The small-signal parameters and the intended purpose served by this amplifier is to boost the signal generated by a previously developed 164-GHz MMIC HEMT doubler [which was described in “164-GHz MMIC HEMT Frequency Doubler” (NPO-21197), NASA Tech Briefs, Vol. 27, No. 9 (September 2003), page 48.] and drive a 164- to 328-GHz doubler to provide a few milliwatts of power at 328 GHz.

The first two stages of the amplifier contain one HEMT each; the third (output) stage contains two HEMTs to maximize output power. Each HEMT is characterized by gate-periphery dimensions of 4 by 37 µm. Grounded coplanar waveguides are used as impedance-matching input, output, and interstage-coupling transmission lines.

The small-signal S parameters and the output power (for an input power of about 5 dBm) of this amplifier were measured as functions of frequency. For the small-signal gain measurements, the amplifier circuit was biased at a drain potential of 2.5 V, drain current of 240 mA, and gate potential of 0 V. As shown in

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**MMIC HEMT Power Amplifier for 140 to 170 GHz**

**Circuits like this one could be useful in radiometers for probing the atmosphere.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Figure 1 shows a three-stage monolithic microwave integrated circuit (MMIC) power amplifier that features high-electron-mobility transistors (HEMTs) as gain elements. This amplifier is designed to operate in the frequency range of 140 to 170 GHz, which contains spectral lines of several atmospheric molecular species plus subharmonics of other such spectral lines. Hence, this amplifier could serve as a prototype of amplifiers to be incorporated into heterodyne radiometers used in atmospheric science. The original
the upper part of Figure 2, the small-signal gain ($S_{21}$), was found to be >10 dB from 144 to 170 GHz, while input and output return losses ($S_{11}$ and $S_{22}$) are both approximately 10 dB at 165 GHz.

For the power measurements, the amplifier circuit was biased at a drain potential of 2.1 V, a drain current of 250 mA, and gate potential of 0 V (these biases were chosen to optimize the output power). As shown in the lower part of Figure 2, the output power ranged from a low of about 11.8 dBm ($\approx 15$ mW) to a high of about 14 dBm ($\approx 25$ mW). The peak power output of about 14 dBm was achieved at 150 GHz at an input power of 6.3 mW, yielding a large-signal gain of slightly less than 8 dBm.

This work was done by Lorene Samoska of NASA’s Jet Propulsion Laboratory, and Vesna Radisic, Catherine Ngo, Paul Janke, Ming Hu, and Miro Micovic of HRL Laboratories, LLC. Further information is contained in a TSP (see page 1). NPO-30127

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**Piezoelectric Diffraction-Based Optical Switches**

*Switching times can be short enough for demanding applications.*

*Ames Research Center, Moffett Field, California*

Piezoelectric diffraction-based optoelectronic devices have been invented to satisfy requirements for switching signals quickly among alternative optical paths in optical communication networks. These devices are capable of operating with switching times as short as microseconds or even nanoseconds in some cases.

The basic principle of this invention can be illustrated with reference to a simple optical switch shown schematically in the figure. Light of wavelength $\lambda$ is introduced via an input optical fiber. After emerging from the tip of the input optical fiber, the light passes through a uniform planar diffraction grating that is either made of a piezoelectric material or is made of a non-piezoelectric material bonded tightly to a piezoelectric substrate. A voltage can be applied to

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*The Period of the Diffraction Grating Is Varied between two values by switching between two values of voltage applied to the piezoelectric substrate, thereby switching between two different angles of $m$th-order diffraction. Output optical fibers are positioned to intercept the diffracted light at the two angles.*

Nasa Tech Briefs, November 2003