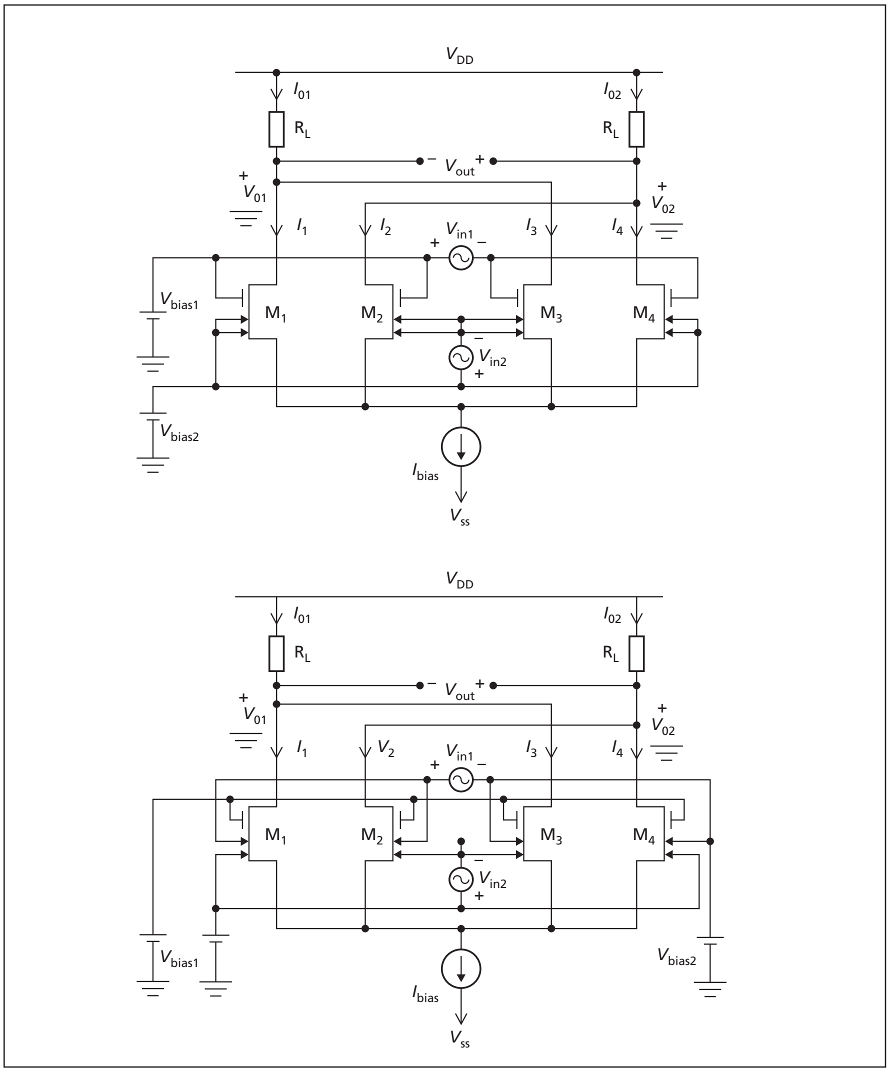

Figure 2. These **Two G^4-FET Analog Multiplier Circuits** are examples of implementation of four-quadrant multipliers using fewer transistors than were previously required for such multipliers.

source and drain of the SOI MOSFET serve, in the G^4-FET, as two junction-based extra gates (JG1 and JG2), which are used to squeeze the channel via reverse-biased junctions as in a JFET. The G^4-FET also includes a polysilicon top gate (G1), which plays the same role as does the gate in an accumulation-mode MOSFET. The substrate emulates a fourth MOS gate (G2).

By making proper choices of G^4-FET device parameters in conjunction with bias voltages and currents, one can design a circuit in which two input gate voltages (V_{in1}, V_{in2}) control the conduction characteristics of G^4-FETs such that the output voltage (V_{out}) closely approximates a value proportional to the product of the input voltages. Figure 2 depicts two such analog multiplier circuits. In each circuit, there is the following:

- The input and output voltages are differential,
- The multiplier core consists of four G^4-FETs (M1 through M4) biased by a constant current sink (I_{bias}), and
- The G^4-FETs in two pairs are loaded by two identical resistors (R_L), which convert a differential output current to a differential output voltage.

The difference between the two circuits stems from their input and bias configurations. In each case, provided that the input voltages remain within their design ranges as determined by considerations of bias, saturation, and cutoff, then the output voltage is nominally given by $V_{out} = kV_{in1}V_{in2}$, where k is a constant gain factor that depends on the design parameters and is different for the two circuits.

In experimental versions of these circuits constructed using discrete G^4-FETs and resistors, multiplication of voltages in all four quadrants (that is, in all four combinations of input polarities) was demonstrated, and deviations of the output voltages from linear dependence on the input voltages were found to amount to no more than a few percent. It is anticipated that in fully integrated versions of these circuits, the deviations from linearity will be made considerably smaller through better matching of devices.

This work was done by Mohammad Mojarradi, Benjamin Blalock, Sorin Cristoloveanu, Suheng Chen, and Kerem Akarvardar 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-41586, volume and number of this NASA Tech Briefs *issue, and the page number.*

Noise Source for Calibrating a Microwave Polarimeter

This compact unit can readily be integrated into an airborne microwave instrumentation.

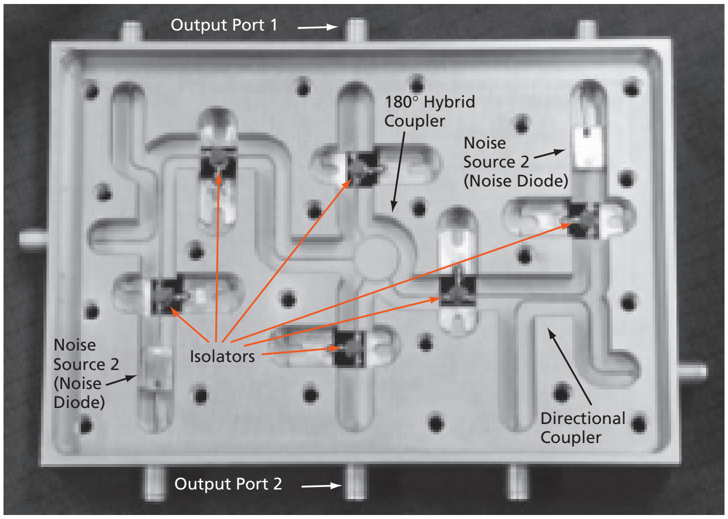
Goddard Space Flight Center, Greenbelt, Maryland

A correlated-noise source has been developed for use in calibrating an airborne or spaceborne Earth-observing correlation microwave polarimeter that operates in a pass band that includes a nominal frequency of 10.7 GHz. Deviations from ideal behavior of the hardware of correlation polarimeters are such as to decorrelate the signals measured by such an instrument. A correlated-noise source provides known input signals, measurements of which can be processed to estimate and correct for the decorrelation effect.

Typical prior correlated-noise sources suitable for this purpose consist of multiple units connected by coaxial cables; as such, they tend to be too bulky and heavy to be incorporated into flight instrumentation assemblies. In contrast, the present correlated-noise source is a single unit (see figure) that is relatively compact and can easily be integrated into a flight instrumentation assembly. The unit includes directional couplers for sampling noise-diode outputs and injection of test signals. This source provides both correlated (sum) and anticorrelated (difference) signal components at the output ports. The source can be operated in four modes: (1) both noise diodes on, (2) both noise diodes off, (3) noise diode 1 on with noise diode 2 off, and (4) noise diode 2 on with noise diode 1 off. Measurements of the resulting combinations of correlated and anticorrelated signal components provide the data needed for calibration.

This work was done by Jeffrey R. Piepmeier and Edward J. Kim of **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center, (301) 286-7351. Refer to GSC-14745-1.



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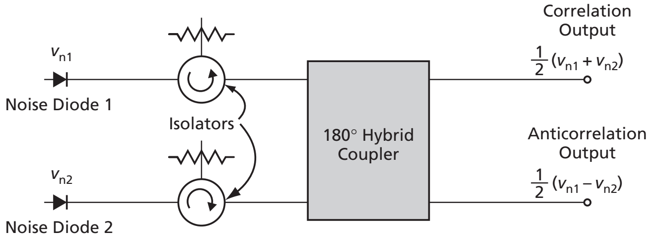

SIMPLIFIED SCHEMATIC DIAGRAM

This **Correlated-Noise Source** includes noise diodes and microstrip components in a single, integral housing. Adherence to geometric tolerances of circuit layout, with special attention to considerations of symmetry, is essential for proper operation.

Hybrid Deployable Foam Antennas and Reflectors

Compressed foam structures would be expanded to full size and shape.

NASA's Jet Propulsion Laboratory, Pasadena, California

Hybrid deployable radio antennas and reflectors of a proposed type would feature rigid narrower apertures plus wider adjoining apertures comprising reflective surfaces supported by open-cell polymeric foam structures (see figure). The open-cell foam structure of such an antenna would be compressed for compact stowage during transport. To initiate deployment of the antenna, the foam structure would simply be released from its stowage mechanical restraint. The elasticity of the foam would drive the expansion of the foam structure to its full size and shape.

There are several alternatives for fabricating a reflective surface supported by a polymeric foam structure. One approach would be to coat the foam with a metal. Another approach would be to attach a metal film or a metal-coated polymeric membrane to the foam. Yet another approach would be to attach a metal mesh to the foam.

The hybrid antenna design and deployment concept as proposed offers significant advantages over other concepts for deployable antennas:

- In the unlikely event of failure to deploy, the rigid narrow portion of the antenna would still function, providing a minimum level of assured performance. In contrast, most other concepts for deploying a large antenna from compact stowage are of an "all or nothing" nature: the antenna is not useful at all until and unless it is fully deployed.
- Stowage and deployment would not depend on complex mechanisms or actuators, nor would it involve the use of inflatable structures. Therefore, relative to antennas deployed by use of mechanisms, actuators, or inflation systems, this antenna could be lighter, cheaper, amenable to stowage in a smaller volume, and more reliable.

An open-cell polymeric (e.g., polyurethane) foam offers several advantages for use as a compressible/expandable structural material to support a large antenna or reflector aperture. A few of these advantages are the following:

- The open cellular structure is amenable to compression to a very small volume — typically to 1/20 of its full size in one dimension.
- At a temperature above its glass-transition temperature (T_g), the foam strongly damps vibrations. Even at a temperature below T_g, the damping