

## Power-Amplifier Module for 145 to 165 GHz

This module represents the highest frequency solid-state power amplifier to date.

NASA's Jet Propulsion Laboratory, Pasadena, California

A power-amplifier module that operates in the frequency range of 145 to 165 GHz has been designed and constructed as a combination of (1) a previously developed monolithic microwave integrated circuit (MMIC) power amplifier and (2) a waveguide module. The amplifier chip was needed for driving a high-electron-mobility-transistor (HEMT) frequency doubler. While it was feasible to connect the amplifier and frequency-doubler chips by use of wire bonds, it was found to be much more convenient to test the amplifier and doubler chips separately. To facilitate separate testing, it was

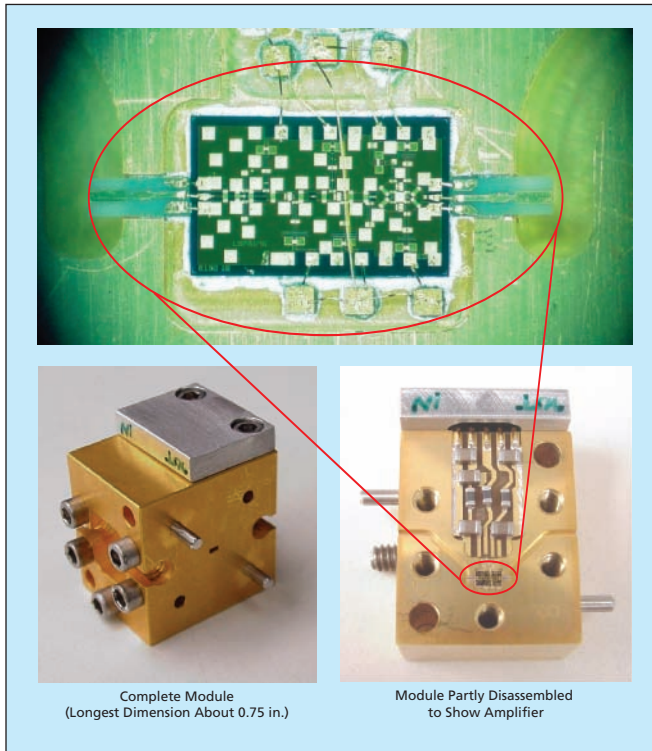


Figure 1. The Amplifier is Packaged in a WR5 waveguide module, with electric-field-plane alumina probes to interface the chip to the waveguide, and bypass capacitors to suppress low-frequency oscillations. The module is compact and can easily be integrated into a test system or with wafer probes.

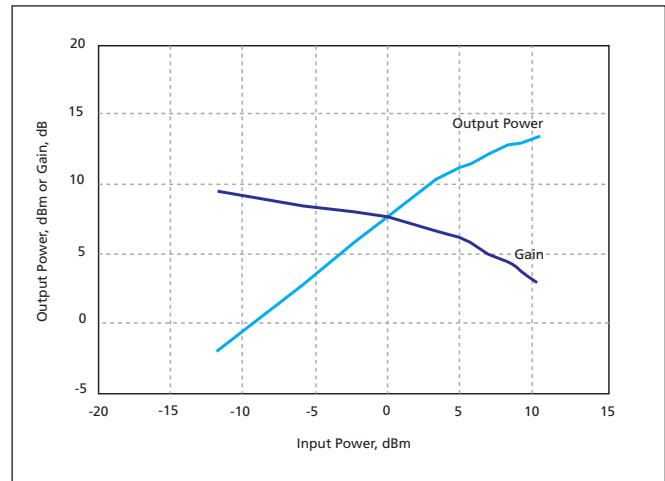


Figure 2. Output Power and Gain at 150 GHz were measured as functions of input power. The output power exhibited saturation at 13 dBm.

decided to package the amplifier and doubler chips in separate waveguide modules. Figure 1 shows the resulting amplifier module.

The amplifier chip was described in "MMIC HEMT Power Amplifier for 140 to 170 GHz" (NPO-30127), *NASA Tech Briefs*, Vol. 27, No. 11, (November 2003), page 49. To recapitulate: This is a three-stage MMIC power amplifier that utilizes HEMTs as gain elements. The amplifier was originally designed to operate in the frequency range of 140 to 170 GHz. The waveguide module is based on a previously developed lower frequency module, redesigned to support operation in the frequency range of 140 to 220 GHz.

Figure 2 presents results of one of several tests of the amplifier module — measurements of output power and gain as functions of input power at an output frequency of 150 GHz. Such an amplifier module has many applications to test equipment for power sources above 100 GHz.

*This work was done by Lorene Samoska and Alejandro Peralta of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).NPO-40260*

## Aerial Videography From Locally Launched Rockets

Images of an event or scene are rapidly collected, processed, and displayed.

Stennis Space Center, Mississippi

A method of quickly collecting digital imagery of ground areas from video cameras carried aboard locally launched rockets has been developed. The method can be used, for example, to record rare or episodic events or to gather image data to guide decisions regarding treatment of agricultural fields or fighting wildfires.

The method involves acquisition and

digitization of a video frame at a known time along with information on the position and orientation of the rocket and camera at that time. The position and orientation data are obtained by use of a Global Positioning System receiver and a digital magnetic compass carried aboard the rocket. These data are radioed to a ground station, where they are processed,

by a real-time algorithm, into georeferenced position and orientation data. The algorithm also generates a file of transformation parameters that account for the variation of image magnification and distortion associated with the position and orientation of the camera relative to the ground scene depicted in the image. As the altitude, horizontal position, and ori-