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Multi-channel front-end ASIC for a 3D position-sensitive detector

Arrays of 3D position-sensitive detectors (3DPSD) operating at room temperature and using cadmium zinc telluride (CZT) and thallium bromide (TlBr) sensors are suitable for gamma-ray spectrometry in many applications [1,2,3]. One detector configuration, the 3D position-sensitive virtual Frisch-grid detector (VFG), is particularly advantageous for integrating into large area arrays. The signals generated inside each detector of the array are captured with the anode, cathode and four pads that enable the reconstruction of the position and energy of the ionizing interaction by measurements of amplitude and timing of the signals.
For these applications, a low-noise front-end ASIC, capable of processing bipolar signals (due to the AC-coupling of some electrodes), is needed. The ASIC can be coupled to a fast ADC in order to form a compound waveform "digitizer"capable of post-processing the analog signals and determining amplitude and timing information.
This paper describes a 32-channel front-end ASIC that is suitable for reading out a 3 x 3 or 4 x 4 element matrix in the VFG configuration [4,5]. Each channel is composed of a low-noise charge amplifier with an adaptive continuous reset [6] feedback circuit suitable for both positive and negative charge, a first order shaper and a single-to-differential converter output stage. Voltage and current references are all internally generated by 10-bit DACs and the chip is fully controllable with the I2C communication protocol. The readout channel response has been verified using the implemented injection circuit, demonstrating linear behavior up to ˜100 ke-/+ with gain of ˜80 mV/fC, and up to ˜200 ke-/+ with gain of ˜40 mV/fC. This paper reports the first test results using radioactive sources (241Am, 137Cs, Tb(kα,kβ)), where inputs have been connected to a small PIN Si diode (size = 2 x 2 mm2, thickness = 50 um, C = ˜8 pf) emulating the typical detector capacitance of the elements (5 –10 pF) used in 3DPSD.

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