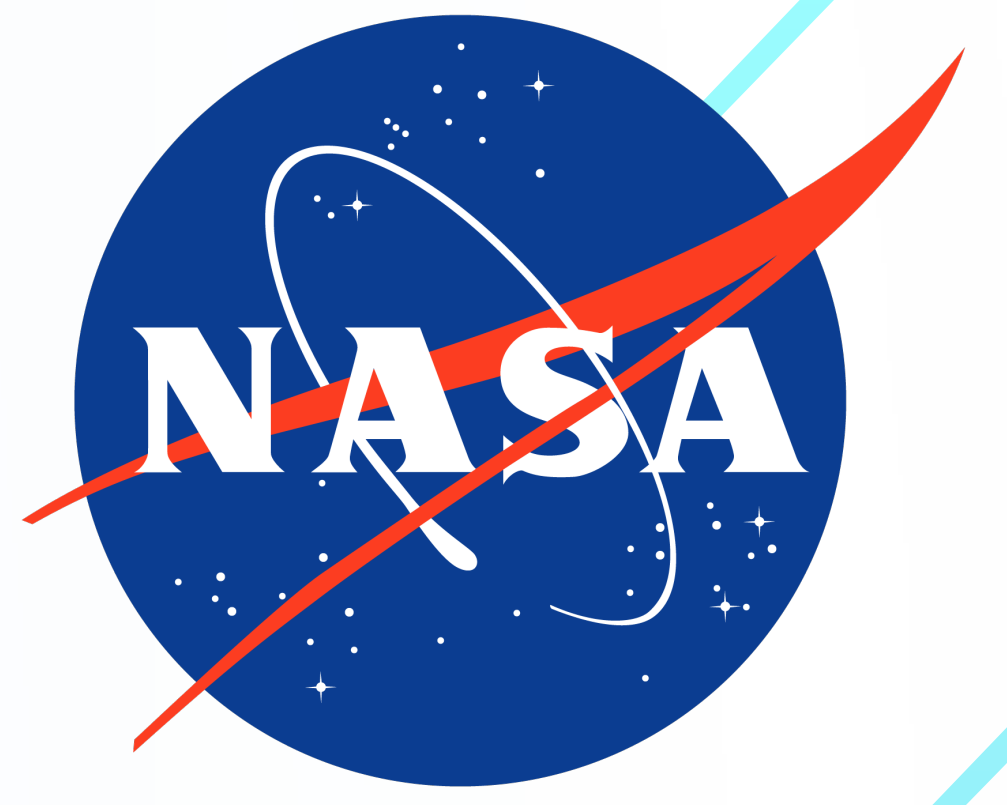


PASSIVE PCB MOUNTED THERMAL SWITCH



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Abstract

A printed circuit board (PCB) generates heat during operation. In a vacuum this heat can only be rejected by conduction and radiation. In order to reject heat effectively the PCB needs to be thermally conductive to the electronics enclosure. However, when the enclosure temperature gets too low, too much heat is rejected from the PCB and it can fail. This thermal switch has been designed to allow for heat rejection when the PCB is sufficiently warm but then greatly reduce heat rejection when the temperature gets low enough.

Problem Statement

There are many thermal challenges with electronics in a space environment. Almost all excess heat from electronics is rejected through conduction to it's enclosure and then the vehicle chassis or equipment shelf. This works best when thermal resistance in the rejection path is minimized. A low thermal resistance is beneficial when the electronics are hot and need to reject heat to a slightly cooler environment. When the electronics are not generating much heat, or the environment is significantly cooler than the electronics this low resistance can cause their temperature to drop dangerously low and might cause damage.

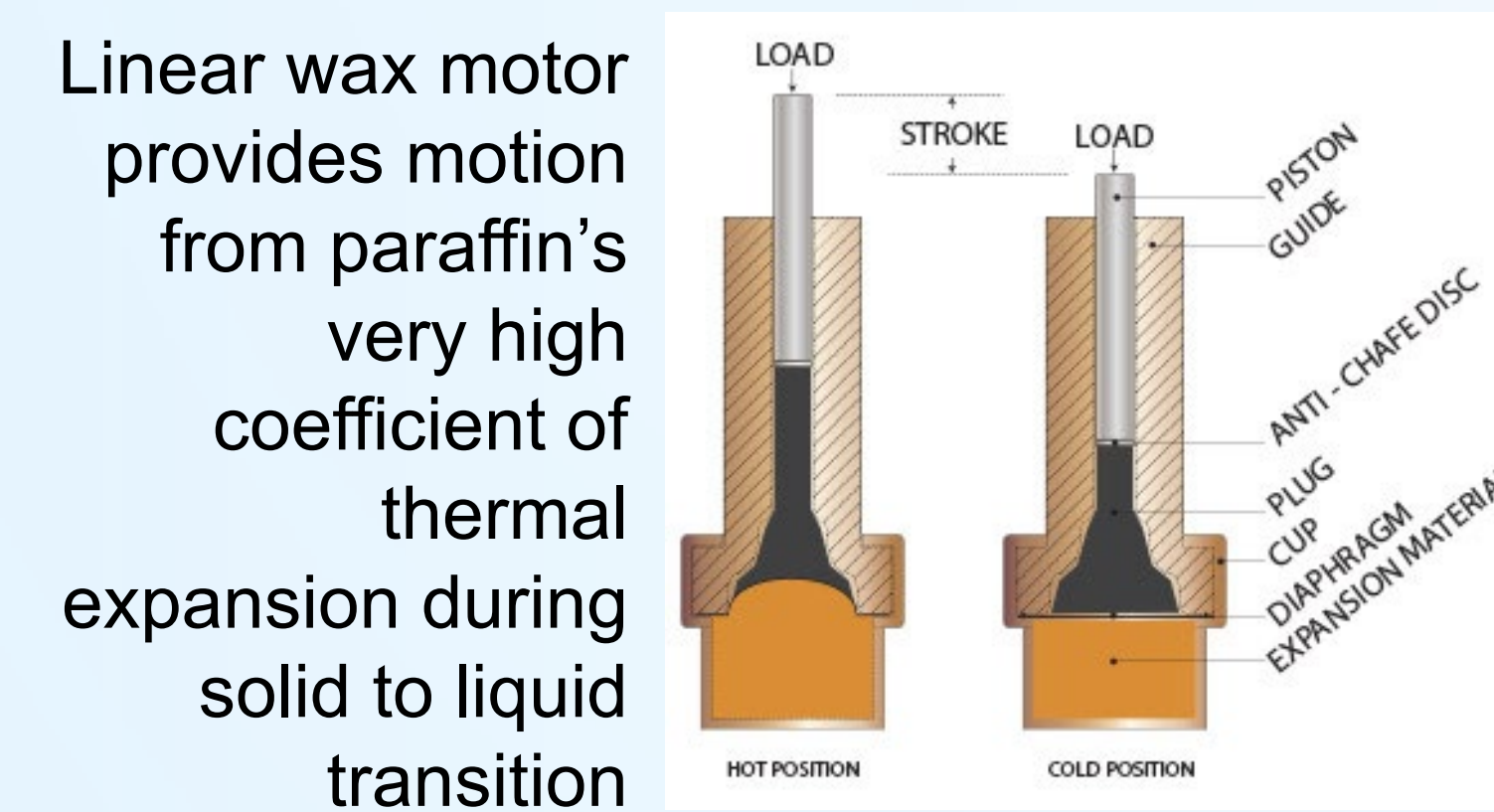
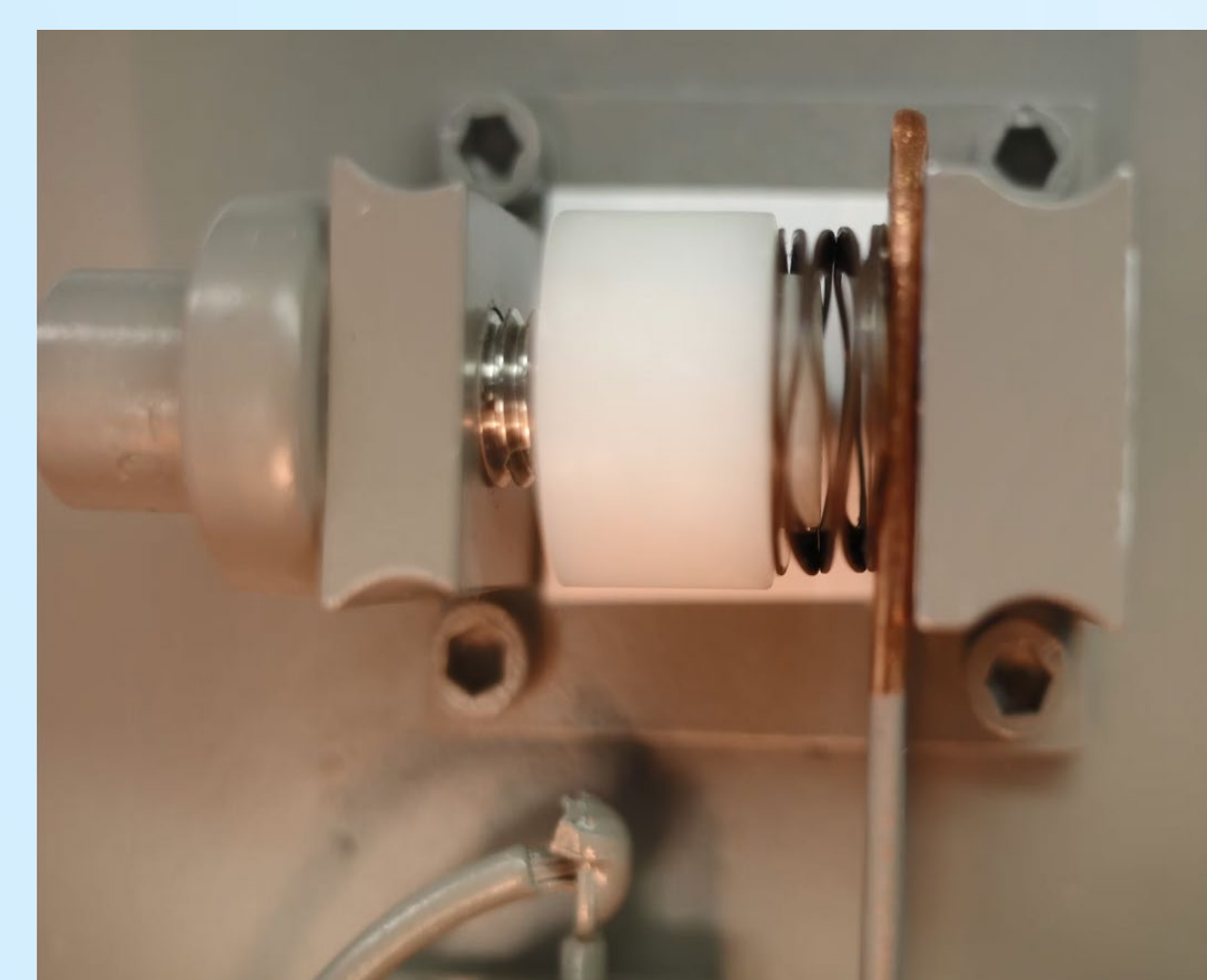
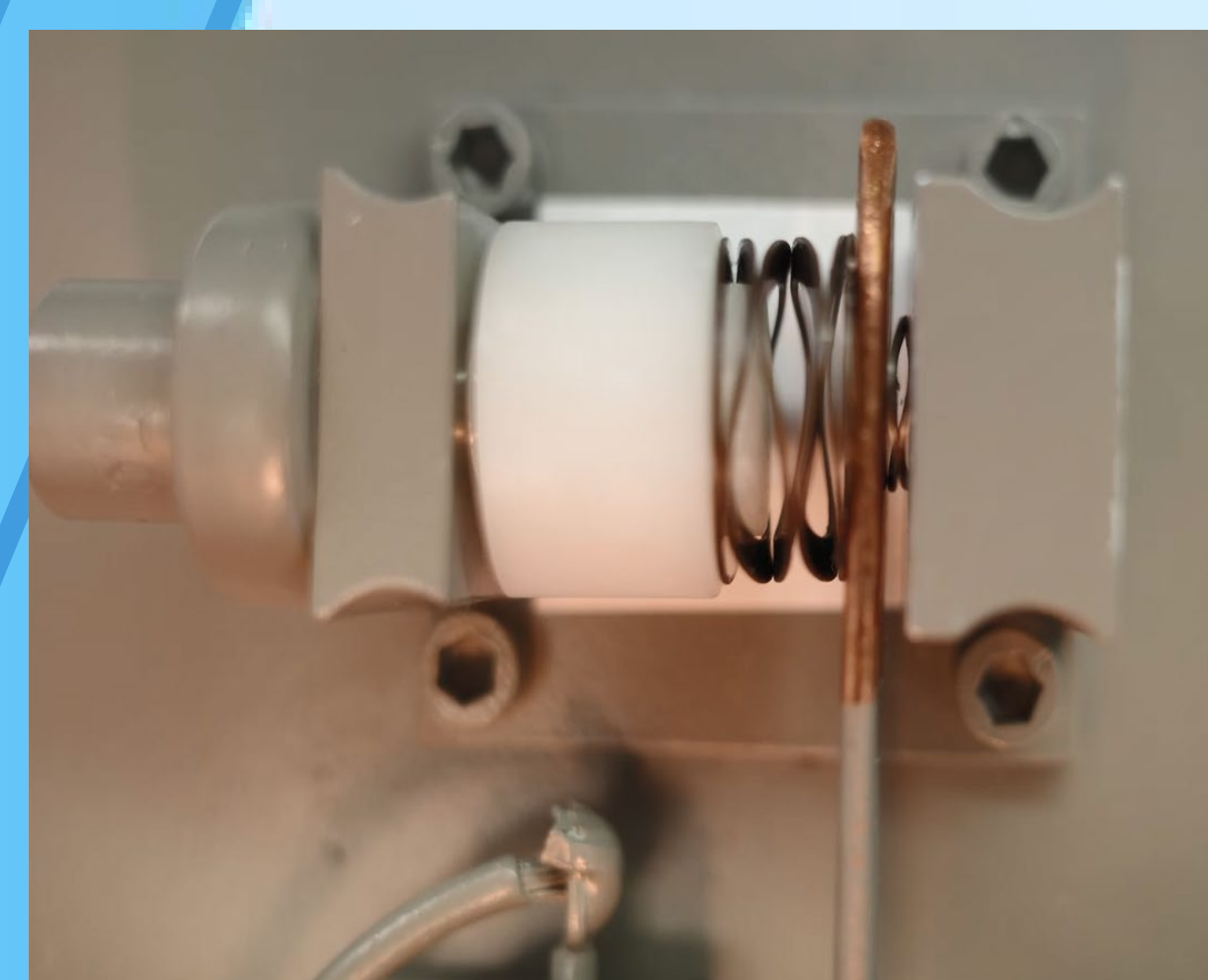
Solution

One solution method is to create a mechanism that mounts directly to electronics boards that can have a low and high thermal conductivity mode. When there is excess heat on the board to dissipate, the mechanism will close and allow conduction. When the board cools, the mechanism will open to thermally isolate the board.

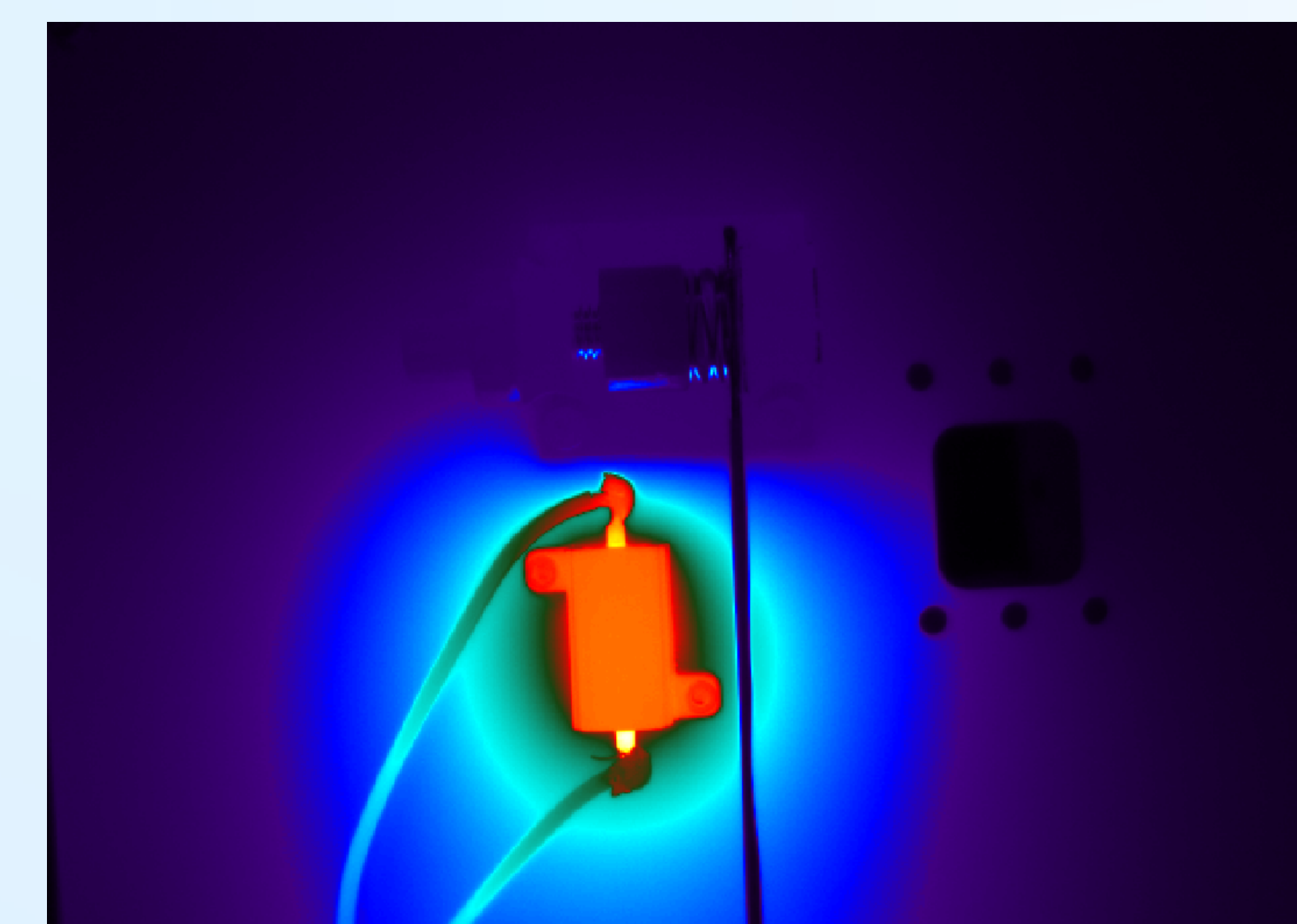
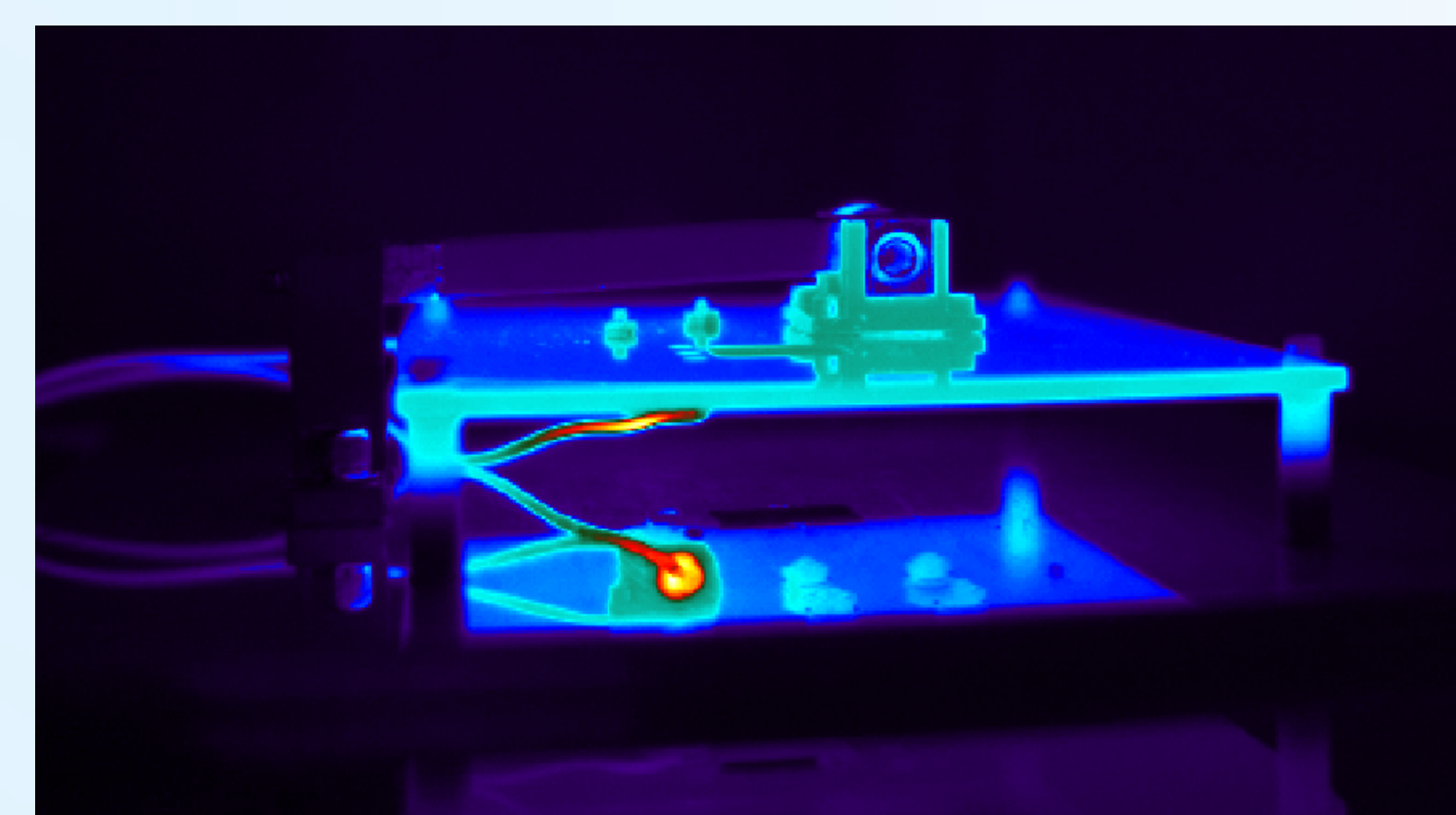
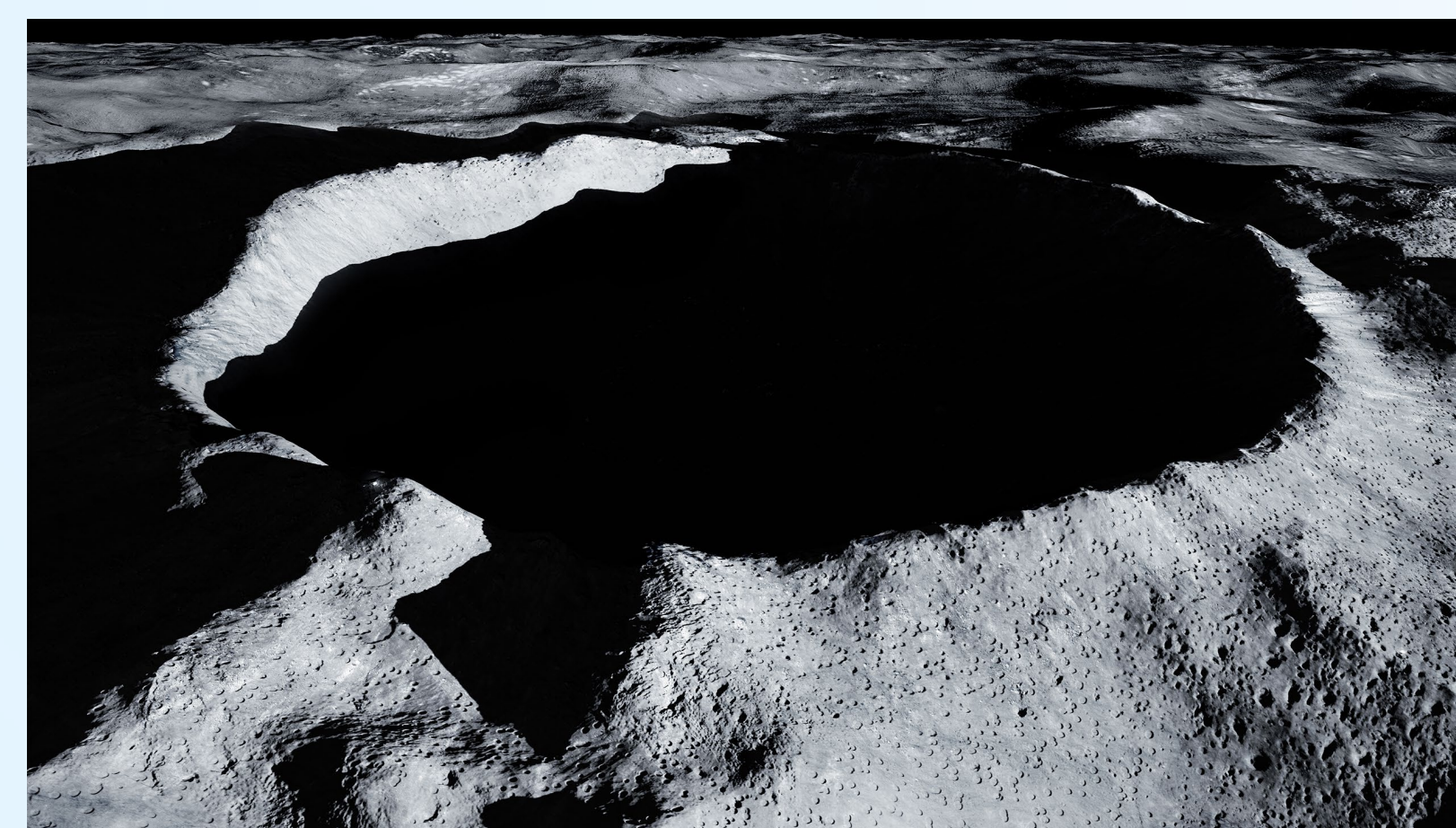
Two Thermal States

Low Thermal Contact

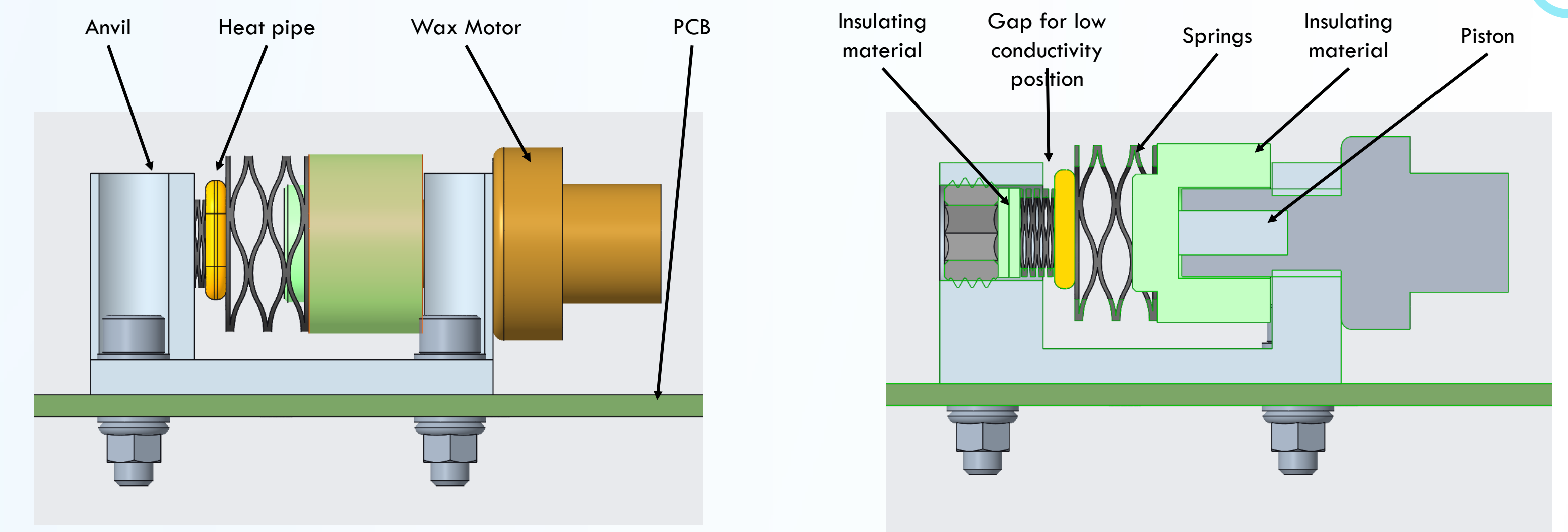
High Thermal Contact



Linear wax motor provides motion from paraffin's very high coefficient of thermal expansion during solid to liquid transition



Switch Design

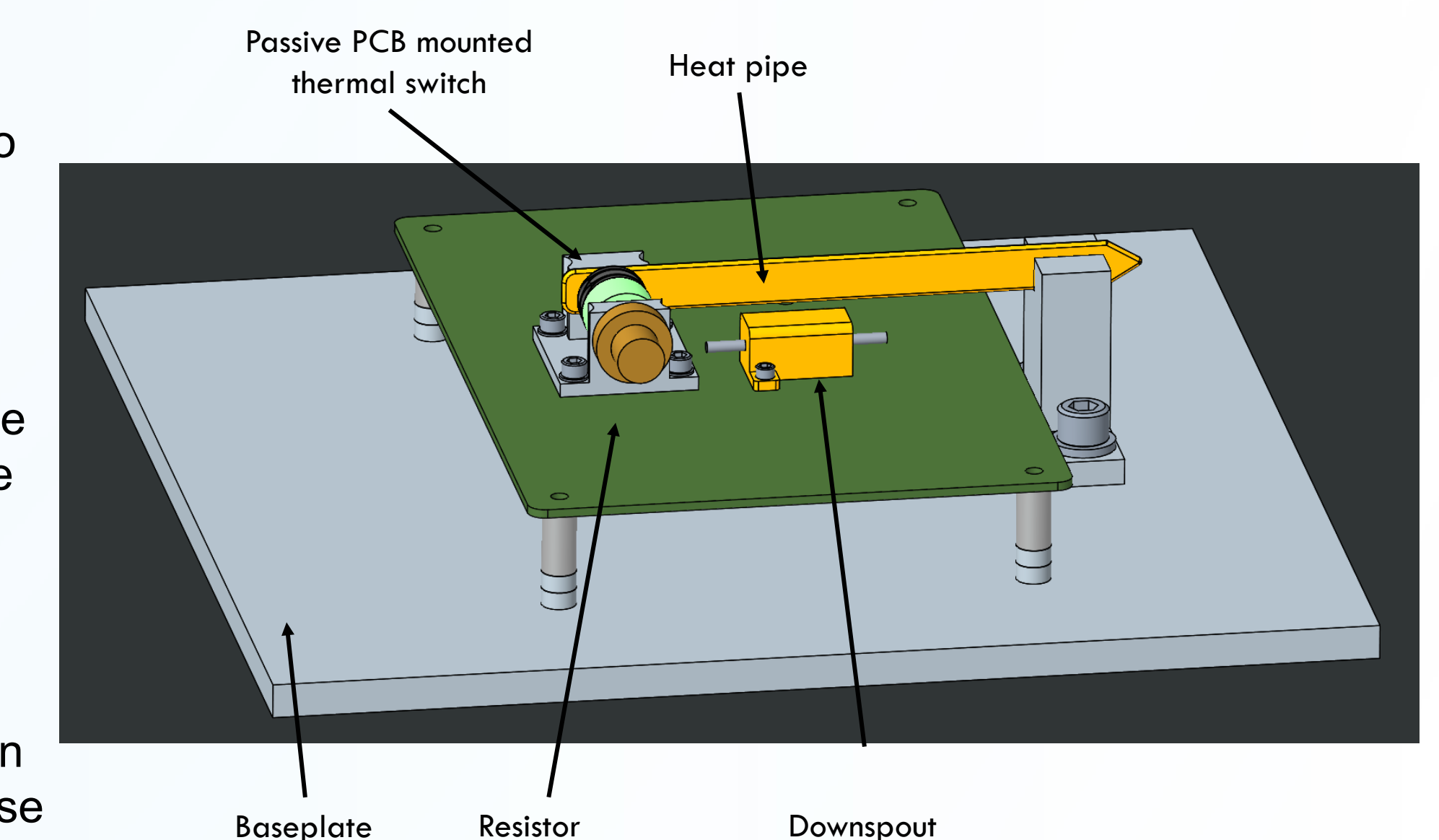


Use Case

This thermal switch is useful in particularly long periods of low environmental temperature or low power consumption. Typically satellites in low earth orbit have many short heating and cooling cycles a day, so they experience fewer extreme highs and lows. The lunar night is a perfect use case for this technology. The lunar night is 14 days long and the lows experienced are extreme. The stored power is rationed as there is no sun to recharge batteries and many components are set to standby.

Test Set Up

- Large resistor generates heat to represent a heat generating IC
- Linear wax motor provides motion to push heat pipe into contact with anvil
- Heat flows through the heat pipe to a thermal downspout with the baseplate acting as a sink
- Test will be conducted in a vacuum with thermos couple instrumentation
- It will be performed in air with an IR camera recording a time-lapse video



Test Results

