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A Cryogenic Readout IC with 100 KSPS in-Pixel ADC for Skipper CCD-in-CMOS Sensors

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The Skipper CCD-in-CMOS Parallel Read-Out Circuit (SPROCKET) is a mixed-signal front end design for the readout of Skipper CCD-in-CMOS image sensors. SPROCKET is fabricated in a 65 nm CMOS process and each pixel occupies a $45\mu\text{m} \times 45\mu\text{m}$ footprint. SPROCKET is intended to be heterogeneously integrated with a Skipper-in-CMOS sensor array, such that one readout pixel is connected to a multiplexed array of nine Skipper-in-CMOS pixels to enable massively parallel readout. The front end includes a variable gain preamplifier, a correlated double sampling circuit, and a 10-bit serial successive approximation register (SAR) ADC. From simulation, the circuit achieves a sample rate of 100 ksp/s with $0.48 e^-$ rms equivalent noise at the input to the ADC. SPROCKET achieves a maximum dynamic range of $9,000 e^-$ at the lowest gain setting (or $900 e^-$ at the lowest noise setting). The circuit operates at 100 Kelvin with a power consumption of $40 \mu\text{W}$ per pixel. A SPROCKET test chip was submitted in September 2022.

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