

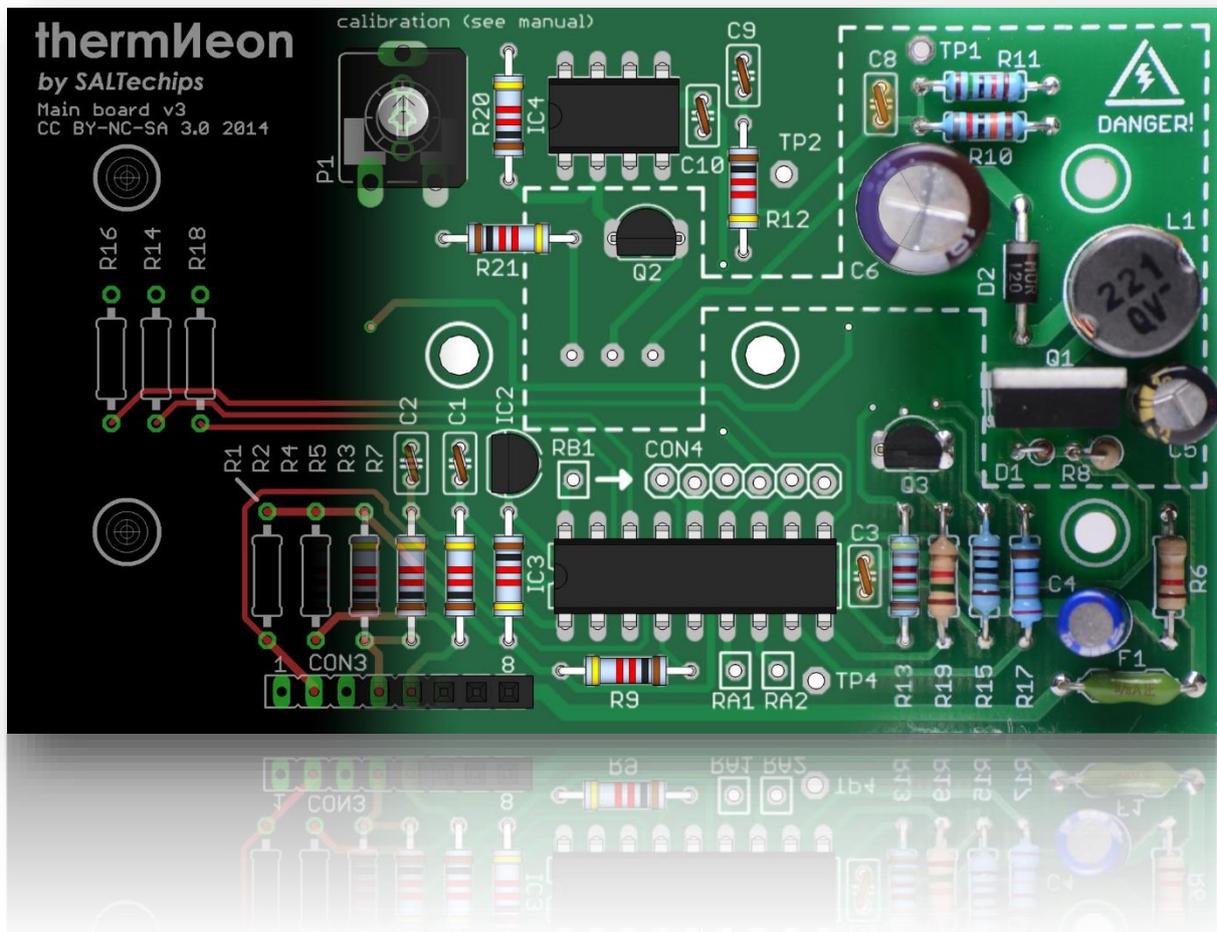
# SALTechips

## *thermMeon*

### Assembly Manual

Hardware version: v3

Software version: v2



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## 1. Introduction

Thank you and congratulations on your purchase of the *thermNeon* kit from SALTechips. We hope you will enjoy assembling the kit and once completed, enjoy the fruits of your labour!

Assembly of the kit requires basic skills in soldering. We recommend the following guides:

*Soldering is easy* - by Mitch Altman, Andie Nordgren and Jeff Keyzer.  
<http://mightyohm.com/blog/2011/04/soldering-is-easy-comic-book/>

*SMT Soldering* - by Greg Peek and Dave Roberts.  
<http://www.siliconfarmers.com/smtmanga/>

For additional product support or feedback please do not hesitate to contact SALTechips.



**Warning** Potentially hazardous voltages are generated within this unit. Assembly of this kit should only be performed by individuals with the necessary skills/experience of working with high voltages. No liability is accepted for any damage, injury or death as a result of assembling this kit.

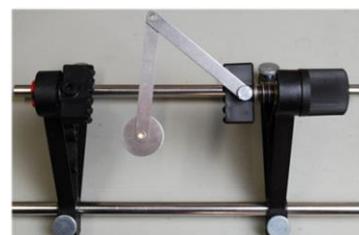
## 2. Tools/materials required during assembly

- ✓ Soldering iron (pencil iron with chisel tip, 18-50W recommended)
- ✓ Solder (0.7mm Sn63/Pb37 recommended)
- ✓ Small wire cutters
- ✓ Small pair of needle nose pliers
- ✓ Multimeter with Resistance function
- ✓ Small Phillips head screwdriver



## 3. Optional tools/materials

- ✓ Vise for Circuit Boards or "third hand"
- ✓ Anti-static mat and wrist strap
- ✓ Safety goggles



## 4. Parts list

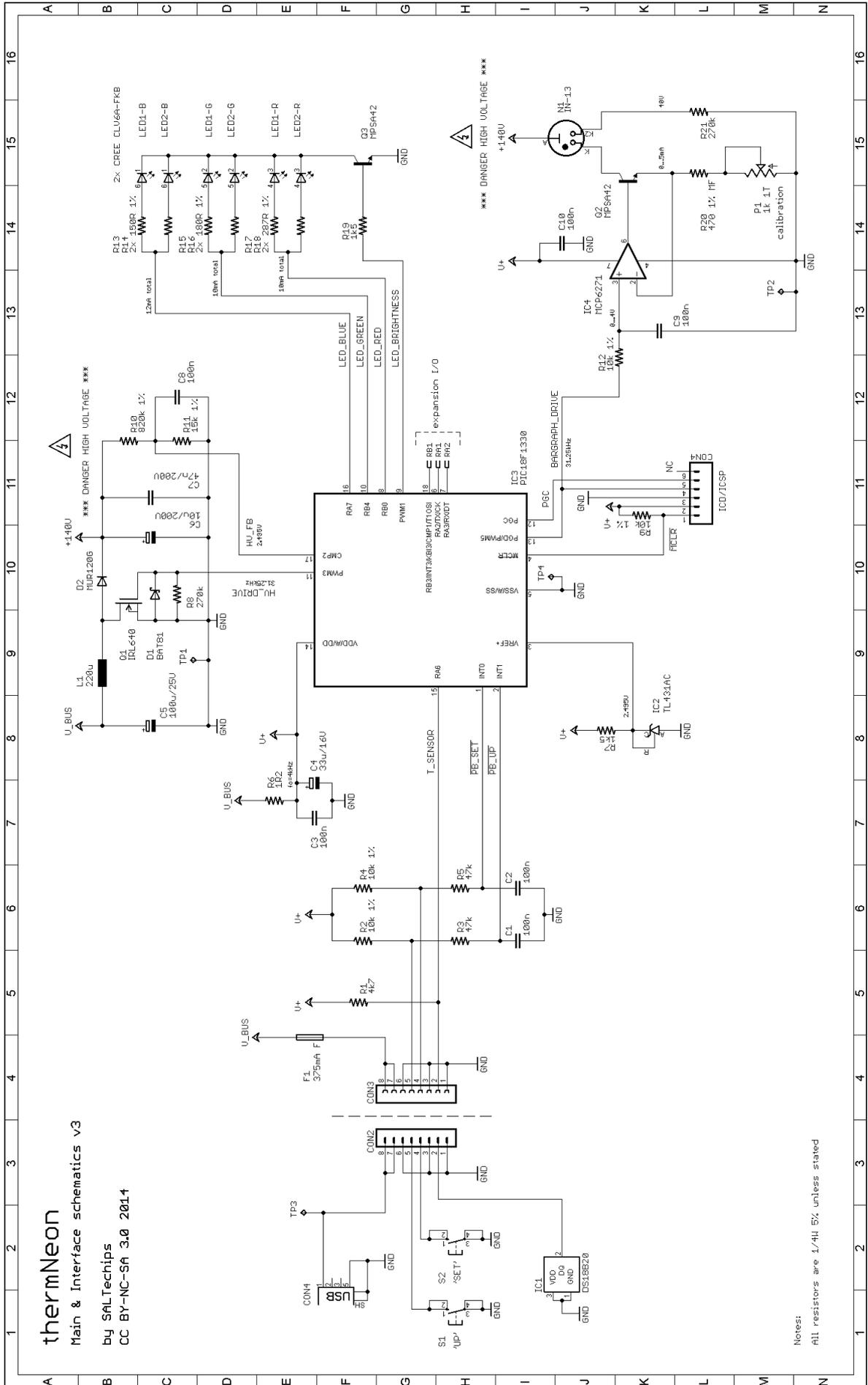
Identifier	Qty	Value	Comments
<b>Resistors</b>			
R1	1	4.7k	
R2, R4, R9, R12	4	10k	1%
R3, R5	2	47k	
R6	1	1R2	
R7, R19	2	1.5k	
R8, R21	2	270k	R8 vertical mount
R10	1	820k	1%
R11	1	15k	1%
R13, R14	2	150R	1%
R15, R16	2	180R	1%
R17, R18	2	287R	1%
R20	1	470R	1%
*(All resistors 1/4W 5% unless stated)			
<b>Capacitors</b>			
C1, C2, C3, C8, C9,C10	6	100n/50V	MLCC
C4	1	33uF/16V	Al. electrolytic
C5	1	100uF/25V	Al. electrolytic Low ESR
C6	1	10uF/200V	Al. electrolytic
C7	1	47nF/200V	SMT 0805 MLCC
<b>Inductors</b>			
L1	1	220uH	
<b>Diodes</b>			
D1	1	BAT81	Vertical mount
D2	1	MUR120G	
LED1, LED2	2	RGB LED	SMT PLCC6 diffused
<b>Transistors</b>			
Q1	1	IRL640	
Q2, Q3	2	MPSA42	
<b>Integrated Circuits</b>			
IC1	1	DS18B20	
IC2	1	TL431A	
IC3	1	PIC18F1330	
IC4	1	MCP6271	
<b>Switches</b>			
S1, S2	2	push tactile 12.5mm	
<b>Connectors</b>			
CON1	1	mini USB-B vert	
CON2	1	8-pin 0.1" RA male header	
CON3	1	8-pin 0.1" vert fem header	
CON4	1	6-pin 0.1" vert male header	

\* Parts supplied in the kit may look different to what is in the assembly manual photos.

Identifier	Qty	Value	Comments
<b>Miscellaneous</b>			
N1	1	IN-13 neon bargraph tube	
P1	1	1k/1Turn	
n/a	1	18-pin DIL socket	
F1	1	375mA fast acting fuse	
<b>Circuit boards</b>			
Interface board	1	V3	
Main board	1	V3	
<b>Fasteners and fixings</b>			
M3x20mm socket cap	4		top half of enclosure bolt
M3x8mm spacer	4		space main PCB from top base piece
Shake-proof washer	6		anti-vibration for scale and enclosure
M3x15mm spacer	4		join enclosure bolts
M3x30mm screw	4		bottom half of enclosure bolt
M3x10mm screw	2		secure scale to PCB
M3x4mm spacer	2		space interface PCB from back base piece
#4 wood screws	2		secure interface PCB to back base piece
2.5mm hex wrench	1		for screwing socket screws
<b>Enclosure</b>			
Top piece	1		
Bottom piece	1		
Front piece	1		
Back piece	1		
Side pieces	2		
<b>Scale</b>			
Acrylic scale piece	1		
<b>Miscellaneous</b>			
Rubber feet	4		

\* Parts supplied in the kit may look different to what is in the assembly manual photos.

# 5. Schematic





## 7. The assembly

We have divided the assembly of the *thermNeon* into four stages:

**Stage 1** will be to solder the components onto the main PCB.

**Stage 2** will be to solder the components onto the interface PCB.

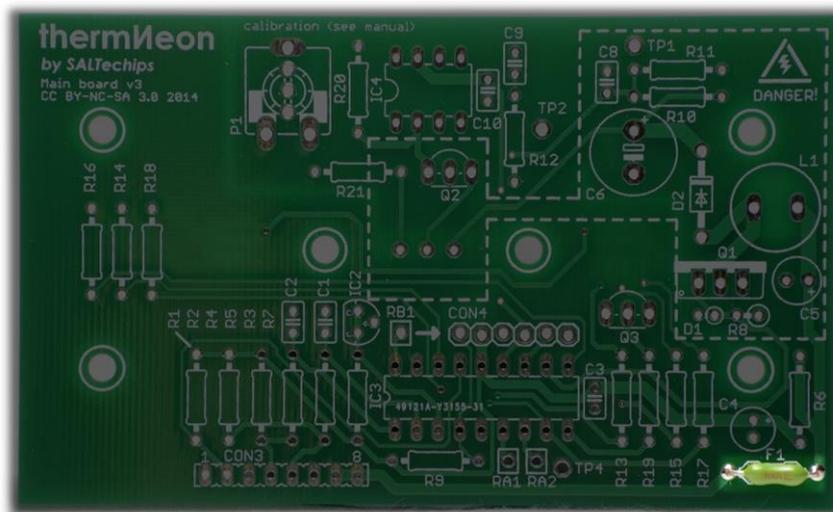
**Stage 3** will be to install the IN-13 display tube onto the main PCB.

**Stage 4** will be final assembly and calibration.

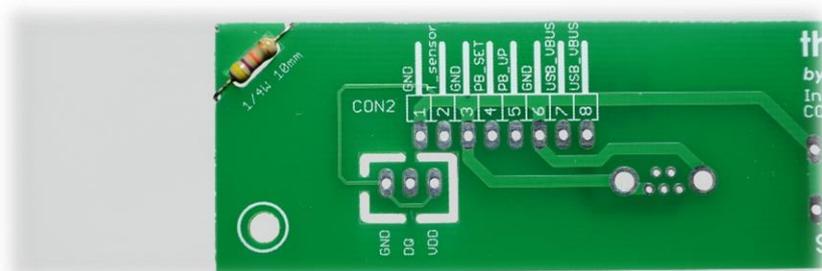
Generally it's easier to install components in order of height, so we will start with the shortest components on the top side. Let's go!

### 7.1. Stage 1 - Installing the components into the main PCB

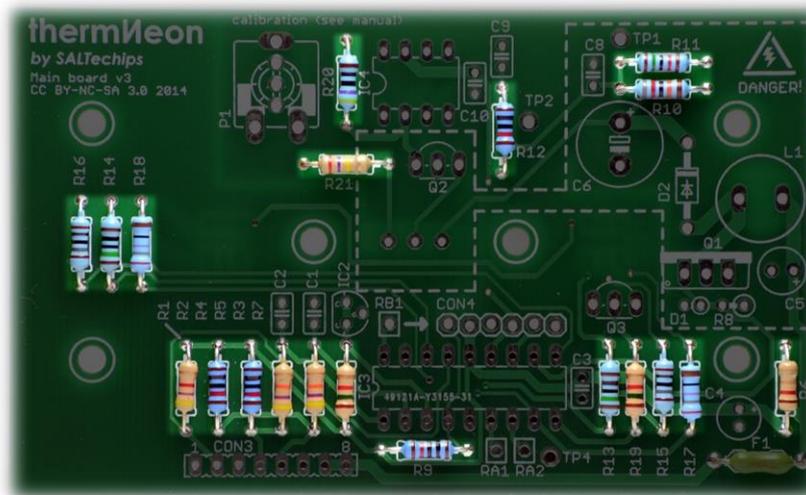
- 7.1.1. Let's start with the fuse. F1 is not polarised and can be installed in either direction.



- 7.1.2. Bend the resistors using the component lead forming tool, which is built into the interface PCB or a pair of pliers. Resistors are not polarised, they can be installed in either direction. *Measure the values of the resistors with a multimeter if you are unsure of their values.*

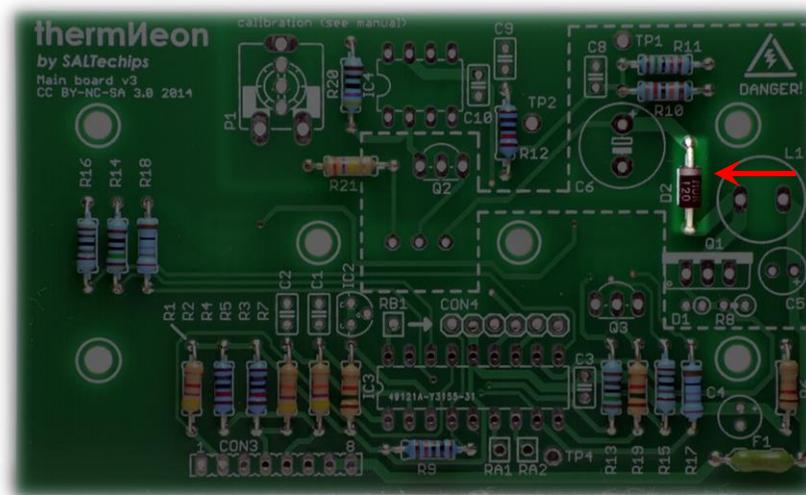


- 7.1.3.** Insert the horizontal resistors into the PCB and slightly bend the legs on the other side of the PCB so they do not fall out when you turn the PCB upside down to solder them in.

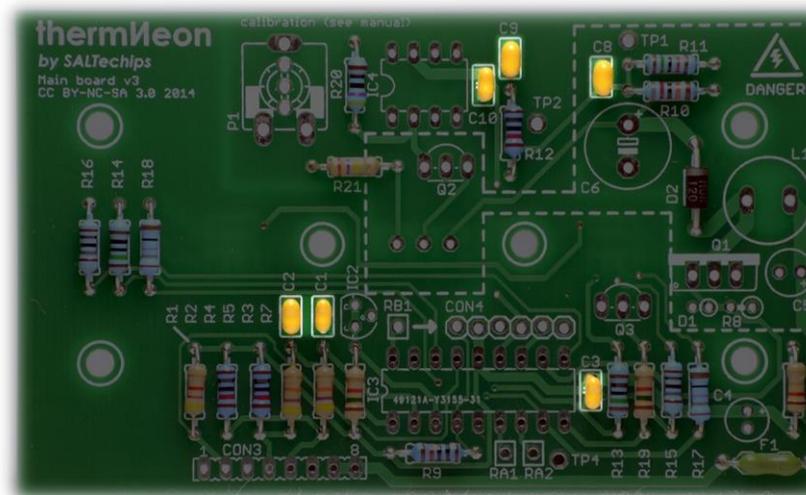


**Don't forget to trim the long leads of any components that you solder in!**

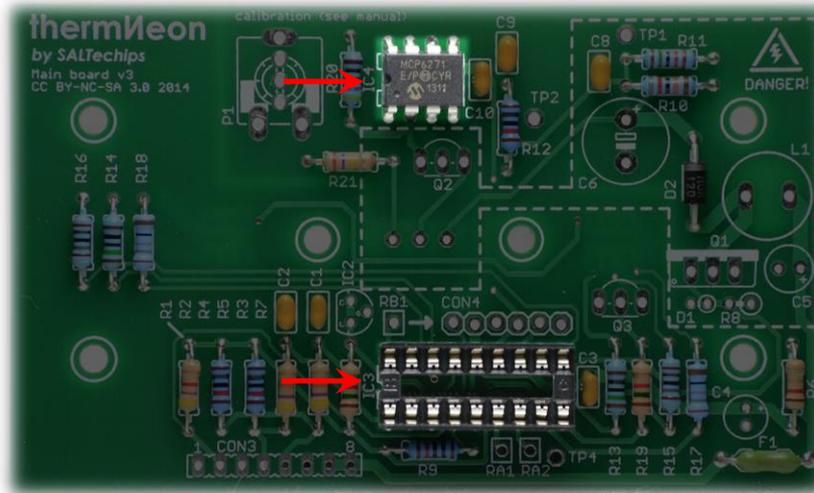
- 7.1.4.** Install the horizontal diode making note of the polarity. Use the silkscreen layout to ensure correct orientation.



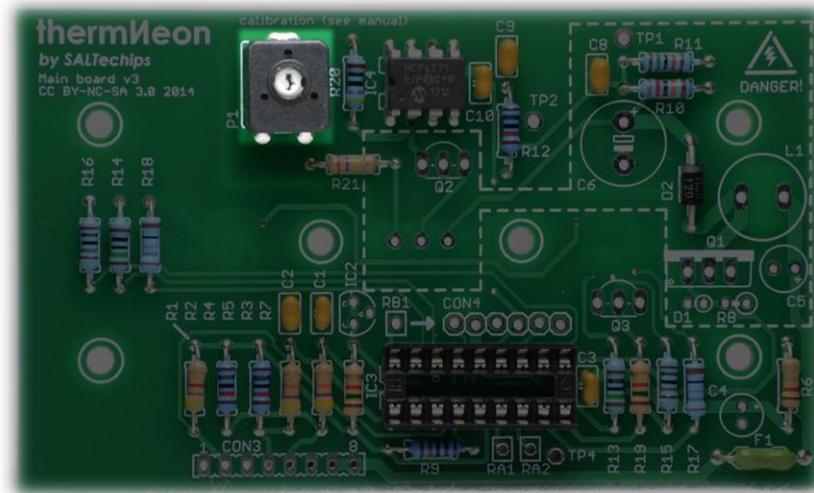
- 7.1.5.** Install the ceramic capacitors, they are not polarised and can be installed in either direction.



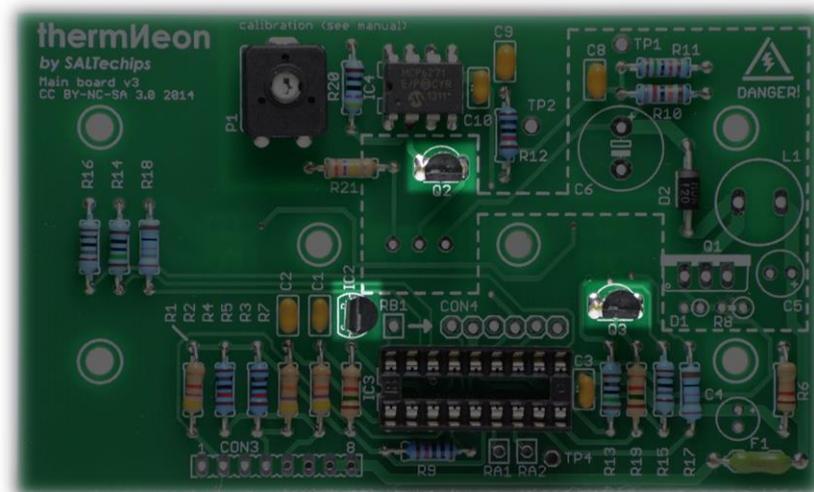
- 7.1.6. Install the 18pin DIL socket and IC4 ensuring the notch/pin 1 is orientated correctly. Do not insert IC3 (PIC18F1330) at this point in time.



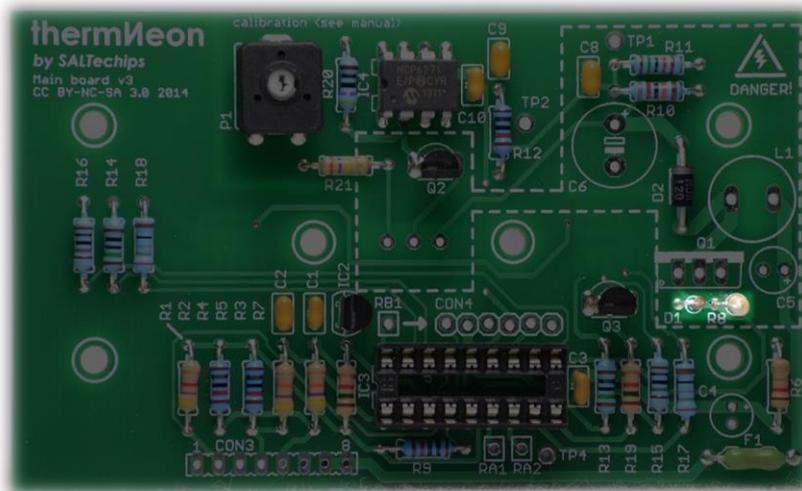
- 7.1.7. Install the potentiometer. Ensure the wiper is set approximately midway.



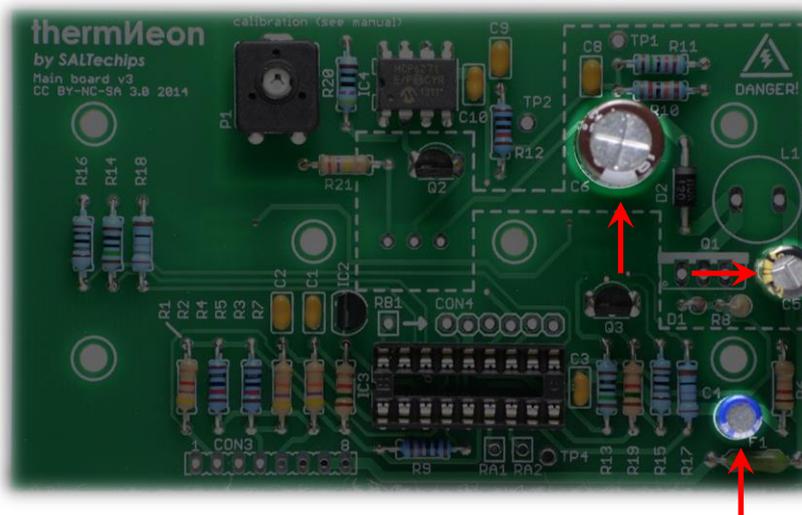
- 7.1.8. Install the transistors and IC2, use the silkscreen layout to ensure correct orientation.



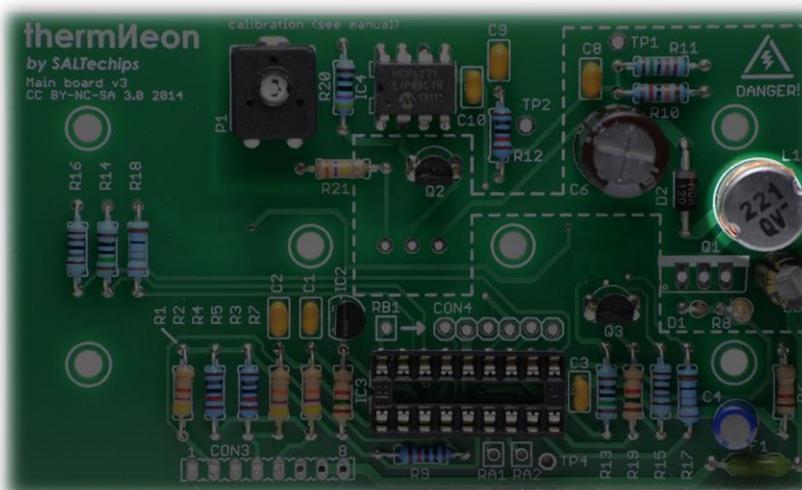
- 7.1.9. Install the vertical resistor, it is not polarised and can be installed in either direction. Also install the vertical diode, it is polarised ensure the cathode (black stripe) is closest to the PCB.



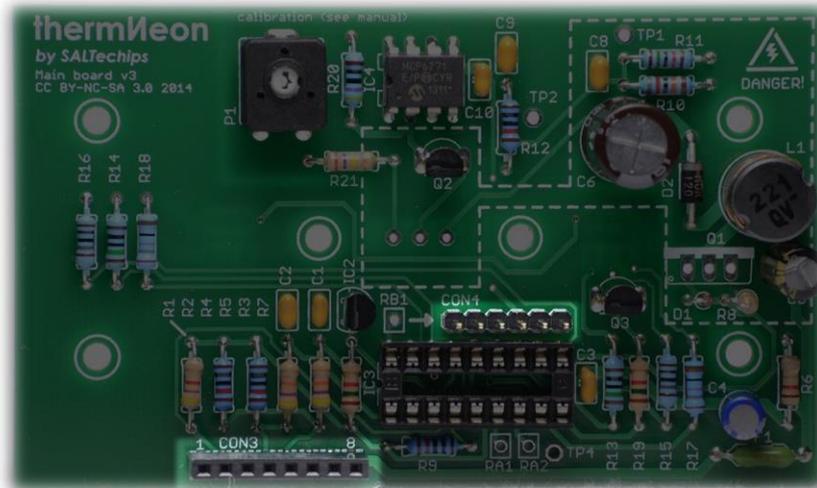
- 7.1.10. Install the electrolytic capacitors. **These capacitors are polarised, the stripe on the side is the negative leg, use the other leg (generally the longer one) to match the + symbol on the PCB.**



- 7.1.11. Install the inductor. It can be installed in either direction.



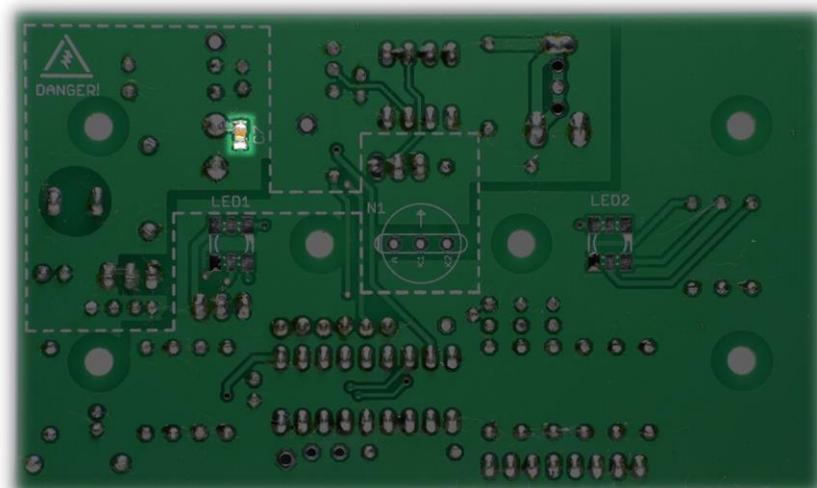
- 7.1.12. Install the 8 pin female header and optional 6 pin male serial programming header. **Please ensure the headers are straight.**



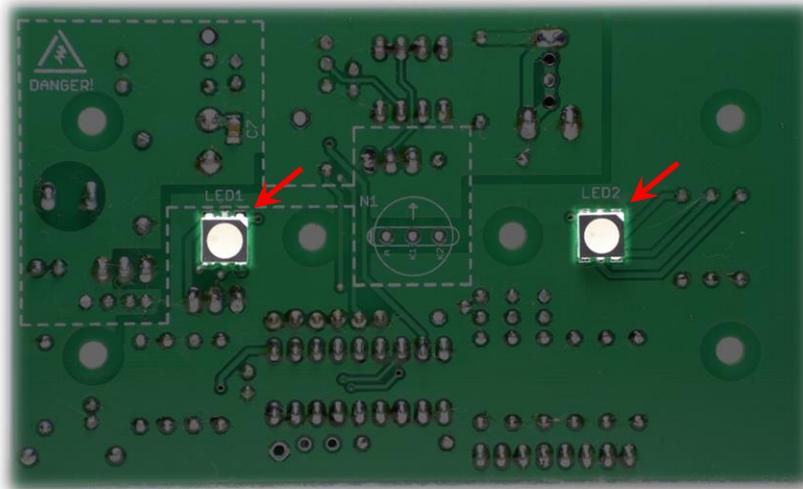
- 7.1.13. Install Q1. This component is polarised, ensure it is orientated correctly using the silkscreen. **Align the metallic side (the back) with the white stripe on the silkscreen layout.**



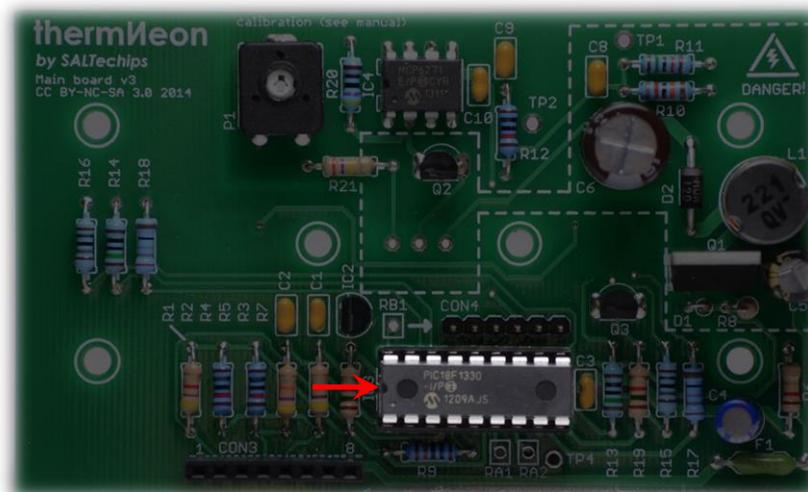
- 7.1.14. Install the 0805 surface mount capacitor on the rear side of the main PCB. It is not polarised and can be installed in either direction.



- 7.1.15. LED's 1 and 2 are installed on the bottom side of the PCB. **Please ensure they are installed the correct way using the corner triangle for orientation.**

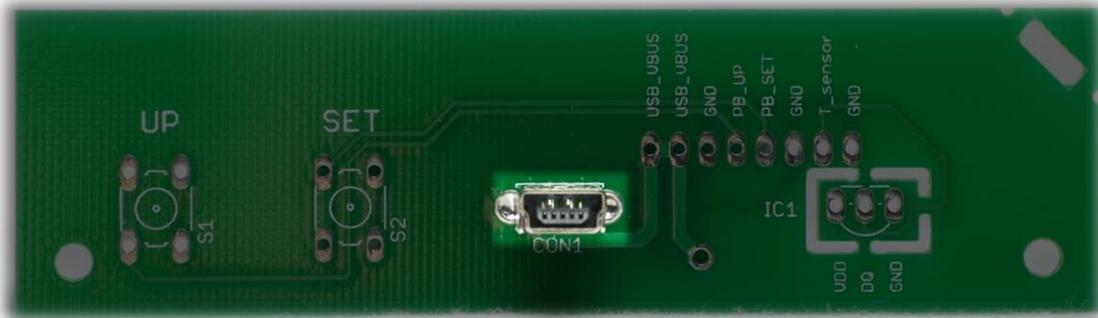


- 7.1.16. You can now insert IC3 (PIC18F1330) into the DIL socket. **Use the notch on the socket to orientate the IC the correct way.** Be careful to align the pins before applying force.

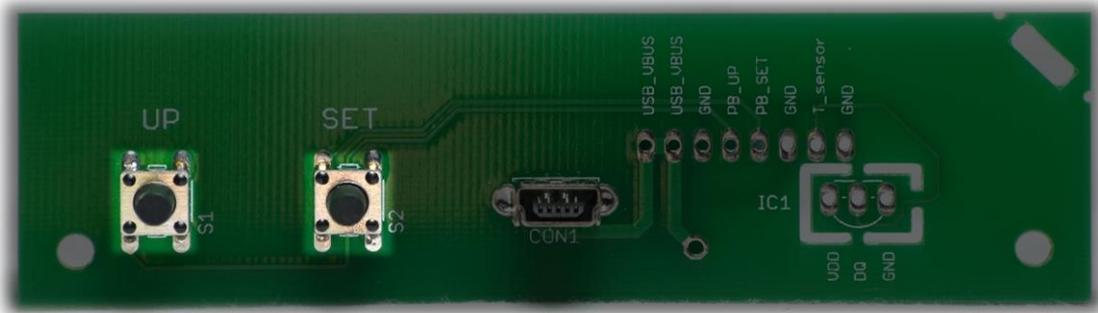


## 7.2. Stage 2 - installing the components into the interface PCB

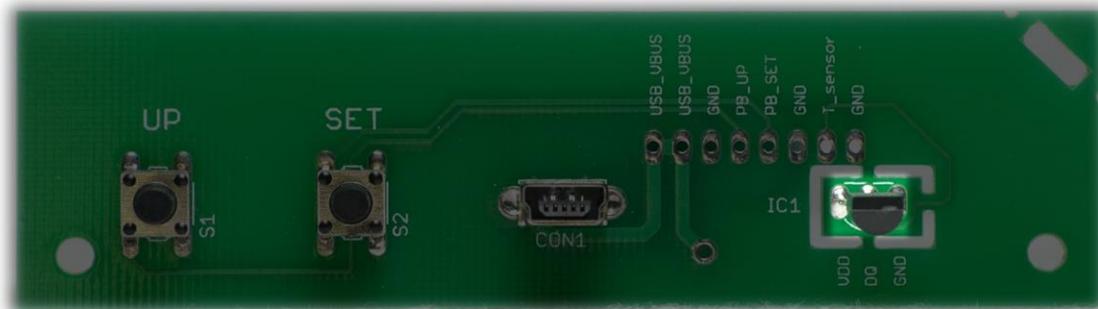
- 7.2.1. Let start with the vertical mini USB connector. **Make sure it is sitting flush and it is straight.**



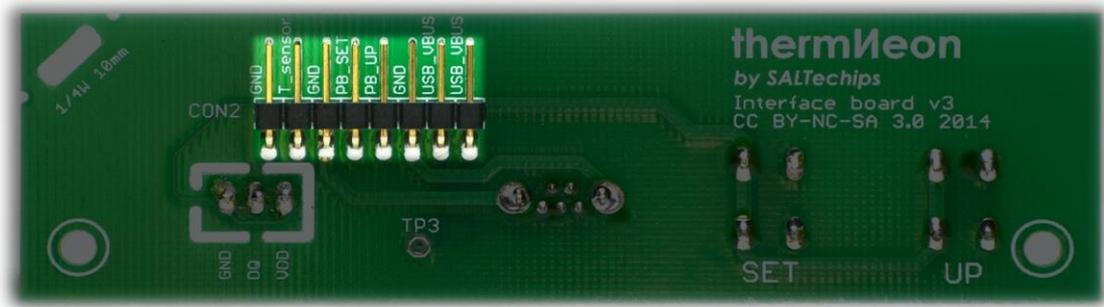
- 7.2.2. Next we will install the two pushbuttons. **Make sure they are sitting flush and are straight. Be careful not to break the shafts by excessive force.**



- 7.2.3. The DS18B20 temperature sensor can be installed next. **Mount this component so the top is flush with the outside face of the rear panel.** You can use the back panel to check that it isn't raised up too much.

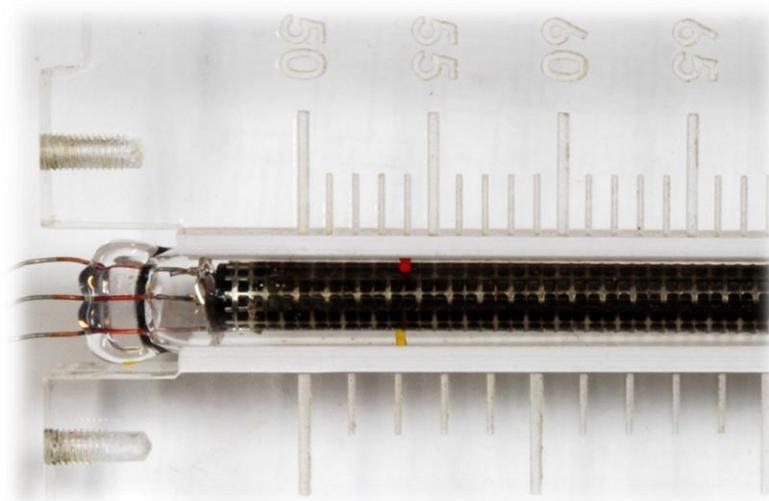


- 7.2.4. Install the 8 Pin male right angle connector on the other side of the interface PCB. Solder one pin and then if need to, **adjust the header so it is parallel to the interface PCB.**

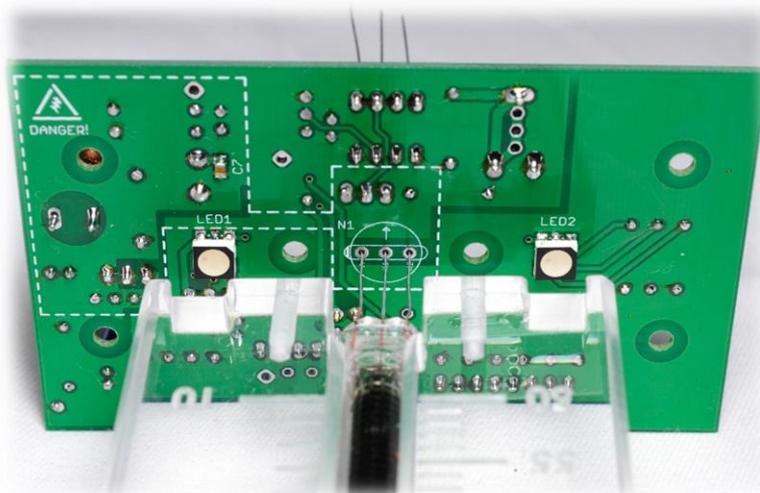


### 7.3. Stage 3 - Installing the IN-13 display tube

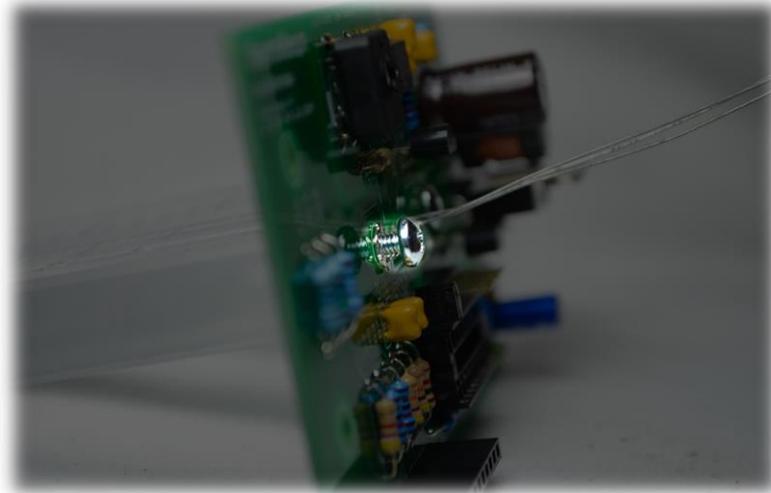
- 7.3.1. Insert the IN-13 display tube into the scale and align the red marking line with the 54°F mark on the scale.



- 7.3.2. Inset the leads of the IN-13 into the main PCB. **Ensure the IN-13 and scale are facing the correct direction.** The arrow on the silkscreen of the IN-13 shows the direction towards the viewer.



- 7.3.3.** Use two of the locking washers with the two 10mm M3 screws on the other side of the scale to secure the scale to the main PCB.



**After screwing in the scale, recheck (and adjust if necessary) the alignment of the red line on the IN-13 to 54°F (step 7.3.1).**

Solder in the leads from the IN-13 to the main PCB.

## **7.4. Testing and troubleshooting**

Having completed the main and interface PCBs, you can now perform a series of tests to ensure everything is operating as intended.

### **7.4.1.** Visual inspection

Several mistakes can be spotted by a visual inspection of the populated boards using this manual as a reference. This way component damage can be averted. Things to particularly look out for are:

- Populating the wrong resistor values.  
It is not difficult to mistake a 4k7 with a 47k resistor. Use the colour bands on the resistors and the PCB silkscreen to check all resistors. Avoid using an ohm-meter for populated resistors.
- Orientation of polarised components.  
Confirm that electrolytic capacitors, diodes, transistors, integrated-circuits and the neon tube are oriented as shown in this manual.
- Solder bridges or excessive contamination.  
Solder bridges can form when pins are closely spaced (e.g. IC3). Remove those by reheating the solder. Excessive contamination from flux (especially water-soluble flux) should be removed with the appropriate solvent.

#### 7.4.2. Quick test of operation



**Warning** Potentially hazardous voltages are generated during this test.

Having visually inspected the boards, you can temporarily power-up the electronics. To do this, connect the interface board to the main board and use the USB cable and adaptor supplied.

After a short delay, both the scale illumination LEDs (LED 1, 2) and neon tube (N1) should light-up, indicating a temperature (exact temperature is not important right now). The scale illumination must not be flashing red. The glow of the tube should not be flickering and it should be anchored to the bottom end of the tube. The LEDs should not be visibly flickering.

Press the SET pushbutton (SW2). In a moment, the scale illumination should be flashing green. Press the UP pushbutton (SW1). The scale illumination should instantly turn flashing red.

The test is complete. If everything behaves as described, it is highly unlikely that the electronics is not operating as intended.

#### 7.4.3. In-depth test of operation (optional)



**Warning** Potentially hazardous voltages are generated during this test.

If you wish to perform a more in depth-test of the electronics, you will need:

**Items A-G:** A DC voltmeter with appropriate compliance markings and CAT I or higher input rating. It must be able to measure 300V DC or higher.

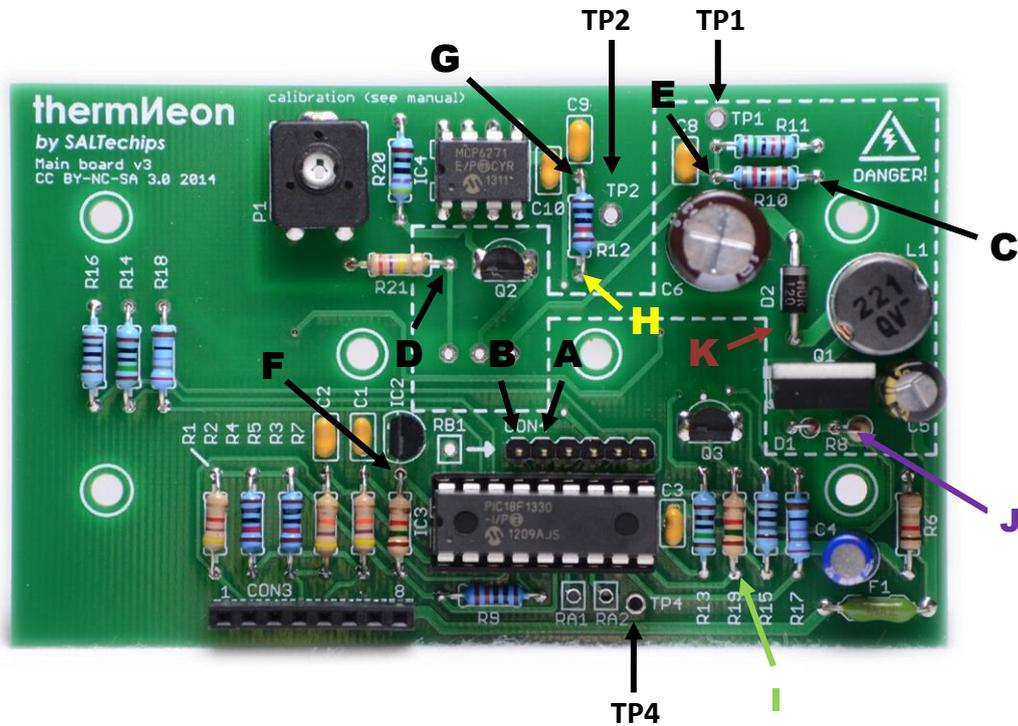
**Items H-K:** An oscilloscope with 10MHz of analogue bandwidth or higher and at least one matching CAT I or higher rated passive probe to measure 300V DC or higher (10x attenuation preferred).



To prevent ground-loops, power the electronics using the supplied adaptor and cable when performing measurements for items H-K.

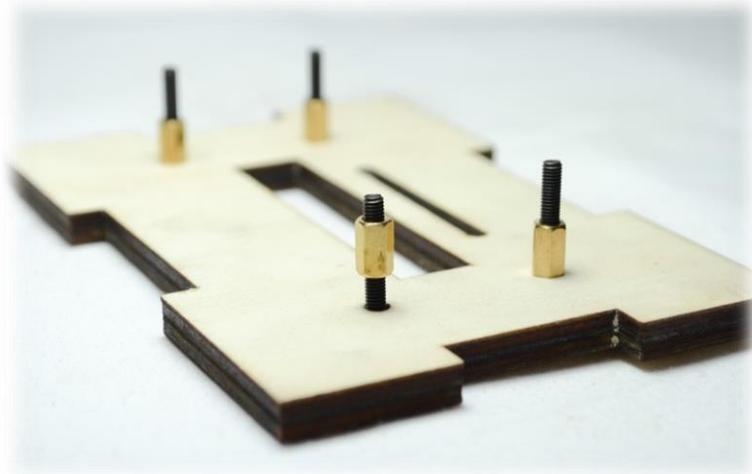
Tool	Item	Description	+ve probe*	-ve probe	Expected	Notes
Voltmeter	A	Board power	CON4 pin 2	TP4	5V	
	B	MCU reset signal	CON4 pin 1	TP4	5V	
	C	Neon tube anode voltage	R10 right	TP1	140V	
	D	Aux. cathode voltage drop	R21 right	TP1	40V	
	E	HV PSU feedback signal	R10 left	TP1	2.5V	
	F	HV PSU reference voltage	R7 top	TP4	2.5V	
	G	Current sink drive signal	R12 top	TP2	take note	
O-scope	H	PWM drive of current sink	R12 bottom	TP2	see plot	
	I	PWM drive of LEDs	R19 bottom	TP4	see plot	
	J	PWM drive of HV PSU	R8 top	TP1	see plot	
	K	Switching wfm. of HV PSU	D2 anode	TP1	see plot	

\*Looking at the "Top view of main PCB" as on page 5.

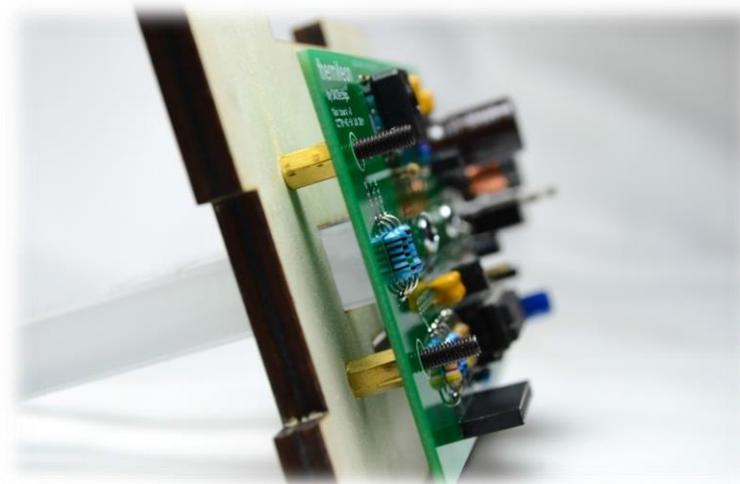


## 7.5. Stage 4 - Final assembly and calibration

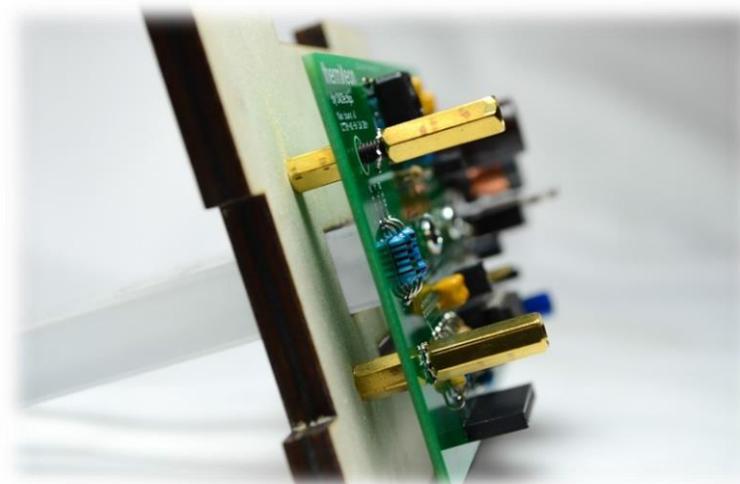
- 7.5.1. Insert the four M3 20mm socket cap screws into the top panel and screw in the four 8mm standoffs on the inside of the top panel. Use a pair of pliers to hold the spacers if necessary.



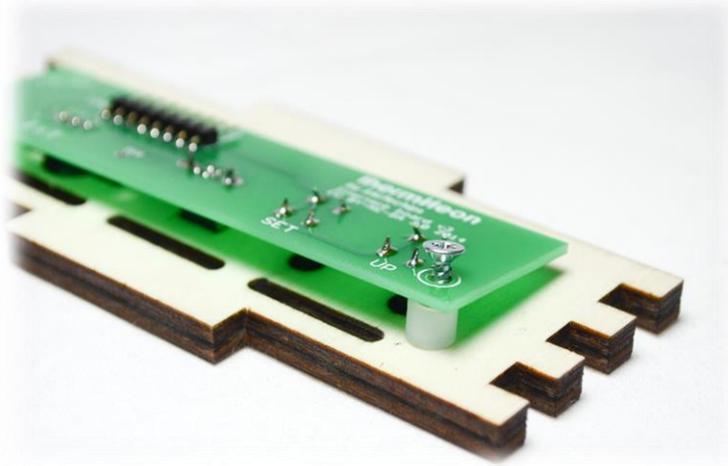
- 7.5.2. Using the thin slot of the top panel for orientation, (it should be behind the scale) slide the scale and main PCB through the slot of the top panel until they are sitting on the standoffs. **Take care not to scratch the scale.**



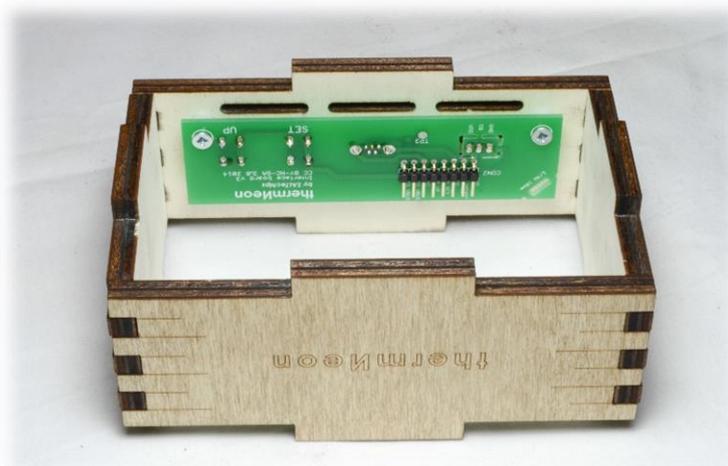
- 7.5.3. Insert the remaining four locking washers over the socket cap and screw in the four 15mm standoffs. Use a pair of pliers to hold the spacers if necessary.



- 7.5.4. Place the interface PCB on to the back panel. Slide the 5mm nylon spacers between the PCB and back panel. Use the self tapping screws to fix the PCB to the back panel. **Take care not to split the wood.**



- 7.5.5. Assemble the front, back and side panels together, taking care not to damage the locking finger joints.



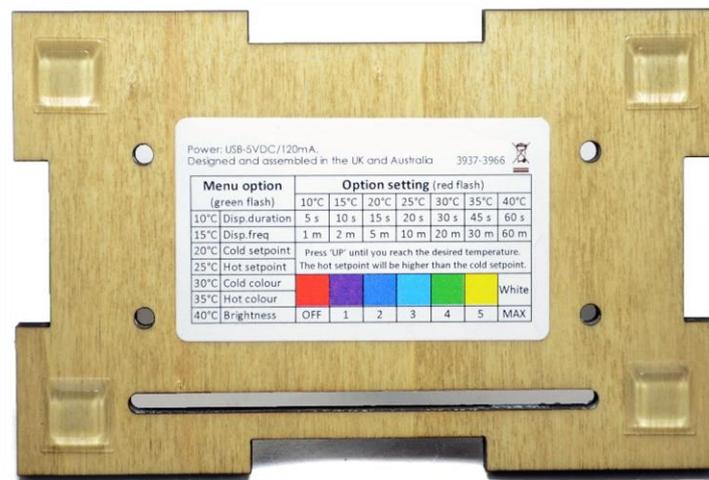
- 7.5.6. Slide the above assembly (step 7.4.5) on to the main PCB, aligning the 8 pin connector and the panels.



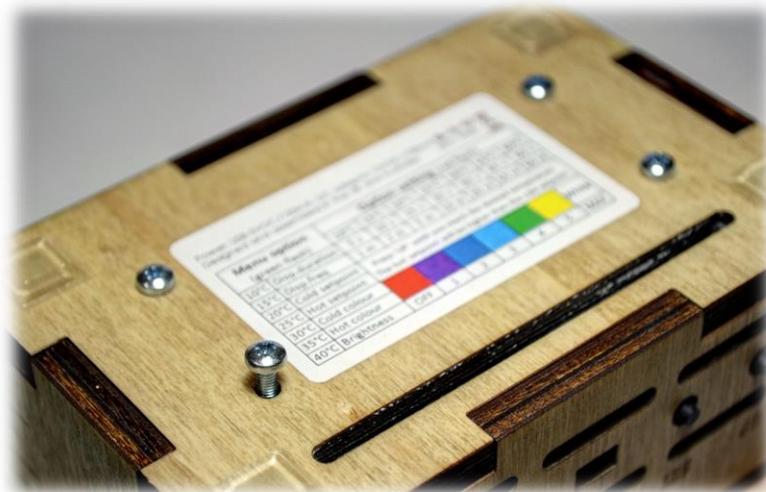
**7.5.7.** Calibrating the unit will ensure that the correct temperature is displayed. The calibration only needs to be performed once. To calibrate the unit follow the steps below in sequence:

- a) Plug-in the power supply adaptor to a wall socket (skip if using USB power).
- b) While pressing the SET and UP buttons, and with the base of the unit open, connect power to the unit. The display tube will illuminate, indicating a temperature value. Release the buttons.
- c) Adjusts the potentiometer P1 until the temperature displayed (very top of the neon glow) is at 100 °F.
- d) Once adjusted, press the SET button once. The entire length of the display tube will be illuminated to clean the electrodes and gas inside the tube (cathodic sputtering).
- e) Wait approximately 3 minutes.
- f) Repeat step c.
- g) Once adjusted, press SET once to complete the calibration procedure.

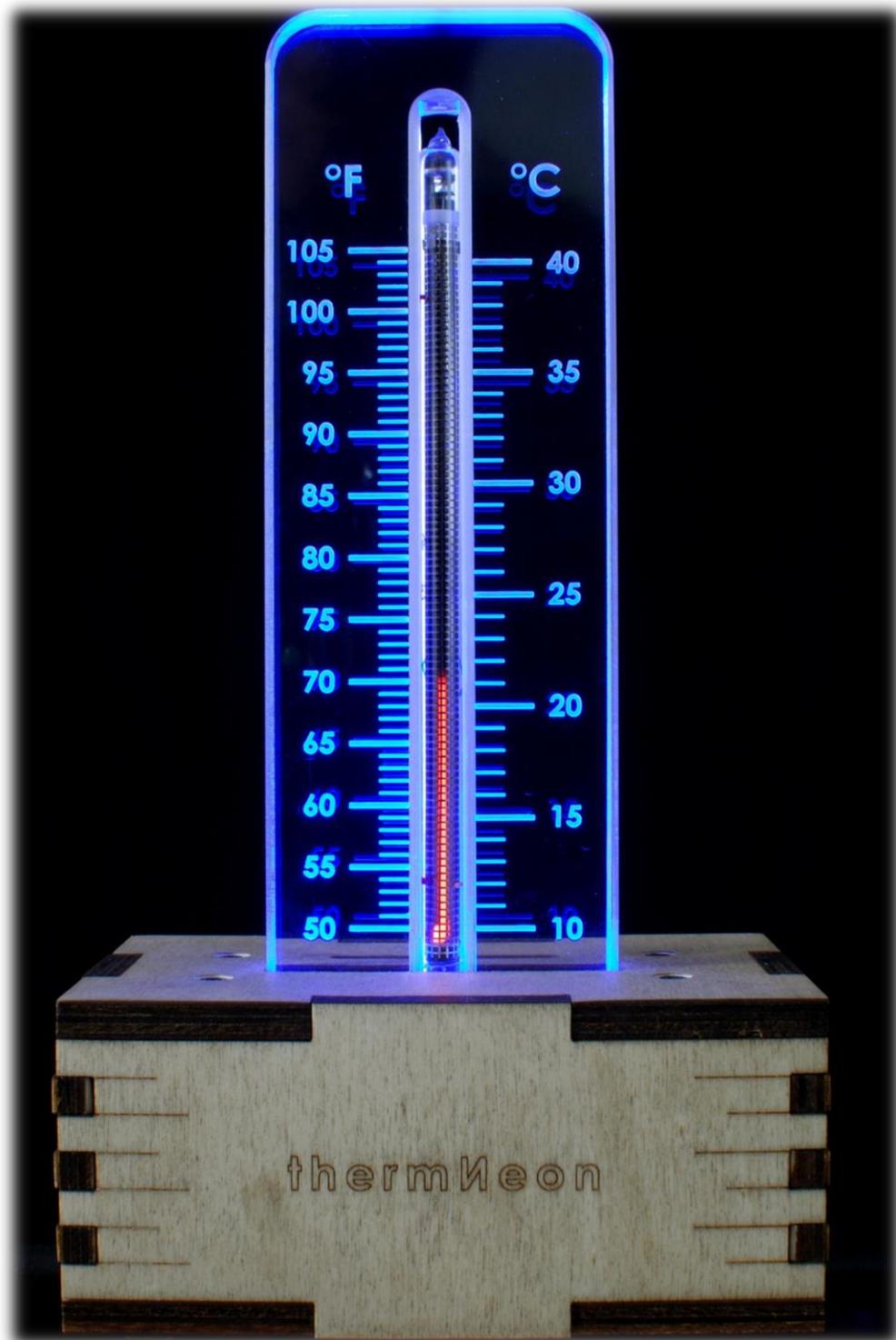
**7.5.8.** Stick on the self-adhesive feet close to the corners of the base.



**7.5.9.** Using the slot for orientation (it should be closest to the rear panel), slide the base panel on to the rest of the assembly. Insert the M3 30mm screws until they find the standoffs from step 7.4.3. **Avoid over-tightening these screws.**



Congratulations on building your very own *thermNeon*!



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