**COM**

The communication subsystem provides a method of verification for the completion of each mission phase. It also provides a way to maintain communication with the primary spacecraft and serves as a means to power on and off the LEDs on the secondary spacecraft. Data sent over the RF link would be relative distances and velocities, images from the payload, and primary spacecraft health. Boeing is providing the communication subsystem on the primary spacecraft and the communication subsystem on the secondary spacecraft consists of an RF receiver and patch antenna.

The primary spacecraft will be sending down relative distances and velocities, images from the payload, and primary spacecraft health and a communication system to support the transfer of that data. The radio will be operating in the 430/440 MHz range using GMSK modulation. The uplink data rate will be at least 4000 bps and the downlink data rate will be at least 100 kbps. Knowing the health of the spacecraft is important, so data such as battery voltage, temperature data, solar panel current, etc. will beacon down periodically. Based off historical data and experience, finding a CubeSat early in its mission can be difficult, so the beacon interval will be no more than 10 seconds to make it an easy target to listen for.

The RF link between the secondary spacecraft and the ground is much simpler. One command needs to be sent to the secondary spacecraft to power the navigation aids on and off. An RF receiver on the secondary spacecraft will listen for a command sent from the ground. The receiver will operate in the 430 MHz range and use FSK modulation.

**CDH**

The Command and Data Handling (CDH) subsystem is responsible for making on-orbit decisions, processing health sensor data, and managing data during downlink. The CDH subsystem will handle the images from the payload and the relative distances and velocities calculated by the payload system. It will also handle all health data and any commands that come from the ground.

PLD

Imager

µController

16GB SD Card

Image Processor

I2C

SPI

The figure above shows how the CDH system will interface with payload. Every 1.25 seconds a picture will be saved to an SD card and every second the relative distance and angle data will be saved to the SD card so they can be downlinked later. The table below shows how much data is generated. Most of the data is from pictures, the data generation was estimated with a 30 fps camera that took pictures that were 640x480 with 8-bit color. The SD is 16 GB in size and in order to have 25% margin only 12 GB was allowed to be usable.

|  |  |  |
| --- | --- | --- |
| Mission Segment | Duration (min) | Data Generated (GB) |
| ISK | 180 | 4.158 |
| Transition | 180 | 4.158 |
| RSK | 90 | 2.079 |
|  | Total | 10.394 |
|  | Margin | 5.606 |

The secondary spacecraft CDH is much simpler. It would the voltage to the radio and LEDs by providing 3.3V. It also handles the power cycle command for the LEDs. The system would be a microcontroller and a voltage regulator.

**MOP**

Due to the nature of the Rascal mission, it will have to be done quickly. Once regular communication has been established with the Rascal spacecraft, separation would be initiated and then there would a limited time to complete the mission. It would be run over the course of a few days before the relative distance between the two spacecraft became too great that mission cannot be completed. Each portion of the mission will be verified on the ground before moving to the next portion. The method of validation to move to the section of the mission will be the downlinking of relative distance and angle data to verify that the appropriate distance has been reached as well as a picture to serve as verification of the distance and angle measurements.



In order for a ground station to support the Rascal mission, the ground station has to meet several requirements. Since both spacecraft will be operating in 433/440 MHz range, the ground station must have an antenna that works at that frequency and a radio that operates in that range. The TNC at the ground station must be able to send and receive GMSK modulated signals from the primary spacecraft and send FSK modulated signals to the secondary spacecraft. The TNC must support an uplink data rate of at least 1200 bps and a downlink data rate of at least 100 kbps.

**Secondary ADC**