AN APPROACH TO THE DESIGN OF A LIGHTWEIGHT LUNAR SPACECRAFT

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Abstract

The Quicksat study, undertaken at the Jet Propulsion Laboratory (JPL), had as its goal the development of low mass, low cost spacecraft that can be implemented within a relatively short time span. As part of this effort, JPL studied a lunar mission referred to as Lunar Prospector (LP). The LP spacecraft carries a spare Apollo gamma ray spectrometer (GRS) in a 100 km polar orbit about the moon in order to obtain a global map of surface composition. The primary mission objective is to search for water in the form of ice trapped within polar craters; this is viewed as an essential precursor to the establishment of permanent lunar colonies. In addition, satellite tracking data will be used to develop a nearly global gravity map of the moon. The planned mission life is 1 year.

The LP spacecraft, as it is currently configured, is a simple spinner with an estimated total mass of less than 600 kg and an estimated dry mass of less than 300 kg. The planned launch vehicle is an Atlas rocket, and trans-lunar injection energy is to be provided by an SGS II upper stage. Trajectory correction maneuvers and lunar orbit insertion will be executed by a 100 lb hydrazine thruster (main engine), which is an integral part of the LP spacecraft. Attitude control will be accomplished using three 5 lb hydrazine thrusters, two for spin control and one for precession maneuvers.

Spacecraft power will be supplied by a 20 Amp-hour, 28 volt DC, Nickel-Cadmium battery system, charged from a 4 m^2 silicon solar array. The spacecraft will be equipped with a NASA standard near Earth S-band transponder and two omni-directional low gain antennas. An on-board digital computer will be used for command and data handling, and for performing attitude control computations.

Attitude determination will be performed on the ground using data from a sun sensor and a fan shaped field of view star scanner. Maneuvers will be executed under ground control, with the exception of initial sun acquisition and scheduled spin rate changes. the latter will be accomplished autonomously, as will sun tracking and spin rate maintenance.

The paper will outline the results of the LP mission study. It will include discussions on mission planning, spacecraft design and operations. Emphasis will be given to the lightweight, short development concepts for spacecraft subsystems, especially the Command, Data and Control Subsystem.