Extreme Temperature (-125°C to 90°C) Thermal Cycling of UC282, LT1813, and LTC1409

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Objective: The objective of this test is to evaluate the package of UC282 (5 pin package, TO/SOT; Fast Transient Response 3 Ampere Low Dropout (LDO) Regulator), LT1813 (Dual Operational Amplifier, 8-pin SO) and LTC1409 (12 bit, 800ksps sampling A/D Converter, 28-Lead Plastic SSOP) via thermal cycling tests and inspection by optical microscopy.

Introduction: The products of UC282, LT1813, and LTC1409 have been proposed for use in the control electronics package of Panoramic Camera Project for Mars Exploration Rover (Cog E: Mark Schwochert, MER). The Jet Propulsion Laboratory (JPL) Parts Group has undertaken an effort to upscreen the parts required to build such a package board for Panoramic Camera electronics. In addition to these, there were several other parts in the complete package board. There are several steps involved in upscreening the parts for any NASA project. Thermal cycling is one of the steps in upscreening the parts to meet the project specific operational environment.

UC282 (Ref.: Website of Texas Instruments): Fast Transient Response 10-mA to 3-A Load Current, Maximum Dropout of 450-mV at 3-A Load Current, Separate Bias and VIN Pins, Available in Adjustable or Fixed-Output Voltages, 5-Pin Package Allows Kelvin Sensing of Load Voltage, Reverse Current Protection. The maximum storage temperature is –65°C to +150°C.

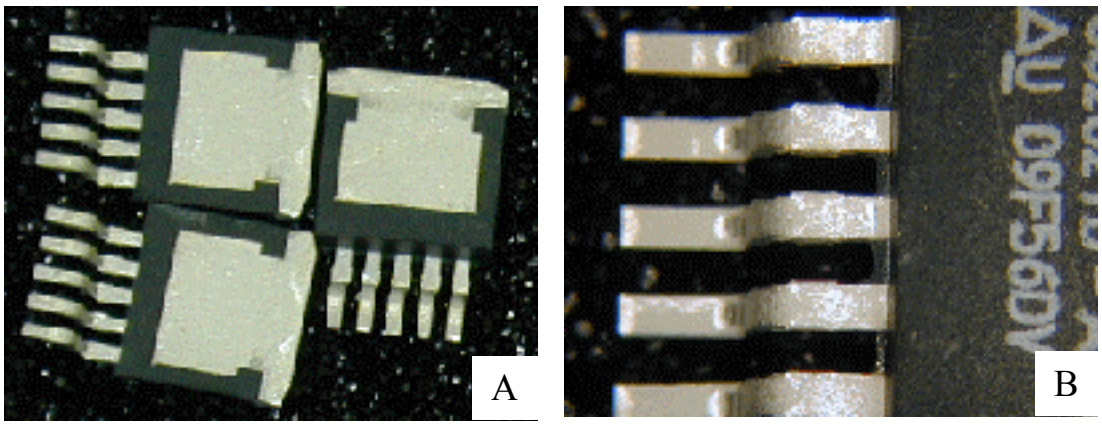

Figure 1: Optical photographs of the UC282 before thermal cycling

LT1813 (Ref.: Website of Linear Technology): This is dual and quad, low power, high speed, very high slew rate operational amplifier with excellent DC performance. These are Available in MS8 and SO-8 Packages. The applications of this device are Wideband Amplifiers Buffers, Active Filters, Video Amplification, Cable Drivers, Data Acquisition Systems, Communication Receivers. The maximum operating temperature range is –40°C to +85°C.

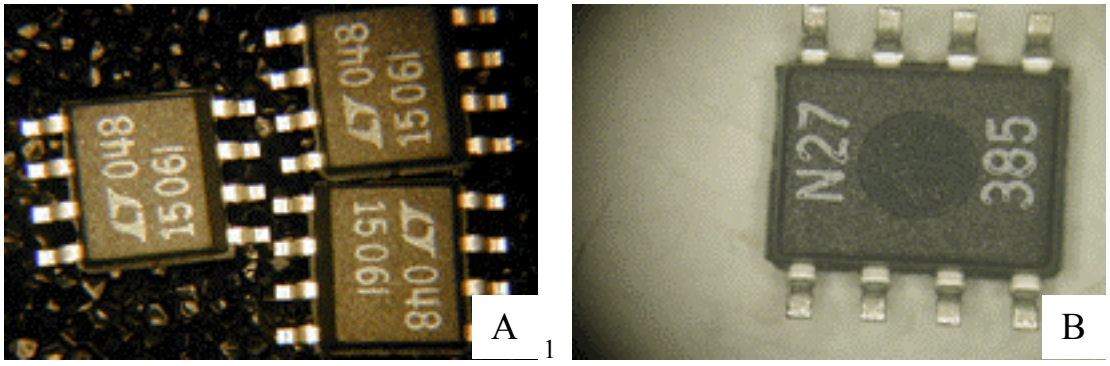

Figure 2: Optical photographs of the LT1813 before thermal cycling

LTC1409 (Ref.: Website of Linear Technology): The LTC 1409 is 1 μs, 800ksps, sampling 12-bit A/D converter that draws only 80 mW from ±5 V supplies. These are available in 28-Pin SO Wide and SSOP Package. The applications for this device are Telecommunications, Digital Signal Processing, Multiplexed Data Acquisition Systems, High Speed Data Acquisition, Spectrum Analysis, and Imaging Systems. The maximum operating temperature range is 0 to +70°C.

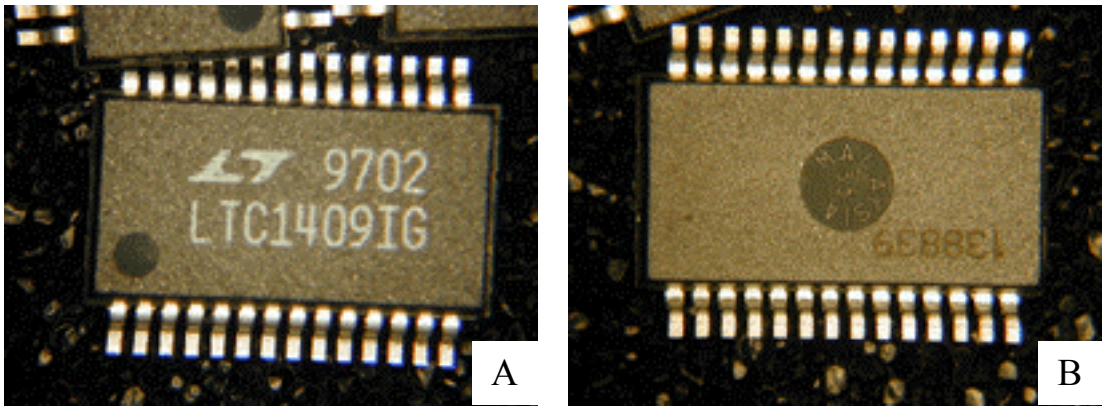

Figure 3: Optical photographs of the LTC 1409 before thermal cycling

Test objective: Based on the technical features of the devices listed above the manufacturer-specified maximum operating temperature varies from –55°C to +90°C. However, these parts have been proposed for usage in the Camera Electronics boards for MER with an operating environment of –125°C to +90°C. Therefore, an assessment of the package reliability is necessary for usage in such an extreme low temperature environment.

Thermal Cycling Tests: The following measurements were taken before thermal cycling.

- After optical inspection, the parts were loaded for thermal cycling. Figure 1,2, and 3 show the optical photograph of the parts that were thermal cycled.
- Dry nitrogen was continuously passed into the chamber to avoid condensation.
- Secondary thermocouple was used to monitor the temperature independently.
- Thermal cycling was performed using LabView in a remote mode.
- Performed 10 thermal cycles from –125°C to +90°C as per the thermal profile. Figure 4 shows the test details and the profile for the thermal cycles. Finally, the test was stopped at +45°C. Primary and secondary thermocouples have shown the temperature readings in an acceptable range of ±5°C from the temperature profile.
- Continuously monitored the thermal cycling test over a period of 17 hours.

- Optical inspection was performed after thermal cycling and unloading the parts. The packages inspected were intact. No cracking was observed even after 10 thermal cycles from –125°C to +90°C. This is based on external inspection of the packages only.

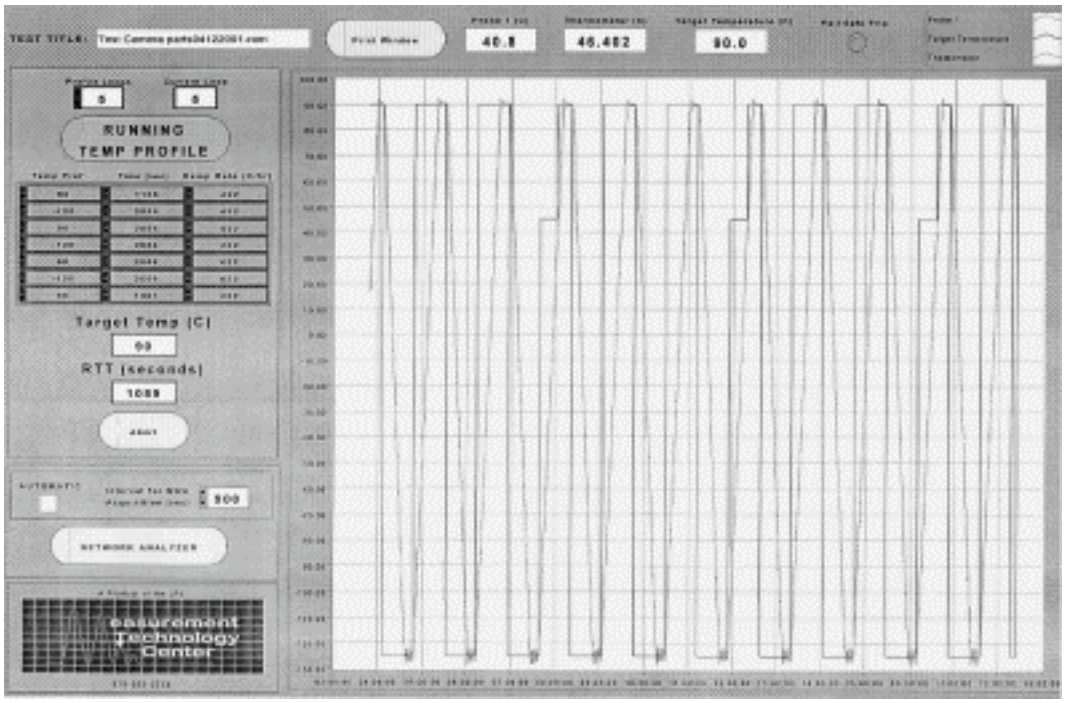

Figure 4: Actual thermal cycling (10 cycle) profile

Summary: UC282, LT1813, and LTC1409 were subjected to ten thermal cycles in the range of –125°C to +90°C. This temperature range is appropriate for a package where no thermal control was provided in a subsystem of the project such as MER. No cracks or damage was observed in the packages after ten thermal cycles in an extreme low temperature range. Surface analytical techniques may be used in the future to characterize the surface of the leads before and after thermal cycling to learn more about the surface characteristics. X-ray and C-SAM may be used before and after thermal cycling in such extreme temperature range to learn more on the interior condition of packages that are being inspected using optical microscopy, which is good only for external features.

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