

Hybrid Avalanche Photodiode ranging and photon-counting altimeter

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Abstract

Avalanche photodiodes are very well suited and extensively used for low light application. We present here a device using avalanche photodiodes in conjunction with a pulsed laser-source to be used as an optical altimeter. The extreme sensitivity of a dedicated silicon SPAD array is combined with a versatile standard CMOS readout circuit to achieve unique performances such as 150ps time of flight accuracy, photon-counting imaging. The ranging accuracy is of 4 cm over 5km distance. In this paper, we describe the optical altimeter principle as well as the development of the hybridized readout-circuit. We show as well the digital ranging function with analog interpolation and the photon-counting function. Finally we discuss measurement results of the final device.

Specification	Value
Pixel pitch	100 x 100 μm
Imaging dynamic range	15bits
Number of transistors per pixel	478 T
High speed digital readout	LVDS @100MHz
Time resolution	150 ps through analog interpolation
Ranging accuracy	@10m : +/-2cm @300m : +/-10cm @5000m: +/-5m

One of the requirements during the development of the device was to be able to configure this device once it is spaceborn in various operation mode to achieve maximum versatility with minimum compromise on the above performances. As such, the device is capable of operating in Geiger photon counting mode, in Geiger time-of-flight (TOF) distance ranging mode, and in non-Geiger photocurrent to frequency mode.

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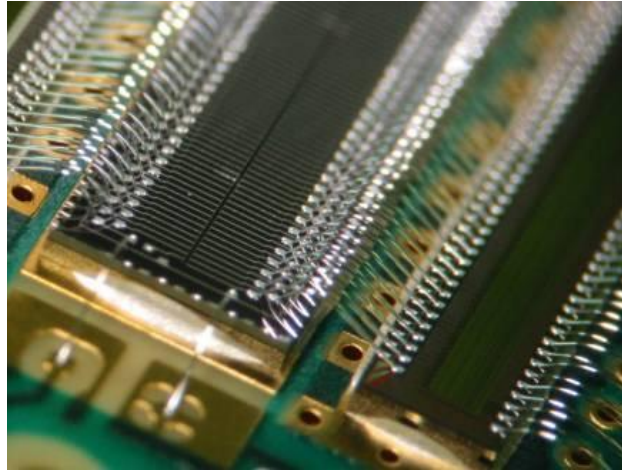


Figure 1: picture of the side by side assembled 256x2 TOF device

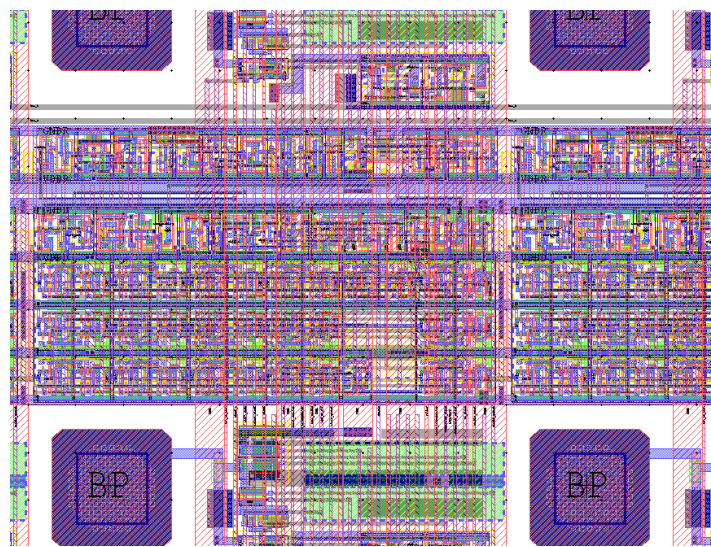


Figure 2: pixel layout



Figure 3: measurement of multiple time firing APD seen at pixel output