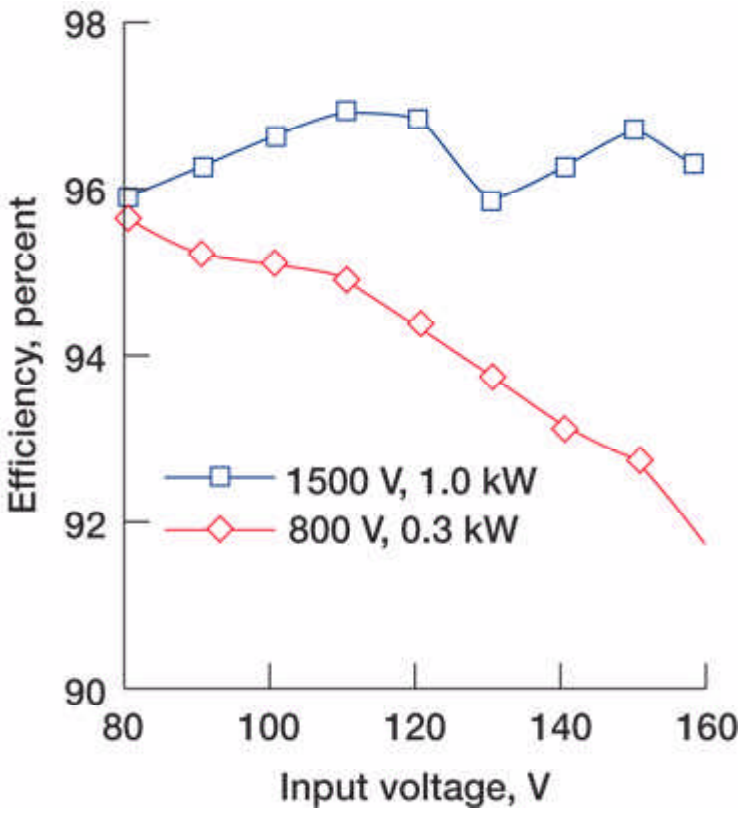
Modular 5-kW Power-Processing Unit Being Developed for the Next-Generation Ion Engine

The NASA Glenn Research Center is developing a 5- to 10-kW ion engine for a broad range of mission applications. Simultaneously, a 5-kW breadboard power-processing unit (PPU) is being designed and fabricated by Boeing Electron Dynamic Devices, Torrance, California, under contract with Glenn. The beam supply, which processes up to 90 percent of the power into this unit, consists of four 1.1-kW power modules connected in parallel, equally sharing the output current. The modular design allows scalability to higher powers as well as the possibility of implementing an $N + 1$ redundant beam supply. A novel phase-shifted/pulse-width-modulated, dual full-bridge topology was chosen for this module design for its efficient switching characteristics.

A breadboard version of the beam power supply module was assembled. Efficiencies ranging between 91.6 and 96.9 percent were measured for an input voltage range of 80 to 160 V, an output voltage range of 800 to 1500 V, and output powers from 0.3 to 1.0 kW. This beam supply could result in a PPU with a total efficiency between 93 and 95 percent at a nominal input voltage of 100 V. This is up to a 4-percent improvement over the state-of-the-art PPU used for the Deep Space 1 mission. A flight-packaged PPU is expected to weigh no more than 15 kg, which represents a 50-percent reduction in specific mass from the Deep Space 1 design. This will make 5-kW ion propulsion very attractive for many planetary missions.



Beam power module efficiency versus input voltage.

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Programs/Projects: The 5- to 10-kW ion propulsion system will benefit/enable many inner planet missions (Mars, Venus, or comet sample return), outer planets missions (Pluto Flyby, Neptune Orbiter, Titan Explorer), and GEO spacecraft (orbit insertion or NSSK).