# High Voltage Generator v1

## Operating Instructions
## &
## Construction Manual

Document V001a

# Contact Information

If you want to get in contact with us, please email to:

nixie@protonmail.ch

We'll usually get back to you right away. We can help you with kits or construction.

# Troubleshooting

If everything does not work as you expect, please carefully look at the tests in the construction steps, and the troubleshooting tips.

At the end of the manual, there is a troubleshooting section, which goes through some of the common problems.

# Description

The High Voltage Generator board is ideal for use in your own Nixie Tube projects. It is a stable, high efficiency design, which requires zero maintenance after the initial set up.

The generator has the following features:

- High efficiency (~ 85%).
- Extremely simple construction
- Extremely simple set up (single multi-turn potentiometer to set the output voltage)
- High stability
- High power output, even with no external heat sink
- Wide range of input voltages (6V DC – 18V DC)
- Wide range of output voltages (40V DC – 200V DC)

# Safety

The voltages produced in the High Voltage circuit can reach peaks of 400V! Take precautions not to electrocute yourself! If you are not sure what this means, please do not use this clock and return it for a full refund.

A shock from the clock high voltage circuit is at least a nasty bite. At worst it can kill you.

We decline any responsibility in the case of injury or death.

**REPEAT**: If you are not sure, please do not use the board.

# External power supply

The perfect voltage for the external power supply is 9V DC or 12V DC.

If you use more than 12V be aware that you might have to provide a heat sink for the power components and adjust the HV voltage generation.

The absolute maximum permissible is 18V DC. Higher voltages than this will surely damage the board.

# Output Voltage Range

The output voltage range is determined by the 1.25V reference inside the 34063 and the potential divider formed by R2 and R3+R5.

The minimum voltage is:

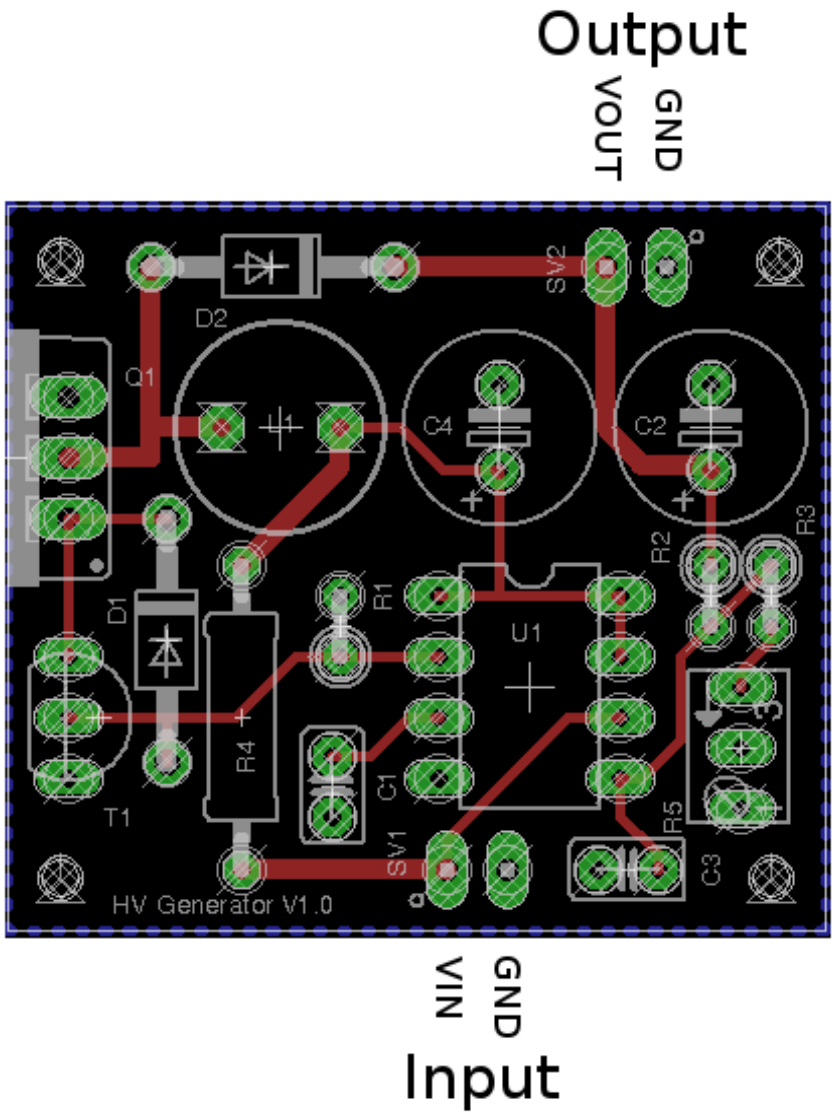
1.25 * (R2+R3+R5)/(R3+R5) = 1.25 * (390 + 2.2 + 10) / (2.2 + 10) = 1.25 * 39.97 = **41.2V**

The maximum voltage is:

1.25 * (R2+R3+R5)/(R3+R5) = 1.25 * (390 + 2.2 + 0) / (2.2 + 0) = 1.25 * 178.2 = **222.8V**

# Board layout

For reference, the board layout is as shown (viewed from the top):

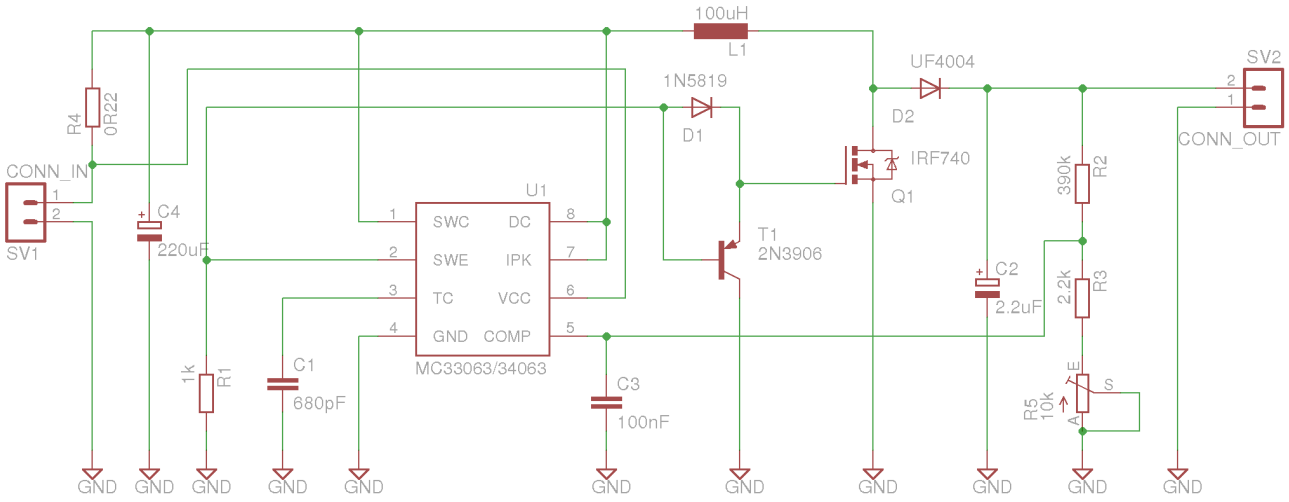



The connections are:

| Connector | Description | Values |
|---|---|---|
| Input | External power should be applied to the board with this connector.<br>Any DC input source is possible, from 6V DV – 18V DC.<br><br>The input current ranges from 300mA to 1A depending on the size of the tubes and the number of LEDs you are driving.<br><br>**GND:** The negative side of the input supply<br>**VIN:** The positive side of the input supply | |
| Output | The high voltage output is available at this connector.<br>**GND:** The negative side of the output.<br>**VOUT:** The positive side of the output. | |

# Schematic

Below is the schematic for the board.



# Construction

## Preparation:

You should have a small tipped soldering iron, some thin (< 1mm) solder, and electronic side cutters.

## Kit Contents:

When you unpack the kit, you should find the following contents as listed in the BOM (Bill of Materials). It is best to check the contents before you start, and notify me straight away if you are missing any components.

Please see the appendix to help you identify individual components.

## Bill Of Materials (BOM)

| | | |
|---|---|---|
| PCB | PCB | ☐ |
| C1 | 680pF | ☐ |
| C2 | 1uF 400V | ☐ |
| C3 | 100nF | ☐ |
| C4 | 220uF | ☐ |
| D1 | 1N5819 | ☐ |
| D2 | UF4007 | ☐ |
| L1 | 100uH | ☐ |
| Q1 | IRF740 | ☐ |
| R1 | 1k | ☐ |
| R2 | 390k | ☐ |
| R3 | 2.2k | ☐ |
| R4 | 0R22 | ☐ |
| R5 | 10k | ☐ |
| SV1 | CONN_IN | ☐ |
| SV2 | CONN_OUT | ☐ |
| T1 | 2N3906 | ☐ |
| U1 | MC34063 | ☐ |

## The instruction manual

http://www.open-rate.com/Downloads/HVGenInstructionManualRev1V001.pdf

**Notes:**

- See the section on “Component Identification” for help with identifying the components.
- D1 and D2 look very similar, but have different jobs to do. Be careful not to mix them up. The UF4004 is an “ultra fast” diode, and putting the 1N5819 in it's place will make the circuit less efficient and unable to reach the maximum voltage.
- D1 and D2 should be placed so that the white stripe on the body lines up with the white stripe on the board.
- C2 and C4 must go the right way round. The negative side is marked with a stripe. (See hint)
- Put Q1 so that the metal tab lines up with the white stripe on the board. The metal side faces to the *outside* of the board.
- Put U1 so that the notch in the case lines up with the notch marked on the board.

Test Step

Once all the components are on the board, you can perform a test. If you have a current limited power supply, set the current limit to 1A.

Turn on the power and check that the output voltage is available.

Trouble shooting

**If you hear any angry sounding buzzing turn the power off immediately and check the orientation of C2!** The circuit should run almost silently, with only a very faint “crackling” or hissing sound.

If you can't reach the target voltage, turn off and check the polarity of your components, especially C2. If you have an oscilloscope, you can check the voltage at the gate of the MOSFET Q1, and it should show pulses of high frequency rectangle wave: this is the driver waveform to the HV generator, which is being turned off and on by the voltage detection, trying to achieve the target voltage.

**Be careful, we are dealing with high voltages now!** The voltage may be significantly higher than 170V at the moment, because the high voltage generator is powerful and the output is not loaded. Once you add a load, (by connecting the tubes), the voltage should oscillate around 170V – 190V, and might have a slight “sawtooth” appearance if you view it with an oscilloscope.

Test Step

Check the high voltage at the output.

You can also test using an old neon lamp if you have one. Temporarily connect the neon lamp between the “GND” test point and the output with an appropriate ballast resistor (turn the power off first). Turn the power on and the neon lamp should come on.

Adjust the potentiometer to achieve your target voltage.

Trouble shooting

Q1 can get warm, **but should not get too hot to touch**. If it gets hot, you need to check the orientation of the components and that there are no solder bridges.

**If you don't get the expected voltage reading**:

- Check your soldering that there are no bridges or dry joints.

- Check that the external power supply is able to supply the power needed to achieve the high voltage: check that the VIN voltage is stable and not fluctuating.

# Component Identification

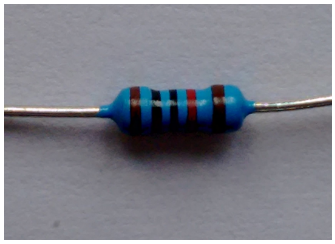
We can't always guarantee to get exactly the the same components. Where we have alternatives, they are listed separately under the same heading.

## 2.2k resistor

Alternative 1

The color code for the 10k resistor is:

RED = 2
RED = 2
BLACK = 0
BROWN = 1 (1 zero in this case)
BROWN = 1 (1% Tolerance)
**= 2 2 0 0 with 1% tolerance**



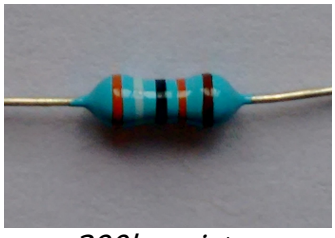
*2.2k resistor*

## 390k resistor

Alternative 1

The color code for the 390k resistor is:

ORANGE = 3
WHITE = 9
BLACK = 0
ORANGE = 3 (3 zeros in this case)
BROWN = 1 (1% Tolerance)
**= 3 9 0 0 0 0 with 1% tolerance**



*390k resistor*

**Hint:** The 220 uF capacitor

The electrolytic capacitor has a stripe on it to denote the **negative** side of the capacitor. The positive side of the capacitor (which goes into the "+" on the board) is the other one!

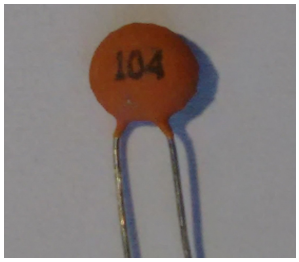
*220uF capacitor "stripe"*

## 100nF capacitor

The coding on the 100nF capactor is “104”. It does not matter which way round it goes.

This is decoded as:

= “1” then a “0” and then 4 more zeros
= 100000 pF
**= 100 nF (1 nF = 1000 pF)**



*100nF capacitor*

Revisions:

V0001a: 03May2016: Initial version