

# A Light and Portable Temperature Chamber for Testing Breadboards in Engineering Labs



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## Abstract

It is important for engineers to be able to test circuits over wide temperature ranges. This device would allow engineering students to test circuit boards under a wide range of temperatures. Without unplugging or detaching any components of the circuit board itself, the student or individual will be able to set a desired temperature, view the actual temperature, and observe the effects. The portable, safe, and easily operable invention can greatly advance the knowledge to improve the results of circuitry building and understanding.

## Introduction

The Northern Illinois University Laboratories need more way's engineers may expand their knowledge. When building circuits on breadboards, the electrical labs have no way to test them at a range of temperatures in order to see the effects on the circuit itself. Any other traditional compressor-based refrigeration unit would be too bulky and complicated for students to use in the lab. The environment's operating temperature should not extend past 50-90 degrees Fahrenheit. This project is to design a Peltier based containment unit that can create an environment that cools and heats a range of 0-70 degrees inside chamber. The device would be beneficial in finding more ways to observe and improve on basic circuits being built by engineering students.

## Methods and Materials

The device shown in figure (1) was made of a box using acrylic sheet and connected using solvent cement. Eight Peltier devices were mounted on top. Each pair of Peltier were cascaded on top of each other and connected in series, and each two pairs connected in parallel. The pair of Peltier's were sandwiched between aluminum heat sinks with thermal paste. Two fans were mounted on the top side of the box, one large fan mounted in the bottom side of the box, and one fan mounted on the back side of the box for the circuit board. A touch screen was mounted on the top front side of the box. A power supply was mounted on the back side of the device. The control circuitry and the raspberry Pi were mounted on top of the power supply on the back side of the box. A printed cover was placed on top of the wires and the back side of the box.



Figure (1): Temperature-controlled Chamber

Peltier's have hot sides and cold sides depending of the direction of current flow. H bridges are used in order to reverse the current directions to heat or cool. Each H-bridge was made of five N-type MOSFET as shown in figure (2). The first MOSFET was placed on the beginning of each H-bridge to simply turn the system on or off. The other MOSFETs were used two make two paths for the current by turning one of the top sides and one of the opposite bottom side. To use the MOSFETs as switches a voltage applied to the gate terminal from a photo diode array that generates the voltage required to turn on the MOSFET. The photovoltaic driver generates a voltage by getting a small current from the Raspberry Pi to illuminate and internal LED to generate the light for the photodiodes to convert to voltage. A 1M ohm resistor was placed between the gate and source terminal of the MOSFETs to discharge the photodiodes when the LED is off. The device circuitry is shown in figure (2).

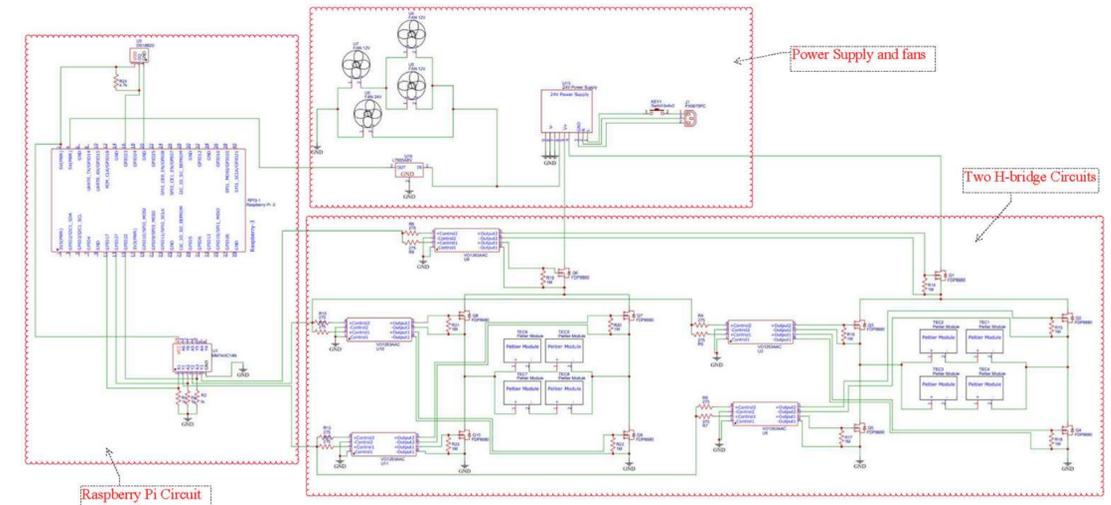


Figure (2): The Device Circuitry

## Results

The circuit was tested using a multimeter to check for the voltage value in each direction. The temperature from the sensor was displayed on a user interface program. A user can set the required value and the output of Raspberry Pi was checked for each direction using a multimeter. The user interface program is displayed in figure (3). This work made an important step in developing a temperature-controlled chamber for lab circuits using inexpensive and commercially available materials.

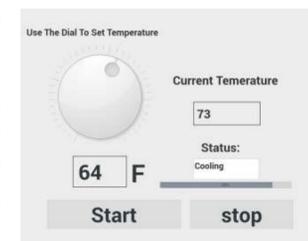


Figure (3): User Interface Program

## Discussion

In the 1800s, the Peltier device came from the discovery that cooling or heating will be produced of an electrical current at the junction of two metals. The reason behind this idea of cooling or heating was found to be because the flow of an electrical current through materials causes heat to be drawn away from one side of the device. This has been useful within many industries when cooling and heating, stabilizing temperature, and large temperature differentials. The Peltier device gives the heating and cooling chamber the best option in finding a thermoelectric cooler with no moving parts, maintenance free, heating and cooling by simply changing the direction of current flow, and highly precise temperature control, including wide operating temperature. The components are placed correctly while using the Peltier device in order to create a chamber that heats and cools the desired circuit and breadboard for the client.

## Conclusions

In conclusion, the project goal is to design and build a temperature-controlled chamber for breadboard circuits. The containment can be set to any temperature between 0 and 70 °C. The customer has asked that a Peltier device be the mode of temperature change. The Peltier is a much simpler, smaller, lighter heat pump than a traditional refrigerant compressor. Peltier's make portability possible by reducing weight and size. the complete chamber includes handles attached to it so that the device may easily be placed over the breadboard. The LCD touchscreen makes it easy to set and monitor internal chamber temperatures.

## Acknowledgements

The authors would like to thank Edward Miguel with the Department of Electrical engineering at Northern Illinois University for his technical assistance and guidance.