Attitude Determination/Magnetometer

This satellite will use the HMC 1000 series of magnetometers from Honeywell for attitude determination. To reduce cost, a HMC 1001 (one axis device) and a HMC 1002 (two axis device) will be combined to get information about all three axes, as opposed to purchasing a HMC2003 (three axis device). This combination of chips will provide three axis magnetometer readings with an accuracy of 26 microGauss after being calibrated to account for the magnetic field produce by the attitude control. Although passive magnetic attitude stabilization will be used and GECOE will not be able to change its attitude, the magnetometer will need to provide information about orientation to determine its effect on the performance of the MRR. This includes determining if there is issue with orientation which is preventing a link from being established.

GECOE will not be able to control its attitude so the information from the magnetometer will be analyzed on the ground. A few samples will be compared to the International Geomagnetic Reference Field to determine orientation. Only a few readings will be sent through radio communication to determine orientation and the MRR will be used to transmit the rest of the readings. The readings from the magnetometer will be combined with the laser ranging data to map out the earth magnetosphere.

Attitude Control

To reduce cost, power requirements, and chances of failure, passive magnetic attitude stabilization (PMAS) will be utilized. This system uses a permanent magnet, rather than a powered magnetic torquer, to align the satellite with the earth’s magnetic field. Hysteretic rods are used to prevent the satellite from rotating around the satellite magnetic field by switching polarity, producing torque and heat, as the satellite turns around the magnetic field. The satellite eventually stabilizes in an orientation determined by the configuration of the magnet and hysteretic rods [7].

This system will not be as accurate as an active system. However one of the benefits of MRRs is that they do not require precision pointing. This is because of the nature of a retroreflector to reflect light in a direction parallel to the angle of incidence. As such, the link will not be significantly affected by the loss in accuracy provide by a passive rather system than an active system.

Since this system uses a permanent magnetic rather than an electromagnet, it will continue to function should the onboard electronics fail. The retroflector also does not require any power to operate so it will function even if the MRR also fails. Because of this, should there be any failure onboard, laser ranging data can still be gathered since the PMAS and retroreflector will continue to function. This will allow a ground station to continue to bounce lasers off GECOE to range it.

Ground Station

There are some current ground stations capable of optical communication with satellites. They will be contacted following this report to ascertain potential collaboration. This needs to be done early to determine the alignment need for the PMAS and to determine what the optimal wavelength for the MQW.

The possibility that collaboration from these facilities won’t be obtained is also being considered. If this is the case then a laser communication ground station will be constructed for this mission. By utilizing one of the larger telescopes at the University of Florida and an approximately 12.5 inch reflector, it may be possible to construct a low cost station that is capable of meeting the needs of this mission.

It would be required to obtain a laser that will work with the MQW. A commercial one watt laser has been proven to be visible from LEO. Currently, a continuous one watt 980nm laser is under consideration. A beam expander will also be used to further reduce the divergence. Beam expanders have the added benefit of making the laser beam wider which will increase the safety of the system. The laser can be modulated either through modulating the power that it is receiving or by using another MQW shutter should the other method not allow for the desired bandwidth. However the beam needs to remain continuous in order for the MRR to be able to utilize the laser to communicate with the ground station.

The telescope will be modified to allow for an avalanche photodiode to be placed on the eyepiece. By monitoring the delay between when the ground laser signal was sent and when it was received, traditional satellite laser ranging data can be obtained. Different modulation schemes will be used to allow the ground station to separate the uplink from the downlink signal. The telescope will further be modified to allow for motorized gimbal system to allow for the precision pointing needed to establish the link.

Software will be written to allow for the ground station to locate and track GECOE. In order to ensure a optimal link, a method developed by the NRL for potentially using MRRs to tag and identify LEO objects launched by nontraditional means, such as by rail guns[5] will be used. This system will have the laser following a grid pattern over the area predicted to contain the MRR. Once the laser hits the MRR and the ground detects the return, it will continue with a smaller grip around were the MRR is now predicted to be based off the location of the return signal. Figure 3 illustrate this concept which continues until a stable link is established and ensures a strong link.

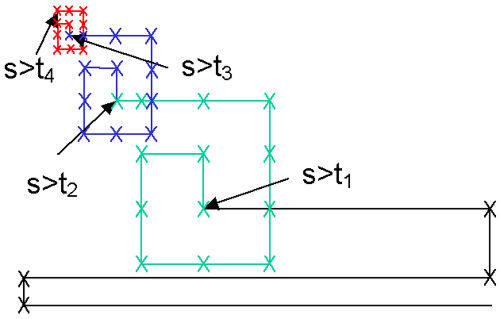


Figure 3 [5]

Since the cubesat will also carry a traditional radio transponder, a radio ground station will be needed also. UF currently has the facilities needed for traditional radio communication with cubesats which can be utilized for this aspect of communication with the satellite.

Redundant communication

Two separate communication systems will be utilized. The MRR will provide primary communication with the satellite. However, this is the test payload and the possibility of not being able to establish a link with the MRR is being considered. A secondary RF communication will be used if a link cannot be established with the MRR to try to determine and possibly fix what went wrong with the MRR.

The RF communication system will consist of a modified VX-3R transceiver handheld radio and a TinyTrak4 to allow the radio to transmit data over the amateur radio frequency bands. The University of Hawaii has used this system before and has posted instructions on performing the necessary modifications. [8] This will provide a limited half-duplex connection with the cubesat which is all that is needed for it to serve its purpose.

The VX-3R will also be further modified to reduce weight and allow the attachment of another antenna. The antenna will be based off the Swampsat design in which the antenna is stored in the cubesat and then released once in orbit.