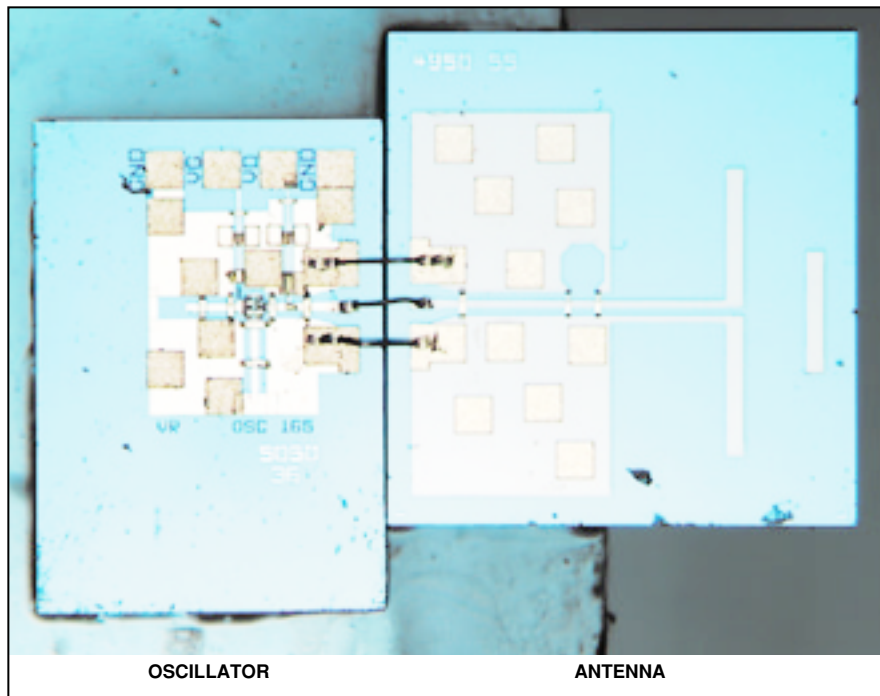


The design of this antenna is a specific instance of a quasi-Yagi generic antenna design (so named because of a resemblance to the classic Yagi-Uda dipole-array antenna design). The design relies on the generation of the  $TE_0$  surface wave as its primary source of free-space radiation. For this reason, the antenna is best suited for fabrication on a substrate that has a high permittivity, making it ideal for integration into an MMIC that is fabricated on an InP or GaAs substrate. Contrary to convention in the design of printed dipole antennas, the grounded metal of the feed line of the antenna is used as a surface-wave-reflecting element that helps to form the radiation into a unidirectional, end-fire beam. The antenna radiates efficiently over a broad frequency band; it is also suitable for use as a transition from the planar MMIC to a waveguide.

In a test, the oscillator-and-antenna combination was found to radiate power along the antenna's end-fire direction into a WR8 open-ended waveguide and power meter. After correction for the gain of the receiving antenna and the free-space loss, the effective isotropically radiated power (EIRP) was estimated to be 12 dBm. The isotropic conversion gain (defined as the ratio between the EIRP and the DC input power) at the frequency of 120 GHz was found to be 18 percent.



This **Oscillator and Antenna** are MMIC components of a prototype compact, lightweight, relatively high-power, 120-GHz source. Future versions could readily be fabricated as single, monolithic MMICs.

*This work was done by Lorene Samoska and Peter Siegel of NASA's Jet Propulsion Laboratory; Kevin Leong, Tatsuo Itoh, and Yongxi Qian of UCLA; and Vesna Radisic of HRL Laboratories, LLC. Further information is contained in a TSP [see page 1]. NPO-21246*

## 80-GHz MMIC HEMT Voltage-Controlled Oscillator

Output power and tuning range exceed those of prior HEMT-based oscillators.

NASA's Jet Propulsion Laboratory, Pasadena, California

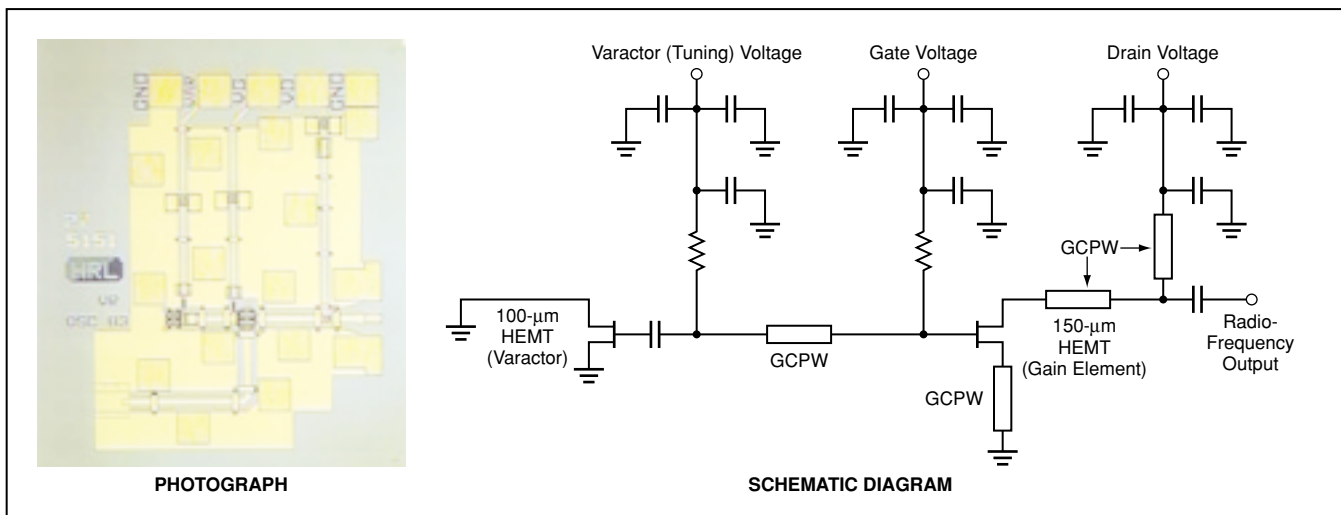


Figure 1. This **MMIC HEMT Oscillator** occupies a chip with dimensions of 1.22 mm by 1.3 mm by 50 μm.

A voltage-controlled oscillator (VCO) that operates in the frequency range from 77.5 to 83.5 GHz has been constructed in the

form of a monolithic microwave integrated circuit (MMIC) that includes high-electron-mobility transistors (HEMTs). This circuit is a

prototype of electronically tunable signal sources in the 75-to-110-GHz range, needed for communication, imaging, and auto-

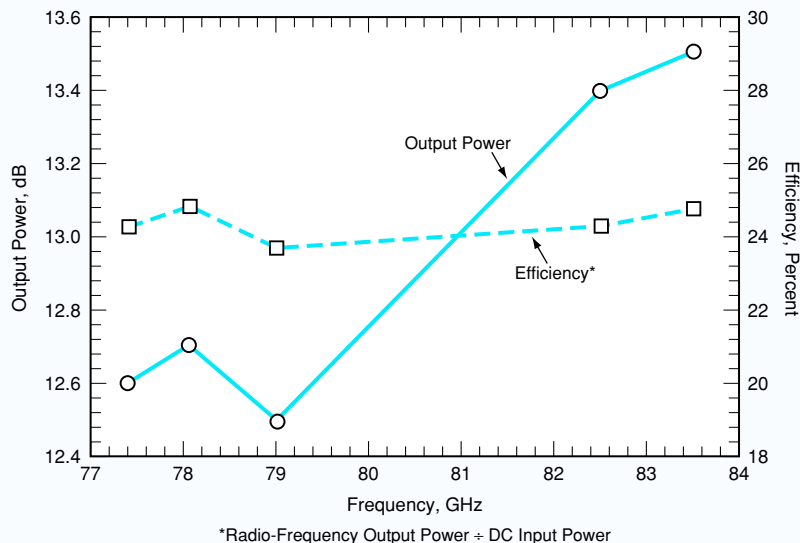


Figure 2. The **Output Power and Power Efficiency** of the frequency oscillator were measured as functions of frequency over its 6-GHz-wide tuning range.

otive radar applications, among others.

This oscillator (see Figure 1) includes two AlInAs/GalnAs/InP HEMTs. One HEMT serves mainly as an oscillator gain element. The other HEMT serves mainly as a varactor for controlling the frequency: the frequency-control element is its gate-to-source capac-

itance, which is varied by changing its gate supply voltage.

The gain HEMT is biased for class-A operation (meaning that current is conducted throughout the oscillation cycle). Grounded coplanar waveguides are used as impedance-matching transmission lines,

the input and output matching being chosen to sustain oscillation and maximize output power. Air bridges are placed at discontinuities to suppress undesired slot electromagnetic modes. A high density of vias is necessary for suppressing a parallel-plate electromagnetic mode that is undesired because it can propagate energy into the MMIC substrate.

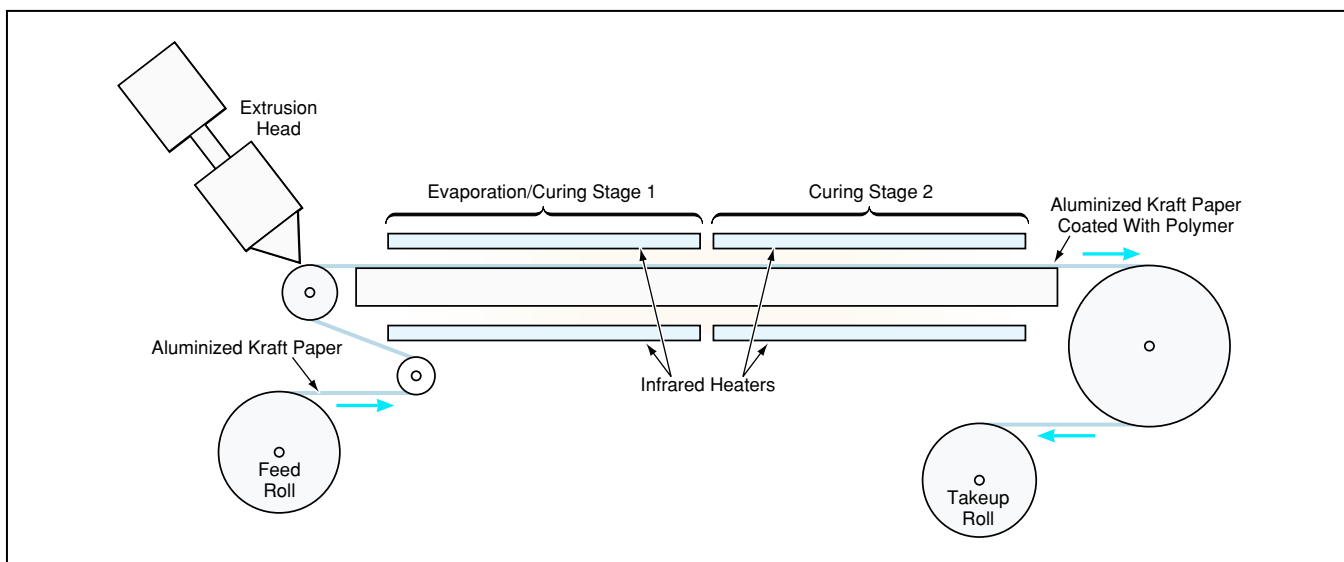
Previous attempts at constructing HEMT-based oscillators yielded circuits with relatively low levels of output power and narrow tuning ranges. For example, one HEMT VCO reported in the literature had an output power of 7 dBm ( $\approx 5$  mW) and a tuning range 2-GHz wide centered approximately at a nominal frequency of 77 GHz. In contrast, as shown in Figure 2, the present MMIC HEMT VCO puts out a power of 12.5 dBm ( $\approx 18$  mW) or more over the 6-GHz-wide frequency range from 77.5 to 83.5 GHz.

*This work was done by Lorene Samoska of NASA's Jet Propulsion Laboratory and Vesna Radisic, Miro Micovic, Ming Hu, Paul Janke, Catherine Ngo, and Loi Nguyen of HRL Laboratories, LLC. Further information is contained in a TSP [see page 1]. NPO-21214*

## High-Energy-Density Capacitors

Maximum sustainable energy density is more than twice that of polypropylene-film capacitors.

*John H. Glenn Research Center, Cleveland, Ohio*



**A Film of Dielectric Polymer Is Cast** on a continuous strip of aluminized kraft paper. High dielectric performance is obtained through selection of the materials and design of the process and machinery.

Capacitors capable of storing energy at high densities are being developed for use in pulse-power circuits in such diverse systems as defibrillators, parti-

cle-beam accelerators, microwave sources, and weapons. Like typical previously developed energy-storage capacitors, these capacitors are made

from pairs of metal/solid-dielectric laminated sheets that are wound and pressed into compact shapes to fit into cans, which are then filled with dielectric