

Assembly Manual

LED Display Module for Stern / Bally Pinball

P/N **TPP-1032**

KIT: PCB and Parts



To improve the looks and reliability of your classic Stern or Bally pinball machine, why not upgrade those aged high voltage displays with this newly designed LED module. This kit provides all the parts and PCBs for upgrading all 5 display modules on your machine.

The Tangles TPP-1032 LED display modules are a drop in replacement for the original Bally part number AS-2518-21 and Stern part number A-434. When constructed, these modules will slide into the existing mounting brackets of the pinball machine and connect simply onto the 20-Way "Molex" connectors.

Out with the Old...

The original display modules are powered with a combination of 5 volt logic power and 185v high voltage for the glass displays. These modules have a limited life and are now commonly showing signs of their age or failing completely. By upgrading to a Tangles LED display system, you can expect the following benefits:

- No high voltage required
- No Fragile glass displays
- Easy to source components
- Modern LED display will last longer than the high voltage glass displays.
- High reliability circuit design with chips and transistors chosen to adequately supply the current needed to drive the LED modules.
- Foam and card light shrouds (supplied) can be used to block side light to improve the aesthetics.

The LED modules work entirely on the 5 volt power rail. By upgrading to the LED modules, owners and operators can deactivate the high voltage power circuit by removing the fuse.

This greatly improves the safety of the machine.

Theory of Operation

The circuitry of the display modules are identical across all 5 modules in the machine. The 4 player score modules and the 5th Credit / Ball display are made identically. The machine's wiring harness has dedicated "strobe" wires for each of the 5 displays. This strobe signal is cycled by the CPU of the machine, addressing each of the displays in turn. When a display is strobed, the display module reads a binary value (representing a single digit) from the signals BCD-A, BCD-B, BCD-C, BCD-D. This value is latched into the CD4543 latch decoder. This chip performs two important functions. It stores the digit in its internal register (memory), and

it decodes the binary value into 7 outputs designed to drive a 7 segment LED display. The memory aspect of this chip is important as the CPU will work through each of the 5 display modules latching required digit 1 (the least significant digit) into the module memory. When complete, the CPU will then apply a +5v signal onto the DIGIT1 line. The DIGIT signals are wired common to all 5 of the displays. When this voltage is applied, all 5 modules will simultaneously display the single digit (stored in their memory) on the first LED. This digit is display for a short period then the signal is removed.

The CPU then repeats the process storing (strobe) numbers into all 5 modules then applying 5v to the DIGIT2 wire. The process continues for all of the digits of the module resulting in a display that wipes from right to left across the 5 displays. This all occurs at a rate far too fast for our eyes to detect. We perceive the displays as showing all digits simultaneously through the persistence of vision in our eyes.

PARTS LIST (Per Module)

1 x PCB Base
 1 x PCB 6 Digit LED (Vertical)
 6 x LED modules
 12 x 1K Resistors
 7 x 68 Ohm Resistors (Yellow)
 7 x 82 Ohm Resistors (White)
 6 x 3.9K Resistors
 6 x 47K Resistors
 1 x 10uF Electrolytic Capacitor
 1 x 0.1uF Ceramic Capacitor
 6 x 2N3904 NPN Transistors
 6 x BC327 PNP Transistors
 2 x 16 pin IC socket
 1 x MC4543 16 pin IC
 1 x ULN2003 16 pin IC
 2 x 8-Way right angle headers
 2 x 10-Way Molex headers
 2 x Foam tape strips
 1 x Printed card shroud.

Additional Parts for 7 digit display

1 x PCB 7 Digit riser
 1 x LED modules
 1 x 1K resistor
 1 x 3.9K resistor
 1 x 47K resistor
 1 x 2N3904
 1 x BC327

CONSTRUCTION

These construction notes are for the 6 digit module. The 7 digit module instruction are identical with the Addition of an extra LED module and additional driver transistors / resistors.

Tools Needed

Tools needed to assemble this kit are:

- Soldering Iron
- Solder
- Side Cutters
- Utility Knife

EXPERIENCE

This kit is not suitable for a beginner. Whilst the assembly is straightforward and no high end skills required, it is recommended the assembler has had prior experience with soldering and electronic kit assembly.

Step 1: Parts Check

Verify you have all parts for the module construction by referring to the photos provided and the parts list.

Step 2: LED PCB

Insert all 6 LEDs into the LED PCB. Ensure each decimal point is positioned on the bottom as it shown on the PCB silk screen.

Be sure to install them onto the side of the PCB with the white silk-screened outlines.

Carefully roll the PCB over onto its face for soldering.

Solder one pin of each LED then turn the board back over for inspection. Ensure all LEDs are the right way up and they are sitting firm against the PCB.

Continue and solder all the remaining LED pins.

Install the right-angle headers on the rear of the display riser. Insert the longest legs through the holes having the black plastic lay flat on its side against the PCB.

IMPORTANT: These headers are installed from the back of the LED board. (Opposite side to the installed LEDs).

Solder one leg of each right-angle-header. Use a finger to hold the plastic flat against the PCB.

Solder the remaining legs of the header and the display riser is complete.

Step 3: Resistors

Install and solder the 6 x 1K (brown-black-red) resistors in positions R1 to R6. Splay the legs of the resistor a little to hold them in place for soldering. Snip the legs of the components when soldering is complete.

Install and solder 6 x 1K (brown-black-red) resistors in positions R16, R19, R22, R25, R28 and R31.

Resistor Colours	
68 Ω	blue-grey-black
82 Ω	grey-red-black
1 KΩ	brown-black-red
3.9 KΩ	orange-white-red
47 KΩ	yellow-purple-orange

All resistors are 5% tolerance so have a gold coloured 4th band.

Install and solder 6 x 3.9K (orange-white-red) into positions R14, R17, R20, R23, R26 and R29.

Install and solder 6 x 47K (yellow-purple-orange) resistors into positions R15, R18, R21, R24, R27 and R30.

If you are making the Yellow LED kit then install 7 x 68 ohm (blue-grey-black) into positions R7 – R13.

If you are making the White LED kit then R7-R13 are 82 ohm resistors (grey-red-black)

Step 4: Transistors

The transistors will need to be installed carefully the correct way around. The PCB silk screen shows the orientation of the transistors. Ensure the flat sides of the transistors match the flat on the silk screen.

Install and solder 6 x 2N3904 transistors into positions Q1, Q3, Q5, Q7, Q9 and Q11 positions. Refer to the photos for a guide on how low to mount these to the PCB.

Repeat the process, mounting and soldering the 6 x BC327 transistors into positions Q2, Q4, Q6, Q8, Q10 and Q12.

Step 5: IC Sockets

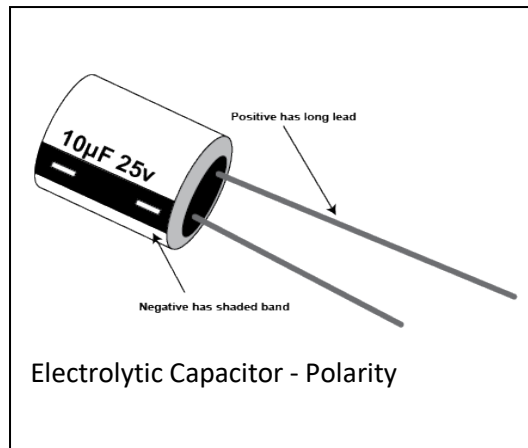
Install and solder the 2 IC sockets into the position U1 and U2. Each IC socket has an indentation between the pin rows to indicate where pin one is. Align the indentation on the silk screen with that on the IC socket.

IMPORTANT: The IC Sockets need to be installed with the correct the orientation!

Step 6: Capacitors

Install the ceramic 0.1uF capacitor into position C1. This capacitor is NOT polarised and can go in any way.

IMPORTAANT: The 10uF capacitor must be installed with the correct orientation.



The 10uF electrolytic capacitor must be installed the correct way around. The black band indicated the negative lead and should go to the pin on the PCB with the white shaded silk screen. Electrolytic capacitor polarity can also be identified by the longer length of the positive lead.

The PCB has a + symbol for the positive and the negative has a white shaded silk screen.

Step 7: 20-Way Connector

The 20-way connector is made up of two 10-way connectors. The two connectors come with a plastic retaining back tabs. You may optionally cut these tabs off using a utility knife.

Install the 2 connectors into the board with the retaining tab (or the edge where the retaining tab was cut off) facing away from the edge of the PCB. (See photos for orientation).

Solder 1 pin of each connector. Inspect to ensure the connectors are flush to the PCB and all 20 pins are aligned in a straight line.

Solder the remaining 18 pins.

Step 8: Joining the Two PBCs

Install the LED riser board into the main PCB. Solder one pin on each of the headers.

Check to ensure the boards are at a right angle. Ensure the LED board is positioned flush onto the main PCB.

Solder the remaining pins of the header.

Step 9: Remove Key Pin

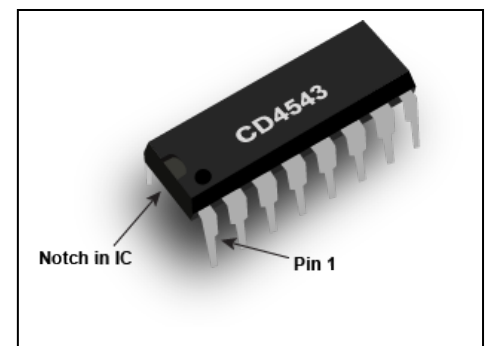
Using a set of side cutters, cut and remove the locating pin (pin 14) on the 20-way connector. The pin is marked with the letter "K" on the PCB silk-screen.

Step 10: Install ICs

You can now install the two IC's. Take care to orientate the notch on the IC to match the notch on the socket.

IMPORTANT: The ICs need to be installed with the correct orientation

IMPORTANT: Take care to ensure the two ICs are now inserted into the wrong socket.



Step 11: Final Checks

- Check All LED orientation
- Check ICs and Sockets are installed the correct way around
- Check the electrolytic capacitor is installed the correct way around.
- Review all solder joints and make sure there are no solder bridges or unsoldered pins.

Installation into the Machine

Ensure the power is turned off.

Unlock and remove the back-glass.

Open the back-box door and unplug and remove all of the original glass display modules by unplugging the 20-way connector and sliding the module out forward.

Install your new LED display module by sliding into the mounting tray from the front.

Connect the 20-way Molex connector using a slight side-to-side angle motion to get it connected with the least force.

High Voltage

When you have completed the installation into the pinball machine, you may choose to remove the high-voltage fuse from the rectifier board.

MAKE SURE THE MACHINE IS UNPLUGGED FROM THE MAINS BEFORE GOING NEAR THE RECTIFIER BOARD

Fuse F2 on the rectifier board may be removed. This will remove the 230VDC from your machine wiring.

POWER CONSUMPTION

All LED upgrade kit for Bally and Stern systems draw on the 5v power rail. Whilst they do not need the high voltage 230V supply to operate, they present an additional load to the 5 volt supply. If your regulator or (more likely) your rectifier board are of poor health, you may experience too great a load on the 5 volt system and game resets could occur.

Note: A correctly functioning 5 volt rail is easily capable of supplying the load for these LED modules.

LED BRIGHTNESS OPTIONS

The Yellow LEDs in this kit are driven with 68 ohm limit resistors (supplied). You may choose to dim the displays by substituting 82 ohm resistor in positions R7 – R13. If you want a brighter display, the resistors may be replaced with 56 ohm resistors.

For White LEDs, the default limit resistors are 82 Ohm. These may be increased to 100 Ohm or reduced to 68 Ohm.

7 DIGIT OPTION

Note that the 7 digit version of this kit utilises a different LED PCB. It has provision for the 7th LED.

In addition to this, components are supplied for the 7th driver section. These are Q13, Q14, R32, R33 and R34.

LIGHT SHROUD

The kit comes supplied with black card light shrouds. These may be optionally used on machines that have light leaking from the sides of the display module.

The shroud needs to be cut out of the card using the lines faintly printed on the card as a guide.

Fold the two triangular wings back at right-angles so they will slide alongside the LEDs.

Foam tape is also provided to stick onto the top and bottom of the LEDs (on the PCB). This foam will block light from leaking between the LEDs.

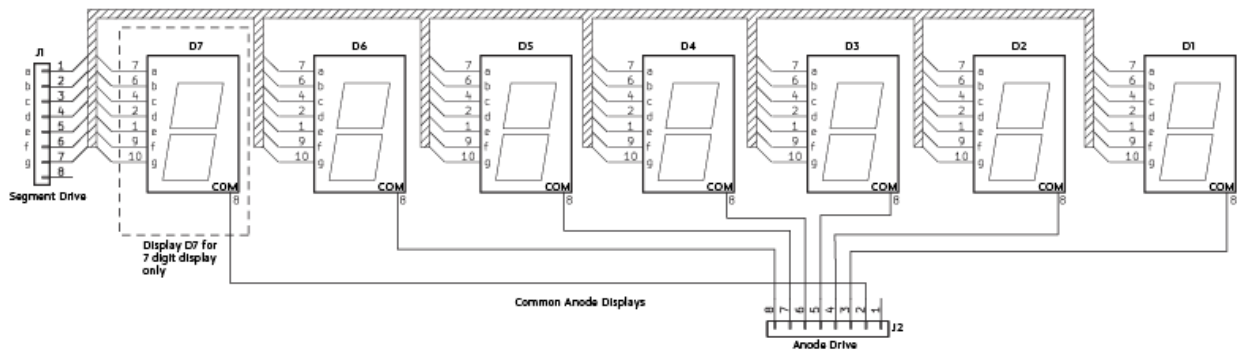
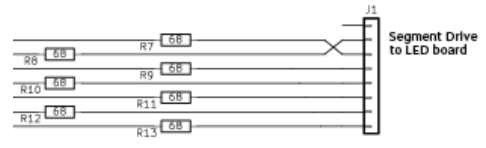
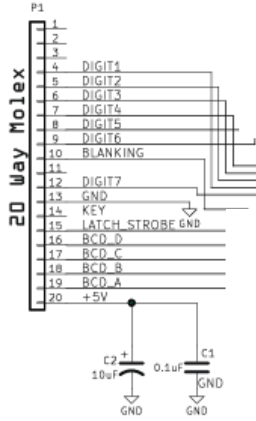
See photos in the gallery section showing the shroud folding and installation.

Anode Drive to LED board



R1
3.9k

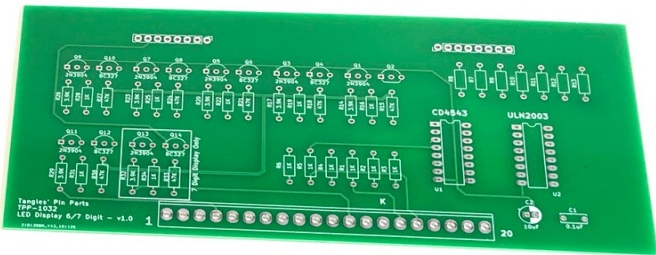
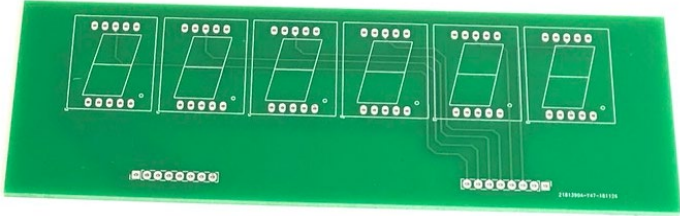
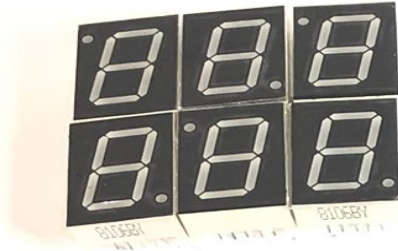

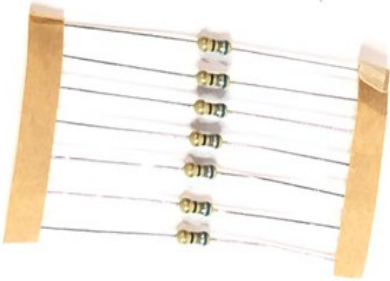
PRINT VERSION ONLY

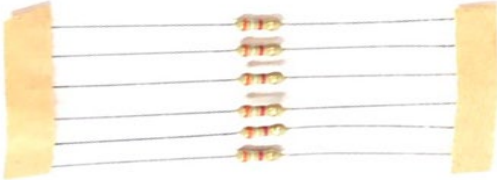




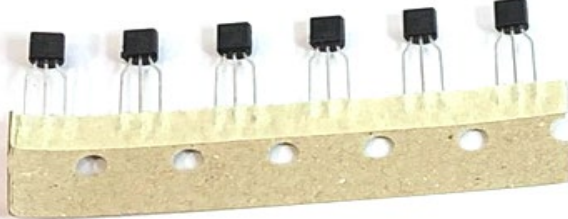



Schematic (7 Digit)

Parts List

Per module (6 digit)

QTY	Description	
1	PCB Base	
1	PCB 6 Digit LED Vertical	
6	LED modules	
12	1K Resistors brown-black-red	
7	68 Ohm Resistors blue-grey-black	

QTY	Description	
6	3.9K Resistors orange-white-red	
6	47K Resistors yellow-purple-orange	
1	10uF Electrolytic Ca- pacitor	
1	0.1uF Ceramic Capaci- tor	
6	2N3904 Transistor	
6	BC327 Transistor	
2	16 Pin IC Socket	

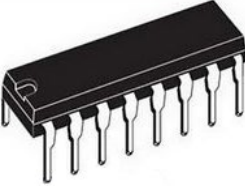
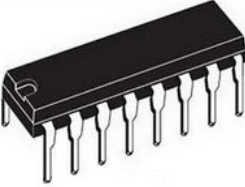

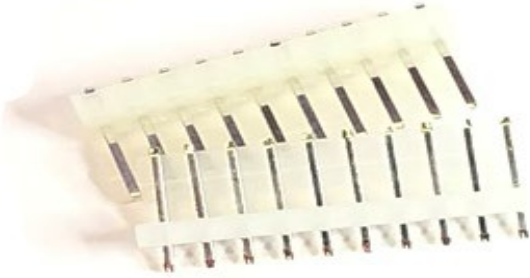
QTY	Description	
1	CD4543 16 pin IC	
1	ULN2003 16 Pin IC	
2	8-Way right angle headers	
2	10-Way Molex headers	

Photo Gallery

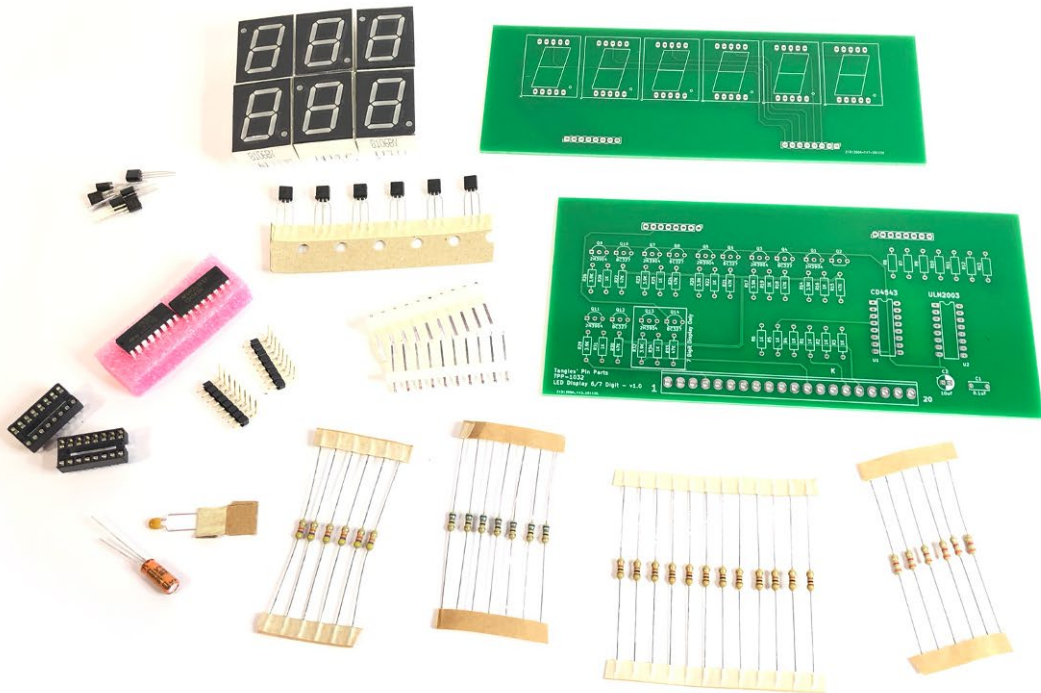


Photo 1: All the parts for a single module. The kit contains 5 sets of these parts.

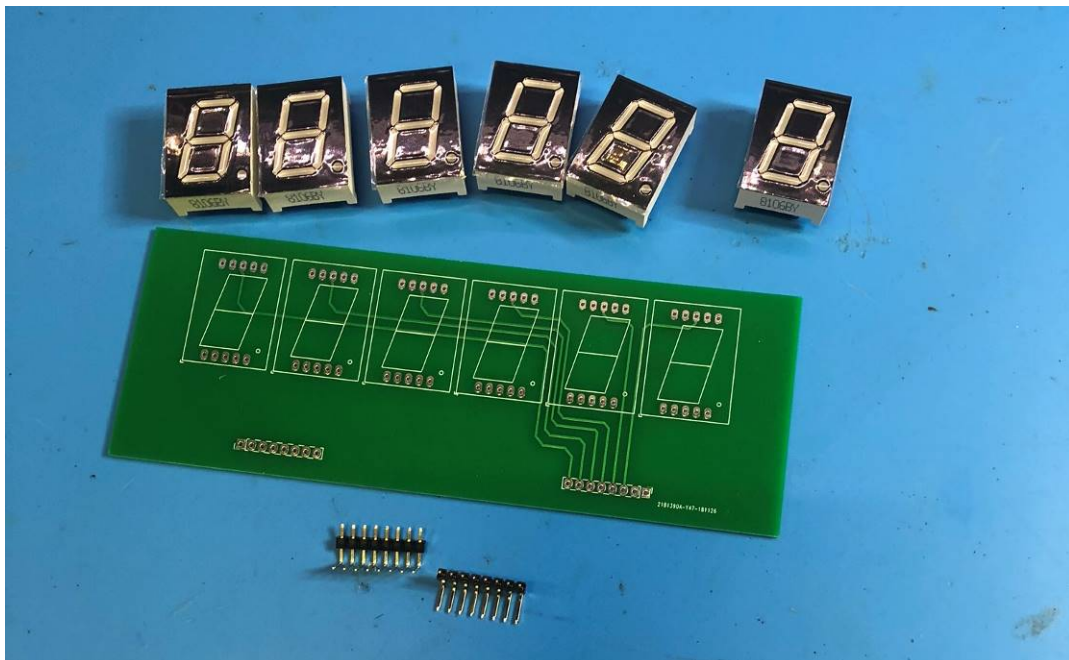


Photo 2: Parts needed for the vertical LED board.

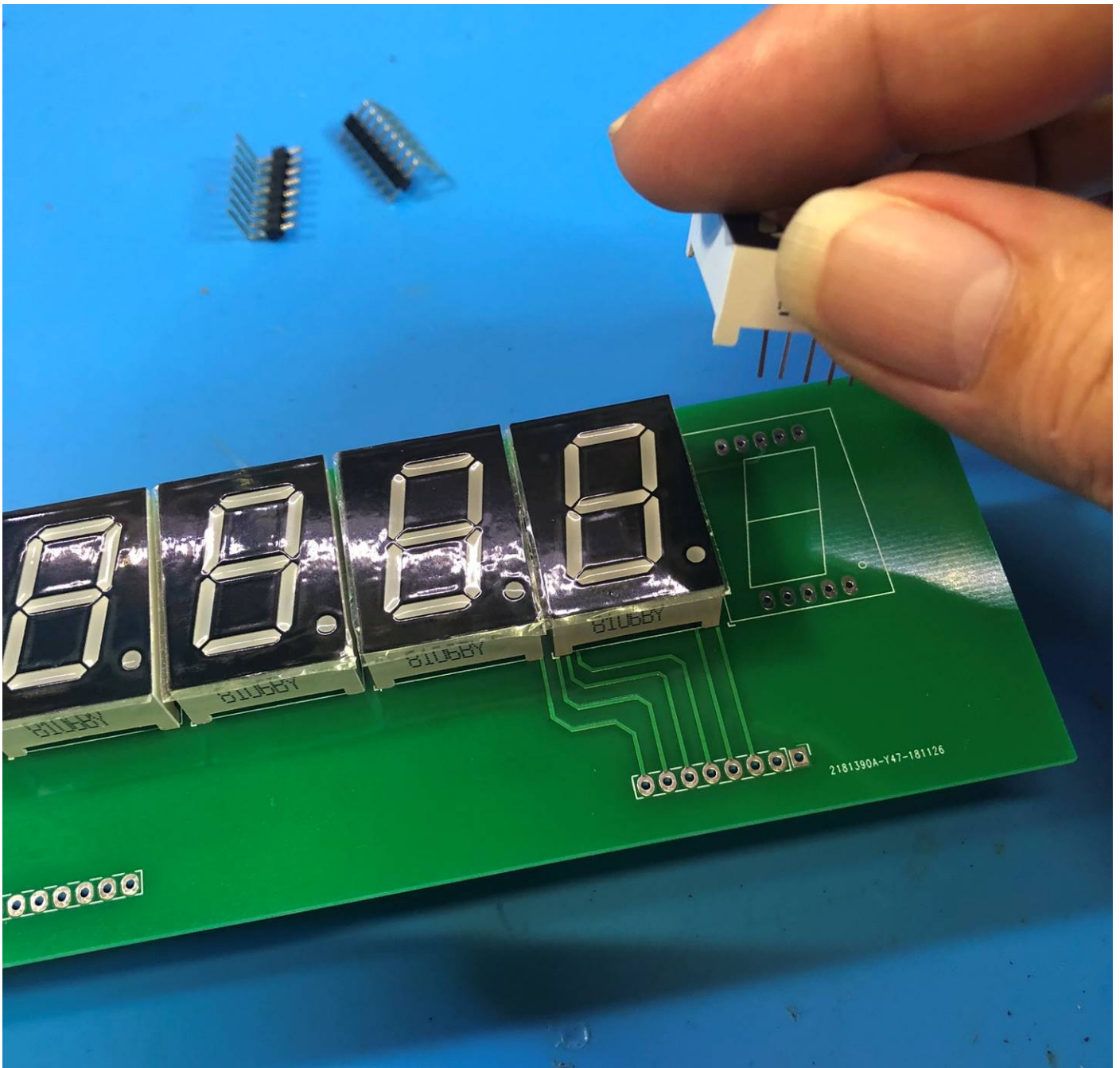


Photo 3: Inserting the LEDs. Be sure to get the decimal points position toward the bottom of the board.

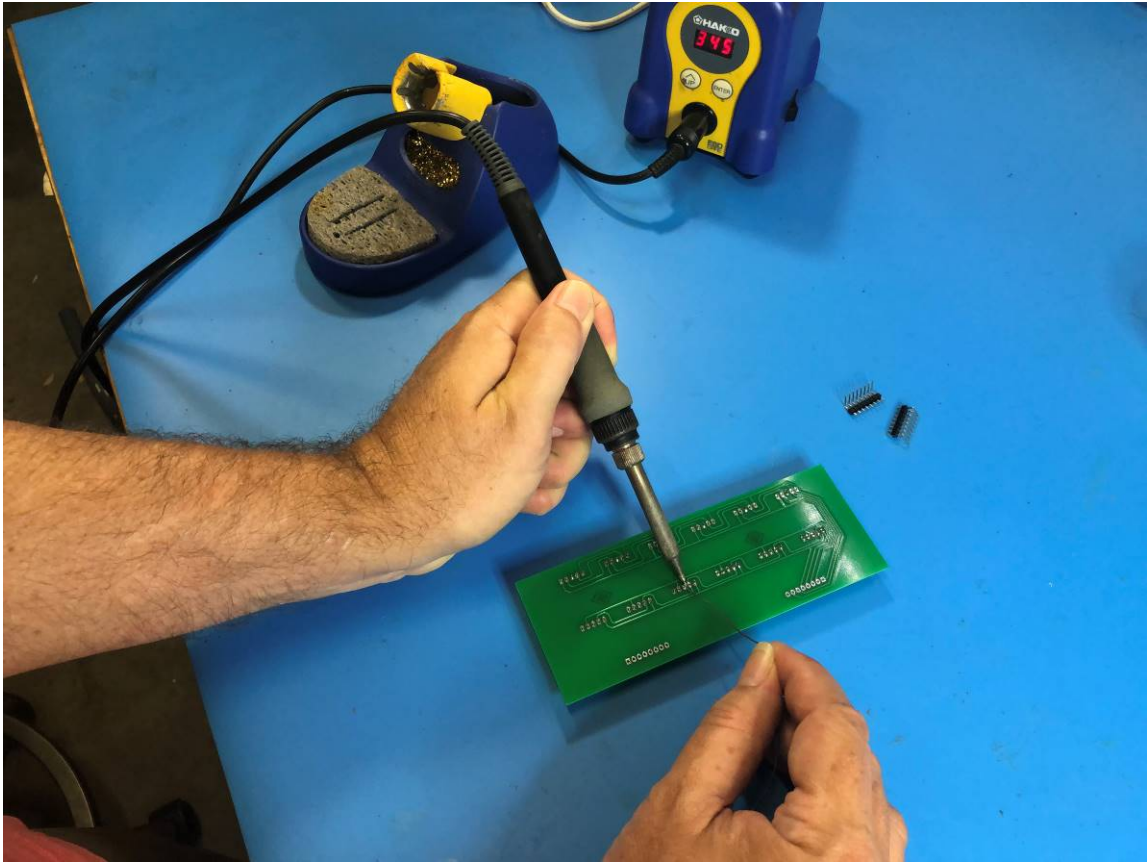


Photo 4: Solder one pin of each led.



Photo 5: Re-Check the LED orientation



Photo 6: Check LEDs are positioned squarely and firmly against the PCB

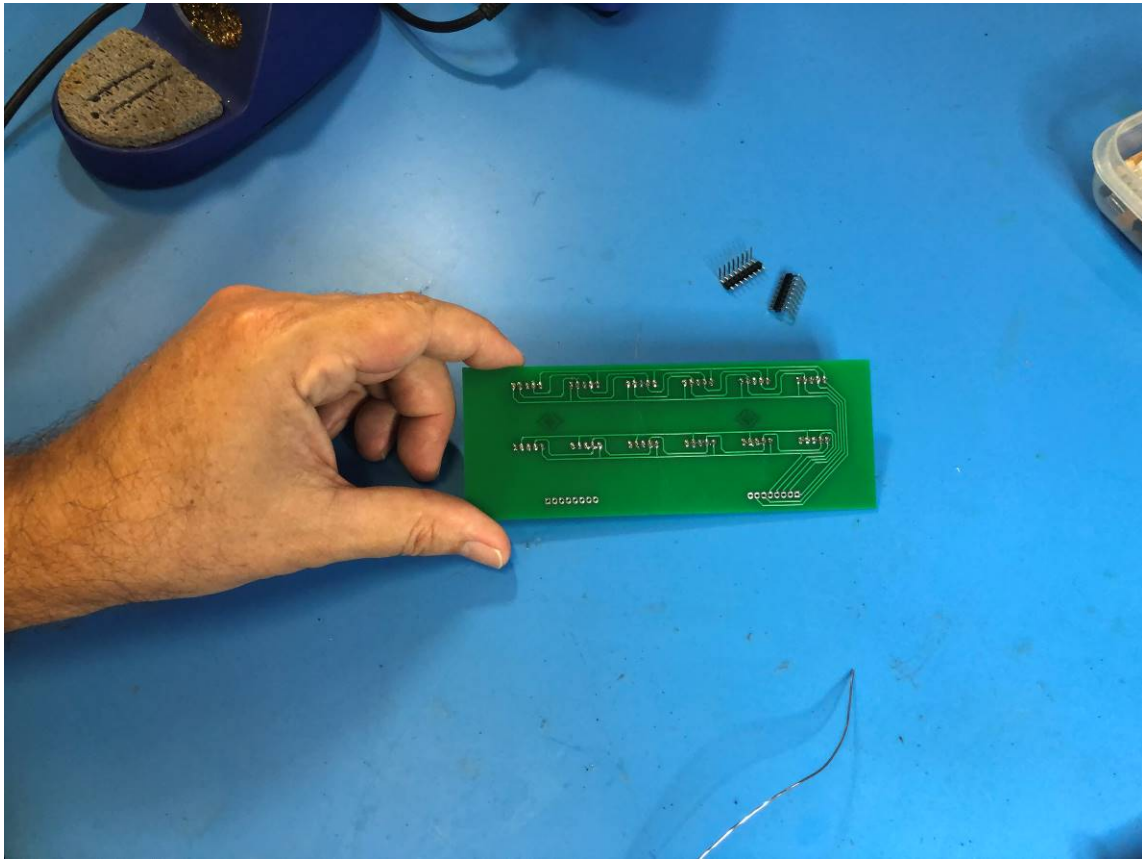


Photo 7: Solder the remainder of the LED pins.

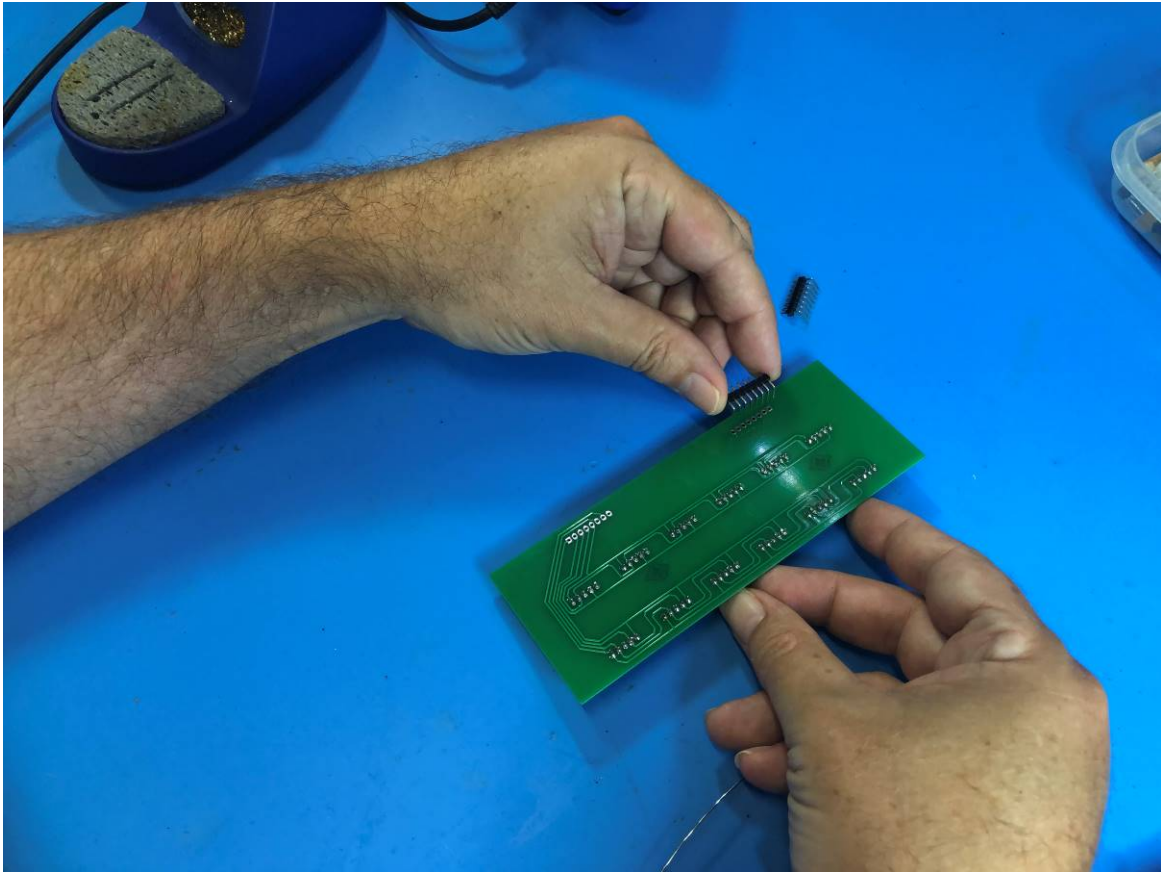


Photo 8: Install the right-angle headers. The longer (bent) side goes through LED vertical board from the back of the PCB.

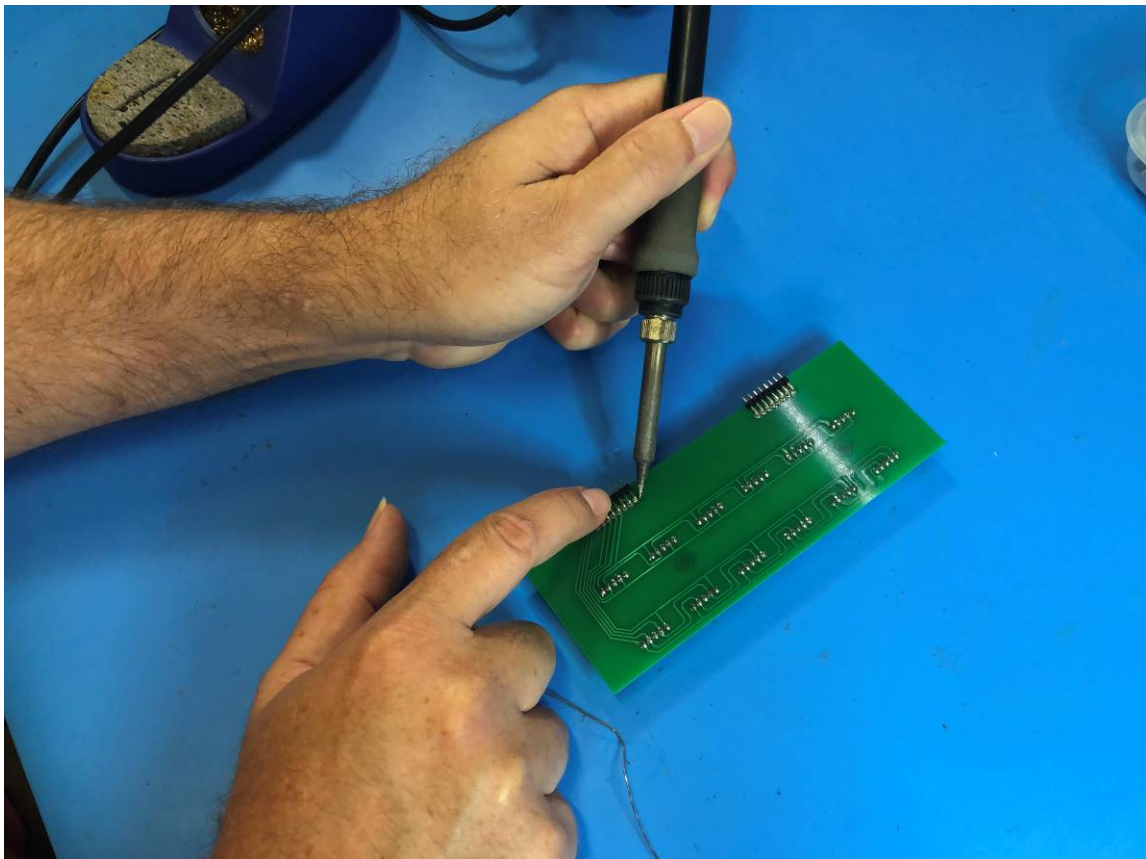


Photo 9: Solder a single pin of each header. Holding them carefully flat to the board. The black plastic strip should be lying flat against the rear side of the PCB

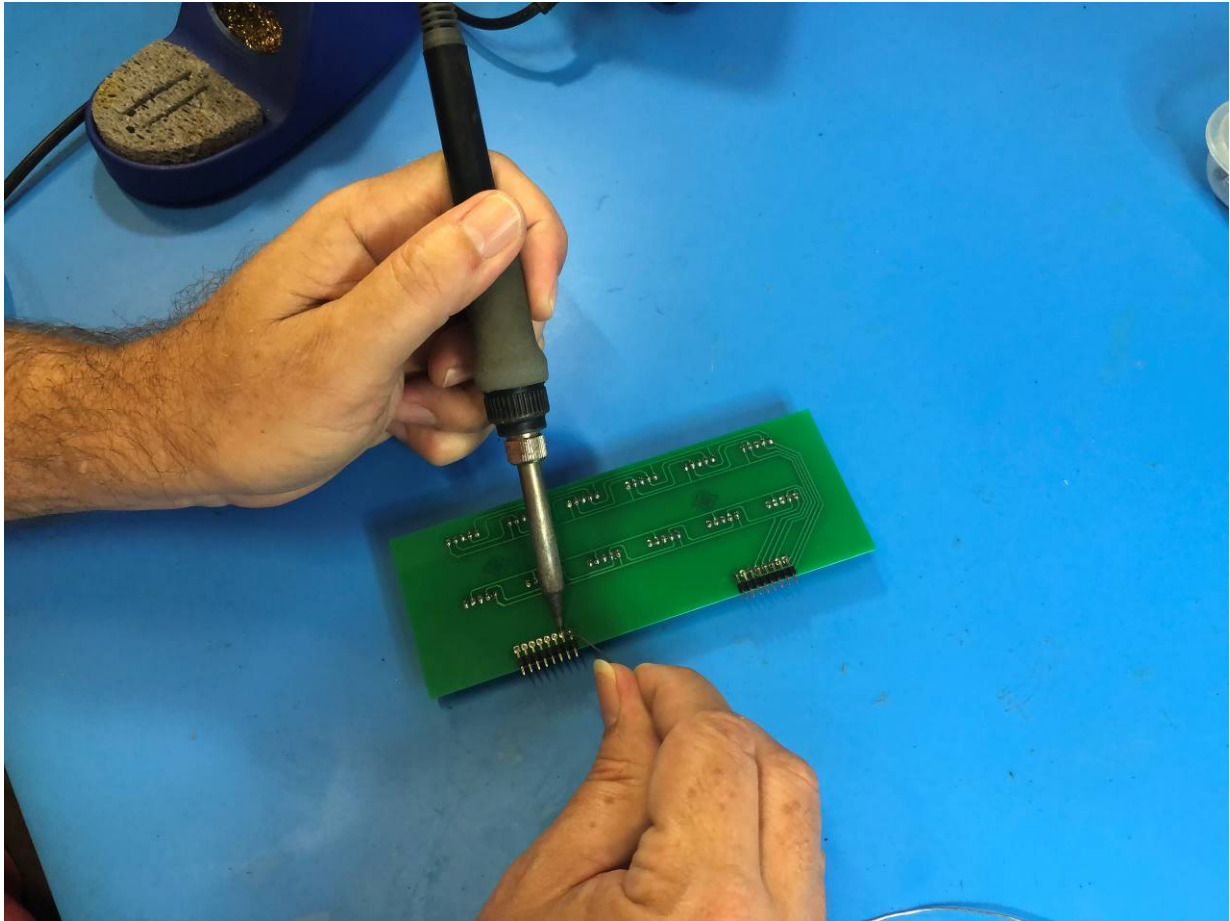


Photo 10: Solder the remaining pins of the headers



Photo 11: Flip the board over and check a good solder to the other side of the board. Add more solder if necessary.

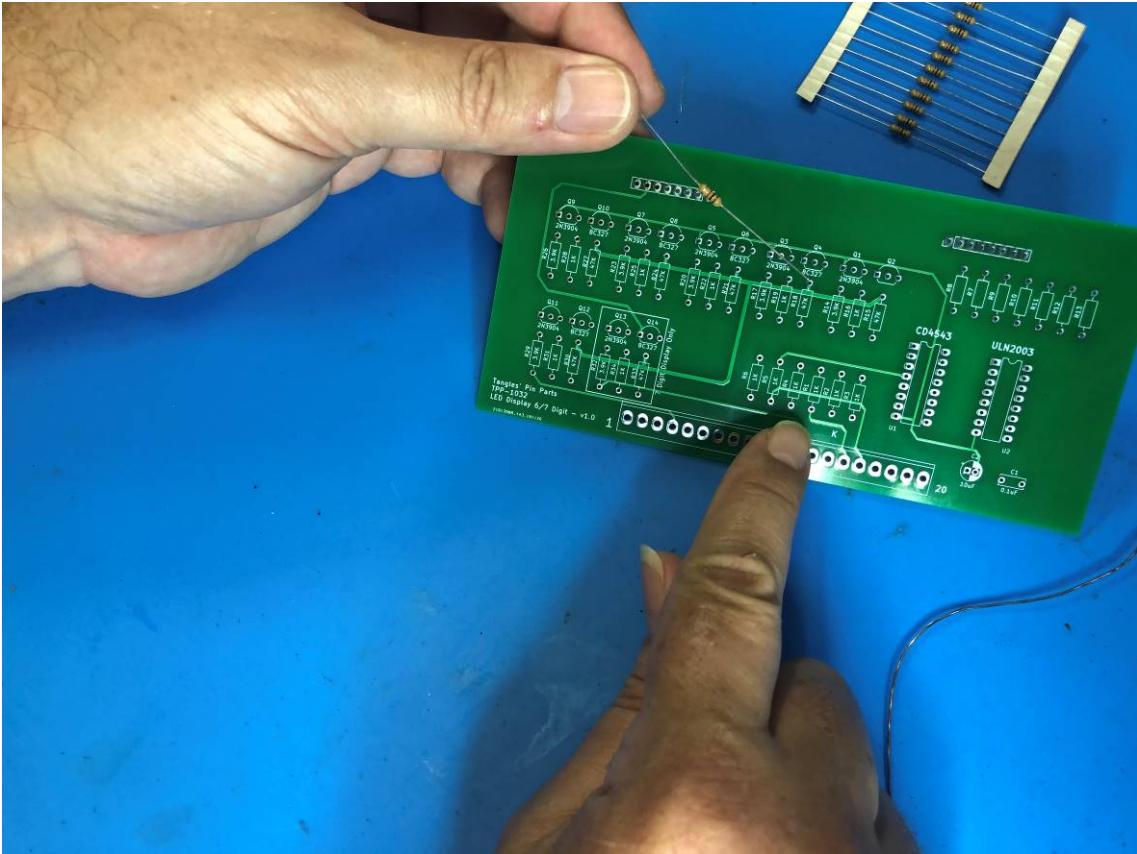


Photo 12: Preparing to insert the 1K resistors.

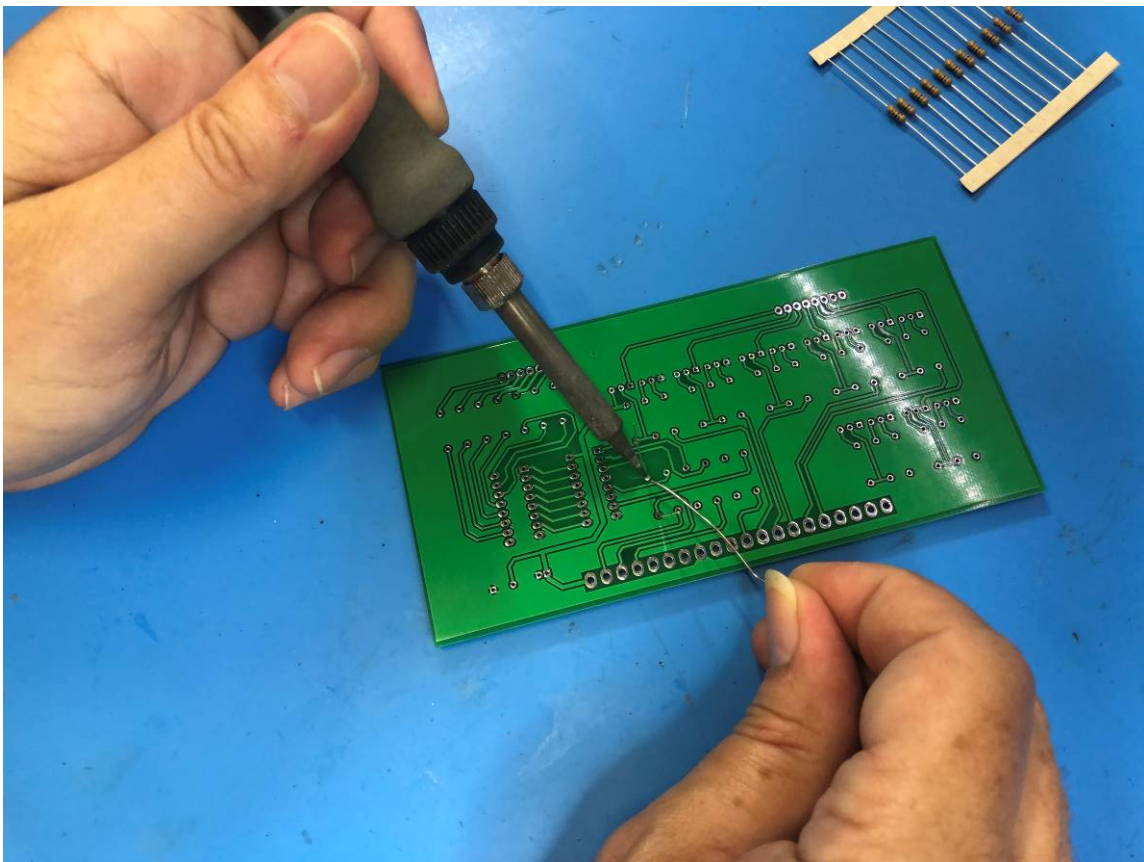


Photo 13: Splay the legs, solder then trim the legs off.

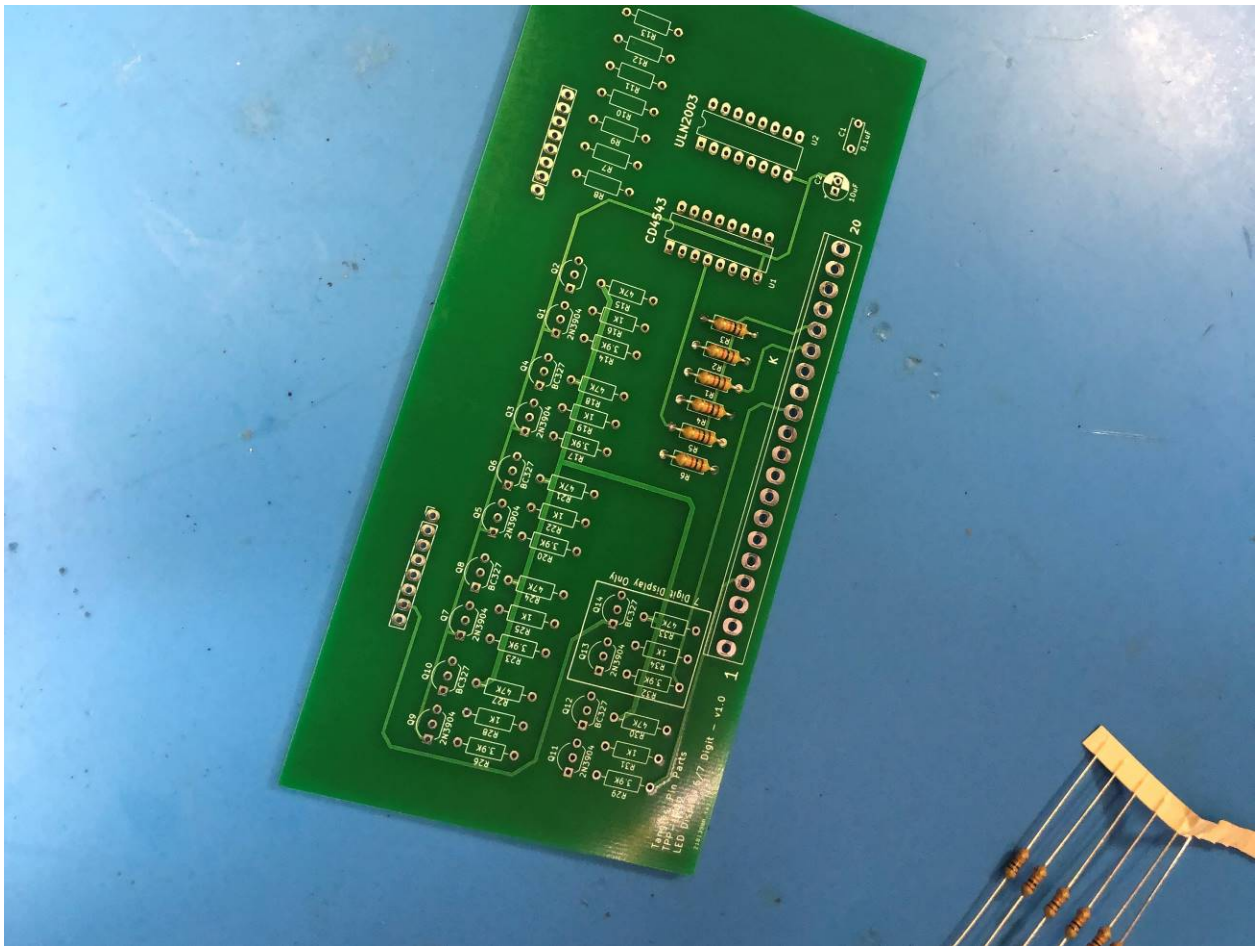


Photo 14: 6 x 1K resistors installed in positions R1 to R6

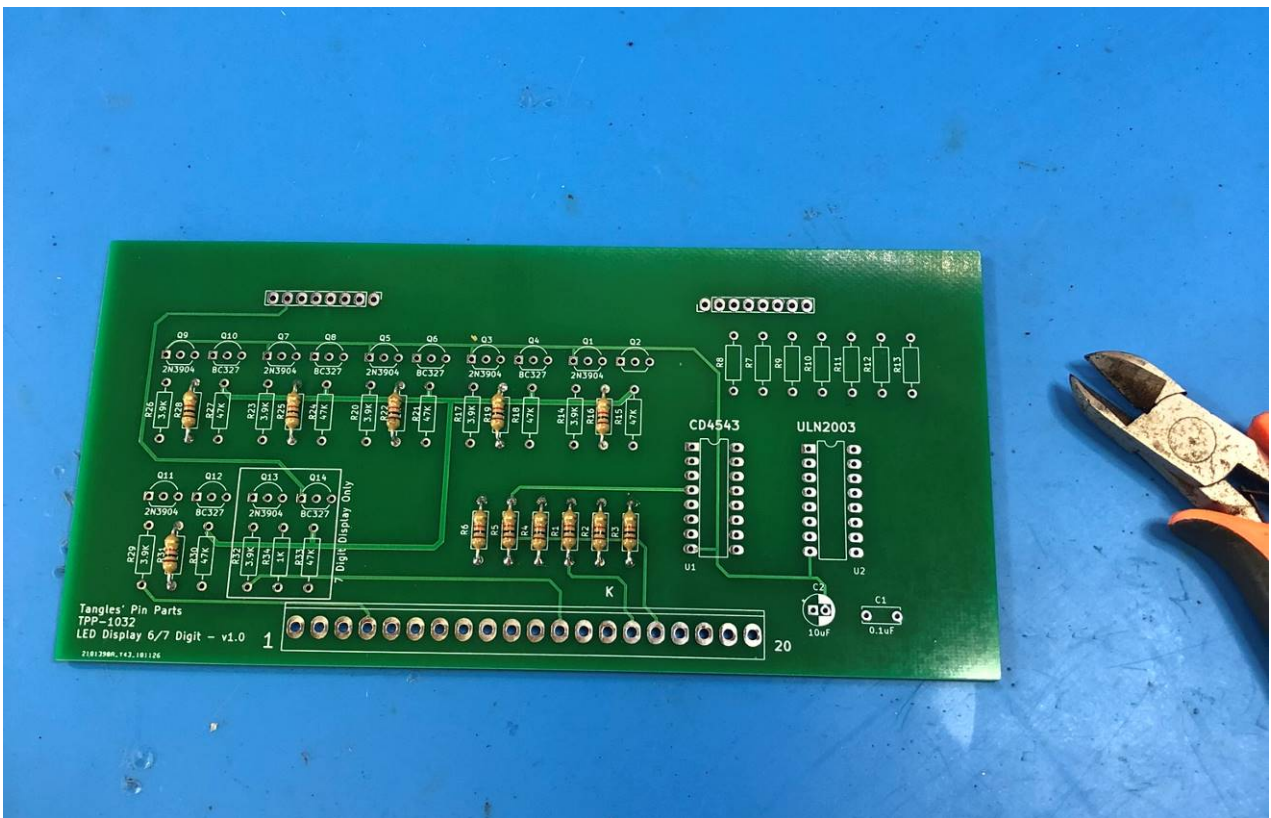


Photo 15: The remaining 6 1K resistors are now installed.

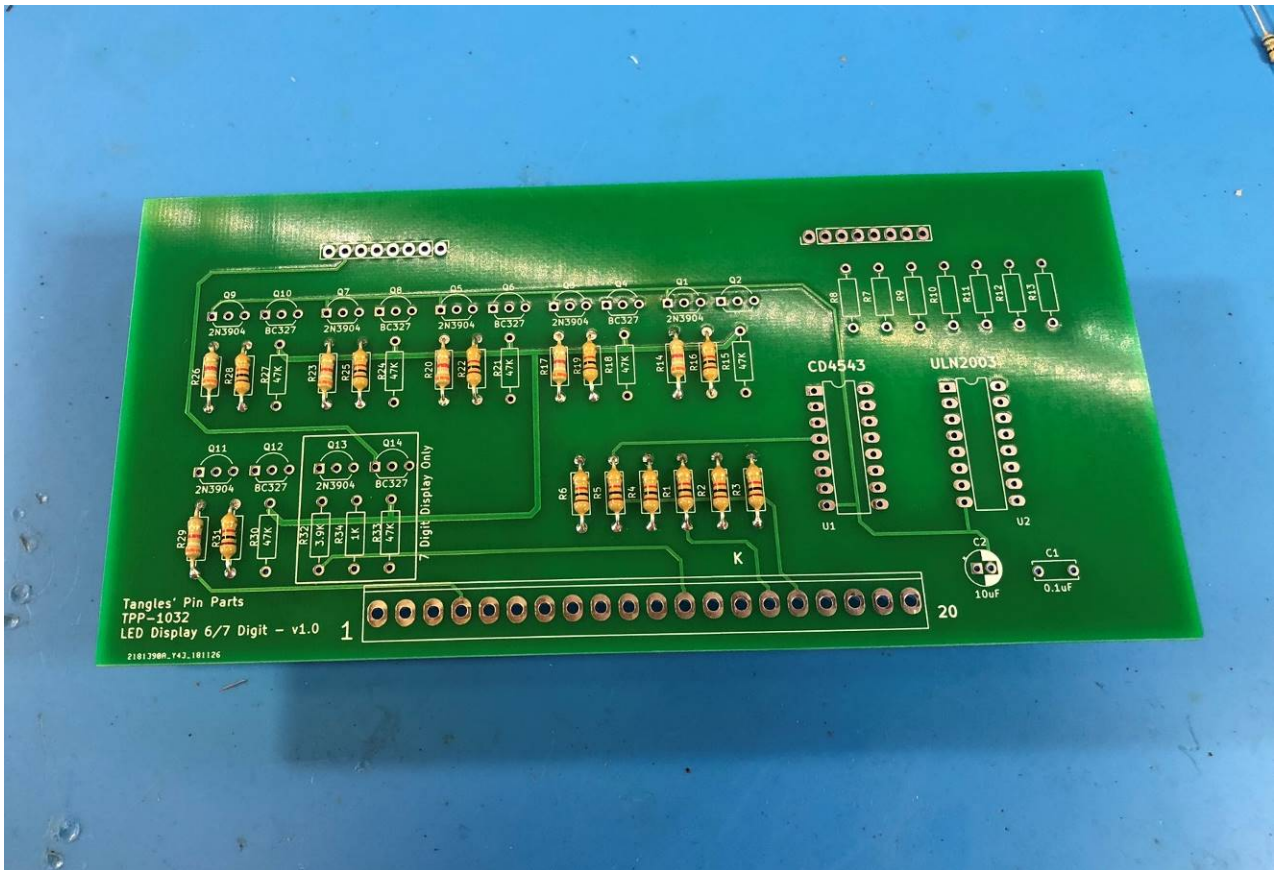


Photo 16: The 3.9K resistors have been installed.

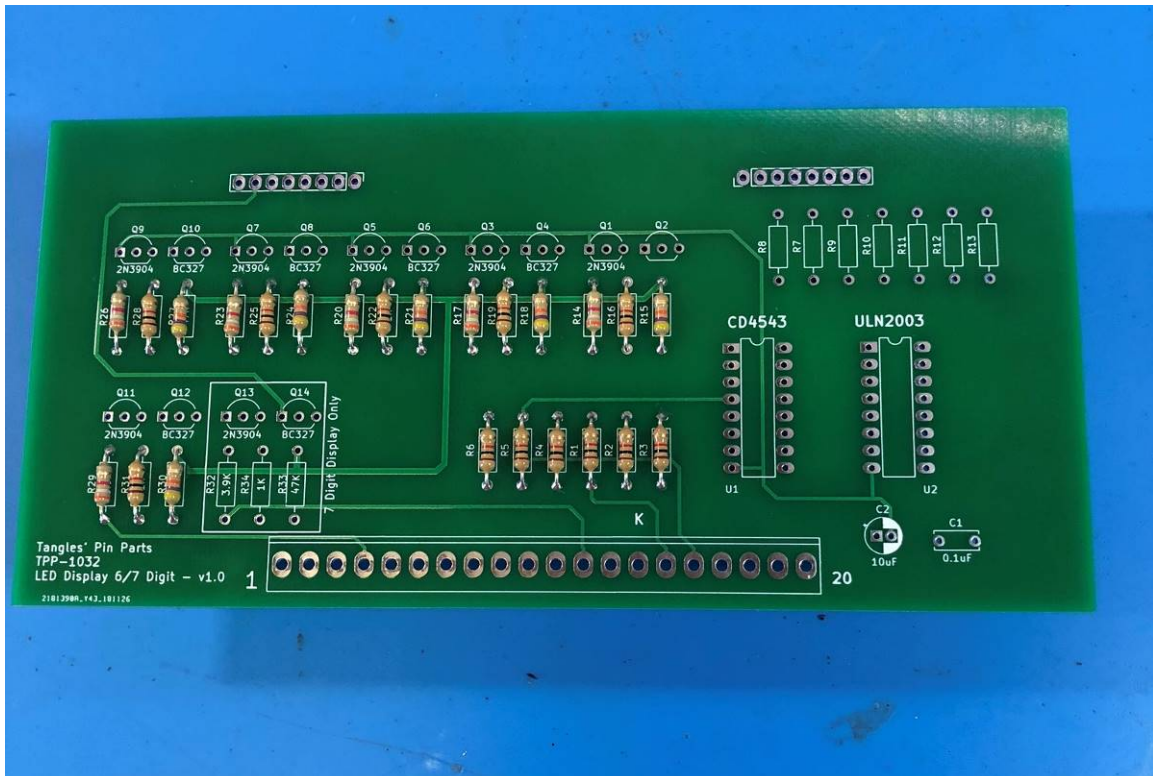


Photo 17: The 47K resistors have been installed.

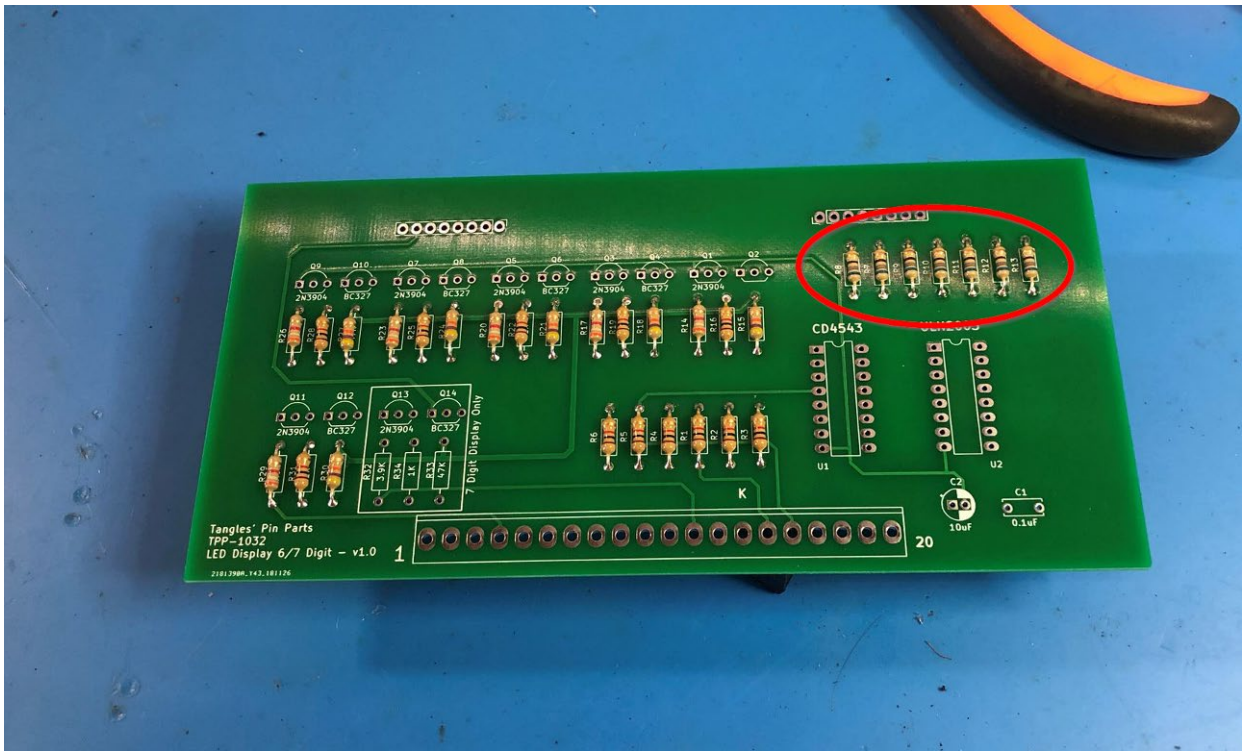


Photo 18: The 68 Ohm resistors are installed. For the White LED option, these resistors are 82 Ohms.

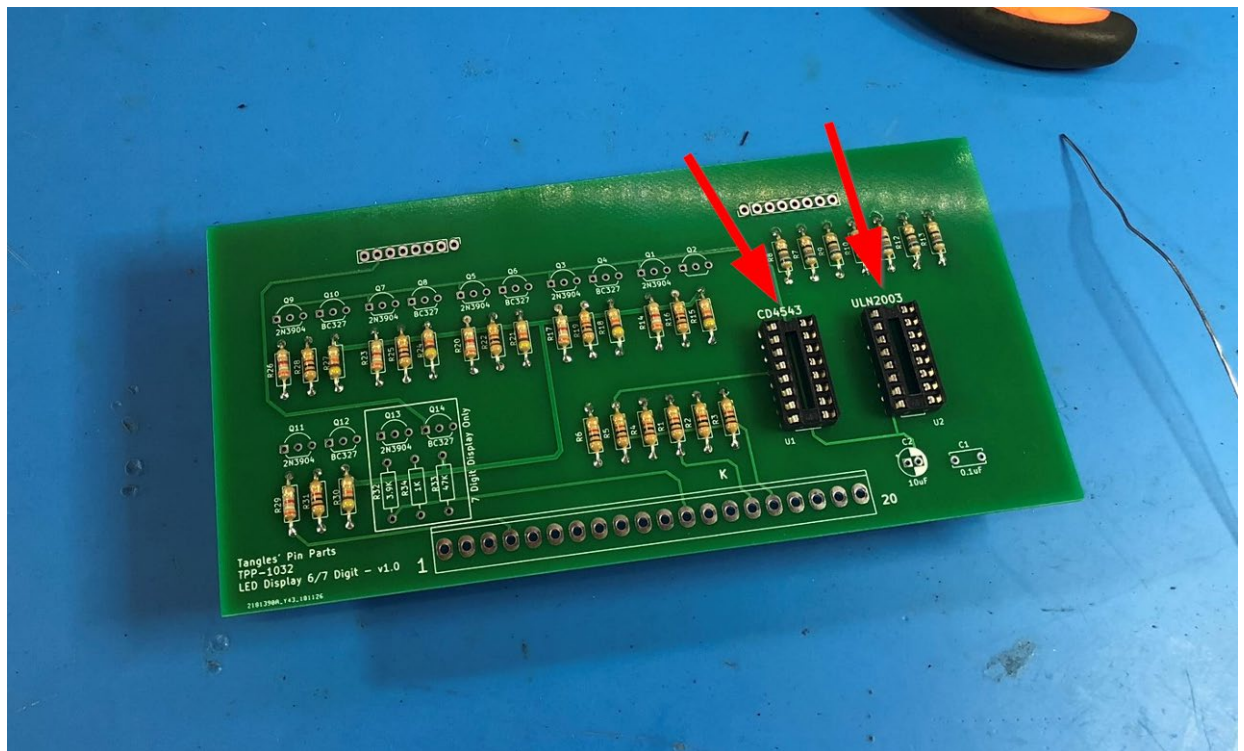


Photo 19: IC Sockets installed. The red arrows point to the notch in the socket.

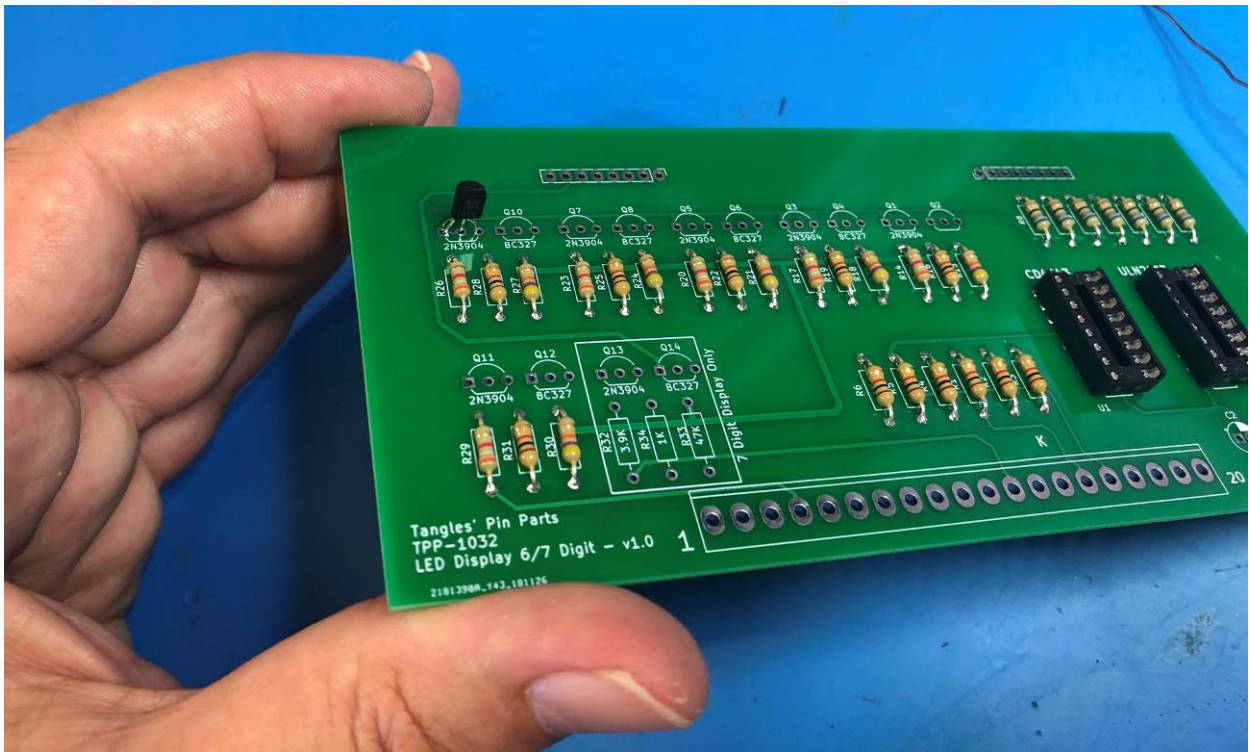


Photo 20: Installing the 2N3904 transistors.

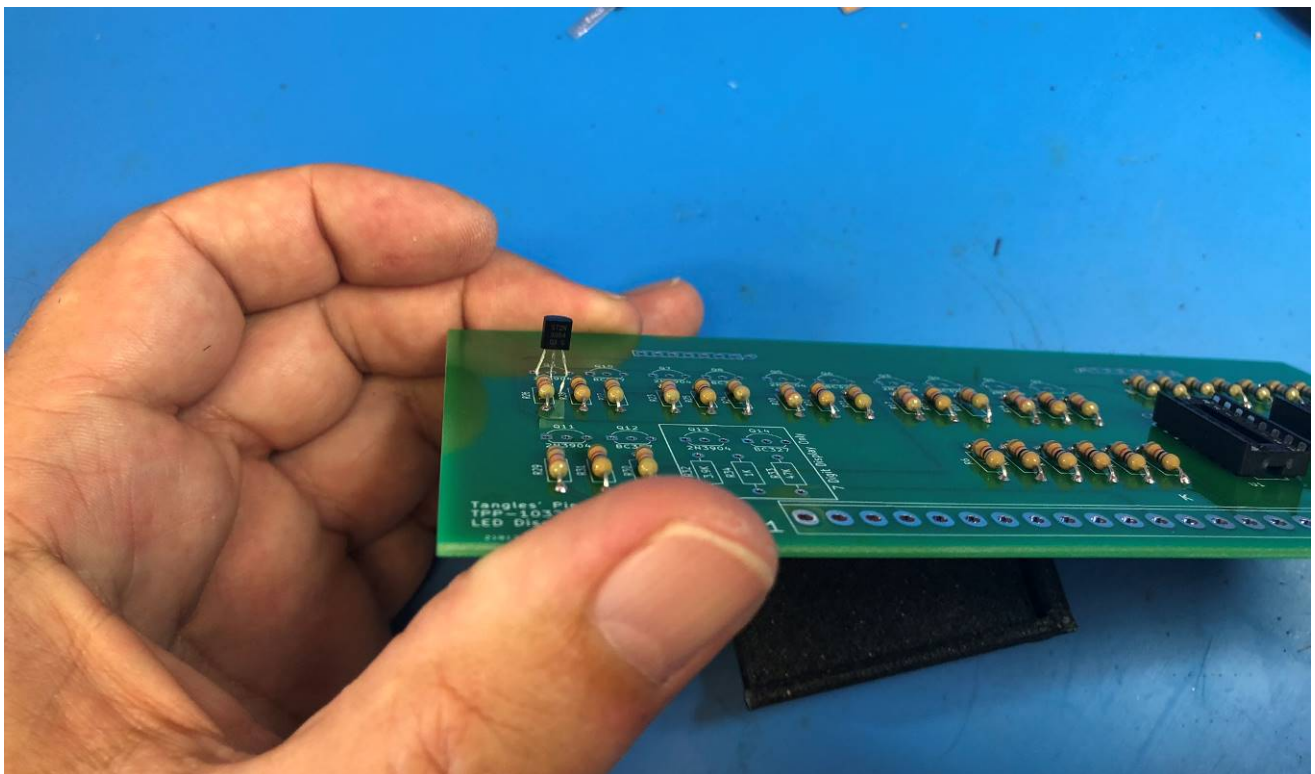


Photo 21: Install transistors with about 6mm above the board.

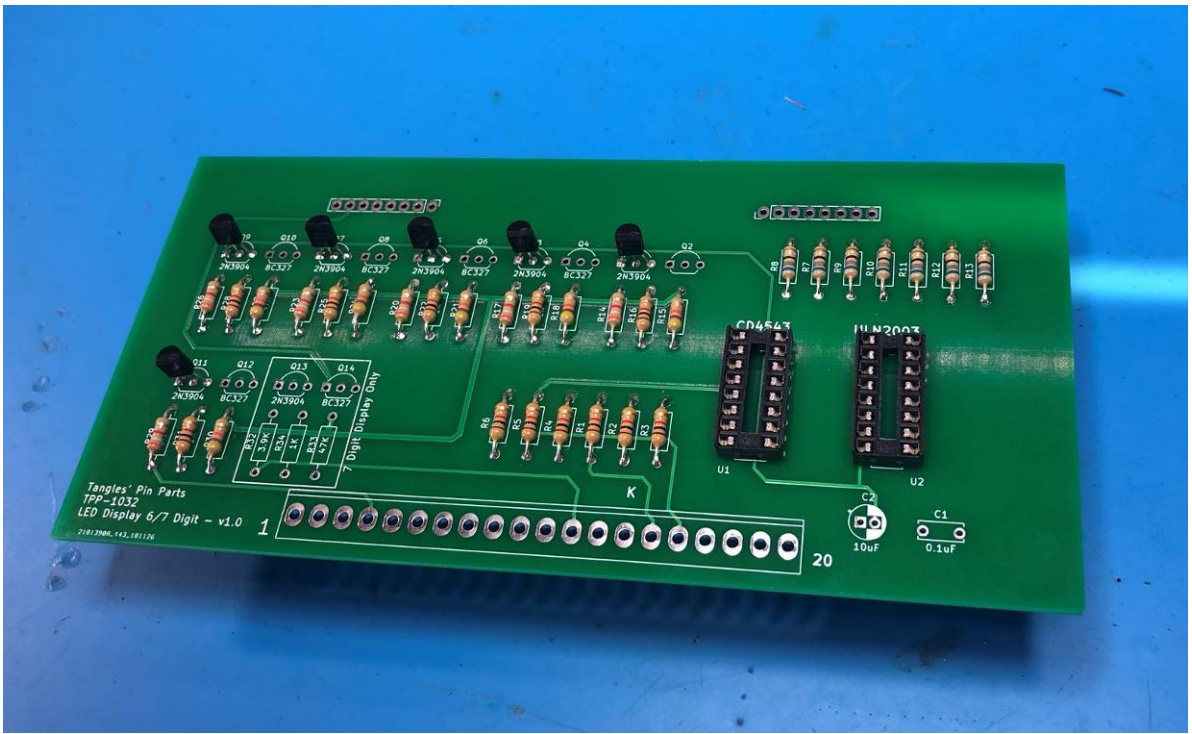


Photo 21: 2N3904 transistors installed.

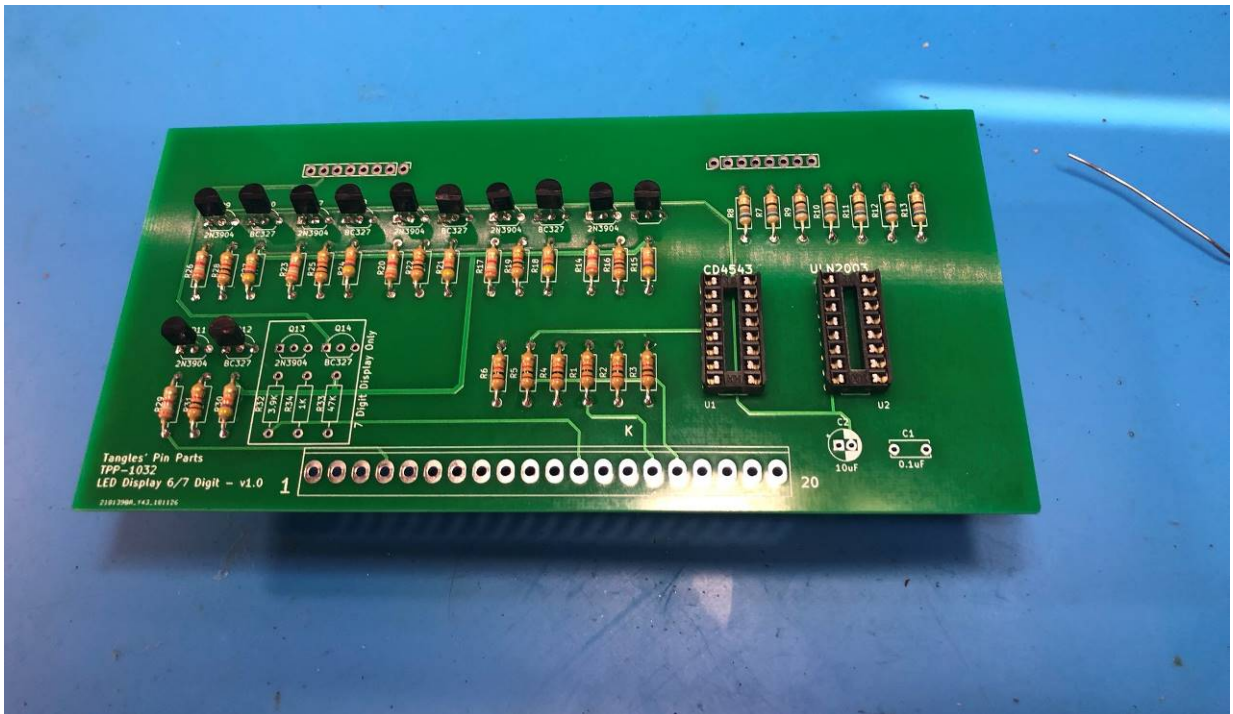


Photo 22: BC327 Transistors installed

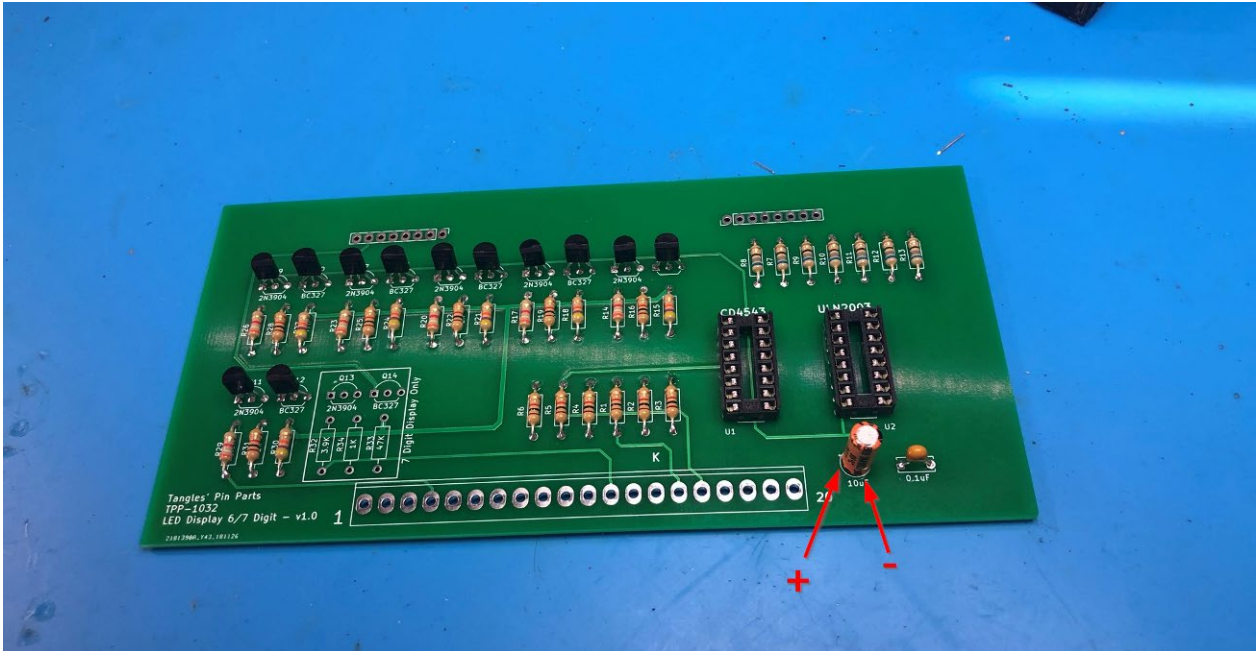


Photo 23: Capacitors installed. Note the polarity of the electrolytic capacitor.

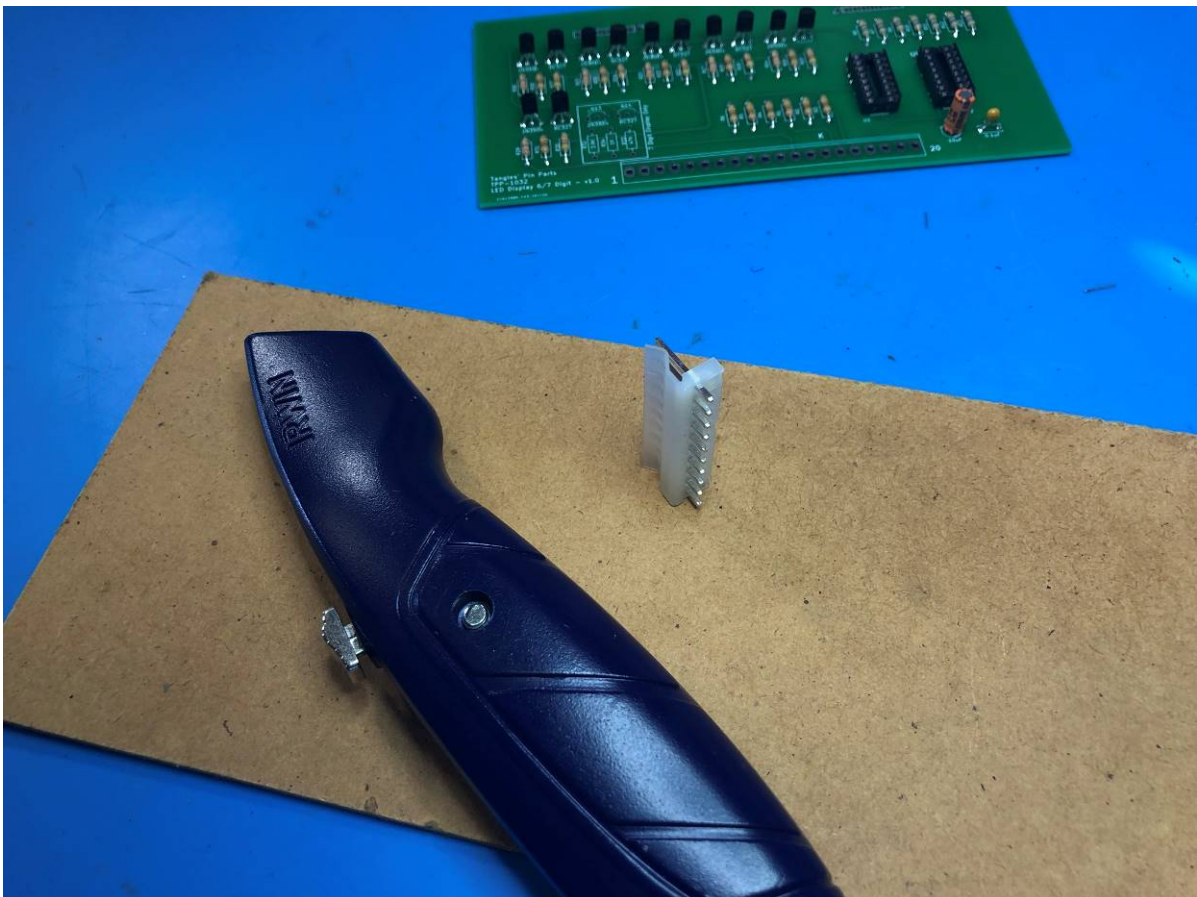


Photo 24: Preparing to Cut the retaining wall off the 10 Way connectors

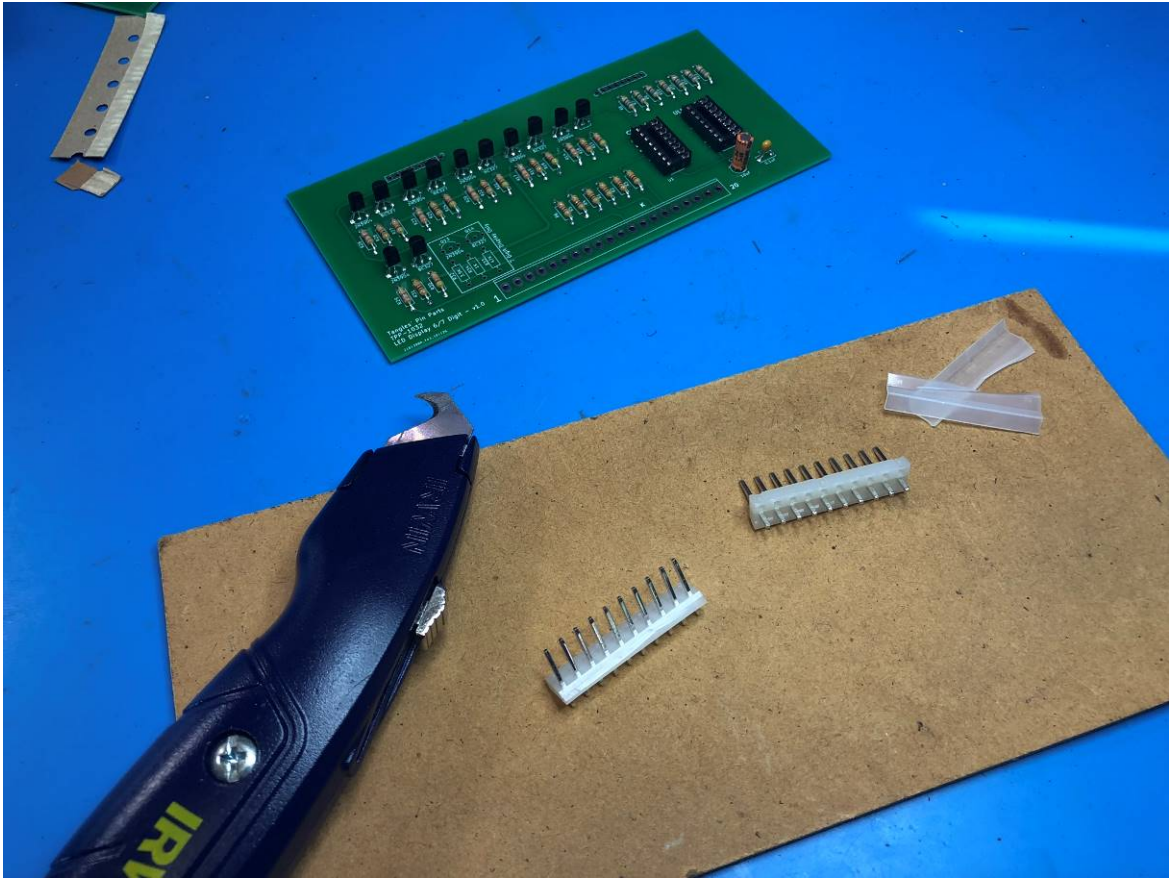


Photo 25: Connectors trimmed and ready for installation. (This is an optional step)

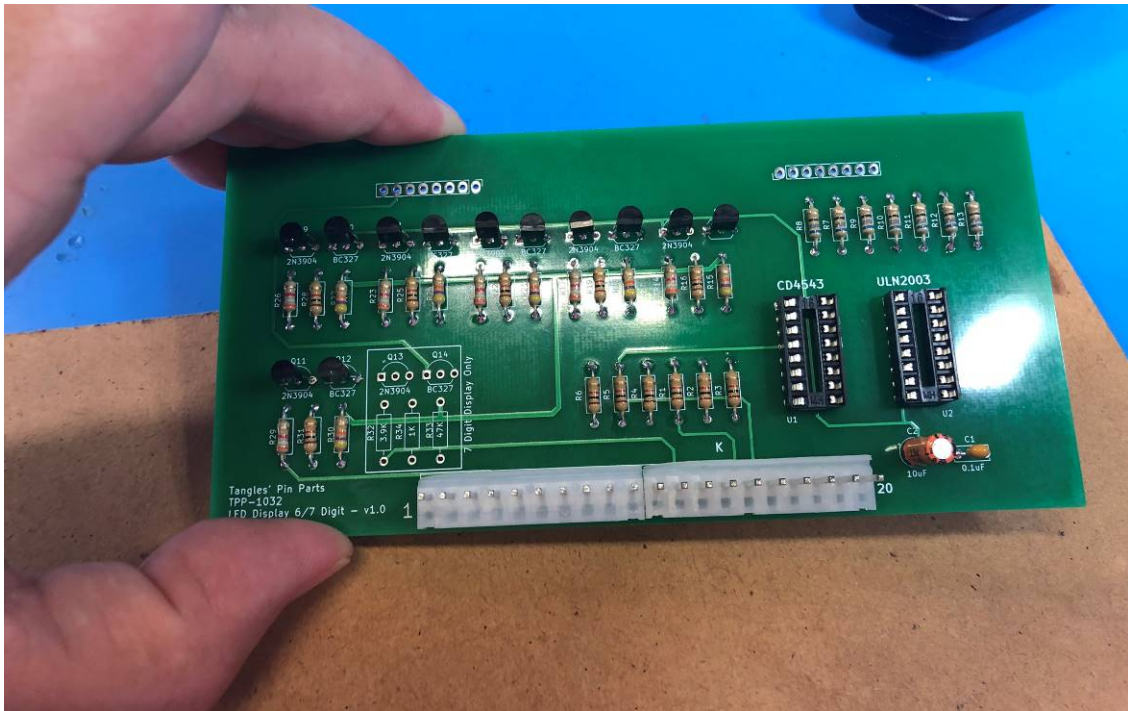


Photo 26: Connectors installed onto the board. Note the orientation. The edge that had the retaining backs is towards the top of the board.

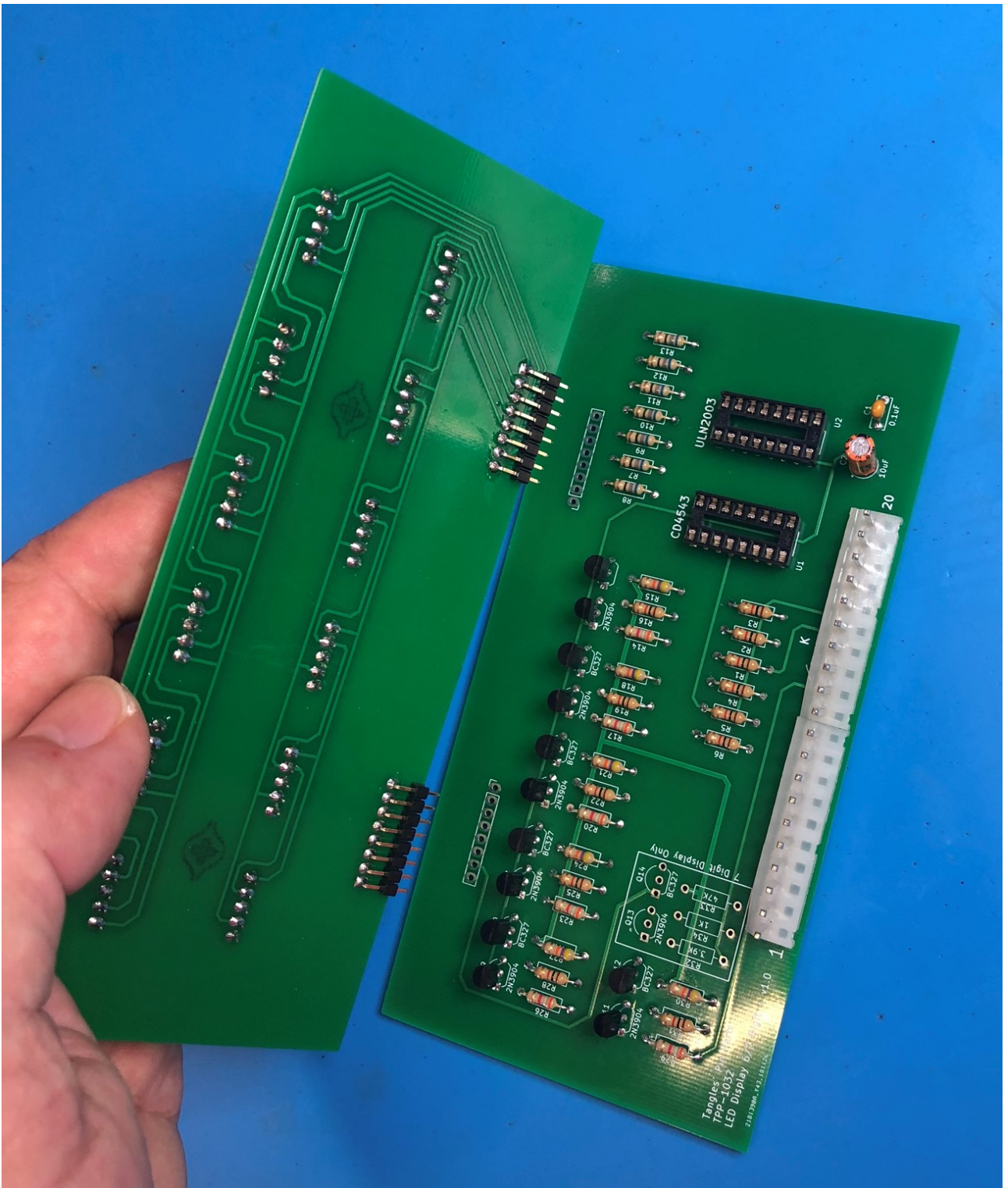


Photo 27: The two boards are ready for joining

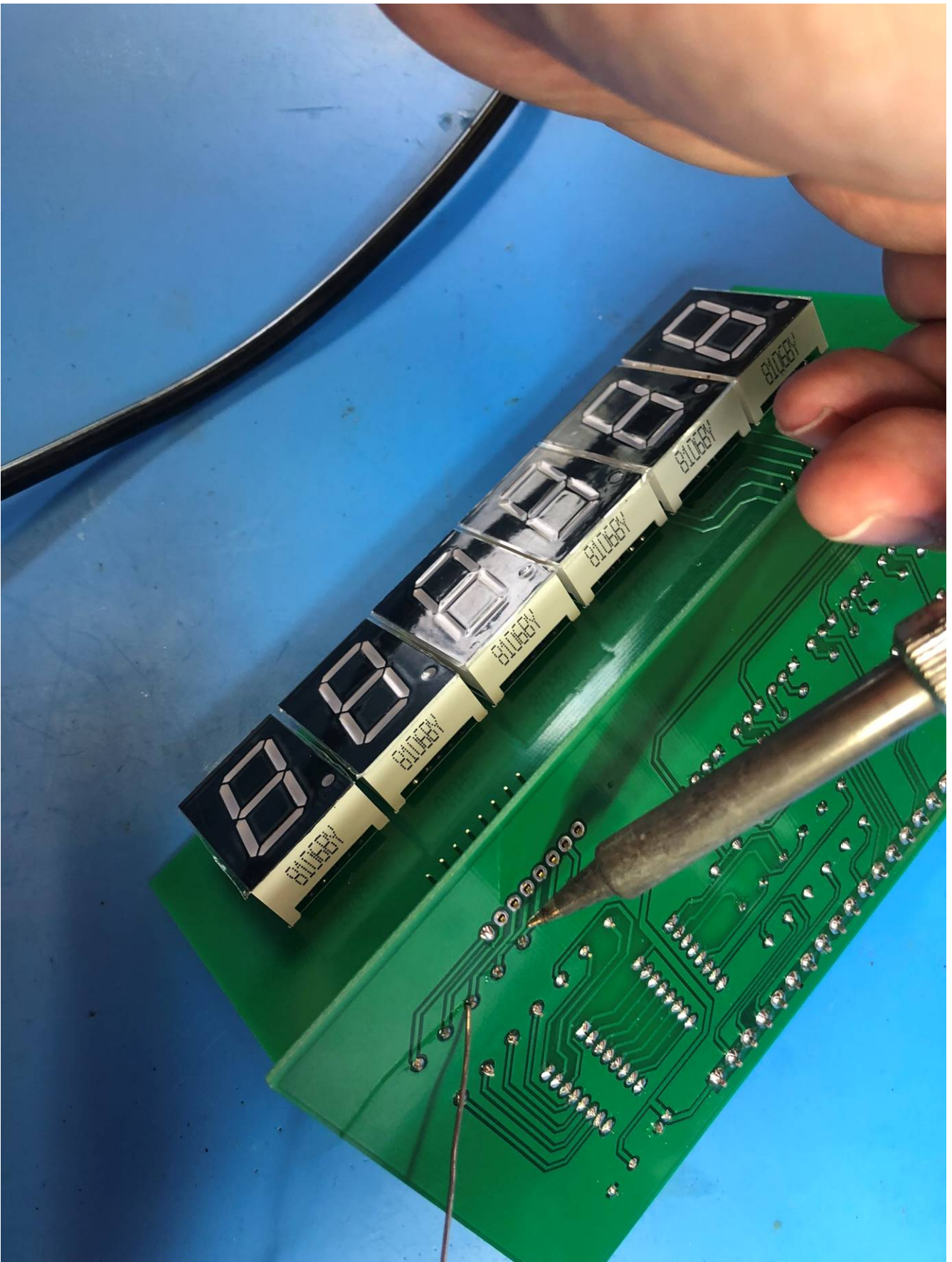


Photo 28: Solder only 1 pin of each connector. Then inspect the boards and ensure they are at right angles to each other.

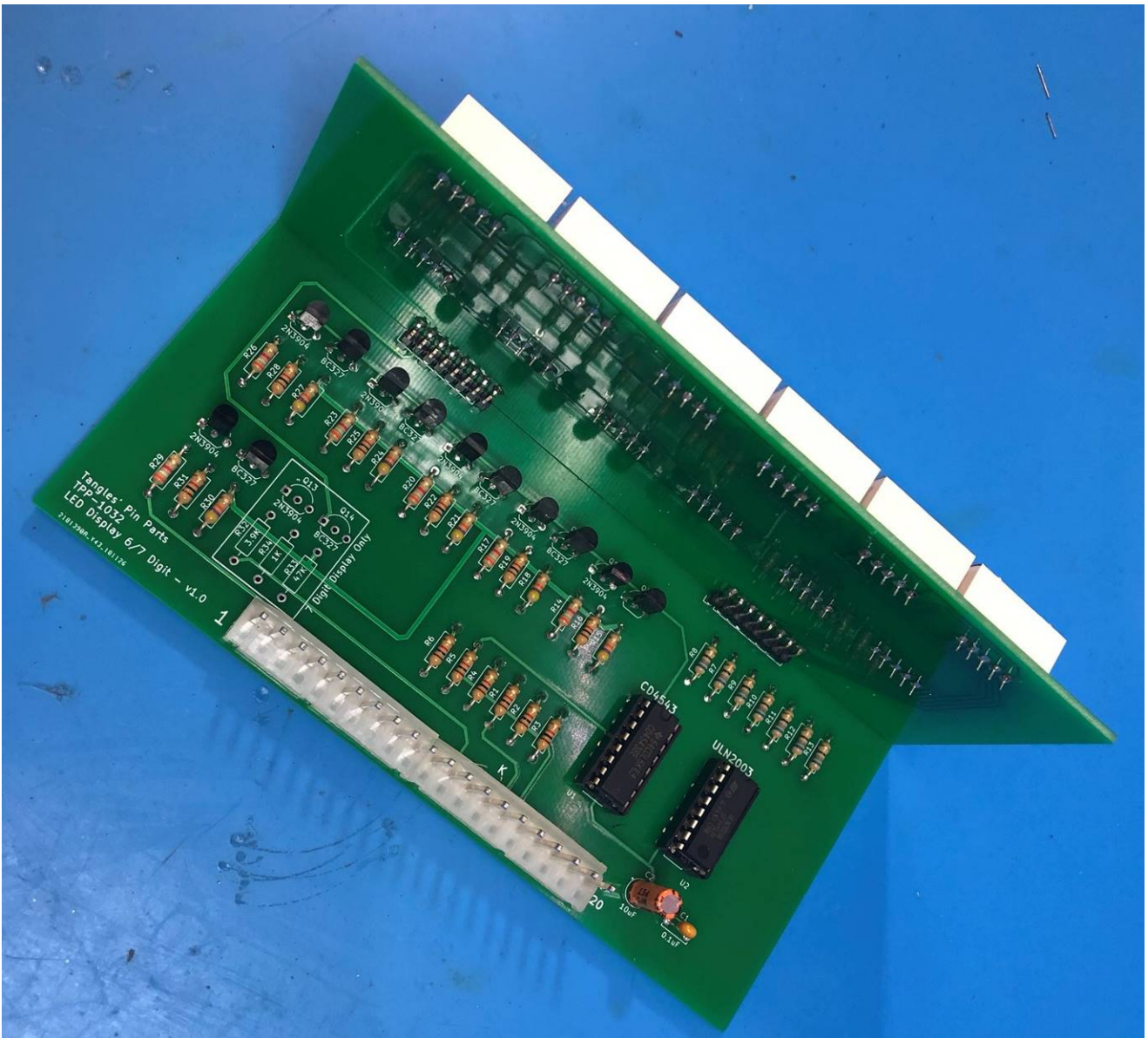


Photo 29: Install the two ICs. 4543 to the middle and 2003 to the side. Ensure the IC notch lines up with the notch on the socket.

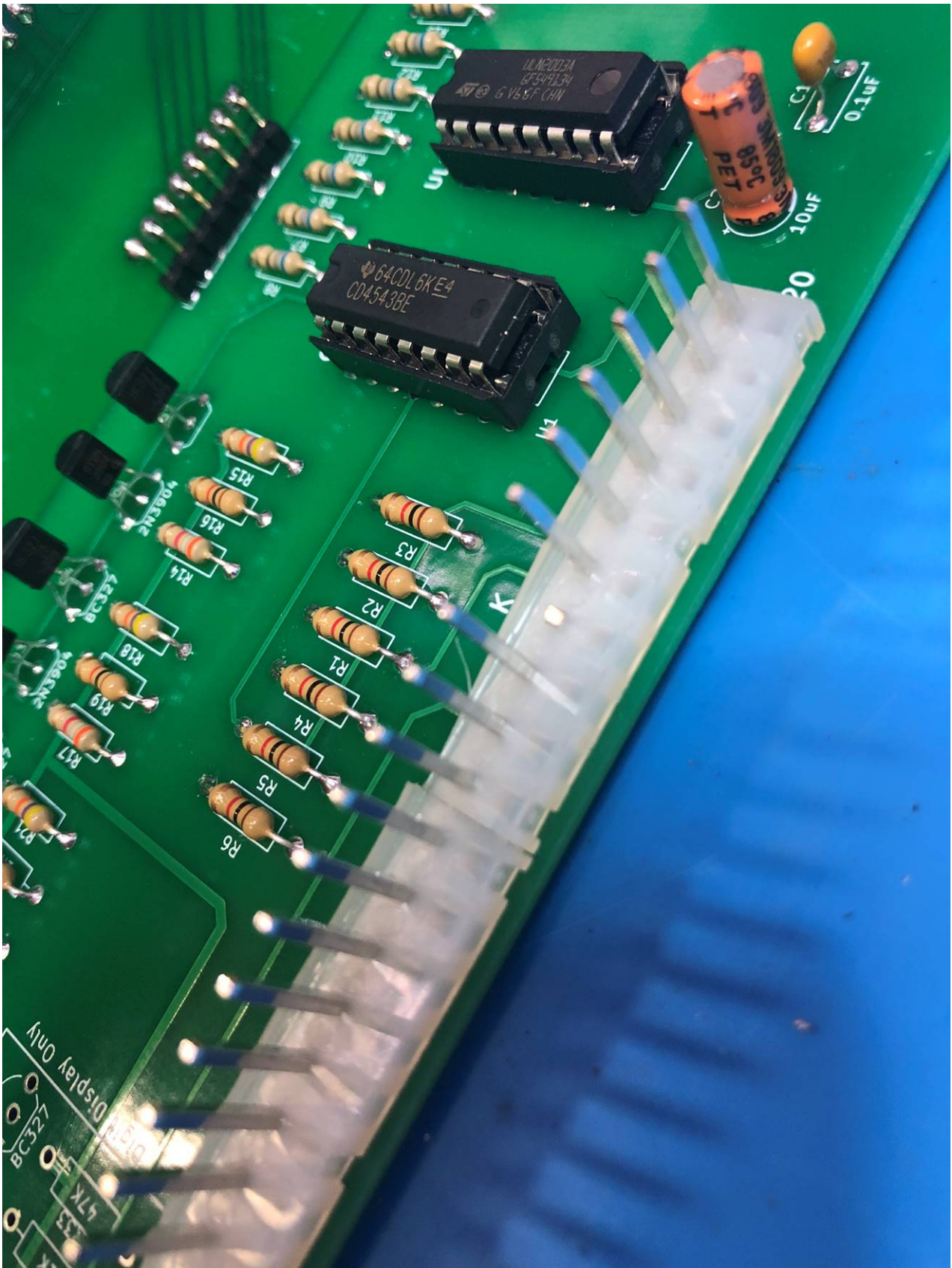


Photo 30: Showing IC notches

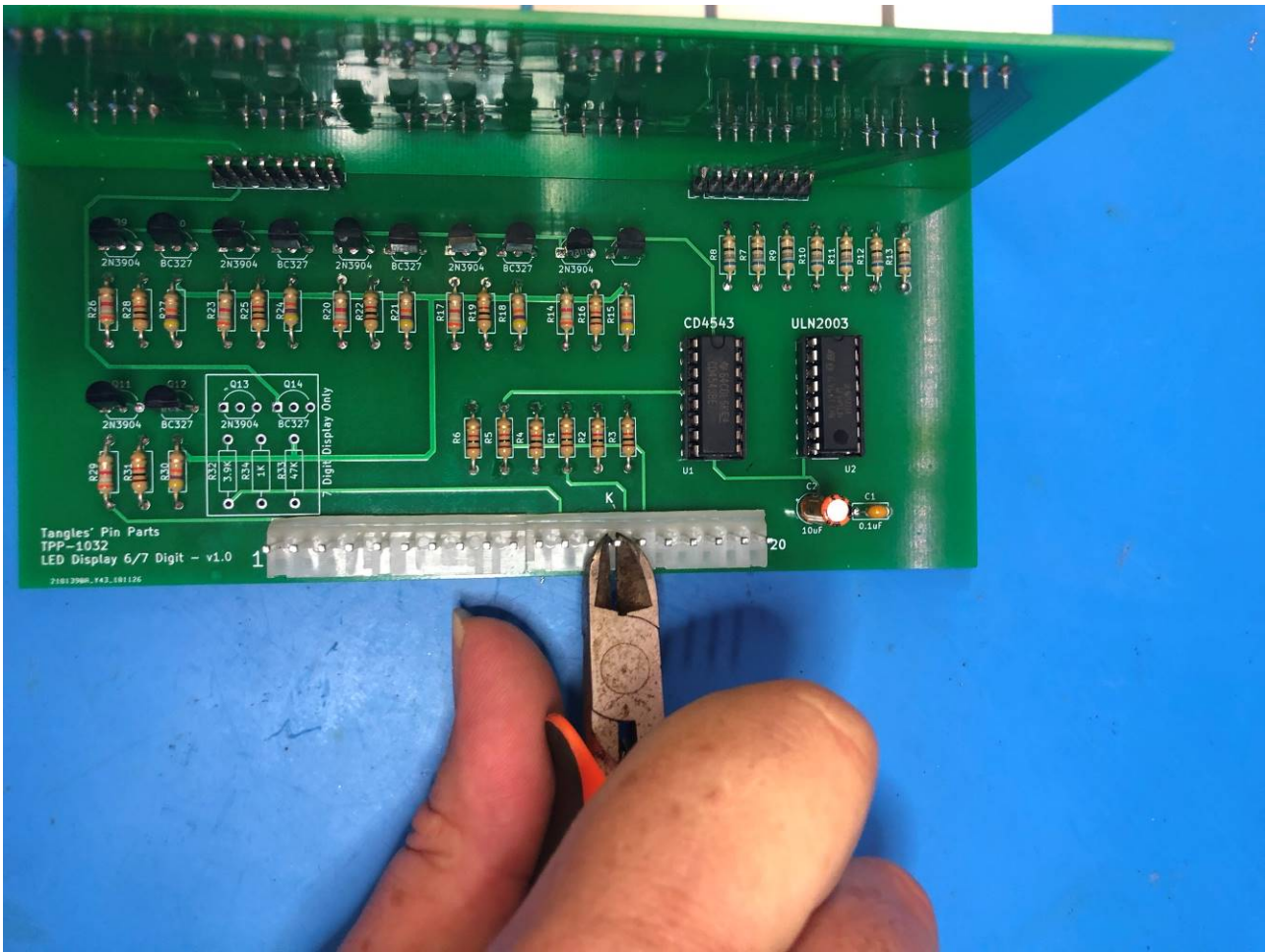


Photo 30: Cut the key pin. Take care of the flying cut pin. The Key pin is marked on the PCB with the letter "K"

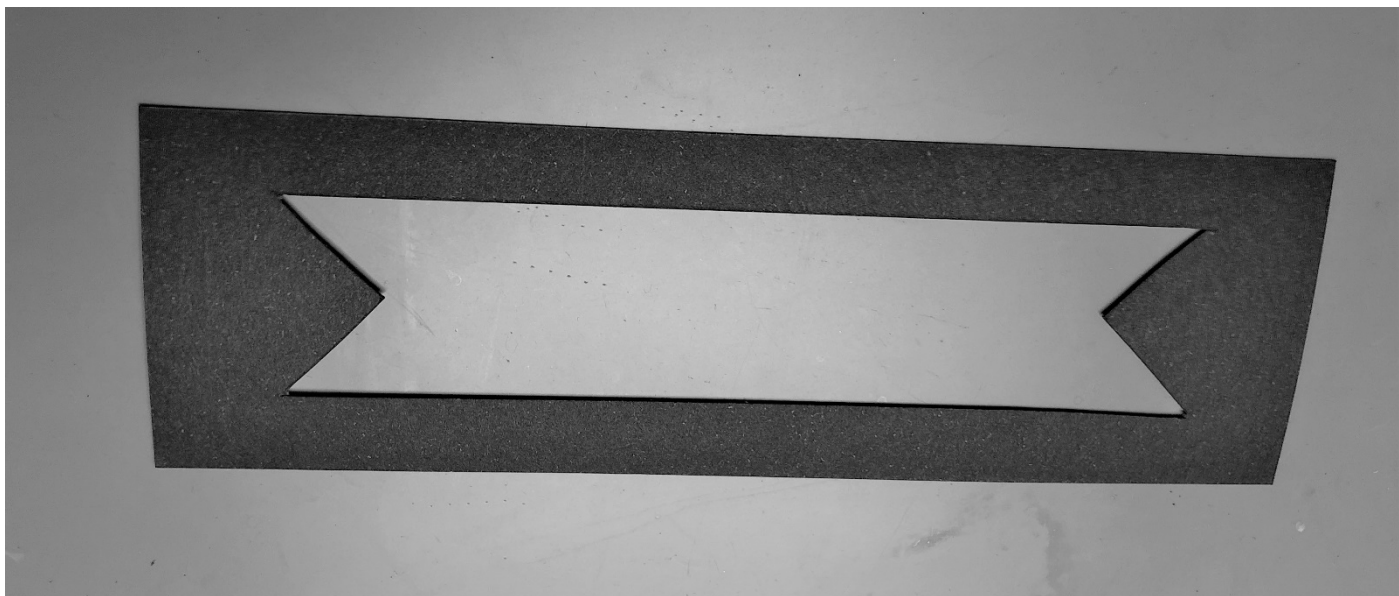


Photo 31: Card shroud cut from the card stock.

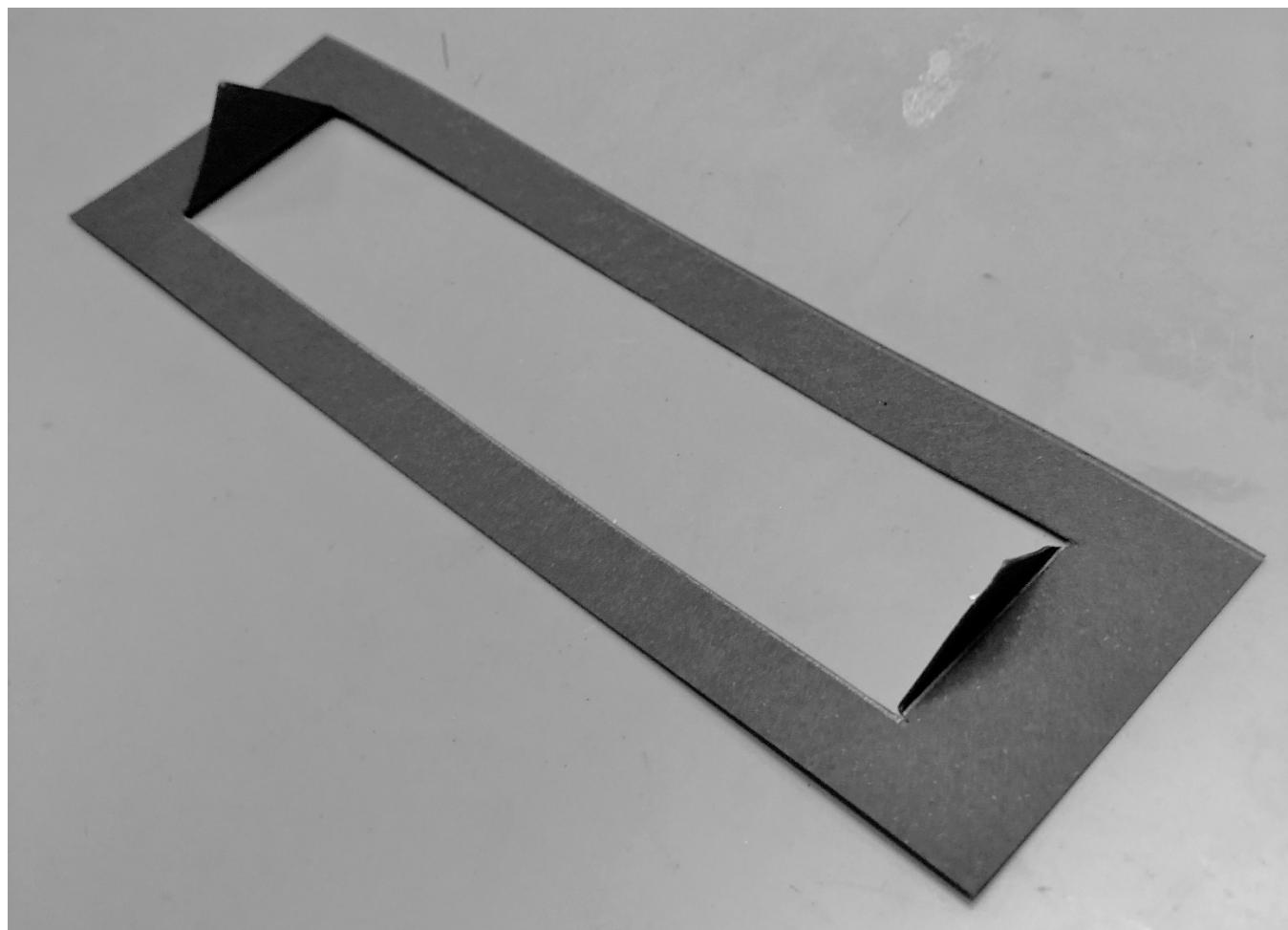


Photo 31: Card Shroud wings folded up.



Photo 32: Foam tape installed on top and bottom of LEDs



Photo 33: Card shroud installed on module. Ready for installation.