Appendix A

Research Project Overview

Introduction

The Space Engineering Research Center (SERC) at the University of Southern California (USC) seeks to validate the operation of a prototype nanosatellite payload capable of advanced functions such as propulsion, attitude control, and power distribution. To test the payload, USC is designing a simple Cubesat (named "Caerus") capable of hosting this payload, operating its subsystems, and relaying results of functional tests to ground operators. This Experimental License Application is being filed for the communication system on this Cubesat.

Communication System Overview

The host nanosatellite ("Space Station"), designed by USC, will contain an independent communications system meeting two objectives. First, the Space Station will establish a bidirectional link with ground operators ("Earth Station") within the Continential U.S. to relay commands and telemetry. Second, the Space Station will beacon at a specified period to assist ground operators (located worldwide) in acquisition and basic state of health assessment. To enable these objectives, this research project also requires an Earth Station capable of transmitting commands to the orbiting satellite.

The bidirectional link will be created using a pair of advanced transceivers from Microhard Systems, one on the Space Station and one at the Earth Station. Both utilize the same frequency to create a link. The researchers will use this link to deliver commands to operate the satellite bus as well as the prototype payload. The same link will then be used to receive satellite state of health as well as results from the payload functional tests.

The second objective, beaconing, will be accomplished using a space-qualified transmitter from the Stensat Group, LLC. At a programmable period, most likely 5 minutes, the beacon will transmit a short message in plain text that may be received by most amateur radio equipment. This transmission will help in determining satellite orbit before current TLEs are published by the government. In addition, this message will contain basic telemetry information that will help establish state of health before the bi-directional link mentioned above is established.

Both systems are being designed to operate in the 435-438Mhz band of the spectrum. However, they will never transmit simultaneously. The satellite computer will schedule operations such that the MHX425 does not transmit during the brief beaconing.

Amateur Radio Band

USC has determined that only the beacon meets the requirements for use of an amateur license. Therefore, we are applying for an experimental license with the FCC for operation of the primary communications system (MHX425). This conservative decision is meant to follow both national and international regulations governing use of the radio frequency spectrum. However, as a University team we have found that most student satellites have operated in the amateur band, specifically at 435-438 MHz, which hardware is readily available to support the very short development and integration timeline to prepare Caerus for the launch vehicle. To utilize this hardware, we are requesting an experimental allocation within this band. See Appendix D for information on frequency coordination with the International Amateur Radio Union.

Disabling Transmitters in case of Harmful Interference

As an experimental licensee, it will be important for us to avoid causing unwanted interference. This a major driver behind the frequency coordination examined in Appendix D. In the case that interference is discovered, there are several methods to disable transmission.

In the case of interference from the Earth Station, the equipment can be easy disabled or powered off manually by research project members.

There exists several ways to disable the two Space Station transmitters (MHX425 and Beacon). Transmissions from both are based on data arriving on serial ports from the main computer. By ceasing data output from the flight computer, RF transmissions are ceased. The research project staff can deliver a command to the Space Station that disables either transmitter. In addition, the flight computer can monitor the transmit state of either transmitter and disable either in the case of spurious continuous transmission.