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10µm Global Shutter Pixel for Radiation Tolerant CMOS Image Sensors

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This article presents a new global shutter pixel design with radiation-hardened-by-design(RHBD) device modifications and correlated double sampling (CDS). Global Shutter Imagers presents undeniable advantages by exposing all pixels simultaneously. Once in-pixel storage is included, the pixel readout can be operated simultaneously with exposure, enabling faster operation and flashed light. Additionally, this architecture is robust against motion defects and easy to operate in synchronous mode. The Radiation tolerance of the outlined pixel is targeted up to 1MGy SiO2 Total Ionizing Dose (TID). A partially pinned photodiode structure, combined with an enclosed transistor layout known as a "butterfly"[1] [2] is used to withstand such a high TID value. The use of P+ implant on SENSOR implant and recessed shallow trench isolation (STI) are specially used to reduce the dark current from the TID-induced interface traps and SiO2 interface while also shielding the photodiode region from TID-induced positive charges in the SiO2. Correlated double sampling (CDS) [3] is required to reduce the read noise by suppressing important noise sources such as photon shot noise, thermal noise (kTC) and flicker noise contributions. Two in-pixel memory and two readout paths are implemented to allow CDS. The pixel operation includes a sample phase where the pixel signal is locally stored followed by a reset phase and the pixel reset store. The in-pixel storage is designed with enclosed butterfly MOS devices that allow great charge density for low area and with limited leakage due to the RHBD. The readout is performed by operating two output SF and two output buses. The pixel is designed using 180nm CMOS Image Sensor (CIS) technology.

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