Satellite Antenna Radiation Pattern Behavior Analysis

University of Minnesota
Nanosat-5 Program

University of Minnesota
107 Akerman Hall
110 Union Street SE
Minneapolis, MN 55455

Signatures

Prepared by:	______________________ Alex Schnedler IT, COMM Team	__________ Date
Approval:	______________________ Erin Mussoni IT, COMM Team	__________ Date
Approval:	______________________ Ellie Field PM	__________ Date

Revisions

Revision	Description	Date	Approval
-	Initial Release		

Contents

1 Overview

It will be shown that an electrically large loop antenna will fulfill the mission requirements of the uplink and secondary downlink, and that a 2.4 GHz patch antenna will fulfill the requirements for the primary downlink.

2 Purpose

The purpose of this analysis is to demonstrate the effectiveness of the proposed 440 MHz uplink and secondary downlink loop antenna as well as the 2.4 GHz primary downlink antenna.

3 Objective

Radiation patterns of the chosen antennas will be demonstrated as sufficient to complete the mission of closing both the uplink and downlinks.

4 Requirements

- The uplink antenna must have 5 dBi of gain
- The downlink antenna must have 13 dBi of gain
- The antennas must meet all FCC regulations

5 Method

Antenna analysis was completed using method of moment. First a model of the proposed antenna was created, then numeric and graphical data was generated using the Numerical Electromagnets Code (NEC) software 4nec2X.

6 Analysis

The uplink antennas bandwidth requirements are very minimal so the major design parameters become the gain, the standing wave ratio (SWR), and the physical requirements. Gain is a product of the antenna geometry while the SWR is also dependant on geometry but can be manipulated with the use of circuitry. The SWR is the ratio of the amplitude of a partial standing wave at a maximum to the amplitude at a minimum. It is desirable to have a low SWR value to reduce loses.

An electrically large square loop antenna and patch antenna were chosen because they are directional, have a relatively low SWR value, and are cost efficient.

The satellite is designed to be oriented toward the ground station so a high gain antenna is desirable for maximum efficiency. To insure that a link can be closed even if the satellite orientation is not precise, antennas with a beamwidth of greater than 30 degrees were chosen.

7 References

1. "Patch Antenna." teletronics.com. http://teletronics.com/15-104.pdf

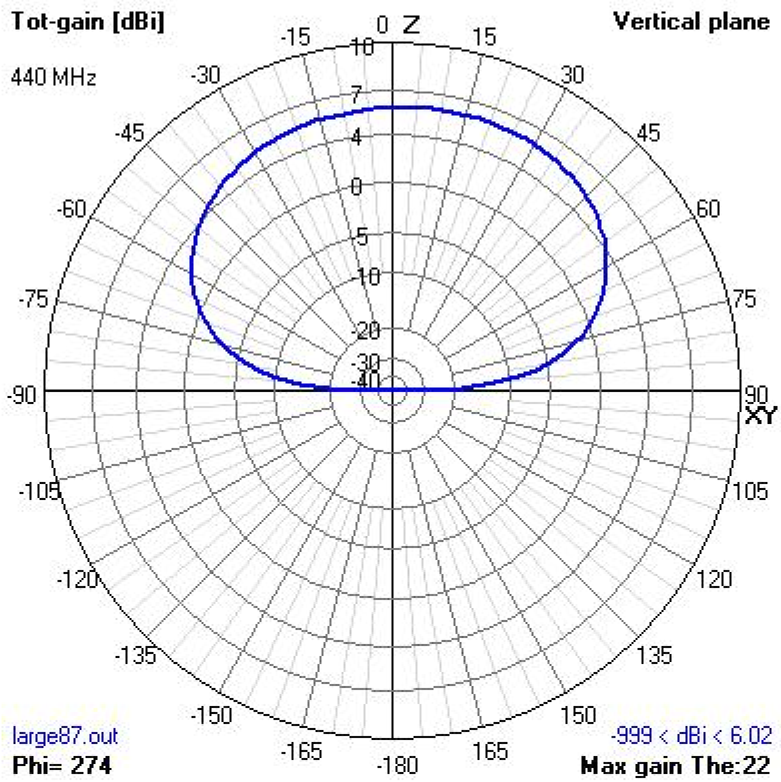

Figure 1: 440MHz Uplink Beam Pattern. The horizontal (xy) axis represents the bottom of the satellite and the z axis points toward Earth. The maximum gain is 5.86dBi. The beamwidth is 62 degrees. The pattern is symmetrical about the Z axis.

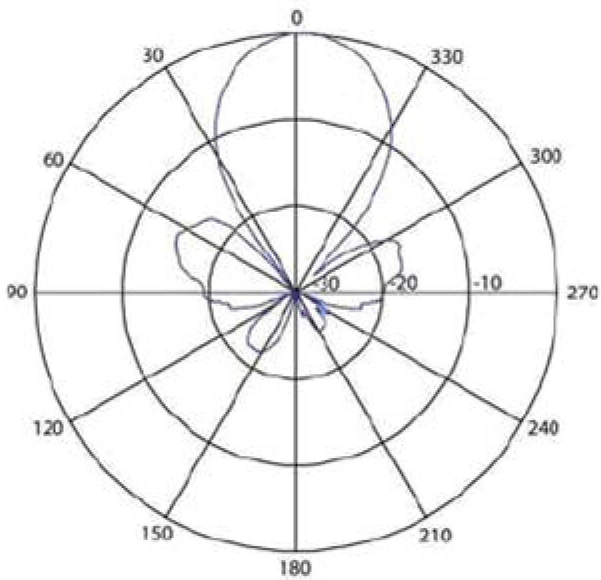

Figure 2: Vertical Polarization of the Patch Antenna. The gain of the antenna is 13 dBi with a vertical beamwidth of 38 degrees. The Voltage Standing-Wave Ratio (VSWR) is less than or equal to 1.5:1 indicating a maximum standing-wave amplitude to be 1.5 times greater than the minimum standing-wave value [1].

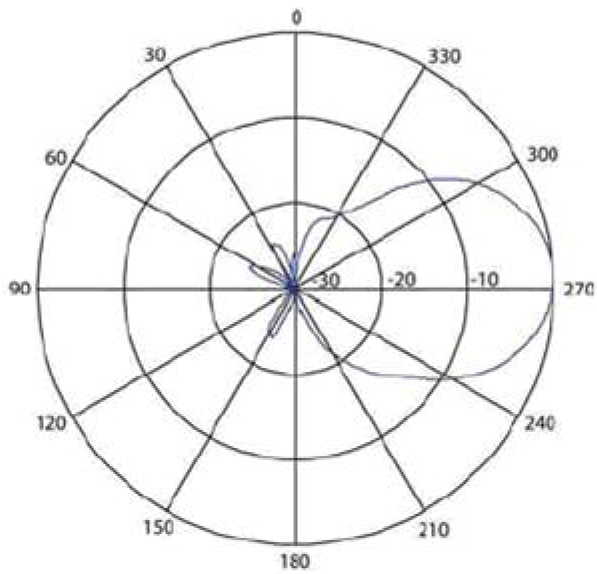

Figure 3: Horizontal Polarization of the Patch Antenna. The gain of the antenna is 13 dBi with a horizontal beamwidth of 38 degrees. The Voltage Standing-Wave Ratio (VSWR) is less than or equal to1.5:1 [1].