

# Simple High-Voltage Generator

## Introduction

For testing HV-capacitors, semiconductors and wirings (cables) with voltages up to 2kV and currents below 1mA, a simple HV-generator is required. A possible solution is the use of a simple and cheap inverter for CCFLs (cold cathode fluorescent lamps).

## Concept

These inverters (picture 1) supply a voltage of app. 500VAC at 4-5mA at 12VDC input. Under no load condition, the output voltage rises up to 2kVpeak and the frequency is about 30 to 50kHz. This voltage is rectified with a bridge rectifier (with HV-diodes) to get an output of 2kVDC maximum. By changing the supply voltage between nearly zero and the specified 12VDC, the output voltage can be set between app. 100VDC (minimum) and 2kV (maximum).



Picture 1 Inverter

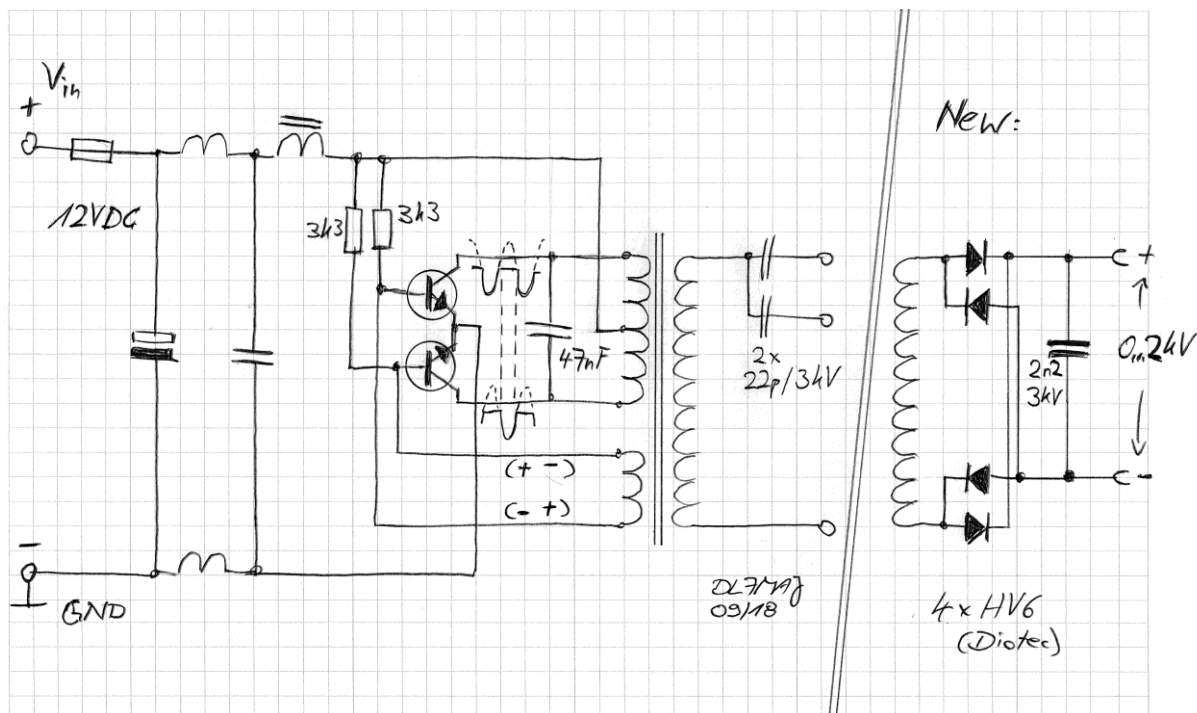
## Principle (Schematic)

Picture 2 shows the principle of such an inverter:

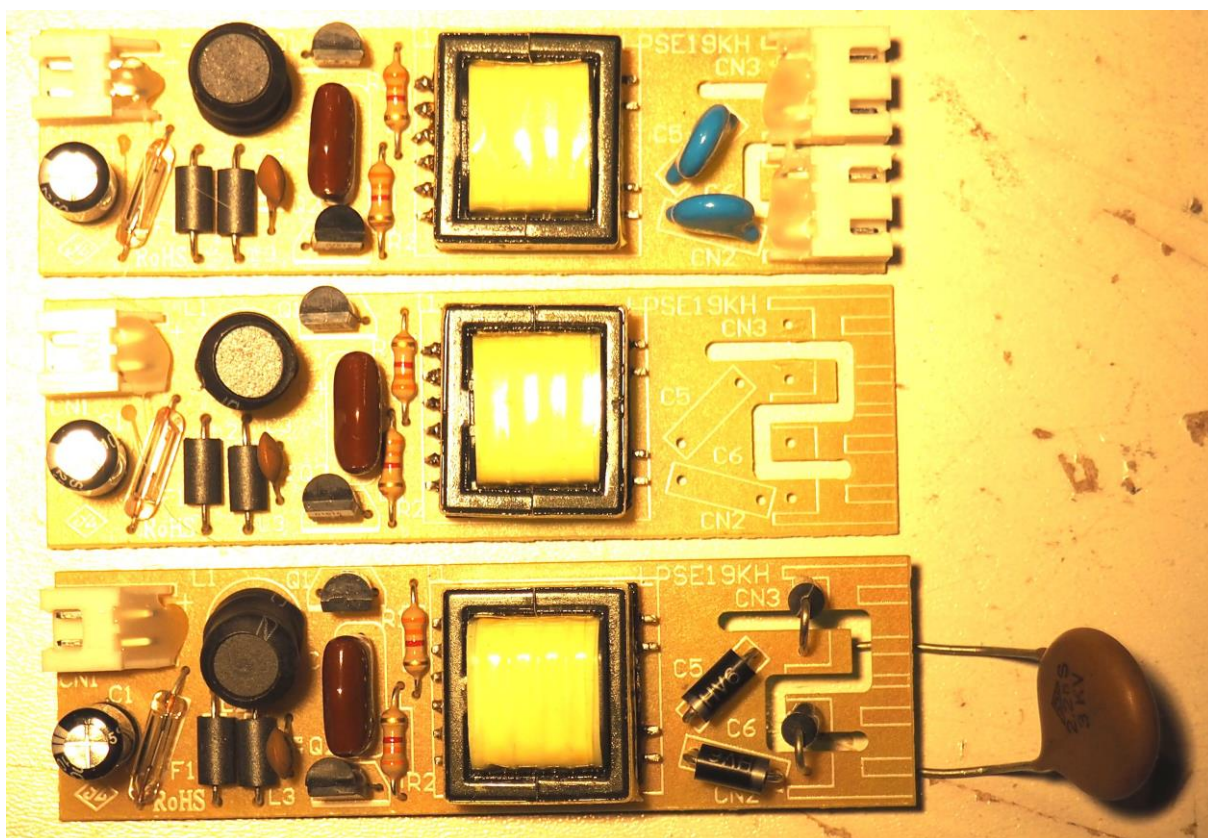
Two transistors are operating in a typical push-pull configuration as inverter, the frequency is determined by the 47nF capacitor. Due to the relatively high feedback and bias, this circuit also operates at voltages much lower than the specified 12VDC; it can be used down to 2VDC!

The necessary modification is: The two output capacitors (app. 22pF) and pinheads, where the CCFLs are connected, are replaced by 4 HV-Diodes type HV6 (diotec), which are used as a bridge rectifier, and a HV-capacitor for filtering (picture 3). These diodes have a reverse breakdown voltage of 6kV, which is sufficient for a rectifier operating at 2kV peak; HV5 should also be good (5kV).

With this modification, the inverter is prepared to work when connected directly to a variable power supply with a current limitation: 0 ... 12VDC and current limit set to 400mA (datasheet of inverter).



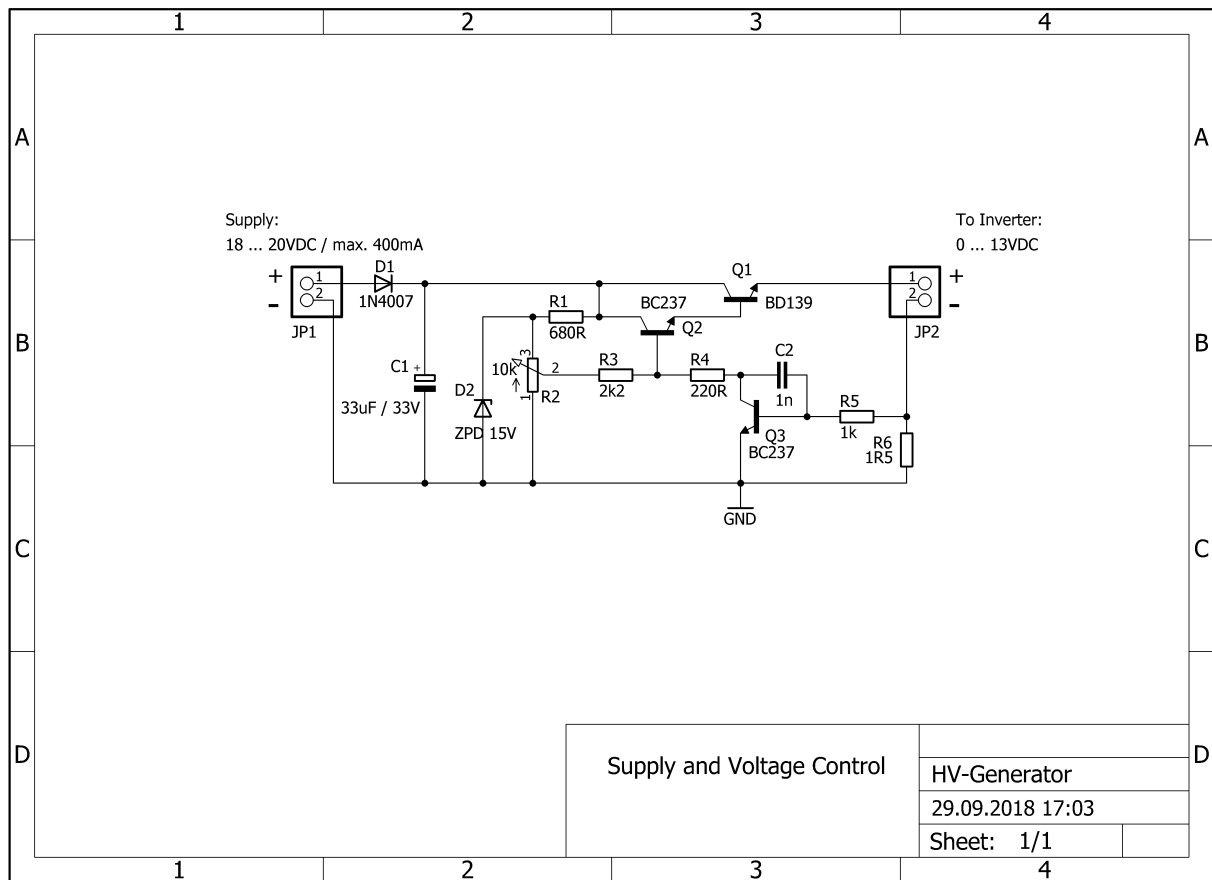
Picture 2: Principle of an inverter for CCFLs



Picture 3 Modifications (from top to bottom)

## Final version

For a more comfortable use, it is a good idea to install an additional circuit for setting the output voltage and have a current limitation (picture 4).



Picture 4 Supply and Control Circuit

Q1 stabilizes the output voltage at JP2 and is controlled via Q2 (Darlington) and R2. The pot R2 is installed at the front of the unit with a big knob and a scale. R6 is a shunt for the current in the inverter and makes the Q3 conductive, when the current exceeds 400mA ( $1R5 \times 400mA = 600mV$ ). Q3 reduces the base voltage at Q2 via R4. The necessary input is 18 to 20VDC at JP1.

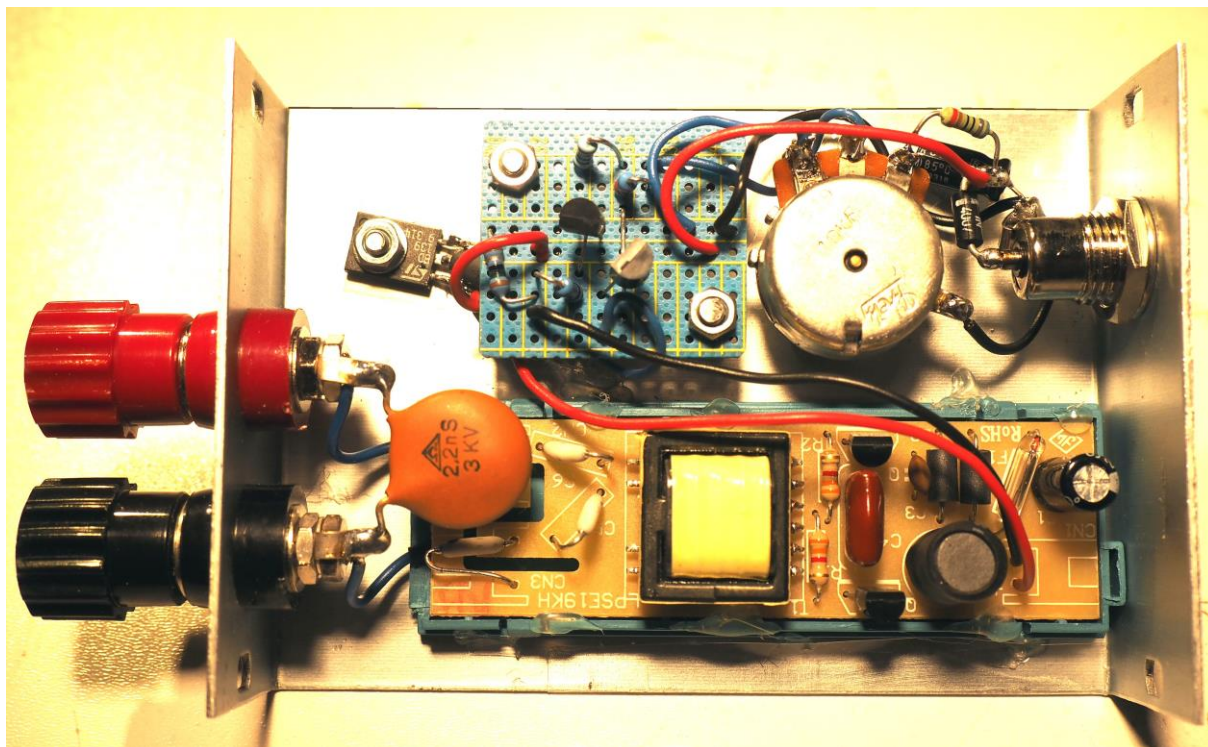
The Z-Diode supplies 15VDC, but more than 1V is lost in the Darlington Q1/Q2 and in the shunt R6 also some mV are lost; so the output for the inverter is limited to app. 13VDC.

The whole circuit is installed on a simple board in an aluminum case (picture 5).

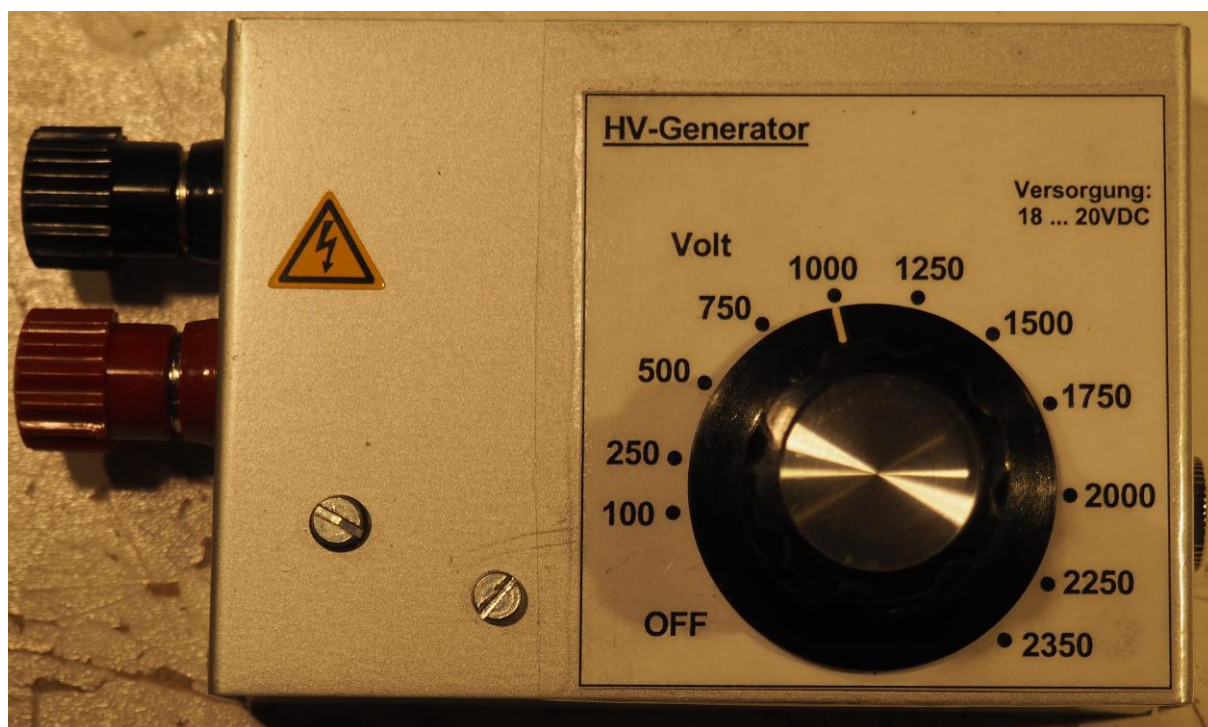
Note: HV-diodes in picture 5 are BY509 and not HV6.

Picture 6 shows the assembled unit – ready for use!





Picture 5 Internal view



Picture 6 HV-Generator – Ready for Use

### Correct U/I Measurement

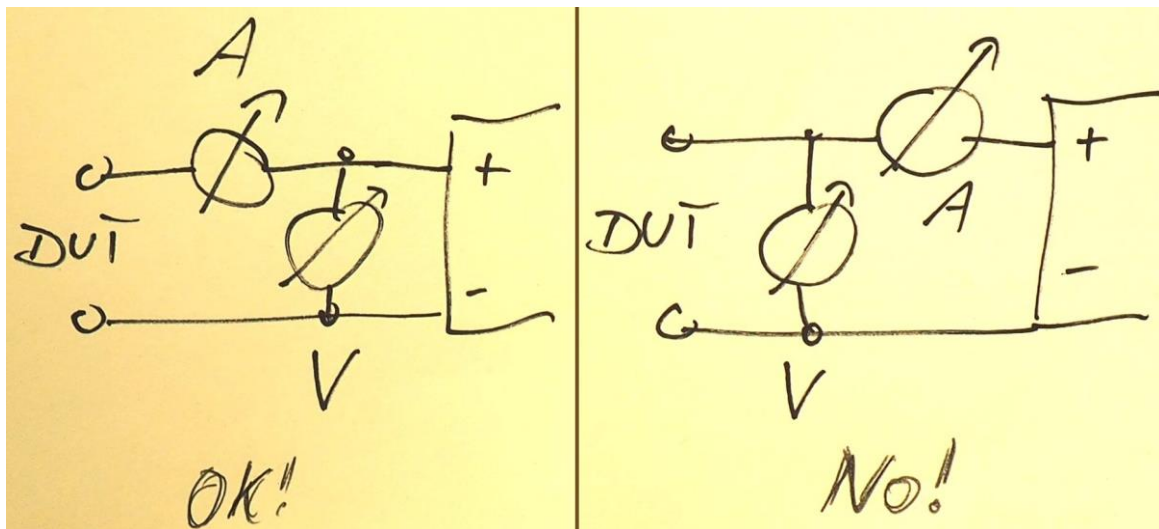
Let's talk about basics of U/I measurement (picture 7):

Modern Voltmeters have an input impedance of 10MΩ; this seems big but these 10MΩ are also valid for the highest voltage range up to 1000V!

Calculate  $1\text{kV} / 10\text{M}\Omega = 100\mu\text{A} = 0,1\text{mA}$ !

At 1kV measured voltage, this means a drawn current of 0,1mA!

To avoid confusion when evaluating a DUT, always connect the voltmeter directly to the HV-generator and THEN the Ammeter "behind" it!



Picture 7 How to Measure – and how not!

### Measurements in Practice

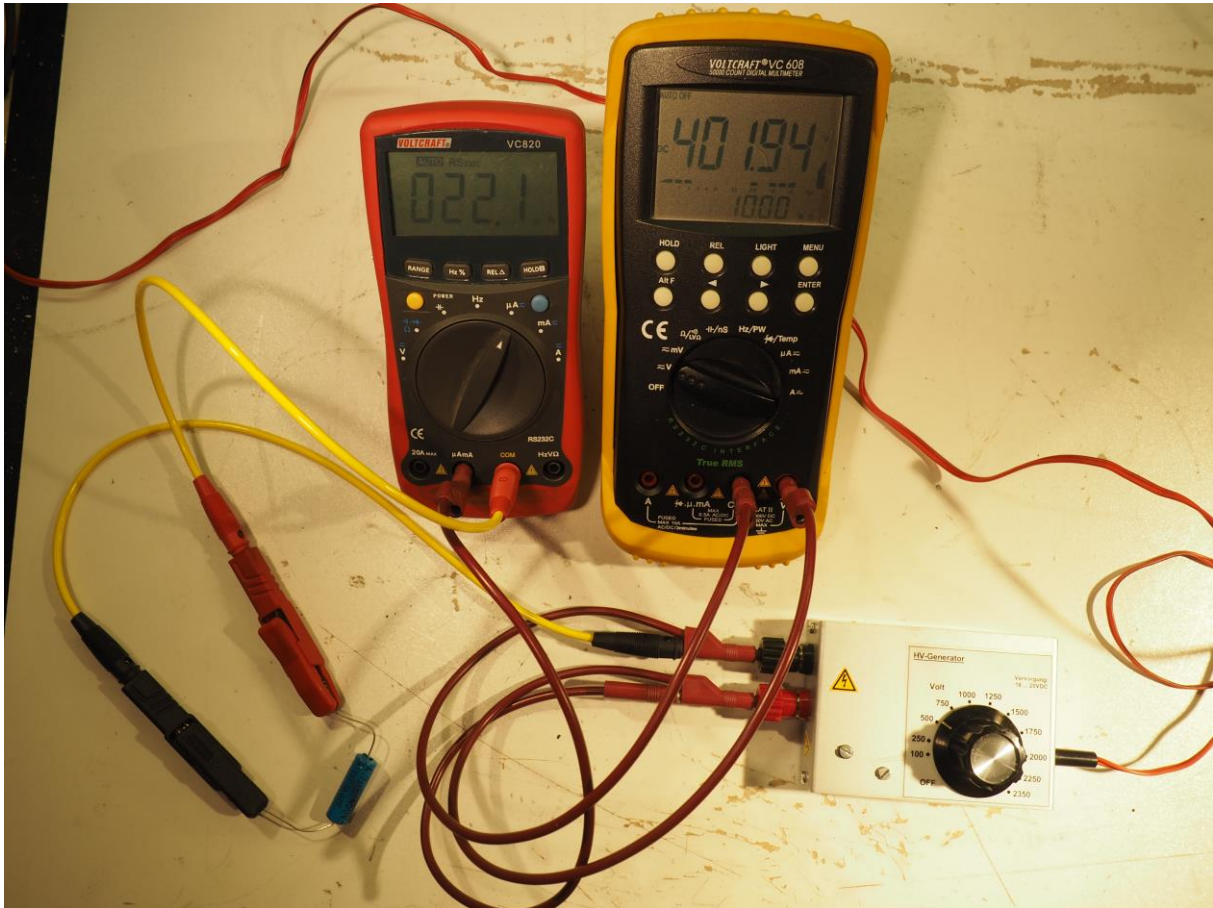
Connect a Voltmeter (if necessary with a HV-probe) parallel to the HV-generator, an Ammeter in series and connect the DUT to it (picture 8).

Whether a DUT is OK or not depends upon the specified data and experience.

### Lethal danger!

Charged capacitors may be LETHAL!

They have to be discharged after measurement!



Picture 8 Practical Testing

### My Video at YouTube<sup>DE</sup>

You can find a video about this HV-generator here in my YouTube<sup>DE</sup> channel DL7MAJ:

<https://www.youtube.com/watch?v=hLx2Qwq1IGQ>

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