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An Accurate Small Direct Currents Measurement System Based on Low-noise and Stable Amplifier

In radionuclide metrology, ionization chambers have been used for activity and half-life determinations. The accurate measurement of the ionization current is required to improve the uncertainty levels of these determinations.
An accurate small direct currents measurement system is designed, including an amplifier circuit, an ADC, an FPGA control and readout circuit, and the user interface. Each part of this system needs careful design to achieve the uncertainty goal of 100 ppm in 100 pA. In particular, the front-end amplifier circuit providing 1 GΩ transresistance gain needs to be low-noise and stable versus time, temperature, and current amplitude. The amplifier circuit has two stages, the first using a reset integrator for the current-to-voltage conversion and the second providing the remaining voltage gain. The low-noise performance is achieved by utilizing the integrator as the first stage, for it doesn't have a feedback resistor. Besides, all capacitors and resistors that provide the gain are composed of multiple elements to improve the stability by the averaging effect.
The ADC is chosen to have high linearity and low noise. The FPGA circuit provides the periodical reset signal to the analog integrator, synchronously differentiates the ADC's sampled data, and transmits the results to the user interface. The integrating-differentiating signal processing is in real-time.
The circuit function has been verified by SPICE simulation. Errors and noise performance have been analyzed and optimized to meet the requirements. The system is currently producing. Subsequently, tests and calibration will be implemented soon.

Minioral

Yes

IEEE Member

No

Are you a student?

Yes

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