CMOS IMAGE SENSORS FOR FLUORESCENT DETECTION FROM DNA MICROARRAY

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Some recent advances in biochemistry through the wide-spread use of DNA diagnostic systems require the development of portable and low cost DNA Microarray testing instruments. One of the common methods for DNA detection is using fluorescent tags for DNA samples [1]. Current commercial equipment for fluorescent detection use photomultipliers or CCDs. However, these detectors cannot be integrated easily with electronic circuits and they consume much power. On the other hand, CMOS image sensors can be easily integrated with other electronics circuits on the same chip and also it consumes lower power. However, the CMOS technology is not optimized for photodetection, so the performance of CCDs is still better than CMOS image sensors. In this paper, we will briefly discuss DNA Microarrays, properties of fluorescent labels and the required characteristics of Microarray detectors. We will review previous research on CMOS image sensors and our approach towards the optimum design of low-light level CMOS detectors. In this research, we are investigating methods to improve the quality of CMOS image sensors for low-light level detection. Therefore, the performance of different structures [2] will be used to determine which structure has better performance at low-light level conditions. For this purpose, we designed different types of photodiodes and phototransistors, and complete blocks of image sensors with different structures and in two different technologies, 0.18µm and 0.35µm standard CMOS technologies (fig. 1 and fig. 2). The simulation results of current mode and voltage mode structures (fig. 3) and some experimental results will be presented. The simulation and experimental results show that current mode structures and phototransistors have higher sensitivity than other structures but since their response is very sensitive to the fabrication tolerances, it requires further research to decrease its fixed pattern noise (FPN).

[1] "Fluorescence Imaging, Principles and methods", http://www4.amershambiosciences.com
[2] Y. Ardeshirpour, M.J. Deen and S. Shirani, "2-D CMOS Based Image Sensors for Fluorescent Detection", *Canadian Conference on Electrical and Computer Engineering* (May 2004).

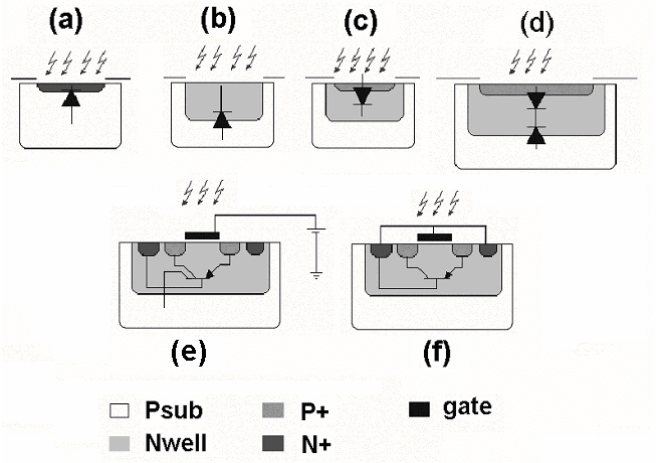
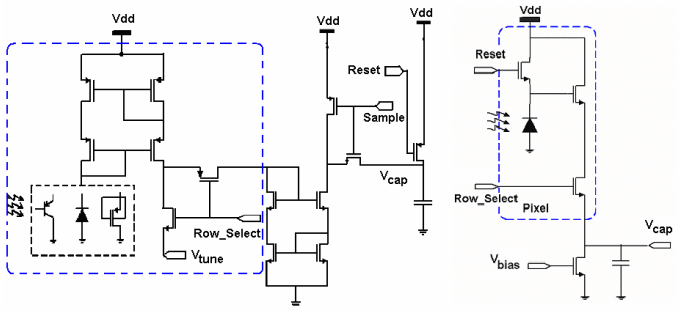


Figure 1: Different pixel architectures: (a) n+/psub, (b) p+/n_well (c) n_well/psub (d) combination of two photodiodes (p+/n_well and n_well/psub) (e) bipolar phototransistor (p+/n_well/psub) (f) n_well/gate tied phototransistor



(a) (b)

Figure 2 a) Current mode pixel. b) Voltage mode pixel.

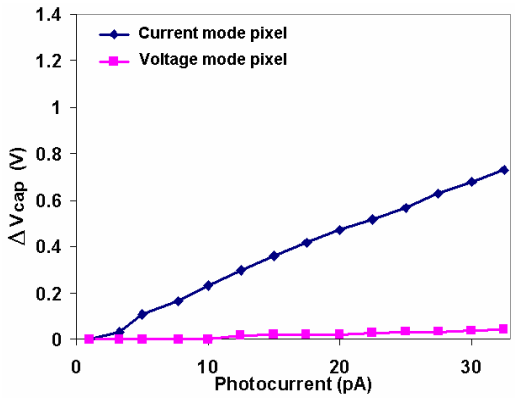


Figure 3**:** Comparison the output response of current mode and voltage mode circuits.