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# A New Test Rig for Accurate Nonparametric Measurement and Characterization of Thermoelectric Generators

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Thermoelectric generators (TEGs) are increasingly employed in large-scale applications, therefore accurate performance data are necessary to permit precise designs and simulations. However, there is still no standardized method to test the electrical and thermal performance of TEGs. This paper presents an innovative test system to assess device performance in the "real world." The fixture allows the hot temperature to be increased up to 800°C with minimal thermal losses and thermal shock; the clamping load can be adjusted up to 5 kN, and the temperatures are sensed by thermocouples placed directly on the TEG's surfaces. A computer program controls all the instruments in order to minimize errors and to aid accurate measurement and test repeatability. The test rig can measure four TEGs simultaneously, each one individually controlled and heated by a maximum electrical power of 2 kW. This allows testing of the effects of series and parallel connection of TEGs under mismatched conditions, e.g., dimensions, clamping force, temperature, etc. The test rig can be employed both as a performance evaluator and as a quality control unit, due to the ability to provide nonparametric testing of four TEGs concurrently. It can also be used to rapidly characterize devices of different dimensions at the same time.

**Key words:** Thermoelectric, characterization, test, measurement, rig

TEG Thermoelectric generator
MPP Maximum power point

## INTRODUCTION

Thermoelectric devices are used in three different operating modes: cooling, heating, and power generating. They convert thermal energy into electrical energy, or the contrary, and they can increase or decrease the heat power flow rate through them.[1] Traditionally, heat power is more difficult to quantify compared with electrical power, because of various losses and ways of transferring heat energy from one body to another. This means that it is not easy to precisely determine the performance of thermoelectric devices; results often depend on how the tests are performed, and they are difficult to replicate on different measurement systems. When designing a thermoelectric system, the thermal/electrical engineer often relies on data provided by the manufacturer, therefore it is important to have precise knowledge of the performance of off-the-shelf thermoelectric devices. Even if other measurement systems have been developed in the past,[2–6] to date there is no standardized way of testing thermoelectric devices. The performance obtained by the user is often better or worse than that written in the datasheets; both cases are not suitable for the user, because the load/supply might not be able to cope with a higher or lower power produced or requested by the thermoelectric device. This problem is particularly acute when dealing with large-scale applications, in which it is more difficult to predict how the whole system

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