

## Dyadnix Nixie Clock Kit Assembly Manual (V1.3)

**Unusual Electronics**



Thank you for purchasing this “UnusualElectronics.co.uk” Kit.

Please use the manual – even if you are an experienced electronics engineer.

**This kit is fairly complex and is not recommended for an absolute beginner.**

If you are unsure of being able to complete the kit successfully – seek assistance from someone with good electronic assembly skills.

Or email us for help and advice

### **WARNING**

**This unit generates a high voltage.**

High voltages can cause serious injury or death!

Only persons who are competent at electronics assembly and understand the dangers of high voltages may attempt to assemble this kit!

Safe assembly and operation of this kit is the users responsibility.

This information is provided 'as is'.

**No responsibility is accepted for any damage, injury or death as a result of assembling this kit.**

***The assembled unit must be properly encased to prevent contact with high voltages and kept out of reach of children.***

UnusualElectronics.co.uk will not be held liable to replace components or refund money as a result of damage occurring during assembly or failure to complete the kit successfully.




If you damage any parts or you cannot get it working, please email with a description of the problem. We will endeavour to offer a reasonable amount of free technical support by email and we can also supply replacement parts or arrange for you to return the kit to us to be repaired at your expense if you wish.

## Things you need during assembly

	<p>Safety Glasses - (Especially while trimming leads) (Always hold the end of leads when trimming them!)</p>
	<p><b>ESD protection - Anti-static Wrist band</b> and ideally an Antistatic Mat to avoid damage to static sensitive parts. </p>
	<p>A good quality, Miniature type, low wattage Soldering iron with a small tip. (e.g. An 18 Watt model with a 1mm tip). Use a solder sponge to keep the iron tip clean.</p>
	<p>A quality, thin (18 or 22SWG), electrical grade of cored solder Lead-free solder can be used (you may need some practice using it first if you have not previously used it.)</p>
	<p>Small, good quality side-cutters for trimming wires etc.</p>
	<p>Small, needle nose pliers to hold components etc.</p>
	<p>A basic Multimeter capable of measuring voltages up to 200V DC may be useful for checking resistance, voltages etc.</p>
	<p>A "Wall-Wart" 9-12 volt unregulated or regulated AC or DC power adaptor 0.3 Amp output rated (or better) With a 2.1mm plug</p>
	<p><u>Needed if you make any soldering mistakes</u> A cheap de-soldering pump (solder sucker) Or de-soldering copper wick.</p>
	<p>A Set-square/ruler for checking the alignment of the tubes</p>
	<p>A hot air gun (or powerful hair-dryer) to heat-up the heat-shrink tubing for the temperature sensor insulation.</p>

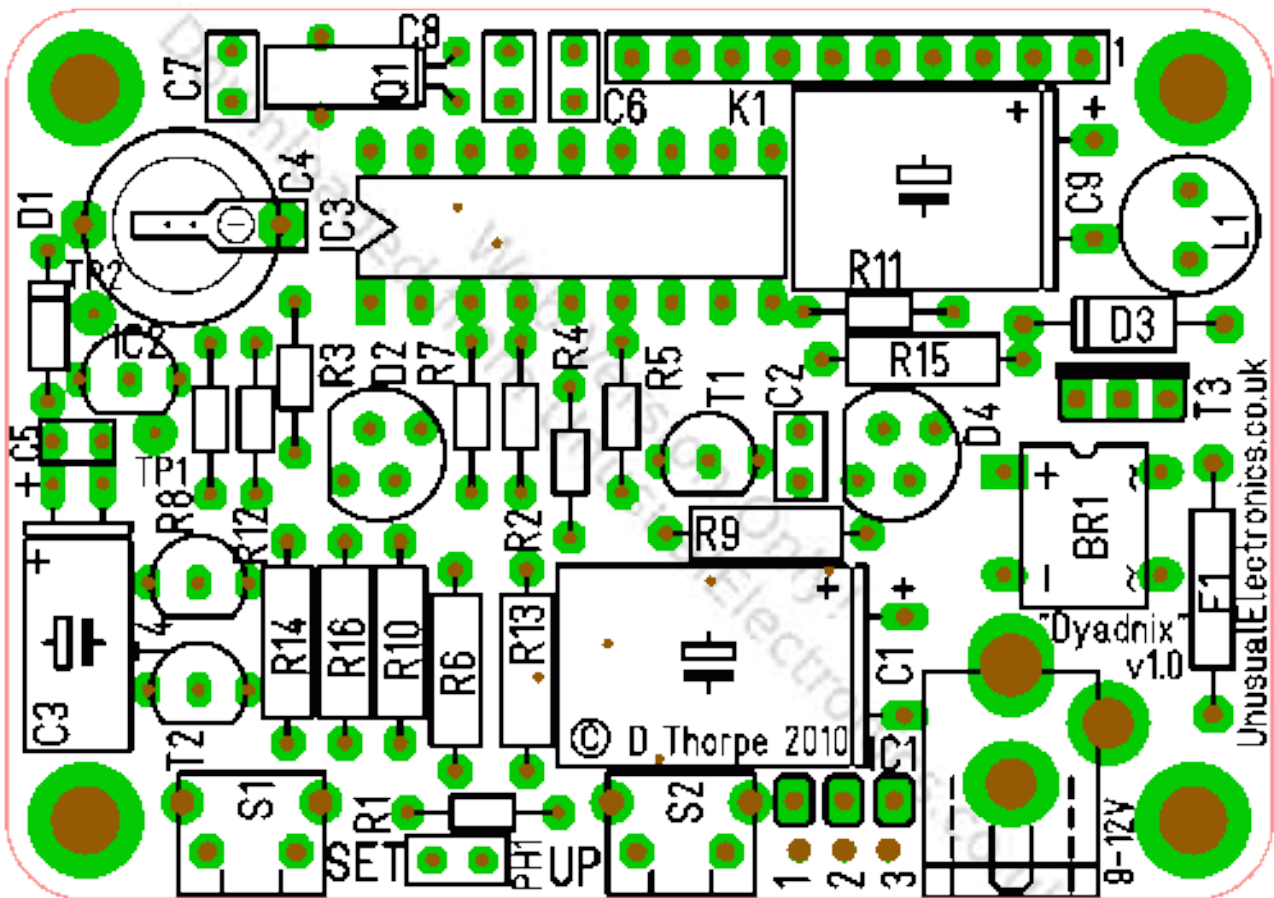
## Parts List

CAPACITORS	Qty	VALUE	PHOTO	DESCRIPTION
C1	1	470 $\mu$ F		Electrolytic 25V working
C2,C5,C6	3	0.1 $\mu$ F		Ceramic 50V working
C3	1	10 $\mu$ F		Electrolytic 25V working
C4	1	0.1F		Supercap for battery backup (5.5V Working)
C7, C8	2	22pF		Ceramic Disc 50V working
C9	1	1 $\mu$ F		Electrolytic 450V working
RESISTORS	Qty	VALUE	PHOTO	DESCRIPTION
R1	1	1K $\Omega$		<b>Brown-Black-Red-Gold</b> Sub-Miniature (0.125W)
R2	1	470K $\Omega$		<b>Yellow-Violet-Yellow-Gold</b> Sub-Miniature (0.125W)
R3,4,5,8,11,12,17 18,19,20,21,22	12	10K $\Omega$		<b>Brown-Black-Orange-Gold</b> Sub-Miniature (0.125W)
R6, 9, 10, 13	4	470 $\Omega$		<b>Yellow-Violet-Brown-Gold</b> 0.25W
R7	1	6.8K $\Omega$		<b>Blue-Grey-Red-Gold</b> Sub-Miniature (0.125W)
R14, 16	2	680 $\Omega$		<b>Blue-Grey-Brown-Gold</b> 0.25W
R15	1	470K $\Omega$		<b>Yellow-Violet-Yellow-Brown</b> Metal Film Resistor ( <b>blue body</b> ) 1% tolerance
R23	1	33K $\Omega$		<b>Orange-Orange-Orange-Gold</b> Sub-Miniature (0.125W)
R24	1	15K $\Omega$		<b>Brown-Green-Orange-Gold</b> 0.25W
SEMICONDUCTORS	Qty	TYPE	PHOTO	DESCRIPTION
D1	1	BAT85		Schottky barrier diode (Low Forward Voltage)
D3	1	UF4004		Schottky High voltage fast recovery diode. 1A
D2, D4	2	RGB Led		5mm RGB LED (Common Anode)
BR1	1	DI104		1 Amp Bridge Rectifier

IC1	1	DS18B20		DS18B20 temperature sensor
IC2	1	LM78L05		5V voltage regulator (100mA Max)
IC3	1	PIC18F1330		PIC Microcontroller
T3	1	FQU3N60CTU		High Voltage MOSFET Power Transistor
T1,T2, T4-T25	24	MPSA42		High Voltage NPN Transistor
<b>OTHER PARTS</b>	<b>Qty</b>	<b>TYPE</b>	<b>PHOTO</b>	<b>DESCRIPTION</b>
S1, S2	2			6mm Tactile horizontal pushbutton
F1	1	500mA		Fuse (Wire ended) Fast Blow. <b>(+1 spare)</b> CamdenBoss CF2470 FF 500mA <a href="http://www.rapidonline.com">www.rapidonline.com</a> order code: 26-2554
L1	1	100µH		100µH inductor (0.66A) Murata 22R104 <a href="http://www.rapidonline.com">www.rapidonline.com</a> order code: 88-1630
PH1	1	GL5528		Light Sensor (LDR) TruOpto GL5528 <a href="http://www.rapidonline.com">www.rapidonline.com</a> order code: 58-0134
PWR1	1			Power socket (2.1mm) (PCB mount)
Q1	1	32,768KHz		Watch crystal
K1	1			10 way header socket, 2.54mm pitch.
K2	1			10 way header pins, 2.54mm pitch.
N1, N2	2			IN-14 Nixie Tube
	4			12mm Hex Metal M3 threaded spacer
	1			18 pin IC Socket
	8			M3 pan head screw (6mm length)
	1			3 wire cable for temperature sensor
	2	2mm & 6.4mm		Heat Shrink Insulation For Temperature Sensor body
	1	5mm		Tube alignment tool (5mm LED)

## Main Board Layout

Please refer to this board layout diagram when placing the components as the pcb print may be difficult to read clearly where components are very close together.



## Main Board Assembly

Many components are static-sensitive – Always use ESD anti-static protection to avoid damaging them!

The lifetime of the LEDs, ICs and MOSFET (T3) can be severely shortened by static electricity, or too much heat during soldering!

It is essential to fit some of the taller parts as close as possible to the board so that they do not touch the Nixie board above it.

### Step 1 – 10K $\Omega$ Resistors

Start by fitting the six miniature 10K $\Omega$  resistors (Brown Black Orange Gold). R3, R4, R5, R8, R11, R12

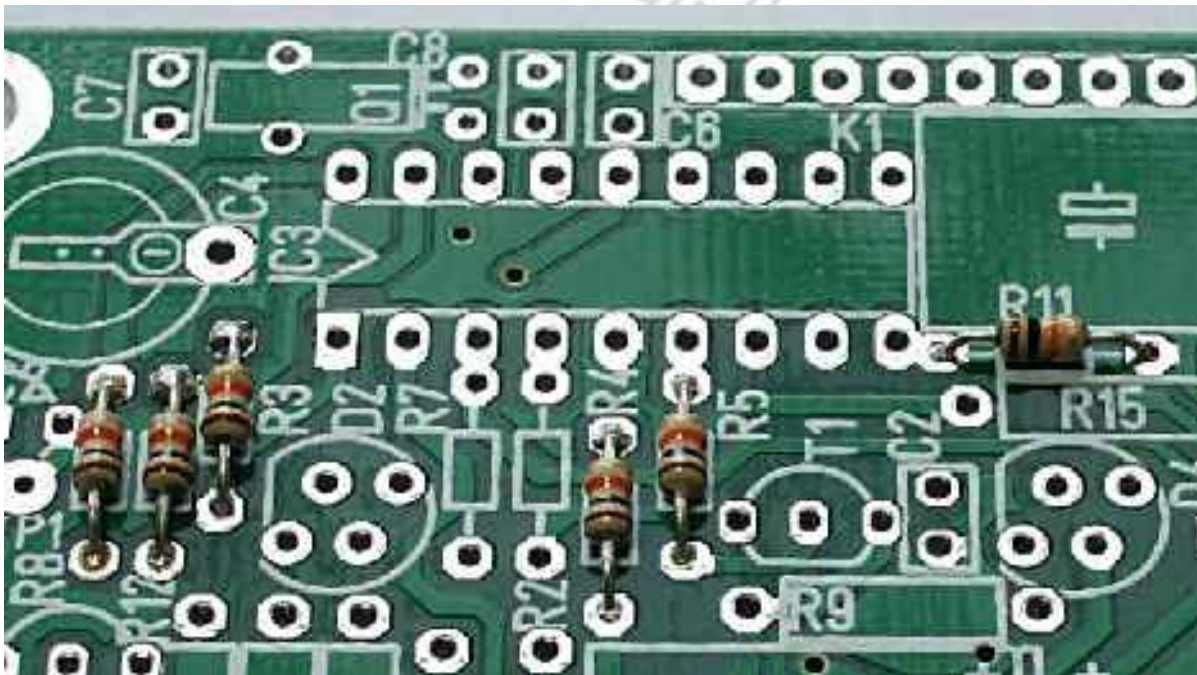


Bend each lead by hand, near to the resistor body as shown.

Insert each resistor fully then spread the leads just enough to stop it falling out. (The resistors can go either way round but look neater with all the gold markings on the same side)

Carefully turn-over the board, ensuring the resistors stay in place.

Then solder and trim all the leads on the underside of the PCB. (Tip. Hold the end of each lead as you trim it)



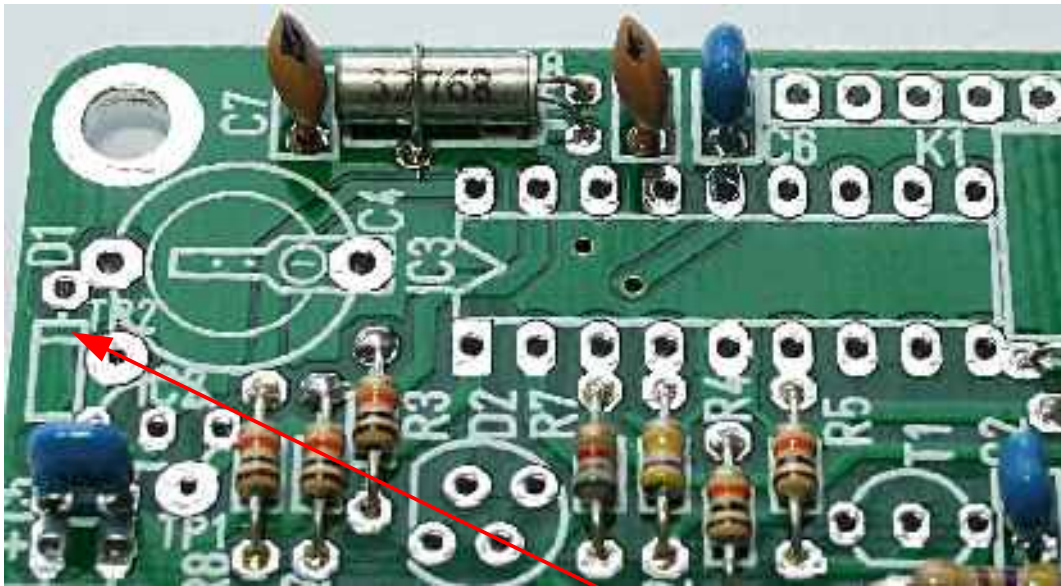


### Step 3 – Small Capacitors, Crystal and Glass Diode

- Fit the three small blue 0.1uF capacitors: C2,C5,C6
- Then the two brown 22pF disc capacitors : C7, C8
- Gently bend the watch crystal leads and fit it lying flat against the board.

Using a piece of previously discarded, trimmed component lead, make a “U” shaped strap to hold the crystal in place. Solder the strap as shown.

**DO NOT APPLY SOLDER OR HEAT TO THE CRYSTAL CASE** – (it will damage it or reduce it's accuracy)



- Fit the glass Diode D1 (BAT85), making sure the black ring matches the mark on the PCB



#### Step 4 – HV Diode, Supercap, IC Socket and 5V Regulator

- Fit Diode D3 (UF4004), ensuring the **silver ring** matches the mark on the PCB



- Fit the Supercap C4 (0.1F) , with the top **-ve polarity tag** on the right.

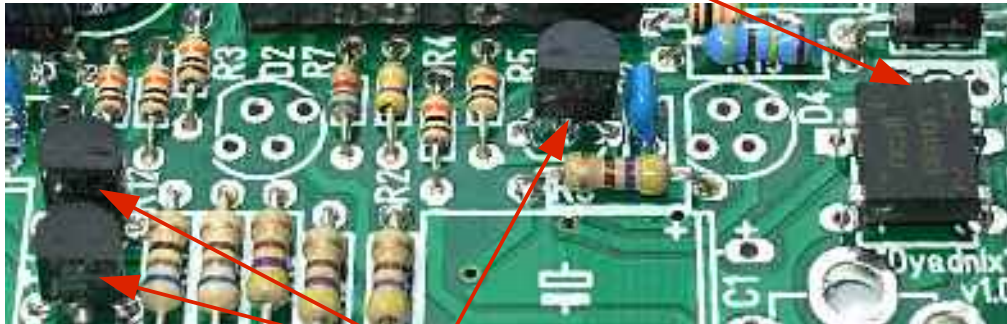


- Fit the IC Socket with **cut-out** matching the mark on the pcb  
(Check that it is completely flush with the pcb before soldering all the pins.)
- Fit the Voltage regulator IC2 (78L05) with the **flat side** matching the pcb marking.  
(Push it in enough so that it protrudes no more than **8-9 mm** above the board.)



## Step 5 – Bridge Rectifier and Transistors

- Fit the Bridge Rectifier BR1 with the **cut-out** matching the pcb marking.



- Then the three Transistors T1, T2 & T4 (MPSA42) as shown.  
(Push them in enough so that they protrude 8-9mm above the pcb)

## Step 6 – Large Capacitors and Inductor

- Fit the 100 $\mu$ H Inductor L1, making sure it is nice and close to the board.

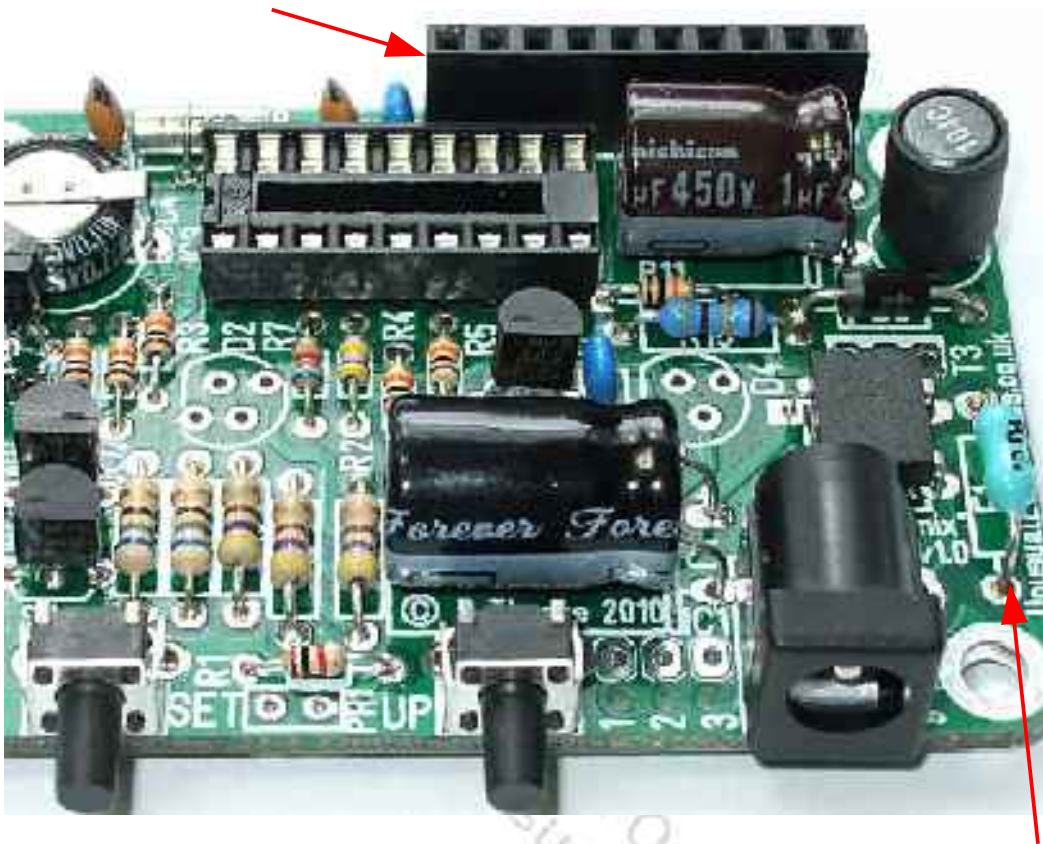


- Then carefully bend the leads of the three Electrolytic Capacitors C1, C3 & C9 and fit with their **Negative polarity stripe markings** as shown.

**Make sure they lie completely flat against the board.**

## Step 7– Header Socket, Push-buttons, Fuse and Power socket.

- Fit the 10 way socket – making sure it is vertical and close against the board.



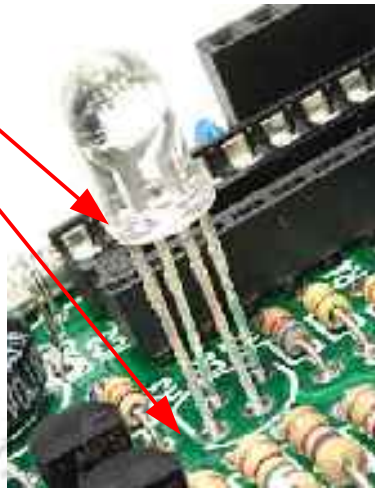
- Then the 500mA fuse, about 4-5mm above the board and be careful not to over-heat it while soldering.
- Push down the two pushbuttons onto the board so they are completely flat against it.
- Fit the power socket – you will need plenty of solder. Make sure it is completely flat against the board.

## Step 8 – RGB LEDs and Light Sensor

**Warning: RGB LEDs are very static-sensitive! - Use ESD protection!**

- Gently fan-out the LEDs leads slightly and push them into the holes as shown.

Ensure the **Flat side** matches the marking on the board. **DO NOT SOLDER YET.**



- Also Insert the Light Sensor PH1, **DO NOT Solder** yet.
- Now temporarily screw the Nixie board onto the main board using the Hex spacers.



- Bend the Light Sensor leads and solder it mid-way between boards as shown.
- Push both LEDs up through the Nixie board as far as they can go then solder.
- Remove the Nixie board and screws.

## Step 9 – MosFET Transistor

**Warning: This part is very static-sensitive! - Use ESD protection!**



- Fit the High Voltage MosFET Transistor T3.

Make sure the Metal tab is on the same side as the marking on the board.

Push the leads in enough so that the top of it's metal tab protrudes no more than 8mm above the board.

- Closely inspect the board on both sides, looking for any solder splashes, un-trimmed or un-soldered leads and double-check that all components are fitted the correct way round.

Do not insert the Microcontroller chip yet – because we will make a few voltage checks first.

## Step 10 – Main Board Preliminary Testing

- Place the board on an insulated surface.
- If you have a test-meter, set it to measure resistance. (on the 200 $\Omega$  range)
- Touch the meter negative lead onto any one of the four ground connection rings around the board mounting holes and measure the resistance to TP1 & TP2 to check for any short-circuit in the main DC power circuits.

If there is a short-circuit – Re-check all your work, look very closely for any solder splashes and check that all parts are fitted correctly.

- If the resistance test was OK, Switch your meter to read DC voltage (20V range).
- Plug in a 9-12V AC or DC power supply and turn on the power.
- Check that the voltage at TP2 is 5 Volts. (TP1 should read over 9 volts)
- **Now turn off the power.**

If the voltage was not correct, check all connections to the voltage regulator IC2 and make sure all parts are fitted correctly. (If there was no voltage reading – check the fuse).

- If the tests were OK, **Discharge the Supercap** (C4) by shorting its' two pins for a few seconds. (this will prevent the microcontroller trying to run when you insert it)
- You can now insert the microcontroller (IC3) into it's socket.

Make sure the chip cut-out matches the cut-out on it's socket and board marking.



### **Warning: When powered on there will be HIGH VOLTAGE – DO NOT TOUCH!**

- Turn on the power.

After a few seconds delay, you should see both LEDs initially start with a sequence of Red then Green then Blue.

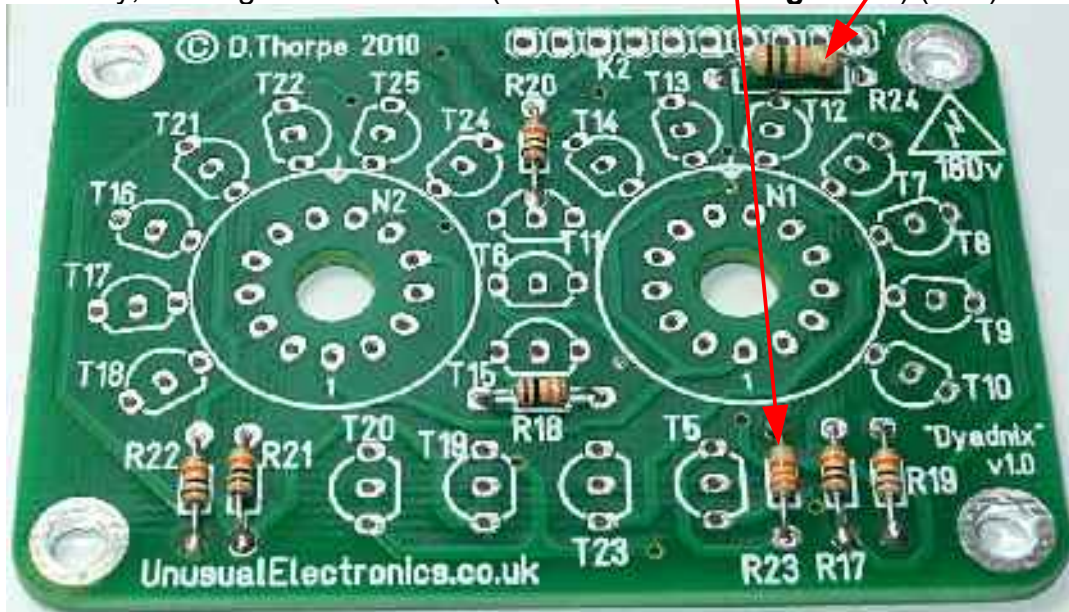
If the LEDs flash rapidly (2 flashes/second), refer to the High Voltage startup diagnostics section in the circuit description manual.

If the LEDs don't light at all: Turn Off, Re-check your work, check the fuse and discharge the Supercap again to ensure the microcontroller was reset.

## TUBE BOARD ASSEMBLY

### Step 11 – Tube Board Resistors and Transistors

- Fit the six **10K** resistors (**Brown Black Orange Gold**) (**R17-R22**).
- Then the **33K $\Omega$**  resistor (**Orange Orange Orange Gold**) (**R23**)
- and lastly, the large **15K $\Omega$**  resistor (**Brown Green Orange Gold**) (**R24**)

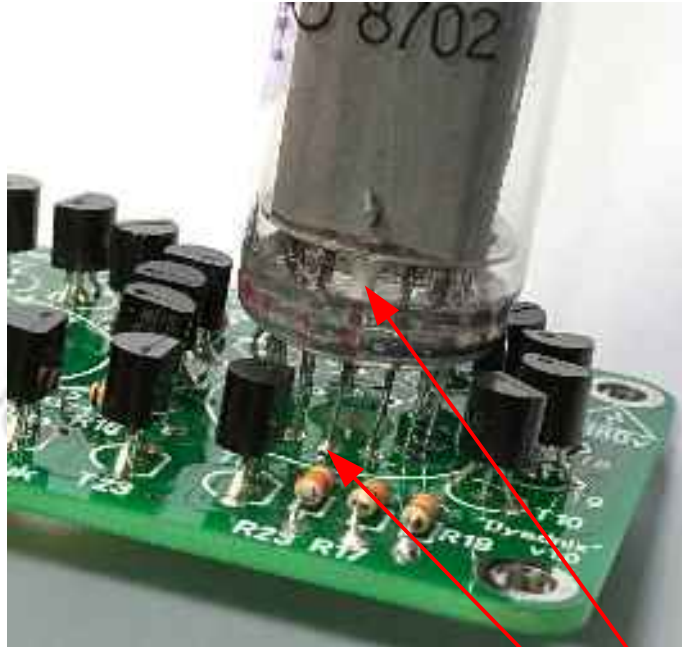


- Now fit the remaining 21 Transistors (**MPSA42**) (**T4-T25**).  
(Make sure the flat face on each transistor matches with it's board outline and push well in so that they all protrude by about 7mm as shown.)
- Solder and closely trim all leads so that they don't foul any parts on the other board.



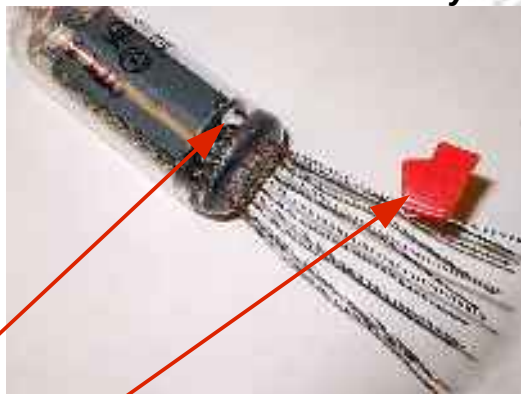
## Step 12 – Nixie Tubes

This step is fiddly to do! You may find it easier if you clamp the board securely. (Try not to bend the tube leads too sharply while locating them in their holes)

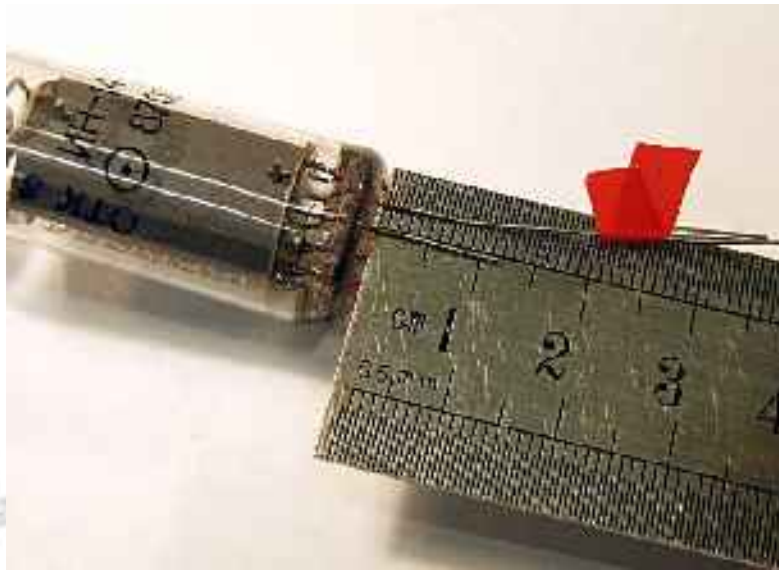


- Remove the plastic spacer (if fitted) from the Nixie tube leads.
- Find the anode lead (1) – it has a white ceramic insulator as shown.
- Using your needle nose pliers, locate the end of this lead into hole 1.
- Work around the tube, locating just the end of each lead until all are in their holes.
- Now gently push the tube in, making sure that no leads get bent.

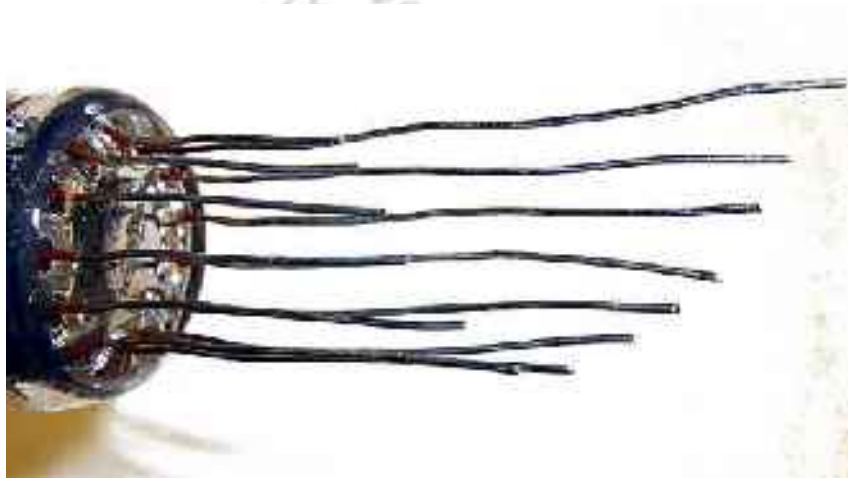
**Tip – If you find it difficult to insert the tube leads – try this suggestion instead:**



- Mark the Anode lead (1) with a piece of tape.
- Straighten the leads as much as possible.



- Trim the lead **next** to the marked lead to **12mm long (no less)**  
**WEAR SAFETY GLASSES!**  
(Always hold the end of a lead while cutting to prevent it flying in your eye!).



- Trim the next lead to be 2mm longer than the previous one (**14mm**)
- **Repeat:** Trimming each 2mm longer than previous until you reach the taped lead. (Do not trim the taped lead.)
- Remove the tape and it should look like the photo above.

You should now be able to insert the tube wires into the pcb (starting with lead 1) much more easily.

*(Thanks very much to Hank Becker for this suggestion)*

**Each tube needs to be positioned exactly the right height above the board.**

- Use the **“Nixie Tube Alignment Tool”** (A spare 5mm LED (supplied)).



- Push the LED through the hole in the board and adjust the tube position until it is almost touching the LED.
- Solder just one of the tube leads and re-check.
- If still OK, Make sure the tube is completely vertical and solder another lead.

Also check that the front face of the tube is correctly aligned, twist the tube slightly if needed.

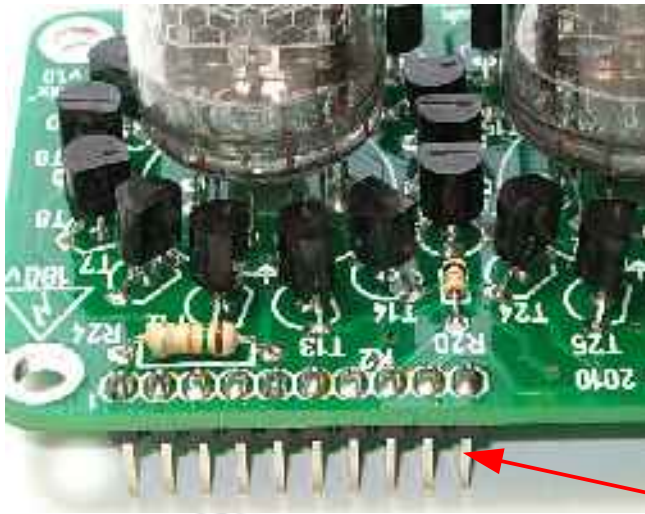


**Tip:** Using a set-square helps to ensure proper alignment.

As you solder more tube leads, it will become much harder to make alignment adjustments, it is best to get it right first!

- Solder each remaining lead, checking all tube alignment as you go.
- Closely trim the leads  
(**WEAR SAFETY GLASSES!, hold each lead as you trim.**)
- Repeat the whole procedure for the other Nixie tube.

### Step 13 – PCB Connector and board checks.



- Insert the 10 way PCB header Pin connector from the underside of the board as shown. Make sure it is fully inserted and vertical before soldering all the pins.

The Tube board is now complete.

- Fit the metal spacers to the main board and temporarily push the tube board into the main board pcb socket (**Do not** screw it in or apply power yet).
- Closely examine the underside of the tube board – make sure that none of the trimmed leads are protruding too much, touching parts below on the main board (especially the metal tab of the Mosfet power transistor.)
- Now plug-in the power lead and switch on (**DO NOT TOUCH THE BOARDS**)

Both Nixie tubes should count down from 9 to 0.

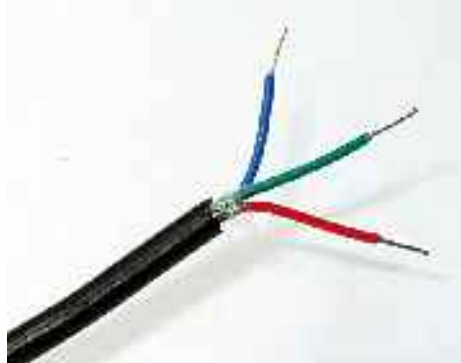
If any digits are missing, turn off the power, unplug the **tube** board and check all solder joints and transistor alignments.

If several digits are missing or lighting incorrectly, also check all the solder joints on the **main** board.

If everything worked OK – remove the tube board and continue on to the next section.

## Step 14 – Temperature Sensor wiring

The DS18B20 temperature sensor will be attached to a short length of cable so that it can accurately measure the room temperature outside of the clock case.



- Carefully remove about 2cm of the black outer insulation from each end of the cable.
- Then remove about 0.5cm of insulation from the end of each wire and twist the strands together as shown above.  
**Tip:** Tin the leads at both ends of the cable. (this will make it easier to solder and will also pre-melt the ends of the wire insulation.)
- Cut 3 lengths of the 2mm heat shrink tubing and place them over each lead, leaving just enough lead protruding to allow soldering.



- Solder the wires as shown: Blue, Green, Red. **Flat Side Top**



- Slide the tubing over the solder joints.
- Heat the tubing until it shrinks around the solder joints. (Ideally you should use a hot air heat gun, although a powerful hair dryer or carefully holding it just above your soldering iron tip will eventually shrink it enough.)

**( DO NOT USE EXCESSIVE HEAT OR ANY FLAME!!)**

- Slide the 6.5mm thick heat shrink tube over the joint and heat it until it shrinks.



The plastic end of the sensor has been deliberately left un-covered so that will react more quickly to temperature changes.



- At the other end of the cable, pass the wires through the holes from the underside of the main board then bend them over and solder them into each hole numbered as shown.  
**1: Blue      2: Green      3: Red**

(When making your case, don't forget to make a hole big enough to pass the sensor through and perhaps anchor the cable to the case using a small nylon cable tie.)

- Plug-in the tube board and secure it with the screws.

**The assembly of your clock is now complete.**

## **Final Testing**

Due to the high voltage present on the board, you must **put the finished clock in a suitable case (not supplied)**.

You can first check that the tubes are working by carefully applying power, **(NEVER TOUCH THE BOARD WHILE POWERED!)**

Both tubes should count down from 9 to 0 and then start showing the time: "12:00 pm"  
(The countdown test at power-on will only happen when the time has not been set.)

## **Troubleshooting**

Please see the "Dyadnix Circuit Description" manual for a complete schematic diagrams and problem diagnosis section.

## **Feedback**

We welcome any suggestions or comments to:  
\*\*\*\*\* or use the contact form on our web site.