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## μPAD Proto Base Assembly Guide

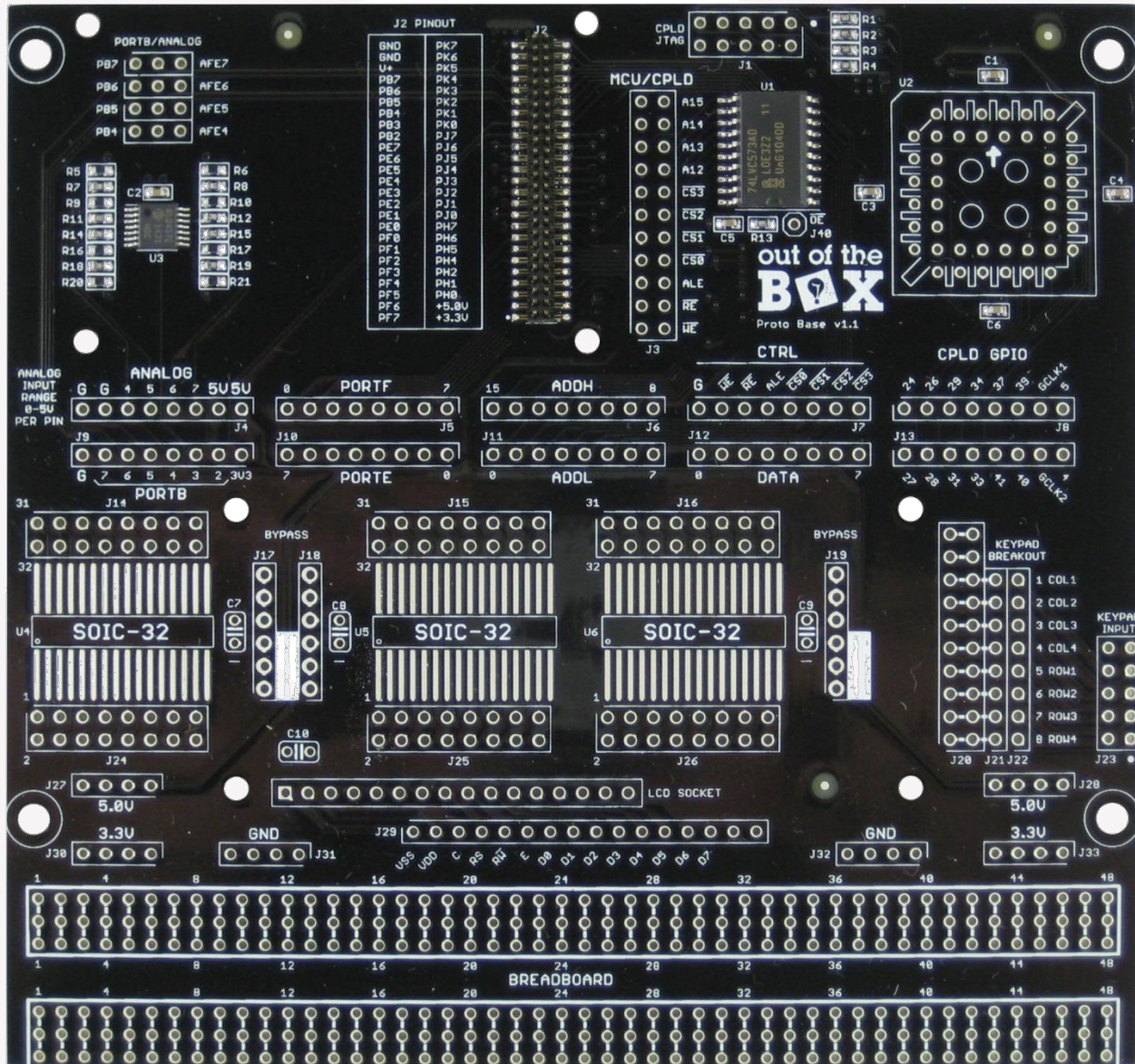
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*Last Updated May 11, 2015*

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## Required Tools

1. Flux Pen
2. Solder
3. Soldering Iron
4. Diagonal Cutters

## Recommended Tools

1. #1 Phillips Screwdriver
2. Nut driver 3/16"
3. Needle Nose Pliers

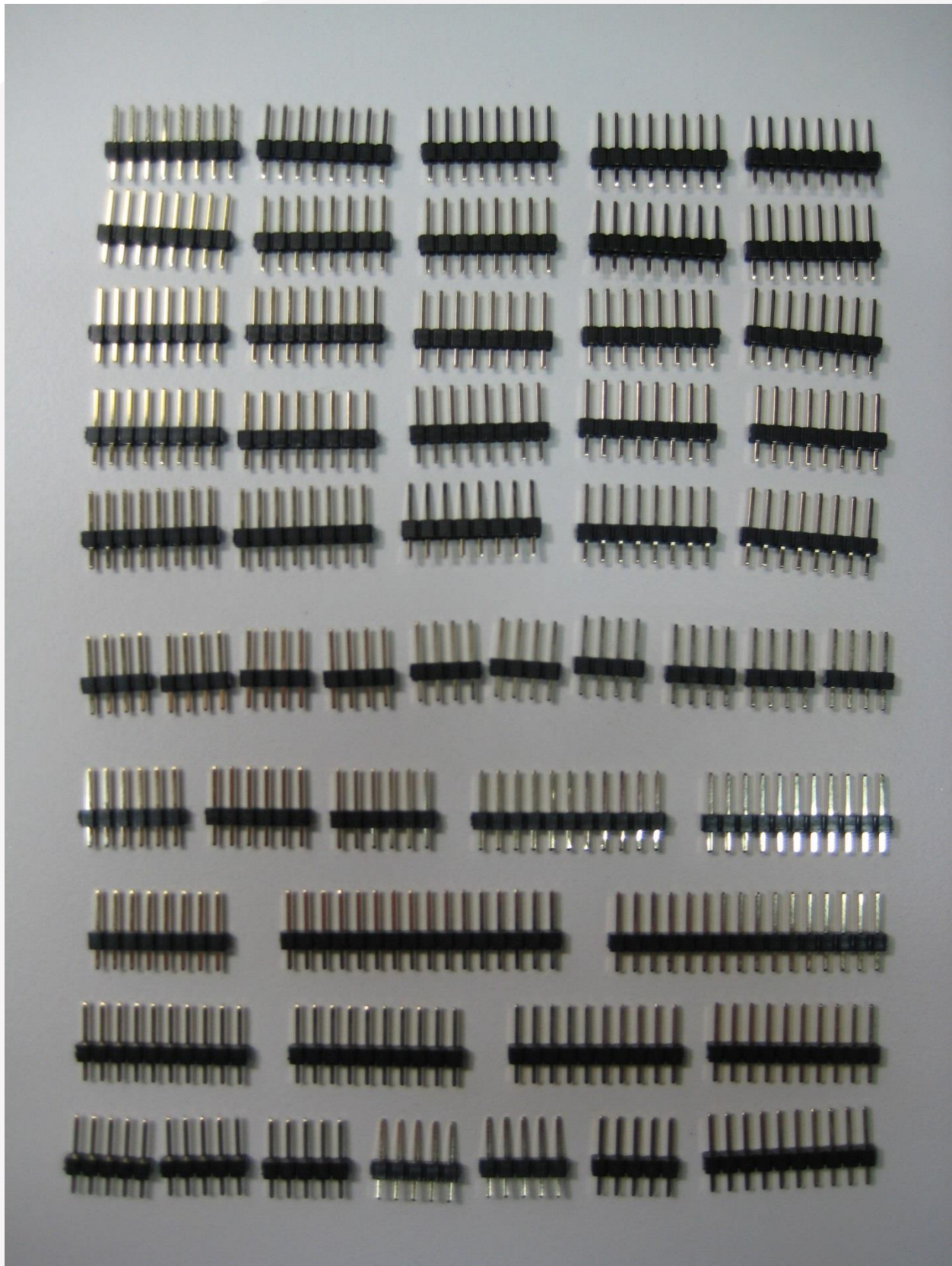
# Assembly Procedure

## Step 1: Break Pin Headers to Size

Table 1: Header Cut Reference

Index	Length 1	QTY	Length 2	QTY
1	8	5	n/a	n/a
2	8	5	n/a	n/a
3	8	5	n/a	n/a
4	8	5	n/a	n/a
5	8	5	n/a	n/a
6	4	10	n/a	n/a
7	6	3	11	2
8	8	1	16	2
9	10	4	n/a	n/a
10	5	6	10	1
11	-	-	-	-
12	-	-	-	-





## Step 2: Soldering

When soldering in this procedure there is a **mantra** to follow

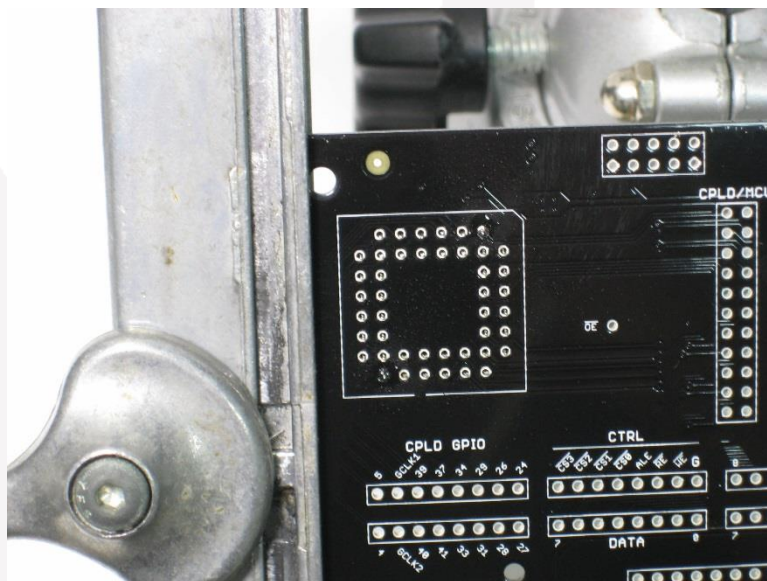
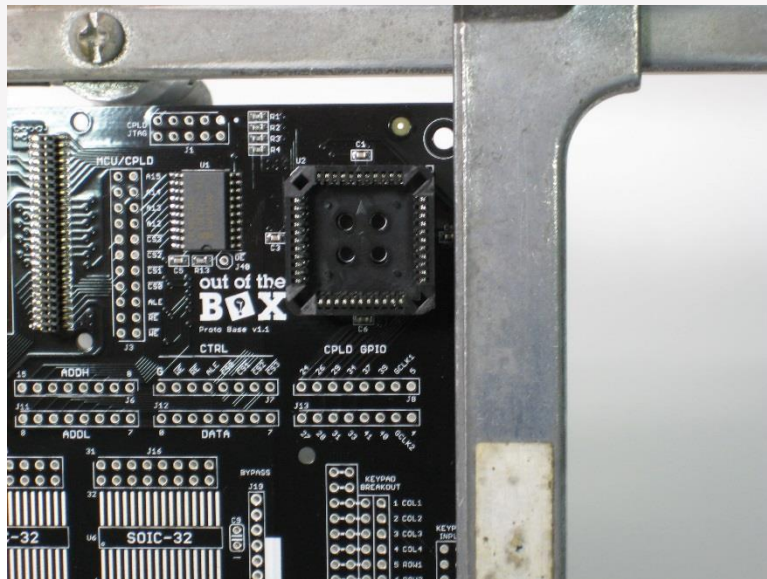
- Affix
- Flux
- Tack
- Check alignment
- Solder fully

This is particularly important for pin headers since they can be misaligned causing issues in the future. This is why it is crucial for you to take your time and be diligent. It is fairly trivial to realign a header that is tacked in place, but realignment of a fully soldered header is very taxing. Likewise, be certain of which side a part is to be soldered upon before doing so. If you have any doubts whatsoever, please consult your TA who will be happy to help you.

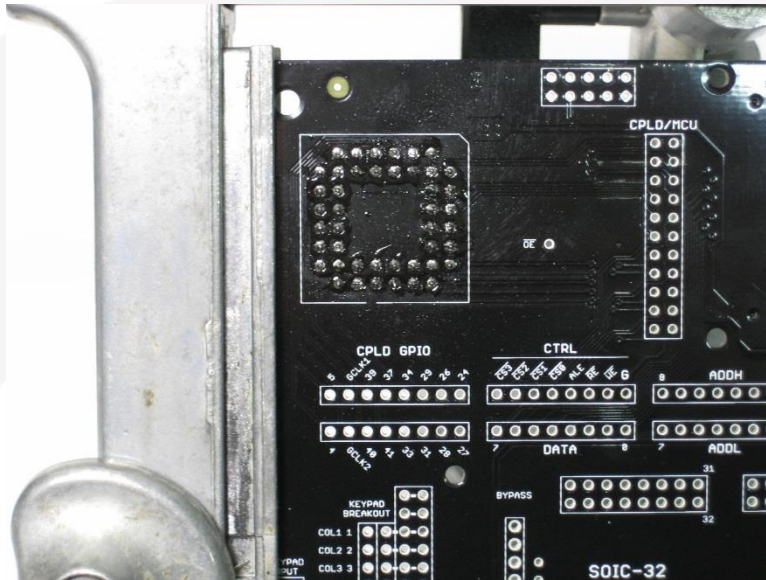


## Step 2.01: Solder U2

U2 is the 44 pin PLCC socket for a CPLD. Note the arrow orientation pictured in the top center of the CPLD socket.



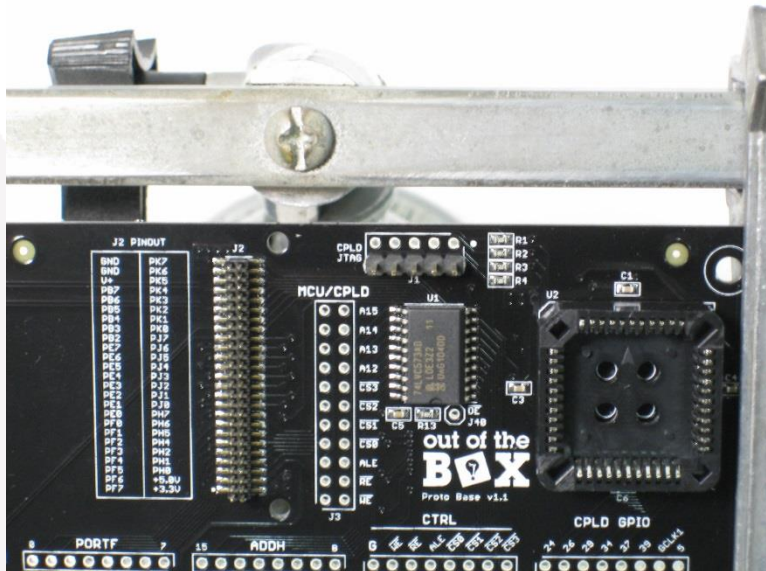
Apply flux to the pins shown soldered above. Then wet your iron with sufficient solder to tack the CPLD socket in place as shown. Before continuing make sure that the socket is seated flat on top of the board. If not, simply press down and apply heat to each of the tacked pins.



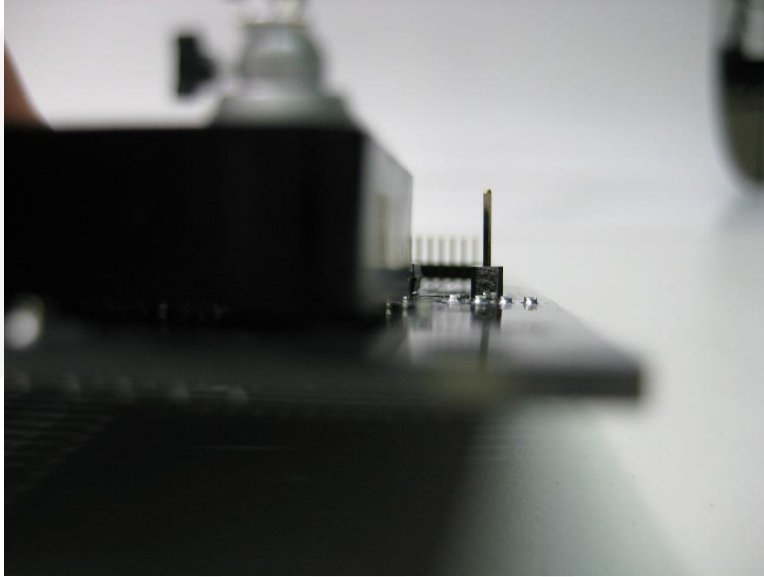
Solder all remaining CPLD socket pins.

### Step 2.02: Solder J1

J1 is the CPLD JTAG header used to program the CPLD.



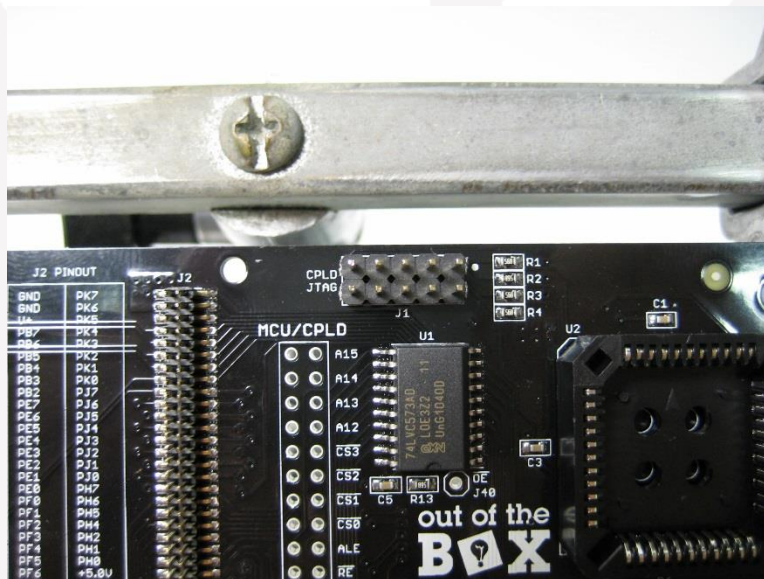
Place one of your 5 pin headers into a row of location J1 as shown above. Hold the header in place and apply flux to one of the outside pins of the header. Once fluxed, wet your iron with sufficient solder to tack the fluxed pin. If the header is aligned correctly it will appear perpendicular from the side as seen in the below image.



If the header is not aligned perpendicular to the surface as shown above, use your iron to reheat the tacked pin to adjust the alignment. Re-fluxing the pin may be beneficial. Once the header is aligned in a satisfactory manner, solder the rest of the remaining pins.

Note: Consider retouching the solder connection to the pin you first tacked down if needed. Use your best judgement.

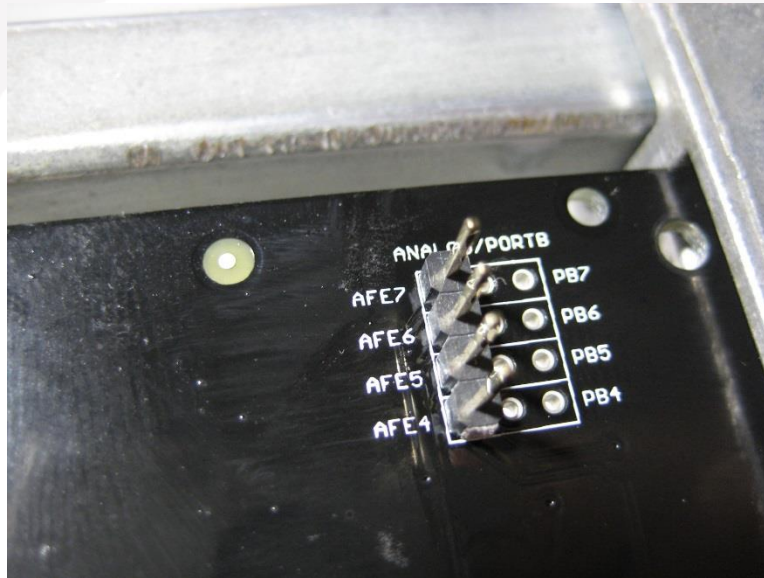
You should now add and tack down the second row of headers to J1 as shown below.



The second row should be considerably easier to align perpendicular to the board surface by using the side of the first header. But, to be safe, you should still verify before soldering the rest of the pins. If you are satisfied with the alignment of the second header, complete the soldering of J1.

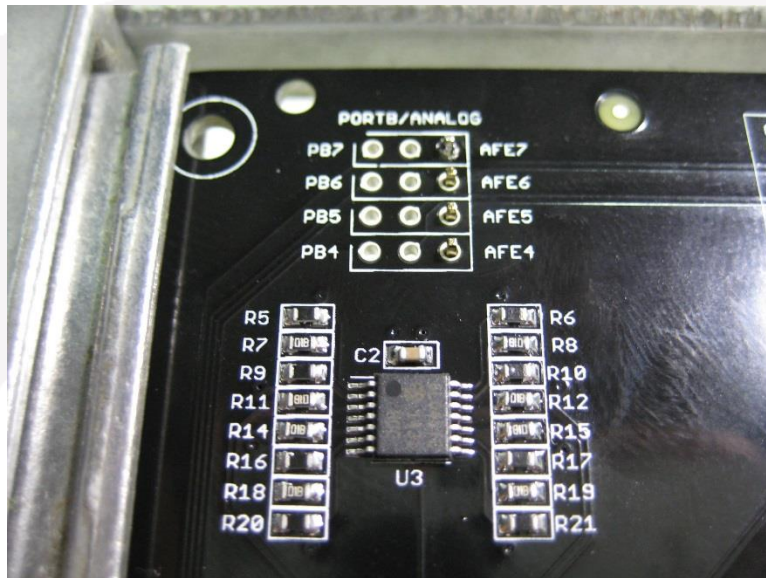
### **Step 2.03: Solder the ANALOG/PORTB selector**

Unlike J1 this set of headers will be soldered on the opposite side of the board. Place one of your 4 pin headers as shown below.

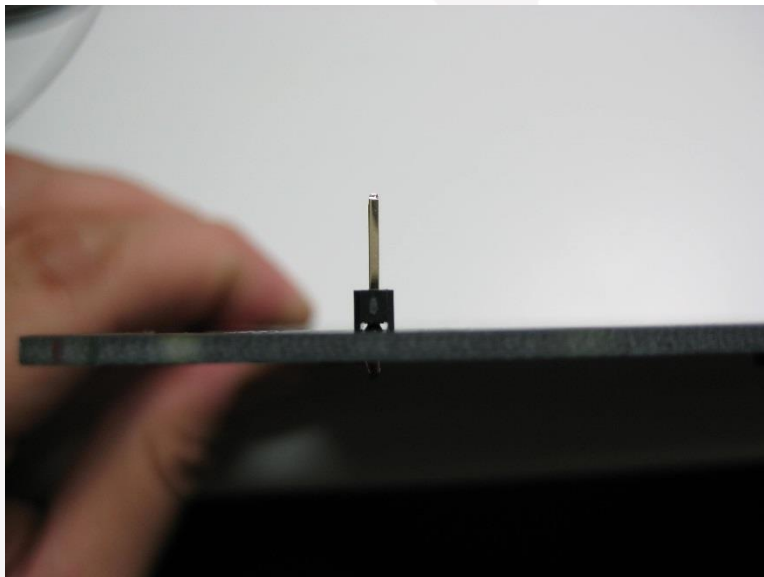


Note that when placed on the correct side of the board the label shown is ANALOG/PORTB. The other side of the board labels the header the opposite way. This is your check.





Once you have determined your header is placed correctly, flux and tack one of the pins as you have done before.

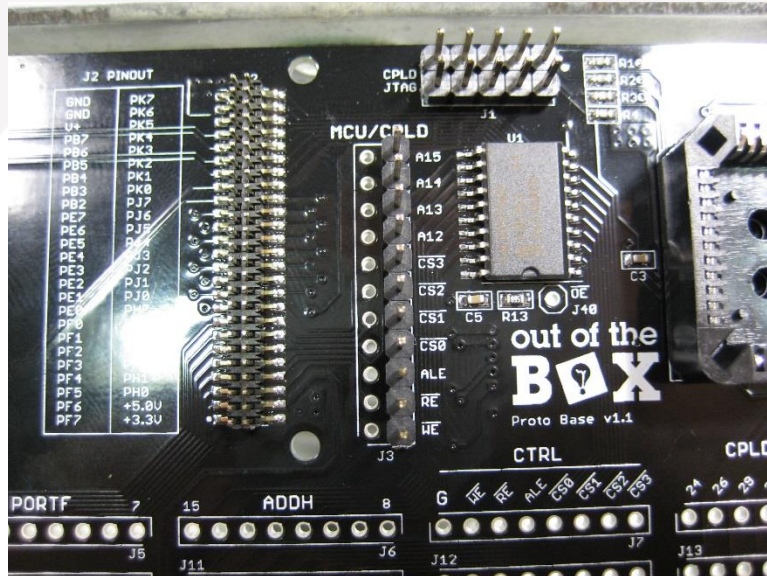


Before soldering the rest of the header pins, determine whether the header is soldered sufficiently, i.e. it is perpendicular to the board. Doing so is particularly critical for this set of headers since they will be used with jumpers. So take caution before proceeding to solder the full row.

Next, solder the 2<sup>nd</sup> and 3<sup>rd</sup> rows of headers using the same procedure as before following the above mentioned mantra.

### Step 2.04: Solder J3

J3 is another connection used with jumpers. These pins are specifically used to connect External Bus Interface control lines of the  $\mu$ PAD to the CPLD.



Place one of your 11 pin headers as shown above, then follow the normal mantra.

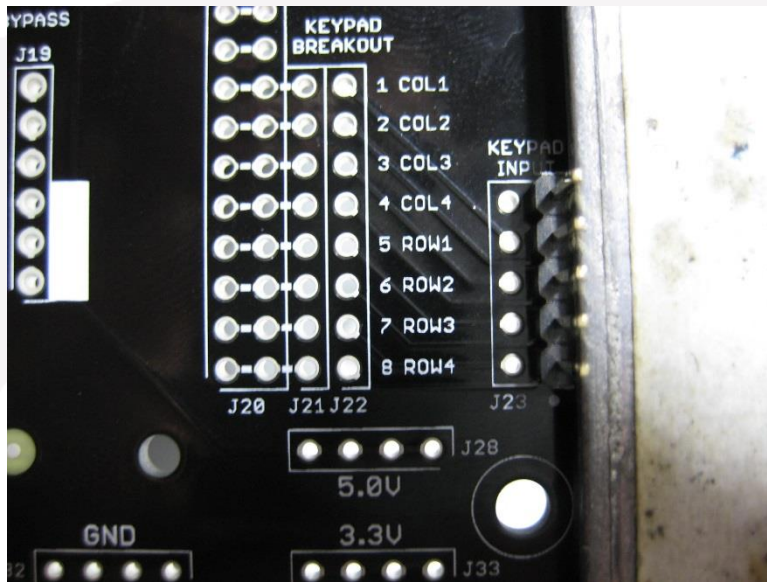
- Affix
- Flux
- Tack
- Check alignment
- Solder fully

Do the same with your other 11 pin header.

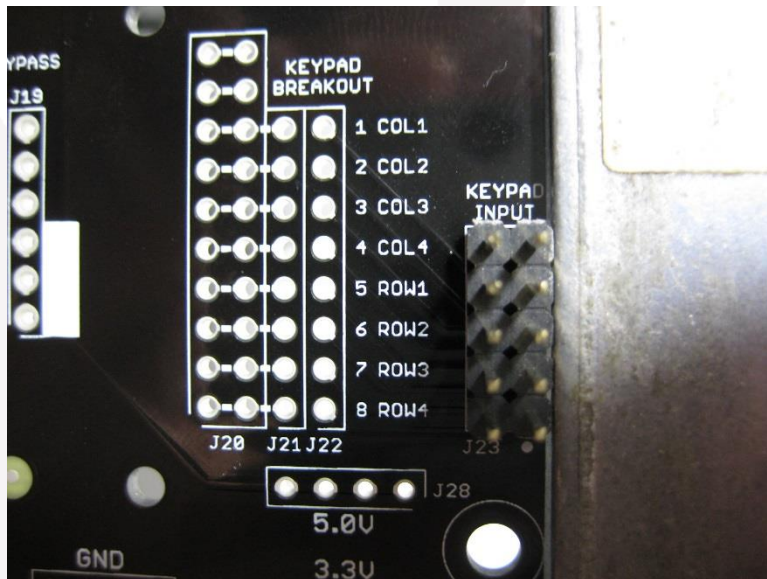
### Step 2.05: Solder J23

J23 is the keypad cable connection. All keypad signals are passed through this header.



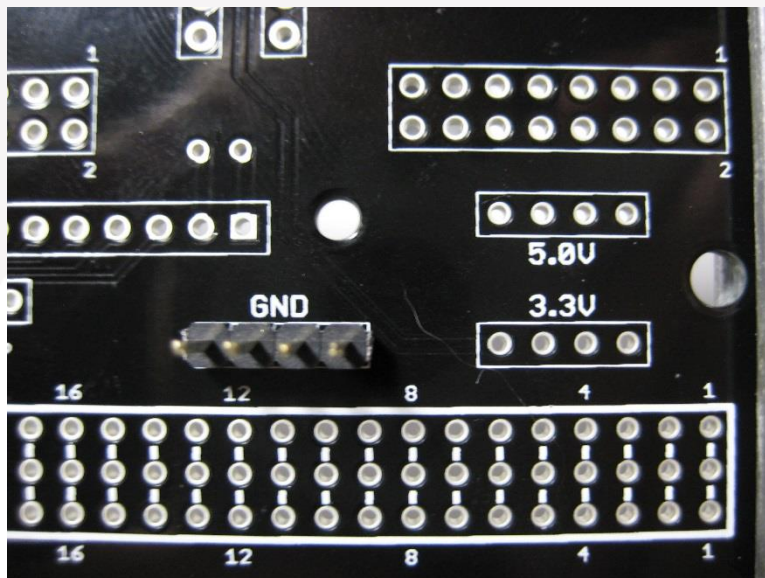


Place one of your 5 pin headers as shown and mount it per the usual mantra. Then place the other header to complete the J23 connector.



### Step 2.06-2.11: Solder J27, J28, J30, J31, J32, and J33

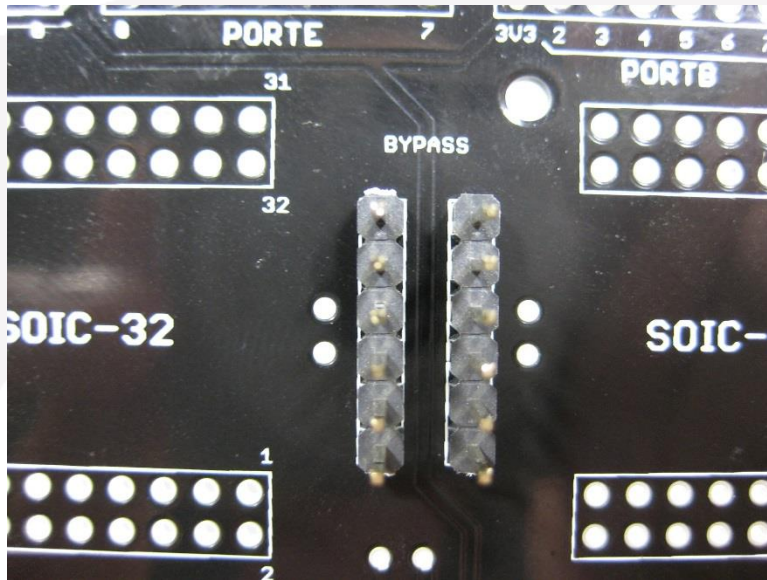
These connections are the primary power connections of the board.



Shown above is J31. Note the placement orientation (side of board). The other side of the board displays the reference designator (REFDES) J32. This is the orientation these connectors should be soldered. Follow the mantra and solder all 6 of the connections.

### Step 2.12-2.14: Solder J17, J18, and J19

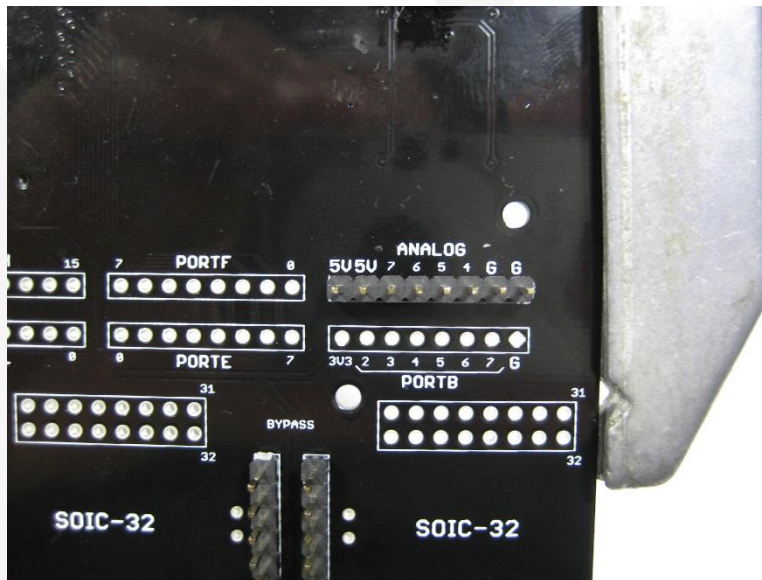
These connections are breakouts for the bypass capacitors that will be soldered later in the procedure. The bypass breakout headers allow for easily wiring of bypass caps to ICs. These headers are divided into a positive and negative section via bold white bars. The pins adjacent to the bars are the negative terminals, and the other pins are the positive terminals



Displayed above are J17 and J18. You can ensure your correct board side placement by the absence of the REFDES. These labels are only on the top of the board. Mount all three connectors in the manner displayed above.

**Step 2.15-2.24: Solder J4, J5, J6, J7, J8, J9, J10, J11, J12, and J13**

These connections are breakouts of the  $\mu$ PAD's and the CPLD's signals.



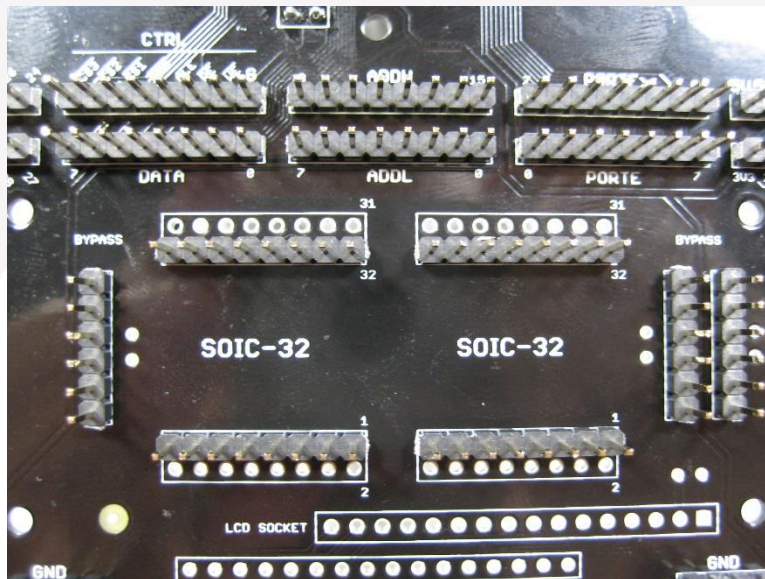
Displayed above is J4. You can verify the side of the board this connector is located on by checking that the REFDES is not present. The other side of the board will label this connector with "J4". Mount all the aforementioned connections with this board side orientation.

**Step 2.25-2.30: Solder J14, J15, J16, J24, J25, and J26**

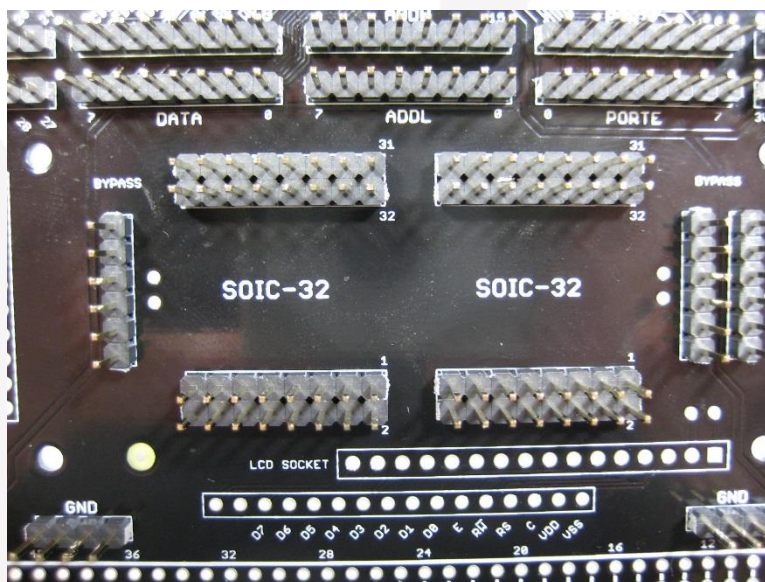
These are the breakout connections for the SOIC surface mount footprints.



Place one 8 pin header in each of the 6 connection locations. The below image depicts J15, J16, J25, and J26.



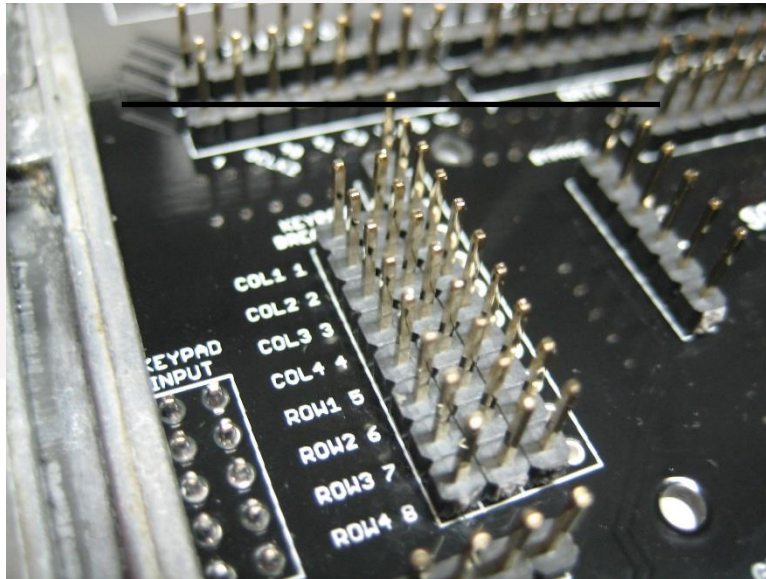
Next mount the second row of headers, and solder them as per usual.



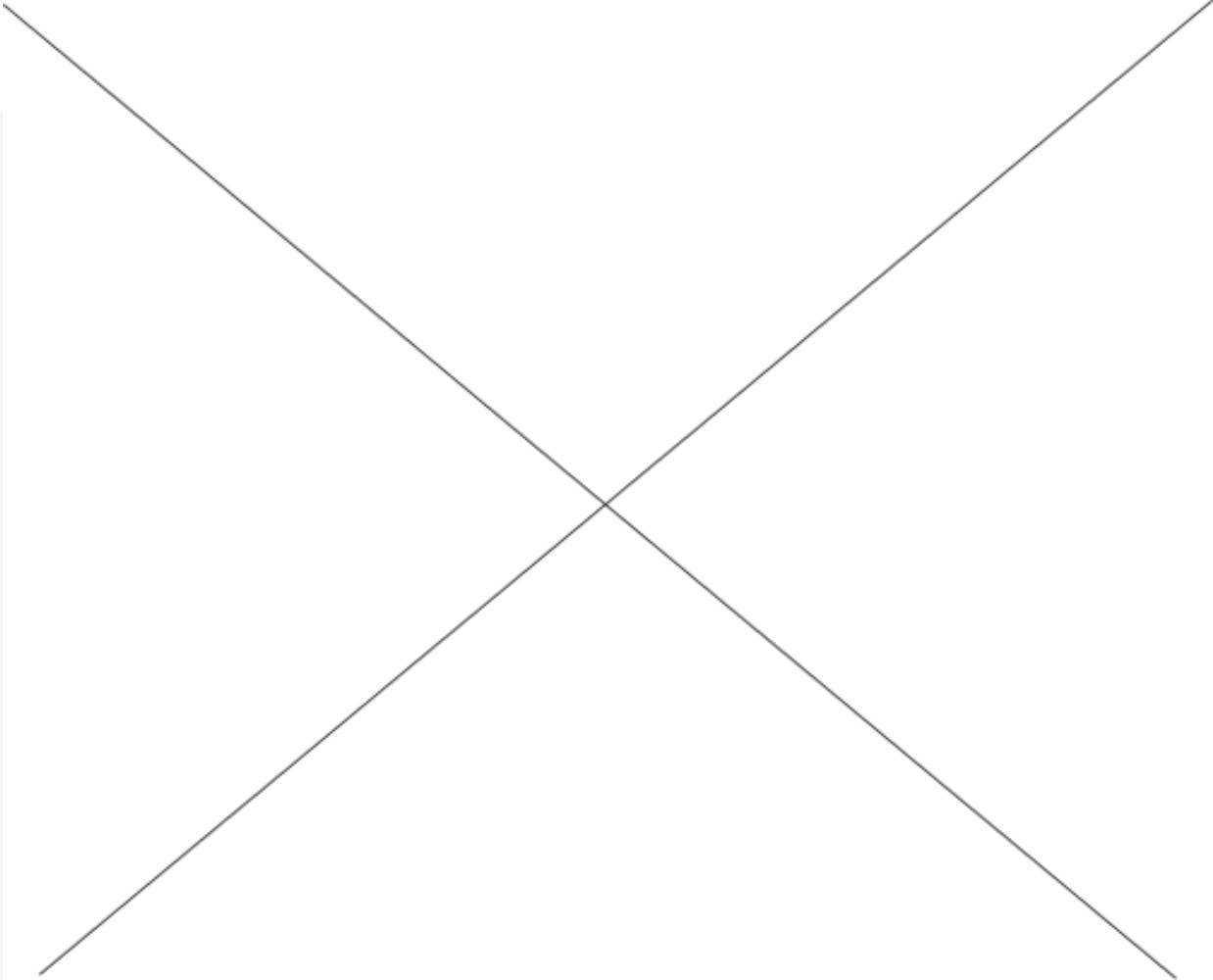
### Step 2.31-2.33: Solder ~~J20, J21,~~ and J22

These connections are used for the keypad interface. J20 is designed to fit a 10 pin header and a 10 pin SIP resistor side by side. J22 is a linear breakout of all the Keypad signals coming from the keypad cable. J21 exists to allow for jumpers to be added to pull-up or pull down rows or columns of the keypad without additional wire wrapping. Pins without jumpers on J22 can then be connected to GPIO pins for reading data from the keypad.

Install the headers exactly as displayed in the below image one row at a time. Starting with the 10 pin header of J20 is advisable. J21 and J22 will be fitted with 8 pin headers.



**NOTE: You only need to solder J22**



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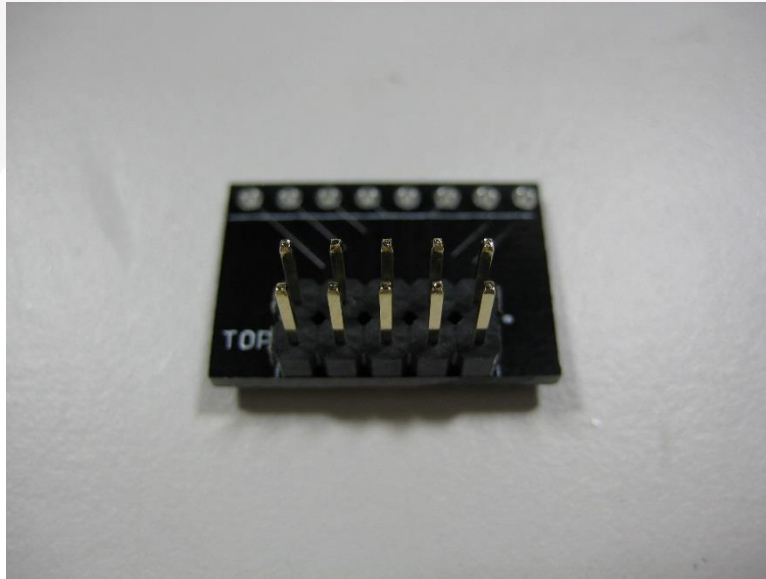
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### Step 2.36: Solder the Keypad Cable Connection of the Keypad Breakout Board

This connection organizes the keypad signals to best fit the keypad cable.

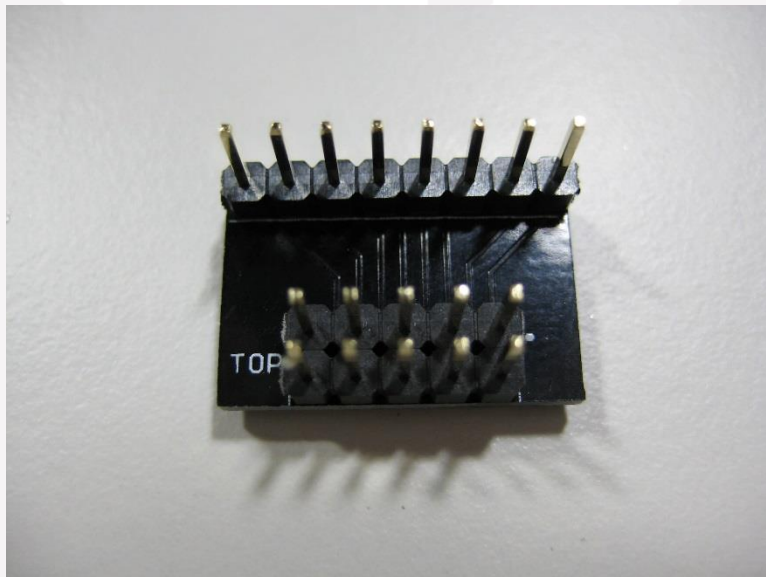
Solder two 5 pin headers one at a time as depicted by the below image. Note the label “TOP” denoting which side of the breakout board is up.



### Step 2.37: Solder the Keypad Connection of the Breakout Board

This connection will be soldered to the keypad directly in a step to follow.

Mount an 8 pin header as depicted in the below image.



Step 2.38: Solder Keypad



The keypad will be used to provide user input to the  $\mu$ PAD.

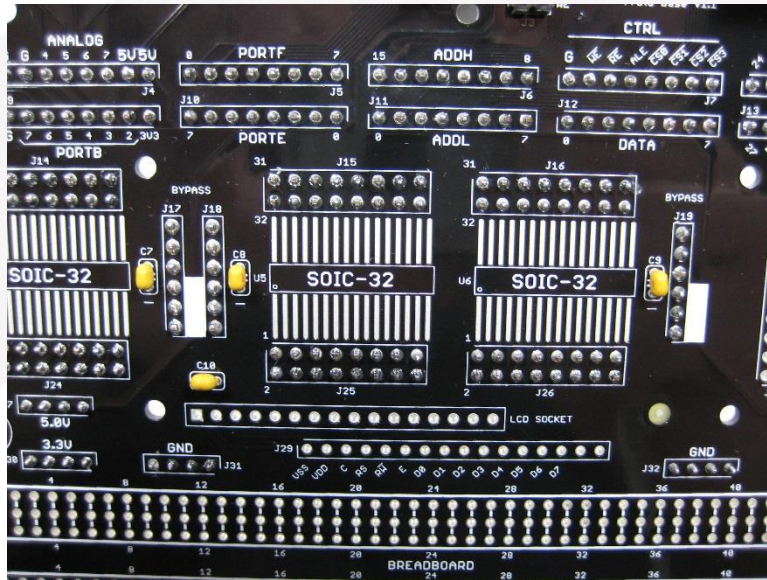
Solder the 8 pin header of the keypad breakout board directly to the keypad. Take care to mount the keypad flat against the plastic portion of the header. Another note: there are 10 holes in the keypad, but only the center 8 have electrical connections. Take care to place/solder the pins into the keypad correctly.



Step 2.39-2.42: Solder C7, C8, C9, and C10

These are bypass capacitors for use with the three SOIC breakouts, and the LCD. Bypass capacitors serve to smooth out power signals to their respective devices. When a burst of current is drawn by a device, a power supply signal often drops in potential. Bypass capacitors such as these are used to field such bursts in current, therefore maintaining proper supply levels.

Place each of the capacitors in their respective locations shown below. To hold these devices in place for soldering, the best practice is to bend the leads flat against the board.



Once soldered, you should use a diagonal cutter to snip the leads off the capacitors.

### Step 3: Mounting the LCD

The  $\mu$ PAD Proto Base is designed to interface directly to the LCD provided in your kit. So precisely, in fact, that it is crucial to fit the LCD and connectors to one another prior to soldering anything. The following instruction will guide you:

#### Step 3.01: Affix Washers to Each of the LCD Mounting Screws.

The reason for these washers is to prevent dissimilar metal corrosion between the mounting screws and the LCD.

Thread a washer all the way up to the head of each of the mounting screws.

#### Step 3.02: Insert LCD Header into the LCD Socket

The header, in a later step, will be soldered directly to the LCD, and the socket, again at a later step, will be soldered to the  $\mu$ PAD Proto Base.

Insert one of your 16 pin headers into the 16 pin LCD socket.

#### Step 3.03: Mount the LCD (Do Not Solder)

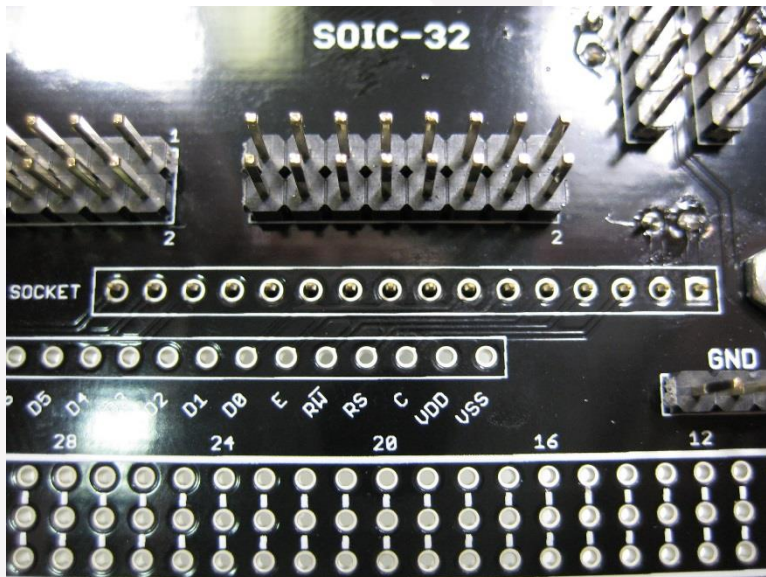
Though not required, this step is most easily performed with a #1 Phillips screwdriver, and a nut driver or a pair of Needle Nose Pliers.

Place the LCD header/socket from the previous step in place and screw the LCD to the  $\mu$ PAD Proto Base.

The proper stack-up for the LCD is; screw, washer; LCD; spacer;  $\mu$ PAD Proto Base; and lastly, a nut.



LCD mounted mechanically as viewed from above. Notice the LCD header pins poke through the LCD's board connections.



LCD mounted mechanically as viewed from below. Notice the LCD socket pins poke through the LCD socket connections of the  $\mu$ PAD Proto Base.



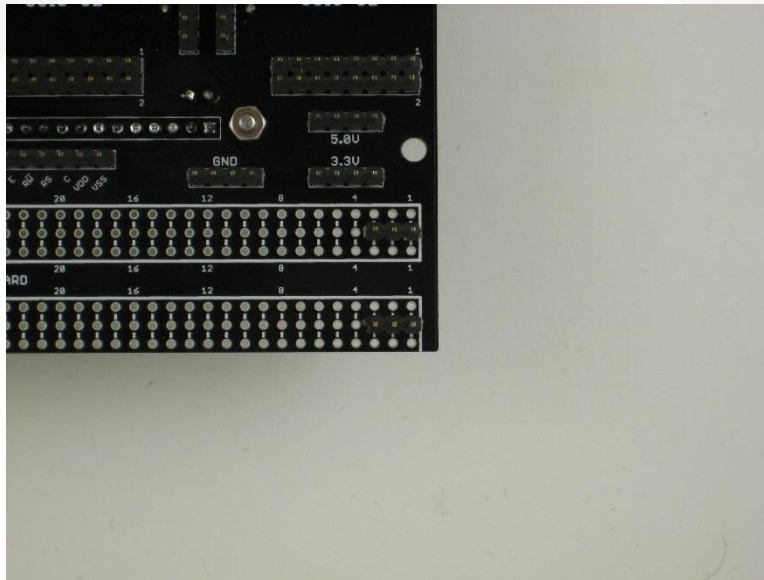


## Step 4: Adding Components to the Breadboard Area

### Step 4.01:- Adding Breakout Headers for the Potentiometers

In step one, ten of the twelve 40 pin headers were broken apart, which means that two of the headers remain intact. For this step, break off two 3 pin headers from a pristine forty pin header.

Mount these two 3 pin headers as shown below.



Next, mount the potentiometers above these headers as shown below.





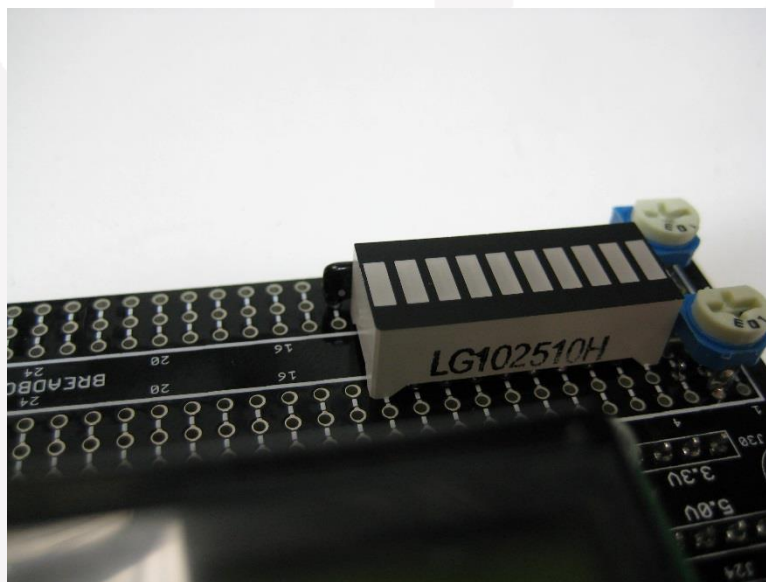
#### Step 4.02: Add the LED Array

Place the LED array as shown below. The side of the array with text upon it should be facing the LCD. Once the orientation of the LED array has been verified, solder it in place.

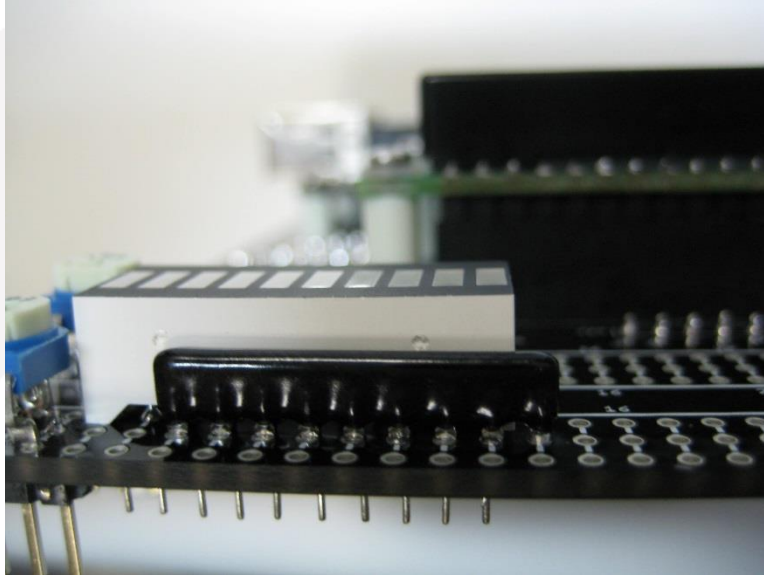


#### Step 4.03: Add the 470 Ohm SIP

Place the SIP as the pictures below depict.



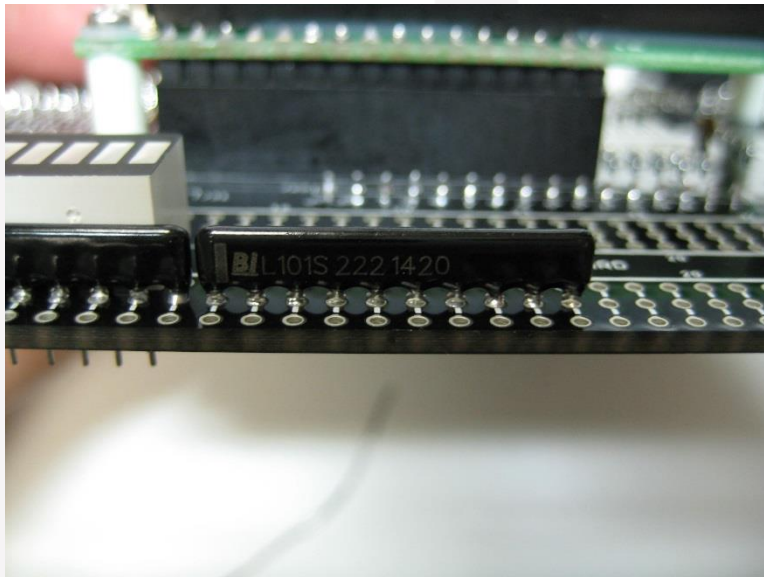
Note the Common indicator is located on the pin just left of the LED Array in this view.



The above image is provided to further illustrate the mounting location of the SIP. Once the location is verified, solder the SIP in place.

#### **Step 4.04: Add a 2.2K SIP**

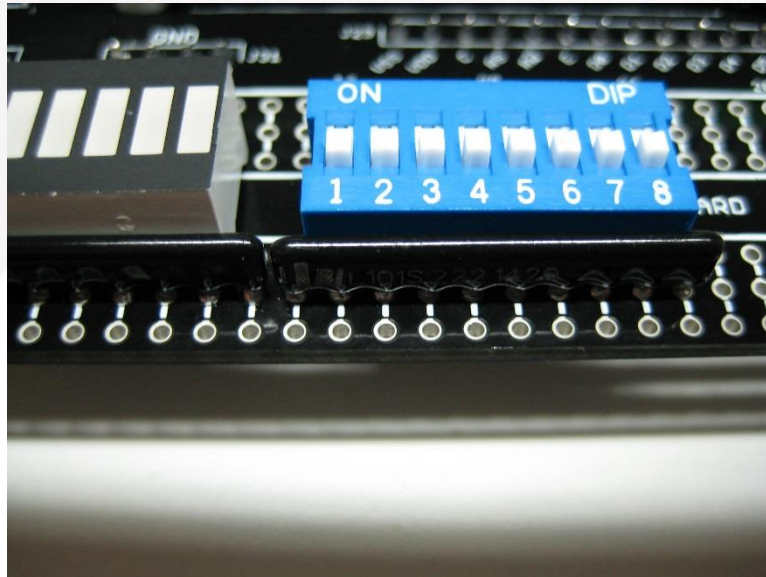
Place the SIP in the location depicted in the picture below.



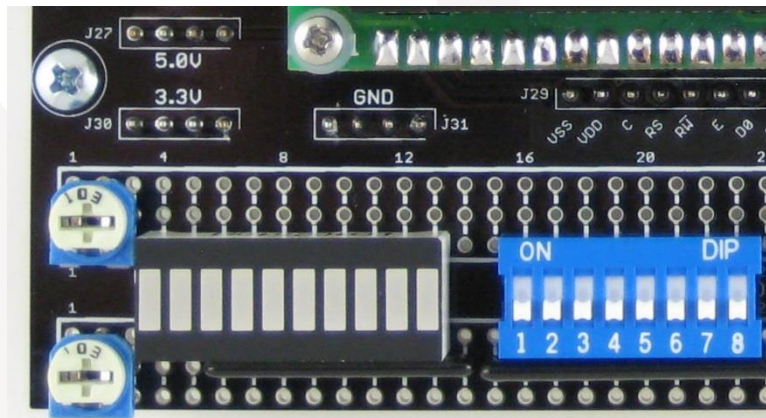
Note that the common of the 2.2K SIP is located adjacent to the 470 Ohm SIP. Once the location and orientation of the SIP is verified, solder the SIP in place.

#### Step 4.05: Add the DIP Switch

Use the following photos as a reference for mounting the DIP switch to the proto area.



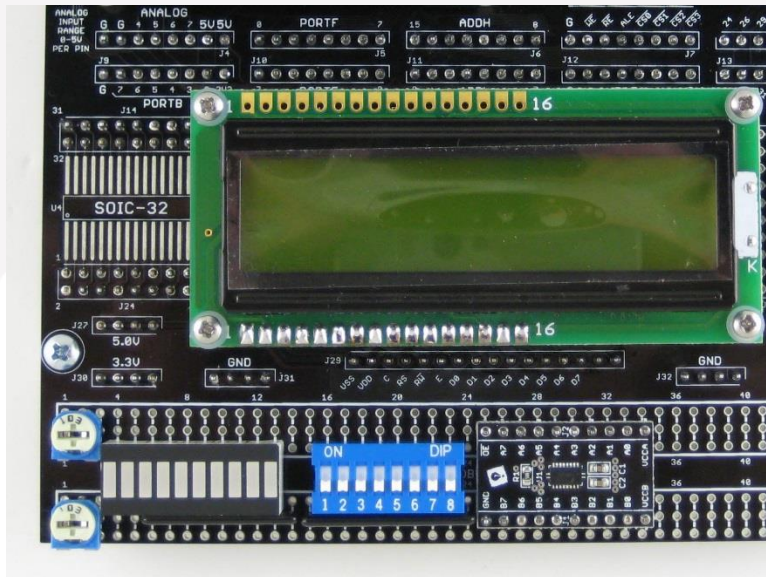
The picture above depicts the pin alignment of the DIP switch. Notice that switch 1's pin is located adjacent, not in line with the common of the 2.2K SIP.



The picture above further depicts the alignment of the DIP switch.

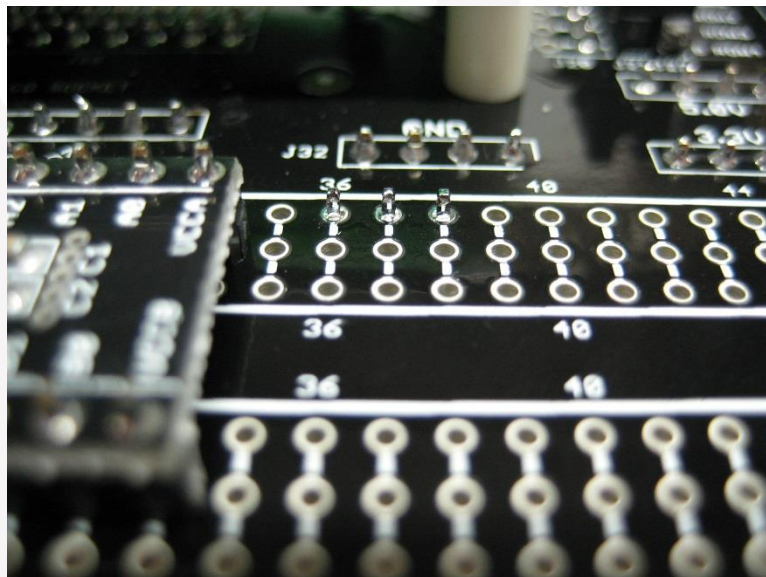
#### Step 4.06: Add the Level Shifter

Insert and solder the level shifter as displayed below.



#### Step 4.07: Add Breakout Headers for the Piezo Buzzer

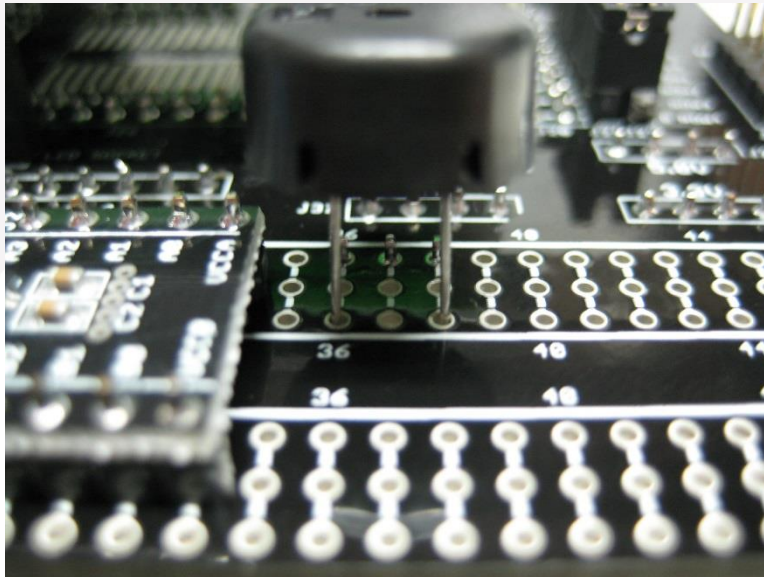
Break off another 3 pin header, and mount it to the location depicted in the below image.





#### Step 4.08: Add the Piezo Buzzer

Align the piezo buzzer as shown in the picture below.



Note the picture above depicts a space between the board and the buzzer. This is simply to further illustrate the location of the buzzer. When you mount your buzzer, the device should not have this space. Solder the buzzer. Using a pair of diagonal cutters snip off the excess of the buzzer pins.



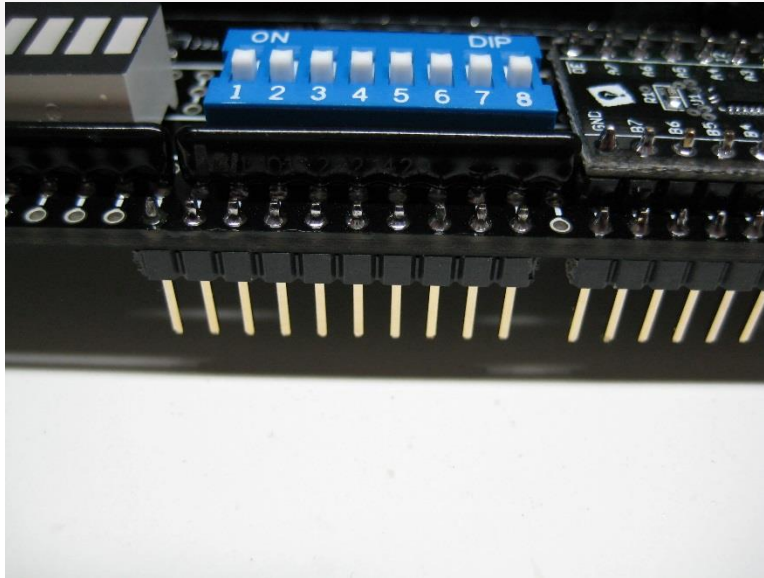
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#### Step 4.10: Add a 10 Pin Header for the DIP Switch and LED Array

This header serves multiple purposes. This header is a means of wire wrapping to the commons of the 470 Ohm SIP, and the 2.2K SIP. Additionally, this SIP exposes the DIP switch signals intended to be connected to the  $\mu$ PAD's I/O pins.



Use the above image as a reference of where the headers should be soldered.

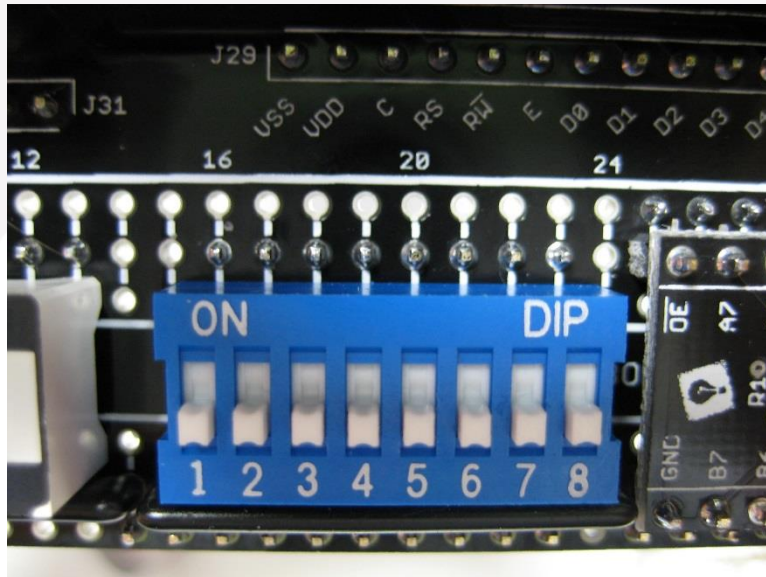
#### Step 4.11: Add a Wire Wrap Header for the LED Array's Signals

Use an 8 pin header to make 8 LED signals accessible via wire wrap. Mount the pin header in the location depicted by the following picture.



#### Step 4.12: Add a Wire Wrap Header for DIP Switch GND Connections

Use an 8 pin header and mount it as shown below. The pins need to be in line with the DIP switch's individual switches.



## Step 5: Mount Standoffs

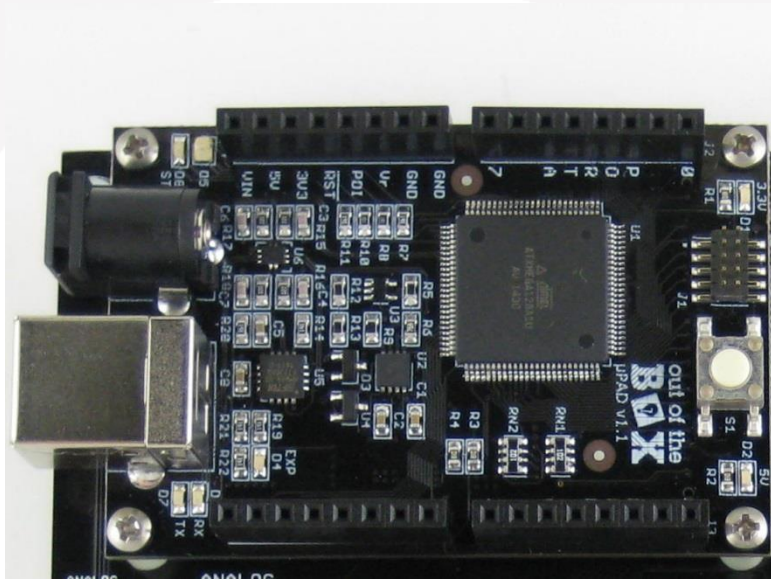
Screw the 4 metal standoffs provided to the  $\mu$ PAD Proto Base.



## Appendix I: Additional Assembly

### Adding Shield Sockets to the $\mu$ PAD

Included in the kit for the  $\mu$ PAD Proto Base are four 8 pin sockets. These sockets are the  $\mu$ PAD Shield Sockets. These sockets solder onto the  $\mu$ PAD as shown below.





## Appendix II: Parts List

### Kit Box Contents

Index	QTY	Description
1	4	LCD Spacers (9MM)
2	4	LCD Screws (3/4")
3	4	LCD Nuts
4	4	LCD Washers
5	3	RES 10K OHM 1/4W 1% AXIAL
6	1	74AHC574
7	2	10k Pot
8	1	Piezo Buzzer
9	2	RES ARRAY 2.2K OHM 9 RES 10SIP
10	1	Resistor Networks & Arrays 10pins 470ohms Bussed
11	1	74AHC573
12	1	RECEIVER IR REM CTRL 3V 40KHZ
13	24	Jumpers
14	1	DIP Switch
15	1	LED Array
16	1	IC SRAM 256KBIT 45NS 28SOP
17	1	LCD Socket
18	4	$\mu$ PAD Shield Sockets
19	1	Keypad
20	1	LCD
21	1	Level Shifter Breakout Board

22	1	Keypad Cable
23	12	1X40 Pin Headers
24	1	Wire Wrap Tool
25	1	CPLD socket



## Additional Components Packaged With Boards

Index	QTY	Description
1	1	USB Cable
2	4	μPAD Spacers (7MM)
3	4	μPAD Screws (9/16")
4	4	μPAD Nuts
5	4	Proto Base Standoffs 1/2"
6	4	Proto Base Standoff Screws

# Appendix III: Full Assembly References

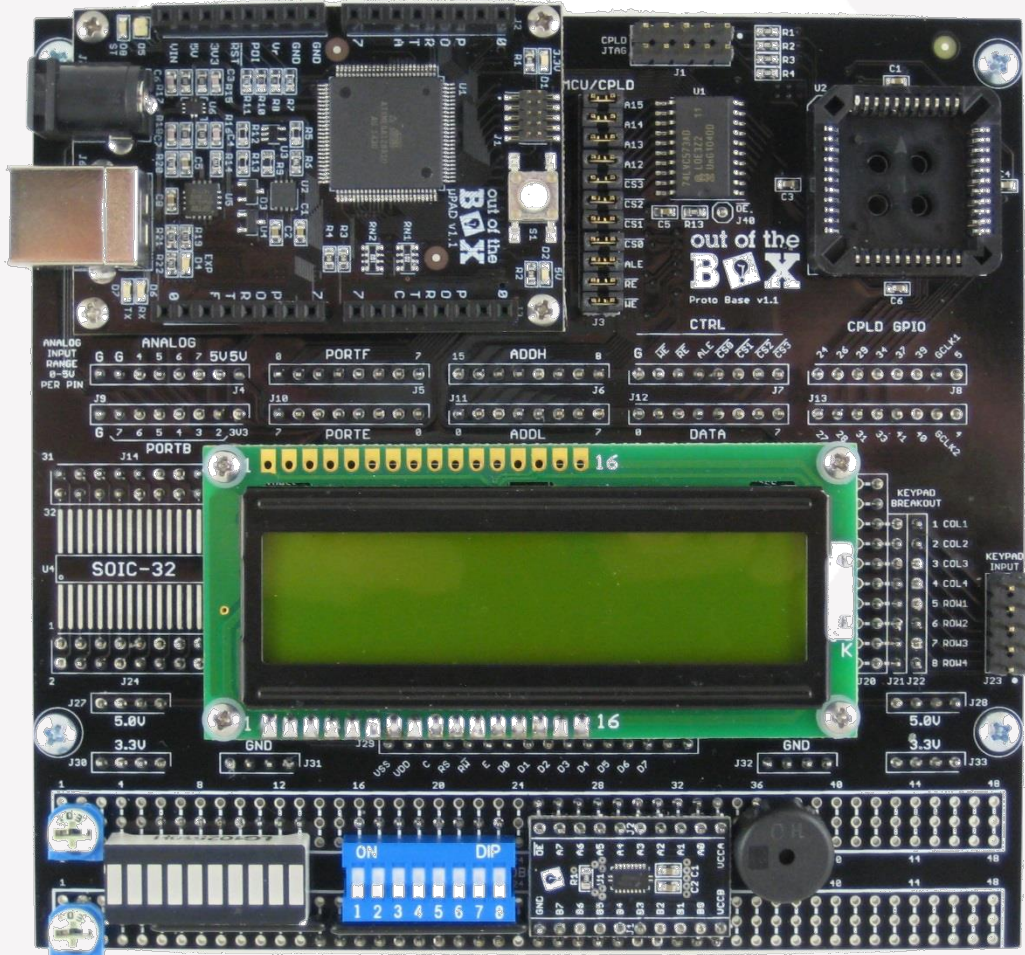


Figure 1: Board Assembly Full Top



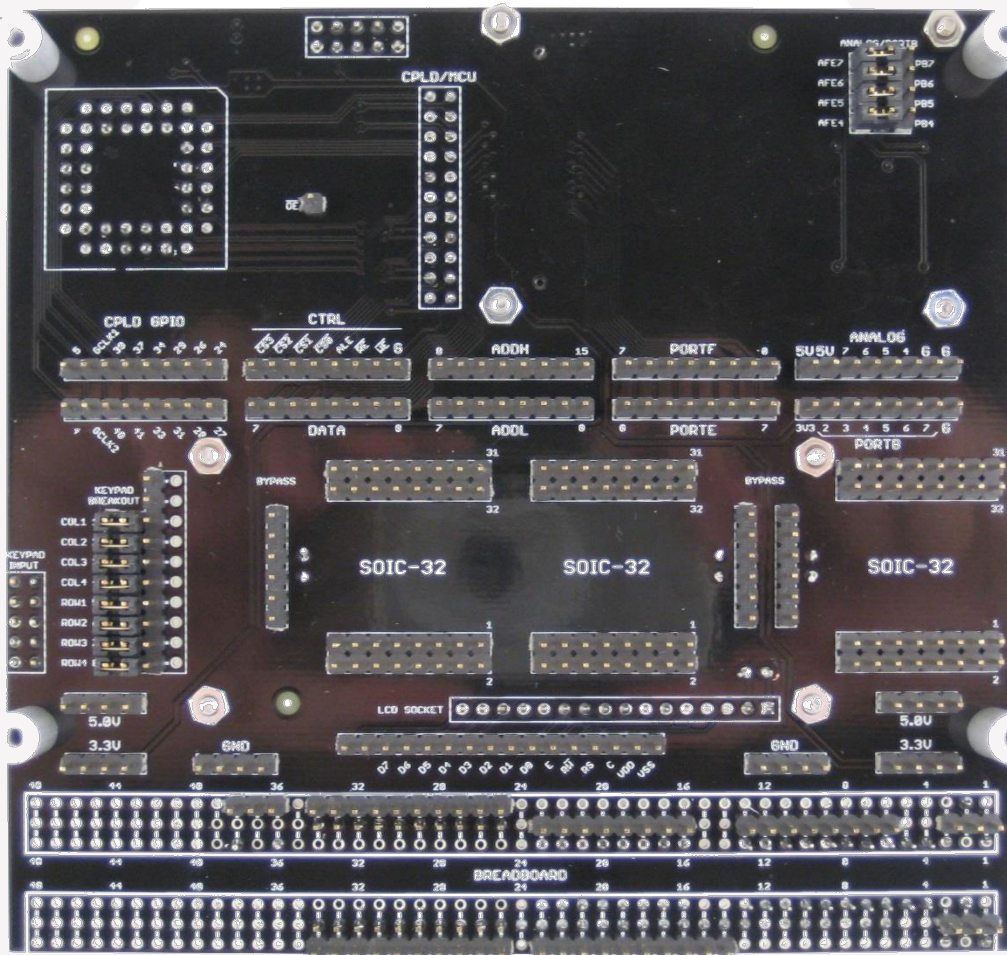


Figure 2: Board Assembly Full Bottom