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# Design Considerations and Ground Testing of Electric Double-Layer Capacitors as Energy Storage Components for Nanosatellites

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**Abstract**

Electric double layer capacitors (EDLCs), also known as supercapacitors, are electrical storage components that have a higher power density and lower storage capability in comparison to batteries. In terms of energy density, EDLC performance is currently between that of batteries and conventional dielectric capacitors. One of the main advantages of capacitors is their wide temperature operating range, whereas their main drawback is their low energy density. This paper presents design considerations for the selection of EDLCs as energy storage components for nanosatellites. As nanosatellite development is driven by a short development time and low cost, a simple EDLC was designed using commercial off-the-shelf (COTS) components. Ground tests simulating real low Earth orbit (LEO) environment conditions were performed. Sunlight and eclipse periods were 65% and 35% for one orbit, respectively, and EDLC performance was analyzed under the simulated conditions. Testing demonstrated EDLC capability for being used as unit storage on nanosatellites under varied temperature, vacuum, radiation, one-week, and mechanical stress conditions. The projected energy density showed that EDLCs could be substitutes for the currently used space proven batteries in the near future.

## 1. Introduction

Every life form or vehicle is dependent on energy to function; satellites, just like other man-made systems, are non-functional boxes without electrical energy. The importance of an electrical power system (EPS) for the functionality of a spacecraft cannot be over-emphasized. The EPS of the satellite primarily functions to generate, store, and distribute electrical energy to the different sub-systems when they require it. The basic units of the subsystem include solar panels, which generate electricity from received solar energy; the power control unit, which is the regulation and distribution unit; and the batteries, which are the storage units for backup in critical situations and/or during an eclipse (Edries et al., 2014; Patel et al., 2005). For the past fifty years, different kinds of batteries have been used to provide an effective and constant power supply for space missions during critical situations and/or eclipse periods. The lifespan of

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