

**THERMOELECTRIC MODULES FOR CRYOSCOPIC ANALYSIS:
EMPLOYING PELTIER ELEMENTS AS BOTH HEAT FLUX SENSORS
AND THERMAL ACTUATORS**

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Thermoelectric modules are widely employed in modern instrumentation for diverse purposes, including thermal management via the Peltier effect when an electric current is passed through the modules, as well as heat flux sensing based on the Seebeck effect [1].

In turn, the use of low-cost “Peltier modules” enables the development of a device that combines both the Seebeck and Peltier effects, as demonstrated in this work through an instrument designed for extended or synchronous cryoscopic analysis. By connecting high-power thermoelectric modules via a reversible semiconductor H-bridge, the measurement zone can be both heated to +60 °C and cooled down to –30 °C.

The heat flux to and from these modules passes directly through differentially connected small-scale Peltier modules characterized by a high Seebeck coefficient, allowing the detection of thermal effects associated with phase transitions in liquid and solid samples, as well as dilution and dissolution effects, with a resolution on the order of milliwatts. Temperature control and monitoring are implemented using a microcontroller-based circuit equipped with digital semiconductor sensors. The study also presents examples of polythermal studies conducted on selected binary systems using this setup. Results of test measurements indicate that the proposed device is well suited for widespread use in standard laboratory conditions.

1. Huang, L., Zheng, Y., Xing, L., & Hou, B. (2023). Recent progress of thermoelectric applications for cooling/heating, power generation, heat flux sensor and potential prospect of their integrated applications // *Thermal science and engineering progress*, 45, 102064. <https://doi.org/10.1016/j.tsep.2023.102064>