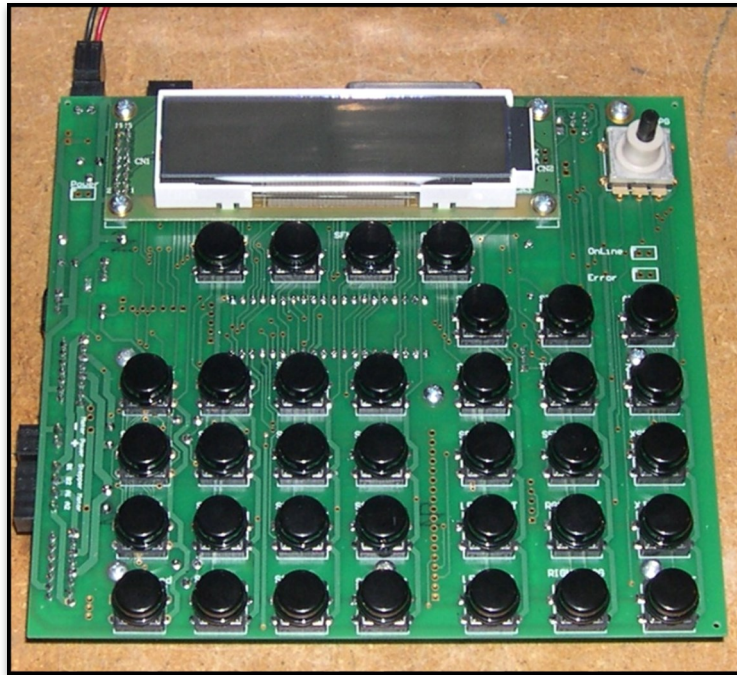


Automation Artisan's



Electronic Lead Screw (ELS)

Open Source GPL

Lead Screw & (optional) Cross Slide Controller

Assembly Manual

Revision 1.03c

E Lead Screw 1.10i

July 7, 2015.

Copyright © Automation Artisans Inc. 2008.

Table of Contents

1. ELS 1.00c Parts List	3
2. Kit Contents	3
2-1. Basic Kit & Optional Connector Kits	4
2-2. Micro-Stepper (optional)	5
3. Assembly Instructions	6
3-1. Pre-Assembly Notes	6
3-2. P6KE33 Transorb, 40 Pin Socket, LCD Header	7
3-3. Spacer Kit (Optional)	9
3-4. Resistors, Regulators, & Capacitors	10
3-5. Jumpers	11
3-6. DB-25, Beeper	13
3-7. Spindle LED, LCD Screen	14
3-8. PCB Screw Terminals (Optional)	15
3-9. Micro-Stepper & CPC Connectors (Optional)	17
3-10. Button Switches, Button Caps	20
3-11. MPG, LED'S	21
4. Fin	22

ELS 1.00c Parts List

Qty	Part Type	Designator	Footprint	Description
	Through Hole Parts Hand Installed			
1	100uF 35V	C25	RAD8.0-3.5	Radial Capacitor
1	100uF 6.3V	C26	RAD6.0-2.5	Radial Capacitor
1	TRANSORB 18V	D6	POLAR0.6	Diode
1	LM317T	U20	TO-220V	TO-220 Transistor
1	LM7805CT	U8	TO-220V	TO-220 Transistor
1	RED LED	D2	LED1	RED - Error
2	GREEN LED	D3,D7	LED1	GREEN - Power, Ready
1	YELLOW LED	D8	LED1	YELLOW - Spindle Sensor
1	5K	VR3	EVND2	Horiz. Trim Pot
1	47R	R22	Axial	Axial Resistor
1	LCD DISPLAY	LCD_Display	LCD2X20-18	LCD20x2, 73-1288-ND(white)
1	MPG	S10	62P-ENCODER	Encoder
1	PIEZO Buzzer	XD1	SONALERT-MSR516N	Beeper
1	DB25	J6	DB25RA/F	DB-25
1	40 pin Socket	U2	DIP 40	Socket
1	PIC18F4685	U2	DIP40	PIC uC
35	SW-PB	SWx..Swy	PB_SWITCH	Through Hole Switch
35	SW_CAP			Button Cap
	Stepper Motor Driver Parts -- Through Hole			
2	LMD18245	U6,U7	TA15A	TA15 PowerPack
2	1.0uF 63V	C17,C18	RAD5.0-2.0	Axial Capacitor
2	100uFd 63V	C19,C20	RAD10.0-5.0	Radial Capacitor
2	20K	VR1,VR2	EVN-8DA TRIM-POT	Vert. trim Pot
1	Optional 4 pin connector for	1.27		
1	Optional 2 pin connector for	0.62		

Basic Kit Contents

- The basic ELS kit consists of all the parts in Figure 1a.
 1. PC Board with SMD parts installed
 2. LCD Display
 3. Bag with DB25, Beeper and MPG
 4. Bag with Buttons and Bag with Button Caps
 5. Envelope with through hole parts.



Figure 1a. Basic ELS Kit



Figure 1b. Hardware Mounting Kit

- If you bought the optional hardware mounting kit you will also have received what is shown in Figure 1b.
- Note that the assembly instructions that follow assume you have this kit but you can build an ELS without one.
- You may also have bought the Full Connector Kit shown in Figure 1c which is not mandatory for assembly .
- Lastly Figure 1d shows the optional CPC Connector and Cable kit used with the Micro-stepper optional upgrade described on the next page.

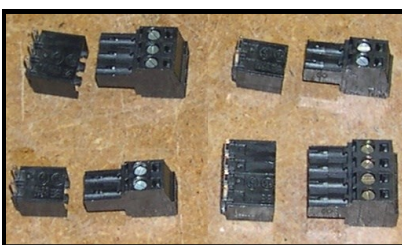


Figure 1c. Full Connector Kit

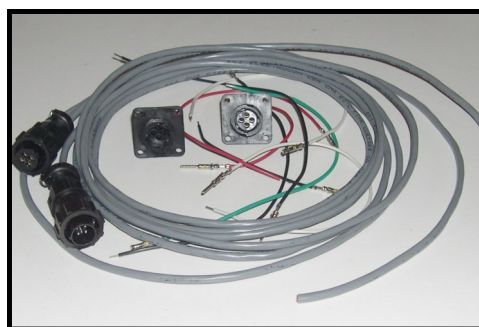
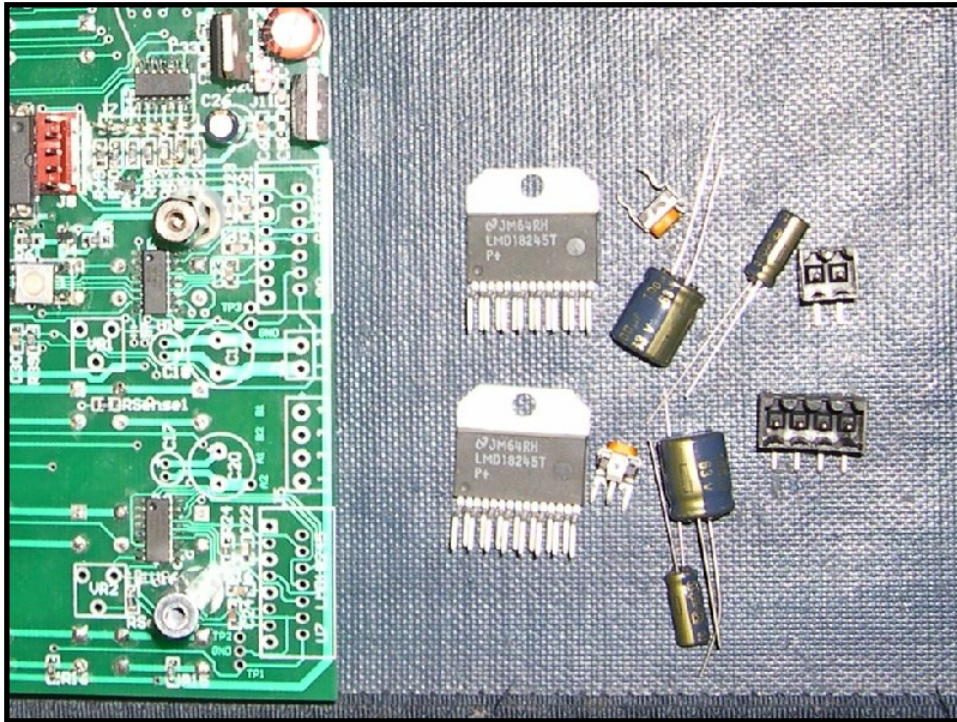


Figure 1d. CPC Connector & Cable Kit

Micro Stepper Kit Contents

- Shown in the photograph below is the kit of parts needed for adding the Micro-Stepping hardware drivers.



- The Micro-Stepping hardware consists of:
 1. LMD15245T Driver x 2
 2. 20K trim pot x2 (But really fixed resistors are better).
 3. 1uFd 63V Capacitor x 2
 4. C v 100uFd 63V Capacitor x2
 5. Optional 4 pin connector for stepper motor.
 6. Optional 2 pin connector for stepper motor power.
- It's easiest to install the kit before the key buttons are soldered in on the top side of the board. If you are retrofitting an existing board the plastic button extensions will be in the way so it's best to pop off the ones near the solder connections otherwise you'll probably bump into them with the soldering iron and create melted deformations.

3-1. Pre-Assembly Notes:

- Set aside the clipped leads from the resistor and capacitors while assembling the ELS. These leads will be used as Jumpers in chapter 3-5.
- Don't forget to turn the potentiometers 90 degrees clockwise, otherwise when testing, the LCD display will not be visible.
- When soldering a component with a high number of pins, solder the opposing two corner pins first, then heat the solder joints and adjust the component accordingly so the component lays flush to the PCB.
- Don't forget to turn the potentiometers 90 degrees clockwise, otherwise when testing, the LCD display will not be visible.
- **ALWAYS double check the polarity** of a component and if it is relevant or not. Installing a component backwards is an easy way to earn a guest ticket to the Electronics Recycling Depot!

3-2. P6KE33 transorb, 40 Pin Socket, LCD Header:

- Next, flip the board back to the bottom side and make sure the socket is completely flush.
- You can heat one pin and press the socket closer to the board if not. You might even then have to do the other pin.

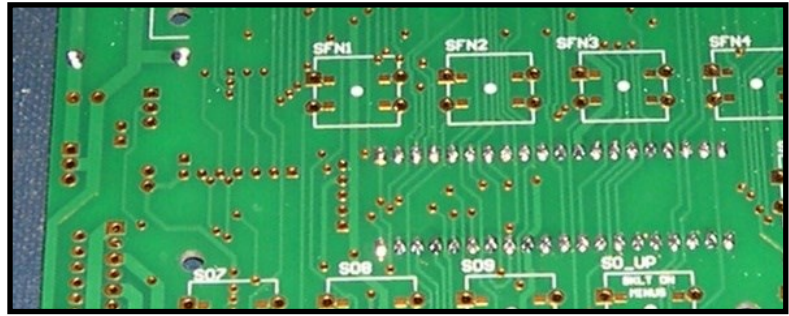


Figure 2d. All 40 pins are soldered.

- After that, solder the other 38 pins.
 - The long pins of the LCD Header are inserted from the top side into the socket in order to align it and hold it in place.
 - The short pins will later be soldered onto the LCD display.

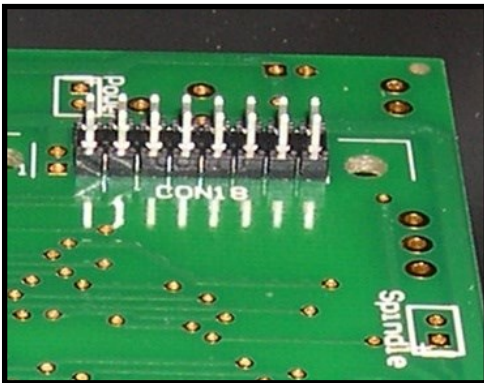


Figure 2e. LCD Header

- **NOTE:** When inserting the LCD Header, through-hole 17 and 18 will left open.

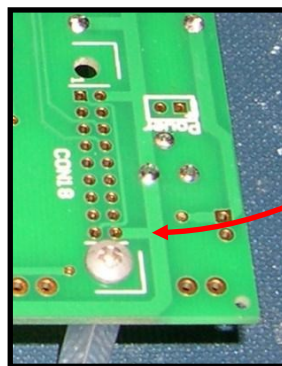


Figure 2f. Don't block holes 17 & 18.

- With the socket and optional header soldered in place it's time to make assembly a bit easier with the optional spacer kit since the rest of the parts stick out from the board.

3-3. Spacer Kit (Optional)

- Use the short screws for all but the top right hand spacer by the D5 bridge rectifier (Figure 3b).
- The top right hand spacer gets a longer screw which will be used to hold the LCD screen further down the assembly line.

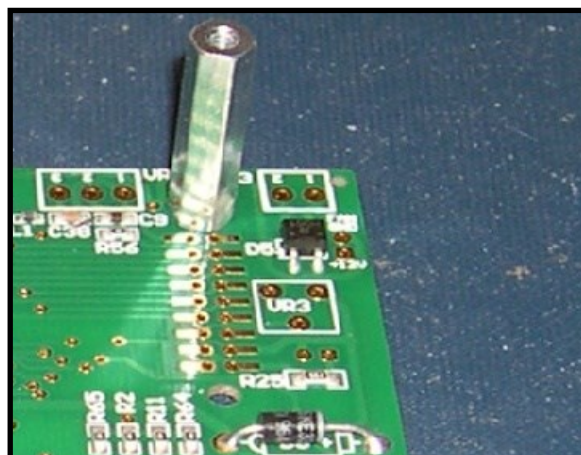


Figure 3b. Top right hand spacer by the D5 bridge rectifier.

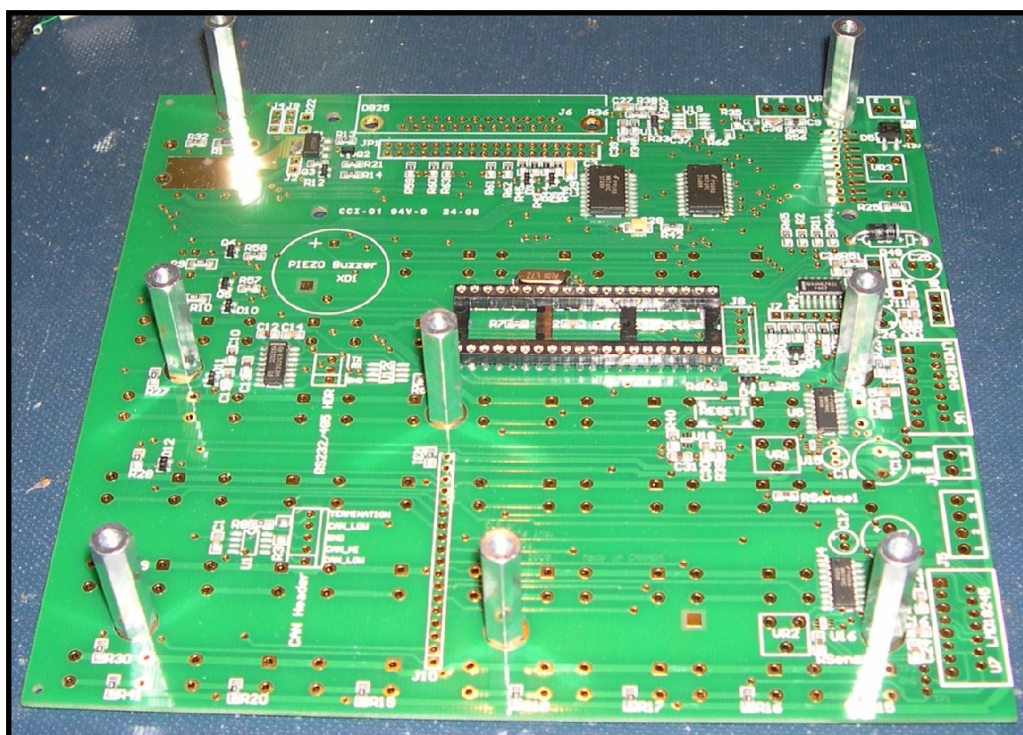


Figure 3a. Installed Spacer Kit.

3-4. Resistors, Regulators, & Capacitors

- Time to install R22 (Figure 4a), The LCD back light current set resistor.
- Don't forget to put aside the clipped leads as we will use them for jumpers in the next chapter.
- Install R3 (Figure 4b), the LCD back-light contrast control. Turn the trim pot adjusting screw so it's all the way clockwise.

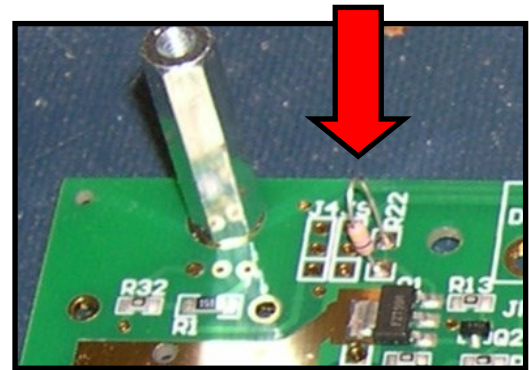


Figure 4a. R22—The LCD Back Light Resistor

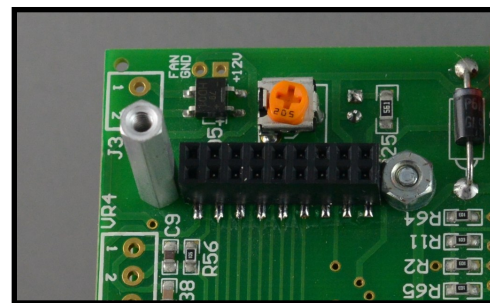
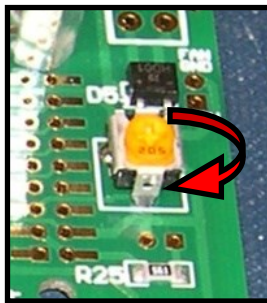


Figure 4b. R3—LCD Contrast Control

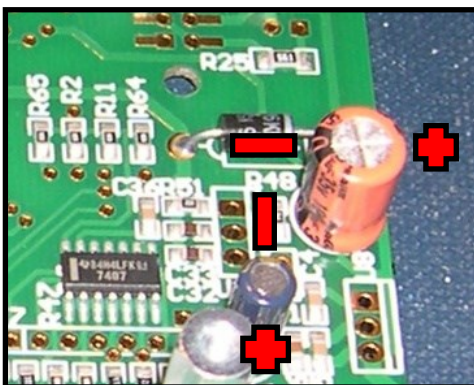
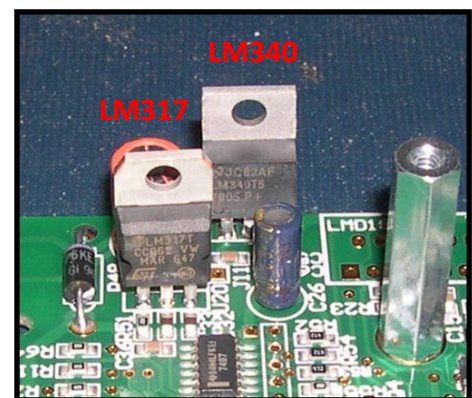


Figure 4c. Capacitor polarity

- Then we will install the two filter capacitors making sure that the polarity is correct:
 + to plus, - to minus.
- A cap installed backwards will eventually explode.

Finally the regulators.

- The LM340-T5.0 goes closest to the edge of the board.
- The LM317 adjustable regulator is used to provide the 13.5V needed for programming the PIC when upgrading.



3-5. Jumpers

Now we start on the fiddly parts.

- The leftover lead clippings from the resistor and capacitors will serve as our jumper wire.
- If you've thrown out the clipped leads then strip about 1/2"-1cm of insulation from the solid 22g hookup wire. Once cut, use your needle nose pliers to form it into a U shape. (Figure 5a).
- Bend the wire so that it just fits in the pair of holes but stands up from the surface of the board. This way you can cut it or remove it more easily in the future if needed.
- You will need three jumper wires one of which is shown in Figure 5b.
- We will also install the jumper strip now.

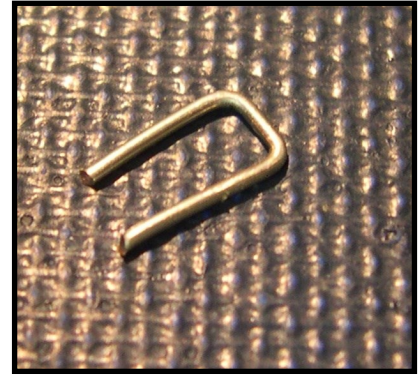


Figure 5a. U Shape Jumper

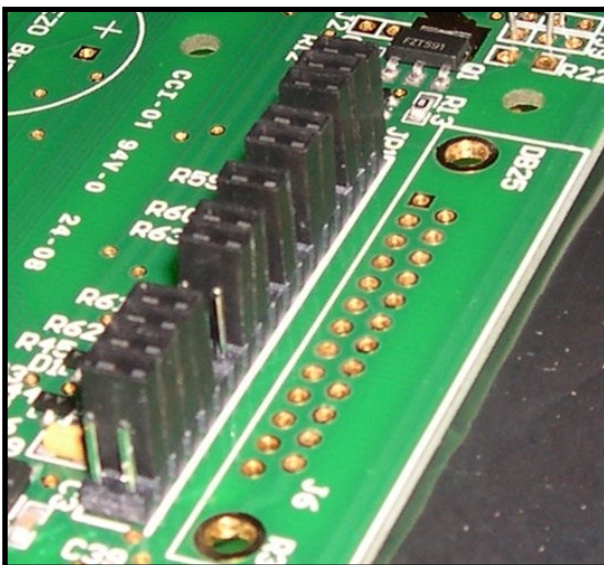


Figure 5b. Jumper Strip

- Using Figure 5b place the Jumper strip on the board matching the orientation.
- Although the jumper pins are removable from the header, moving every pin after soldering would not be practical.
- Solder the jumper strip using the same method we used on page 6 and 7 installing the 40 pin socket.

- On the top side you **must** install the programming voltage jumper. (Figure 5c).
- Without the programming jumper the ELS will not run properly if at all.

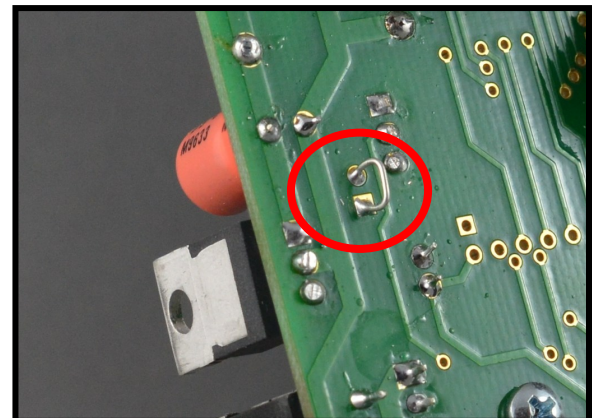


Figure 5c. Programming Jumper Wire.

3-5. Jumpers

Now for the J4 and J9 jumper wires:

- These two jumper wires determine which voltages go to the DB-25 Pin #1 and to the LCD backlight constant current regulator. Most of us are probably using a simple opto interrupter or a Hall effect sensor that requires 5V.

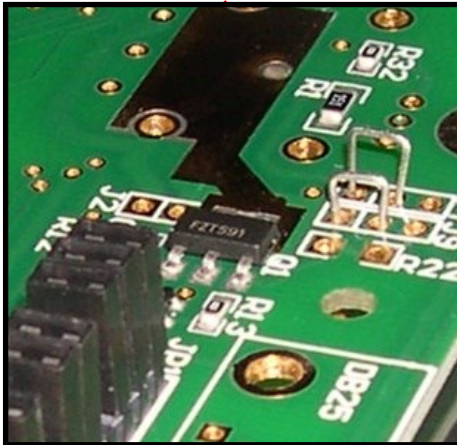


Figure 5d. J4 & J9 in 5V position

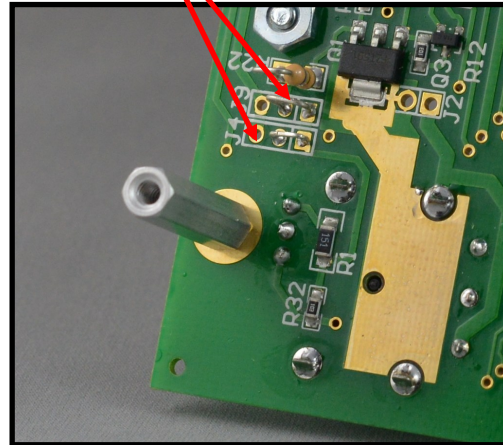


Figure 5e. J4 & J9 5V position, different view.

- Jumper J4 connects 5V or 12V to Pin #1 of the DB-25. In most cases 5V is adequate. Similarly, the backlight for the display I'm supplying works best with 5V into the constant current regulator. A different LCD display needed a lot more current at a lower voltage so 5V was better for power dissipation. Jumper Block Pin 1 is the square pad and is 5V while Pin 3 is 12V.
- **NOTE :** The Figure 5f shows J9 in the 12V position but for best performance you should put it in the 5V position just like J4.

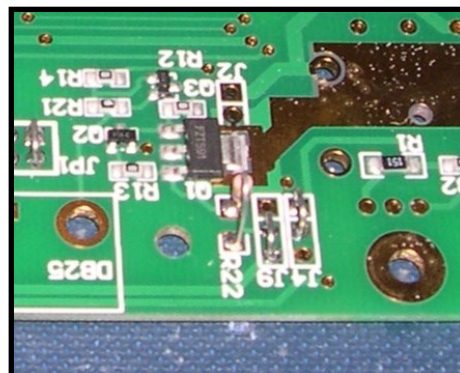


Figure 5f. J9 in the 12V position.

- It's easy to solder them from the same side and then when they are all installed and soldered clip off the protruding ends from the top side so they won't touch the LCD display that will be mounted above them.

3-6. DB-25, Beeper

- With the jumpers installed and soldered carefully insert the DB-25 connector on the bottom side (Figure 6b.) of the board making sure all pins go through the holes.
- Ensure it makes good contact with the PCB and solder all 25 pins and the two mounting pins.
- Clip the DB-25 pins flush so they won't touch the LCD

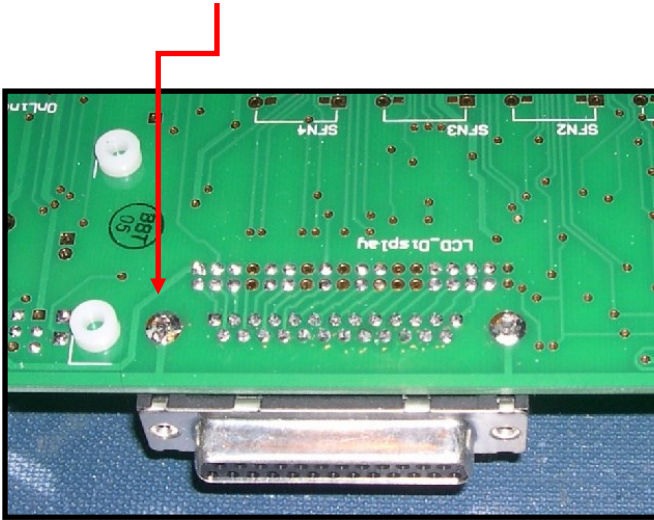


Figure 6a. DB-25 top side of the board.

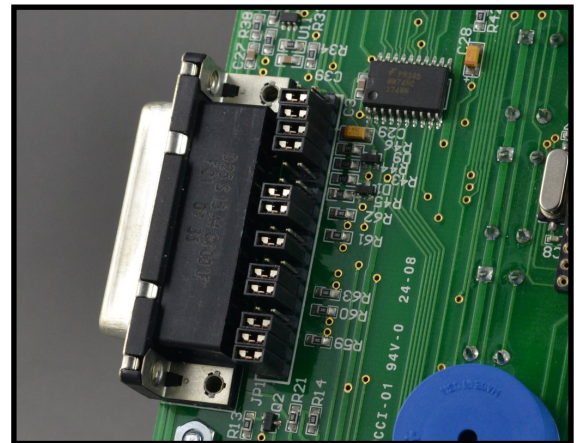


Figure 6b. DB-25 connected through bottom side of the board.

- Solder the beeper flush to the back side as shown in the picture below. (Figure 6c).
- Note the polarity of the pins. Get it wrong and it won't work.

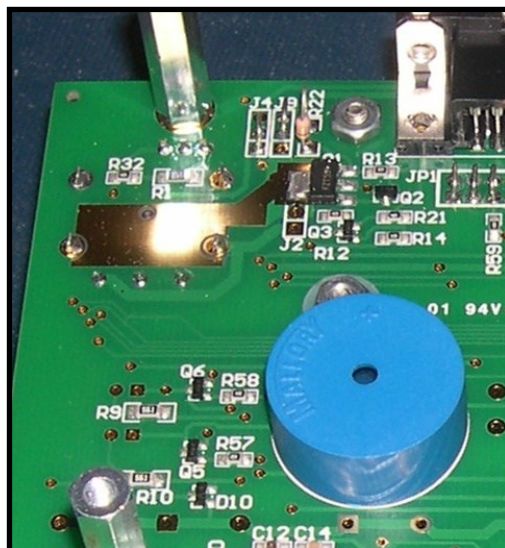


Figure 6c. Beeper installation.

3-7. Spindle LED, LCD Screen

- The spindle LED is placed through the back side of the board and positioned upwards so the bottom of the LED is in line with the edge of the board.
- **NOTE :** The short lead goes in the hole marked “ + ”
- If done correctly when looking straight on you won't see the curved edge of the LED. See Figure 7a as a guideline.

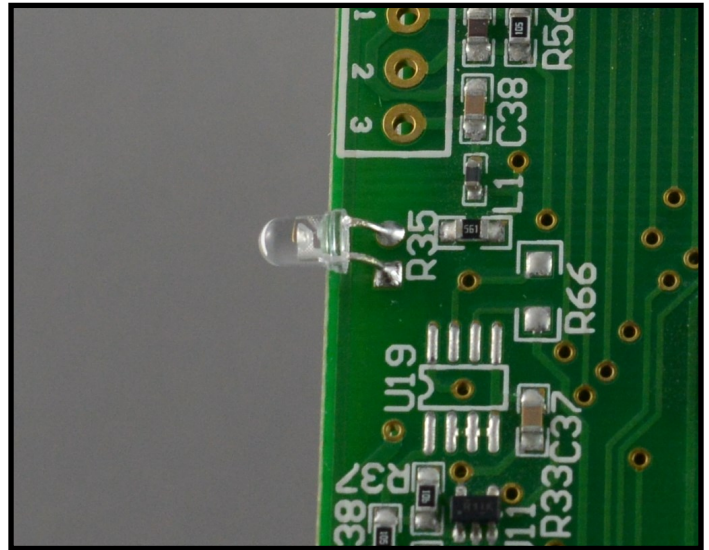


Figure 7a. Spindle LED

- Start the LCD installation, remove the top left hand screw and place the 4 optional 0.125" #4 spacers



Figure 7b. Spacers placed where LCD is to be installed.

3-7. LCD Screen

- Place the LCD on top of the spacers and insert the 4 longer screws through the LCD, the spacers and the PCB.
- The Bottom RH screw can be immediately screwed into the spacer.
- Carefully turn the board on edge and use the nuts and washers to fasten the LCD into place.
- Trim the one washer so it doesn't cover the LCD connector holes.
- In Figure 7c. the LCD has already been soldered to the ELS PCB.

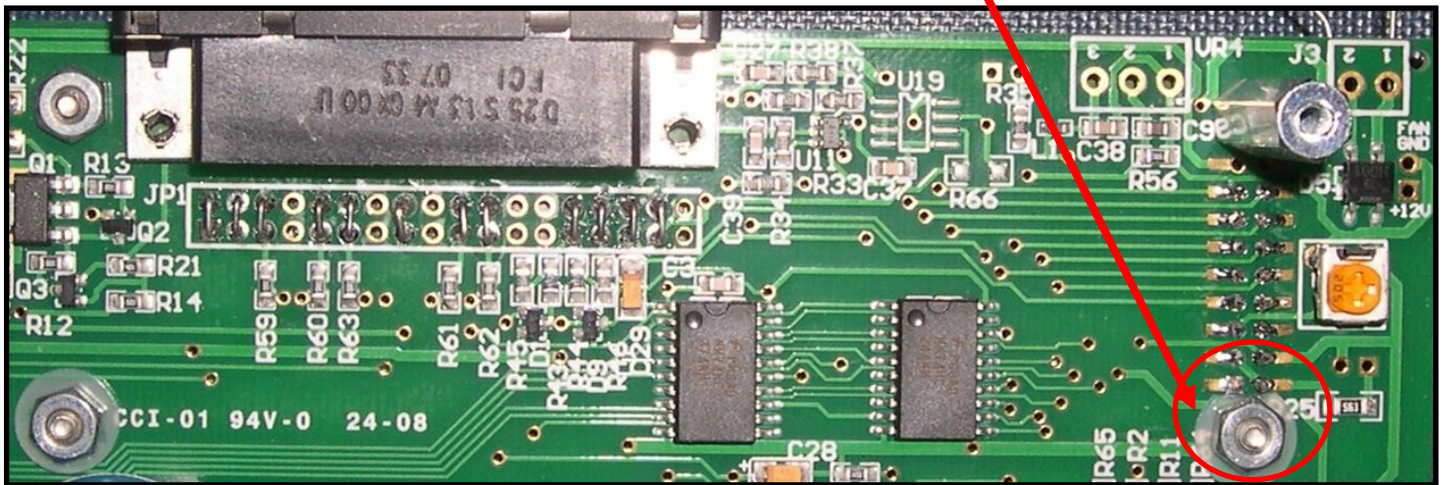


Figure 7c. Bottom side of board after LCD has been screwed into place.

- To connect the LCD there are several options:
- Solder on to the optional header described on Page 8 and shown in Figure 7d & 7e.

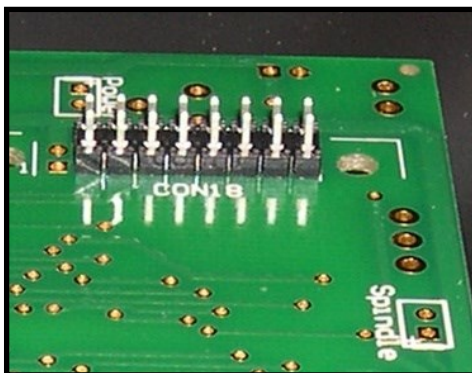


Figure 7d. LCD Header before the screen is attached.

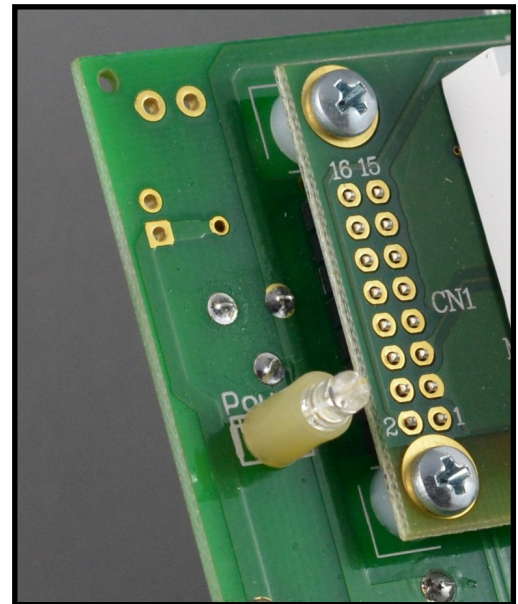


Figure 7e. LCD screwed onto the PCB neatly fitted on the header.

NOTE: *The LCD still needs to be soldered in Figure 7e.*

3-7. LCD Screen

- Option #2:
- The low cost kit approach uses more of the 22g hook-up wire.
- Trim 1/2" or 12mm insulation from the end but don't clip it off yet. T
- Then insert from the bottom side into LCD display so it comes out pin #1 and protrudes about .125" or about 1 or 2mm and solder it.

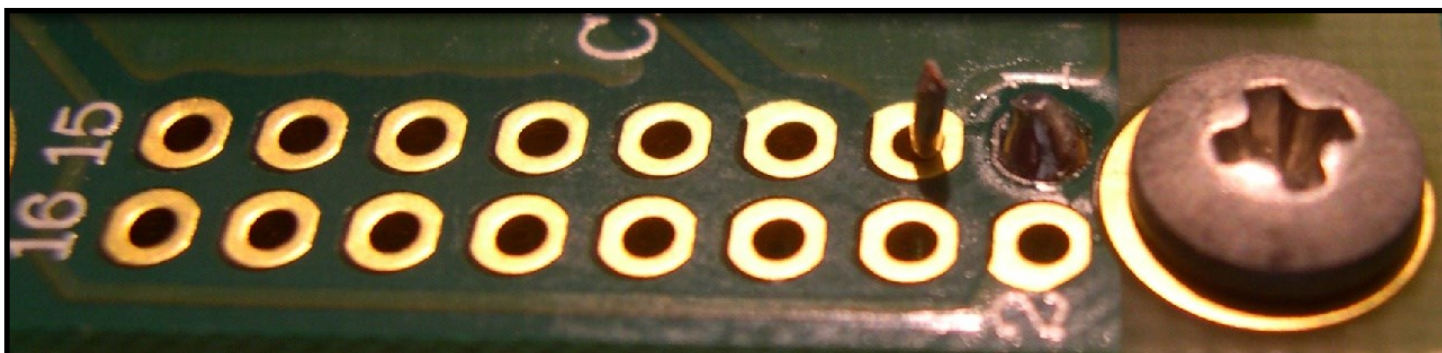


Figure 7f. Soldering 22g hook-up wire as header pins for the LCD Display.

- Turn the board over and clip the length of wire off leaving 1 to 2mm proud off the board.
- Solder the 1-2mm length wire and clip flush to the board.
- Repeat for all 16 connections.

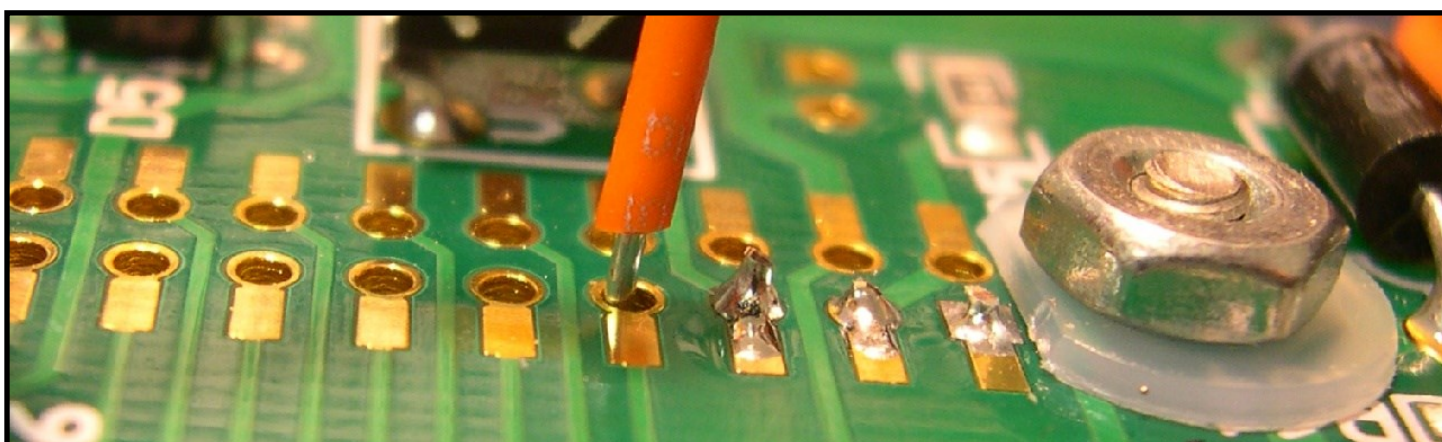


Figure 7g. Final step in soldering the LCD display using 22g hook-up wire.

3-8. PCB Screw Terminals (Optional)

- There are all sorts of options on how to power the ELS so the basic kit doesn't come with connectors. If you use the optional PCB screw terminal kit you can install them now.

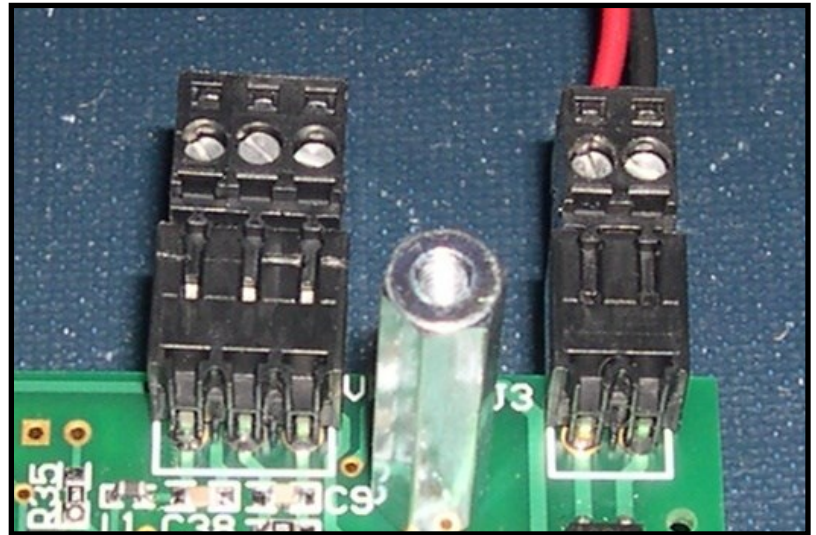


Figure 8a. PCB Screw Terminal Kit.

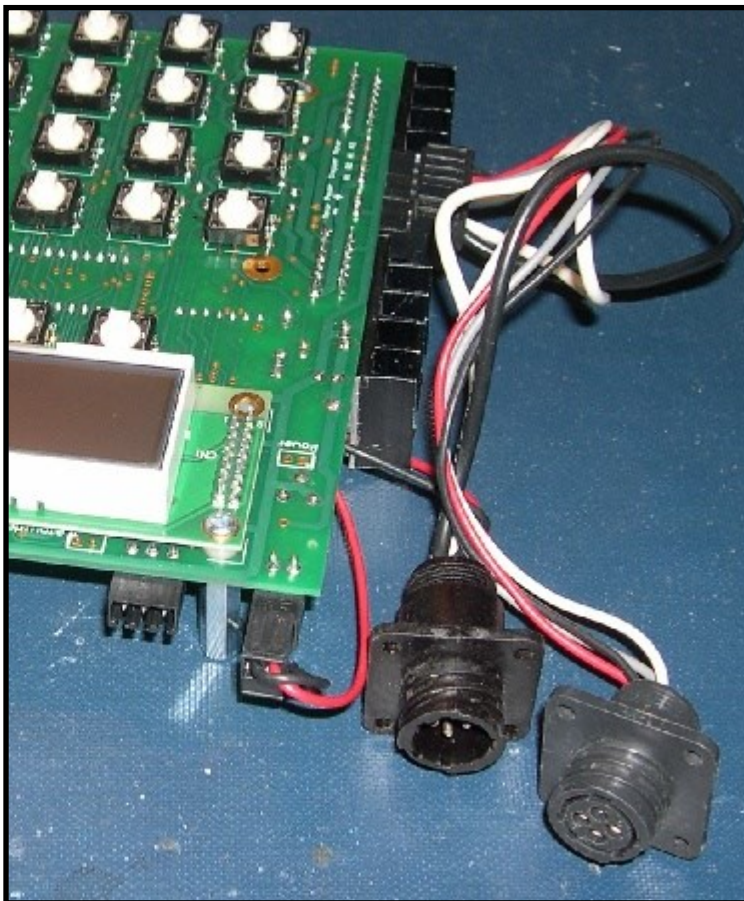


Figure 8b. CPC Connector Kit.

- Or there's the optional CPC connector kit which provides power for both the ELS and the on board Micro-Stepper found on Page 19 of this manual.

3-9. Micro-Stepper & CPC Connectors (Optional)

NOTE

If you are retrofitting an existing board the plastic button extensions will be in the way so it's best to pop off the ones near the solder connections otherwise you'll probably bump into them with the soldering iron and create melted deformations.

- The best way to install the two LMD18245s is to screw a heatsink or thick flat bar to the LM7805 regulator and the two LMD18245's.

The devices are held in the position from the heatsink and will fit when later assembled into a box. If you don't line up the devices when soldering them, you may stress the leads when bolting it in place if the devices have been soldered slightly crooked.

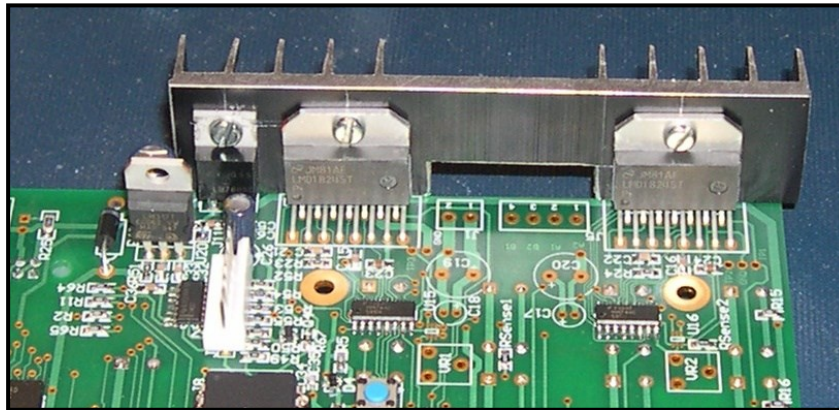


Figure 9a. Screw a heatsink to the regulator and two LMD18245's to keep them in line with the PCB while soldering.

- There's no reason to install the LMD18245s first. In fact it's probably easier to do the trim pots and capacitors (in that order) first. I've done it this way so the caps don't obscure the LMD18245s

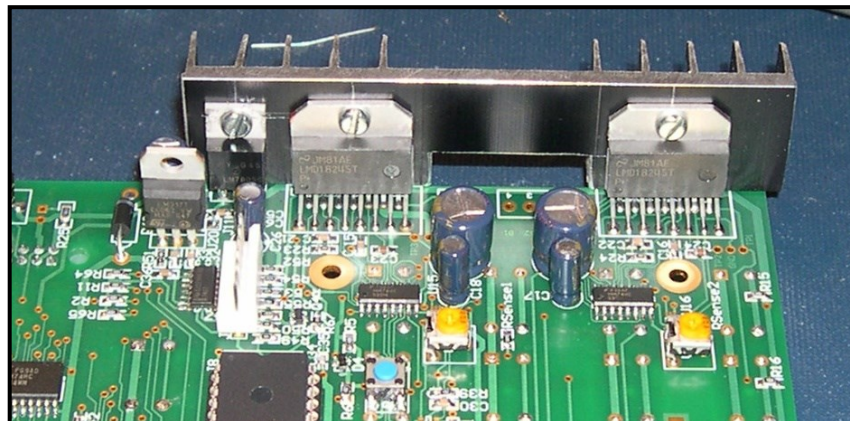


Figure 9b. Capacitors and trim pots installed with the LMD18245's.

3-9. Micro-Stepper & CPC Connectors (Optional)

- Now here's a picture with everything installed. I use connectors directly on the board because I'm swapping all sorts of ELS prototypes around.
- If you're mounting the ELS into a box that has connectors for the motor and power at the back then you can just run wires from those connectors directly to the circuit board.

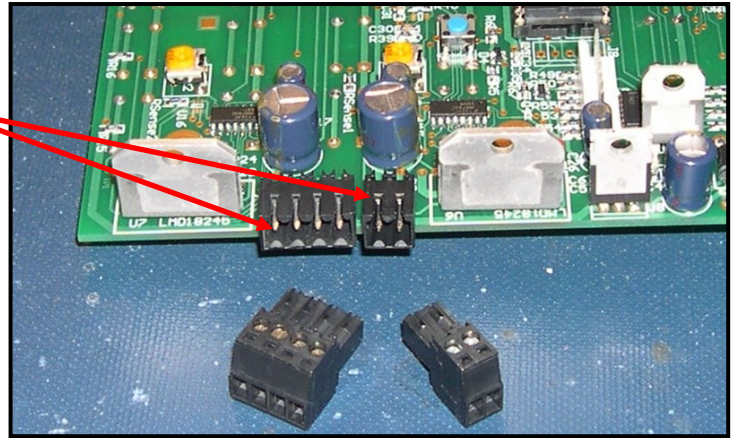


Figure 9c. PCB Connector Kit Soldered directly onto the PCB.

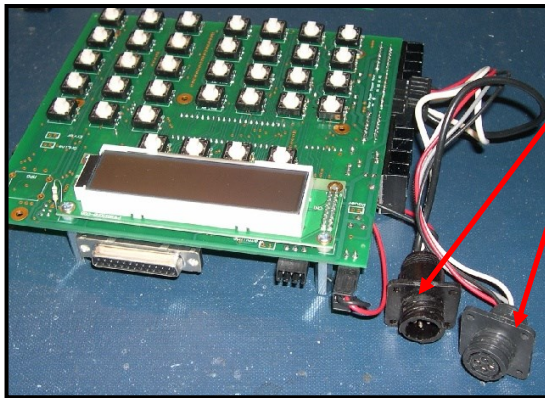


Figure 9d. Socket and plug style connectors for supplying and accepting power.

The back panel area with larger AMP CPC connectors. The one with the female sockets connects to the stepper motor while the one with the pins connects to +12V and +44V. (The connector supplying power is always a socket while the connector accepting power in is a plug).

- Next it's time to set the Micro-Stepper current limit. The two trim pots are adjusted to a specific resistance which can be measured at the TP2 and TP3 relative to GND.

From the LMD18245 data sheet:

CS OUT current sense resister

$$\frac{(DAC_REF \times [MX4..MX0]/16)}{(250E-6 \times A)} = R_{SenseX}$$

Or if terms are reduced:

$$TPx = 18.75K / \text{Motor Coil Amps}$$

$$TPx = 18.75K \text{ for } 1 \text{ Amps}$$

$$TPx = 9.375K \text{ for } 2 \text{ Amps}$$

$$TPx = 6.8K \text{ for } 2.75A \text{ (RHT23-260 Oz Motors)}$$

$$TPx = 6.25K \text{ for } 3 \text{ Amps}$$

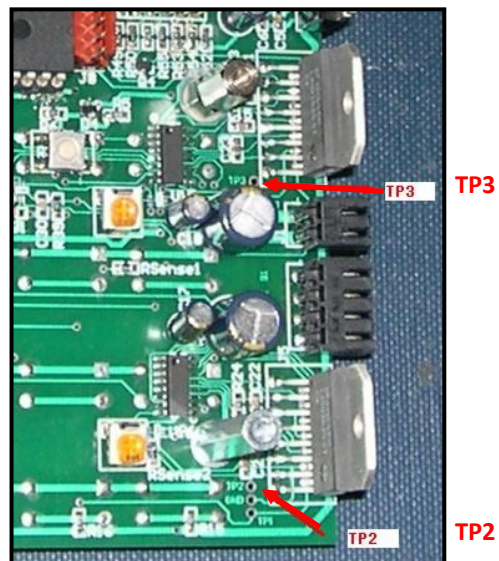


Figure 9e. Measuring the Micro-Stepper current limit at TP2 and TP3 relative to GND.

- I used an Ohmmeter to measure between TP2 and GND and turned the bottom trim pot until the required resistance was displayed; in my case I needed 6.8K. I did the same with TP3 and GND.

3-10. Switches & Button caps

- Snap each switch into the holes and solder from the bottom side.
- Tip: Snap in all 35 switches before soldering for a faster more efficient result.

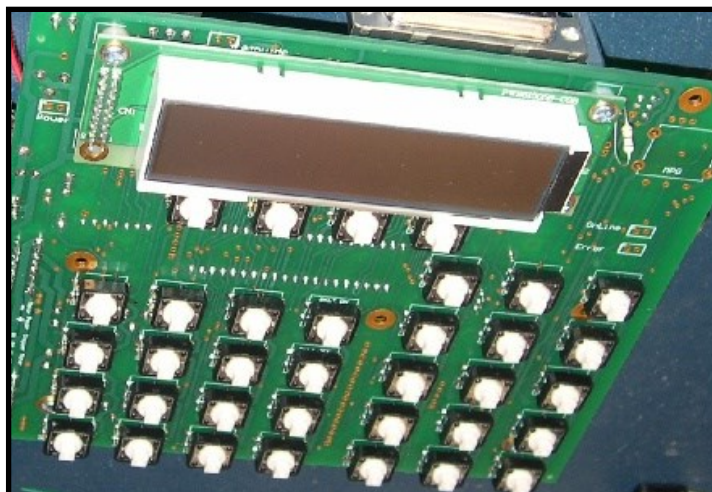


Figure 10a. ELS switches installed without button Caps.

***** Solder the switches to the board before adding the button caps! *****

- The reasoning behind soldering first is because even though the switches do snap into the board, they can still shift position a little and with the button caps on it is already much more difficult to tell if the switch has popped out a little or been soldered on an angle.

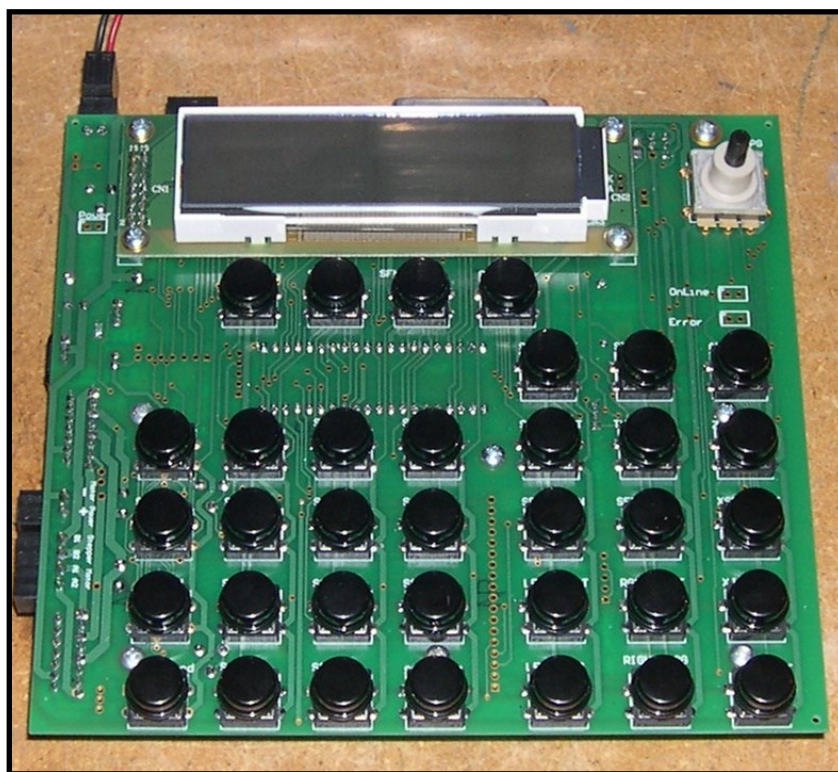


Figure 10b. Button caps on, switches soldered.

3-11. MPG, LED'S

- Turn the board over so it's sitting on the spacers and install the MPG.
- The leads on this device are very fragile so it make take several tries to line them up and get the MPG installed. When it's done right it just slips into place.
- Solder the pins and mounting tabs. (Figure 11a).

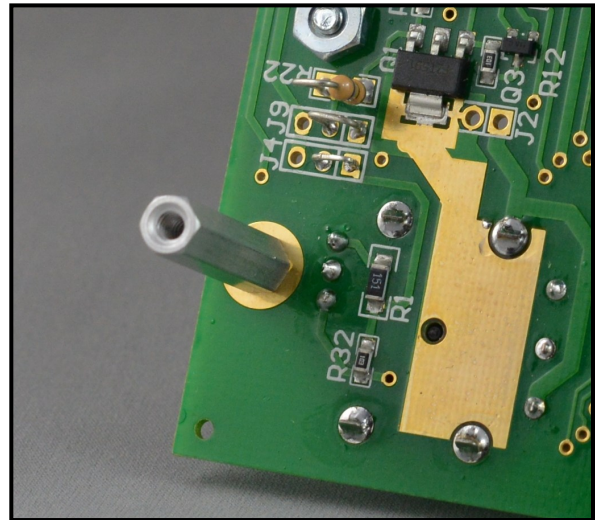


Figure 11a. Soldered MPG joints



Figure 11c. Online LED & Error LED



Figure 11b. Installed MPG

- With the Spindle LED installed, you will have two green and one red LED left over: POWER, ONLINE, ERROR.
- I think we can determine that the single red LED is suitable for the ERROR SLOT (Figure 11c).
- Put the LED through the rubber spacer with the bumpy side facing the PCB. LED goes through the top of the PCB and we solder on the back side.
- Clip the leads, adjust the position if needed, the LED should be standing up strong with the rubber base perpendicular to the board.
- Repeat with the two green LED's the installation for POWER and ONLINE. (Figure 11c. & Figure 11d).

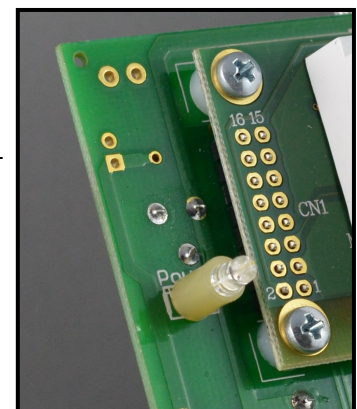


Figure 11d. Power LED

Fin.