Title: ***Electronics for Extreme Environments*** (#8 combined with #10)

Program Group: Electronic Parts Project

Proposing Centers: JPL, GRC (co-contributing centers)

Points of Contact: Dr. R. David Gerke, **JPL**
(818) 393-6372
david.gerke@jpl.nasa.gov

Mr. Richard L. Patterson, **GRC**
(216) 433-8166
Richard.L.Patterson@lerc.nasa.gov

Objective: Characterize the electrical performance and susceptibilities of spaceflight electronic systems under extreme environments, and to provide solutions and recommendations for reliability improvement and mission success.

Description: In order to meet power, mass, and overall mission requirements, current NASA mission applications require the use of microelectronic devices at temperatures much above the range of typical commercial characterization limits. Certain electronic components including passive and active devices, designated circuits, mission modules, and other specific test articles such as MEMS and GaAs devices need to be characterized in terms of their performance under various test parameters including low and high temperatures, thermal cycling, and aging. Degradation mechanisms and failure modes, which would influence the operation and reliability of the tested devices and systems also need to be determined and utilized to assess the risks associated with exposure to extreme temperatures and to identify the enabling technologies needed to improve operation, reliability, and lifetime. Of particular interest are emerging scaled technologies with feature sizes below 0.25 μm where metal grain size and void propagation plays a critical role in the overall performance and reliability of these structures.

Technical Approach: We propose to address the various aspects of the application of electronic devices at extreme environments, and to provide solutions and recommendations for reliability improvement and mission success. We intend to address the problem by leveraging off of work started in FY99 in the area of effects of low temperature on semiconductor characteristics and device performance. Issues such as mobility effects, threshold voltage shift and others will be investigated via literature search, numerical analysis and analytical calculations. Consideration for device feature size and scaling effects will also be addressed via analytical and numerical calculations. Temperature cycling effects on the die and package interface will be investigated to provide an understanding of the resultant stress conditions and to provide a more suitable choice of materials.

Benefits: The outcome of this effort will include reports and analysis results for material selection, device performance, and optimum methods and materials for minimal stress conditions during operation to benefit:
X-2000 Program (Code S)
EOS (Code Y & S)
Space Interferometry Mission (SIM) (Code S & Y)
Space Infra Red Telescope Facility (SIRTF) (Code S & Y)
NM-DS4 (Code S)

Deliverables: The outcome of this effort will include reports and analysis results for material selection, device performance, and optimum methods and materials for minimal stress conditions during operation. The information will be published in suitable technical journals and disseminated via the NASA Parts and Packaging (NPPP) homepage, EEE Links and other media.

Schedule:

Determine Mission Requirements and establish test matrix Joint effort	Q1 FY00	
Identify, select and acquire components for testing	Q1 FY00	|
Initiate aging tests on selected components	Q2 FY00	|
Document data and publish in technical journals	Q3 FY00	|
Final Report	Q4 FY00	|
Update test article list, make selection	Q1 FY01	|
Temperature Cycling Effects	Q2 FY01	|
Extreme Temperature Effects Workshop	Q3 FY01	|
Design Considerations	Q3 FY01	|
Final Report	Q4 FY01	\/

Partnerships: Partnerships between JPL and GRC will be used to benefit X-2000 Program (Code S) and others by allowing these programs to select test articles that will be characterized over extreme. The programs could then procure and infuse the parts that meet extreme temperature performance characteristics directly into their program.