Two-Band, Low-Loss Microwave Window

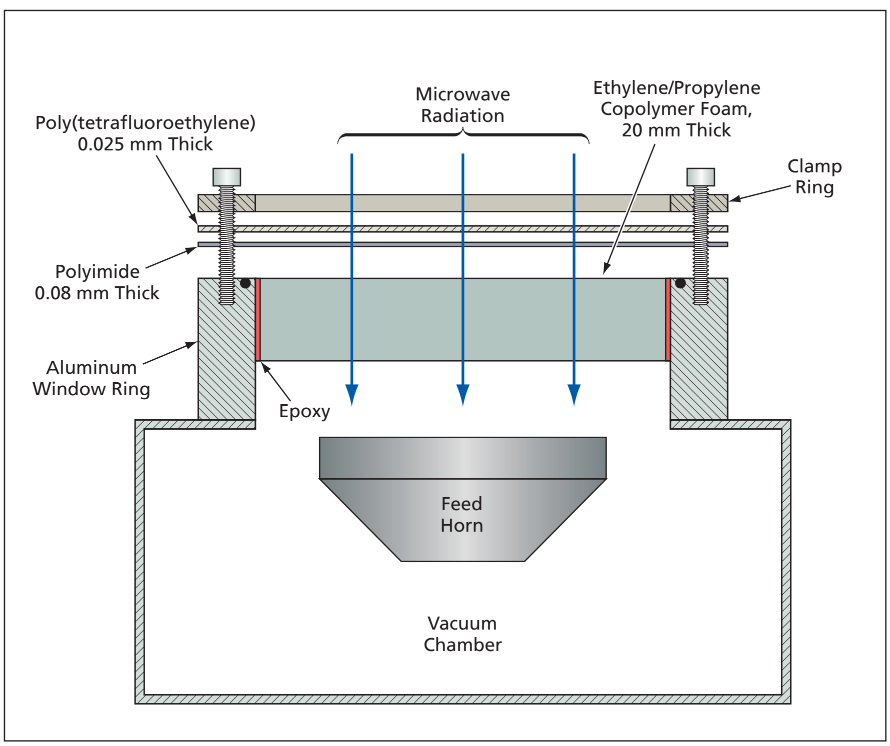
Microwave loss is only about 0.4 percent.

NASA's Jet Propulsion Laboratory, Pasadena, California

A window for a high-sensitivity microwave receiving system allows microwave radiation to pass through to a cryogenically cooled microwave feed system in a vacuum chamber, while keeping ambient air out of the chamber and helping to keep the interior of the chamber cold. The microwave feed system comprises a feed horn and a low-noise amplifier, both of which are required to be cooled to a temperature of 15 K during operation. The window is designed to exhibit very little microwave attenuation in two frequency bands: 8 to 9 GHz and 30 to 40 GHz.

The window is 15 cm in diameter. It includes three layers (see figure):

- The outer layer is made of a poly(tetrafluoroethylene) film 0.025 mm thick. This layer serves primarily to reflect and absorb solar ultraviolet radiation to prolong the life of the underlying main window layer, which is made of a polyimide that becomes weakened when exposed to ultraviolet. The poly(tetrafluoroethylene) layer also protects the main window layer against abrasion. Moreover, the inherent hydrophobicity of poly(tetrafluoroethylene) helps to prevent the highly undesirable accumulation of water on the outer surface.
- The polyimide main window layer is 0.08 mm thick. This layer provides the vacuum seal for the window.
- A 20-mm-thick layer of ethylene/propylene copolymer foam underlies the main polyimide window layer. This foam layer acts partly as a thermal insulator: it limits radiational heating of the microwave feed horn and, concomitantly, limits radiational cooling of the window. This layer has high compressive strength and provides some mechanical support for the main window layer, reducing the strength required of the main window layer.



This **Low-Loss Microwave Window** is made from commercially available materials and is relatively inexpensive.

The ethylene/propylene copolymer foam layer is attached to an aluminum window ring by means of epoxy. The outer poly(tetrafluoroethylene) film and the main polyimide window layer are sandwiched together and pressed against the window ring by use of a bolted clamp ring.

The window has been found to introduce a microwave loss of only about 0.4 percent. The contribution of the window to the noise temperature of the microwave feed system has been found to be less than 1 K at 32 GHz and 0.2 K at 8.4 GHz.

This work was done by Michael Britcliffe and Manuel Franco of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page1).

NPO-40846

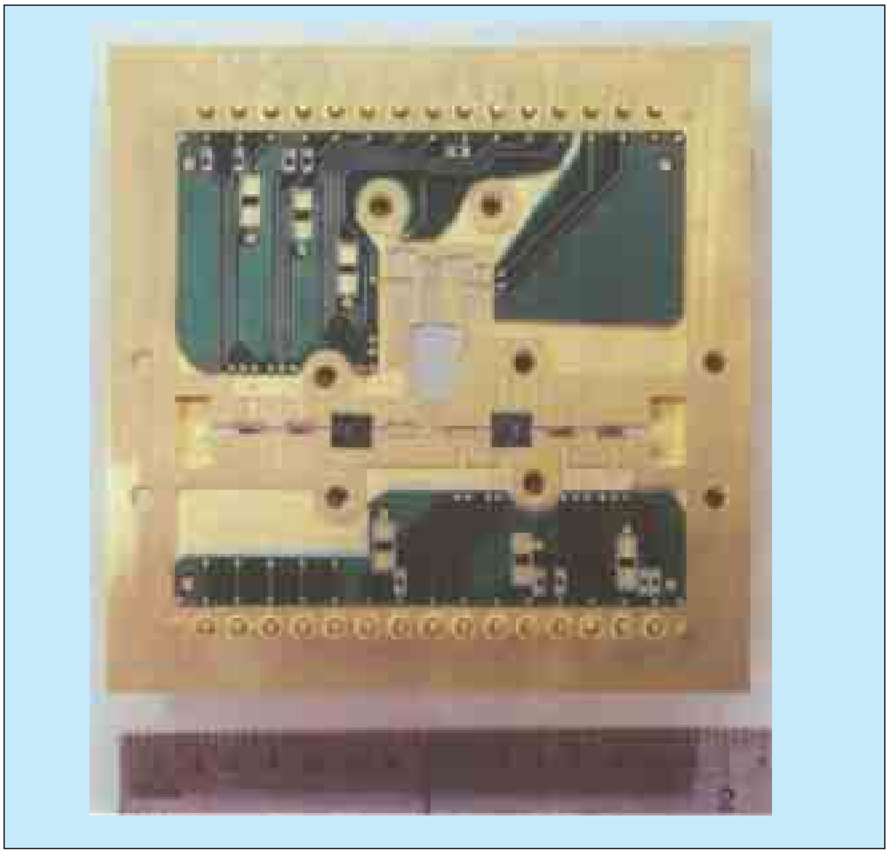
MCM Polarimetric Radiometers for Planar Arrays

In mass production, these would cost less than do traditional polarimetric radiometers.

NASA's Jet Propulsion Laboratory, Pasadena, California

A polarimetric radiometer that operates at a frequency of 40 GHz has been designed and built as a prototype of multiple identical units that could be arranged in a planar array for scientific measurements. Such an array is planned for use in studying the cosmic microwave background (CMB).

All of the subsystems and components of this polarimetric radiometer are integrated into a single multi-chip module (MCM) of substantially planar geometry. In comparison with traditional designs of polarimetric radiometers, the MCM design is expected to greatly reduce the



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-