Quest-1 Satellite Functional Description

Overview

The Valley Christian High School Quest-1 Satellite is based on the CubeSat Standard that measures 10 cm x 10 cm x 10 cm and weighs less than 1.33 kilograms. The Quest-1 Satellite will be launched from the International Space Station (ISS) NanoRacks CubeSat deployer on approximately November 1, 2013.

Payload

Immediately after deployment, the Quest-1 Satellite will measure the tip off rates by recording the outputs from the 3-axis gyros, the 3-axis magnetometer, the five sun sensors, and three power sensors. After the Quest-1 Satellite orbital parameters are determined by NORAD, the Quest-1 Satellite will have the capability of transmitting prestored data files to the ham radio ground stations. As commanded from the Valley Christian High School Ground Station, the Quest-1 Satellite will photograph and store selected earth locations using one or all five color digital cameras. One 105 degree field of view camera will be located along the +Z axis, and will be used to take wide angle photos of ISS and the earth. The remaining four 36 degree cameras will located at each corner of the +Z panel angled 36 degrees away from the +Z axis and will be used to take narrow field of view photos of selected earth targets. Having four cameras taking the same photos increases the probability that the selected target is within the field of view of one of the cameras as the Quest-1 Satellite spins about the Z axis.

Sensors

The Quest-1 Satellite will have various sensors to monitor and record the local environment. These sensors include the following: one 3-axis gyro, one 3-axis magnetometer, one 3-axis accelerometer, five 2-axis sun sensors, three current sensors, and numerous temperature sensors.

Power System

The Quest -1 Satellite will be powered from five pairs of two 28% solar cells in series and five isolation diodes and five SP Microelectronics SPV 140 based peak power tracker circuits mounted on five solar panels that charge four NASA ISS qualified Nanoracks LLC 585460 2000 mA-hr lithium ion battery cells with self-contained over charge, over discharge and short circuit protection. The peak power tracker provides additional over current and overvoltage battery protection. The four batteries and associated battery pack protection circuitry are housed in a battery pack container that provides temperature controlled battery heaters to maintain the battery temperatures above the (–) 20 degree C minimum cell charge temperature and minimum charging temperature of 0 degrees C. Two independent commands are required to turn on the automated heater control circuitry. Voltage regulators with selectable current limit provide regulated 3.3 volts, 5.0 volts and selectable 1.8 volts to 5.5 volts to the spacecraft and payload.

Deployment Switches

Three deployment switches wired in series detect the ISS deployment and power up the Quest-1 Satellite except for the UHF and VHF RF subsystems that are not powered up until 40 minutes after deployment and the associated UHF and VHF antennas that are deployed 30 minutes after deployment from the ISS. Two of the deployment switches open circuit the 3.7 Volt unregulated Bus and the third deployment switch open circuits the unregulated bus return. A Remove Before Flight (RBF) safety switch open circuits the 3.7 Volt nominal unregulated bus and is closed to arm the unregulated bus after the Cubesats are installed and integrated in the deployer.

Attitude Determination and Control Subsystem

The Quest-1 Satellite attitude determination and control subsystem is a passive system consisting of Grade N40 Neodymium-Iron-Boran magnets that align the Quest-1 Satellite Z axis along the earth's local magnetic field. Perpendicular to the Z axis are hysteresis rods that reduce the angular rotation about the Quest-1 Satellite Z axis.

Sun Sensors

Five 2-axis solar sensor outputs can be used by the Quest-1 Satellite microprocessor software program to determine the sun's location with respect to the Quest-1 Satellite X, Y, and Z-axis.

Microcontroller, Command and Telemetry System

The UHF and VHF RF subsystems together with the microcontroller provide the capability to downlink both real-time health and status data and stored data and photos to the ground stations. The UHF/FM and VHF/FM subsystems each provide a half-duplex command and telemetry capability. The UHF/ FM transmitter and the VHF/FM receiver provide full duplex command and telemetry capability. The VHF/FM receiver will remain powered over selected earth ground stations to provide an emergency transmitter power off command capability to satisfy FCC requirements.

Morse Code Beacon and SSTV Images

Upon deployment it is planned to operate the UHF communication system in a beacon Morse code mode to provide health and status data and to aid the ground stations in locating and tracking the Quest-1 Satellite. In the UHF/CW beacon mode transmits a group of Morse Code characters that can be received by ham radio stations to help locate the Quest-1 Satellite. In the operational mode the VHF communications system will be used to transmit slow scan photo images to selected earth ground stations. This mode will be used to transmit prestored photos of the Valley Christian High School and the Chinese high school bands performing in the 2012 New Year's Rose Parade. Both UHF/FM and VHF/FM subsystems will be powered on during Valley Christian High School Ground Station passes to maximize the number of photos and digital data transmitted to the ground.

VHF and UHF Radio

The UHF 70 cm Amateur Radio Band transceiver is designed by Tyvak Systems around the AX5042 transceiver integrated circuit. It provides up to a watt of output power in the 70CM amateur radio satellite band with FM modulation using the standard ham AX.25 protocol at a 9600 baud rate. The 2 meter VHF Amateur Radio Band 500 mw transceiver is designed by Valley Christian High School and operates at using FM modulation using the standard ham radio AX.25 protocol for uplink commanding and a downlink rate of 1200 baud.