Assembly Instructions
And
User Guide

SN-Class
Nixie Clock Kits
For parts bag serial numbers 500 onwards
Sold from June 2021

REVISION HISTORY

Issue Number	Date	Reason for Issue
2	27 May 2021	New anode resistor values
1	20 November 2017	New document

1. INTRODUCTION

1.1 About the SN-Class Nixie Clock Kits

How can the clock display the time with only a single digit?
The clock flashes up the time in the sequence HHMM, with appropriate pauses between each digit, and a longer pause between each time cycle ie. H.H...M.M.....H.H...M.M.... and so on. It is really very intuitive, and once you 'get it', it is really obvious and simple to read the time!

1.2 Features

The SN-Class Nixie Clock Kit has the following features:

· Hours and Minutes display
· 12 or 24 hour modes
· Uses 5V USB Power
· Uses a Quartz Crystal Oscillator as the timebase
· Optional GPS or WiFi 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
· Seconds can be reset to zero to precisely the set time
· Programmable night mode blanking to save tubes or prevent sleep disturbance
· RGB tube lighting – select your favourite colour from 21 options
· Not AC frequency dependent – works in all countries
· All user preferences stored to non-volatile memory

1.3 Compatible Tubes:

IN-18 (40mm / 1.6” digit height)
R|568M (50mm / 2” digit height)
Z568M (50mm / 2” digit height)

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 Other items you will need.

The clock kit does not include a USB Power Cable.

The following type of adapter should be obtained and used with the kit:

USB A to Mini B.

A suitable cable is shown below:

3. LIST OF COMPONENTS

3.1 Table of Electronic Components

Circuit Designation	Part Description
Resistors	
R1	4.7 KΩ, ¼ Watt
R2	390 KΩ, ¼ Watt
R3, R4	4.7 KΩ, ¼ Watt
R5	8.2 KΩ or 47KΩ ¼ Watt
R6 – R10	270 Ω, ¼ Watt
Capacitors	
C1	100nF Ceramic
C2	220uF, 16-25V, Electrolytic
C3 – C5	1uF, 250V,
C6	10pF Ceramic
C7	33pF Ceramic
C8	0.22F
C9	100nF Ceramic
Transistors	
Q1	FQU13N10L MOSFET
Diodes	
D1 – D3	UF4004
D4	1N5819
D5	5mm Yellow LED
D6	3mm Green LED
RGB	RGB 5mm LED, common cathode
Integrated Circuits	
IC1	PIC16F1936 8-bit microcontroller
IC2	K155ID1 Nixie Driver
Miscellaneous	
L1	100uH inductor
SET, ADJ, DST	Miniature vertical push button
IC1 Socket	28 Way narrow IC socket for IC1
IC2 Socket	16 Way narrow IC socket for IC2
J1	6X2 way 0.1" male header
J2	6X2 way 0.1" female header
PWR	Mini B USB Socket
GPS	Surface mount 3.5mm jack socket
FUSE	500mA fuse
X1	32.768KHz watch crystal

3.2 Parts list / Packing Sheet - Component Bag

Part Description	Quantity
Resistors	
270 Ω, ¼ Watt	5
4.7 KΩ, ¼ Watt	4
8.2 KΩ, ¼ Watt	1
390 KΩ, ¼ Watt	1
Capacitors	
10pF, Ceramic	1
33pF, Ceramic	1
100nF, Ceramic	2
1uF, 250V, Electrolytic	3
220uF, 16-25V, Electrolytic	1
0.22F	1
Transistors	
FQU13N10L MOSFET	1
Diodes	
1N5819	1
UF4004 fast recovery diode	3
3mm Green LED	1
5mm Yellow LED	1
5mm RGB LED common cathode	1
Integrated Circuits	
PIC16F1936 8-bit microcontroller	1
K155ID1 Nixie Driver	1
Miscellaneous	
100uH inductor	1
Miniature vertical push button	3
28 way narrow IC Socket for IC1	1
16 way narrow IC Socket for IC2	1
Mini B USB Socket	1
Surface mount 3.5mm jack socket	1
500mA fuse	1
2X6 way 0.1” male header	1
2X6 way 0.1” female header	1
32.768KHz watch crystal	1

Hardware	
M3 X 6mm screw	3
11mm Male / Female spacer	3
18mm Female spacer	3

Parts for R|568M Tube	
Harwin H3161 socket receptacle	11

Parts for IN-18 Tube	
1mm Gold socket	14
IN-18 Black cover plate (acrylic)	1

Parts for Z568M Tube	
Harwin H3161 socket receptacle	11
1mm Gold socket	11
Z566M Black cover plate (acrylic)	1

It is recommended that the kit is checked against the list above, to ensure all parts are present before commencing assembly. Don't be alarmed if there are some extra components, as some component bags are shared between different kit types.

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

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

4. ASSEMBLY OF THE TUBE PCB

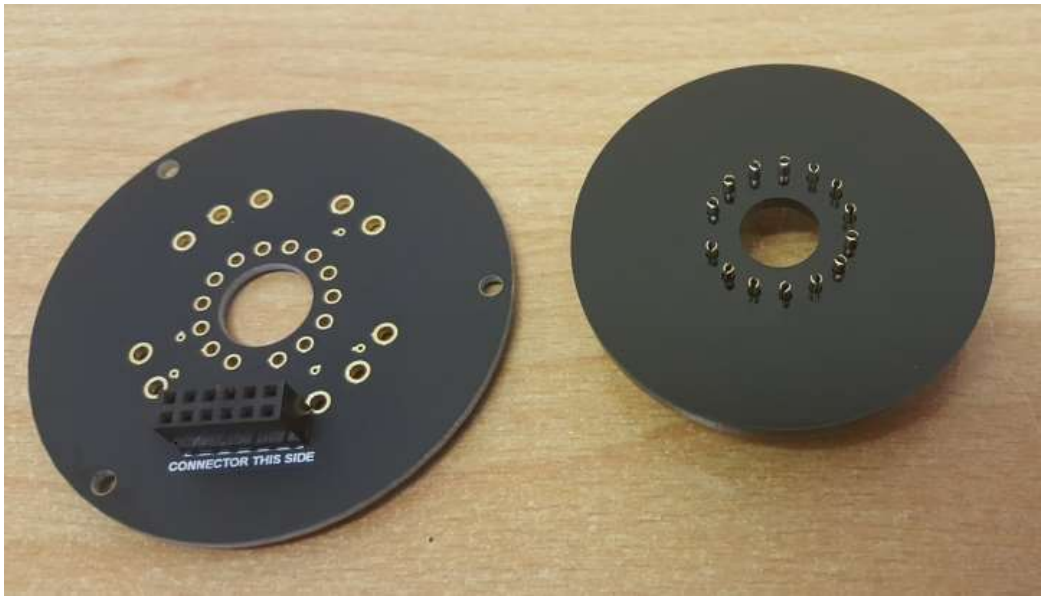
DUE TO PRODUCT DEVELOPMENT AND IMPROVEMENTS, YOUR PCB MAY NOT LOOK EXACTLY LIKE THE ONE PICTURED.

Proceed according to the tube type you will use with your kit.

4.1 IN-18 Nixie Tube

Start with the Socket holder and 14 gold sockets.

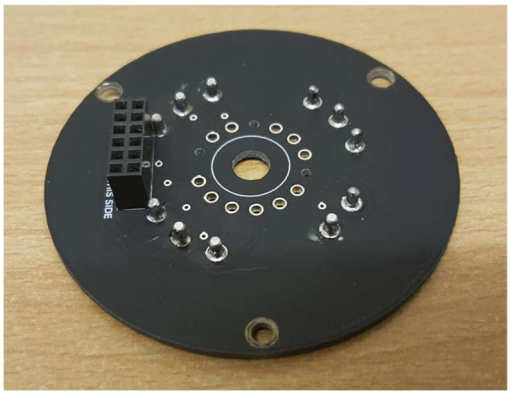
Remove the protective film from both sides, and insert all the sockets into the socket holder from the side engraved 'SKT'. Insert the socket with the open jaws first. You may need to push each socket in firmly, with a hard object. Also solder the 6X2 FEMALE connector to the tube PCB. This is what you end up with:



Now you can push the socket holder into the PCB firmly and fully, and solder in place:

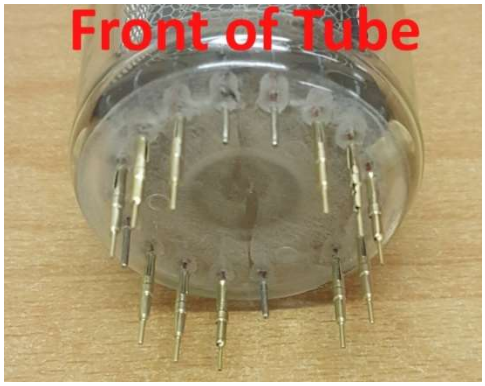
4.2 R|Z568M Nixie Tube

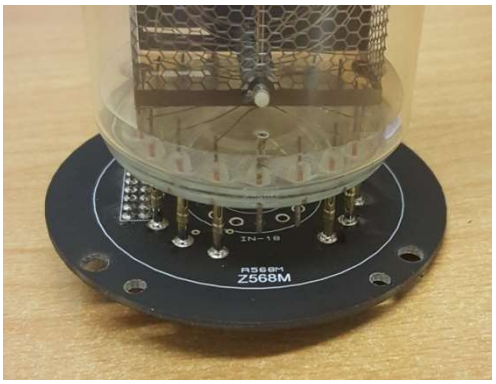
Start by soldering the 6X2 Female connector to the PCB, then insert and solder the 11 socket receptacles from the othe side. You can use masking tape to keep them in place as you solder them.



4.3 Z568M Nixie Tube

First, complete step 4.2 above. The push the 11 gold sockets onto your tube as shown**.**





Then insert the tube into the PCB, engaging the 11 gold sockets into the 11 sockets soldered to the PCB. Solder the gold sockets to the PCB sockets.

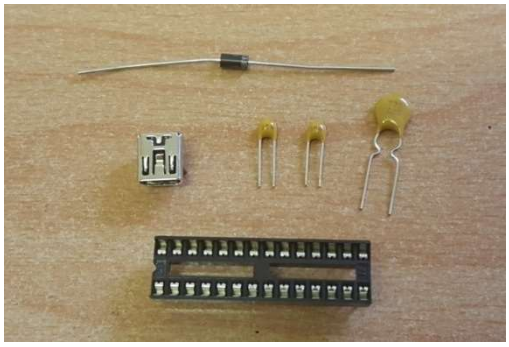
Withdraw the tube and place over the black cosmetic cover, after removing the white protective film. The holes on 1 side are wider than on the other. Insert with the sockets going into the wider side holes.

5. ASSEMBLY OF THE MAIN PCB

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

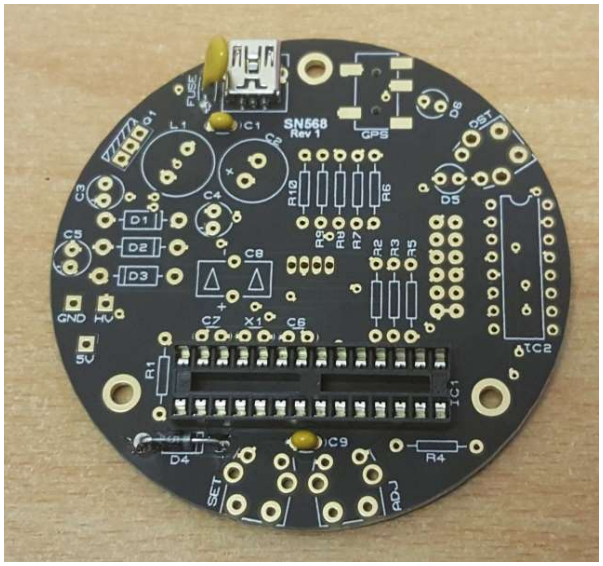
5.1 Low Voltage Power components:

PWR (USB Socket)
FUSE
D4 (1N5819)
Socket for IC1
C1, C9 (100nF)



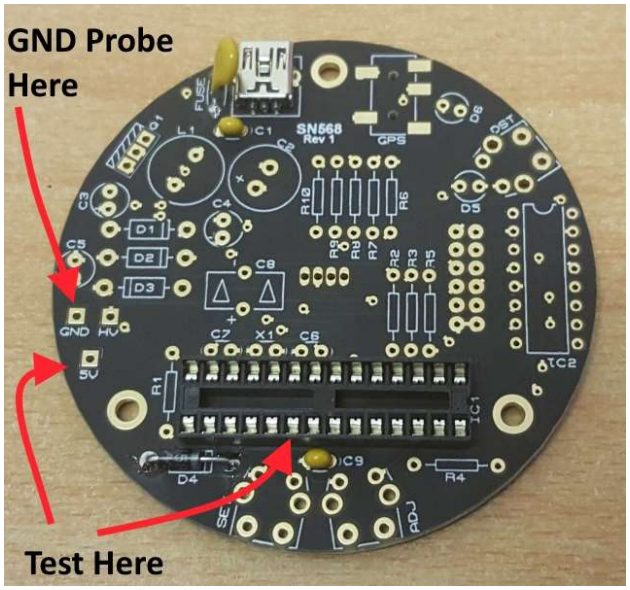
C1 and C9 will be marked '104'. Align the band on D4 with the band marked on the PCB. Orient the notch on the IC socket with the corresponding marking on the PCB.

IF YOU GET THE ORIENTATION OF THE IC SOCKET WRONG, DO NOT ATTEMPT TO REMOVE IT! JUST ENSURE THE ACTUAL IC IS INSERTED THE CORRECT WAY.



5.2 Testing Low Voltage Power Supply.

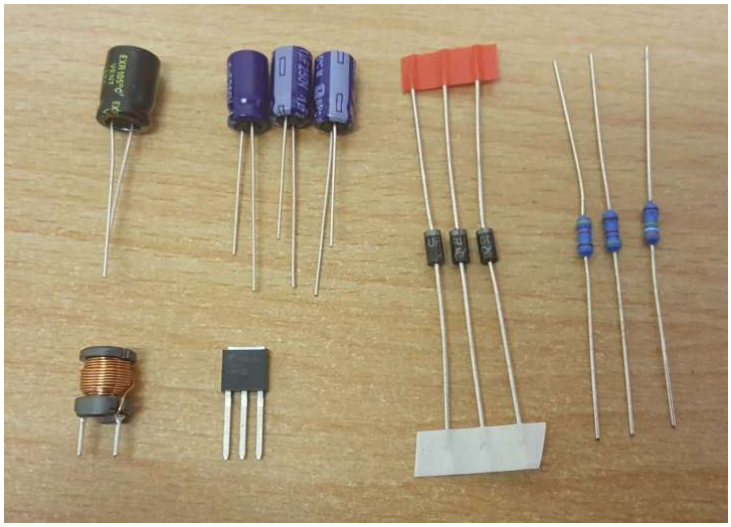
This is a good time to check we have 5V on the board, and also have 5V going into the power supply pin for IC1 (pin 20). Connect a suitable USB cable, and with a meter on 20 V DC range, test the points shown below for 5V, with the black probe on the GND test point at all times.



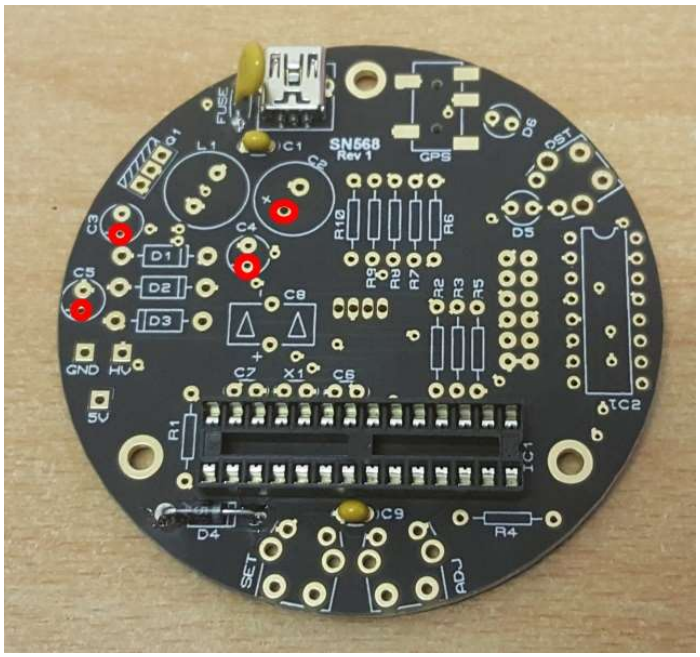
The voltages should measure between 4.9 and 5.2 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

5.3 High Voltage Generator Components.

R1, R3 (4.7 KΩ)
R2, (390 KΩ)
C2 (220uF)
C3 - C5 (1uF)
Q1 (FQU13N10L)
L1 (100uH Inductor)
D1 – D3 (UF4004)

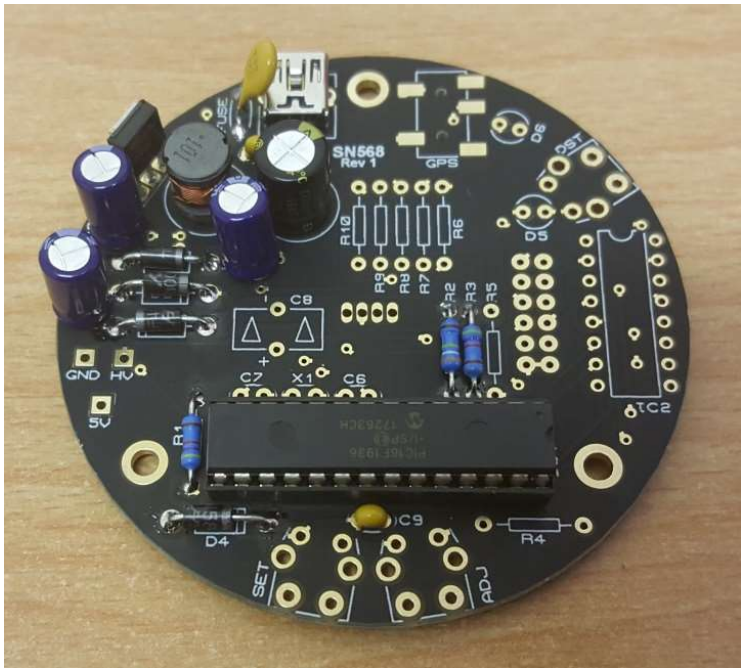


Orient the diodes with the white band matching the corresponding band on the PCB. Also the capacitors are polarised. The longer, positive lead for each goes in the hole marked below.



Do not solder Q1 fully flush with the PCB. It is best for it to be 5mm or so from the PCB, so you are not soldering so close to the body of the part, so less heat will reach the part.

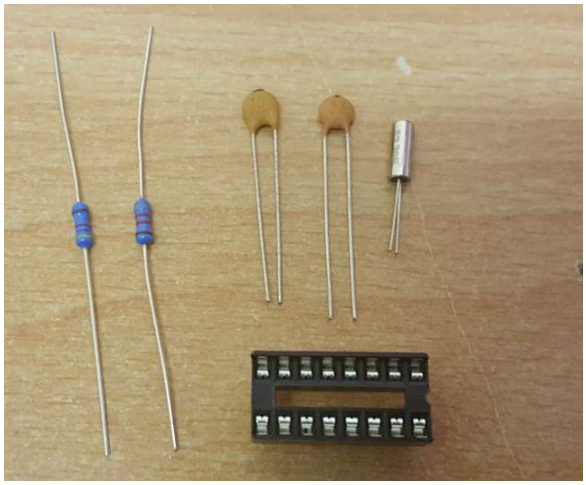
Insert IC1 into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.



5.4 High Voltage Generator Test.

- Refer to the warnings on page 5.
- 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 165 and 175 Volts. If this is in order, disconnect the power supply.

5.5 R4 (4.7 KΩ)
R5 (8.2 KΩ)
C6 (10pF)
C7(33pF)
X1 (32.768KHz Crystal)
Socket for IC2

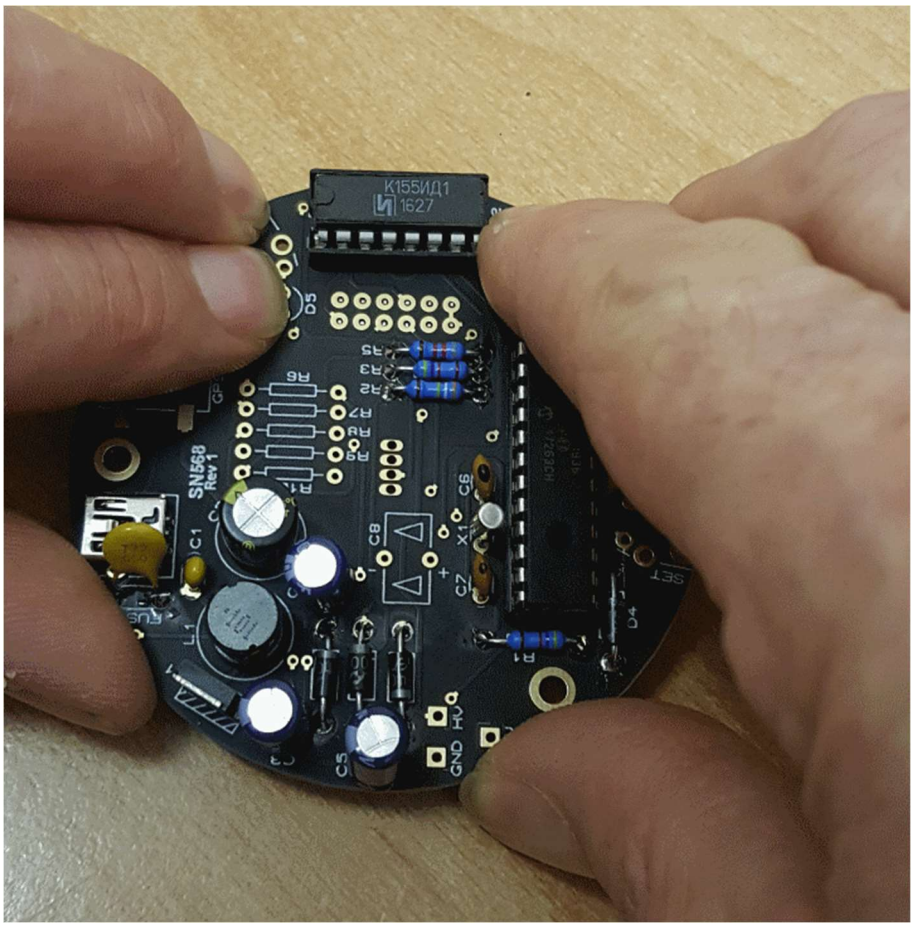


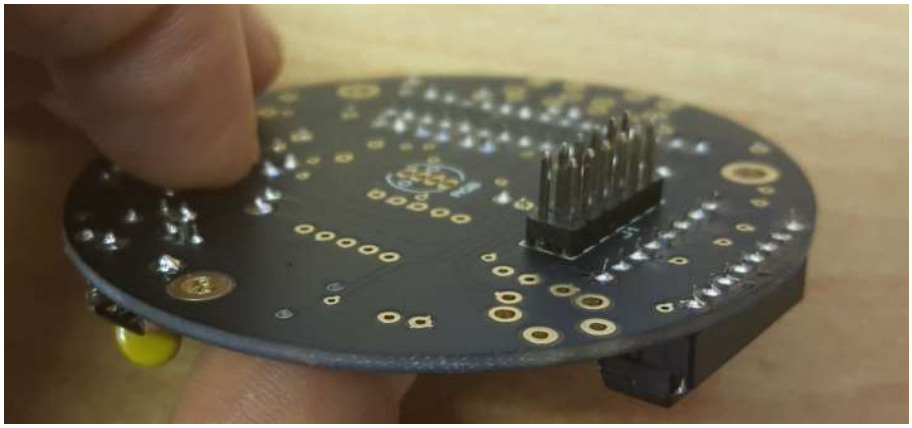
Orient the notch on the IC socket with the corresponding marking on the PCB.

IF YOU GET THE ORIENTATION OF THE IC SOCKET WRONG, DO NOT ATTEMPT TO REMOVE IT! JUST ENSURE THE ACTUAL IC IS INSERTED THE CORRECT WAY.

5.6 6X2 Way male header

This is soldered to the opposite side of the PCB. It may be a firm push fit. First, push in by hand to engage it, then flip the PCB and push hard as shown against a hard flat surface, to push the connector fully and evenly into positon, and then solder:



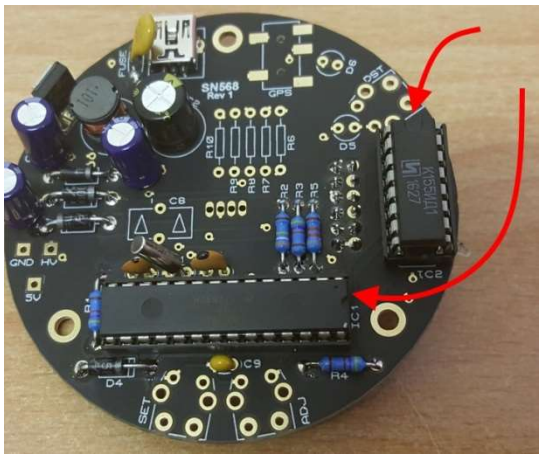


6. FIRST CLOCK TEST

It is now time to check the basic clock functions.

6.1 Insert IC1 and IC2

If you removed IC1 and IC2, Insert into their sockets, with the notches aligned as shown below:



6.2 First Tube Test

Insert the a tube into the tube PCB, and connect the tube PCB to the main PCB by engaging the 6X2 connectors.

Connect a USB power supply cable and power up.

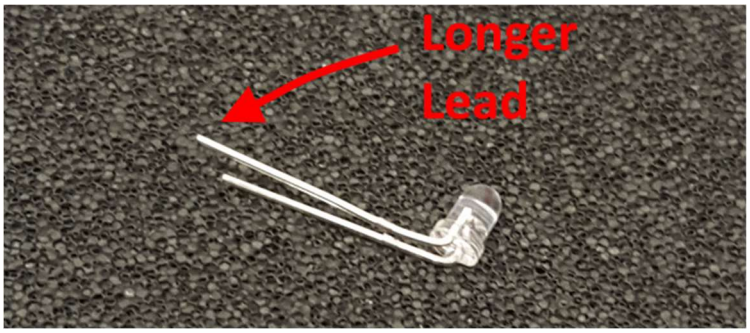
The clock should displaying the time, starting at 12.XX. The minutes shown on the clock on a cold startup is the firmware version. If this does not happen, power off and check all tubes are connected correctly.

If all is well, power off and separate the two PCBs.

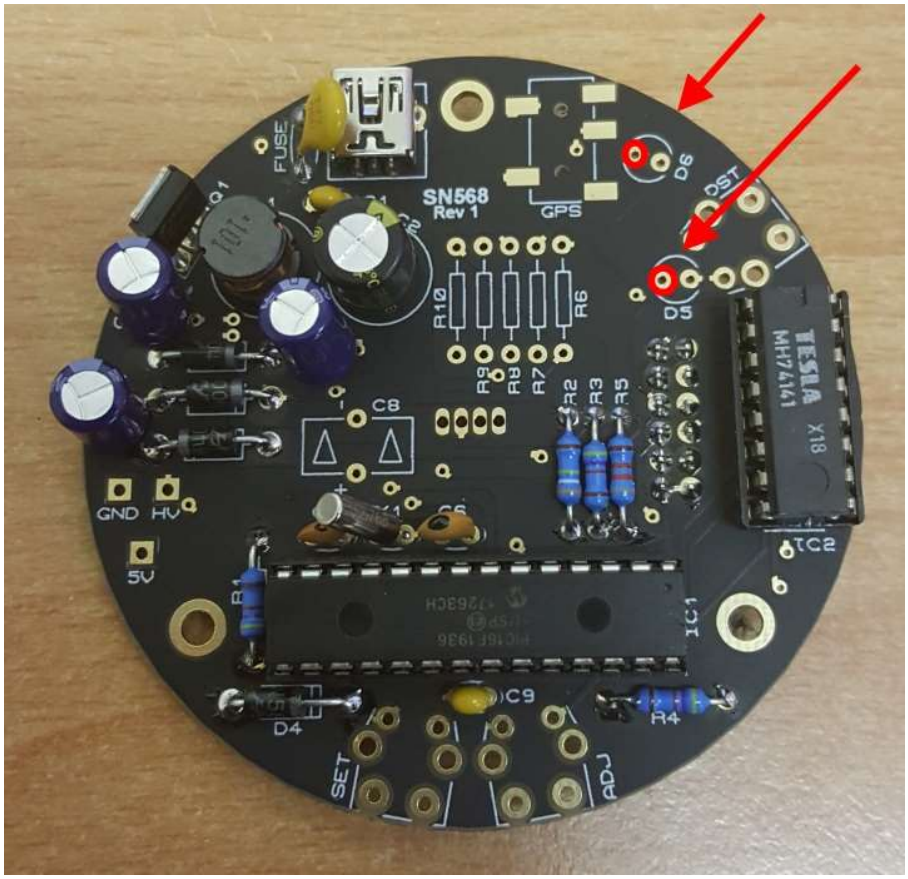
7. COMPLETION OF THE MAIN PCB

7.1 R6 – R10 (270 Ω)
D5 (5mm Yellow LED)
D6 (3mm Green LED)
C8 (0.22F Capacitor)

First bend D6 as shown below.



D5 and D6 are polarised. The longer lead is the positive (anode) and goes in the holes marked below.



Note that D6 points sideways, as it will shine through the corresponding hole in the case. If you are making your own case, you can solder both LEDs differently.
C8 must be soldered with the arrows on the part matching the direction of the arrows on the PCB.

7.2 SET, ADJ, DST (Vertical push buttons) GPS (3.5mm Jack socket)

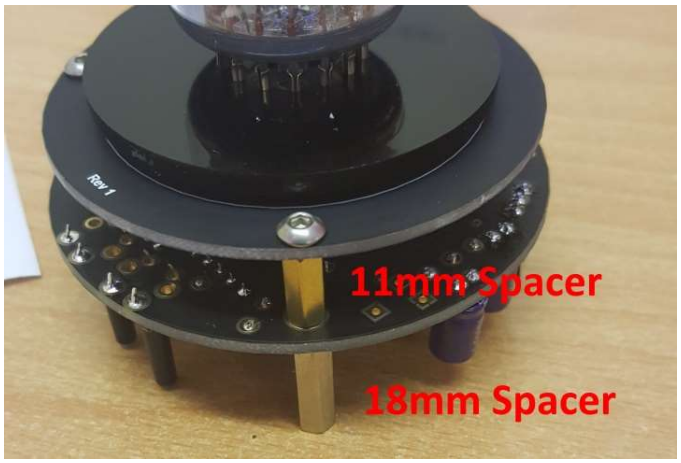
To solder the GPS connector: First wet one pad on the PCB with solder. Then place the connector in position and re-touch the pad with the soldering iron. This will anchor the component and then you can solder the remaining pads.

7.3 RGB (5mm RGB LED, common cathode)

This can be soldered later, when the tube is in place. You can push the LED as far up as it will go with the tube in place. The small circle on the PCB denotes the longest lead of the LED.

7.4 Hardware and Screws

The two PCBs can be assembled using the supplied hardware, as shown below.



8. HOW TO OPERATE THE CLOCK

The three buttons have the following functions:
SET: Exit Config Menu if held on power-up;
Set time;
ADJ: Adjust time, config parameters; Enter colours menu.
DST: Toggle between DST and Standard Time (+/- 1 Hour)

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 whilst the clock is power off and then connect power.

In configuration mode the clock will initially display the number '1' to indicate that parameter 1 is being viewed / edited. Pressing SET will scroll through each parameter 1 to 11 in turn.
Press ADJ will enter that parameter and first show the current parameter, and pressing ADJ further will adjust the parameter. When completed each parameter, press SET again to move to the next parameter. After parameter 11, you will exit to time display.

Refer to the table on the next page. It may help to make a pencil note of your intended setting before starting.

The time offsets are applicable if you are using a WiFi or GPS time receiver, as you need to use the settings to tell the clock your time zone.

Most time zones are whole hours only from GMT, so parameter 7 will rarely need to be changed from the default 0.

Parameter	Description	Values
1	12 / 24 Hr mode	0 – 12 Hr (default) 1 – 24 Hr
2	Night Mode start hour	0 - 23
3	Night Mode end hour	0 - 23
4	Time display mode	0 – Standard display 1 – Crossfade display (default)
5	RGB Display Mode	0 – RGB Disabled 1 – Always on (default) 2 – On, and follows night blanking
6	Radio time offset hours	0-13 (default 0)
7	Radio time offset mins	0-45 (default 0)
8	Radio time offset polarity	0 - Minus time (default) 1 – Plus time
9	Time Calibration Factor	0 - 99 (each unit adjusts by 0.2s per day)
10	Time Calibration Polarity	0 - Make clock slower 1 - Make clock faster
11	Night Mode Override minutes	0 – 50 (default 0 gives 15 seconds override)

Setting the Time:
Before setting the time, press 'DST' briefly to toggle between DST and standard time as indicated by the yellow LED. Set according to whether you are currently in DST time or not.

From time display mode, press and hold 'SET' button for 2 seconds then release. The seconds will be displayed.
Press the 'ADJ' button to reset seconds to zero.

Briefly Press 'SET' again and the hours will be displayed.
Press the 'ADJ' button to set the hours. The hours are always set in 24 hour (military time) format, to ensure correct AM or PM time is set.

Briefly Press 'SET' again and the minutes will be displayed.
Press the 'ADJ' button to set the minutes.

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

Night Blanking Override:
During programmed night blanking, the blanking may be overridden to see the time by briefly pressing the 'SET' button. Tubes will remain lit for the period defined in parameter 11.

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

Note, that GPS or WiFi time data does not contain DST information, so the DST status will need to be set manually in GPS/ WiFi 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 9 and 10. 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 10.
Set parameter 9 to 0 to slow down the clock and to 1 to speed up the clock.
This adjustment is not relevant if you are using GPS or WiFi time synchronisation.

9. CONFIGURING THE RGB BASE LIGHTING

9.1 Entering RGB LED menu

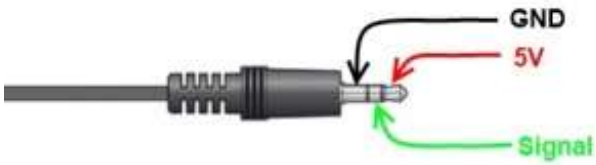
From time display, press and hold the ‘ADJ button for 2 seconds then release. The clock will then display the current setting (0 to 20) and show this colour on the RGB LED. Note that value 0 is for autocycling.

Press ADJ to scroll through all the colours until you find your chosen colour. Exit the menu and save your setting by simply leaving it for 30 seconds to auto exit.

10. CONNECTING A GPS OR WIFI TIME SYNC DEVICE

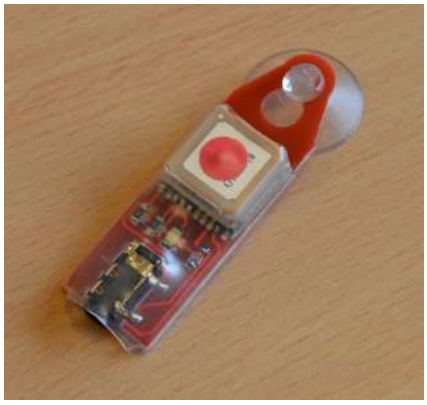
10.1 Principle of operation

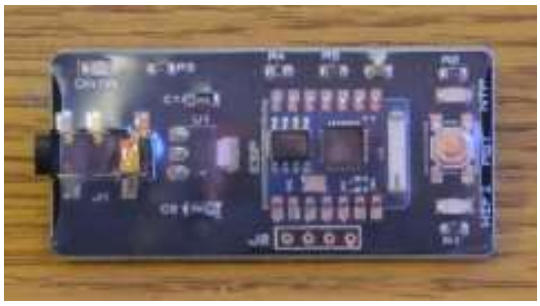
The clock has a dedicated jack socket, connections as per the diagram below. It will respond to a standard GPS $GPRMC sentence, and set the time accordingly, allowing for time zone offsets as per the configuration settings.



The signal requirements are as follows:
9,600 bps
Valid $GPRMC sentence with correct checksum
Signal level: TTL UART

Our GPS and WiFi time sync devices can be used to synchronise the clock. Please consult the relevant pages on our website.





10.2 Function of the GPS indicator LED (D6):

The LED will be ON if the clock has synchronised in the last two hours; slowly flashing if the last synchronisation was between 1 hour and 24 hours ago; and off if the last synchronisation is older than 24 hours.

11. CIRCUIT DIAGRAM