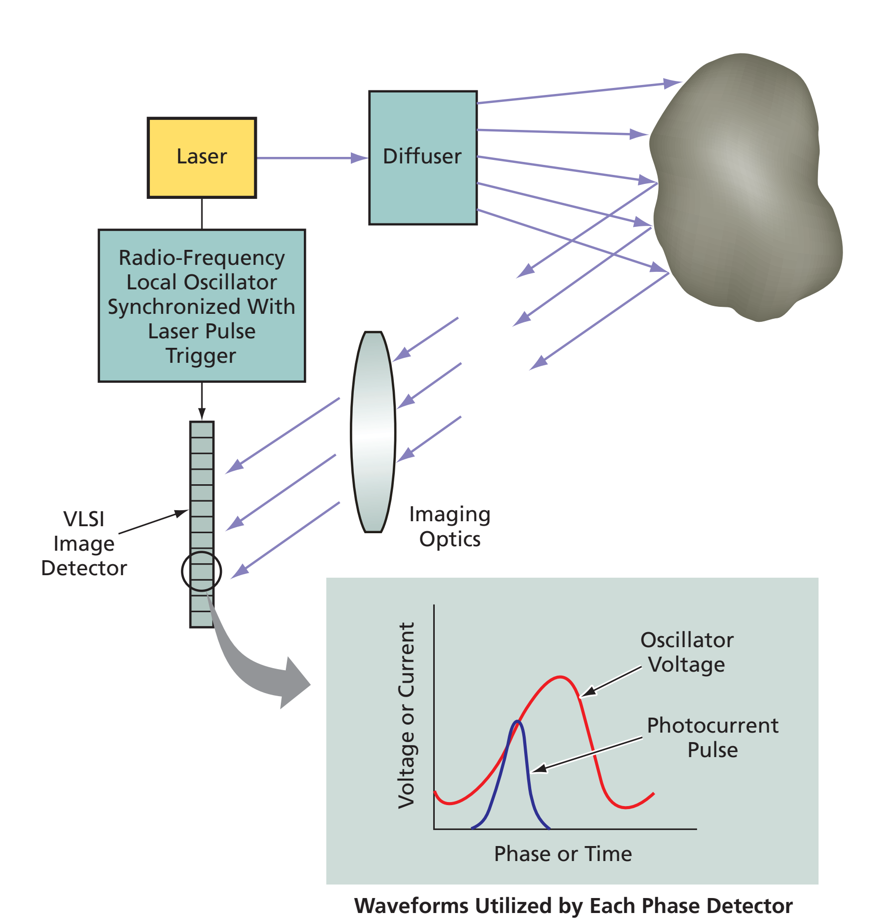

In this **Lidar Range-Imaging System** voltage-to-phase converter circuits in each pixel that would be used to measure the phase of the lidar return pulse relative to the phase of a local-oscillator signal synchronized with the laser pulse.

nal are fed as inputs to a current-mirror circuit to obtain output currents proportional to the value of the local-oscillator sinusoid at the time of return of the laser pulse. In each of several phase-detector circuits, one of the current-mirror output currents is integrated in a capacitor to obtain a low-noise voltage indicative of the phase difference. This design enables accurate measurement of the phase difference because it is possible to measure voltage very accurately (to within microvolts) in VLSI circuits. The use of several phase detectors, each excited with a differently delayed replica of the local oscillator signal, makes it possible to measure the target distance accurately in the presence of unknown background illumination, unknown target albedo, and full-cycle phase ambiguities.

This work was done by Bedabrata Pain and Bruce Hancock 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-40811, volume and number of this NASA Tech Briefs *issue, and the page number.*

Integrated Radial Probe Transition From MMIC to Waveguide

Packaging based on wire bonding would be supplanted by monolithic integration.

NASA's Jet Propulsion Laboratory, Pasadena, California

A radial probe transition between a monolithic microwave integrated circuit (MMIC) and a waveguide has been designed for operation at frequency of 340 GHz and to be fabricated as part of a monolithic unit that includes the MMIC. Integrated radial probe transitions like this one are expected to be essential components of future MMIC amplifiers operating at frequencies above 200 GHz. While MMIC amplifiers for this frequency range have not yet been widely used because they have only recently been developed, there are numerous potential applications for them — especially in scientific instruments, test equipment, radar, and millimeter-wave imaging systems for detecting hidden weapons.

One difficult problem in designing and fabricating MMIC amplifiers for frequencies greater than 200 GHz is that of packaging the MMICs for use as parts of instruments or for connection with test equipment. To package an MMIC for use or testing, it is necessary to mount the MMIC in a waveguide package, wherein the cross-sectional waveguide dimensions are typically of the order of a few hundred microns. Typically, in an MMIC/waveguide module for a microwave frequency well below 200 GHz, electromagnetic coupling between the MMIC and the waveguides is effected by use of a microstrip-to-waveguide transition that is (1) fabricated on a dielectric [alumina or poly(tetrafluoroethylene)] substrate separate from the MMIC and (2) wire-bonded to the MMIC chip. In the frequency range above 200 GHz, wire bonding becomes lossy and problematic, because the dimensions of the wire bonds are large fractions of a wavelength. In addition, fabrication of the transition is difficult at the small required thickness [typically of the order of 1 mil (25.4 μm)] of the dielectric substrate. The present design promises to overcome the disadvantages of the separate substrate/wire-bonding approach.

The radial probe design could readily be adapted to integration with an MMIC amplifier because it provides for the fabrication of the transition on a substrate of the same material (InP), width (310 μm), and thickness (50 μm) typical of substrates of MMICs that can operate above 300 GHz. The figure depicts the basic geometric features of the design. The conductive part of the transition would be deposited on the InP substrate. The transition (and the rest of the MMIC chip if the transition were integrated with the MMIC) would reside in a metal cavity 360 μm wide having a stepped vertical dimension of total height 200 μm. The metal cavity would be essentially a reduced-cross-section lateral extension of the waveguide. The waveguide would be of a standard rectangular cross section, known in the art as WR2.2, having dimensions of 559 μm by 279 μm. There would be a 50-μm backshort between one vertical side of the metal cavity and the near end of the waveguide. The transition is designed to effect coupling between the microstrip mode of the MMIC chip and the transverse electric 10 (TE_{10}) electromagnetic mode of the waveguide. The choice of dimensions of the metal cavity and the waveguide is governed partly by the requirement that the cutoff frequency of the waveguide be less than the frequency of operation while the cutoff frequency of the transition's cavity must exceed the frequency of operation.

This work was done by Lorene Samoska and Goutam Chattopadhyay of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-43957

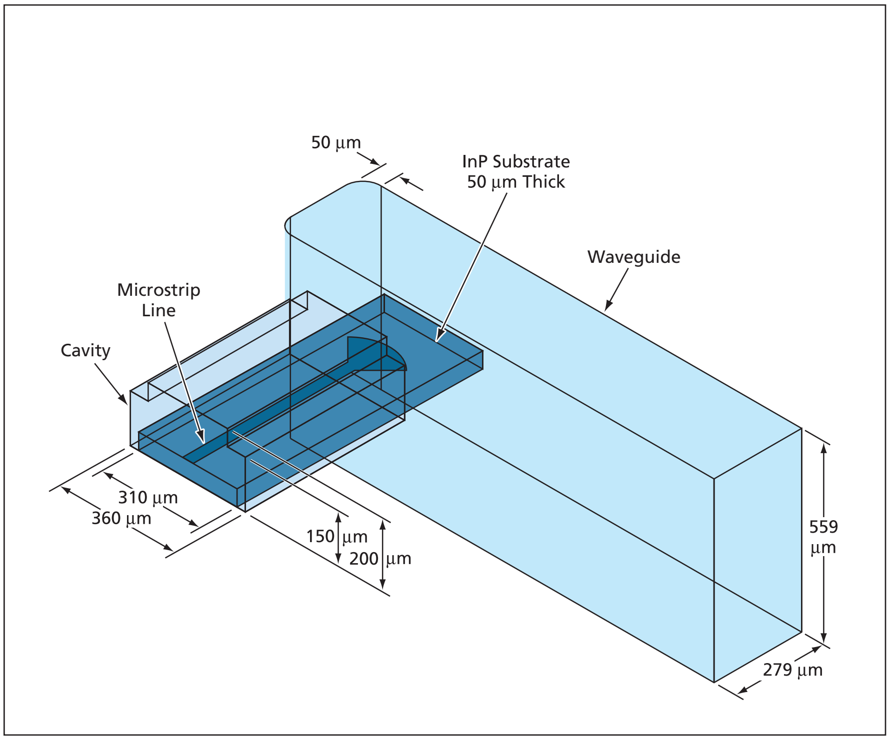

Figure 1. The **Integrated Radial Probe Transition** would couple 340-GHz electromagnetic radiation from an MMIC (not shown) on the InP substrate to the waveguide.

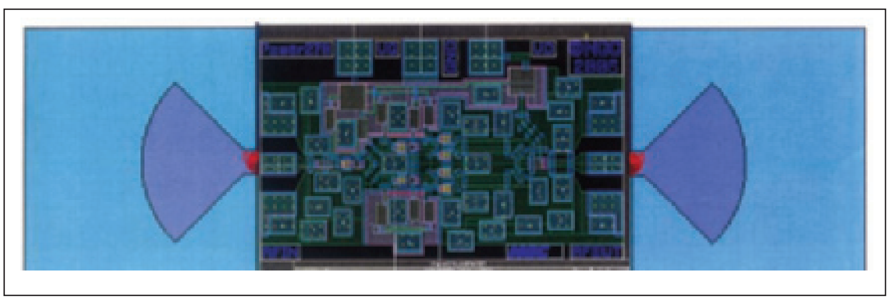

Figure 2. **This Is an Example Plan View of a 340-GHz MMIC** amplifier chip that would incorporate radial probe transitions like that of Figure 1 at both ends. Backside metal would be removed in the probe areas.

Bar-Code System for a Microbiological Laboratory

Time is saved and the incidence of errors is greatly reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

A bar-code system (see figure) has been assembled for a microbiological laboratory that must examine a large number of samples. The system includes a commercial bar-code reader, computer hardware and software components, plus custom-designed database software. The software generates a user-friendly, menu-driven interface.

Traditionally, microbiological samples have been labeled by hand, and recording of results of microbiological assays has entailed handwriting of bacterial-colony counts in notebooks. This traditional approach is both time-consuming and susceptible to human error, especially when large numbers of samples are involved. By automating the routine aspects of tracking microbiological samples, recording data, and documentation of samples and results, the bar-code system saves time and greatly reduces the incidence of errors.

The bar-code system prints unique bar-code labels that can be easily affixed to test tubes and Petri dishes. During sampling, a technician or microbiologist affixes the labels and uses a personal digital assistant (PDA) with a built-in bar-code scanner to scan the bar codes and record notes. After sampling, the data acquired by the bar-code scanner are downloaded to the bar-code-system database, and then a microbiologist assays the samples.

To record assay results, the microbiologist scans the bar-code label on each test tube or Petri dish and records the data specific to that sample container on