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DESIGN, FABRICATION AND CHARACTERIZATION OF A K BAND REFLECTARRAY ANTENNA FOR USE IN A CUBESAT APPLICATION

Abstract

The number of CubeSat launched in space has grown rapidly in recent years, comparing 20 launches in 2006 to 288 in 2017. This interest is mainly driven by the faster and cheaper development time for a mission. The counter part is that miniaturization brings forth a lot of challenges in the design of the satellite subsystem. For instance, parabolic antennas are mainly used on conventional satellites to offer high gain, high throughput communications. This solution when transpose on nanosatellite is a lot harder to implement due to the size constraint. Therefore, a lot of research is being made to find a reliable and efficient high gain antenna solution. In this paper, we designed and built a double square ring reflectarray to study its viability in a telecommunication subsystem for a CubeSat.

The design was made using a technique which consider a single unit cell instead of the whole array. This in turn, allows one to investigate and study many different geometries in a timely manner. In this paper, we used the FEKO® simulation tool from Altair to solve using the Method of Moments a basic square and a double square ring unit cell. The basic square geometry phase-length curve did not offer sufficient phase variation however, the double ring demonstrated a double resonant which allowed the phase variation to exceed 360. Then, the antenna was made using FEKO's scripting language (based on Lua) to generate a Gerber file based on the phase description of the array (1) and the phase curve of the single cells. The file was then used by our in-house etching laboratory to produce the antenna on a Duroid 5880 substrate. Finally, the characterization of the antenna was made in an anechoic chamber. We found a gain of about 34 dB with cross-polarization of about 10dB and a bandwidth of 6.5% centered at 20 GHz.

Our results show that a reflectarray could be used to offer a high gain antenna for CubeSats. In 2017, a mission (CUMULOS) was launched using a similar array (ISARA) and successfully established a downlink of more than 100 Mbps (baseline rate was 9.6 kbps) hence proving the viability of this technology.

$$\phi_R = k_0(d_i - (x_i cos(\phi_b) + y_i sin\phi_b) sin\theta_b) \tag{1}$$