July 24, 2017

Specification Report on 400 MHz Antenna

Contents

The antenna presented herein are feasible to construct. These are deployable antennas. The antenna bifilar loops are constructed using NiTinol wire. These bifilar loops are situated on a printed wiring board. The capacitor and inductor components are realizable; that is, they are of practical values. The NiTinol construction allows the antenna to be stowed within the cube sat structure. After launching into Low Earth Orbit, the antenna may be deployed by applying an electrical direct current. HCT advocates use of a High Efficiency Voltage Regulator with Current Limiting circuit placed on the underside of the antenna PCB. Recent measurements recommend a current limiting circuit at about 4 amperes. The Voltage floats from about 3 to 5 volts. The power is applied for about 60 seconds. The antenna deployment benefits from solar heating in Low Earth Orbit.

We look forward to working with Magnitude Space to develop a Quadrifilar Helical Antenna suited to your desired specifications.

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1 Specification

This report presents a Specification Report for a Single Quadrifilar Helical Antenna. The Feasibility Study results have shown that a single Quadrifilar Helical Antenna really is the practical way to proceed. It offers a nearly uniform X axis and Y axis footprint on earth below the satellite.

The report establishes performance of a Single QHA on a 100x100mm ground plane as a baseline.

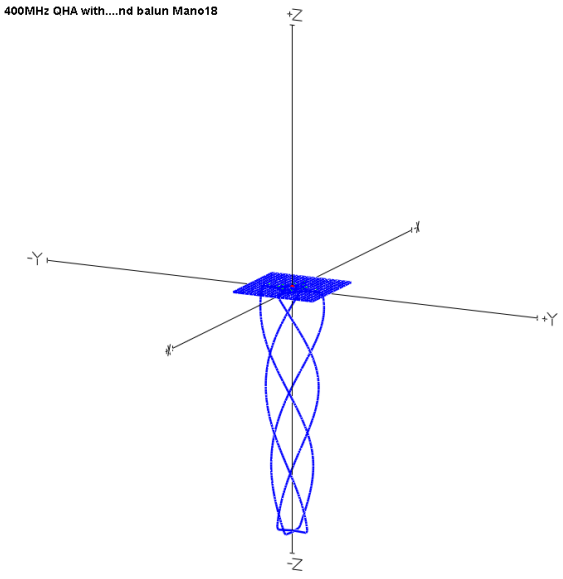
For the graphs that follow, +X is pictured as the forward direction of the spacecraft and -Z is the nadir. It is important to be aware of the orientation of the antenna and 3D views. The orthogonal views of the antenna pattern and gain vs frequency graphs are plotted with respect to origin. The rectangular view shows the beamwidth in the nadir.

Gain directed at the nadir: Greater than +4 dBiRHCP

Beamwidth mounted on 6U ISIS Cube Sat structure: Between 110 and 120 Degrees

2 Single QHA directed at the Nadir

2.1 Geometry of a single QHA

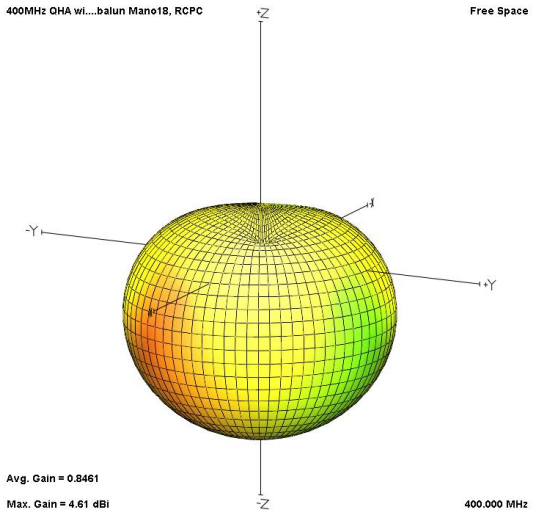


Axial Ht = 286 mm Prox Dia = 75 mm Dist Dia 35.5 mm Pitch.Angle = 58 Deg

Cseries = 15 pF Lshunt = 8 nH Lmatch = 62 nH Cbalun = 6.6 pF Lbalun = 18.5 nH

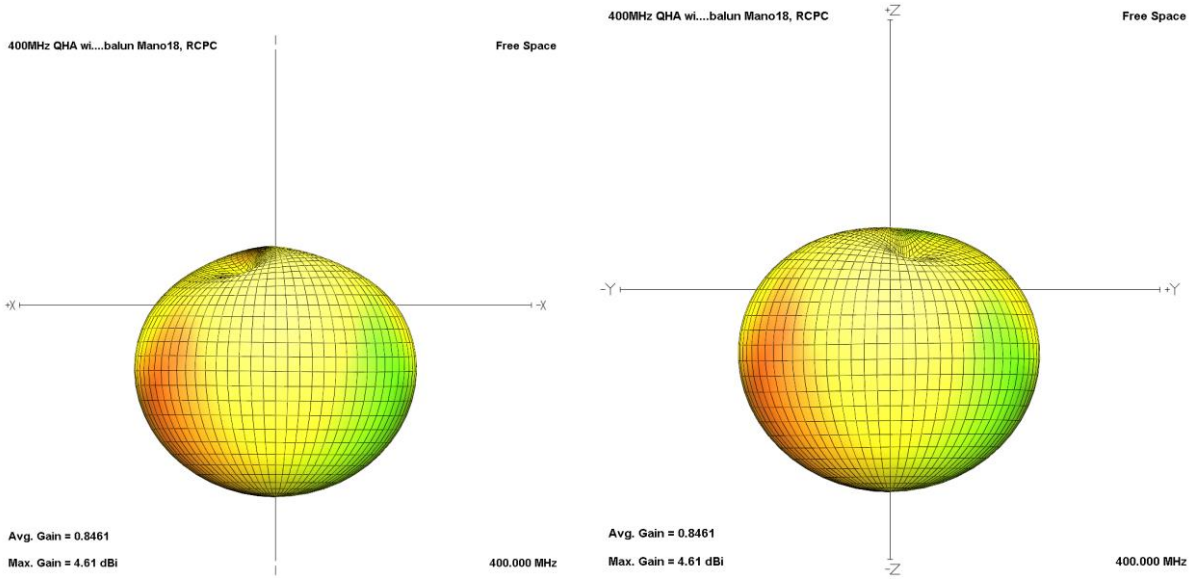
The single QHA by itself is an appropriate reference antenna

2.2 3D View of the Right Hand Circular Antenna Pattern



Maximum RHCP Gain = 4.6 dBirhcp, Orthographic View

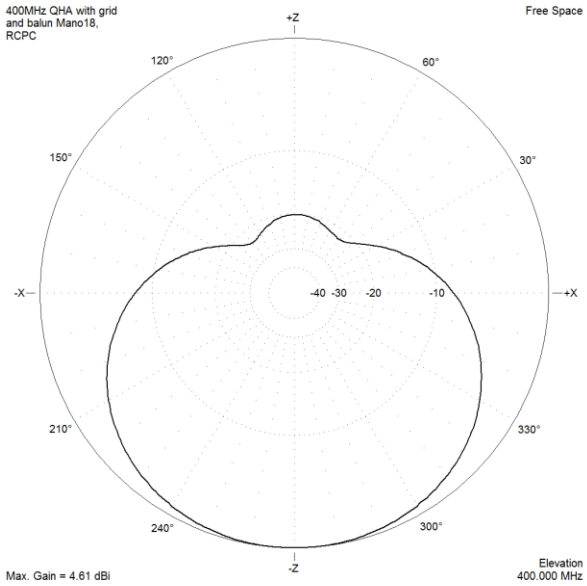
2.3 3D antenna pattern along X and Y axis



Maximum RH Gain = 4.61 dBi

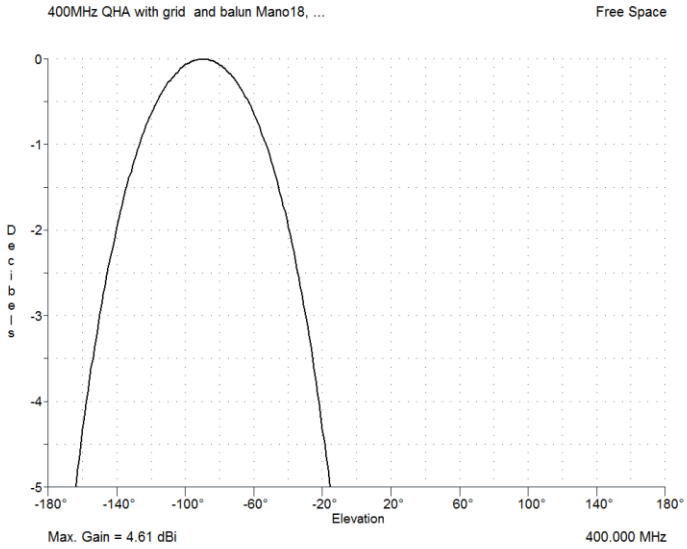
These graphs show symmetrical X and Y axis performance.

2.4 2D Polar View, showing Max RHCP Gain is >4.6 dBirhcp



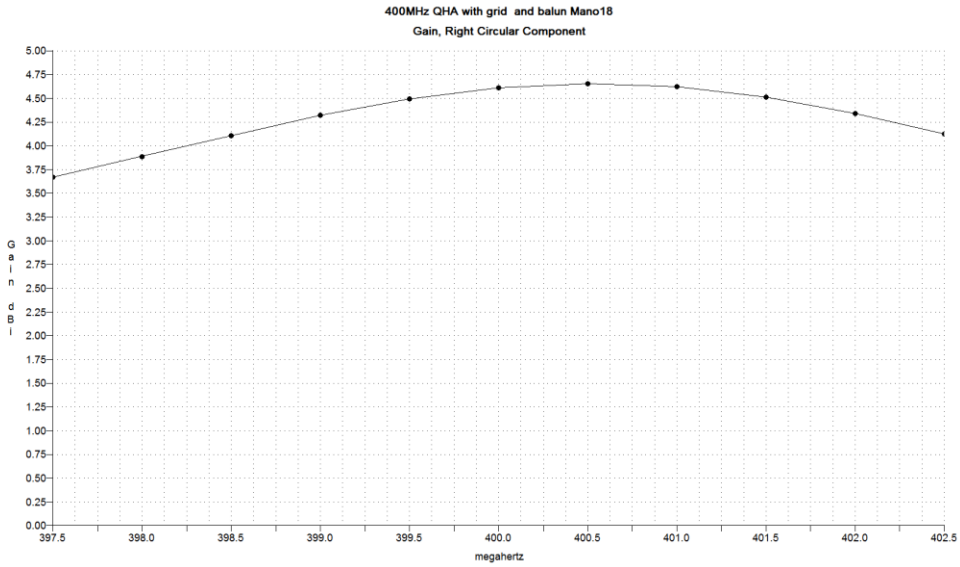
This view is in the Y axis, in the XZ plane. The background is scaled in 2 dBi increments.

2.5 Rectangular view showing -3 dBi Beamwidth of 120Deg

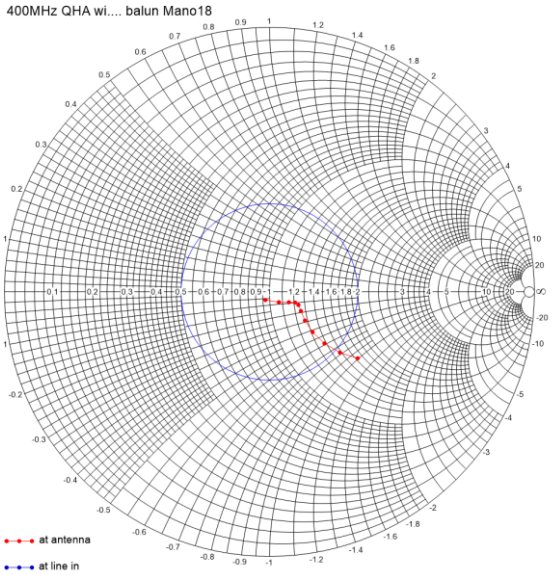


This view is in the Y axis, in the XZ plane. The background is scaled in 2 dBi increments.

2.6 Gain vs Frequency shows 4.6 dBiRHCP gain at 400 MHz



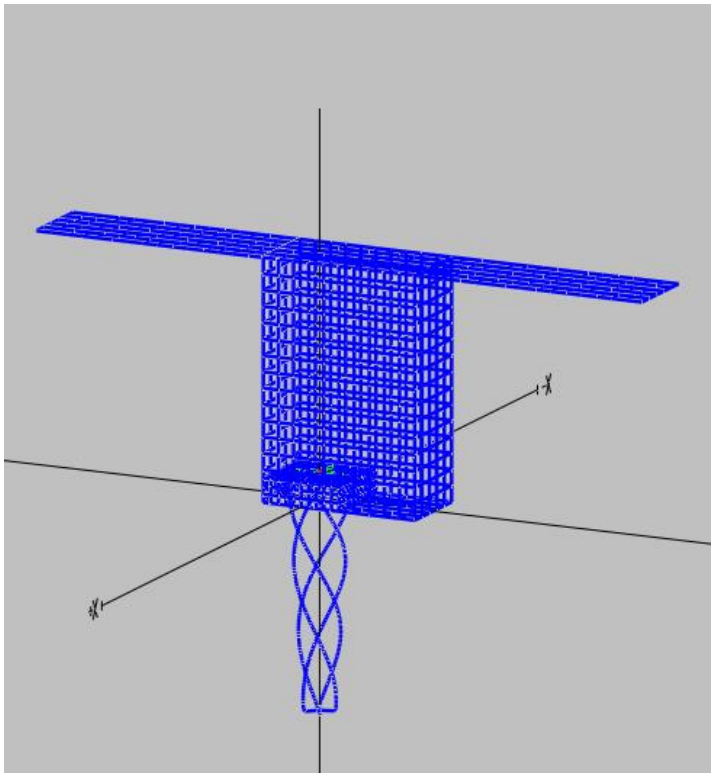
2.7 Smith Chart



The antenna is matched well over the 5 MHz bandwidth centered on 400 MHz.

3 Single QHA Recessed 30 mm into 6U Cube Sat

3.1 Geometry of 30mm Recessed QHA



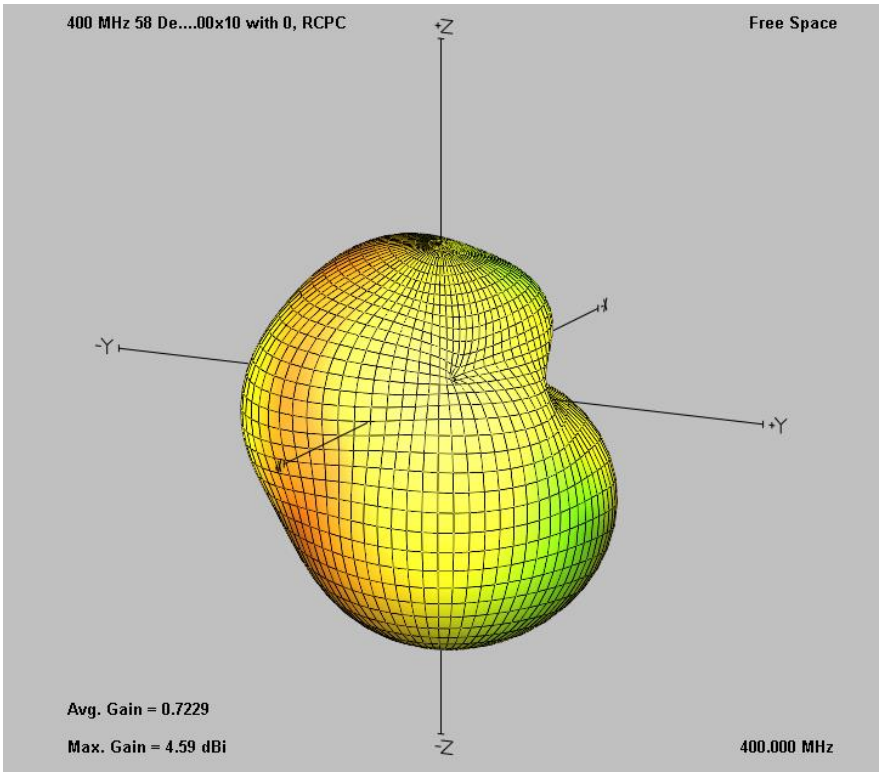
The recessed distance of the antenna into the structure affects the antenna pattern. This case uses a 100x100x10 Grid, representing the Printed Circuit Board the antenna is mounted on.

Axial Ht = 293 mm Prox Dia = 75 mm Dist Dia 35.5 mm Pitch.Angle = 56 Deg

Cseries = 270 pF Lseries = 4 nH Lshunt = 50 nH Cbalun = 7.7 pF Lbalun = 4.6 nH

HCT is in the process of changing to use the High Frequency Structure Simulator. The main improvement is likely to be in the printed circuit board impedances. Therefore, the capacitor and inductor values are likely to change.

3.2 3D View of the Right Hand Circular Antenna Pattern

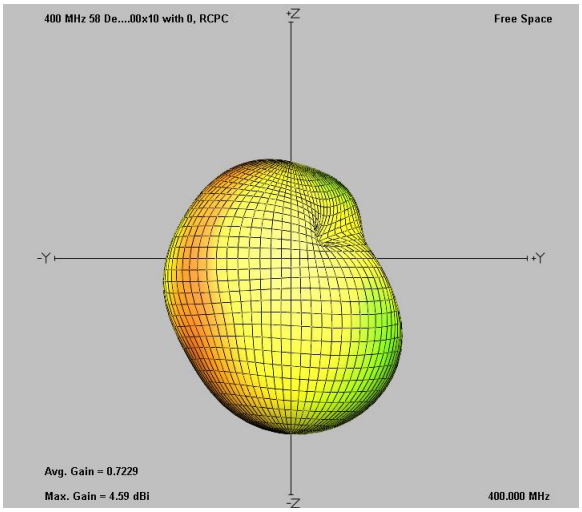


Maximum RHCP Gain is 4.6 dBi

Orthographic View.

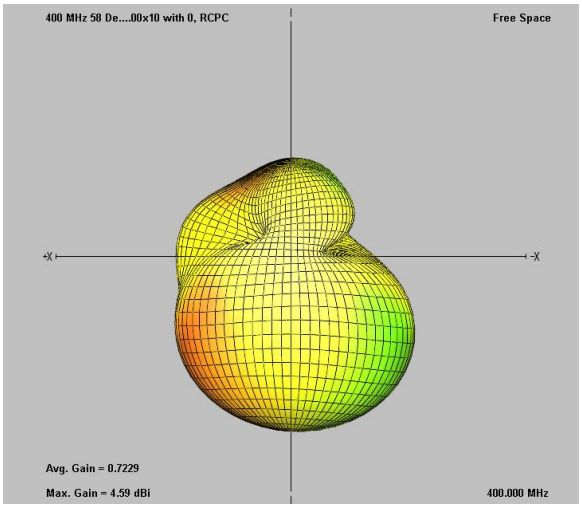
The antenna recess mounted in the Cube Sat structure 30 mm indicates 0.2 dB decrease over the antenna by itself.

3.3 3D ant pattern along X axis, in YZ plane



Maximum RH Gain = 4.6 dBi

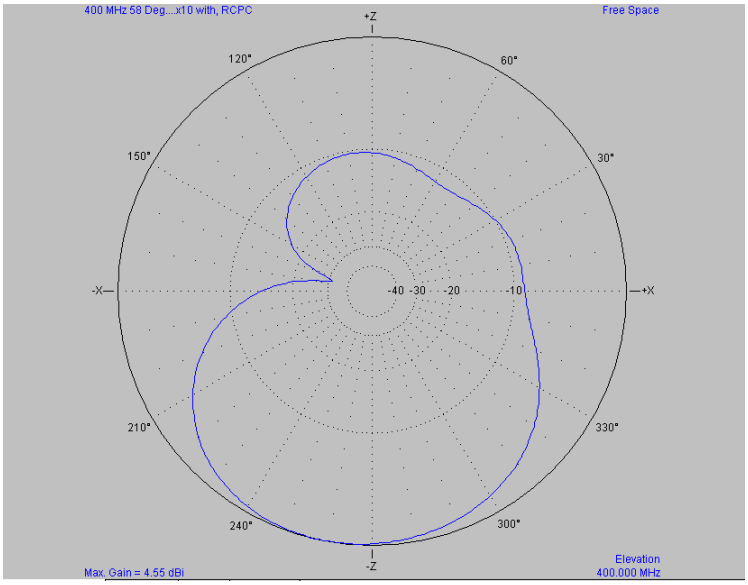
3.4 3D ant pattern in YZ plane



Maximum RH Gain = 4.6 dBi

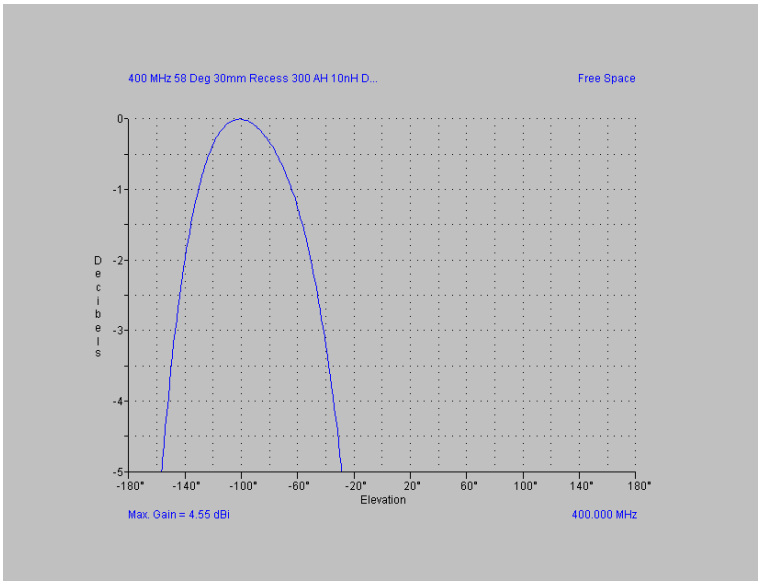
Note: The XZ and YZ plane views are nearly identical indicating a very symmetrical pattern.

3.5 2D Polar Elevation View, Y axis, in XZ plane



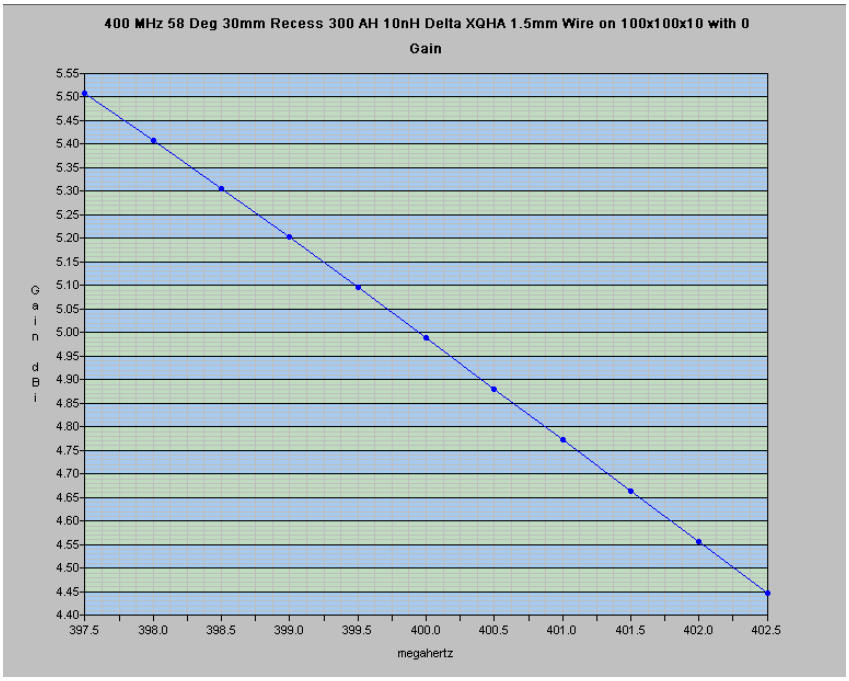
Maximum RH Gain = 4.6 dBi

3.6 Rectangular view showing -3 dBi Beamwidth of 107 Deg



The beamwidth is slightly affected by the cube sat structure. The beamwidth may vary when the actual antenna is built and placed on the satellite with the solar panels.

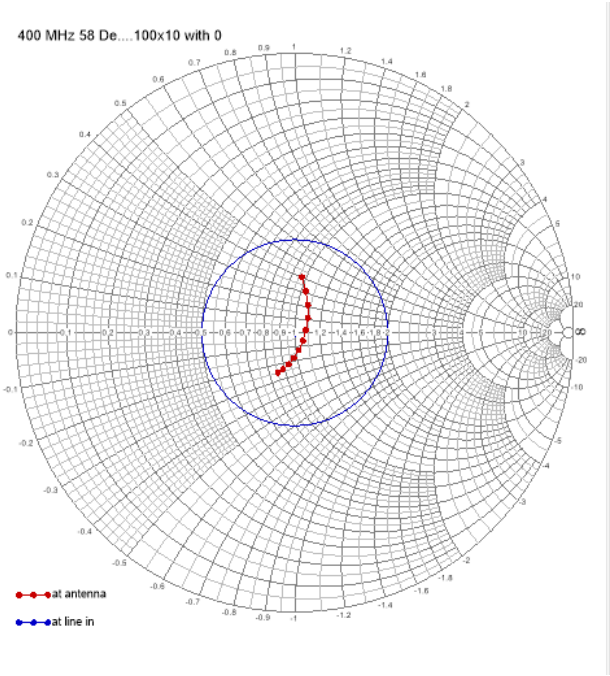
3.7 Gain vs Frequency showing 4.6 dBiRHCP gain at 400 MHz



The gain vs frequency varies 1.1 dB over the 5 MHz band.

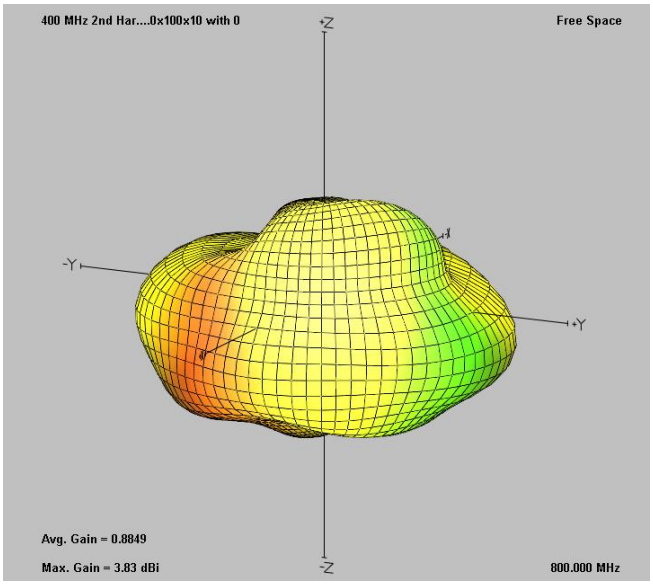
The satellite structure and the solar panels affect the antenna pattern and impedance match. After considerable simulation HCT has determined it will be best to operate the antenna significantly off maximum gain. This allows the antenna to perform with minimum affects to the performance compared to an antenna without the satellite structure and the solar panels.

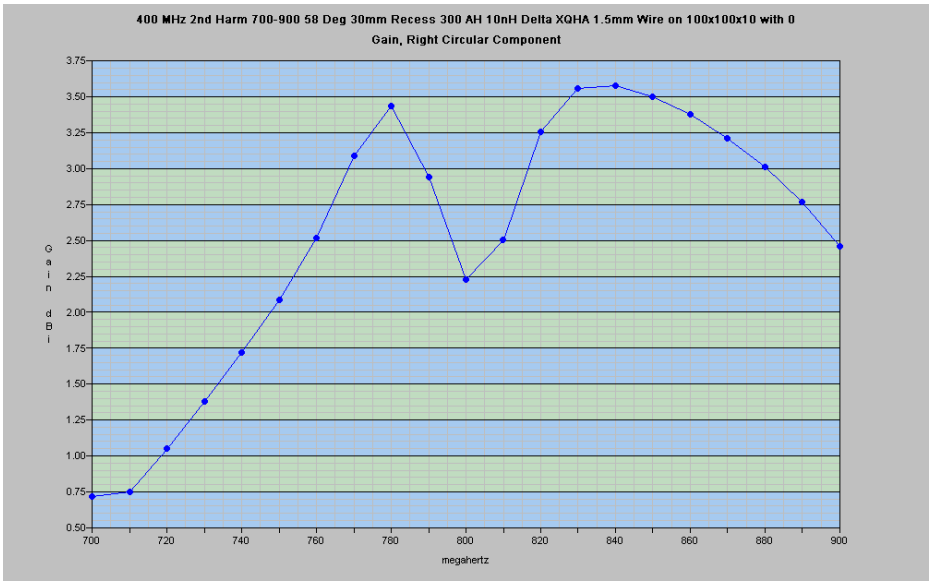
3.8 Smith Chart



The antenna driving point impedance shows a very good SWR.

4 2ND HARMONIC RESPONSE FOR SINGLE QHA RECESSED 30 MM INTO 6U CUBE SAT





5 3RD HARMONIC RESPONSE FOR SINGLE QHA RECESSED 30 MM INTO 6U CUBE SAT