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Author: Dr. Riccardo Monti
Sapienza University of Rome, Italy, riccardo.monti-somministrato@thalesaleniaspace.com

Prof. Renato Barboni
University of Rome "La Sapienza", Italy, renato.barboni@uniroma1.it
Prof. Paolo Gasbarri
Università di Roma "La Sapienza", Italy, paolo.gasbarri@uniroma1.it
Dr. Leonardo Chiwiacowsky
University of Vale do Rio dos Sinos, Brazil, ldchiwiacowsky@unisinos.br

OPTIMIZATION AND THERMAL CONTROL OF A MULTI-LAYERED STRUCTURE FOR SPACE ELECTRONIC DEVICE

Abstract

All electronic devices present heat dissipation, by Joule Effect, when they are electrically fed. The heat overstocking produces efficiency and performances reduction. On account of this the thermal control is mandatory. On small electronic equipments, the difficult or impossibility of using a cooling fluid for the free or forced convection heat dissipation, imposes the presence of cooling systems based on another kind of functioning principle such as the conduction. In this paper the thermal control, via pyroelectric materials is presented. Furthermore, an optimization of geometric, thermal and mechanical parameters, influence the thermal dissipation, is studied and presented. Pyroelectric materials are able to convert heat into electrical charge spontaneously and due to this capability, such materials could represent a suitable choice to increase the heat dissipation. The obtained electric charge or voltage could be used to charge a battery or to feed other equipments. In particular, a sequence of different materials such as Kovar, Molybdenum or Copper-Tungsten, used in a multi-layer pyroelectric wafer, together with their thicknesses, are design features to be optimized in order to have the optimal thermal dissipation. The optimization process is performed by a hybrid approach where a genetic algorithm (GA) is used coupled with a local search procedure, in order to provide an appropriate balance between exploration and exploitation of the search space, which helps to find the optimal or quasi-optimal solution. Since the design variables used in the optimization procedure are defined in different domains, discrete (e.g. the number of layers in the the pyroelectric wafer) and continuous (e.g. the layers thickness) domain, the genetic representation for the solution should take it into account. The chromosome used in the genetic algorithm will mix both integer and real values, what will also be reflected in the genetic operators used in the optimization process. Moreover, a parallel version of the genetic algorithm is used to speed up the optimization process. The GA parallelization is based on the island model and is developed by using the MPI library. Finally, numerical analyses and results complete the work.