ROM through all phases of testing.

The controller has been designed as an integral subsystem of a system that includes not only the controller and the controlled EEPROM aboard a spacecraft but also computers in a ground control station, relatively simple onboard support circuitry, and an onboard communication subsystem that utilizes the MIL-STD-1553B protocol. (MIL-STD-1553B is a military standard that encompasses a method of communication and electrical-interface requirements for digital electronic subsystems connected to a data bus. MIL-STD-1553B is commonly used in defense and space applications.) The intent was to both maximize reliability while minimizing the size and complexity of onboard circuitry.

In operation, control of the EEPROM is effected via the ground computers, the MIL-STD-1553B communication subsystem, and the onboard support circuitry, all of which, in combination, provide the multiple layers of protection against inadvertent writes. There is no controller software, unlike in many prior EEPROM controllers; software can be a major contributor to unreliability, particularly in fault situations such as the loss of power or brownouts. Protection is also provided by a power-monitoring circuit.

This work was done by Richard Katz and Igor Kleyner of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15492-1

Quad-Chip Double-Balanced Frequency Tripler

This technology has uses such as high-resolution radar and spectroscopic screening.

NASA's Jet Propulsion Laboratory, Pasadena, California

Solid-state frequency multipliers are used to produce tunable broadband sources at millimeter and submillimeter wavelengths. The maximum power produced by a single chip is limited by the electrical breakdown of the semiconductor and by the thermal management properties of the chip. The solution is to split the drive power to a frequency tripler using waveguides to divide the power among four chips, then recombine the output power from the four chips back into a single waveguide.

To achieve this, a waveguide branch-line quadrature hybrid coupler splits a 100-GHz input signal into two paths with a 90° relative phase shift. These two paths are split again by a pair of waveguide Y-junctions. The signals from the four outputs of the Y-junctions are tripled in frequency using balanced Schottky diode frequency triplers before being recombined with another pair of Y-junctions. A final waveguide branch-line quadrature hybrid coupler completes the combination.

Using four chips instead of one enables using four-times higher power input, and produces a nearly four-fold power output as compared to using a single chip. The phase shifts introduced by the quadrature hybrid couplers provide isolation for the input and output waveguides, effectively eliminating standing waves between it and surrounding components. This is accomplished without introducing the high losses and expense of ferrite isolators.

A practical use of this technology is to drive local oscillators as was demonstrated around 300 GHz for a heterodyne spectrometer operating in the 2–3-THz band. Heterodyne spectroscopy in this frequency band is especially valuable for astrophysics due to the presence of a very large number of molecular spectral lines. Besides high-resolution radar and spectrographic screening applications, this technology could also be useful for laboratory spectroscopy.

This work was done by Robert H. Lin, John S. Ward, Peter J. Bruneau, and Imran Mehdi of Caltech; Bertrand C. Thomas of Oak Ridge Associated Universities; and Alain Maestrini of the Observatoire de Paris for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46567

Ka-Band Waveguide Two-Way Hybrid Combiner for MMIC Amplifiers

This technology is applicable as a power combiner for solid-state power amplifiers (SSPAs) with unequal and arbitrary power output ratios.

John H. Glenn Research Center, Cleveland, Ohio

The design, simulation, and characterization of a novel Ka-band (32.05±0.25 GHz) rectangular waveguide two-way branch-line hybrid unequal power combiner (with port impedances matched to that of a standard WR-28 waveguide) has been created to combine input signals, which are in phase and with an amplitude ratio of two. The measured return loss and isolation of the branch-line hybrid are better than 22 and 27 dB, respectively. The measured combining efficiency is 92.9 percent at the center frequency of 32.05 GHz. This circuit is efficacious in combining the unequal output power from two Ka-band GaAs pseudomorphic high electron mobility transistor (pHEMT) monolithic microwave integrated circuit (MMIC) power amplifiers (PAs) with high efficiency.

The component parts include the branch-line hybrid-based power combiner and the MMIC-based PAs. A two-waybranch-line hybrid is a four-port device with all ports matched; power entering port 1 is divided in phase, and into the ratio 2:1 between ports 3 and 4. No power is coupled to port 2.

MMICs are a type of integrated circuit fabricated on GaAs that operates at microwave frequencies, and performs the function of signal amplification. The power combiner is designed to operate over the frequency band of 31.8 to 32.3