Mars Exploration (3)
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PERFORMANCE AND RELIABILITY OF ELECTRONIC COMPONENTS IN EXTREME TEMPERATURE MARTIAN APPLICATIONS

Abstract

Mars exploration mission is one of the most challenging areas that require electronics to be capable of operating efficiently and reliably under extreme temperature conditions. Parts of electronic components was needed to be placed outside of the spacecraft and, therefore was exposed to a radiation environment and a temperature range of -130 to 70, which is beyond the military standard operation and storage temperature range of -55 to 125. Therefore a high level performance and reliability was required for electronic components outside of the spacecraft. In this paper the electronics and packaging technologies have been evaluated for extreme environment applications for Mars exploration missions. A list of electronics for Mars was selected based on the design need and encompassed diodes, chip-capacitors, tantalum-capacitor, resistors, inductors, magnetic-beads and fuses. Two experiments were conducted to characterize the electronics and packaging technologies at extremely low temperature. First experiment was storing in extremely low temperature. This test was conducted to store half of electronics in liquid nitrogen for 500 hours to determine the resistance of devices and material to extremely low temperature. Second experiment was thermal shock for the other half and test condition was range from -193 to +80. The transition time is less than 1 minute and hold time is at least 10 minutes. The results show that forward voltage of diodes after storing at extremely low temperature for a long time may exceed the eligibility criteria. It may be caused by thermal expansion of metallic elements in extremely low temperature. A large number of tests are still needed to verify the results. Electronic performance of other devices after storing meets requirement of corresponding handbook. And the Electronic performance of chip-capacitors, diodes, tantalum-capacitor, resistors, inductors, magnetic-beads and fuses in thermal shock also meets requirement of corresponding handbook. Through the Destructive physical analysis, it can be seen that these electronic components after the test still keep the original structure shape and without physical failure such as falling off, cracking and layering.