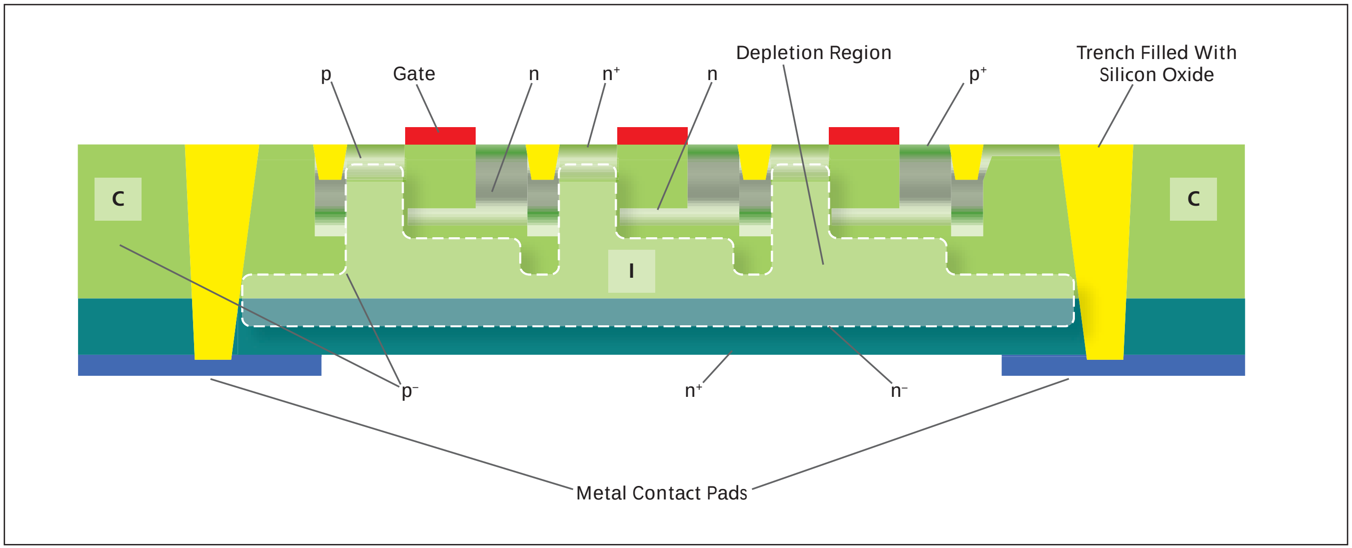

This **Simplified Cross Section** (not to scale) shows essential features of the developmental device structure. A key feature of the structure is the depletion region (indicated by the dashed outline) along the entire n^-/p^- junction.

The n^- and p^- doping concentrations are chosen such that everywhere in area I, a depletion region exists between the n^- and p^- layers. This depletion region enables electrical isolation between the several front (top) doped regions and the back (bottom) n and n^+ layers. Consequently, the bias potentials applied to the top of the diode and the adjacent transfer gate can be different from the bias applied to the bottom. Thus, while CMOS-compatible potentials (e.g., 3 V) are applied at the top, the bottom of the structure can be biased to greater potential (e.g., 5 V) via the back-side metal contact pads to completely deplete the photodiode. The resulting depletion region is indicated in the figure as the area enclosed by the dashed outline. Complete depletion of the photodiode results in collection of charge carriers (holes in this case) under the influence of an electric field, and hence, a significant reduction of cross-talk. Complete depletion also increases the charge-storage volume, and, hence, the charge-handling capacity. Thus, the structure described here provides for large depletion width around each photodiode, independent of the CMOS power-supply voltage and pixel size.

This work was done by Bedabrata Pain and Thomas J. Cunningham of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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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Refer to NPO-45964, volume and number of this NASA Tech Briefs *issue, and the page number.*

High-Performance Wireless Telemetry

This technology is applicable to any kind of aviation or power-plant turbine testing.

John H. Glenn Research Center, Cleveland, Ohio

Prior technology for machinery data acquisition used slip rings, FM radio communication, or non-real-time digital communication. Slip rings are often noisy, require much space that may not be available, and require access to the shaft, which may not be possible. FM radio is not accurate or stable, and is limited in the number of channels, often with channel crosstalk, and intermittent as the shaft rotates. Non-real-time digital communication is very popular, but complex, with long development time, and objections from users who need continuous waveforms from many channels.

This innovation extends the amount of information conveyed from a rotating machine to a data acquisition system while keeping the development time short and keeping the rotating electronics simple, compact, stable, and rugged. The data are all real time. The product of the number of channels, times the bit resolution, times the update rate, gives a data rate higher than available by older methods. The telemetry system consists of a data-receiving rack that supplies magnetically coupled power to a rotating instrument amplifier ring in the machine being monitored. The ring digitizes the data and magnetically couples the data back to the rack, where it is made available.

The transformer is generally a ring positioned around the axis of rotation with one side of the transformer free to rotate and the other side held stationary. The windings are laid in the ring; this gives the data immunity to any rotation that may occur.

A medium-frequency sine-wave power source in a rack supplies power through a cable to a rotating ring transformer that passes the power on to a rotating set of electronics. The electronics power a set of up to 40 sensors and provides instrument amplifiers for the sensors. The outputs from the amplifiers are filtered and multiplexed into a serial ADC. The output from the ADC is connected to another rotating ring transformer that conveys the serial data from the rotating section to the stationary section. From there, a cable conveys the serial data to the remote rack, where it is reconditioned to logic level specifications, de-serialized, and converted back to analog. In the rotating electronics are code generators to indicate the beginning of files for data synchronization.

An alternative method would be to use two symmetrical coils. Since the two coils are rotationally symmetrical, rotation does not influence the magnetic coupling from the primary to the secondary. Since the secondary coil is electrostatically shielded, environmental noise pickup is intrinsically low. Since the transformer is air-core, the uncompressed bandwidth can be high — 50 MHz, 200 MHz, or higher.

The rotating coil is the primary component of the transformer and is in the shape of a thin ring, containing a few turns of wire. The plane of the ring is perpendicular to the axis of rotation. Radially, just beyond the rotating primary coil, is the secondary coil in the shape of a ring, and lying close to the primary. The secondary coil is a single turn of coaxial cable with the center conductor connected to the shield of the cable where it leaves the coil. The binary data are fed into both ends of the primary coil through an impedance matching resistor, with one end receiving the data inverted. This double-ended (full-bridge) approach reduces propagation delay distortions and increases signal strength. The secondary coil has an impedance matching resistor at the end of the cable. Use of a coaxial cable reduces capacitive coupling, but freely allows magnetic coupling. To enhance the coupling, ferrite cloth can be laid into a groove and the primary coil wound on top of it. Similarly, ferrite cloth can be formed around the secondary coil. Copper rings can be placed on either side of the coil set to reduce outside influences.

This work was done by Elmer Griebeler, Nuha Nawash, and James Buckley of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18575-1/7-1.

Telemetry-Based Ranging

NASA's Jet Propulsion Laboratory, Pasadena, California

A telemetry-based ranging scheme was developed in which the downlink ranging signal is eliminated, and the range is computed directly from the downlink telemetry signal. This is the first Deep Space Network (DSN) ranging technology that does not require the spacecraft to transmit a separate ranging signal. By contrast, the evolutionary ranging techniques used over the years by NASA missions, including sequential ranging (transmission of a sequence of sinusoids) and PN-ranging (transmission of a pseudo-noise sequence) — whether regenerative (spacecraft acquires, then regenerates and retransmits a noise-free ranging signal) or transparent (spacecraft feeds the noisy demodulated uplink ranging signal into the downlink phase modulator) — relied on spacecraft power and bandwidth to transmit an explicit ranging signal.

The state of the art in ranging is described in an emerging CCSDS (Consultative Committee for Space Data Systems) standard, in which a pseudo-noise (PN) sequence is transmitted from the ground to the spacecraft, acquired onboard, and the PN sequence is coherently retransmitted back to the ground, where a delay measurement is made between the uplink and downlink signals. In this work, the telemetry signal is aligned with the uplink PN code epoch. The ground station computes the delay between the uplink signal transmission and the received downlink telemetry. Such a computation is feasible because symbol synchronizability is already an integral part of the telemetry design.

Under existing technology, the telemetry signal cannot be used for ranging because its arrival-time information is not coherent with any Earth reference signal. By introducing this coherence, and performing joint telemetry detection and arrival-time estimation on the ground, a high-rate telemetry signal can provide all the precision necessary for spacecraft ranging.

This work was done by Jon Hamkins, Victor A. Vilnrotter, Kenneth S. Andrews, and Shervin Shambayati of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47170