Paper ID: 13994
oral

19th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Small/Micro Platforms (6A)

Author: Mr. Aimal Siraj
Void inc., Japan, aimal@void.co.jp

# USING THIN-FILM THERMOELECTRIC COOLERS FOR THERMAL MANAGEMENT ONBOARD SMALL LEO SATELLITES

**Abstract**

PURPOSE: Thermoelectric coolers (TECs) are semiconductor devices that utilize the Peltier effect to transfer heat from one side of the device to the other when an electrical current is passed through them. They can be used for either heating or cooling depending on the direction of current. Even though conventional TECs offer reliable operation due to their solid-state construction, they are generally inefficient, fragile, and relatively bulky, which limits their application. Recent development focusing on thin-film thermoelectric materials has shown that such materials can be formed by semiconductor deposition methods, and thus TEC devices can be fabricated using conventional semiconductor fabrication techniques. These new thin-film TEC devices are not only much smaller in size, they are also able to pump much more power, and have response times in the milliseconds versus seconds of the conventional devices. As LEO (low Earth orbit) satellites have short orbital periods, they are subject not only to harsh temperatures but also to extreme temperature gradients during orbit. Given the size and cost requirements of small satellites, small LEO satellites need to have a compact and economical thermal solution to ensure that all onboard electronics are operated within their specified temperature ranges throughout orbit. In this paper we explore the possibility of applying thin-film TECs to the thermal control of such small LEO satellites.

METHODOLOGY: We create an experimental setup mimicking the LEO satellite internal operational environment. For satellite onboard electronics we employ a COTS CPU board, and mount it with thermistors for temperature monitoring and dual thin-film TECs for temperature control. The sides of the TECs opposite the CPU board are attached to metal plates mounted with metal-clad power resistors that can be rapidly switched to emulate the high temperature environment. The temperatures of the CPU board and of the metal plates are monitored by an independent FPGA controller board, which also controls the switching of the power resistors as well as the current-flow through the TECs. The FPGA board takes the whole system through multiple thermal cycles and monitors the temperatures experienced by the CPU board.

RESULTS AND CONCLUSIONS: By running the experimental system through multiple thermal cycles, we are able to determine the precision with which temperature control can be exercised using thin-film TECs. In addition, we get useful insight into the control mechanism required for implementing such a thermal management system onboard small LEO satellites.