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SIW PATCH ANTENNA FOR COMMUNICATION BETWEEN NANOSATELLITES IN LAUNCH TUBES

Abstract

Satellite technology has been intertwined with the space industry since the beginning, and the current developments leading to satellite miniaturization are enabling this exciting space technology of the future with new developments in CubeSats and other small satellites.

In this project, we investigate the design of an antenna that is specialized for near-field communication with a CubeSat that is inside of a metallic launch tube. This antenna is needed for pre-deployment communication between the Seeker and Kenobi CubeSats. The metallic environment of the launch tube will detune an ordinary microstrip patch antenna, resulting in a very poor impedance match. NASA-JSC, working with the University of Houston, has been able to design a substrate integrated waveguide (SIW) microstrip patch antenna on a lossy FR4 substrate to achieve a good match in this scenario. The purpose of this project is to investigate why a lossy SIW patch is more effective than a regular patch in this scenario, and to develop conclusions that will help with the design of an SIW patch for similar scenarios in the future.

For this investigation, the modeling software Ansys HFSS (High Frequency Structure Simulator) is used. The SIW patch is modeled with metallic walls on the sides instead of conductive vias for simplicity. The patch's input resistance is found to have a sinusoidal-squared variation with feed position, based on cavity model reasoning.

To compare performance, four patches are simulated for the same input resistance and resonance frequency: a regular patch with a regular substrate, a regular patch with a lossy substrate, an SIW patch with a regular substrate, and an SIW patch with a lossy substrate. Metal sheets are added above and below the antennas in the simulation to observe the effect of a conductive environment on each of the patches (simulating a launch tube environment). Among the four patches considered, the resonant input resistance of the lossy SIW patch is the least sensitive to the conducting environment. This shows that this antenna in an excellent candidate for future applications in space technology, whenever an antenna is need for operation in a tightly confined conductive environment.