NASA SBIR 2017 Phase I Solicitation

Z8.03 Small Spacecraft Power and Thermal Control

Lead Center: GRC

Participating Center(s): GSFC, JPL, MSFC

Technology Area: TA3 Space Power and Energy Storage

SmallSats and CubeSats offer several new opportunities for space science, including multipoint in-situ measurements and disaggregation of larger science missions into constellations. These missions require reliable operation for several years in potentially harsh radiation environments. Industry has developed numerous cubesat components, but they lack the robustness needed for long duration missions. To address this capability gap, this subtopic will develop high reliability smallsat power generation and storage and thermal control systems that meet the performance and resource requirements of upcoming missions, while maximizing flexibility. An emphasis should be considered for energy management systems that combine power generation, storage and heat rejection in the compact cubesat platform as well as systems that enable electric propulsion.

The development of advanced power generation and energy storage technologies are critical to enabling and expanding the use of future small satellite missions. Proposed research may focus on the development of new power generation and storage technologies, with particular interest in technologies that are approaching readiness for spaceflight testing. This subtopic solicits the development of modular, highly-reliable solar array, battery, power system electronics technologies that enable scalable smallsat and cubesat power systems with the following specifications:

- Solar array input power ranging from 15 W to 100 W.
- Battery capacity ranging from 5 Amp-hours to 20 Amp-hours (volume dependent).
- Provides from 12 to 20 switched power services to users, with output voltages configurable to meet mission-specific requirements.
- Maximum board size of 90 mm x 90 mm for power system electronics.
- Configurable via I2C, SPI, or CAN bus interface.
- Simple/modular power component designs (“plug and play”).
- Supports body mounted or deployed solar arrays.
- Supports power system reset initiated by external command (typically received from radio).
- Tolerant of extreme thermal and/or radiation environments.
- Ability to be stored in space for several years prior to use.
- Novel and/or integrated power with other subsystems (i.e., power and communications, energy storage and satellite structure, combined power/propulsion subsystems, etc.).

Integration of the power and thermal subsystems is a synergistic combination that can result in mission-enabling resource savings. For example, batteries often carry the most restrictive temperature range of all spacecraft hardware, which can drive the thermal design. An integrated heat transfer turn-down device that helps to regulate temperature in extreme environments is a technology sought in this solicitation. Examples include miniaturized heat switches and lightweight thermal capacitance devices that are integrated into the battery assembly, each being scalable and tunable to a specific mission's requirements.

Deployable solar array systems are associated with higher waste heat dissipations, which in turn leads to higher volumetric heat fluxes for the small spacecraft. With limited area for suitable radiator placement, deployed radiator systems will also become necessary. Combining the radiator with the solar array will reduce the need for another deployment while also taking advantage of the environmental views. Technologies are sought to provide efficient heat transfer across the deployment mechanism. Thin radiator assemblies are needed to minimize increases in solar array thickness while also providing thermal isolation from the side with solar cells. Radiator concepts can be passive (e.g., solid-state material or heat pipes) or active (e.g., integrated fluid tubing is assumed to interface with a spacecraft-provided pumped loop).

Integrating high thermal conductivity pathways from high heat flux power electronics components to chassis interfaces can provide incremental reductions in radiator sizes. Order of magnitude improvements over copper thermal ground plane/card-lock technologies are sought.

In Phase I, contractors should prove the feasibility of proposed innovations using suitable analyses and tests. In Phase II, significant hardware or software capabilities that can be tested at NASA should be developed to advance their Technology Readiness Level (TRL). TRLs at the end of Phase II of 3-4 or higher are desired. NASA's Small Spacecraft Technology Program will consider promising SBIR technologies for spaceflight demonstration missions and seek partnerships to accelerate spaceflight testing and commercial infusion.