

strate, as shown in the upper part of the figure. In terms that are necessarily oversimplified for the sake of brevity, the process can be summarized as follows: Through multiple steps of patterning, etching, and deposition, holes through the substrate would be formed at the desired front-side locations and the metal plugs and their protrusions would be formed in the holes. In subsequent steps, the back-side metal pads would be deposited on the metal plug protrusions, then color filters and/or mi-

cro-lenses would be formed between and in alignment with the metal contact pads, yielding the device structure shown in the lower part of the figure. (Not shown in the figure is a back-side antireflection coat that would be added near the end of the process.)

This work was done by Bedabrata Pain of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to

this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Compact, Single-Stage MMIC InP HEMT Amplifier

This amplifier exhibits gain of 5 dB at 340 GHz.

NASA's Jet Propulsion Laboratory, Pasadena, California

Figure 1 depicts a monolithic microwave integrated-circuit (MMIC) single-stage amplifier containing an InP-based high-electron-mobility transistor (HEMT) plus coplanar-waveguide (CPW) transmission lines for impedance matching and input and output coupling, all in a highly miniaturized layout as needed for high performance at operating frequencies of hundreds of gigahertz. This is one in a series of devices that are intermediate products of a continuing effort to develop advanced MMIC amplifiers for submillimeter-wavelength imaging systems, scientific instrumentation, heterodyne receivers, and other applications.

The amplifier is designed for operation at a nominal frequency of 340 GHz. The HEMT in this amplifier has a gate length of 35 nm and two fingers each 15 μm wide. The CPWs have a ground-to-ground spacing of only 14 μm . The inclusion of quarter-wavelength-long CPWs for imped-

ance matching and of on-chip shunt capacitors makes it possible to obtain about 5 dB of gain with respectable values of input and output return losses at the design frequency of 340 GHz (see Figure 2). This is among the highest gains per stage at this frequency reported to at the time of this work. Moreover, the measurement data suggest potential for further increase in gain with frequency beyond the 345-GHz limit of the test equipment used to perform the measurements.

This work was done by David Pukala,

Lorene Samoska, King Man Fung, and Todd Gaier of Caltech and W. R. Deal, Gerry Mei, Vesna Radisic, and Richard Lai of Northrop Grumman Corporation for NASA's Jet Propulsion Laboratory. The contributors would like to acknowledge the support of Dr. Mark Rosker and the Army Research Laboratory. This work was supported by the DARPA SWIFT Program and Army Research Laboratory under the DARPA MIPR no.06-U037 and ARL Contract no. W911QX-06-C-0050. Further information is contained in a TSP (see page 1). NPO-44962

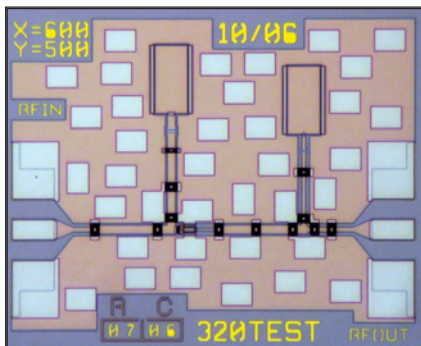


Figure 1. This MMIC Single-Stage Amplifier is a prototype of larger, multistage MMIC amplifiers that will incorporate HEMTs of 35-nm gate length.

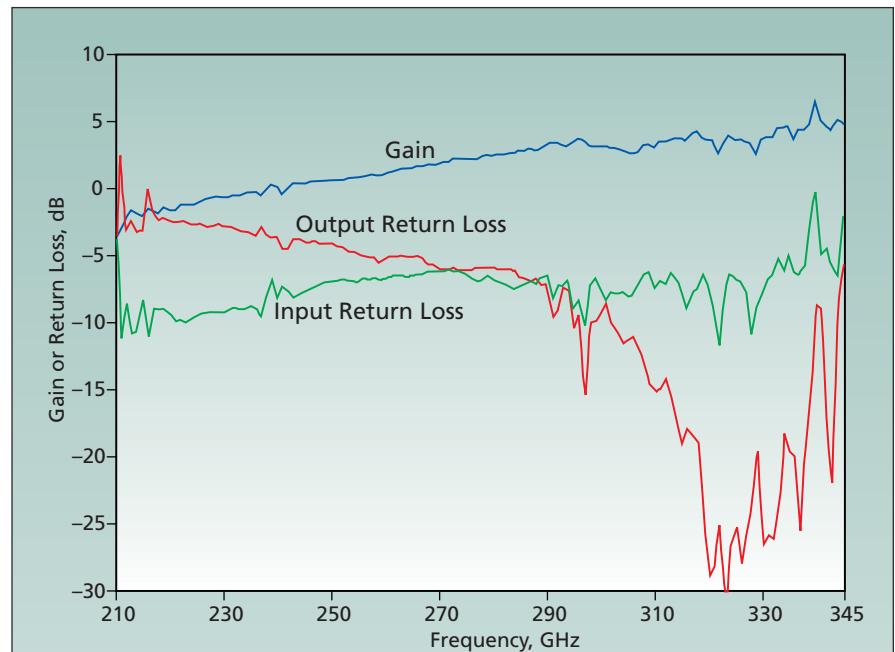


Figure 2. Gain and Input and Output Return Losses of the amplifier of Figure 1 were measured as a function of frequency.