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ELECTRONICS ENCLOSURE TO REDUCE THE THERMAL IMPACT OF THE HARSH LUNAR ENVIRONMENT

Abstract

The harsh environment found on the surface of the moon presents a massive challenge when designing components that have to survive the lunar daily cycle. This is even more challenging when the components have moving parts or electronics that have to function again when the sun rises once more. The lunar day and night last about 15 earth days each, and the corresponding surface temperature range from about 374K in full sun, down to 92K at night. The vast temperature swing presents a significant problem for electronics since they have to be joule heated at night to prevent damage or cold start problems and also must have an effective thermal management solution during the day.

In recent times, there has been renewed interest in travelling the moon's surface again due to the promise of relatively cheap space flight afforded by private space companies. There is even plans for somewhat permanent laboratories stationed on the moon surface. If this is to become a reality, serious engineering attention has to be given to thermal management of electronics exposed to this harsh environment. Even in shaded areas during the lunar day, temperatures can drop rapidly resulting in the surface element experiencing thermal shock, this is of particular importance when choosing landing sites, orientation, and lunar vehicle navigation.

This paper presents a novel heat transfer device that has a very large thermal resistance when electronic component temperatures drop below 323K and a very low thermal resistance when component temperatures are above this threshold. There are three parts to this device, an evaporator which is in contact with the electronics; a condenser which forms the outer part of the electronics enclosure; and a thermally insulating layer that separates the evaporator from the condenser but allows vapour and liquid to flow through with minimal obstruction. This device is capable of efficiently transferring heat from the electronics when they are above 323K via two phase heat transfer. Vapour and liquid are allowed to flow through the insulating layer resulting in a very low thermal resistance between the evaporator and the outer enclosure condenser. However, should component temperatures drop below 323K phase change will no longer occur, in this situation heat is only transferred through the insulating layer giving a very large thermal resistance. This heat transfer device reduces the dependency on heaters to maintain component temperatures during the harsh thermal environment found on the moon.