

# Miniature 900-V microcontrolled power supply for photomultiplier tubes

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This report presents a compact digitally-stabilized high-voltage power supply suitable for biasing photomultiplier tubes (PMTs) in nuclear instrumentation. It was conceived to overcome many deficiencies of outdated high-voltage power supplies currently in use throughout this Institute's facilities. Its main features are:

- powered by a single low-cost 5-V supply,
- programmable output voltage from 700V to 1000V,
- miniature size matching the PMT's diameter,
- output digital stabilization by micro-controlled sensing and control.

The power supply utilizes a compact DC-DC converter which generates voltages up to 1000V from a single 5-V input voltage. The output voltage *OUT* is determined by a control voltage *CTL* raging from 0V to 3.3V via a dedicated input pin. Combined with a high-processing microcontroller unit (MCU) and Surface-Mount Device (SMD) components, the power supply can be as small as the PMT's diameter and consequently be physically mounted as close as possible to the radiation detector, a significant advantage over other MCU-controlled power supplies recently proposed [1]. The 16-MHz 16-bit MCU incorporates a 12-bit Analog-to-Digital Converter (ADC) which constantly monitors the output voltage *OUT* through a resistive voltage divider. The correlation between the control voltage *CTL* and the output voltage *OUT* is not linear so it has been empirically measured and then mathematically modeled within the MCU's software. The targeted output voltage was set by software as 900V. The MCU compares it with every ADC result and, if their difference exceeds 1%, the MCU adjusts the control voltage *CTL* based on the difference and the *CTL-OUT* mathematical model. The MCU does not encompass a Digital-to-Analog Converter (DAC) therefore the newly calculated control voltage is serially

transmitted as a 12-bit digital word to an external DAC, which is responsible for driving the converter's control pin. Figure 1 shows photographs of a prototype of the power supply highlighting its main components and signals. It measures only 50 millimeters in diameter and consumes 0.7 Watts.

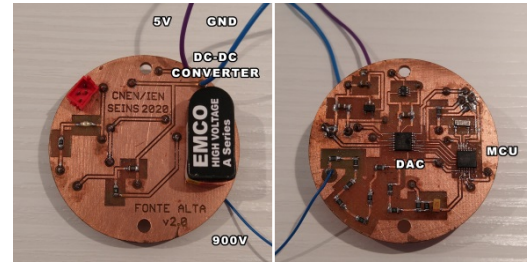


Figure 1. Power supply prototype: top view (left) and bottom view (right)

Figure 2 illustrates the quadratic correlation between the DC-DC converter's output voltage and its control voltage. The red lines correspond to the targeted 900-V output.

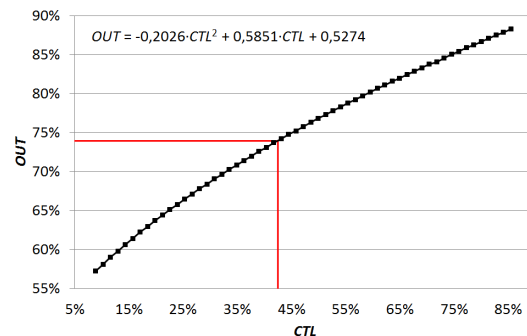


Figure 2. DC-DC converter's control curve

This power supply is currently in use by a photomultiplier tube coupled to a NaI(Tl) scintillator as part of a multichannel analyzer under development at the SEINS laboratory. Nonetheless its features, as well as its simplicity of use and installation, make it attractive to many other similar instrumentation setups based on PMTs currently in use at other laboratories at this Institute as well as other CNEN's Institutes.

## References

- [1] MITEV, M.; TSANKOV, L.; DUTSOV, C.; MITEV, K. High voltage power supply for photomultipliers with extended functionality, IEEE XXVII International Scientific Conference Electronics – ET (2018) 1-4.