NASA SBIR 2020 Phase I Solicitation

Z1.05 Lunar & Planetary Surface Power Management & Distribution

Lead Center: GRC

Participating Center(s): GSFC, JSC

Technology Area: TA3 Space Power and Energy Storage

Scope Title

Innovative ways to transmit high power for lunar & Mars surface missions

Scope Description

The Global Exploration Roadmap (January 2018) and the Space Policy Directive (December 2017) detail NASA’s plans for future human-rated space missions. A major factor in this involves establishing bases on the lunar surface and eventually Mars. Surface power for bases is envisioned to be located remotely from the habitat modules and must be efficiently transferred over significant distances. The International Space Station (ISS) has the highest power (100kW), and largest space power distribution system with eight interleaved micro-grids providing power functions similar to a terrestrial power utility. Planetary bases will be similar to the ISS with expectations of multiple power sources, storage, science, and habitation modules, but at higher power levels and with longer distribution networks providing interconnection. In order to enable high power (>100kW) and longer distribution systems on the surface of the moon or Mars, NASA is in need of innovative technologies in the areas of lower mass/higher efficiency power electronic regulators, switchgear, cabling, connectors, wireless sensors, power beaming, power scavenging, and power management control. The technologies of interest would need to operate in extreme temperature environments, including lunar night, and could experience temperature changes from -153°C to 123°C for lunar applications, and -125°C to 80°C for Mars bases. In addition to temperature extremes, technologies would need to withstand (have minimal degradation from) lunar dust/regolith, Mars dust storms, and space radiation levels.

While this subtopic would directly address the lunar and Mars base initiatives, technologies developed could also benefit other NASA Mission Directorates including SMD (Science Mission Directorate) and ARMD (Aeronautics Research Mission Directorate). Specific projects which could find value in the technologies developed herein include Gateway, In-Situ Resource Utilization (ISRU), Advanced Modular Power Systems (AMPS), In-Space Electric Propulsion (ISP), planetary exploration, and Hybrid Gas Electric Propulsion. The power levels may be different, but the technology concepts could be similar, especially when dealing with temperature extremes and the need for electronics with higher power density and efficiency.

Specific technologies of interest would need to address the lunar or Mars environment, and include:

- Application of wide bandgap electronics in DC-DC isolating converters with wide temperature (-70°C to 150°C), high power density (>2 kW/kg), high efficiency (>96%) power electronics and associated drivers for
电压调节。
- 低质量、高导电性电线和终端，提供可靠的细线规格，用于长距离电力传输，质量为1-10kW范围，质量轻、导电性高的绝缘材料，具有增加电介质击穿强度和减少600 V或更高评级的空隙，以及低损耗/低质量屏蔽。
- 电力传输概念，以实现高效灵活/移动电力传输，在100-1,000W范围，包括电力/通信/导航的融合。

（见Z13.02 - 污尘耐受机制子主题，建议提出不受环境灰尘影响的电源连接/终端相关技术，以及能够实现机器人部署的技术，如机器人高电压连接器和/或近场无线电力传输。）

参考文献


太空政策指令，2017年12月：https://www.nasa.gov/topics/moon-to-mars/overview

预期TRL或TRL范围在项目完成时 3到6

希望完成的项目

原型，分析，硬件，研究

希望完成的项目描述

通常，完成的项目旨在探讨与相关的分析和设计。最终报告通常足以概述工作。第二阶段的硬件原型将有机会融入NASA技术测试床和商业登月器。

技术状态和关键差距

虽然地面电力分配系统存在，但没有等同的月球或行星基地。必须克服独特的挑战，以实现这些未来应用的现实电力架构，特别是当处理环境极端时。温度波动将是任何开发的技术的要求，从电源转换器到电缆或电力传输概念。此外，如果有必要，将考虑月球表层和火星尘暴。

相关/科学可追溯性

这一子主题将直接解决月球和火星表面倡议。有可能与SMD（科学任务管理）的商业着陆器负载服务和HEOMD（人类探索和操作任务管理）的灵活月球探索（FLEX）着陆器融合。此外，开发的技术可能为其他NASA任务包括Gateway带来好处。功率水平可能不同，但技术概念可能相似，特别是当处理温度极限时。