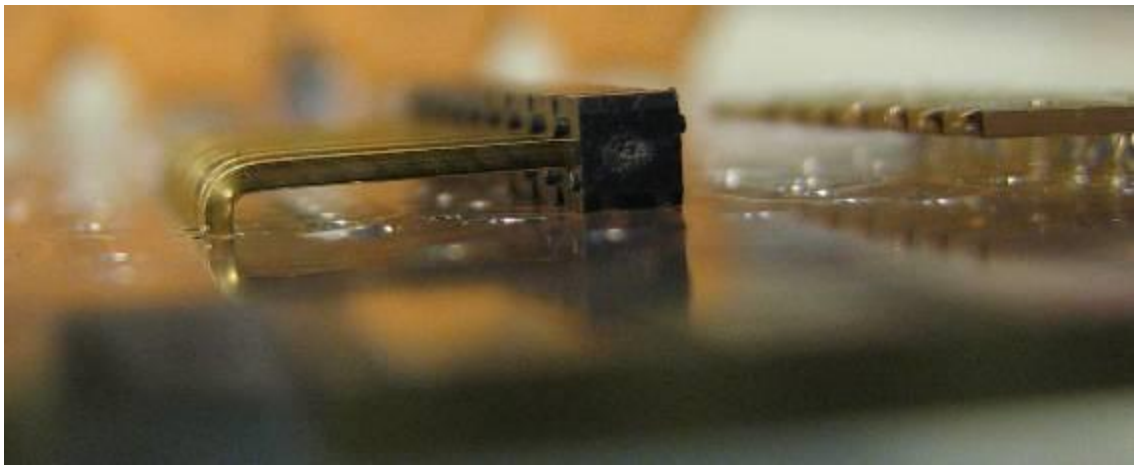


Ignore the two sets of soldered in parts on the right side of the photo – that was when I did inside columns first – don't do that!

The part on the left has the 9 pins set in the outside set of 9 holes. Notice that only the top and bottom pins are soldered. Start with soldering just one pin and adjust until the pins are level and horizontally straight. If the black portion is slanted (some leads at one end are sticking in or out differently than the other end) the pins start to become slanted and you don't want that.

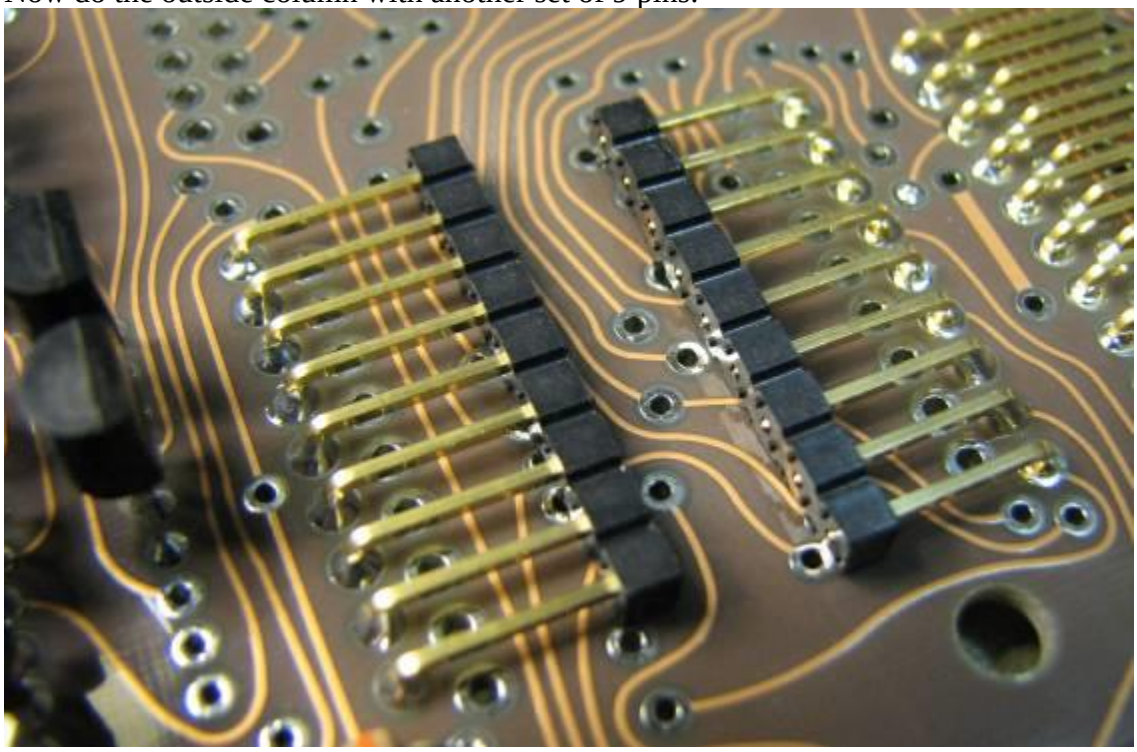
All soldering is done on the backside of the circuit board. You should hold the part in place with your finger when soldering the one pin down. Hold the part at the opposite end of the part so you do not burn your finger that is doing the holding.

Here is a low angle shot to show that the leads are parallel to the board and the height is determined by the black plastic part. It does allow the leads to be very uniformly placed:



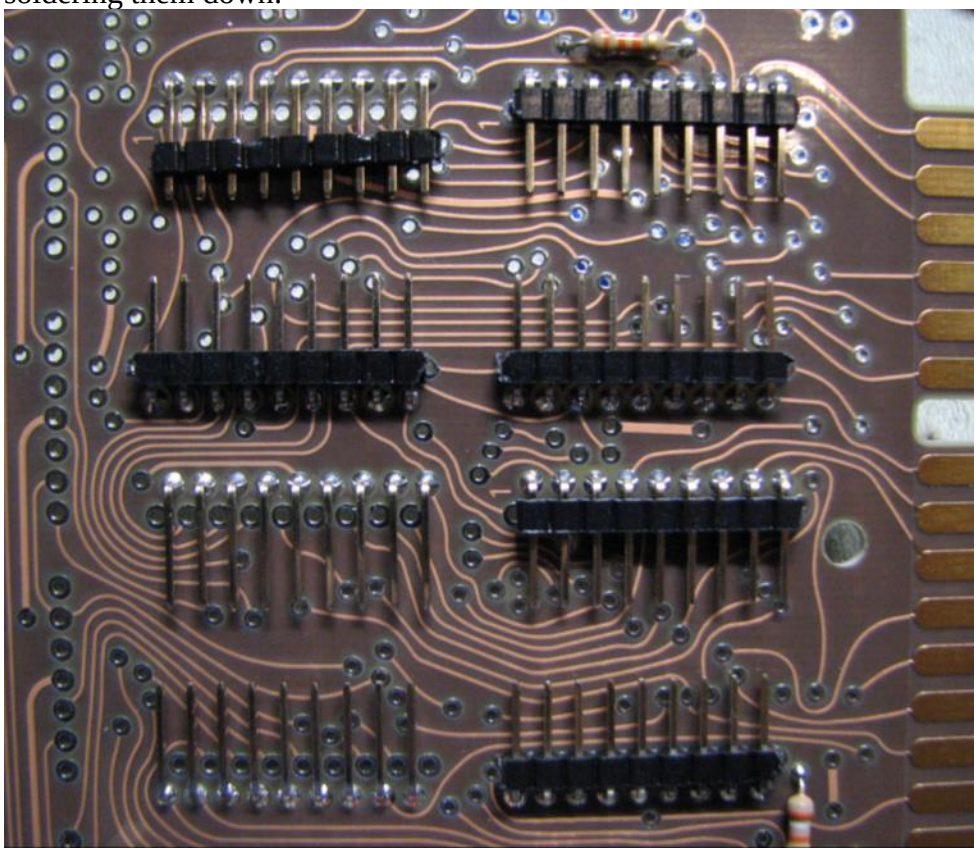
When one side looks good, solder down the pin at the opposite side of the 9 pins and make sure it also looks good. When you are satisfied with the placement, you should now be able to solder down the middle 7 pins.

Now do the outside column with another set of 9 pins:



I also tried moving the black piece back in the original position after I moved it without heat. The parts sit very nicely on the board, so the pins were more level than when I left the black part all the way at the end.

Here is a photo that has most of the black parts in the original position when I was soldering them down:

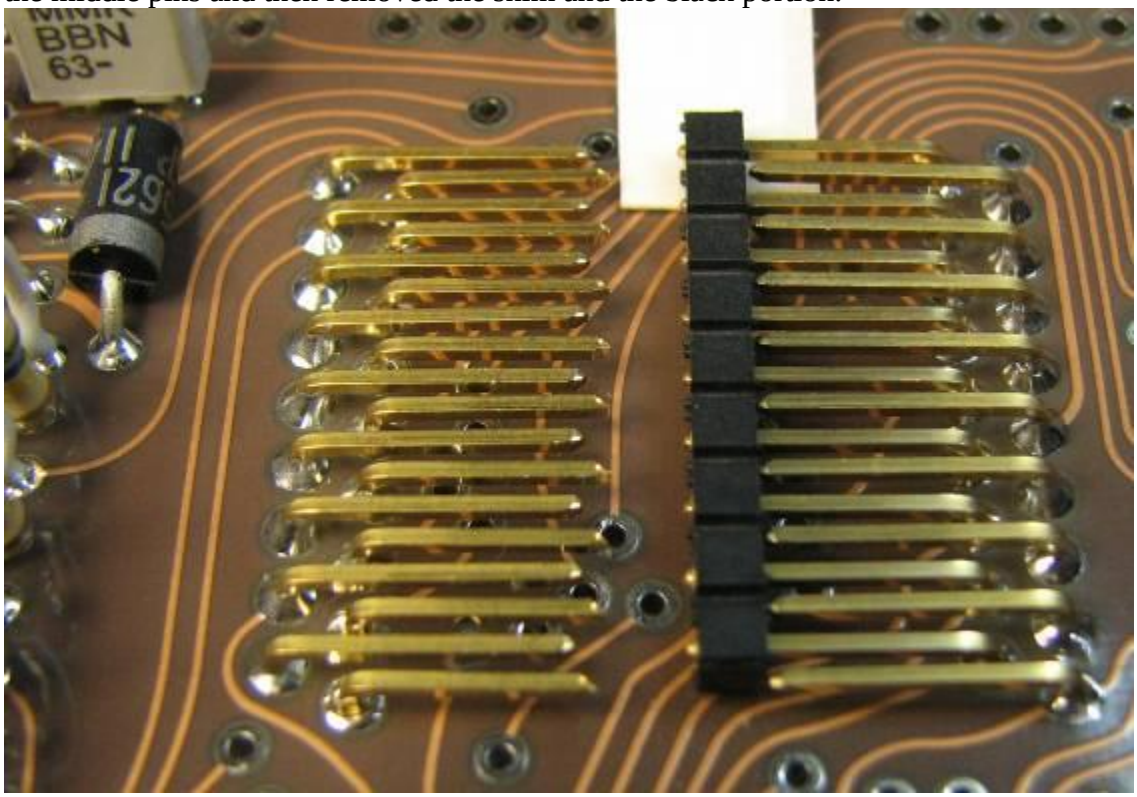


The next step is to slide off the black portion and once you do that you do not want to solder any of the pins again. The black portion is what was holding them in place so without it the pins can move around considerably and it will be a pain to get them back in place. So now slide off the black pieces so there is room to place the pins for the inner columns of pins.

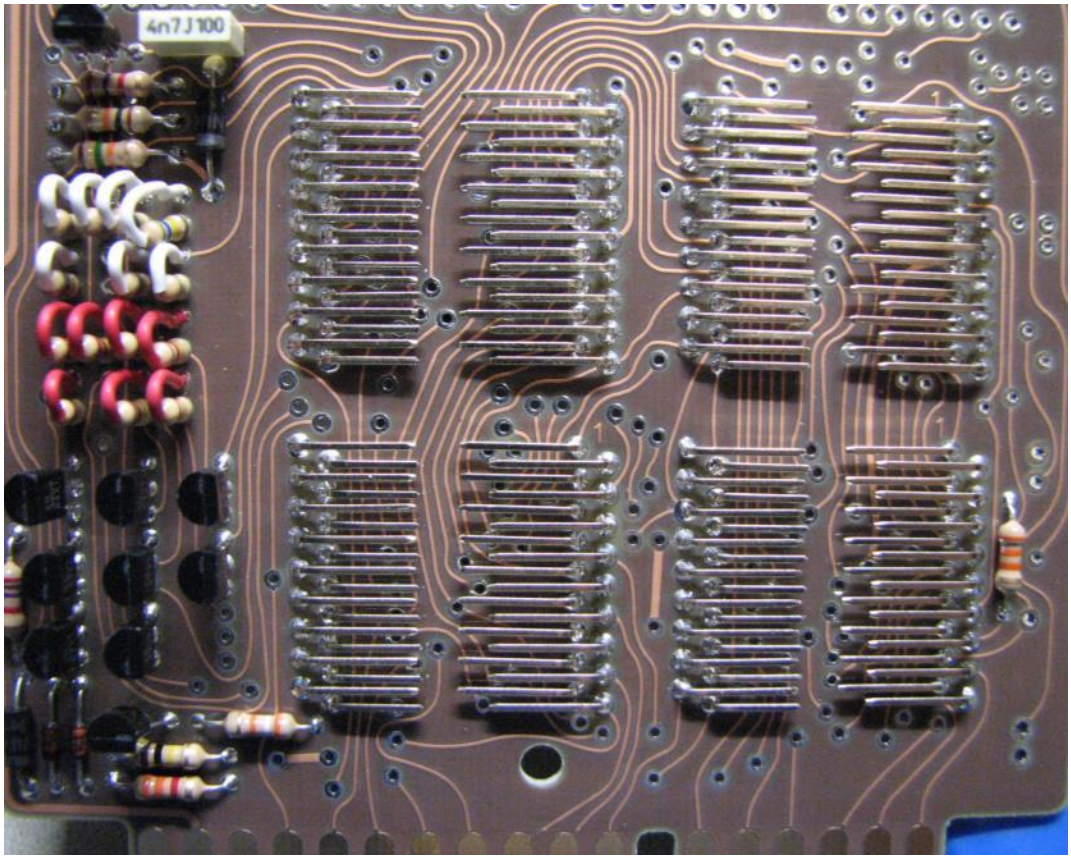
I did forget to solder the middle pins and when I pulled off the black part the 7 middle pins just fell out. After a mild panic, I just individually put the pins back in the middle positions of the connector and then slid the black connector w/7 pins back onto the 2 soldered down pins. It takes a bit of work and the outer pins do get bent upwards a little but it can be done. Got the whole thing back into position and then I soldered down the 7 middle pins.

The inner columns should be done one at a time. They also need to be level with the outer pins. Here I am showing the last of the 4 sets being placed and I used a piece of

paper to shim the connector to get it level with the outside set of pins I can no longer adjust with the soldering iron. When they looked level with the others, I soldered down just the outside pins and verified the placement. When it looked good I soldered all of the middle pins and then removed the shim and the black portion.



With all of the pins soldered and all of the black portions removed, here is what the board looks like:

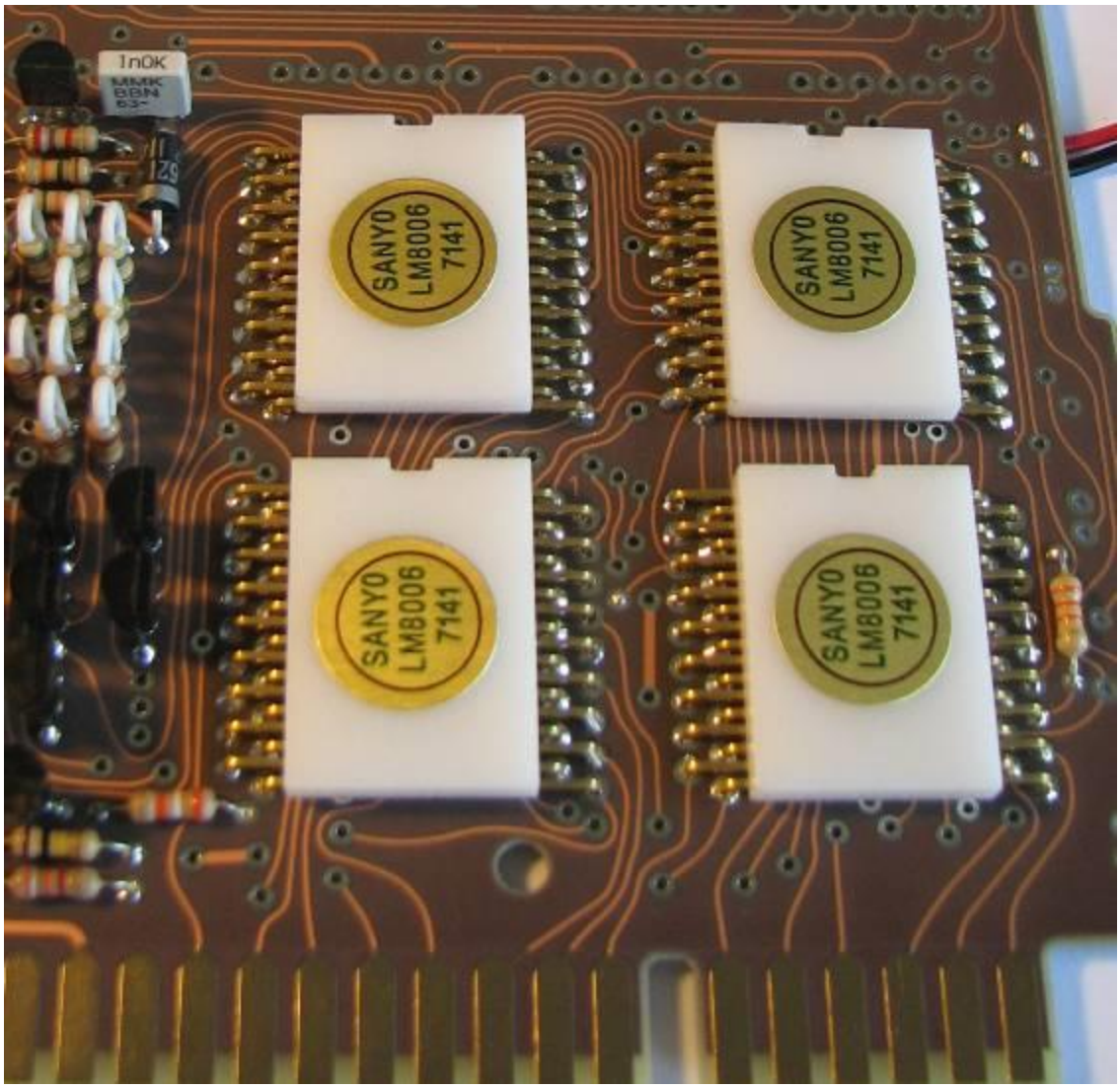


Grab the white (thinner) laser cut piece of acrylic and peel off the protective paper coating on both sides. One side is glossy and the other has a matte finish. I chose to have the matte finish on the top side, but which ever you like best use that.

I then put the gold foil stickers on and roughly centered the sticker on the part. In the actual parts, the labeling was sometimes at a small random angle, but I chose to make them all straight and nearly identical.

After the labels are put on, the parts need to be attached to the leads on this board. I used Loctite Ultra Gel Control Super Glue. A few drops on the inside tops of the inner portions of pins from all four columns. I did not put glue on the outside pins and only on the inside portion of the pins so no glue would reach the edge of the acrylic part and show. Then I carefully positioned and centered the part on the pins and wait a few minutes for the glue to dry. I did this one at a time, since I tended to bump the other pieces I wanted to make sure they were firmly attached before moving on to the next one.

Others have suggested roughening up the underside of the plastic parts for better glue adhesion. Also consider using an epoxy instead of superglue.


1n0K
SANYO
LM8006
7141
SANYO
LM8006
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7141
SANYO
LM8006
7141

Now for the Black ICs...

I decided to apply the dry rub on labels before mounting the parts to the board. I cut the rub-ons into the individual labels:

Then use a piece of cellophane tape to hold it in place while it gets burnished:

Try to only rub on the white lettering directly and not just across the entire surface. There is adhesive over the entire surface of the transfer, so you do get extra goop on the part if you just rub across the entire surface. Notice the notch on the left and the lettering is right side up.

Peel up the tape and carrier from one side and make sure all of the lettering is transferred. By keeping the other side still taped down if something didn't transfer this will help keep it all aligned.

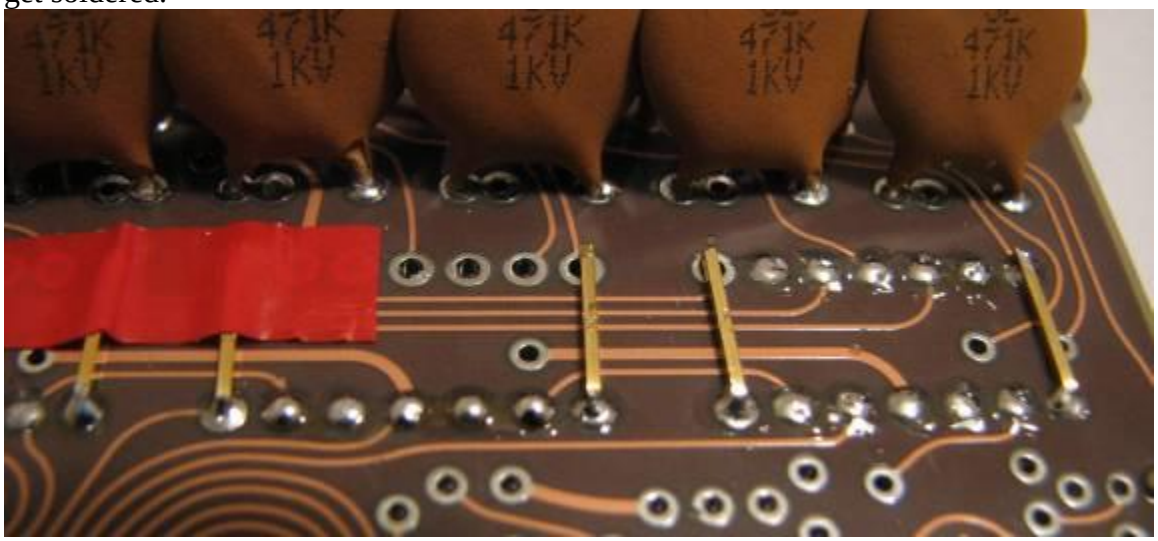
When removed, you can use the other portion of the rub-on (the backing that was keeping it from stickling to something else) to place over the finished part and rub down the whole thing again to make sure it is well attached to the black part.

Tips for rubdown application from the dry rub manufacturer:

- Remove backing sheet and place the rubdown in the appropriate place.
- It is important not to move the sheet once you start burnishing the letters.
- When burnishing, be sure not to miss any part of the letterforms, especially the thinnest parts. Also, try to burnish only the letters to avoid transferring excess adhesive from the back of the sheet. You will see a slight change in color as the rubdown releases.
- When complete, slowly remove the sheet, starting with one corner and taking care that the entire rubdown is releasing. You may need to reburnish any part that was missed.
- Once complete, place the backing sheet over the rubdown and reburnish lightly.
- Excess adhesive can be cleaned with a solvent, such as Bestine®, a rubber cement thinner. Carefully wipe the rubdown area with a soft, cotton pad with the solution.

I haven't tried any solvent and since this is on acrylic, you should test any solvent on the bottom side of the part to make sure it does not do something whacky to the surface you want to clean.

You can glue the part directly to the board or you can use your spare pins to have the part lifted a bit off the board. I chose to add the pins and am not sure it makes much difference. I used electrical tape to hold the pins in place when soldering on the back side of the board. The pins had to be trimmed a bit not to go passed the other set of holes that get soldered.

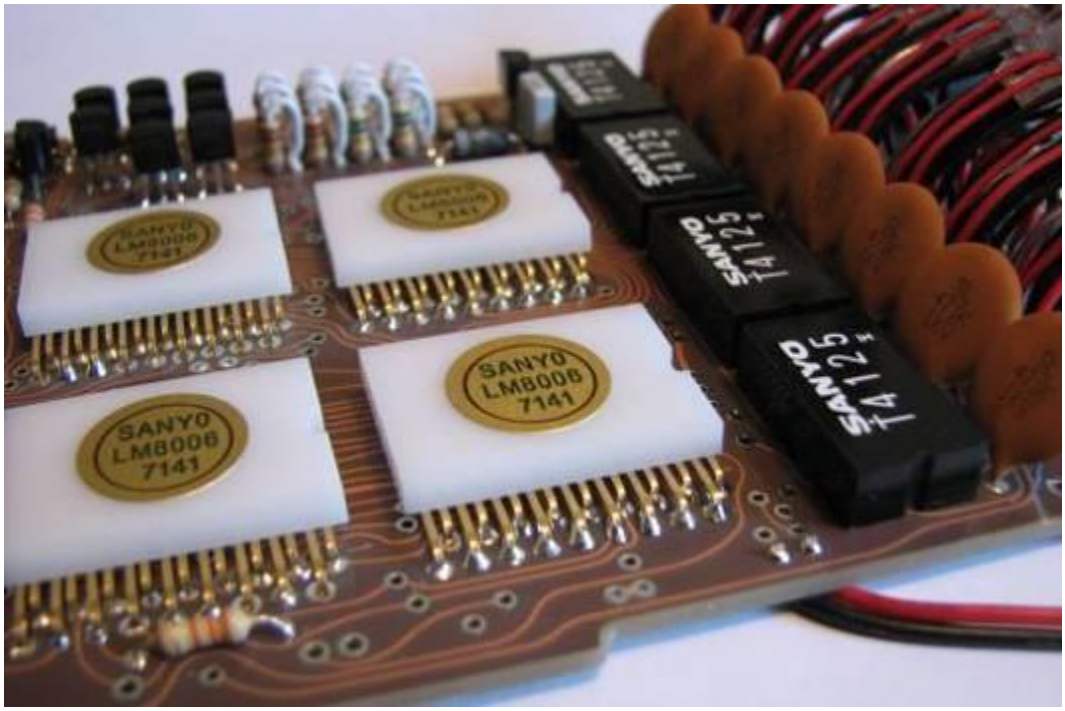


I then placed a drop of superglue on the middle of the two pins and placed the black part on them and lined it up. I set all 4 on and spaced them about right and then glued in one of the middle ones and then worked outward.

Others have suggested roughening up the underside of the plastic parts for better glue adhesion. Also consider using an epoxy instead of superglue.

All of the black parts are mounted with the indent to the right and the lettering upside down with the board gold edge fingers pointing down. See the reference photos below.

Here is the end result (yes the display tubes are in this shot and you haven't mounted those yet!)



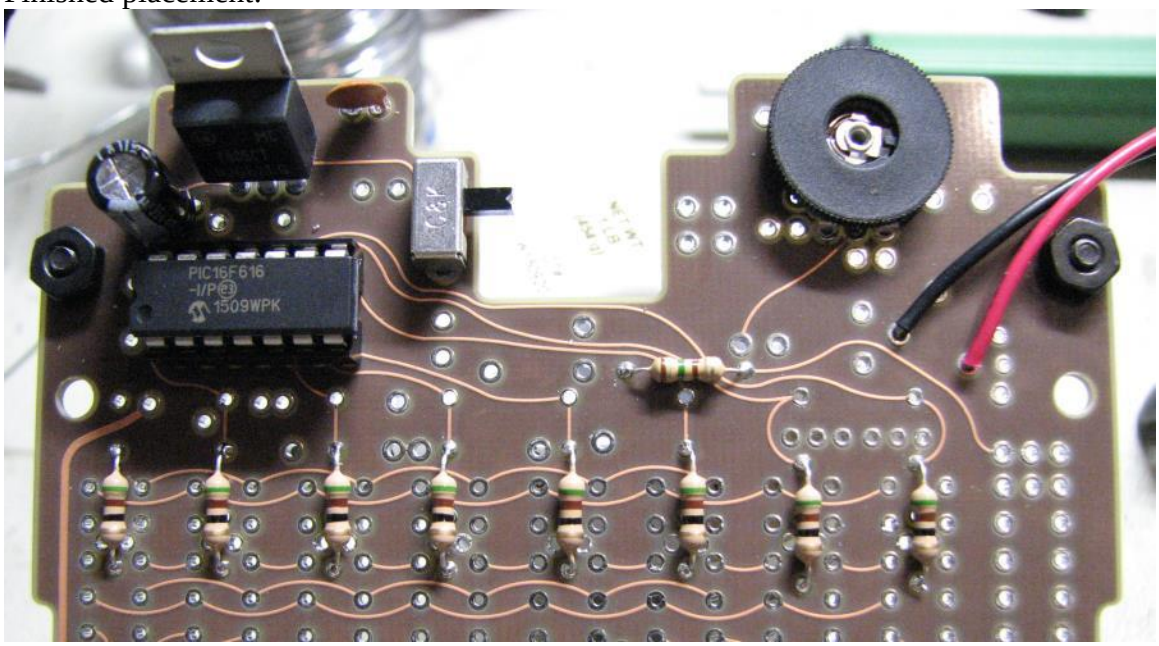
"Display" circuitry parts kit assembly

The Display driver circuitry is mostly installed near the top of the board. The Battery connector is soldered to the board in one of two different places (you choose which one you want) either the area below the thumbwheel pot or the middle of the right hand side of the board.

The kit does contain some small loose parts (like the switch) so be carful when opening the parts bag. Seven of the parts should be placed in a small pink piece of static dissipative foam.

There are seven components and 9 resistors that need to be soldered to the top side of the circuit board and are show installed in this photo.

Finished placement:



Notice that the single horizontal resistor has a color code of Brown-Green-Brown-Gold and the 8 vertical resistors have a color code of Green- Brown-Black-Gold. The correct resistor placement is critical.

On the back side of the board there are white silk screened indicators that will help you make sure the parts are in the correct location. Normally the silk screen is on the top side to help you build, but the Sanyo board we are emulating did not have any silk screen on the top side and so this makes the board look more like the original even though it does make building a bit harder.

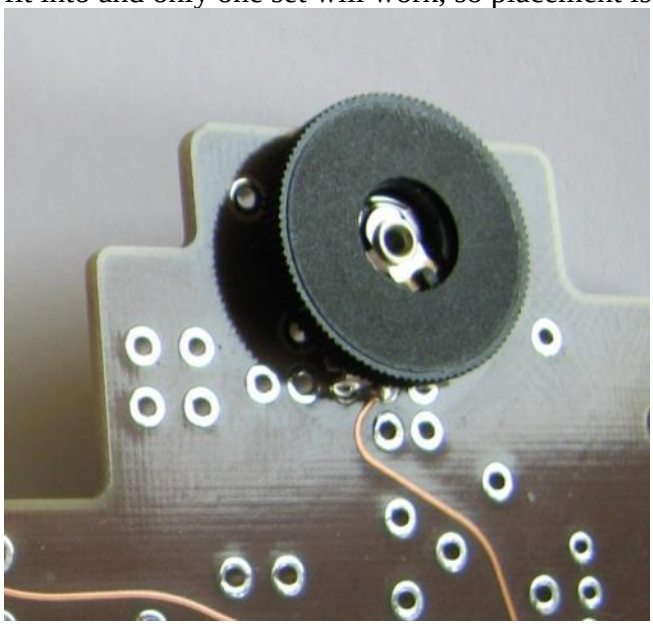
The board is typically built with the shortest components first, but you may already have the “BP” parts installed and they will hold the board up off the surface when you flip the board over to solder. This is fine, just be aware that the components can fallout or shift positions when flipping the board over to solder in the components.

The soldering done for this kit of parts is important and since all of the parts are functional and shorts or “cold” solder joints (non functioning solder joints) can cause the circuit to malfunction or not work at all.

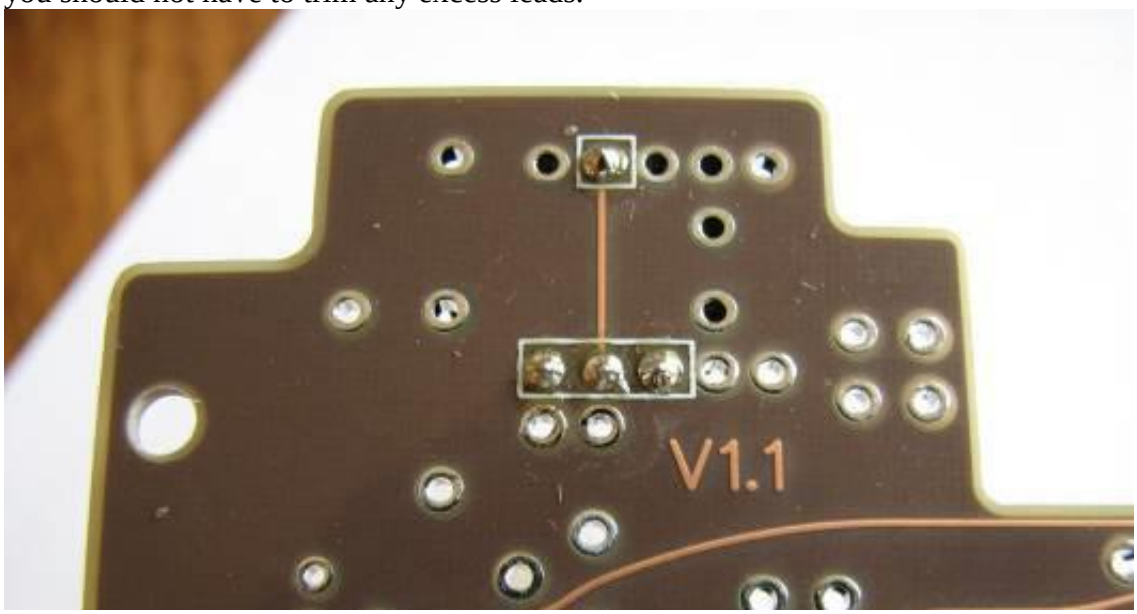
*** WARNING ***
Solder can contain lead and that is a poisonous substance, so be sure to keep the solder out of kids reach and wash your hands after handling the solder and before you eat or prepare food. It is best not to directly breath in the smoke when soldering, so a ventilated area is best and a light breeze from a fan can be very beneficial if you do not solder equipment designed to remove the fumes (much more expensive than the typical soldering tools most people have or purchase).
*** END OF WARNING ***

Let’s get started!

Looking at the front side of the board, at the upper right edge we want to place the potentiometer – it has a large black disk on top that you use to adjust the speed of several different available patterns. The potentiometer has 4 leads that will go through the circuit board: 3 on the bottom and one at the top. There are several holes available that this will fit into and only one set will work, so placement is critical!

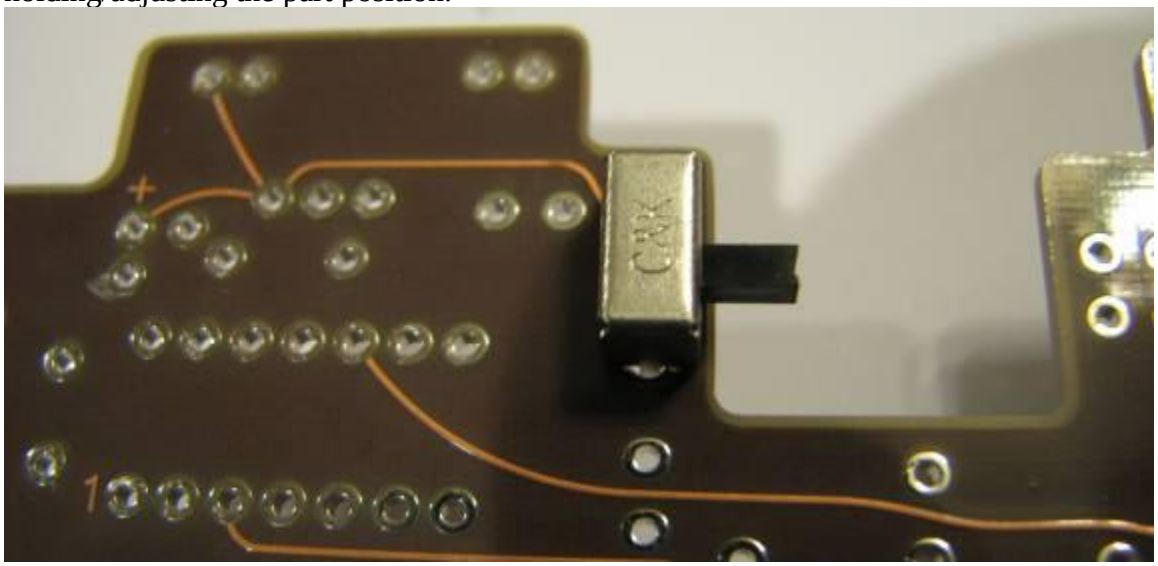


The back side of the board has white rectangles drawn to indicate which holes the potentiometer should be placed in and you need to solder all four leads (pins) in those holes. You can solder one and then make sure the potentiometer is sitting flat on the board. The leads should only stick through the bottom of the board a short distance and you should not have to trim any excess leads.

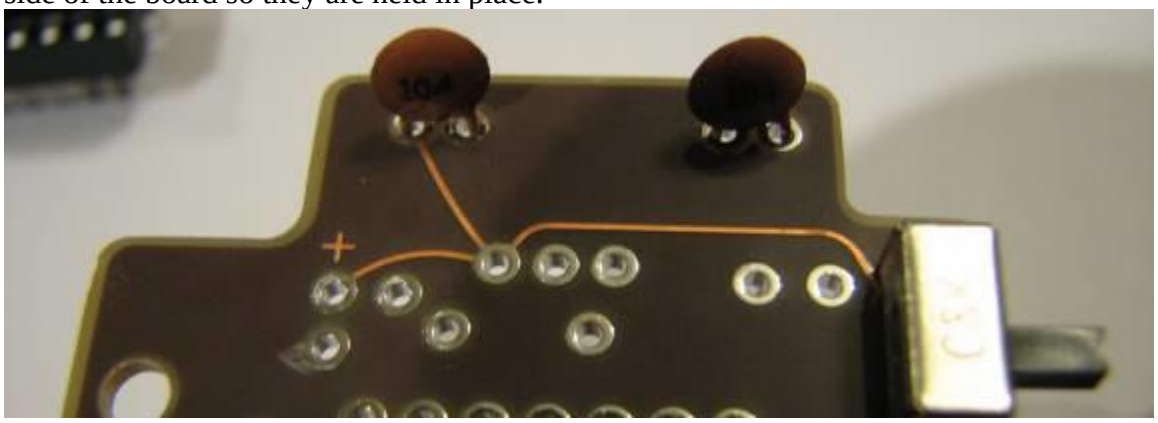


Next place the small slide switch (the main power on/off switch) on the board and solder it on the backside. You can see this metal rectangle in the center of the picture below. The black slide portion of the switch should be facing to the right (like in the photo) or it will be very difficult for you to operate when the Gizmo is finished.

The switch will fall out of the holes when flipping the board over to solder if there is nothing to hold it in place, so use some electrical tape or just your finger when you flip the board over and make sure the switch is resting on a hard surface when you go to solder the leads. You may wish to solder just a single lead then flip the board over and make sure the part is sitting flat against the board and re-solder the lead while holding/adjusting the part position.

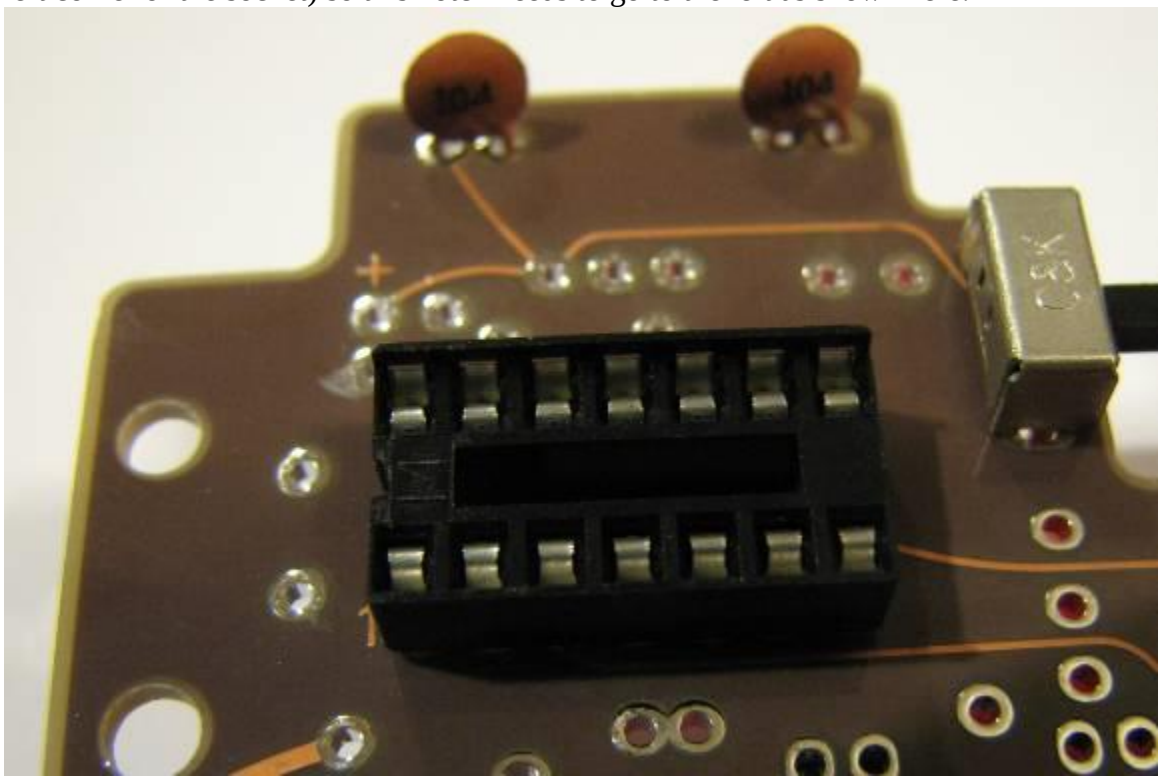


Next let's put in the two small brown ceramic disc capacitors. Looking at the front side of the board, they are placed at the upper left edge of the circuit board and are at the top of the photo above. They can go in either way so just choose which side you want the writing to face. Place the parts in the holes and then spread the wires apart on the bottom side of the board so they are held in place.



The bottom of the board has two ellipses to indicate the position of the caps. The leads are fairly long, so after soldering you will want to trim off the excess leads very close to the board. Small diagonal cutters work very well for this.

Next we want to solder in the 14 pin black socket that will hold the microcontroller that controls the LEDs. The socket does have a notch that we want to be near pin 1 (the lower left corner of the socket) so this notch needs to go to the left as shown here:

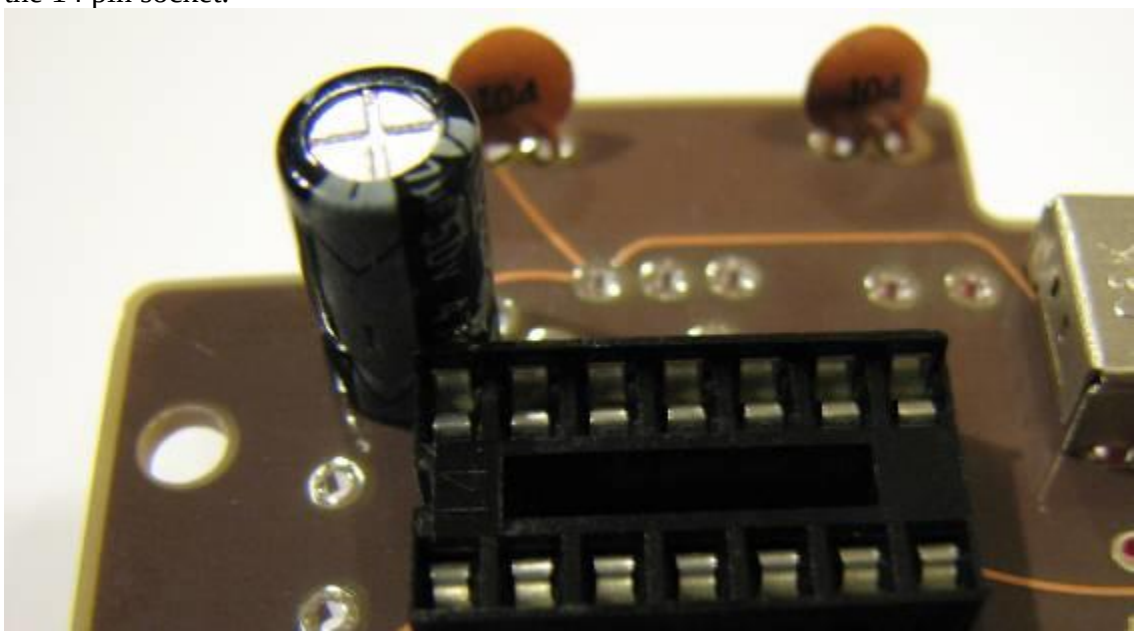


The socket will be similar to the switch in that it will want to fall out when you flip the board over. Use electrical tape or your finger to hold the part while you flip the board over and then have it rest on something flat and hard to make the soldering easier. You may want to solder just two opposite corner pins and then check to make sure the socket is flat against the board. After any needed adjustments (using the soldering iron and holding the board and the part – this takes some practice!) solder the other 12 pins on the bottom side of the board. The leads are not long enough to require any trimming.

Next we want to attach the electrolytic capacitor – the larger black cylinder with two leads coming out of one end of the cylinder. This part also needs to go in the correct way, so only one way is correct and you need to be careful. The capacitor has the "-"

lead marked on the cylinder with a wide light gray stripe with "-" indicated a couple of times. The "+" lead is on the other side and usually denoted by having a longer lead coming out of the part. The "+" lead needs to go into the top hole that has the "+" sign in copper on the top side of the board.

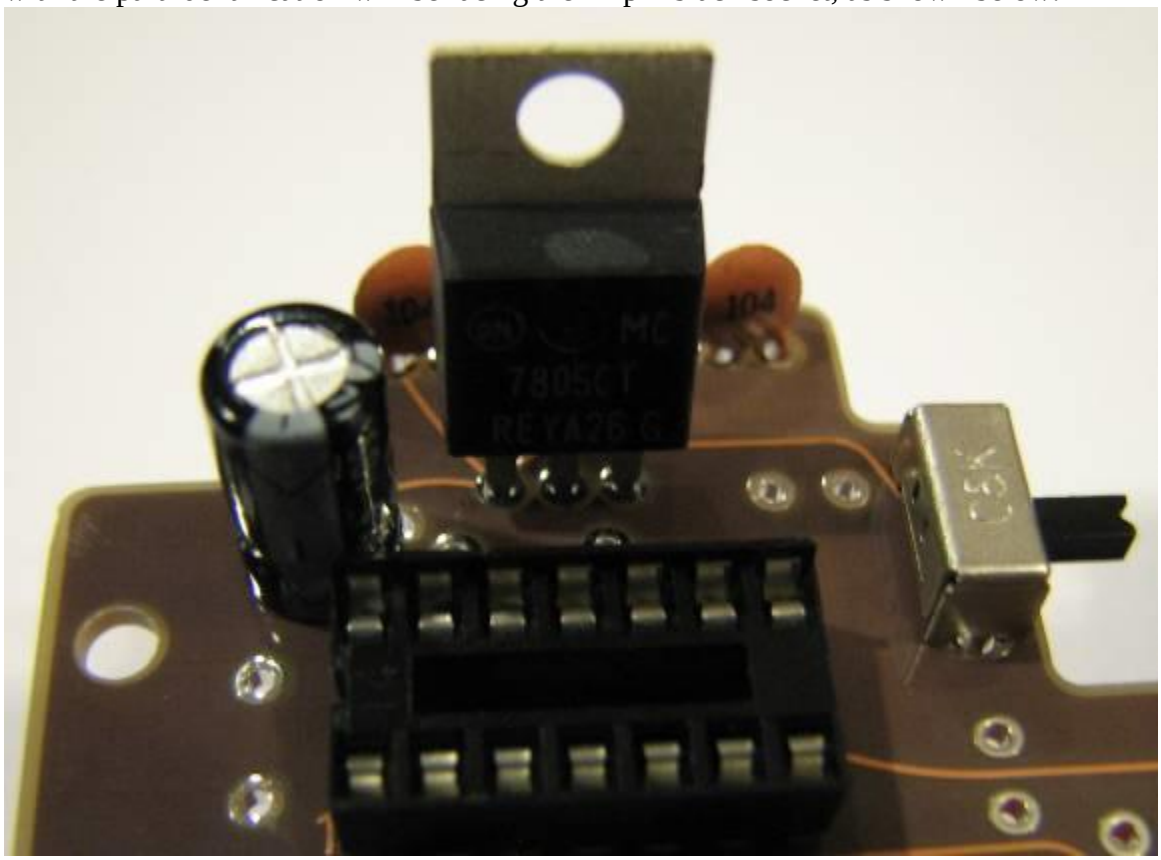
In this photo you can see the "-" markings on the cylinder and the "-" lead is closest to the 14 pin socket.



On the bottom side of the board this capacitor's holes are indicated by a white circle and the "+" lead (usually longer) is also indicated in white. Solder and trim the excess leads.

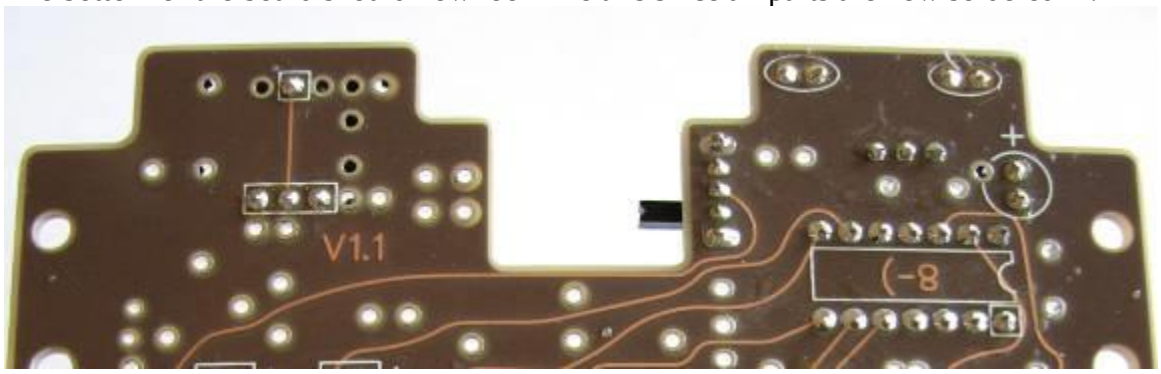
Next the large Voltage regulator part will need to be attached. This is a part that is very similar to the one used in the Sanyo board and it is placed in the same holes that were used in the Sanyo board. This adds authenticity to the board even though we are using it for a different purpose.

The part must be oriented the correct way or the board will not work. The large metal heat sink portion of the part must be facing the top of the board and the black portion with the part identification will be facing the 14 pin black socket, as shown below:



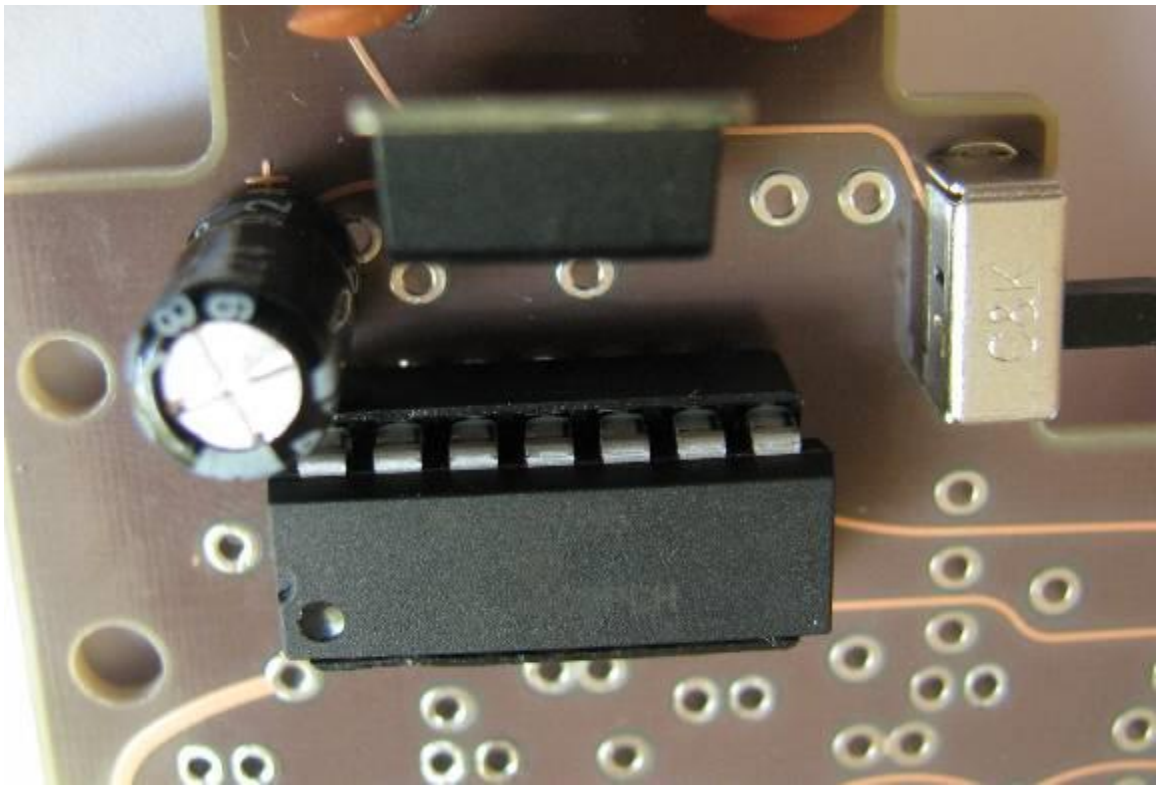
Flip the board over, solder the three pins and trim the excess leads near the bottom surface of the board.

The bottom of the board should now look like this since all parts are now soldered in:



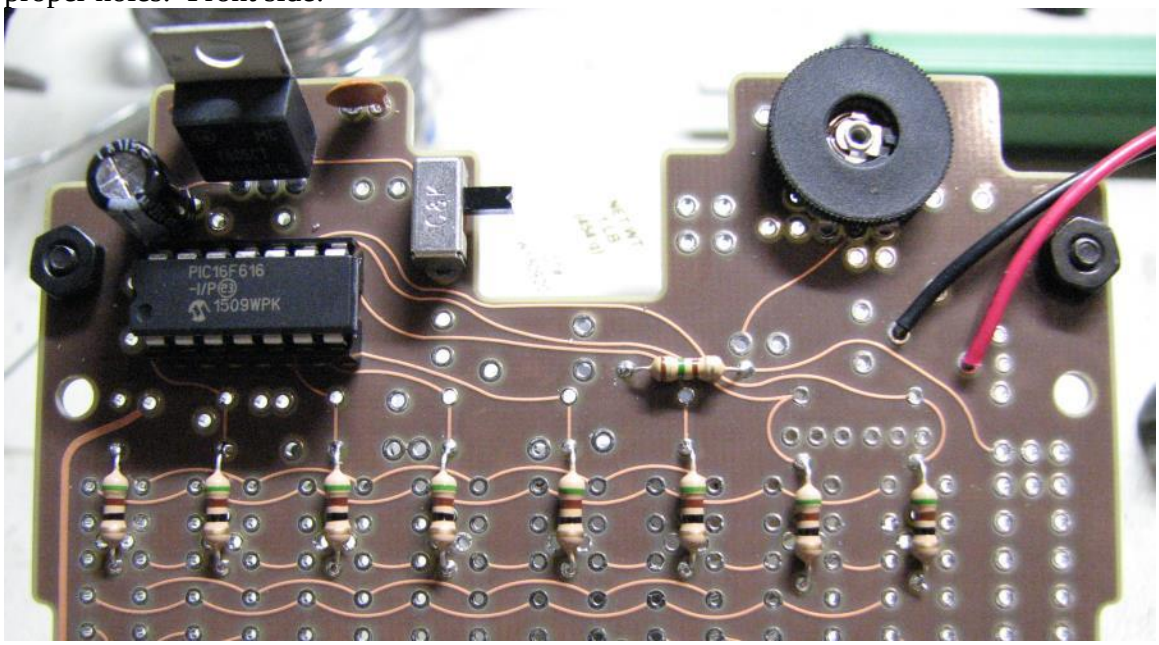
The PIC controller needs to be placed in the soldered in socket. Orientation is critical and all leads must go into the socket (sometimes you can miss or a lead gets bent under and it is difficult to see – you may need to remove the part and look to make sure the leads are all still straight – use a small flat blade screwdriver to carefully pry each side of the part out of the socket).

One side of the PIC controller will have an indicator for pin 1. That needs to go on the left side so that it is near the same indicator on the 14 pin socket and also the “1” in copper on the top of the circuit board:

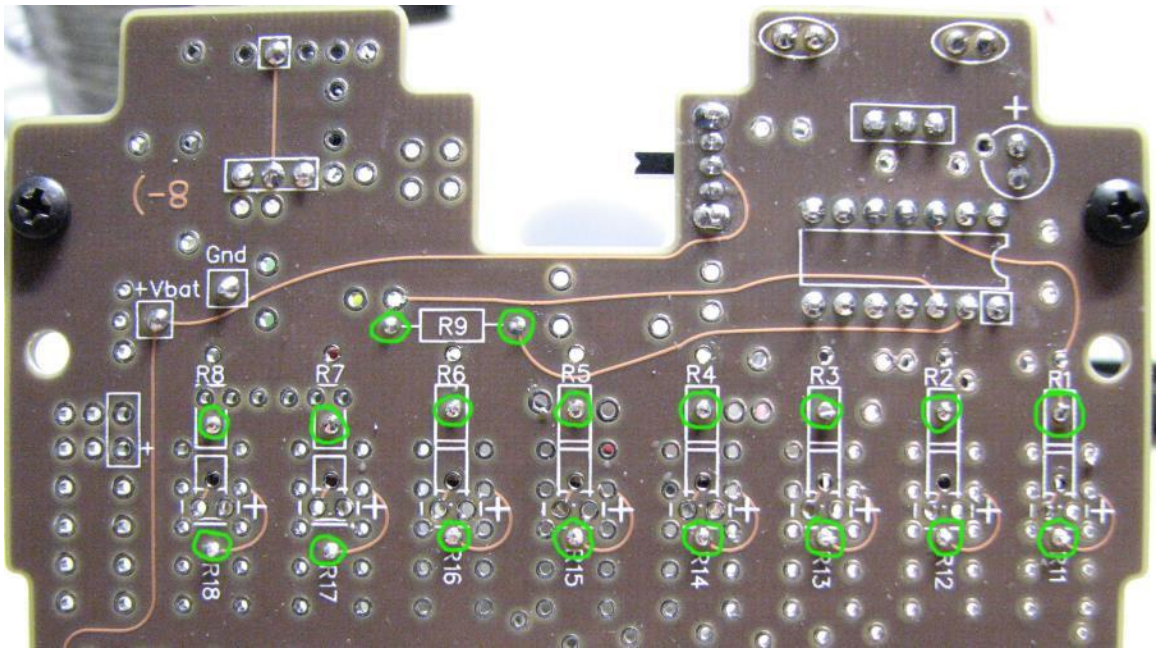


Next we need to install the 9 resistors, one for each thing we want to illuminate.

Since there are two build options, great care must be made in placing the resistors in the proper holes. Front side:



Back side:



The resistors go in the holes that are circled in GREEN. Resistors work in either direction so orientation is not critical.

The “R9” resistor that is 150 ohms (Brown-Green-Brown-Gold) that is near the center of the top of the board and is horizontal while the rest of the resistors we will install are all vertically oriented.

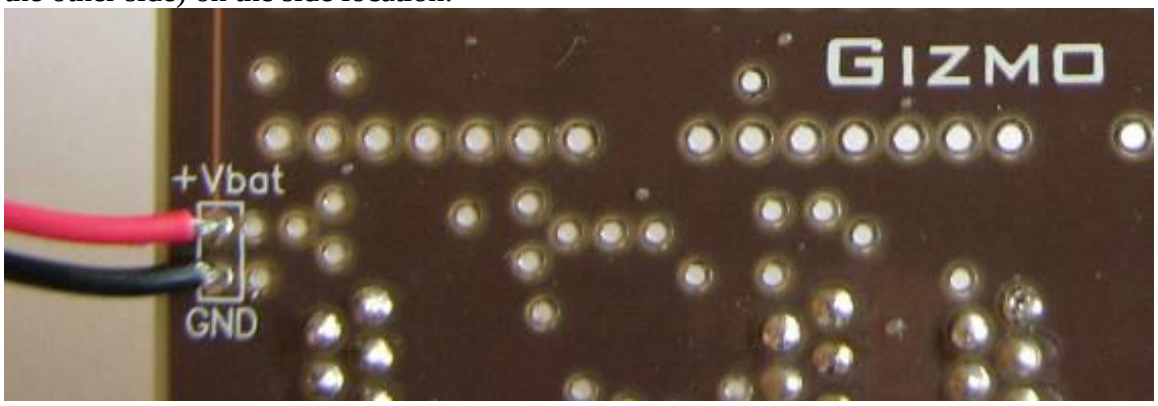
The next 8 resistors will be used to illuminate wither the display tube
There are eight 51 ohm resistors (Green-Brown-Black-Gold) in positions that use holes that are just above the R11-R18 labels and also just below the R1-R8 labels.

The 9V battery connector can go in next.
The wires can attach to two different locations on the board and they can be soldered in from the top or the bottom of the board. One location is below the thumbwheel pot and the other is on the side of the board near the middle. Since this board may be shown off, you may want to attach the wires to the bottom of the board and soldered to the top side. This makes the board look as authentic as possible.

The Black wire from the battery connector must go to a hole with a rectangle around it on the back side of the board and labeled with “Gnd” or “GND”. The Red wire from the battery connector must go to a hole with a rectangle around it on the back side of the board and labeled with “+Vbat”

There is no strain relief for the 9V battery connector wires, so take care not to bend/yank on them or they may break and you will have to strip the wire and re-solder them. This should be fine since the wires are plenty long and once the board is mounted in some holster, the wires will probably not move around much. If needed, you can glue the wires down on the back side and the bending should take place farther from the solder joint and that will last much longer.

Here is showing the battery connector mounted on the back side of the board (soldered on the other side) on the side location:

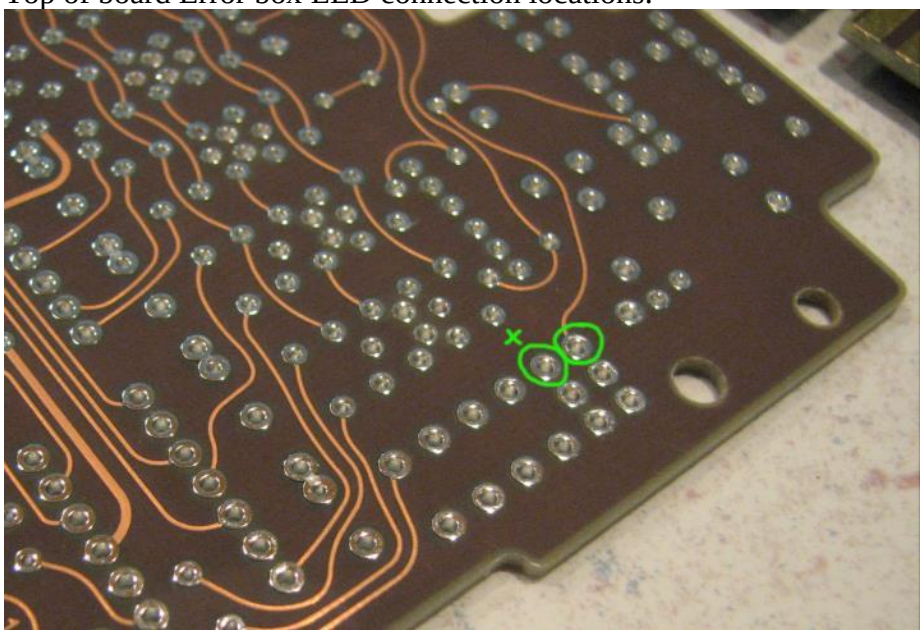


The 9V battery holder clip can be mounted to the Leather holster inside the strap that goes across the front of the board. You could mount it to the board, but after all this work do you really want to attach the battery to the top of this beautiful work of art?!?

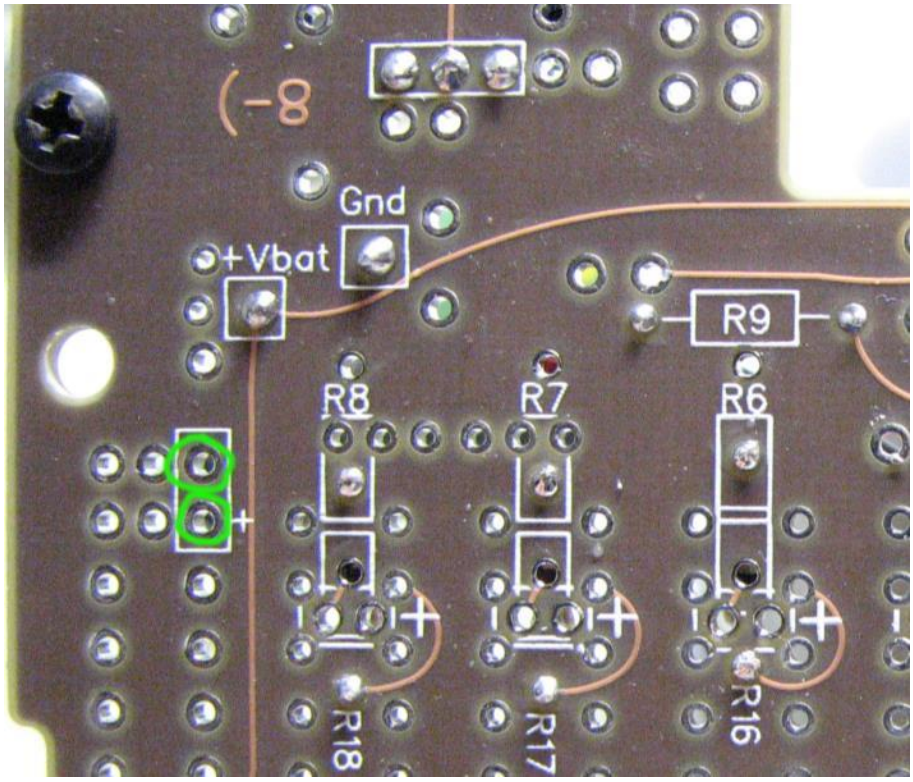
Testing the Error Box LED:

The LED can be set in the proper holes and it will illuminate (may take several seconds, depending on the thumbwheel pot setting.

Top of board Error box LED connection locations:



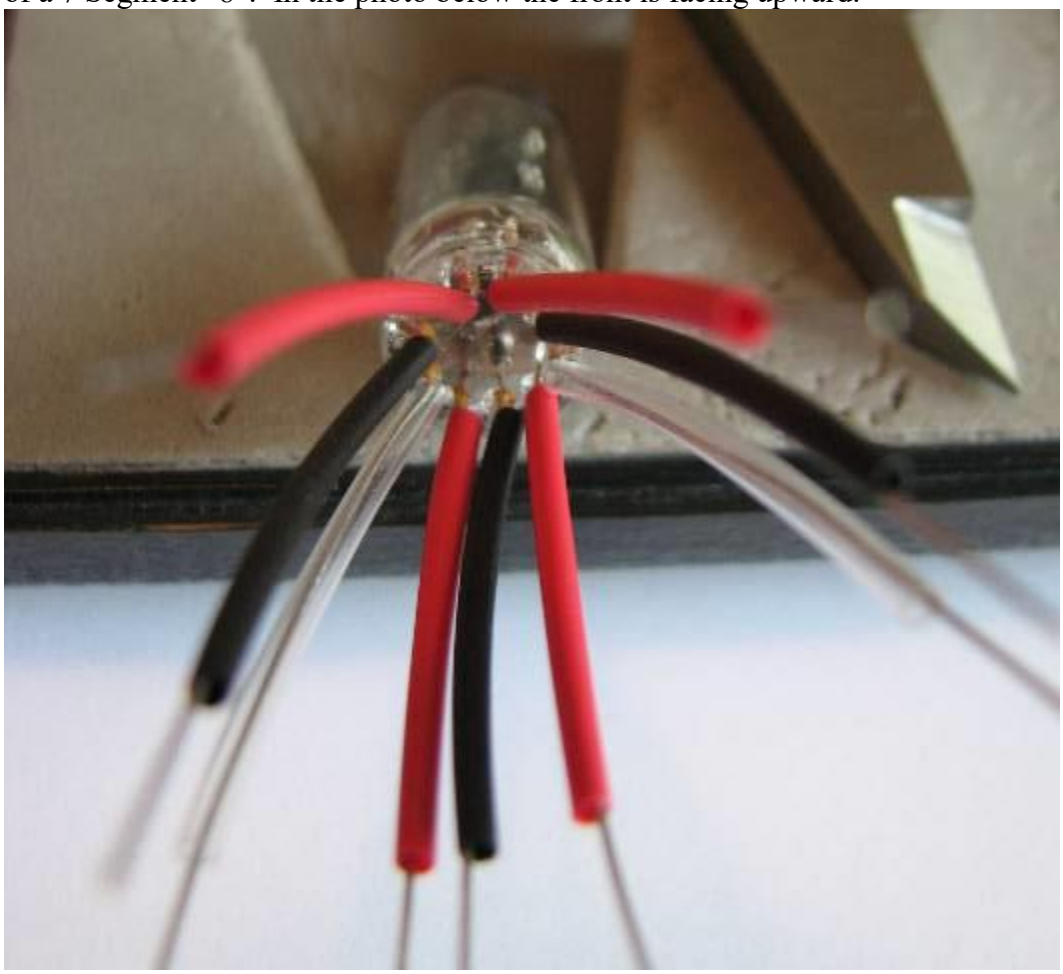
Bottom of board Error box LED connection locations:



Display Tube parts kit assembly

You should have 8 display tubes. There is also enough Clear, Red and Black tubing in a separate zip lock baggie to cover the leads in the way shown below.

Looking at the reference photos, the display tube has the front two leads in Red, the next pair of Leads in Black, a Pair of Clear tubing, a pair of Reds and the back lead is Black. Here is what we are making (front of display tube has thin suspended wires in the shape of a 7 Segment "8". In the photo below the front is facing upward.



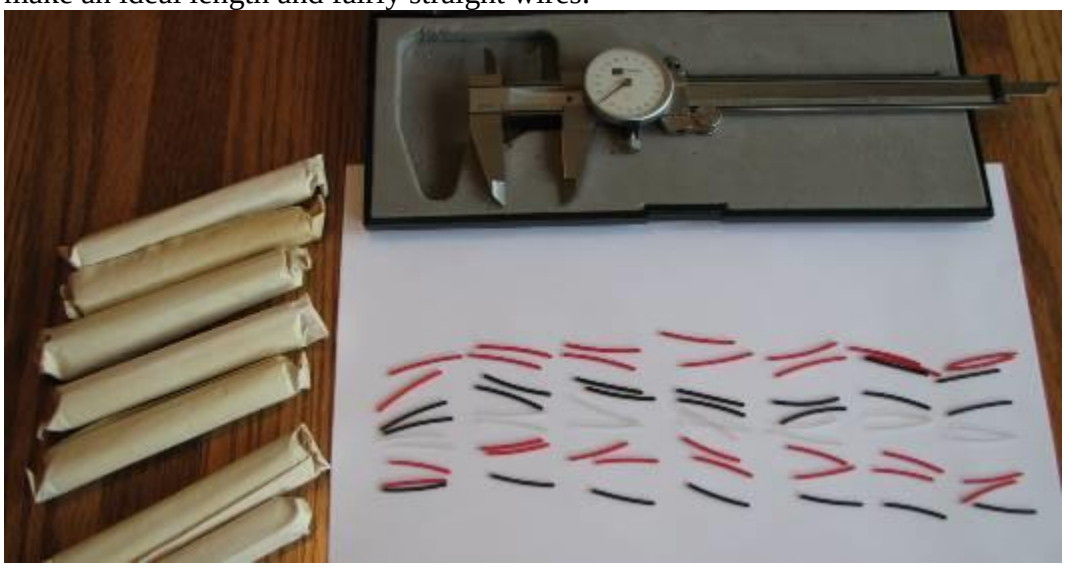
The display tubes will be sitting at an angle, so the front tubing longer than the back tubing. This also appears to be what was done in the Sanyo board based on some measurements of the wire in the photos.

I started by cutting one tubing the desired length then used it to measure and cut the other tubing that will be the same size. By using the one tubing as a reference it was easier to get them all about the same length.

You will need:

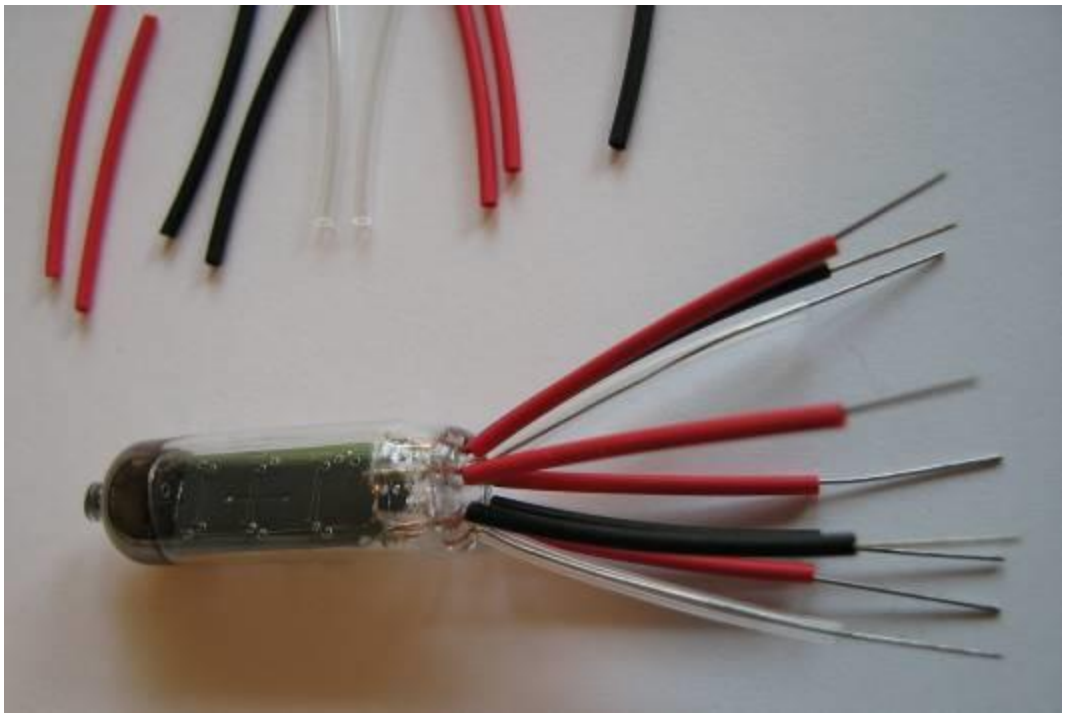
Tubing Color	Length	Quantity
RED	1.05”	16
BLACK	0.97”	16
CLEAR	0.87”	16
RED	0.8”	16
BLACK	0.7”	8

I used my calipers to get the first one as close as possible to the desired length. This will make an ideal length and fairly straight wires.



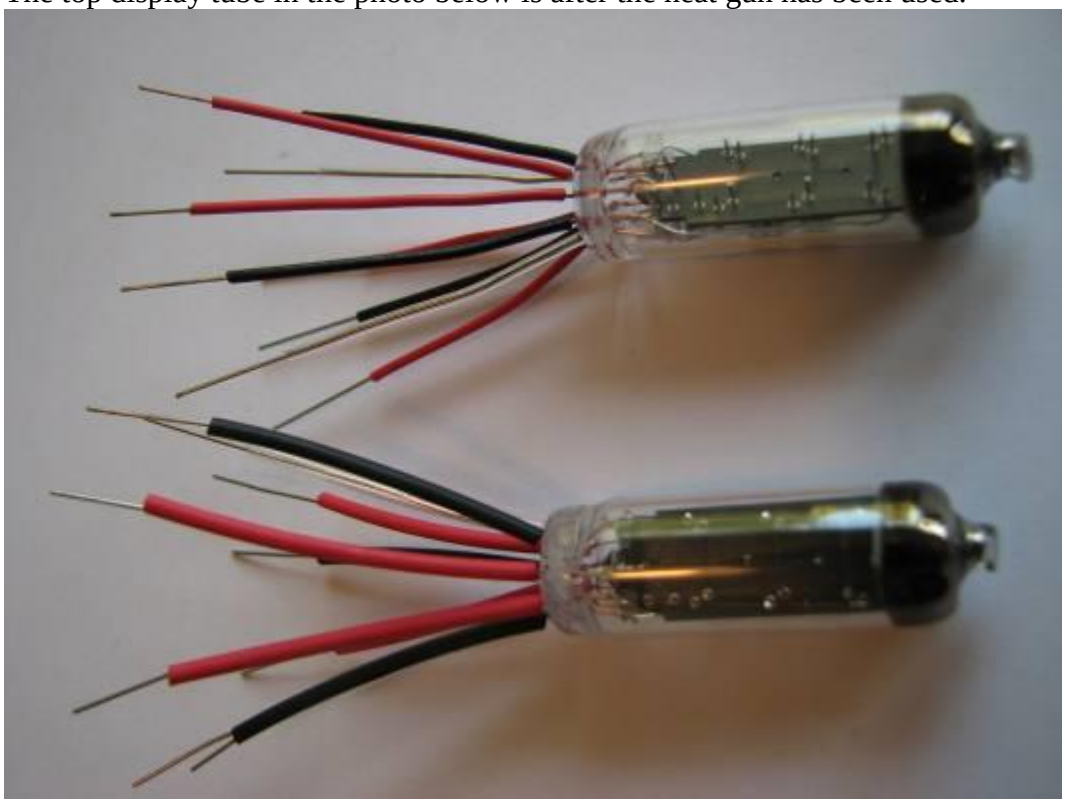
Next straighten and slightly fan-out all of the leads of a display tubes and put the longest tubing in the front side (look at the face of the display tube to make sure you know where the front is located) and work your way back.

The tubing should be loose and if you turn the display tubes over all of the tubing will fall off and you will have “fun” finding them, picking them up and putting them back on.



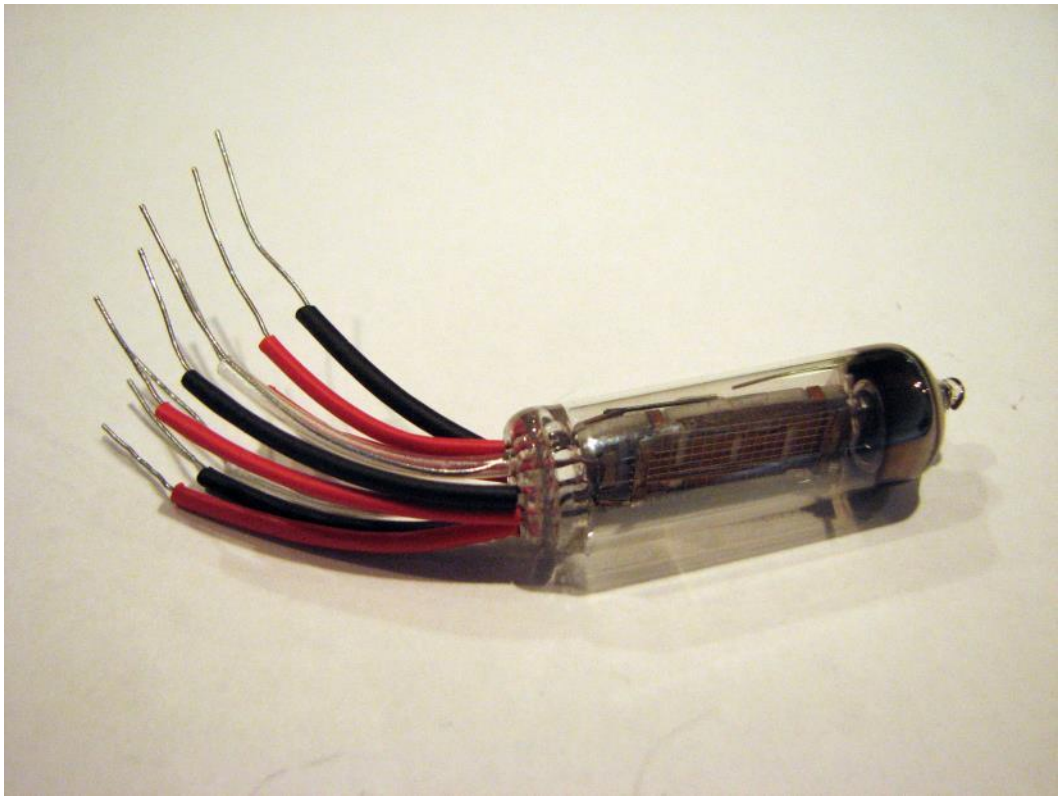
Here is a close-up of the installed parts to make sure you have the colored tubing on the correct leads. It is very important to get the correct leads in the correct holes, or else the display tubes will not light up.

You now have a choice – leave them as-is and just dealing with the loose nature while mounting or using your heat shrink gun and shrinking the tubing onto the leads. This will allow them to be just tight enough not to fall off, though you can slide them off if desired. The top display tube in the photo below is after the heat gun has been used.



You can do this one at a time or just get the tubing on all of the display tubes and then get to mounting them on the board.

The next step is getting the leads in about the right shape before you get to mount these on the board. This will make it easier to mount and probably save you time overall. The holes in the PCB are two sets of vertical columns. Bend and line up the leads in two columns 4 leads on the right half of the display tube and 5 Leads (they get the extra Black lead in the back) on the left side. They are also bent in an arch so that the tubing ends are roughly all in a line:



Test fit one and you may want to apply what you learn putting this one on the board to the others so the leads are bent for easiest installation into the board holes.

You may want the display tube stand mounted on the board. This helps with aligning up the display tube, but can also get in the way. I ended up doing this all with the display stand installed. It can be removed later, even after the display tubes are all in place.

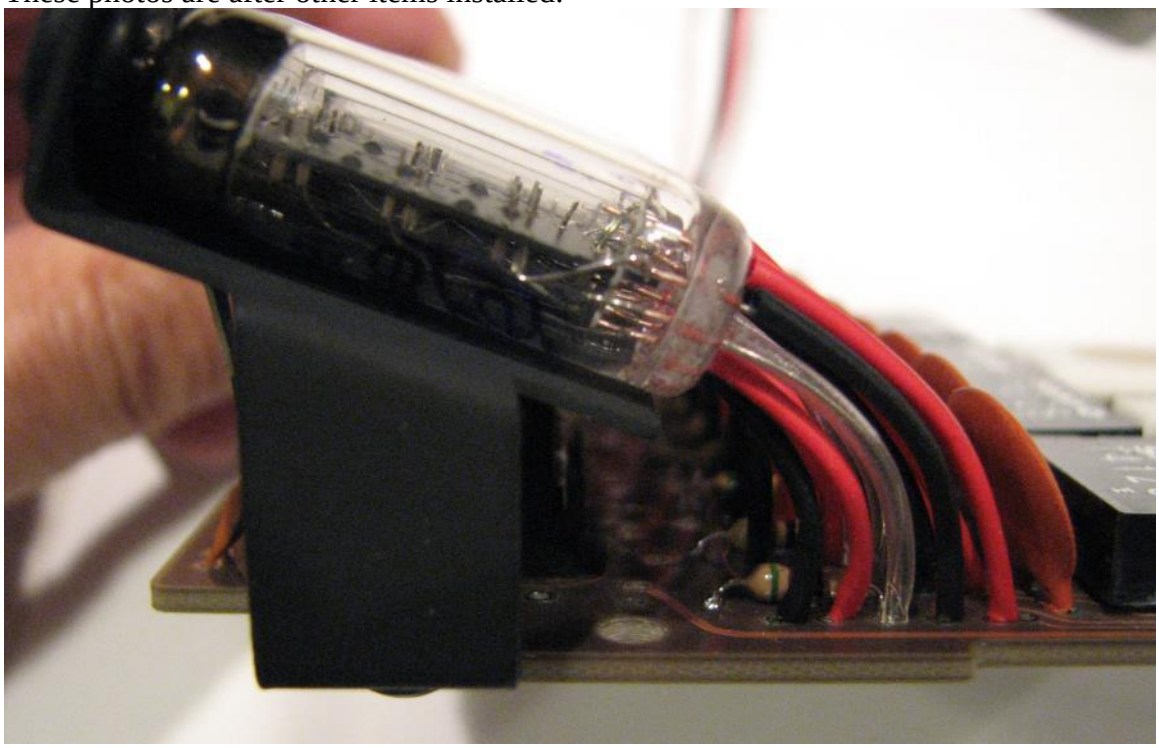
I installed starting from the left side – not sure where it is best to start but this at least makes the photos easy and worked fine. I was able to get a few wires from one side into the holes, and then used tweezers to get the wires into the hole. If your tubing is loose, take care to make sure the wire is in all the way and there isn't a gap between the tubing and the display tube and the tubing and the printed circuit board. I bent a couple of wires on the bottom of the board to hold the part in pace. I then pressed on the display tube to help make sure the wire tubing covered the wire leads on both ends and soldered the first and last wire to hold the part in securely. I then made sure the other wires were in place and tugged on them and bent them slightly on the bottom of the board to hold them in place before soldering.

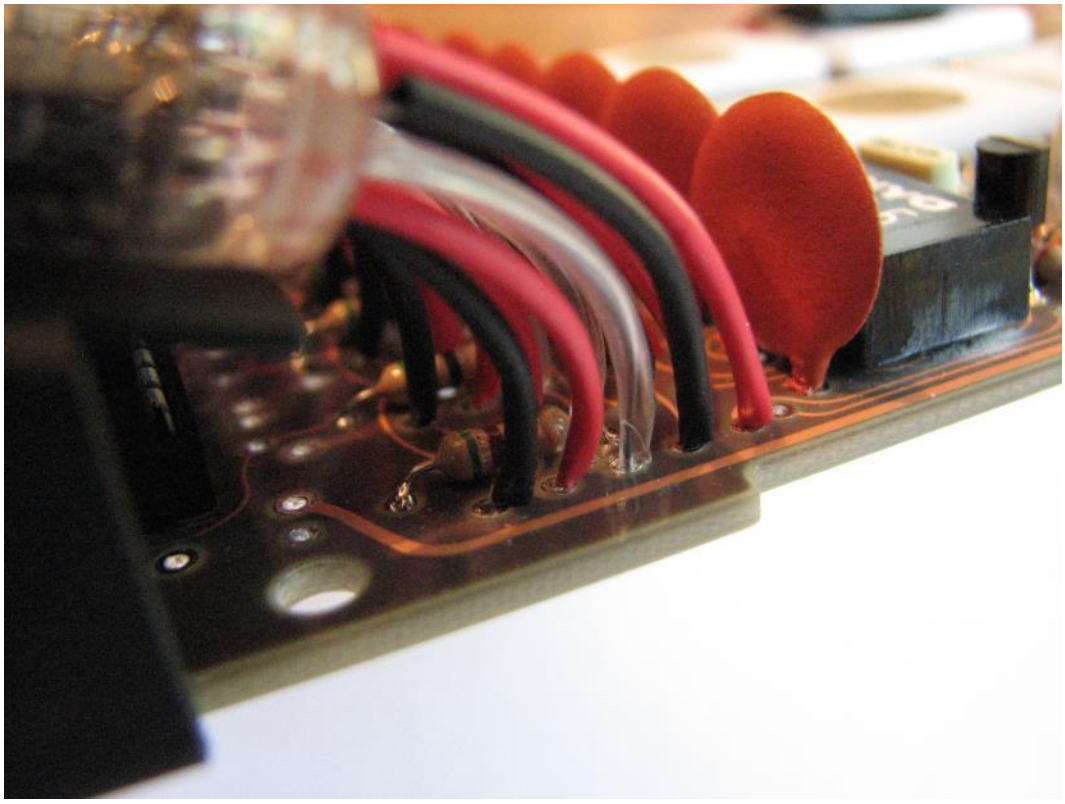
From a top view here is the color coding into the two columns of holes:

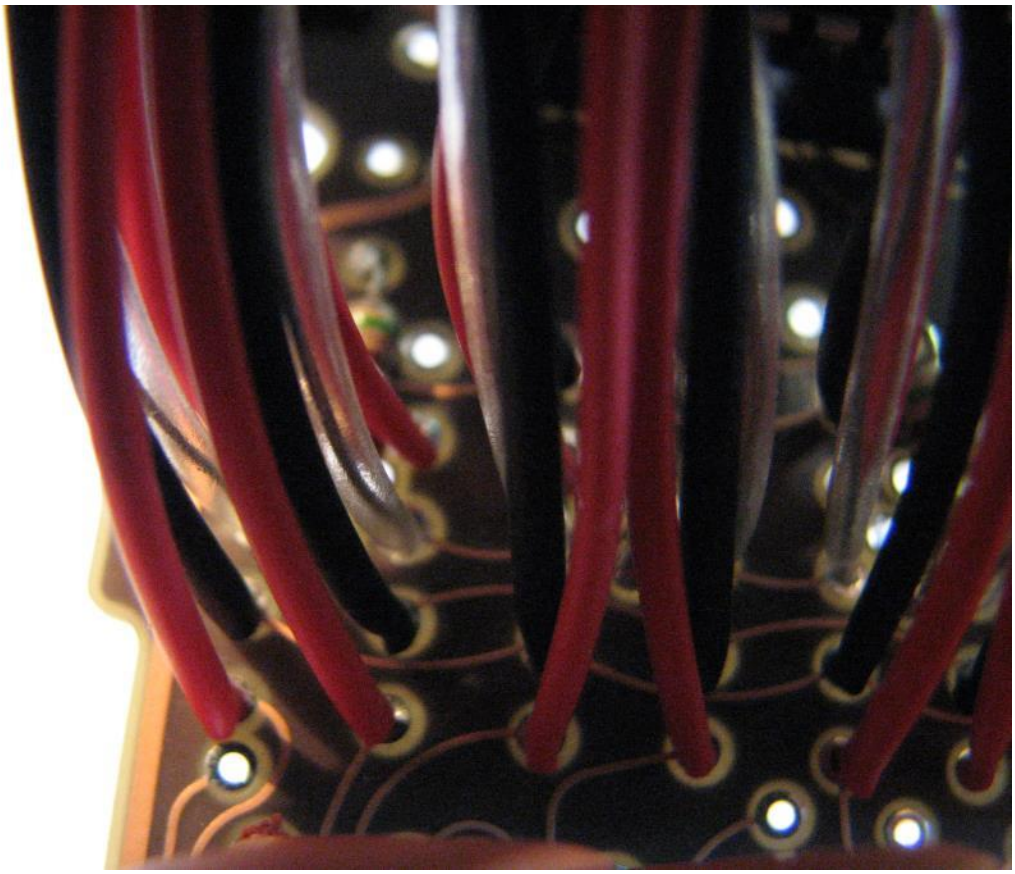
Back BLACK	X
RED	**RED**
CLEAR	**CLEAR**
BLACK	**BLACK**
Front RED	**Front RED**

Be sure to start with the holes on the farthest left of the board just above the large brown ceramic disc capacitors. There are 5 holes in each column all with the same spacing. Each display tube will use two columns.

These photos are after other items installed:







After positioned and you check to make sure all of the wires are pulled tight enough that the wires are covered by the tubing, you can flip the board over and solder and then trim off the extra wire.

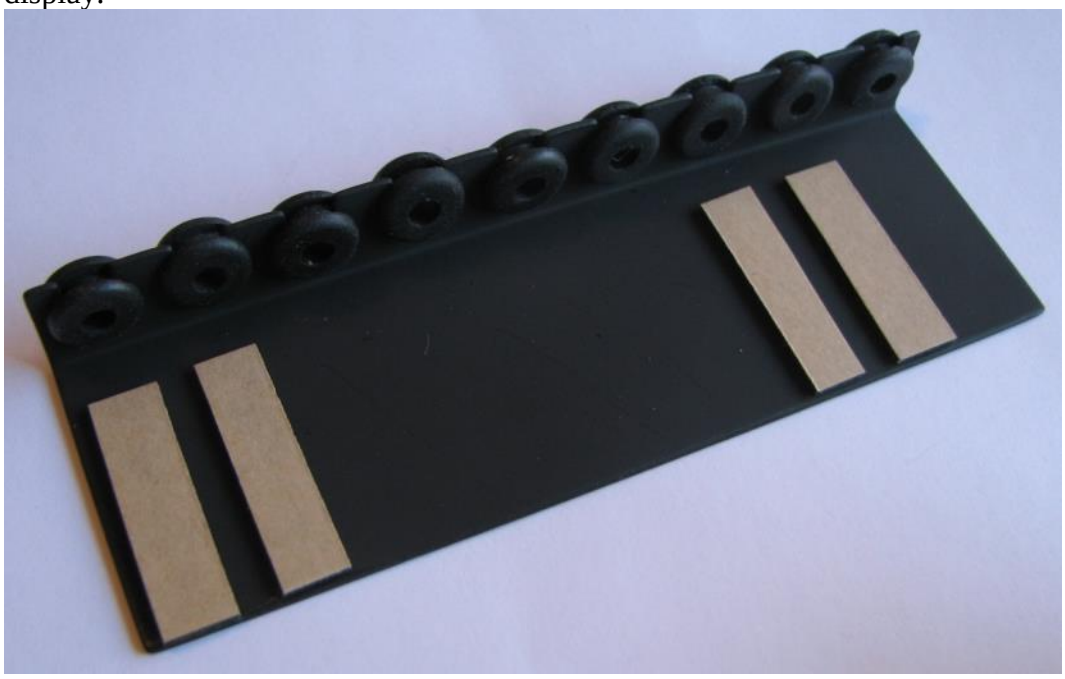
Just repeat the install for the next 7, using the next available columns of holes (do not skip any columns of holes!), and you are now done with the display tubes

With the display tubes in place, you can check the illumination by connecting the 9V battery, turning on the power switch and adjusting the thumbwheel pot.

“SGL” Display Tube Shelf with Grommets and Legs

This metal bracket sits between the display tubes and the printed circuit board. You may want to remove the grommets (they just pull out) and sand and paint the bracket black. When you are ready to add this to the board, put the grommets back in all of the slots. If you want the display tubes to be more firmly attached to the shelf, you can put some double sided foam adhesive tape down under the location of some of the display tubes. I skipped this part because the display tubes are fine without it for the shelves with legs. I still use some of the tape to mount the error box.

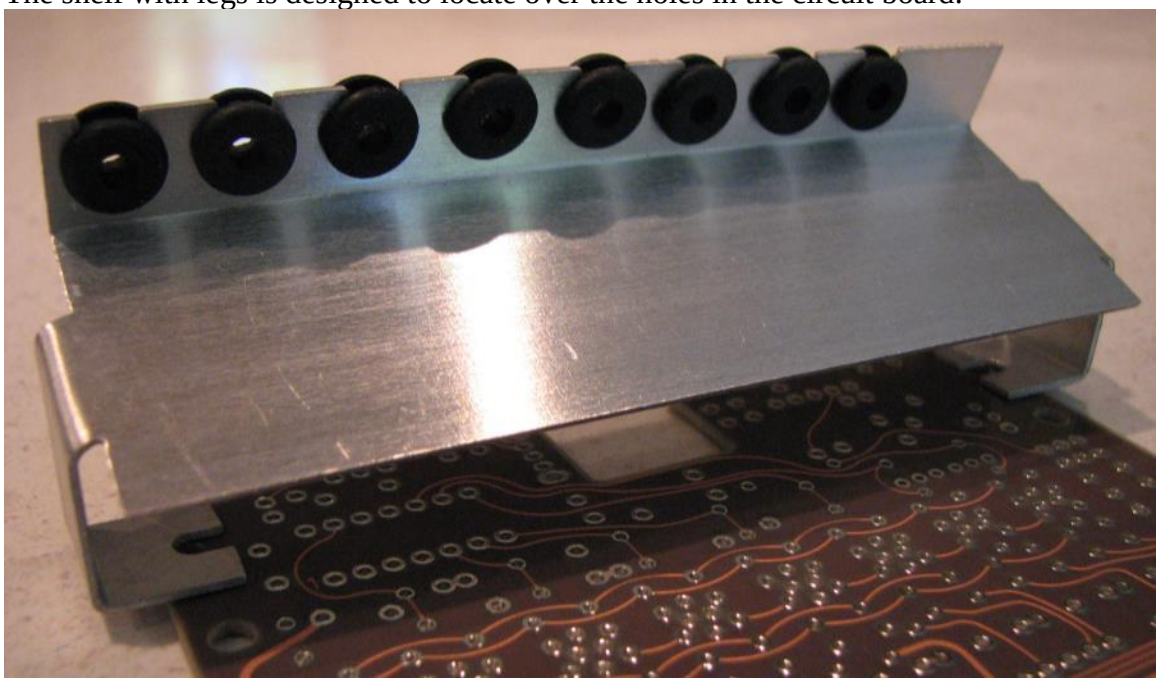
Below is a picture of a flat black painted floating shelf (no longer offered), with 4 pieces of the black foam tape placed under the outside two display tubes on each side of the display:



The tape is quite sticky, so be careful when adding the shelf. I did this after all 8 of the display tubes were mounted. With all eight I angled the self and just made sure the tip of each display tube was in the grommet. After all 8 were in I rotated the shelf and the tape held the shelf in place. I first did a trial placement without the tape to see how difficult this was going to be. It wasn’t too hard and the shelf stayed in place, so the tape was not required.

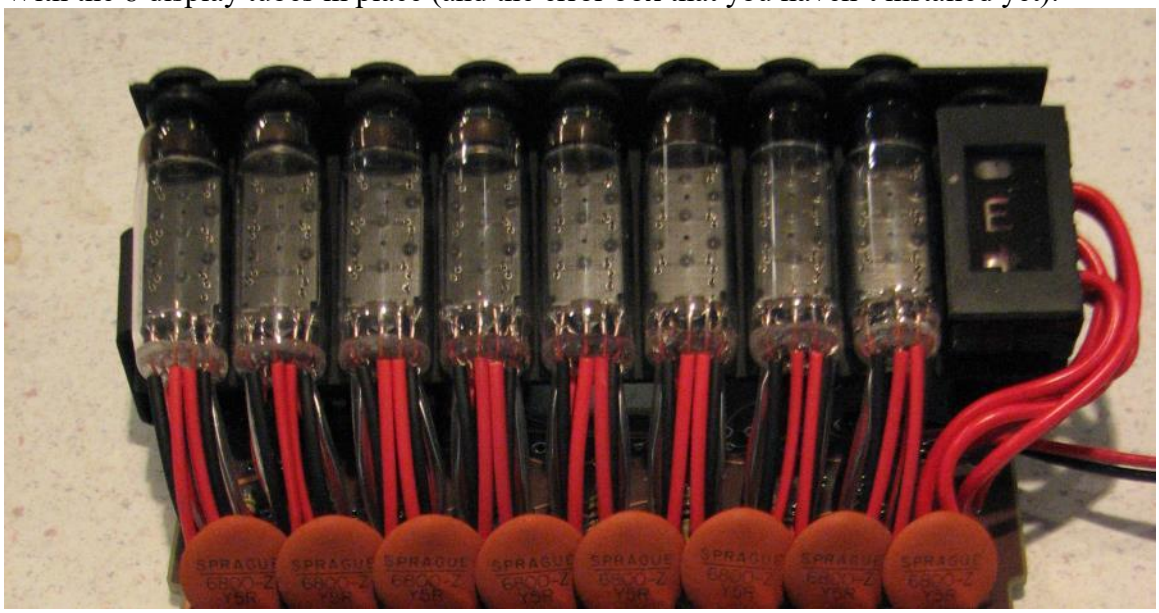
If you use the shelf with legs, you probably do not need the tape for the display tubes. If you do wish to use the tape (it looks like the Sanyo used some sort of foam to separate the shelf from the display tubes) you may want to mount one display tube (and tape) at a time since rotating the shelf with legs may not be easy to do as with the floating shelf.

The shelf with legs is designed to locate over the holes in the circuit board:



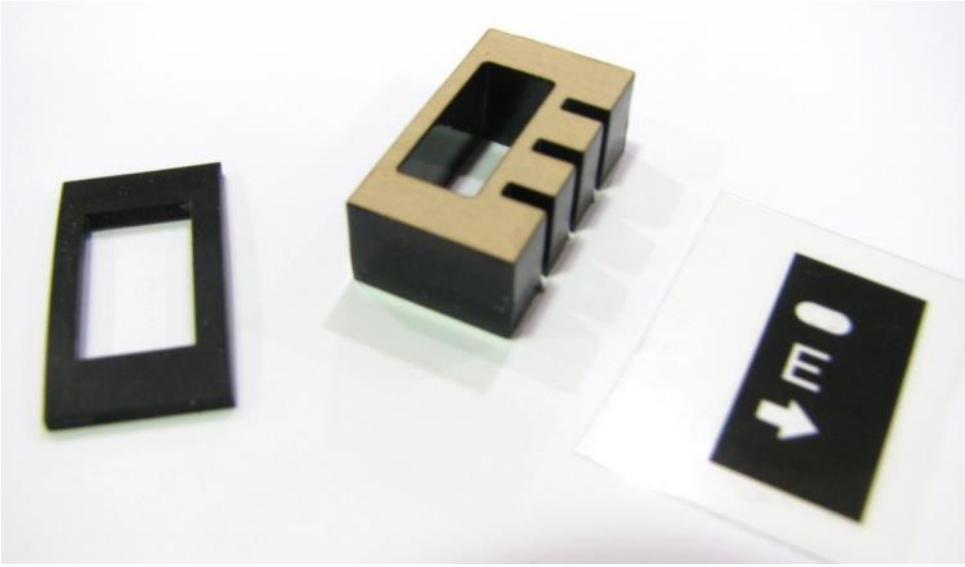
You attach this to the circuit board with the included small screws.

With the 8 display tubes in place (and the error box that you haven't installed yet):



”ER” Error Box

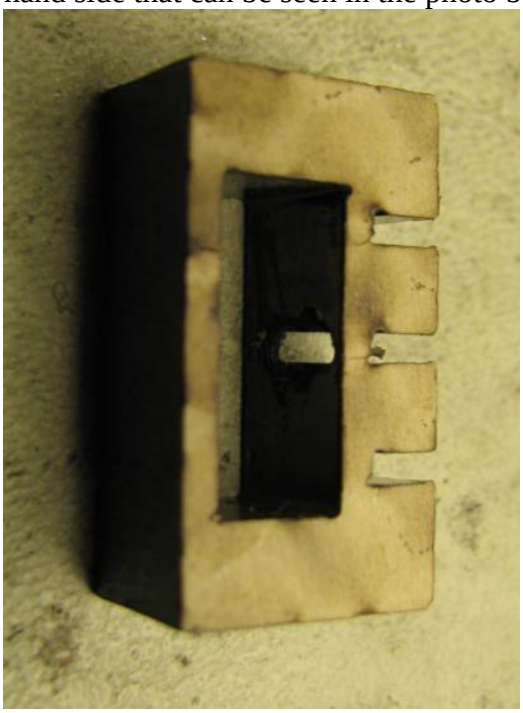
The Error Box is a small box that sets on the shelf to the right of the display tubes. In the actual calculator 3 neon lights are used to light up the three separate symbols: a bar on top, the letter “E” in the middle and a right arrow on the bottom.



The error box can be held on to the shelf with the two sided foam tape. Remove any protective tape on the error box black part and cut a piece that is the height of the error box and attach it to the bottom of the error box. The slots cut into the side of the error box are where the wires will be pushed into place so need to be toward the outside of the shelf.

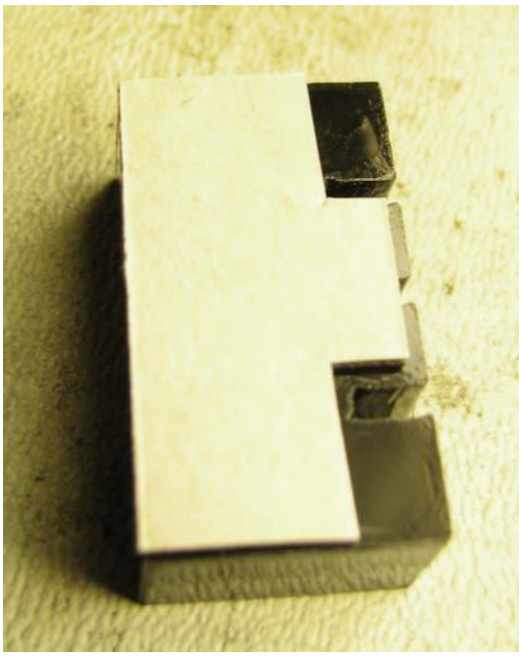
The symbols are not easy to see. Something inside the box could make them more visible. Some have placed white paper inside, I chose to cut a clear straw the right length and place it inside the error box. This is somewhat subtle but I liked the look and it almost appears that a display tube is in there.

To get the Red LED to light up the error box, we need to get wires all the way inside the box. You could do it some other way, but I like adding a hole in the center of the right hand side that can be seen in the photo below before I peeled off the protective paper:

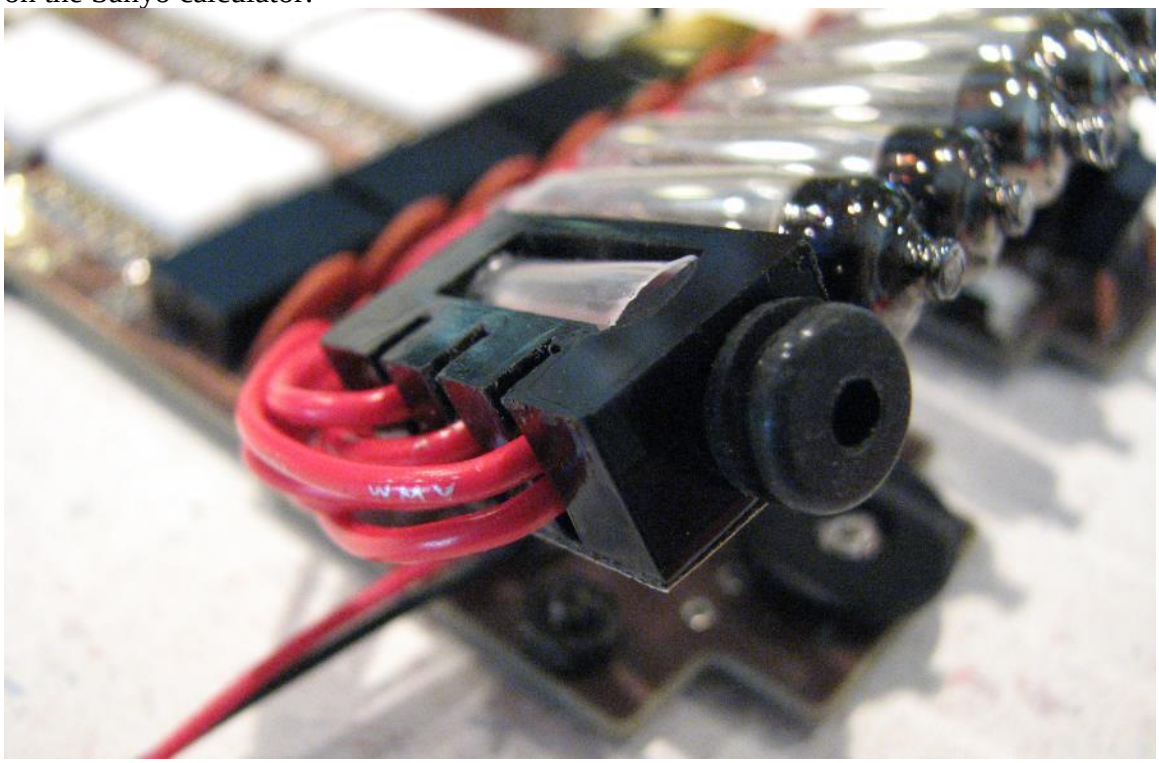


I used a Dremel with a very small grinding head, but a tiny drill bit would also work.

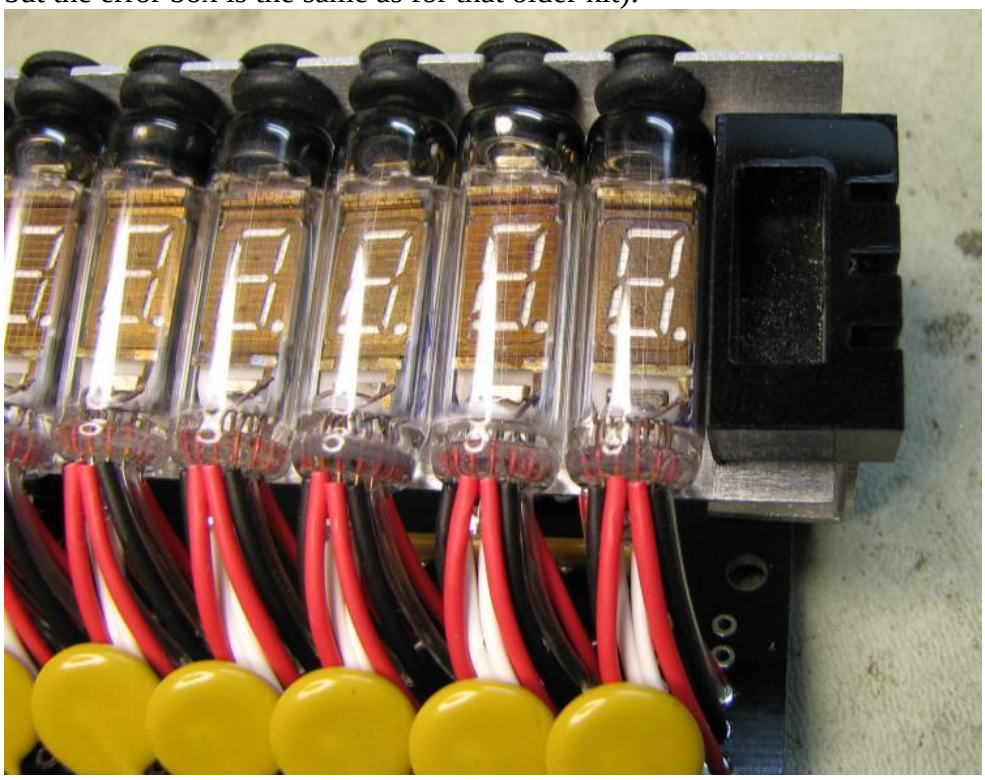
Next use some double faced black foam tape and cut out a shape that can be attached to the bottom of the error box and hold it to the display shelf. You could use glue, but this worked out real well.



I glued one grommet to the top of the error box to make it look more like what was used on the Sanyo calculator:

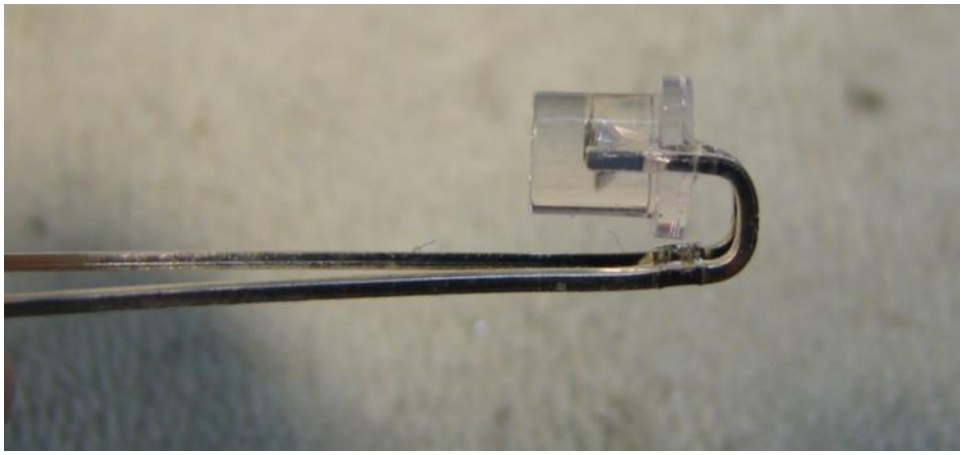


Now place the error box on the shelf (shown with older design display tubes and LEDs, but the error box is the same as for that older kit):



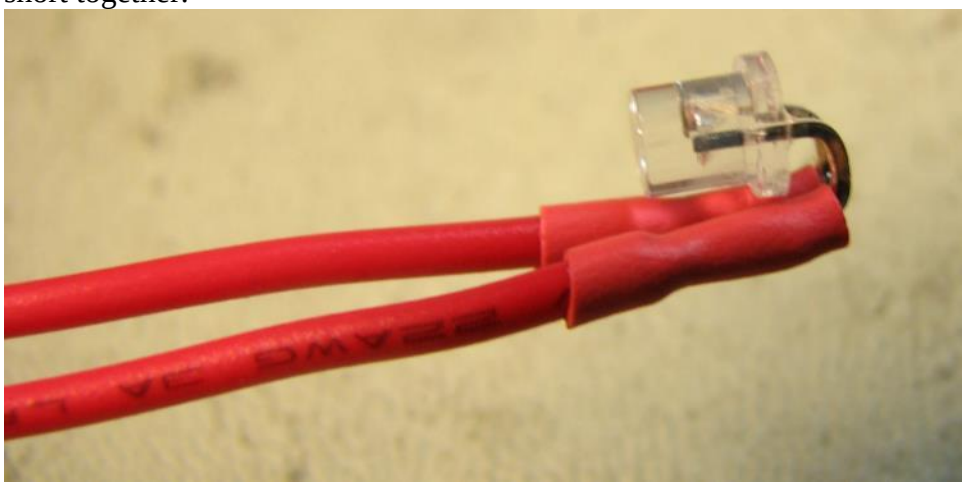
Time to form the leads on the Red LED. I tried to keep track of the long lead so I could get it to the correct hole on the gizmo board but eventually forgot so just ended up testing it and by holding the wires both ways in the board before soldering the wires to the gizmo board.

First bend the leads around like this:

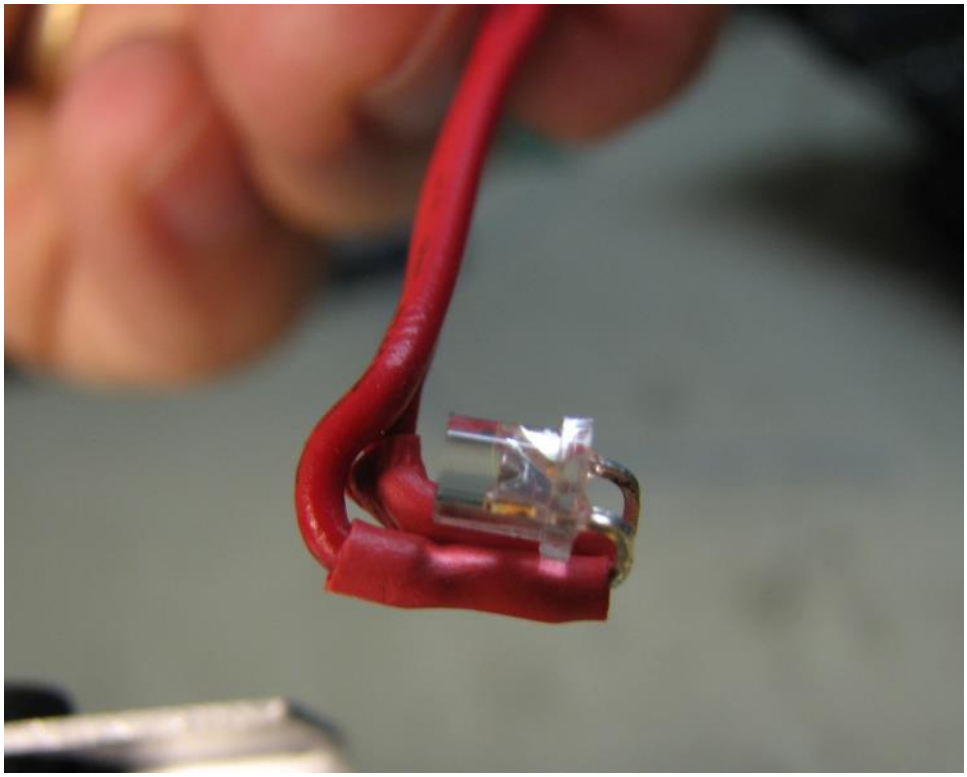


You will need 6 red wires coming from the error box, two from the LED and two more pairs just for show. The extra 4 wires will go to the four solder through pads on the far right side of the board next to the last leads from the far right display tube.

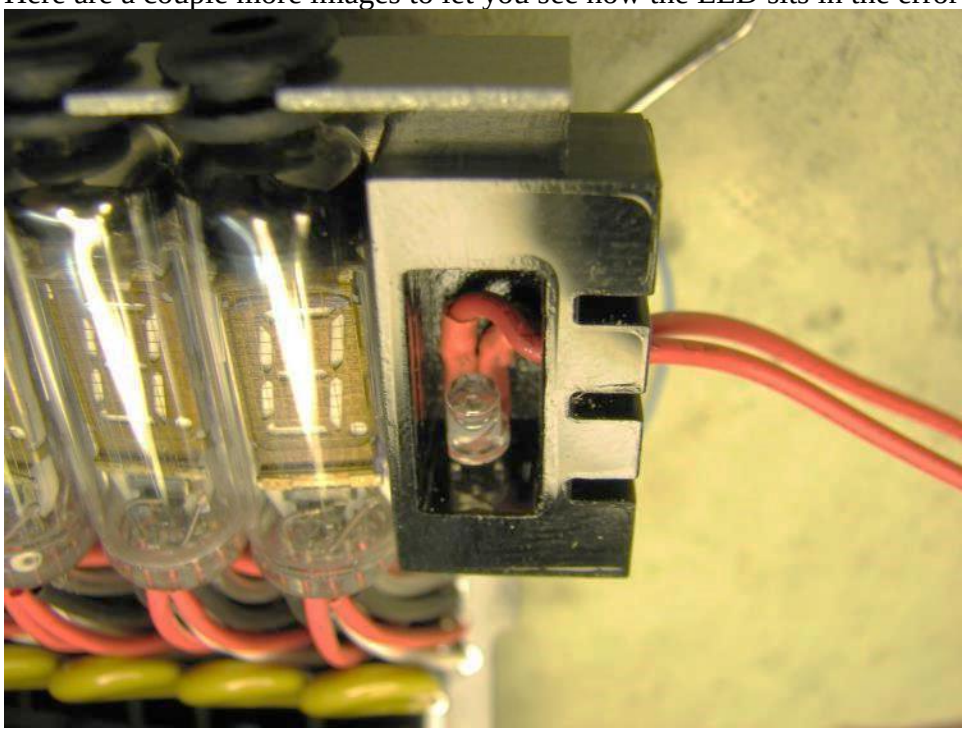
Attach red wires to the LED and use heat shrink tubing to cover the leads so they do not short together.



Now bend the wires in some way so that they will come out of the error box, but position the LED at the bottom of the error box facing the inside top of the error box to light it up.

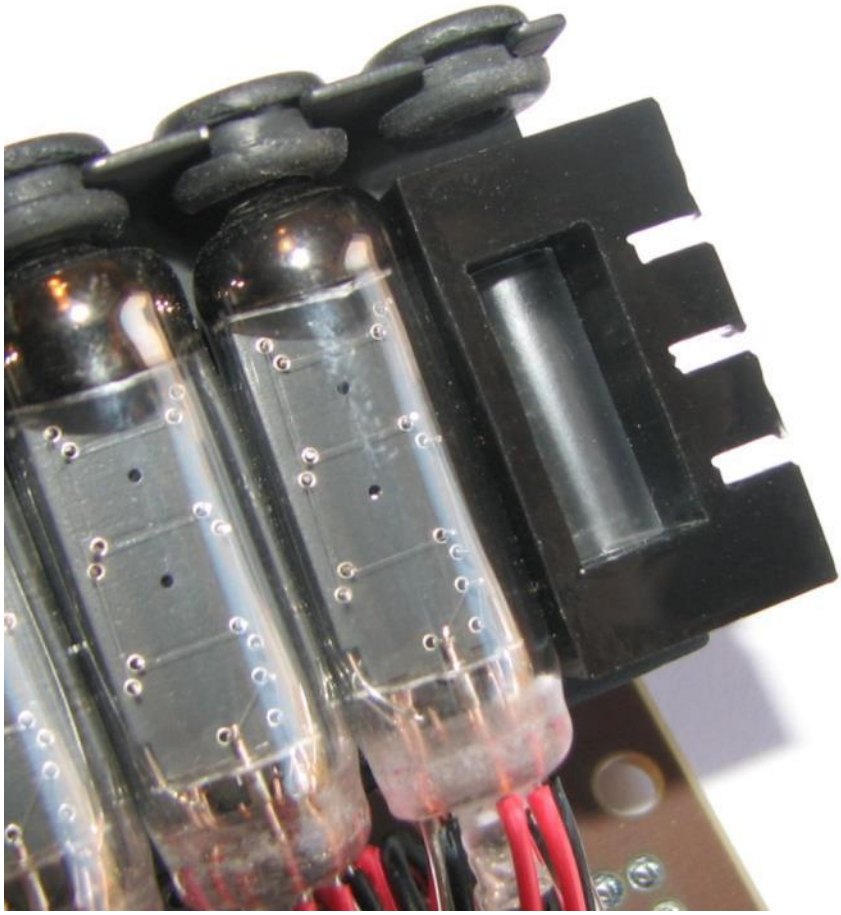


Here are a couple more images to let you see how the LED sits in the error box:



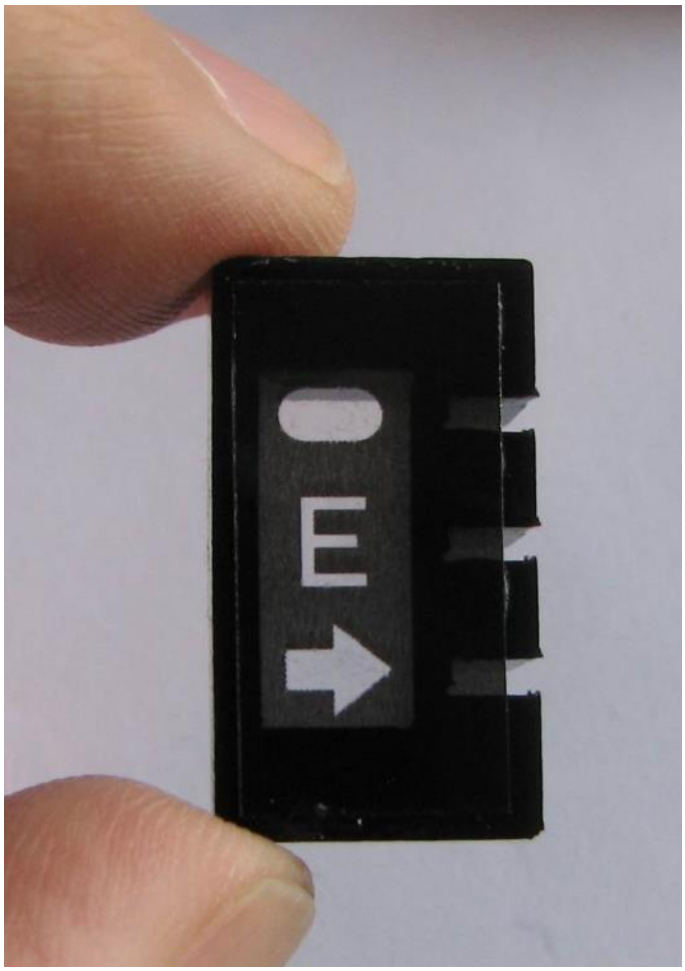
You can slide a small straw over the LED to make it look more like a display tube is inside, but it is a tough fit and you may have to trim the straw a lot to get it to fit.

Here is a view of the straw if there was no LED illumination:



Without the LED, the straw will stick to the foam tape so will not move around.

The Error box graphic needs to go on next. It was harder to align it without a lot of light, so you may want to attach it to the error box first before the straw and the foam tape. Either way is fine, but it was way easier to photograph the alignment with the box not attached to the shelf:



I used some superglue to attach the graphic to the top of the black laser cut piece. Just a couple of drops on the top and the bottom and on the right had side. Do not get too close to the center hole as the super glue will tend to flow a little bit and you don't want it to get out under the open parts of the graphic.

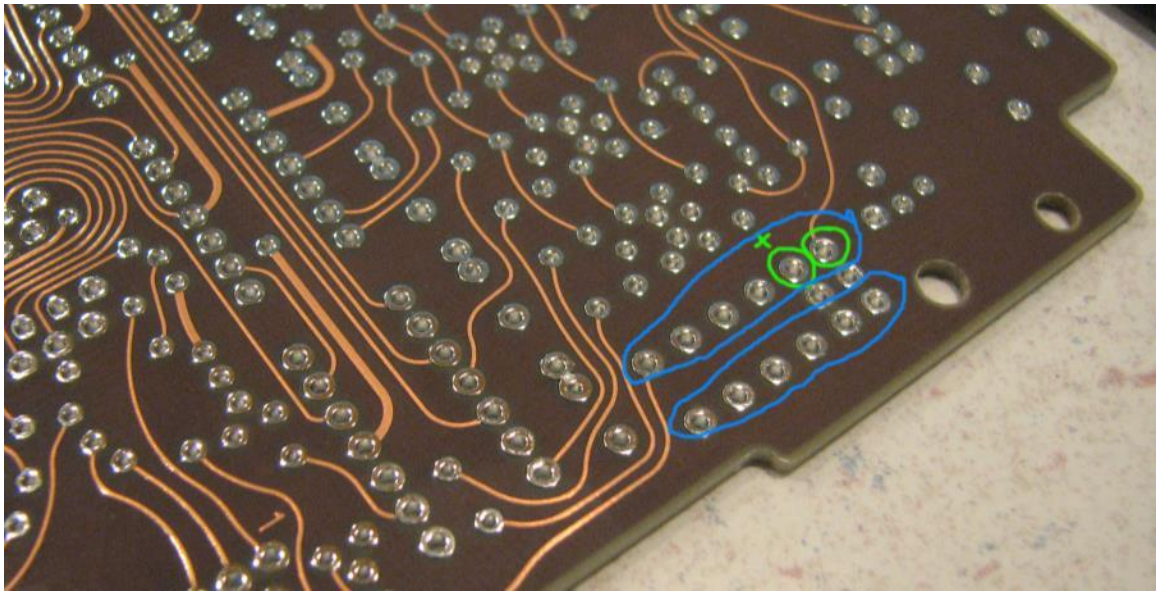
The silicone rubber gasket was also held in place over the top of this graphic with super glue. The super glue holds OK, but you may want to get some better adhesive that will adhere better to the silicone rubber. Others have suggested roughening up the surfaces that are to be glued for better glue adhesion. Also consider using an epoxy instead of superglue. Wharin suggested Barge General Purpose Cement for this.

There is about 18” of wire available to make the connection between the circuit board and the error box. I just cut 2 pieces about 3” long for the LED (or center connections with no LED), then cut the wire in half for the other 4 connections to the circuit board.

For each wire, strip off 3/16 of an inch of the insulation on one end only and solder them to the board. Just route them as you would like and push them into the three slots as far as possible. You can pull them back out and trim them some if the length is too long. Do not strip the end that goes into the slots in the error box since the insulation is what holds the wire in place. No need to glue them in, but you can if you want to make them very strongly attached.

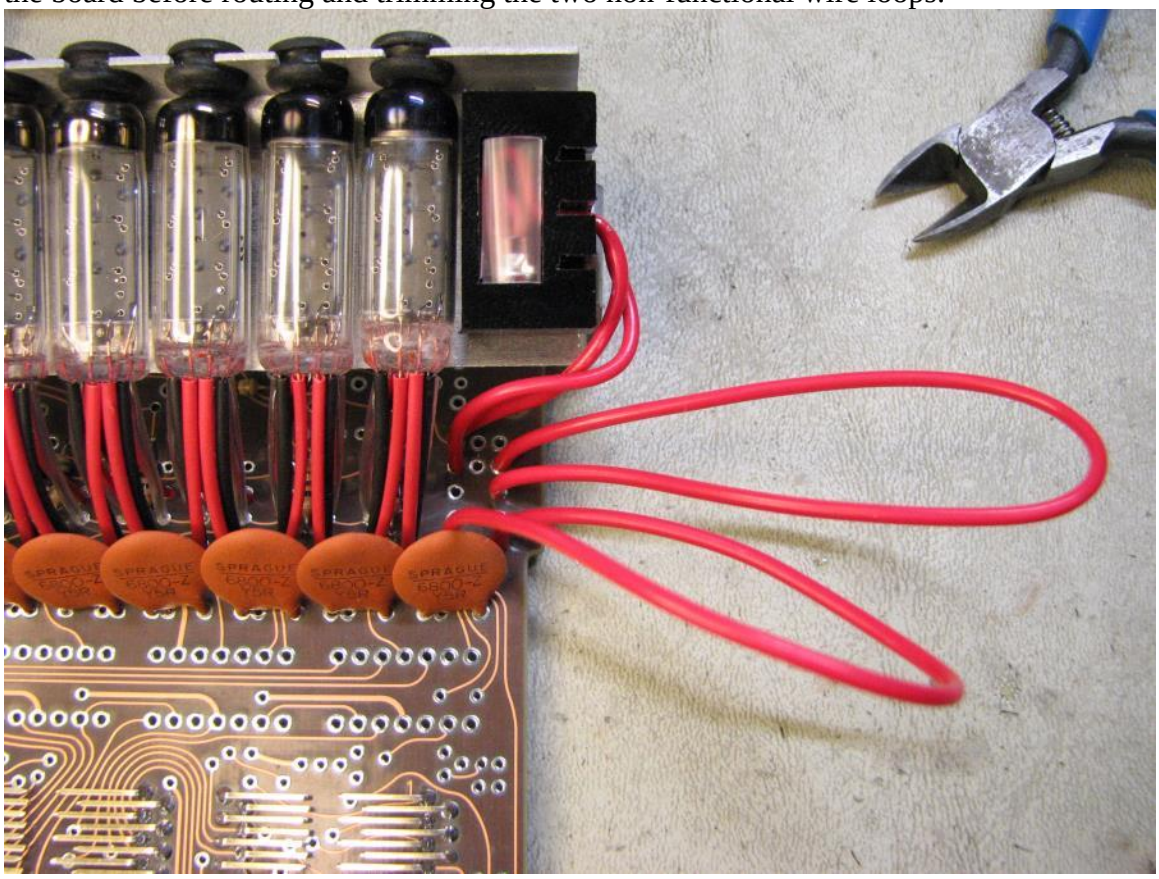
The wires can go into the holes that form two rows of holes (circled in Blue):

A B C D E F
G H I J K L

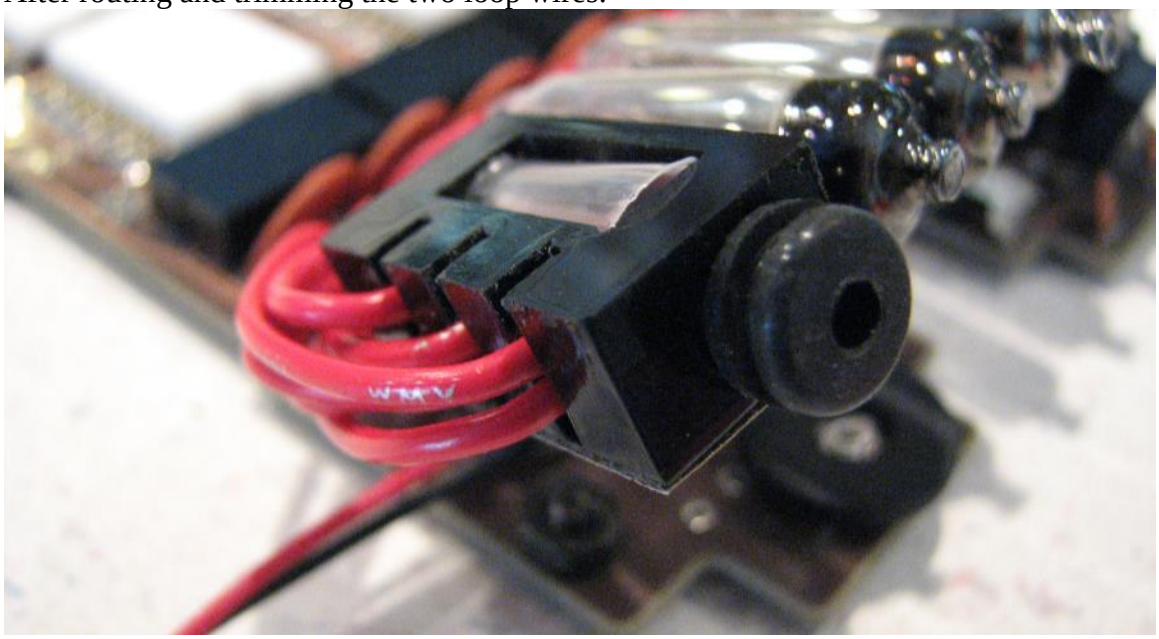


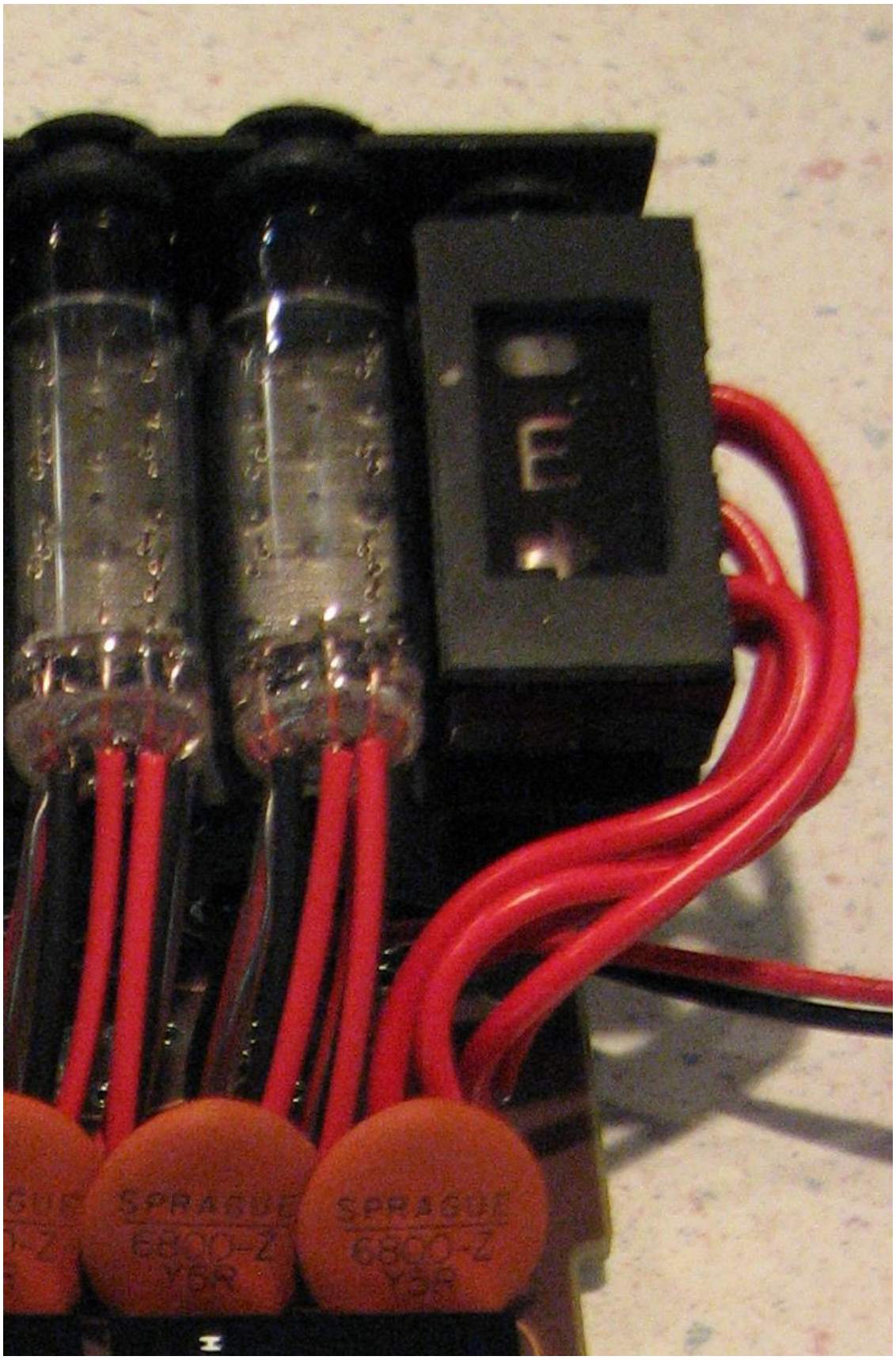
Use whatever holes you want to if there is no Error Box LED. If you are using the Error box LED, Hole E is the positive (“+”) connection and F is the negative connection for the LED.

The error box LED attached (tried connecting both ways with the battery connected and powered on to see which way made the LED illuminate) and the two wires soldered to the board before routing and trimming the two non-functional wire loops:



After routing and trimming the two loop wires:

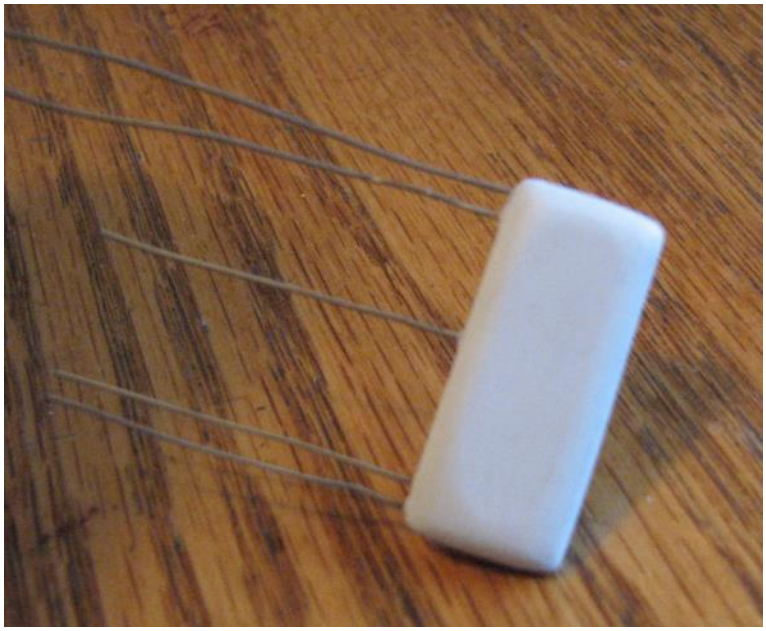



E
SPRAGUE
6800-Z
Y5R
SPRAGUE
6800-Z
Y5R

”Pillow Shaped Part”

I originally glued two 0.1" thick pieces of styrene together (1 1/8” x 0.5”) and sanded it down around the edges for the shape, used solid wire, heated with the soldering iron and melted each of the 5 wires into the end of the glued styrene pieces. The placement of the wires was based on the holes that will be used in the circuit board.

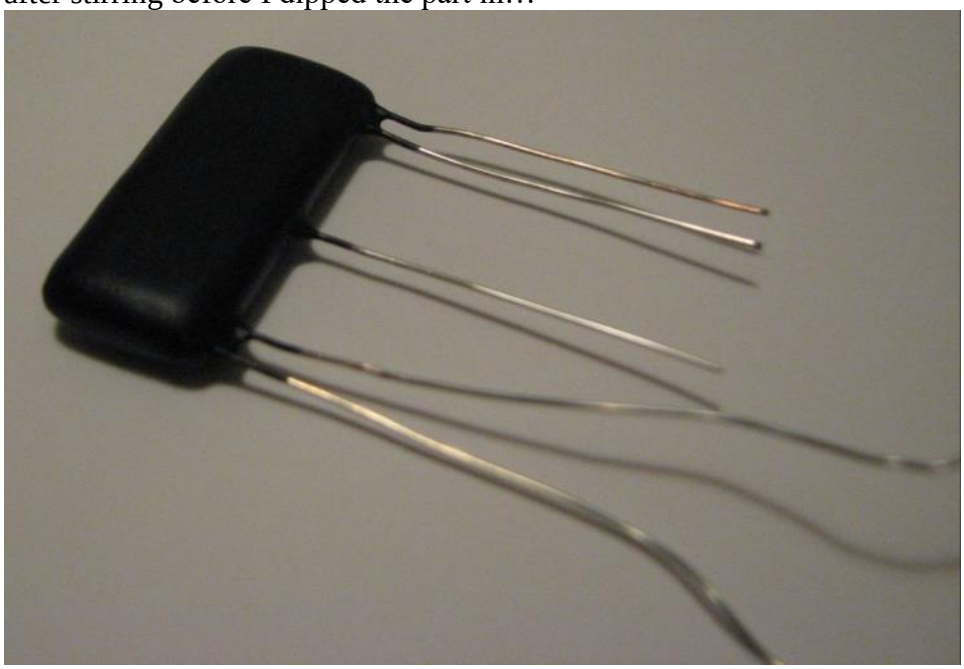
Now a 3D printed part that is black is included, but I didn’t take new pictures of the process.



Strip one of the solid core wires about ¼”. Then while using a soldering iron to heat the wire, push the wire into the part. Repeat this for all 5 wires. If the wires are a bit loose, you can always pull the wire out of the part and add a drop of superglue and push it back in.

Then the part is dipped the part in Plasti Dip - the stuff that you can dip tools into to get rubberized handles.

There are some bubbles from stirring the Plastic Dip. Maybe I should have waited longer after stirring before I dipped the part in…

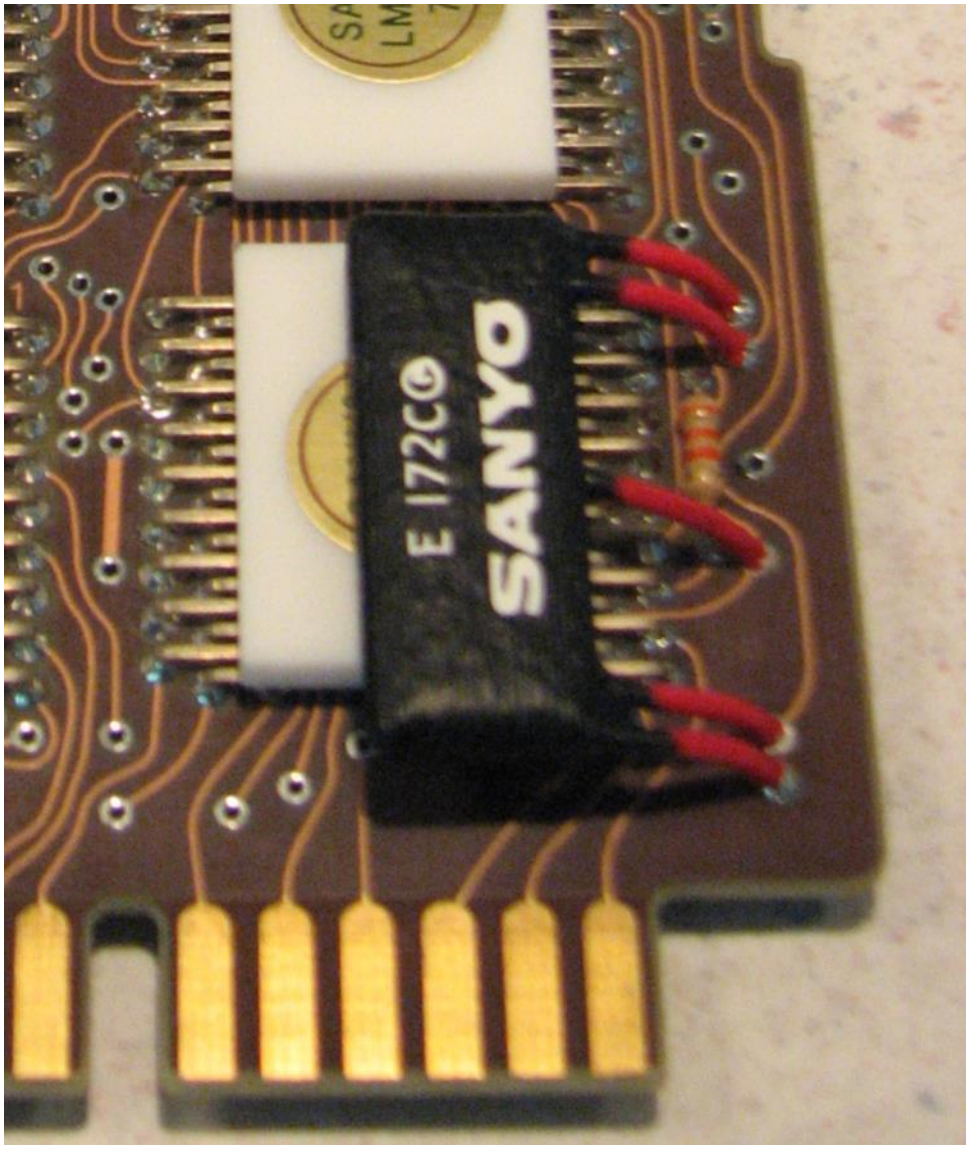


Here bare wire was used, but the new kit supplied solid core red wire so it already has the red insulation on the wire. Be care not to get too much plastidip covering the red wires.

Then apply the rub-on transfer like what was used for the IC parts (it is larger than the rub-on transfers for the IC parts), trim and strip the red wires to the correct length (test fit!) and then solder the wires to the board:

I found that the 3D printed part still has some texture from the layers with only a single coat of plastidip. To get a smooth part, you will probably want multiple plastidip coats, or sand the pillow shape part first to minimize the SD printed layer texture. Some 3D printing sites show acetone baths, etc. all attempting to get smoother surfaces.

Here you can see that a single coating is not smooth, but the dry-rub transfer still worked fine:



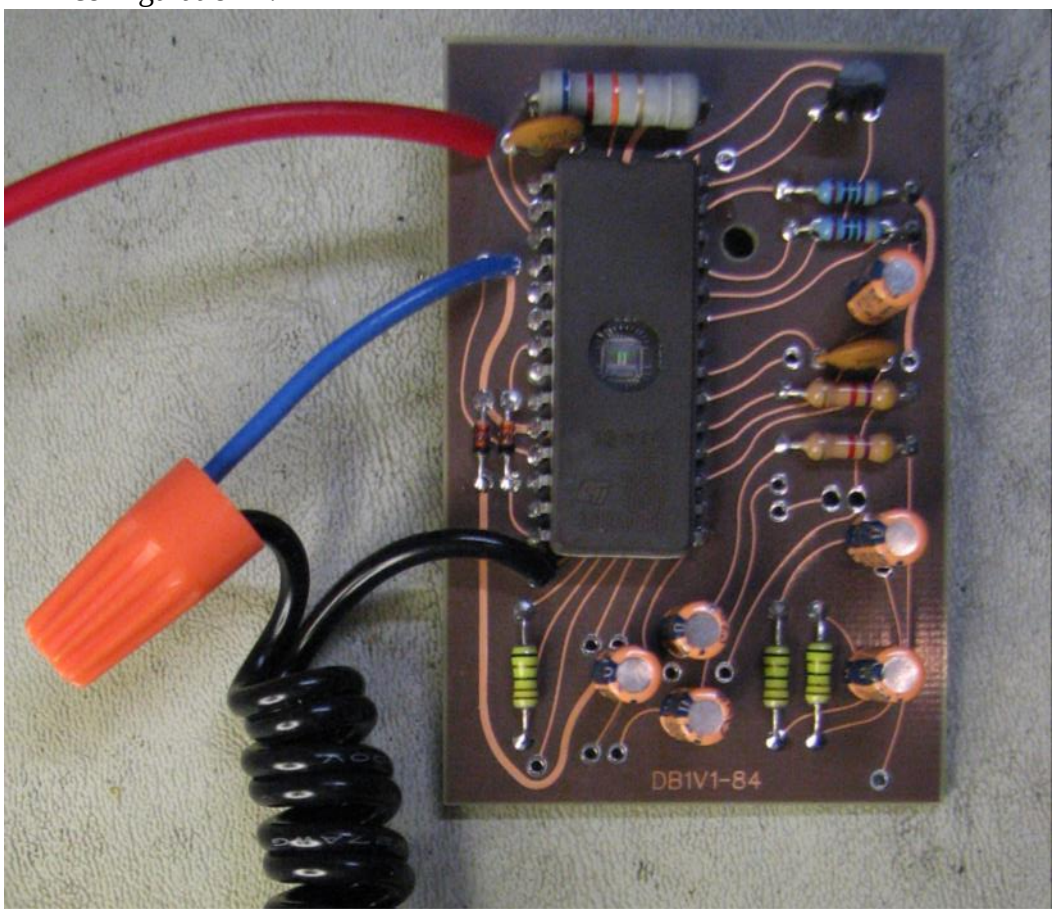
”DB1” Daughter board

Here is the short version of the Dauighterboard build. A more detailed version is next for those wanting all the gory details. There is a single daughterboard circuit board that can be used to build up either of two different versions of the DB1 board or your own placement of the parts.

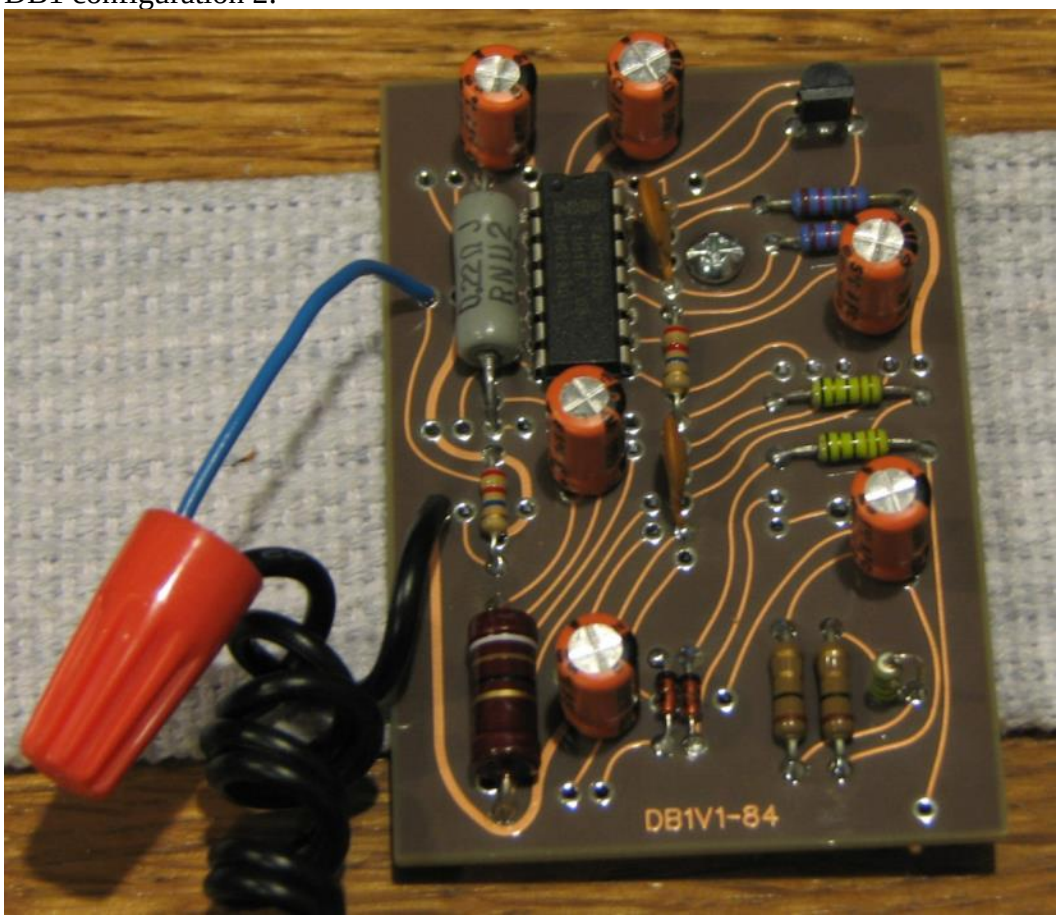
Start with the parts that are lowest height first since it makes flipping the board over and soldering easier. If you start with the tallest parts, when you flip the board over the parts may fall out since the board is not resting on them.

The main things that can be seen in the GB1 movie reference photos are the 6 capacitors (orange cylinders with metal top in the photos below) and there were two distinct arrangements. The rest of the components could not be easily distinguished, so the parts used are representative of what could have been in the actual boards. Some parts may be a bit different as vintage parts may not be available in sufficient quantities to make every kit identical.

DB1 configuration 1:



DB1 configuration 2:

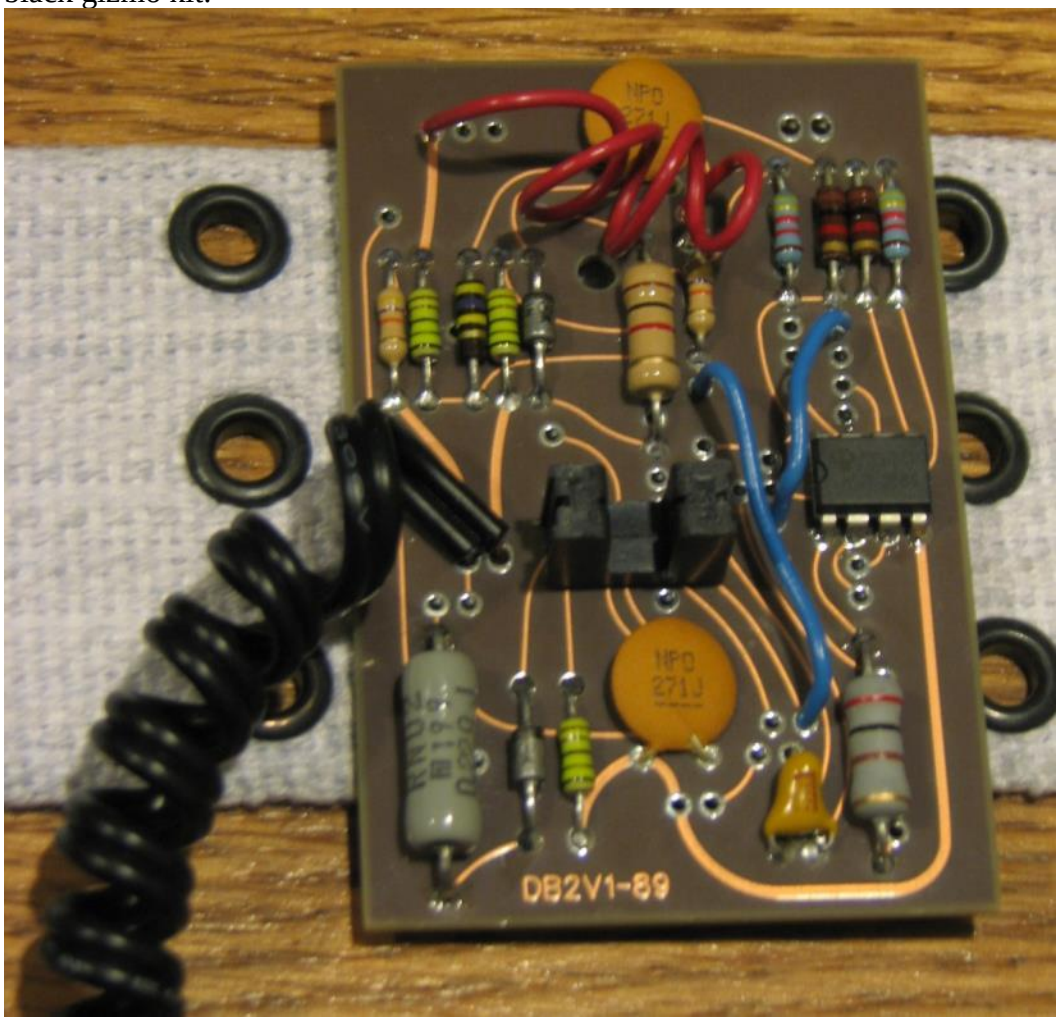


In the lower right hand corner of the board a green colored resistor is standing up next to the two brown resistors. This is a previous version of the kit so the two large resistors on the left are now a bit different: a large grey resistor with color code stripes and a large yellow capacitor are included. You can decide which one goes on the top left and the bottom left.

In some photos, a red wire with an alligator clip or some other red connector end is seen going from the daughter board to the black shaver cord. See the last photo below for an idea of where one of these cables could be placed.

The daughterboard clips onto the belt with a metal clip that is attached to the back side of the printed circuit board through a hole in the upper middle of the daughterboard:

The DB2 version is no longer offered since this is available in a black version with the black gizmo kit:

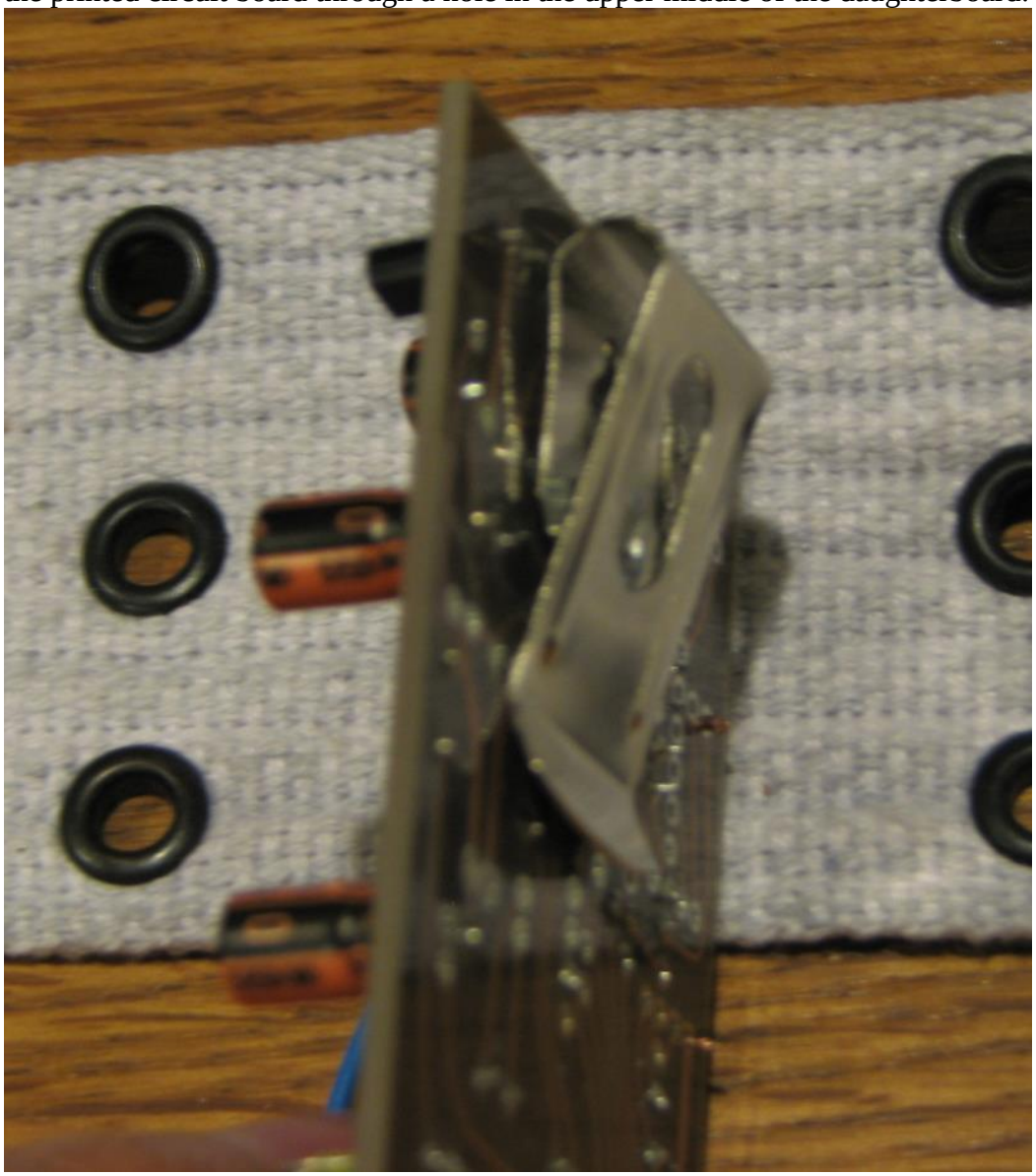


This DB2 version was based on the rubber stunt version that does have clear reference photos. The stunt version did not have real components or a real circuit board so this one was made with parts that had similar shape and size to the molded in parts of the stunt board used in the GB2 movie.

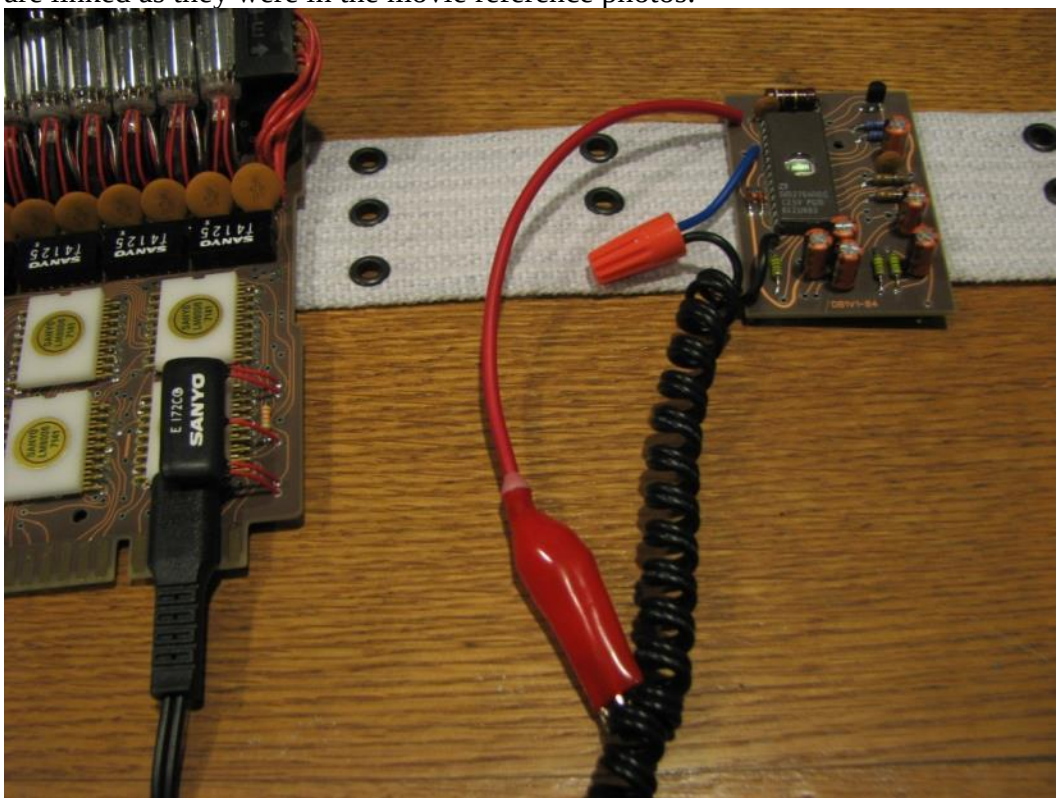
The shaver cord connection shown above was a bit fragile, so you may consider tying the shaver cord down with a wire that goes through the two holes just below where the shaver cord is soldered to the board in the above photo.

Belt Clip:

The daughterboard clips onto the belt with a metal clip that is attached to the back side of the printed circuit board through a hole in the upper middle of the daughterboard:



The shaver cord can just be glued to the Gizmo board on the other end so the two boards are linked as they were in the movie reference photos:

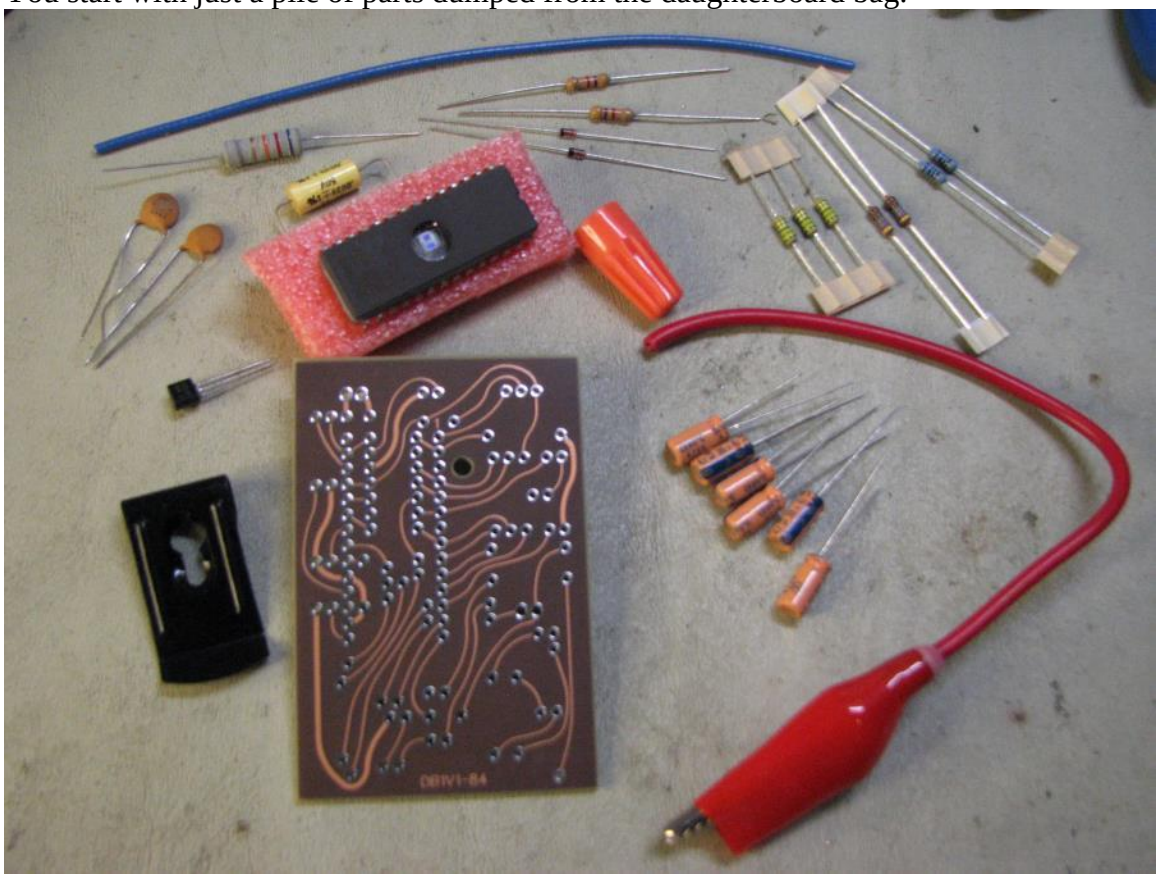


Have fun!

Detailed Daughterboard Instructions

The Daughterboard can be built up in many different ways, but here is a detailed writeup for the first version.

You start with just a pile of parts dumped from the daughterboard bag:

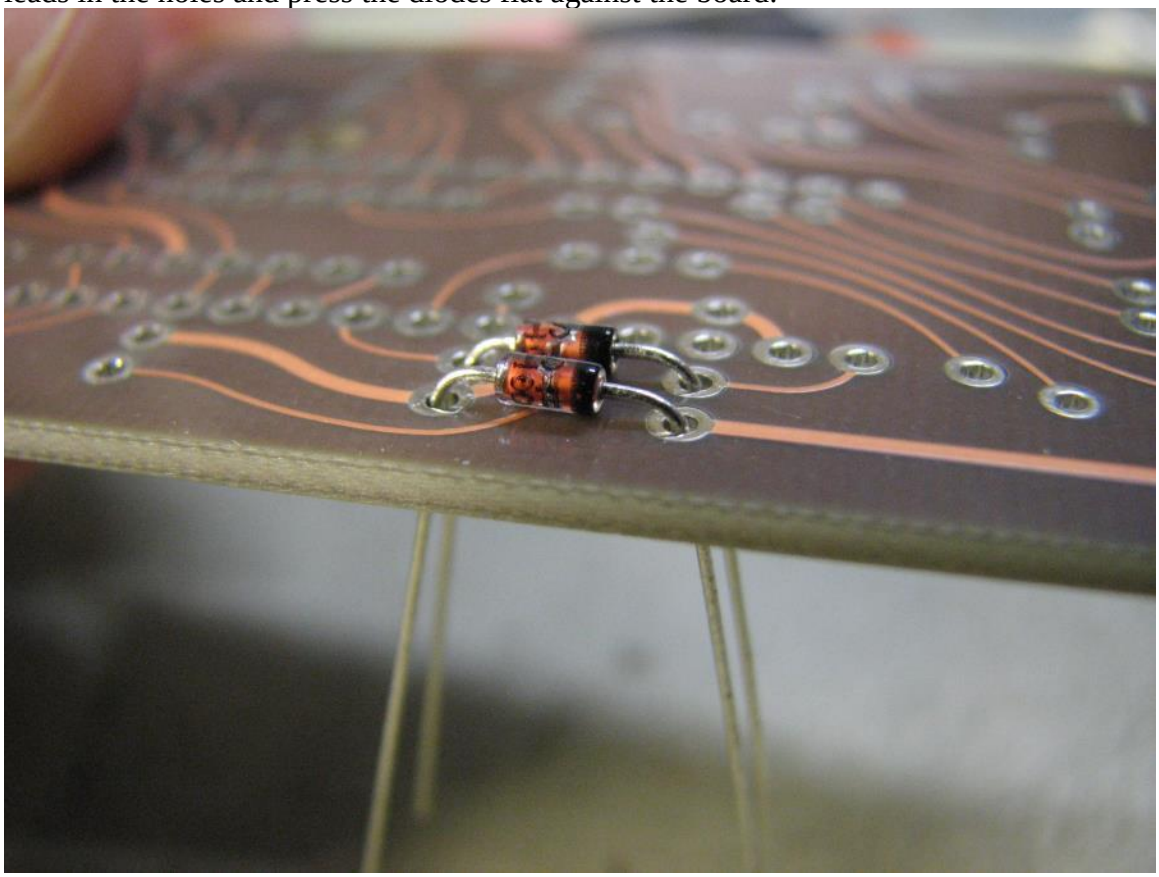


If needed, you could glue the parts in, but soldering is more accurate.

*** WARNING ***
Solder can contain lead and that is a poisonous substance, so be sure to keep the solder out of kids reach and wash your hands after handling the solder and before you eat or prepare food. It is best not to directly breath in the smoke when soldering, so a ventilated area is best and a light breeze from a fan can be very beneficial if you do not solder equipment designed to remove the fumes (much more expensive than the typical soldering tools most people have or purchase).
*** END OF WARNING ***

It is best to build up the board with the shortest parts first. This allows you to place the parts on the board and then flip the board over, resting on the parts, when you go to solder the parts on the board. This order is not necessary, and I don't always remember and it still works out OK, though it may be a bit more difficult.

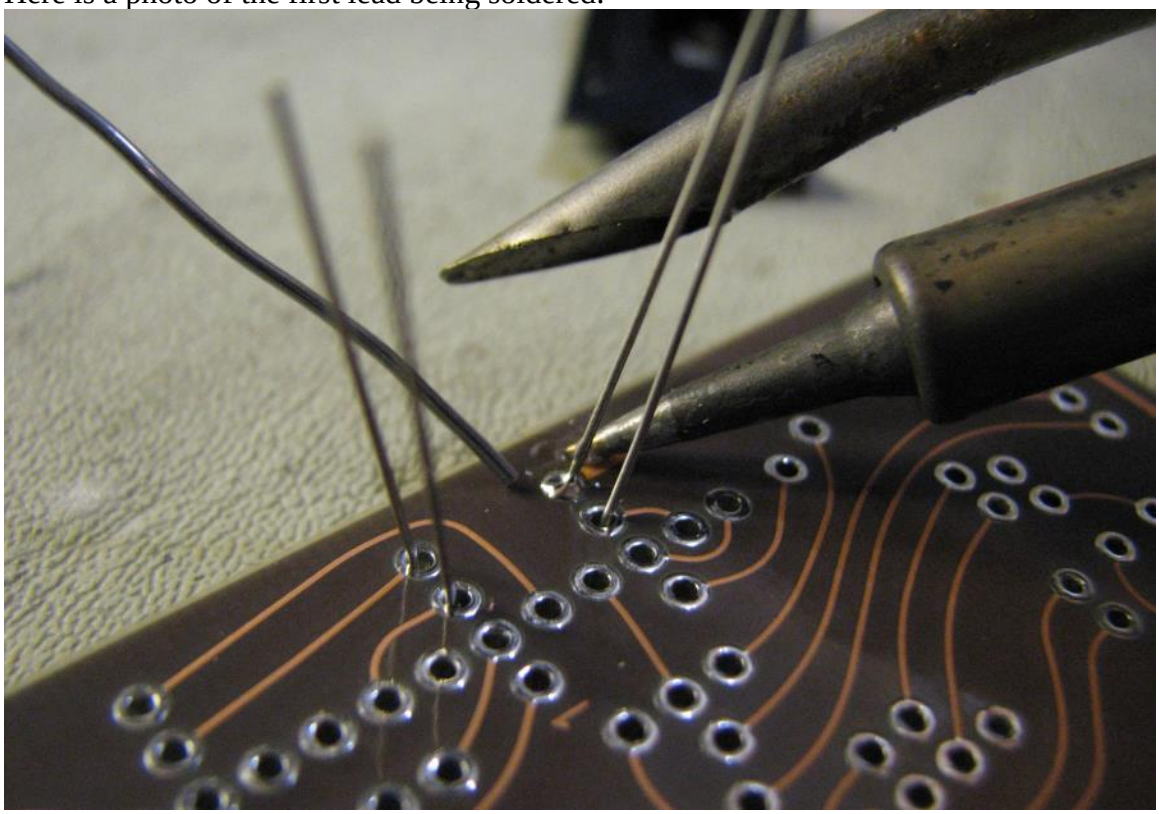
The shortest parts are the two diodes, so let's start with those. Bend the leads, instert the leads in the holes and press the diodes flat against the board:



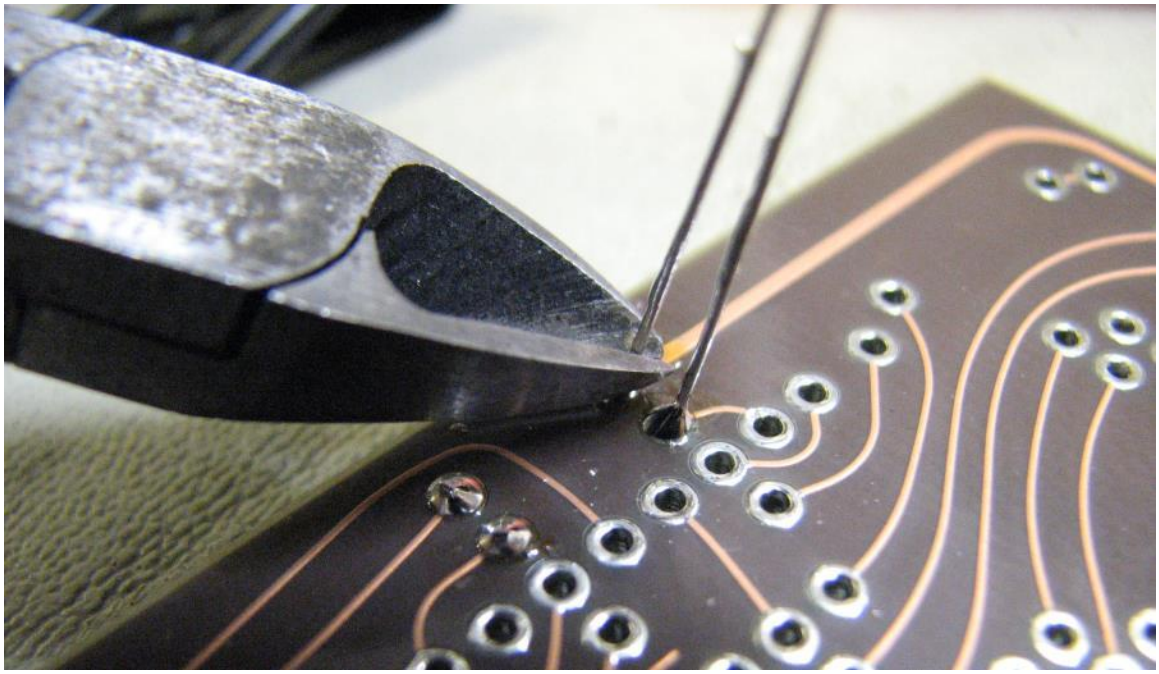
Now flip the board over (you can bend the leads a bit to hold the diodes in place or hold on to the leads or parts as you flip the board over so they do not fall out), and make sure the parts are still flat against the board.

Now solder at least one wire from each component to the board. By only soldering one wire, you can flip the board over and make sure the part is positioned properly. It is much easier to adjust the part position with only a single wire soldered to the board!

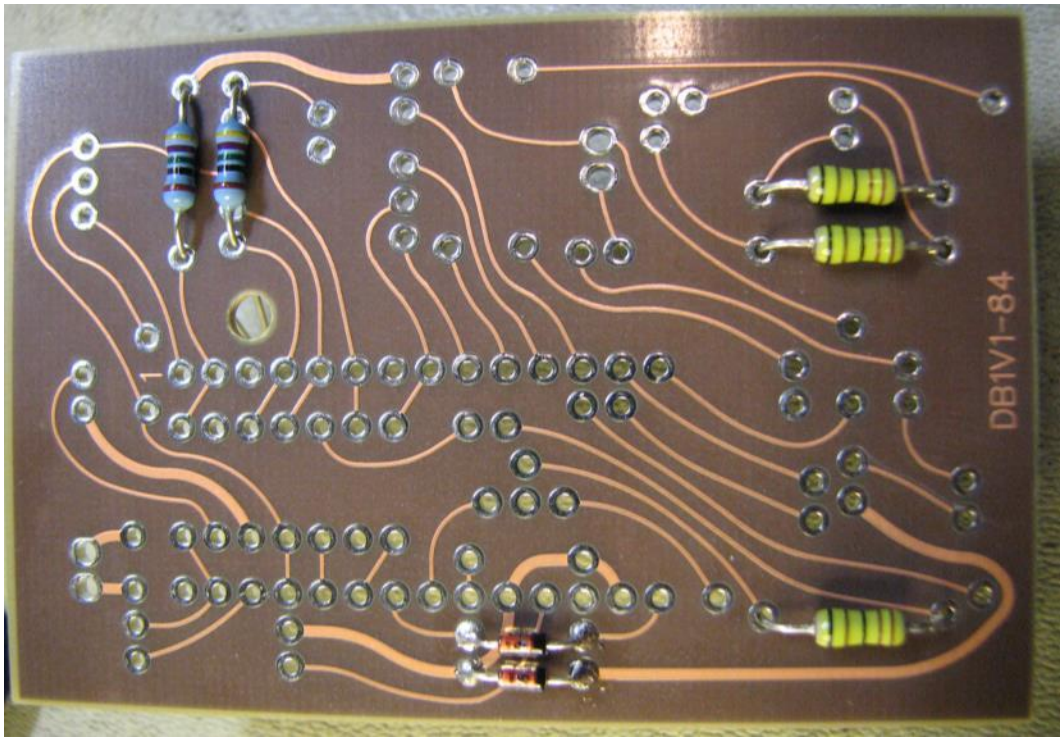
Here is a photo of the first lead being soldered:



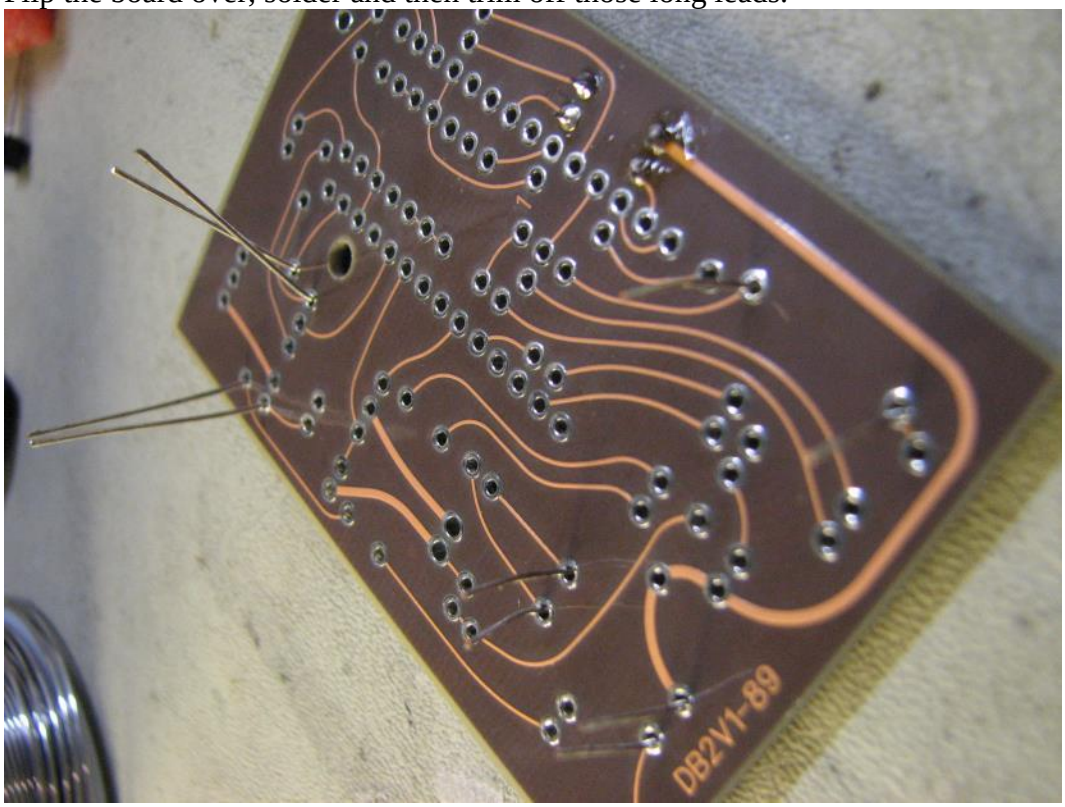
After the part is verified to be in the correct position and all the leads are soldered, use some diagonal cutters to trim the leads on the solder side of the board very close to the board:



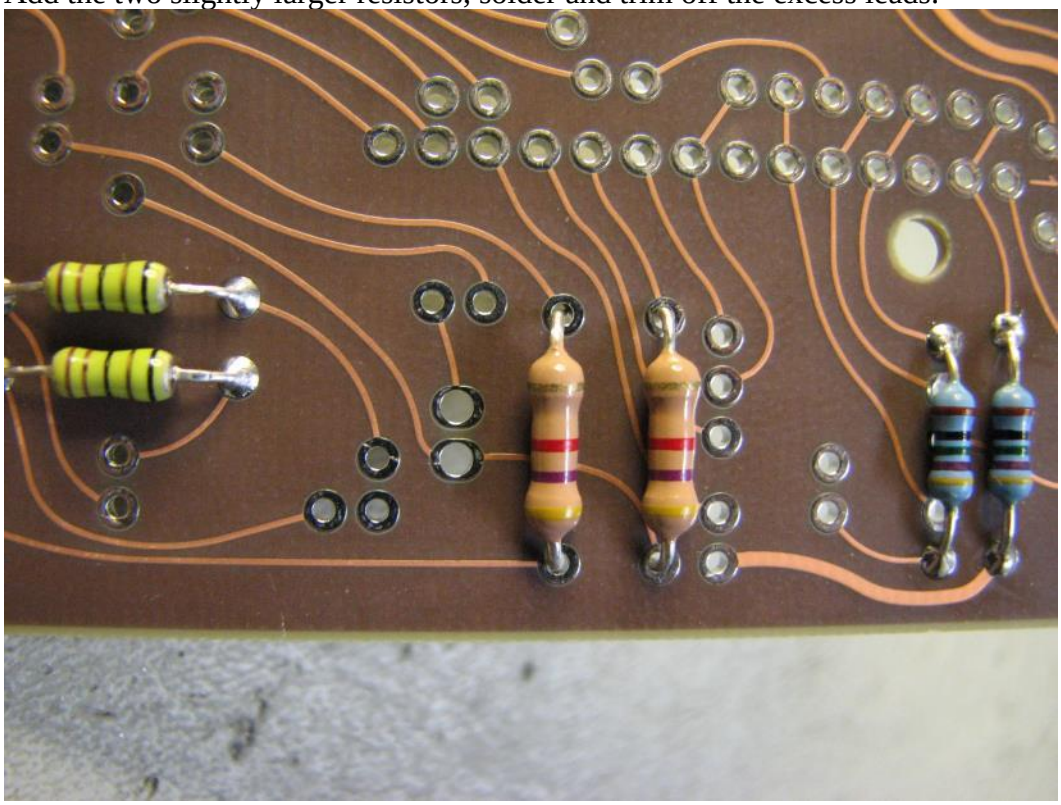
Next, mount the 5 smaller resistors at the same time since they are about the same size:



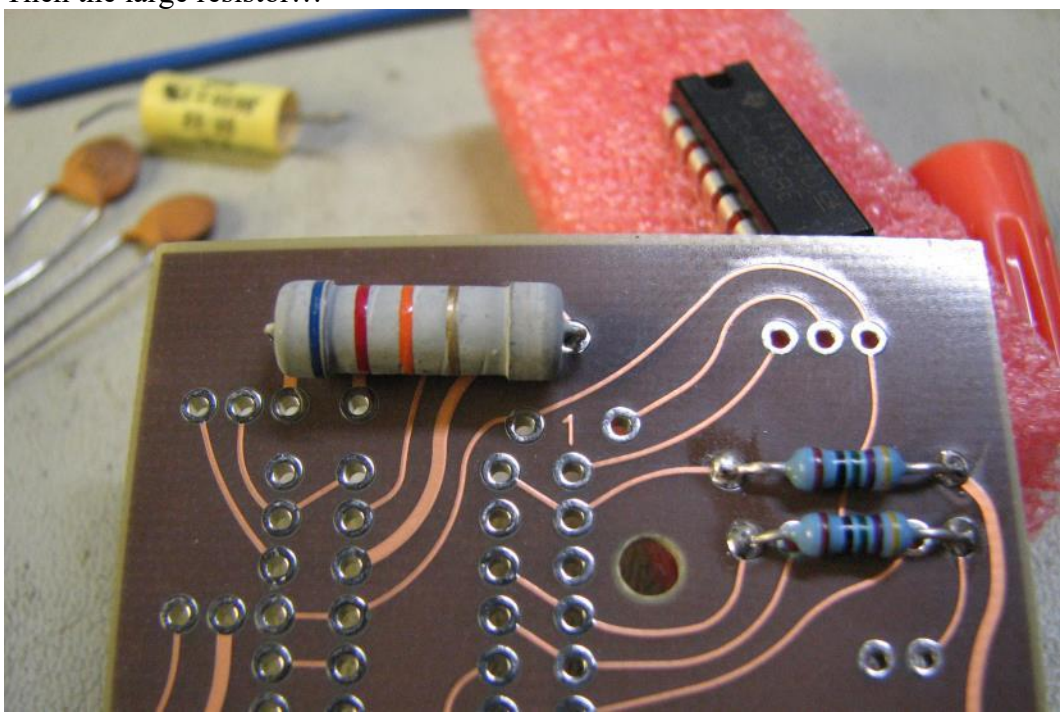
Flip the board over, solder and then trim off those long leads.



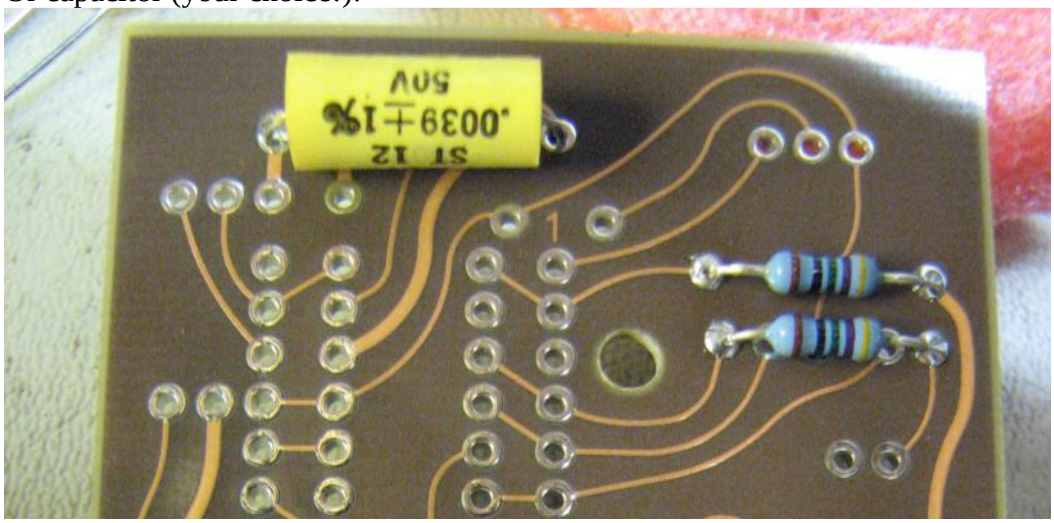
Add the two slightly larger resistors, solder and trim off the excess leads:



Then the large resistor…

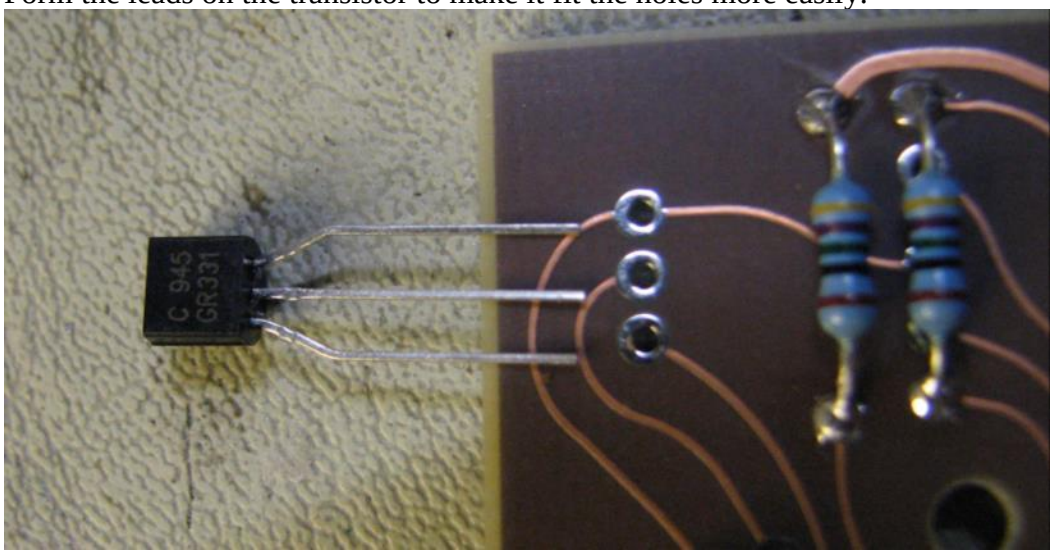


Or capacitor (your choice!):

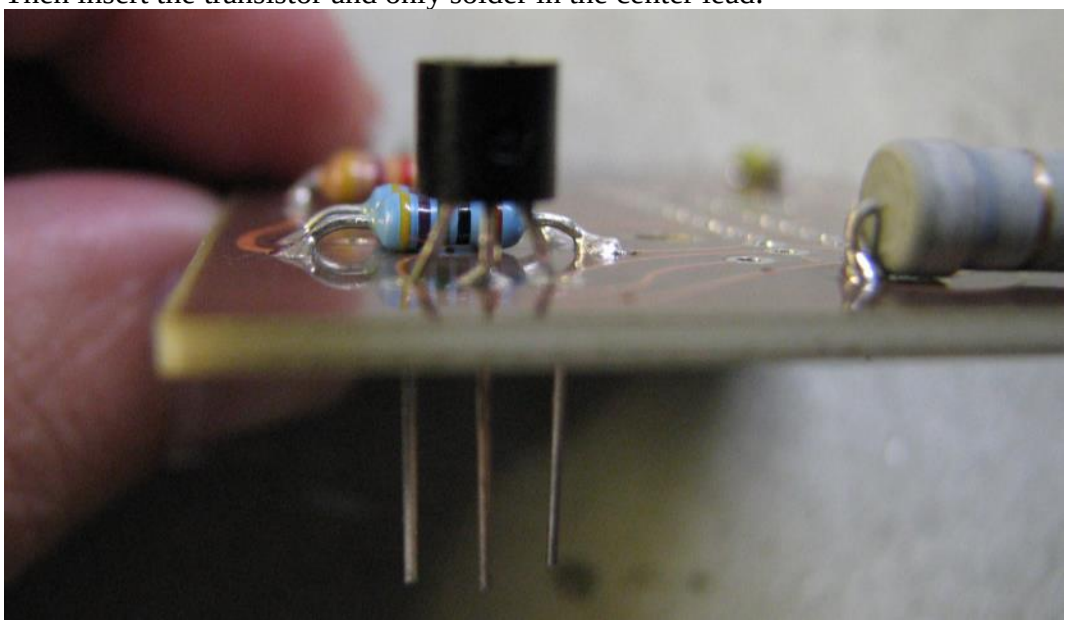


Next should have been the large integrated circuit, but I placed the transistors and smaller capacitors in next (they are taller than the integrated circuit, so I will show you later what to do if this happens to you)

Form the leads on the transistor to make it fit the holes more easily:

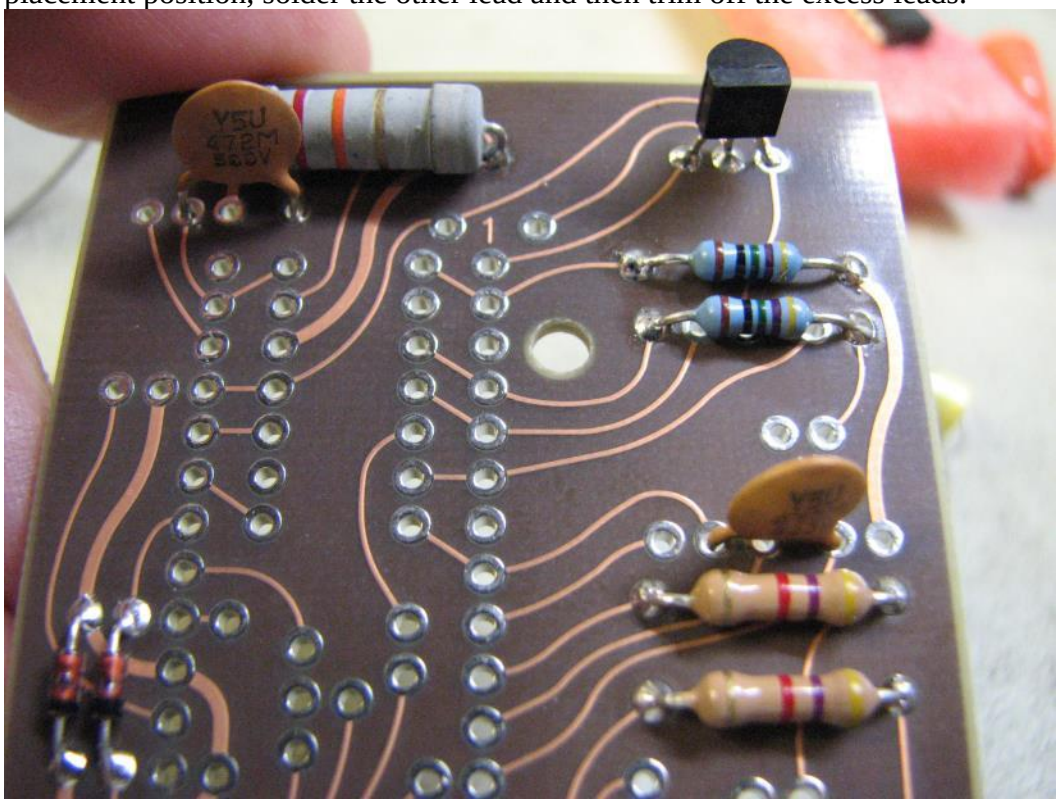


Then insert the transistor and only solder in the center lead:

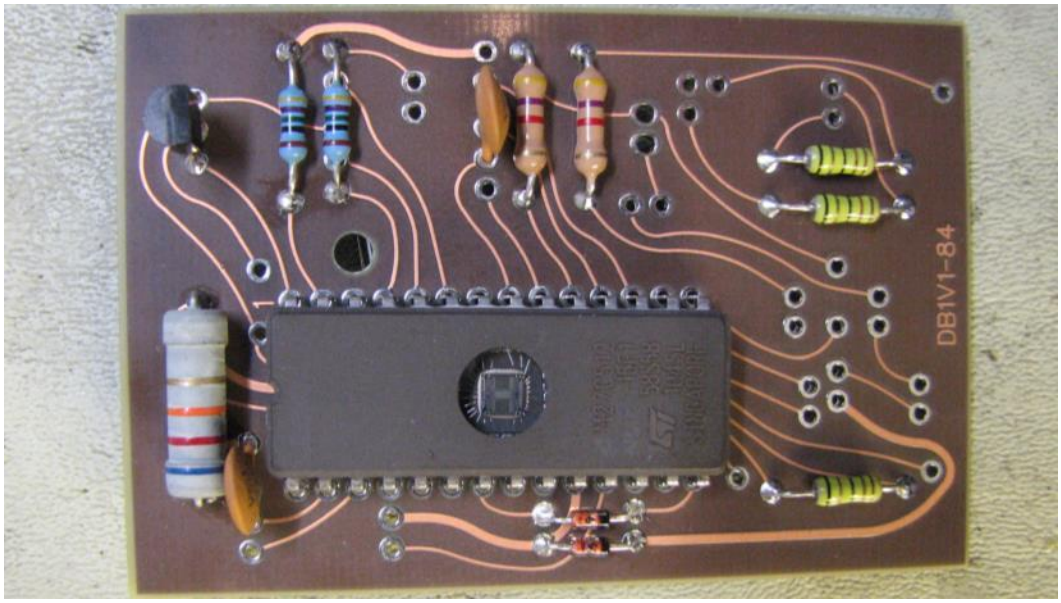


This allows you to adjust and level out the transistor before you solder the other two leads and fix the position of the transistor in place. Then trim off the excess leads.

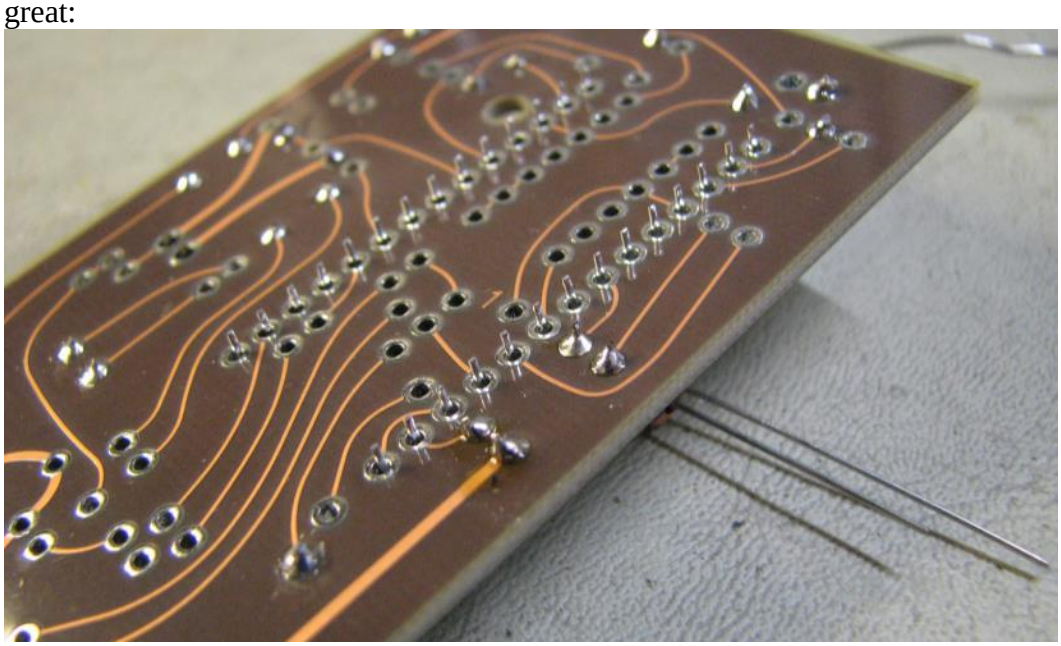
Next place the two smaller caps on the board, solder one lead of each, adjust the placement position, solder the other lead and then trim off the excess leads.



If you didn't already mount the large integrated circuit, we get to do this next. This part is shorter than the caps and transistor, so may not be able to sit on the table when the board is flipped over and it may just fall completely out of the board while you are trying to solder.



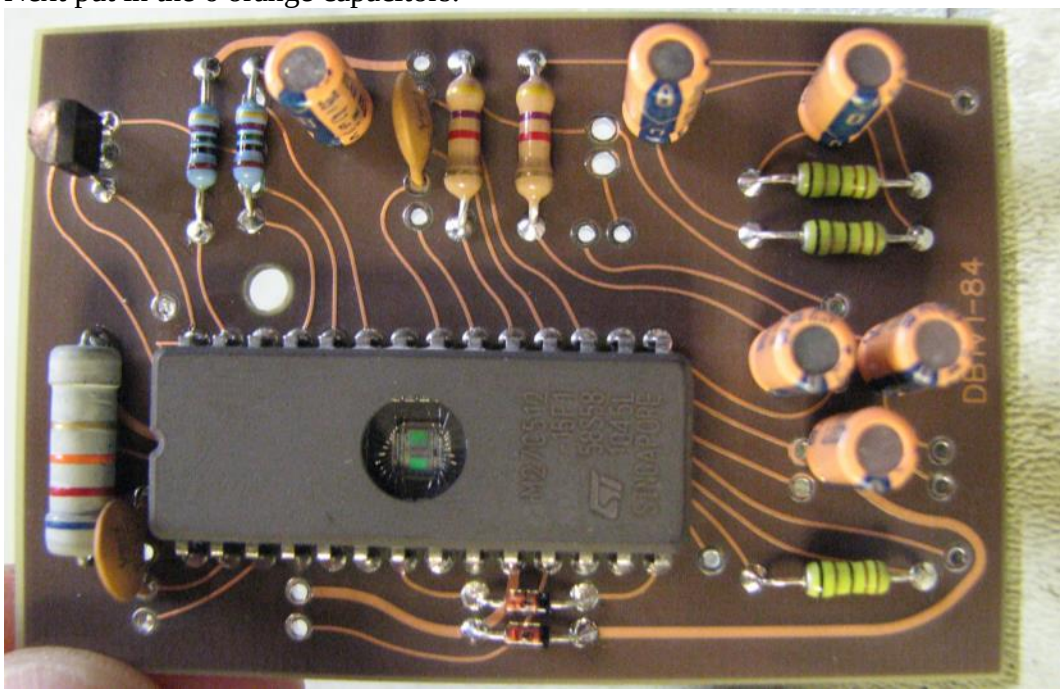
So, set something under the part when it is flipped over so the part is firmly held in place when you are soldering. I just set one of the orange capacitors underneath and it worked great:

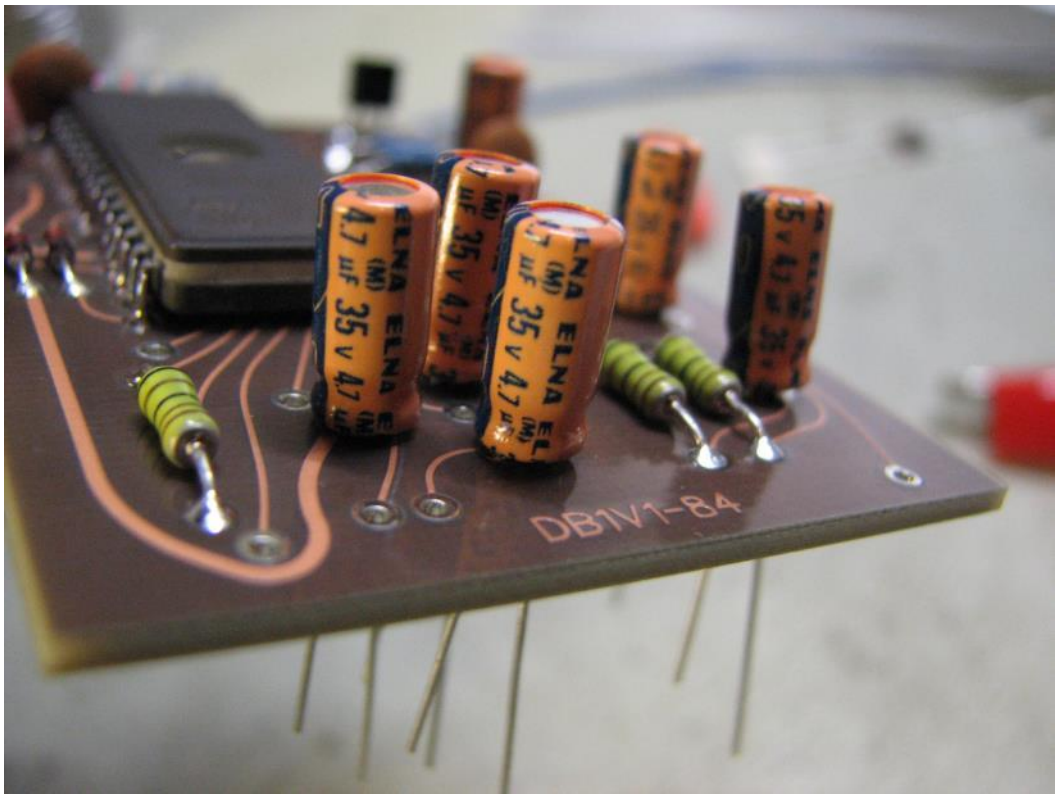


Now solder two pins on opposite corners and then flip the board over and make sure the part is sitting against the board. If you solder a lot of pins before you check for this it will be very difficult repositioning the part. If the part is not quite on the board you can hold the board up, put the soldering iron on the pin you want to adjust and press on the

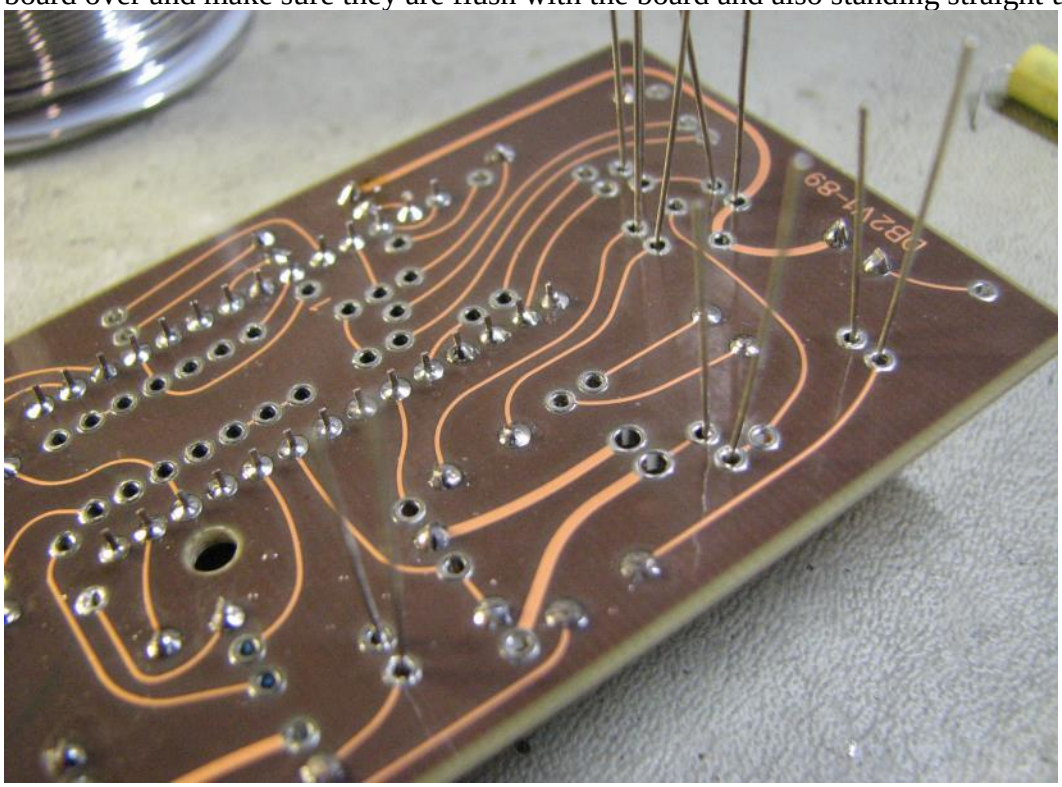
part at the same time. When the solder melts, you should be able to press the part into the board.

Next put in the 6 orange capacitors:

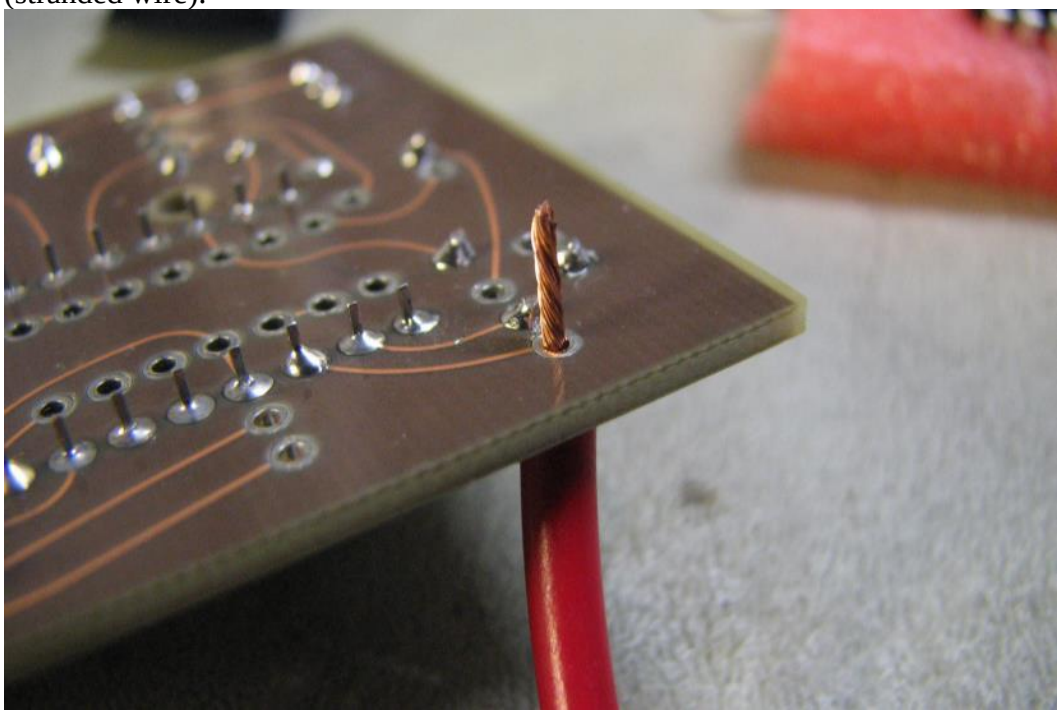




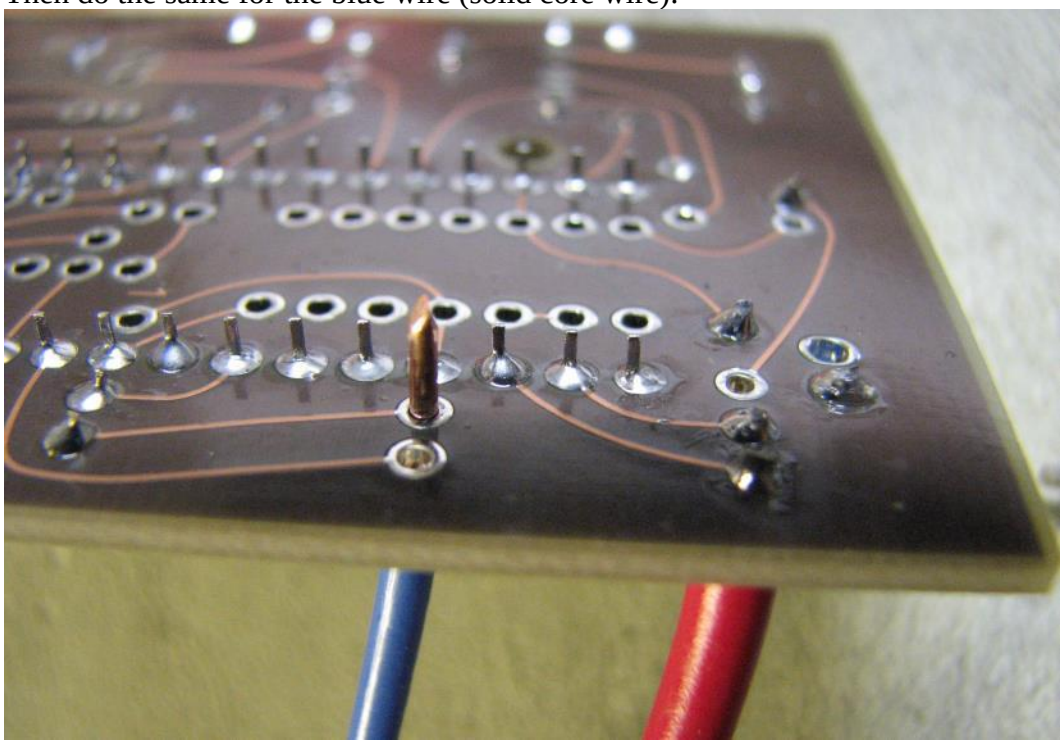
Flip the board over and solder one lead from each of the orange capacitors. Then flip the board over and make sure they are flush with the board and also standing straight up.



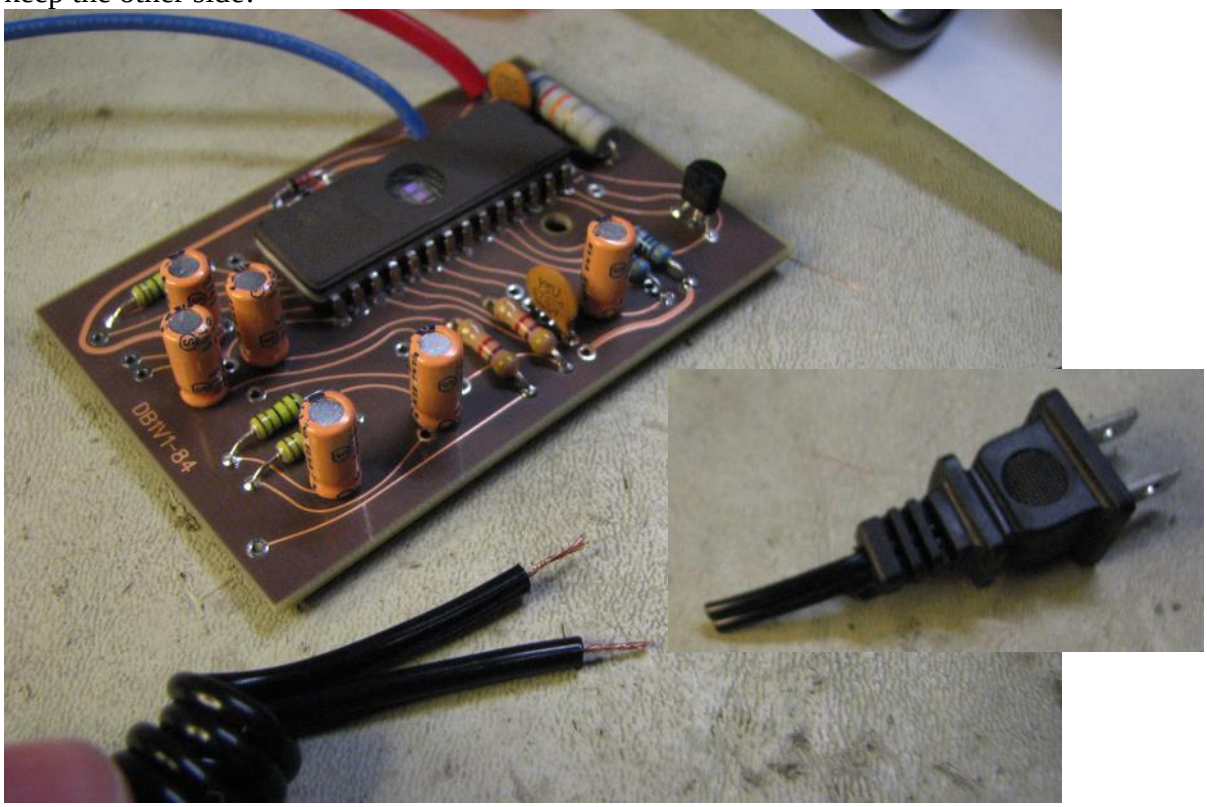
Next strip the end of the red wire with the alligator clip on it and solder it into the board (stranded wire):



Then do the same for the blue wire (solid core wire):



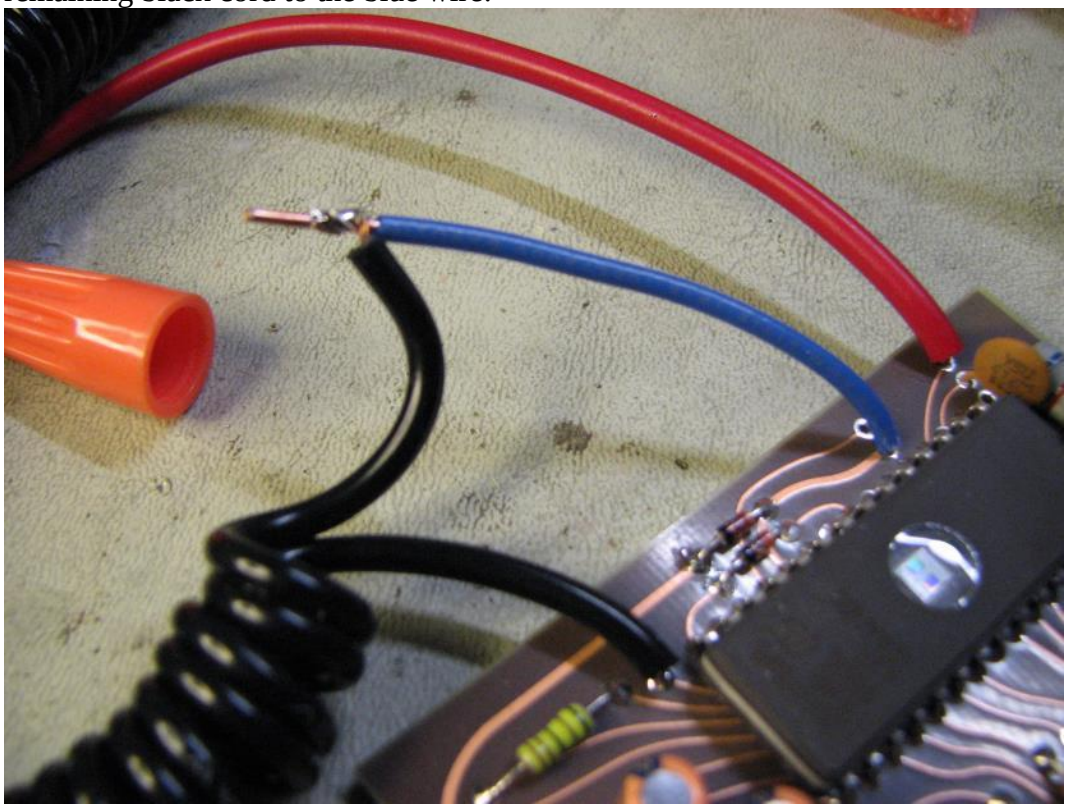
Get the shaver cord, cut off the AC plug (the side that plugs into the wall, you want to keep the other side!



The shaver cord has VERY fine wires, so take great care when stripping the wire. You may want to practice stripping the wire on the AC plug that you will not be using.

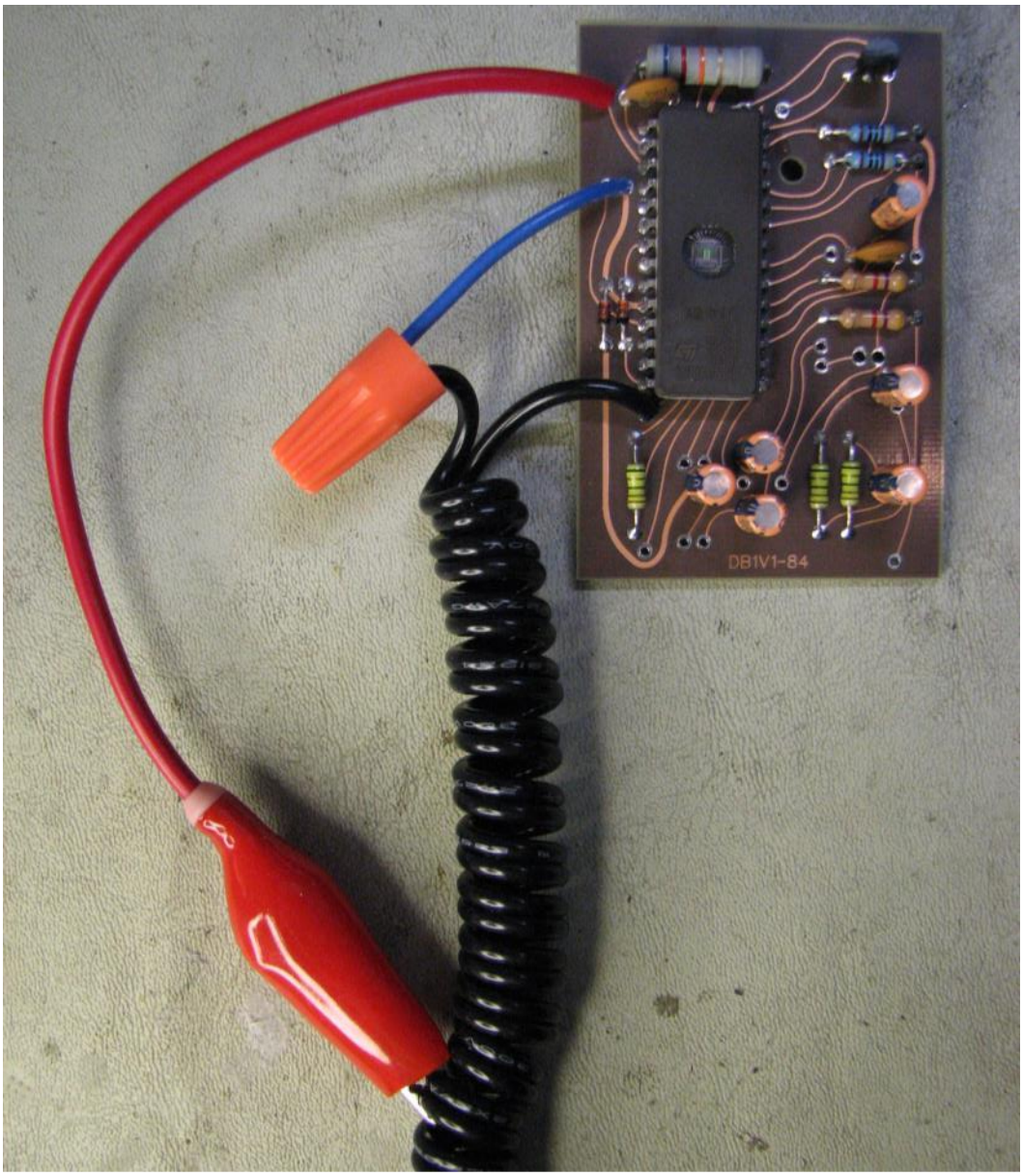
Solder one end of the shaver cord's wire to the board. The Orange wire nut that is normally used to hold wires together will not work very well with the shaver cord's tiny wires, so it is best to solder this other black wire to the blue wire.

Trim the blue lead to the desired length and then strip about a ½" of the wire. Solder the remaining black cord to the blue wire:



Attach the orange wire nut to the Blue wire and then attach the belt clip with a small black screw and nut that were included in the bag with the display tube stand.

Now you can sit back and enjoy the amazing creation you just completed!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