

Designing 3-channel Solid-State Particles Detector for Multiple Radiation Sources

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Novel applications of fundamental particle detectors often require that the final device has a compact and lightweight design that offers more than one sensing mechanism covering a wide energy range. Radiation emitted from different radioactive sources often consists of various types of radiation (alpha, beta, gamma).

This article describes the design of an amplification and biasing circuit for a 3-channel solid-state particle detector for multiple radiation sources. The TINA-TI V9 [1] and LTSpice [2] simulation tools were used in this study to verify and fine-tune the parameters of the selected components. In particular, the size of the feedback capacitor CF and resistor RF significantly influences the bandwidth of the charge-sensitive preamplifier.

The OPA818 [3] was chosen for our application due to its high bandwidth and low noise capabilities. A simulation diagram used for OPA818 is shown in Figure 1.

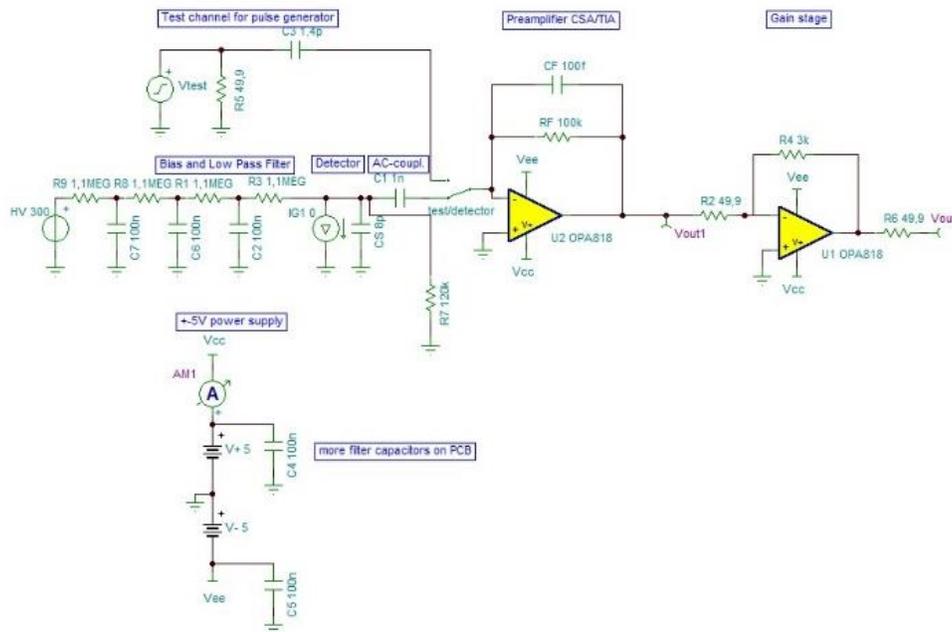


Figure 1. OPA818 simulation diagram in TINA-TI

Figure 2 displays the AC simulation results for the circuit depicted in Figure 1, while the transient simulation results can be seen in Figure 3.

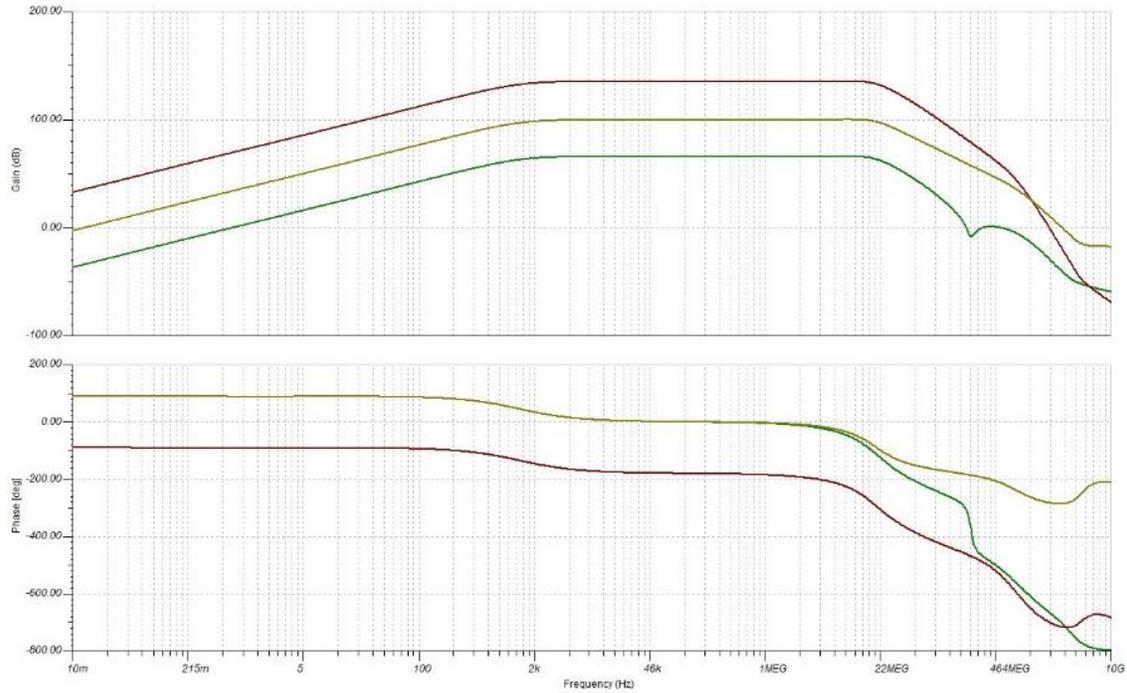


Figure 2. AC simulation results in TINA-TI for the OPA818 circuit shown in Figure 1.

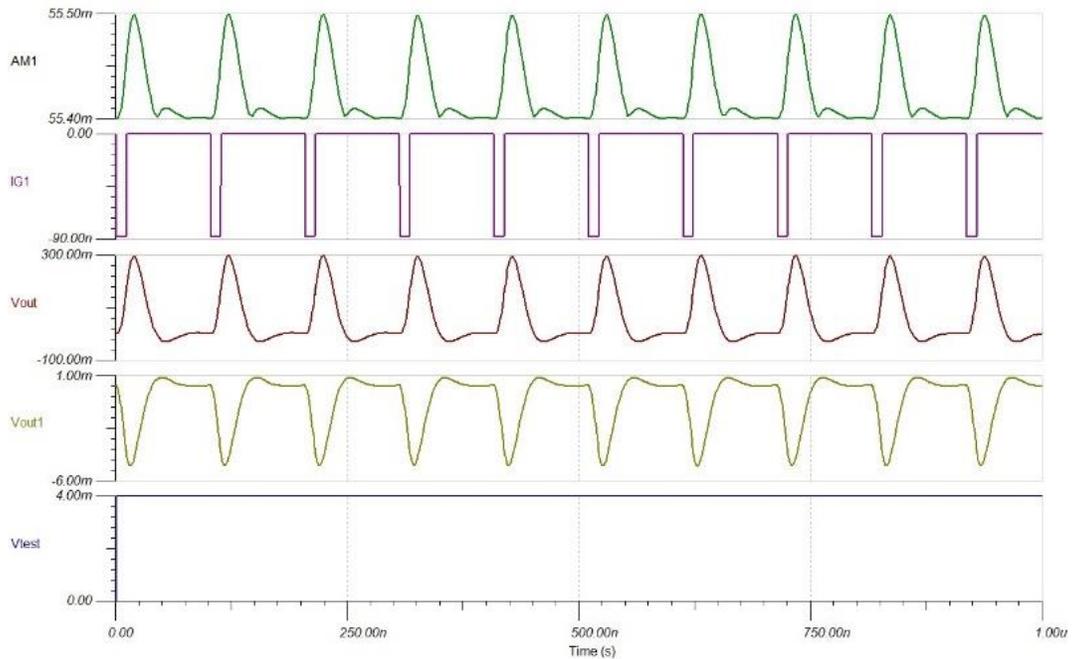


Figure 3. Transient simulation results in TINA-TI for the OPA818 circuit shown in Figure 1.

The AC simulations showed that the bandwidth sufficiently exceeds the desired 10 MHz level, while the transient simulations confirmed that the circuit functions as intended with input charge, current

source IG1 emulating the sensor signals. Furthermore, because the sensor signal was known to be weak, a separate gain stage was required to enhance the gain to a sufficient level. Additional care was paid to the biasing circuits of the many solid-state sensors, which required separate high voltages of up to 300VDC. Most of the sensors used in this study were fabricated in Micronova [4] and assembled at the Detector Laboratory at Helsinki Institute of Physics.

Figure 4 shows a prototype PCB created to carry sensors and front-end amplifiers. The entire circuit consisted of commercial off-the-shelf electronics components, and it was assembled and evaluated at LUT.



Figure 4. Prototype R10 used for Operational amplifier selection

Lastly, the desired performance of the amplifier to provide optimum results for accurate and reliable measurement in a broad energy spectrum is discussed in our article.

[1] TINA-TI V9 simulation software, <https://www.ti.com/tool/TINA-TI>, accessed April 2025

[2] LTSpice simulation software, <https://www.analog.com/ltspice-simulator.html>, accessed April 2025

[3] OPA818, 2.7-GHz, High-Voltage, FET-Input, Low Noise, Operational Amplifier, <https://www.ti.com/product/OPA818>, accessed April 2025

[4] Micronova Nanofabrication Centre, <https://labbooking.micronova.fi/>, accessed April 2025