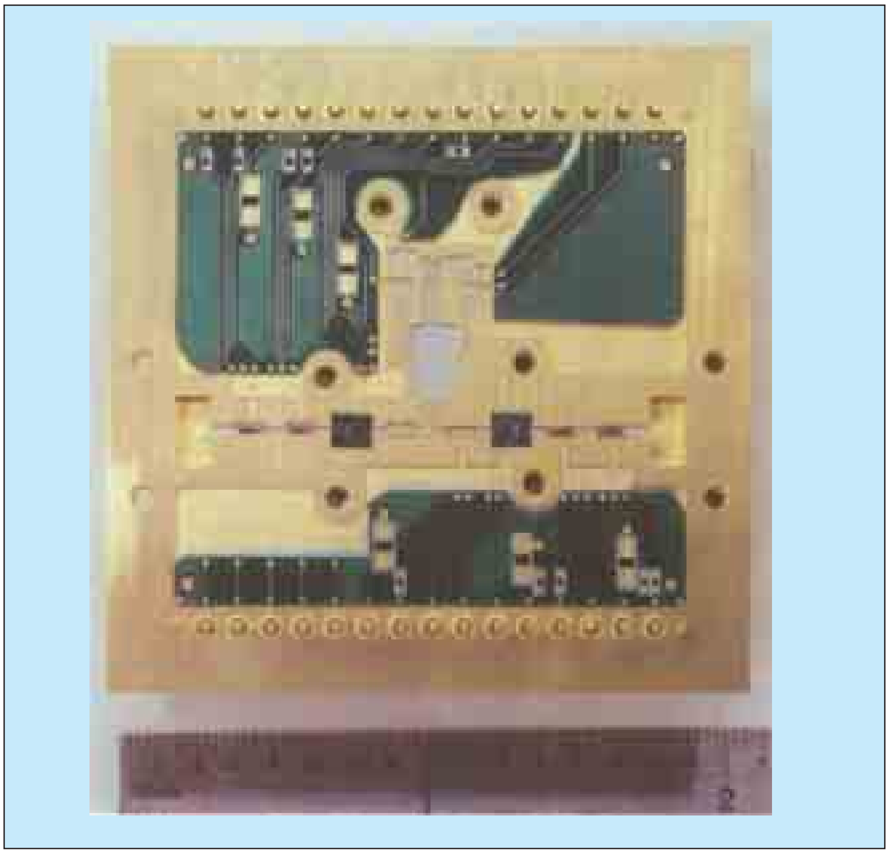


The **MCM** performs all the microwave functions (other than initial reception and orthomode transduction) of a polarimetric microwave radiometer.

cost per unit in an array of many such units.

The design of the unit is dictated partly by a requirement, in the planned CMB application, to measure the Stokes parameters I, Q, and U of the CMB radiation with high sensitivity. (A complete definition of the Stokes parameters would exceed the scope of this article. In necessarily oversimplified terms, I is a measure of total intensity of radiation, while Q and U are measures of the relationships between the horizontally and vertically polarized components of radiation.) Because the sensitivity of a single polarimeter cannot be increased significantly, the only way to satisfy the high-sensitivity requirement is to make a large array of polarimeters that operate in parallel.

The MCM includes contact pins that can be plugged into receptacles on a standard printed-circuit board (PCB). All of the required microwave functionality is implemented within the MCM; any required supporting non-microwave ("back-end") electronic functionality, including the provision of DC bias and control signals, can be implemented by standard PCB techniques.

On the way from a microwave antenna to the MCM, the incoming microwave signal passes through an orthomode transducer (OMT), which splits the radiation into an $h + iv$ beam and an $h - iv$ beam (where, using complex-number notation, h denotes the horizontal component, v denotes the vertical component, and $\pm i$ denotes a $\pm 90°$ phase shift). Each of these beams enters the MCM through one of two WR-22 waveguide input terminals in the lid of the MCM. The $h + iv$ and $h - iv$ signals are amplified, then fed to a phase-discriminator hybrid designed specifically to fit the predominantly planar character of the MCM geometry and to enable determination of Q and U. The phase-discriminator hybrid generates four outputs, which are detected and used to calculate I, Q, and U.

This work was done by Pekka Kangaslahti, Douglas Dawson, and Todd Gaier of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-41335

Aperture-Coupled Thin-Membrane L-Band Antenna

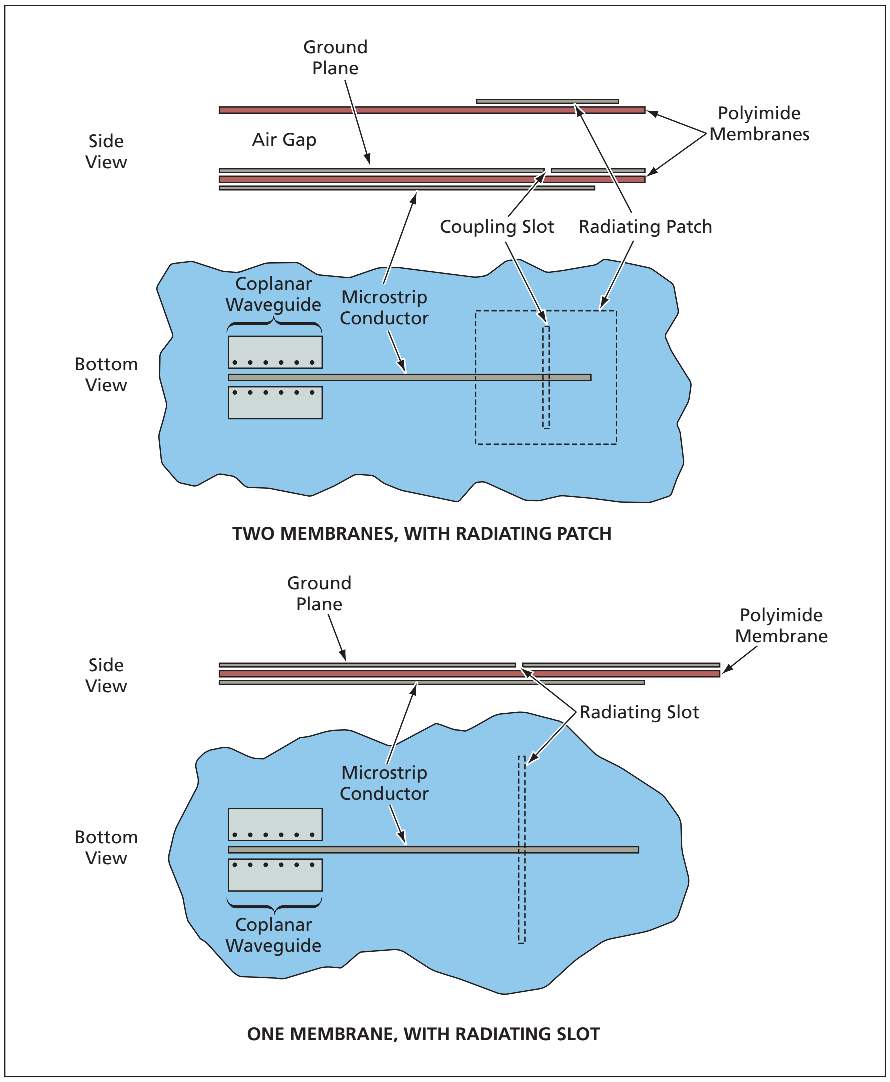
Two- and one-membrane designs offer advantages over prior three-membrane designs.

NASA's Jet Propulsion Laboratory, Pasadena, California

The upper part of the figure depicts an aperture-coupled L-band antenna comprising patterned metal conductor films supported on two thin polyimide membranes separated by an air gap. In this antenna, power is coupled from a microstrip line on the lower surface of the lower membrane, through a slot in a metal ground plane on the upper surface of the lower membrane, to a radiating metal patch on the upper surface of the upper membrane.

The two-membrane configuration of this antenna stands in contrast to a three-membrane configuration heretofore considered as the basis for developing arrays of dual-polarization, wideband microwave antennas that could be thin and could be, variously, incorporated into, or supported on, thin structures, including inflatable structures. By reducing the number of membranes from three to two, the present design simplifies the problems of designing and fabricating such antennas or arrays of such antennas, including the problems of integrating such antennas or arrays with thin-membrane-mounted transmit/receive modules. In addition, the use of aperture (slot) coupling eliminates the need for rigid coaxial feed pins and associated solder connections on thin membranes, making this antenna more mechanically reliable, relative to antennas that include coaxial feed pins.

This antenna is designed for a nominal frequency of 1.26 GHz. The polyimide membranes are 0.05 mm thick and have a relative permittivity of 3.4. The radiating patch is square, 8.89 cm on each side. This radiating patch lies 1.27 cm above the ground plane. The feeding mi-



Aperture (Slot) Coupling is utilized in two- and one-membrane designs that are amenable to incorporation into thin structures and to integration with membrane-supported transmit/receive modules.

crostrip line is 0.12 mm wide and has a characteristic impedance of 50 Ω. The aperture-coupling slot, etched in the ground plane, is 0.48 mm wide and 79.5 mm long. In order to maximize coupling, the microstrip line is extended beyond the middle of the slot by a length of 36 mm, which corresponds to a transmission-line electrical length of about a quarter wavelength. The other end of the microstrip line is transformed to a 50-Ω coplanar waveguide line, which is used for connection to a transmit/receive module. Some plated-through vias are added to the outer conductors of the coplanar waveguide to suppress parallel-plate modes. The measured and calculated 10-dB-return-loss bandwidth of the antenna is 100 MHz.

By eliminating the radiating patch and the upper membrane that supports it, and performing two other simple modifications, one can convert the two-membrane antenna described above to a paper-thin single-membrane antenna, shown in the lower part of the figure. One modification is to increase the slot length to 104.95 mm; the other is to extend the microstrip to 36.68 mm past the middle of the slot. With these modifications, the slot now becomes a half-wavelength radiator with a nearly omnidirectional radiation pattern. In one potential use, such a paper-thin antenna could be pasted on an automobile window to enable omnidirectional communication.

This work was done by John Huang of Caltech for NASA's Jet Propulsion Laboratory. For further information contact iaoffice@jpl.nasa.gov. NPO-41416

WGM-Based Photonic Local Oscillators and Modulators

Efficient devices for detecting low-power terahertz radiation are proposed.

NASA's Jet Propulsion Laboratory, Pasadena, California

Photonic local oscillators and modulators that include whispering-gallery-mode (WGM) optical resonators have been proposed as power-efficient devices for generating and detecting radiation at frequencies of the order of a terahertz. These devices are intended especially to satisfy anticipated needs for receivers capable of detecting low-power, narrow-band terahertz signals to be used for sensing substances of interest in scientific and military applications. At present, available terahertz-signal detectors are power-inefficient and do not afford the spectral and amplitude resolution needed for detecting such signals.

The proposed devices would not be designed according to the conventional approach of direct detection of terahertz radiation. Instead, terahertz radiation would first be up-converted into the optical domain, wherein signals could be processed efficiently by photonic means and detected by optical photodetectors, which are more efficient than are photodetectors used in conventional direct detection of terahertz radiation. The photonic devices used to effect the up-conversion would include a tunable optical local oscillator and a novel electro-optical modulator.

A local oscillator according to the proposal would be a WGM-based mode-locked laser operating at a desired pulse-repetition rate of the order of a terahertz. The oscillator would include a terahertz optical filter based on a WGM microresonator, a fiber-optic delay line, an optical amplifier (which could be either a semiconductor optical amplifier or an erbium-doped optical fiberamplifier), and a WGM Ka-band modulator (see figure). The terahertz repetition rate would be obtained through har-