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Spacecraft Charging Analysis of a CubeSat

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Spacecraft charging occurs when charged particles from the surrounding space plasma environment contact a spacecraft and unequal charging currents result in a net charge density accumulation on or in spacecraft materials. Charging becomes a threat when differential potentials between two points on the spacecraft or between the spacecraft and the ambient space environment build to the level that electric fields associated with the potentials exceed the electric breakdown strength of the spacecraft materials and electrostatic discharge arcs are generated. Electrostatic discharges resulting from spacecraft charging can adversely affect telemetry and cause irreparable damage to electronics. Other spacecraft charging effects include damage of solar arrays and thermal protection, enhancement of contamination of surfaces, and degradation of optics. Typically, the large government and commercial space programs include spacecraft charging analysis as part of the design process. CubeSat projects, however, usually do not have the time or funding to include a spacecraft charging analysis due to their low budget and quick-turnaround requirements. CubeSat projects also tend to rely heavily on commercial "off-the-shelf" products, many of which are not qualified for use in space, and are particularly vulnerable to the effects of the space environment. As the demand for longer and more complex CubeSat missions increases, it is becoming more and more important to consider the effects of spacecraft charging in the design process. Results of surface charging analysis using Nascap-2k on a typical CubeSat design for a polar orbit scenario are illustrated. These results show that for a polar orbiting CubeSat, spacecraft charging could be an issue and steps should be taken to mitigate the effects for these small satellites.