Books & Reports

Silicon-Germanium Voltage-Controlled Oscillator at 105 GHz

A group at UCLA, in collaboration with the Jet Propulsion Laboratory, has designed a voltage-controlled oscillator (VCO) created specifically for a compact, integrated, electronically tunable frequency generator useable for submillimeter-wave science instruments operating in extreme cold environments. The VCO makes use of SiGe heterojunction bipolar transistors (HBTs). The SiGe HBTs have a 0.13-micrometer emitter width. A differential design was used with two VCOs connected to form a quadrature signal. A 2.5-V supply is required to power the circuit. A cross-coupled CMOS pair is used for emitter-degeneration of the SiGe HBTs, and the design uses coupled load and base inductors. The circuit oscillates at 105 GHz. A linear superposition of VCOs has been designed to achieve four times the oscillation frequency of the fundamental oscillator.

This work was done by Alden Wong, Tim Larocca, and M. Frank Chang of UCLA , and Lorene A. Samoska of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).NPO-47116

Estimation of Coriolis Force and Torque Acting on Ares-1

A document describes work on the origin of Coriolis force and estimating Coriolis force and torque applied to the Ares-1 vehicle during its ascent, based on an internal ballistics model for a multi-segmented solid rocket booster (SRB).

The work estimates Coriolis force and torque applied to the vehicle during its ascent. Maveric flight simulation software was used to produce the required angular velocity data for the Coriolis force and torque computations. For the simulation of gas movement in SRB, software was developed using a dynamical model of internal ballistics of the five-segmented SRB. Also included in the work are a study and estimate of Coriolis force and torque applied to the rocket due to SRB nozzle movement. For calculation of internal ballistics, Coriolis force, and torque computations, MATLAB software was used.

Coriolis force and torque were calculated and applied to Ares-1 during its ascent. Two cases were considered: Coriolis force and torque applied to the rocket originating from gas movement in SRB, and Coriolis force and torque originating from exhaust gas movement in SRB nozzle. Coriolis force and torque are the largest during the first 20 seconds after the launch when rocket angular velocity is large. SRB Coriolis force is about 5.4 times larger than nozzle Coriolis force, and SRB Coriolis torque is about 2.8 times larger than the nozzle Coriolis torque at the time t=10 seconds. The inclusion of flexible rocket model does not provide a significant change to the results of Coriolis force and torque computations in comparison with a rigid rocket model.

This work was done by Ryan M. Mackey and Igor K. Kulikov of Caltech; Vadim Smelyanskiy and Dmitry Luchinsky of Ames Research Center; and Jeb Orr of BD Systems Inc. for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47326.

Null Lens Assembly for X-Ray Mirror Segments

A document discusses a null lens assembly that allows laser interferometry of 60° slumped glass mirror segments used in x-ray mirrors. The assembly consists of four lenses in precise alignment to each other, with incorporated piezoelectric nanometer stepping actuators to position the lenses in six degrees of freedom for positioning relative to each other.

Each lens is first installed and epoxied into a 410 stainless steel "cell." The outer housing is designed to allow five degrees of freedom of the lens. The cell is placed onto a 3/8-in. (≈ 9-mm) ball bearing in the base of the housing, which provides a pivot point for the rotations, and allows slight x and y translations (microns) by allowing the cell to slide against it. Rotations are accomplished by 5 commercial picomotors that push on the cell in 30-nanometer increments. Spring plungers on the opposite side of the cell from the picomotors secure the cell in the housing.

The 410 stainless steel is used for the cell, baseplate, and rails because it has a low CTE (coefficient of thermal expansion) relative to most other metals. It is used exclusively in the "growth path" of the optical assembly so that when bulk temperature changes occur in the lab, the lenses will move a consistent amount apart from each other (which is a less sensitive factor in alignment), but will not tilt or rotate (alignment is very sensitive to rotations).

This work was done by David W. Robinson of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC 15790-1

High-Precision Pulse Generator

A document discusses a pulse generator with subnanosecond resolution implemented with a low-cost field-programmable gate array (FPGA) at low power levels. The method used exploits the fast carry chains of certain FPGAs. Prototypes have been built and tested in both Actel AX and Xilinx Virtex 4 technologies. In-flight calibration or control can be performed by using a similar and related technique as a time interval measurement circuit by measuring a period of the stable oscillator, as the delays through the fast carry chains will vary as a result of manufacturing variances as well as the result of environmental conditions (voltage, aging, temperature, and radiation).

This work was done by Richard Katz and Igor Kleyner of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC- 15831-1