Power Supply for Glow Lamps with Low DC Voltage

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1 Introduction

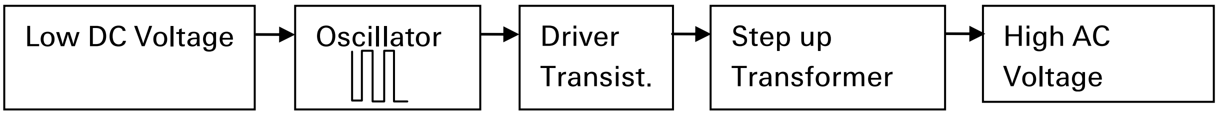
Especially in amateur circles glow lamps are used for the calibration of spectra, which require ignition and operating voltages of mostly >100V. Supply with mains voltage is risky, especially when operating the light source outdoors or inside a metal spectrograph housing. In addition to isolating transformers and RCD protection, this hazard potential can also be mitigated with inverters, which autonomously generate the required high operating voltage with a harmless, low DC voltage and therefore do not carry any voltage potential against ground.

2 Supplement in Document Version 3

The circuit, which was presented in versions 1 and 2, has now been supplemented with additional components significantly increasing the operational stability.

3 Basic Principle of the Inverter

All inverters, regardless of their design, must first convert the DC voltage into AC voltage, which is essential for transforming to a higher voltage level. This task is performed by an oscillator, which usually generates a square wave of low power. This must then usually be amplified with a transistor driver stage and then transformed to the required voltage.



As an alternative to step up the voltage with a transformer, cascades with diodes and capacitors are also applied, as in principle they are also used in high-voltage laboratories under the terms Cockroft/Walton or Villard. This principle is used e.g. in the inverter circuit of the Lhires III spectrograph from Shelyak Instruments. At first glance, these circuits are convincing because they do not require transformers. However, they require large chokes in order to generate not only the required voltage but also the required current. In addition, this does not generate AC but clocked DC voltage. Tests have also shown that this type of supply may result in a shorter lifetime of the lamp and may show a different light output if the polarity of the supply is changed.

The glass bulbs of glow starters contain a bimetal switch within a thin noble gas atmosphere. In contrast to the neon glow lamps originally used, these are designed to generate the ignition voltage in ballasts of fluorescent tubes. For our calibration purposes, however, this switch is "misused" as a gas discharge lamp. An appropriately dimensioned circuit of this inverter ensures that the output current does not become too high, thus preventing the switch from closing and thus operating as a "lamp". Depending on the manufacturer, these switches show a more or less large specimen scattering, which does not play any role for the originally designed purpose and primarily concerns the gap between the switching electrodes. For the modified operation as a "lamp", however, these variations result in different current consumption and luminous power, which can be corrected in our inverter circuit by a potentiometer (see below).

4 Circuit Proposal with Step Up Transformer

Preliminary remarks

The reproduction, and in particular the possible installation of this circuit in spectrographs, is done at your own risk! It requires minimal electronic knowledge and skills in handling soldering material. A multi meter is also indispensable, which is required for the measurement of AC/DC voltages up to approx. 500 V and for determining the current consumption of the circuit (1A range is sufficient).

This voltage source generates >200V AC voltage. Due to the high internal resistance, possible electric shocks are annoying, but should be harmless for healthy persons. Before installation in a spectrograph, a load test over a longer period of time is recommended for the selected circuit configuration. Possible scenarios to be tested are the continuous operation of the light source possibly combined with a defect of the glow lamp (no load and short circuit operation of the inverter).

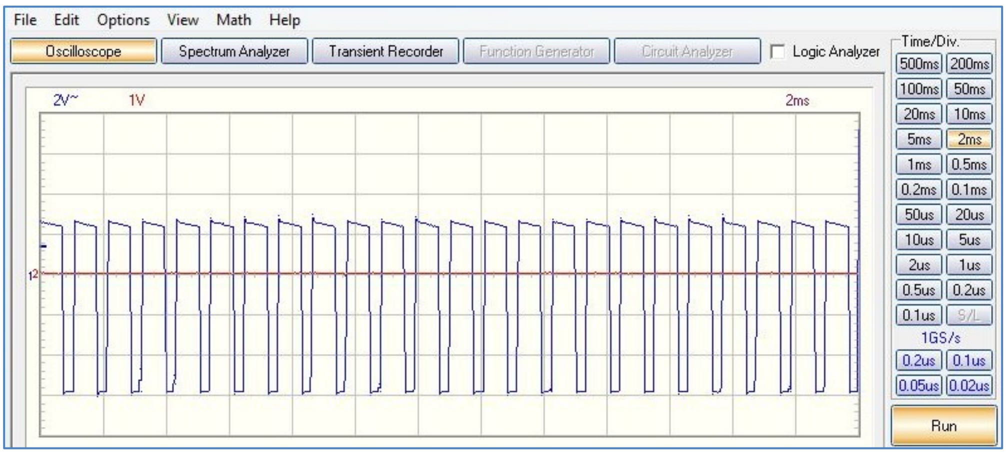
Objectives

The previously presented minimum equipment of the circuit was extended by additional components, e.g. with a reverse polarity protection diode, a fine fuse, a smoothing capacitor parallel to the DC supply voltage, etc. This circuit allows a stable operation of conventional neon indicator lamps as well as all so far tested, modified glow starters.

Circuit description

The universal timer module NE555 forms the heart of the system. If you enter this designation, together with "inverter", into Google, you get far over 100'000 hits with corresponding circuit suggestions.

The external wiring of the NE555 consists mainly of a 6.8KΩ fixed resistor, a 0.1µF capacitor and a 50KΩ miniature potentiometer. With the latter, the frequency of the rectangular oscillation of the oscillator can be set in the range between approx. 200 - 1000 Hz. This allows the luminous power and the current consumption of the circuit to be influenced in such a way that the unavoidable specimen scattering is compensated and flexible adaptation to different lamps and supply voltages is possible. If a resistance value has proven itself during operation for a fixed configuration, the potentiometer could also be replaced by a resistor with a corresponding fixed value.



As a driver stage, the transistor 2N2219A is used, which has a maximum collector current of Ic = 0.8A and slightly more reserve than the mostly suggested 2N2222A, used e.g. also in the Lhires III circuit. The power consumption will be slightly higher, but the transistor will hardly heat up noticeably with optimally adjusted operation. The square wave signal is routed from pin 3 of the NE555 via a 2.2KΩ resistor to the base of the driver transistor. The diode and resistor connected in series parallel to the primary winding of the transformer serve to protect the driver transistor against overvoltage.

Transformer and supply voltage

As step up transformer for 6 - 9V primary voltage is used a circuit board transformer of the company www.block-trafo.de, model *VB 1.0/1/6 6V/230V, 1VA*. The smallest version with 0.35 VA has proved to be too weak. The 0.5 VA intermediate size type 0.5/1/6 is ideal for 12V operation. Experienced DIY hobbyists can also try a transformer of a decommissioned mini charger.

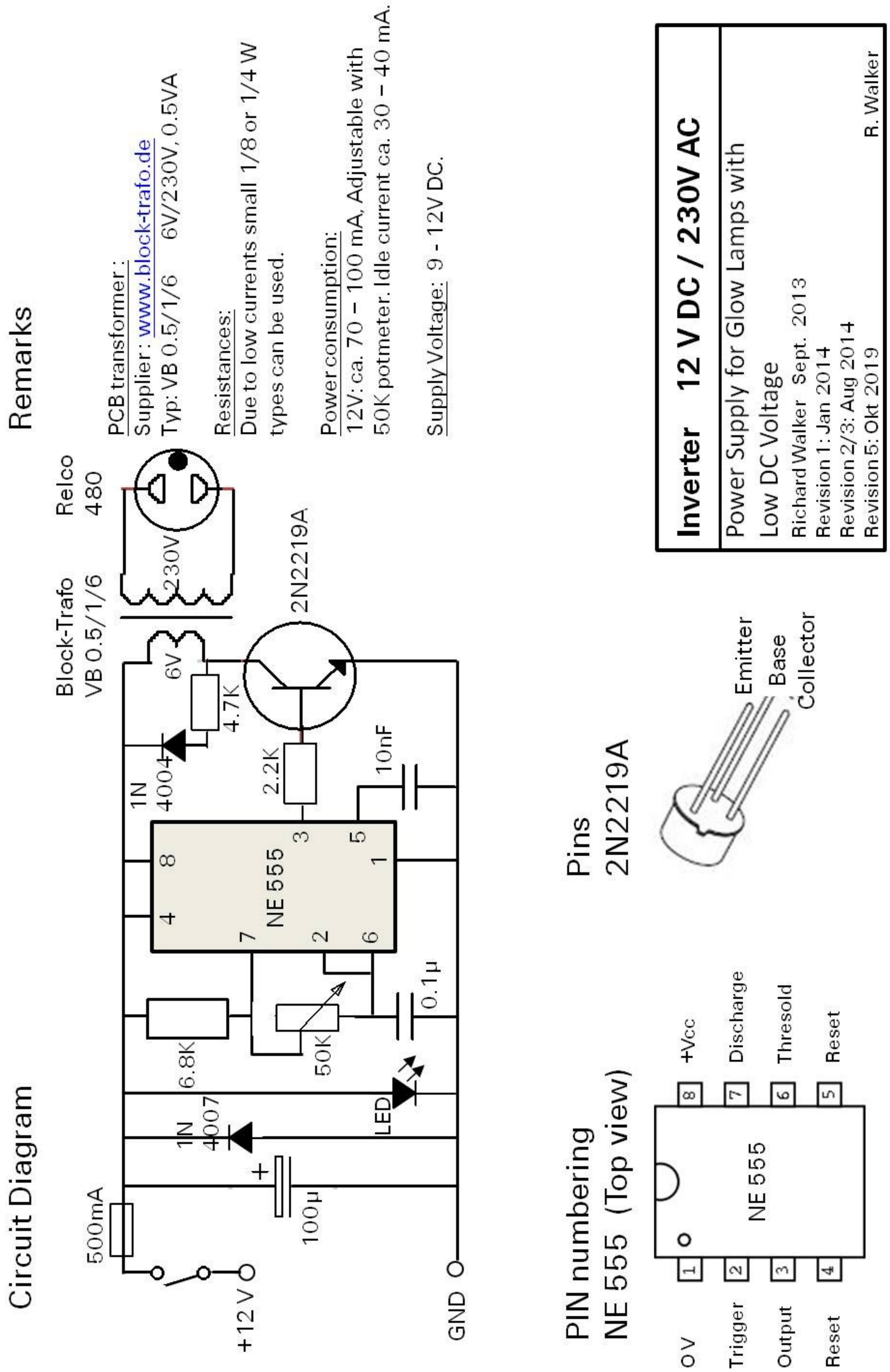
Power consumption and adjustment

This amounts to approx. 80 - 120 mA at maximum light output and 12V supply voltage. In a completely trimmed state of the circuit (end stop of the 50KΩ potentiometer) up to >300mA can occur.

Recommendation:

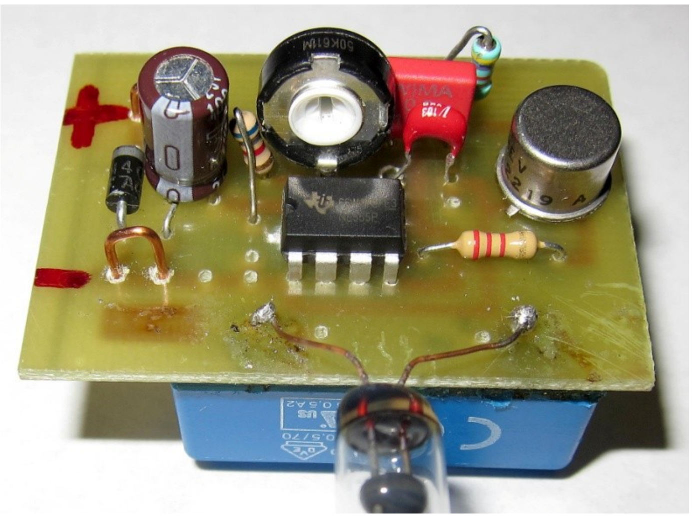
In order to achieve a stable operation the circuit should be trimmed with the potentiometer for to approx. 3/4 of the maximum luminous power.

5 Circuit diagram



6 Layout Proposal

Mounting the printed circuit board on the connection pins of the transformer.



7 Literature

Internet Links:

Author:

Various publications on the subject of spectroscopy can be downloaded from this link:

www.ursusmajor.ch/astrospektroskopie/richard-walkers-page/index.html

Books:

- Marc Trypsteen, Richard Walker: *Spectroscopy for Amateur Astronomers - Recording, Processing, Analysis and Interpretation*, 2017 Cambridge University Press, ISBN: 9781107166189
- Richard Walker: *Spectral Atlas for Amateur Astronomers - A Guide to the Spectra of Astronomi-cal Objects and Terrestrial Light Sources*, 2017 Cambridge University Press, ISBN: 781107165908

Electronics:

Ne555:
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Trafo:
www.block-trafo.de