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Modular Solar Power System (MSPS)

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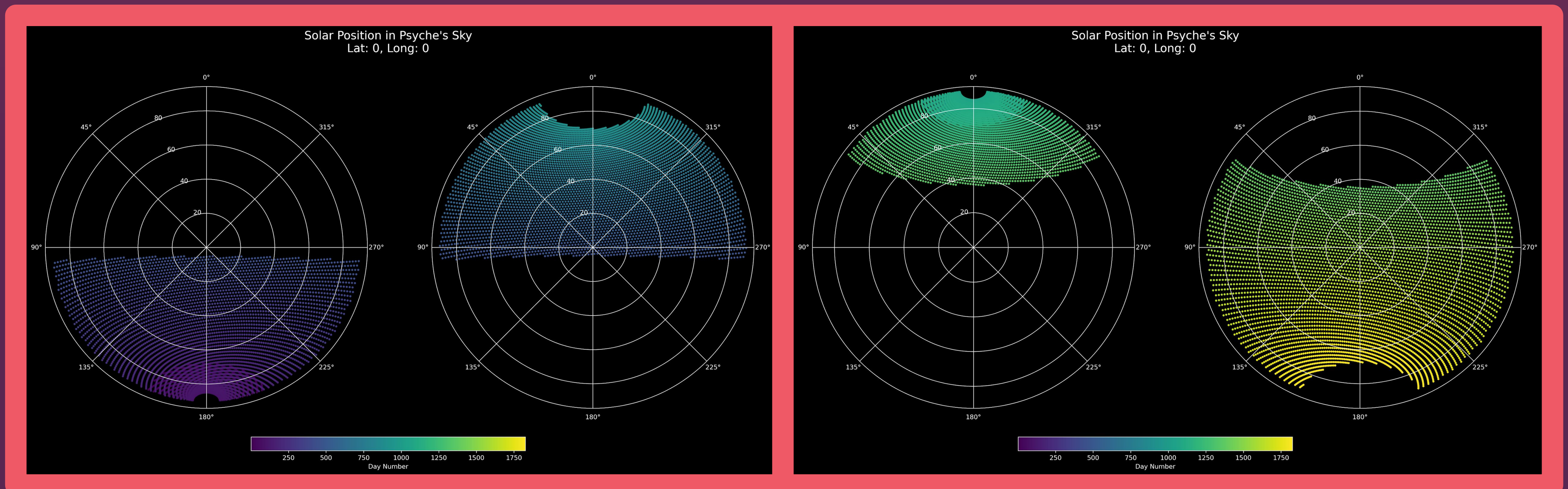
Mission Statement

The Psyche spacecraft is traveling to a unique metal-rich asteroid with the same name, orbiting the Sun between Mars and Jupiter. By August 2029 the spacecraft will begin exploring the asteroid from orbit that scientists think – because of its high metal content – may be the partial core of a planetesimal, a building block of an early planet.

Background

The Modular Solar Power System (MSPS) is a capstone project in electrical engineering aimed at solving the challenge of solar power harvesting for possible future surface missions to asteroid 16-Psyche. Developed in partnership with NASA and Arizona State University (ASU), the project focuses on maximizing solar energy collection despite Psyche's limited sunlight and long periods of darkness. Over two semesters, the team researched, designed, prototyped, and tested a system optimized for deep-space efficiency and cost constraints.

Located about 2.6 Astronomical Units from Earth, 16-Psyche is a metal-rich asteroid with a 4-hour daylight cycle. Believed to be the exposed core of a planetesimal, it offers unique insight into the formation of molten core planetary bodies. NASA's Psyche mission launched in October 2023 and will reach the asteroid in July 2029. With limited access to energy in deep space, the MSPS aims to provide a lightweight, renewable power solution that enhances future mission longevity and data collection.

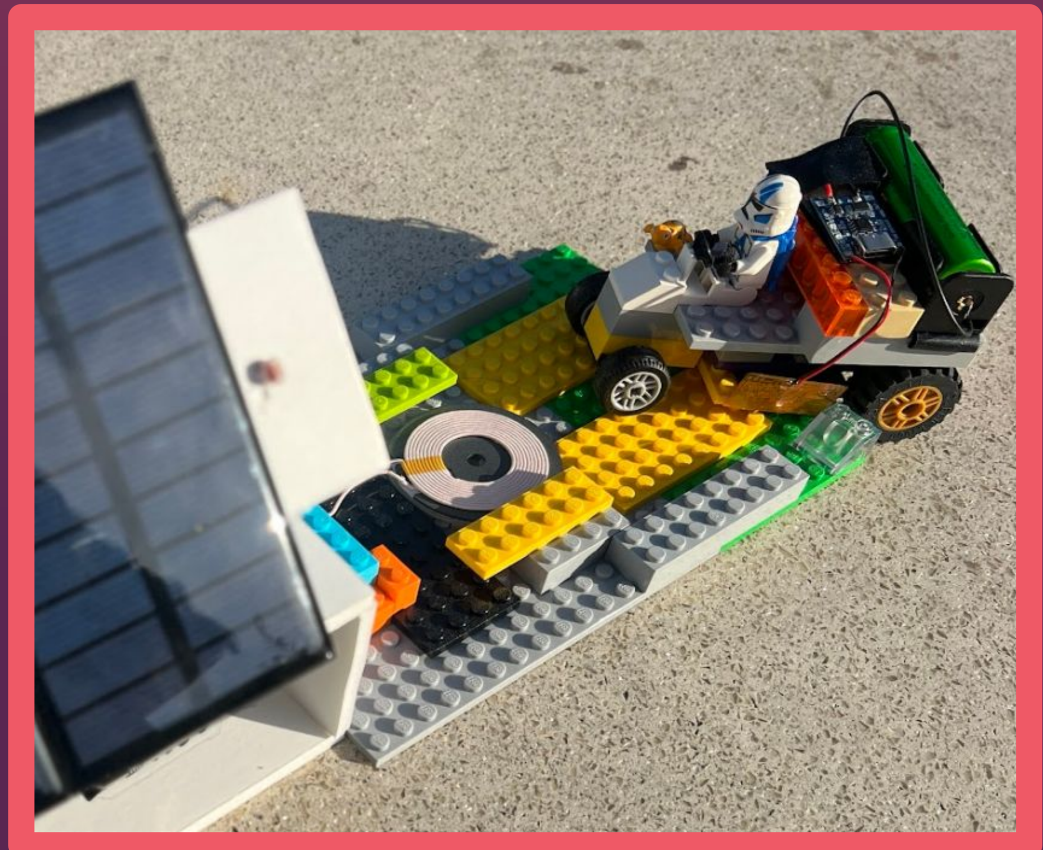


Solar Position in Psyche's Sky at Lat: 0, Long: 0 for one period, 1858 Earth Days

Prototype

The MSPS prototype was tested using natural sunlight. The tracking system successfully orients the panel from 12PM to 4PM, as seen in the figure below. The accumulated energy releases through the charging pad according to proximity.

Outdoor testing showing cell positions (left to right: 12pm, 1pm, 2pm,3pm,4pm)



Miniature rover holding a battery rolling towards an induction charging pad connected to the MSPS

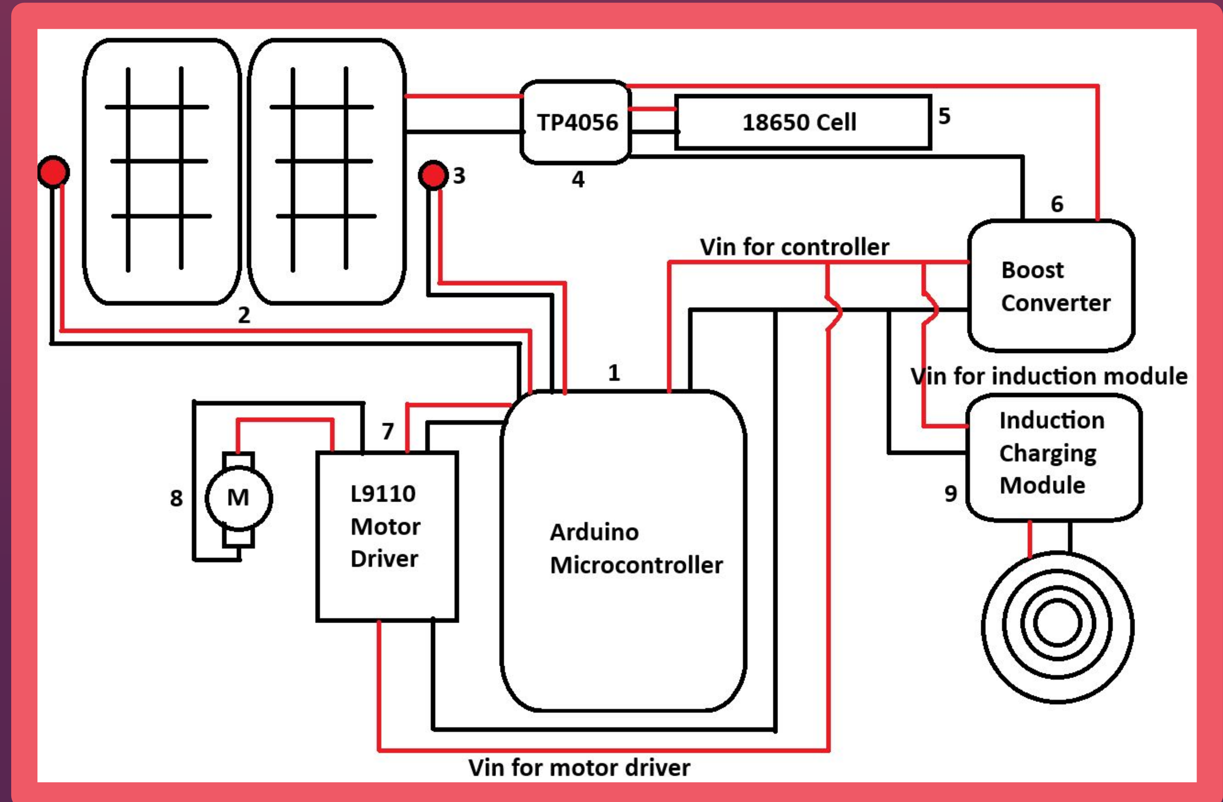
Timeline

Nov. Research → Dec-Jan Simulation → Feb Prototyping → March-May Refining

Circuitry

The MSPS uses a modular circuitry design centered around energy harvesting, regulation, and distribution. A solar tracking system with photoresistors detects light intensity differences, which are processed by an Arduino microcontroller. The microcontroller commands a DC motor to orient the solar panels for optimal exposure.

Power from the solar panels is routed through a TP4056 charging module with built-in protections and a boost converter. The TP4056 raises the voltage to safely charge a 3.7V 18650 Li-ion battery, while the boost converter elevates it further to 5V for system-wide power delivery. This setup ensures consistent microcontroller operation and supports wireless rover charging even in fluctuating light conditions.



System Circuit Diagram 1)Microcontroller 2)Solar Cell 3)Photoresistor 4)Charging Module 5)Battery Cell 6)Boost Converter module 7)Motor Driver 8)DC motor 9)Induction Charging Module

This work was created in partial fulfillment of **Arizona State University** Capstone Course "**EEE 489**". The work is a result of the Psyche Student Collaborations component of NASA's Psyche Mission (https://psyche.asu.edu). "Psyche: A Journey to a Metal World" [Contract number NNM16AA09C] is part of the NASA Discovery Program mission to solar system targets. Trade names and trademarks of ASU and NASA are used in this work for identification only. Their usage does not constitute an official endorsement, either expressed or implied, by Arizona State University or National Aeronautics and Space Administration. The content is solely the responsibility of the authors and does not necessarily represent the official views of ASU or NASA.