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# NASA Tech Briefs

*The Design/Engineering Technology Digest*

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respective values plus a source-follower voltage threshold component. Immediately after CLAMP is turned off, the DDS switch (the transistor labeled "DDS" in Figure 2) and two column-selection switches (COL) on opposite sides are used to short CR and CS together. The result is a difference voltage coupled to the output drivers (VR\_OUT and VS\_OUT) that is free of the voltage threshold component.

This work was done by Robert Nixon, Eric Fossum, and Sabrina Kemeny of Caltech for **NASA's Jet Propulsion Laboratory**. For further information, **write in 5** on the TSP Request Card.

In accordance with Public Law 96 517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Pasadena, CA 91125  
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Refer to NPO-19582, volume and number of this NASA Tech Briefs issue, and the page number.

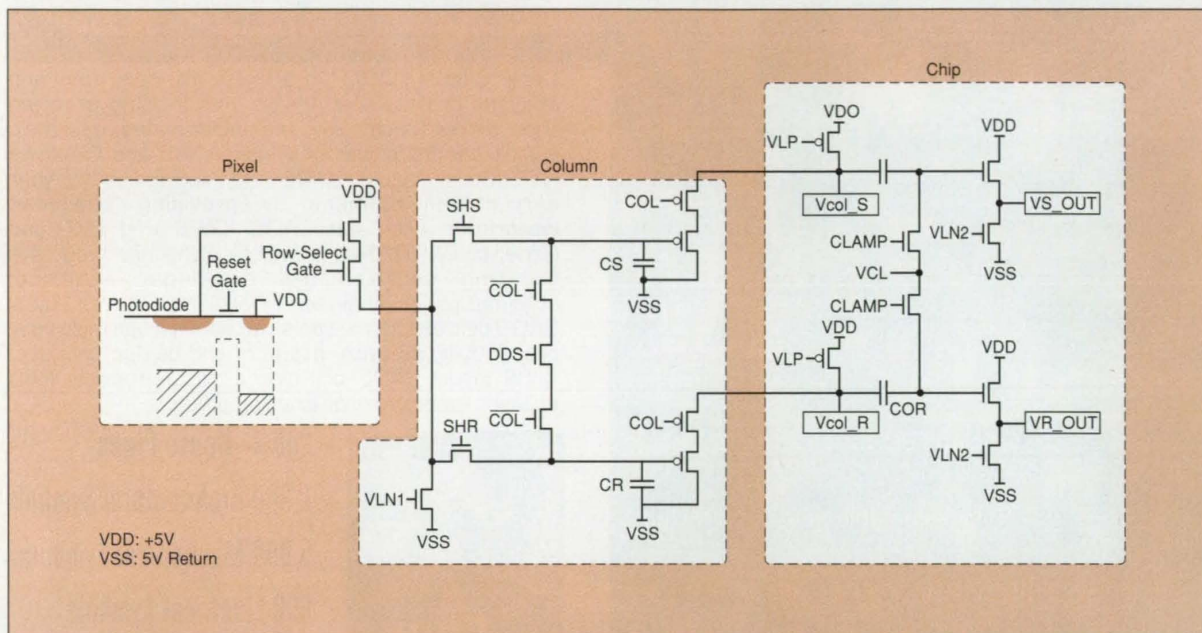


Figure 2. Each Active Pixel Contains Part of the Readout Circuitry, while some of the readout circuitry is common to all the pixels in a column and some serves all the columns on the chip.

## ► CMOS Active-Pixel Image Sensor Containing Pinned Photodiodes

Lower dark current and higher blue response are anticipated.

NASA's Jet Propulsion Laboratory, Pasadena, California

A complementary metal oxide/semiconductor (CMOS) active-pixel image sensor containing pinned photodiodes has been built (but not yet tested) in an effort to improve on a silicon-based active-pixel image sensor that was developed previously and is now in use at NASA's Jet Propulsion Laboratory. The older sensor operates with high quantum efficiency except in the blue part of the spectrum, where the response is diminished by photogates made of polycrystalline silicon ("poly" for short). In addition, the dark current ( $1 \text{ nA/cm}^2$ ) of the older sensor is greater than desired. Accordingly, the present sensor was designed to incorporate pinned photodiodes as its photoelements because pinned photodiodes

can be fabricated without overlying poly. Pinned photodiodes are characterized by no lag, low reset noise, low dark current, and high quantum efficiency.

The sensor contains an array of  $256 \times 256$  pixels on an integrated-circuit chip with an overall size of  $1.2 \times 1.2 \text{ cm}$  and with a 40-pin pad frame. All of the row and column addressing of the pixels is accomplished via 8-input NAND gates (one such gate for the rows, the other for the columns). Each 8-input NAND gate contains eight n-channel transistors in series, implemented by use of overlaid

poly-1/poly-2 gates, somewhat as in a charge-coupled device.

A column-control logic circuit generates a column-selection signal, which is used to control the serial readout of data and is used with a crowbar signal to perform an operation that reduces fixed pattern noise. Each column-readout circuit contains two sample-and-hold capacitors; one for the signal level and one for the reset level. The crowbar signal activates a crowbar switch, which is a transistor switch in each column-readout circuit that is used to selectively short-circuit the two sample-and-hold capacitors together to reduce the fixed pattern noise generated by threshold-voltage offsets in p-channel source followers in the readout circuitry.

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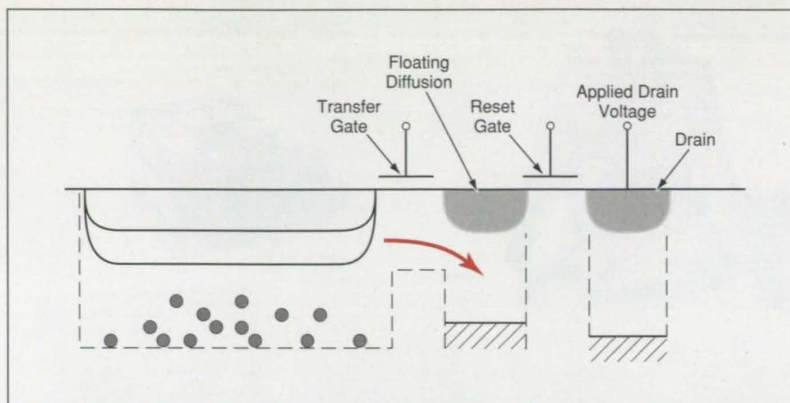
For More Information Write In No. 642

Patent Owner Collect, LLC  
Ex. 2055, p. 3

Both the signal and reset levels of each pixel are read out, providing for off-chip subtraction to reduce the noise from each pixel.

The figure illustrates the active-photo-sensor part of a pixel, with its pinned photodiode and integral transistors. It includes a transfer gate, a reset gate, and a floating diffusion node that connects to the input node of an n-channel source follower. A row-control logic circuit generates a row-selection signal plus the signals that are applied to the transfer and reset gates of each pixel in the selected row. The transfer gate is clocked to transfer the signal charge to the floating diffusion node. A frame-reset signal is also available; this signal is an inverted one that, when low, switches on the reset transistors in all pixels, putting all the floating diffusion nodes at the reset level but not emptying the signal charge from the pinned photodiodes.

The signals from the array of pixels are read out a row at a time. The reset and signal level from each pixel in the selected row is loaded in the sample-and-hold capacitors at the bottom of the column of that pixel. The levels from the columns are then read out serially.



A Pinned Photodiode in Each Pixel is expected to give higher blue response and lower dark noise than does a poly photogate in each pixel in an older device.

This work was done by Eric R. Fossum and Russell C. Gee of Caltech and Paul P. K. Lee, and Teh Hsuang Lee of Eastman Kodak Company for **NASA's Jet Propulsion Laboratory**. For further information, **write in 10** on the TSP Request Card.

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Refer to NPO-19648, volume and number of this NASA Tech Briefs issue, and the page number.

## Magnetostrictive Transducers Would Sense and Damp Vibrations

These devices would incorporate a high-energy magnetostrictive material.

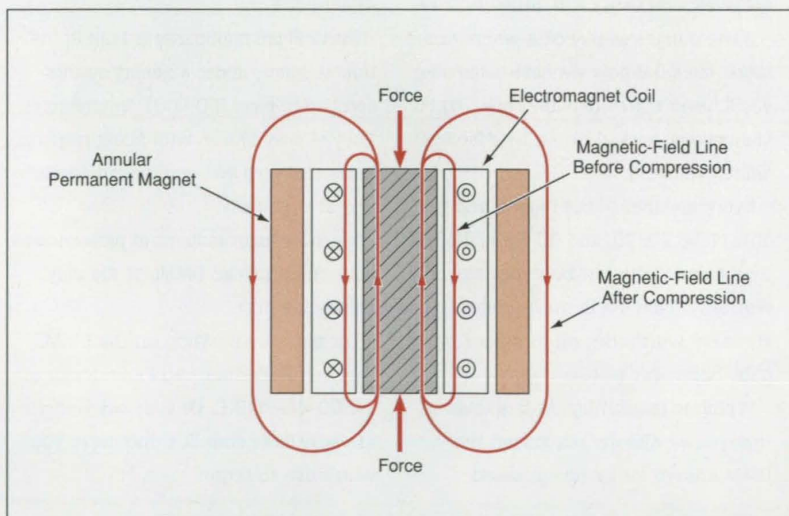
*Marshall Space Flight Center, Alabama*

Magnetostrictive transducers are being investigated for potential use in sensing and damping vibrations of structures. The magnetostrictive material to be used in these transducers is Terfenol-D (or equivalent). Previously, magnetostrictive transducers have been operated in a "forward" mode, in which electrical currents are applied to electromagnets that, in turn, apply magnetic fields to magnetostrictive components to generate large forces via the magnetostrictive effect. The advantage of Terfenol-D (or equivalent) is that it can also effect the "reverse" transduction from mechanical to electrical energy with equal efficiency.

In a typical application, a structure would contain one or more members made at least partly of the magnetostrictive material surrounded by an electromagnet coil and an annular permanent magnet (see figure). When a force (e.g., a vibrational force) was applied to the magnetostrictive material, a magnetic field would be generated by the magne-

tostrictive effect and intercepted by the coil. The ends of the coil could be connected to sensing circuitry for measure-

ment of vibrations. The ends of the coil could also be connected to a suitable resistor or short circuit to damp the elec-



This **Magnetostrictive Transducer** could be used as a passive vibration damper, a vibration sensor, or a force actuator.