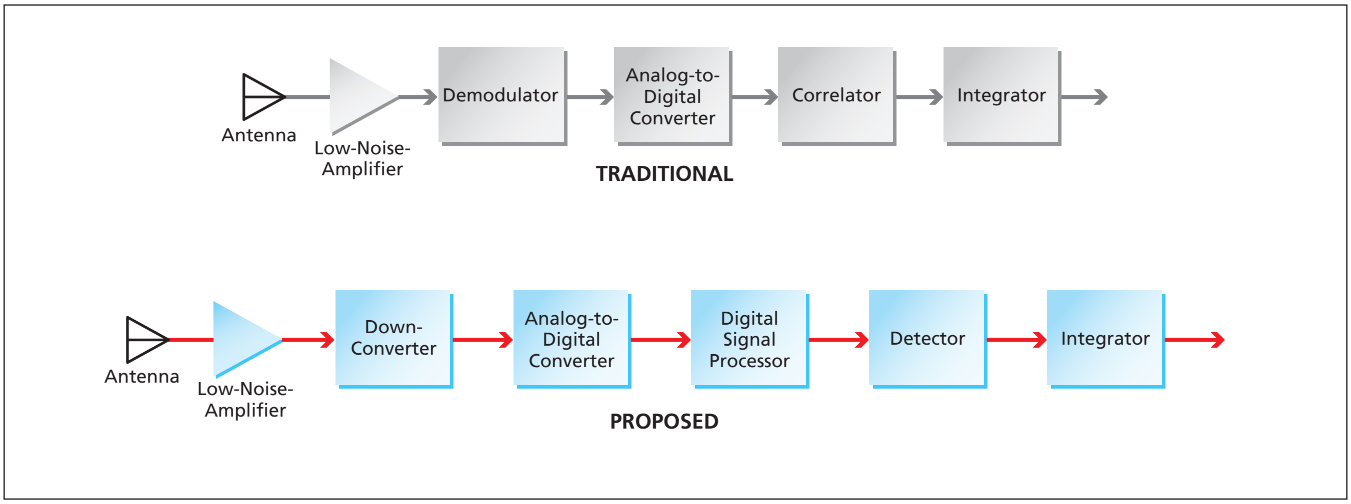
Digital Receiver for Microwave Radiometry

Interfering signals would be suppressed in digital signal processing.

Goddard Space Flight Center, Greenbelt, Maryland



The **Proposed Microwave Radiometer Receiver** would include a digital signal processor that would execute interference-suppression algorithms.

A receiver proposed for use in L-band microwave radiometry (for measuring soil moisture and sea salinity) would utilize digital signal processing to suppress interfering signals. Heretofore, radio-frequency interference has made it necessary to limit such radiometry to a frequency band about 20 MHz wide, centered at ≈1,413 MHz. The suppression of interference in the proposed receiver would make it possible to expand the frequency band to a width of 100 MHz, thereby making it possible to obtain greater sensitivity and accuracy in measuring moisture and salinity.

The receiver would digitize a portion of the received signal spectrum up to 100 MHz wide. The digitized signals would be processed to extract either the total power or the power spectral density associated with the physical processes of interest. The processing would involve the use of adaptive and parametric filtering techniques implemented in real time by use of reconfigurable digital hardware in the form of field-programmable gate arrays.

The microwave signals emitted by the physical processes of interest are quasi-stationary and noiselike. The signal-processing algorithms would include interference-suppression algorithms, which would be based partly on the assumption that signals that are not both quasi-stationary and noiselike must be interfering signals. For example, pulses would be detected and blanked. Following blanking of pulse and other suppression of interfering signals, a fast Fourier transform (FFT) would be applied. The FFT outputs would be integrated, and the results of the integrations would be transferred to a computer for storage.

This work was done by Steven W. Ellingson, Grant A. Hampson, and Joel T. Johnson of Ohio State University for **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*
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Printed Antennas Made Reconfigurable by Use of MEMS Switches

MEMS switches offer advantages over electronic control circuits.

John H. Glenn Research Center, Cleveland, Ohio

A class of reconfigurable microwave antennas now undergoing development comprise fairly conventional printed-circuit feed elements and radiating patches integrated with novel switches containing actuators of the microelectromechanical systems (MEMS) type. In comparison with solid-state electronic control devices incorporated into some prior printed microwave antennas, the MEMS-based switches in these antennas impose lower insertion losses and consume less power. Because the radio-frequency responses of the MEMS switches are more nearly linear, they introduce less signal distortion. In addition, construction and operation are simplified because only a single DC bias line is needed to control each MEMS actuator.

The incorporation of the MEMS switches makes it possible for an antenna of this class to operate over several frequency bands without undergoing changes in its dimensions other than the small deflections associated with opening and closing gaps between switch contacts. In addition, the polarization of the radiation emitted or received by the antenna can be

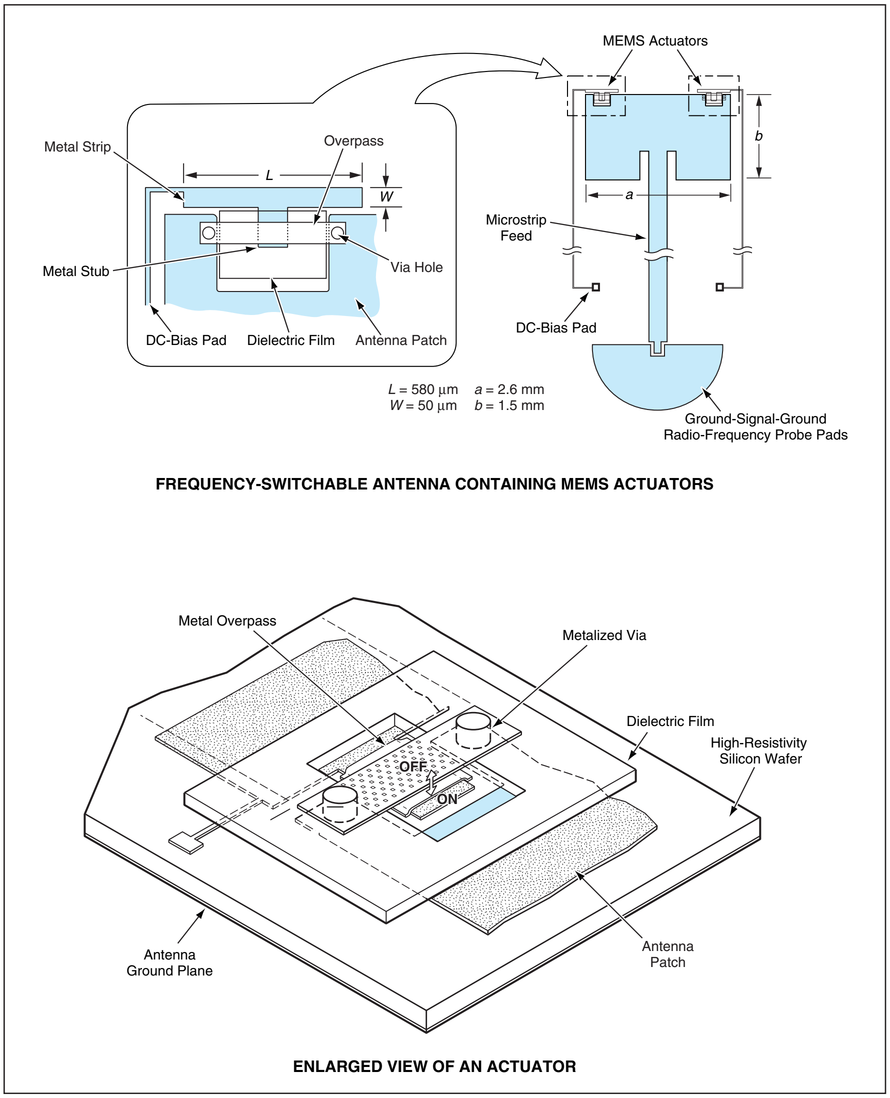

Figure 1. The **Two Independent MEMS Actuators** in this patch antenna can be used to change the operating frequency. When both actuators are off, the frequency is about 25.0 GHz. When one of the actuators is on, the frequency is 24.8 GHz. When both actuators are on, the frequency is 24.6 GHz.

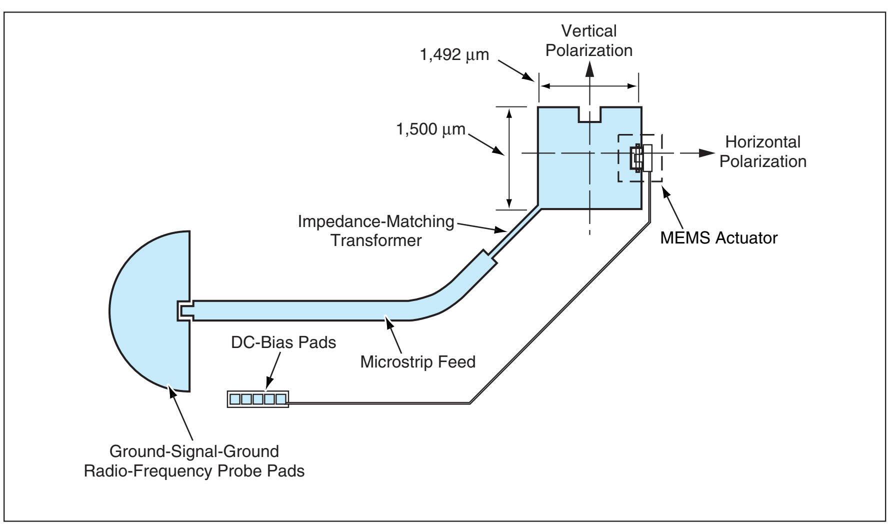

Figure 2. This **Patch Antenna** radiates in circular polarization when the actuator is off and in dual linear polarization when the actuator is on.

switched between linear and circular. The ability to change frequency and polarization makes these antennas attractive for inclusion in planar phased antenna arrays.

The upper part of Figure 1 shows the layout of one such antenna containing two MEMS actuators, while the lower part of this figure presents an enlarged view of one of the actuators. Each actuator includes a flexible metal overpass suspended over a metal stub. The overpass is supported at its ends by metal vias electrically connected to the antenna patch. A dielectric film occupies part of the gap between the stub and the overpass. The overpass is free to bend up and down and is actuated in bending by electrostatic attraction by a DC bias voltage applied between the overpass and the metal stub. A metal strip of length L and width W attached to metal stub behaves as a parallel-plate capacitor.

When an actuator is in the “off” state (voltage not applied, overpass not bent), the antenna patch operates at a nominal frequency determined by the dimension b. When the actuator is in the “on” state (voltage applied, overpass bent down), the capacitance of the metal strip appears in shunt with the input impedance of the antenna patch. This capacitance tunes the antenna to a lower operating frequency. During the design-synthesis process, the inductances and capacitances of the actuators and their locations in the patch should be taken into account in order to ensure constant input impedance.

The antenna depicted in Figure 2 is designed to support two degenerate orthogonal modes when excited at a corner. When the MEMS actuator in this antenna is in the “off” state, the perturbation of the modes is negligible and the patch radiates a circularly polarized wave. When the actuator is in the “on” state, the phase relation between the two modes is perturbed to a degree that causes the patch to radiate dual linearly polarized waves.

This work was done by Rainee N. Simons of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland Ohio 44135. Refer to LEW-17389.