1 GHz Multiple Output 128x256 Element Area Array

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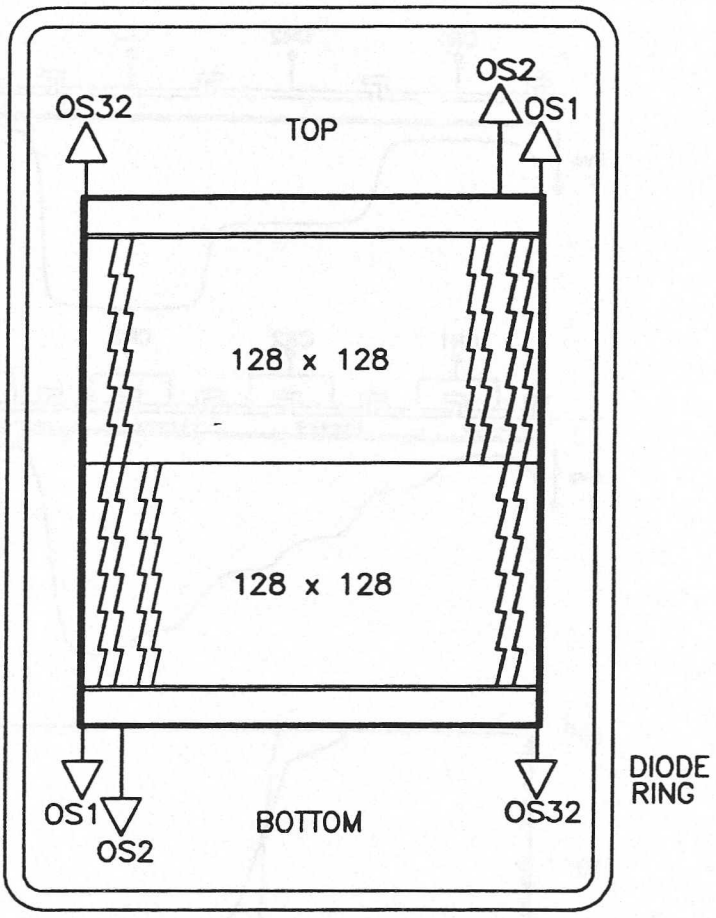
Abstract

A high speed imager capable of a 1 Gigahertz frame rate was developed with 80µm x 80µm pixels. A photodiode, interline transfer pixel architecture is used with lateral antiblooming and exposure control capability. A special multi-phase readout shift register and parallel to serial transfer structure are designed for high charge transfer efficiency operation across a large 80µm pitch at high speed. The charge transfer efficiency is modelled analytically as well as with a 2-dimensional transient device simulator for both a conventional 4 phase and the special multiphase shift register.

A total of 64 outputs each designed to operate at 16 MHz are distributed around the array. In order to minimize power dissipation, a single output MOSFET operating in conjunction with an off-chip transimpedance amplifier was used. The configuration is compared to a conventional two stage source follower with respect to bandwidth, noise and physical size.



Array Architecture

- INTERLINE ARCHITECTURE
- 128 x 256 PHOTODIODE PIXELS
- 80µm x 80µm PIXEL SIZE
- EXPOSURE CONTROL AND LATERAL ANTIBLOOMING
- 64 OUTPUTS (2x32)
- CENTER BUS SUPPLIES PIXEL CLOCKS

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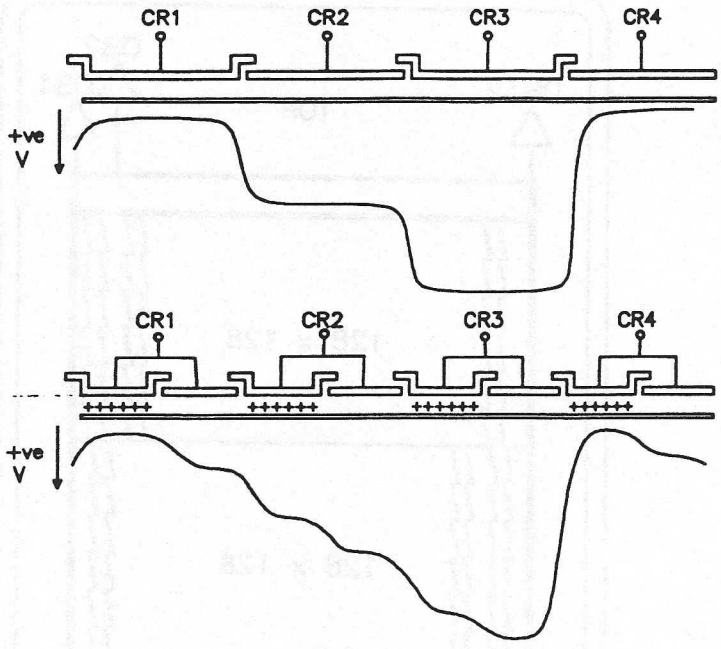
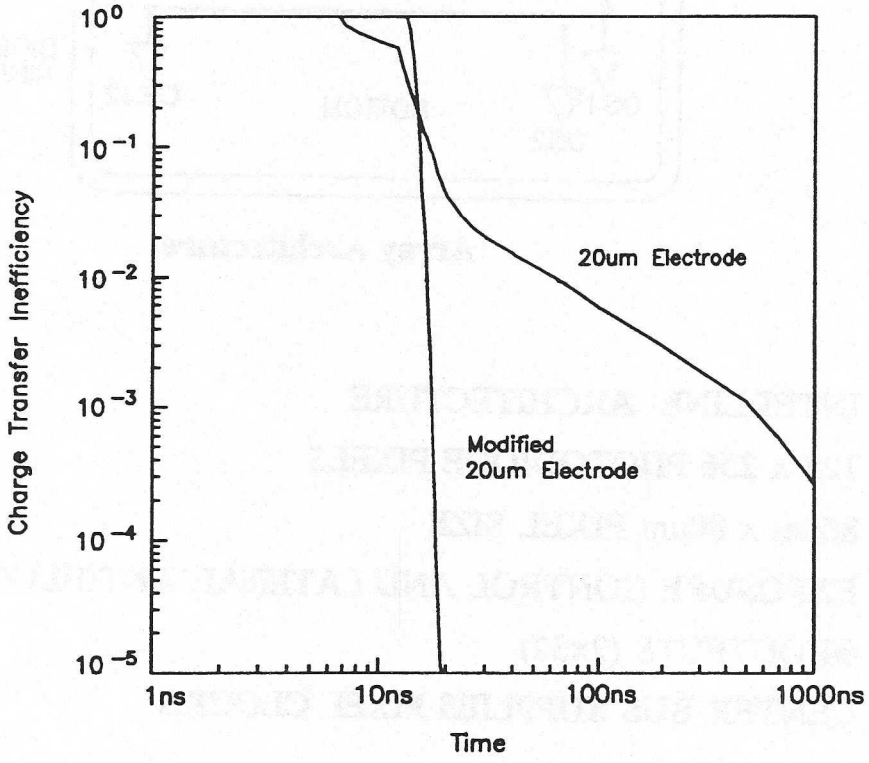
MODIFIED HCCD STRUCTURE





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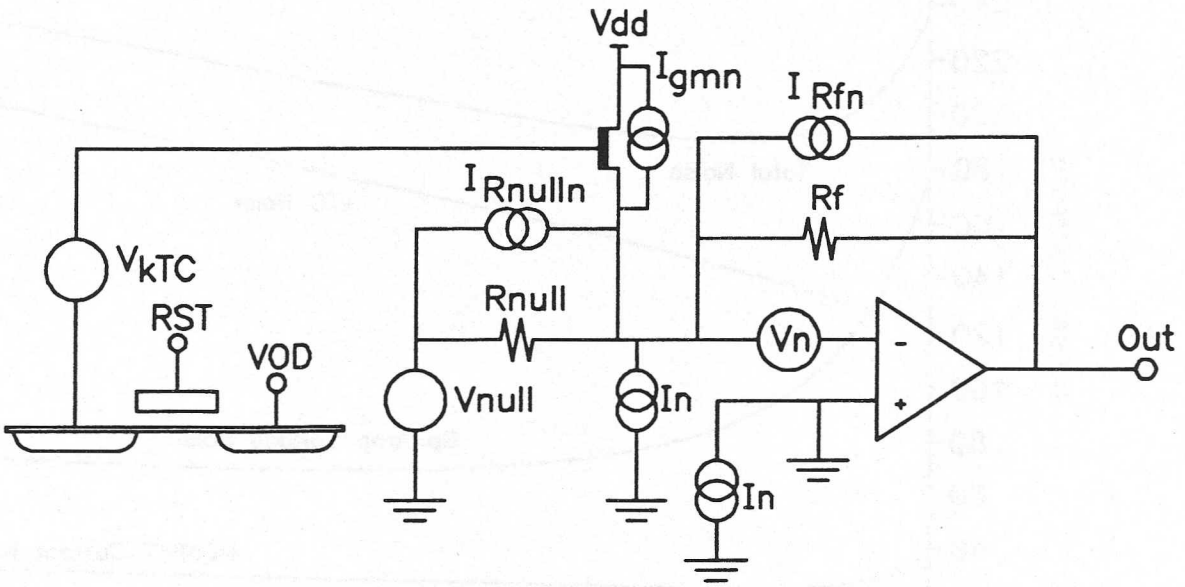
OUTPUT CIRCUIT

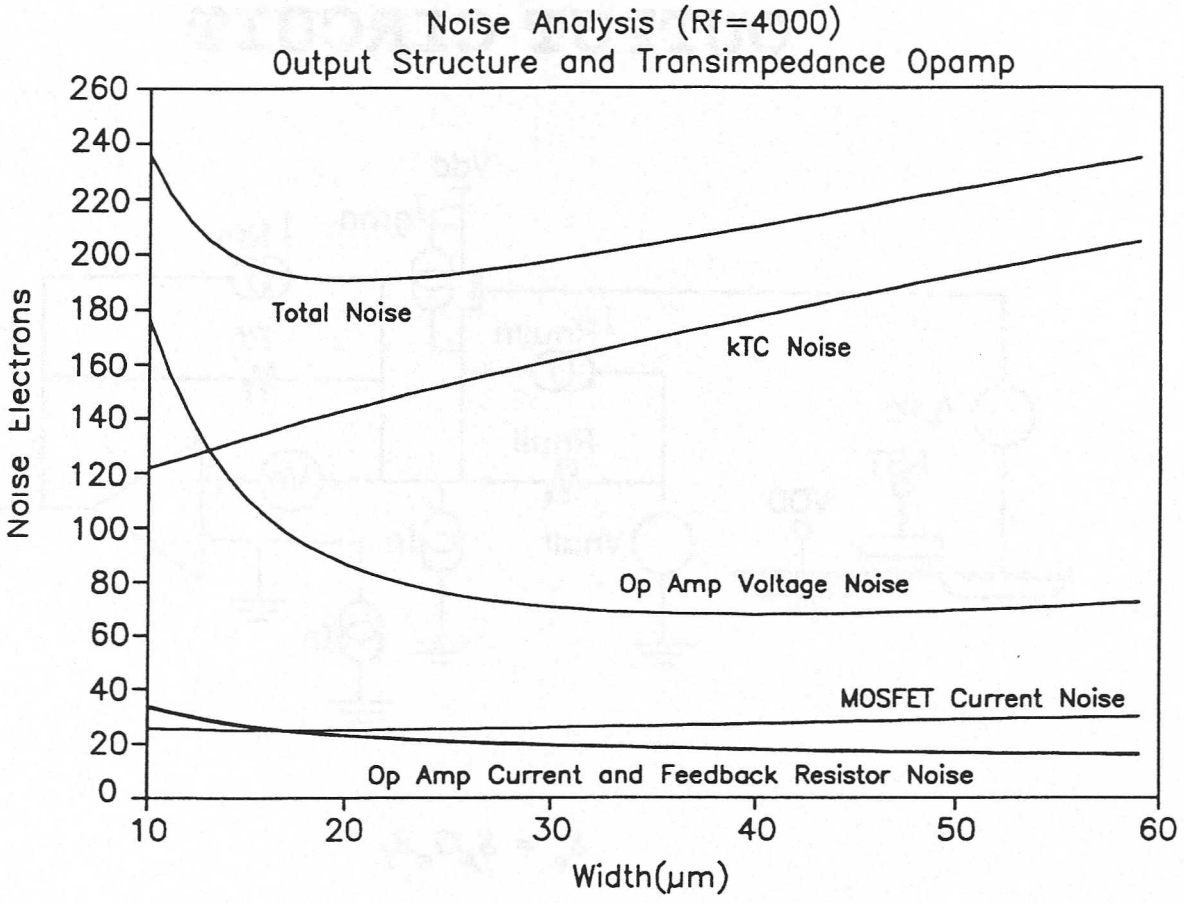


$$S_o = S_{fd} G_m R_f$$

- A 25µm/5µm ON-CHIP SINGLE MOSFET IS CONNECTED TO AN OFF-CHIP OPAMP YIELDING A CURRENT MODE HIGH SPEED (10ns EDGES) CONFIGURATION THAT OCCUPIES LITTLE PHYSICAL SPACE ON-CHIP

- USING THE TRANSIMPEDANCE APPROACH WITH A 4000Ω FEEDBACK RESISTOR THE TOTAL CONVERSION EFFICIENCY IS 2.4µV/e COMPARED TO 0.8µV/e IF THE ON-CHIP MOSFET IS CONFIGURED AS A SOURCE FOLLOWER WITH A MUCH LOWER BANDWIDTH

- CONFIGURATION OPERATES WITH REDUCED ON-CHIP POWER DISSIPATION



- PLOT OF FLOATING DIFFUSION NOISE ELECTRONS TO MOSFET WIDTH (LENGTH = 5μm)
- AT W = 25μm NOISE IS AT ITS MINIMUM - 190 ELECTRONS
- AS W INCREASE BEYOND 25μm, kTC NOISE DOMINATES
- IF CDS IS USED TO ELIMINATE kTC COMPONENT, A LARGER W INCREASES GM AND THUS TOTAL CONVERSION EFFICIENCY
- FOR HIGH SPEED OPERATION, NOISE IS COMPARABLE TO A TWO STAGE SOURCE FOLLOWER