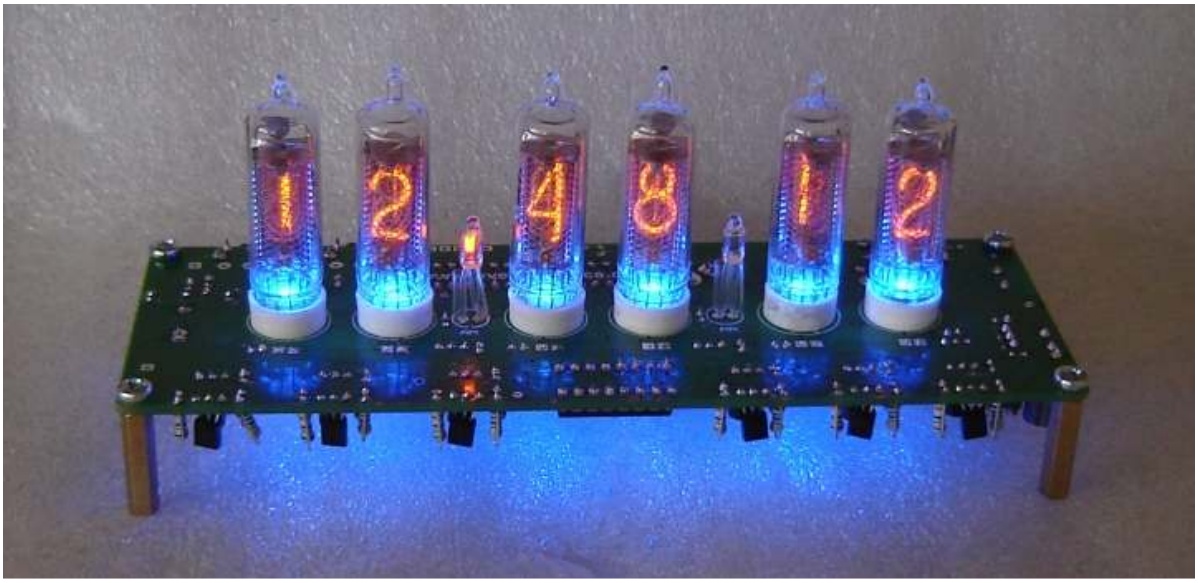
Assembly Instructions
And
User Guide

Nixie Clock Type
'SixNix'



REVISION HISTORY

Issue Number	Date	Reason for Issue
4	1 Jan 2012	Added new fuse type
3	6 Sept 11	Added dimensioned drawing
2	5 Sept 11	Errors corrected
1	20 July 2011	New document

1. INTRODUCTION

1.1 About the clock

Nixie clock type 'SixNix' 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 type IN-16.

1.2 Clock Features

Nixie clock type 'SixNix' 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
- 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 170 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. The 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 – R6	4K3, ¼ Watt
R7	560R, ¼ Watt
R8	4K3, ¼ Watt
R9, R10	560R, ¼ Watt
R11 – R18	4K3, ¼ Watt
R19 – R24	2K7, ¼ Watt
R25 – R32	390K, ¼ Watt
R33 – R35	560R, ¼ Watt
R36	Not installed
Capacitors	
C1	470uF, 16-25V, Electrolytic
C2	100uF, 16-25V, Electrolytic
C3	1uF, 250V, Electrolytic
C4, C5	33pF Ceramic
C6	0.1F
C7	100nF Ceramic
Transistors	
Q1	IRF730 or IRF630 MOSFET
Q2 – Q10	MPSA42 NPN
Q11 – Q16	MPSA92 NPN
Q17	MPSA42 NPN
Diodes	
D1 – D3	1N5817 or 1N5819
D4	UF4004
D5	5mm Orange LED
D6 – D8	1N4148
D9 – D14	3mm Blue LED
D15	Not installed
Integrated Circuits	
IC1	78L05 5V voltage regulator
IC2	PIC16Fxxxx 8-bit microcontroller
IC3	74141 / K155ID1 Nixie driver
Miscellaneous	
L1	100uH
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
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	6
2K7, ¼ Watt	6
4K3, 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	10
Diodes	
1N581x	3
UF4004 fast recovery diode	1
1N4148	3
5mm Orange LED	1
3mm Blue LED	6
Integrated Circuits	
78L05 5V voltage regulator	1
PIC16Fxxxx 8-bit microcontroller	1
74141 / K155ID1 Nixie driver	1
Miscellaneous	
100uH	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
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

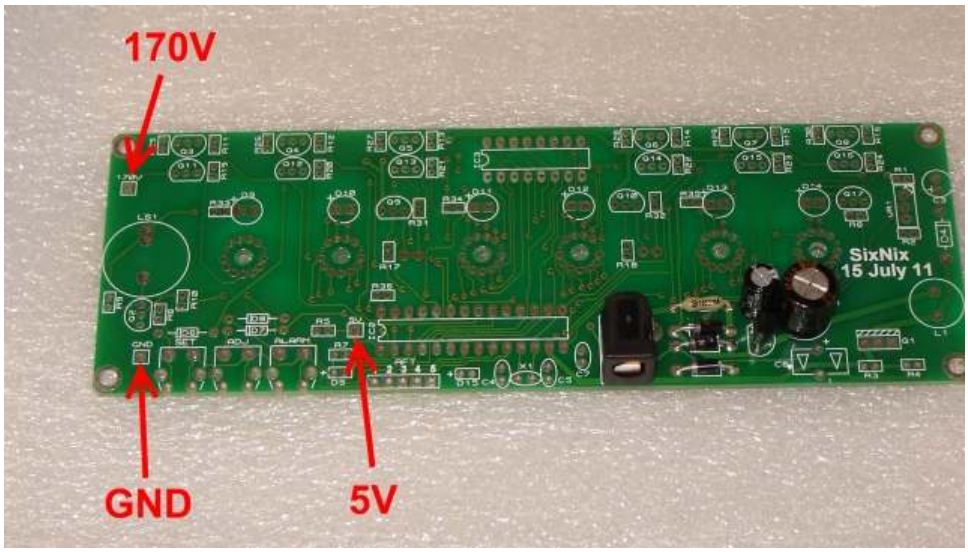
4.1 Low Voltage Power components: J1, FUSE, D1-D3, IC1, C1, C2

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

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.



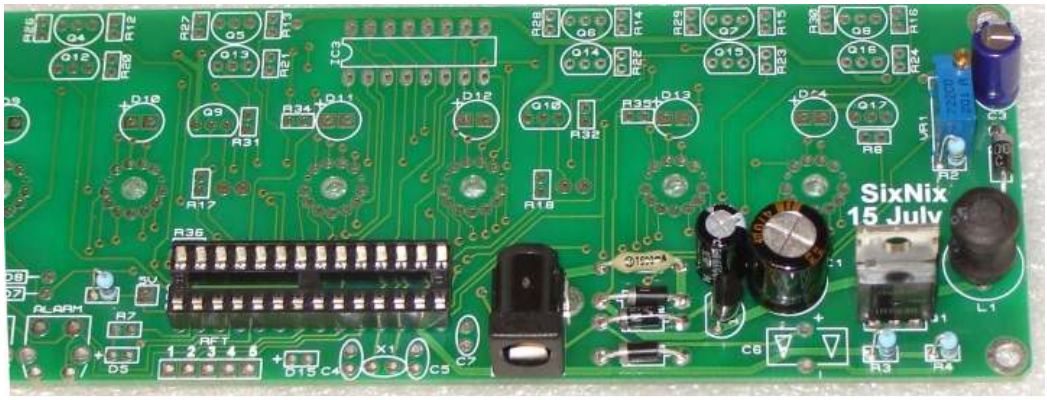
Plug in the power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 5.1 and 5.3 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected.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

4.3 High Voltage Generator components.
R1 – R5, Q1, D4, C3, VR1, L1, Socket for IC2

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-R5, 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 into 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:

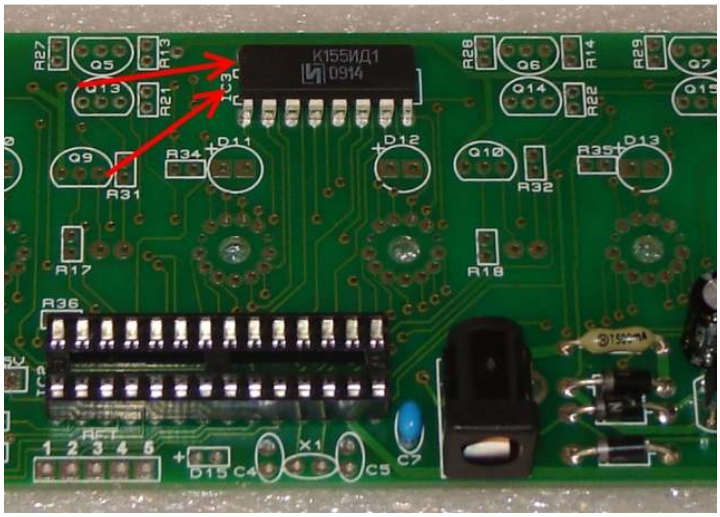


4.4 High Voltage Generator Test.

- 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 between 170 and 175V. 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.

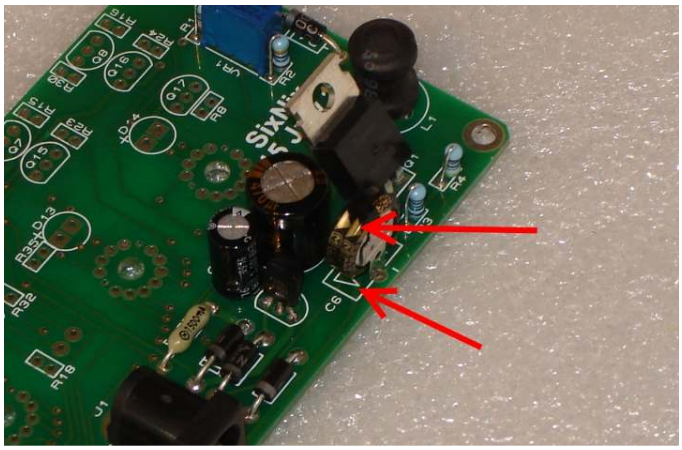
4.7 IC3 – 74141 / K155N Nixie Driver IC, C7

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



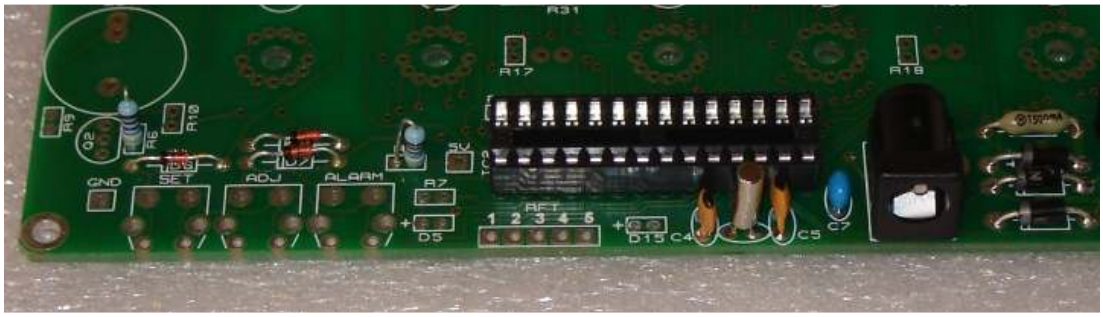
4.5 C6

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.



4.5 D6 – D8, R6, C4, C5, X1

Align the black bands on D6-D8 with the white band markings on the PCB.



4.8 Q2 – Q10, Q17 (All MPSA42)

After placement of these 10 transistors, the board should look like this:

4.9 Q11 – Q16 (All MPSA92)

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

4.10 R11 – R18 (4K3)
R19 – R24 (2K7)
R25 – R32 (390K)

See picture below:

4.11 R8 (4K3)
R7, R9, R10 (560R)

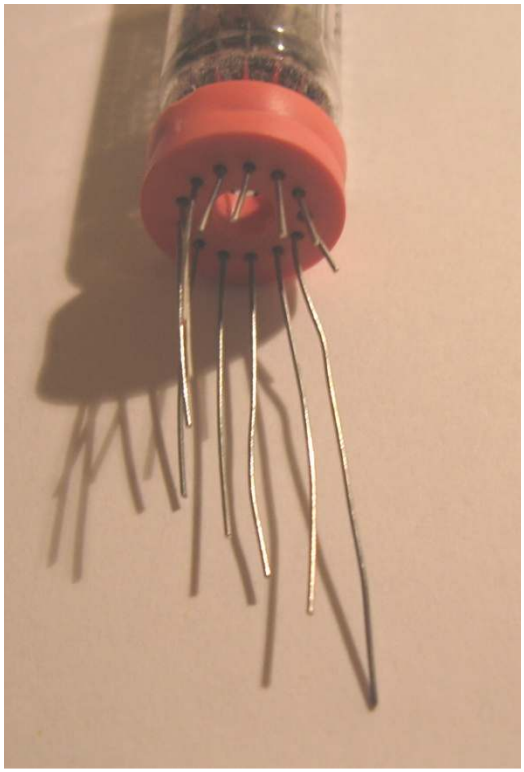
4.12 R33 – R35(560R)
These are the current-limiting resistors for the LED tube underlights. If you don't want to have LED tube underlighting you can omit this step.

5. INSTALLING THE NIXIE TUBES

5.1 IN-16 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 4mm hole in the middle of the spacer, to 'let the light shine through'. Some tubes already have the hole moulded in which case you can omit this step.

Identify the anode pads at each tube location. It is the rearmost pad. 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 170V 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.

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.

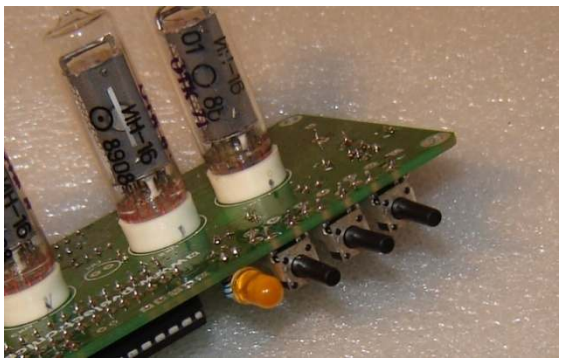
The 2 neons can now be mounted at a suitable height. Use small lengths of the clear insulation supplied on the leads to prevent shorts.

6.3 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.

6.4 D5 (Orange LED).

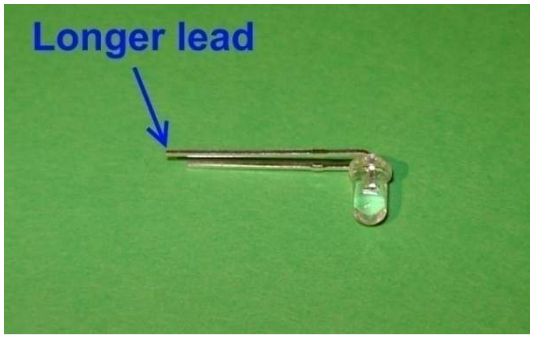
Mount as shown below if you are using one of our cases. Ensure the longer lead goes in the hole marked (+):



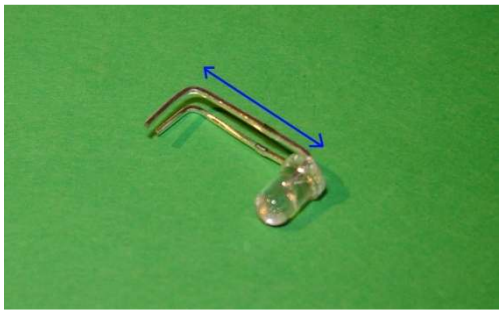
Otherwise, if you will be using your own case, it may be mounted as you prefer.

6.6 D9 – D14 (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:

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: 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	10 = version 3.0, 11 = version 1.1 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	Auto date display each minute	0 – Off 1 – On (default)[3]
13	LED backlights	0 - Always off 1 - Always on 2 - On, and follows tube nightblanking (default)
14	Reserved – leave as 0	0
15	Reserved – leave as 0	0
16	Slots Mode[4]	0 – Slots disabled 1 – Slots every minute 2 - Slots every 10 minutes (default) 3 - Slots every hour 4 – Slots at midnight
17	Restore default settings	0 – Keep user settings 1 – Restore original default settings[5]

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. Date will be displayed each minute between 50 and 55 seconds past the minute.
4. 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).
5. 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 (12) 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).

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.

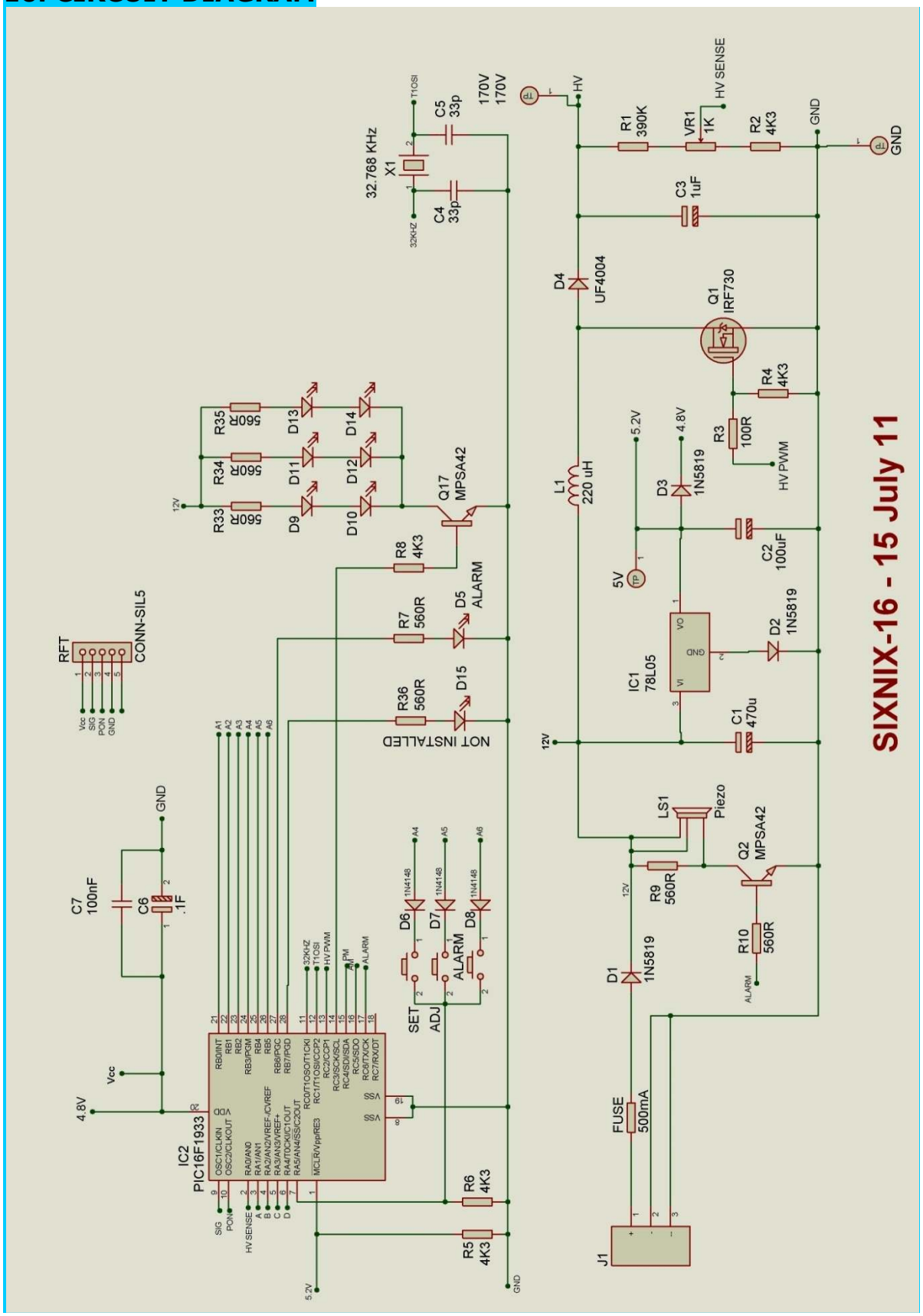
8. PIC CONTROLLER SECURITY CODE

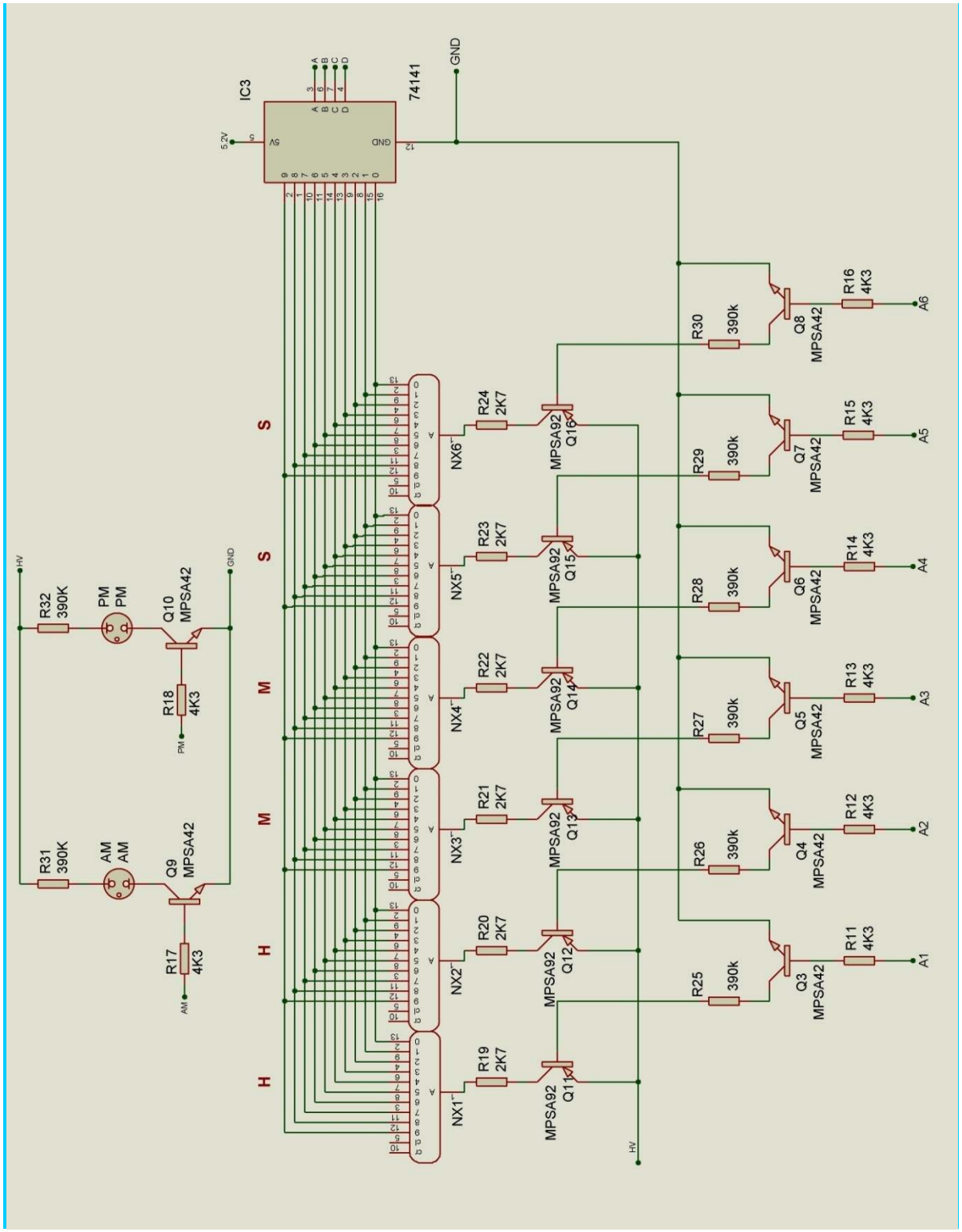
To add extra security to the product in shipment, and to help protect code security a security code lock feature is built into the PIC Controller. This helps to ensure that the product can only be used by the intended recipient who purchased the product either direct or from an authorised distributor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

10. CIRCUIT DIAGRAM




IC3
74141
GND
5.2V
5V
A
B
C
D
HV
PM
AM
R32 390K
R31 390K
Q10 MPSA42
Q9 MPSA42
R18 4K3
R17 4K3
S
S
M
M
H
H
NX6
NX5
NX4
NX3
NX2
NX1
R24 2K7
R23 2K7
R22 2K7
R21 2K7
R20 2K7
R19 2K7
MPSA92 Q16
MPSA92 Q15
MPSA92 Q14
MPSA92 Q13
MPSA92 Q12
MPSA92 Q11
R30 390k
R29 390k
R28 390k
R27 390k
R26 390k
R25 390k
Q8 MPSA42
Q7 MPSA42
Q6 MPSA42
Q5 MPSA42
Q4 MPSA42
Q3 MPSA42
R16 4K3
R15 4K3
R14 4K3
R13 4K3
R12 4K3
R11 4K3
A6
A5
A4
A3
A2
A1

10. DIMENSIONED DRAWING