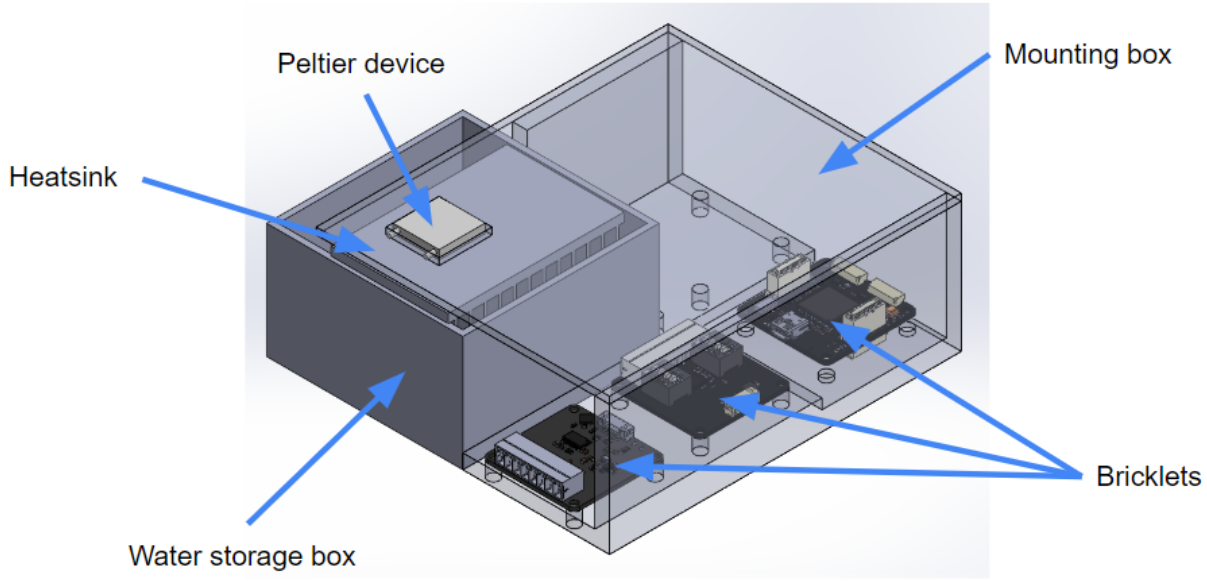
Thermal Box Documentation

Last updated August 2022 by Sofia Kwok

Electrical

The electrical setup for this is relatively straightforward. All of the TinkerForge bricklets can be plugged in using screw connections, and there should be no need for soldering. To provide the power for the Peltier device, we are using a 20V DeWalt drill battery, which can last around a week without charging. The three brick/bricklets currently in use are the DC brick, the Industrial PTC bricklet, and the temperature IR bricklet. The one thing to keep in mind is that sometimes while testing with the TinkerForge software, the DC brick can exceed the allowed voltage draw while in the Drive/Brake mode. If this happens, just restart the software. Also, be sure not to exceed the current/voltage limits for the Peltier device.

Mechanical



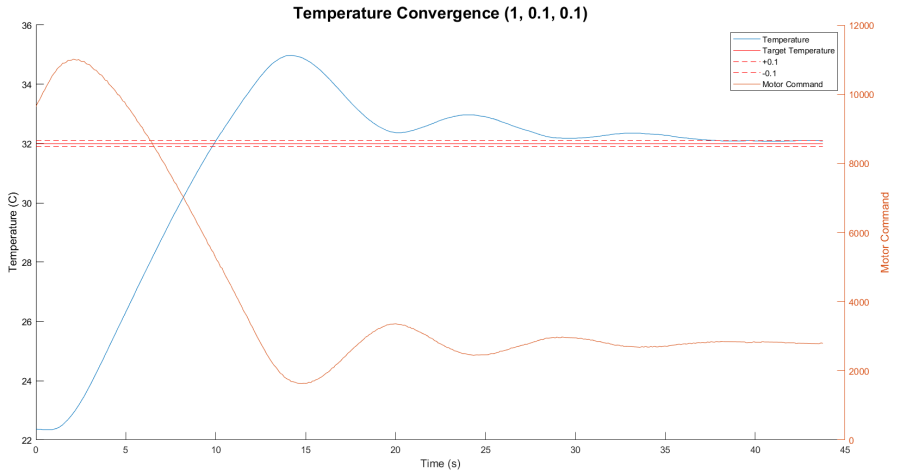
The mechanical setup is also fairly straightforward. The most important thing is to be careful that the water the heatsink is submerged in does not get in any of the electronics. All of the bricklets are mounted inside the box. All TinkerForge CAD models are available online on the TinkerForge website.

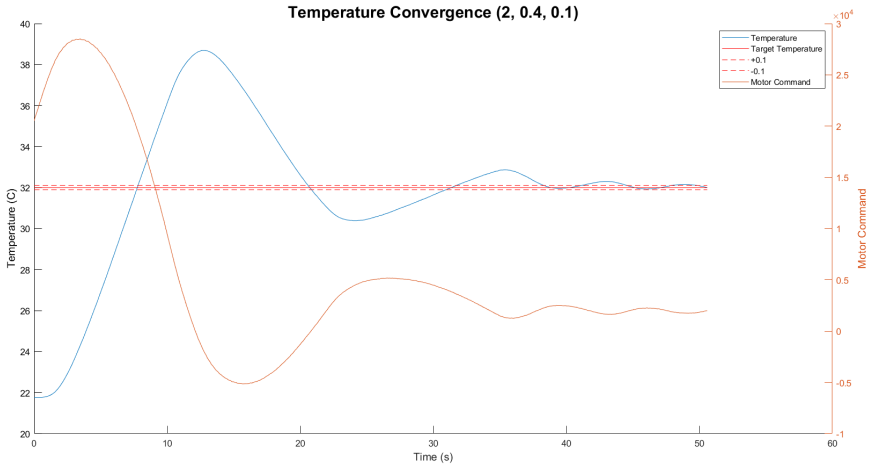
Code

The TinkerForge website (https://www.tinkerforge.com/en/doc/) has code examples for every brick and bricklet. All of the code for this project can be found at https://github.com/sofiakwok/TinkerForge. The code to control the thermal profiles is thermalprofiles.py, and the code for PID control is in PIDcontrol.py. The data from most sessions and plots can also be found in this repository. I would recommend testing out large temperature changes (i.e. setting the DC bricklet to an output of 30000) first on the TinkerForge software (https://www.tinkerforge.com/en/doc/Downloads.html) to make sure that it does not exceed the voltage/current limits for the Peltier device.

Plots

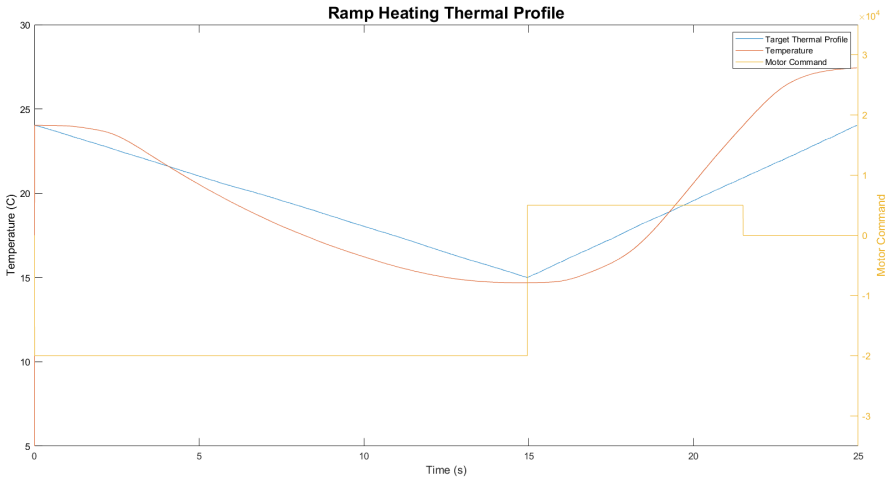
All plots generated using Matlab (graphing.m on GitHub)
PID control:

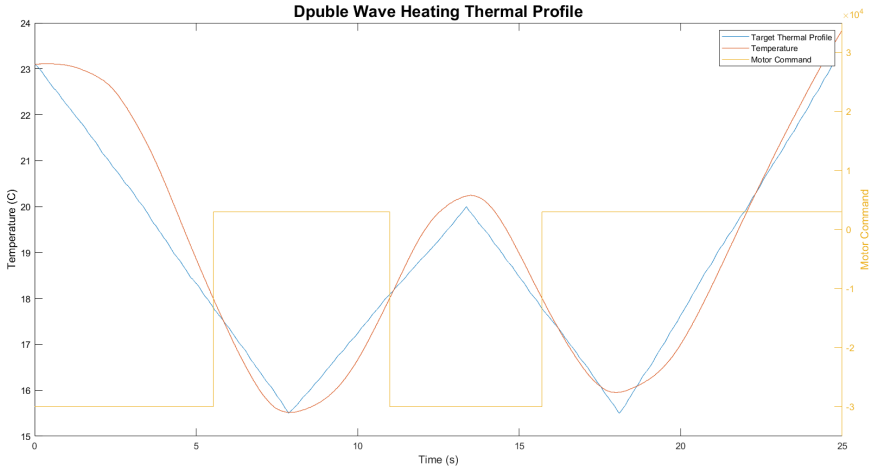


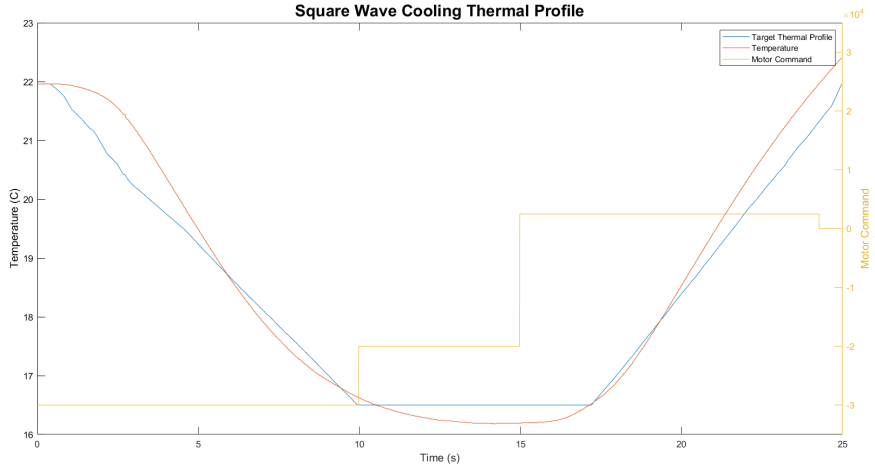


Thermal profiles

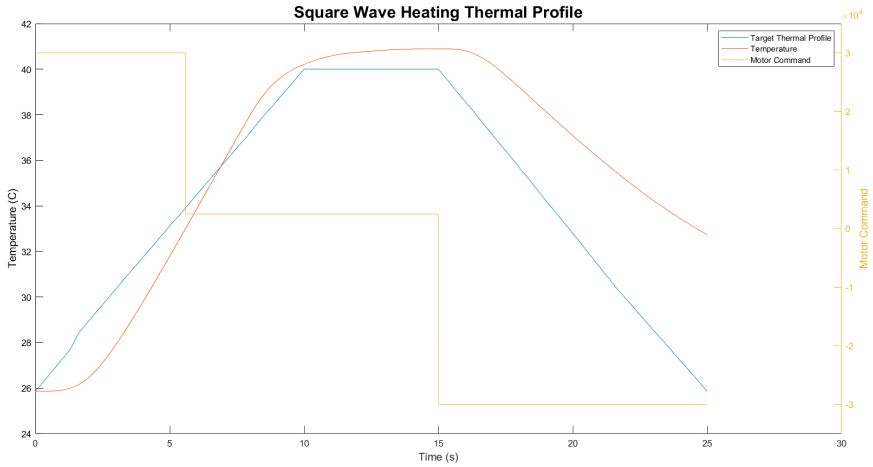
Cooling:

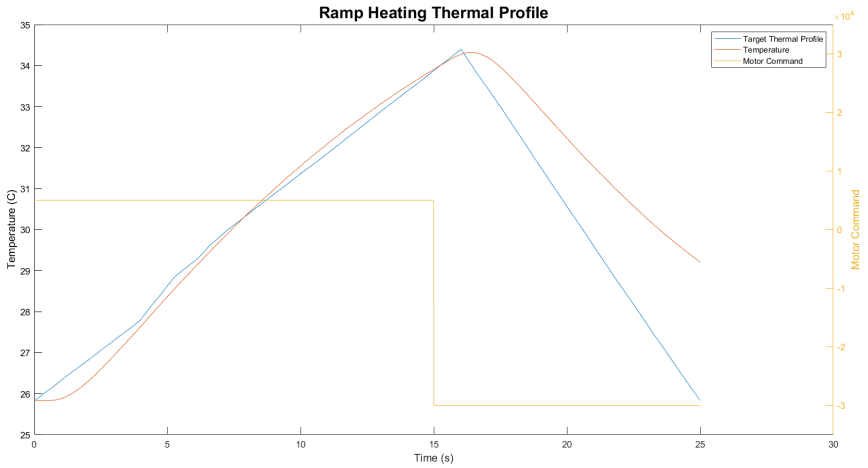


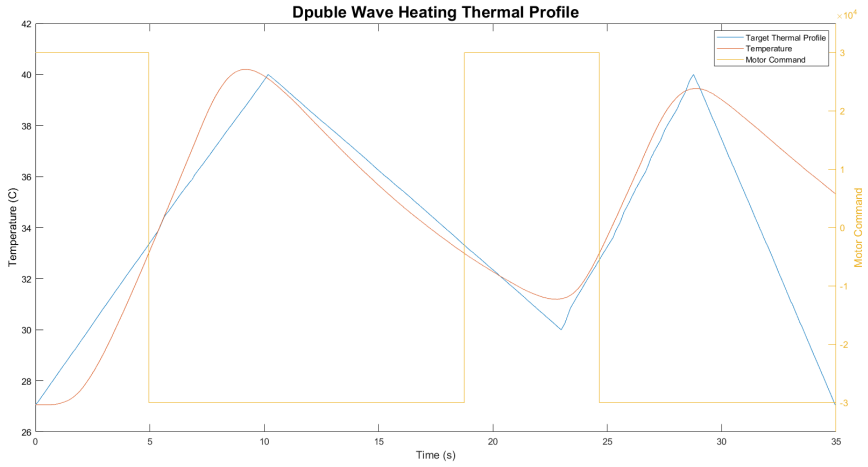




Heating:


Square Wave Heating Thermal Profile
Target Thermal Profile
Temperature
Motor Command
Temperature (C)
Motor Command
Time (s)


Ramp Heating Thermal Profile
Target Thermal Profile
Temperature
Motor Command
Temperature (C)
Motor Command
Time (s)


Dpuble Wave Heating Thermal Profile
Target Thermal Profile
Temperature
Motor Command
Temperature (C)
Motor Command
Time (s)

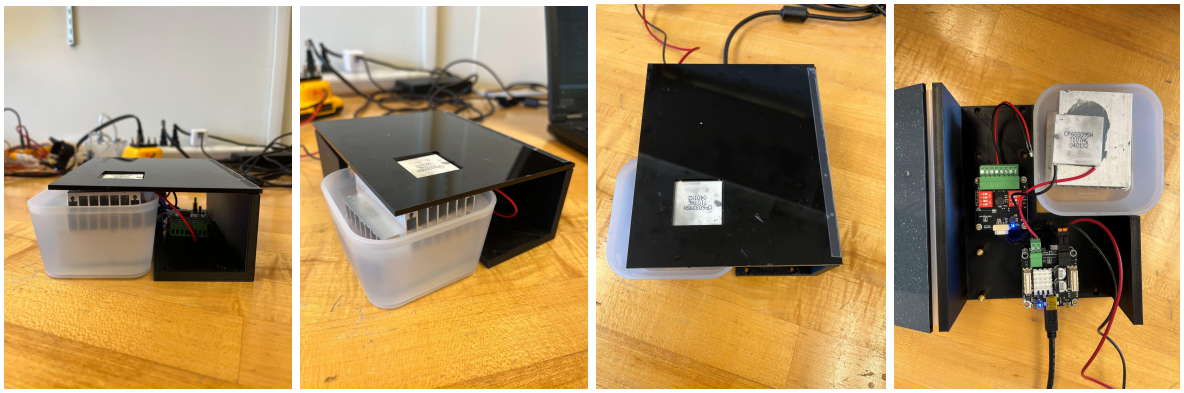
Other

The thermal paste can occasionally become less effective if the Peltier gets too hot (above 50C) for too long. Check occasionally if the device suddenly stops cooling to make sure the thermal paste between the Peltier and the heatsink is still a paste, not a crust.

The Peltier can get very hot (temperatures of over 40C) very quickly - be careful while testing!

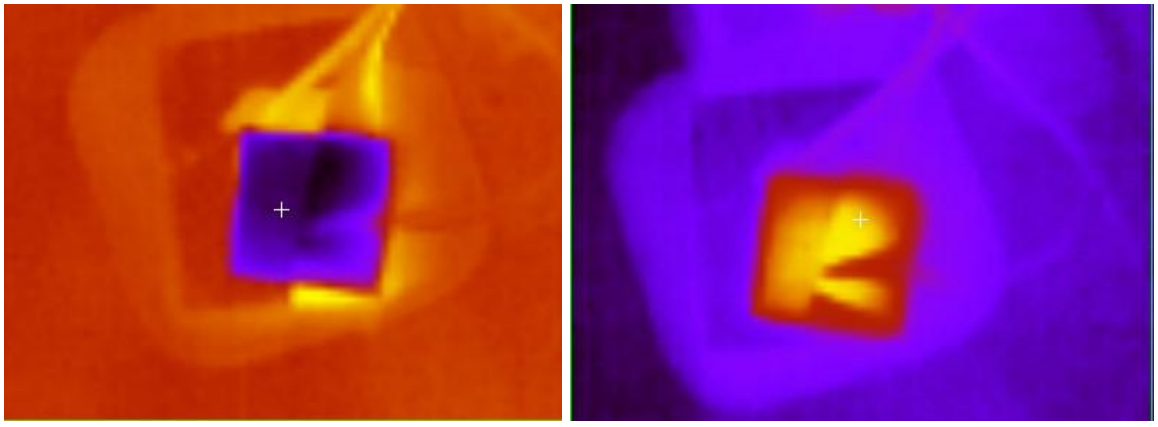
Images

Setup & Final Layout



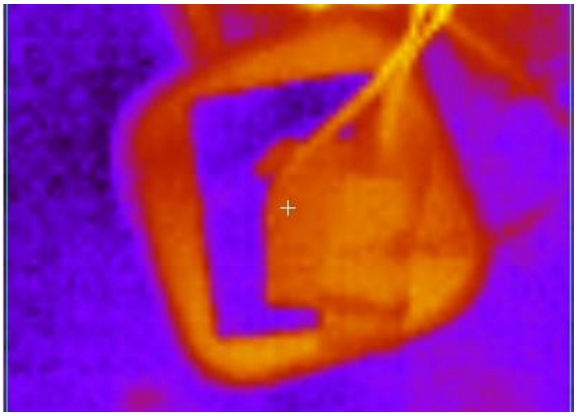
Pictures of the final device setup

Thermal Images

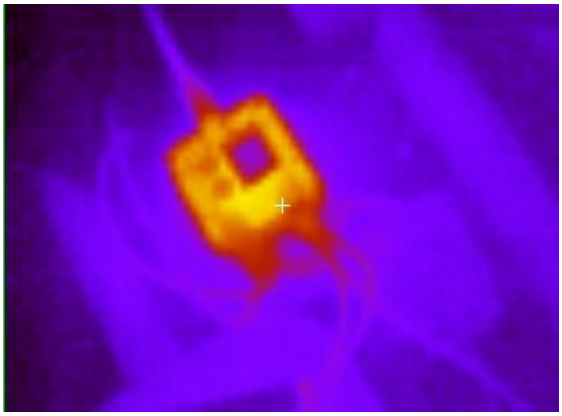


Peltier device during cooling

Peltier device during heating



Peltier device at normal temperature



Birds-eye view of water cooling and Peltier setup

Future Work

- Add felt on top of box
- Better integrate water cooling into box