PRY FURTHER AT EDN.COM

Go to www.edn.com/pryingeyes for past Prying Eyes write-ups.

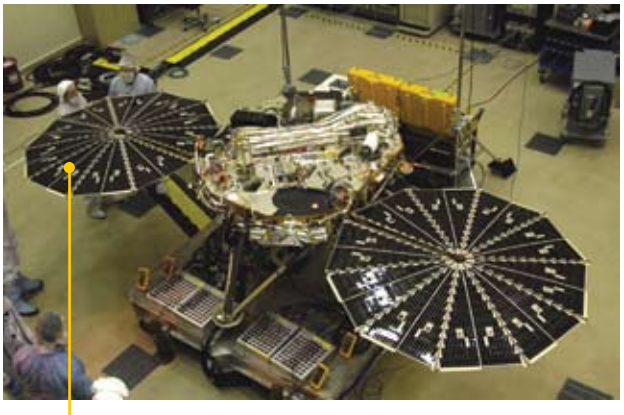
Way, way off the grid: powering the Phoenix Mars lander

The Phoenix lander's 90-day mission at the Mars pole is to gather dirt and rock samples with its robotic arm, analyze the samples with onboard instruments, and communicate results and respond to commands with its earthbound project engineers. All of these tasks require electrical power. The power-generation, -regulation, and -delivery system for the Phoenix comprises a lithium-ion-battery pack from Yardney Technical Products and two solar arrays from ATK Space Systems.

The oncoming Martian winter constrains the mission to a tight, 90-day window. Temperatures then drop to the point at which the atmosphere, which is more than 95% carbon dioxide, freezes solid and shrouds the lander in dry ice. The Phoenix will then shut down for the winter—and, most likely, forever.

Each array unfolds like an oriental fan into a circular shape 2.1m in diameter and can generate 770W of power from sunlight at the distance Earth is from the sun. Because Mars is approximately 1.5 times farther from the sun, the solar arrays will produce less than half the power possible on Earth.

The lithium-ion battery comprises two identical battery modules as well as the electronics to monitor cell voltages, control charging and discharging, and perform cell balancing. The two modules form a V shape measuring 13.38×10×9.5 in. and weighing 17.8 kg. Each module's maximum continuous-output current is 12A at 28.8V, with an ampere-hour capacity of 33 Ahr and an energy-storage capacity of 950.4 Whr.



The Phoenix batteries will provide power at night when there is no sunlight for the solar panels to convert to electricity. The lander can also use the batteries whenever a task requires more power than the solar arrays can deliver. The battery fits inside a thermal enclosure, insulation surrounding it, on the component deck on the underside of the lander.

Solar arrays are the primary power source for the lander. The arrays' gallium-arsenide crystalline-photovoltaic cells have an efficiency of 27%. Developers grew the cells on a germanium substrate and then bonded them to a flexible substrate structure. The cells have the maximum photovoltaic-conversion efficiency available given the spectral content of sunlight on the Martian surface.

Just how cold does it get at the poles during a Martian winter, when the carbon dioxide atmosphere freezes solid? The atmospheric pressure fluctuates but, at its highest, is 100 times less than Earth's, where the freezing temperature of carbon dioxide is −78.5°C at 1 atm (atmosphere) pressure. At Mars' lower atmosphere, carbon dioxide freezes at −125°C (−193°F).