



NASA SBIR 2018 Phase I Solicitation

S3.03 Power Electronics and Management, and Energy Storage

Lead Center: GRC

Participating Center(s): ARC, GSFC, JPL

Technology Area: TA3 Space Power and Energy Storage

Power Electronics and Management

NASA's Planetary Science Division is working to implement a balanced portfolio within the available budget and based on a decadal survey that will continue to make exciting scientific discoveries about our solar system. This balanced suite of missions shows the need for low mass/volume power electronics and management systems and components that can operate in extreme environment for future NASA Science Missions.

Advances in electrical power technologies are required for the electrical components and systems of these future spacecrafts/platforms to address program size, mass, efficiency, capacity, durability, and reliability requirements. Radioisotope power systems (RPS), Advanced Modular Power Systems (AMPS) and In-Space Electric Propulsion (ISP) are several programs of interest which would directly benefit from advancements in this technology area. These types of programs, including Mars Sample Return using Hall thrusters and power processing units, require advancements in components and control systems beyond the state-of-the-art. Of importance are expected improvements in system robustness, energy density, speed, efficiency, or wide-temperature operation (-125° C to over 450° C) with a number of thermal cycles. Novel approaches to minimizing the weight of advanced PPU are also of interest. Advancements are sought for power electronic devices, components, packaging and cabling for programs with power ranges of a few watts for minimum missions to up to 20 kilowatts for large missions. In addition to electrical component development, the Science Mission Directorate has a need for intelligent, fault-tolerant Power Management and Distribution (PMAD) technologies to efficiently manage the system power for deep space missions.

Overall technologies of interest include:

- High power density/high efficiency power electronics and associated drivers for switching elements.
- Non-traditional approaches to switching devices, such as addition of graphene and carbon nanotubes to material.
- Lightweight, highly conductive power cables and/or cables integrated with vehicle structures.
- Intelligent power management and fault-tolerant electrical components and PMAD systems.
- Advanced electronic packaging for thermal control and electromagnetic shielding.
- Integrated packaging technology for modularity.

Energy Storage

Future science missions will require advanced primary and secondary battery systems capable of operating at temperature extremes from -100°C for Titan missions to 400 to 500°C for Venus missions, and a span of -230°C to $+120^{\circ}\text{C}$ for Lunar Quest. The Outer Planet Assessment Group and the 2011 PSD Relevant Technologies Document have specifically called out high energy density storage systems as a need for the Titan/Enceladus Flagship and planetary exploration missions. In addition, high energy-density rechargeable electrochemical battery systems that offer greater than 50,000 charge/discharge cycles (10-year operating life) for low-earth-orbiting spacecraft, 20-year life for geosynchronous (GEO) spacecraft, are desired. Advancements to battery energy storage capabilities that address one or more of the above requirements for the stated missions combined with very high specific energy and energy density ($>200\text{ Wh/kg}$ for secondary battery systems), along with radiation tolerance are of interest.

In addition to batteries, other advanced energy storage/load leveling technologies designed to the above mission requirements, such as mechanical or magnetic energy storage devices, are of interest. These technologies have the potential to minimize the size and mass of future power systems.

Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II, and when possible, deliver a demonstration unit for NASA testing at the completion of the Phase II contract. Phase II emphasis should be placed on developing and demonstrating the technology under relevant test conditions. Additionally, a path should be outlined that shows how the technology could be commercialized or further developed into science-worthy systems.