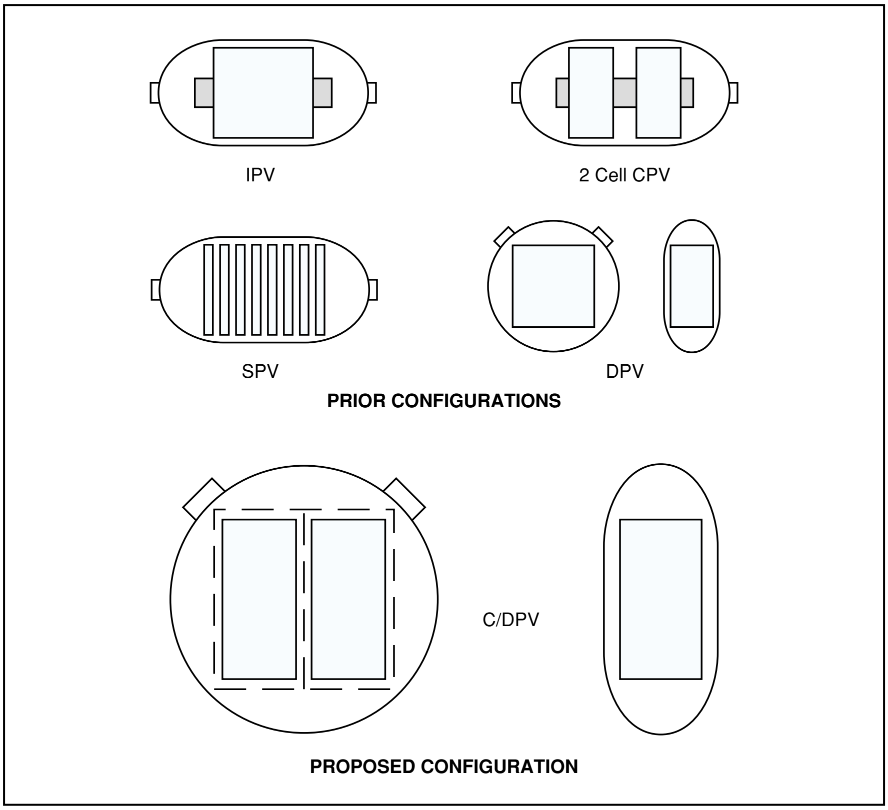


The **C/DPV Configuration** would be a hybrid of the older CPV and DPV configurations (and, to some extent, of the SPV configuration). Modular designs could provide ranges of capacities and voltages.

The figure depicts examples of the proposed C/DPV configuration along with the CPV and DPV configurations and two other prior configurations called "individual pressure vessel" (IPV) and "single pressure vessel" (SPV). The following characteristics of the prior configurations are particularly relevant to the proposal of the C/DPV configuration:

- A DPV has a pocket-watch shape that is both advantageous and disadvantageous, in comparison with the shapes of the IPV, CPV, and SPV. The advantage is that a battery or cell can be made relatively flat and thin to fit in a thin space; the disadvantage is that a pressure vessel of this shape is not self-supporting and therefore must be mounted between objects that restrain it. DPV cells have not been widely used.
- The SPV and CPV configurations have been the basis of the established method for designing pressure vessels containing multiple cells.

Like the CPV and SPV configurations, the C/DPV configuration is one of multiple cells contained within a DPV. This configuration would afford the advantages and disadvantages of the DPV configuration (thinness and the need for mechanical restraint, respectively), while making it possible to use an electrolyte-containment system like that of the SPV. Although it is not readily apparent by visual examination of the figure, calculations have shown that for a given small charge capacity, the volumetric efficiency of a battery in the C/DPV configuration would exceed the volumetric efficiencies of batteries in the other configurations mentioned. Other anticipated advantages of the C/DPV configuration include improved thermal properties, greater simplicity and reliability (in comparison with the SPV configuration), lower costs associated with the simpler designs, and amenability to replacement and matching of cells.

This work was done by Paul J. Timmerman of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP [see page 1].*
NPO-20769

120-GHz HEMT Oscillator With Surface-Wave-Assisted Antenna

This is a compact, lightweight alternative to vacuum-tube oscillators.

NASA's Jet Propulsion Laboratory, Pasadena, California

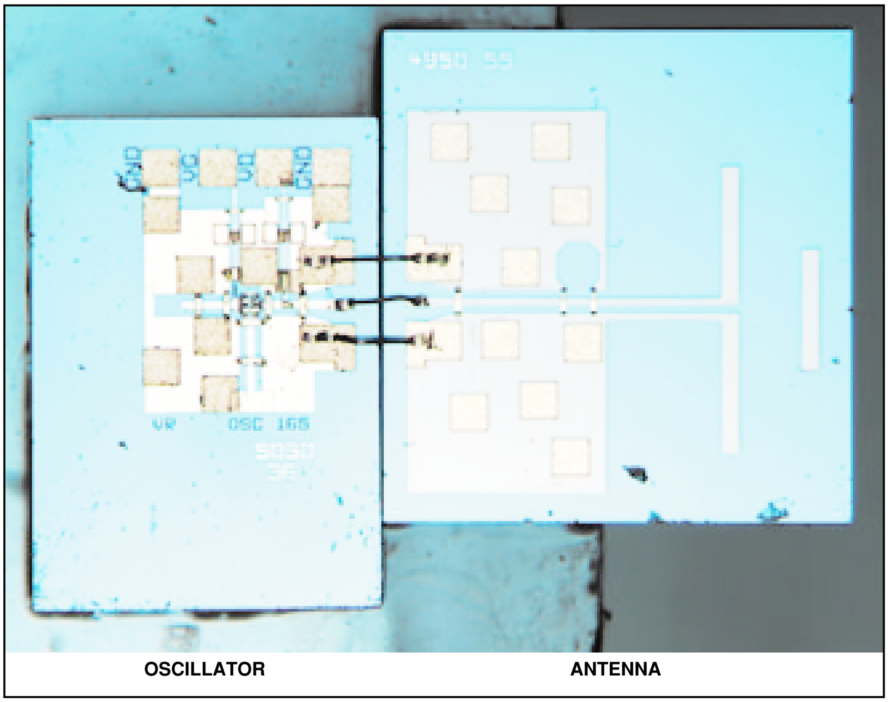
Two monolithic microwave integrated circuits (MMICs) have been designed and built to function together as a source of electromagnetic radiation at a frequency of 120 GHz. One of the MMICs is an oscillator and is the highest-power 120-GHz oscillator reported thus far in the literature. The other MMIC is an end-fire antenna that radiates the oscillator signal. Although these MMICs were constructed as separate units and electrically connected with wire bonds, future oscillator/antenna combinations could readily be fabricated as monolithic integrated units. Such units could be used as relatively high-power solid-state microwave sources in diverse applications that include automotive radar, imaging, scientific instrumentation, communications, and radio astronomy. As such, these units would be attractive alternatives to vacuum-tube oscillators, which are still used to obtain acceptably high power in the frequency range of interest.

The oscillator (see figure) includes a high-electron-mobility transistor (HEMT), with gate-periphery dimensions of 4 by 37 μm, in a common-source configuration. The series feedback element of the oscillator is a grounded coplanar waveguide (CPW) at the source. The HEMT is biased for class-A operation (meaning that current is conducted throughout the oscillation cycle) to maximize the output power of the oscillator. Input and output impedance-matching circuit elements are designed to maximize output power and to establish the conditions needed for oscillation.

The design of the antenna takes advantage of surface waves, which, heretofore, have been regarded as highly disadvantageous because they can leak power and degrade the performances of antennas that have not been designed to exploit them. Measures taken to suppress surface waves have included complex machining of circuit substrates and addition of separate substrates. These measures are difficult to implement in standard MMIC fabrication processes. In contrast, because the design of the present antenna eliminates the need to suppress surface waves, the fabrication of the antenna is fully compatible with standard MMIC fabrication processes.

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

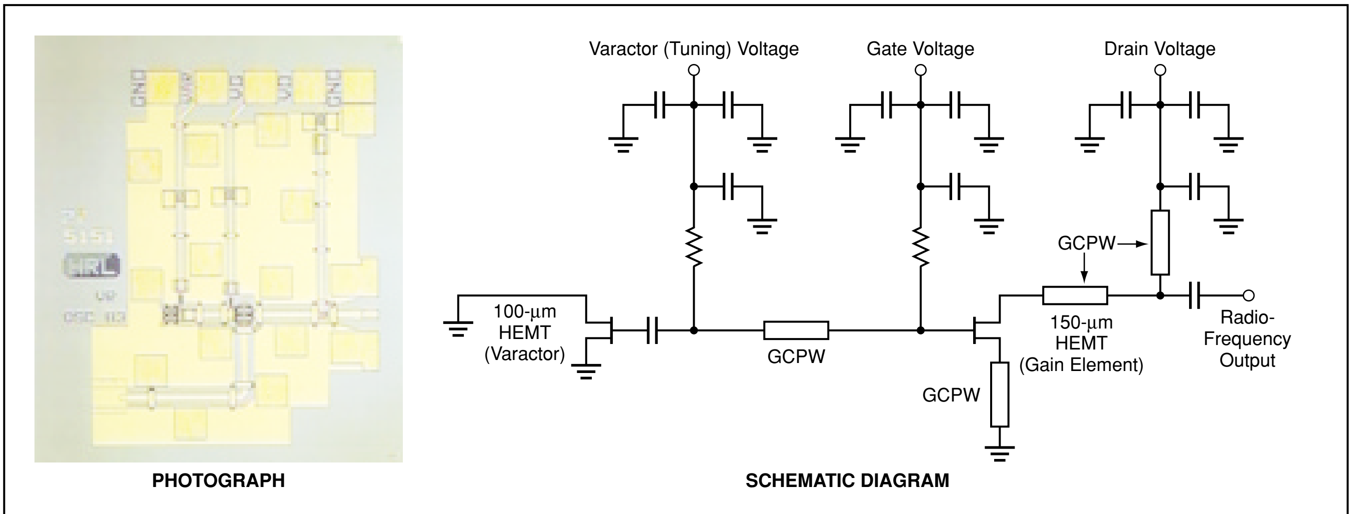


Figure 1. This **MMIC HEMT Oscillator** occupies a chip with dimensions of 1.22 mm by 1.3 mm by 50 µm.

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-