Assembly Instructions
And
User Guide

Nixie Clock Type
'Halo Chroma'

For Parts Bag Serial
Numbers from 200 onwards

REVISION HISTORY

Issue Number	Date	Reason for Issue
2	8 March 2023	Changed values for C5 and C6
1	1 April 2021	New document

1. INTRODUCTION

1.1 Halo Chroma - Features

- Hours, Minutes and Seconds display
- Drives Z560M, Z5600M, GN-4, ZM1022 and many other compatible tubes
- Uses a Quartz Crystal Oscillator as the timebase
- 12 or 24 hour modes
- 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 GPS / WiFi / XTERNA 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
- Configurable for leading zero blanking
- Double dot colon neon lamps
- 11 colon neon modes including AM / PM indication (top / bottom or left / right), railroad (slow or fast) etc.
- 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 tubes and LEDs on weekends or during working hours
- Separate modes for colon neons during night mode
- Standard, fading, or crossfading 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
- Supports output Sync Pulse for our DekaDuo Dekatron Driver Board
- All user preferences stored to non-volatile memory
- Additional wireless functions if XTERNA module used:
  - Display of outdoor temperature in Celsius or Fahrenheit. Configurable.
  - Min / Max temperature in last 24 hours
  - Wireless, Auto Sync of time from GPS with auxilliary TCXO
  - GPS Sync time, and time since last GPS Fix
  - Voltage of XTERNA module battery

1.2 Tubes Supported

There are many types of tube this kit will drive – all have the same pinout. The commonest types are as follows:

Z560M
Z5600M
GN-4
ZM1022
ZM1020
B-5092

Digit height is generally 15.5mm for all these tubes. A typical tube is shown below:

1.3 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 (25W fixed temperature recommended) 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).
- Multimeter for voltage tests and for identifying the resistors.
- A small hot air gun will be needed to shrink the heat shrink tubing over the neon lamp wires.

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 500mA
Output plug: 2.1mm pin, centre positive.

A suitable adapter is shown below:

3. LIST OF COMPONENTS

3.1 Table of Components

Circuit Designation	Part Description
Resistors	
R1, R2	4.7 KΩ, ¼ Watt
R3, R4	390 KΩ, ¼ Watt
R5	300 KΩ, ¼ Watt
R6 - R11	270 Ω, ¼ Watt
R12	4.7 KΩ, ¼ Watt
R13 – R15	1 KΩ, ¼ Watt
R16 – R21	4.7 KΩ, ¼ Watt
R22 – R25	15 KΩ, ¼ Watt
Capacitors	
C1, C2, C4	220uF Electrolytic
C3	1uF, 250V,
C5	22pF Ceramic
C6	47pF Ceramic
C7	100nF Ceramic
C8	0.22F
C9	100nF Ceramic
Transistors	
Q1	IRFD220 MOSFET
Q2 – Q4	EL817 Optocoupler
Q5 – Q9	MPSA42
Diodes	
D1 – D3	1N5819
D4	1N4148
D5	UF4004
D6, D8	5mm Yellow LED
D7	5mm Green LED
RGB1 – RGB6	APA106 RGB LED
Integrated Circuits	
IC1	LM2576 5V voltage regulator SMD
IC2	PIC16F1938 8-bit microcontroller
IC3	HV5812
Miscellaneous	
L1, L2	100uH inductor
AM1, AM2, PM1, PM2	4mm wire ended neon lamp
ALARM, SET, ADJ, DST	Vertical miniature push button
IC2 Socket	28 Way narrow IC socket for IC2
IC3 Socket	28 Way PLCC Socket
J1	2.1mm Vertical power socket
SYNC	Vertical 3.5mm jack socket
LS1	Piezo sounder
FUSE	500mA fuse
Insulation	25 cm Clear insulation for neons
X1	32.768KHz watch crystal
Tube Sockets	Harwin 1mm sockets
Sockets for EL817's	2 X 6 way SIL socket strips
DEKA	3 Way 0.1" header

3.2 Parts list / Packing Sheet - Component Bag

Part Description	Quantity
Resistors	
270 Ω, ¼ Watt	6
1 KΩ, ¼ Watt	3
4.7 KΩ, ¼ Watt	9
15 KΩ, ¼ Watt	4
300 KΩ, ¼ Watt	1
390 KΩ, ¼ Watt	2
Capacitors	
22pF, Ceramic	1
47pF, Ceramic	1
100nF, Ceramic	2
1uF, 250V, Electrolytic	1
220uF, 16-25V, Electrolytic	3
0.22F	1
Transistors	
IRFD220 MOSFET	1
MPSA42	5
EL817 Optocoupler	3
Diodes	
1N5819	3
UF4004 fast recovery diode	1
1N4148	1
5mm Green LED	1
5mm Yellow LED	2
APA106 RGB LED	6
Integrated Circuits	
LM2576 5V voltage regulator SMD	1
PIC16F1938 8-bit microcontroller	1
HV5812	1
Miscellaneous	
100uH inductor	2
4mm wire ended neon lamp	4
Miniature vertical push button	4
28 way narrow IC Socket for IC2	1
28 Way PLCC Socket	1
2.1mm Vertical power socket	1
Vertical 3.5mm jack socket	1
Piezo sounder	1
500mA fuse	1
25cm Clear insulation for neons	1
32.768KHz watch crystal	1
10 Way 0.1” Female socket strip	1
2 X 6 way SIL socket strips	1
1mm Harwin Socket	66
3 Way 0.1” header	1
Plexi Tool for bending the RGB LEDs	1

We recommend to check against the list above, to ensure all parts are present before commencing assembly.

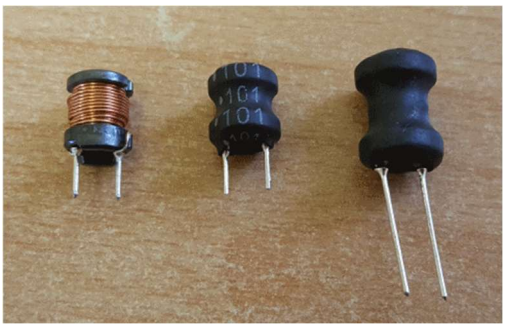
The resistors used in the kit are 1% tolerance metal film. They are marked with 4 coloured bands to identify the value. However it is sometimes unclear in which direction the bands should be read. Therefore, we recommend that the resistors be identified with a multimeter.

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

The 22pF and 47pF capacitors will be marked 22 or 220 and 47 or 470 respectively. The 100nF capacitors will be marked 104.

Q1 (IRFD220) is in a very similar package to Q2 – Q4 (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 – Q4 have 4 separate pins.

Inductors L1 and L2 may be one of three types:

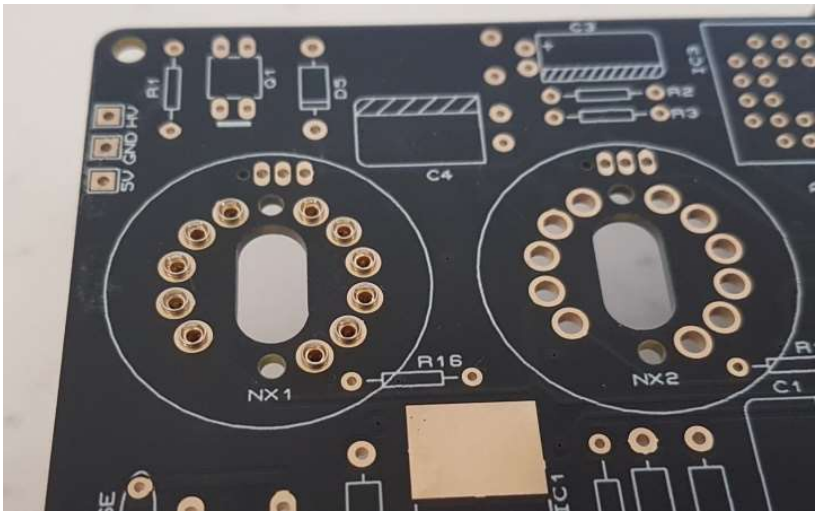


4. ASSEMBLY OF THE PCB

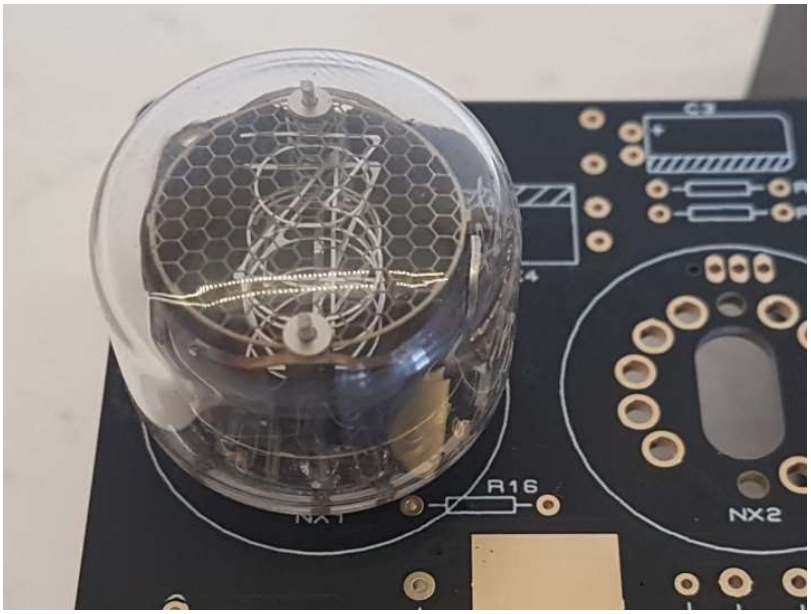
4.1 1mm Sockets For Nixie Tubes

There are 66 individual sockets that need to be placed. Note that there are 2 holes per tube with NO SOCKET.

Be sure to insert the sockets from the front side of the PCB. This is the side with substantially more white component markings on it. Insert and solder all the sockets for each tube at a time, before moving to the next tube location. Be sure to insert the sockets FROM the tube side of the PCB – the side with the tube markings.



After inserting the sockets, the best way to hold all the sockets in place whilst soldering them is to insert a tube.

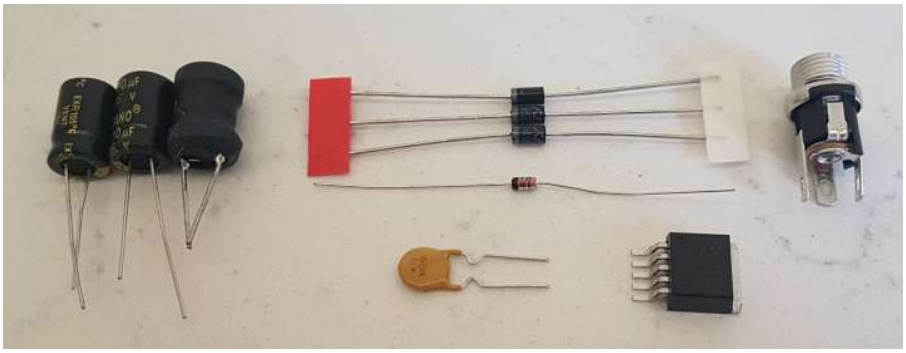


Then flip over the PCB and solder the 11 sockets in place, then remove the tube.

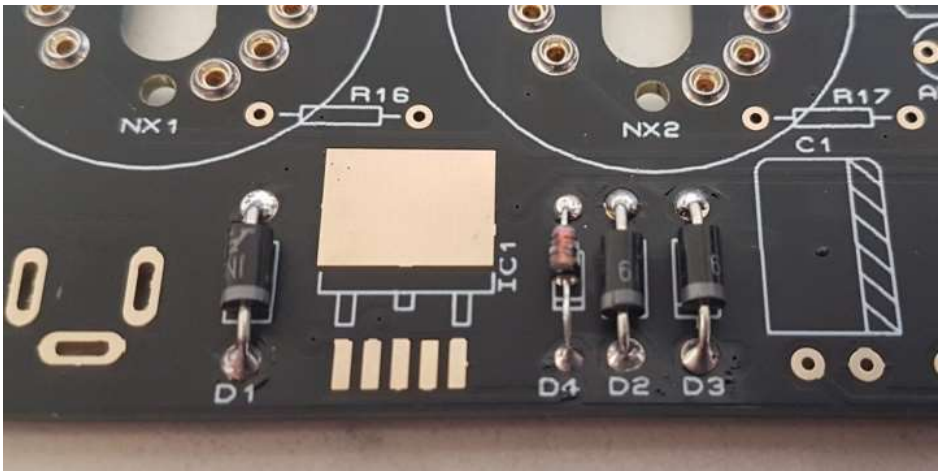
Repeat this for all six tube locations.

4.2 Low Voltage Power Components:

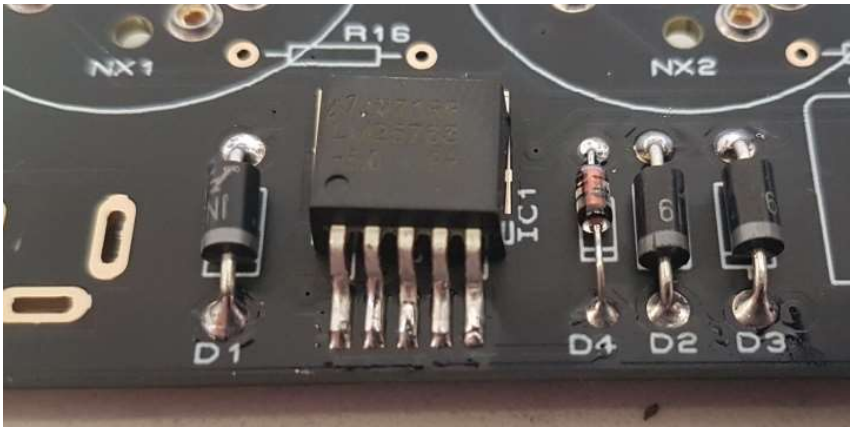
J1, FUSE
D1-D3 (1N5819)
D4 (1N4148)
IC1 (LM2576)
L1 (100uH Inductor)
C1, C2 (220uF)



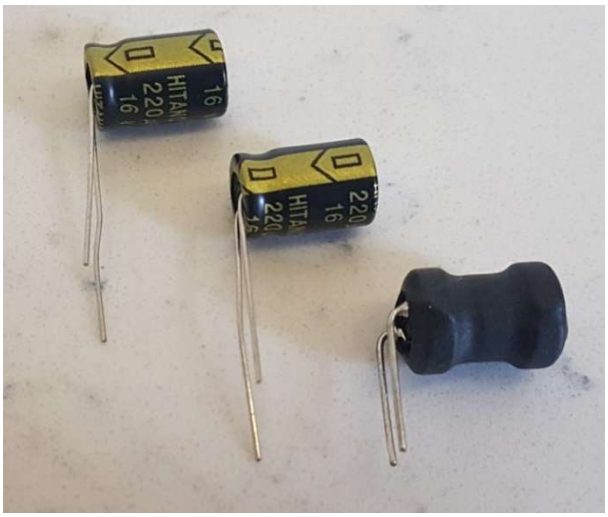
Start by installing D1-D4. The diodes are polarized – the band on the part must match the band marked on the white PCB marking.



IC1 is a Surface Mount part, but it is large and easy to solder. Start by wetting one pad with solder. Then place the part in position and heat the lead so the solder below it melts and anchors the part. The four other leads can then be soldered. Do not solder the heatsink tab.

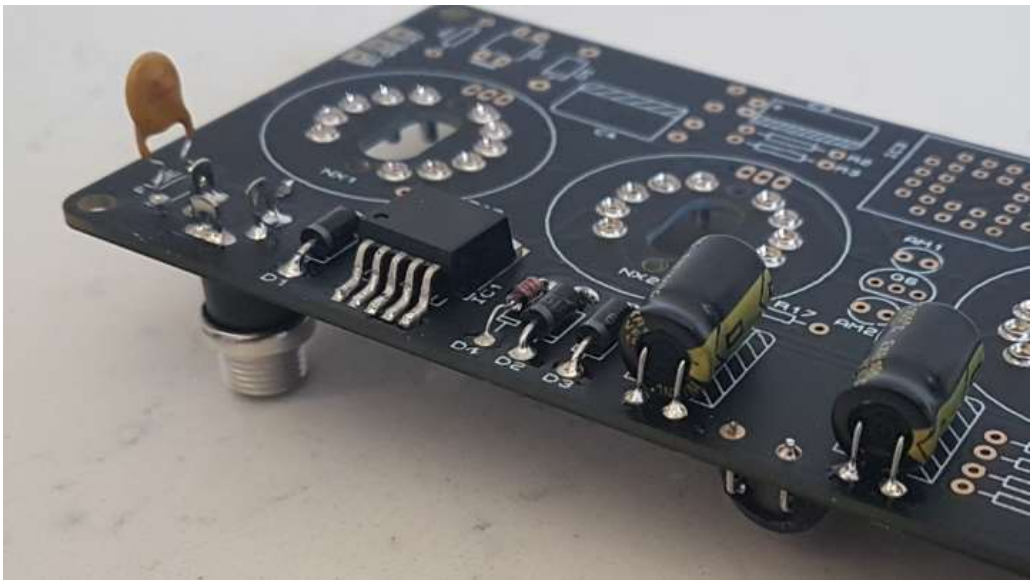


The leads of C1, C2 and the inductor L1 need to be bent as shown below. The inductor is not polarized, but C1 and C2 are polarized so note the positon of the pale stripe when bending the leads. This will ensure the pale stripe matches up with the cross hatched marking on the PCB.



Then solder these three parts noting that the inductor L1 is placed on the opposite side of the PCB to the capacitors C1 and C2.

Finally solder the fuse and connector J1 which is soldered on the opposite side of the PCB to the fuse.



4.3 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 5.4 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.

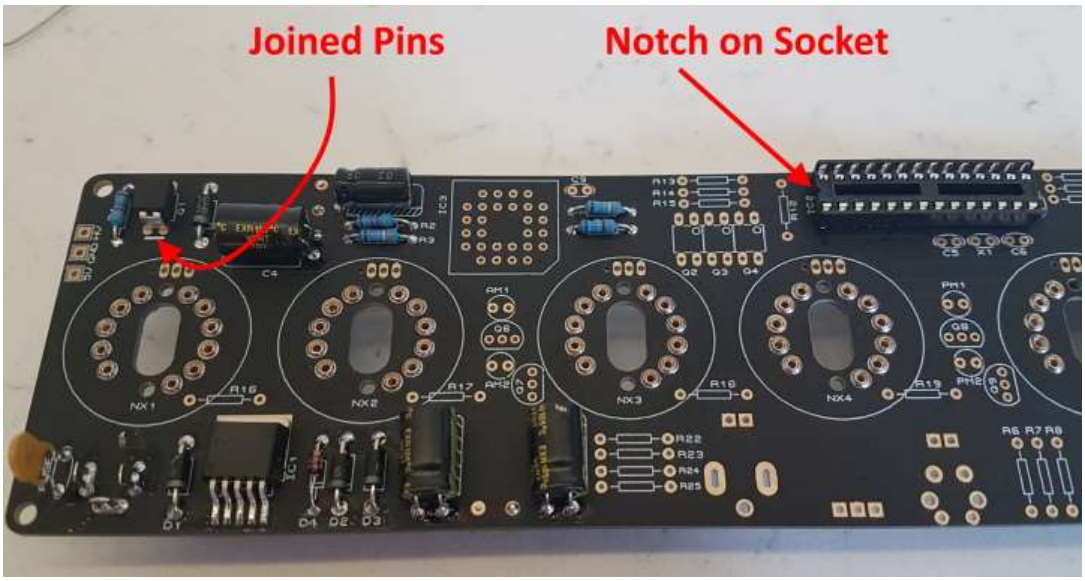
IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT VOLTAGE, WE WILL NOT BE ABLE TO OFFER SUPPORT

4.4 High Voltage Generator components.

Socket for IC2
R1, R2 (4.7 KΩ)
R3, R4 (390 KΩ)
R5 (300 KΩ)
C3 (1uF)
C4 (220uF)
Q1 (IRFD220)
L2 (100uH Inductor)
D5 (UF4004)

Solder the 5 resistors and the diode first as they are lower profile – its easier to solder the top pad rather than the bottom pad. This prevents the component falling out as you try to solder an inverted PCB! L2, C3 and C4 need to have their leads bent, and for C3 and C4 the polarity is critical, so do as you did with C1 and C2 to ensure the pale strip on the part matches the cross hatching on the PCB.

Also the MOSFET needs to be placed with the two joined pins at the position shown on the PCB by a thick white line.



Take care that the notched end of the IC socket is at the end shown. However, if you find you soldered it with the wrong orientation, do not try to remove it. It is perfectly fine with the notch at the wrong end, just be sure to place the IC in the socket with the IC's notch in the correct position.

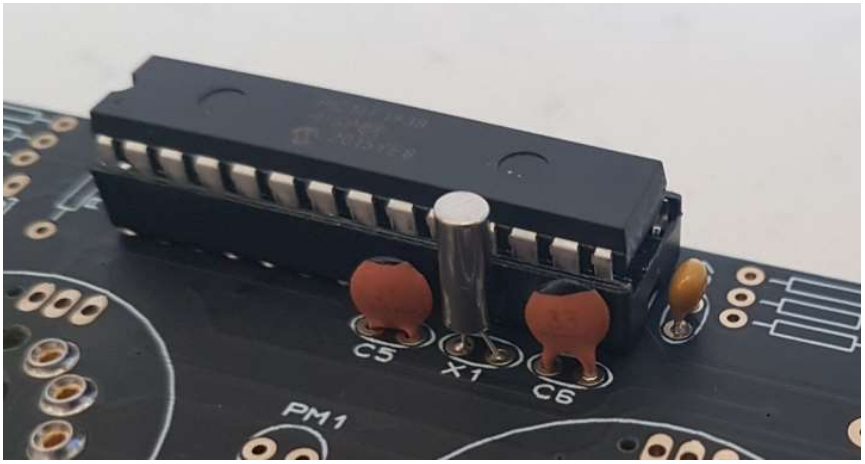
4.5 High Voltage Generator Test.

- 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 164 and 176 Volts. If this is in order, disconnect the power supply. If you do not get this voltage, do not proceed.

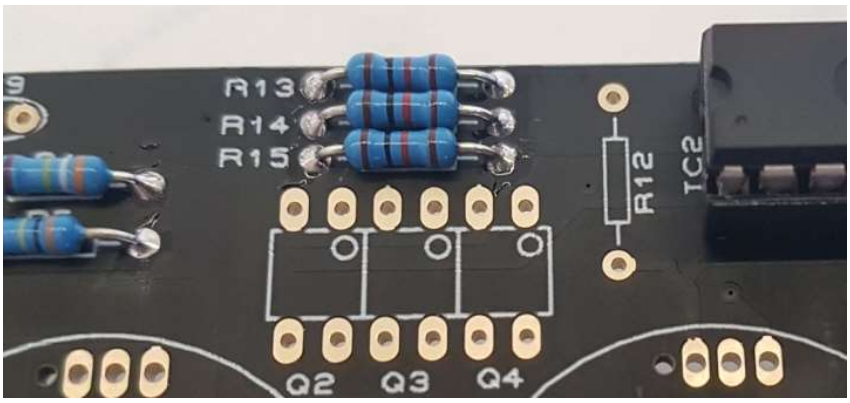
IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT VOLTAGE, WE WILL NOT BE ABLE TO OFFER SUPPORT

4.6 C5 (22pF)
C6 (47pF)
X1 (32.768KHz Crystal)
C7 (100nF but marked '104')

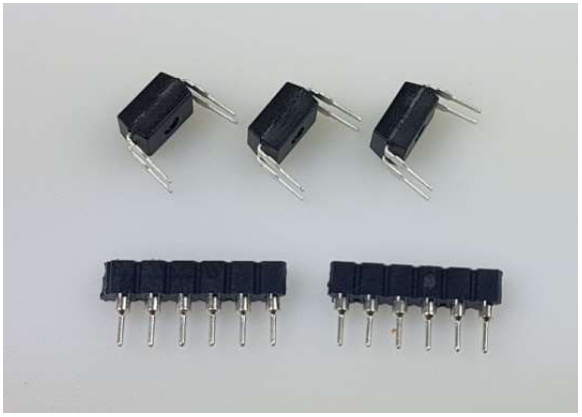
(Capacitors may be a different colour than in the photo)



4.7 R13, R14, R15 (1 KΩ)



4.8 Q2, Q3, Q4 (EL817)
SIL Socket Strip



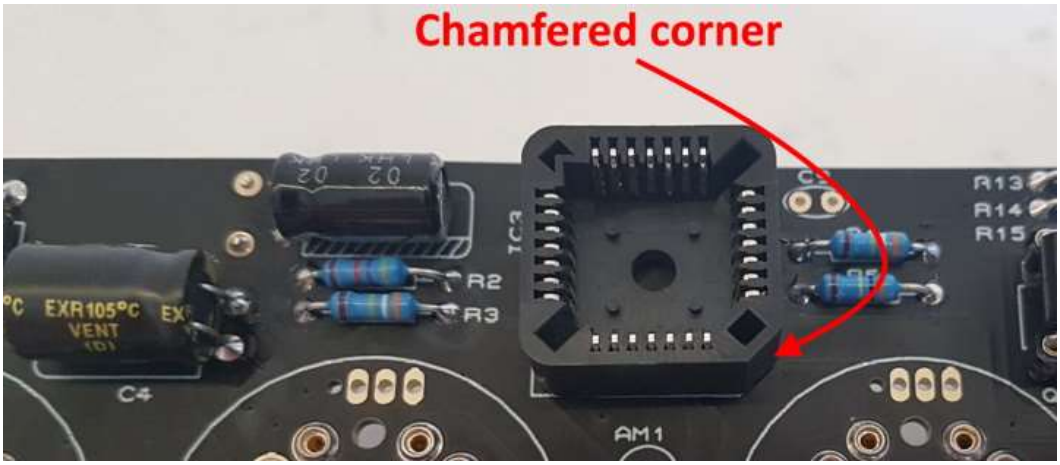
You will either receive 2 X 6 Way sockets, or a 12 way IC socket. Assemble the parts as shown below, paying attention to the orientation of the dot on the body of the parts.

4.9 R16, R17, R18, R19, R20, R21 (4.7 KΩ)

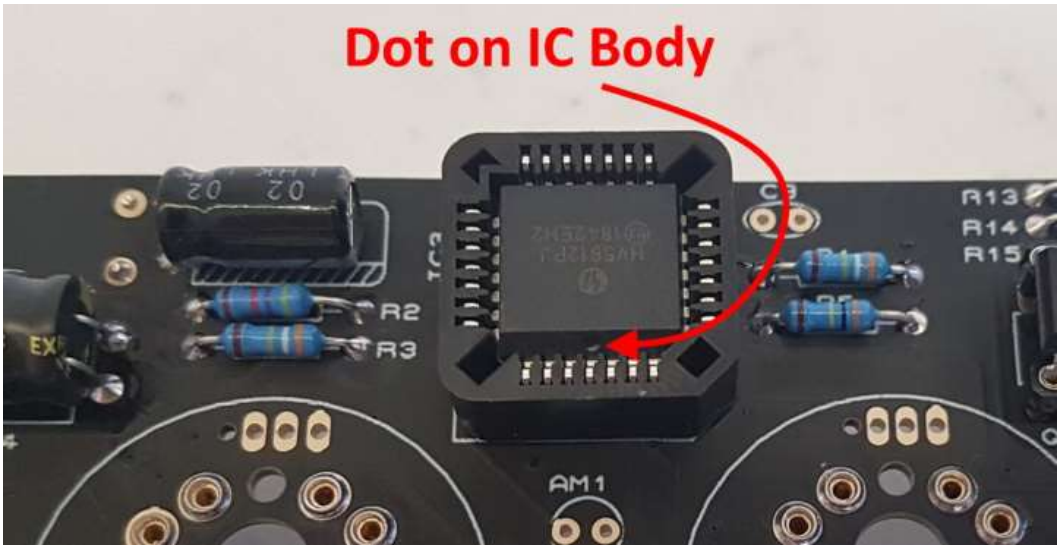
These are the anode resistors.

4.10 Socket for IC3 and IC3

Align the chamfer 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. If you find you soldered it in the wrong orientation, don't try to remove it. Contact us for an easy remedy.



Now insert IC3, with the dot and chamfered edge aligned as shown by the arrow in the picture below.



5. FIRST TUBE TEST

It is now time to check that all tubes are working correctly.

5.1 Insert the Tubes

Insert six compatible tubes into the sockets. You can look into the glass body and see the orientation of the digits as a guide to getting the orientation of the tube correct.

5.2 First Tube Test

Now power up. After a short delay, the tubes should light and all start counting from 0 to 9 and repeat. Please note this is a count UP, not a count DOWN. If you contact us with a support issue at this stage, please be clear about the count up. If you refer to a count down, it will be very confusing and slow down your support query!

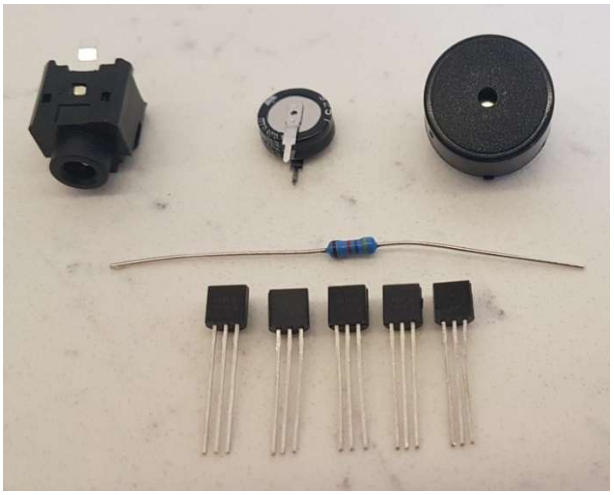
If you do not get this count up, or have missing or overlapping digits, stop and check your work. Try swapping tubes around to see if the problem is with the tube, or the location. Please make these basic tests before contacting us for help and have the results to hand.

IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT TUBE CYCLING, WE WILL NOT BE ABLE TO OFFER SUPPORT

6. PCB ASSEMBLY CONTINUED

6.1 R6, R7, R8, R9, R10, R11 (270 Ω)

6.2 Q5 – Q9 (MPSA42)
R12 (4.7 KΩ)
SYNC (Vertical Jack Socket)
LS1 (Piezo Buzzer)
C8 (0.22F)



The jack socket, piezo buzzer and C8 are mounted on the back of the PCB. Ensure the arrows on C8 are aligned with the corresponding arrows on the PCB

6.3 C9 (100nF)
Note this part is likely to be marked '104'.

6.4 D7 (5mm Green LED)
D6, D8 (5mm Yellow LED)
SET, ADJ, ALARM, DST (Push switches)
All these components are mounted on the back of the PCB. For the four switches, you only need to actually solder the two pads of each switch closest to the PCB edge. The other two pins / pads are not used. It makes it easier in case you ever need to change a switch.

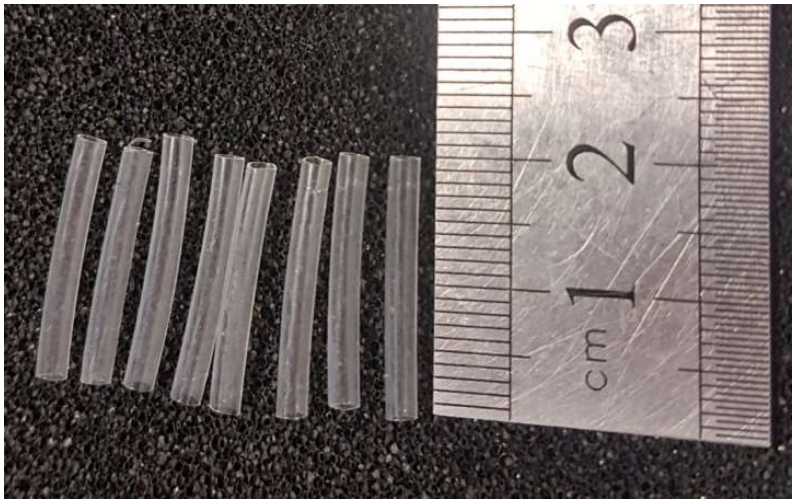
The LEDs are polarized. The longer lead is the positive anode, and goes into the hole that is marked with a + sign.

6.5 R22 – R25 (15 KΩ)

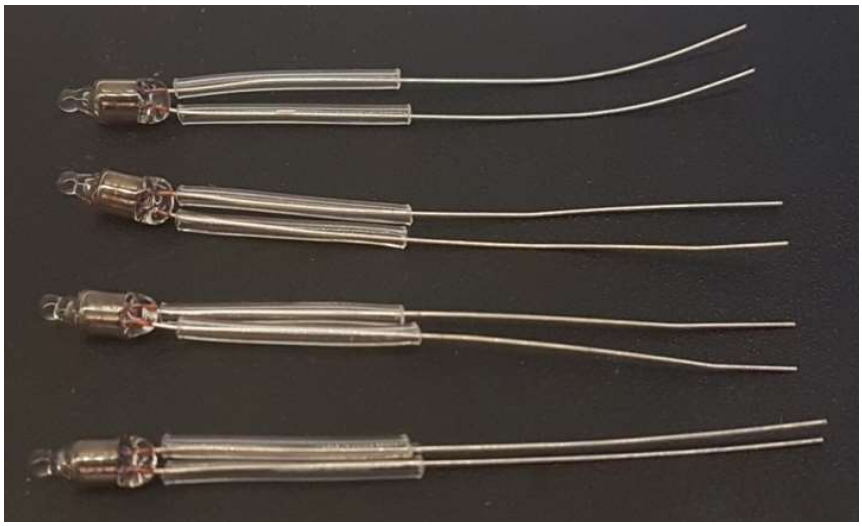
6.6 AM1, AM2, PM1 PM2 (4mm neon lamp)

Each neon is separately addressable, and many flashing and indication modes are implemented – see the configuration setup later in the manual.

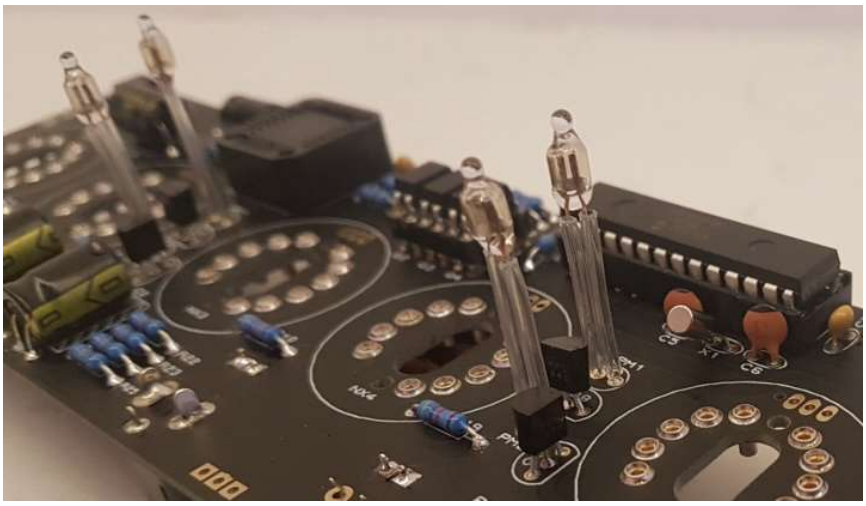
Cut the clear heat shrink tubing into 8 lengths. Our suggestion is 20mm, which puts the top of the neons roughly in line with the front of the tubes, but you may want to experiment with different lengths, if you prefer the neons more or less protruding.



Slip the insulation over the neon lamp leads and with a hot air gun, shrink the tubing:



Finally, solder the neons in place on the PCB. Its easier to solder one pad of the neon first, then make adjustments to make sure it is perpendicular, before soldering the second pad.



6.7 Test the Neons

After soldering the four neons, be sure to quickly power up the clock. All neons should light with uniform brightness.

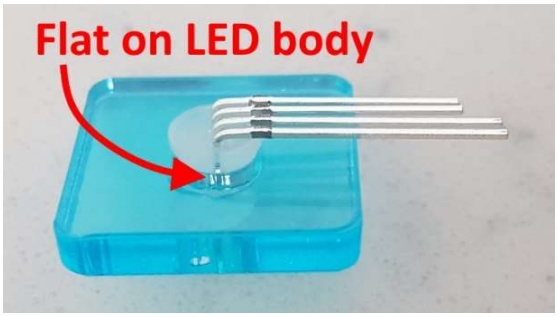
This test is more important than just testing the neons, because it confirms the clock is working before the next stage of installing the RGB LEDs. Installing the RGB LEDs can be a major reason for the clock not working at the end, due to solder bridges on the RGB pads. Having done the above test, you will know the reason is due to one of the RGB LEDs.

6.8 RGB1 – RGB6 (APA106 RGB LED).

Be sure you have done the neon test as per 6.7.

Also, install each RGB LED one at a time, and after soldering, power up the clock without the tubes in. The neons should light and the LED should cycle through various colours. By doing this, you can be sure there are no solder bridges before moving to the next RGB LED. Don't press any buttons, or the clock will exit this cold start LED (and tube) testing cycling.

Insert the LED into large hole in the LED jig, noting the position of the flat on the LED body. Bend the LED leads in two steps as shown below, The leads of the LED may have a different length configuration than shown below.



Then install the RGB LED from the back of the PCB, and solder from the front of the PCB. Clip off the excess leads.

6.9 DEKA (3 way 0.1" male header)

This part is optional, it only needs to be soldered if you intend to use our DekaDuo double Dekatron Driver Board with this clock.

7. 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: Adjust: time, date, alarm time, configuration parameters;
Enter XTERNA Stats Menu;
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	1.0 = version 1.0, 12 = version 1.2 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
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 – Both off 1 – AM/PM Indication, left / right 2 – AM/PM Indication, left / right flashing 3 – AM/PM Indication, top / bottom 4 – AM/PM Indication, top / bottom flashing 5 – All slow flashing 6 – Slow flashing left / right 7 – All flashing 8 – Both illuminated 9 – Railroad fast 10 – Railroad slow
11	Colon neons during night dimmed mode [2]	As per parameter 10
12	Radio time signal source[3]	0 to 3 reserved 4 – GPS 5 - XTERNA
13	GPS Baud rate	0 – 4.8 Kbps 1 – 9.6 Kbps (default)
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	
18	Snooze period	0 – 6 minutes (default) 1 – 9 minutes 2 – 12 minutes 3 – 15 minutes
19	Reserved	
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	Dekatron Sync Sleep Mode	0 – Dekatron always on 1 – Dekatron off when night dimmed Dekatron off when tubes master blanked 2 – Dekatron off in night blanked mode Dekatron off when tubes master blanked
24	Reserved	
25	Reserved	
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)[6]
28	Night Mode Override minutes	0 – 50 (default 0 gives 15 seconds override)
29	Thermometer Settings with Xterna	0 – Don't display temperature 1 – Fahrenheit display (default) 2 – Celsius display
30	Reserved	
31	Restore default settings	0 – Keep user settings 1 – Restore original default settings[8]

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 GPS / XTERNA 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.
6. Date will be displayed each minute between 50 and 55 seconds past the minute.
7. Press 'SET' briefly during Night Mode to show time for prescribed period.
8. Set this parameter to '1' to restore factory configuration 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. The adjacent DST LED will light or extinguish accordingly.

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.

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 subsequent days.

Rapid DST Adjustment
Press 'DST' briefly to toggle between DST and standard time. The indicator shows whether DST mode is active or not.

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.

Invoking Cold Start Tube Test
A cold start is when the Supercapacitor C8 is discharged. On a cold start, time and date are lost and the clock will perform the ascending tube test on power up. To force a cold start, do the following:

- Toggle the DST LED on by pressing the DST button if necessary
- From time display, press ALARM once.
- Press ADJ once to illuminate the ALARM LED
- Immediately disconnect power.

The power sensing / sleep routine is not called from within the Alarm setup, so the clock will drain the supercapacitor via the DST and ALARM LEDs. Wait 2-3 minutes until the LEDs are fully off. On powering up again, you will get the cold start tube test.

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.

8. XTERNA FUNCTIONS

8.1 About the XTERNA Module

XTERNA is our new concept for synchronising time and capturing outdoor temperature for display on our clock and thermometer kits. Driven by a PIC microcontroller with advanced low power modes, the XTERNA captures time from GPS satellites every 6 to 48 hours, and stores in an on-board Temperature Controlled Crystal Oscillator (TCXO). Further, the device captures outdoor temperature every 10 minutes from an on-board DS18B20 digital temperature sensor. Every 10 minutes XTERNA transmits the time and temperature data, which can be received by our XTERNA compatible clocks.

Additional data is transmitted such as battery voltage and GPS fix time.

Supplied as a complete hobby kit of parts (For shipping reasons, batteries are not included), the kit takes approx 30-40 minutes to comfortably assemble. The TCXO IC is pre-soldered, so there is no fiddly SMD soldering to worry about.

Naturally, XTERNA is sealed against rain ingress. Battery life is estimated between 6 to 12 months. We recommend high quality branded batteries for the longest operation between battery changes.

The module should be placed outdoors. But as close as possible to the indoor clock or thermometer and away from direct sunlight.

8.2 Specification

Working Temperature Range: -40 °C to +60 °C. (-40 °F to +140 °F)
Typical Reception Range: 10 to 30 Metres (30 to 100 ft).

8.3 Configuring for XTERNA Reception

Elite Class Nixie Clocks are configured by default for XTERNA reception. If you have changed your configuration settings, you need to set parameter 12 to value 5. Also parameters 14, 15, 16 need to be set to specify your location's offset from UTC.

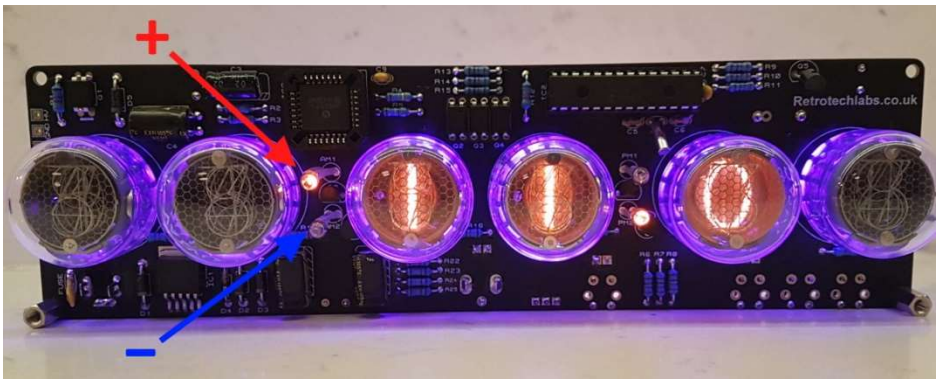
8.4 Time Synchronisation Function

XTERNA broadcasts every 10 minutes. After configuring your clock, please be patient in waiting for the first Synchronisation. Upon synchronisation the yellow LED D7 will illuminate. Remember to set DST ('Summer Time') with the DST button.

8.5 Temperature Display

The temperature is also transmitted with the time. Therefore, temperature will not be displayed until after the first synchronisation.
Set Celsius or Fahrenheit using parameter 29:
Fahrenheit: 1
Celsius : 2

Temperature is displayed between 30 and 35 seconds past each minute. Celsius is displayed with 0.5 °C resolution. Fahrenheit is displayed with 1 °F resolution.
Positive and negative temperature is indicated by the left hand neons: Neon indicator PM2 acts as a decimal point.



8.6 Temperature Validity

If no valid data is received on the next scheduled sync (every 10 minutes), the temperature will be deemed to be old and invalid. Temperature will not be shown until a new valid temperature is received.

8.7 XTERNA Stats menu

The Stats menu is accessible only if relevant XTERNA data has been received. From time display, press ADJ to enter the Stats Menu. Six items of data are displayed in sequence, stepped through by pressing the ADJ button sequentially, and finally exiting back to time display. Please see the table below.

Stats Menu Item	Description	Range of Values	Example
1	Minimum Temperature in last 24 hours	-40°C to +60°C 40°F to 140 °F	
2	Maximum Temperature in last 24 hours	-40°C to +60°C 40°F to 140 °F	
3	Voltage of XTERNA Battery	2.5V to 5.0V	
4	Time required for last GPS fix loaded into the TCXO	0 to 98 sec 99 = no fix at last attempt	
5	Hours and minutes since last GPS fix loaded into the TCXO	00:00 to 99:99	
6	XTERNA Firmware version	1.00 onwards	

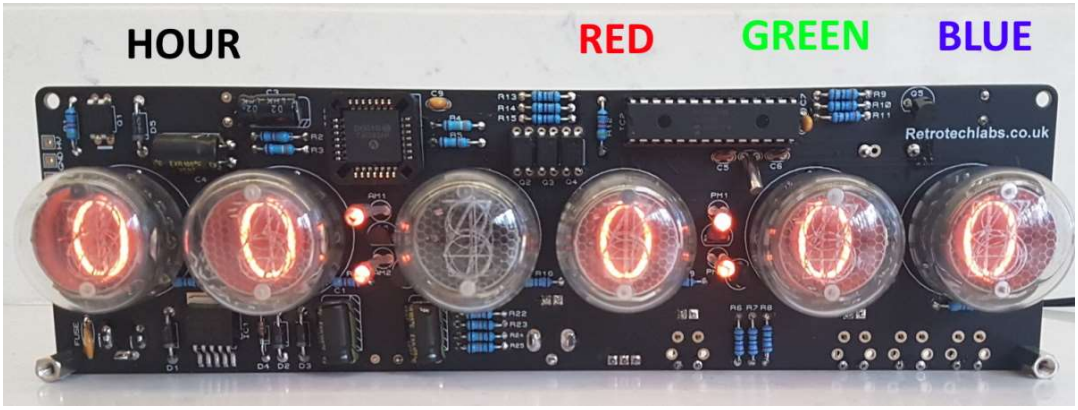
9. CONFIGURING THE RGB LED TUBE LIGHTS

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 after 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.

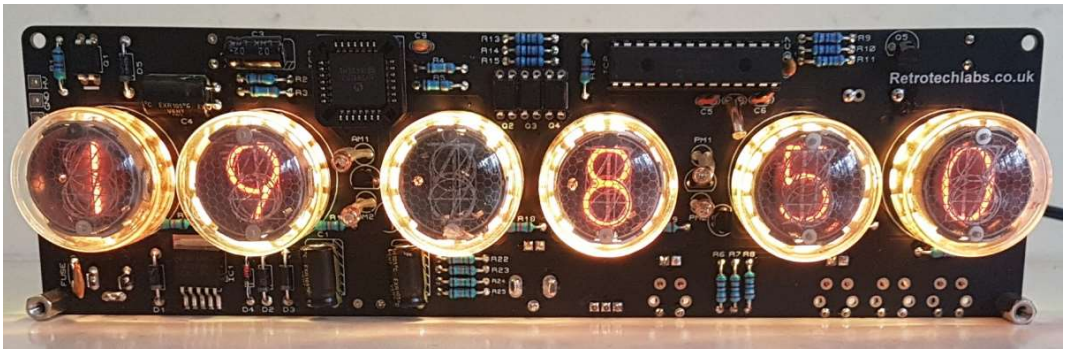


- For each hour (0-23), you can set a custom colour
- Each custom colour can have your choice of RED GREEN and BLUE values from 0 (colour off) to 8 (maximum brightness)
- Mix the colours using the ALARM, ADJ, SET buttons.
- Use low values (1,2 and 3) for low brightness, eg. For night time
- Set the value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

- In the example below, between 19 and 20 hours, the LEDs will be Orange green (8 red, 5 green and 0 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 GPS OR WiFi RECEIVER

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

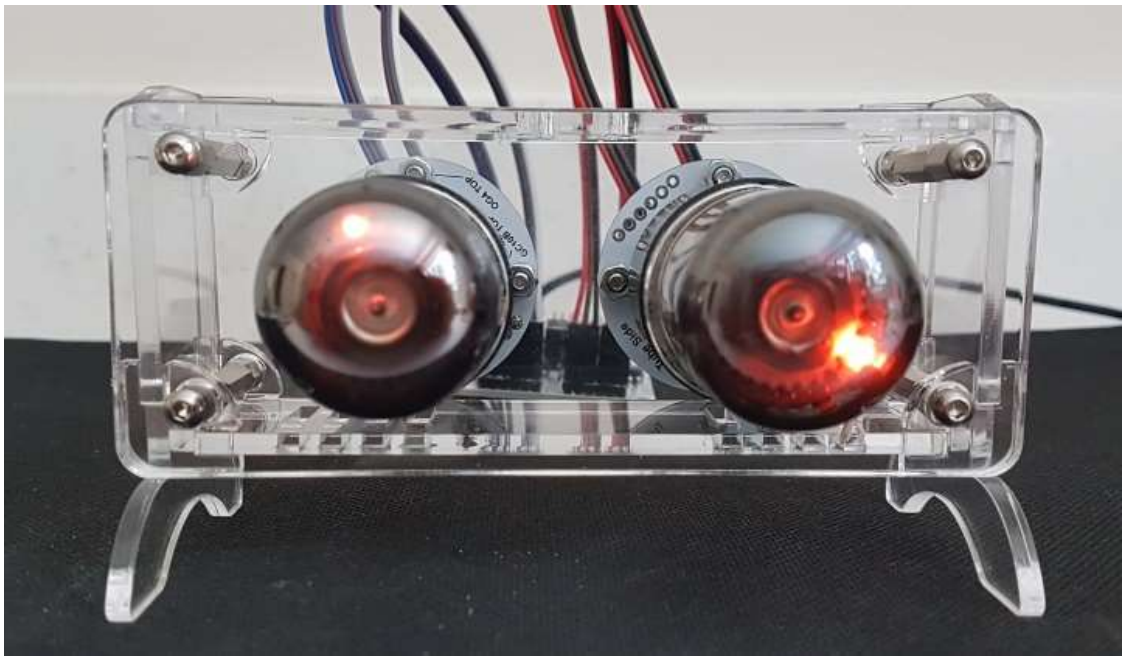
10.1 Configuring for GPS Synchronisation.

- Set parameter 12 to value 4.
- Set the baud rate in parameter 13.
- Set parameters 14 and 15 for the hours and minutes your time zone is offset from UTC Time. This is usually only whole hours.
- Set parameter (16) to identify whether the offset is minus (0) or positive (1) of the time source.

The Green 5mm LED will light when the clock has received a recent GPS, WiFi or XTERNA synchronisation data.

11. CONNECTING OUR DEKATRON DRIVER

The clock can be connected by just 3 wires to our DekaDuo Dual OG4 Dekatron Driver. Please refer to the separate DekaDuo instructions for full details on how to do this. Control of the Dekatron in night modes is possible using parameter 23.



12.1 Problems getting the correct High Voltage

This is the most common issue. Did you insert IC2? IC2 is needed to generate the HV. If IC2 is in its socket and you don't get HV, please record the following DC voltages with IC2 out of its socket.

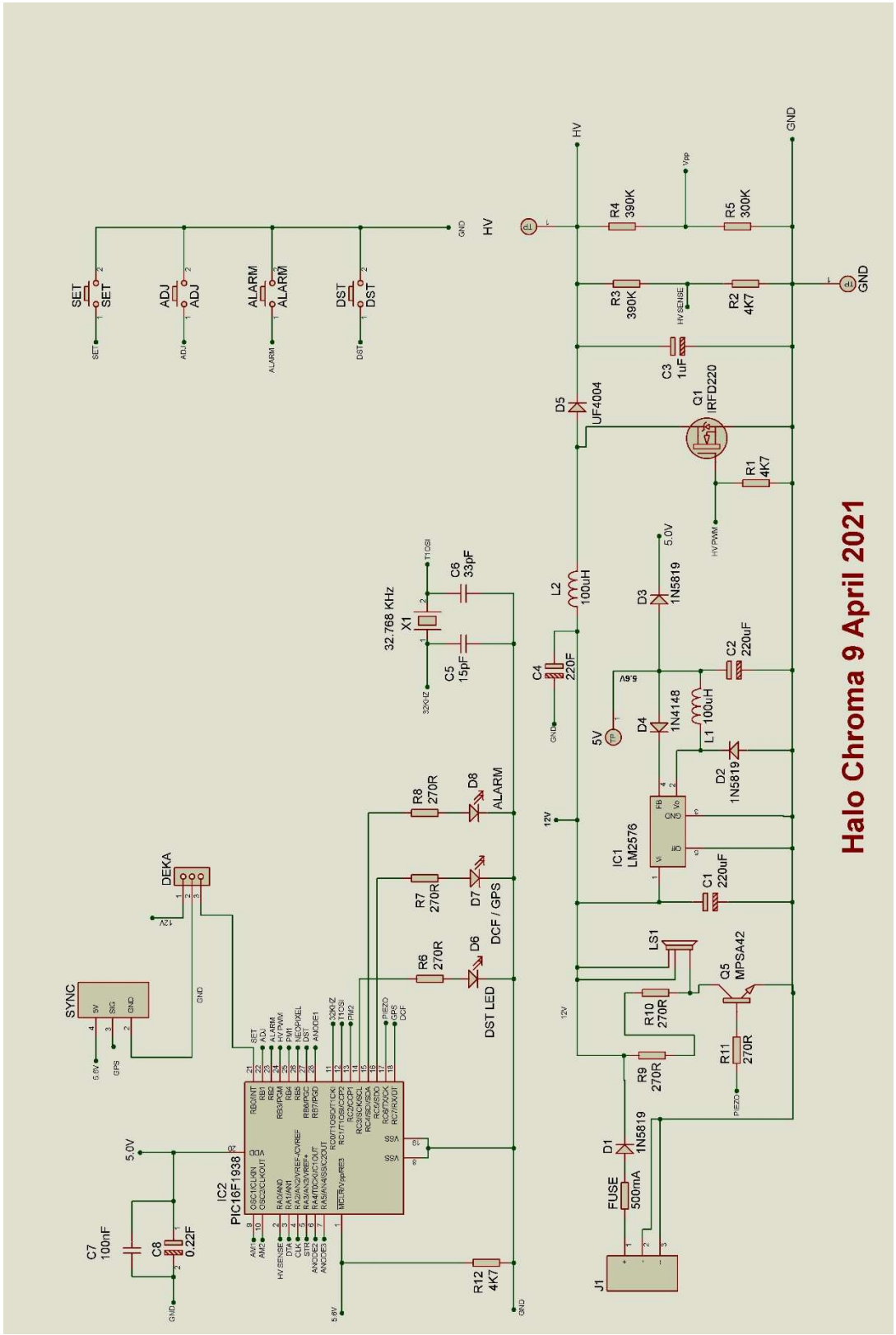
5V test Point	Should be 5.6V
HV test point	Should be approx 12V
IC2 Socket, Pin 1	Should be ~5.6V
IC2 Socket, Pin 2	Should be ~0.14V
IC2 Socket, Pin 24	Should be 0V
IC2 Socket, Pin 20	Should be ~5.2V

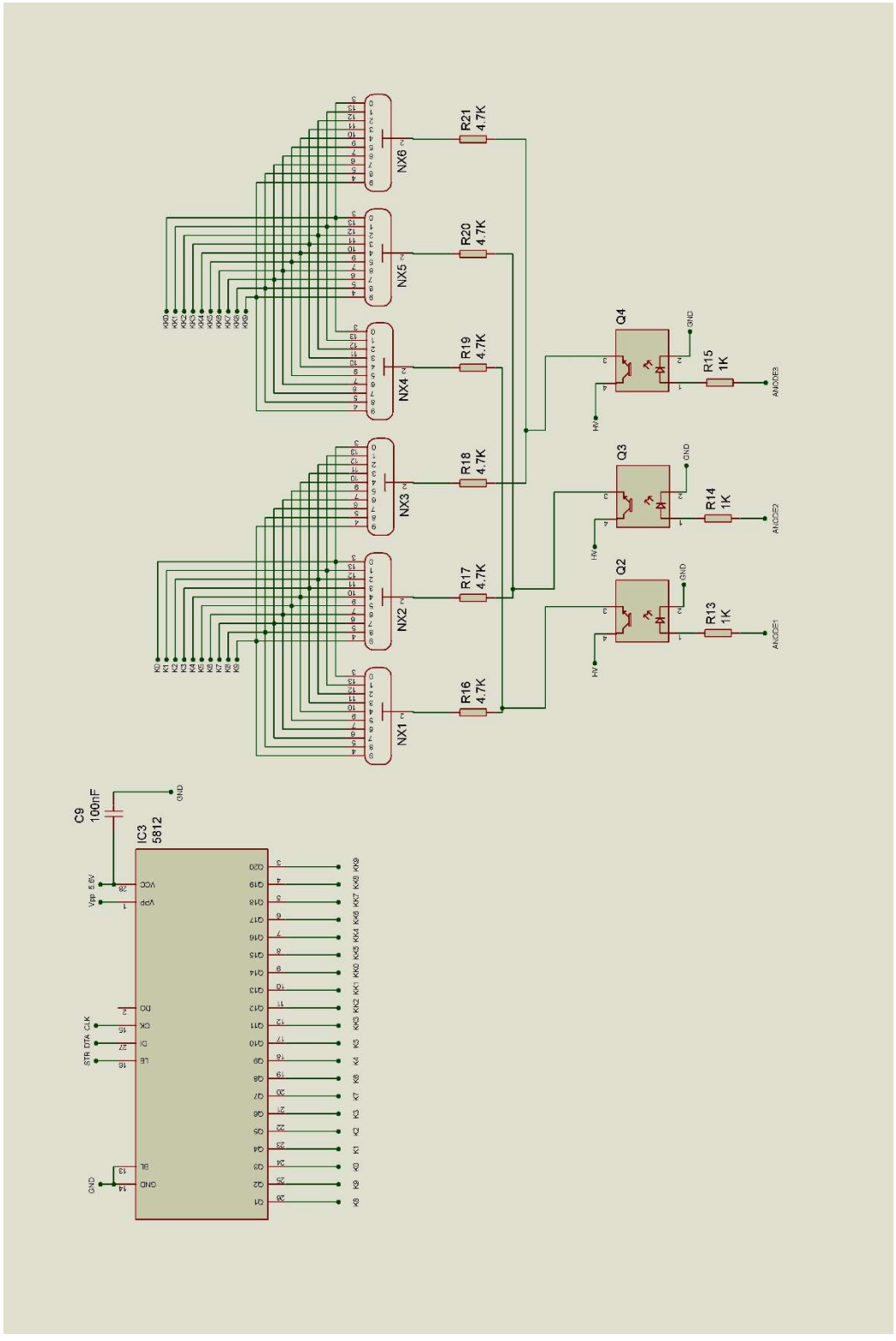
If pin 2 is not to spec, check the feedback resistors R2 and R3 are correct and correctly soldered.

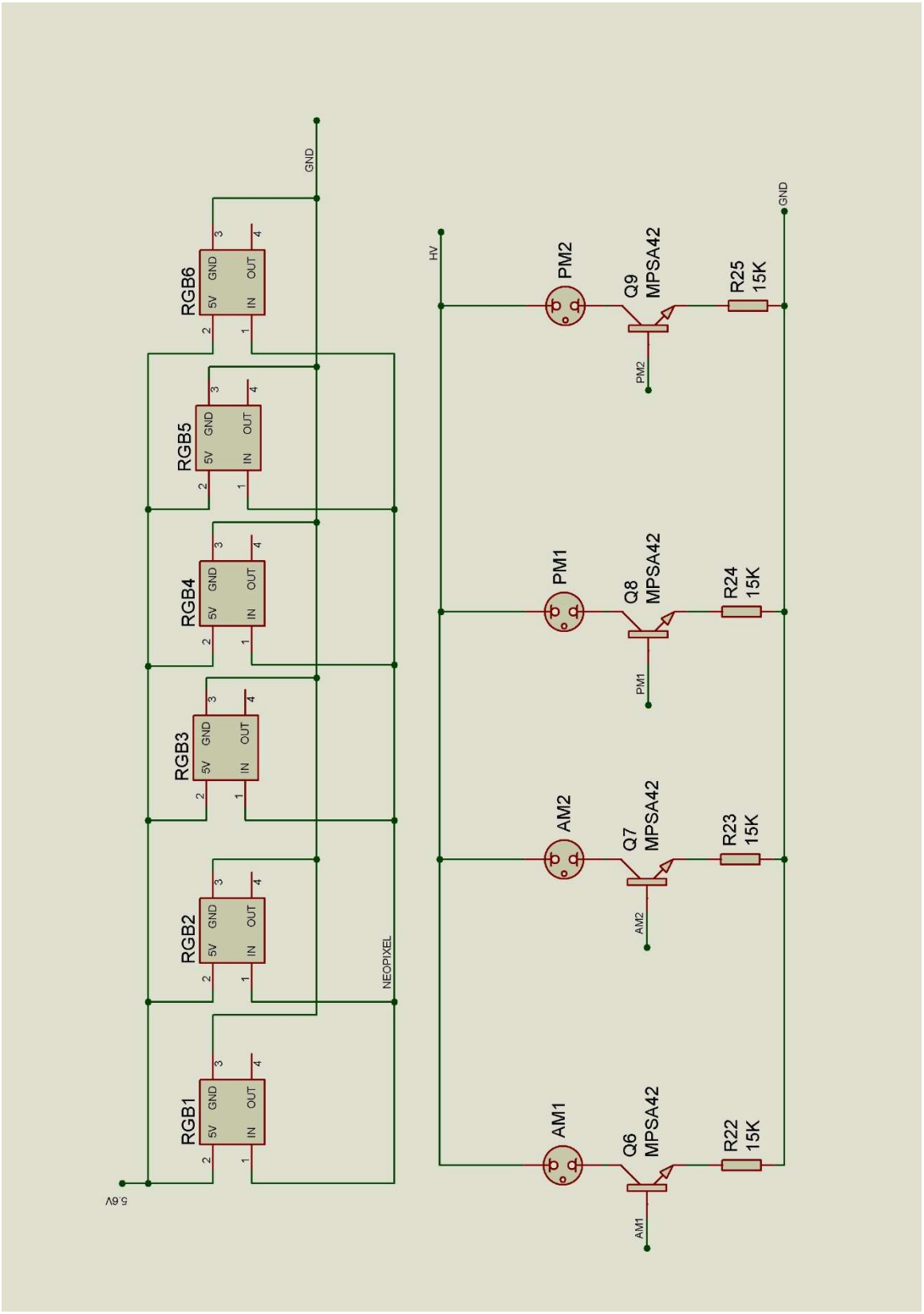
If pin 20 is not to spec, check why the PIC is not getting power via D3 (Orientation?)

If contacting us about an HV issue, please measure and give us these voltages in your email.

13. CIRCUIT DIAGRAM




R21 4.7K
R20 4.7K
R19 4.7K
R18 4.7K
R17 4.7K
R16 4.7K
NX6
NX5
NX4
NX3
NX2
NX1
Q4
Q3
Q2
R15 1K
R14 1K
R13 1K
GND
HV
ANODE3
ANODE2
ANODE1
C9 100nF
IC3 5812
Vpp 5.6V
STR DTA CLK


GND
RGB6
RGB5
RGB4
RGB3
RGB2
RGB1
5V
GND
IN
OUT
NEOPIXEL
5.6V
HV
PM2
PM1
AM2
AM1
Q9
Q8
Q7
Q6
MPSA42
R25
R24
R23
R22
15K