High voltage power supply for Geiger counter

- 2011-05-02 First edition
- 2011-05-14 2nd edition PWM output circuit added
- 2011-05-29 3rd edition
- 2011-06-04 4th edition

Introduction

- Approximately 500V DC is required to drive a Geiger Muller tube.
- No current required.
- The noisy high voltage becomes indistinguishable from the detected voltage.
- This is achieved without using any special parts. Does not use a transformer.
- Use readily available parts.
- It can be adjusted according to the recommended voltage of the Geiger-Muller tube.
- Considering battery operation, low current consumption.

Notes

- High voltage is dangerous.
- Please use at your own risk. The author does not take any responsibility.
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- This high voltage circuit is designed assuming around DC500V.
- Therefore, voltages above approximately 700V exceed the (instantaneous) withstand voltage. Please use this area amateurishly.
- Or change to parts with higher pressure resistance.
- It is necessary to allow some margin in circuit design.
- I see Geiger counter kits using this circuit at auctions, but I have no connection with them.
- I won't disclose the details, but there seems to be a problem with the auction item.

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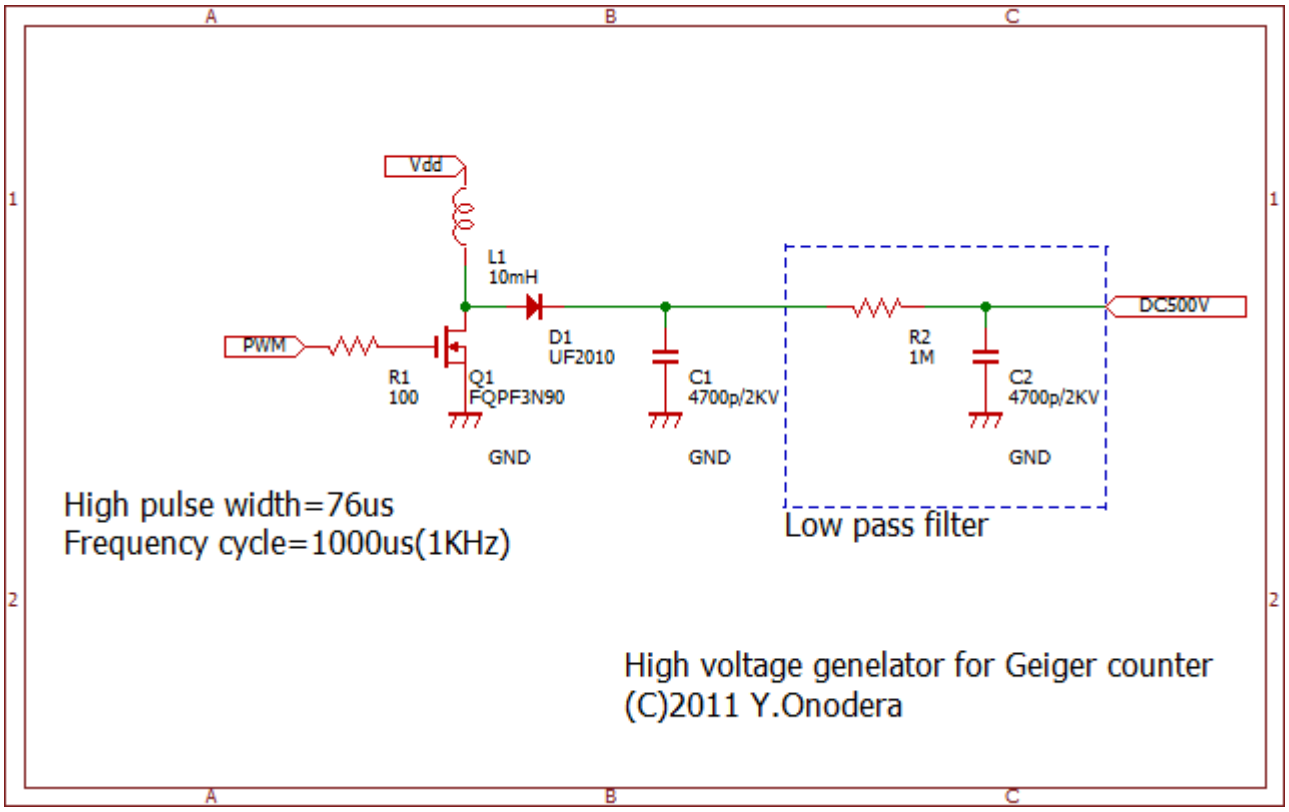
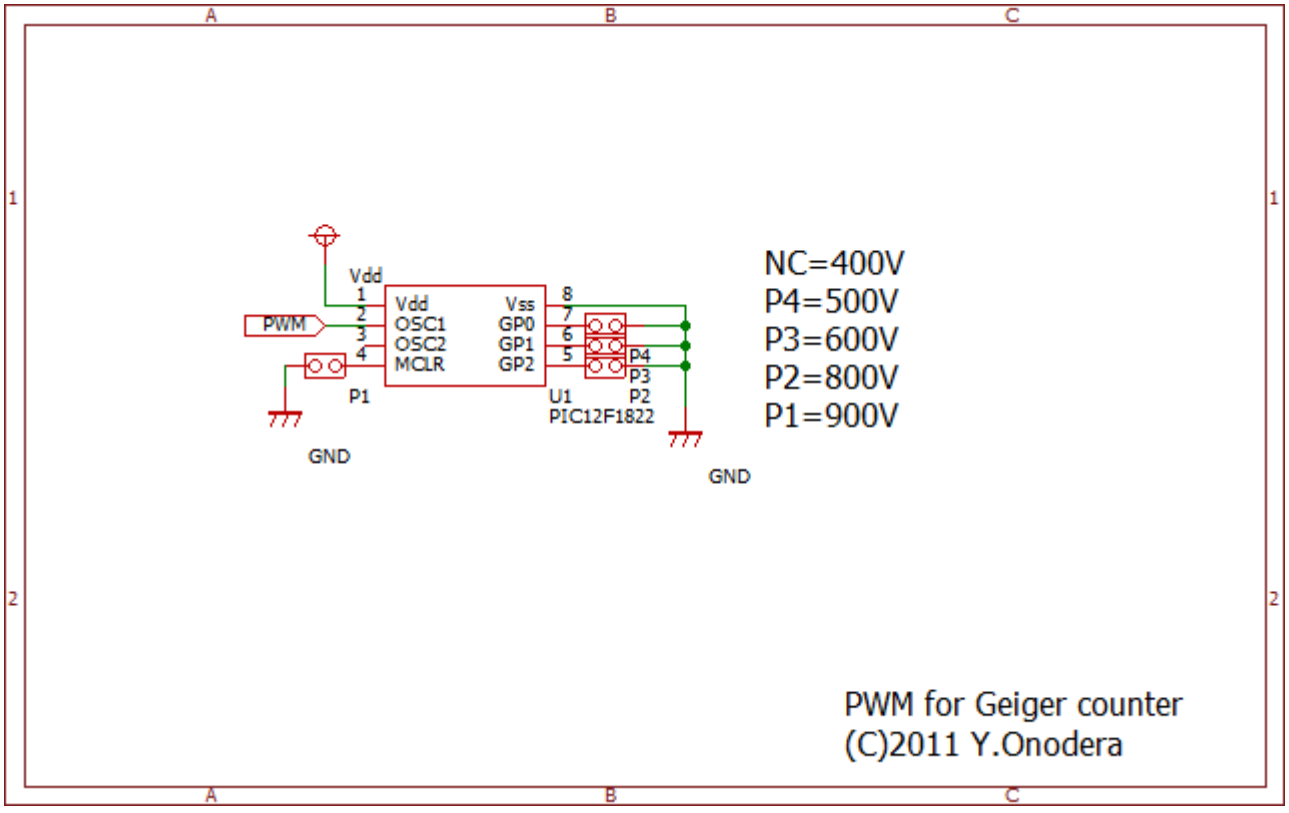
- Specifications are subject to change without notice.

Circuit diagram (low power consumption type)



- Adjust the high voltage by pulse width.
- PWM control of pulse width. The fundamental frequency is 1KHz.
- A one-chip microcontroller supplies pulses according to the voltage you want to generate.
- Feedback control is not used to utilize the stable region of plateau voltage.
- In the plateau region, even if the drive voltage changes slightly, it does not affect the measured value much. Therefore, there is no need to strictly control it.
- For example, the LND712 has a wide operating range of 200V with a plateau voltage range of 450V to 650V.
- The recommended plateau voltage is 500V, so 200V allows a fluctuation range of 200V/500V=40% .
- The recommended plateau voltage is generally set at 1/3 of the starting voltage of the plateau voltage range. Taking LND712 as an example, 450V+(650V-450V)/3=517V.
- The plateau slope of LND712 is 6%/100V, which means that the measured value increases by 6% per 100V.
- For example, a measured value of 650V will increase by 12% compared to a measured value of 450V. Even if the plateau voltage fluctuates, it only affects the measured value by about 10%.
- Radiation is emitted stochastically, so there is always variation. Low measurements are particularly variable due to the small number of samples.
- For example, the measured values can easily vary by a factor of two. In comparison, fluctuations in measured values due to drive voltage fluctuations account for only 10% at best.
- If you take the average of the measured values, you can reduce the variation, but that doesn't mean that only that value is correct.
- Just as the temperature fluctuates throughout the day, the radiation dose also fluctuates (within a short period of time). Just as there are daily maximum, minimum, and average temperatures, radiation levels also vary. Average values are not always correct.
- Noise is generated by MOSFET switching. Therefore, use R2 and C2 low-pass filters to cut the noise.
- Finding the fundamental frequency and pulse width is extremely difficult, and would normally be a trade secret.
- You have to find it from infinite combinations.
- These are precautions when designing the board.
- Electromagnetic waves are emitted from L1. Avoid placing or wiring high impedance components nearby. Picks up pulse noise.
- Keep high voltage wiring apart from other wiring. The standard is 1mm per 100V. For 500V, it is 5mm.



- This is a versatile PWM output circuit.
- Select the desired voltage with the jumper switch.
- Requires 5V power supply. It does not work at 3.3V (it may work by chance).
- Vgs of FQPF3N90 must be at least 3V. On the other hand, the guaranteed value of the PIC port output voltage Voh is Vdd-0.7V=2.6V. Due to design, there is insufficient voltage.

Parts list (low power consumption type)

value	number	remarks	unit price
100	1	R1 carbon film resistor 1/4W	Ten

1M	1	R2 carbon film resistor 1/2W	Ten
10mH	1	L1 inductor (Taiyo Yuden LHLC08NB 103J), Sengoku	50
4700pF	2	C1,C2 Ceramic capacitor (Murata withstand voltage 2KV), Suzusho	50
UF2010	1	D1 First recovery diode (PANJIT breakdown voltage 1KV), Akizuki	40
FQPF3N90	1	Q1 NMOS-FET (Fairchild withstand voltage 900V), Akizuki	50

- Please use this model number as the voltage generated varies depending on the characteristics of L1.
- The maximum current of the inductor is 0.11A. It falls below this. Since inductors are current elements, their withstand voltage is not specified.
- The withstand voltage of the resistor is about 700V for a 1/2W carbon film resistor. For a 1W carbon film resistor, it is about 1000V.
- Please use a three-terminal regulator for the power supply .

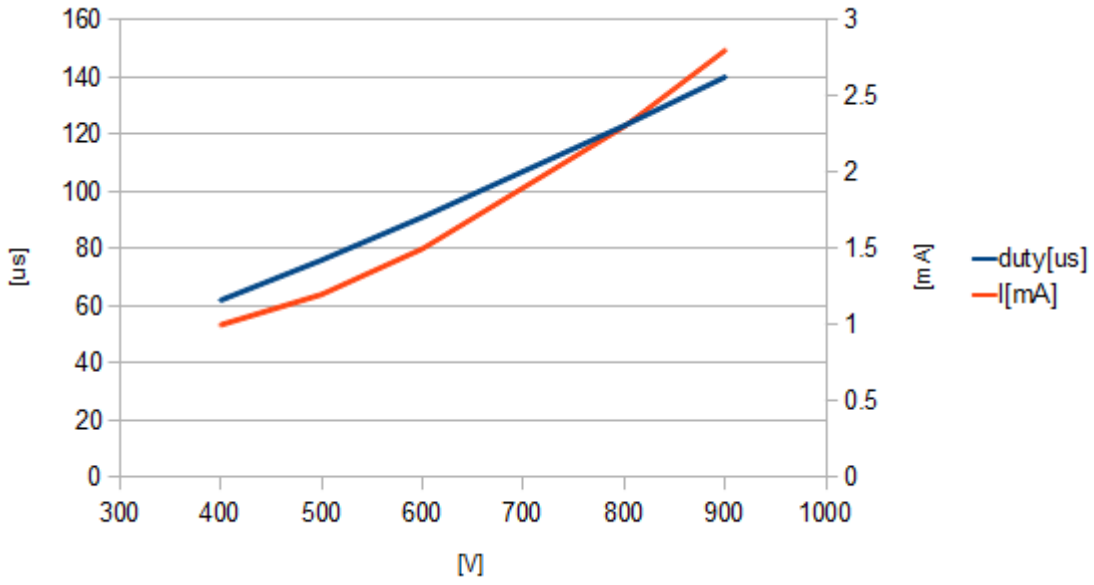
Evaluation (low power consumption type)

- Improved voltage accuracy. (2011-06-04)
- There may be slight deviations depending on the board material, wiring method, and humidity, but it is generally within an acceptable range.
- Glass epoxy (FR-4), which is not easily affected by humidity and has high insulation properties, is ideal. Insulation resistance is on the order of 10G.
- Paper phenol and paper epoxy are not suitable. Insulation resistance is on the order of 1G.
- Measuring this high voltage requires special circuitry.
- It cannot be measured with a tester. The voltage drops rapidly due to the tester's internal resistance.
- There is an error even when measuring a 1GΩ load. A special method improves voltage accuracy.

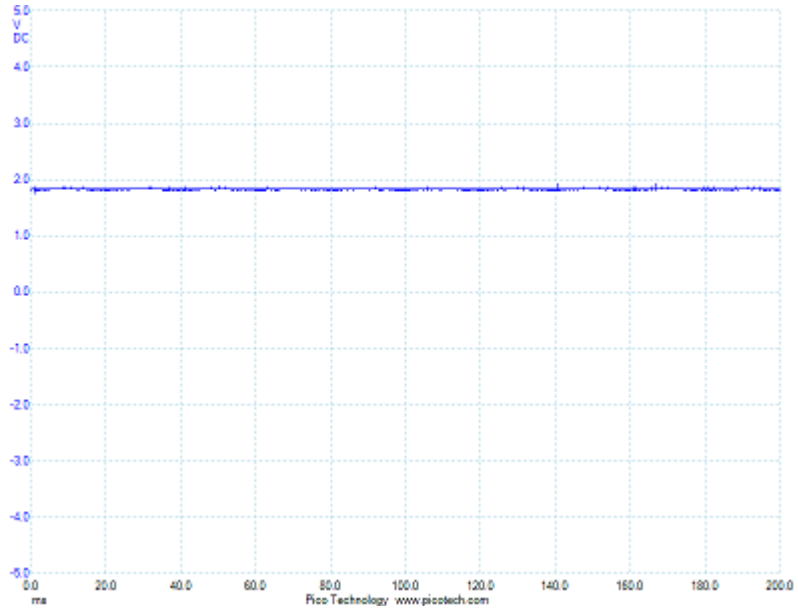
Characteristics when Vdd=5V

Voltage [V]	Pulse width [us]	Current consumption [mA]
400	62	1.0
500	76	1.2
600	91	1.5
700	107	1.9
800	one two three	2.3
900	140	2.8

- High voltage can be obtained almost linearly according to the pulse width.
- 900V or more exceeds the withstand voltage.
- It can generate more than 1000V, so care must be taken with the pulse width.

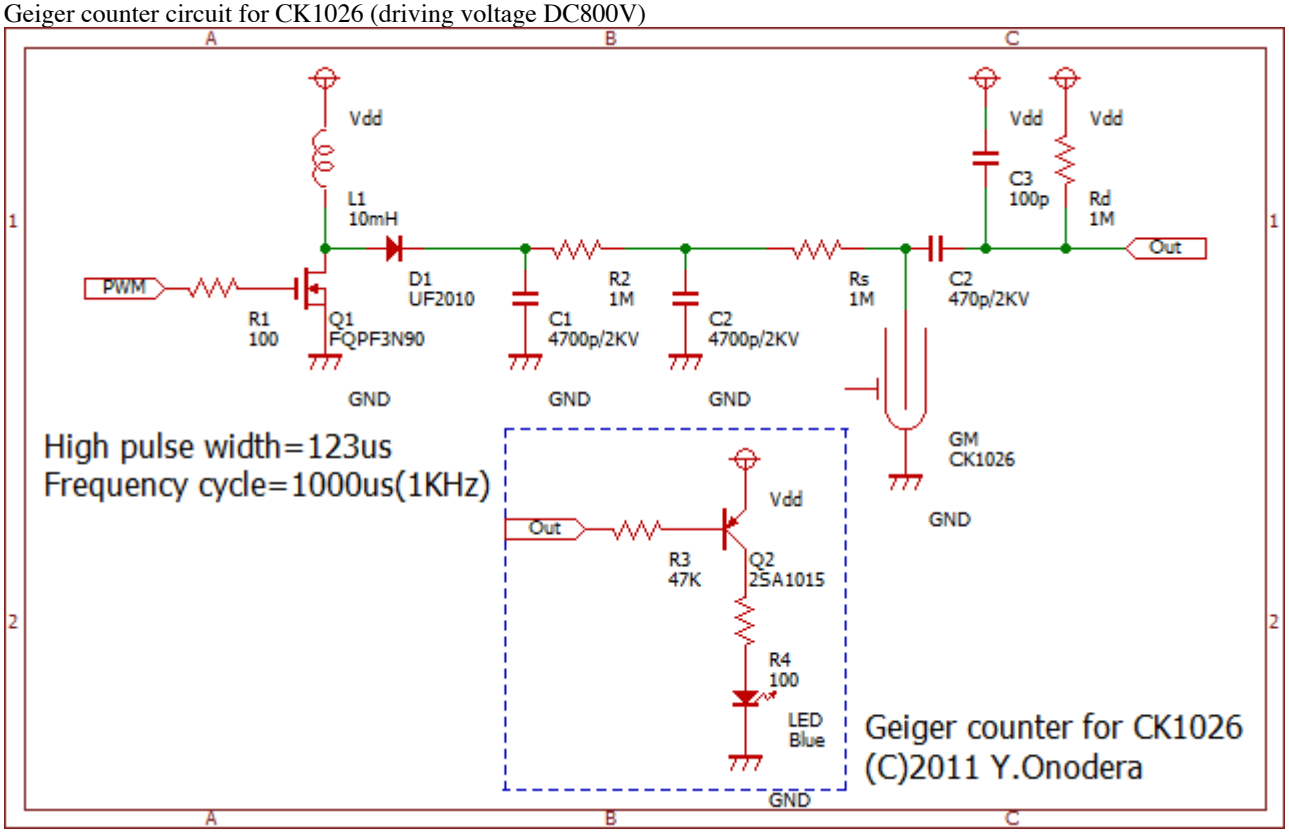


- If Vdd is stable even without feedback control, a stable high voltage can be obtained.
- The following is the state at 900V. The voltage is measured at 1/500. 20ms/div



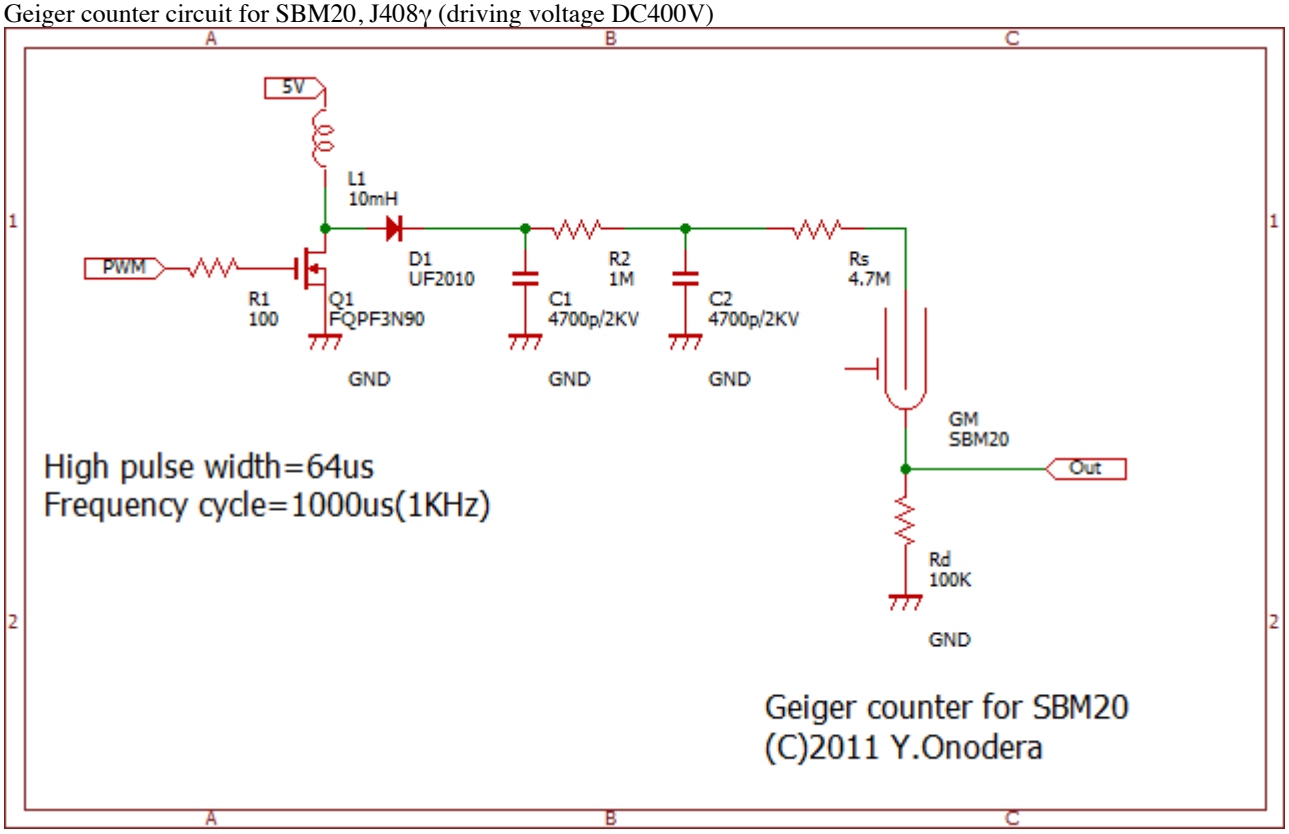
Application example

Geiger counter circuit for CK1026 (driving voltage DC800V)



- Added C3 for noise removal (2011-06-04)
- Detection pulses around (Vdd-2V) are output, so all you have to do is count.
- The detection pulse is a pulse in the negative direction.
- Added LED confirmation circuit.
- For safety reasons, the drive voltage is set to 800V.
- Precautions when using CK1026
- Due to aging, the rubber coating on both ends may be partially peeled off. You can check it by holding it up to the light.
- It will malfunction if visible light enters it. It's not stable.
- It must be protected from light by a black case or vinyl.
- The markings seem to vary depending on the manufacturing date. The right one is malfunctioning.

Geiger counter circuit for SBM20, J408γ (driving voltage DC400V)



- Rs and Rd require some adjustment depending on the type of GM tube.
- If the drive voltage is set to 500V, it will be used for LND712.

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