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Short Communication

Super Capacitors Technologies Used Onboard Micro Satellites for Energy Storage

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Abstract

Small satellites, in particular microsatellites, have shown, in recent years, very advanced performances comparable to large satellites, especially in the field of remote sensing and scientific studies, and this with an affordable overall cost of production.

However, given the overall area available, these satellites have shown some limitations in their ability to support high power consumption demands. These demands come mainly from payloads, for example, Synthetic Aperture Radars (SAR) due to the constraint on the allowable weight and volume of the onboard battery pack.

During the last decades many research activities were coordinated to develop various environment friendly technologies. In addition to sustainable energy sources, efficient energy storage systems are needed. Amongst others high performance batteries and supercapacitors were developed to meet the need of efficient energy storage devices [2-6].

Recently, capacitors called supercapacitors have become a practical alternative energy storage device to batteries. These super capacitors have the ability to deliver high power at low weight and volume. They can store more energy than other capacitors, such as ceramic capacitors, tantalum capacitors, and aluminum electrolytic capacitors. They also have multiple charge/discharge capability and can operate in a wider temperature range. They have been applied to terrestrial applications which require multiple charge/discharge cycle tolerance and high peak input/output power capability [2-7].

Keywords: Super Capacitors; Energy Storage; Double Layer Capacitor; Micro Satellites

Introduction

Supercapacitors are the ideal electrochemical energy storage devices that bridge the gap between conventional capacitors and batteries tolerating the applications for various power and energy requirements

The supercapacitor, also known as ultracapacitor or double-layer capacitor, differs from a regular capacitor in that it has very high capacitance. A capacitor stores energy by means of a static charge as opposed to an electrochemical reaction.

Super capacitors reside between batteries and conventional capacitors in terms of energy and power density. They are typically used in applications where batteries come up short when it comes to high power/life and conventional capacitors cannot be used because of a lack of energy [2-7].

Energy storage devices

Batteries are the most common and widely known energy storage devices. Especially secondary batteries, so-called rechargeable batteries, are often used in energy storage applications. A typical application for rechargeable batteries is that for the space field. In addition to batteries various other energy storage technologies are commercially available, e. g. capacitors and supercapacitors [2-7].

Capacitors

Capacitors can be divided into three main categories, electrolytic capacitors, non-electrolytic capacitors and supercapacitors. The latter can further be split into electric double-layer capacitors (EDLCs), pseudo capacitors and hybrid capacitors. These categories can be further specified by means of material combinations. A capacitor stores energy electrostatically. It consists of two conducting metal plates and a dielectric medium in between. Capacitors store rather small amounts of energy and are widely used in electronic devices [1,7].

Supercapacitors

Supercapacitor is a general term for different types of electrochemical capacitors. A distinction is made between EDLCs, pseudo capacitors and hybrid capacitors. There is a wide range of applications for supercapacitors, from simple components on circuit boards. Furthermore, supercapacitors can be used to complement batteries or to extend the life-time of batteries by balancing temporary power peaks. A supercapacitor is a special type of capacitor which has a larger energy density than conventional capacitors. Furthermore, supercapacitors obtain capacitances that are a few orders of magnitude higher compared to regular capacitors [2-6].

Advantages of super capacitors

The Supercapacitor Secondary Power Source (SPS) offers the following advantages:

- Longer life under multiple charge/discharge cycles, hence longer satellite life,
- Ability to operate power-demanding payloads with lower weight and volume
- High charge/discharge efficiency
- Easily measurable State of Charge (SoC), improving power distribution management
- Less sensitive to temperature, therefore simpler thermal system therefore lower weight
- Environment friendly as it does not contain toxic materials like the cadmium in the Ni-Cd battery [5,6].

Conclusion

The battery energy storage system has been the most popularly used. In this work, the potentials of the supercapacitor energy storage device in space applications has been accessed. Various technologies of supercapacitors available in the industry today are being tried for space missions. Some commercially available supercapacitor types were subjected to various laboratory tests and their performance at different conditions compared. The battery-type hybrid supercapacitor has so far proved to be the best available supercapacitor technology in terms of energy density. The 40,000 Farad battery-type hybrid supercapacitor is one of the highest capacities of such technology successfully produced [6,8].

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