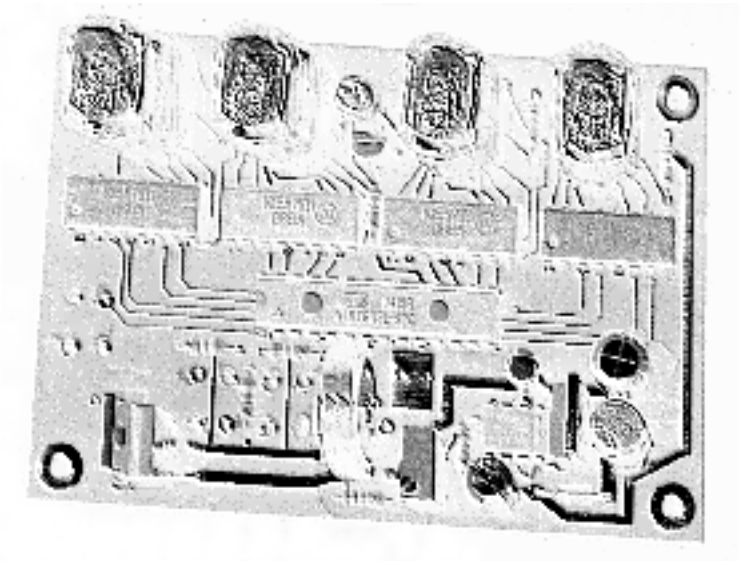
NIXIE TUBE
Clock Kit

4 Digit • IN-17 • Direct Drive



Assembly and Owners Manual
Model # IN174D

www.neonixie.com

!!!! WARNING !!!

This kit generates high voltage.
High voltage can cause serious injury or death.
Assembly should only be attempted by competent persons familiar with electronics and high voltage safety.

Safe assembly and operation of this kit is the users responsibility. In no event shall Neonixie be held liable to you or any third parties for any special, punitive, incidental, indirect, consequential, or any other damages resulting from the assembly or use of this kit.

The assembled unit should be properly encased to prevent contact with high voltages.

Metal enclosures should be tied to the negative ground on the unit. If an insulated case is used, precautions should be taken to insure no conductive parts can accidentally come in contact with the high voltage supply.
Conductive parts, such as metal screws and standoffs, should be tied to the negative ground on the unit.

!!!! WARNING !!!

Introduction

Neonixie Clock Kit model # IN174D is a 4 digit Nixie tube clock. Russian IN-17 Nixie tubes, which are among the smallest Nixie tubes ever manufactured, are directly driven using high voltage driver ICs. The high voltages needed for the tubes are generated by an efficient DC-DC converter. The heart of the clock is a pre-programmed Micro-Controller. Driven by a watch crystal and backed up by a high power capacitor, it can withstand power outages in excess of 12 hours without losing time.

Features

- Unique, tiny, 9mm digit height Nixie tubes.
- Directly Driven, solid, reliable operation.
- Efficient DC-DC converter, no line voltages to handle.
- Pre-programmed micro-controller.
- User selectable 12/24 hour mode.
- Crystal controlled, with software correction.
- Powered by a DC source, can be used worldwide.
- High quality, double sided PCB with plated-through holes.
- Flexible tube mounting options, upright or edge-view.
- Capacitor time backup of 12+ hours.

Questions, Comments? Please email nixietubes@neonixie.com

ASSEMBLY

!!! Electrostatic Discharge Warning !!!

Many components in this kit are sensitive to electrostatic discharge, Symptoms of such damage include completely inoperative components to unreliable/intermittent operation, making troubleshooting very difficult. Before unpacking components for inventory check and assembly, we recommend you take the following precautions.

- Wear an anti-static wrist strap. If none is available, you should touch a ground before beginning work and frequently while handling components and the PCB.
- Leave static sensitive components in their protective carriers until you are ready to install them.
- Use a soldering iron that is ESD safe.
- Use a properly grounded anti static mat at your worksation.

Damage caused by Electrostatic Discharge
is not covered under warranty.

TOOLS

- An ESD safe, temperature controlled soldering iron is needed. A fine tip is recommended for the surface mount components.
- Small diagonal cutters are recommended for cutting component leads.
- Small diameter rosin-core solder is recommended.
  DO NOT use acid core solder, or any other solder containing corrosive or conductive flux. Damage caused by using incorrect solder is not covered under warranty.
- Digital Multimeter.

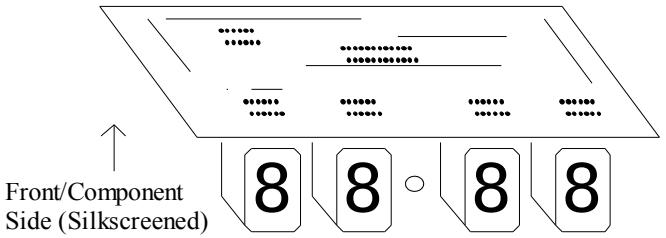
INVENTORY

Before beginning assembly, unpack and take inventory of all parts.
Be careful not to damage or lose the small surface mount capacitors, resistor and watch crystal, these parts are packed in a separate bag.

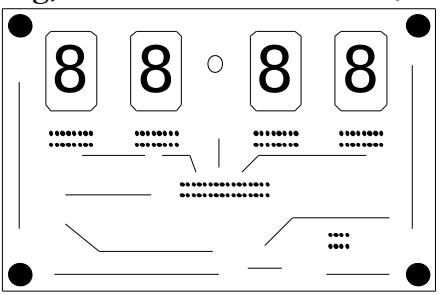
ASSEMBLY OPTIONS

Before beginning assembly you should decide on how you wish to mount the tubes. There are two common mounting options, 'upright' and 'edge-view'.

Edge View mounting



Upright mounting, tubes mounted on Front/Component Side



Depending on your tube mounting selection and case design, you should choose which side you will be mounting the reset and time set switches.

You also have the option of mounting all of the tall components on the back of the PC board (front = silkscreen, back = no silkscreen). As an example, this can be done for clearance on an upright mounted design where the tubes would be exposed from the case. When no specific side is noted for a component, we assume the component is mounted on the front of the PC board. If mounting components on the reverse side, pay special attention to polarity and correct orientation. All silkscreen printing refers to components mounted on the front of the board (silkscreen side). Some components, such as Q1, Q2 and U1, if reverse mounted, will need to be oriented opposite the silkscreen pattern show to maintain correct pin orientation.

Components which can be reverse mounted:
All switches, Q1, Q2, U1, 1F, VR, C1, C2, C3, and L1.

BEGINING ASSEMBLY

You can assemble the kit in any order you wish, but following the order listed below is recommended.

Surface Mount Components

There are 6 surface mount components: 5 capacitors and 1 resistor. All are mounted on the back of the board. The back of the board can be easily identified by a part number and www.neonixie.com printed in copper. Also, the back of the board does not have silkscreen printing.

● Solder the surface mount resistor marked 'R100'. There are no PCB markings for this part. It's location is on the back of the board under D2, and is soldered across one of the pins of Q1 and the ground plane on the edge of the board. See figure 1.

● Solder the .33uf surface mount capacitor. This is the largest of the 5 remaining surface mount capacitors, there is only one of this type. There are no PCB markings for this part. It's location is on the back of the board near U1, and is soldered across the positive and negative supply traces. See figure 2.

● There will be 4 remaining surface mount capacitors. All similar.
  - ● One is located near U1 on the back of the board. It is soldered across a trace that leads from the center pin of U1 and the pin furthest away from the boards edge. Figure 2.
  - ● Solder the next one on the back of the board between the traces leading from pins 7 and 22 of 'uC'. Figure 3.
  - ● The other two are soldered on the back of the board, directly underneath the 'DC-DC' IC. Figure 4.

After you are done soldering the surface mount parts, it is a good idea to check that there are no solder bridges between each of the components. This can easily be done with a DMM set to check continuity.

Figure 1

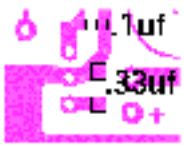


Figure 2

Figure 3

Figure 4

DC-DC CONVERTER ASSEMBLY

The high voltage DC-DC converter is located on the lower right hand corner of the PC Board, and is composed of the following components: DC-DC (8-pin DIP IC), Q1 (3 pin TO-220, marked IRF740B), L1, D2, VR, R10, R11, C1, C2 and C3, as well as the 2 surface mount capacitors and 1 resistor which you have already installed.

● Install R10, R11, D2, and the 8-pin DIP IC. **Do not socket the 8-pin DIP IC. Pay special attention to the orientation of D2 and the IC.** Align D2's stripe with the one printed on the PCB. Since there are two similarly sized diodes in this kit, make sure you are using the correct one for D2, it is marked 'STTH106'. Do NOT rely on the 'square' pads for placement of Pin 1 of the IC. Pin 1 can be identified by the silkscreen printing and is the one closest to the letter 'Q' of Q1.

● Install the remaining components, VR, Q1, C1, C2, C3 and L1. **Pay special attention to the orientation of Q1, C1, C2, and C3.** The bold striped silkscreen printing for Q1 refers to the metal side of the TO-220 package. In this case, it is facing the right edge of the board. C1, C2 and C3 have their positive terminals marked in silkscreen. The negative terminal on the capacitors are marked with a band. L1 can be installed in either orientation, but because of the close proximity to Q1, make sure they do not contact each other.

● You are now ready to test and adjust the high voltage converter. Temporarily hookup the positive and negative power supply leads to the DC jack. **Do NOT apply power at this time.** The power supply connections on the board are located on the lower left hand corner, the positive terminal is marked on the back of the board with a '+' indicator. The supplied DC adapter is center pin positive. Make sure to observe correct polarity by checking the DC jack output with your DMM.

When powered, some components in the DC converter, Nixie tube supply traces and vias/pads are at voltages near 200v!!! Do not touch the board or any components on the board while it is powered. Place the board on a non-conductive surface, away from metal objects while under test. Use test leads that are rated for high voltage use. After powering down the unit, wait at least 30 seconds to allow the capacitors in the circuit to bleed off any stored high voltages before handling the unit or any test leads connected to the unit.

TESTING and ADJUSTING THE DC-DC CONVERTER

Connect a multimeter capable of measuring high DC voltages to the unit, set the meter to its high range, 200 volts or above. The negative terminal can be hooked up to one of the 4 mounting holes on the corners of the board. Hook up the positive terminal of the multimeter to the striped cathode end of D2.

Apply power to the unit. You should be measuring somewhere between 140 and 200 volts DC on your meter. Our goal is to get the voltage close to 170 volts, + or - 2 volts. Turn off the unit, wait 30 seconds for the high voltage to bleed down, and adjust VR to increase or decrease the voltage. Clockwise will increase the voltage, counter-clockwise will decrease. Repeat this process until the converter is adjusted properly.

MICRO-CONTROLLER

● Install R3, R6, R7, R8 and R9.

● Install the Set and Advance push buttons, located below R7 (Advance), and R9 (Set). You have the option of installing either the small tactile buttons, or the taller blue buttons, on either side of the board.

● Install Q2, correctly mount it according to the silkscreen printing.

● Install the small diameter insulating tubing provided to the leads of the neon bulb, install the neon bulb above Q2.

● Install D1, match the striped cathode end with the silkscreen printing.

● Install U1 (TO-220, marked 7805), match the bold stripe silkscreen printing with the metal side of the TO-220 package.

● Install the reset tactile button, it is located just below the part number on the left side of the board. Do not install the black button cover on the reset button.

● Install the micro-controller, solder a few of the outer pins to keep it in place. Do not solder all of the pins at this point.

● Install the watch crystal, a small metal cylinder, on the back of the board to pins 9 and 10 of the micro-controller. These pins are labeled in small copper text, x1 and x2.

Make sure the metal cylinder of the crystal rests completely inside the ground plane, and is flat against it. Trim the leads to the minimum amount needed to properly solder it directly to the pins of the micro-controller. Solder both the crystal and the micro-controller pins to the board at the same time.

Do not solder the case of the crystal to the ground plane, heat damage will occur.

● Solder the remaining pins on the micro-controller.

TESTING THE MICROCONTROLLER

At this point we can verify proper assembly and operation of the micro-controller. Power up the unit, observing all high voltage precautions. After a few seconds, the neon bulb should blink at a rate of 1 second off, 1 second on. Power down the unit and wait 30 seconds before handling the clock.

NIXIE TUBES and DRIVER ICs

● Install the four 74141 Driver ICs, be sure to properly orient pin 1.

● Install R1, R2, R4 and R5.

● Install the four IN-17 nixie tubes. If you are using the upright mounting method, occasionally the plastic bases on the tubes might have casting flash on them, if there is extra material near the two bump guides on the bottom, remove these with a set of small clippers.

If you are using the edge view mounting method, make sure to insulate, or properly protect the exposed tube wiring. These wires carry high voltage and damage will result if they contact. The plastic bases can be omitted in edge view mounting if desired.

● Install 1F, the large 1 Farad disk shaped capacitor. The board is marked with arrows indicating the ground pin, match these with the marks on the capacitor.

CONGRATULATIONS! You have finished assembly of your Nixie tube clock!

Power up the unit, observing all high voltage precautions.
After a short lamp test routine, the clock will start running at 12:00.
Turn off the unit, wait 30 seconds for the high voltage to bleed down.

NOTE: Once the clock is powered up, the 1 Farad backup capacitor will store voltages for many hours, be careful not to short any leads on the clock, even when the clock is not powered. You will no longer see the lamp test routine as the clock continues to run while unplugged.

Before permanently operating your clock, you will need to build a suitable enclosure to house it. Do NOT operate the clock with the components or board exposed, high voltages are present.

ENCLOSURE

See the appendix for PCB mounting dimensions, this will help you in building an enclosure for your clock.

Enclosure Notes

● The four mounting holes on the PCB are electrically attached to the negative ground on the clock. Do NOT use screws, standoffs, or other mountings which extend beyond the pad diameter of the mounting holes. Pads are 0.250" (6.35mm) in diameter.

● Metal or electrically conductive enclosures should be tied to the negative ground on the unit. This is done to prevent electrical shock should high voltage accidentally contact the case.

● Care should be taken on enclosures made of electrically insulating materials. Metal mounting components, especially ones that pass from the interior of the case to the exterior, should be grounded to the unit to prevent electric shock should high voltage contact these parts.

● Space is provided below the reset switch for passing the terminals of the metal DC power jack. This can be useful to reduce the case depth of an upright mounted design. A through-hole is mounted in the center of this area, in which a maximum 0.4" (10.15mm) diameter hole can be drilled for this purpose.

OPERATION

Once powered up the clock will go through a short lamp test routine and will start with a time of 12:00 PM in 12 hour mode.

The clock is adjusted using two buttons, Set and Advance.
Set is located below R9. Advance is located below R7.

SETTING THE TIME

Hold down the Set button for a few seconds, the hours or minutes will start to blink. You are now in the time set mode. Pressing the Set button chooses between hours and minutes. Pressing the Advance button will increment the hours or minutes. Holding down the Advance button will quickly advance the time.

When adjusting minutes, the clock will reset the seconds counter to 0 at each increment. Seconds are not reset when adjusting hours.

The clock will return to normal operation if no buttons are pressed for a few seconds.

SETTING USER OPTIONS

Several user options are available. These options are stored in non-volatile EEPROM and will be maintained even after a power outage or long term storage of the clock.

The clock options menu can be accessed by holding down both SET and ADVANCE buttons for a few seconds.

Each option is indicated by an option number displayed on the tens digit of the hours indicator, the left most Nixie tube. The Set button is used to change option numbers, and the Advance button is used to alter the option.

- 12/24 Hour mode. This is option #1 on the menu.

Press the Advance button to change between 12 or 24 hour modes.

● Digit cycling. This is option #2 on the menu.
This option is used to prevent cathode poisoning of digits not used in the normal operation of a clock. It will cycle all the digits at a predefined time.

- 0: No cycling takes place.
- 1: Cycles at midnight (Default value).
- 2: Cycles at the top of every hour.

● Software time correction. This is option #3 on the menu.
This option can have a value from -99 to +99. Negative values are indicated by lighting the center colon indicator. Use the Advance button to adjust this value. The Advance button alternates between incrementing and decrementing this value on each press.

NOTES ON SOFTWARE TIME CORRECTION

The software time correction value entered by the user refers to the number of seconds per week of correction. For example, if the clock is slow 14 seconds per week, a value of +14 entered into the software correction option will compensate for this drift.

Software time correction is preferred over physically adjusting the crystals load capacitance, since adjustment can be done with no tools by the end user. Software time correction also allows the user to easily compensate for crystal aging and for adjusting the clock for accuracy in different temperature environments.

When taking measurements to find the proper correction value, remember that average temperature plays a large role in the clocks accuracy. A clock corrected to operate precisely at an average temperature of 50 degrees, will drift slightly if operated at 80 degrees, and vice-versa.

When taking time readings for software correction, be sure to use an accurate source. Accurate sources include an atomic clock that has recently synced, a PC that is synced to a time server, or a GPS receiver. The clock is shipped with a default value of +14 seconds.

Once software adjusted, and kept in a controlled environment with minimal temperature drifts, such as an air conditioned or heated home, accuracies of greater then 1 second per week can be achieved.

Part List

PCB MARKING	PART NAME	VALUE	NOTES
H, H, M, M	IN-17 Nixie Tubes	n/a	Fragile Glass!
R1, R2, R4, R5	Nixie tube anode resistors	36k	Orn-Blu-Orn
R3	Neon Bulb anode resistor	390k	Orn-Wht-Yel
R6	Transistor base resistor	33k ohms	Orn-Orn-Orn
R7, R8	Switch resistors	4.7k ohms	Yel-Vio-Red
R9	Power sense resistor	4.7k ohms	Yel-Vio-Red
R10	Resistor	10k ohms	Brn-Blk-Orn
R11	Resistor	1.2M ohms	Brn-Red-Grn
n/a	Rsense resistor (SMD)	.100 ohms	Marked R100
C1	Capacitor 25v	47uf	
C2	Capacitor 35v	150uf	
C3	HV Capacitor 250v	2.2uf	Green Color
n/a	.1uf 0805 bypass caps (SMD)	.1uf	Qty 4
n/a	.33uf 1206 cap (SMD)	.33uf	
Q1	IRF740B FET	n/a	TO-220
Q2	MPSA42, Transistor	n/a	TO-92
U1	7805 Regulator	n/a	TO-220
74141	HV Nixie Driver IC, 16-pin DIP	n/a	Qty 4
DC-DC	Max1771, 8-pin DIP	n/a	
uC	Microcontroller, 28-pin DIP	n/a	
D1	1N5817	n/a	
D2	STTH106	n/a	
1F>>	1 Farad backup cap	1f	
VR	Variable Pot	5k ohms	
L1	Inductor TV-1363-B	220uH	
n/a	Switches, small pushbutton	n/a	Qty 3
n/a	Buttons for small switches above	n/a	Qty 2
n/a	Switches, optional tall blue switches	n/a	Qty 2
n/a	Buttons for optional switches above	n/a	Qty 2
n/a	DC power jack, metal thread	n/a	Users choice
n/a	DC power jack, plastic thread	n/a	Users choice
n/a	Neon Bulb	n/a	Fragile Glass!
n/a	32 Khz Watch Crystal	n/a	n/a

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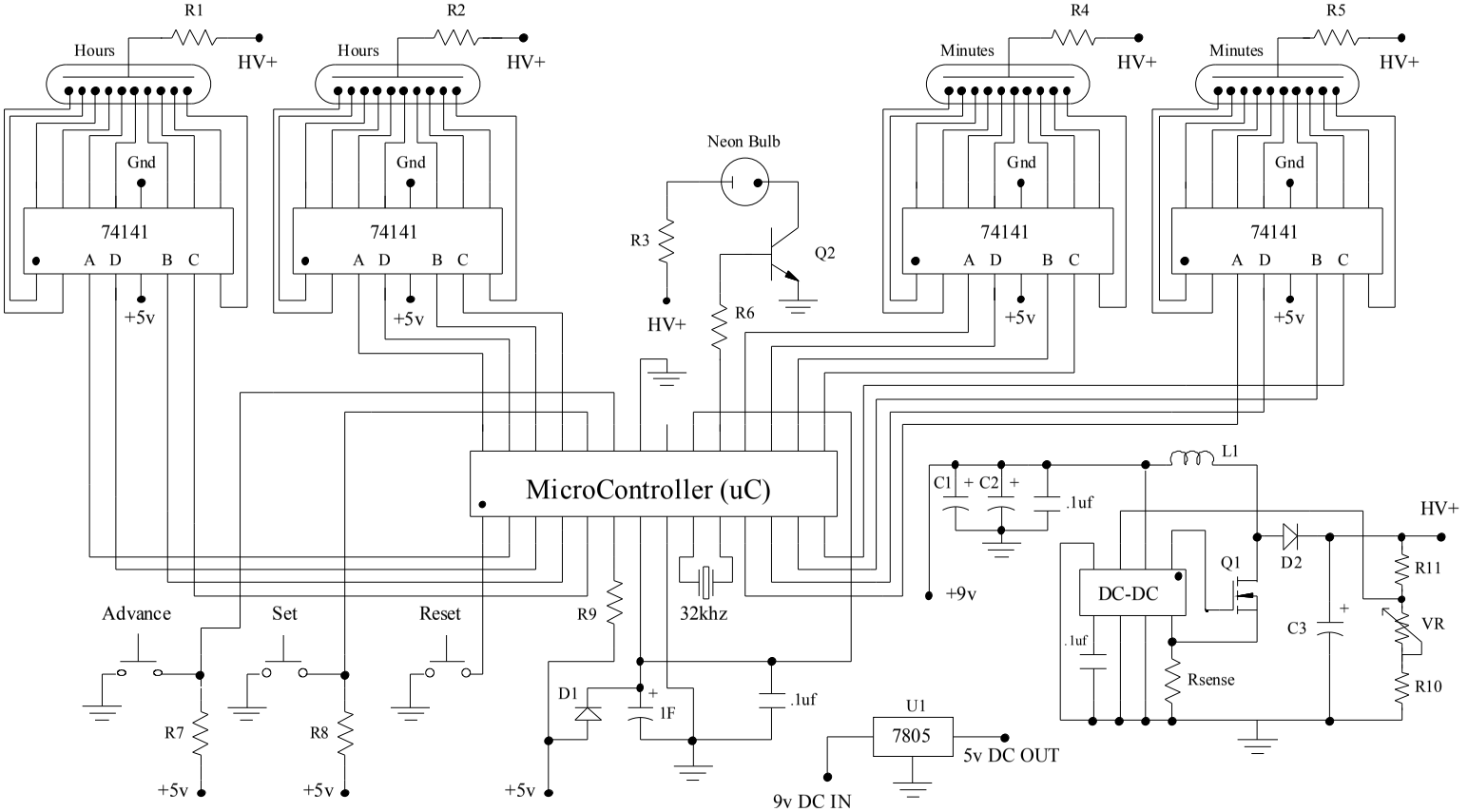
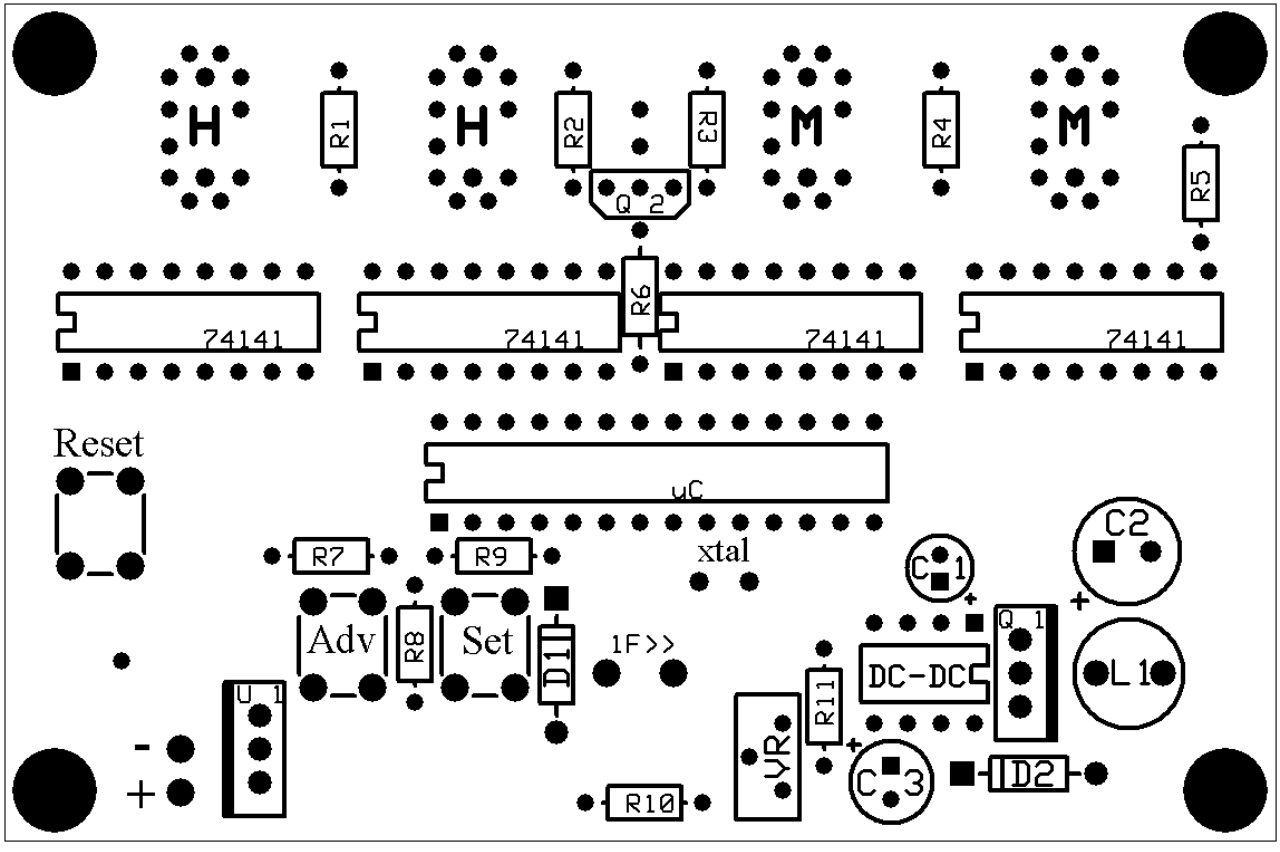

R1
Hours
HV+
R2
Hours
HV+
R4
Minutes
HV+
R5
Minutes
HV+
Gnd
74141
A D B C
+5v
Neon Bulb
R3
Q2
R6
HV+
MicroController (uC)
C1
C2
.1uf
L1
+9v
DC-DC
Q1
D2
HV+
R11
VR
R10
C3
Rsense
.1uf
Advance
Set
Reset
R9
32khz
D1
1F
.1uf
R7
R8
U1
7805
5v DC OUT
9v DC IN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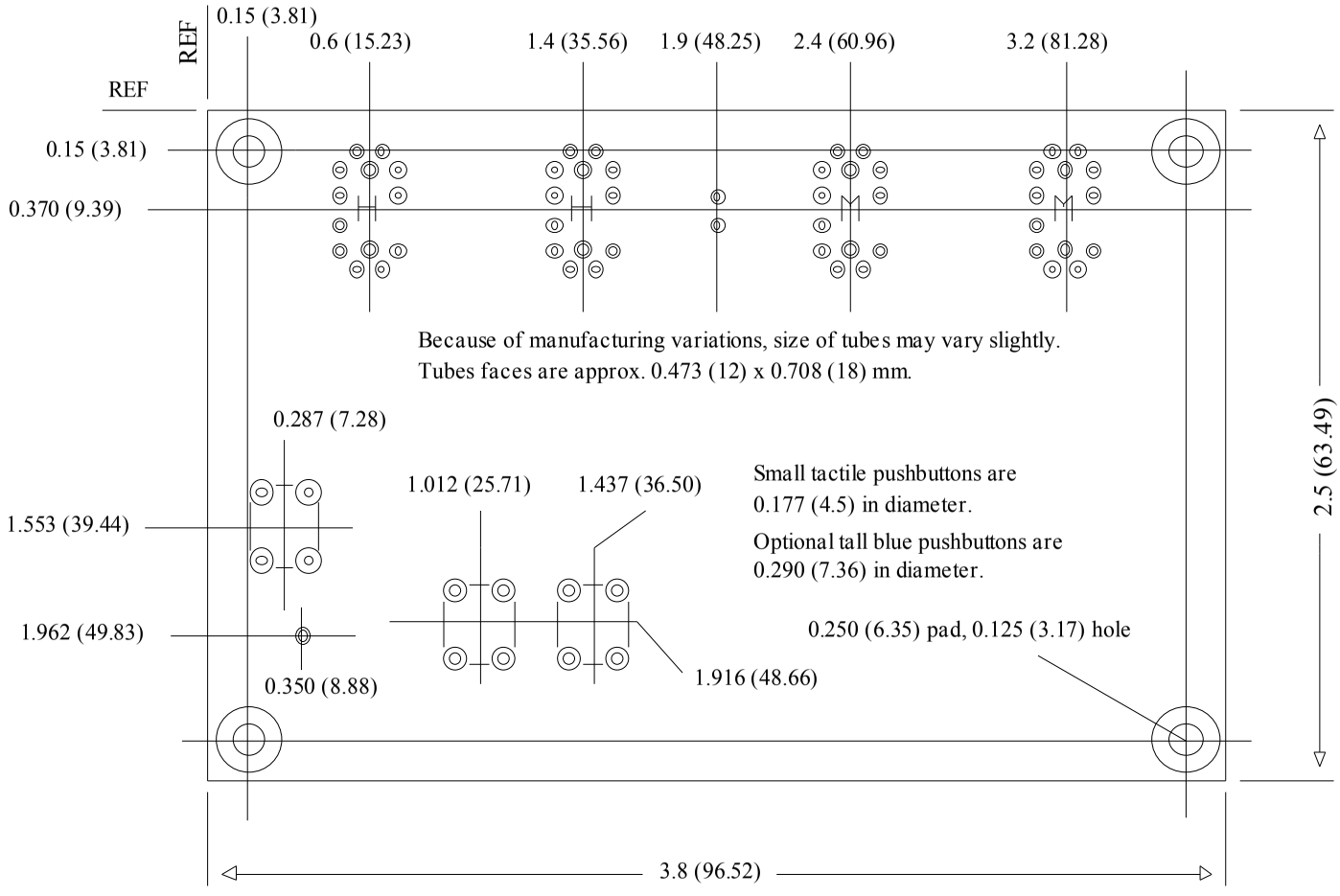
Adv
R8
Set
D1
1F>>
U 1
R10
VR
R11
C 1
C2
Q 1
DC-DC
L1
C 3
D2
-
+


REF
0.15 (3.81)
0.6 (15.23)
1.4 (35.56)
1.9 (48.25)
2.4 (60.96)
3.2 (81.28)
REF
0.15 (3.81)
0.370 (9.39)
Because of manufacturing variations, size of tubes may vary slightly.
Tubes faces are approx. 0.473 (12) x 0.708 (18) mm.
0.287 (7.28)
1.553 (39.44)
1.962 (49.83)
0.350 (8.88)
1.012 (25.71)
1.437 (36.50)
1.916 (48.66)
Small tactile pushbuttons are
0.177 (4.5) in diameter.
Optional tall blue pushbuttons are
0.290 (7.36) in diameter.
0.250 (6.35) pad, 0.125 (3.17) hole
2.5 (63.49)
3.8 (96.52)

Electrical Specifications

Voltage:	9v DC No-load voltage not to exceed 14 volts from an unregulated DC adapter.
Current consumption:	Average 150 ma Initially as high as 200ma due to charging of backup memory capacitor.
Power consumption:	Average 1.35 watts

Questions, Comments? Please email nixietubes@neonixie.com

Manual Revision: 1.01
Board Revision: 1.02
Firmware Revision: 1.00

Warranty

Neonixie warranties the components in this kit to be free from defects for a period of 90 days from the date of purchase. Defective components will be replaced at our cost. If you suspect a component to be defective, please contact us for troubleshooting assistance and/or return instructions. Please do not return the whole kit.

Components must be returned in good condition, free of physical damage. Damage caused by incorrect placement or ESD are not warrantied.

In case a part is damaged by incorrect assembly or use, replacements are available at reduced prices for kit purchasers.
Contact us for details.

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