Assembly Instructions
And
User Guide

Nixie Clock Type
'Spectrum 18'
'Spectrum 1040'

For Parts Bag Serial Numbers from 1500 to 1999

REVISION HISTORY

Issue Number	Date	Reason for Issue
7	15 June 18	Added XTERNA support
6	20 July 2016	Specifics for new Stainless Steel Case
5	15 October 2015	New PCB Dated 1 Oct 15 Alarm Aux removed HV Disable Pads removed For firmware V2.0 onwards
4	20 August 2015	Minor errors corrected
3	1 June 2015	Changed resistor values
2	15 Feb 2015	Errors in Resistor values corrected Resistor networks not polarized
1	10 Feb 2015	New document

1. INTRODUCTION

Here are the key features of the SPECTRUM 18 / 1040:

- Hours, Minutes and Seconds display
- 40mm (1.5”) Digit height (Spectrum 18)
- 30mm (1.2”) Digit height (Spectrum 1040)
- Dedicated, plug-in High Voltage Module (Included)
- Noiseless, Direct Drive giving optimum digit clarity
- 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
- PIR Motion Sensor input and accessory available. Configurable timeout period
- 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
- Provision for adding switch for independently switching off RGB LEDs
- Not AC frequency dependent – works in all countries
- 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

1.4 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.
- 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 1A
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	6.8 KΩ, ¼ Watt
R2 – R7	8.2 KΩ, ¼ Watt
R8 – R11	270 KΩ, ¼ Watt
R12 – R14	270 Ω, ¼ Watt
R16	10 KΩ, ¼ Watt
R17 – R19	270 Ω, ¼ Watt
R20	1 KΩ, ¼ Watt
RN1 – RN6	Quad Resistor Network, 220Ω
Capacitors	
C1, C2	220uF Electrolytic 16-25V
C3	10pF Ceramic
C4	15pF Ceramic
C5	100nF Ceramic
C6	0.1F or 0.22F Supercapacitor
C7 – C9	100nF
Transistors	
Q1	MPSA42
Q2 – Q4	2N7000 MOSFET
Diodes	
D1 – D3	1N5819
D4	5mm Yellow LED
D5	5mm Green LED
D6	5mm Yellow LED
RGB1 – RGB8	RGB 5mm LED, common anode
Integrated Circuits	
IC1	LM2576 5V voltage regulator
IC2	PIC16F1938 in socket
IC3, IC4	HV5622 in socket
IC5	Not Installed
Miscellaneous	
L1	100uH inductor
AM1, PM1, AM2, PM2	4mm wire ended neon lamp
ALARM, SET, ADJ, DST	Miniature push button
IC2 Socket	28 Way narrow IC socket for IC2
IC3, IC4 Socket	PLCC44 IC socket for IC3
J1 (12V IN Socket)	2.1mm PCB power socket
GPS / RFT and GPS2	Surface mount 3.5mm jack socket
PIR and PIR2	Surface mount 3.5mm jack socket
LS1	Piezo sounder
FUSE	500mA fuse
VR1	1KΩ Potentiometer
X1	32.768KHz watch crystal
HV Module	High Voltage Module in header

3.2 Parts list / Packing Sheet - Component Bag

Part Description	Quantity
Resistors	
270 Ω, ¼ Watt	6
6.8 KΩ, ¼ Watt	1
8.2 KΩ, ¼ Watt	6
10 KΩ, ¼ Watt	1
1KΩ, ¼ Watt	1
270 KΩ, ¼ Watt	4
220 Ω Resistor Network	6
Capacitors	
10pF, Ceramic	1
15pF, Ceramic	1
100nF, Ceramic	4
220uF, 16-25V, Electrolytic	2
0.1F or 0.22F	1
Transistors	
MPSA42	1
2N7000 MOSFET	3
Diodes	
1N5819	3
5mm Green LED	1
5mm Yellow LED	2
5mm RGB LED	6
Integrated Circuits	
LM2576 5V voltage regulator	1
PIC16F1938 8-bit microcontroller	1
HV5622	2
Miscellaneous	
100uH inductor	1
4mm wire ended neon lamp	4
Miniature push button	4
28 way narrow IC Socket for IC2	1
PLCC44 IC Socket	2
2.1mm PCB power socket	1
Surface mount 3.5mm jack socket	2
Piezo sounder	1
1A fuse	1
1KΩ Potentiometer	1
2 way header with jumper	1
6 way female header 0.1”	1
32.768KHz watch crystal	1

3.3 Parts list / Packing Sheet - Additional parts

- PCB
- 6 X 15mm M3 hex spacers with screws
- HV Module with male header
- 2 X Glass neon covers
- 30cm Clear heat shrink insulation for neons
- 6 X Socket holders and 66 sockets

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 one of the pictures below. It can easily be confused for a capacitor. It is a self-resetting fuse.

3.4 SPECIAL NOTE - IMPORTANT:

Please note that several components can be possibly mounted on either side of the PCB, and white component print for the part is on both sides of the PCB. This is to offer maxiumum flexibility of the kit: For our clear cases, most components will be soldered on the top (tube) side of the PCB, so they are visible on the finished clock.

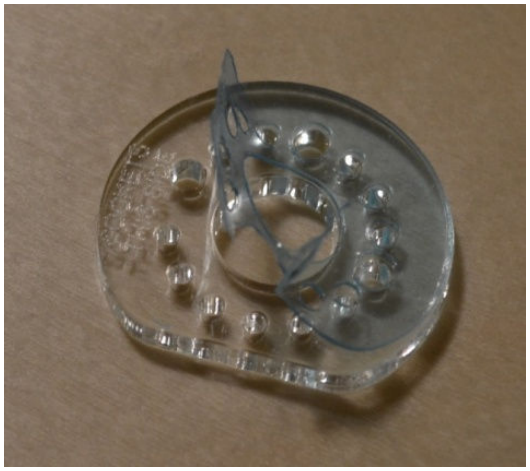
However, for the Viso case and for customers making their own case, it is possible to mount some of the taller components on the bottom of the PCB, so that the PCB can fit inside a case with the tubes protruding. Please follow carefully the instructions. Unless specified otherwise, please solder all components on the top of the PCB.

4. ASSEMBLY OF THE PCB

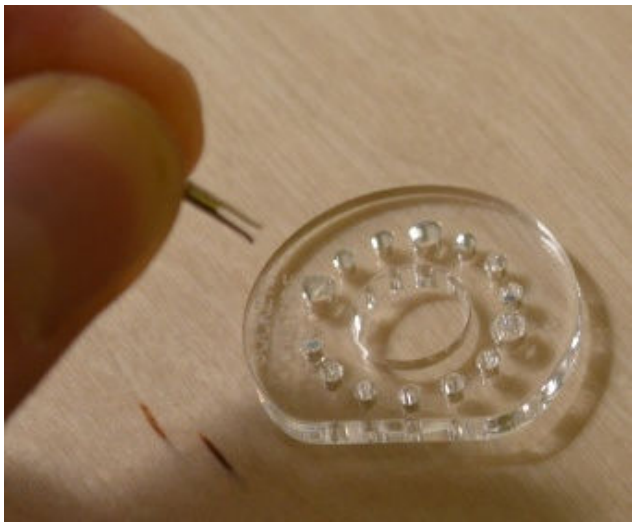
DUE TO PRODUCT DEVELOPMENT AND IMPROVEMENTS, YOUR PCB MAY NOT LOOK EXACTLY LIKE THE ONE PICTURED.

4.1 Assembly of the tube sockets

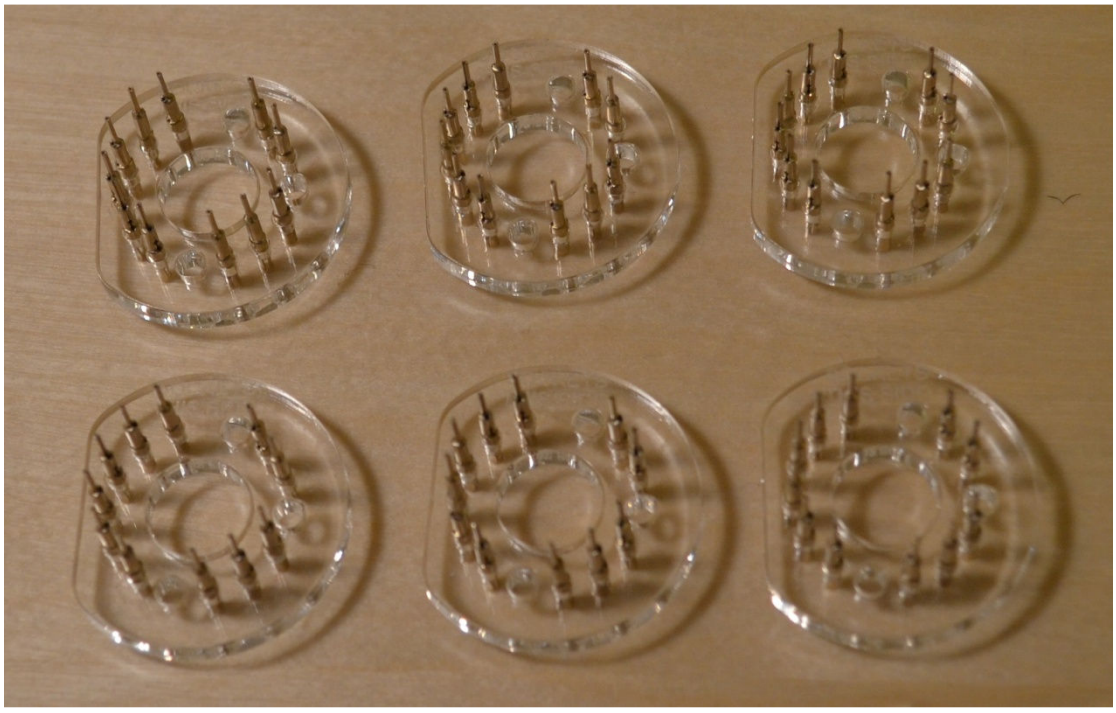
Remove the protective film from both sides of the six laser-cut tube socket holders and identify the side that is engraved 'SOCKETS THIS SIDE' or simply 'SKT'.



For each socket holder, you need to push in 11 socket receptacles. Push them in from the 'SOCKETS THIS SIDE' side. Push them with the 2 open jaws going in first. Look at the photo below.

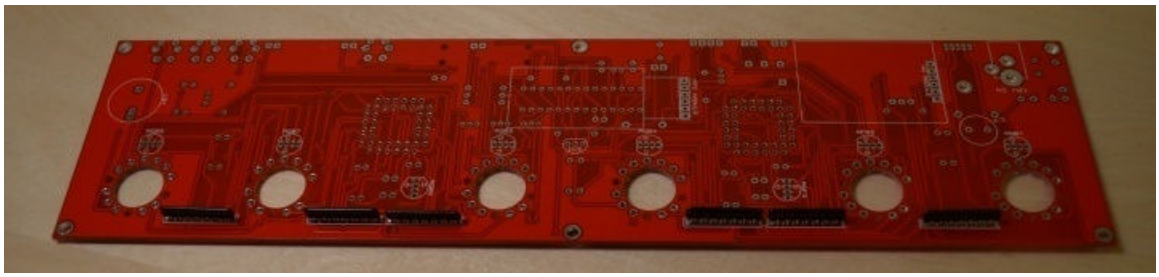


Push all the sockets firmly into place until they stop. You will end up with 6 socket assemblies. Put them to one side. Do not solder them to the PCB yet.



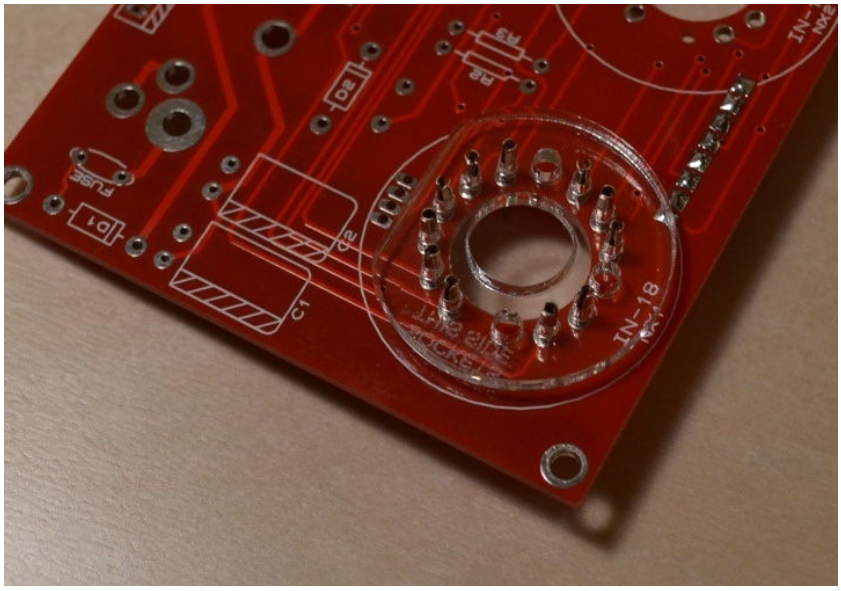
4.2 Resistor Networks RN1 – RN6

Solder the 6 resistor networks on the bottom side of the PCB as shown below. These parts are not polarized, so the orientation does not matter.



4.3 Nixie Tube Sockets.

Now you can solder the 6 Nixie sockets that you assembled in step 4.1. Push each socket assembly into the PCB so that the flat is aligned as shown below. There is only one way the socket can be inserted, so it should be impossible to orient incorrectly. be sure to push the socket fully in, so that the larger diemater portion of the socket receptacles goes into each hole. The plastic socket should be 2-3mm from the PCB.



After soldering all 66 contacts, clip off the lower, very thin part of the connector.

4.4 Low Voltage Generator components.

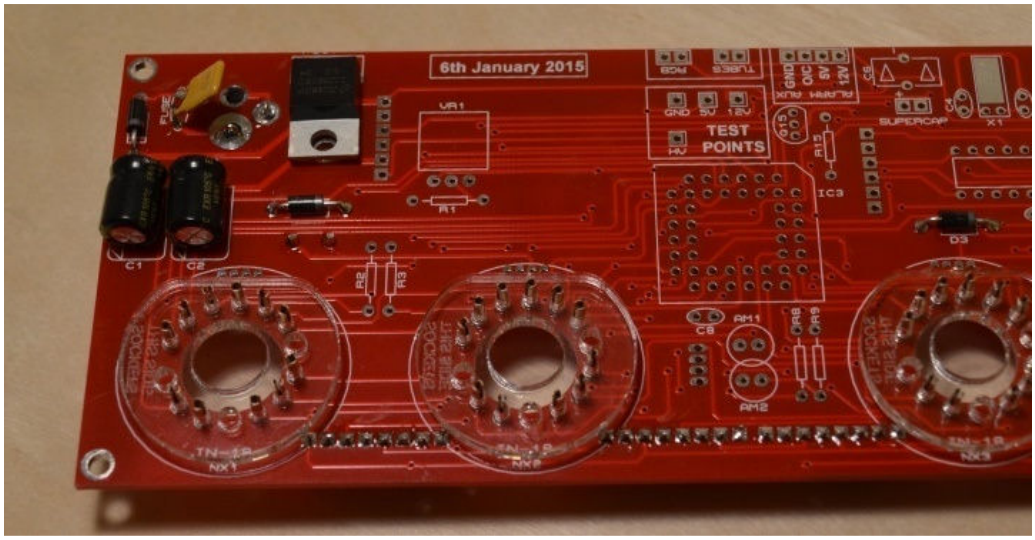
Fuse
D1, D2, D3 (1N5819)
C1, C2 (220uF)
J1 (12V IN), L1
IC1 (LM2576)

Depending on the fuse you have been supplied with, the leads may not fit through the holes. If this is the case, simply wet the 2 pads with solder and pre-cut the fuse leads very short. Solder the fuse leads onto the top of the two wetted pads.

Bend the legs of IC1 to a 90 degree angle so that the component lies along the PCB. Solder it so it does not quite touch the PCB. But is approx 2-3 mm from it. (1/8”)

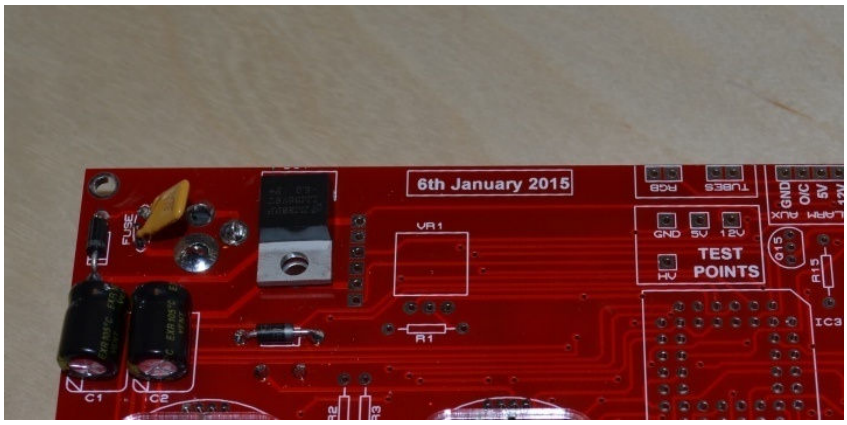
C1 and C2 are polarized. The light stripe on the body of the component indicates the negative side. This must match the cross hatched side on the PCB Marking.

Please note that J1 and L1 must be soldered on the bottom of the PCB in all cases.



4.5 Testing Low Voltage Power Supply.

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

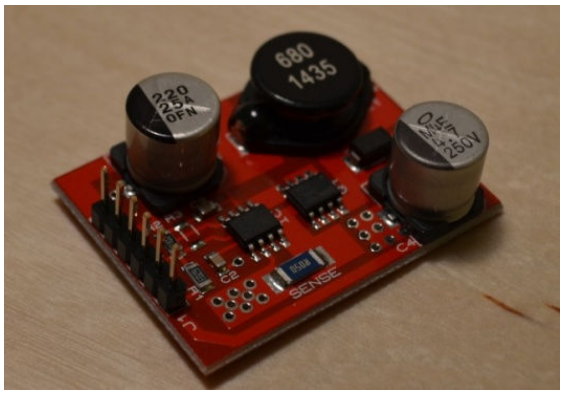


Plug in the power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 4.8 and 5.2 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

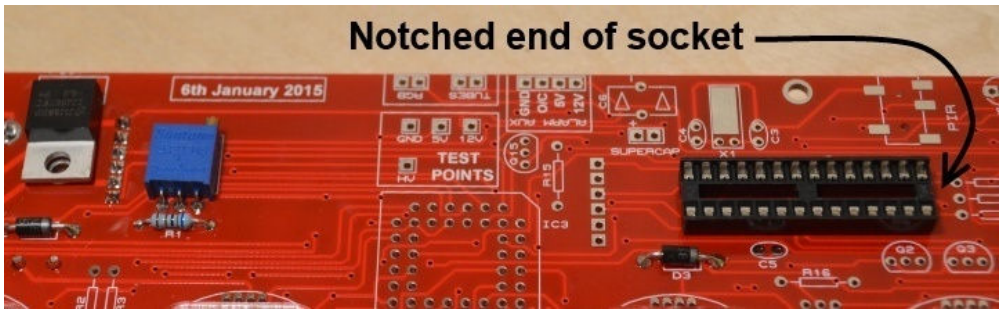
4.6 High Voltage Generator Components.

6 Way female header
28 Way IC socket for IC2
R1 (6.8 KΩ)
VR1 (1 KΩ Potentiometer)
HV Module

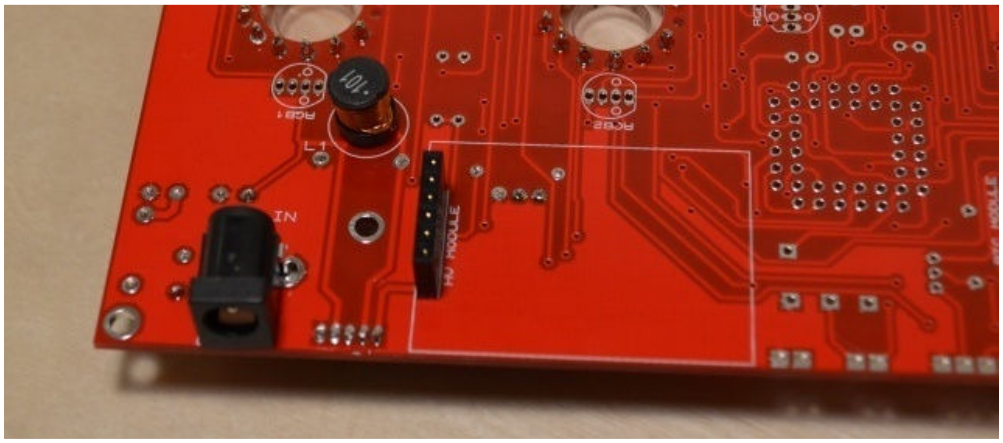
Start by soldering the 6 way male header to the HV Module.



then solder the parts to the main PCB: 6 way female header on bottom of PCB, and VR1 and R1 on the top of the PCB. Also solder the socket for IC2, noting the orientation of the small notch at one end:



Here you can see how the 6 way female header is soldered on the bottom of the PCB:



And now you can push the HV Module into place:

4.7 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. Adjust the brass screw on VR1 until the HV is close to 170V.

Disconnect power, and remember that the HV module can still hold charge at 170V. carefully remove the HV module and place it safely away until later.

4.8 Tube Drive Components

R2 – R7 (8.2 KΩ)
C5, C8, C9 (100nF)
Sockets for IC3 and IC4

Be very careful when inserting the two IC sockets. Make sure the flattened corner of the IC socket is oriented with the matching flattened corenr marking on the PCB. You can also now insert IC3 and IC4 into their sockets, taking care of orientation.

4.9 C3 (10pF)
C4 (15pF)
X1 (32.768KHz Crystal)

4.10 First Tube test

Now it is time to make a first test of the tube drive circuit. Start by replacing the HV module, and also if you removed IC2, place this back in its socket. Also now insert IC3 and IC4 into the sockets, taking great care the flat at one corner of the IC matches the flat on the IC socket.

This is a good time to attach the six M3 X 15mm hex spacers, so the PCB will sit neatly during the tube test.

With great care, and looking carefully at tube alignment (tube faces forwards), insert six IN-18 Nixie Tubes into the sockets. Power up the PCB, and watch the tubes. They should count 0 through to 9 and back to 0 again, and repeat this sequence. If any digits or tubes do not light, go back and check your work. If any tube does not light, swap it with a known working tube to check if it is the tube or the location that is faulty.

Once all is well, power off, carefully remove the tubes, and with care remove the HV module.

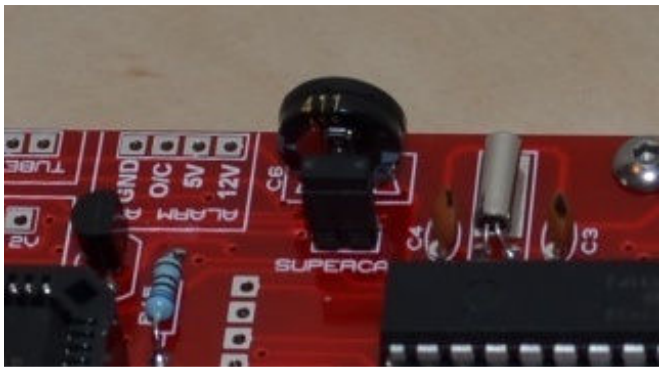
4.11 R8 – R11 (4 X 270 KΩ)
R12 – R14, R17 – R19 (6 X 270 Ω)
R16 (10 KΩ)
R20 (1 KΩ)

4.12 Q1 (MPSA42)
Q2 – Q4 (3 X 2N7000)

4.13 C6 (0.22F)
C7 (100nF)
2 Way pin-header and jumper

NOTE: C6 and the 2 Way jumper need to be soldered on the bottom side of the PCB if you are mounting the clock in the Visio or Stainless Steel Cases.

Take care that C6 is mounted with its arrows matching the arrows on the PCB.



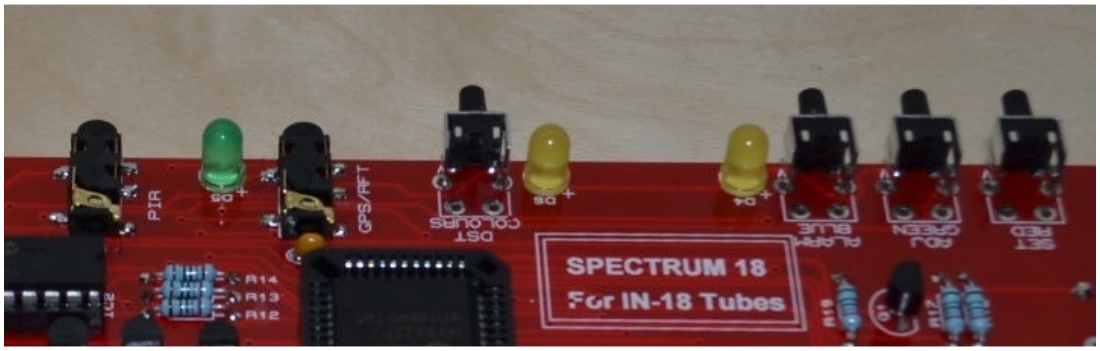
4.14 D4, D6 (5mm Yellow LED)
D5 (5mm Green LED)
SET, ADJ, ALARM, DST (buttons)
GPS / RFT (3.5mm Jack socket)
PIR (3.5mm Jack socket)

PLEASE READ THIS SECTION CAREFULLY, IF YOU ARE USING ONE OF OUR CASES.

VISIO AND PRISMA CASE:

For our Visio and Prisma cases, mount all these components on the top (tube) side of the PCB as shown below.

The longer lead on the LEDs goes in the hole marked +.



STAINLESS STEEL CASE:

Solder the two jack sockets and four switches on the BOTTOM of the PCB (non-tube side). Do not solder the three LEDs at this stage. This is covered in the guide to the Stainless Steel Case.

To solder the GPS / RFT and PIR connectors: 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.

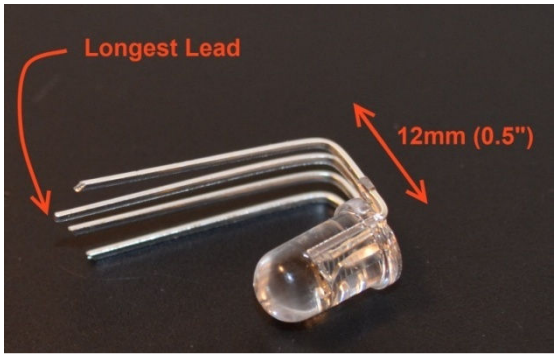
4.15 LS1 (Piezo Buzzer)

The Piezo Buzzer is soldered on the bottom of the PCB.

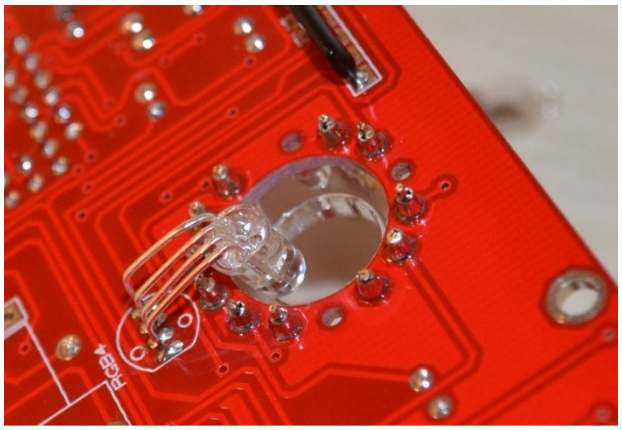
4.16 RGB LEDs

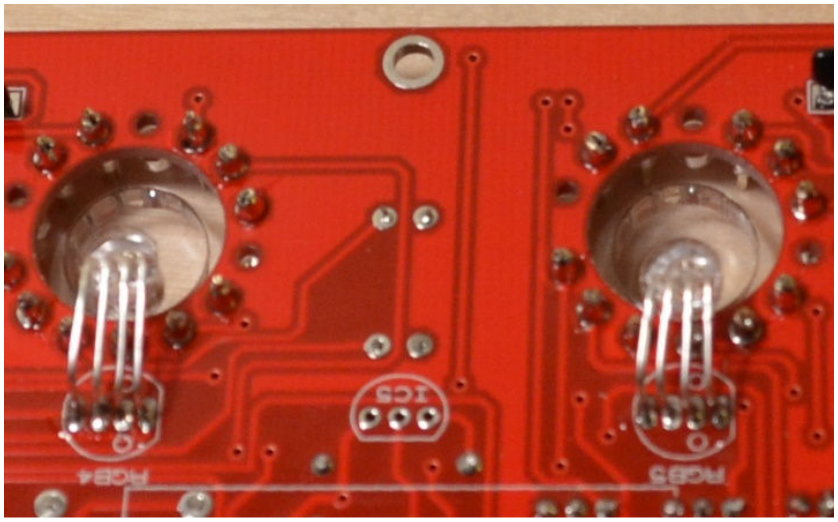
There are 6 RGB LEDs, one under each Nixie Tube. Note that there are a further 2 locations for RGB LEDs under the neon colon separators. These are not supplied and not installed, because the RGB lighting from the tube LEDs provides sufficient illumination of the colon neons.

Start by bending the leads of each RGB LED as shown below, noting the orientation of the longest lead.



If you follow the bending instructions above, then the longest lead should go into the hole marked with 2 small circles at each RGB LED location. Solder each LED and clip the leads short.

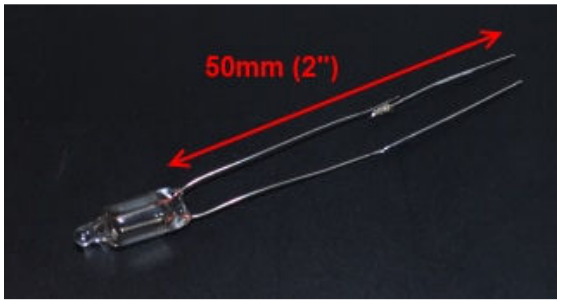




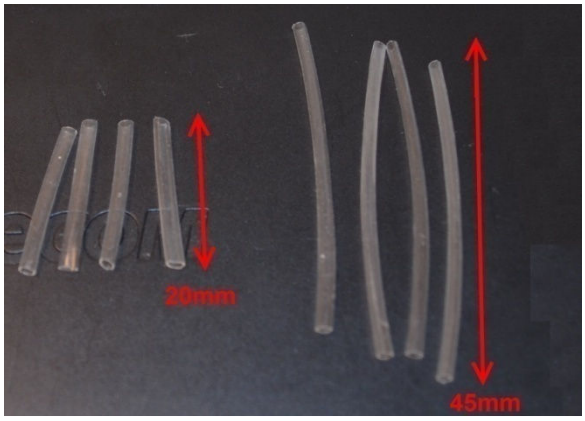
4.17 AM1, AM2, PM1, PM2 (4 X 4mm Neon lamps)

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

The AM1 and PM1 neons are taller, and mounted on the rear 2 locations. The leads of the two rear neons may need to be extended. Use pieces of wire cut from leads of resistors to extend the wires so they are at least 500 (2”) long:

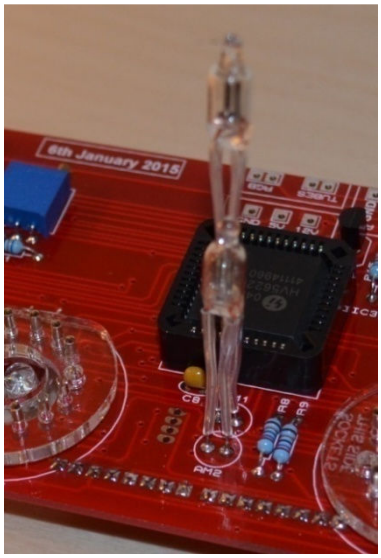


Next, cut the clear heat shrink tubing into 8 lengths: 4 lengths of 20mm and 4 lengths of 45mm:



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, with the taller neons at the back. The glass cover tubes can be placed over later.



5. 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	20 = version 2.0, 12 = version 2.1 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
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 / WiFi 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	PIR Motion Sensor Period	0 – No PIR installed (default) 1 – 15 seconds 2 – 30 seconds 3 – 1 minute 4 – 2 minutes 5 – 5 minutes 6 – 10 minutes 7 – 15 minutes 8 – 20 minutes 9 – 30 minutes

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	Reserved	
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)[7]
29	Thermometer Settings[8]	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[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). 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. If an XTERNA module is configured, outdoor temperature is displayed
9. 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'. You can also restore factory configuration settings by pressing and holding 'SET' as you power up from a cold start. A cold start is a startup with a fully discharged Supercapacitor, or with the Supercapacitor jumper removed.

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 the next day.

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

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

Calibration of Timekeeping Accuracy
Over time you may observe the clock runs faster or slower than an accurate time standard. You can finely adjust the timekeeping by setting configuration parameters 20 and 21. We recommend to precisely set the clock against a known accurate clock, and then record the time drift in seconds after 5 full days (120 hours). Program this value into parameter 20.
Set parameter 21 to 0 to slow down the clock and to 1 to speed up the clock.

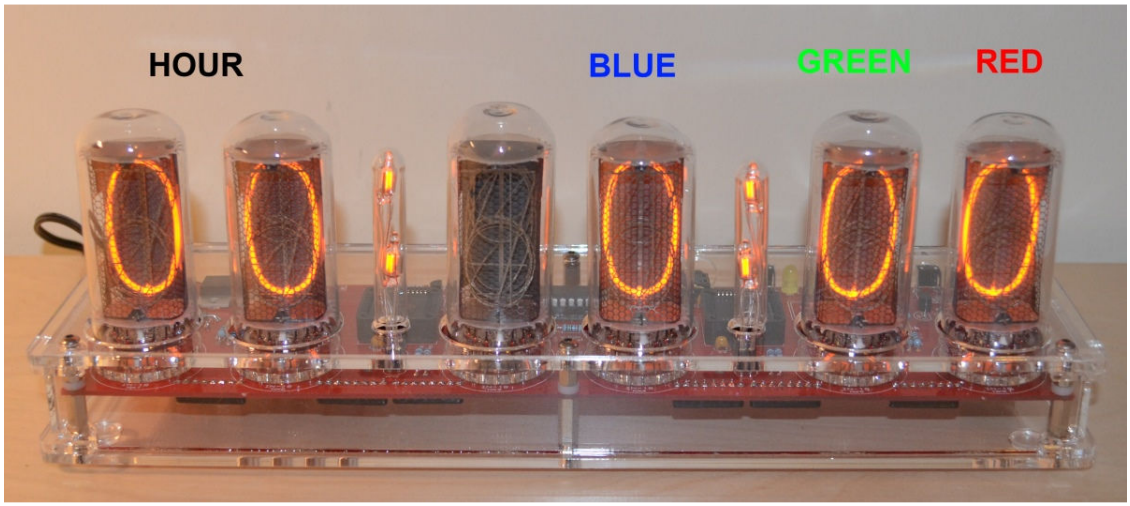
6. CONFIGURING THE RGB LED TUBE LIGHTS

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.

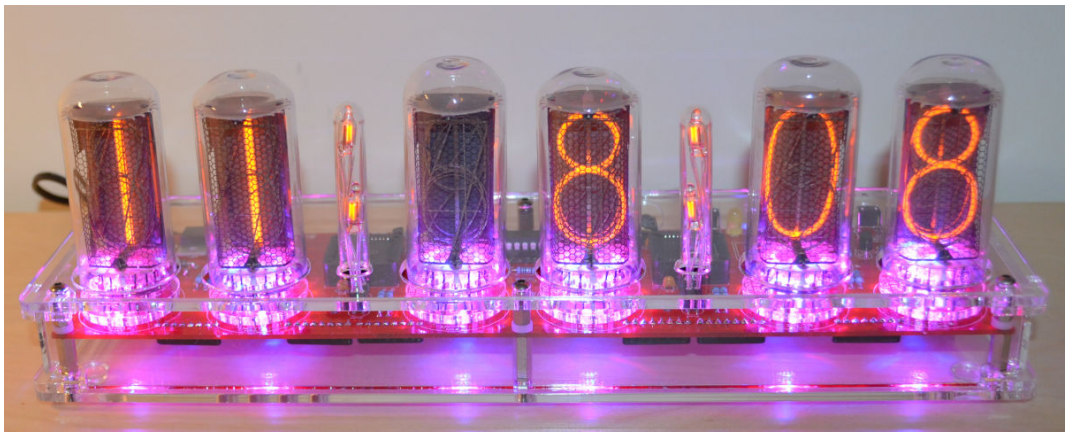
6.1 Entering RGB LED menu

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



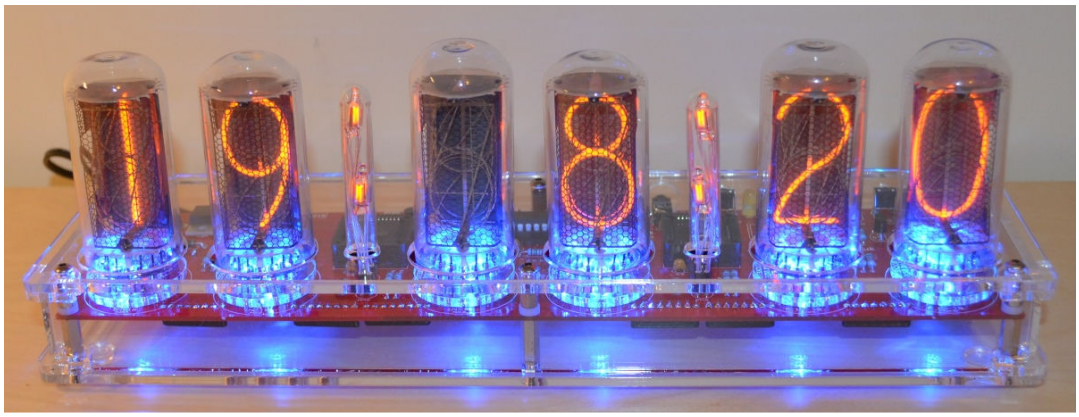
- For each hour (0-23), you can set a custom colour
- Each custom colour can have your choice of BLUE, GREEN and RED values from 0 (colour off) to 8 (maximum brightness)
- Mix the colours using the ALARM, ADJ, SET buttons.
- Use low values (1,2 and 3) for low brightness, eg. For night time
- Set the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



6.2 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:

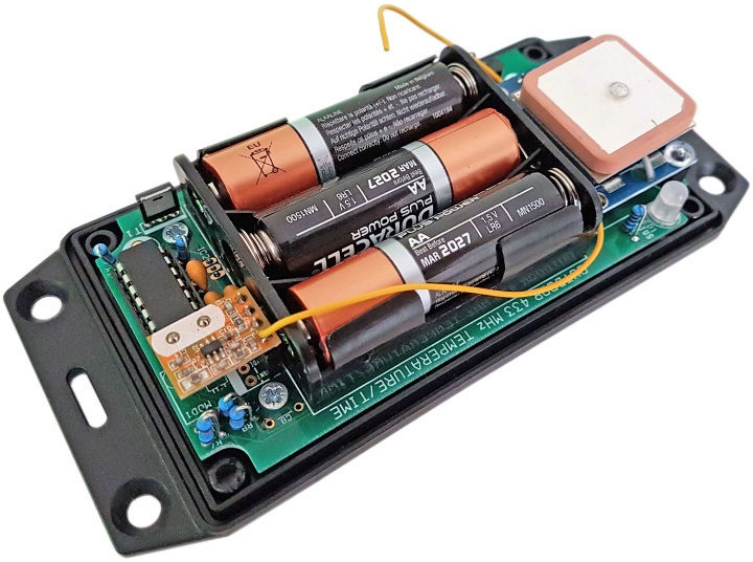
Red = 9, therefore Auto Colour Cycling is enabled for 12-13 hours
Green = 3, so speed is 3.
Blue value has no effect.

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

7. XTERNA FUNCTIONS

7.1 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 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. The Spectrum kits are compatible if equipped with a receiver adapter module (See next page).



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.

7.2 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).

7.3 XTERNA Adapter

Spectrum kits require a small, low cost adapter to be plugged into the GPS socket, to be able to receive the time and temperature broadcasts from the XTERNA Module.

7.4 Configuring for XTERNA Reception

Set parameter 12 to value 5. Also parameters 14, 15, 16 need to be set to specify your location's offset from UTC.

7.5 Time Synchronisation Function

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

7.6 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.

7.7 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.

7.8 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	

8. USING A GPS or WiFi Time RECEIVER

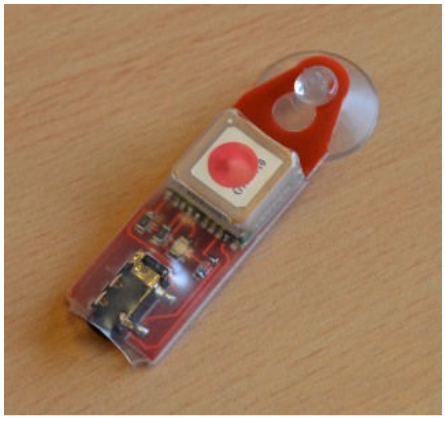
The clock can also receive time from a GPS receiver that transmits information using NMEA-0183 protocol, using the $GPRMC sentence.

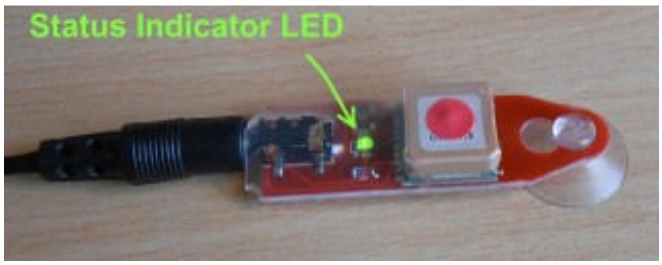
8.1 Configuring for GPS or WiFi Synchronisation.

- 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 the synchronisation source. This is usually only whole hours.
- Set parameter (16) to identify whether the offset is minus (0) or positive (1) of the time source.

8.2 Connecting a GPS receiver

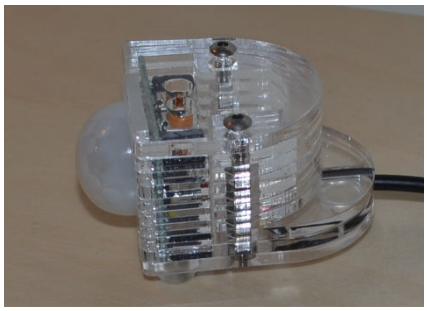
The clock has been designed for, and tested with our GPS Receivers (available separately from PV Electronics)





9. PIR MOTION SENSOR

The clock has a 3.5mm Jack Plug socket for connection of our PIR Motion Sensor Accessory, available separately as a quick – build kit. This useful accessory helps save tube life and power by powering down the clock when it senses the room is empty. The sensing range is typically up to 12 ft (3.5 metres)



When installed and configured (configuration parameter 17), the sensor will sense motion in the room, and switch off the High Voltage generator, tubes and RGB LEDs when the PIR time period has expired.

Configuration Parameter 17:

0 – No PIR installed (default)
1 – 15 seconds
2 – 30 seconds
3 – 1 minute
4 – 2 minutes
5 – 5 minutes
6 – 10 minutes
7 – 15 minutes
8 – 20 minutes
9 – 30 minutes

It is important to remember that the function does not override Night Blanking and Master Blanking, so when the clock is in Night Blanking or Master Blanking, no amount of waving around in front of the sensor will light the tubes! If you are using the PIR motion sensor, the Night Blanking and Master Blanking periods are rather redundant, so it is recommended to not use these if you have the PIR installed.

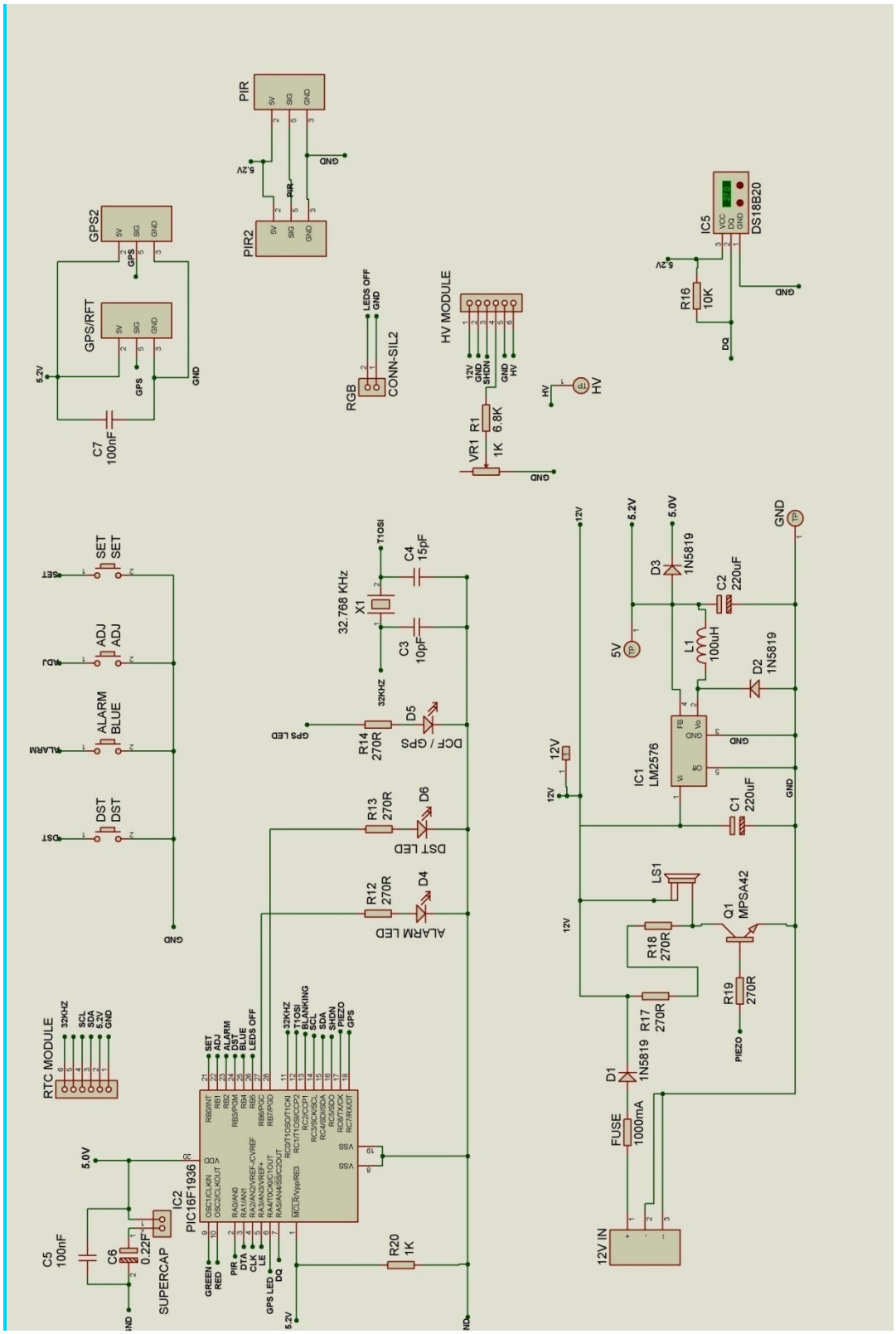
The suggested initial PIR period is 10 minutes (Config 17 = 6).

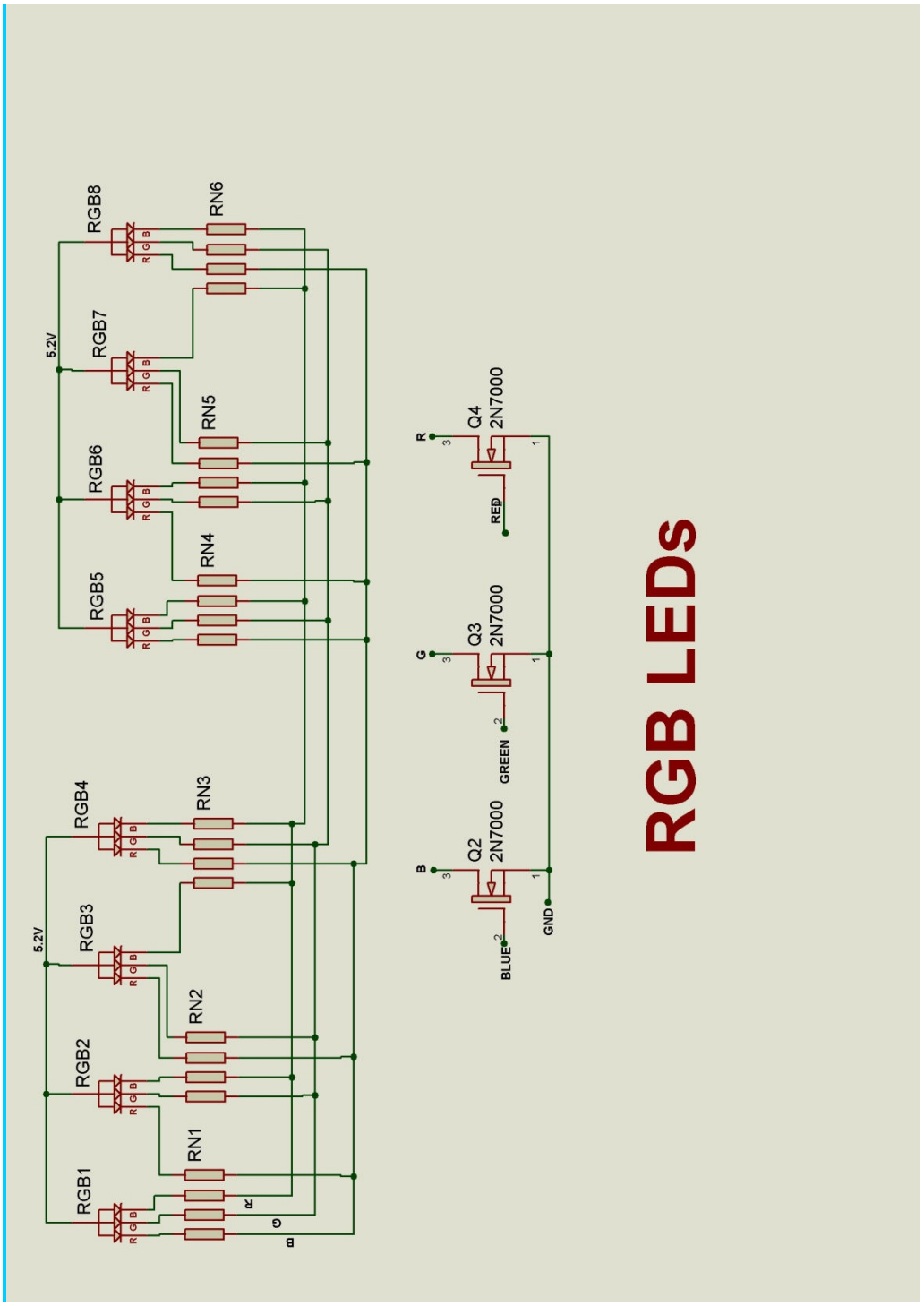
10. RGB LED OVERRIDE

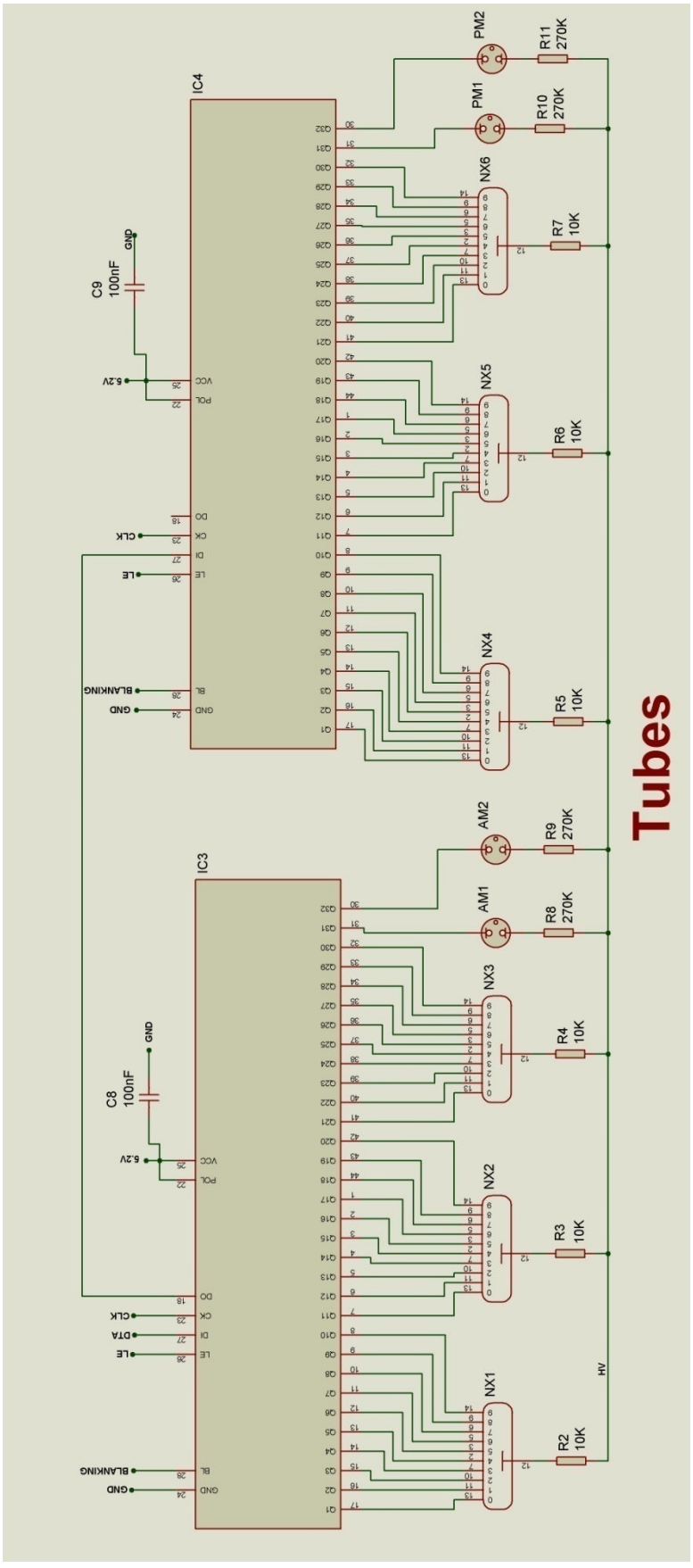
Pads are provided at the rear of the PCB to allow a user to connect a remote switch for switching off the RGB LEDs.

Shorting the two 'RGB' pads will switch off the RGB LEDs.

11. CIRCUIT DIAGRAM




RGB LEDs
RGB8
RGB7
RGB6
RGB5
RGB4
RGB3
RGB2
RGB1
RN6
RN5
RN4
RN3
RN2
RN1
5.2V
5.2V
R
G
B
Q4
2N7000
Q3
2N7000
Q2
2N7000
RED
GREEN
BLUE
GND


Tubes
IC4
IC3
PM2
PM1
AM2
AM1
R11 270K
R10 270K
R9 270K
R8 270K
R7 10K
R6 10K
R5 10K
R4 10K
R3 10K
R2 10K
NX6
NX5
NX4
NX3
NX2
NX1
C9 100nF
C8 100nF
GND
5.2V
CLK
LE
DTA
BLANKING
HV