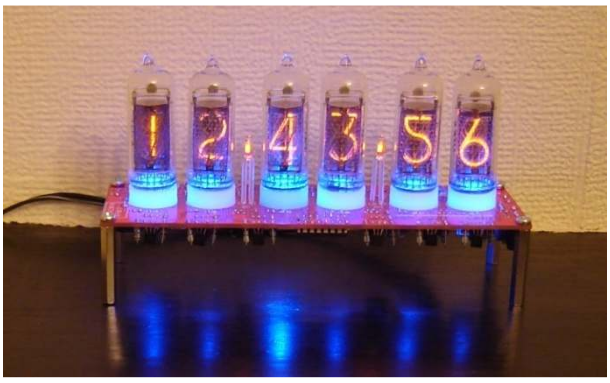
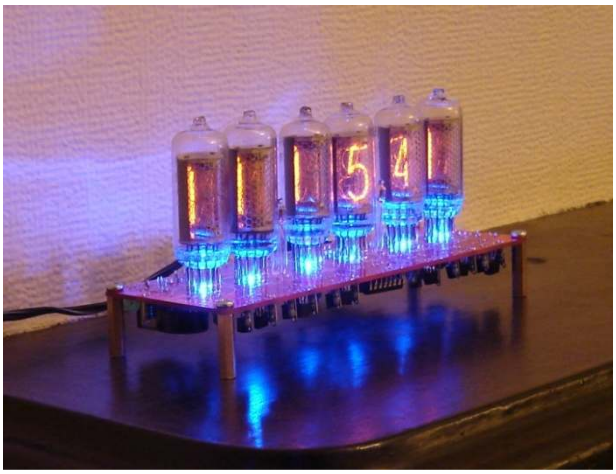
Assembly Instructions
And
User Guide

Nixie Clock Type
'Frank 2'
2011 Edition





REVISION HISTORY

Issue Number	Date	Reason for Issue
8	24 Jan 12	Shared board for Z570M and IN-8-2
6a	01 Jan 12	HV Voltage set to 165V
6	27 Dec 2011	Code security details added / New fuse
5	14 June 2011	Added Z570M / ZM1080 Tube PCB details
4	05 June 2011	Revised HV test procedure, misc amends
3	18 April 2011	Added IN-8 Tube PCB details
2	05 April 2011	Added info on drilling IN-14 tube spacers
1	24 March 2011	New document

1. INTRODUCTION

1.1 About the clock

Nixie clock type 'Frank 2' is a compact design with all components and tubes mounted on a single PCB. The efficient use of board space is achieved by using a multiplex design to drive the display tubes. Only a single high-voltage binary-to-decimal decoder IC (74141) is required, and each tube is switched on in sequence very quickly to give the illusion that all the tubes are actually lit.
The Clock is designed for tube types: IN-14, IN-8-2, IN-8, Z570M, Z573M, ZM1080, ZM1082.

The optional wooden case and hardware pack (base cover, screws), supplied rough-machined, can be finished to give a very attractive clock for everyday living spaces. The quality of the final finish will reflect the time and care that is taken to finish the wood with successively finer grades of sandpaper. Alternatively, you may wish to design your own enclosure for the clock.

1.2 Clock Features

Nixie clock type 'Frank 2' has the following features:
- Hours, Minutes and Seconds display
- 12 or 24 hour modes
- Date display in either DD.MM.YY or MM.DD.YY format
- Alarm, with programmable snooze period
- Programmable date display each minute
- Attractive LED tube lighting
- Uses a Quartz Crystal Oscillator as the timebase
- Optional DCF / WWVB / MSF / GPS synchronisation with status indicator LED
- Supercapacitor backup. Keeps time during short power outages
- Simple time setting using two buttons
- Programmable leading zero blanking
- Five programmable neon colon settings (Flashing AM/PM indication, illuminated AM/PM indication, both flashing, both on, both off)
- Maintains time during setup mode, eg. When changing between Standard Time and Daylight Savings Time
- Seconds can be reset to zero to precisely the set time
- Programmable night mode - blanked or dimmed display to save tubes or prevent sleep disturbance
- Separate modes for colon neons during night mode
- Standard or fading change of digits
- 'Slot Machine' Cathode poisoning prevention routine
- All user preferences stored to non-volatile memory

1.3 SAFETY

DANGER: The clock pcb includes a switched-mode voltage booster circuit. This generates nominally 165 Volts DC, but is capable of generating up to 300 Volts before adjustment. Assembly may only be undertaken by individuals who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. If in doubt, refer to a suitably qualified engineer before proceeding.

The voltages generated by this circuit can give a potentially LETHAL ELECTRIC SHOCK.

DISCLAIMER: This product is supplied as a kit of parts, intended only for suitably qualified electronic engineers, who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. The supplier, his agents or associates accept no liability for any damage, injury or death arising from the use of this kit of parts.

This is not a finished product, and the person assembling the kit is responsible for ensuring that the finished product complies with any applicable local regulations governing electrical equipment, eg. UL, CE, VDE.

2. TOOLS AND EQUIPMENT REQUIRED

2.1 Tools required to assemble the PCB.

The following tools will be required to assemble the PCB:

- Soldering iron with a small tip (1-2 mm)
- Wire cutters (TIP: A small pair of nail clippers works very well for this function)
- Wire strippers (TIP: A small pair of scissors is quite suitable)
- Multimeter for voltage tests and for identifying the resistors.
- Small flat screwdriver for adjusting the high voltage supply

2.2 Materials you will need.

Solder – lead / tin solder is preferred. Lead free solder, as now required to be used in commercial products in Europe, has a much higher melting point and can be very hard to work with.
Desoldering wick (braid) can be useful if you accidentally create solder bridges between adjacent solder joints.

2.3 Other items you will need.

The clock kit does not include a power adapter. This is because the kit is sold to many countries around the world, each with very different household mains outlet socket types. It is more efficient for the user to buy a suitable adapter locally. This saves shipping a heavy adapter with the kit, and also the extra costs of managing stocks of many varied power adapters. If you are using a WWVB, DCF or MSF receiver avoid cheap Chinese switching power supplies, as they can cause interference problems.
The type of power adapter can be obtained at very low cost. The following type of adapter should be obtained and used with the kit:

Output 12V DC
Minimum power output capability of 250 mA
Output plug: 2.1mm pin, centre positive.

A suitable adapter is shown below:

3. LIST OF COMPONENTS

3.1 Table of components

Circuit Designation	Part Description
Resistors	
R1	390K, ¼ Watt
R2	4K3, ¼ Watt
R3	100R, ¼ Watt
R4	4K3, ¼ Watt
R5 – R7	560R, ¼ Watt
R8 - R10	10K, ¼ Watt
R11	560R, ¼ Watt
R12, R13	10K, ¼ Watt
R14 - R19	2K7, ¼ Watt
R20 – R25	390K, ¼ Watt
R26 – R33	10K, ¼ Watt
R34, R35	390K, ¼ Watt
R36 – R41	560R, ¼ Watt
R42	Not Installed
Capacitors	
C1	470uF, 16-25V, Electrolytic
C2	100uF, 16-25V, Electrolytic
C3	1uF, 250V, Electrolytic
C4	33pF Ceramic
C5	33pF Ceramic
C6	0.1F
C7	100nF Ceramic
Transistors	
Q1	IRF730 or IRF630 MOSFET
Q2, Q3	MPSA42 NPN
Q4 – Q9	MPSA92 PNP
Q10 – Q18	MPSA42 NPN
Diodes	
D1 – D3	1N5817 or 1N5819
D4	UF4004
D5	Not installed
D6 – D8	1N4148
D9	5mm Green LED
D10	5mm Orange LED
D11 – D16	3mm Blue LED
Integrated Circuits	
IC1	7805 5V voltage regulator
IC2	PIC16F1936 8-bit microcontroller
IC3	74141 / K155N Nixie driver
IC4	Not installed
Miscellaneous	
L1	100uH – 470uH inductor
NE1, NE2	4mm wire ended neon lamp
SW1, SW2, SW3	Miniature push button
VR1	1K Potentiometer
IC Socket	28 Way IC socket for IC2

J1	2.1mm PCB power socket
GPS / RFT	6 way mini DIN PCB socket
LS1	Piezo sounder
FUSE	500mA fuse
Insulation	Clear insulation for neons
X1	32.768KHz watch crystal

3.2 Parts list / Packing sheet

Part Description	Quantity
Resistors	
100R, ¼ Watt	1
560R, ¼ Watt	10
2K7, ¼ Watt	6
4K3, ¼ Watt	2
10K, ¼ Watt	13
390K, ¼ Watt	9
Capacitors	
470uF, 16-25V, Electrolytic	1
100uF, 16-25V, Electrolytic	1
1uF, 250V, Electrolytic	1
100nF, Ceramic	1
33pF, Ceramic	2
0.1F	1
Transistors	
IRF730 or IRF630 MOSFET	1
MPSA92 PNP	6
MPSA42 NPN	11
Diodes	
1N581x	3
UF4004 fast recovery diode	1
1N4148	3
5mm Green LED	1
5mm Orange LED	1
3mm Blue LED	6
Integrated Circuits	
7805 5V voltage regulator	1
PIC16Fxxxx 8-bit microcontroller	1
74141 / K155N Nixie driver	1
Miscellaneous	
100uH – 470uH inductor	1
4mm wire ended neon lamp	2
Miniature push button	3
1K potentiometer	1
28 way IC Socket for IC2	1
2.1mm PCB power socket	1
6 way mini DIN PCB socket	1
Piezo sounder	1
500mA fuse	1
6 cm clear insulation	1
32.768KHz watch crystal	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.

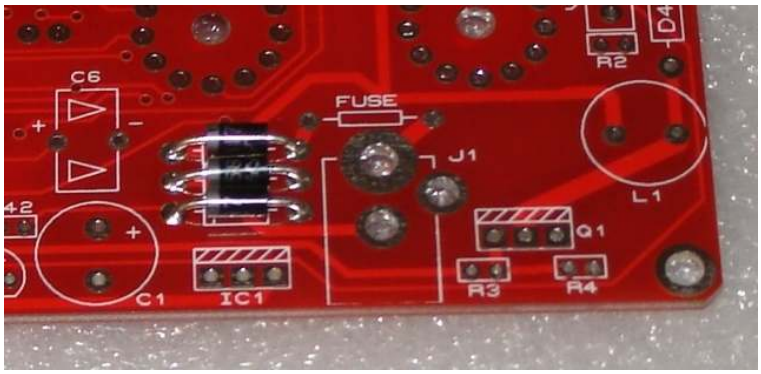
The fuse component may be one of two types, so may not look like the fuse in the pictures later in this guide. From August 2011, the fuse will look like the picture below:

4. ASSEMBLY OF THE PCB

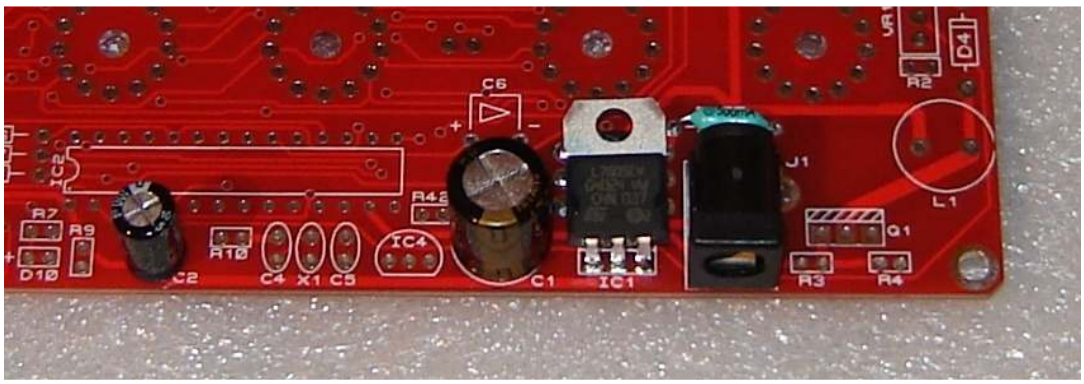
NOTE THAT THESE INSTRUCTIONS ARE SHARED BETWEEN SEVERAL VERY SIMILAR CLOCK TYPES. YOUR PCB MAY NOT LOOK EXACTLY LIKE THE ONE PICTURED.

4.1 Low Voltage Power components: J1, FUSE, D1-D3, IC1, C1, C2

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

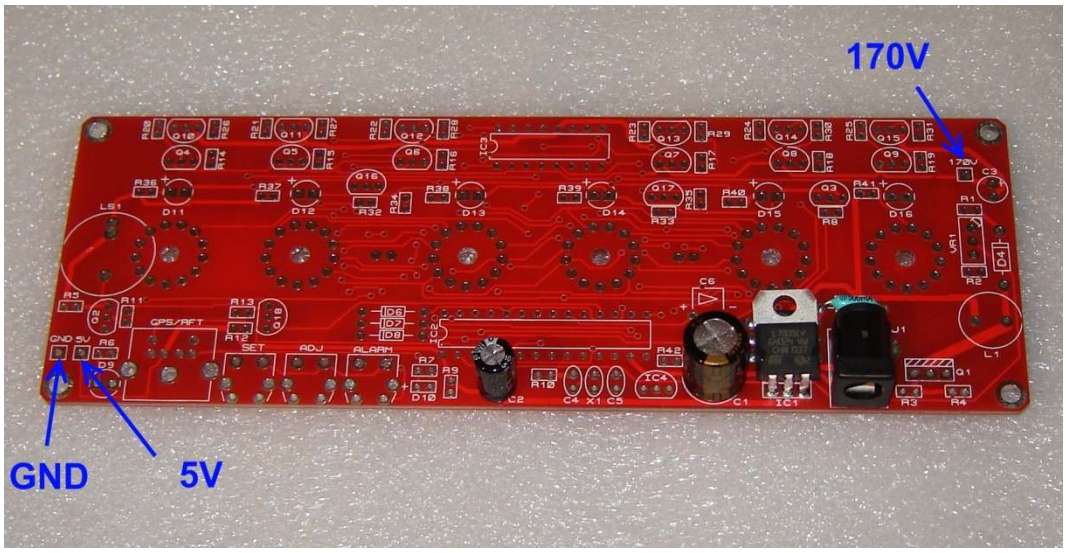


After placement, IC1 can be placed and bent over these diodes to reduce the height of the assembled PCB. Continue to mount C1, C2, J1 and FUSE Note that C1 and C2 are polarised. The longer lead goes in the hole marked (+).
The PCB should now look like the picture below:



4.2 Testing Stage 1 Power Components.

Identify the test GND, 5V and 170V test points as shown below.



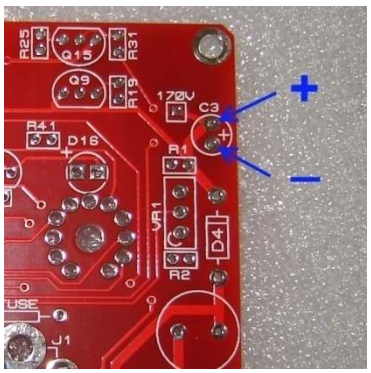
Plug in the power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 5.1 and 5.3 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

4.3 High Voltage Generator components.

R1, R2, R3, R4, R9, R10,
Q1, D4, C3, VR1, L1, Socket for IC2

IMPORTANT:

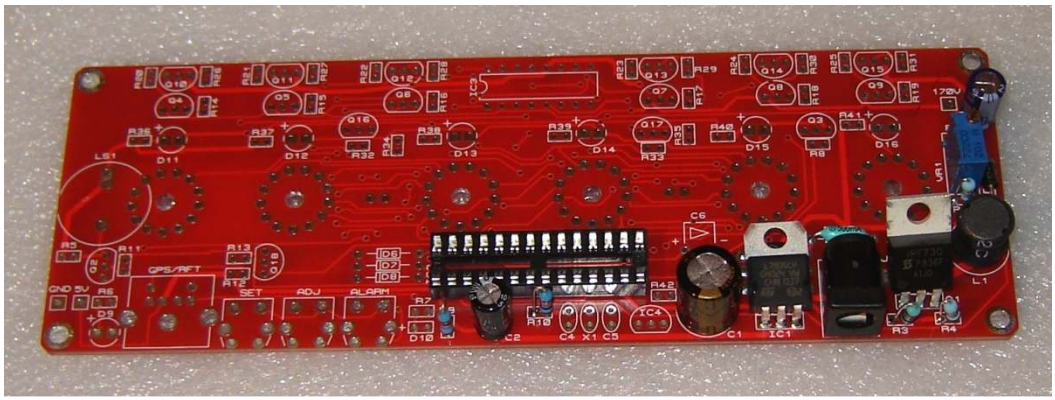
If you have the IN-8 kit, PCB version 29 March 2011, there is a small board error: It is not clear the correct orientation of C3. Refer to the picture below for clarification:



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

Resistors R1-R4, R9 and R10, indeed all the resistors on the board need to be mounted upright to save space. The leads need to be formed as shown below. Bend the leads of each resistor as shown and solder in to the correct postion, making sure the component body is as close to the board as possible.

After installation of step 4.3 components, this is how the PCB should look:

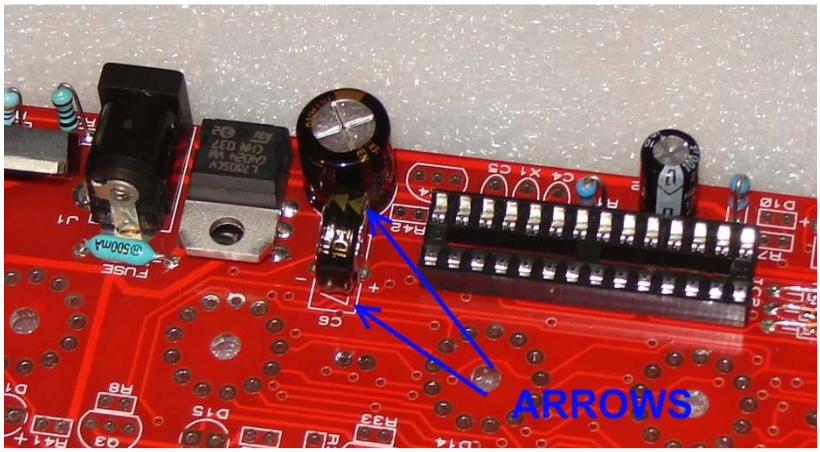


4.4 High Voltage Generator Test.

- Refer to the warnings on page 4
- Insert IC2 into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.
- Power up the PCB, and using the GND and 170V test points, measure the high voltage generated. It should be initially between 150 and 190V. Using the VR1 brass screw, slowly adjust the screw until the voltage is 165V. Disconnect the power supply.
- Finally, remove IC2 from its socket and replace on its static-protective foam. It is best kept safe until needed for the tube tests later in the assembly.

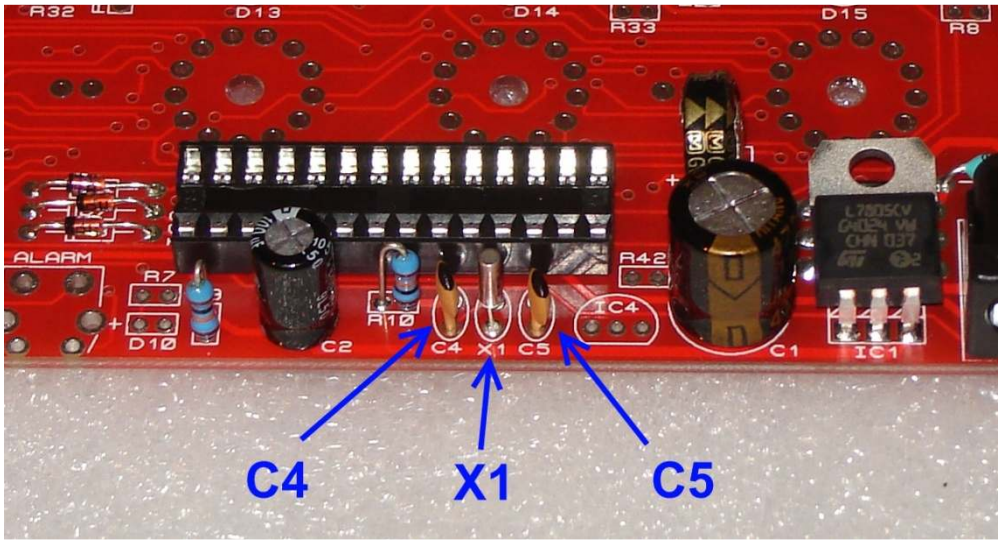
4.5 D6 - D8, C6.

C6 is a high capacity 'Super Capacitor', intended to keep the processor powered for short periods in the event of a main power failure. It is vital that it is placed in the correct orientation. See below. There are arrows on the component that need to be pointing the same way as the arrows on the PCB.



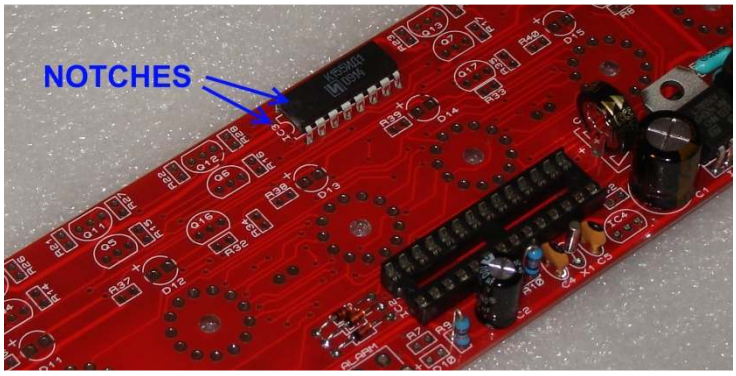
4.6 C4, C5, X1.

These are the timekeeping components: 32.768KHz crystal and two load capacitors. See below:



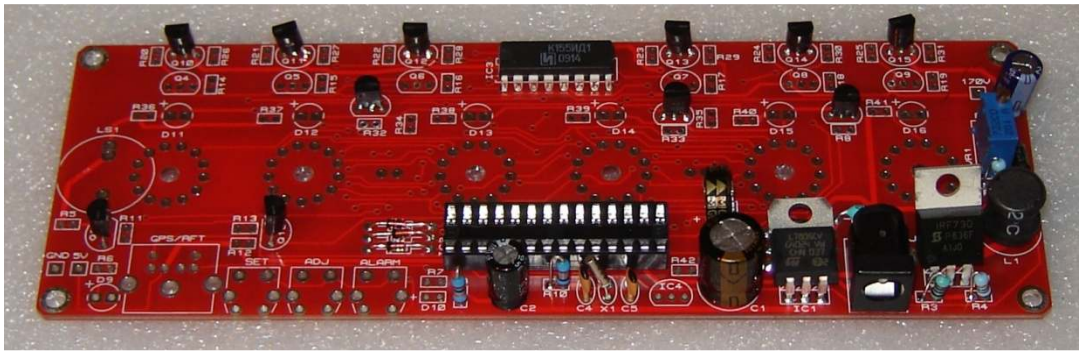
4.7 IC3 – 74141 / K155N Nixie Driver IC.

Align the notch on the IC body with the corresponding PCB mark. See below:



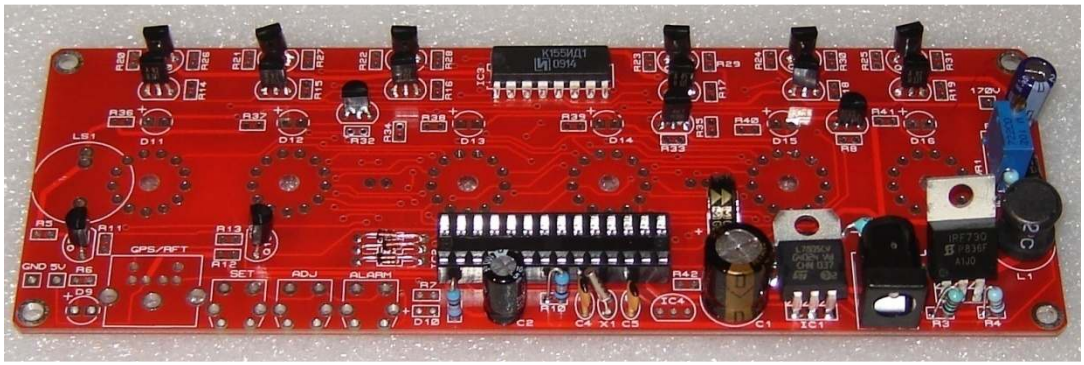
4.8 Q2, Q3, Q10 – Q18 (All MPSA42)

After placement of these 11 transistors, the board should look like this:

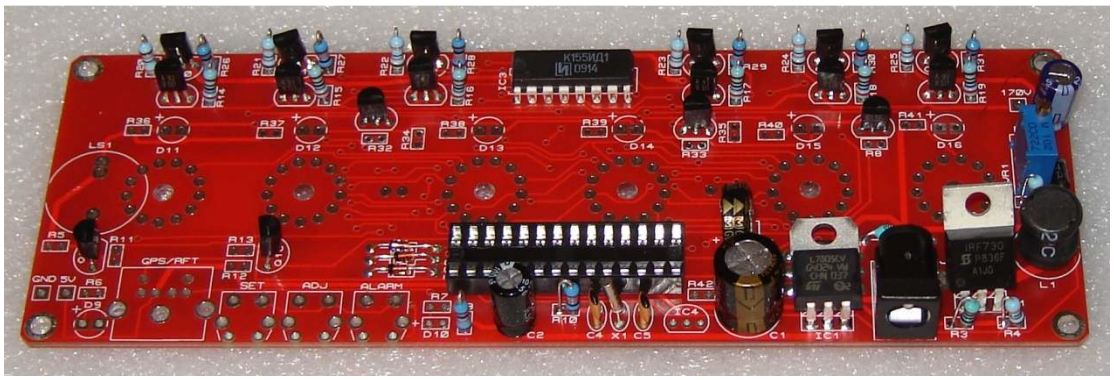


4.9 Q4 – Q9 (All MPSA92)

After placement of these 6 transistors, the board should look like this:



4.10 R14 – R19 (2K7)
R20 – R25 (390K)
R26 – R31 (10K)
See picture below:



4.11 R12, R13, R32, R33 (10K)
R34, R35 (390K)
R8 (10K)
R5, R6, R7, R11 (560R)

4.12 R36 – R41 (560R)
These are the current-limiting resistors for the LED tube underlights. If you don't want to have LED tube underlighting you can omit this step.

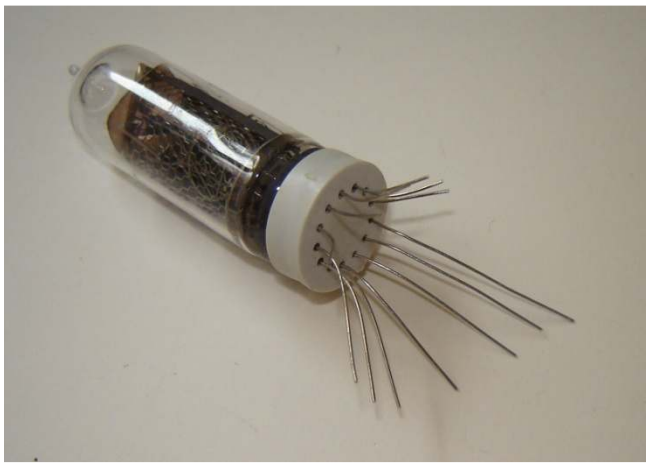
5. INSTALLING THE NIXIE TUBES

PLEASE REFER TO THE APPROPRIATE SECTION FOR YOUR NIXIE TUBE TYPE.

5.1 IN-14 Nixie Tubes.

To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors as shown below. Start by identifying the anode lead at the back of the tube. It has a white coating where it enters the glass.

Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.

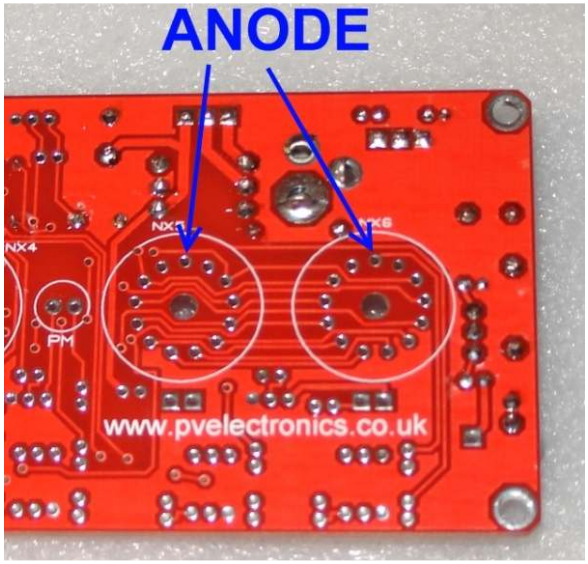


IMPORTANT:

If you will be installing the LED tube lights, now is the time to slip off the plastic spacer and drill a 5mm hole in the middle of the spacer, to 'let the light shine through'.

Referring to the picture below, identify the anode pads at each tube location. It is the rearmost pad.

NOTE: PLACE THE TUBES ON THE OPPOSITE SIDE OF THE PCB TO THE COMPONENTS!!



Now you can insert and solder in the tubes, starting at NX1, one at a time. Feed all the wires in progressively. It is not as hard as it seems at first. After soldering in, trim flying leads. After soldering in each tube, test the tube as follows:

Ensure the IC2 (PIC16Fxxxx) is placed in its socket, and remembering that 165V will be generated, power up the PCB. The tube should count repeatedly from 0 to 9. This tube test routine allows you to check each tube as it is placed, and if there are any tube or PCB shorts this will expose them as they happen. Because is is a multiplex design, any shorts between cathodes (even an internal tube defect), will show on ALL TUBES. So it would be very hard to diagnose a short after placing all tubes. Be sure to test each tube after placement, before moving on to solder in to the next tube.

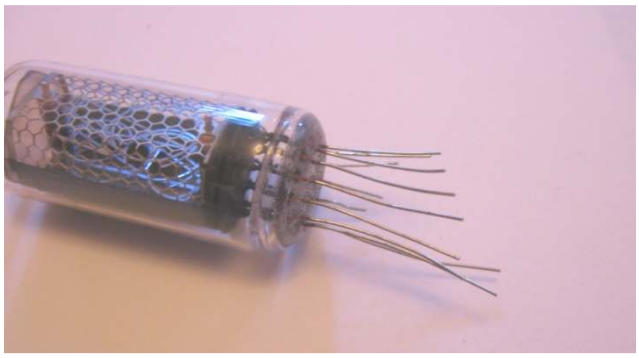
Do not proceed if you observe any of the following:

- Tube does not light (check anode is soldered)
- Tube does not show all digits (check all leads are soldered)
- Tube shows one or more digits simultaneously (check for shorts between adjacent tube connections)

Once all tubes have been placed correctly, move to step 6.

5.2 IN-8-2 Nixie Tubes.

To facilitate easy insertion of the flying leads into the small holes, it helps enormously to trim the flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube. Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.



NOTE: PLACE THE TUBES ON THE OPPOSITE SIDE OF THE PCB TO THE COMPONENTS!!

Now you can insert and solder in the tubes, starting at NX1, one at a time. Feed all the wires in progressively. It is not as hard as it seems at first.

IMPORTANT: If you will be using one of our cases, you should mount the tubes with a spacing of approx ¼ inch (6mm) away from the PCB, so that the tubes rise sufficiently above the height of the case.

After soldering in, trim flying leads.

IMPORTANT: After soldering in each tube, test the tube as follows:

Ensure the IC2 (PIC16Fxxxx) is placed in its socket, and remembering that 165V will be generated, power up the PCB. The tube should count repeatedly from 0 to 9. This tube test routine allows you to check each tube as it is placed, and if there are any tube or PCB shorts this will expose them as they happen. Because is is a multiplex design, any shorts between cathodes (even an internal tube defect), will show on ALL TUBES. So it would be very hard to diagnose a short after placing all tubes. Be sure to test each tube after placement, before moving on to solder in to the next tube.

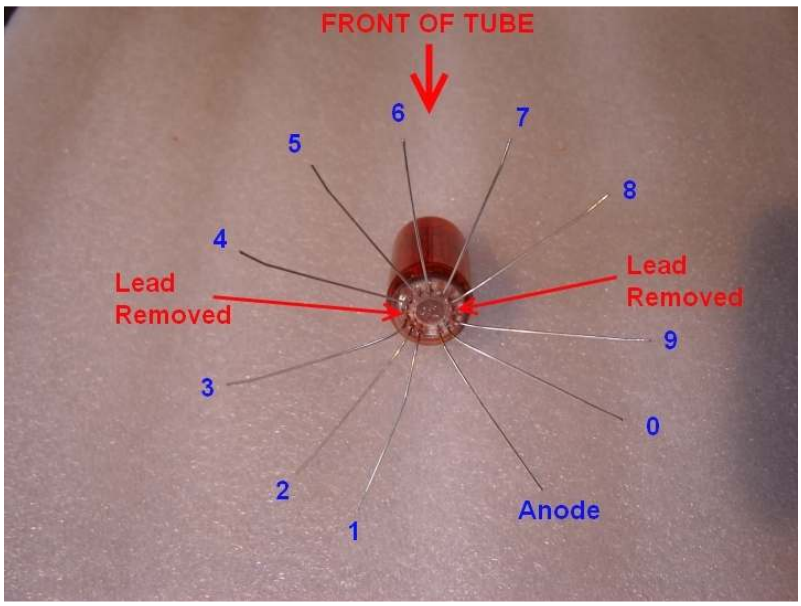
Do not proceed if you observe any of the following:

- Tube does not light (check anode is soldered)
- Tube does not show all digits (check all leads are soldered)
- Tube shows one or more digits simultaneously (check for shorts between adjacent tube connections)

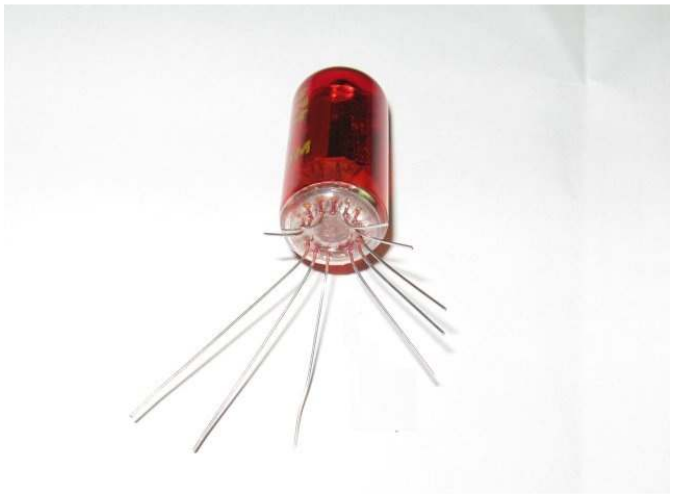
Once all tubes have been placed correctly, move to step 6.

5.3 Z570M, Z573M, ZM1080, ZM1082, GN9A Nixie Tubes.

From Jan 2012, Kits for Z570M and equivalent type tubes are supplied with a shared board that is also used for IN-8-2 tubes. It is necessary to clip off two of the Z570M and equivalent tube leads:

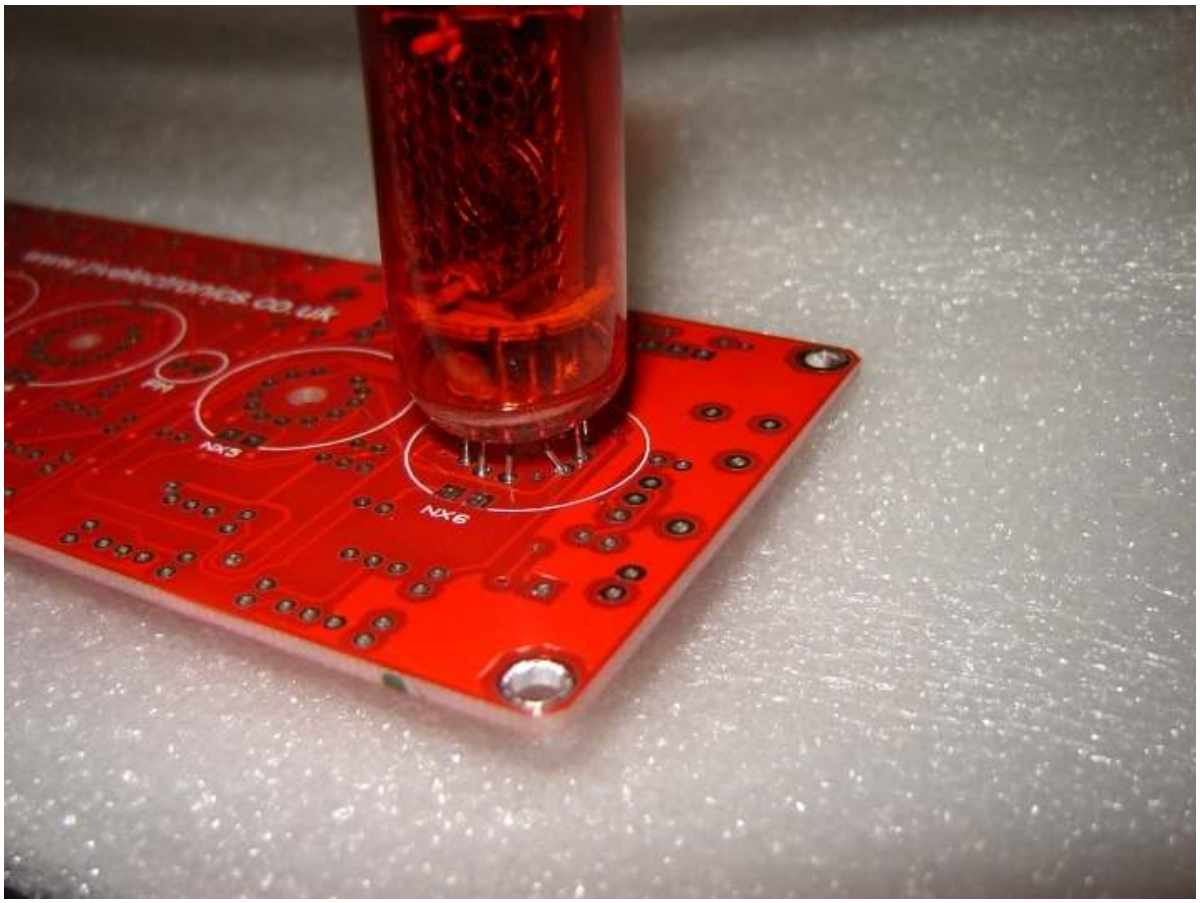


To facilitate easy insertion of the flying leads into the PCB holes, it helps enormously to trim the remaining flying leads with a pair of scissors as shown below. Start at one of the leads at the back of the tube.
Then, working around the tube, cut each sucessive lead approx 2mm shorter than the previous one. This will allow you to feed each lead in in turn.



NOTE: PLACE THE TUBES ON THE OPPOSITE SIDE OF THE PCB TO THE COMPONENTS!!

Now you can insert and solder in the tubes, starting at NX1, one at a time. Feed all the wires in progressively. It is not as hard as it seems at first. Note that one hole has no lead - this is shown below, but it is clear as it is the hole that is just a hole, without a pad. The tube will sit 3-4mm above the PCB, but this makes soldering safer as you are heating further away from the tube, so there is less risk of tube damage.



IMPORTANT: If you will be using one of our cases, you should mount the tubes with a spacing of approx ¼ inch (6mm) away from the PCB, so that the tubes rise sufficiently above the height of the case.

After soldering in, trim flying leads.

IMPORTANT: After soldering in each tube, test the tube as follows:

Ensure the IC2 (PIC16Fxxxx) is placed in its socket, and remembering that 165V will be generated, power up the PCB. The tube should count repeatedly from 0 to 9. This tube test routine allows you to check each tube as it is placed, and if there are any tube or PCB shorts this will expose them as they happen. Because is is a multiplex design, any shorts between cathodes (even an internal tube defect), will show on ALL TUBES. So it would be very hard to diagnose a short after placing all tubes. Be sure to test each tube after placement, before moving on to solder in to the next tube.

Do not proceed if you observe any of the following:

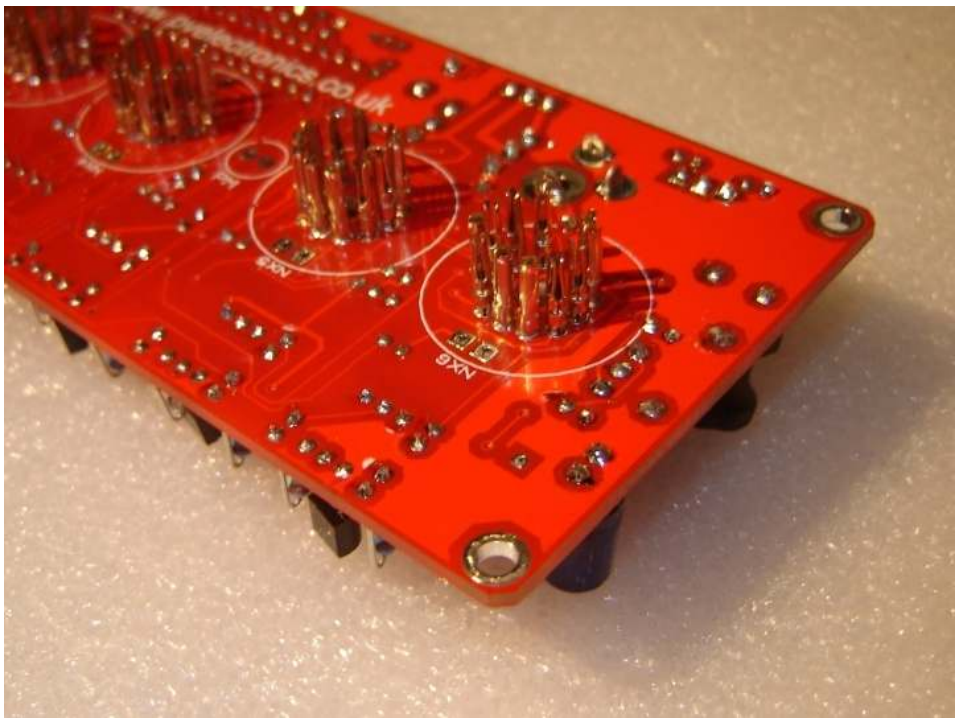
- Tube does not light (check anode is soldered)
- Tube does not show all digits (check all leads are soldered)
- Tube shows one or more digits simultaneously (check for shorts between adjacent tube connections)

Once all tubes have been placed correctly, move to step 6.

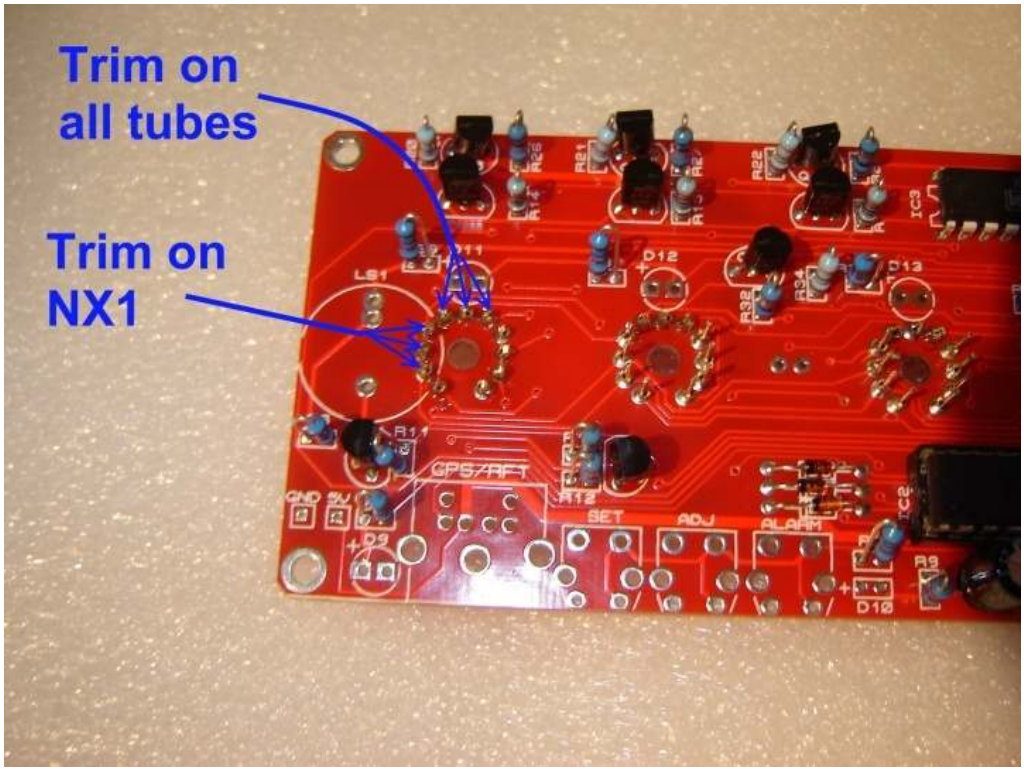
5.4 IN-8 Nixie Tubes.

You will need 66 1mm socket receptacles, which should have been supplied if you ordered the IN-8 version of the kit.

Insert the 66 sockets on the OPPOSITE side of the PCB to the rest of the components. They will be a firm push fit into their holes, so it can help to partially insert, and then use a hard object to push against to fully insert the socket. After placement, the sockets may be soldered into place.



It is necessary to trim the sockets on the main component side where the tube light LEDs will be placed as shown below. Trim the central pin and the pin either side. Do this for all tube locations.



Also, trim 3 sockets on NX1 location, to allow mounting of LS1 the Piezo sounder.

It is now possible to mount all six tubes in their sockets for a tube test.

Ensure the IC2 (PIC16Fxxxx) is placed in its socket, and remembering that 165V will be generated, power up the PCB. The tubes should count repeatedly from 0 to 9. This tube test routine allows you to check each tube, and if there are any tube or PCB shorts this will expose them.

Do not proceed if you observe any of the following:

- Tube does not light (check socket is soldered)
- Tube does not show all digits (check all sockets are soldered)
- Tube shows one or more digits simultaneously (check for shorts between adjacent tube connections)

Once all tubes have been tested, move to step 6.

6. MOUNTING THE REMAINING COMPONENTS

6.1 SET, ADJ, ALARM.

Push buttons SET, ADJ and ALARM can be mounted on either side of the PCB, depending on your case design. For the cases supplied by us, mount the switches on the component side of the PCB

6.2 NE1, NE2.

The 2 neons can now be mounted at a suitable height. Use small lengths of the clear insulation supplied on the leads to prevent shorts.

6.3 RFT / GPS Connector.

If you will not be using a time synchronisation source, you may omit this connector. Also, if you are connecting a time receiver module close to the clock PCB without using the connector you may omit this connector (refer to step 8.5 for the connections)

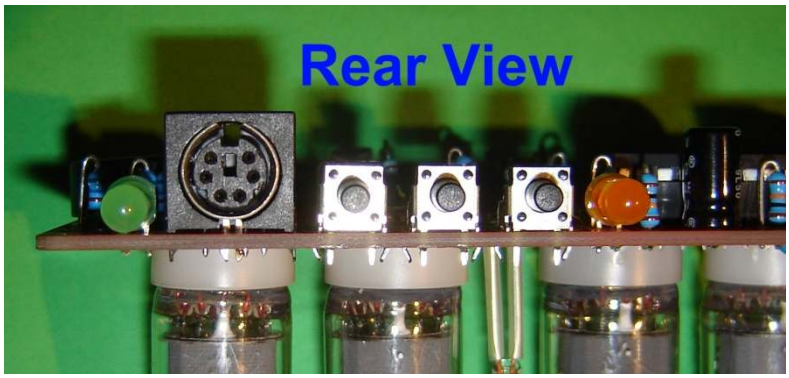
6.4 LS1 – Piezo Sounder.

First, ensure the leads for NX1 are trimmed very short. There are two sets of holes for this component, as two different types may be supplied depending on component availability.

6.5 D9, D10.

Mount as shown below if you are using one of our cases:

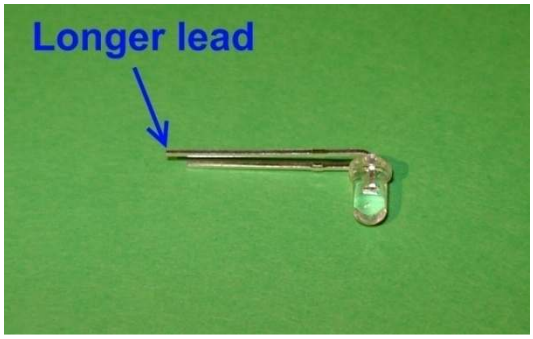
The three switches and the two LEDs should be in the same line:



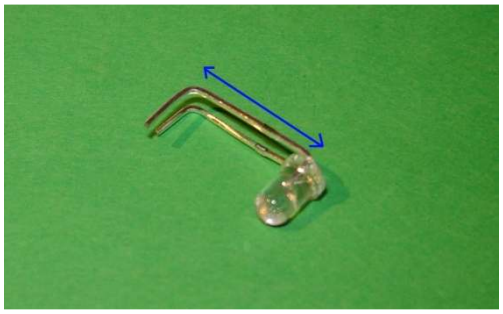
Otherwise, if you will be using your own case, they may be mounted as you prefer.

6.6 D11 – D16 (3mm Blue LED).

You can substitute other colour 3mm LEDs if you wish.
Bend the leads of each LED as shown below. Note that the longer (+) lead is on the top. This is important as the leads will be trimmed to the same length, so you need to be sure that you have the correct (longer) lead in the (+) hole.



Now bend again, appropriate to the spacing between the pads for the LED and the hole for the LED. Cut the leads to the same length:



The six LEDs may now be installed, as shown below. Insert and solder on the COMPONENT side. Take care that the LED leads are well clear of the tube leads:

6.6 C7 – decoupling capacitor for IC2.

On the IN-14 board, this component needs to be mounted on the TUBE side of the PCB, directly across the power terminals into IC2. Refer to the picture below. The location is marked on the PCB in white ink:

On other boards C7 is located close to IC2 on the component side.

7. HOW TO OPERATE THE CLOCK

The three buttons have the following functions:
SET: Exit tube test routine on cold power-up;
Show date;
Set: time, date;
Enter configuration menu;
ADJ: Call WWVB / DCF / MSF;
Adjust: time, date, alarm time, configuration parameters;
ALARM: Set alarm time; snooze; cancel snooze/alarm;

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 seconds 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	30 = version 3.0, 31 = version 3.1 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
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 (default) 1 – Dimmed display
7	Display mode	0 – standard change of digits(default) 1 – fading digits
8	Night mode override period (minutes)	0 – 50 (default 3) [1]
9	Snooze period	0 – 6 minutes (default) 1 – 9 minutes 2 – 12 minutes 3 – 15 minutes
10	Colon neons mode	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Both flash (default) 3 – Both illuminated 4 – Both off
11	Colon neons during night dimmed mode [2]	0 – AM/PM Indication, flashing 1 – AM/PM Indication, illuminated 2 – Both flash 3 – Both illuminated (default) 4 – Both off
12	Radio time signal source	0 – No Radio Time source (default)[3] 1 – DCF 2 - WWVB 3 – MSF 4 - GPS
13	GPS Baud rate	0 – 4.8 Kbps (default) 1 – 9.6 Kbps 2 – 19.2 Kbps 3 – 38.4 Kbps
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	WWVB Auto DST Disable /Set DST in GPS mode	*WWVB Sync Mode:* 0 –Auto DST on WWVB Sync (default) 1 – Disable Auto DST on WWVB Sync[5] *GPS Sync Mode:* 0 – No DST offset 1 – 1 hour DST offset[6]
18	Auto date display each minute	0 – Off 1 – On (default)[7]

19	LED backlights	0 - Always off 1 - Always on 2 - On, and follows tube nightblanking (default)
20	Reserved – leave as 0	0
21	Reserved – leave as 0	0
22	Slots Mode[8]	0 – Slots disabled 1 – Slots every minute 2 - Slots every 10 minutes (default) 3 - Slots every hour 4 – Slots at midnight
23	RFT Sync Mode[9]	0 – DCF / WWVB / MSF Sync once per day only as per parameter(24) 1 – DCF / WWVB / MSF Sync every hour (default)
24	RFT Daily Sync Hour	0 – 23 (default 2)
25	RFT Seek Blanking	0 – Keep tubes lit for DCF / WWVB / MSF seek (default) 1 – Blank tubes for DCF / WWVB / MSF seek
26	Reserved – leave as 0	
27	Reserved – leave as 0	
28	Restore default settings	0 – Keep user settings 1 – Restore original default settings[10]

Notes:

1. Press 'SET' briefly during blanking to show time for prescribed period.
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 WWVB / DCF / MSF / GPS synchronisation. Set time manually.
4. Enter your time zone offset from the synchronisation source. Note that WWVB transmits UTC.
5: Set this to '1' to disable Auto DST adjust on WWVB Sync – eg. Arizona does not observe DST. Only active in WWVB Sync mode.
6. In GPS Sync mode, this parameter is used to set DST. Set to '1' during DST.
7. Date will be displayed each minute between 50 and 55 seconds past the minute.
8. Visual effect / cathode poisoning prevention – all digits on all tubes are cycled for 10 seconds. This setting overrides night blanking or dimming for the duration of the effect (10 seconds).
9. DCF / WWVB /MSF synchronisation takes place on the hour. If no valid frame is received in 6 minutes, the clock reverts to normal operation.
10. Set this parameter to '1' to restore original default settings. Internal operations will then load all the original settings and restore the value to '0'

Setting the Time and Date:
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 (18) to '1' 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 (8).

Manual RFT Call:
In DCF / WWVB / MSF modes, pressing 'ADJ' briefly during time display will initiate a manual time seek for maximum 6 minutes, or until a valid time frame is received.

Setting Alarm:
Press the 'ALARM' Button. The seconds digits show the on / off status of the alarm: 00 or 01 (off or 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.

***Canceling 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.

8. PIC CONTROLLER SECURITY CODE

To add extra security to the product in shipment, and to help protect code security a security code lock feature is built into the PIC Controller. This helps to ensure that the product can only be used by the intended recipient who purchased the product either direct or from an authorised distributor or reseller.

During the first 45 days of product use, the clock may stop displaying the time and display a 6 digit security code. This is a self-generated true random number. If your clock displays the security code, please write down the number carefully, switch off power to the clock and contact the seller of your clock for the unlock code and unlock procedure.

Do not attempt to unlock or change any settings yourself, as doing so will more than likely make the PIC permanently unusable.

9. USING A RADIO FREQUENCY TIME RECEIVER OR GPS RECEIVER

The clock can automatically synchronise time from DCF (Europe), WWVB (USA), and MSF (UK) long wave time transmitters.
The clock can also receive time from a GPS receiver that transmits information using NMEA-0183 protocol, using the $GPRMC sentence.

9.1 Configuring for RFT or GPS Synchronisation.

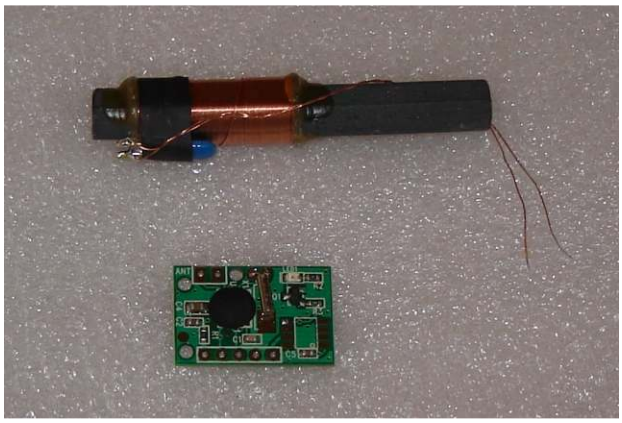
- Set parameter 12:
  - 1: DCF
  - 2: WWVB
  - 3: MSF
  - 4: GPS
- If using GPS, set the baud rate in parameter (13)
- Set parameters 14 and 15 for the hours and minutes your time zone is offset from the synchronisation source. This is usually only whole hours. Examples:
  - Eastern USA is 5 hours offset from UTC transmitted by the WWVB transmitter.
  - UK is 1 hour offset from the time transmitted by the DCF transmitter
  - France has no offset from the time transmitted by the DCF transmitter
- Set parameter (16) to identify whether the offset is minus (0) or positive (1) of the time source.
- If using WWVB source, and you do NOT require automatic DST adjustment (eg. Arizona does not observe DST), then set parameter (17) to 1.
- If using GPS, parameter (17) acts as a DST bit. Set to 1 during DST period, and 0 during standard time period.
- Set parameter (23) to select between hourly seek and daily seek in DCF / WWVB / MSF modes.
- If you have selected daily seek, use parameter (24) to set the time of the daily seek in DCF / WWVB / MSF modes.
- If you intend to place the RFT receiver module closer to the clock PCB than 6 ft / 2 metres, the clock will need to disable HV and switch off the tubes for time seek, otherwise the switch-mode power supply will prevent reception. Select blanking during time seek by setting parameter (25) to 1. Leave as 0 to keep tubes lit during time seek.

9.2 DCF / WWVB / MSF Synchronisation.

An optional receiver and 3 metre cable is available. The Radio Frequency Time (RFT) receiver module plugs into the mini-DIN socket on the rear of the PCB.

9.3 Connecting the DCF / WWVB / MSF receiver.

The clock is designed to be used with Symtrik RFT time receiver module type SYM-RFT-xx
These modules feature an on-board indicator LED to indicate the regular pulses from the time transmitter. This is very useful in setting up the module, to determine if a good signal has been found. The modules output coded time information in inverted format and this is the format the clock can decode.
An additional feature of the modules is the PON pin, which is used to place the module is an ultra low power standby mode when not being used for time seek.



If you are using our module and 3 metre extension cable, proceed to step 8.4. If you are wiring in the module close to the main clock PCB or by direct soldering to the clock PCB pads, refer to step 8.5.

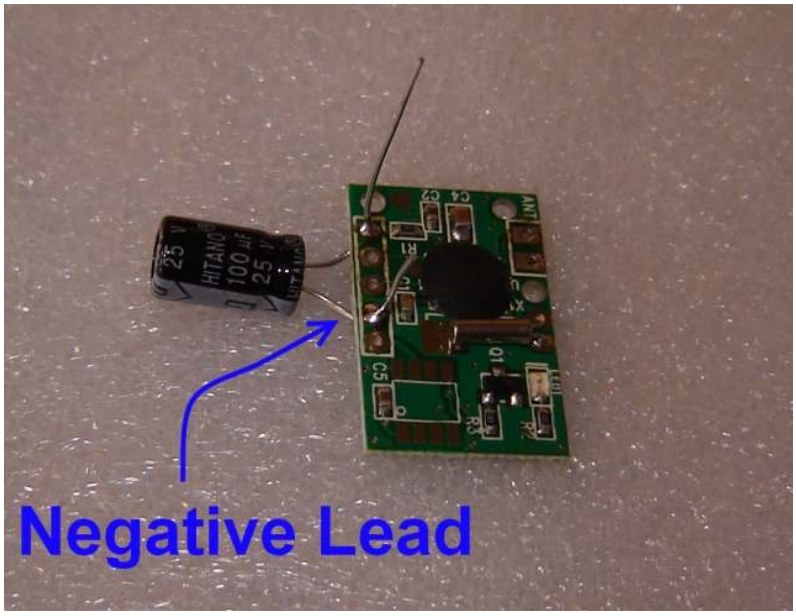
Some Notes on WWVB / DCF / MSF Reception:
Many other electrical applicances such as TVs and Mobile phones reception when in close proximity. Metal objects cause reception problems too. It is suggested to start off with the antenna by a window, in the approximate direction of the signal Do not point the antenna at the direction of the signal, but have the antenna side-on to the signal direction.
Once a good signal has been obtained, try different locations, and progressively further from the window.

Place and design your case so the antenna is as far away from the PCB as possible.

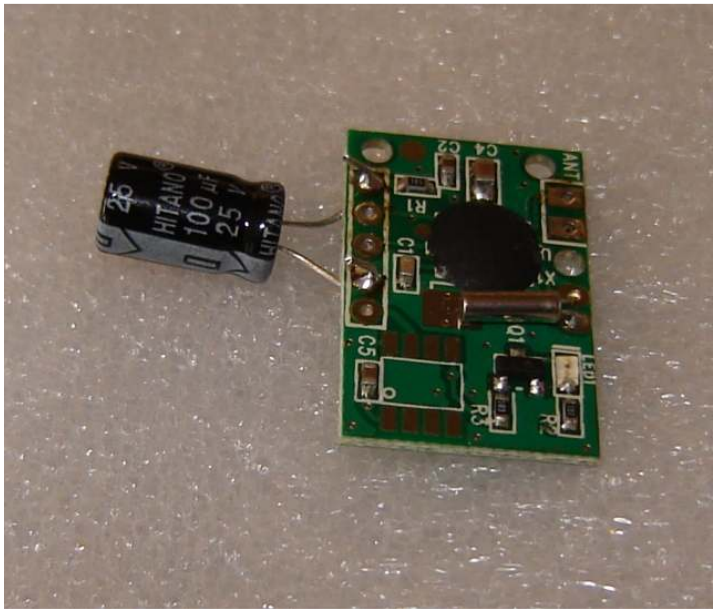
9.4 Making up the RFT Module and cable.

Make connections to the RFT module as follows:
First, strip approx 15mm / 0.6” of the other grey sheath of the cable. Identify the Black, Orange, Yellow and Brown cables and clip off all the rest as they are not required.

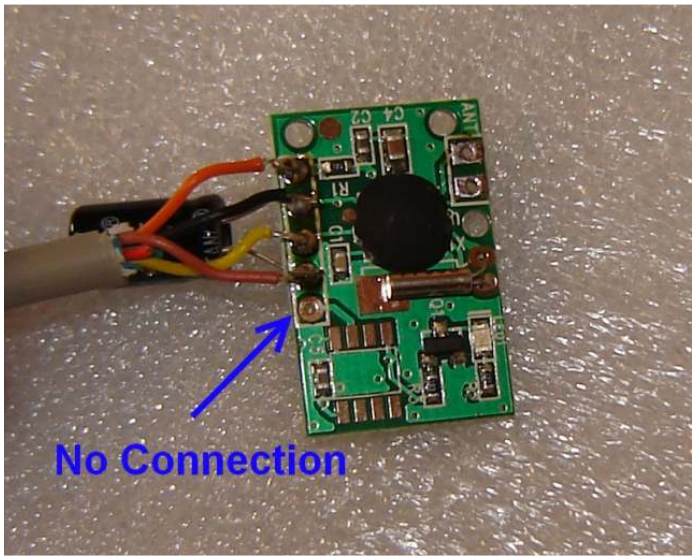
Attach a 100uF capacitor to the module as shown below to pads #1 and #4 noting the correct orientation of the negative lead of the capacitor.



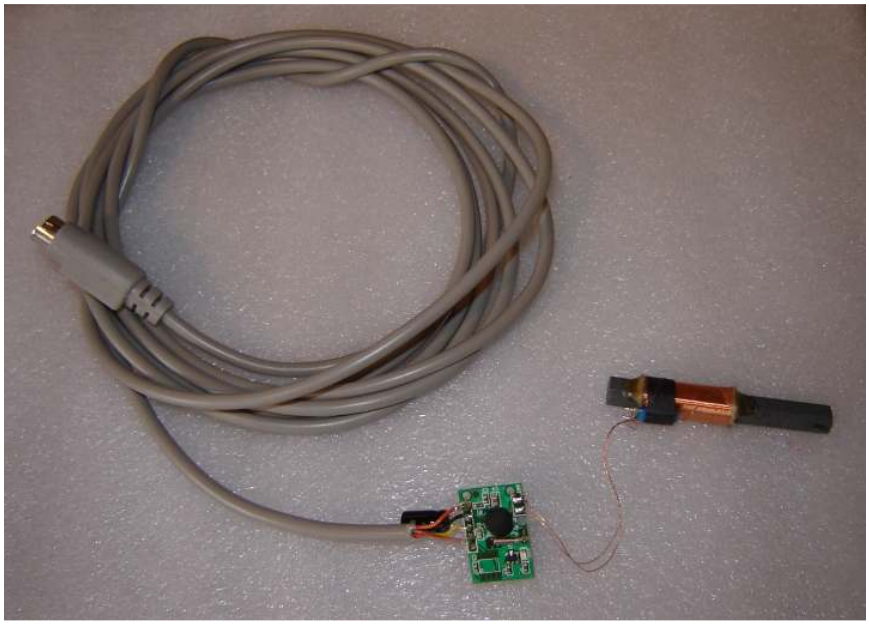
Then clip the excess capacitor leads so there is only 1-2mm remaining.



Now connect the cables to the module as shown below. It is not necessary to feed the cables into the holes – it is sufficient to lay the cables over the PCB pads and solder on.



Now attach the antenna by soldering the two antenna wires to the pads marked 'ANT':

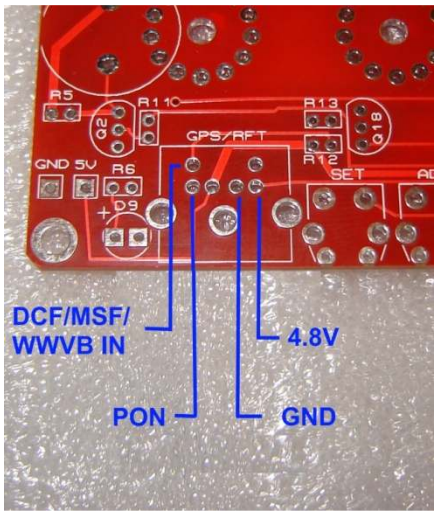


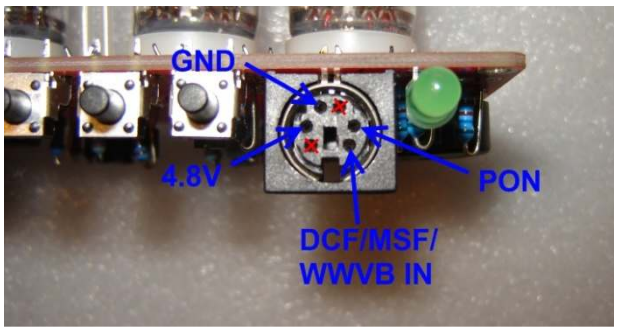
The RFT Module is now ready to connect and use with the clock.

9.5 Mini-DIN Connector and PCB pinout.

This information is needed if you are connecting a DCF / WWVB / MSF receiver to the clock PCB directly, or without using our mini-DIN extension cable. The following connections are required for connecting a DCF / WWVB / MSF receiver module:

Bare PCB and DIN Socket connections:





Module connections:

Note that one pad is not connected (NC).
We recommend connecting a 100uF electrolytic capacitor across the 4.8V and GND pads as close as possible to the module.
There are no special requirements for the cable used: light duty 4-way signal cable is suitable for making the connections.

9.6 Connecting a GPS receiver

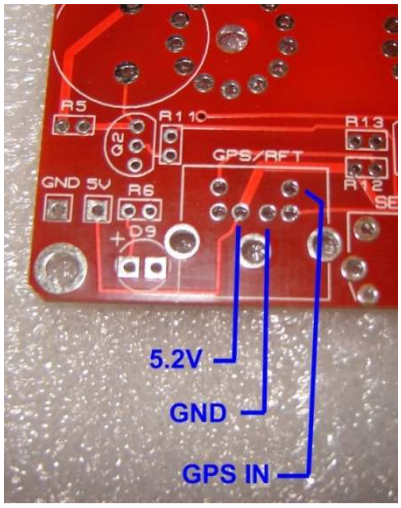
The clock has been designed for, and tested with a Globalsat BR-355 GPS receiver (available separately from PV Electronics)

It may be possible to connect other GPS receivers with the following specification:

Power consumption max 50mA
Supply voltage 5V
Output signal levels: RS232 or TTL
Serial baud rate: 4,800 bps, 9,600 bps, 19,400 bps or 38,400 bps
Output protocol: NMEA-0183, including $GPRMC sentence

The Globalsat BR-355 receiver plugs directly into the mini-DIN connector on the rear of the clock PCB.

To connect a different GPS receiver, the following connections are required:



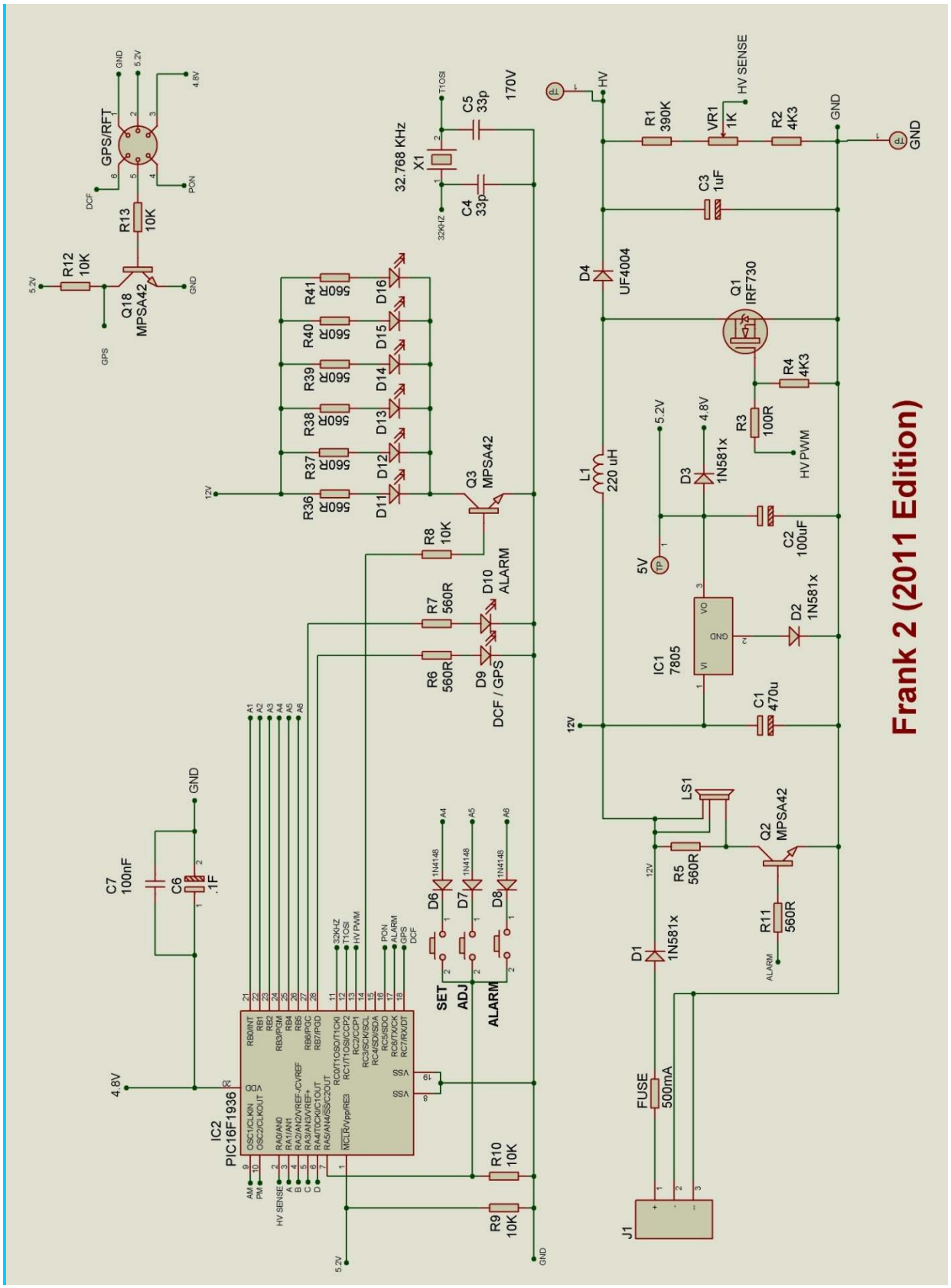
9.7 Function of the GPS / RFT indicator LED (D9):

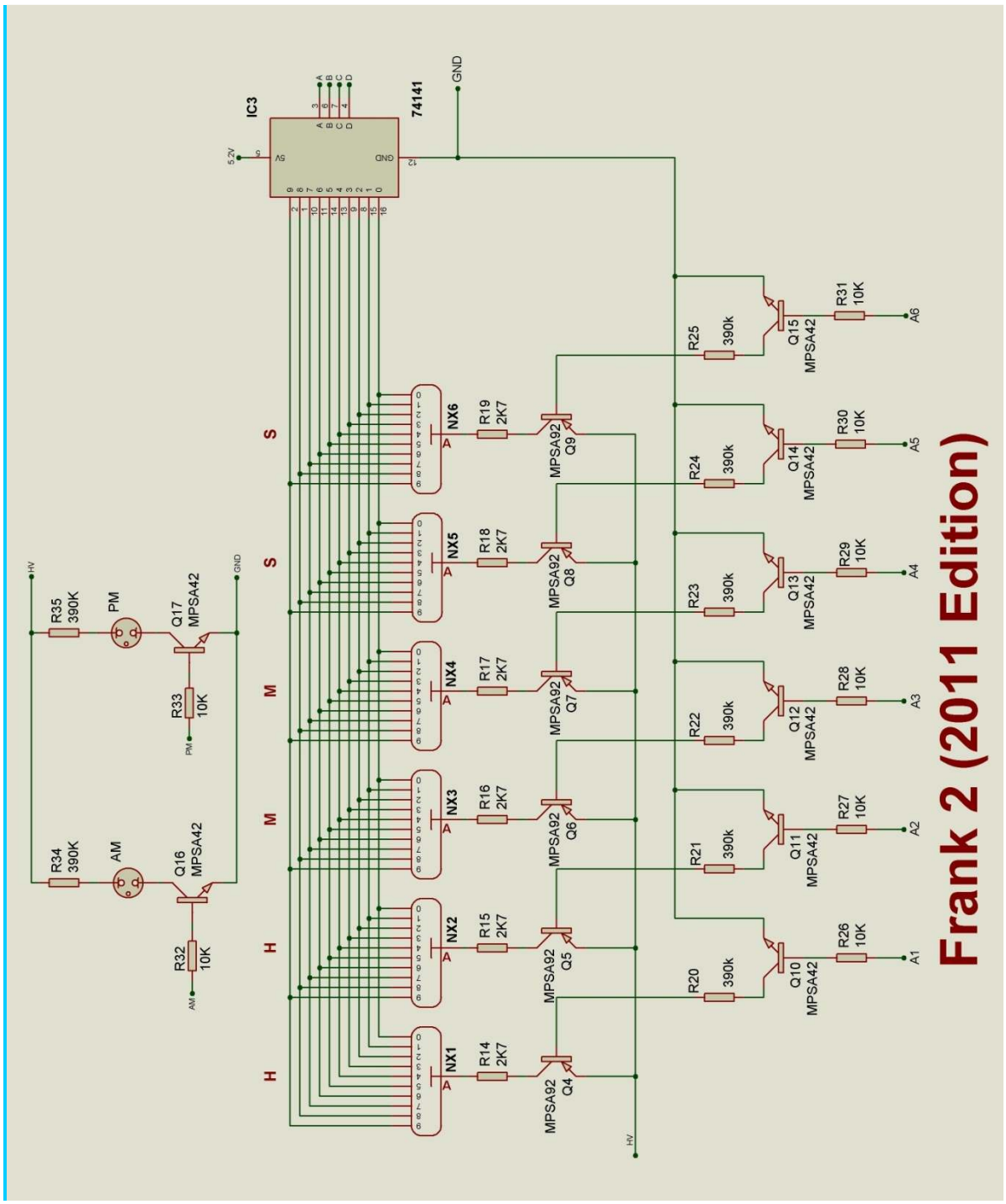
- *No Radio Synchronisation source installed (parameter (12) = 0)*
  LED is permanently off
- *RFT or GPS Synchronisation enabled (parameter (12) = 1-4)*
  The LED will be ON if the clock has synchronised in the last two hours; slowly flashing if the last synchronisation was between 2 hours and 24 hours ago; and off if the last synchronisation is older than 24 hours.
- Additionally, if DCF, WWVB or MSF mode is selected, the indicator will flash rapidly whilst the clock is actually receiving and processing a valid time frame.

  The function of the RFT indicator LED may be summarised in the table below:

Radio Time Source	**Sync < 2 Hrs**	**Sync >2 Hrs Sync < 24 Hrs**	**Sync > 24 Hrs**	**Aquiring RFT Frame**
None	Off	Off	Off	-
DCF / WWVB / MSF	On	Slow Flash	Off	Fast Flash
GPS	On	Slow Flash	Off	-

10. CIRCUIT DIAGRAM




Frank 2 (2011 Edition)
IC3
74141
GND
5V
5.2V
HV
PM
AM
R35 390K
R34 390K
Q17 MPSA42
Q16 MPSA42
R33 10K
R32 10K
S
S
M
M
H
H
NX6
NX5
NX4
NX3
NX2
NX1
R19 2K7
R18 2K7
R17 2K7
R16 2K7
R15 2K7
R14 2K7
MPSA92 Q9
MPSA92 Q8
MPSA92 Q7
MPSA92 Q6
MPSA92 Q5
MPSA92 Q4
R25 390k
R24 390k
R23 390k
R22 390k
R21 390k
R20 390k
Q15 MPSA42
Q14 MPSA42
Q13 MPSA42
Q12 MPSA42
Q11 MPSA42
Q10 MPSA42
R31 10K
R30 10K
R29 10K
R28 10K
R27 10K
R26 10K
A6
A5
A4
A3
A2
A1