

## **A 5040 x 5040 Multi-Tap Image Sensor For High Frame Rate Applications**

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**ABSTRACT** - Until recently large format area arrays have been limited to staring applications confined to long integration times and slow readout rates. A unique metal-strapped CCD architecture has been developed to enable high speed vertical clocking. In combination with multi-tap output structures, frame rates over 10 frames per second are possible for sensors with over 4 Megapixels. This architecture has been applied to very large full frame CCD sensors having 2048 x 2048 and 5040 x 5040 pixel formats. Pixel pitch is 12 microns in both cases and the charge storage capacity of each photosite is approximately 200,000 electrons. The minimum detectable charge is 50 electrons when correlated double sampling is used. Reduced dark leakage operation of 60 pA/cm<sup>2</sup>, when operated in the surface inversion mode, has been demonstrated.

## LARGE AREA CCD SENSORS FOR HIGH FRAME RATE APPLICATION

### REQUIREMENTS

- REPLACEMENT OF LARGE FORMAT FILM BASED CAMERA TECHNOLOGY WITH E-O FOCAL PLANE TECHNOLOGY
- REAL TIME, HIGH RESOLUTION, FAST FRAME RATE PHOTOGRAPHY
- HIGH RESOLUTION  $\geq 25$  MILLION PIXELS  $f_n \geq 42$  Lp/mm
- HIGH FRAME/PIXEL RATES  $\geq 2.5$  FPS  $\geq 60$  MEGAPIXELS/SECOND
- WIDE DYNAMIC RANGE  $\geq 4000:1$
- HIGH MTF AT  $f_n \geq 0.45$

## LARGE AREA CCD SENSORS FOR HIGH FRAME RATE APPLICATIONS

### TECHNOLOGY ISSUES

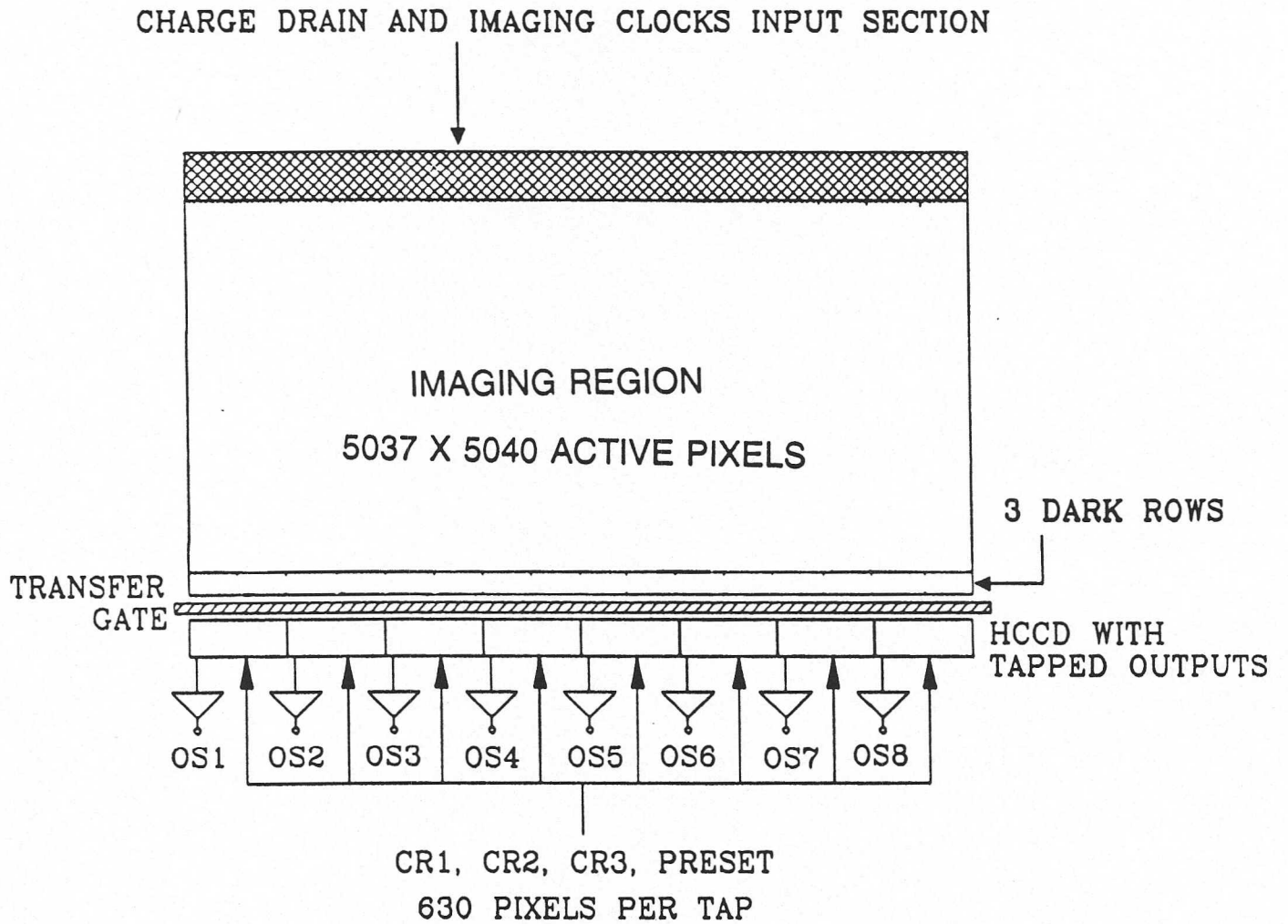
- SMALL PIXEL  $\geq 12 \mu\text{m}$  WITH LARGE NSAT  $\geq 200,000$  ELECTRONS
- MINIMIZED RC FOR VERTICAL CLOCKS  $\geq 5 \mu\text{s}$
- MULTITAP READOUT REGISTER WITH WIDE BAND, HIGH CONVERSION EFFICIENCY AMPLIFIERS
- LOW DARK CURRENT  $\leq 0.1 \text{ nA/cm}^2$
- WAFER SCALE SENSOR FABRICATION WITH YIELD  $\geq 5\%$
- DRIVE CIRCUITRY/POWER DISSIPATION  $\approx 6 \text{ WATTS}$  @ 5 fps, 1.3 MICROFARAD TOTAL GATE CAPACITANCE

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### SENSOR DESIGNS

	(1991)	(1992)	(1993)
ARRAY SIZE	2048 X 2048	5120 X 5120	5040 X 5040
TECHNOLOGY	3 POLY NMOS	3 POLY NMOS	3 POLY NMOS
ARCHITECTURE	4 OUTPUT TAP FULL FRAME	4 QUADRANT FULL FRAME	8 OUTPUT TAP FULL FRAME
PIXEL PITCH	12um x 12um	12um x 12um	12um x 12um
NSAT	$\geq 200,000$ el	$\geq 130,000$ el	$\geq 200,000$ EL.
FRAME RATE	$\geq 10$ FPS	$\approx 0.5$ FPS	$\geq 2.5$ FPS
RESPONSIVITY	$\geq 1.5V/\mu J/cm^2$	$\geq 1.5V/\mu J/cm^2$	$\geq 3.0V/\mu J/cm^2$

# 5040 X 5040 Element Sensor



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