Assembly Instructions
And
User Guide

Nixie FunKlock
For Parts Bags Serial Numbers 4000 onwards

REVISION HISTORY

Issue Number	Date	Reason for Issue
5	14 Nov 2019	Added support for DekaDuo and 3 way header to PCB
4	1 February 2017	New diode for D2
3	27 December 2013	C7 / C8 error page 15
2	7 November 2013	Errors corrected
1	1 November 2013	New document

1. INTRODUCTION

1.1 Nixie FunKlock - Features

- Hours, Minutes and Seconds display on four IN-12 Nixie Tubes
- Uses a Quartz Crystal Oscillator as the timebase
- Programmable leading zero blanking
- Supercapacitor backup. Keeps time during short power outages
- Simple time setting using two buttons
- Variable intensity LED backlighing in a variety of colour options
- 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.
- Separate modes for colon neons during night mode
- Standard, or scrollback display modes
- 'Slot Machine' Cathode poisoning prevention routine
- Not AC frequency dependent – works in all countries
- All user preferences stored to non-volatile memory
- Timekeeping trimmable in configuration setup
- Dedicated 3 way header to power and Synchronise our DekaDuo Dekatron driver.

1.3 SAFETY

DANGER: The clock pcb includes a switched-mode voltage booster circuit. This generates nominally 170 Volts DC, but is capable of generating up to 300 Volts before adjustment. 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 (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.
- Small flat screwdriver for adjusting the high voltage supply

2.2 Materials you will need.

Solder – lead / tin solder is preferred. 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.

The suitable type of power adapter can be obtained at very low cost. The following specification of adapter should be obtained and used with the kit:

Output 12V DC regulated, minimum output capability of 300 mA
Output plug: 2.1mm pin, centre positive.
There is no maximum power output for the adapter as the clock only draws what it needs.

A suitable adapter is shown below:

3. LIST OF COMPONENTS

3.1 Table of Electronic Components

Circuit Designation	Part Description
Resistors	
R1	4.7K, ¼ Watt
R2	390K, ¼ Watt
R3, R4, R5	4.7K, ¼ Watt
R6 - R9	1K or 1.1K, ¼ Watt
R10 - R13	2.7K, ¼ Watt
R14, R15	4.7K, ¼ Watt
R16, R17	390K, ¼ Watt
R18, R19	270R 1/4 Watt
Capacitors	
C1, C2	100nF Ceramic
C3	1uF 250V Electrolytic
C4	220uF 16-25V Electrolytic
C5	15pF Ceramic
C6	33pF Ceramic
C7	100nF Ceramic
C8	0.1F or 0.22F
Transistors	
Q1	IRFD220 MOSFET
Q2 – Q5	EL817 Optocoupler
Q6, Q7, Q8	MPSA42 NPN
Diodes	
D1, D3	1N5819
D2	1N4001
D4	UF4004
D5 - D8	3mm LED (various colours)
Integrated Circuits	
IC1	78L05 5V voltage regulator
IC2	PIC16Fxxxx 8-bit microcontroller
IC3	74141 / K155ID1 Nixie driver
Miscellaneous	
L1	100uH Radial Inductor
AM, PM	4mm wire ended neon lamp
SET, ADJ	Miniature push button
IC Socket for IC2	28 Way IC socket for IC2
J1	2.1mm PCB power socket
J2, J5	10 way pin header
J3, J4	10 way socket
FUSE	500mA fuse
Insulation	Clear insulation for neons
X1	32.768KHz watch crystal
Misc	44 X 1mm sockets
Deka	3 way 0.1" Male Header for DekaDuo

3.2 Electronic Components Parts List / Packing Sheet

Part Description	Quantity
Resistors	
270R, ¼ Watt	2
1K or 1.1K, ¼ Watt	4
2.7K, ¼ Watt	4
4.7K, ¼ Watt	6
390K, ¼ Watt	3
Capacitors	
220uF, 16-25V, Electrolytic	1
1uF 250V, Electrolytic	1
100nF Ceramic	3
15pF Ceramic	1
33pF Ceramic	1
0.1F or 0.22F	1
Transistors	
IRFD220 MOSFET	1
EL817	4
MPSA42 NPN	3
Diodes	
1N5819	2
1N4001	1
UF4004 fast recovery diode	1
3mm LED (various colours available)	4
Integrated Circuits	
78L05 5V voltage regulator	1
PIC16Fxxxx 8-bit microcontroller	1
74141 / K155ID1 Nixie driver	1
Miscellaneous	
100uH Radial inductor	1
4mm wire ended neon lamp	2
Miniature push button	2
28 Way IC socket for IC2	1
2.1mm Chassis power socket	1
500mA fuse	1
6 cm clear insulation	1
10 way female socket	2
10 way male socket	2
1mm socket receptacle	44
32.768KHz watch crystal	1
3 way 0.1” Male header	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.

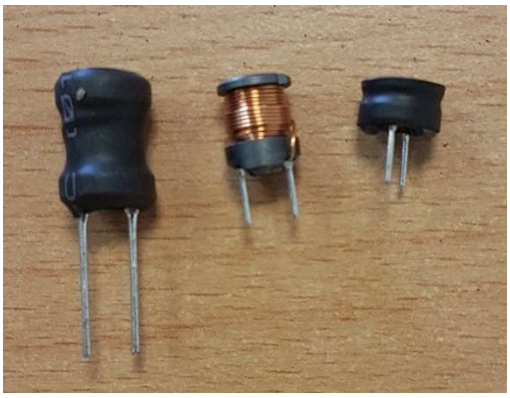
C1, C2 and C7 may be marked '104' and although the photos in the instructions show them blue, they are more likely to be mustard-yellow due to supply availability.

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.

The fuse is a self-resetting type and can be confused for a Capacitor. This is what it looks like:

Q1 (IRFD220) is in a very similar package to Q2 - Q5 (EL817). You can tell the difference, in addition to the part marking by looking at the pins. Q1 has two pins that are actually joined at the resin body. Q2 - Q5 have 4 separate pins.

Inductor L1 may be one of three types:

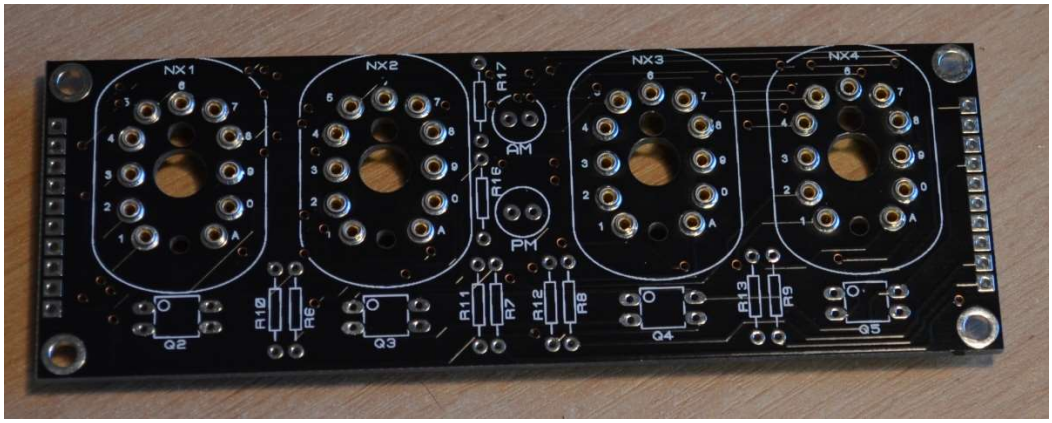


4. ASSEMBLY OF THE PCB

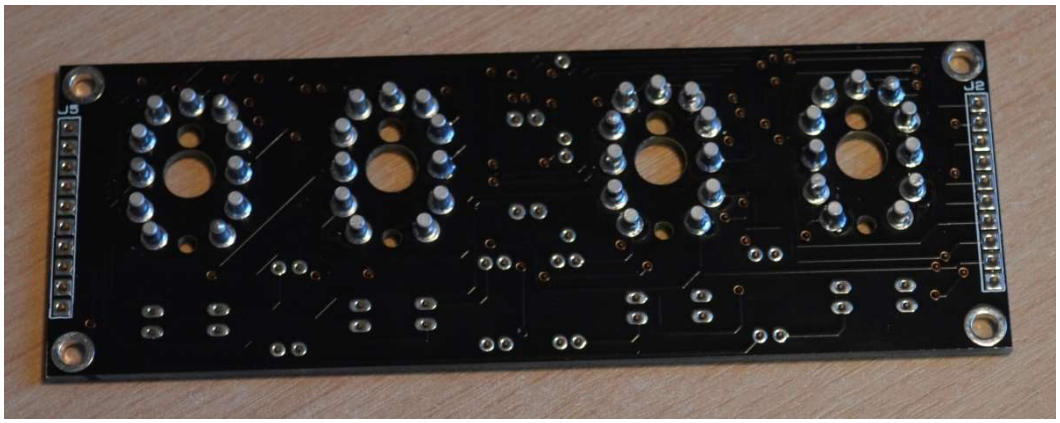
The PCB is supplied as a single board, with a V-score to break in half. Simply bend at the score line and the PCB will split into two parts. Start work below on the tube board:

4.1 1mm Sockets For Nixie Tubes

There are 44 individual sockets that need to be placed. Note that there is 1 hole per tube with NO SOCKET.
Insert the sockets from the side shown below:



Then place a hard flat object over the sockets and flip over the PCB and solder the sockets in place as shown below:

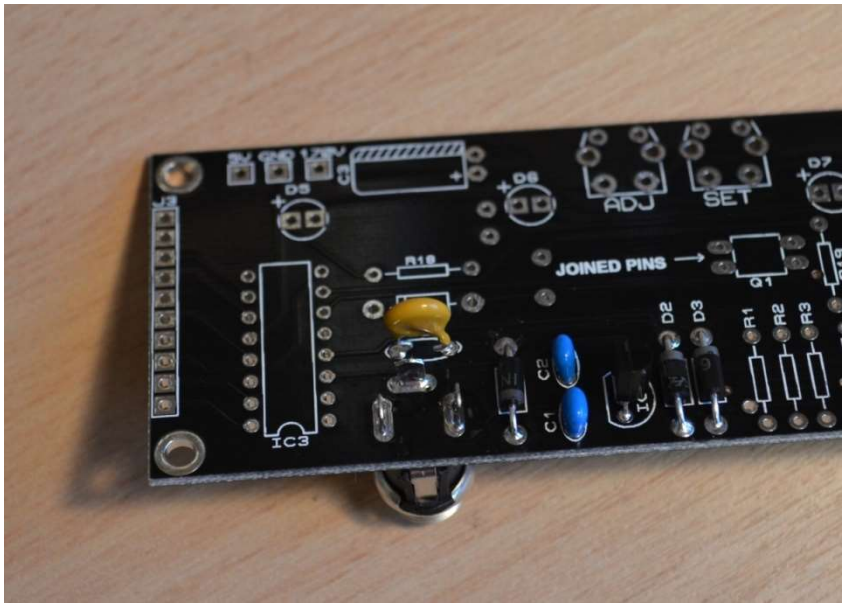


4.2 Low Voltage Power components:

J1, FUSE,
D1, D3 (1N5819)
D2 (1N4001)
IC1 (78L05)
C1, C2 (100 nF)

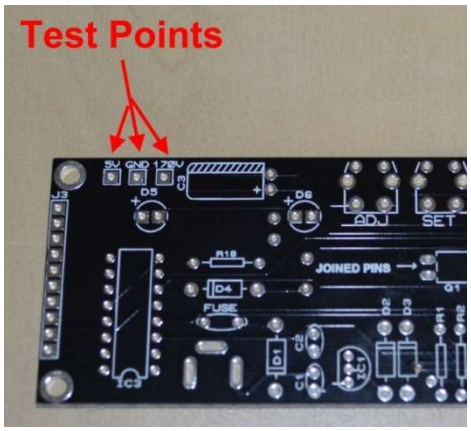
Start by installing D1-D3. Align the white band on the components with the band marked on the PCB.

Continue to mount C1, C2, J1, IC1 and FUSE. Note that J1, the DC power socket, is mounted on the opposite side of the PCB to the other components.



4.2 Testing Low Voltage.

Identify the test 5V, GND and 170V 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 5.5 and 5.8 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.

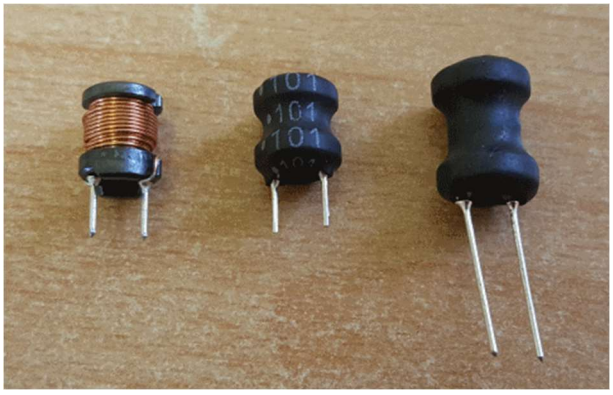
4.3 High Voltage Generator components.

R1, R3 (4.7 KΩ)
R2 (390 KΩ)
Q1 (IRFD220)
D4 (UF4004)
C3 (1 µF)
C4 (220 µF)
L1 (100 µH Inductor)
Socket for IC2

Pay attention to mount D4 with the white band aligned with the PCB marking. Insert the 28 way IC socket into the PCB at the IC2 position, ensuring that the notch at one end is aligned with the corresponding marking on the PCB.

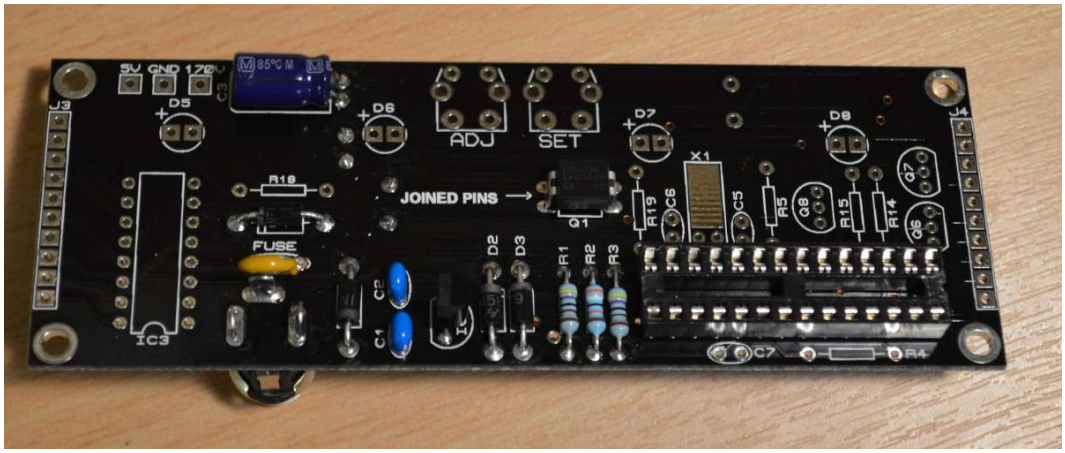
C4 and L1 are soldered on the opposite side of the PCB to the other components. The white PCB marking will guide you.

Note that L1 will be one of three possible types.



If your L1 is the type with the longer wires, you will need to bend the wires over so the part is soldered laying on the PCB, as marked on the PCB. Otherwise install the component conventionally.

C3 and C4 are polarised so must be inserted the right way round. The white stripe on the body of the component must be next to the corresponding white marking on



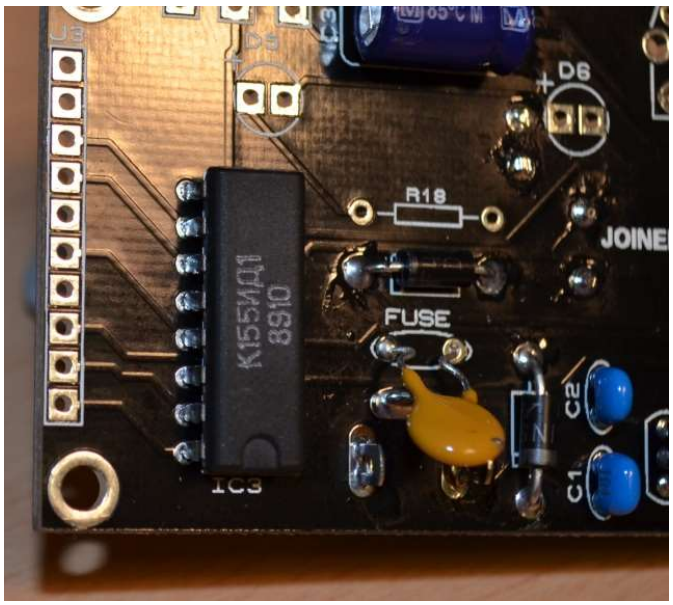
4.4 High Voltage Generator Test.

- Refer to the warnings on page 4
- 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 170V test points, measure the high voltage generated. It should be between 167 and 173V. 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.
- If you do not get this voltage, disconnect the power supply and check your work carefully. Do not proceed until you get the correct voltage at this stage.

4.5 Nixie Driver

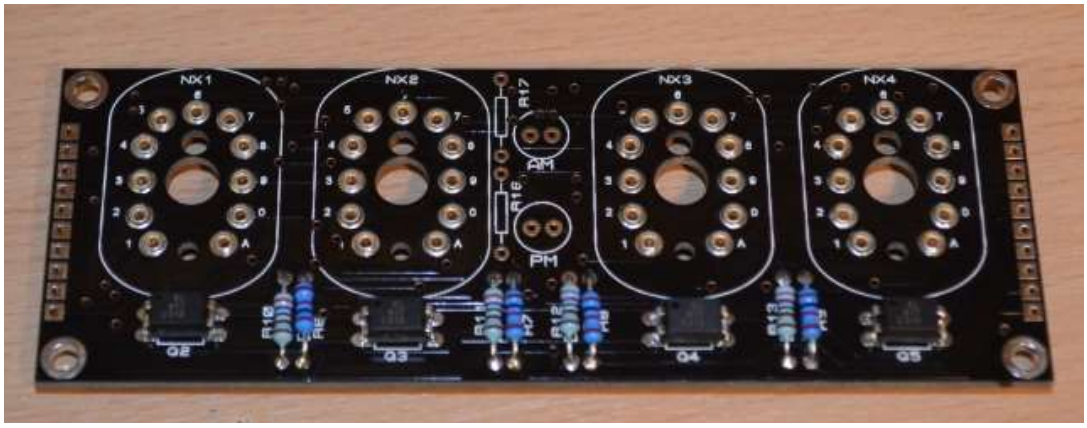
IC3 (K155ID1)

Orient the notch on the IC body with the notch on the PCB marking and solder in place. Note that no socket is used.

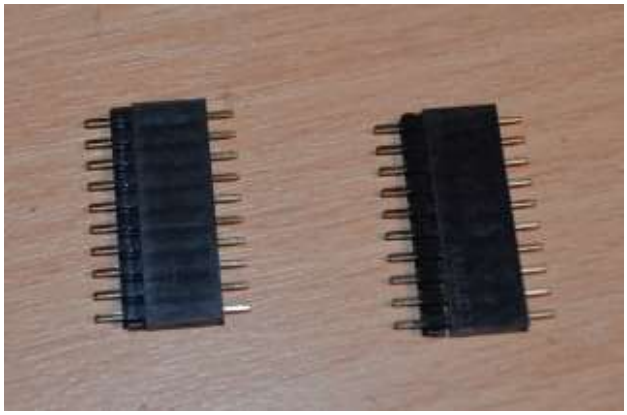


4.6 Anode Driver Components
Q2 - Q5 (EL817)
R6 - R9 (1 KΩ or 1.1 KΩ)
R10 - R13 (2.7 KΩ)

Assembly now continues on the tube PCB:
Orient the dot on the EL817 each optocoupler with the corresponding PCB mark.

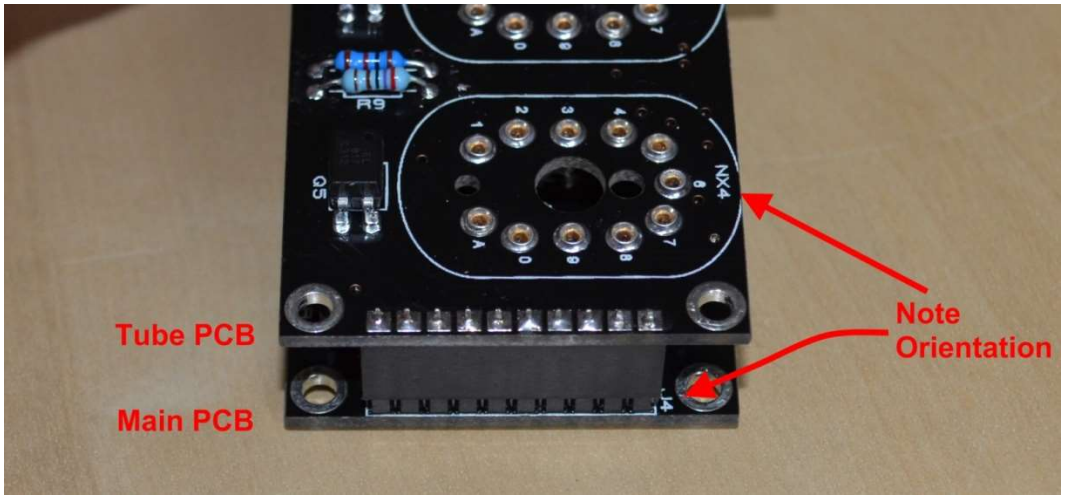


4.7 Board Connectors
J2, J5 (10-Way female connector)
J3, J4 (10-Way male connector)
At this point, you will join the 2 PCBs together with the 10-way connectors. Slide the connectors together as shown below.



Place the connectors into the main component PCB with the male connector in this PCB, so that when you place the tube PCB over the top, the female connectors go into the holes on the tube PCB.

Be sure the 'NX4' and 'J4' component markings are at the same side of the stack, or else your tubes will be upside down!



Ensure the two PCBs are perfectly square and true, and then solder all the connectors in place. It is a good idea to solder the four top corner pins in place and then the four bottom corner pins first, so the connectors are anchored. Then you can solder all the remaining pins. After soldering, the PCBs can be split into 2 parts again.

4.8 X1 (32.768 KHz Crystal)
C5 (15pF)
C6 (33pF)
R4, R5, R14, R15 (4.7 KΩ)
R18, R19 (270 Ω)

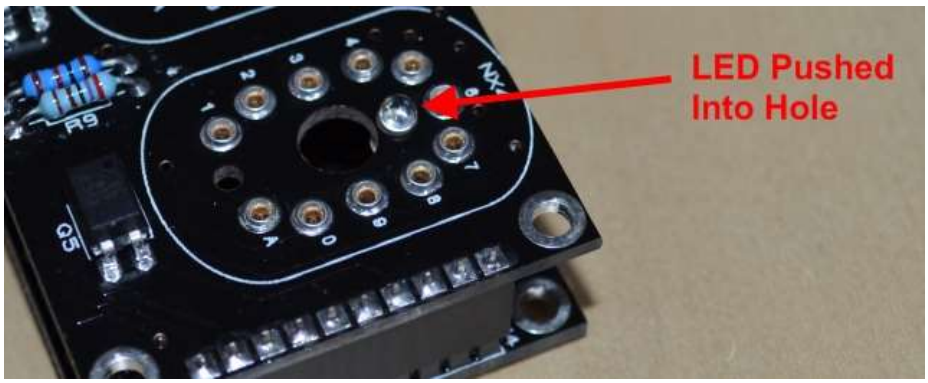
Do not solder the body of the crystal to the PCB, just lay it over the large rectangular pad.

4.9 Q6 - Q8 (MPSA42)

Ensure these three transistors are mounted with their flat / rounded body matching the part marking on the PCB.

4.10 D5 - D8 (3mm Coloured LED)

The LONG lead goes in the hole marked '+'. Put each LED loosely into its holes, and then place the tube PCB into position. Now you can push each LED into the matching small hole in the tube PCB.



Turn the PCBs over so you can solder the LEDs in place, ensuring they are pushed completely into the holes in the tube PCB. The two PCBs may now be pulled apart for the rest of the assembly.

4.11 C7 (100 nF)
C8 (0.1 F or 0.22 F)

There are arrows on the component that need to be pointing the same way as the arrows on the PCB. Simply solder the component in place ensuring the arrows match up. Keep the component as close to the PCB as possible so it does not prevent the tube PCB from fitting correctly.

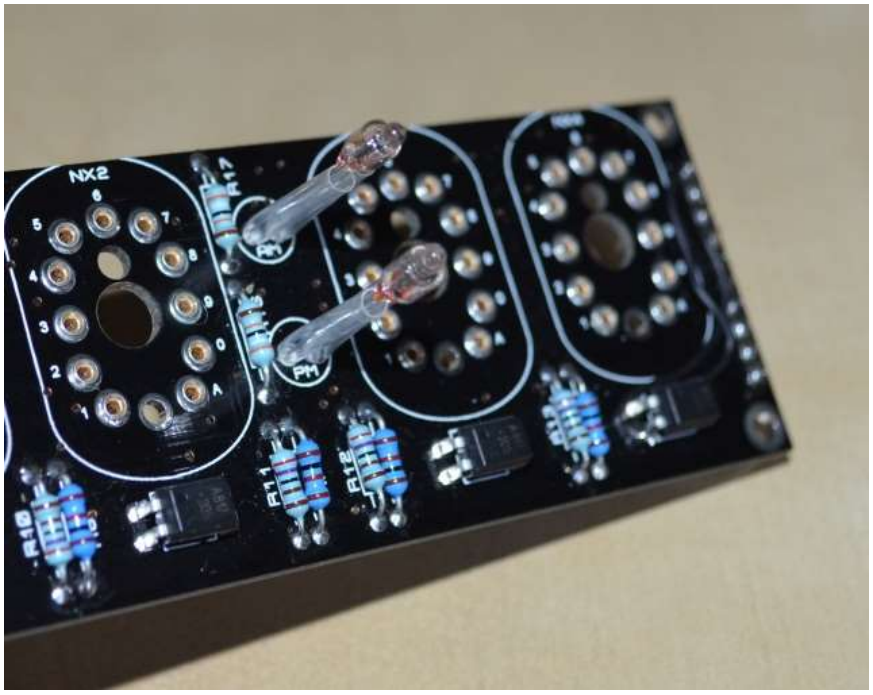
4.12 SET, ADJ (push buttons)

The two push buttons are now soldered onto the main component side of the PCB.

If you have purchased the Finned Aluminium Case, do not use the switches supplied with the kit, but the alternative vertical switches supplied with the case

4.13 R16, R17 (390 KΩ)
AM, PM (4mm neons)

Use small pieces of the clear insulation provided, on the leads of the 2 neons to prevent shorts. You can make a test fit of the IN-12 tubes to help you decide the best height from the PCB for them. The insulation is actually heat-shrinkable, so for a very neat finish you can gently blow with hot air to shrink the insulation after soldering the neons in place.



4.14 Tube Test

The clock is now ready for final powering up. Insert 4 IN-12 or other compatible tubes into the tube sockets. If you look inside the tubes, you can see the correct orientation of the digits. Insert the 4 tubes and THEN assemble the 2 PCBs together, ensuring the 4 LEDs go into the holes in the tube PCB.

Power up the PCB with a 12V DC supply (centre positive). Take great care not to touch live parts on the PCB.

If all is well, the tubes should all count 0..1..2.....9 repeatedly. Pressing the SET button will exit from the tube test and the clock will start showing the time.

If this does not happen, remove power immediately and check your work carefully.

5. HOW TO OPERATE THE CLOCK

The two buttons have the following functions:
SET: Set time.
Enter configuration menu.
ADJ: Adjust time.
Adjust configuration values.

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 display. Continue holding the button a further 2 seconds until the clock displays in this format: 00-XX.
XX is the software verson. eg. 11 means version 1.1

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	Leading zero blanking eg. *0*1:54:32	0 – leading zero blanked (default) 1 – leading zero displayed
3	Night Mode start hour	0 - 23
4	Night Mode end hour	0 - 23
5	Night Mode	0 – Tubes off 1 – Dimmed display (default)
6	AM / PM neon mode	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Flashing (default) 3 – Illuminated 4 – Off
7	AM / PM neon during night dimmed mode [1]	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Flashing 3 – Illuminated (default) 4 – Off
8	LED Tube Lighting Brightness	0 - 9 (default 9)
9	LED Tube Lighting Brightness (Night Mode)	0 - 9 (default 3)
10	Time Calibration Factor	0 - 99 (each unit adjusts by 0.2s per day)
11	Time Calibration Polarity	0 - Make clock slower 1 - Make clock faster
12	Slots Mode[2]	0 – Slots disabled 1 – Slots every minute 2 - Slots every 10 minutes (default) 3 - Slots every hour 4 – Slots at midnight
13	Display Mode	0 – Standard change of digits 1 – Cross-fading digits with scrollback effect (default)
14	Seconds display each minute	0 – Off 1 – On (default)[3]
15	Night Mode Override Period	0 – 50 (default 0 gives 15 seconds override)[4]
16	Dekatron Sync Sleep Mode	0 – Dekatron always on 1 – Dekatron off when night dimmed 2 – Dekatron off in night blanked mode
17	Reserved	
18	Reserved	
19	Restore default settings	0 – Keep user settings 1 – Restore original default settings[5]

Notes:

1. Night time neon mode is active when night mode is set to dim. During night time blanking the tubes AM and PM neon are disabled.
2. Visual effect / cathode poisoning prevention – all digits on all tubes are cycled for 10 seconds. Not active during night blanking or dimmed modes.
3. Seconds will be displayed each minute between 55 and 58 seconds past the minute.
4. Press 'SET' briefly during Night Mode to show time for prescribed period.
5. 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:
From time display mode, press and hold 'SET' button for 2 seconds until the seconds digits are displayed
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.

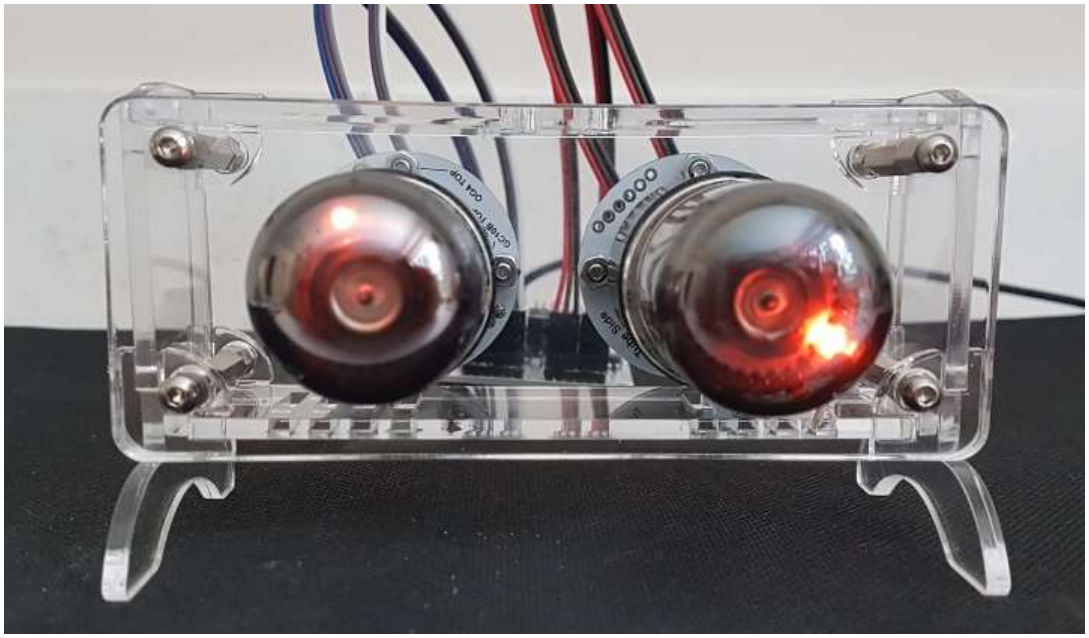
Briefly Press 'SET' again and the hours will be highlighted.
Press the 'ADJ' button to set the hours.

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

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 (15).

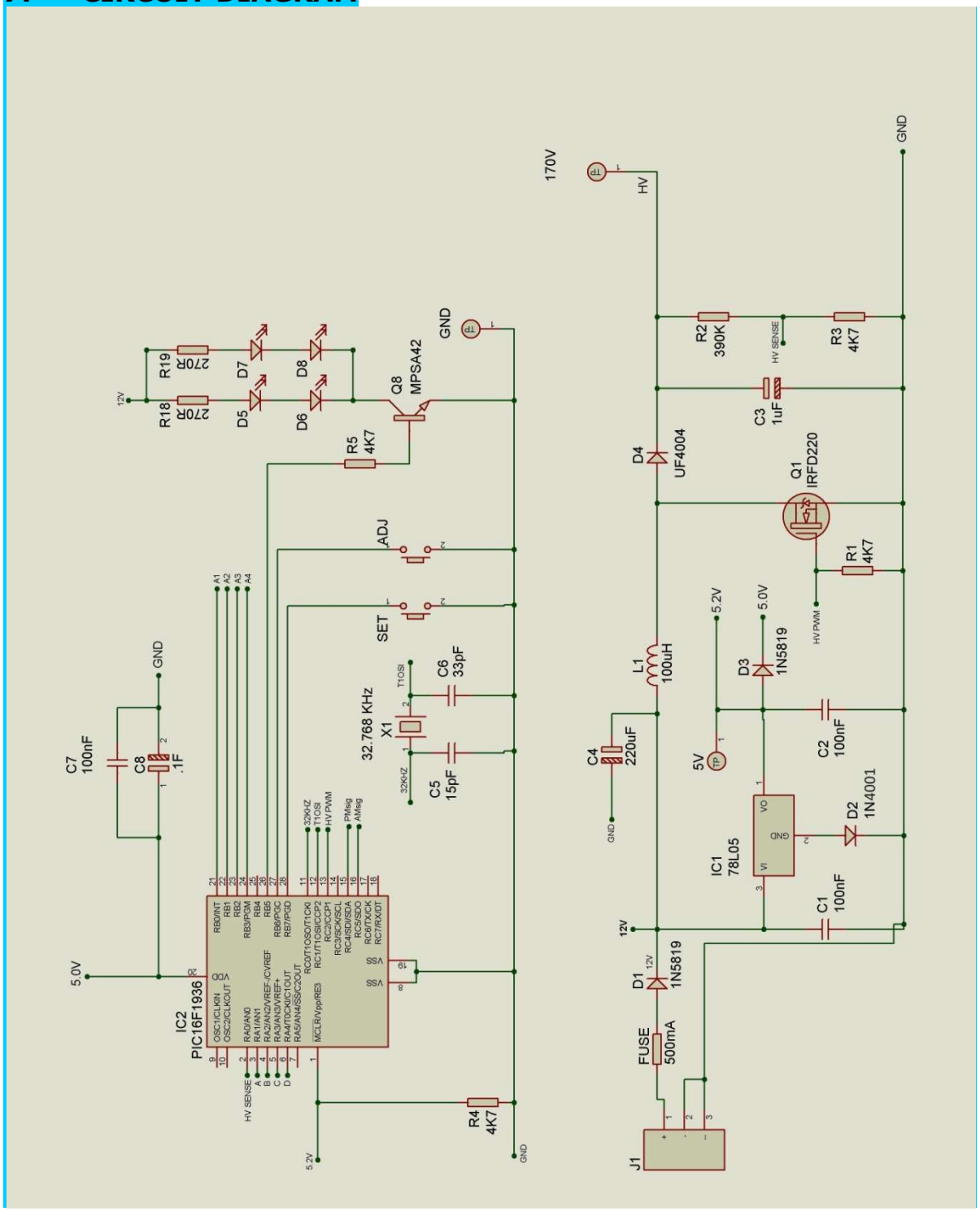
6. CONNECTING OUR DEKATRON DRIVER

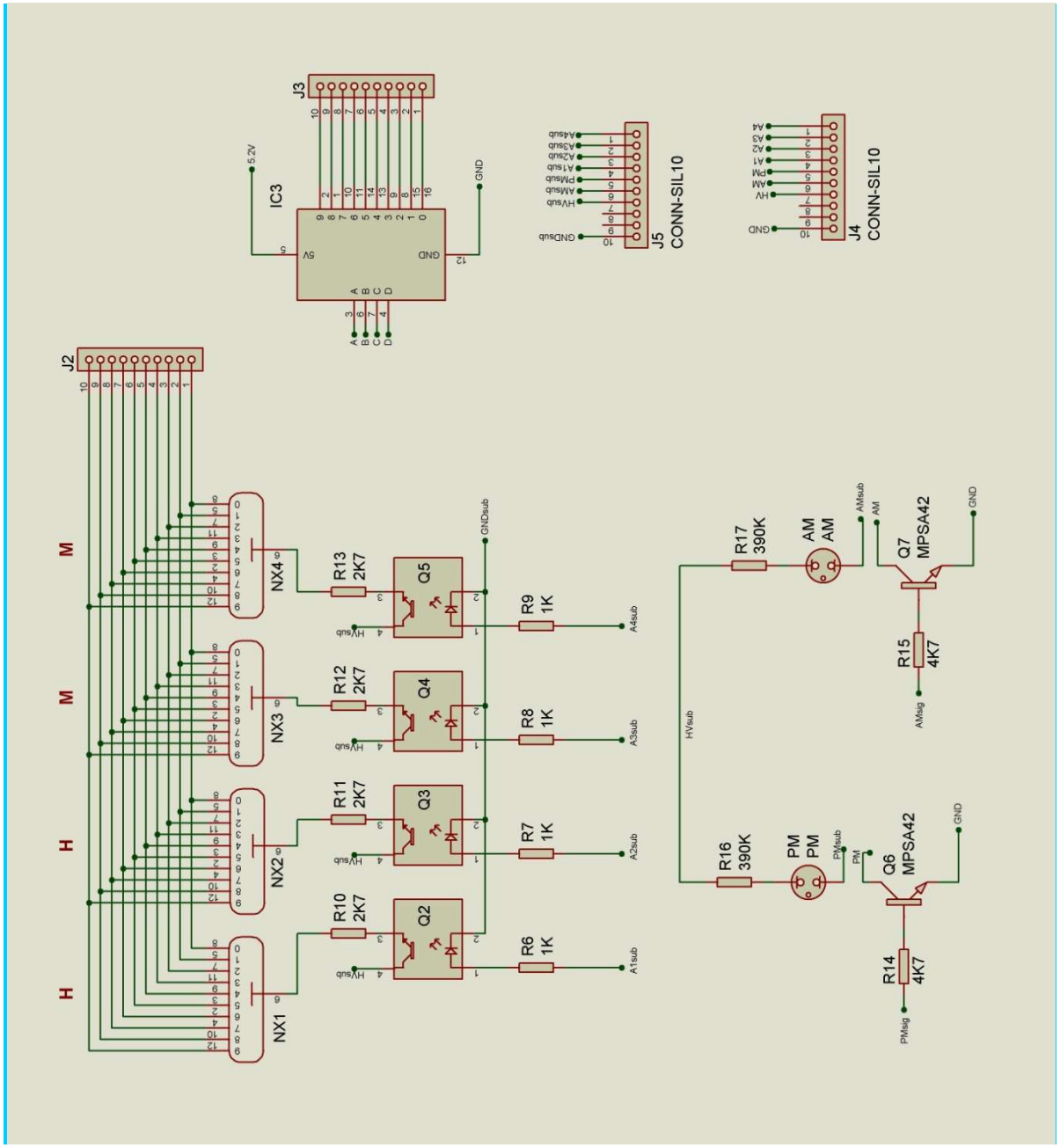
The clock can be connected by just 3 wires to our DekaDuo Dual OG4 Dekatron Driver. Solder the 3 way header as shown below. Control of the Dekatron in night modes is possible using parameter 16.




SET
ADJUST

7. CIRCUIT DIAGRAM




J3
IC3
5.2V
GND
5V
A
B
C
D
J5
CONN-SIL10
J4
CONN-SIL10
J2
M
M
H
H
NX4
NX3
NX2
NX1
R13 2K7
R12 2K7
R11 2K7
R10 2K7
Q5
Q4
Q3
Q2
R9 1K
R8 1K
R7 1K
R6 1K
GNDsub
A4sub
A3sub
A2sub
A1sub
HVsub
R17 390K
R16 390K
AM
PM
AMsub
PMsub
Q7 MPSA42
Q6 MPSA42
R15 4K7
R14 4K7
AMsig
PMsig