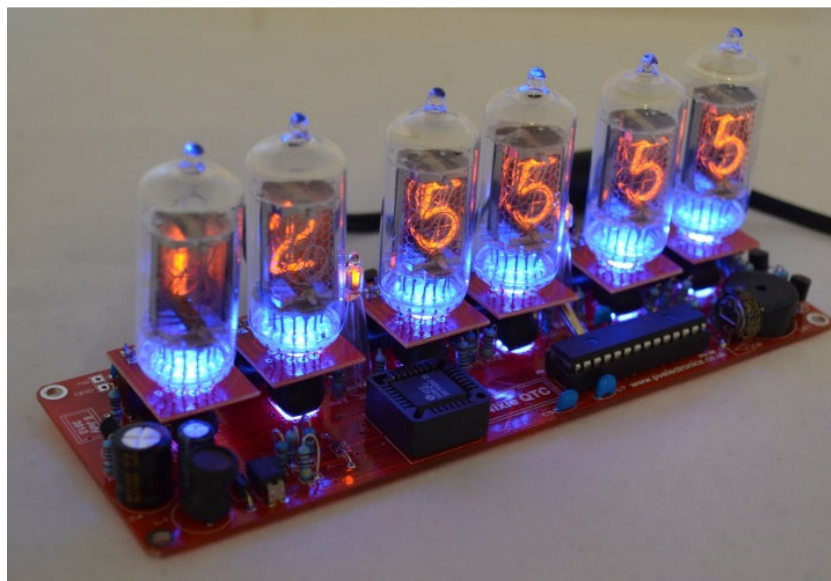


# **Assembly Instructions And User Guide**

## **Nixie Clock Type 'Nixie QTC'**

For PCB dated 30 Sept 2014,  
parts bags up to Serial Number 1100



## REVISION HISTORY

| Issue Number | Date              | Reason for Issue   |
|--------------|-------------------|--|
| 11a          | 11 December 2014  | C5 changed to 10pF. Typing errors corrected                                |
| 11           | 17 October 2014   | New PCB – 30 September 2014  |
| 10a          | 21 March 2014     | Errors corrected   |
| 10           | 20 March 2014     | New tube types added and code configuration procedure                      |
| 9            | 03 April 2013     | Troubleshooting connections chart added<br>ZM1177 tube procedure clarified |
| 8a           | 09 September 2013 | Improved IN14 cell details   |
| 8            | 21 October 2012   | WWVB No Longer supported   |
| 7            | 8 October 2012    | ZM1177 Tube details added  |
| 6            | 5 August 2012     | Component designation errors corrected                                     |
| 5            | 27 July 2012      | New PCB date 5 July 2012   |
| 4            | 14 June 2012      | 1 <sup>st</sup> review   |
| 3            | 29 May 2012       | Errors in component listing corrected                                      |
| 2            | 22 May 2012       | Anode resistors corrected to 10K $\Omega$                                  |
| 1            | 20 May 2012       | New document   |

## 1. INTRODUCTION

### 1.1 What is Nixie QTC?

Nixie QTC takes a new path for Nixie Clocks for mid-sized solder-in tubes. Learning from our past experiences of thousands of kits sold, we recognise a major customer concern and possibly the biggest drawback with solder-in tubes: They are soldered in!

Previously, a failed tube always meant a treacherous operation to delicately remove the tube whilst trying to preserve all traces intact. Whilst this was certainly possible, It was never easy, and made it uncomfortable to give a Nixie Clock as a gift in case a tube ever failed. With Nixie QTC ('Quick Tube Change'), each tube is soldered only to its own mini 'tube cell' PCB. A tube can be changed in minutes with no danger to the main PCB. The small addition in cost is dwarfed by the huge advantage this gives. A single main board is capable of driving tens of different types of solder-in Nixie Tube. You can even completely change the tube type of your clock by installing new tube cells and tubes.

#### **Software**

But at such a major change in direction, we have also taken the opportunity to build on the solid software foundations of the predecessor 'Frank 2' format and add some truly useful and productive software features. As before, the main controller is the mighty PIC16F1936 running at 16Mhz. The code is programmed entirely in the 'C' programming language.

#### **Drive Mode**

The former K155ID1 / 74141 nixie driver IC is now replaced by a modern HV5812 High Voltage Driver IC by Supertex. With 20 outputs, it is able to drive the six Nixie Tubes in a very comfortable and low noise 3X2 multiplex.

#### **GPS Time Synchronisation**

A radical new clock design deserves a new and exciting GPS receiver module for those that demand the best timekeeping. And, with a groundbreaking price for a GPS receiver, a fully featured Nixie Clock with GPS synchronisation is now within the price range of most buyers.

## **1.2 Nixie QTC - Features**

Nixie clock type 'Nixie QTC' has the following features:

- Hours, Minutes and Seconds display
- 12 or 24 hour modes
- Uses a Quartz Crystal Oscillator as the timebase
- Programmable leading zero blanking
- Date display in either DD.MM.YY or MM.DD.YY or YY.MM.DD format
- Programmable date display each minute
- Scrolling display of date or standard display
- Alarm, with programmable snooze period
- Optional DCF / MSF / GPS synchronisation with status indicator LED
- Dedicated DST button to switch between DST and standard time
- Supercapacitor backup. Keeps time during short power outages
- Simple time setting using two buttons
- Programmable leading zero blanking
- Five programmable neon colon settings (Flashing AM/PM indication, illuminated AM/PM indication, both flashing, both on, both off)
- Seconds can be reset to zero to precisely the set time
- Programmable night mode - blanked or dimmed display to save tubes or prevent sleep disturbance
- Rear Indicator LEDs dim at night to prevent sleep disturbance
- Weekday aware 'Master Blank' function to turn off HV/ tubes and LEDs on weekends or during working hours
- Separate modes for colon neons during night mode
- Standard or fading change of digits
- Standard, fading, or fading with scrollback display modes
- 'Slot Machine' Cathode poisoning prevention routine
- Programmable RGB tube lighting – select YOUR favourite colour palette
- 729 colours possible. Have a different colour or your choosing every hour, or autochanging colours.
- Not AC frequency dependent – works in all countries
- All user preferences stored to non-volatile memory

### 1.3 Tubes Supported

Each tube is soldered to a mini PCB 'Cell', making tubes easily changeable. Through the use of 2 different cell types, and 3 different configurations of the microcontroller, it is possible for the kit to drive a wide range of solder-in tubes as detailed in the table below. There are detailed and specific instructions for mounting each type of tube, in sections 5.1 to 5.8 of this manual.

| Tube types  | Cell type | Code Configuration | Section |
|---|-----------|--------------------|---------|
| IN-14   | IN-14     | A                  | 5.1     |
| IN-8-2, ZM1177  | IN-8-2    | A                  | 5.2     |
| Z570M, Z5700M, Z573M, Z5730M, Z574M, Z5740M, GN-9A, B570M, TAF1317A, TAU7030, F9080B, F9080BA, TAF1093A, ZM1080, ZM1082, ZM1134, ZM1135, ZM1136, ZM1136A, ZM1136L, ZM1136R, ZM1138A, ZM1138L, ZM1138R | IN-8-2    | A                  | 5.3     |
| GNP-17A   | IN-8-2    | A                  | 5.4     |
| GNP-7A, GNP-7AH   | IN-8-2    | A                  | 5.5     |
| ZM1210, ZM1212  | IN-8-2    | B                  | 5.6     |
| IN-16   | IN-14     | C                  | 5.7     |
| CD66, ZM1240, ZM1242, XN11, XN12  | IN-8-2    | A                  | 5.8     |

## 1.4 SAFETY

**DANGER:** The clock pcb includes a switched-mode voltage booster circuit. This generates nominally 170 Volts DC. Assembly may only be undertaken by individuals who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. If in doubt, refer to a suitably qualified engineer before proceeding.

**The voltages generated by this circuit can give a potentially LETHAL ELECTRIC SHOCK.**

DISCLAIMER: This product is supplied as a kit of parts, intended only for suitably qualified electronic engineers, who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. The supplier, his agents or associates accept no liability for any damage, injury or death arising from the use of this kit of parts.

This is not a finished product, and the person assembling the kit is responsible for ensuring that the finished product complies with any applicable local regulations governing electrical equipment, eg. UL, CE, VDE.

## 2. TOOLS AND EQUIPMENT REQUIRED

### 2.1 Tools required to assemble the PCB.

The following tools will be required to assemble the PCB:

- Soldering iron with a small tip (1-2 mm).
- Wire cutters to trim the excess component leads after soldering.  
(TIP: A small pair of nail clippers works very well for this function).
- Wire strippers (TIP: A small pair of scissors is quite suitable).
- Multimeter for voltage tests and for identifying the resistors.
- For the RGB LED tube lighting, a small hot air gun will be needed to shrink the heat shrink tubing over the LEDs to form the light guides. A small hair dryer may work for this.

### 2.2 Materials you will need.

Solder – lead / tin solder is highly recommended. **USE LEAD/ TIN SOLDER!**

Lead free solder, as now required to be used in commercial products in Europe, has a much higher melting point and can be very hard to work with.

Desoldering wick (braid) can be useful if you accidentally create solder bridges between adjacent solder joints.

### 2.3 Other items you will need.

The clock kit does not include a power adapter.

The following type of adapter should be obtained and used with the kit:

*Output 12V DC regulated, minimum power output capability of 500 mA  
Output plug: 2.1mm pin, centre positive.*

A suitable adapter is shown below:



### 3. LIST OF COMPONENTS

#### 3.1 Table of Components – Driver Board

| Circuit Designation        | Part Description                 |
|----------------------------|----------------------------------|
| <b>Resistors</b>           |                                  |
| R1                         | 4.7 K $\Omega$ , ¼ Watt          |
| R2                         | 390 K $\Omega$ , ¼ Watt          |
| R3                         | 4.7 K $\Omega$ , ¼ Watt          |
| R4                         | 390 K $\Omega$ , ¼ Watt          |
| R5                         | 4.7 K $\Omega$ , ¼ Watt          |
| R6 - R11                   | 270 $\Omega$ , ¼ Watt            |
| R12 - R14                  | 4.7 K $\Omega$ , ¼ Watt          |
| R15 - R17                  | 390 K $\Omega$ , ¼ Watt          |
| R18 - R20                  | 10 K $\Omega$ , ¼ Watt           |
| R21 - R28                  | 4.7 K $\Omega$ , ¼ Watt          |
| R29, R30                   | 390 K $\Omega$ , ¼ Watt          |
| R31 - R48                  | 270 $\Omega$ , ¼ Watt            |
| <b>Capacitors</b>          |                                  |
| C1, C2                     | 220uF Electrolytic               |
| C3                         | 1uF, 250V,                       |
| C4                         | 220uF, 16-25V, Electrolytic      |
| C5                         | 10pF Ceramic                     |
| C6                         | 15pF Ceramic                     |
| C7                         | 100nF Ceramic                    |
| C8                         | 0.1F or 0.22F                    |
| C9, C10                    | 100nF                            |
| <b>Transistors</b>         |                                  |
| Q1                         | IRFD220 MOSFET                   |
| Q2 - Q4                    | 2N7000 MOSFET                    |
| Q5 - Q7                    | MPSA42                           |
| Q8 - Q10                   | MPSA92                           |
| Q11 - Q13                  | MPSA42                           |
| <b>Diodes</b>              |                                  |
| D1 - D3                    | 1N5819                           |
| D4                         | 62V zener                        |
| D5                         | UF4004                           |
| D6                         | 5mm Yellow LED                   |
| D7                         | 5mm Green LED                    |
| D8                         | 5mm Yellow LED                   |
| D9                         | 62V zener                        |
| D10 - D15                  | RGB 5mm LED, common anode        |
| <b>Integrated Circuits</b> |                                  |
| IC1                        | LM2576 5V voltage regulator      |
| IC2                        | PIC16F1936 8-bit microcontroller |
| IC3                        | HV5812                           |
| <b>Miscellaneous</b>       |                                  |
| L1, L2                     | 100uH inductor                   |
| AM, PM                     | 4mm wire ended neon lamp         |
| ALARM, SET, ADJ, DST       | Miniature push button            |
| IC2 Socket                 | 28 Way narrow IC socket for IC2  |
| IC3 Socket                 | PLCC28 IC socket for IC3         |



|            |                                 |
|------------|---------------------------------|
| J1         | 2.1mm PCB power socket          |
| GPS / RFT  | Surface mount 3.5mm jack socket |
| LS1        | Piezo sounder                   |
| FUSE       | 500mA fuse                      |
| Insulation | Clear insulation for neons      |
| NX1 – NX6  | 2X6 way 0.1" header plug        |
| X1         | 32.768KHz watch crystal         |

### 3.2 Parts list / Packing Sheet - Component Bag

| Part Description                 | Quantity |
|----------------------------------|----------|
| <b>Resistors</b>                 |          |
| 270 $\Omega$ , ¼ Watt            | 24       |
| 4.7 K $\Omega$ , ¼ Watt          | 14       |
| 10 K $\Omega$ , ¼ Watt           | 3        |
| 390 K $\Omega$ , ¼ Watt          | 7        |
| <b>Capacitors</b>                |          |
| 10pF, Ceramic                    | 1        |
| 15pF, Ceramic                    | 1        |
| 100nF, Ceramic                   | 3        |
| 1uF, 250V, Electrolytic          | 1        |
| 220uF, 16-25V, Electrolytic      | 3        |
| 0.1F or 0.22F                    | 1        |
| <b>Transistors</b>               |          |
| IRFD220 MOSFET                   | 1        |
| MPSA42                           | 6        |
| MPSA92                           | 3        |
| 2N7000                           | 3        |
| <b>Diodes</b>                    |          |
| 1N5819                           | 3        |
| UF4004 fast recovery diode       | 1        |
| 62V Zener diode                  | 2        |
| 5mm Green LED                    | 1        |
| 5mm Yellow LED                   | 2        |
| 5mm RGB LED                      | 6        |
| <b>Integrated Circuits</b>       |          |
| LM2576 5V voltage regulator      | 1        |
| PIC16F1936 8-bit microcontroller | 1        |
| HV5812                           | 1        |
| <b>Miscellaneous</b>             |          |
| 100uH inductor                   | 2        |
| 4mm wire ended neon lamp         | 2        |
| Miniature push button            | 4        |
| 28 way narrow IC Socket for IC2  | 1        |
| PLCC28 IC Socket for IC3         | 1        |
| 2.1mm PCB power socket           | 1        |
| Surface mount 3.5mm jack socket  | 1        |
| Piezo sounder                    | 1        |
| 500mA fuse                       | 1        |
| Clear insulation for neons       | 1        |
| 2X6 way 0.1" header plug         | 6        |
| 2X6 way 0.1" header socket       | 6        |
| 32.768KHz watch crystal          | 1        |

It is recommended that the kit is checked against the list above, to ensure all parts are present before commencing assembly. Don't be alarmed if there are some extra components, as some component bags are shared between different kit types.

The resistors used in the kit are 1% tolerance metal film. They are marked with 4 coloured bands to identify the value. However it is sometimes unclear in which direction the bands should be read.

Therefore, we recommend that the resistors be identified with a multimeter.

Please note the fuse will look like the picture below. It can easily be confused for a capacitor. It is a self-resetting fuse.



## 4. ASSEMBLY OF THE PCB

**DUE TO PRODUCT DEVELOPMENT AND IMPROVEMENTS, YOUR PCB MAY NOT LOOK EXACTLY LIKE THE ONE PICTURED.**

### 4.1 Low Voltage Power components:

**J1, FUSE**

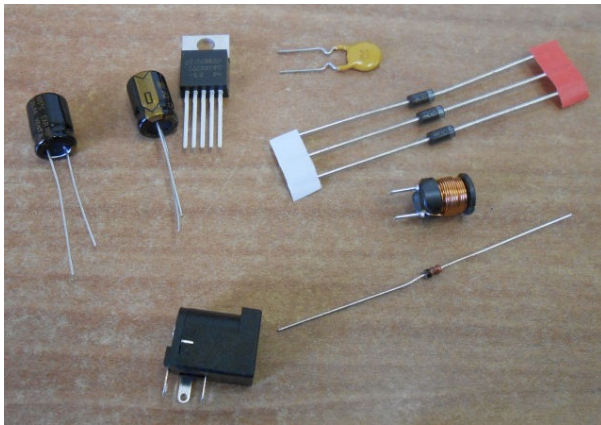
**D1-D3 (1N5819)**

**D4 (62V Zener Diode)**

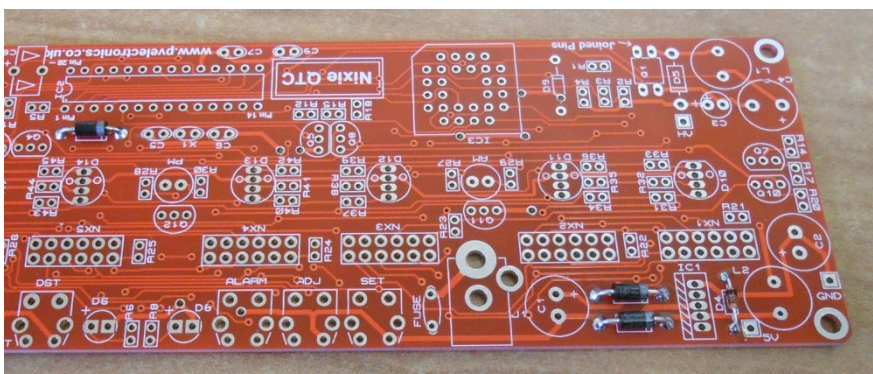
**IC1 (LM2576)**

**L2 (100uH Inductor)**

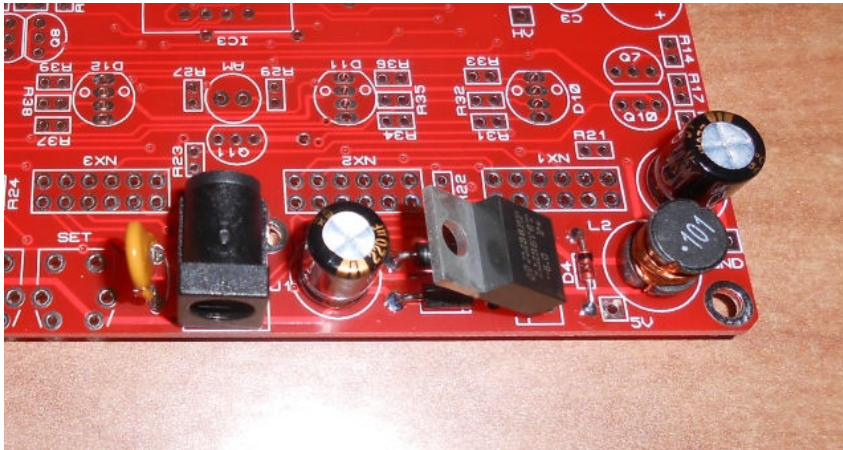
**C1, C2 (220uF)**



Start by installing D1-D4. Align the band on the components with the band marked on the PCB.

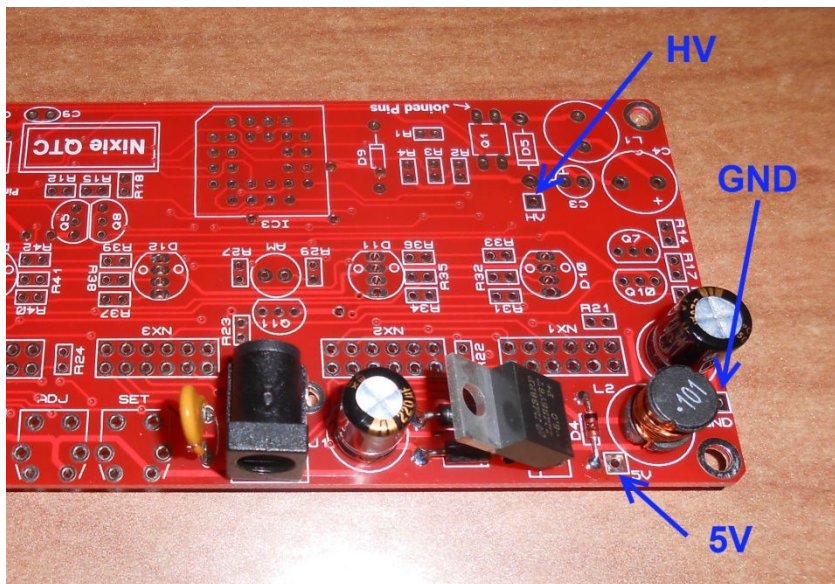


After placement, IC1 can be placed and bent over these diodes to reduce the height of the assembled PCB. Continue to mount C1, C2, J1 and FUSE. C1 and C2 are polarized. The longer lead goes in the hole marked '+'.



#### 4.2 Testing Low Voltage Power Supply.

Identify the test GND, 5V and HV test points as shown below.



Plug in the power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 5.6 and 5.9 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.



#### **4.3 High Voltage Generator components.**

**Socket for IC2**

**R1, R3 (4.7 K $\Omega$ )**

**R2, R4 (390 K $\Omega$ )**

**C3 (1 $\mu$ F)**

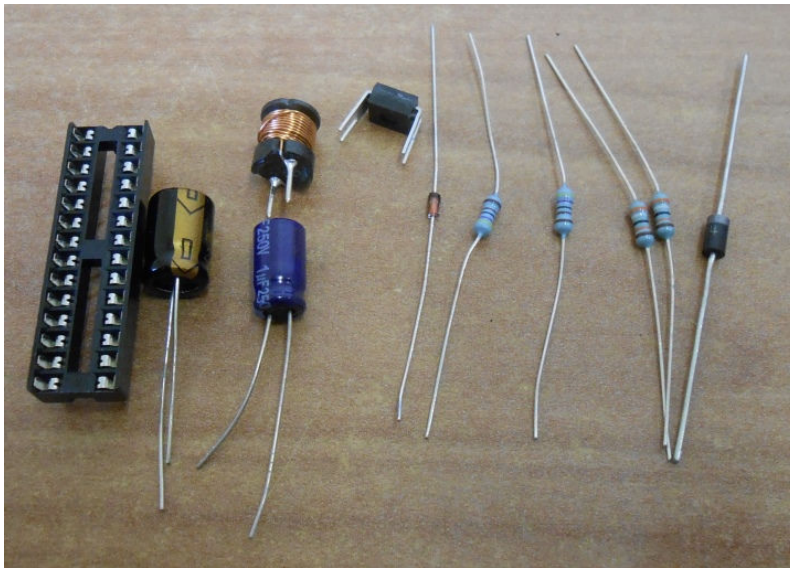
**C4 (220 $\mu$ F)**

**Q1 (IRFD220)**

**L1 (100 $\mu$ H Inductor)**

**D5 (UF4004)**

**D9 (62V Zener diode)**

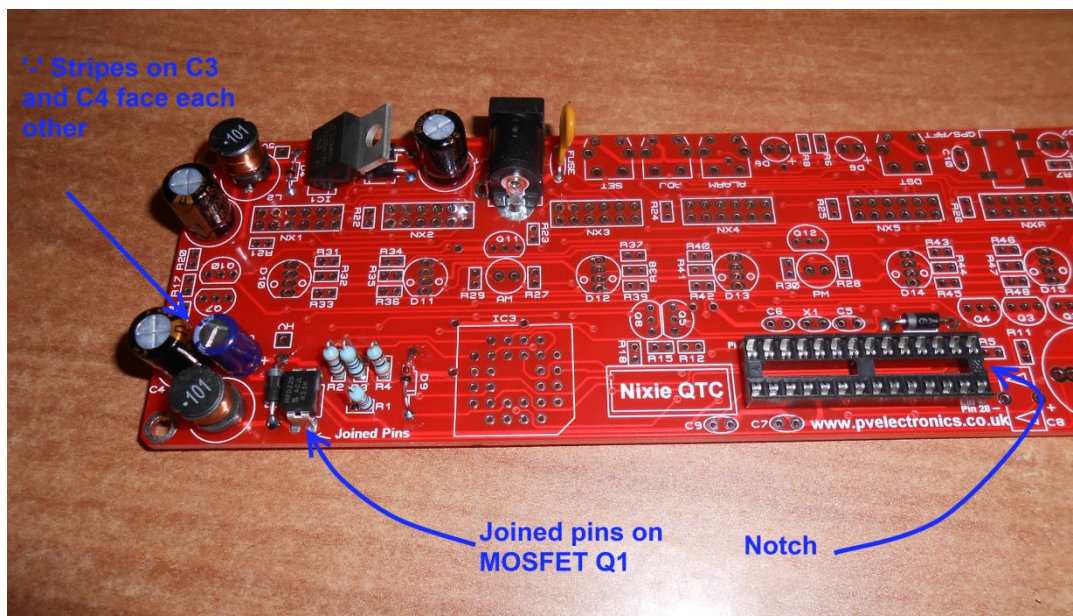


All the resistors on the board need to be mounted upright to save space. The leads need to be formed as shown below. Bend the leads of each resistor as shown and solder in to the correct position, making sure the component body is as close to the board as possible.



Take care that the notched end of the IC socket is at the end shown. Also the MOSFET needs to be placed with the two joined pins at the position shown below.

Ensure that the (-) light stripes on C3 and C4 are facing inwards towards each other as shown below.



#### **4.4 High Voltage Generator Test.**

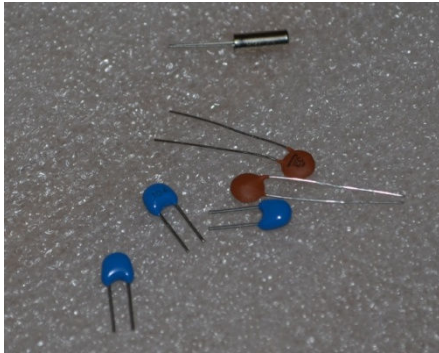
- Refer to the warnings on page 5
- Insert IC2 into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.
- Power up the PCB, and using the GND and HV test points, measure the high voltage generated using a voltmeter on DC setting. It should be between 165 and 175 Volts. If this is in order, disconnect the power supply.

#### **4.5 C5 (10pF)**

**C6 (15pF)**

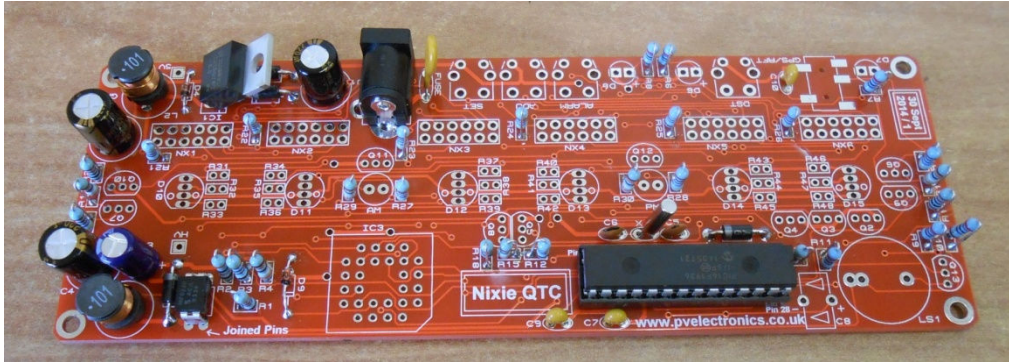
**X1 (32.768KHz Crystal)**

**C7, C9, C10 (100nF)**





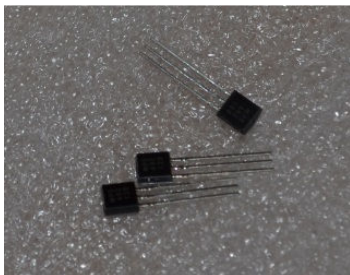
- 4.6 R6 - R11 (270  $\Omega$ )  
R5, R12 - R14, R21 - R28 (4.7 K $\Omega$ )  
R15 - R17, R29, R30 (390 K $\Omega$ )  
R18 - R20 (10 K $\Omega$ )**



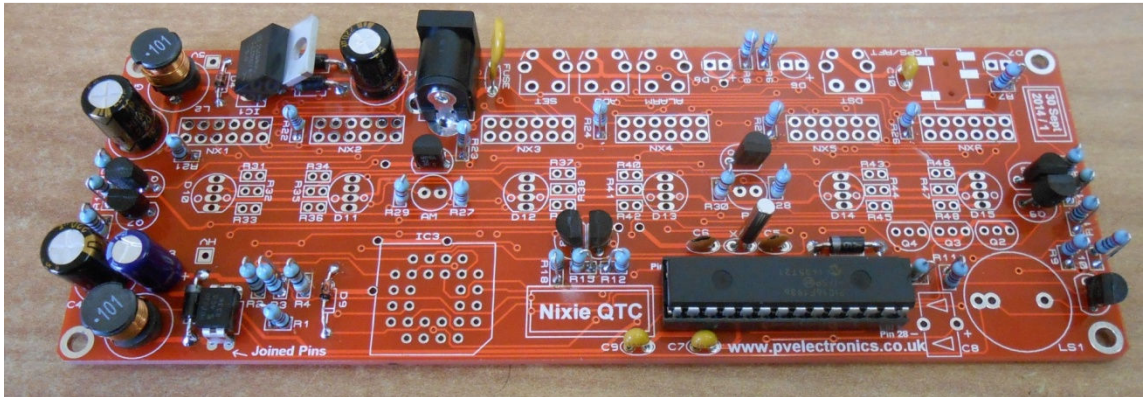
- 4.7 Q5, Q6, Q7, Q11, Q12, Q13 (MPSA42)**



- 4.8 Q8, Q9, Q10 (MPSA92)**

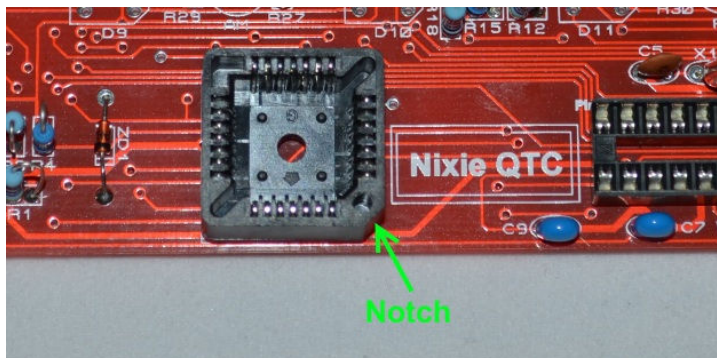


**This is how the PCB should look now:**



#### **4.9 Socket for IC3**

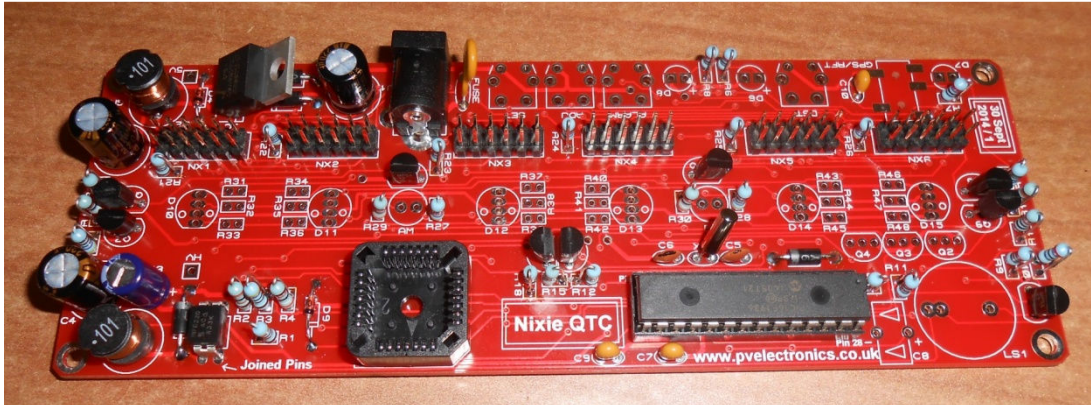
Align the notch on one corner of the socket with the marking on the PCB. Be careful not to force in the socket if all pins are not aligned. Ensure all pins are fully pushed through the holes before soldering in place.



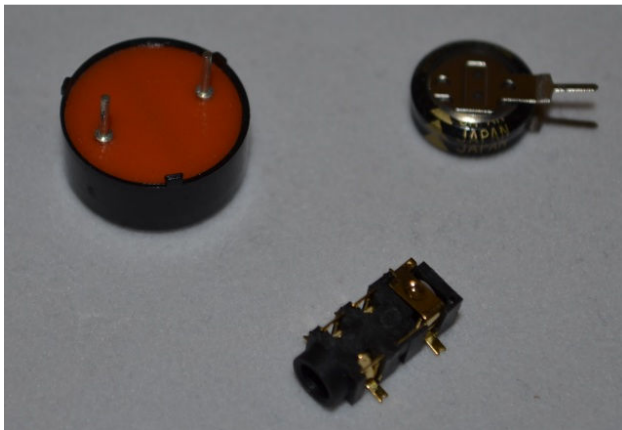
#### **4.10 NX1 – NX6 (6X2 way male pin header)**



Ensure the connectors are soldered very close to the PCB.



#### 4.11 GPS/ RFT Connector LS1 (Piezo Buzzer) C8 (0.1F)



To solder the GPS / RFT connector: First wet one pad on the PCB with solder. Then place the connector in position and re-touch the pad with the soldering iron. This will anchor the component and then you can solder the remaining pads.

Ensure the arrows on C8 are aligned with the corresponding arrows on the PCB

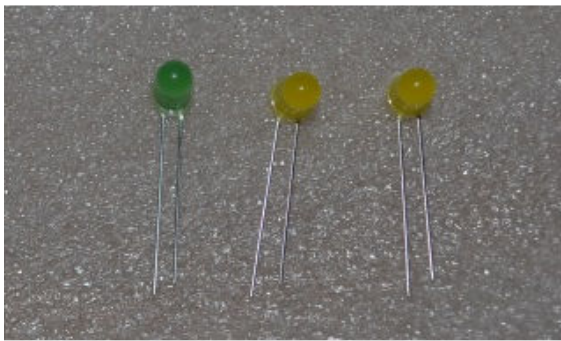


#### 4.12 D7 (5mm Green LED)

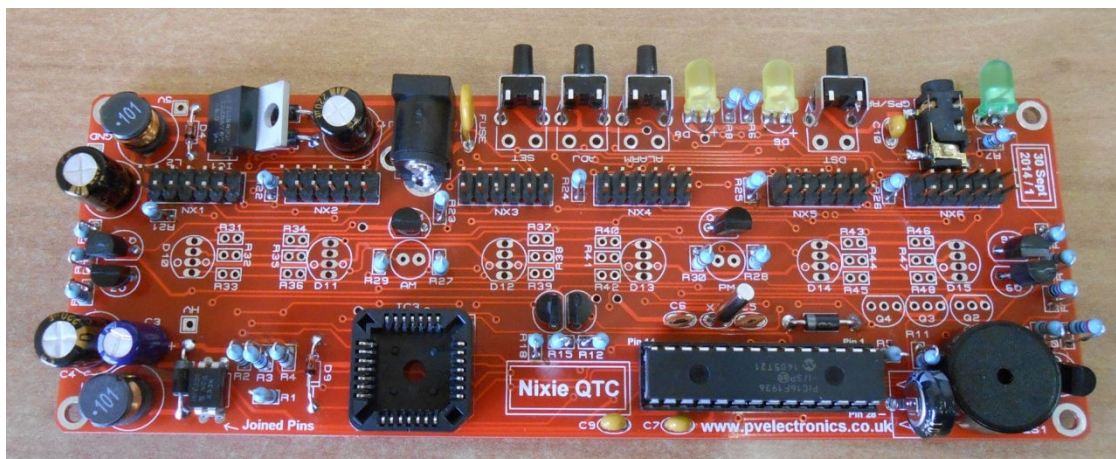
#### D6, D8 (5mm Yellow LED)

#### SET, ADJ, ALARM, DST (Push switches)

First, bend the leads of the LEDs as shown below, paying attention to the longer (+) lead being on the left hand side. Then solder in place with the body of the LED just touching the PCB.



Then place and solder the 4 push button switches:



#### 4.13 AM, PM Neon Indicators

It is a good idea to install these components at the very end of the assembly, when you have a better idea of a suitable height that will look perfect with your design of case. So, do not install them now but remember to install them some time later! Use small pieces of the clear insulation supplied to prevent shorts on the leads.

## 5. ASSEMBLING THE NIXIE TUBE CELLS

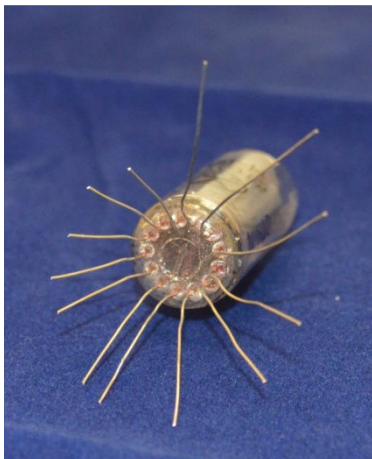
PLEASE REFER TO THE APPROPRIATE SECTION FOR YOUR NIXIE TUBE TYPE.

### 5.1 IN-14 Nixie Tubes.

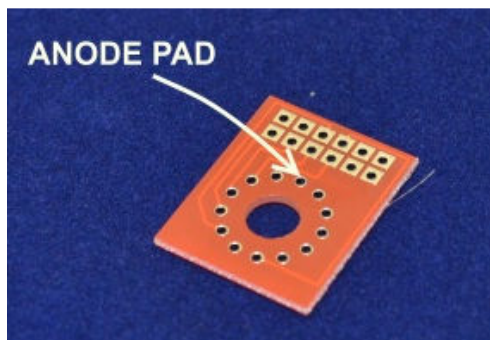
***Tube cell type: IN-14***  
***Code configuration: A***

To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors as shown below. Start by identifying the anode lead at the back of the tube. It has a white coating where it enters the glass.

Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

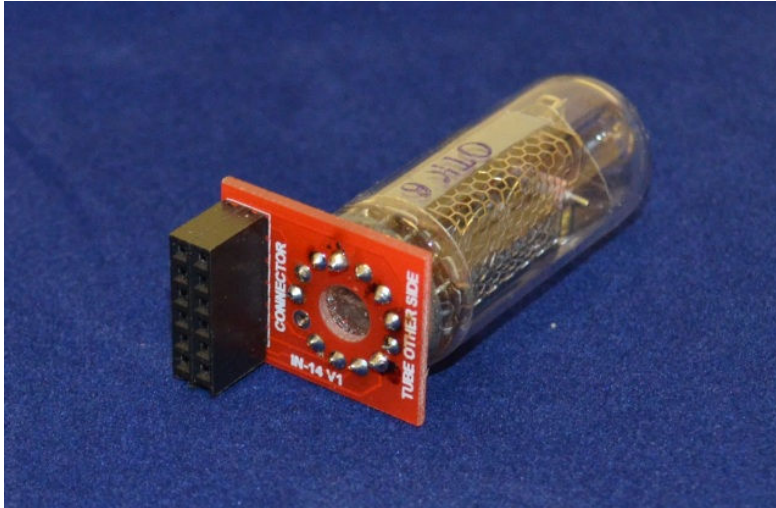


Referring to the picture below, identify the anode pad on the tube cell PCB. The tube is inserted from the side with no white markings:



**NOTE: IN-14 Cells supplied from August 2013 will not have the two holes either side of the anode. Simply clip off the two leads either side of the anode.**

Now you can insert and solder in the tube. Pay attention that the tube sits squarely on the PCB.  
Then solder on the connector (which may be in two pieces).



The tube cell is now complete. Repeat for the other 5 tubes.  
Then move on to step 6.

## 5.2 IN-8-2 and ZM1177 Nixie Tubes.

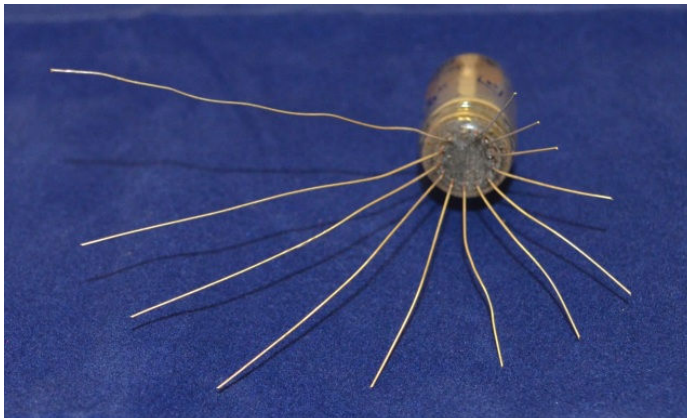
***Tube cell type: IN-8-2***

***Code configuration: A***

These tubes have a gap between leads at the back of the tube. The ZM1177 in fact has a small stub of a lead that is trimmed at manufacture. This helps identify the back of the tube, as well as being opposite to the viewing face of the tube.

The ZM1177 also has a gap between tubes near the front. Disregard this gap - the wires at either side will fit into adjacent holes on the PCB. Remember: 12 wires into 12 holes.

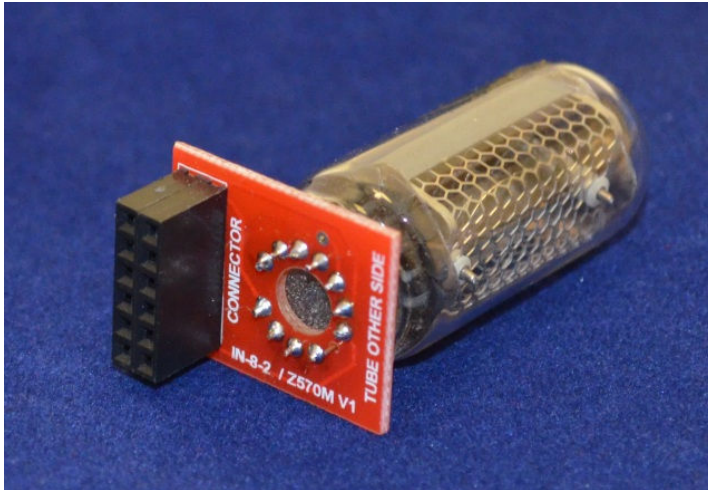
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.



Now you can insert and solder in the tube. Insert the 12 leads into the 12 holes. Insert from the side of the PCB with no markings. Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Note that there is one hole that is unused - simply trim off this lead without soldering.

Then solder on the connector (which may be in two pieces).



The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 6.

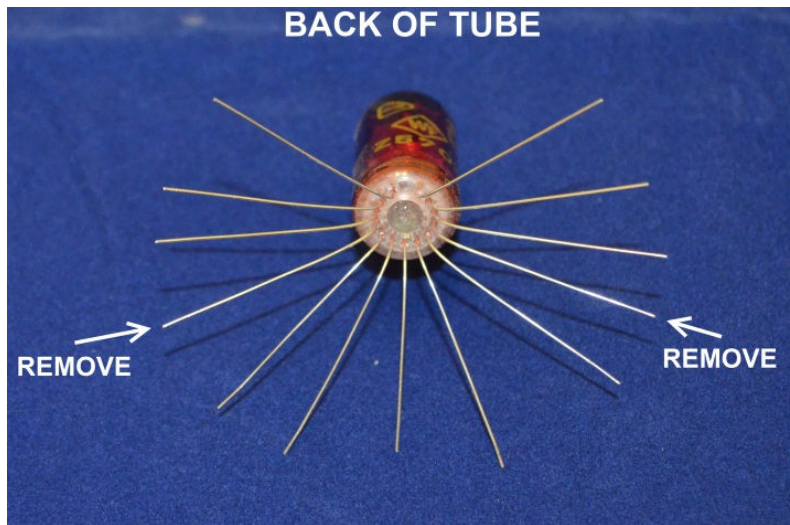


### 5.3 Z570M, Z573M, ZM1080, ZM1082, GN9A, ZM1136 Nixie Tubes.

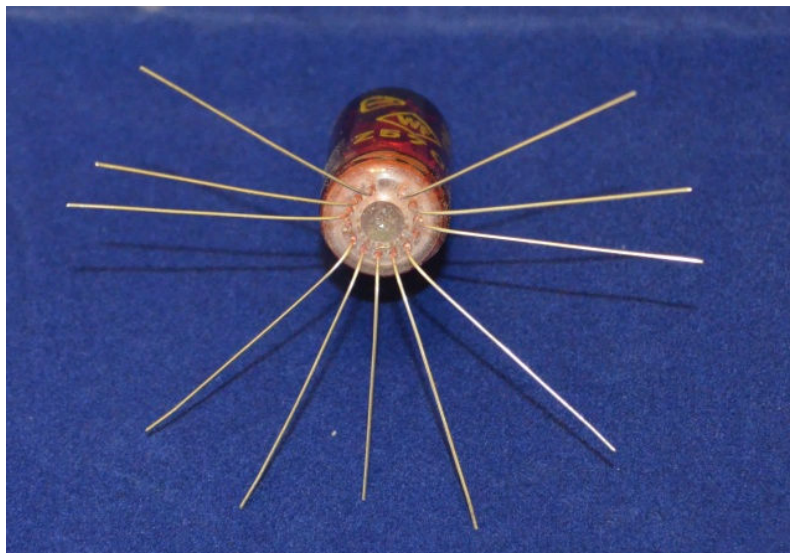
***Tube cell type: IN-8-2***

***Code configuration: A***

It is necessary to clip off two of the Z570M and equivalent tube leads: Clip off the two leads as shown below:

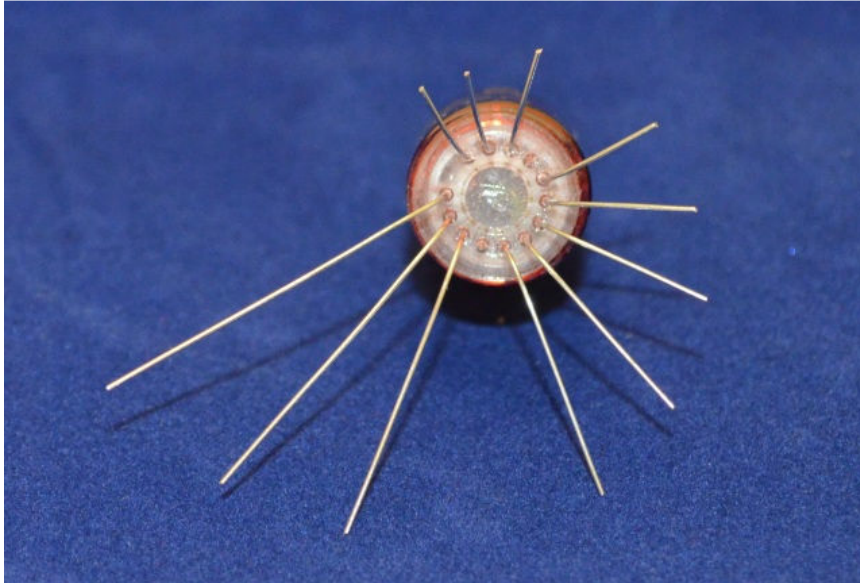


This is how the tube will look after removing the leads:

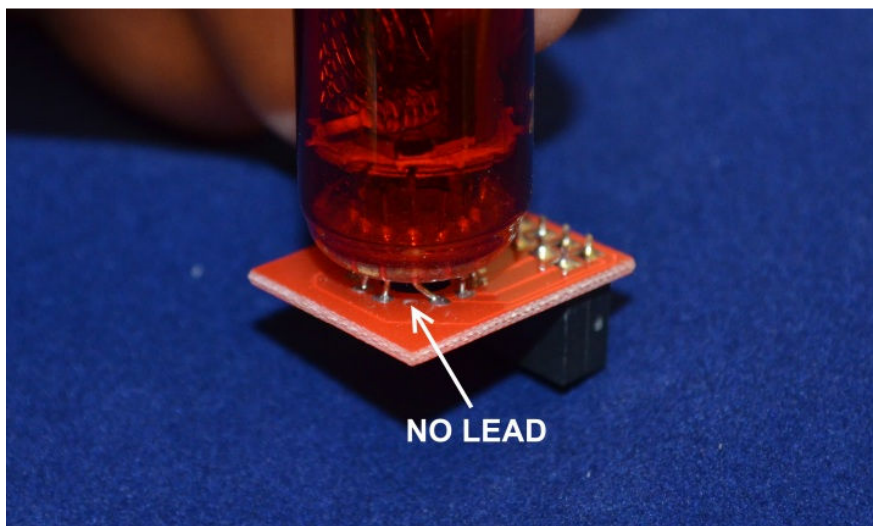


To facilitate easy insertion of the flying leads into the PCB holes, it helps enormously to trim the remaining flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube.

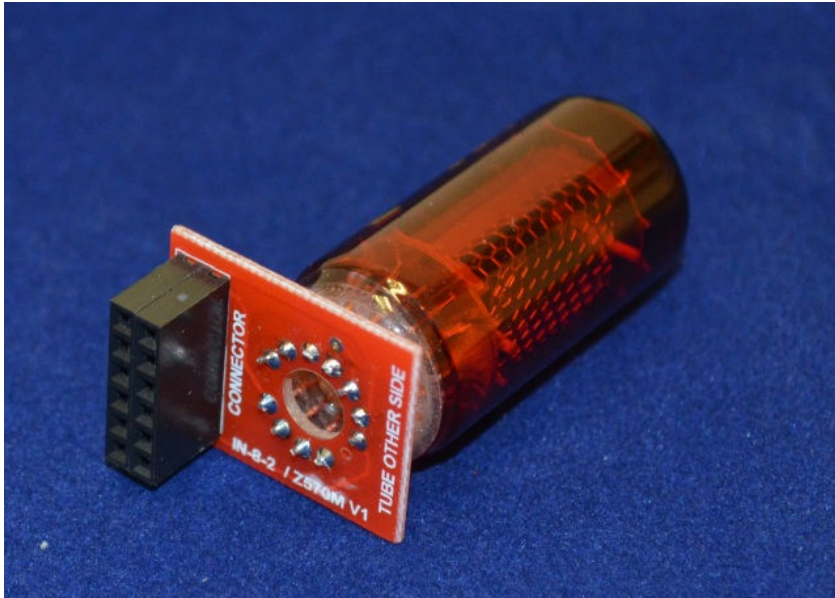
Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.



Now you can insert and solder in the tube.  
There are 11 leads on the trimmed tube and 12 pads on the PCB.  
One of the pads on the PCB is unconnected. DO NOT INSERT A LEAD INTO THIS HOLE:



Insert from the side of the PCB with no markings.  
Pay attention that the tube sits squarely on the PCB.  
Then solder on the connector.



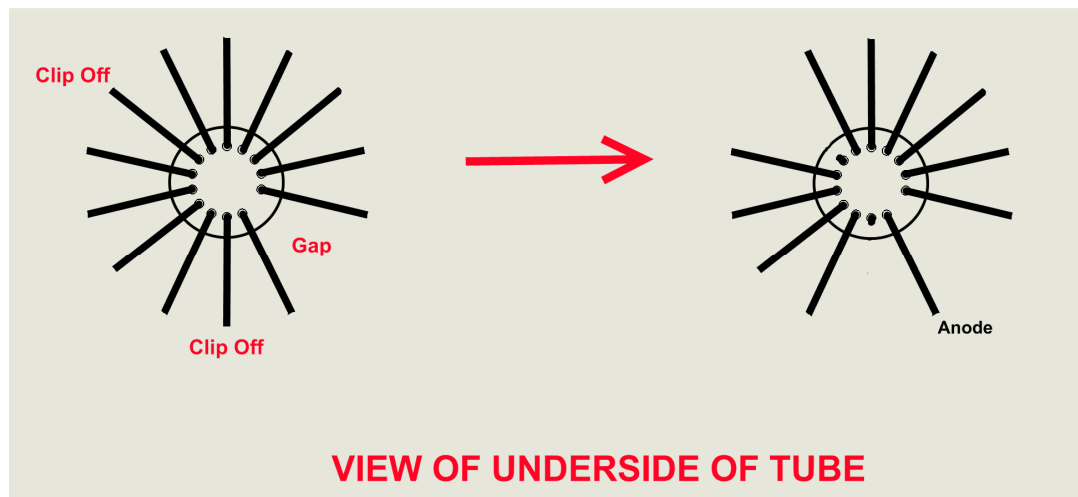
The tube cell is now complete. Repeat for the other 5 tubes.  
Then move on to step 6.

## 5.4 GNP-17A Nixie Tubes.

**Tube cell type: IN-8-2**

**Code configuration: A**

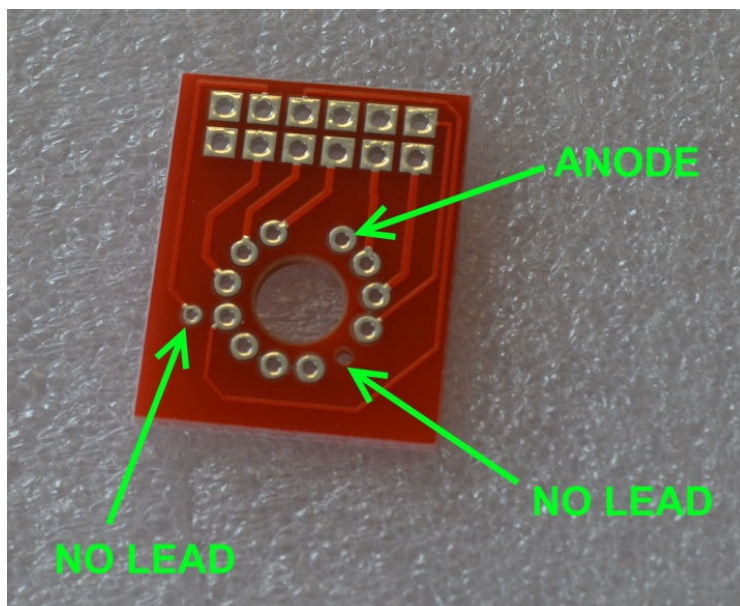
These tubes have 2 leads that need to be removed as shown below. Use the gap to correctly orient the tube:



To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

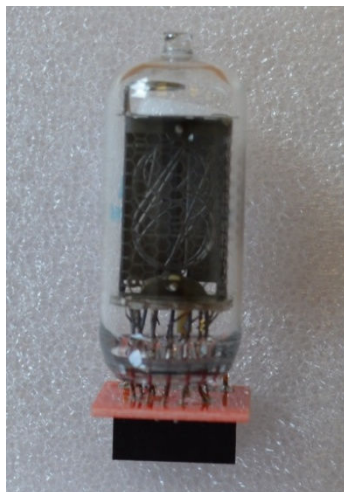
Now you can insert and solder in the tube. Insert the 11 leads into the 11 holes with pads as shown below. Insert from the side of the PCB with no markings.





Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Then solder on the connector .



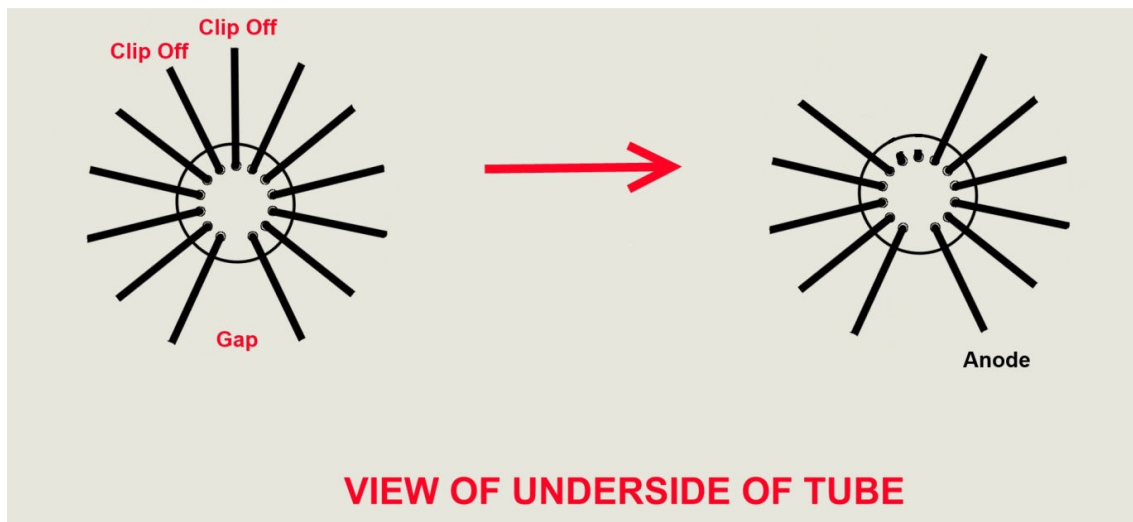
The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 6.

## 5.5 GNP-7A and GNP-7AH Nixie Tubes.

**Tube cell type: IN-8-2**

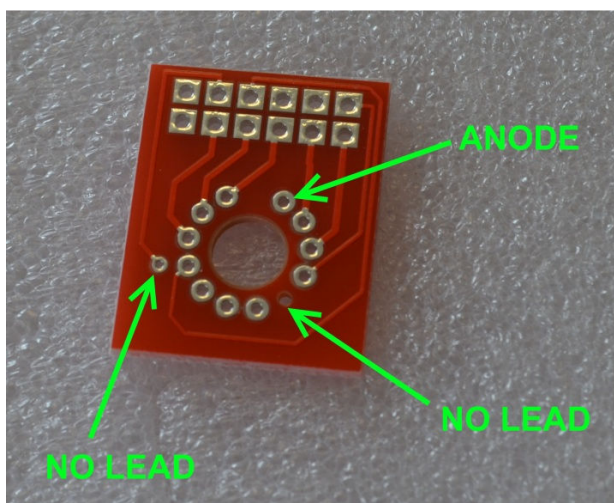
**Code configuration: A**

These tubes have 2 leads that need to be removed as shown below. Use the gap to correctly orient the tube:



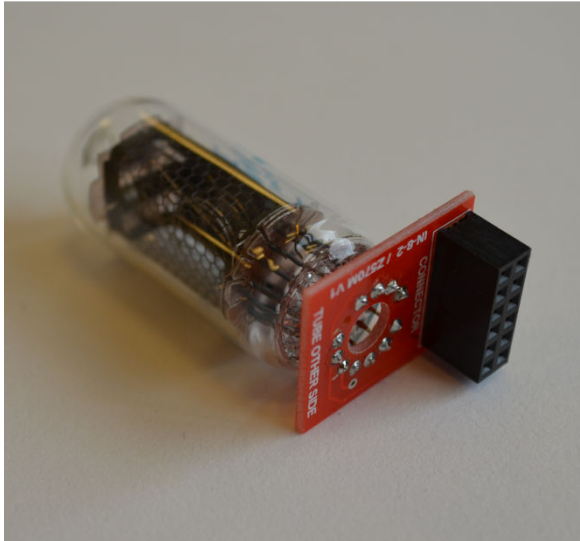
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

Now you can insert and solder in the tube. Insert the 11 leads into the 11 holes with pads as shown below. Insert from the side of the PCB with no markings.



Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Then solder on the connector.



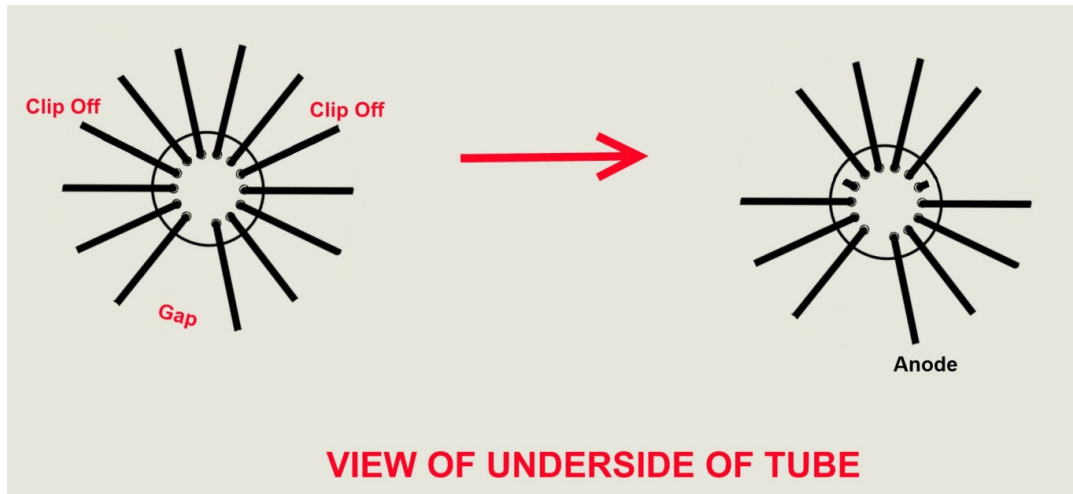
The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 6.

## 5.6 ZM1210 and ZM1212 Nixie Tubes.

**Tube cell type: IN-8-2**

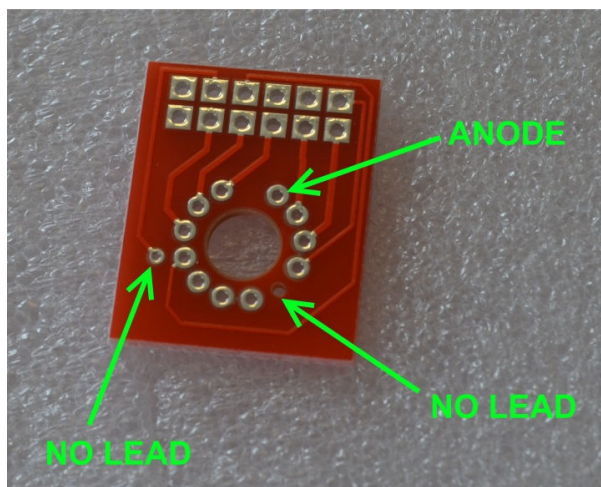
**Code configuration: B**

These tubes have 2 leads that need to be removed as shown below. Use the gap to correctly orient the tube:



To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

Now you can insert and solder in the tube. Insert the 11 leads into the 11 holes with pads as shown below. Insert from the side of the PCB with no markings.





Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Then solder on the connector .



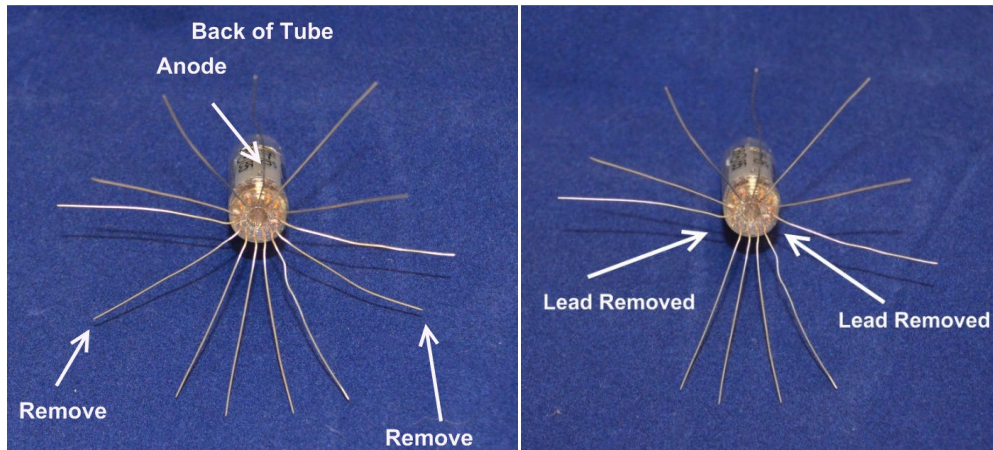
The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 6.

## 5.7 IN-16 Nixie Tubes.

**Tube cell type: IN-14**

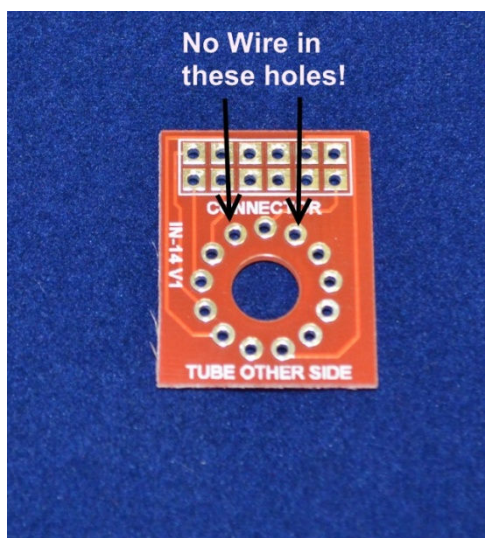
**Code configuration: C**

These tubes have 2 leads that need to be removed as shown below. Use the back of the tube to correctly orient the tube:



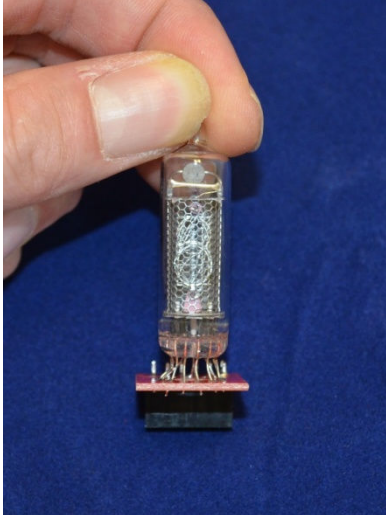
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

Now you can insert and solder in the tube. Insert the 11 leads into the 11 holes with pads as shown below. Insert from the side of the PCB with no markings.



Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Then solder on the connector .



The tube cell is now complete. Repeat for the other 5 tubes.  
Then move on to step 6.

## 5.8 CD66, ZM1242, ZM1240, XN11 and XN12 Nixie Tubes.

**Tube cell type: IN-8-2**

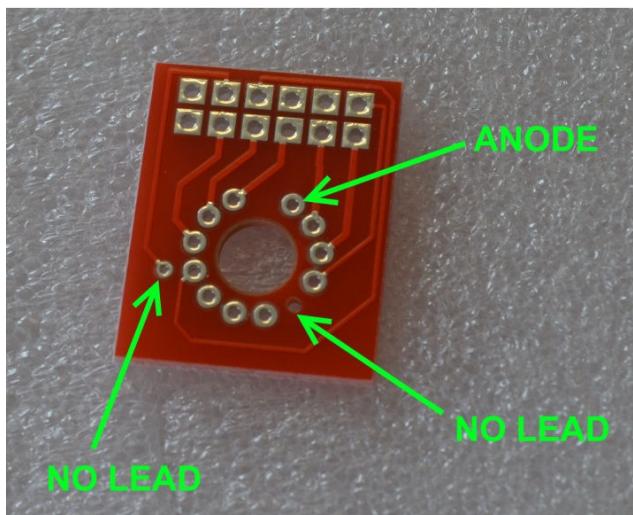
**Code configuration: A**

**CD66, ZM1240 and ZM1242:** These tubes have 1 lead at the very back of the tube that needs to be removed. Ensure you only clip the lead at the very back of the tube, this will leave you with 11 leads remaining and a gap at the back of the tube. Proceed as for XN11 and XN12 below.

**XN11 and XN12:** These tubes have 11 leads and a gap at the very back of the tube.

To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each successive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

Now you can insert and solder in the tube. Insert the 11 leads into the 11 holes with pads as shown below. Insert from the side of the PCB with no markings.



Pay attention that the tube sits squarely on the PCB. Ensure the tube is facing perfectly forwards before soldering - you may need to twist it a little.

Then solder on the connector.

The tube cell is now complete. Repeat for the other 5 tubes.

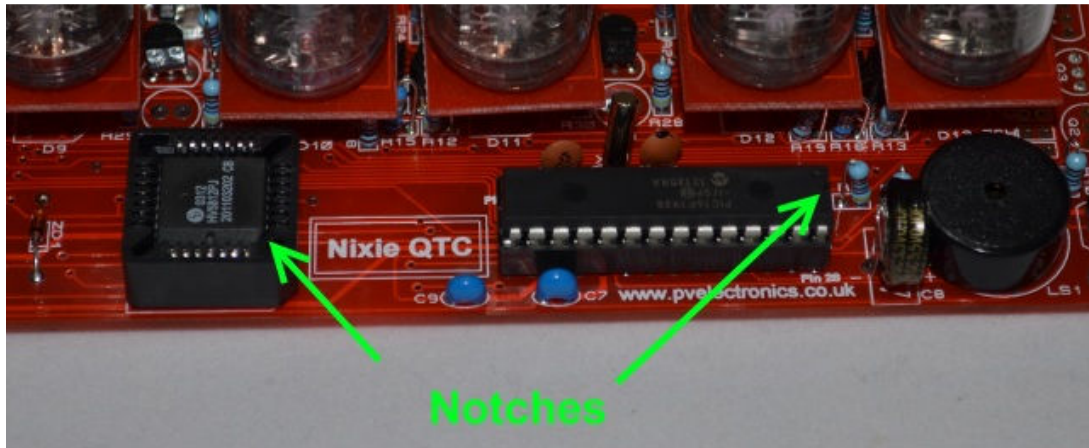
Then move on to step 6.

## 6. FIRST CLOCK TEST

It is now time to check the basic clock functions and that all tubes are working correctly.

### 6.1 Insert IC2 and IC3

Insert IC2 and IC3 into their sockets, with the notches aligned as shown below:



### 6.2 Microcontroller Code Configuration

The Microcontroller IC2 needs to be setup for your tube type as the tube connections differ for the 3 types of pinout that the kit supports. However, most tubes use configuration 'A'. If you are using a tube which requires configuration 'A', you can omit this step as the microcontroller is programmed to this configuration as a factory default. However it is still worth noting the procedure below, in case for some reason you accidentally change the configuration you can then change it back.

To change the configuration, be sure the supercapacitor is discharged. If it is not discharged, leave the clock unplugged for 6 hours to fully discharge it.

Then keep one of the following buttons pressed whilst re-connecting power. This will reconfigure the controller and the change will be stored to non-volatile memory.

Configuration A: Press the SET button

Configuration B: Press the ADJ button

Configuration C: Press the ALARM button

After configuring the controller as above you can immediately power off the clock, and proceed to the first tube tests below.

### **6.3 First Tube Test**

Insert the 6 tube cells into the main PCB, ensuring the tubes face forwards (The switches are at the back).

Connect a 12V DC power supply (2.1mm central pin type, centre positive) and power up.

The clock should start counting 0-9 repeatedly on all tubes. If this does not happen, power off and check all tubes are connected correctly. If the counting order is wrong, go back and repeat step 6.2.

Pressing 'SET' will exit the tube test mode with a bleep and the clock will start time display.

Do not be tempted to press buttons without knowing the function. If the clock bleeps, shows the time and is incrementing time, this is sufficient at this stage. Power off and disconnect the power supply.



## 7. MOUNTING THE RGB TUBE LIGHTING COMPONENTS

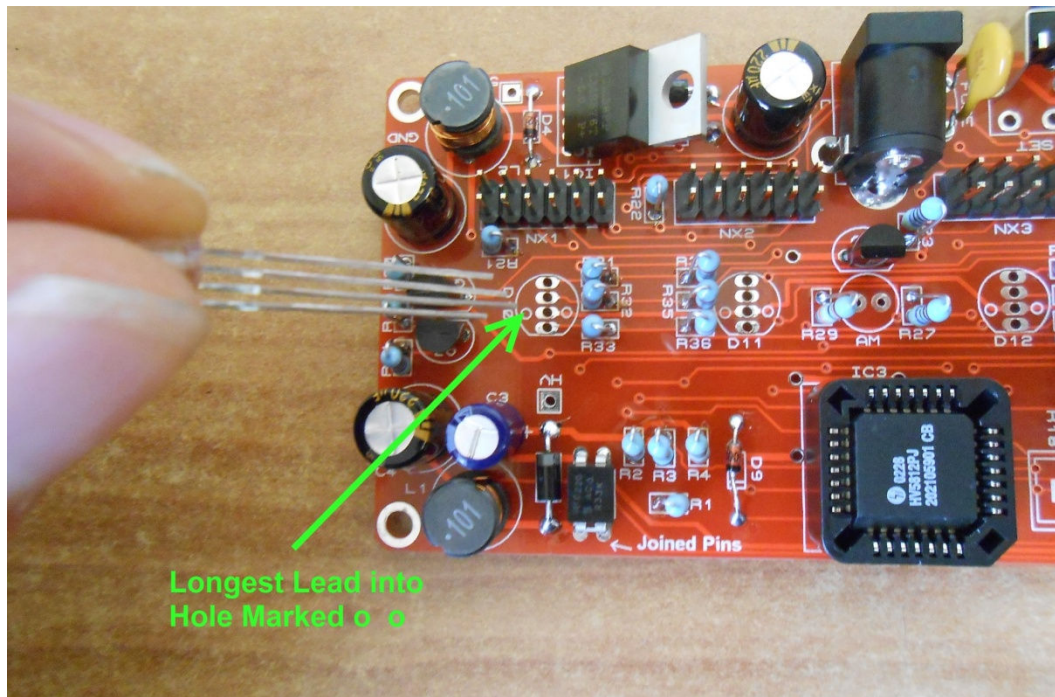
### 7.1 RGB LEDs D10 – D15.

**Q2 – Q4 (2N7000)**

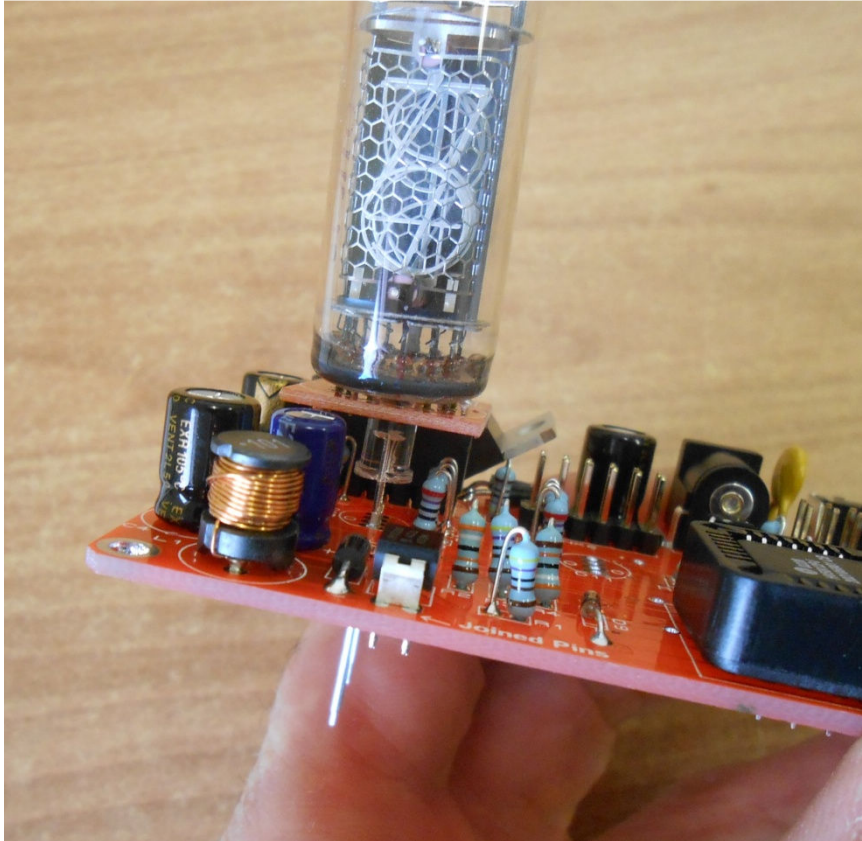
**R31 – R48 (270  $\Omega$ )**

Start by installing the 18 resistors R31 to R48 and then the 3 transistors Q2, Q3 and Q4.

To install the RGB LEDs, first note the longest of the 4 leads and ensure it goes into the pad marked with the two small circles:



Then, place a Nixie Tube assembly into position on the 6X2 connectors. Push the RGB LED gently into position under the tube and then solder in place:





## 8. HOW TO OPERATE THE CLOCK

The four buttons have the following functions:

SET: Exit tube test routine on cold power-up;

Show date;

Set time and date;

Enter configuration menu;

ADJ: Call DCF / MSF;

Adjust: time, date, alarm time, configuration parameters;

ALARM: Set alarm time; snooze; cancel snooze/alarm;

DST: Toggle between DST and Standard Time (+/- 1 Hour)

Enter colour setup menu; scroll through colour / time options

### *Entering configuration mode:*

The principal settings of the clock are stored in flash memory – your preferred configuration is stored even after powering off the clock for extended periods. To access the configuration mode press and hold the 'SET' button. After 2 seconds the seconds will become highlighted. Continue holding the button a further 2 seconds until the clock displays in this format:

00-XX-99. The '99' in the seconds digits tells you that you are in the configuration menu.

In configuration mode the hours digits display the current parameter being adjusted, and the minutes digits display the current value stored against the parameter.

For each parameter, and referring to the table below, scroll through the range of possible values by pressing the 'ADJ' button. When the desired value has been reached, move on to the next parameter by pressing the 'SET' button. When the last parameter has been set, pressing 'SET' one more time will revert the clock back to time display mode. The first parameter (0) cannot be changed as it is the software revision number. It will show for several seconds and then move to parameter 1.

In all correspondence on support issues, please quote the board type, revision date and software version.

| Parameter | Description  | Values  |
|-----------|--|---|
| 0         | Software revision                                    | 10 = version 1.0, 11 = version 1.1 etc  |
| 1         | 12 / 24 Hr mode                                      | 0 - 12 Hr (default)<br>1 - 24 Hr  |
| 2         | Date format  | 0 = MM.DD.YY (default)<br>1 = DD.MM.YY<br>2 = YY.MM.DD (from V1.1 onwards)  |
| 3         | Leading zero blanking<br>eg. 01:54:32                | 0 - leading zero blanked (default)<br>1 - leading zero displayed  |
| 4         | Night Mode start hour                                | 0 - 23  |
| 5         | Night Mode end hour                                  | 0 - 23  |
| 6         | Night Mode   | 0 - Tubes off<br>1 - Dimmed display (default)   |
| 7         | Master Blank start hour <sup>1</sup>                 | 0 - 23  |
| 8         | Master Blank end hour <sup>1</sup>                   | 0 - 23  |
| 9         | Master Blank days <sup>1</sup>                       | 0 - Off (default)<br>1 - Weekdays<br>2 - Weekends<br>3 - All days   |
| 10        | Colon neons mode                                     | 0 - AM/PM Indication, flashing<br>1 - AM/PM Indication, illuminated<br>2 - Both flash (default)<br>3 - Both illuminated<br>4 - Both off |
| 11        | Colon neons during<br>night dimmed mode <sup>2</sup> | 0 - AM/PM Indication, flashing<br>1 - AM/PM Indication, illuminated<br>2 - Both flash<br>3 - Both illuminated (default)<br>4 - Both off |
| 12        | Radio time signal source                             | 0 - No Radio Time source (default) <sup>3</sup><br>1 - DCF<br>2 - not used<br>3 - MSF<br>4 - GPS  |
| 13        | GPS Baud rate  | 0 - 4.8 Kbps (default)<br>1 - 9.6 Kbps<br>2 - 19.2 Kbps<br>3 - 38.4 Kbps  |
| 14        | Radio time offset hours                              | 0-13 (default 0) <sup>4</sup>   |
| 15        | Radio time offset mins                               | 0-45 (default 0) <sup>4</sup>   |
| 16        | Radio time offset<br>polarity                        | 0 - Minus time (default)<br>1 - Plus time   |
| 17        | Reserved - leave as 0                                | 0   |
| 18        | Snooze period  | 0 - 6 minutes (default)<br>1 - 9 minutes<br>2 - 12 minutes<br>3 - 15 minutes  |
| 19        | Reserved - leave as 0                                | 0   |
| 20        | Time Calibration Factor                              | 0 - 99 (each unit adjusts by 0.2s per day)  |
| 21        | Time Calibration Polarity                            | 0 - Make clock slower<br>1 - Make clock faster  |

|    |                               |   |
|----|-------------------------------|---|
| 22 | Slots Mode <sup>5</sup>       | 0 – Slots disabled<br>1 – Slots every minute<br>2 – Slots every 10 minutes (default)<br>3 – Slots every hour<br>4 – Slots at midnight |
| 23 | RFT Sync Mode <sup>6</sup>    | 0 – DCF / MSF Sync once per day only as per parameter 24 (default)<br>1 – DCF / MSF Sync every hour                                   |
| 24 | RFT Daily Sync Hour           | 0 – 23 (default 2)  |
| 25 | RFT Seek Blanking             | 0 – Keep tubes lit for DCF / MSF seek<br>1 – Blank tubes for DCF / MSF seek (default)   |
| 26 | Display Mode                  | 0 – standard change of digits<br>1 – fading digits<br>2 – fading digits with scrollback effect (default)                              |
| 27 | Auto date display each minute | 0 – Off<br>1 – Static display of date<br>2 – Scrolling display of date (default) <sup>7</sup>   |
| 28 | Night Mode Override minutes   | 0 – 50 (default 0 gives 15 seconds override) <sup>8</sup>   |
| 29 | Restore default settings      | 0 – Keep user settings<br>1 – Restore original default settings <sup>9</sup>  |

*Notes:*

1. Master Blanking Mode has priority over Night Mode. Use to disable the clock on weekends (eg clock is in office), or during office hours (eg clock is at home). Complete HV shutdown to save power and tube life.
2. Night time neons mode is active when night mode is set to dim. During night time blanking the tubes AND neons are disabled.
3. Clock is fully functional without DCF / MSF / GPS synchronisation. Set time manually.
4. Enter your time zone offset from the synchronisation source. Note that GPS transmits UTC.
5. Visual effect / cathode poisoning prevention – all digits on all tubes are cycled for 10 seconds. This setting overrides night blanking or dimming for the duration of the effect (10 seconds).
6. DCF / MSF synchronisation takes place on the hour. If no valid frame is received in 6 minutes, the clock reverts to normal operation.
7. Date will be displayed each minute between 50 and 55 seconds past the minute.
8. Press 'SET' briefly during Night Mode to show time for prescribed period.
9. Set this parameter to '1' to restore original default settings. Internal operations will then load all the original settings and restore the value to '0'

***Setting the Time and Date:***

Before setting the time, press 'DST' briefly to toggle between DST and standard time modes. Set according to whether you are currently in DST time or not.

From time display mode, press and hold 'SET' button for 2 seconds until the seconds digits are highlighted.

Press the 'ADJ' button to reset seconds to zero.

Briefly Press 'SET' again and the minutes will be highlighted

Press the 'ADJ' button to set the minutes.

Briefly Press 'SET' again and the hours will be highlighted.

Press the 'ADJ' button to set the hours.

Proceed in this fashion to set the calendar: Year, Month and Day.

Finally, briefly Press 'SET' again to revert to normal clock operation.

***Showing Date:***

From time display mode, briefly press 'SET' button. Date will be shown for 5 seconds, then revert to time display.

***Auto Date Display:***

Setting parameter (27) to 1 or 2 will enable auto display of date between 50 and 55 seconds past each minute.

***Night Blanking Override:***

During programmed night blanking, the blanking may be overridden to see the time by briefly pressing the 'SET' button. Tubes will remain lit for the period defined in parameter (28).

***Manual RFT Call:***

In DCF / MSF modes, pressing 'ADJ' briefly during time display will initiate a manual time seek for maximum 6 minutes, or until a valid time frame is received.

***Setting Alarm:***

Press the 'ALARM' Button. The seconds digits show the on / off status of the alarm: 00 (off) or 01 (on).

Set on / off status, then minutes followed by hours by using the 'ALARM' and 'ADJ' buttons. When set, the alarm LED will also light.

***Cancelling Alarm:***

Press 'ALARM' briefly to cancel alarm and enter snooze mode, or a longer press until the clock beeps, to cancel snooze. Alarm remains set for the next day.

***Rapid DST Adjustment***

Press 'DST' briefly to toggle between DST and standard time. The indicator shows whether DST mode is active or not. If time has been synchronised from DCF or MSF sources, this light will be set or cleared automatically. It can still be manually overridden, however the system will re-set the DST status again at the next valid time sync.

Note, that GPS time data does not contain DST information, so the DST status will need to be set manually in GPS sync mode as well as manual time-set mode.

***Calibration of Timekeeping Accuracy***

Over time you may observe the clock runs faster or slower than an accurate time standard. You can finely adjust the timekeeping by setting configuration parameters 20 and 21. We recommend to precisely set the clock against a known accurate clock, and then record the time drift in seconds after 5 full days (120 hours). Program this value into parameter 20.

Set parameter 21 to 0 to slow down the clock and to 1 to speed up the clock.



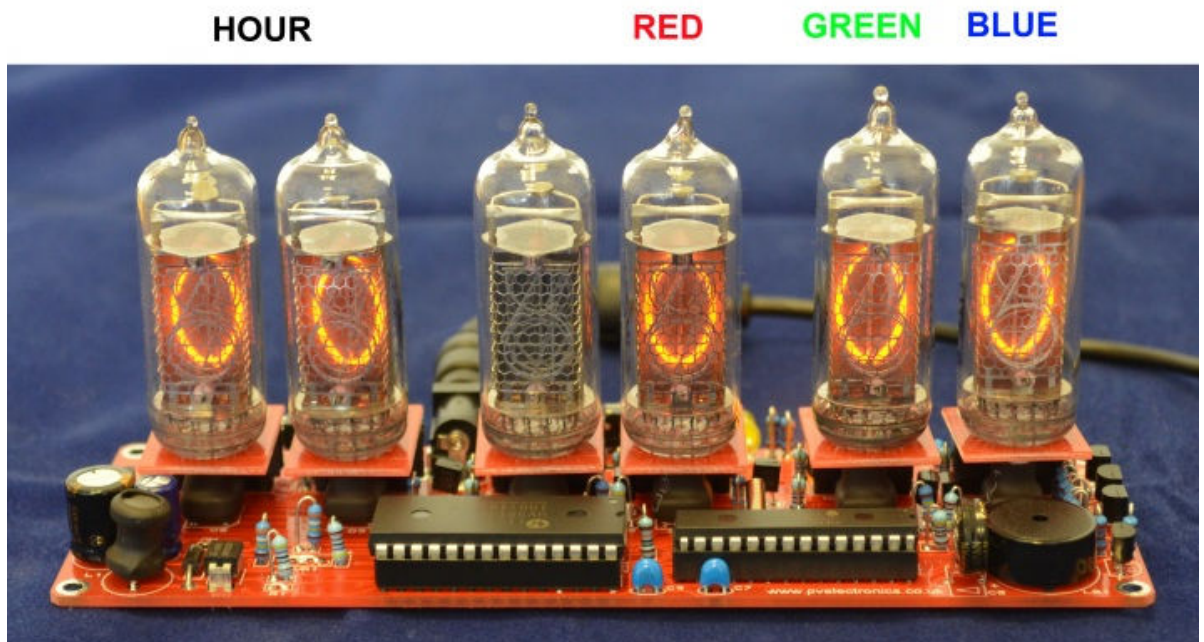
## 9. CONFIGURING THE RGB LED TUBE LIGHTS

The clock features a separate and dedicated setup menu for the RGB LED lights, accessed from the 'DST' button. All settings are stored to non-volatile memory, so your favourite colours will still be there after even a long power off.

You can set fixed colours and intensities, or program an auto colour cycling effect at your choice of speed.

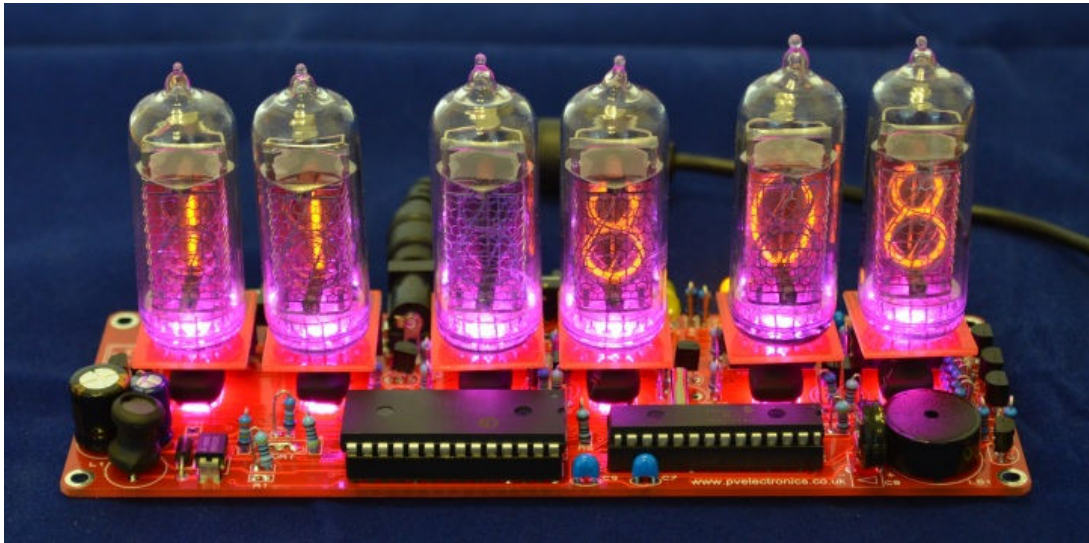
### 9.1 Entering RGB LED menu

Press and hold the 'DST' button until the display shows: 00: 0:00. NX3 will not be lit.

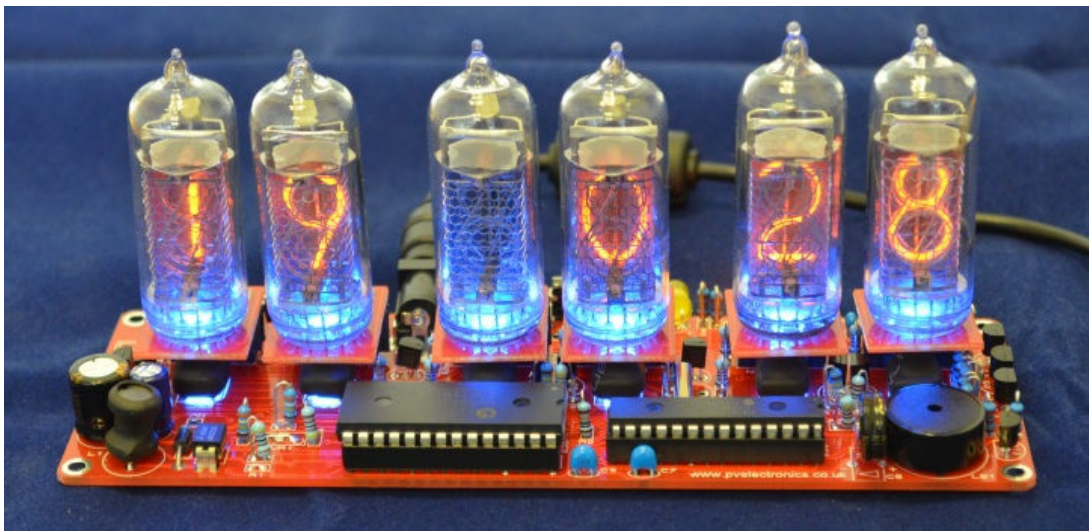


- For each hour (0-23), you can set a custom colour
- Each custom colour can have your choice of **RED**, **GREEN** and **BLUE** values from 0 (colour off) to 8 (maximum brightness)
- Mix the colours using the **SET**, **ADJ**, **ALARM** buttons.
- Use low values (1,2 and 3) for low brightness, eg. For night time
- Set the value to '0' for that colour to be off
- Once you are happy with the colour for that hour, press 'DST' to move to the next hour
- Have fun playing with your favourite colours and intensities!

- Colours are displayed live during RGB menu:



- In the example above, between 11 and 12 hours, the LEDs will be purple (8 red, 0 green and 8 blue)
- In the example below, between 19 and 20 hours, the LEDs will be blue with a hint of green ( 0 red, 2 green and 8 blue)



## 9.2 Setting auto colour cycling

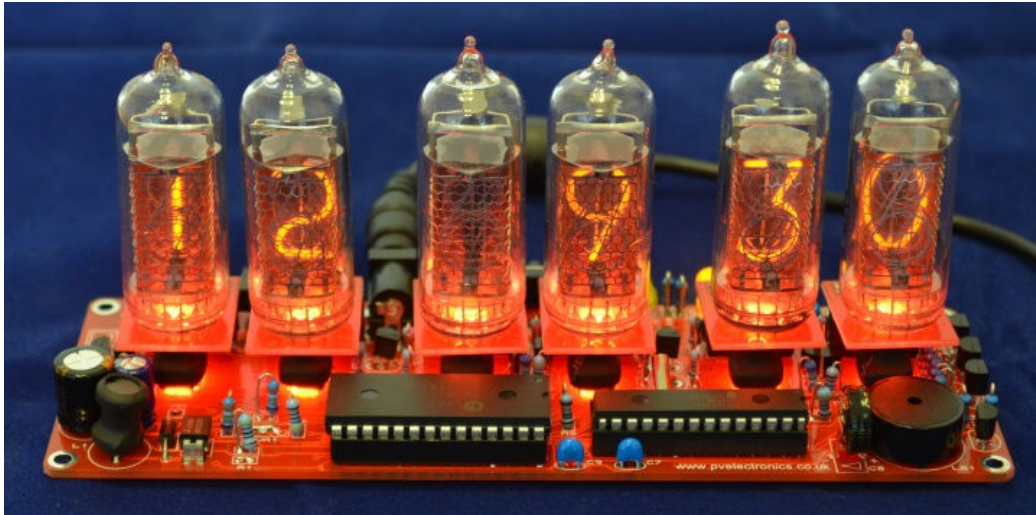
Setting colour **RED** to value 9 has a special meaning:

This will enable auto colour cycling for the specified hour. The speed of the cycling will then be governed by the **GREEN** value:

0 = very slow change

9 = very fast change

This auto colour cycling mode is explained in the picture below:



Red = 9, therefore Auto Colour Cycling is enabled for 12-13 hours

Green = 3, so speed is 3.

Blue value has no effect.

Note: The colours do not cycle live during Auto Colour Cycling setup. The cycling starts only during normal time and date display.

## **10. USING A RADIO FREQUENCY TIME RECEIVER OR GPS RECEIVER**

The clock can automatically synchronise time from DCF (Europe), and MSF (UK) long wave time transmitters.

The clock can also receive time from a GPS receiver that transmits information using NMEA-0183 protocol, using the \$GPRMC sentence.

### **10.1 Configuring for RFT or GPS Synchronisation.**

- Set parameter 12:
  - 1: DCF
  - 2: unused
  - 3: MSF
  - 4: GPS
- If using GPS, set the baud rate in parameter (13)
- Set parameters 14 and 15 for the hours and minutes your time zone is offset from the synchronisation source. This is usually only whole hours. Examples:
  - UK is 1 hour offset from the time transmitted by the DCF transmitter
  - France has no offset from the time transmitted by the DCF transmitter
- Set parameter (16) to identify whether the offset is minus (0) or positive (1) of the time source.
- Set parameter (23) to select between hourly seek and daily seek in DCF / MSF modes.
- If you have selected daily seek, use parameter (24) to set the time of the daily seek in DCF / MSF modes.
- If you intend to place the RFT receiver module closer to the clock PCB than 6 ft / 2 metres, the clock will need to disable HV and switch off the tubes for time seek, otherwise the switch-mode power supply will prevent reception. Select blanking during time seek by setting parameter (25) to 1.



## 10.2 Connecting a Radio Time receiver

The clock has been designed for, and tested with our Radio Frequency Time (RFT) Receiver Modules. (available separately from PV Electronics).



**DCF Module:** For receiving time signals from transmitter at Frankfurt, Germany. Reception is possible within a 2000Km radius of Frankfurt.

**MSF Module:** For receiving time signals from the transmitter at Anthorn, UK. Reception is possible within the UK, Eire, Northern France, and Norway.

*Please note:*

1. The long wave signals propagate further at night, so the clock is configured by default to synchronize at 2am.
2. Suitable Power Supplies: If using a switching power supply, it must have an earth connection. Cheap Chinese switching adapters cause too much interference and will not work. Alternatively use an old-fashioned transformer type AC to DC adapter.
3. The time signals are intended that a receiving clock may collect time data intermittently. The signal strength and fidelity is not like a 'TV Signal', where one can get a perfect signal any time at will.

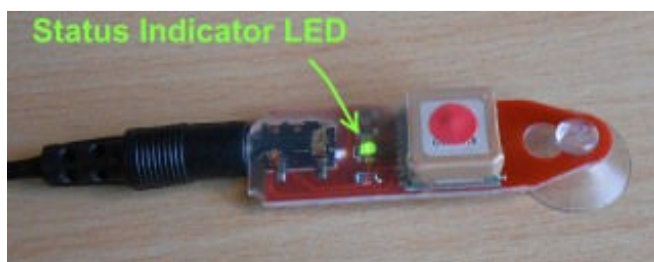
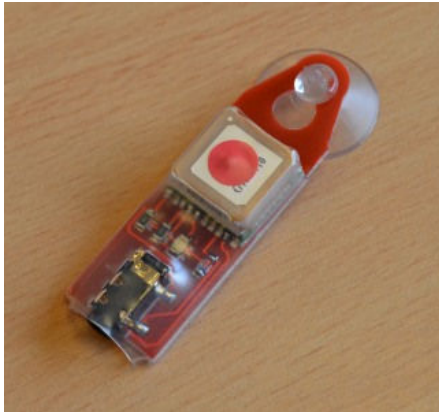


### 10.3 Setting Up for First Reception.

1. Ensure the correct setting has been applied to Config 12:  
    1 = DCF  
    3 = MSF
2. For the first tests, ensure Config 25 is set to value 1, to make the HV converter switch off for synchronisation. This stops any noise created by the HV converter.
3. Set Config 14 - 17 for your location's time zone offset from the transmitter.
4. Connect the receiver, and place horizontally by a window, broadside on to the transmitter as far as is possible.
5. Wait until after dark, and preferable the early hours.
6. Command a manual seek, by pressing the middle 'Adj' button. The tubes should switch off. The LED on the receiver module will now not be affected by the HV converter, and after 15-30 seconds start to flash regularly, showing the one pulse per second data from the transmitter.  
If your Module's red LED does not start to flash regularly, go back and check 1-6. of this section. If the red LED does not flash regularly, you will not get synchronisation!
7. At the start of the minute, the clock should start collecting data, and if so it will start flashing the green LED rapidly. Look for any LED activity at the start of the minute, using a known time source as the reference.
8. After 60 seconds of gathering data, the clock will illuminate the green LED, set the time and switch the tubes back on.
9. Once the system has been seen to work correctly, you can experiment with the antenna in different locations, and it may be possible to have the tubes stay on for time synchronisation.
10. Many other electrical appliances such as TVs and mobile phones reception when in close proximity. Metal objects cause reception problems too Place and design your case so the antenna is as far away from the PCB as possible.

#### 10.4 Connecting a GPS receiver

The clock has been designed for, and tested with our Micro GPS Receiver (available separately from PV Electronics)



### 10.5 Function of the GPS / RFT indicator LED (D7):

- *No Radio Synchronisation source installed (parameter (12) = 0)*  
LED is permanently off
- *RFT or GPS Synchronisation enabled (parameter (12) = 1-4)*  
The LED will be ON if the clock has synchronised in the last two hours; slowly flashing if the last synchronisation was between 2 hours and 24 hours ago; and off if the last synchronisation is older than 24 hours.
- If DCF or MSF mode is selected, the indicator will flash rapidly whilst the clock is actually receiving and processing a valid time frame.
- Additionally, the indicator will flash very briefly each second whilst seeking a RFT frame.

The function of the RFT indicator LED may be summarised in the table below:

| <b>Radio Time Source</b> | <b>Sync &lt; 2 Hrs</b> | <b>Sync &gt;2 Hrs<br/>Sync &lt; 24 Hrs</b> | <b>Sync &gt; 24 Hrs</b> | <b>Seeking RFT Frame</b> | <b>Aquiring RFT Frame</b> |
|--------------------------|------------------------|--|-------------------------|--------------------------|---------------------------|
| None                     | Off                    | Off  | Off                     | -                        | -                         |
| DCF / MSF                | On                     | Slow Flash                                 | Off                     | Intermittent Flash       | Fast Flash                |
| GPS                      | On                     | Slow Flash                                 | Off                     | -                        | -                         |

## 11. CONNECTIVITY DIAGRAM FOR TROUBLESHOOTING

Please refer to the diagram on the next page. If you have problems with missing digits from the display or no digits displaying at all (even though High voltage is present and the clock makes bleeps when pressing the 'SET' Button) then you should check all connections to the HV5812 IC using the chart below.

Set your meter to continuity setting. This is the setting where it bleeps when you touch the two probes together.

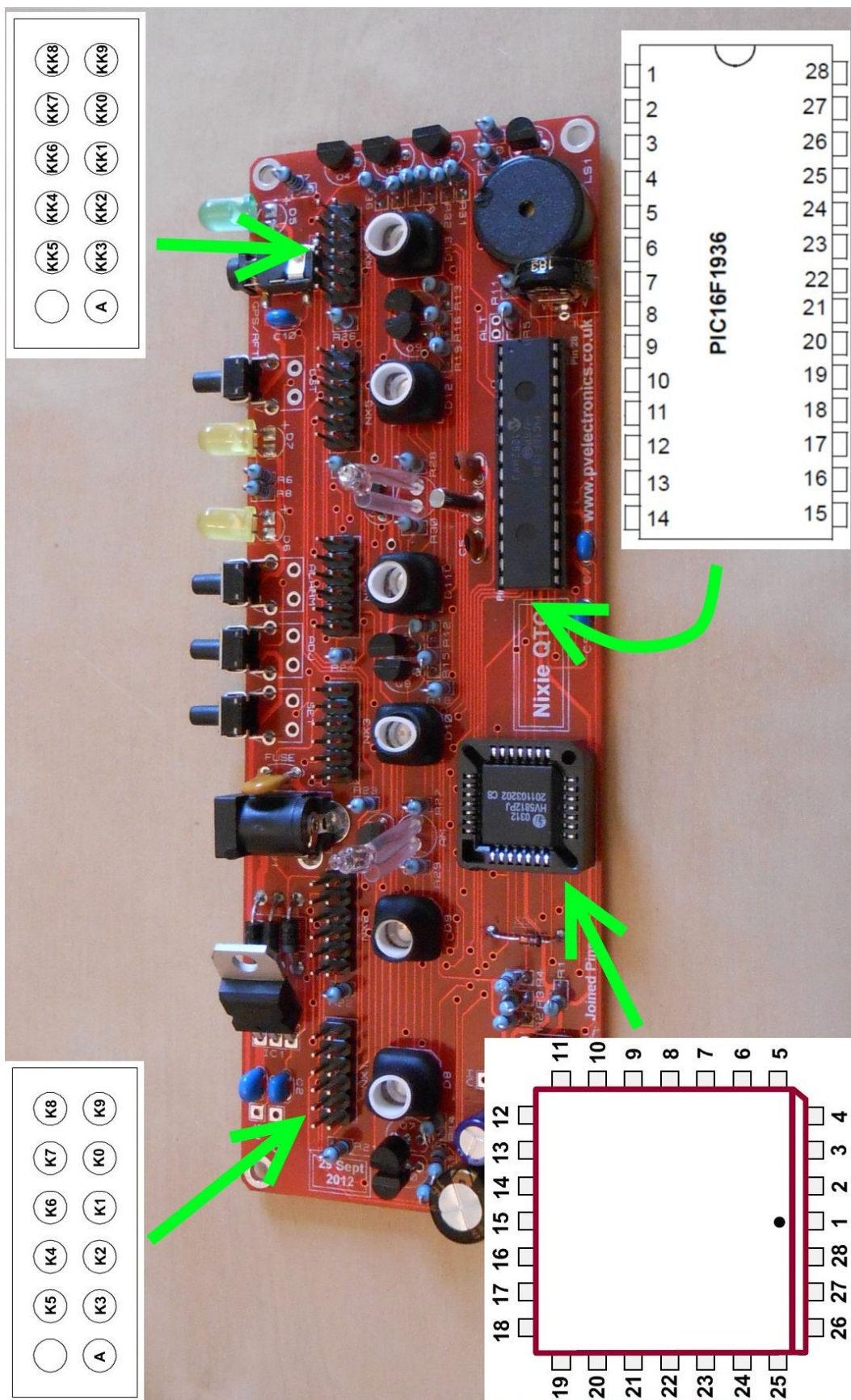
### 11.1 Data connections from IC2 to IC3

| IC3 (HV5812)<br>Pin Number | IC2 (PIC 16F1936)<br>Pin Number | Function |
|----------------------------|---------------------------------|----------|
| 27                         | 3                               | Data     |
| 15                         | 4                               | Clock    |
| 16                         | 5                               | Strobe   |

### 11.2 Cathode connections from IC3 to tube pin headers

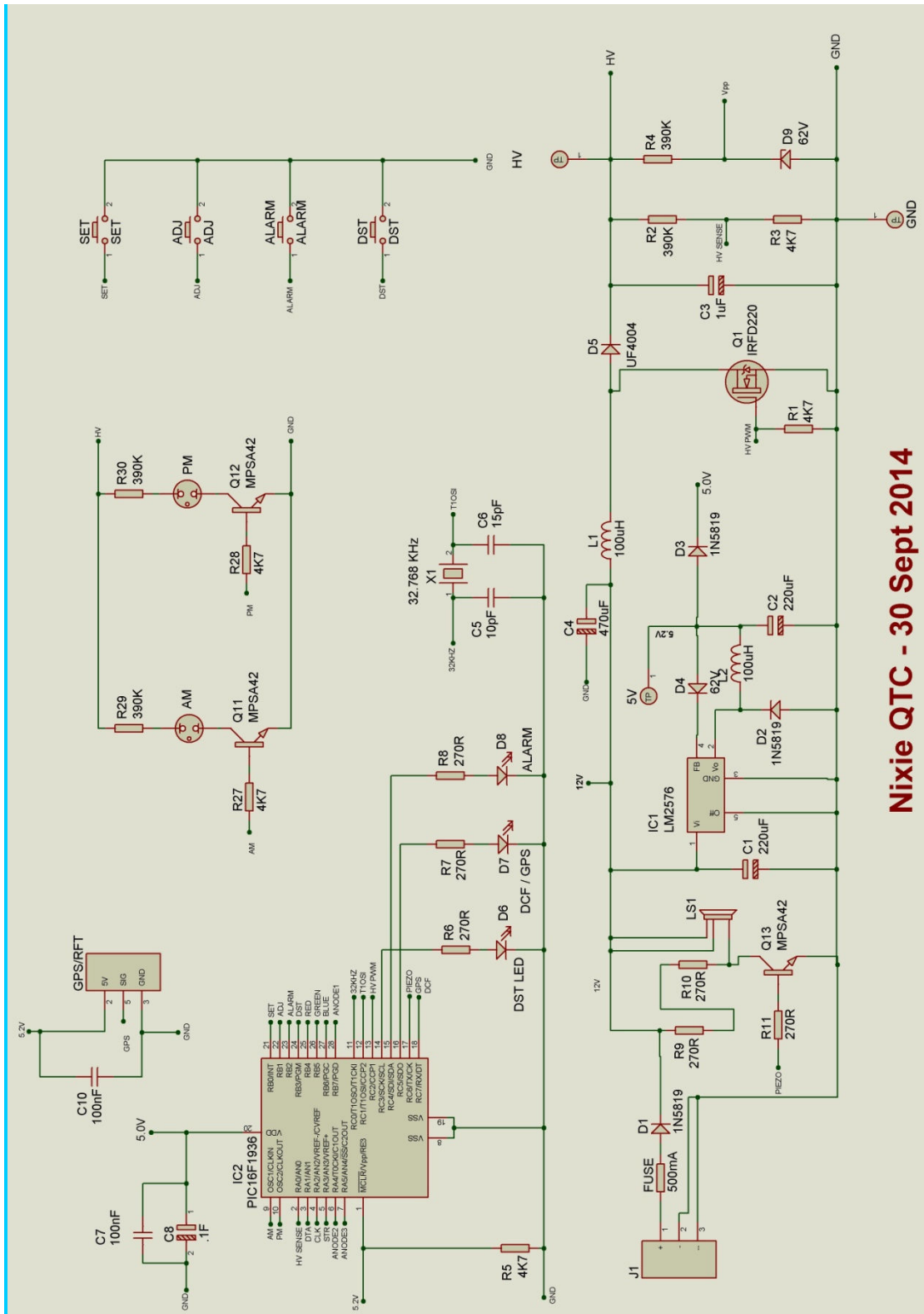
| IC3 (HV5812)<br>Pin Number | NX1, NX2, NX3<br>Cathode |
|----------------------------|--------------------------|
| 17                         | K5                       |
| 18                         | K4                       |
| 19                         | K6                       |
| 20                         | K7                       |
| 21                         | K3                       |
| 22                         | K2                       |
| 23                         | K1                       |
| 24                         | K0                       |
| 25                         | K9                       |
| 26                         | K8                       |

| IC3 (HV5812)<br>Pin Number | NX4, NX5, NX6<br>Cathode |
|----------------------------|--------------------------|
| 3                          | KK9                      |
| 4                          | KK8                      |
| 5                          | KK7                      |
| 6                          | KK6                      |
| 7                          | KK4                      |
| 8                          | KK5                      |
| 9                          | KK0                      |
| 10                         | KK1                      |
| 11                         | KK2                      |
| 12                         | KK3                      |





## 12. CIRCUIT DIAGRAM



Nixie QTC - 30 Sept 2014

