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Strip Sensor Readout Circuit for X-ray Spectroscopy: Design and Performance Evaluation

X-ray imaging systems designed for X-ray spectroscopy, based on semiconductor strip sensors, have recently been a key research area. A major objective is to enhance spectroscopic and spatial resolution [1–3]. In spectroscopic applications, short-strip silicon detectors are widely employed due to their low capacitance and leakage current. Using a strip pitch below 100 μm enables high spatial resolution, which is crucial for energy-dispersive X-ray detection [3]. The Charge Sensitive Amplifier (CSA) has been optimized for a detector capacitance of approximately 1.5 pF, with a shaping amplifier default peaking time of about 1 μs, controlled via switchable settings.

To minimize noise, both internal sources (related to front-end electronics) and external disturbances in the radiation imaging system were analyzed [4]. Maintaining a noise level below 50 electrons rms is a key design goal, alongside low power consumption (below 10 mW per channel) and a compact layout. To accelerate processing of incoming events (more than 100 kps/ch), a continuous-time resistive CSA feedback combined with a digital feedback reset is utilized. These approaches align with previous advancements in low-noise charge-sensitive preamplifiers used in high-resolution X-ray spectrometry.

The prototype integrated circuit was designed and fabricated in 180 nm CMOS technology, incorporating eight charge-processing channels, biasing circuits, reset and baseline restoration logic, and a calibration system. This work presents the design, characterization, and measurement results of the strip sensor readout circuit, contributing to the ongoing development of high-performance silicon-based X-ray detectors.

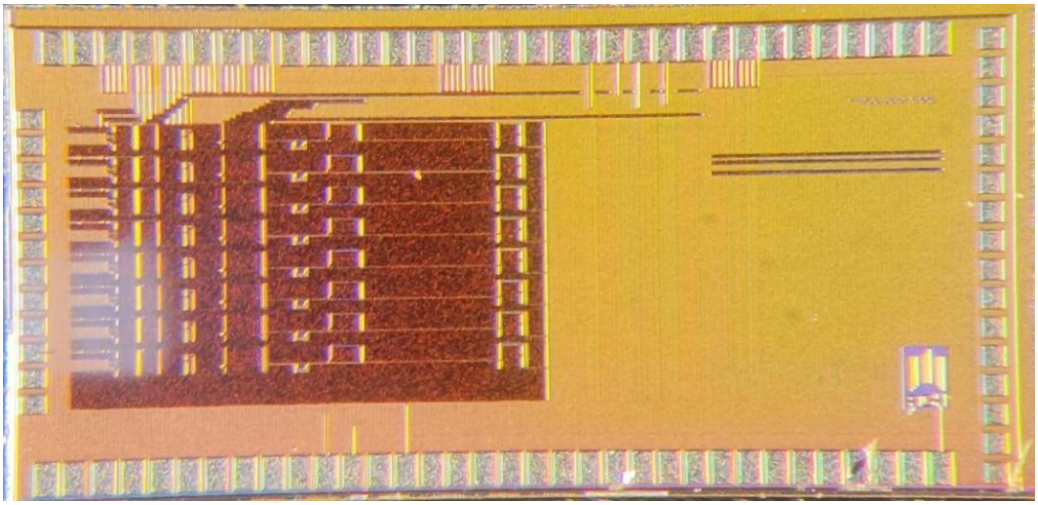

Figure 1 The 8-channel prototype front-end

Literatura:

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