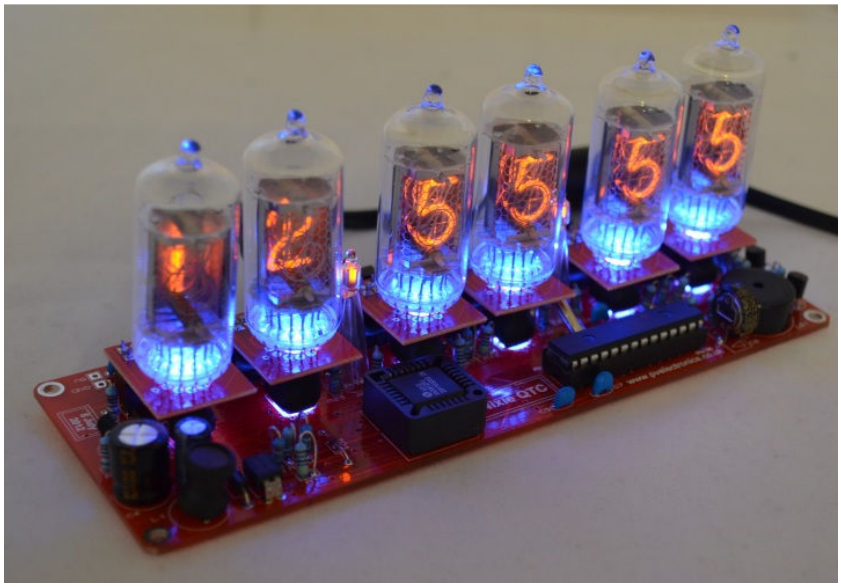
Assembly Instructions
And
User Guide

Nixie Clock Type
'Nixie QTC'

For PCB Dates 5 July 2012 and 29 Sept 2012



REVISION HISTORY

Issue Number	Date	Reason for Issue
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 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	1st review
3	29 May 2012	Errors in component listing corrected
2	22 May 2012	Anode resistors corrected to 10KΩ
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 Nixe 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 synchronsation 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 6.1 to 6.8 of this manual.

Tube types	**Cell type**	**Code Configuration**	**Section**
IN-14	IN-14	A	6.1
IN-8-2, ZM1177	IN-8-2	A	6.2
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	6.3
GNP-17A	IN-8-2	A	6.4
GNP-7A, GNP-7AH	IN-8-2	A	6.5
ZM1210, ZM1212	IN-8-2	B	6.6
IN-16	IN-14	C	6.7
CD66, ZM1240, ZM1242, XN11, XN12	IN-8-2	A	6.8

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. This is because the kit is sold to many countries around the world, each with very different household mains outlet socket types. It is more efficient for the user to buy a suitable adapter locally. This saves shipping a heavy adapter with the kit, and also the extra costs of managing stocks of many varied power adapters. If you are using a DCF or MSF receiver avoid cheap Chinese switching power supplies, as they can cause interference problems.

The type of power adapter can be obtained at very low cost. 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
Resistors	
R1	4.7 KΩ, ¼ Watt
R2	390 KΩ, ¼ Watt
R3	4.7 KΩ, ¼ Watt
R4	390 KΩ, ¼ Watt
R5	4.7 KΩ, ¼ Watt
R6 - R11	270 Ω, ¼ Watt
R12 – R14	4.7 KΩ, ¼ Watt
R15 – R17	390 KΩ, ¼ Watt
R18 – R26	10 KΩ, ¼ Watt
R27, R28	4.7 KΩ, ¼ Watt
R29, R30	390 KΩ, ¼ Watt
R31 – R36	270 Ω, ¼ Watt
Capacitors	
C1, C2	100nF Ceramic
C3	1uF, 250V, Electrolytic
C4	470uF, 16-25V, Electrolytic
C5	33pF Ceramic
C6	15pF Ceramic
C7	100nF Ceramic
C8	0.1F
C9, C10	100nF
Transistors	
Q1	IRFD220 MOSFET
Q2 – Q4	2N7000 MOSFET
Q5 – Q7	MPSA42
Q8 – Q10	MPSA92
Q11 – Q13	MPSA42
Diodes	
D1 – D3	1N5819
D4	UF4004
D5	5mm Green LED
D6, D7	5mm Yellow LED
D8 – D13	RGB 6-pin LED
ZD1	62V Zener diode
Integrated Circuits	
IC1	7805 5V voltage regulator
IC2	PIC16F1936 8-bit microcontroller
IC3	HV5812
Miscellaneous	
ALT	Not Installed
L1	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

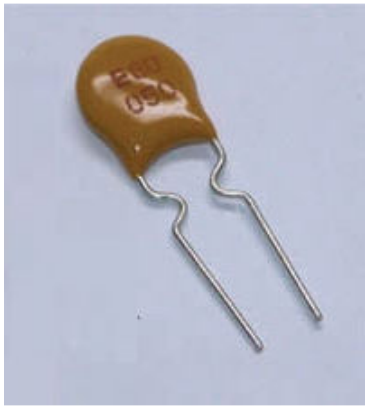
3.2 Parts list / Packing Sheet - Component Bag

Part Description	Quantity
Resistors	
270 Ω, ¼ Watt	12
4.7 KΩ, ¼ Watt	8
10 KΩ, ¼ Watt	9
390 KΩ, ¼ Watt	7
Capacitors	
33pF, Ceramic	1
15pF, Ceramic	1
100nF, Ceramic	5
1uF, 250V, Electrolytic	1
470uF, 16-25V, Electrolytic	1
0.1F	1
Transistors	
IRFD220 MOSFET	1
MPSA42	6
MPSA92	3
2N7000	6
Diodes	
1N5819	3
UF4004 fast recovery diode	1
62V Zener diode	1
5mm Green LED	1
5mm Yellow LED	2
6 Pin RGB LED	6
Integrated Circuits	
7805 5V voltage regulator	1
PIC16F1936 8-bit microcontroller	1
HV5812	1
Miscellaneous	
100uH inductor	1
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
8cm white 10mm heat shrink	1
8cm black 10mm heat shrink	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.



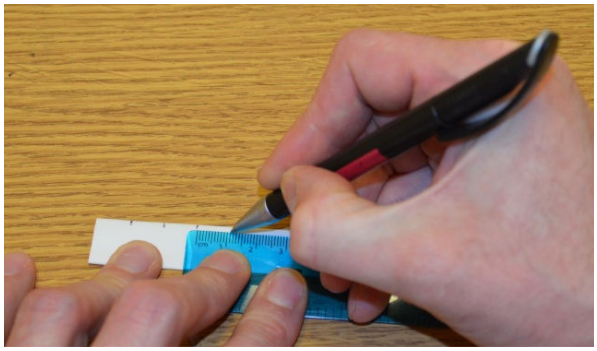
4. PREPARING THE RGB LED LIGHT PIPES

If you are not using the RGB LEDs you should omit this step.

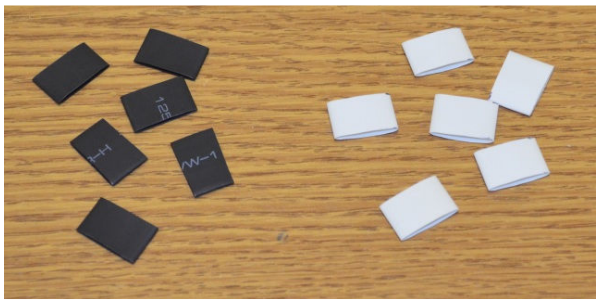
A white then black heat shrink tube is attached to each LED to form a 'light pipe' to concentrate the light at the bases of the Nixie Tubes.

4.1 Cut the heatshrink tubing to 11mm lengths

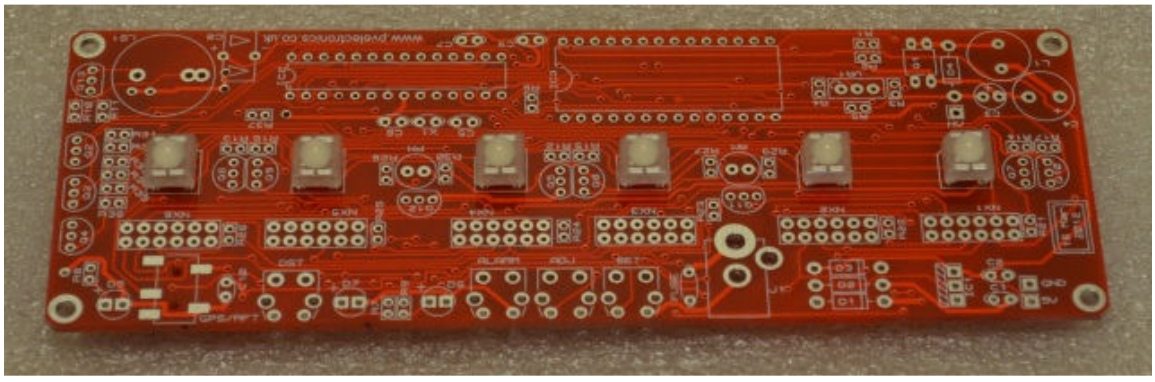
Using a ruler and a pen, mark the black and white tubing at 11mm intervals.



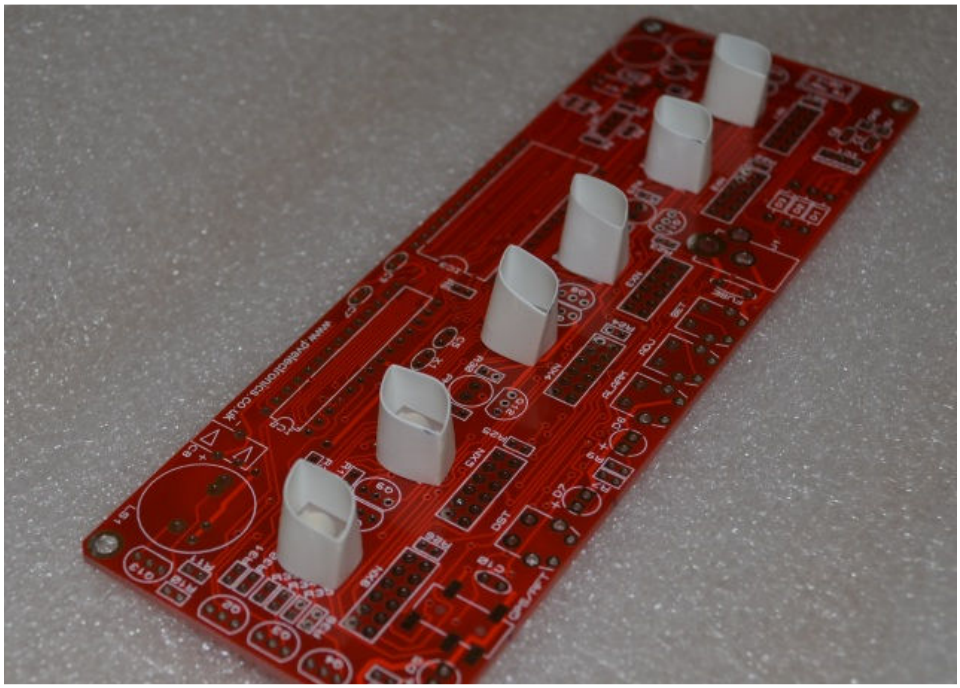
Then cut with scissors to make 6 white and 6 black pieces:



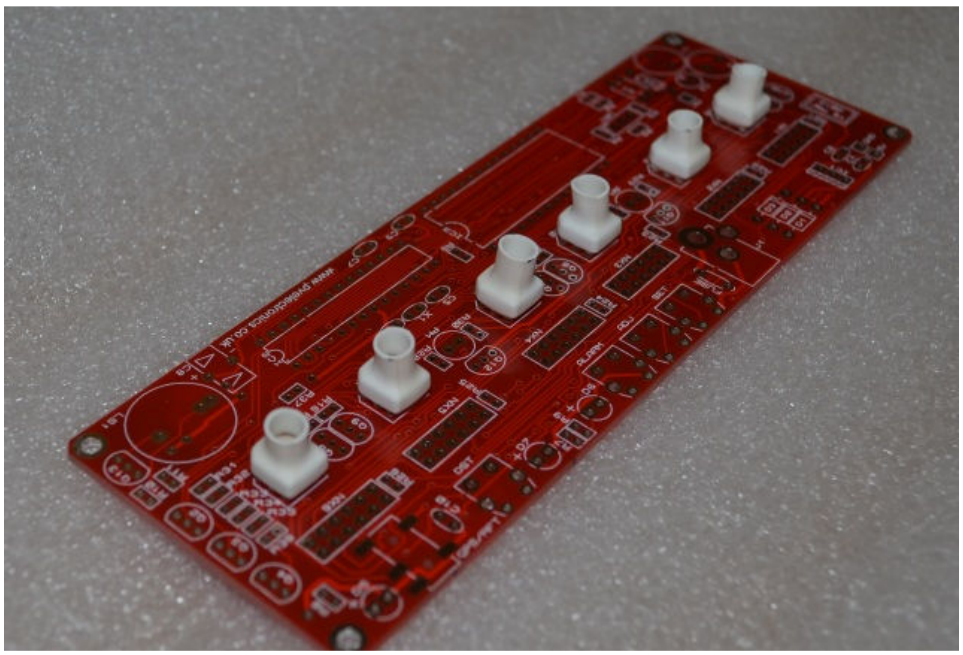
4.2 Place the 6 RGB LEDs in their locations in the PCB, BUT DO NOT SOLDER.



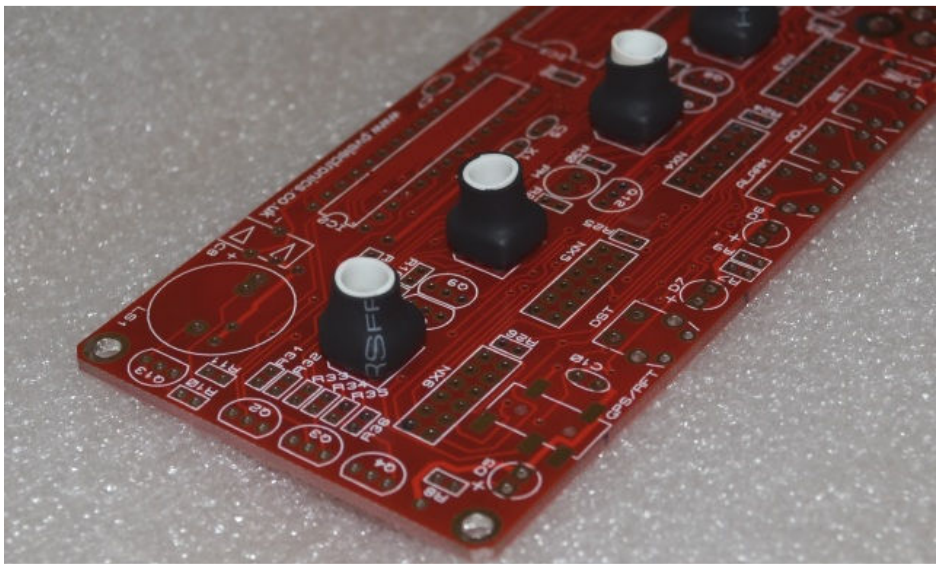
4.3 Place a piece of white tubing over each LED so it is touching the PCB.



4.4 Using the hot air gun or hairdryer, GENTLY shrink the tubing over the LEDs Using low heat setting and keep the gun far from the PCB and keep moving. Rotate the PCB to shrink the back of the tubing as well. Then let the PCB cool for 2 minutes at is will be quite warm. It should now look like this:



4.5 Repeat with the black tubing:



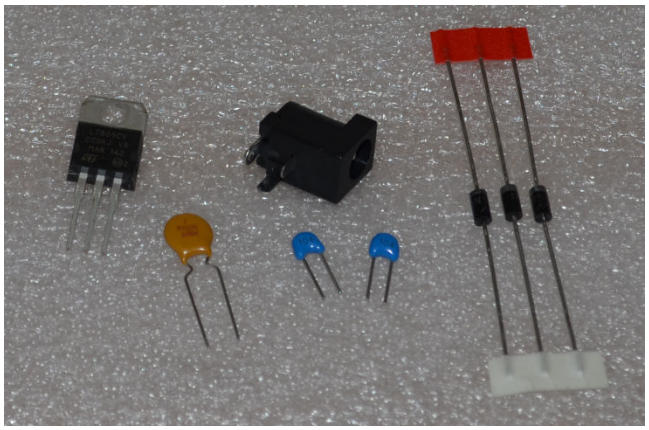
4.6 Finally, remove the six LEDs and put to aside for later in the assembly.

5. ASSEMBLY OF THE PCB

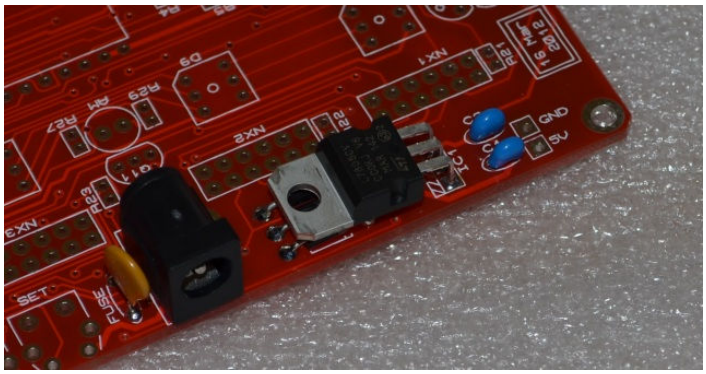
DUE TO PRODUCT DEVELOPMENT AND IMPROVEMENTS, YOUR PCB MAY NOT LOOK EXACTLY LIKE THE ONE PICTURED.

5.1 Low Voltage Power components:

J1, FUSE
D1-D3 (1N5819)
IC1 (7805)
C1, C2 (100nF)

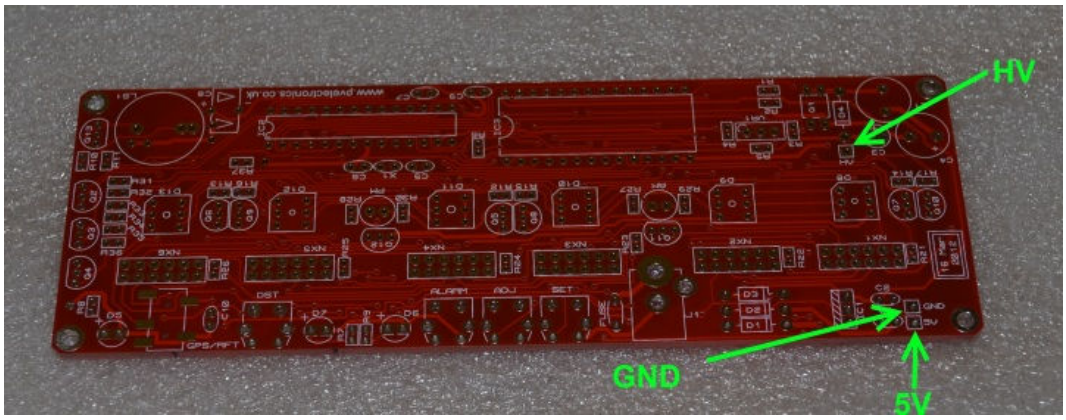


Start by installing D1-D3. Align the white band on the components with the band marked on the PCB. After placement, IC1 can be placed and bent over these diodes to reduce the height of the assembled PCB. Continue to mount C1, C2, J1 and FUSE.



5.2 Testing Low Voltage Power Supply.

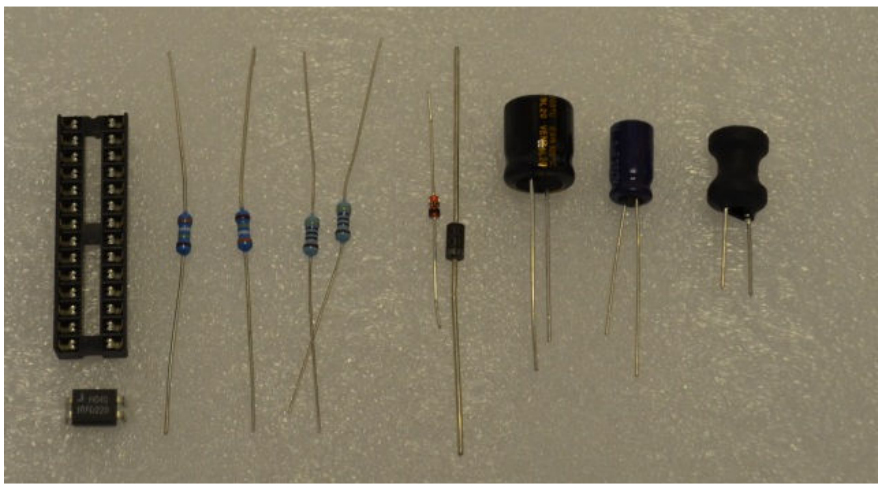
Identify the test GND, 5V and HV test points as shown below.



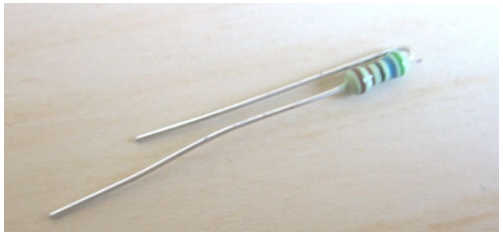
Plug in the power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 5.1 and 5.3 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

5.3 High Voltage Generator components.

Socket for IC2
R1, R3 (4.7 KΩ)
R2, R4 (390 KΩ)
C3 (1uF)
C4 (470uF)
Q1 (IRFD220)
L1 (100uH Inductor)
D4 (UF4004)
ZD1 (62V Zener diode)

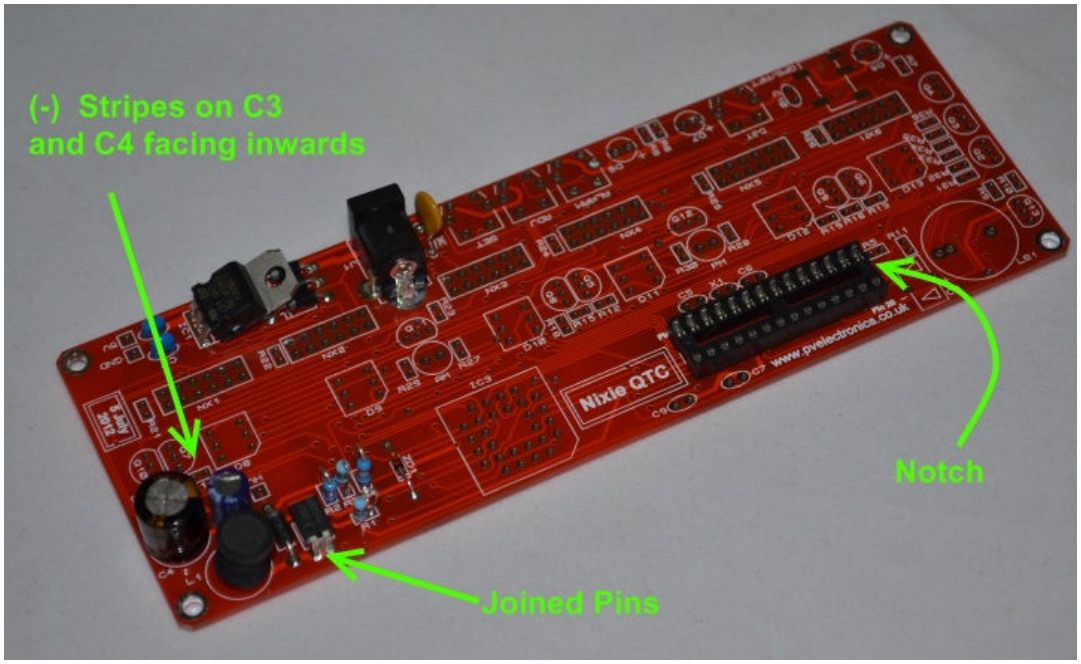


All the resistors on the board need to be mounted upright to save space. The leads need to be formed as shown below. Bend the leads of each resistor as shown and solder in to the correct postion, making sure the component body is as close to the board as possible.



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.

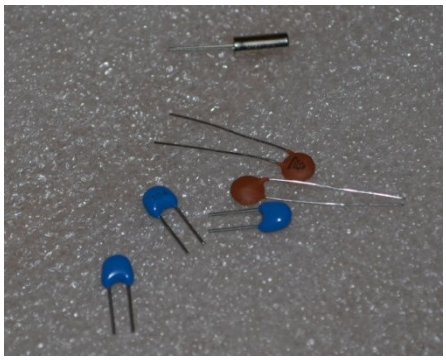


5.4 High Voltage Generator Test.

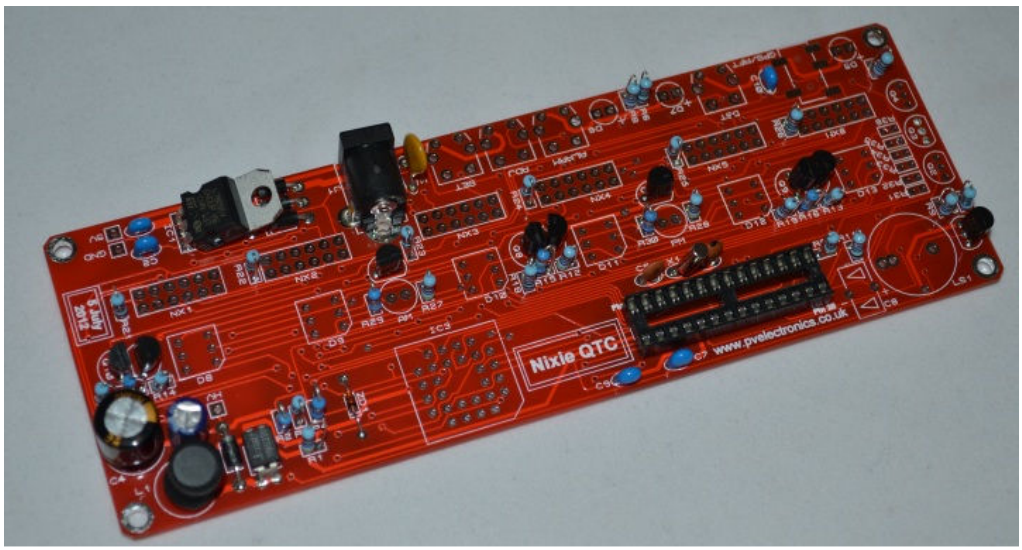
- Refer to the warnings on page 5
- Insert IC2 into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.
- Power up the PCB, and using the GND and HV test points, measure the high voltage generated using a voltmeter on DC setting. It should be between 167 and 173. If this is in order, disconnect the power supply.

Finally, remove IC2 from its socket and replace on its static-protective foam. It is best kept safe until needed for the tube tests later in the assembly.

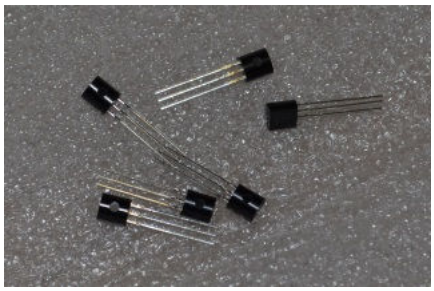
5.5 C5 (33pF)
C6 (15pF)
X1 (32.768KHz Crystal)
C7, C9, C10 (100nF)



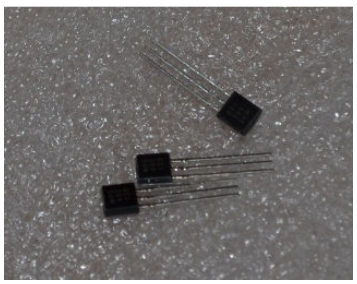
5.6 R6 - R11 (270 Ω)
R5, R12, R13, R14, R27, R28 (4.7 KΩ)
R15 - R17, R29, R30 (390 KΩ)
R18 - R26 (10 KΩ)



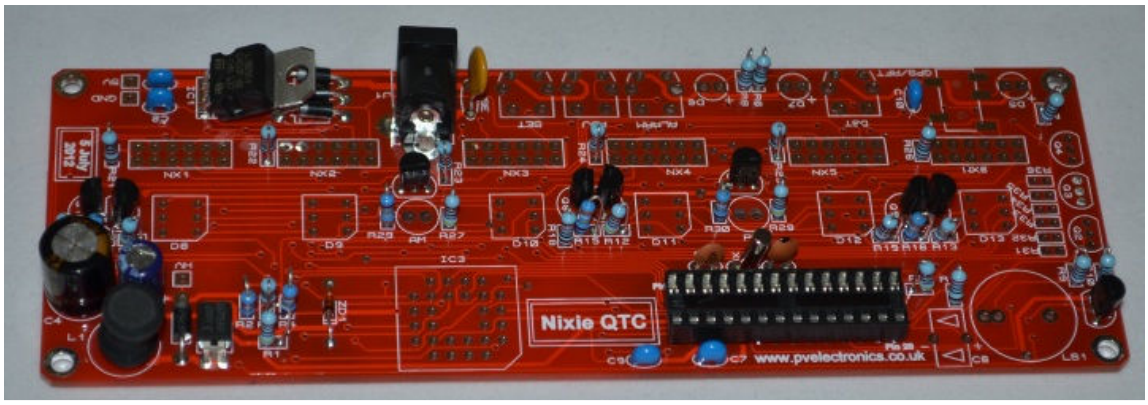
5.7 Q5, Q6, Q7, Q11, Q12, Q13 (MPSA42)



5.8 Q8, Q9, Q10 (MPSA92)

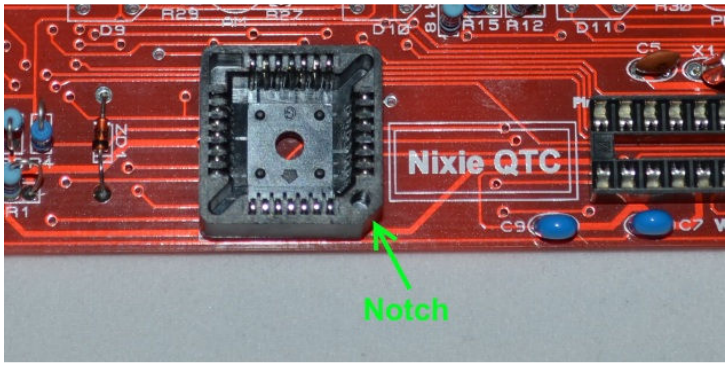


This is how the PCB should look now:



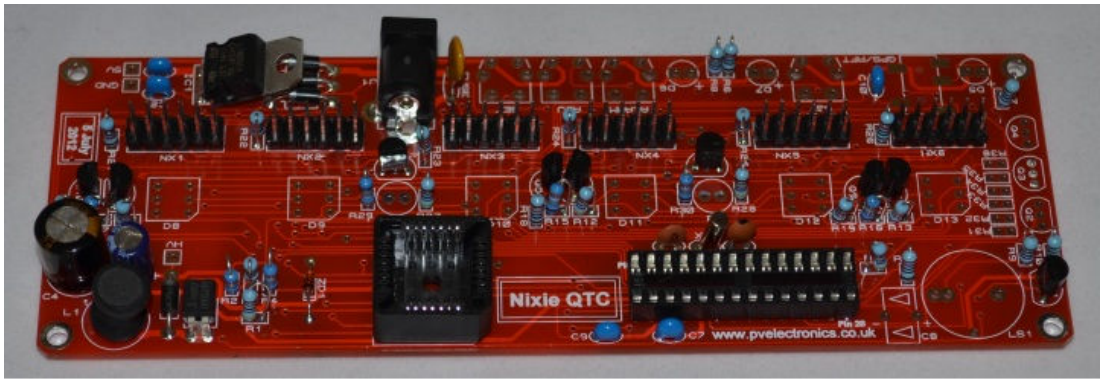
5.9 Socket for IC3

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.

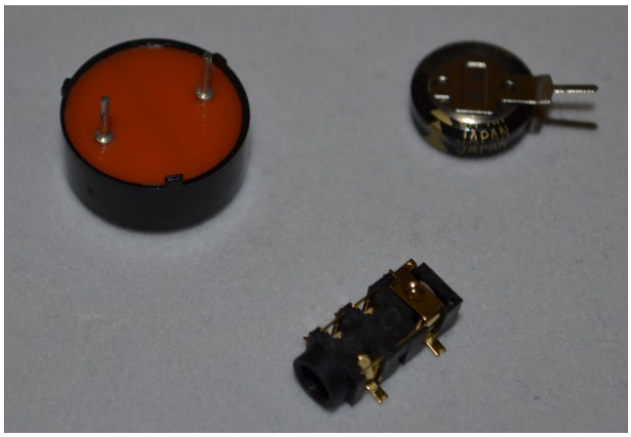


5.10 NX1 – NX6 (6X2 way male pin header)

Ensure the connectors are soldered very close to the PCB.



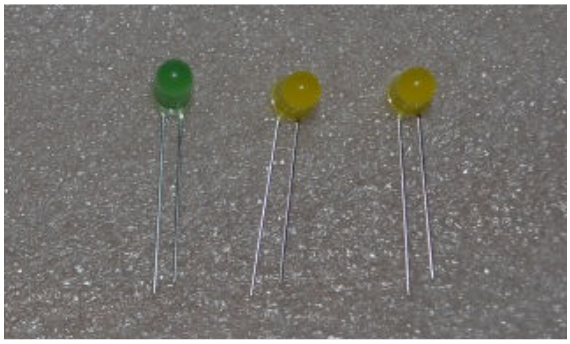
5.11 GPS/ RFT Connector
LS1 (Piezo Buzzer)
C8 (0.1F)



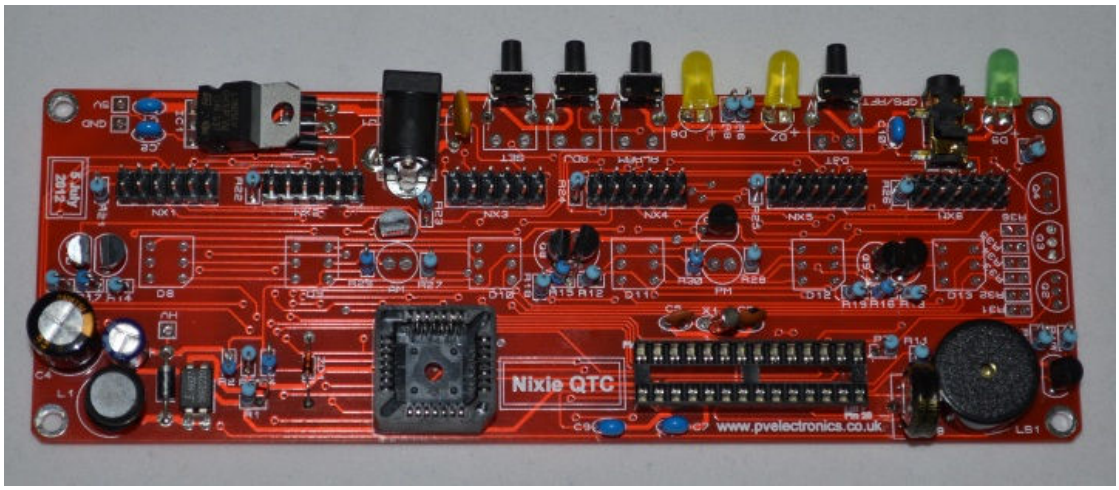
To solder the GPS / RFT connector: First wet one pad on the PCB with solder. Then place the connector in position and re-touch the pad with the soldering iron. This will anchor the component and then you can solder the remaining pads.
Ensure the arrows on C8 are aligned with the corresponding arrows on the PCB

5.12 D5 (5mm Green LED)
D6, D7 (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:



5.13 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.

6. ASSEMBLING THE NIXIE TUBE CELLS

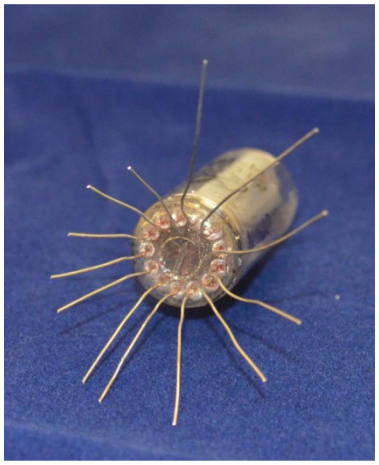
PLEASE REFER TO THE APPROPRIATE SECTION FOR YOUR NIXIE TUBE TYPE.

6.1 IN-14 Nixie Tubes.

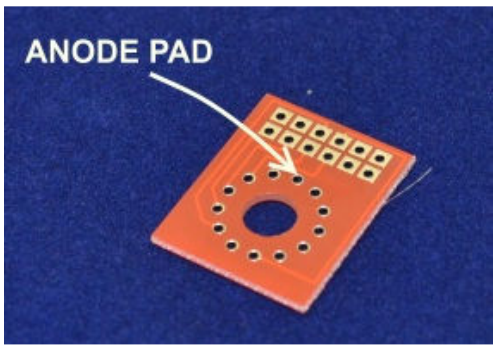
Tube cell type: IN-14
Code configuration: A

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 sucessive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

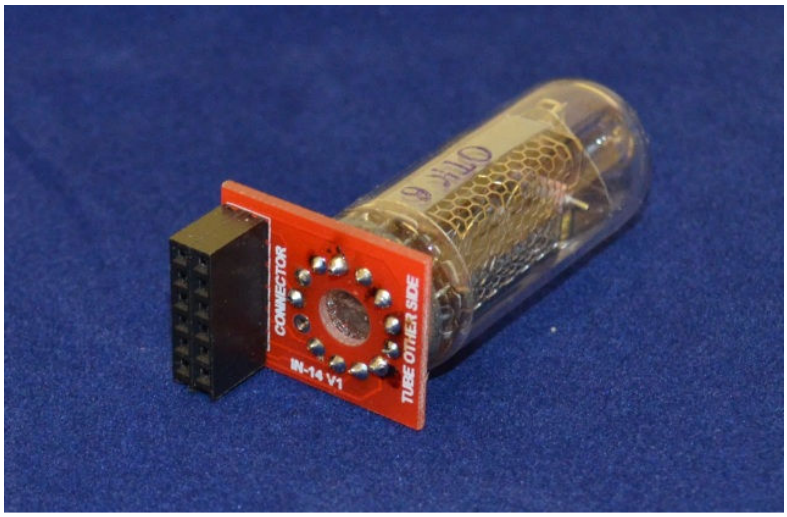


Referring to the picture below, identify the anode pad on the tube cell PCB. The tube is inserted from the side with no white markings:



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 7.

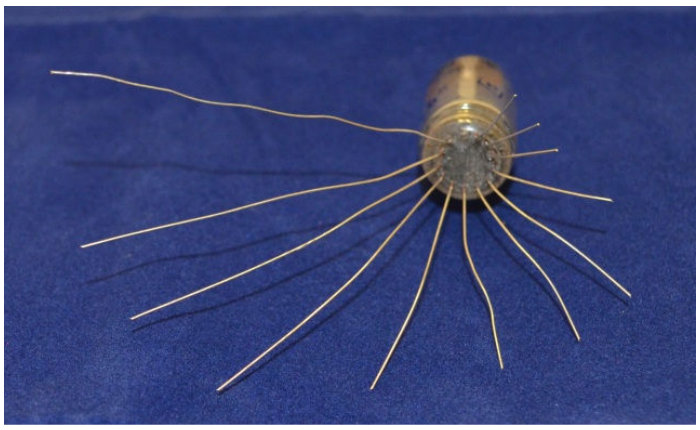
6.2 IN-8-2 and ZM1177 Nixie Tubes.

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.

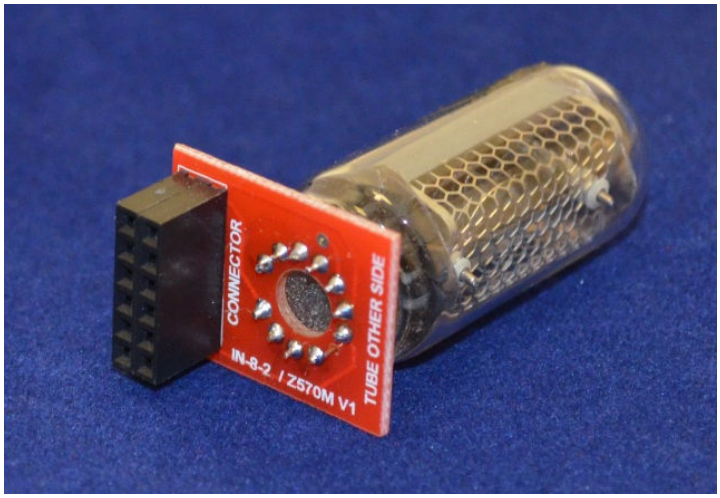
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube. Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one.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

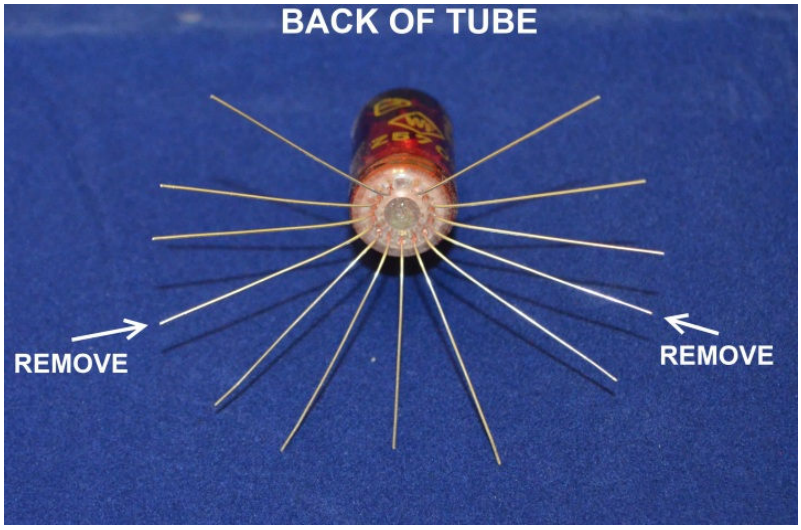


The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 7.

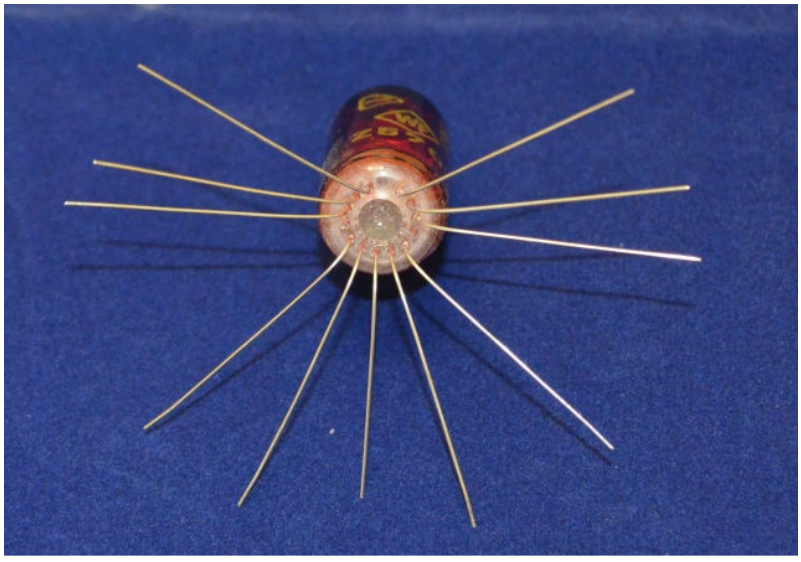
6.3 Z570M, Z573M, ZM1080, ZM1082, GN9A, ZM1136 Nixie Tubes.

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:

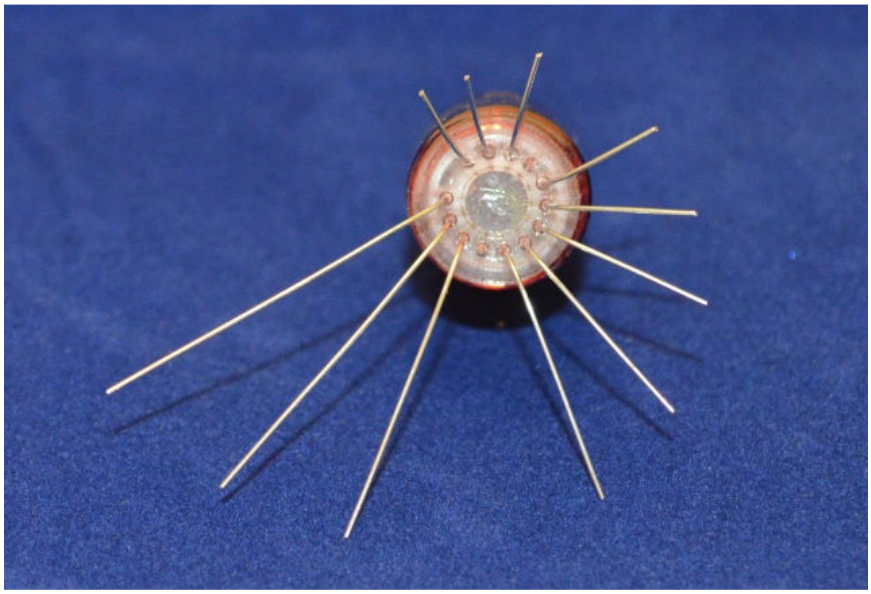


This is how the tube will look after removing the leads:

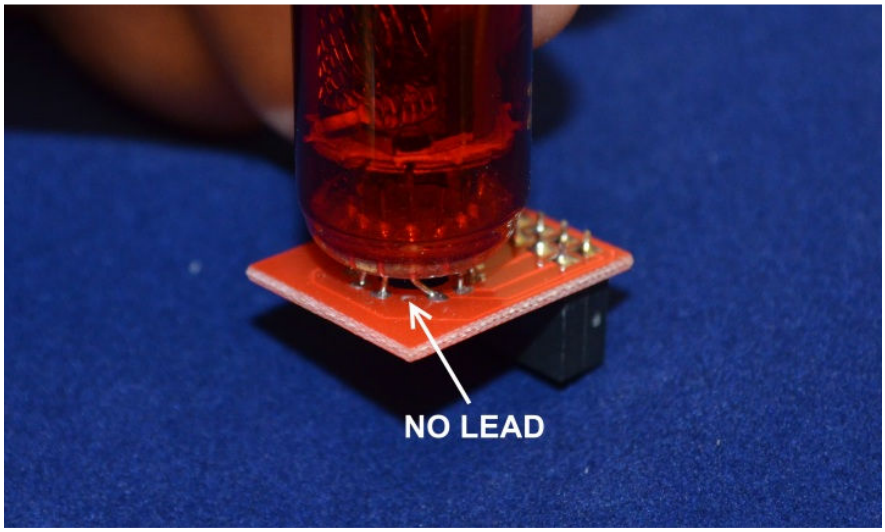


To facilitate easy insertion of the flying leads into the PCB holes, it helps enormously to trim the remaining flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube.

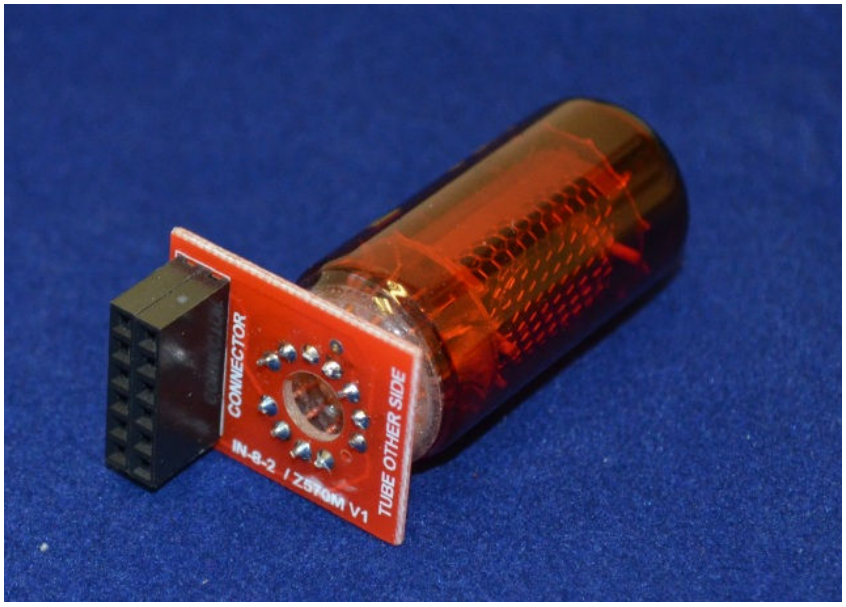
Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.



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.

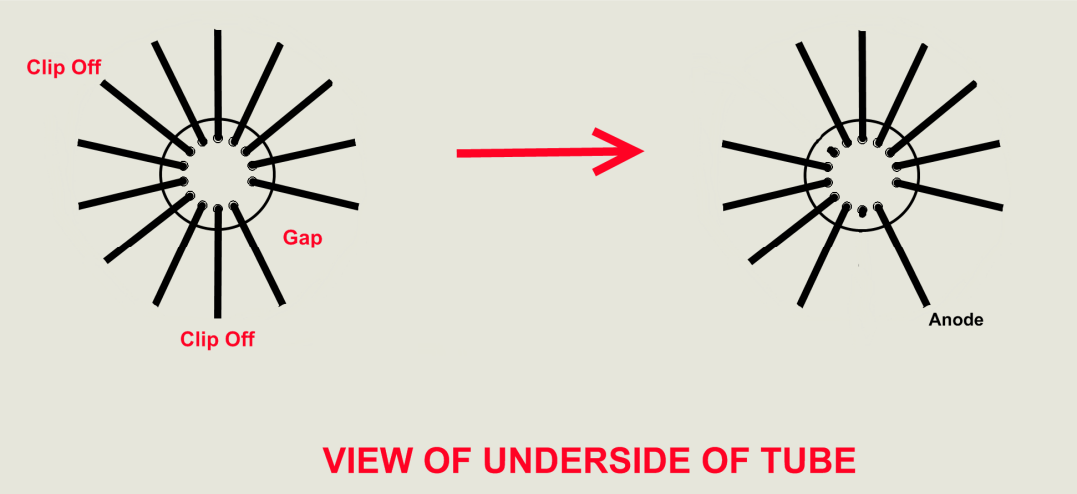


The tube cell is now complete. Repeat for the other 5 tubes.
Then move on to step 7

6.4 GNP-17A Nixie Tubes.

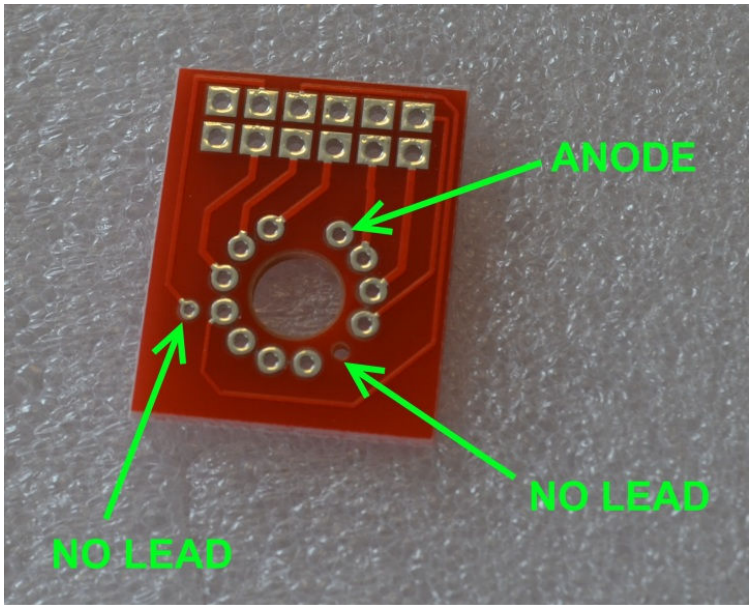
Tube cell type: IN-8-2
Code configuration: A

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



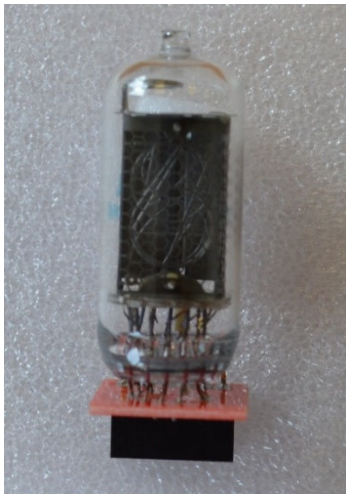
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow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

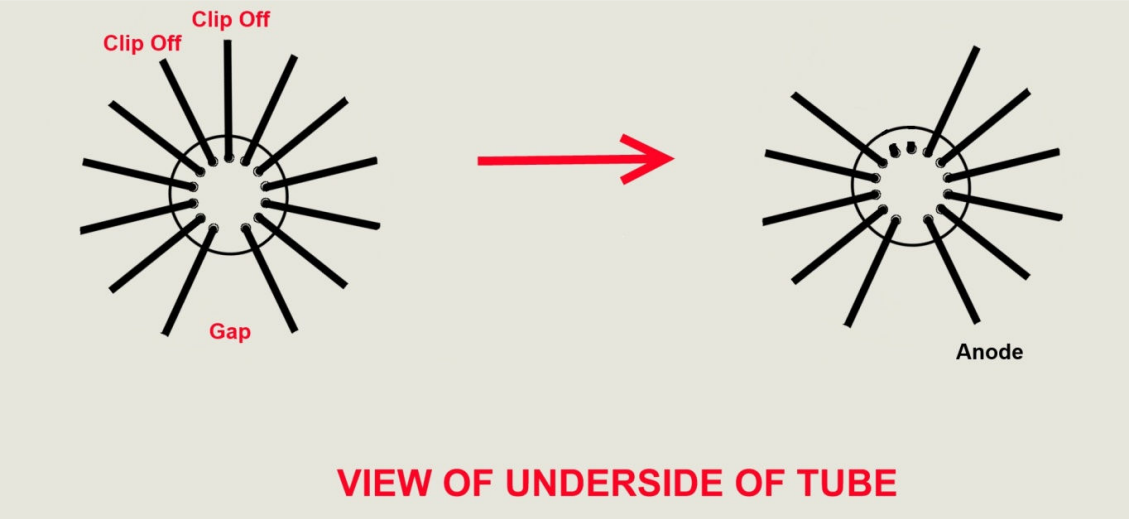


The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 7.

6.5 GNP-7A and GNP-7AH Nixie Tubes.

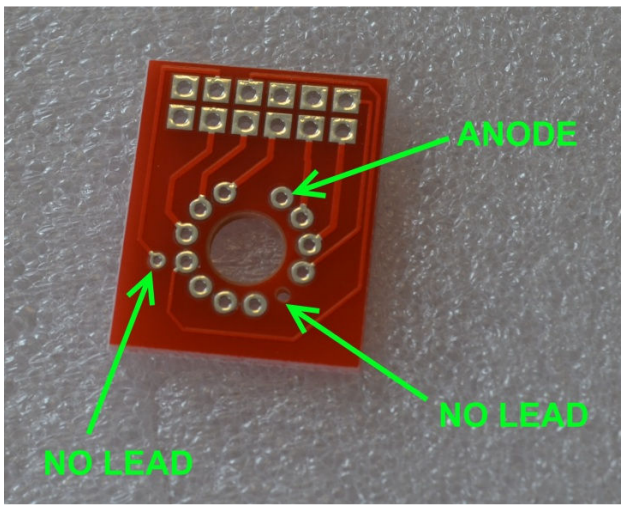
Tube cell type: IN-8-2
Code configuration: A

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



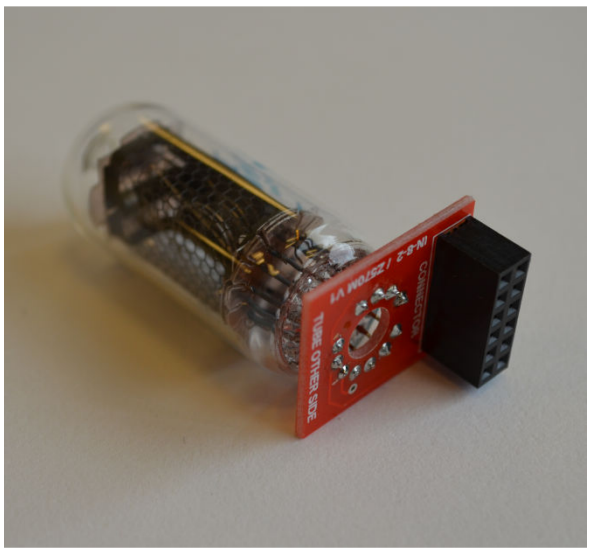
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow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

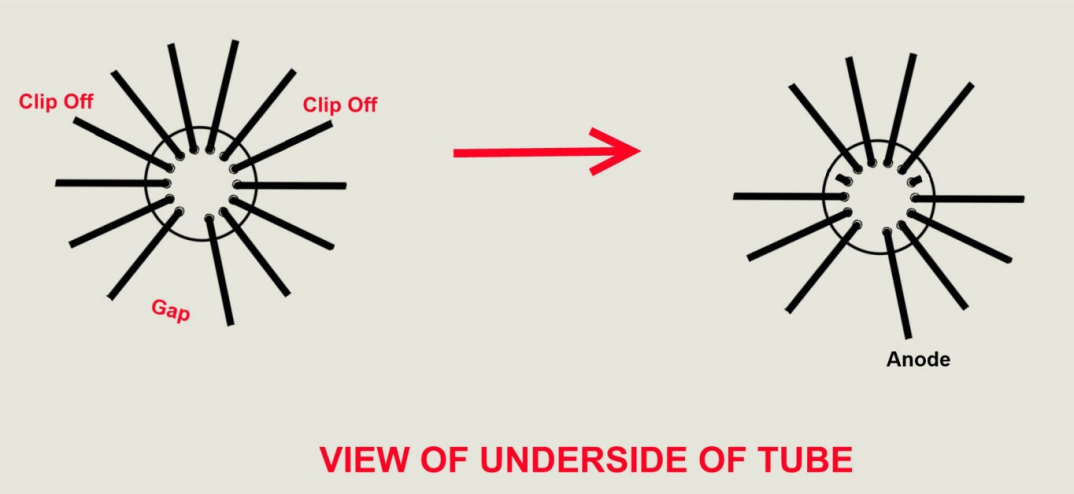


The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 7.

6.6 ZM1210 and ZM1212 Nixie Tubes.

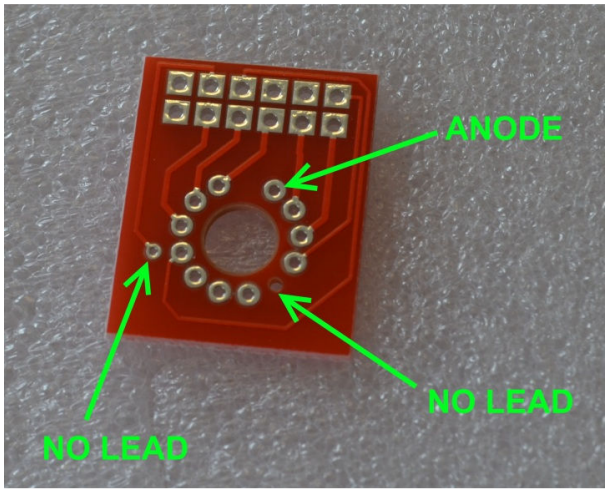
Tube cell type: IN-8-2
Code configuration: B

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 sucessive 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.

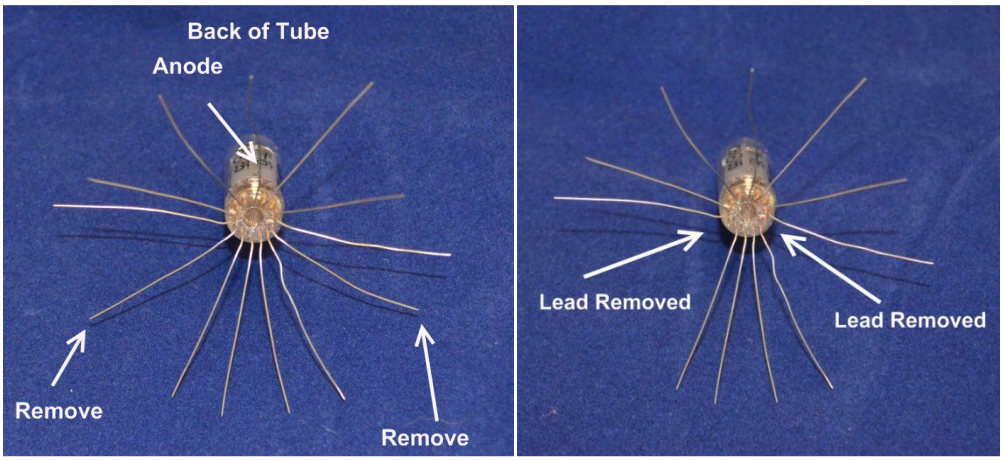
Then solder on the connector .

The tube cell is now complete. Repeat for the other 5 tubes. Then move on to step 7.

6.7 IN-16 Nixie Tubes.

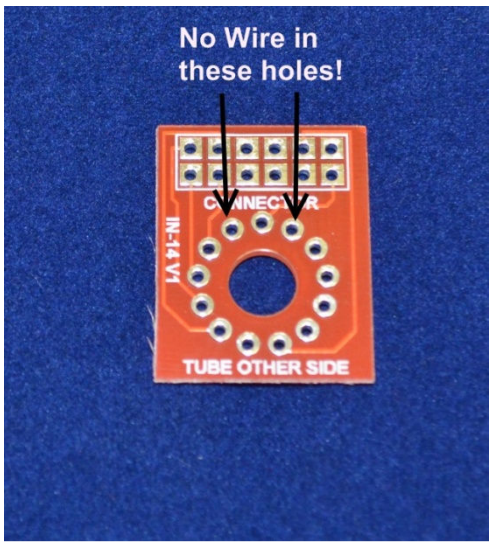
Tube cell type: IN-14
Code configuration: C

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



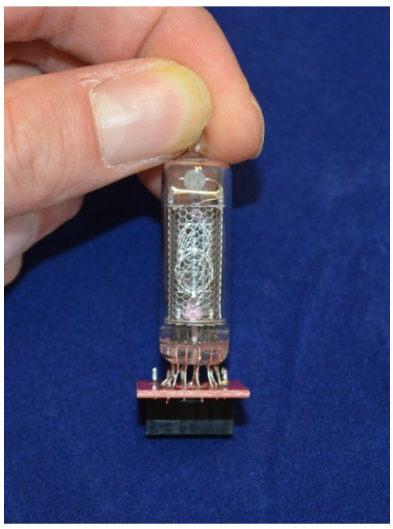
To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors. Start at one of the leads at the back of the tube. Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow 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 7.

6.8 CD66, ZM1242, ZM1240, XN11 and XN12 Nixie Tubes.

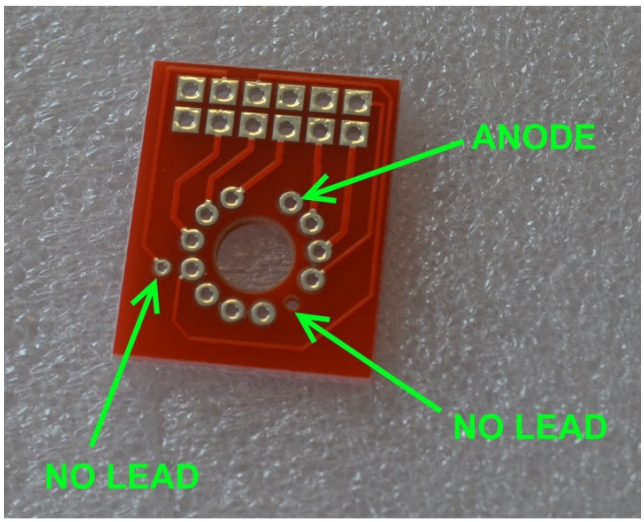
Tube cell type: IN-8-2
Code configuration: A

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 sucessive 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.

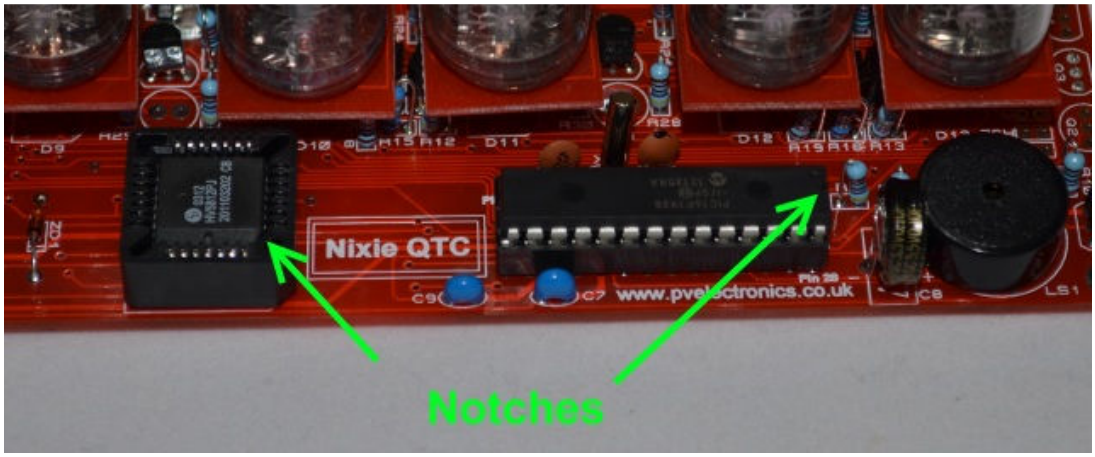
Then solder on the connector.
The tube cell is now complete. Repeat for the other 5 tubes.
Then move on to step 7.

7. FIRST CLOCK TEST

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

7.1 Insert IC2 and IC3

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



7.2 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.

7.3 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 7.2.

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.

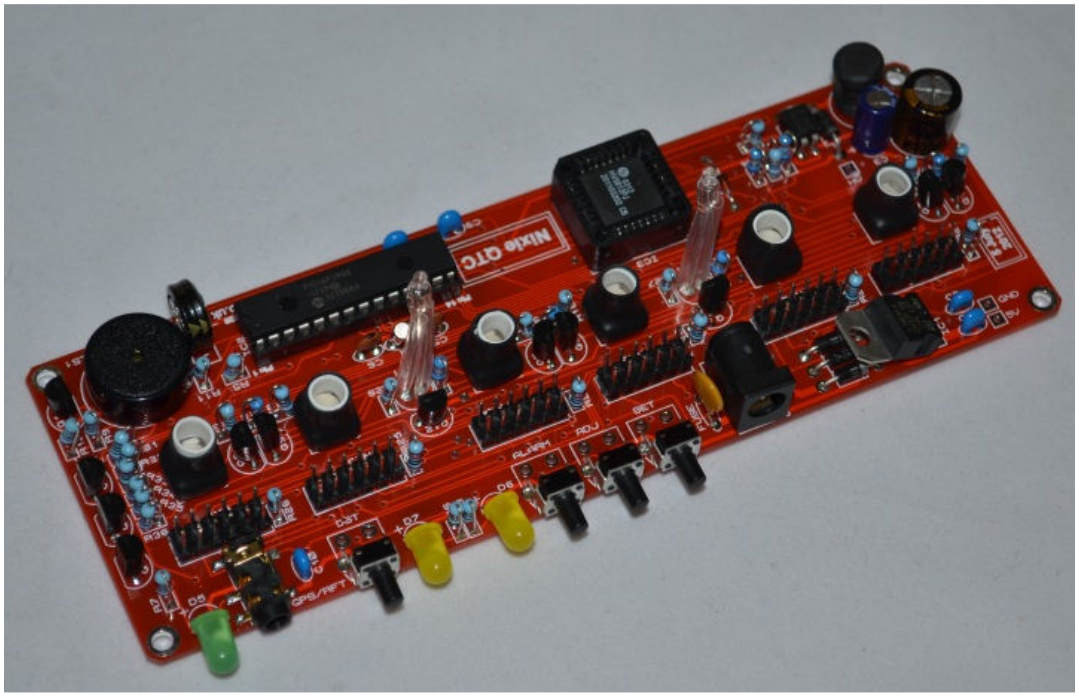
8. MOUNTING THE RGB TUBE LIGHTING COMPONENTS

Complete step 8 if you have selected the optional RGB Tube Lighting Pack. Alternatively, you may choose to install a single colour LED (Step 9), or no LEDs at all.

8.1 RGB LEDs D8 – D13.
Q2 – Q4 (2N7000)
R31 – R36 (270 Ω)

Retrieve the 6 LEDs from earlier, complete with light pipes:

Install an LED at each LED location, looking carefully for the 'notched' corner on each LED which is partially masked by the heat shrink, but still visible. This aligns with a corresponding PCB mark . Solder in each LED and then the other components of this step:

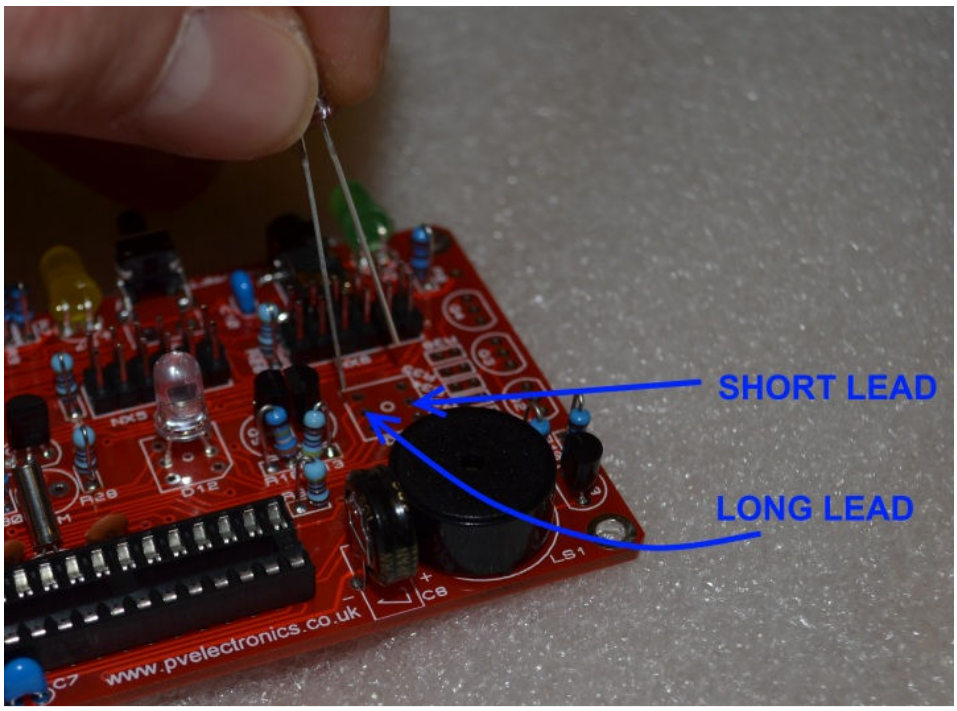


9. MOUNTING SINGLE COLOUR TUBE LEDs

Complete step 9 if you wish to use a single standard LED per tube location. Note that the components for this step are not supplied. The information is supplied for guidance only.

It is suggested to install each single LED across the central of the RGB pin pairs. This corresponds to the Green LED channel in the software settings. You will use the Green values to set the LED brightness (regardless of the actual colour of the LEDs installed)

The circuit uses 2 X (3 LEDs in series), driven from 12V. The current limiting resistors for the Green channel are R33 and R34. Calculate the value of the resistors needed and ensure the power rating of the resistor is suitable for the current that will be flowing. A 2N7000 MOSFET transistor will need to be installed at the Q3 position to drive the LEDs in software on the Green channel.



10. 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 diplay 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) 1 – 24 Hr
2	Date format	0 = MM.DD.YY (default) 1 = DD.MM.YY 2 = YY.MM.DD (from V1.1 onwards)
3	Leading zero blanking eg. *0*1:54:32	0 – leading zero blanked (default) 1 – leading zero displayed
4	Night Mode start hour	0 - 23
5	Night Mode end hour	0 - 23
6	Night Mode	0 – Tubes off 1 – Dimmed display (default)
7	Master Blank start hour[1]	0 - 23
8	Master Blank end hour[1]	0 - 23
9	Master Blank days[1]	0 – Off (default) 1 – Weekdays 2 - Weekends 3 – All days
10	Colon neons mode	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Both flash (default) 3 – Both illuminated 4 – Both off
11	Colon neons during night dimmed mode [2]	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Both flash 3 – Both illuminated (default) 4 – Both off
12	Radio time signal source	0 – No Radio Time source (default)[3] 1 – DCF 2 – not used 3 – MSF 4 - GPS
13	GPS Baud rate	0 – 4.8 Kbps (default) 1 – 9.6 Kbps 2 – 19.2 Kbps 3 – 38.4 Kbps
14	Radio time offset hours	0-13 (default 0)[4]
15	Radio time offset mins	0-45 (default 0)[4]
16	Radio time offset polarity	0 - Minus time (default) 1 – Plus time
17	Reserved – leave as 0	0
18	Snooze period	0 – 6 minutes (default) 1 – 9 minutes 2 – 12 minutes 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 1 - Make clock faster

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

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 hours 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 bleeps, 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.

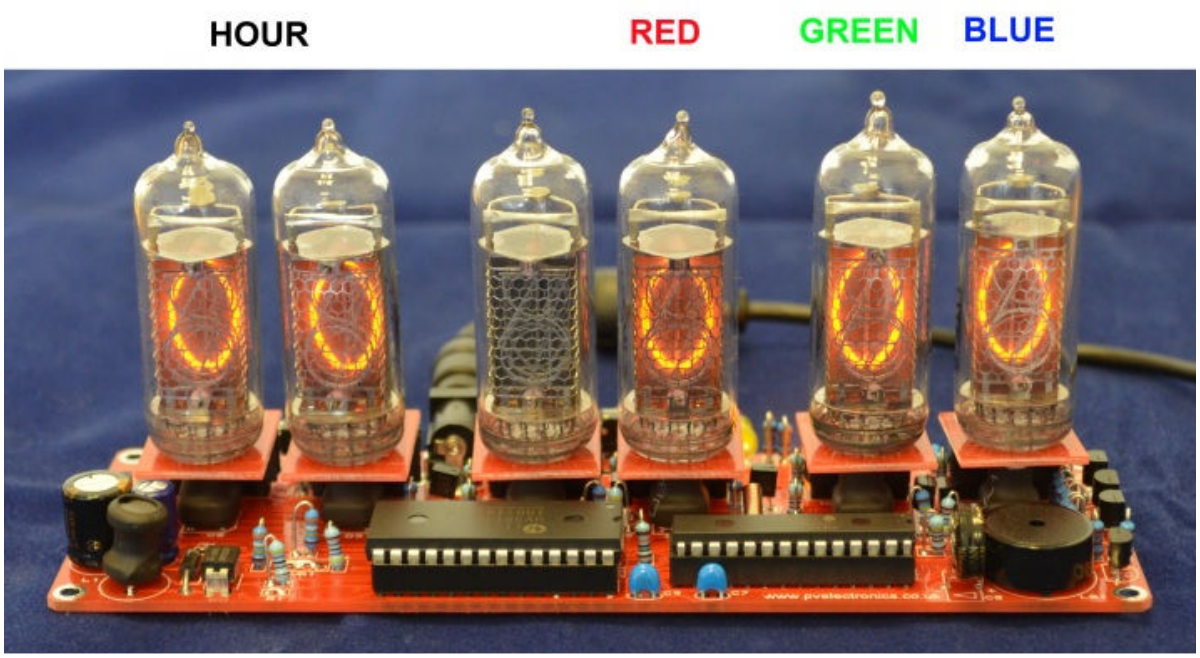
11. CONFIGURING THE RGB LED TUBE LIGHTS

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.

11.1 Entering RGB LED menu

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

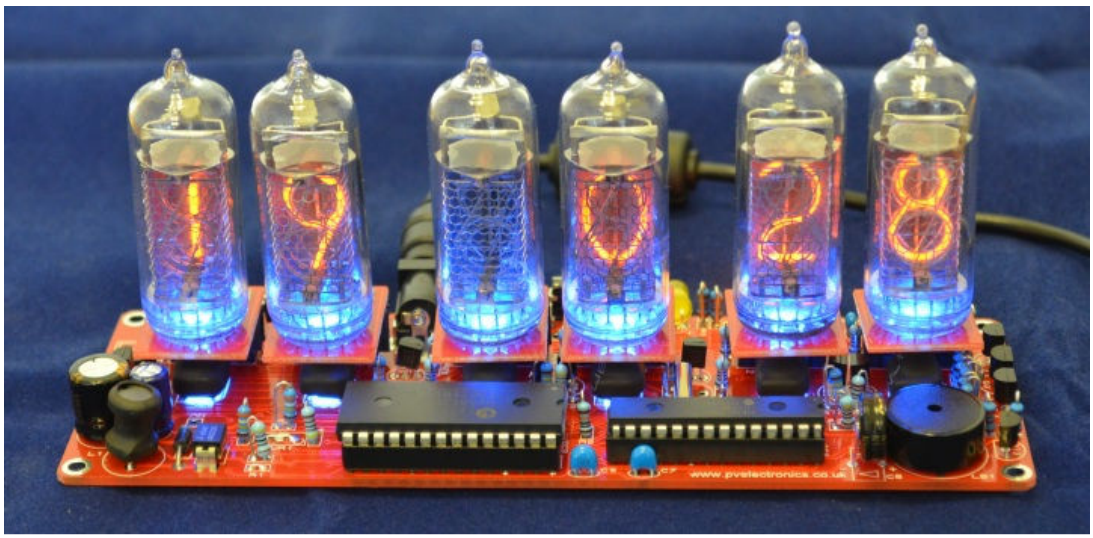


- For each hour (0-23), you can set a custom colour
- Each custom colour can have your choice of RED, GREEN and BLUE values from 0 (colour off) to 8 (maximum brightness)
- Mix the colours using the SET, ADJ, ALARM buttons.
- Use low values (1,2 and 3) for low brightness, eg. For night time
- Set the 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)

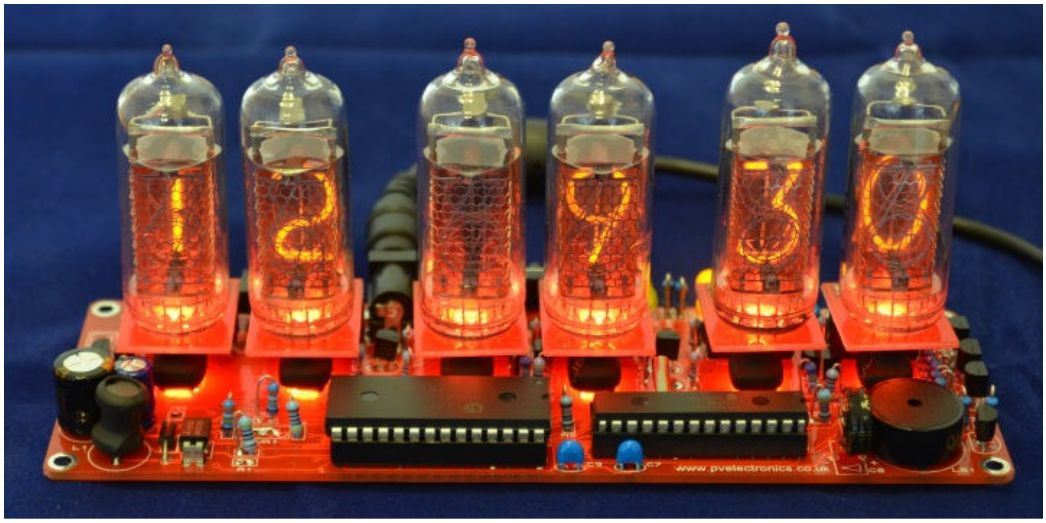
- In the example below, between 19 and 20 hours, the LEDs will be blue with a hint of green (0 red, 2 green and 8 blue)



11.2 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.

12. 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.

12.1 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.

12.2 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.

12.3 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.

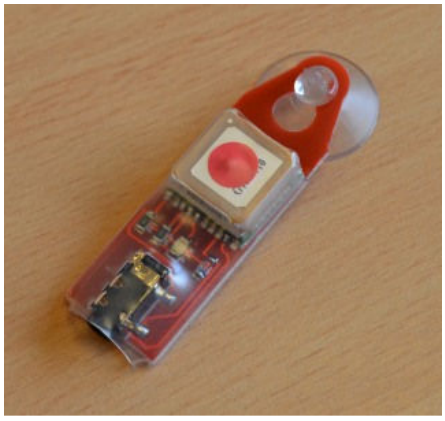
8. After 60 seconds of gathering data, the clock will illuminate the green LED, set the time and switch the tubes back on.

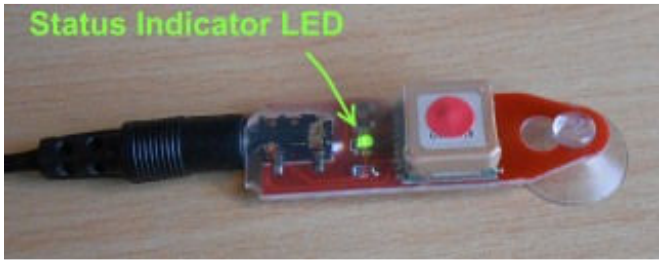
9. Once the system has been seen to work correctly, you can experiment with the antenna in different locations, and it may be possible to have the tubes stay on for time synchonisation.

10. Many other electrical applicances 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.

12.4 Connecting a GPS receiver

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





12.5 Function of the GPS / RFT indicator LED (D5):

- *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:

Radio Time Source	**Sync < 2 Hrs**	**Sync >2 Hrs Sync < 24 Hrs**	**Sync > 24 Hrs**	**Seeking RFT Frame**	**Aquiring RFT Frame**
None	Off	Off	Off	-	-
DCF / MSF	On	Slow Flash	Off	Intermittent Flash	Fast Flash
GPS	On	Slow Flash	Off	-	-

13. 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.

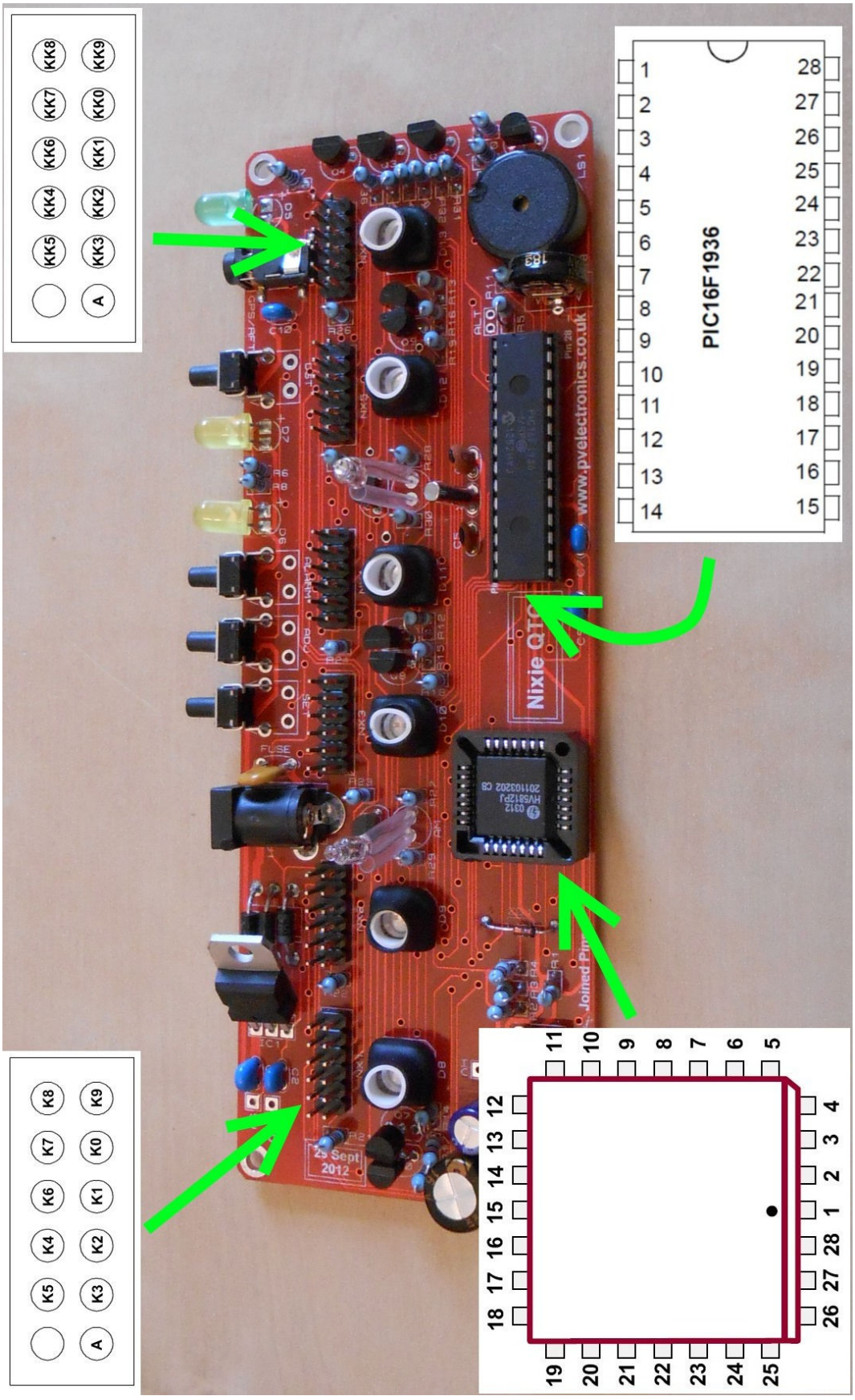
13.1 Data connections from IC2 to IC3

IC3 (HV5812) Pin Number	IC2 (PIC 16F1936) Pin Number	Function
27	3	Data
15	4	Clock
16	5	Strobe

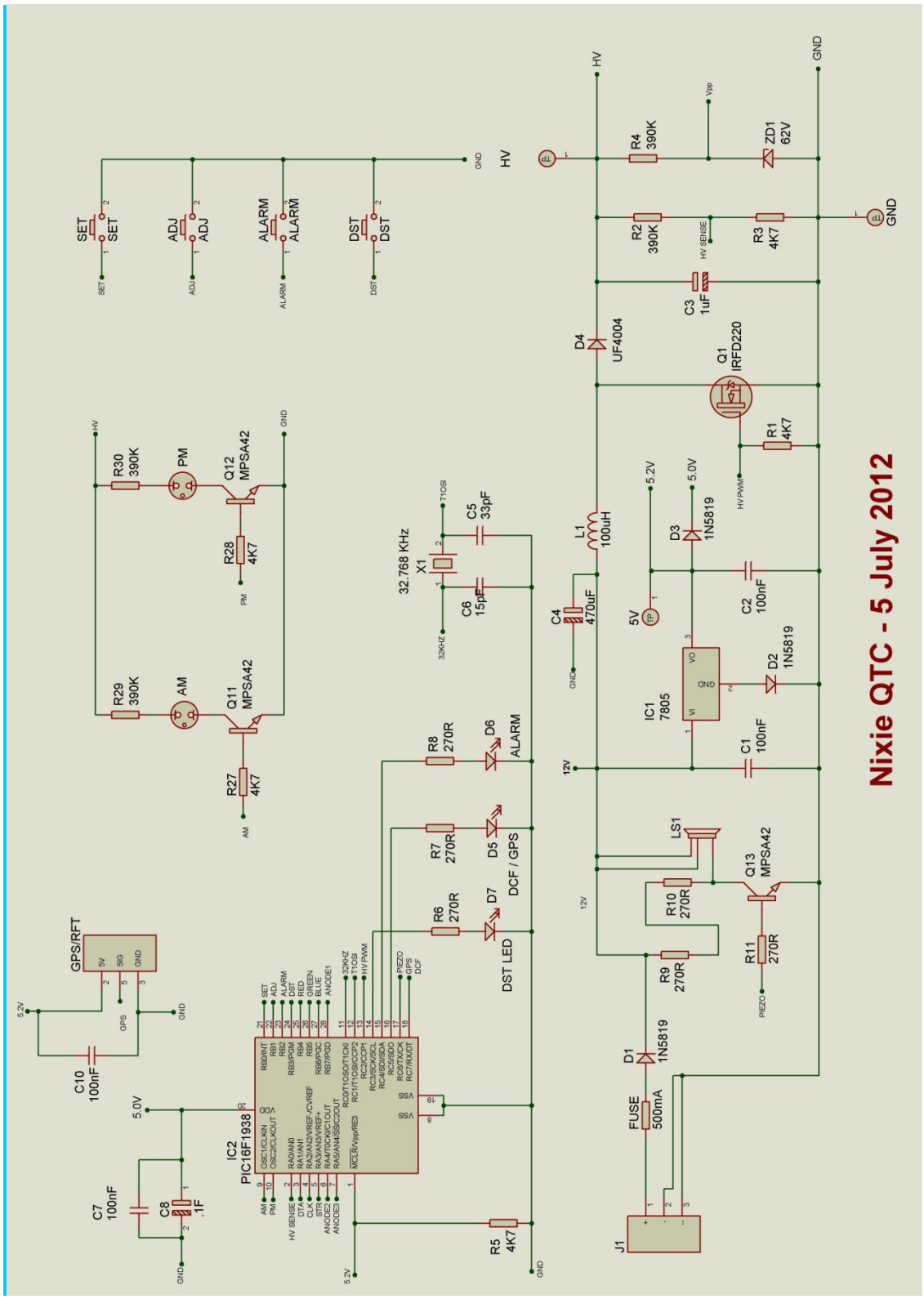
13.2 Cathode connections from IC3 to tube pin headers

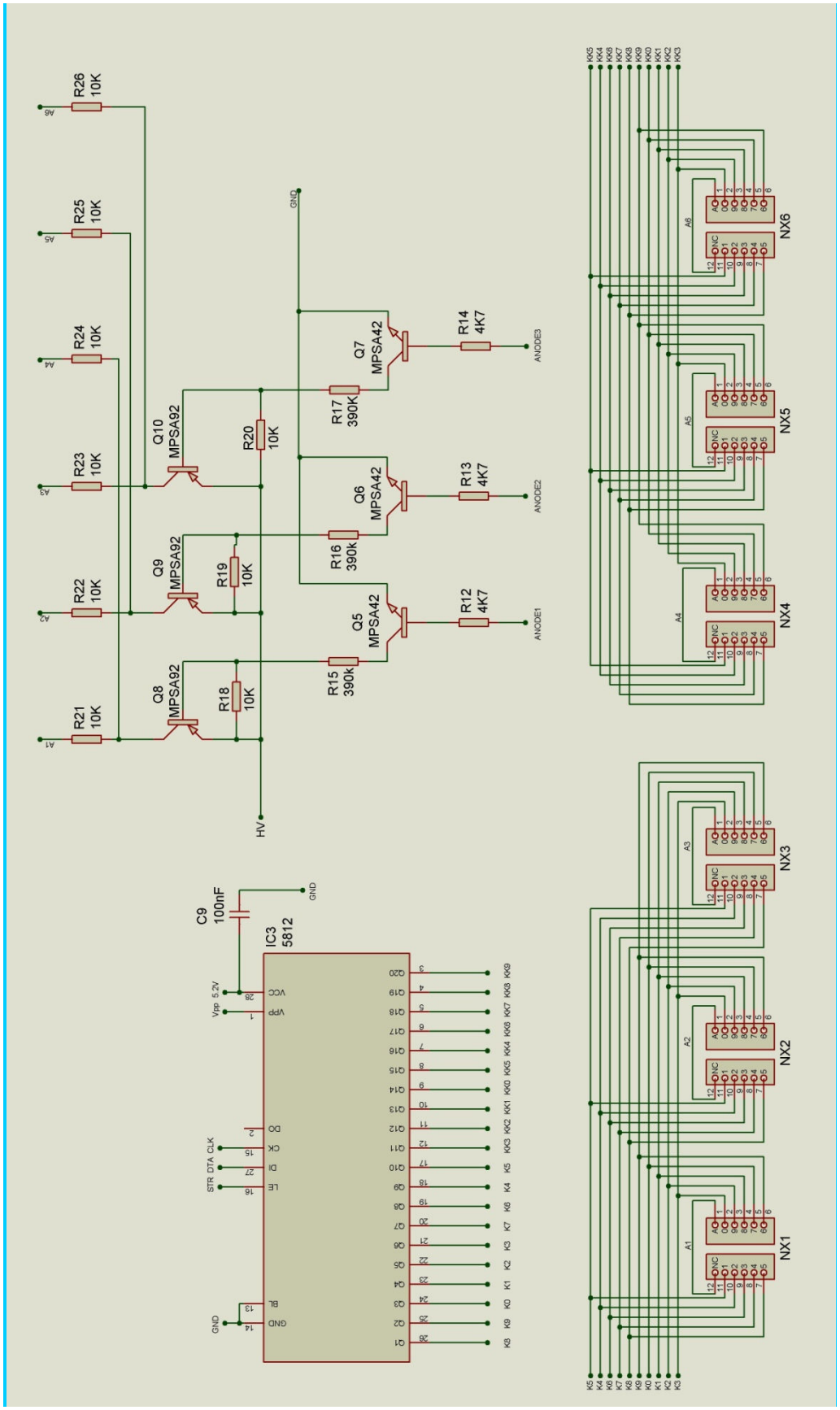
IC3 (HV5812) Pin Number	NX1, NX2, NX3 Cathode
17	K5
18	K4
19	K6
20	K7
21	K3
22	K2
23	K1
24	K0
25	K9
26	K8

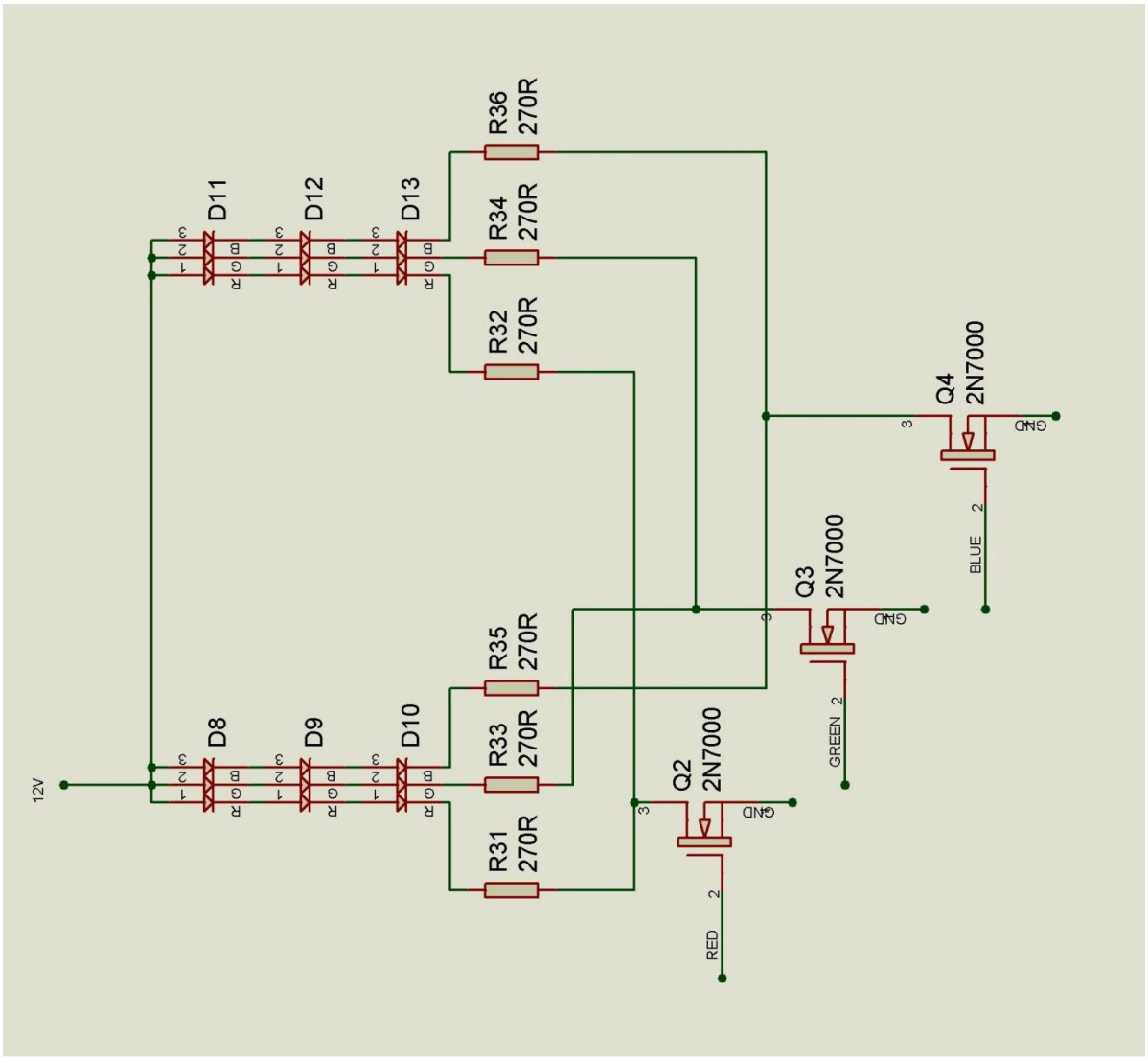
IC3 (HV5812) Pin Number	NX4, NX5, NX6 Cathode
3	KK9
4	KK8
5	KK7
6	KK6
7	KK4
8	KK5
9	KK0
10	KK1
11	KK2
12	KK3


KK8
KK9
KK7
KK0
KK6
KK1
KK4
KK2
KK5
KK3
A
PIC16F1936
1 2 3 4 5 6 7 8 9 10 11 12 13 14
28 27 26 25 24 23 22 21 20 19 18 17 16 15
www.pvelectronics.co.uk
Nixie QTC
25 Sept 2012
K8
K9
K7
K0
K6
K1
K4
K2
K5
K3
A
11 10 9 8 7 6 5
12 13 14 15 16 17 18
4 3 2 1 28 27 26
19 20 21 22 23 24 25

14. CIRCUIT DIAGRAM




R26 10K
R25 10K
R24 10K
R23 10K
R22 10K
R21 10K
Q10 MPSA92
Q9 MPSA92
Q8 MPSA92
R20 10K
R19 10K
R18 10K
Q7 MPSA42
Q6 MPSA42
Q5 MPSA42
R17 390K
R16 390k
R15 390K
R14 4K7
R13 4K7
R12 4K7
ANODE3
ANODE2
ANODE1
GND
HV
C9 100nF
IC3 5812
Vpp 5.2V
STR DTA CLK
NX1
NX2
NX3
NX4
NX5
NX6


12V
D8
D9
D10
D11
D12
D13
R31 270R
R32 270R
R33 270R
R34 270R
R35 270R
R36 270R
Q2 2N7000
Q3 2N7000
Q4 2N7000
GND
RED
GREEN
BLUE