

Development of a Modular Geiger Counter Platform for Educational Applications

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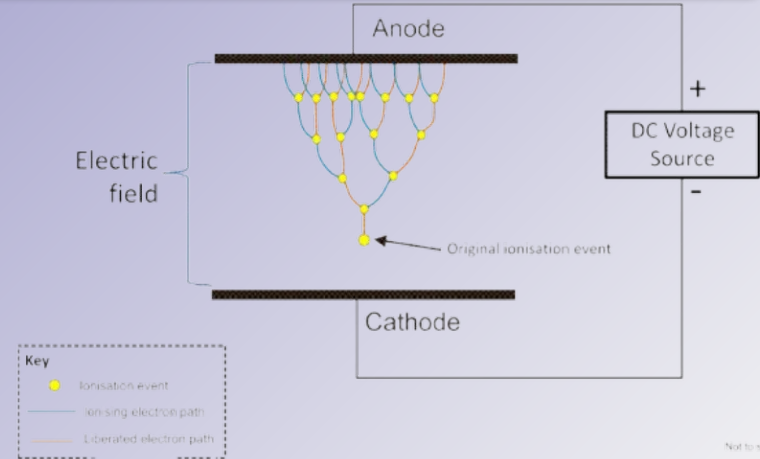
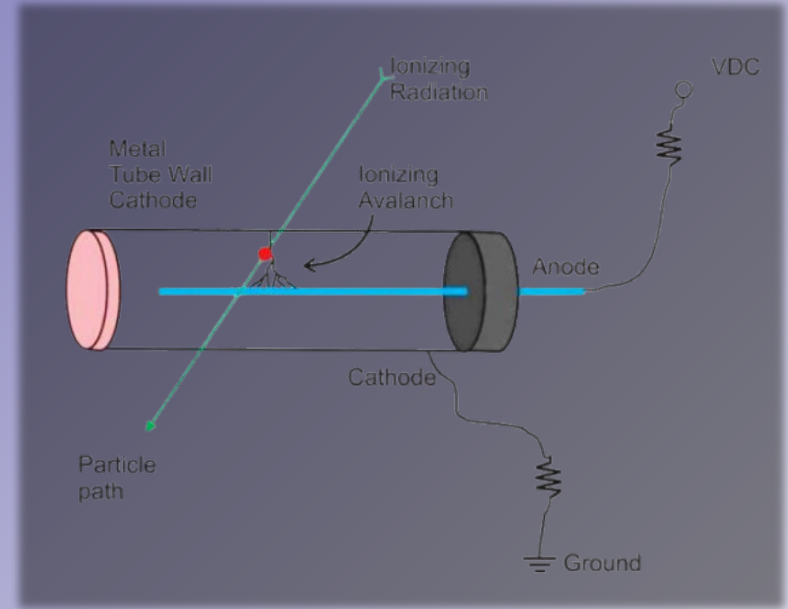
Motivation





Geiger-Müller Tube

- Operates in the avalanche saturation regime at high voltage.
- Gas mixture: Neon, Argon, and Bromine.
- Incident particles trigger the Townsend Avalanche effect.
- High-value anode resistor imposes "dead time" and limits current to microamperes.



The circuit board layout is divided into four main sections: A, B, C, and D. Section A contains the High Voltage Step Up DC Converter (5V to 400V) and the Impulse Detection circuit. Section B contains the 3.7V Li-Po Battery charger and the 3.7V to 5V Boost DC Converter. Section C contains the USB/Battery detector and the Raspberry Pi Pico microcontroller. Section D contains the title block and revision information.

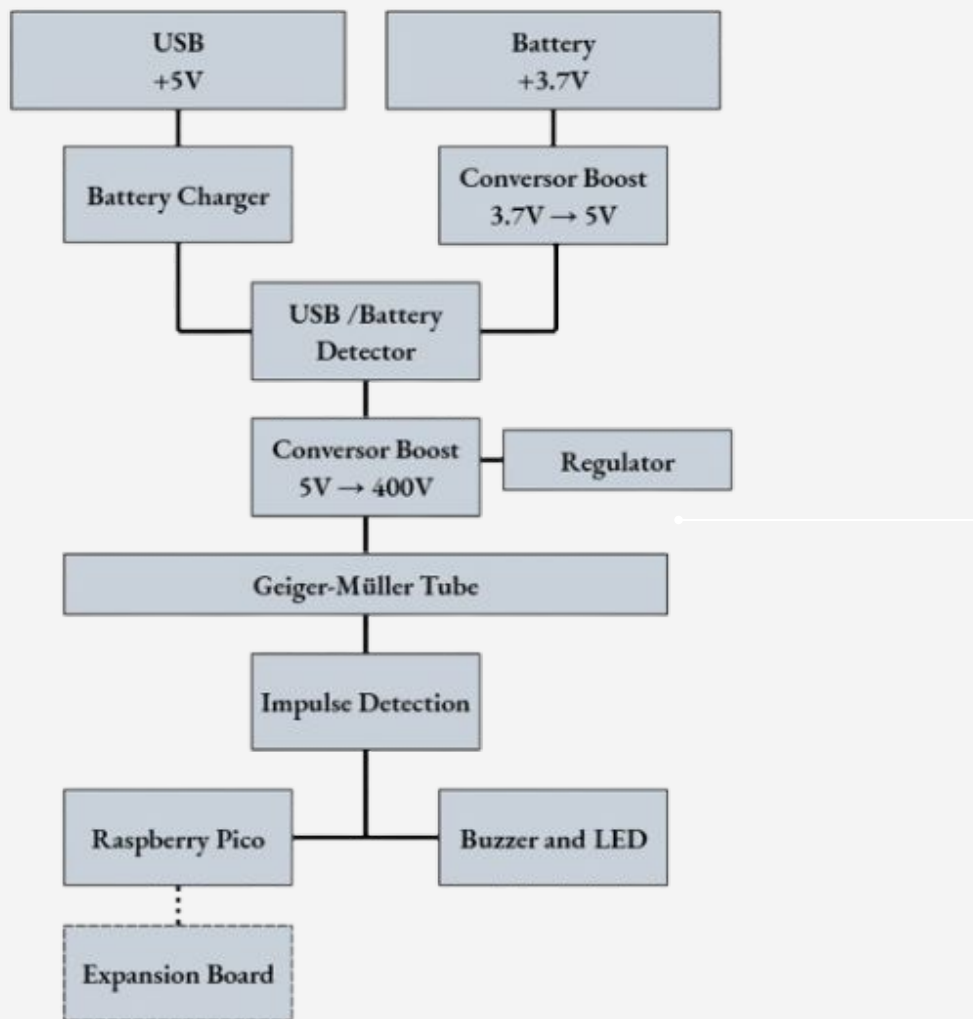
Section A: High Voltage Step Up DC Converter (5V to 400V)

- U3: TLC3552P (Comparator)
- U4: 2N3904 (Transistor)
- U5: FJN3303FTA (Transistor)
- U6: 2N3904 (Transistor)
- U7: 1N4937-E3/54 (Diode)
- U8: 1N914B (Diode)
- U9: 2N3904 (Transistor)
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- U100: 2N3904 (Transistor)

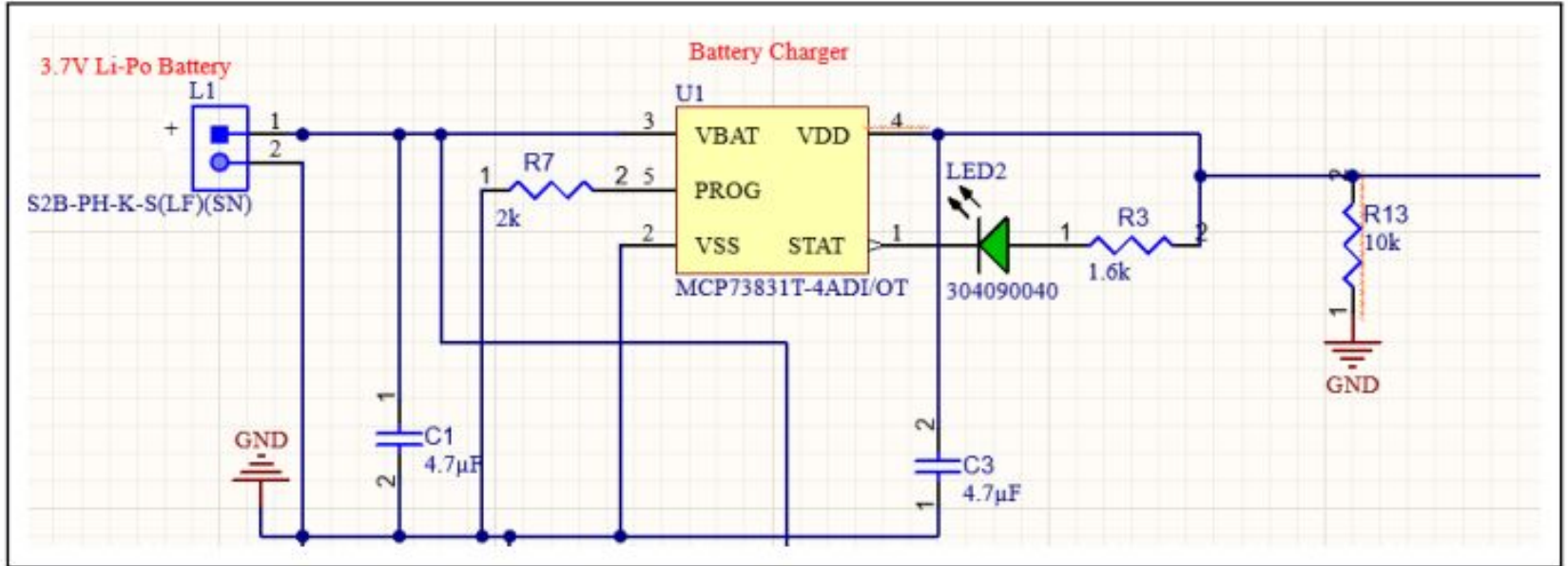
Section B: 3.7V Li-Po Battery

- U1: MCP73831T-4ADUOT (Battery Charger)
- U2: AO3401A (Transistor)
- U3: 1N914B (Diode)
- U4: 2N3904 (Transistor)
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Title		
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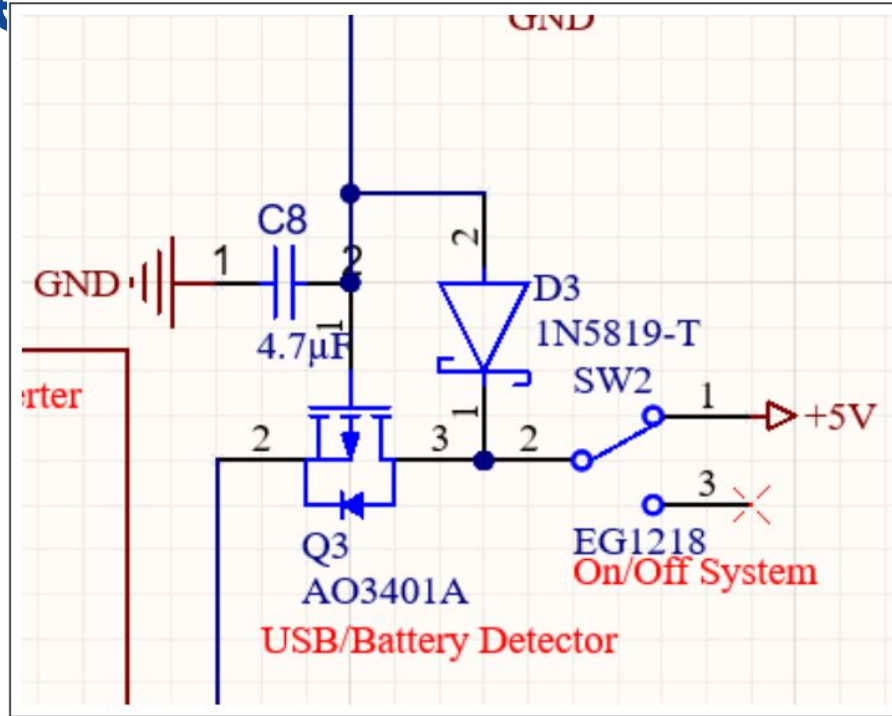


Battery Charger



The system is powered by a 3.7V Li-Po battery managed by an integrated MCP73831 charge controller.

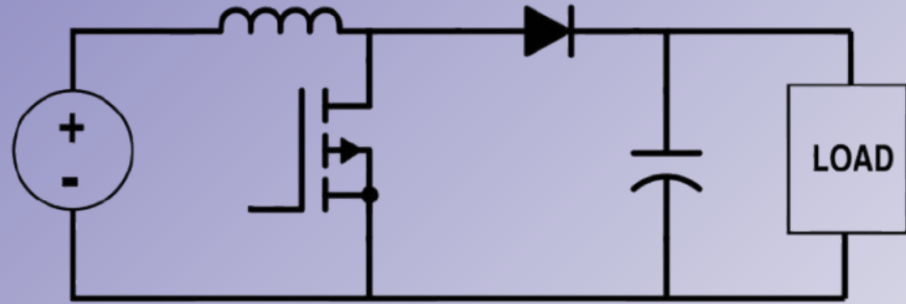
USB / Battery Detector



A P-channel MOSFET and a parallel Schottky diode work together to switch between USB and battery power.

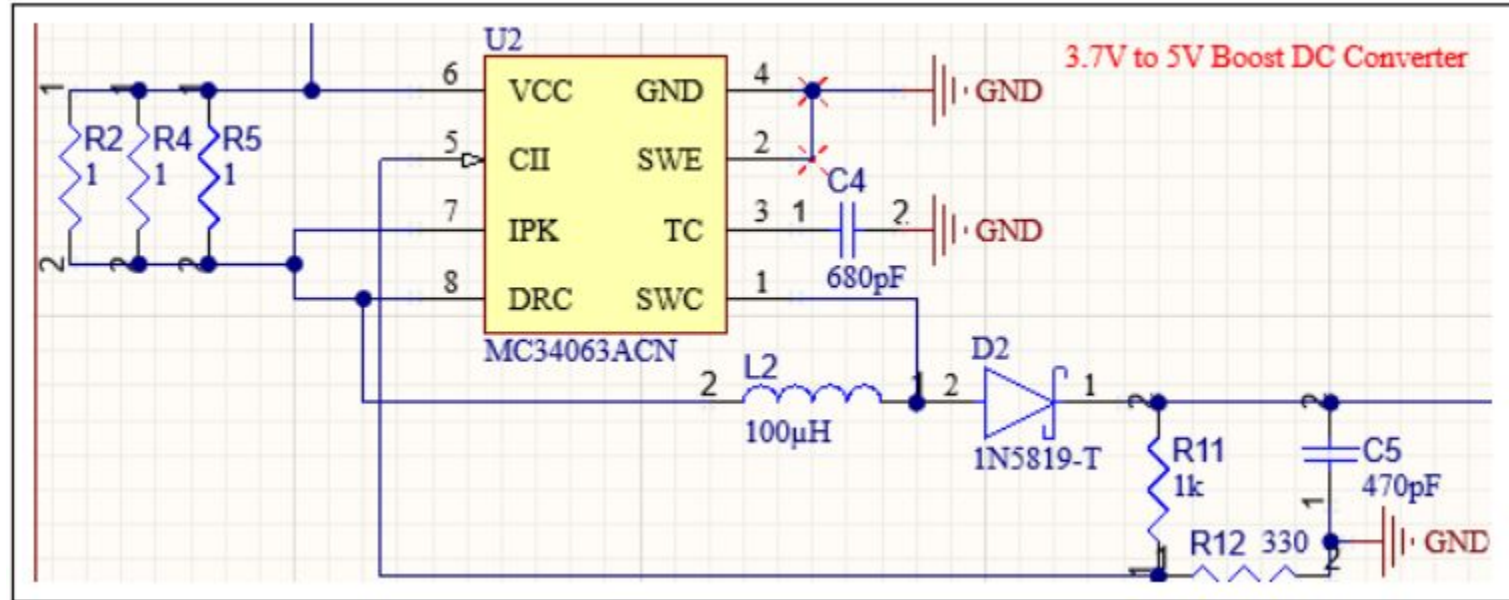
Boost Converters

A converter in the Boost topology relies on the cyclic storage of magnetic energy in an inductor. Upon interrupting the current flow, the abrupt variation (di/dt) originates an electromotive force (e.m.f.) that superimposes on the input voltage.



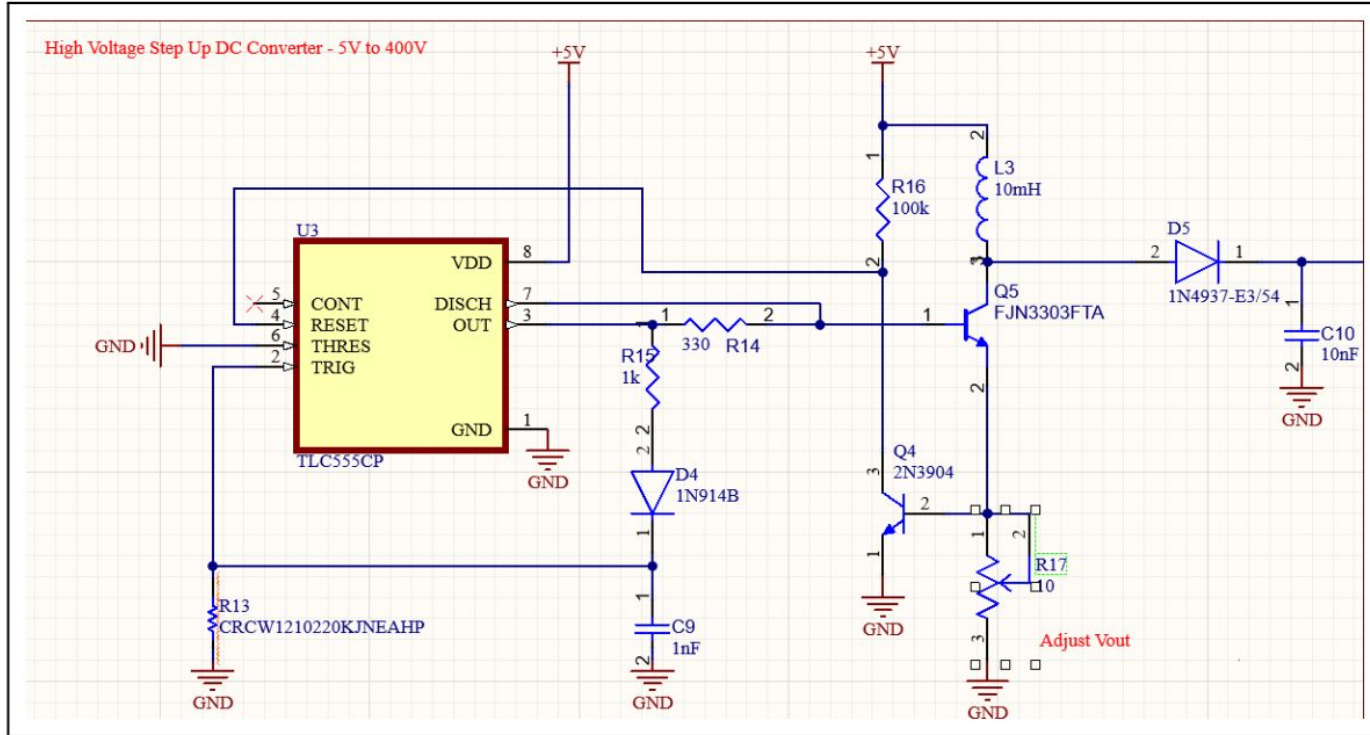
$$V_{out} = \frac{V_{in}}{1-D} \quad D = \frac{V_{out}-V_{in}}{V_{out}}$$

3.7V -> 5V



Closed-loop regulation using MC34063

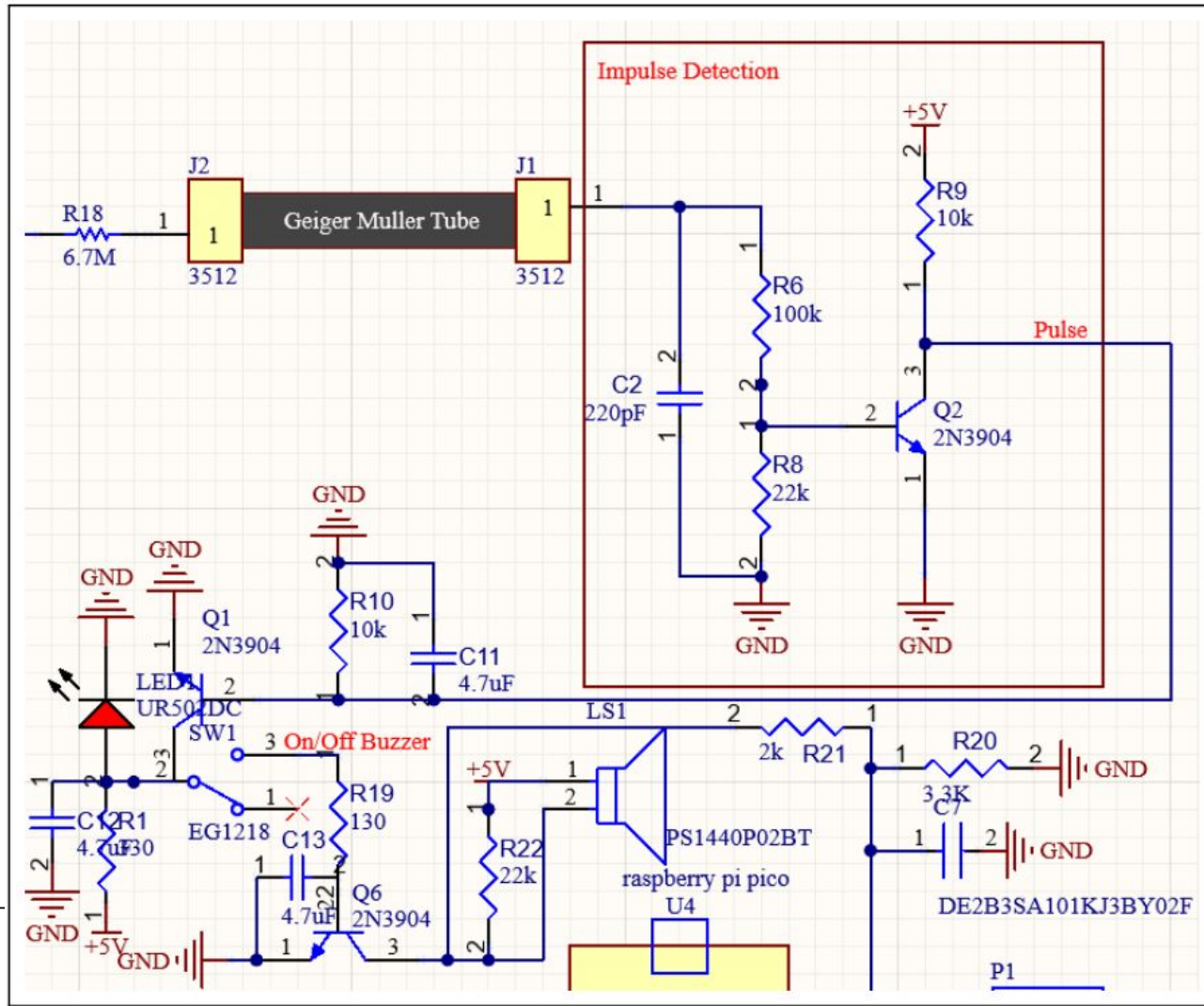
5V -> 400V



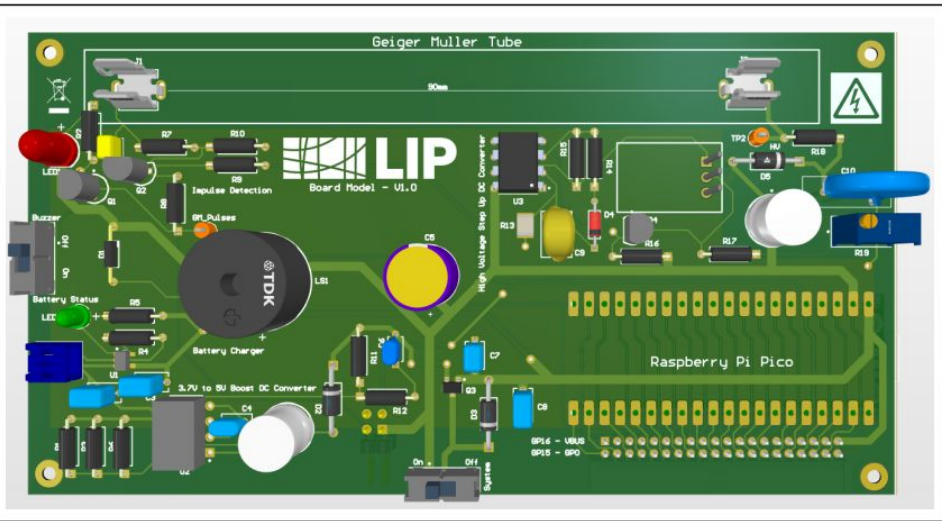
Discrete Peak Current Mode operation

Impulse Detection

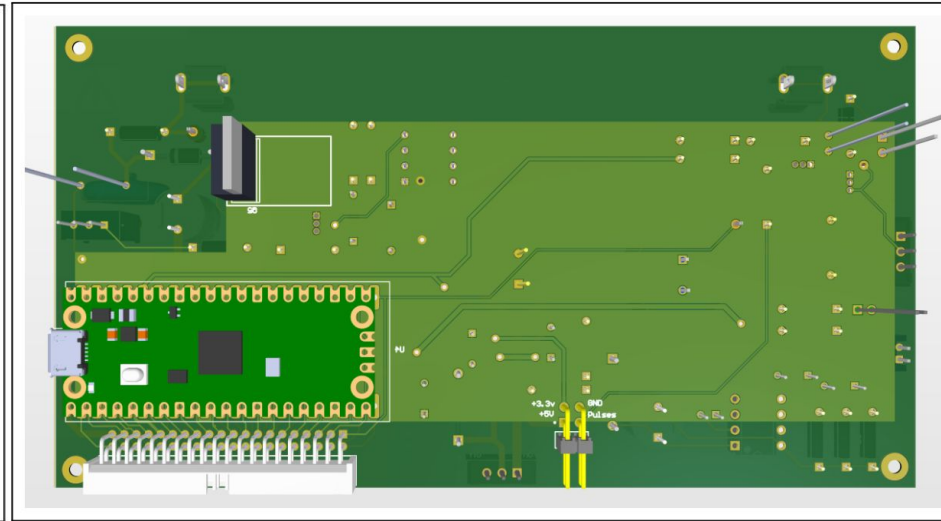
- Fast comparator/inverter (2N3904) generates an active-low digital pulse
- Voltage Divider to strictly conditioned to 3.3V to protect the RP2040 GPIOs
- RC monostable pulse stretching ensures visible/audible sensory feedback



PCB



3D Front View

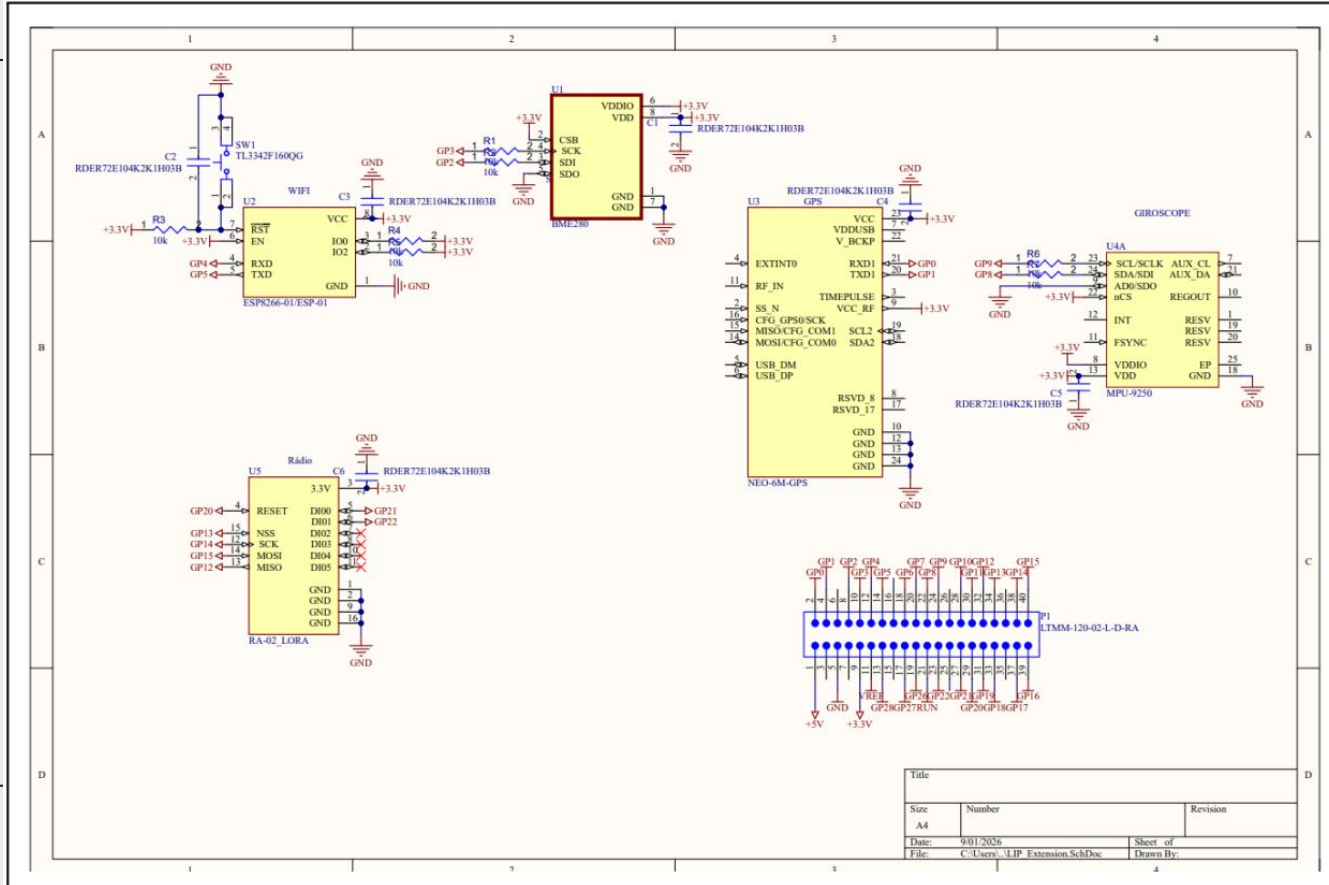


3D Back View

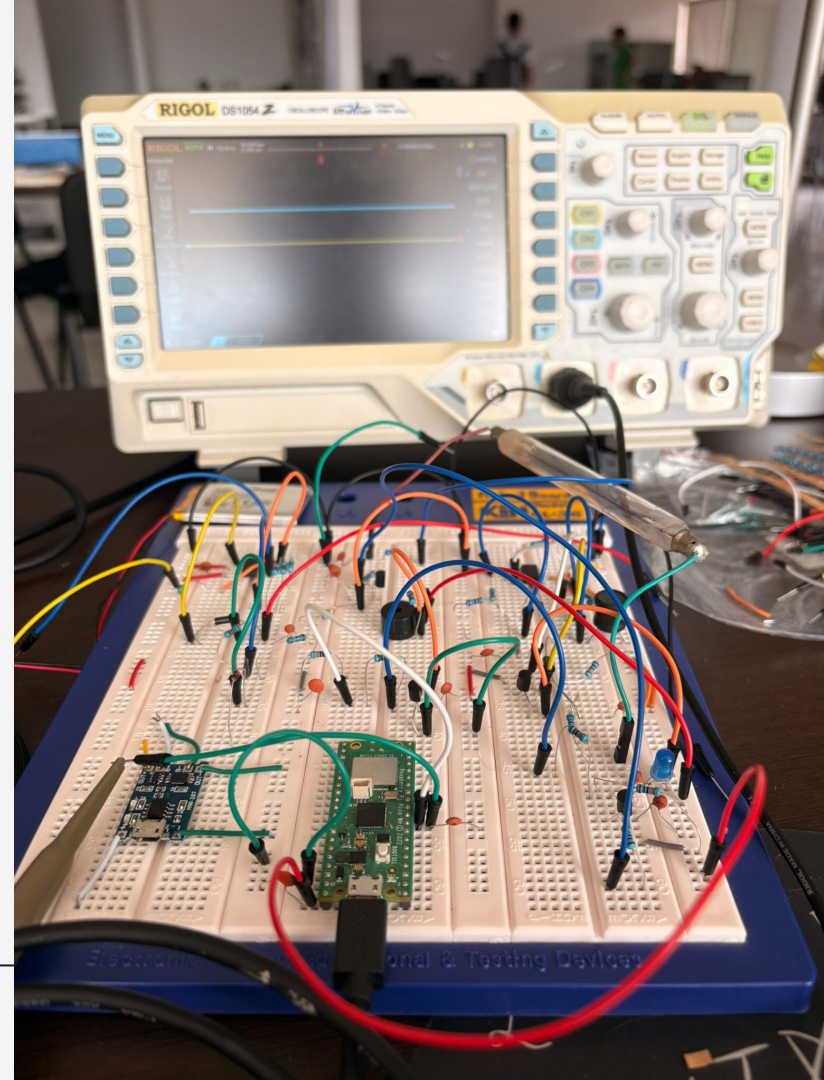
- Through Hole Components for manual assembly.
- Trace sizing: 1.5mm (Power) and 0.254 mm (Logic signals)

Expansion Board

- Meteorology
- GPS
- Gyroscope
- Radio
- Wi-Fi



Experimental Application

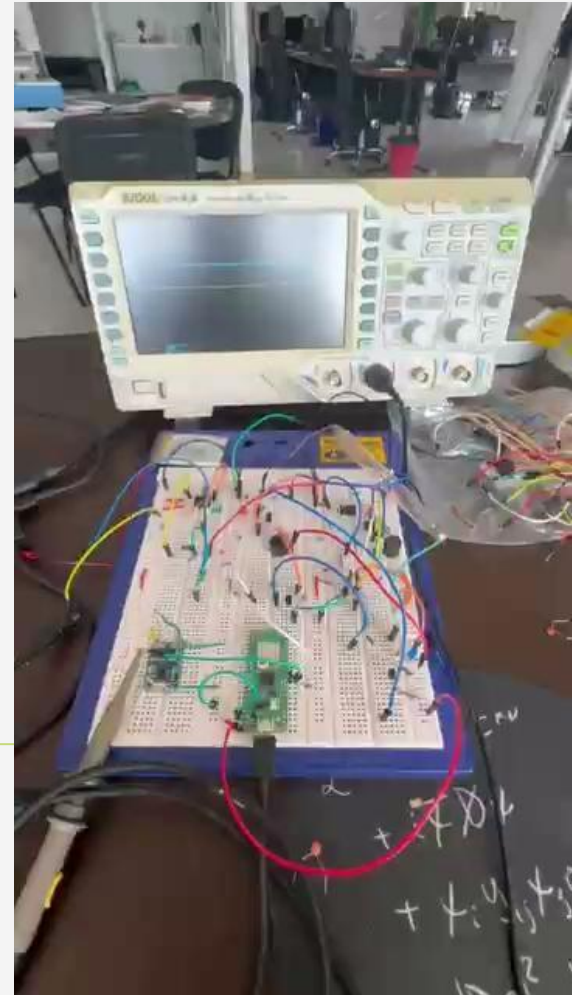


Working MicroPython
code, with consistent
measures equivalent to
an commercial Geiger
Counter

1

Results

2



Thank you for your attention.



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Partículas e Tecnologia