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Author: Mr. Yianni Hudon-Castillo
Polytechnique Montreal, Canada

Ms. Sabrina Kirk
Université du Québec à Montréal, Canada
Mr. Michael Mayerhofer
Polytechnique Montreal, Canada
Mr. Louis-Frédéric Racicot
Polytechnique Montreal, Canada
Mrs. Chloé Mireault-Lecourt
Canadian Space Agency, Canada
Mr. Marco Luccini
Canadian Space Agency, Canada

MULTILAYER MICROSTRIP PATCH ANTENNA ARRAY SYSTEM FOR THE CANADIAN PEEKBOT LUNAR ROVER

Abstract

As part of a Canadian inter-university initiative, the Canadian Space Agency (CSA) is studying the practicality of a mini lunar rover surviving the lunar night using Polyether ether ketone (PEEK) structural panels. Named PEEKbot, this rover requires a high-gain, X-band planar antenna system to communicate directly with the CSA's ground station network. Few existing antennas are suited to such an application due to the volume, mass, and power constraints of this rover platform. Therefore, a multilayer microstrip patch antenna array was designed, manufactured and tested by a team of engineering physics students at Polytechnique Montréal. With a central frequency between 8.4-8.5 GHz and a gain of at least 12 dBi, this multilayer antenna array of 8x8 elements has a thickness of 3 mm and measures 15.2 cm by 15.2 cm. Using a maximum power of 20 W and a circular polarization, this antenna design aims to provide a steady data rate of 40 kbits/s, which will enable to downlink to Earth PEEKbot's scientific data and telemetry, followed by the uplink of its commands.

This paper will embark on a comprehensive project description by first detailing the objectives and constraints, followed by the antenna's concept of operations put in context of PEEKbot's mission. Through these operations, the elaboration of its interfaces with the other subsystems of the rover will be addressed and complemented by the antenna's link budget, which will allow to establish its system requirements.

In order to properly depict the design choices of this antenna array, a literature review covering microstrip patch arrays and multilayer feeding networks will be detailed with the according antenna theory. The design choices identified will allow to produce a design rendering of the antenna using Ansys HFSS software, which will then be optimized through an incremental array size technique.

Furthermore, the manufacturing, assembly and testing processes of the antenna array will be explored. This includes microfabrication using lithography techniques, soldering of components and its installation inside Polytechnique Montréal's own anechoic chamber at Poly-Grames Research Center.

Finally, the characterization results obtained through testing will be discussed and compared to the results obtained by numerical simulation on Ansys HFSS, followed by the integration results with the other subsystems of the lunar rover.