SILICON-GERMANIUM INTEGRATED ELECTRONICS FOR EXTREME ENVIRONMENTS

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Invited Paper

The extreme temperature conditions on the lunar surface (at worst case, -230°C in shadowed polar craters, and across -180°C (night) to +120°C (day) with 28 day cycles) precludes the use of conventional electronics for sensing, actuation, and control. Currently, this need for protective electronic "warm boxes" critically limits the mission architect's ability to create a truly distributed, modular electronics systems, resulting in excessive point-to-point wiring, increased system weight and complexity, lack of modularity, and an overall reduction in system reliability. We intend to change this situation.

The overall goal of this project is to develop and demonstrate extreme environment electronics components required for electronic systems with distributed architecture, using low-cost, commercial silicon-germanium (SiGe) BiCMOS technology. Unlike other COTS integrated circuit technologies, SiGe BiCMOS offers unparalleled cryogenic temperature performance (to 4K), inherent total dose radiation tolerance, wide temperature range capability, and optimal monolithic mixed-signal circuit design flexibility, by offering power efficient high-speed transistors (SiGe HBTs) together on the same piece of silicon wafer with high density Si CMOS and a suite of passive components.

This NASA ETDP project directly addresses the development of: 1) low-power, radiation tolerant (to 300 krad to support Moon+Mars missions), integrated SiGe BiCMOS mixed-signal (digital + analog + power) electronic components for sensor/imager and control/actuator systems that can operate reliably across -180°C to +120°C; 2) High-density packaging of these SiGe BiCMOS electronic components (with integrated passives); and 3) modeling/CAD tools for both SiGe BiCMOS devices and packaging, to accurately predict and simulate the electrical performance, reliability, and radiation tolerance of these SiGe BiCMOS mixed-signal circuits and packages. This SiGe ETDP team includes: Georgia Tech (lead), JPL, Auburn University, University of Tennessee, IBM, Boeing, BAE Systems, Lynguent, University of Arkansas, Vanderbilt University, and the University of Maryland.

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