Development of Diamond Vacuum Differential Amplifier for Harsh Environment Power Electronics, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Scientic, Inc., in collaboration with Vanderbilt University, proposes to develop a novel vacuum field emission differential amplifier (VFEDA) using low electron affinity nanodiamond (ND) material as electron emitters for high-power electronic application in harsh environments. The ND VFEDA is a fundamental circuit building block for vacuum integrated circuits (VICs) ideally suited for space applications. The proposed high-power nanodiamond-based VFEDA will be capable of operating over a wide-temperature range (-125 C to 450 C), possess tolerance to extreme doses of ionizing radiation and deliver the long-term reliability and stability needed to successfully execute environmentally stressful space science missions. Successfully developed, the proposed innovation will enhance NASA?s ability to reliably power spacecraft subjected to the harsh rigors of space, as-well-as autonomous systems engaged in the surface exploration of icy moons or operating in the high-temperature/high radiation environments of other solar bodies. It also has the potential to provide power components for nanosats and cubesats, thus improving the performance of systems engaged in near-Earth space science missions.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The anticipated exceptional radiation hardness, temperature intensity, and performance parameters of the proposed diamond-based vacuum differential amplifier devices make them well suited to all space-based applications. Scientic market research has found a need for high power amplifiers in NASA satellite operations. High speed, low impedance power amplifier use in communication link RF infrastructure has the potential to increase efficiency and lower power requirements for future space systems. Scientic market research has found a need for low to no impedance high power switching requirements in

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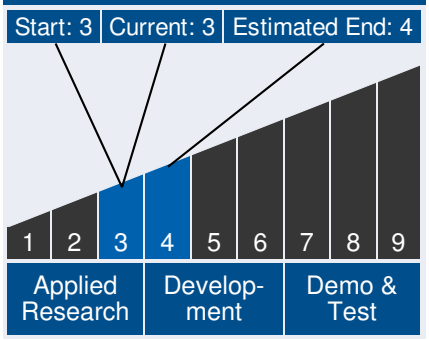
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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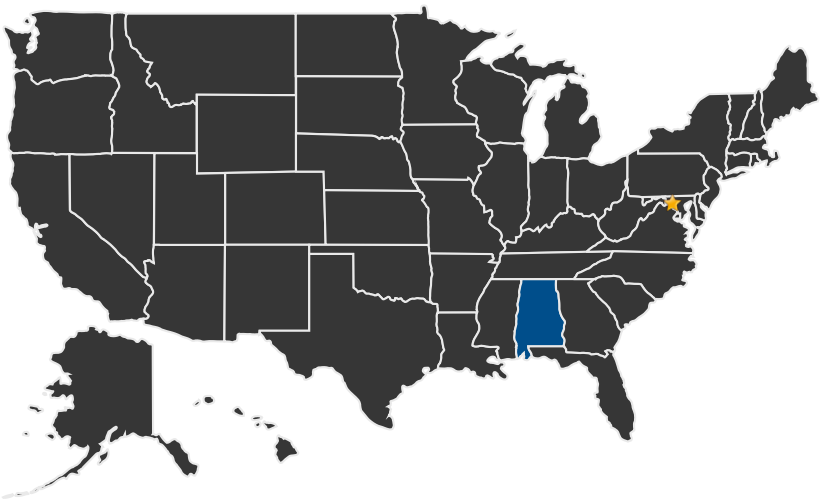
NASA deep space nuclear propulsion programs. Current silicon based devices are not well suited for these functions in harsh space environments. Scientic believes power amplifiers and power switches built with VFEDA would push the ability to design these systems to a higher voltage requiring less cooling due the extreme temperature and radiation tolerance demonstrated by VFEDA nanotechnology.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Similarly to NASA, DOD requires similar performance improvements in future space and missile systems. Scientic has strong ties to Air Force Research Laboratory efforts to improve microelectronic response in these harsh space environments in which products developed and manufactured using VFEDA would have immediate impact on near term and future missions.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Management Team *(cont.)*

Principal Investigator:
- Steven Renfrow

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
- Power Management and Distribution (TA 3.3)
  - Conversion and Regulation (TA 3.3.5)

Other Organizations Performing Work:

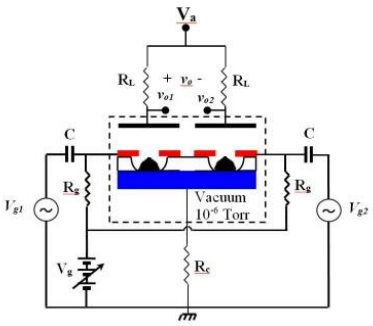
- Scientic, Inc. (Huntsville, AL)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23429)

IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

Development of Diamond Vacuum Differential Amplifier for Harsh Environment Power Electronics, Phase I

Potential Applications

The anticipated exceptional radiation hardness, temperature intensity, and performance parameters of the proposed diamond-based vacuum differential amplifier devices make them well suited to all space-based applications. Scientic market research has found a need for high power amplifiers in NASA satellite operations. High speed, low impedance power amplifier use in communication link RF infrastructure has the potential to increase efficiency and lower power requirements for future space systems. Scientic market research has found a need for low to no

impedance high power switching requirements in NASA deep space nuclear propulsion programs. Current silicon based devices are not well suited for these functions in harsh space environments. Scientic believes power amplifiers and power switches built with VFEDA would push the ability to design these systems to a higher voltage requiring less cooling due the extreme temperature and radiation tolerance demonstrated by VFEDA nanotechnology.