Sweeping Impedance Probe for Space Missions

DETERMINING PLASMA DENSITY

Plasma density is determined by measuring impedance. A hollow probe is swept with an AC signal at a large range of frequencies. The magnitude and phase of the output signal is monitored in order to find the resonance frequency. This data along with some knowledge about properties of the probe are used to calculate what the dielectric is between the probe and body of the satellite. This is then used to determine the plasma density.

INTRODUCTION

Impedance probes have been used for decades to measure the electron density of the Ionosphere. These measurements have been extremely important due to the affect the Ionosphere has on telecommunications. Traditionally, impedance probes have gone on large satellites. The latest trend; however, is to use small cost effective Cube Satellites. The current impedance probe designs are too large and power hungry to be used on a Cube Satellite. The purpose of this project is to design an energy efficient impedance probe that will run on 400 mW and that could be flown on future Cube Satellite missions.

MODE OF OPERATION

In creating a low power impedance probe we researched many low powered parts. After choosing all of the hardware we interfaced with them in a way that would allow give us similar results to the older power hungry probes.

1) On-Board Computer sends “Start” Command to FPGA
2) FPGA sends frequency command to DDS chip
3) The DDS sends one signal through the probe, and one is used as reference
4) The Probe and reference signals are sent to the magnitude and phase detector
5) One DAC measures the signal amplitude and sends the data to the FPGA
6) The other DAC measures and sends the phase difference to the FPGA
7) Steps 2-6 are repeated for frequencies from 1 MHz to 30 MHz
8) Resonant frequency is calculated using magnitude and phase data
9) That data is then sent back to on-board computer