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THERMAL CONTROL OF HIGH POWER APPLICATIONS ON CUBESATS

Abstract

The increase of CubeSat missions with energy demanding payloads and the ongoing miniaturization of electric components lead to growing thermal challenges in those standardized small satellites. For upcoming commercial and scientific missions it is important to overcome these challenges and to provide the necessary thermal conditions for demanding payloads and subsystems in the dense package of the CubeSat form factor. CubeSats evolved from mostly educational tools to accepted platforms for business and science and thus thermal management for small spacecraft gained more and more significance over the last years. In past research, the Technical University of Munich focused on thermal modelling of CubeSats and passive thermal control mechanisms. We continued this, researching novel, high power applications for CubeSats, where passive thermal control might not be sufficient. The inherent limits of the CubeSat form factor strongly limits the option for active thermal control. Thus, we first review current thermal control systems used on conventional, bigger satellites regarding their adaptability to the CubeSat form factor. This includes the miniaturization of pumped fluid loops, heat pipes, loop heat pipes, phase change materials, heat straps, and radiators. To evaluate the active thermal control mechanisms, we will summarize mathematical models of the physical principals and give an overview of preliminary calculations. A case study of the analyzed thermal control mechanisms, a power-demanding electric propulsion system for CubeSats, shows the feasibility of the evaluated mechanisms. We will present the results of using various thermal control systems in a reference mission in ESATAN-TMS, giving a first evaluation of the impact each thermal control method has on the designed mission and the electric propulsion system.