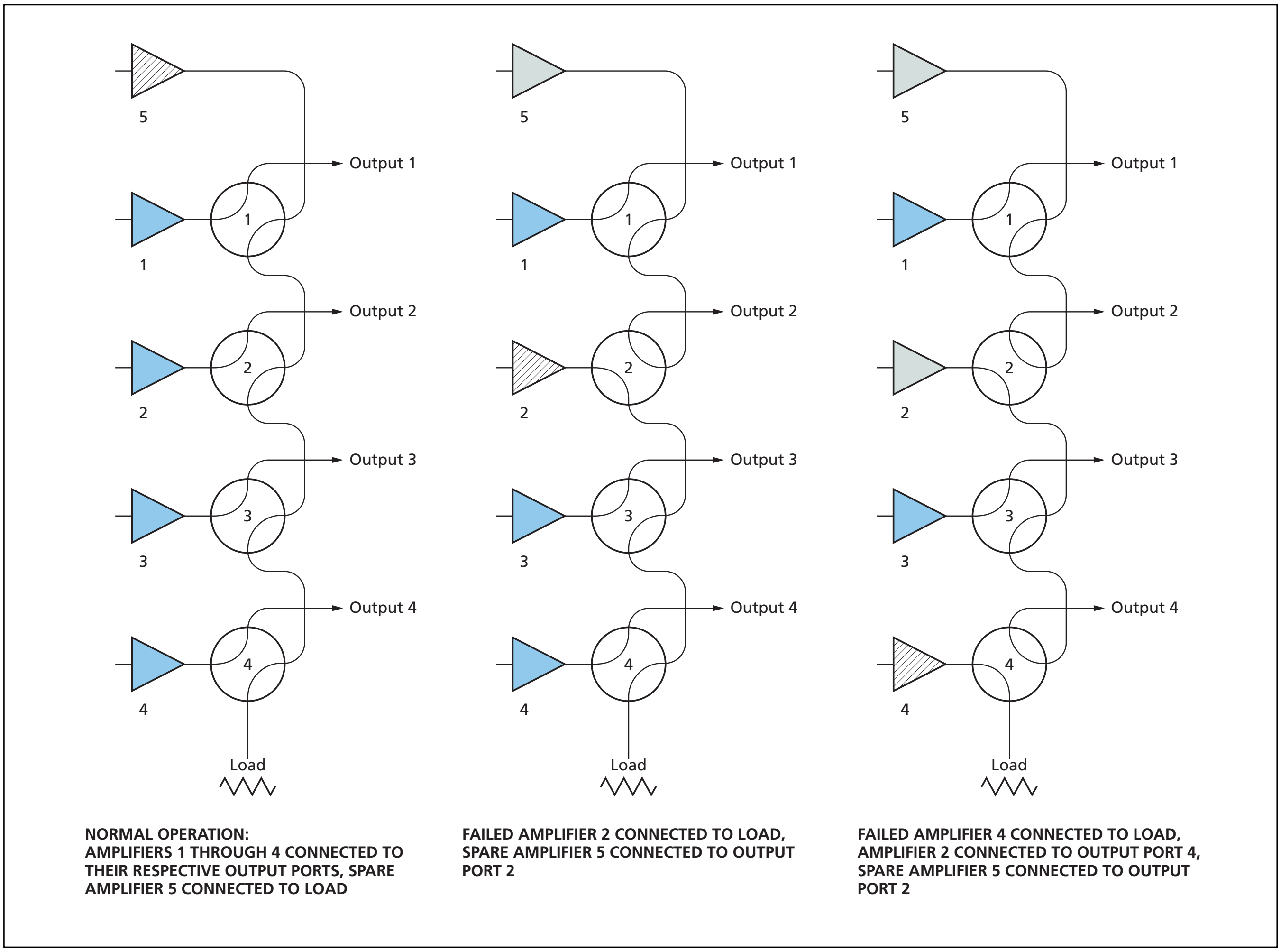


Figure 2. These **Three Switching Configurations** are a few examples of the larger number of allowable configurations for directing the outputs of four of the five amplifiers to the four output ports.

ically actuated waveguide switches. The arrangement could also be generalized to devices other than microwave amplifiers, to switches other than mechanically actuated microwave switches, and to greater numbers of switches, ports, and devices (*N*, *N*, and *N* + 1, respectively, where *N*>4).

The mechanically actuated microwave switches in the original application would be two-position, four-port switches of a type known in the art as "baseball switches" because of the resemblance between their waveguide cross sections and the patterns of stitches on baseballs. Figure 1 depicts the two positions of a baseball switch and the corresponding positions of a nominally equivalent circuit containing a double-pole, double-throw (DPDT) switch.

Figure 2 depicts three examples of useable switching configurations representative of the modes of operation described above. It should be apparent from casual inspection that any of those modes can be attained by actuation of one or more switches. In the original application and perhaps in other potential applications, safety considerations dictate that switching configurations be limited to those in which every amplifier is connected to either an output port or to the load; non-connection of an amplifier or connection of an amplifier to another amplifier is not allowed.

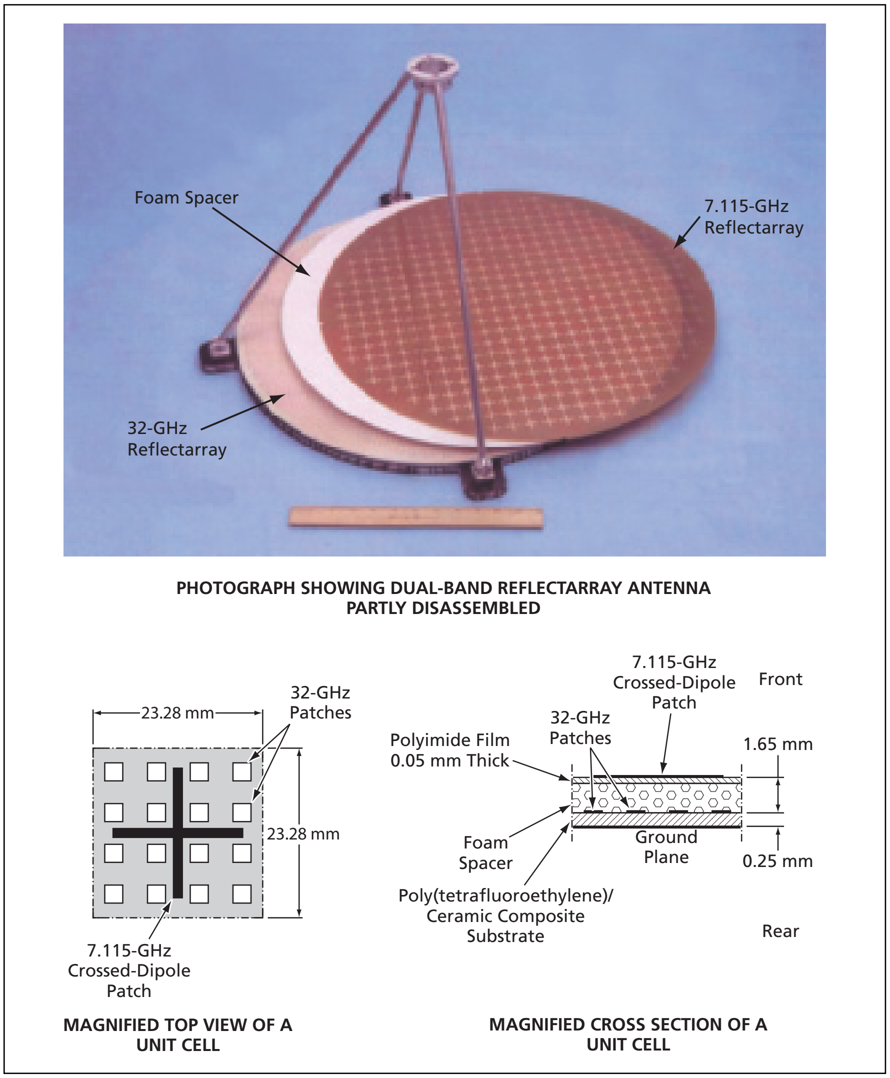
This work was done by James Lux and Robert McMaster of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-41421

Lightweight Reflectarray Antenna for 7.115 and 32 GHz

Reflectarrays for two different frequency bands share the same aperture.

NASA's Jet Propulsion Laboratory, Pasadena, California

A lightweight reflectarray antenna that would enable simultaneous operation at frequencies near 7.115 GHz and frequencies near 32 GHz is undergoing development. More precisely, what is being developed is a combination of two reflectarray antennas — one for each frequency band — that share the same aperture. (A single reflectarray cannot work in both frequency bands.) The main advantage of the single dual-band reflectarray is that it would weigh less and occupy less space than do two single-band reflectarray antennas.



Two Reflectarrays for Different Frequency Bands are sandwiched together with a dielectric foam spacer to form a single dual-band reflectarray.

A reflectarray antenna consists mainly of a planar array of microstrip patches on a suitable dielectric substrate. In a prototype of the dual-band reflectarray antenna (see figure), the 7.115-GHz reflectarray antenna consists of crossed dipole microstrip patches on a thin polyimide membrane; the 32-GHz reflectarray antenna consists of square microstrip patches on top and a ground plane on the bottom of a poly(tetrafluoroethylene)/ceramic composite substrate. The ground plane is bonded to a supporting aluminum plate. The 7.115-GHz reflectarray is placed in front, and the two reflectarrays are sandwiched together with a dielectric foam spacer between them. The crossed-dipole patches of the front (7.115-GHz) reflectarray are positioned between the square patches of the rear (32-GHz) reflectarray to minimize blockage of radiation from the rear array.

In tests of the prototype antenna, it was found that the front (7.115-GHz reflectarray) caused a 1.8-dB reduction in the 32-GHz gain, while the effect of the rear (32-GHz) reflectarray on the 7.115-GHz performance was negligible. It was also concluded, on the basis of the test data, that there is a need to refine understanding of interactions between the individual reflectarrays and to refine their designs accordingly.

This work was done by Mark Zawadzki and John Huang of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-40689

Opto-Electronic Oscillator Using Suppressed Phase Modulation

Phase noise would be much lower than in prior OEOs.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed opto-electronic oscillator (OEO) would generate a microwave signal having degrees of frequency stability and spectral purity greater than those achieved in prior OEOs. The design of this system provides for reduction of noise levels (including the level of phase noise in the final output microwave signal) to below some of the fundamental limits of the prior OEOs while retaining the advantages of photonic generation of microwaves. Whereas prior OEOs utilize optical amplitude modulation, this system would utilize a combination of optical phase modulation and suppression thereof. The design promises to afford, in the opto-electronic domain, the low-noise advantages of suppression of carrier signals in all-electronic microwave oscillators.

OEOs that utilize suppression of radio-frequency carrier signals have already been demonstrated to reject amplifier flicker noise. However, a second important advantage of microwave carrier suppression — reduction of the effects of thermal noise or shot noise (photon-counting noise) — has not previously been realized in OEOs. In microwave applications, realization of this advantage is made possible by (1) use, in oscillators or interferometers, of power levels higher than can be tolerated by a low-noise follower amplifier, combined with (2) means for reducing power levels at detectors while preserving sensitivity. In the proposed system, realization of this advantage would be made possible by notable aspects of the design that would enable the use of high optical power levels to reduce shot-noise-induced variation in the frequency of an OEO.

The proposed system (see figure) would include two subsystems: a phase-