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THERMOELECTRIC GENERATION FOR A SELF-POWERING AUTONOMOUS SENSOR IN A SMALL SATELLITE

Abstract

There are several benefits of using autonomous sensors in spacecrafts. Avoidance of wired connections reduces cost, mass, and increases the flexibility and reliability of the system. The impact of wire reduction can be significant, especially for small satellites with many sensors, like temperature and sun sensors. Previous research has focused on wireless intra-spacecraft communications. To the best of our knowledge, no research has focused on the application of internal self-powering techniques for autonomous sensors in small satellites. This research tests the power capabilities of a system based on a COTS thermoelectric generator (TEG) connected to a Bluetooth Low Energy (BLE) communication system, with a built-in controller and temperature sensor, and a power management interface. The system will be demonstrated as a remote temperature sensor in a future PocketQube mission of Delft University of Technology.

Controlled temperature differences can be achieved in a test environment, allowing the measurement of the TEG power capabilities. It is tested that the system requires, for operation, a minimum temperature difference of 2 degrees between the extremes of the TEG. The TEG generates a peak power of 160 μW for that difference. In addition, the voltage difference obtained of 32 mV exceeds the minimum voltage required by the power management subsystem to be used. The power management sub-system consists of an ultra-low power converter that provides an output voltage of 3.3V and a measured power efficiency of 30%. Moreover, thanks to the management of the BLE sleeping modes, with the built-in controller, an average power consumption of 5μW is required. The case studied allows measuring temperature and sending the data over a BLE link to the on-board computer every 10 to 60 seconds.

It is concluded that the technology, based on COTS components, can be implemented and considered as the first step for a fully autonomous sensor with thermoelectric power generation in small satellites. The tested performance values provide the foundation to develop the technology further.