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# Uncertainty Evaluation of the Unified Method for Thermo-Electric Module Characterization

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## Abstract

In this paper the uncertainty evaluation of the recently proposed Unified Method for Thermo-Electric Module characterization is carried out. The measurement model is detailed and individual uncertainty contributions are highlighted, with close reference to the instrumentation and measurement setup. The uncertainty evaluation is performed by means of a Monte Carlo Simulation. The same algorithm is used to perform a sensitivity analysis, giving a comprehensive insight into the most critical issues of the proposed method and assessing the performance of the two adopted electrical stimuli. The experimental results thereby obtained are discussed and improvements to the measurement setup and technique are finally proposed.

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*Keywords:* Thermoelectric devices, Estimation, Monte Carlo methods, Measurement uncertainty, Sensitivity analysis

## 1. Introduction

Thermoelectricity is an emerging technology capable of harvesting electrical energy from waste heat, thus potentially increasing the energy-efficiency in many applications ranging from aerospace [1–3], to industrial ones [4–7] with low environmental impact.

Thermo-Electric Modules (TEMs), due to their high reliability and compactness, are well suited to work alongside other energy harvesting technologies

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