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1/2U Cube Satellite Antennas for Application in the AMSAT UHF and SHF Frequency Bands

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Abstract

This Thesis identifies the state-of-the-art in satellite antennas in support to the George Mason University Small Satellite deployment program. This need includes the support of a Cubesat UHF Command Uplink receive antenna and a S-Band Data Downlink transmit antenna. A literature search was conducted in the academic, science and commercial satellite fields for satellite antennas of low operational failure and flawless deployment reliability. The conclusion of the survey was the down selection to a UHF half wavelength dipole receive antenna and a square patch linear polarized transmit antenna. To push the patch state-of-the art envelope, a third, linear polarized experimental fractal SHF antenna was investigated.

The UHF Dipole, linear probe fed Patch and an experimental Minkowski Fractal patch antenna were then designed, modeled and tested to operate in the AMSAT frequency bands. These three antennas will support a UHF ground-to-satellite command uplink and a SHF satellite-to-ground station data down link.

A UHF command link receive dipole was designed using closed formula and then modeled using ANSYS HFSS electromagnetic software. The antenna was then subsequently built and tested at the Orbital Sciences, Dulles Virginia antenna range. The measured return loss and antenna impedance bandwidth agreed well with designed predictions.

G10 epoxy board was used to build the S-Band patch antennas for its easy availability and low cost. However, G10 gain measurements was down 1 dB indicating that G10 epoxy board is loss at RF frequencies. For a critical, high performance fight antenna design, any low-insertion loss RF material such as the Rogers Duroid Substrate is the preferred choice for a low insertion loss antenna.

The RF measure gain and input match results for each antenna show a working UHF dipole and SHF patch design that can be built, tested and installed within a Cubesat structure with predictable RF performance results. This work will aid in the design of a successful Ground-to-Satellite and a Satellite-to-Ground communication link.