

## Abstract

This study aims to design a heat transfer system that utilizes Laird HT8-12 thermoelectric modules (TEMs) to power a circuit that sends a short message service (SMS) message with geolocation coordinates to alert users of a fire alarm. Multiple microcontrollers were tested, including an Arduino Uno platform utilizing the ATmega328P microcontroller, a stand-alone ATmega328P microcontroller and an Arduino MKR GSM 1400 utilizing the Atmel SMART SAM D21 microcontroller. The MKR GSM 1400 was chosen for the final alarm circuit due to its low power consumption, integrated cellular capabilities and CellLocate feature, which can estimate geolocation coordinates based on the locations of nearby cellular towers. A dedicated GPS module was also integrated with the MKR GSM 1400 in one test configuration.

A power delivery circuit was also designed, which incorporates a supercapacitor that gets charged by the TEMs and a boost converter to increase the voltage output from the supercapacitor to a constant 5.2 V. A control system that uses a watchdog timer was implemented. This system resets the MKR GSM 1400 in the event that the power output from the supercapacitor is not high enough to allow it to acquire a cellular signal.

A heat transfer system was designed incorporating a hot block, TEMs and a cold block. It was found that using two TEMs connected in series in conjunction with a four-inch thick Aluminum 6061-T6 cold block produced the largest recorded power output of 2.46 W at a temperature differential of 96.27°C, while producing the lowest temperature change in the cold block. When testing the alarm circuit powered by the heat transfer system, the configuration with the CellLocate feature required approximately 133 seconds to send an SMS message when the CellLocate coordinate accuracy was programmatically required to be less than 1 km. The configuration with the GPS module required only 82 seconds to send an SMS message.