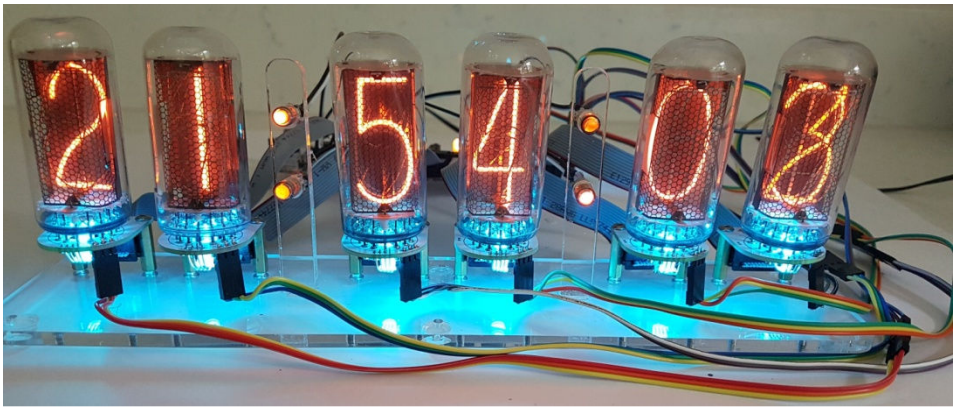
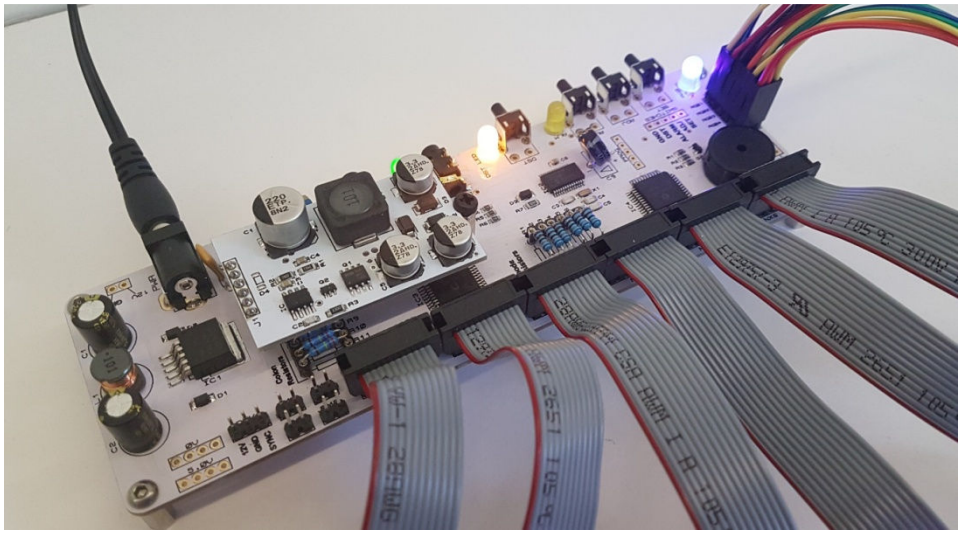
# Assembly Instructions
# And
# User Guide

# ‘RemoteSystem’
## For Building
## Nixie Tube Clocks

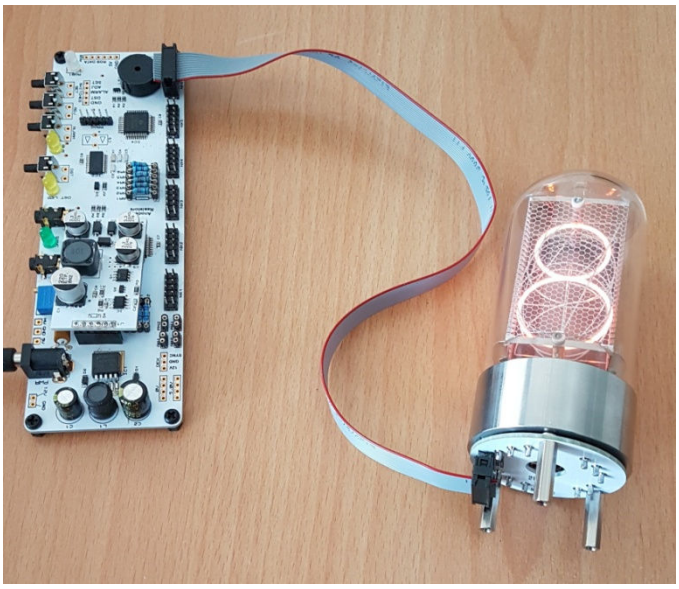




## REVISION HISTORY

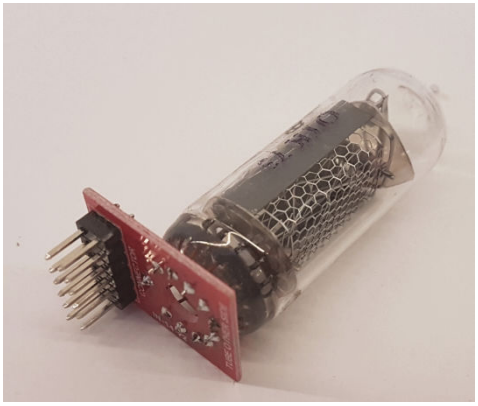
| Issue Number | Date | Reason for Issue |
|---|---|---|
| Issue 1 | 1 June 2019 | New document |

Here are some random pictures to save wasting a full page:!



Yes, the kit can drive Dalibor Farny's tubes, and
We have cell PCBs for this tube.

IN-18 tubes, of course,



The system is fully compatible
With smaller tubes from our
QTC + Range

## 1. INTRODUCTION

**Here are the key features of the RemoteSystem Kit:**
**ALL SMD COMPONENTS ARE PRE-SOLDERED!**

- Hours, Minutes and Seconds display
- Direct drive to six remotely mounted Nixie Tubes
- Connection via 12 way ribbon cable
- 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 / 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 of 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.
  - 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.

### 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.

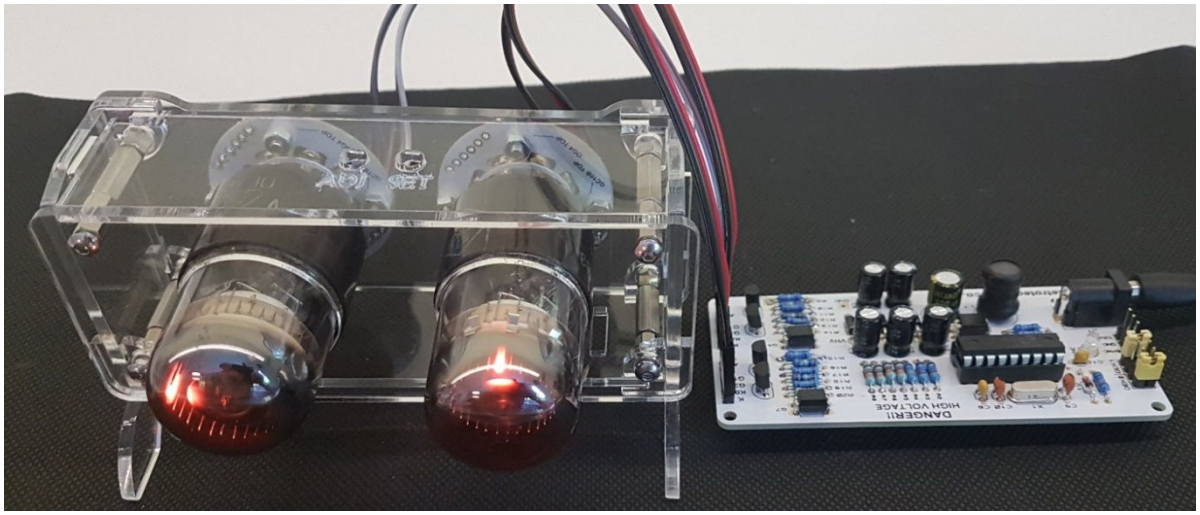
## 2.3 What else will you need to make the clock?

In addition to the main driver board, you will need the following:
- 12V DC Power Adapter (minimum 1A).
- 12 IDC connectors and sufficient ribbon cable to prepare the tube ribbons.
- 6 tube cell PCBs for your chosen tube type. You can absolutely mix different tubes on your clock.

**Optionals:**
If you want the four neon lamp colon separators, you need 4 neon lamps and four 2-way wiring cables.
For RGB Tube lighting, you need 6 X APA106 LEDs and sufficient / long enough 3 way connector cables to wire back to the headers on the main board.
Wifi or GPS time sync modules are also optional.
A PIR motion sensor kit to power down the clock when you leave the room.

All the above items are easily found on our website.

Please also check out our compatible DekaDuo Dekatron driver, which plugs directly into a dedicated header on the main board to provide power, GND and a Sync Signal. It even knows when the clock is sleeping and powers down the Dekatrons too!



# 3. LIST OF COMPONENTS

## 3.1 Table of Components – Driver Board

| Circuit Designation | Part Description |
|---|---|
| Resistors | |
| R8 | 6.8 KΩ, ¼ Watt |
| R9, R10, R11, R12 | 270 KΩ, ¼ Watt |
| VR1 | 1 KΩ Trimmer potentiometer |
| AR1 – AR6 | 15 KΩ or 8.2 KΩ suggested, depending on tube |
| Capacitors | |
| C1, C2 | 220uF, 16-25V, Electrolytic |
| C9 | 0.22F, 250V, Electrolytic |
| Diodes | |
| SYNC | 5mm Green LED |
| ALM, DST LED | 5mm Yellow LED |
| RGB1 | APA106 RGB LED |
| Miscellaneous | |
| L1 | 100uH Radial inductor |
| PWR | 2.1mm PCB power socket |
| SYNC CONN, PIR | Surface mount 3.5mm jack socket |
| LS1 | Piezo sounder |
| F | 1A fuse |
| NX1 – NX6 | 6X2 Way 0.1” male header |
| HV MODULE | 6 Way 0.1” female header |
| SET, ADJ, ALARM, DST | Miniature push button |
| AR1 – AR6 | SIL Socket Strips (6+6) |
| R9, R10, R11, R12 | SIL Socket Strips (4+4) |
| Various headers | 5 X 10 way male header |

Recommended Anode Resistor values (AR1 – AR6)
IN-18 tube: 8.2 KΩ
R|568M tube: 8.2 KΩ
Z5660M / ZM1040 tube: 8.2 KΩ
IN-12 tube: 15.0 KΩ
Z560M / ZM1022 tube: 15.0 KΩ

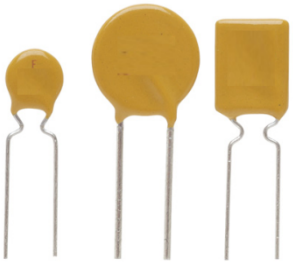
## 3.2 Packing Sheet – Driver Board Parts Bag

| Part Description | Quantity |
|---|---|
| Resistors | |
| 6.8 KΩ, ¼ Watt | 1 |
| 270 KΩ, ¼ Watt | 4 |
| 1 KΩ Trimmer potentiometer | 1 |
| 8.2 KΩ, ¼ Watt | 6 |
| 15 KΩ, ¼ Watt | 6 |
| Capacitors | |
| 220uF, 16-25V, Electrolytic | 2 |
| 0.22F Supercapacitor | 1 |
| Diodes | |
| 5mm Green LED | 1 |
| 5mm Yellow LED | 2 |
| APA106 RGB LED | 1 |
| Miscellaneous | |
| 100uH Radial inductor | 1 |
| 2.1mm PCB power socket | 1 |
| Surface mount 3.5mm jack socket | 2 |
| Piezo sounder | 1 |
| 1A fuse | 1 |
| 6X2 Way 0.1” male header | 6 |
| 6 Way 0.1” female header | 1 |
| Miniature push button | 4 |
| 20 Way SIL Socket Strips (6+6+4+4) | 1 |
| 10 Way male header | 5 |
| Pre-assembled SMD HV Module | 1 |
| M3 X 5mm nylon screw | 2 |
| 11mm Female/ Female hex spacer | 1 |
| 2cm 12 way ribbon cable for tube tests | 1 |
| 12 way IDC female connector for tube tests | 2 |
| 6X2 Female connector for assisting in soldering the RGB LED headers | 1 |

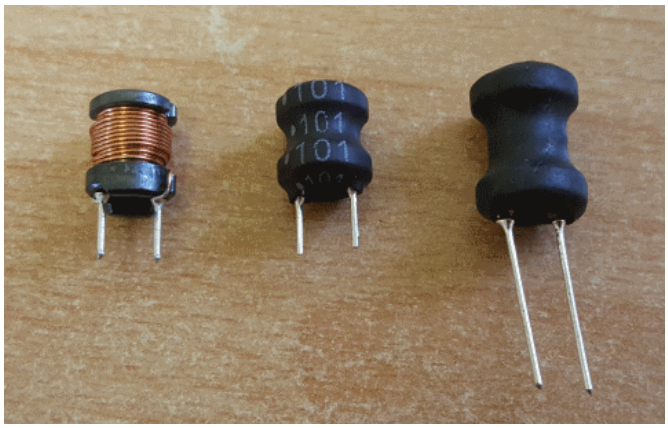
## 3.3 Parts Identification

The resistors used in the kit are 1% tolerance metal film. They are marked with four 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.



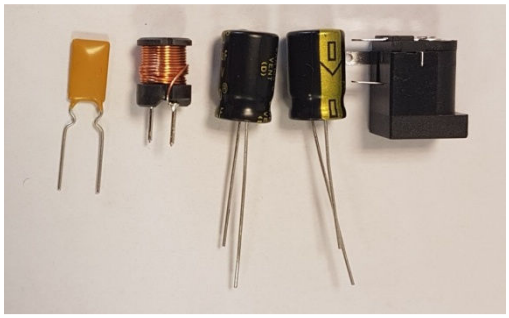
Inductor L1 may take different apperances:



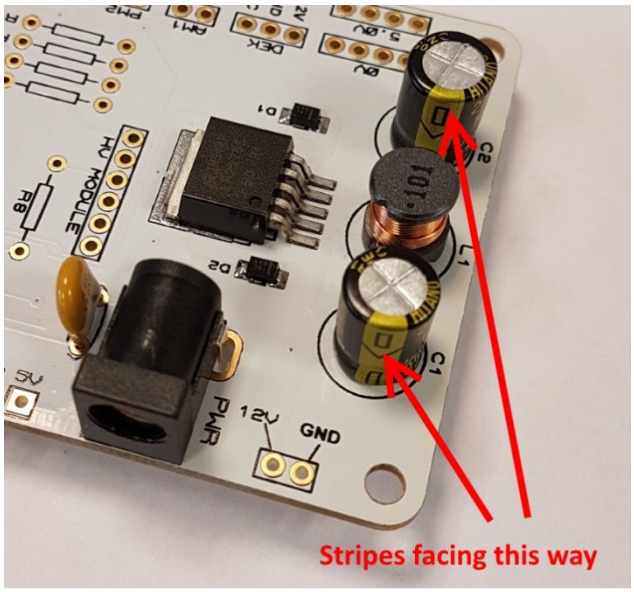
## 4. ASSEMBLY OF THE DRIVER PCB

### 4.1 Low Voltage Generator components.

**1A Fuse (F)**
**L1(100uH Inductor)**
**C1, C2 (220uF)**
**PWR (DC Socket)**

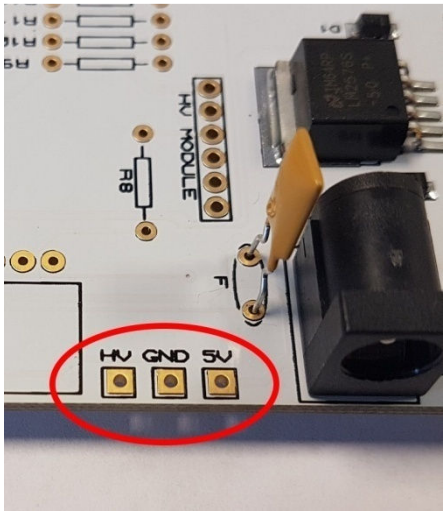


C1 and C2 are polarized. The positive lead is the longest, and goes in the pad marked '+'.



## 4.2 Testing Low Voltage Power Supply.

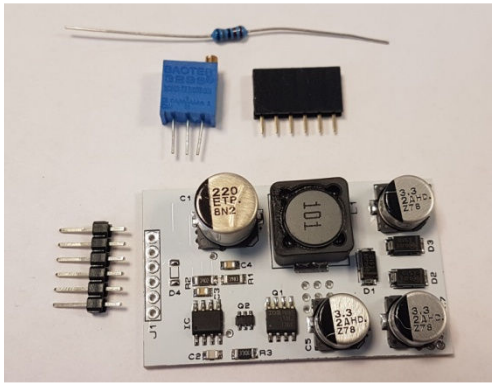
Identify the test GND, 5V and HV test points at the side of the PCB.

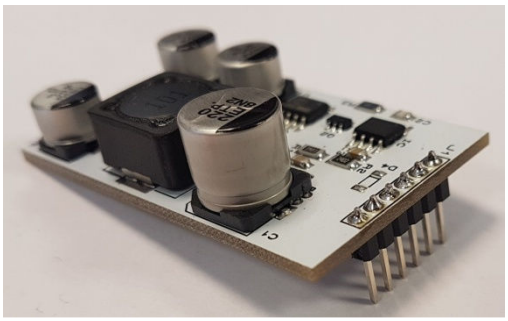



Plug in the 12V DC power supply, and then test using a DC voltmeter on 20V DC setting: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 4.9 and 5.2 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

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

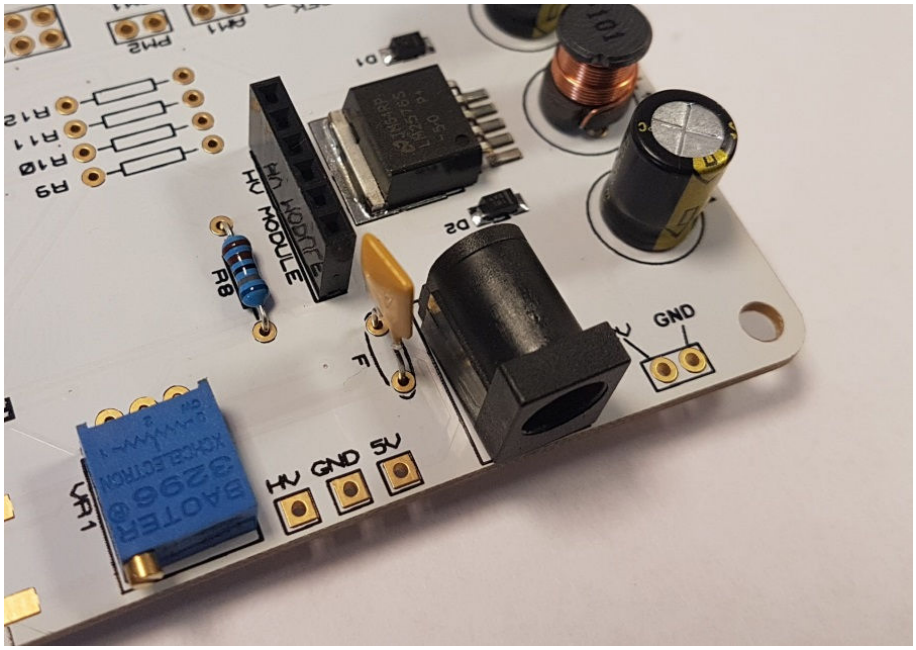
## 4.3 High Voltage Generator components.
**R8 (6.8 KΩ)**
**HV MODULE (0.1” X 6 way female header)**
**VR1 (1 KΩ Trimmer potentiometer)**
**HV Module with 6 way male header**





First solder the Male header to the PCB Module as shown above.

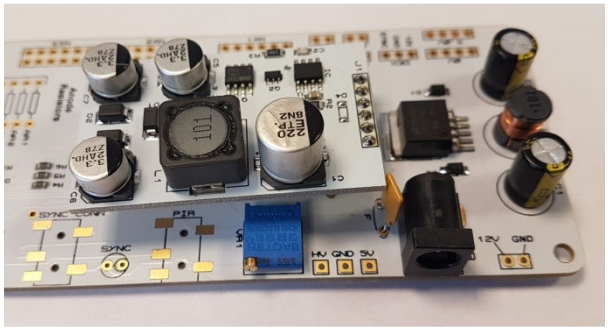
Then solder the remaining 3 components. The potentiometer lies horizontally on the PCB, so bend the wires over first before installling.



## 4.4 High Voltage Generator Test.

**- REFER TO THE WARNINGS ON PAGE 5**

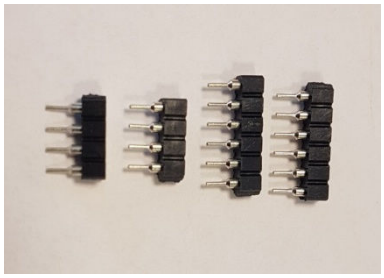
- Insert the HV Module into its socket, oriented so it is completely over the main PCB.



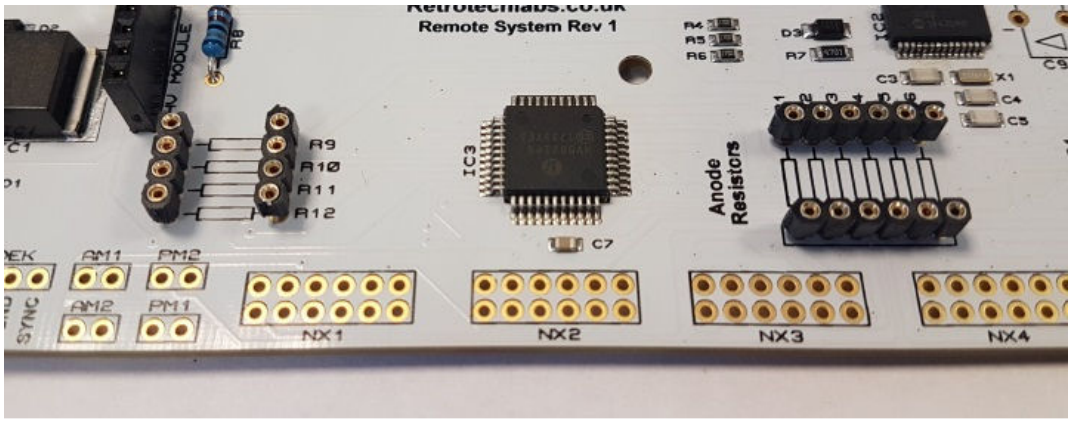

-Power up the PCB, and using the GND and HV test points, measure the high voltage generated using a voltmeter on DC setting. It should be between 164 and 178 Volts. Use the brass trimmer screw to adjust to close to 170V. If this is all in order, disconnect the power supply.

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

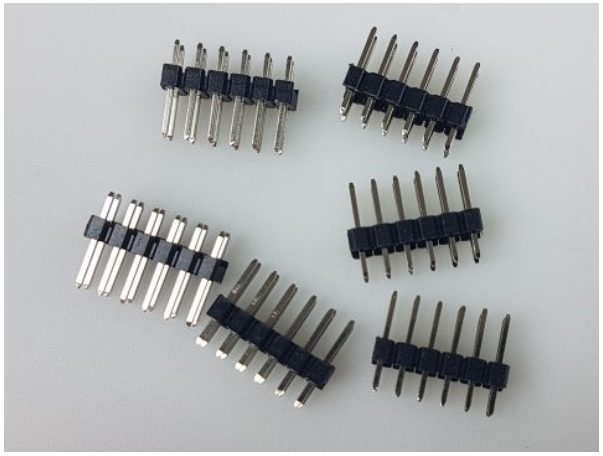
## 4.5 AR1 to AR6 sockets
## R9 – R12 sockets



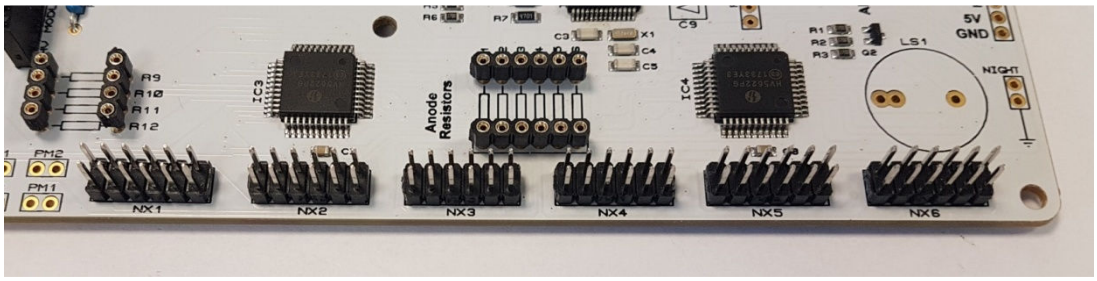
We have chosen to provide sockets for these resistors, to allow flexibility of design so that users can change tube type easily and experiment with different anode resistors to get the brightness they want from the tubes. No desoldering / soldering is necessary to change the resistors!




## 4.6 Nixie Tube Headers NX1 to NX6

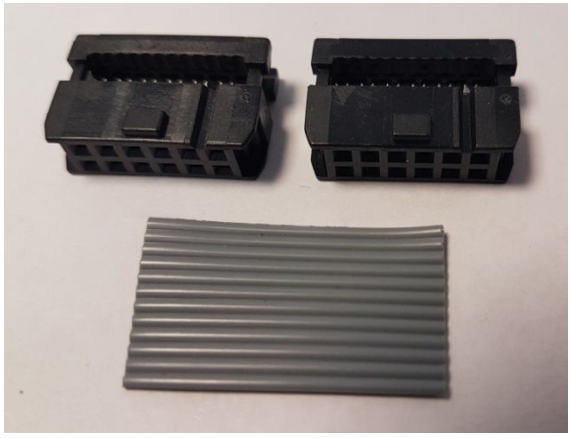


Take care that the headers are fully flush against the PCB when soldering. It helps to solder a single pin first, then check (and if necessary adjust), before soldering the remaining 11 pins.



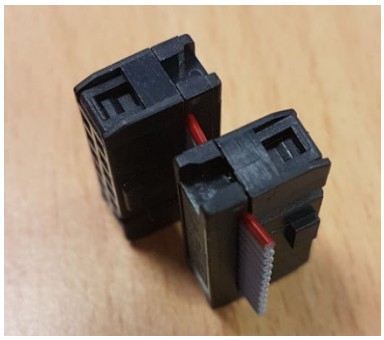
## 4.7 Tube Test

First, you will need to assemble the small tube test socket / ribbon cable. This simple basic interconnection, allows you to test the board AND tube assemblies before having to make all the ribbon cable assemblies. You will find these parts in the main parts bag:



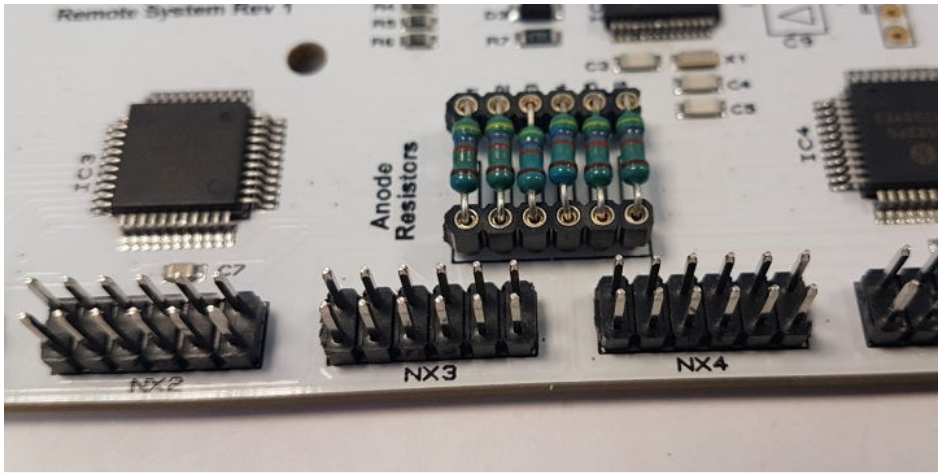
Using a pair of pliers or a plumber's wrench (or, even better the correct tool for these connectors!). crimp one connector to one end of the cable:

Now crimp the other connector facing the opposite direction, so you end up with this:

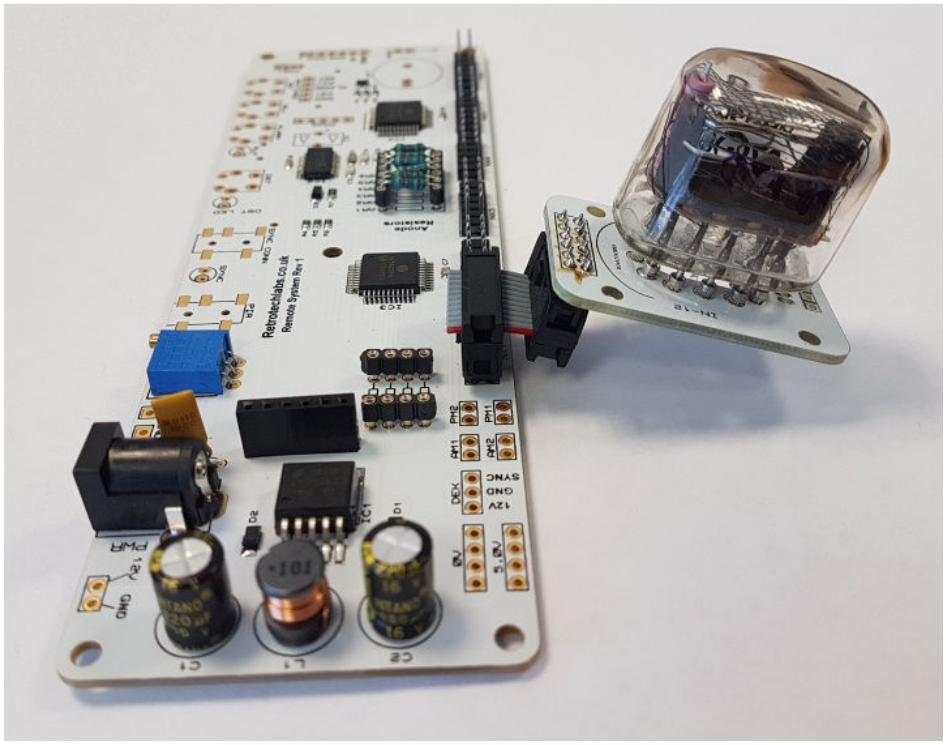


Consult section 5 for how to make up the tube cells, and prepare a single tube cell. In this case we have shown IN-12, but any RemoteSystem cell will work for the test.

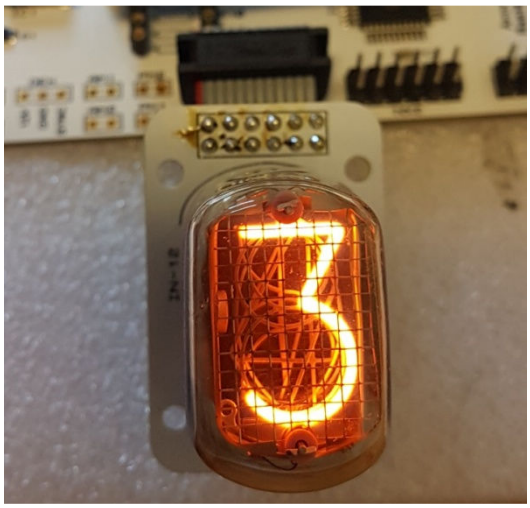
You will need to insert your six Anode resistors at the AR1 to AR6 positions:




Insert the tube assembly, using the adapter connector, at the first NX1 Nixie location:



Insert again the HV Module, and now taking care that high voltage will be present on the PCB, power up the board. After a short pause, the tube should start counting 0 through to 9 and repeating.



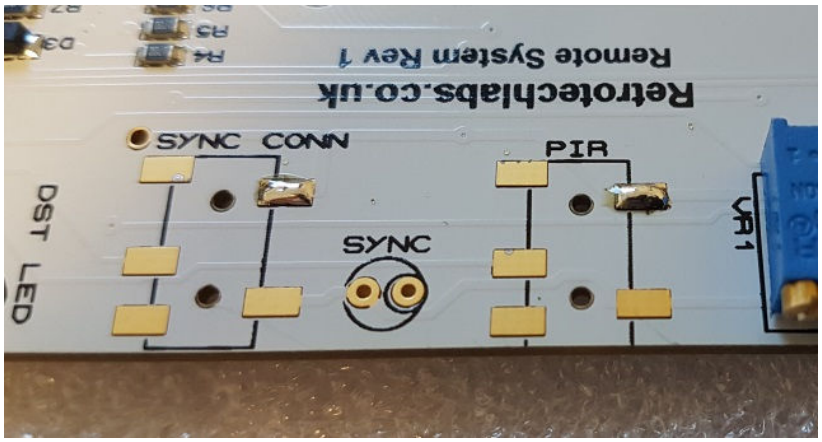
Use the tube and connector assembly to check that each digit shows at each location from NX1 to NX6. Power off the board each time as you switch the tube between locations.

For the remainder of the assembly, it is easier to remove the HV module and the test tube assembly.

## 4.8 LS1(Piezo sounder)<br>C9 (0.22F)<br>PIR, SYNC CONN (SMD Jack Sockets)

The 0.22F capacitor is polarised – note the arrows on the PCB, to correspond with the arrows on the part.

To solder the SMD jack sockets, first tin one pad per jack socket:




Then place the socket over the pad and re-heat the pad to wet the solder and anchor the part. The remaining pads can then be soldered.

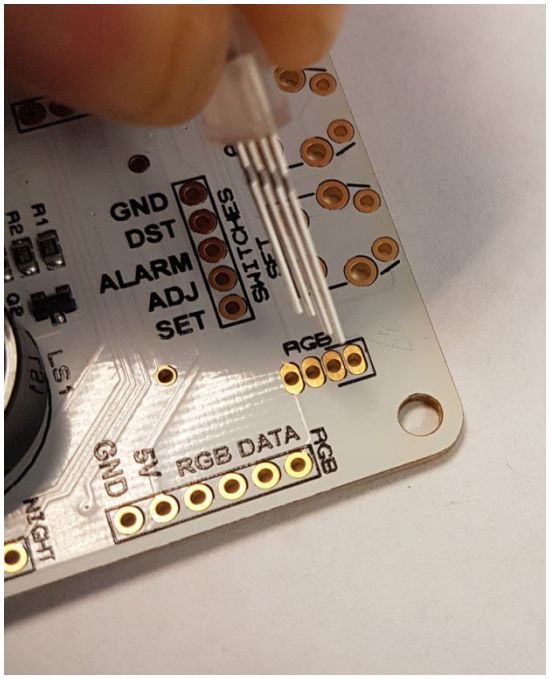

## 4.8 SYNC (5mm Green LED)<br>DST LED, ALM (5mm Yellow LED)<br>SET, ADJ, ALARM, DST (Push switches)

The longer lead of the LEDs goes in the hole marked with a black circle. Depending on your design, you may wish to mount them rear-pointing, vertical pointing, or even remote from the PCB.

Then place and solder the 4 push button switches. Only solder the two pins closest to the board edge. Depending on your design, you may choose to omit the switches and use remote switches, wired to the 'SWITCHES' pads instead. See section 7 '**customisation and wiring**' for more details on this.

## 4.9 RGB1 (APA106 RGB LED)

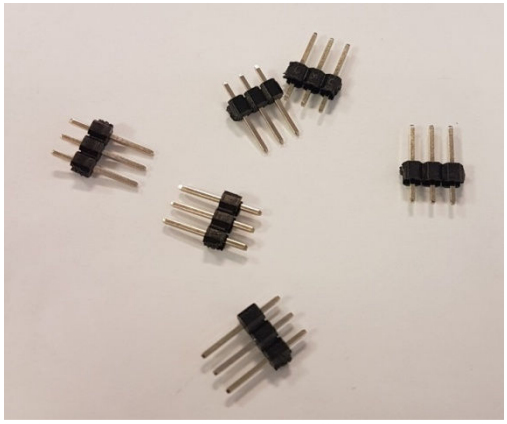
The RGB LED mirrors the colours of the RGB colour output of the adjacent 'RGB' 6-way header pads. It can be useful to see what colour the other tube LEDs should be displaying, or for troubleshooting.



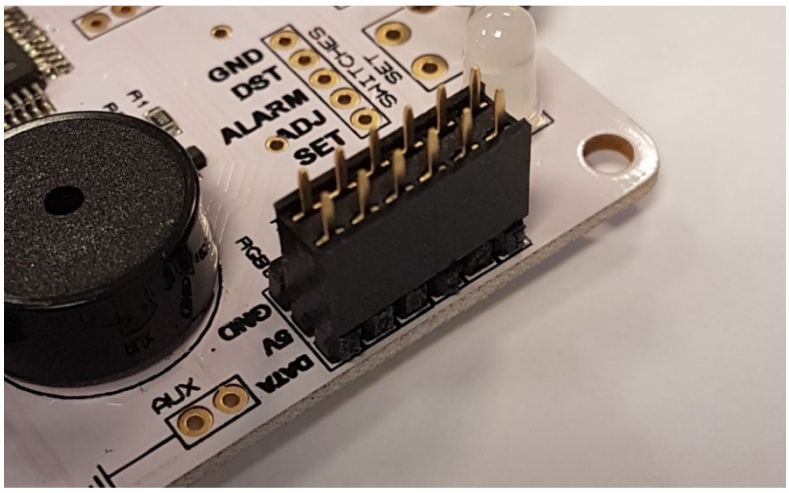

Alternatively,you may choose to mount this LED remotely for additional case lighting.

## 4.10 RGB LED Headers

Start by snapping the male headers so you have SIX headers of 3-way each:

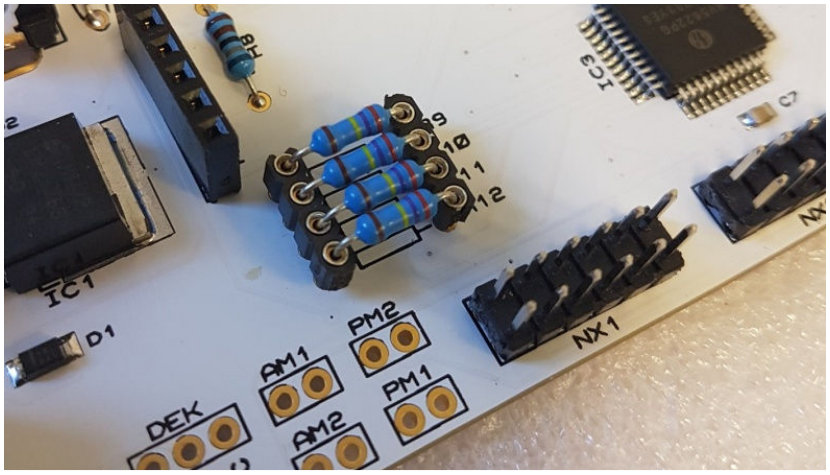


Now place the headers into the PCB and secure with the 6X2 Female connector. It will hold them perfectly in place whilst you solder all 18 pads. It has no other purpose – it is just a jig to hold all the pins in position whilst you solder the pads.



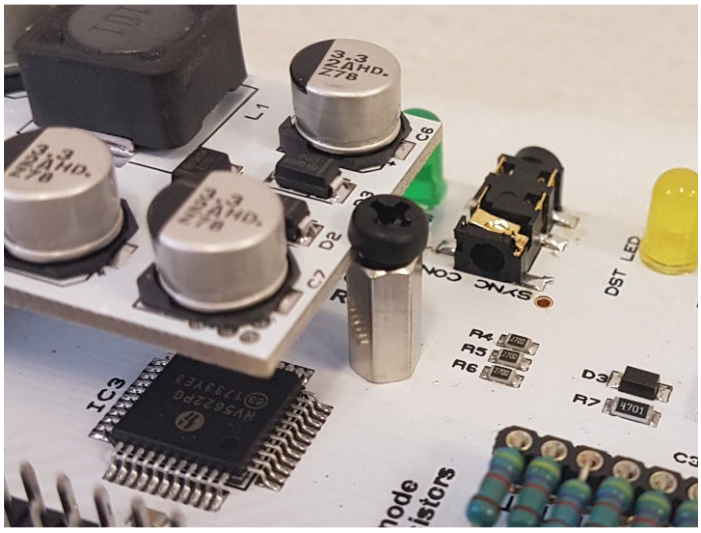

## 4.11 Neon Resistors R9, R10, R11 R12 (270KΩ)

As per the anode resistors, these are socketed. Trim to a suitable length and bend to fit the sockets. Depending on your final design, you may wish to solder male headers at the AM1, AM2, PM1, PM2 positions.



## 4.11 Securing the HV Module

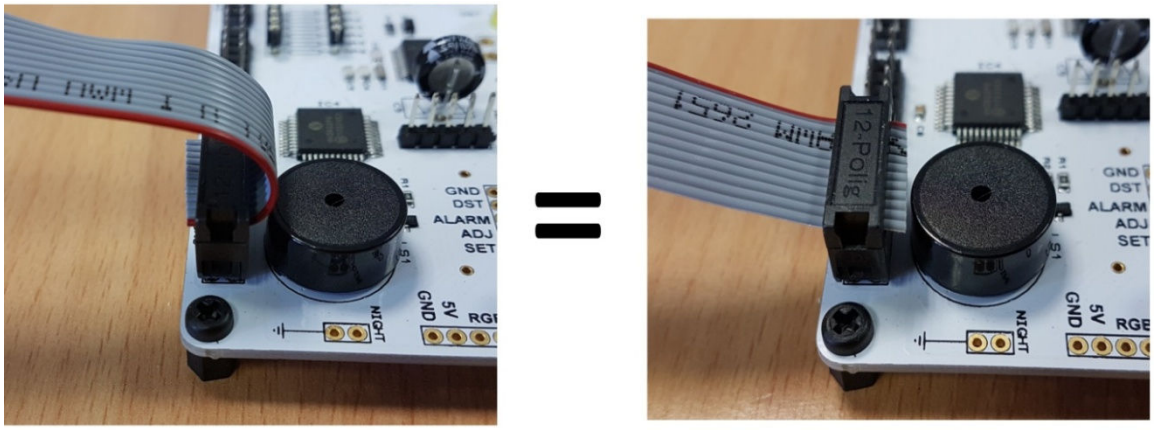
Use the two M3 black nylon secrews and 11mm hex spacer to secure the HV module as shown below.



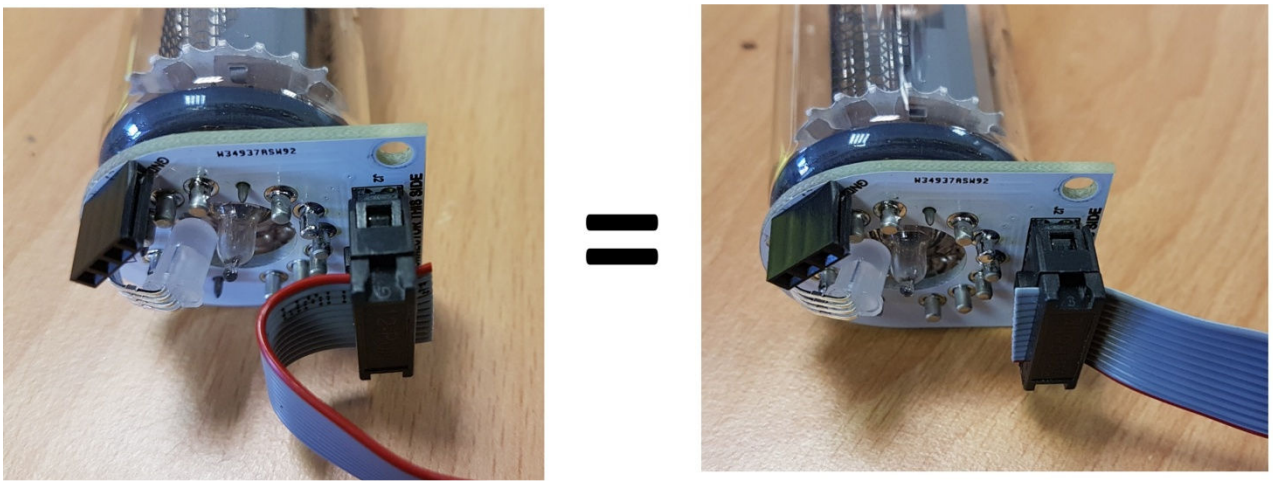
# 5. MAKING UP THE CABLE ASSEMBLIES AND TUBE CELLS

## 5.1 Cable Assemblies

The critical thing to bear in mind is that the ribbon cables should not be twisted, or the connections will not be in the right places. But also note that the direction the cable leaves the connector is not relevant, so you should plan your overall case and clock design bearing in mind the following options:

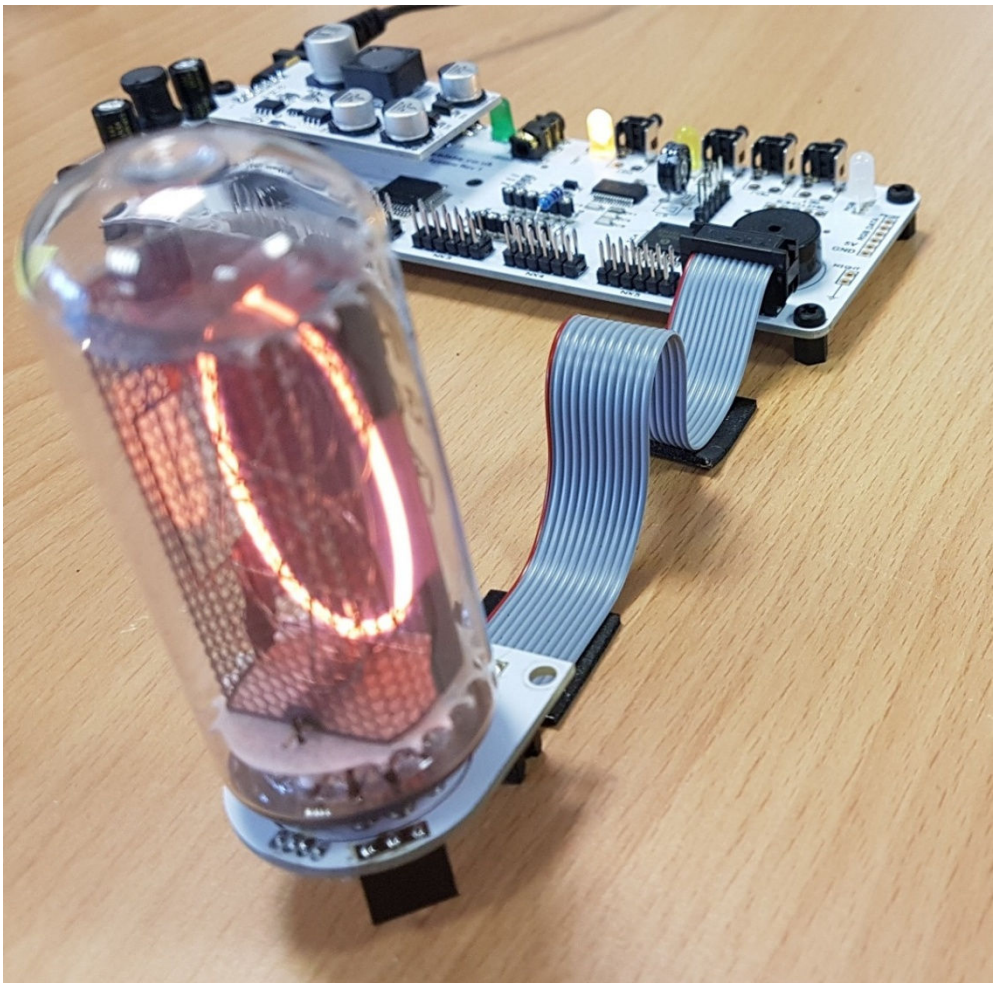



**The direction the ribbon leaves the driver board does not matter**



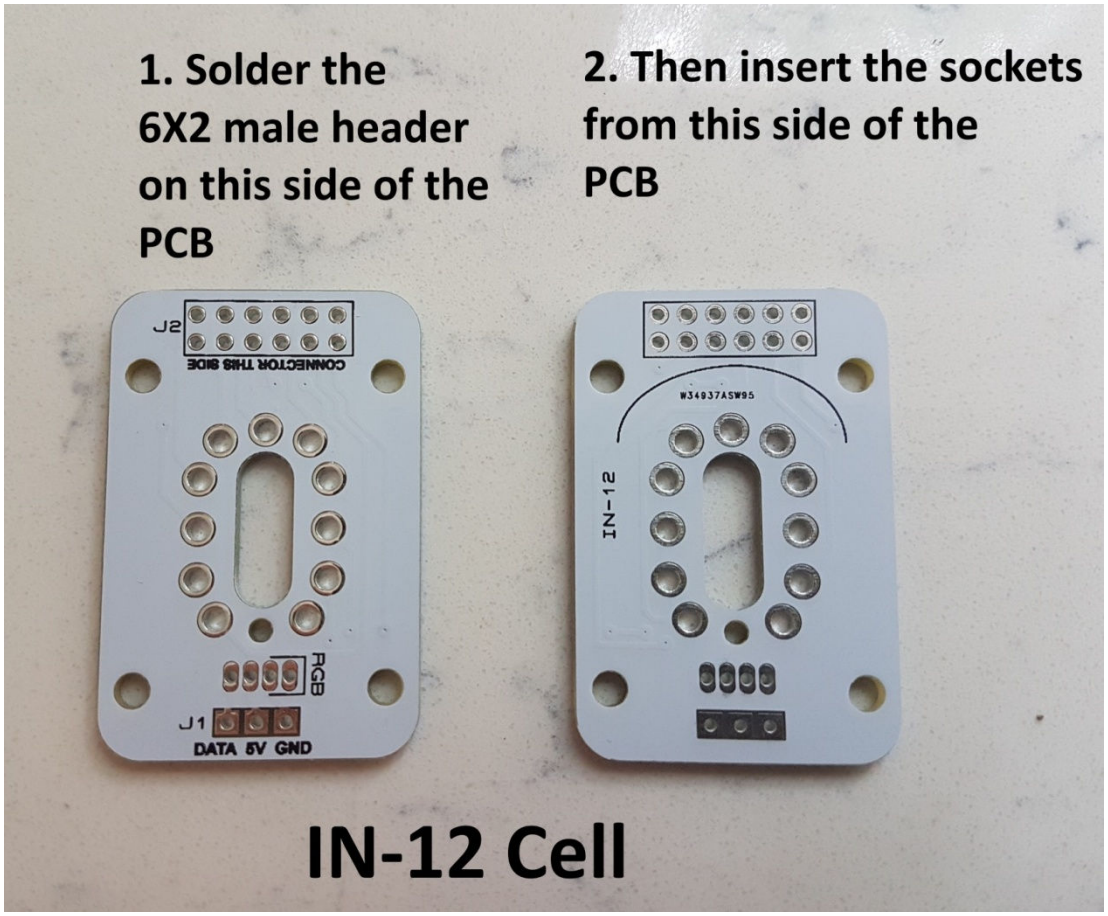
Also note that the IDC connectors may face the same direction or in opposition, it does not matter. Plan what is best for YOUR installation:

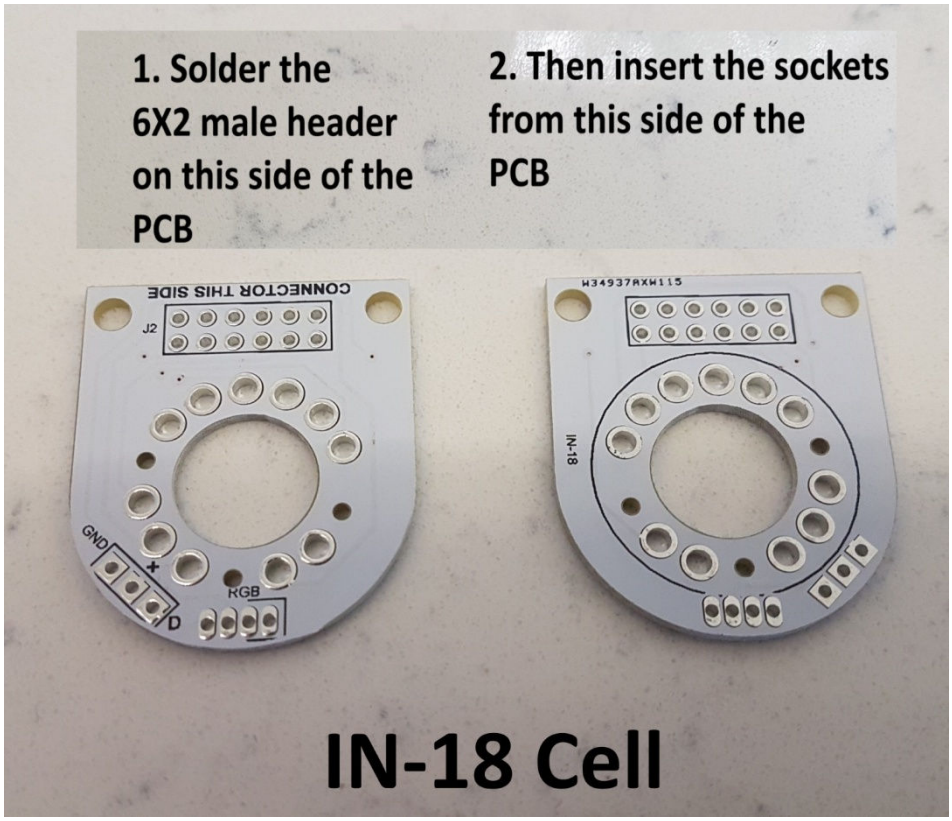
Finally, to ensure the connections are all in the correct positions, the tubes must placed so viewing is from the FRONT of the PCB. The front of the PCB is the opposite side to the side with the switches and power socket etc.

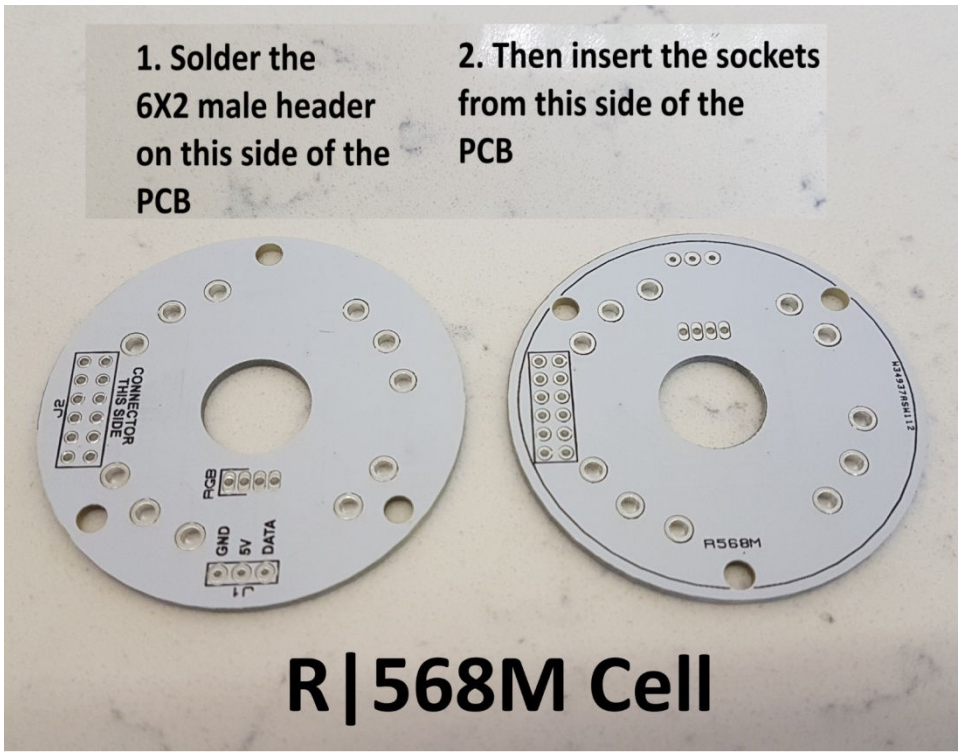


## 5.2 Tube Cells

It is critical that the tube sockets are soldered on the correct side of the PCB. Therefore it is best to solder the 6X2 male header first, and then solder the sockets which are inserted from the opposite side of the cell PCB to the connector. The best way to keep all the sockets in place whilst soldering, is to insert a tube into the cell sockets. When you order the cell PCBs, this will include high quality Harwin sockets so the tube will be easily replaceable. The Male header is also included with the cell PCBS.



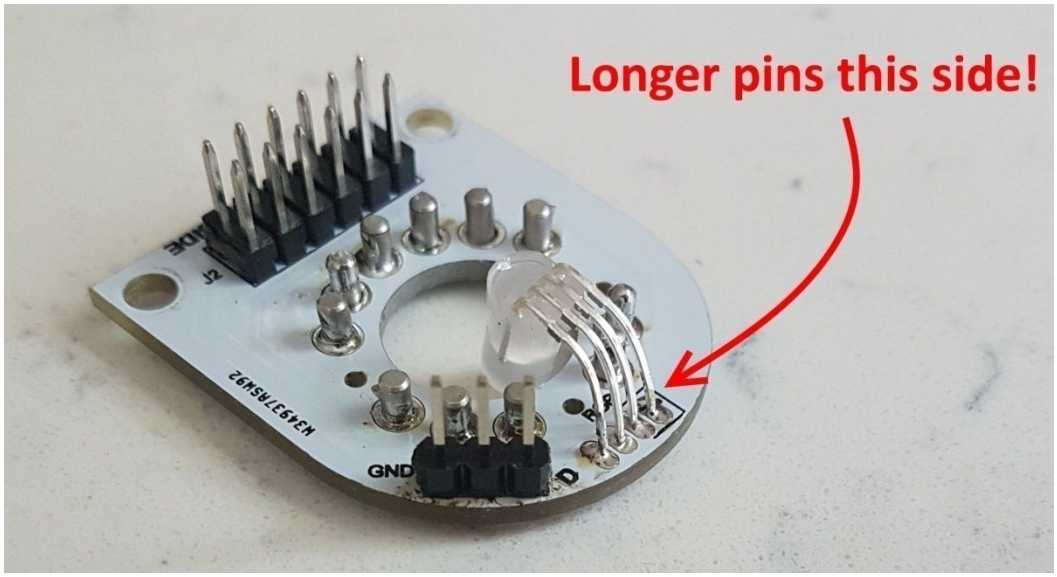

1. Solder the 6X2 male header on this side of the PCB
2. Then insert the sockets from this side of the PCB
CONNECTOR THIS SIDE
J2
GND
+
RGB
D
IN-18
IN-18 Cell


1. Solder the 6X2 male header on this side of the PCB
2. Then insert the sockets from this side of the PCB
CONNECTOR THIS SIDE
J2
RGB
GND
5V
DATA
J1
R568M
R|568M Cell

## 5.3 RGB LEDs and Headers

Note that it is not mandatory to install RGB tube lighting – simply omit this step if you prefer a traditional look, without tube lighting.

Solder the RGB LED paying attention that the longer leads are at the side that has the marking on the PCB. The photo below makes this clear. Then bend the LED over to protrude through the large hole. It helps to have the tube in place so you can position the LED to avoid a base nipple if the tube has one.

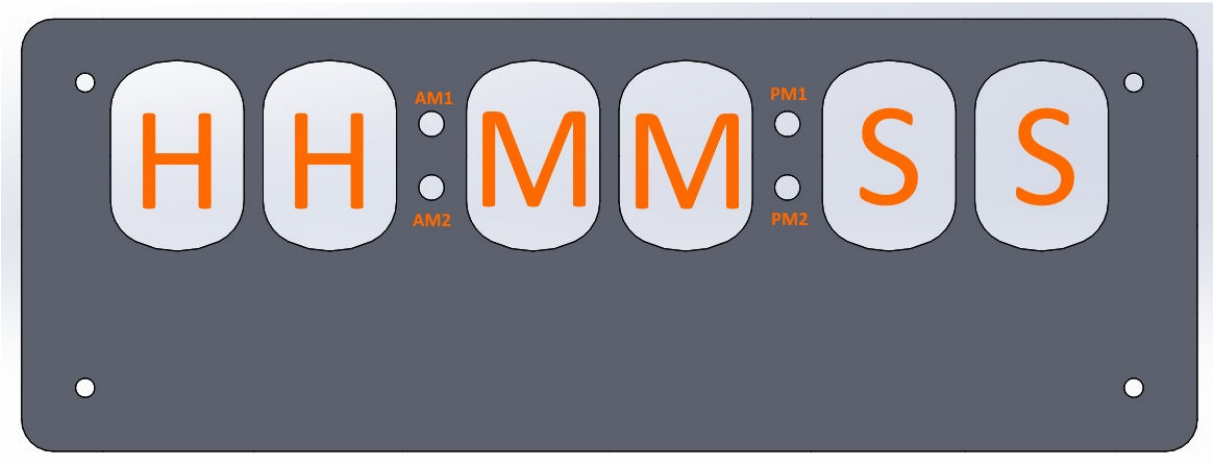



Solder the 3 way header too, as shown above. The connection to the main board is now easily made with 3 way cables as available on our website in several lengths.

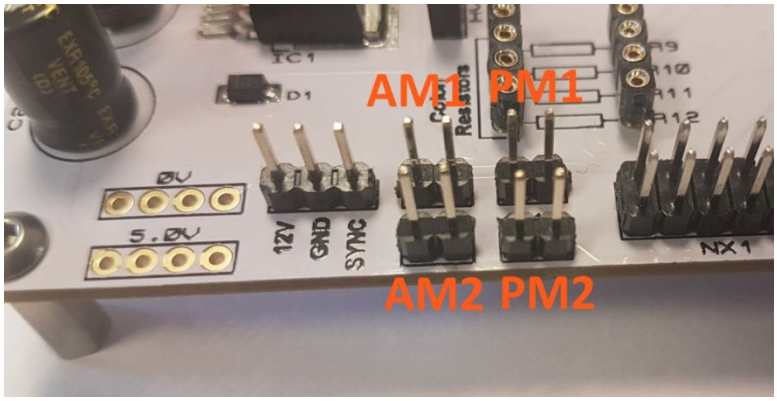
## 6. AM / PM Neon Colons

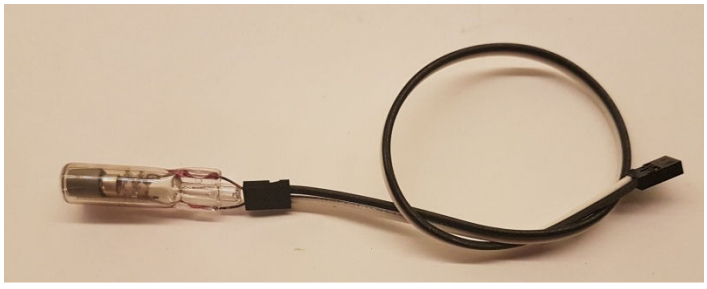
### 6.1 Description and Function

Provision is made for driving four small neon lamps to act as colon separators, with various modes of operation and flashing modes. They should be positioned as follows




We have a variety of neons available on our website and all work with the 270K resistors provided in the kit. The neons are most conveniently connected by using 2-way 0.1” female connector cables as available on our website. They plug directly into the male headers provided:

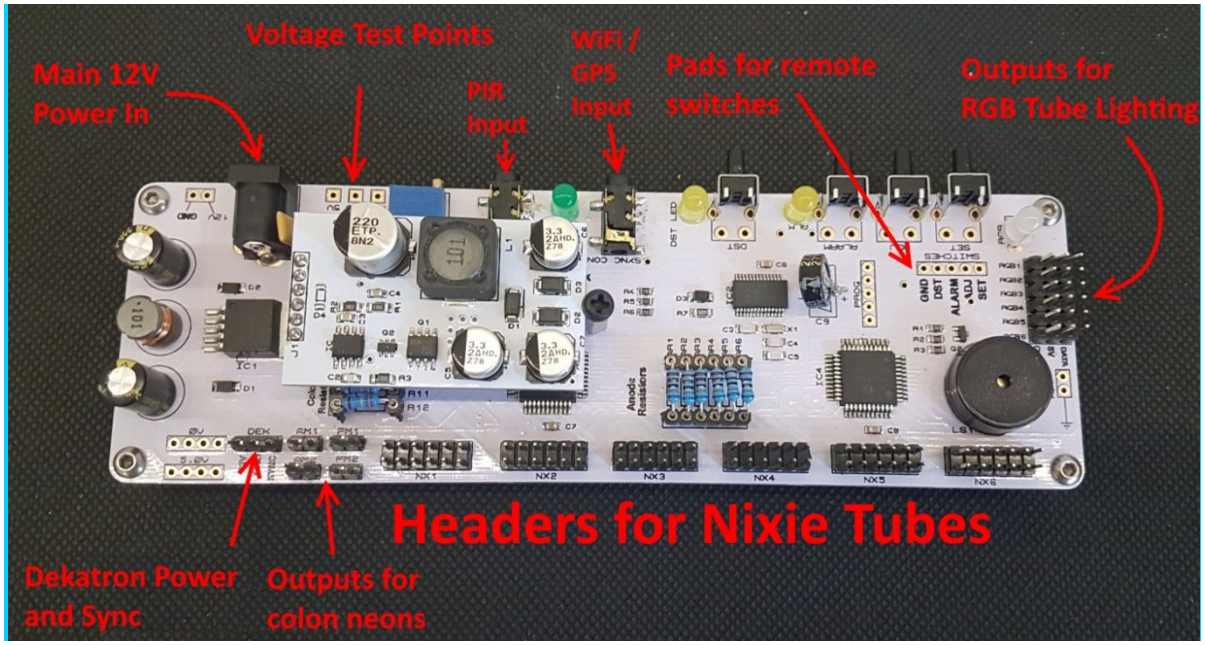


# 7. Customisation and Wiring

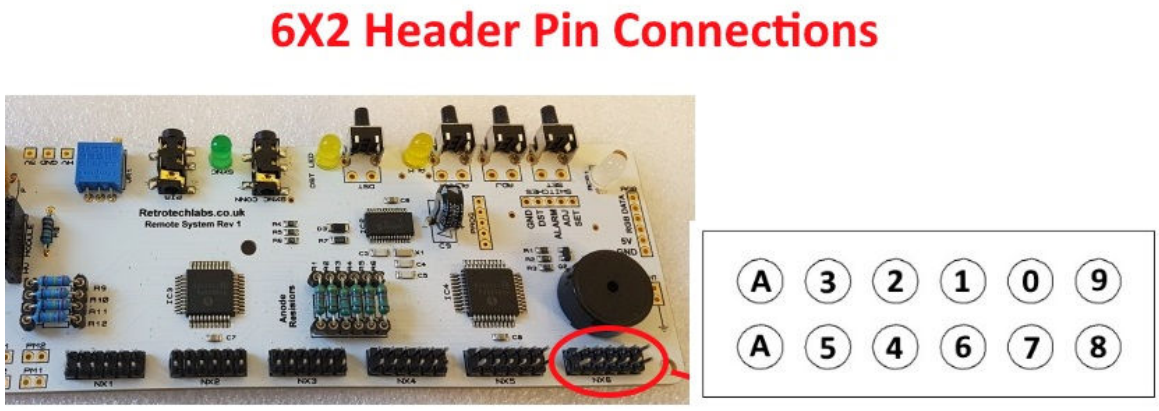
## 7.1 Description and Function

The diagram below shows the principal wiring and customisation options. Note that the alternative switch pads can be used even if the main switches have been soldered.




You may have noticed there are some other pads marked GND and 5V. These can be used for your own customisations and additions, always paying attention to overall load of the 5V regulator.

For reference, here are the pin assignments at each of the 6X2 headers:

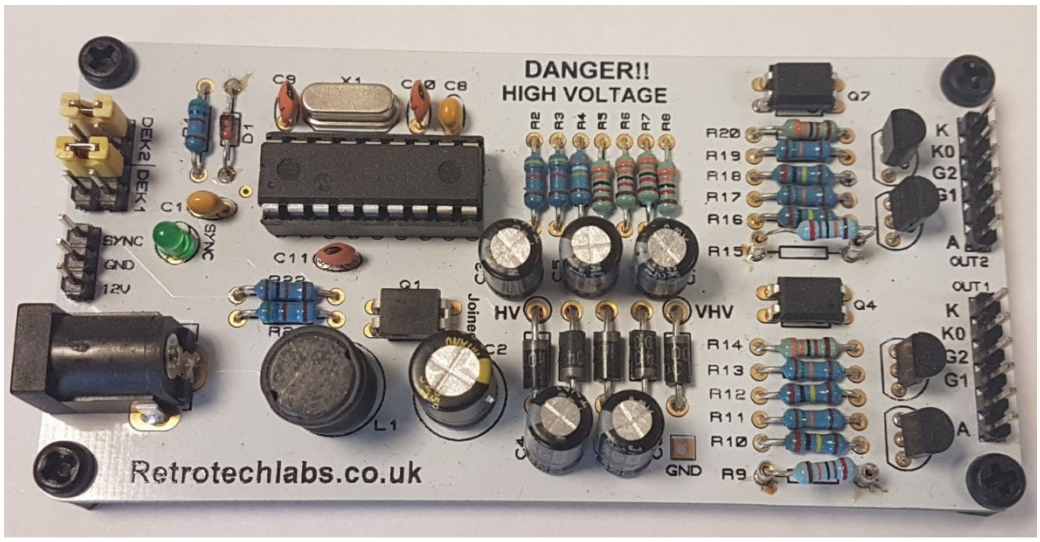


# 8. Dekatron Accessory

## 8.1 Description and Function

The 3-Way male header next to the AM / PM headers can be used to both power and synchronise our DekaDuo Dual Dekatron Driver board. Use a 3 way connection cable for simple interconnection.

Control of the Dekatrons during night blanking / dimming and master blanking is configured using parameter 23 (see configuration table in section 9).



## 9. 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 1.2 etc |
| 1 | 12 / 24 Hr mode | 0 – 12 Hr (default)<br>1 – 24 Hr |
| 2 | Date format | 0 = MM.DD.YY (default)<br>1 = DD.MM.YY<br>2 = YY.MM.DD |
| 3 | Leading zero blanking<br>eg. *0*1:54:32 | 0 – leading zero blanked (default)<br>1 – leading zero displayed |
| 4 | Night Mode start hour | 0 - 23 |
| 5 | Night Mode end hour | 0 - 23 |
| 6 | Night Mode | 0 – Tubes off<br>1 –5 Dimmed display (default 1) |
| 7 | Master Blank start hour[1] | 0 - 23 |
| 8 | Master Blank end hour[1] | 0 - 23 |
| 9 | Master Blank days[1] | 0 – Off (default)<br>1 – Weekdays<br>2 - Weekends<br>3 – All days |
| 10 | Colon neons mode | 0 – Both off<br>1 – AM/PM Indication, left / right<br>2 – AM/PM Indication, left / right flashing<br>3 – AM/PM Indication, top / bottom<br>4 – AM/PM Indication, top / bottom flashing<br>5 – All slow flashing<br>6 – Slow flashing left / right<br>7 – All flashing<br>8 – Both illuminated<br>9 – Railroad fast<br>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<br>4 – GPS<br>5 - XTERNA |
| 13 | GPS Baud rate | 0 – 4.8 Kbps<br>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)<br>1 – Plus time |
| 17 | PIR Motion Sensor Period | 0 – No PIR installed (default)<br>1 – 15 seconds<br>2 – 30 seconds<br>3 – 1 minute<br>4 – 2 minutes<br>5 – 5 minutes<br>6 – 10 minutes<br>7 – 15 minutes<br>8 – 20 minutes<br>9 – 30 minutes |

| | | |
|---|---|---|
| 18 | Snooze period | 0 – 6 minutes (default)<br>1 – 9 minutes<br>2 – 12 minutes<br>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<br>1 - Make clock faster |
| 22 | Slots Mode[5] | 0 – Slots disabled<br>1 – Slots every minute<br>2 - Slots every 10 minutes (default)<br>3 - Slots every hour<br>4 – Slots at midnight |
| 23 | Dekatron Sleep Mode | 0 – Dekatron always on<br>1 – Dekatron on when tubes night dimmed<br>Dekatron off when tubes off<br>2 – Dekatron off when tubes night blanked |
| 24 | Reserved | |
| 25 | Reserved | |
| 26 | Display Mode | 0 – standard change of digits<br>1 – fading digits<br>2 – fading digits with scrollback effect (default) |
| 27 | Auto date display each minute | 0 – Off<br>1 - Static display of date<br>2– Scrolling display of date (default)[6] |
| 28 | Night Mode Override minutes | 0 – 50 (default 0 gives 15 seconds override)[9] |
| 29 | Thermometer Settings | 0 – Don't display temperature<br>1 – Fahrenheit display (default)<br>2 – Celsius display |
| 30 | Reserved | |
| 31 | Restore default settings | 0 – Keep user settings<br>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 C9 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 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.

# 10. XTERNA FUNCTIONS

## 10.1 About the XTERNA Module

To use the XTERNA with this kit you will need our low cost adapter, which contains the 433MHz

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.

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.

## 10.2 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).

## 10.3 Configuring for XTERNA Reception

RemoteSystem 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.

## 10.4 Time Synchronisation Function

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

## 10.4 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.

## 10.5 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.

**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<br>40°F to 140 °F |  |
| **2** | Maximum Temperature in last 24 hours | -40°C to +60°C<br>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<br>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 |  |

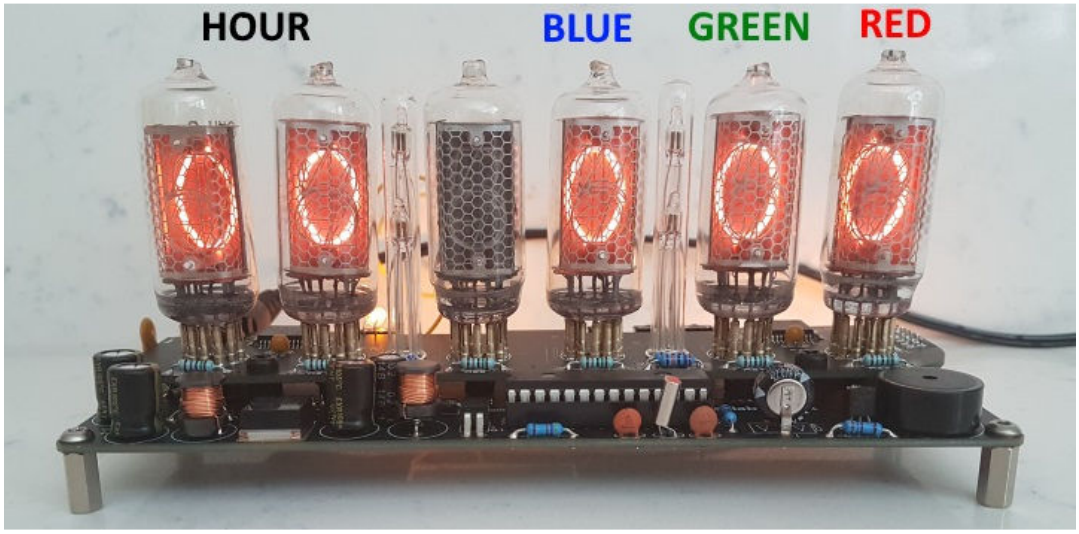
# 11. CONFIGURING THE RGB LED TUBE LIGHTS

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

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

## 11.1 Entering RGB LED menu

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




- For each hour (0-23), you can set a custom colour
- Each custom colour can have your choice of 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:

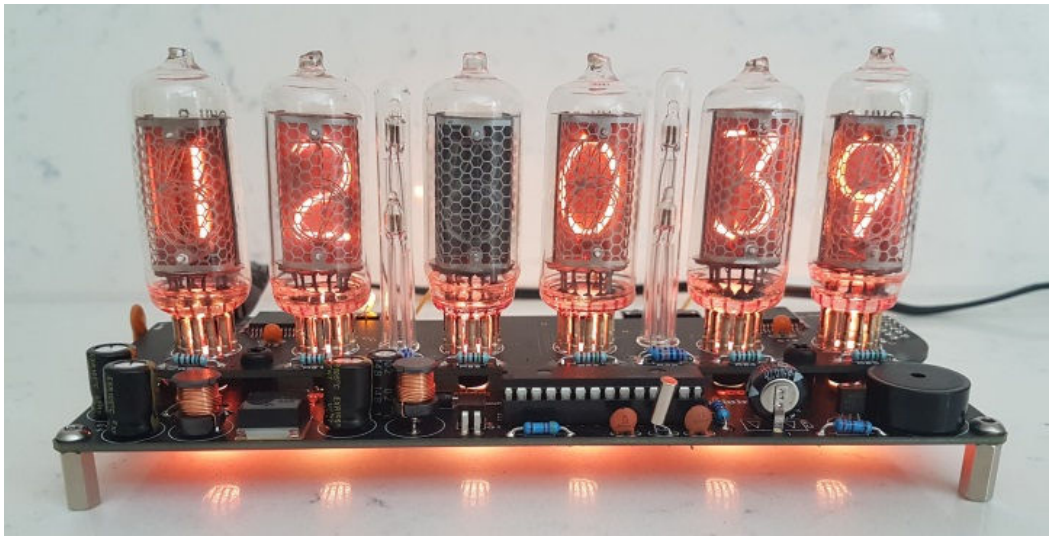
- In the example above, between 11 and 12 hours, the LEDs will be purple (8 blue, 0 green, 8 red)

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

## 11.2 Setting auto colour cycling

Setting colour RED to value 9 has a special meaning:
This will enable auto colour cycling for the specified hour. The speed of the cycling will then be governed by the GREEN value:
0 = very slow change
9 = very fast change

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



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

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

## 12. USING A GPS RECEIVER

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

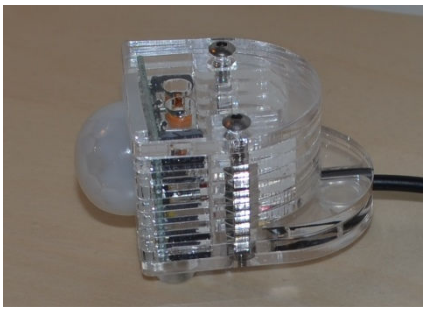
### 12.1 Configuring for GPS Synchronisation.

- 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 SYNC will light when the clock has received a recent GPS or XTERNA synchronisation data.

## 13. 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

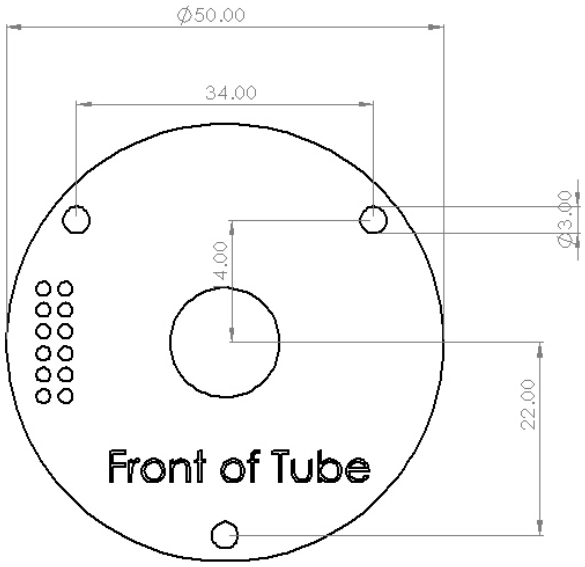
It is important to remember that the function does not override Night Blanking and Master Blanking, so when the clock is in Night Blanking or Master Blanking, no amount of jumping around in front of the sensor will light the tubes! If you are using the PIR motion sensor, the Night Blanking and Master 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).

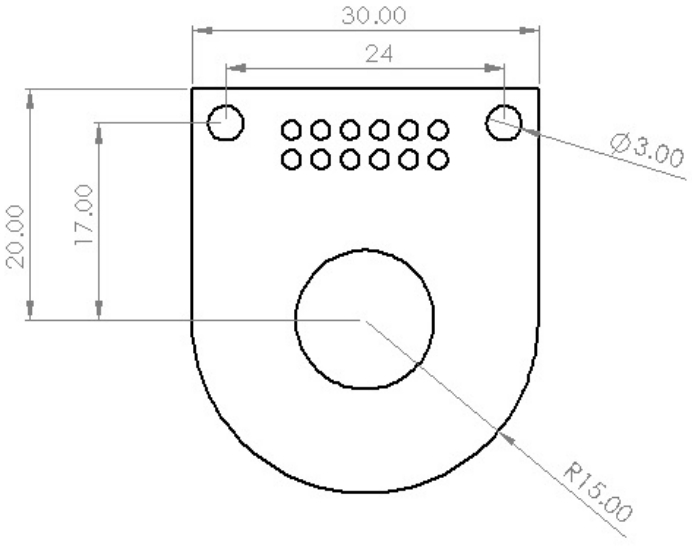
# 14 Dimensioned Drawings

The following diagrams will help you design your overall clock. They are best reviewed when you have the actual cell PCBs to hand – they will make more sense.

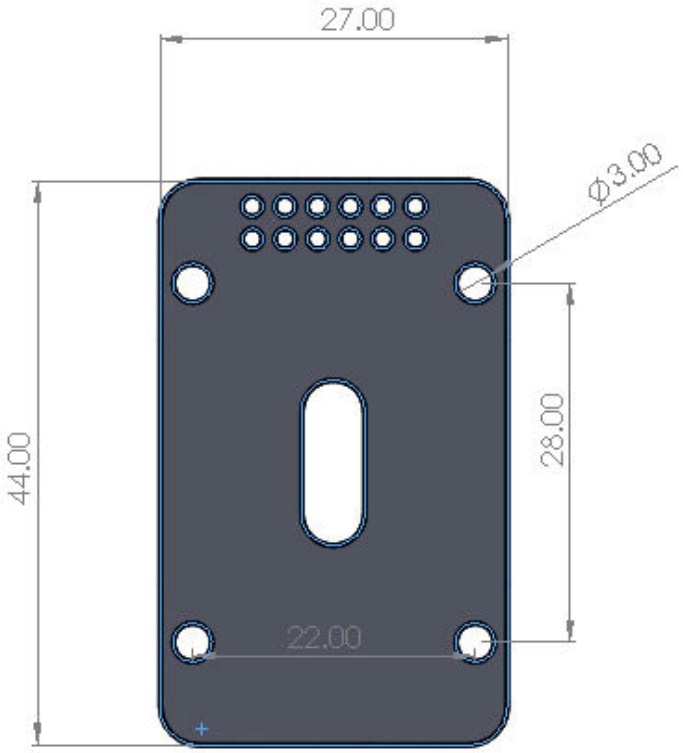
The main driver PCB measures 172mm X 55mm, with 3mm mounting holes 3mm from each edge / corner.



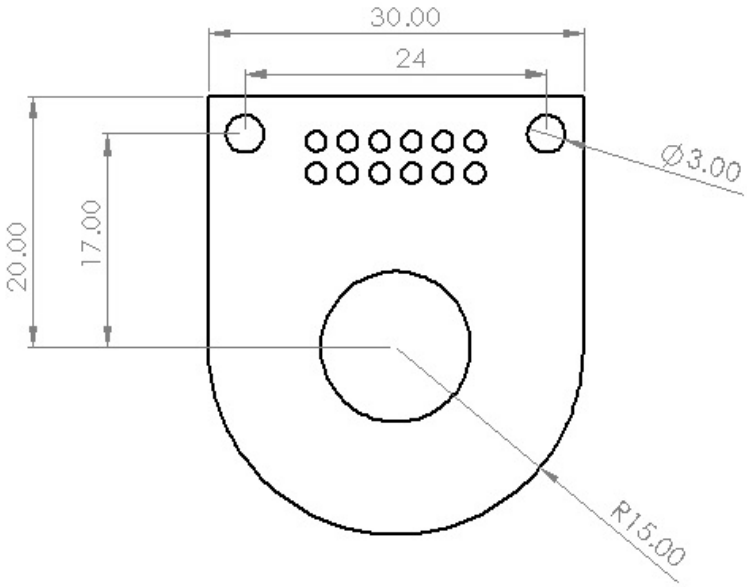

Dimensions and layout of R|568M Cell PCB




Dimensions and layout of Z5660M / ZM1040 Cell PCB

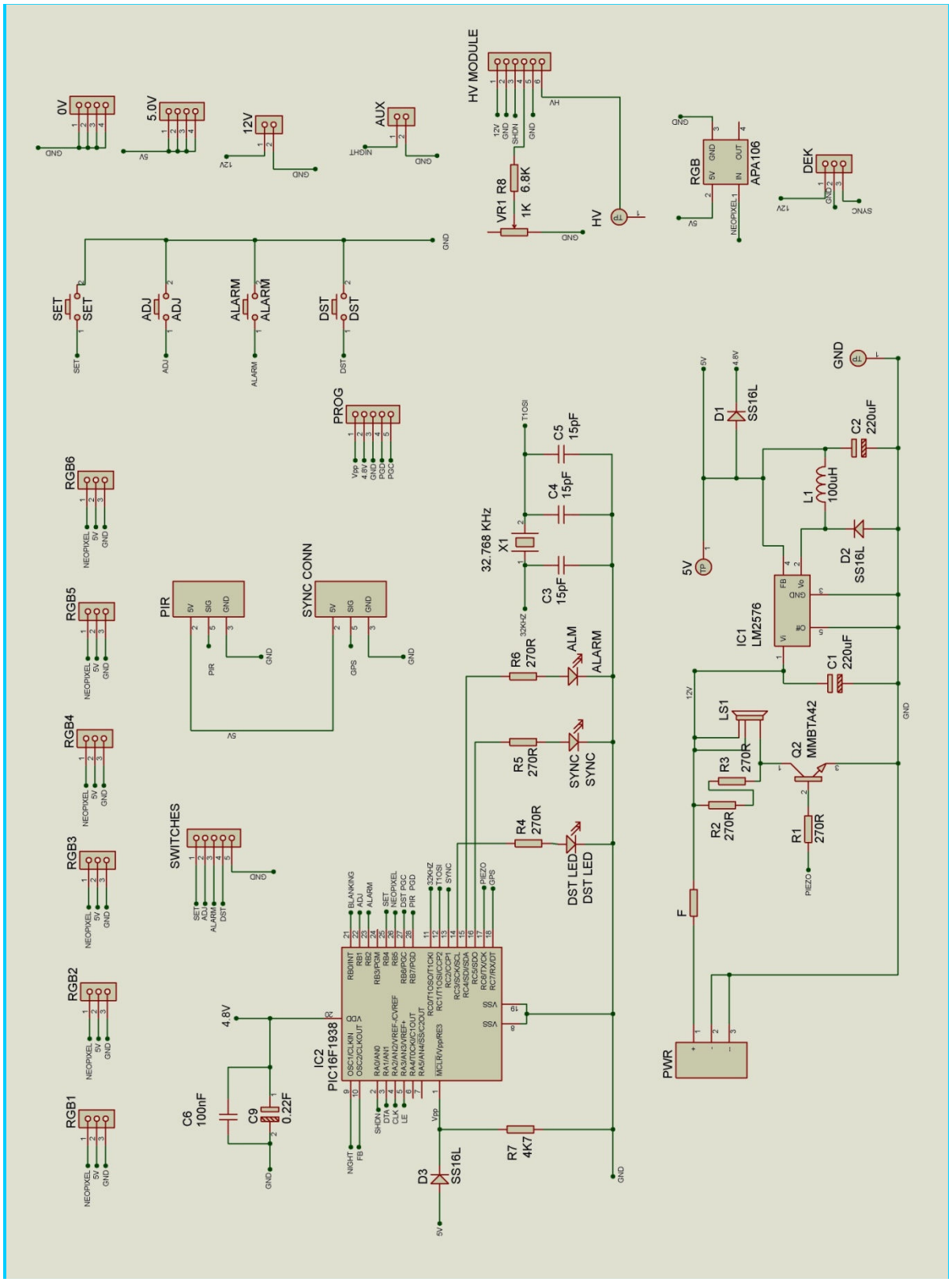


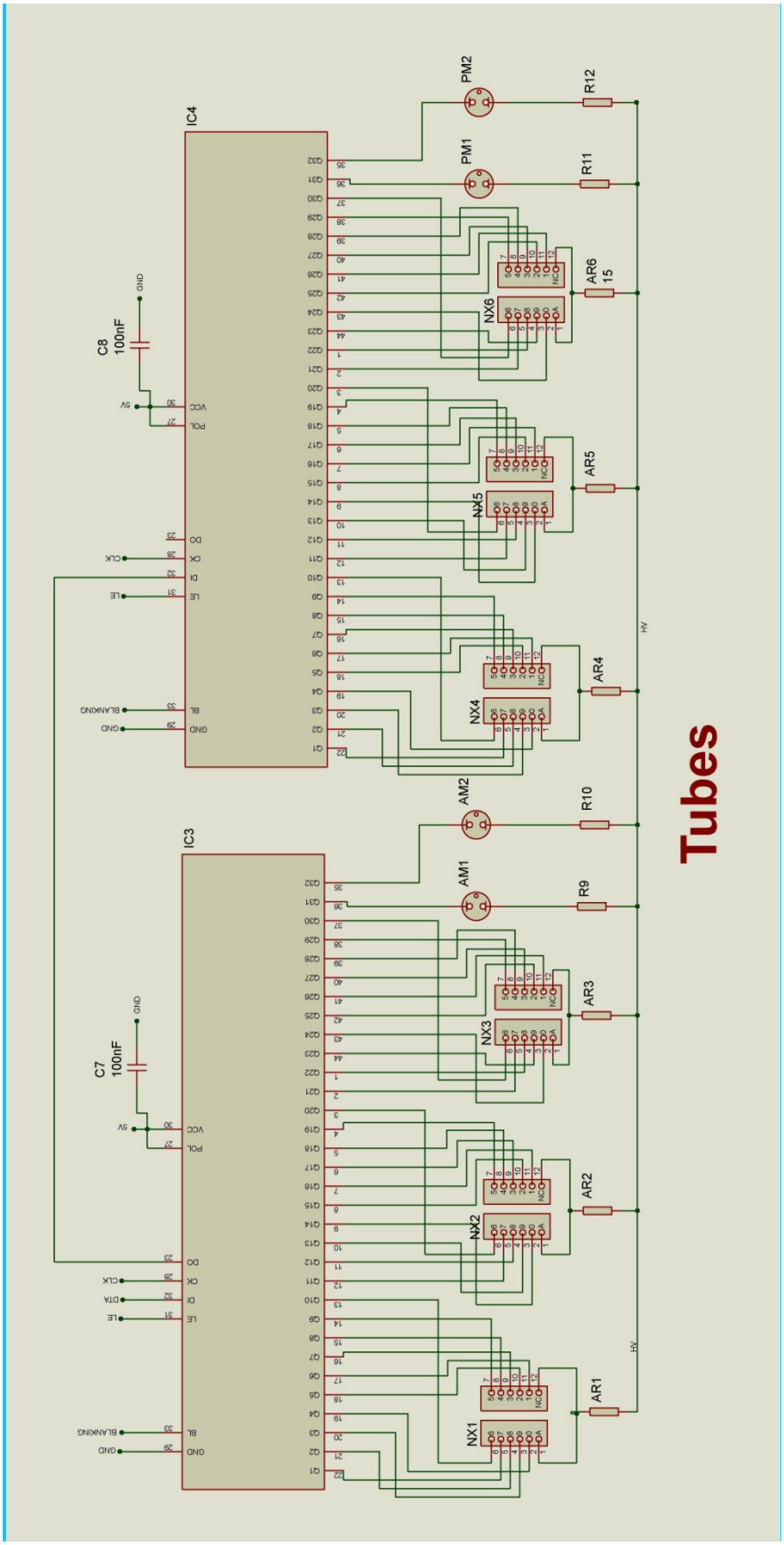

Dimensions and layout of IN-12 Cell PCB




Dimensions and layout of IN-18 Cell PCB

## 15. CIRCUIT DIAGRAM




Tubes
IC4
IC3
PM2
PM1
AM2
AM1
R12
R11
R10
R9
AR6
15
AR5
AR4
AR3
AR2
AR1
NX6
NX5
NX4
NX3
NX2
NX1
C8
100nF
C7
100nF
GND
5V
VCC
POL
DO
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BLANKING
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