National Aeronautics and Space Administration

NASAfacts

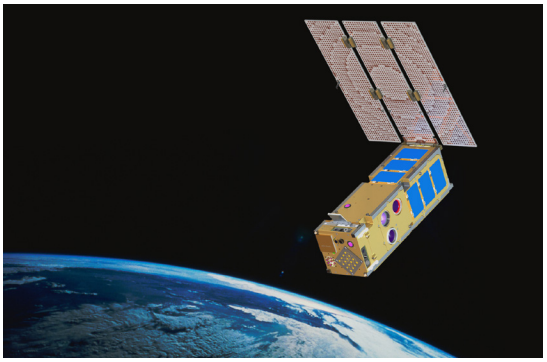
Integrated Solar Array and Reflectarray Antenna for High Bandwidth CubeSats

Increasing CubeSat Downlink Data Rates to 100 Mbps

The Integrated Solar Array and Reflectarray Antenna (ISARA) mission will demonstrate a reflectarray antenna that increases downlink data rates for CubeSats from the existing baseline rate of 9.6 kilobits per second (kbps) to more than 100 megabits per second (Mbps).

The reflectarray antenna consists of three panels, electrically tied together through hinges, which have an array of printed circuit board patches on them. The size of the patches are adjusted so that the phase of the reflected feed illumination collimates the radiation in much the same way a parabolic dish reflector would. Unlike a parabolic dish, however, the reflectarray panels are flat, which enables them to be folded down against the CubeSat. On the opposite side of the printed reflectarray antenna, solar cells have been added. This makes the overall antenna/solar array panel assembly slightly thicker, but the cells are stowed in the "dead space" between the launch rails that would have otherwise been left empty. This combination of antenna and solar cells makes for a very efficient use of CubeSat volume, leaving plenty of room for payloads such as science instruments or imaging systems.

The ISARA technology will be validated in space during a five-month mission to measure key reflectarray antenna characteristics, which include how much power can actually be obtained over its field of view. ISARA contains a transmitter and an avionics subsystem that features a Global Positioning System (GPS) receiver and a high precision attitude control system designed to orient the CubeSat to enable accurate antenna beam pointing. Once in orbit, ISARA will deploy its solar array and reflectarray antenna. It then will use its attitude determination and control system to stabilize itself. An ultra high frequency (UHF) communications system will be used to make initial contact with the satellite and perform in-orbit checkout procedures.



ISARA Spacecraft Configuration with 3U CubeSat and Solar Array with Integrated Reflectarray Antenna

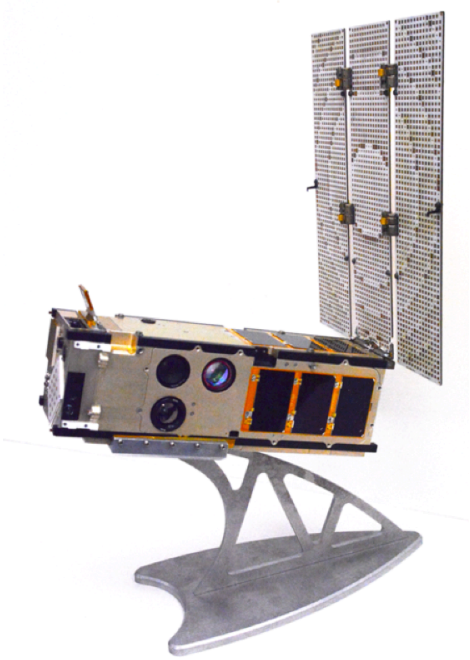
During the in-orbit test, ISARA's reflectarray antenna will transmit a signal that will be received by a ground station located at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. The spacecraft's location and orientation telemetry data will be analyzed to reconstruct the antenna signal pattern, which will then be compared against pre-flight ground measurements.

The stowage volume and spacecraft power provided by ISARA technology also enabled the ISARA mission to carry a secondary payload known as the CubeSat Multispectral Observation System (CUMULOS), an experimental Aerospace Corporation remote sensing payload. CUMULOS is composed of a 0.4-0.8 micrometer (μm) visible camera, a 0.9-1.7 μm short-wavelength infrared camera, and

an 8.0-13.5 µm long-wavelength infrared, microbolometer camera.

The CUMULOS sensors provide a small-aperture, large field-of-view, remote sensing payload suitable for testing the performance of passively-cooled commercial sensors for weather and environmental monitoring missions. CUMULOS is designed for point-and-stare imaging and will allow almost simultaneous 3-band coverage of regions 230 x 180 kilometers (km) in size, at ground sample distances from 180 to 600 meters from an orbital altitude of 600km. Remote sensing applications to be investigated include: cloud cover detection, surface temperature measurement, hotspot detection (including fires, gas flares, and volcanic activity), and detection of nighttime lights.

At the end of the validation mission, the reflectarray antenna technology will be available for use on other missions that need high bandwidth telecommunications. The ISARA technology will enable CubeSats and other small satellites to serve as viable platforms for performing missions that were previously only possible on larger and more costly satellites. For a modest increase in mass, volume and cost, the high data rate this technology enables will pave the way for high value science missions and formation flying missions that use distributed CubeSats and small satellites.



The engineering qualification model of the ISARA spacecraft showing the 3 CUMULOS cameras.

The ISARA payload is being developed by JPL and will be demonstrated on a CubeSat developed by The Aerospace Corporation in El Segundo, California. JPL partnered with Pumpkin Inc. in San Francisco, California, to develop the solar array.

ISARA was selected for a flight opportunity as part of the CubeSat Launch Initiative in NASA's Human Exploration and Operations Mission Directorate. A launch opportunity for ISARA is pending.

The ISARA mission is funded through NASA's Small Spacecraft Technology Program (SSTP), which is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. SSTP is one of nine programs within NASA's Space Technology Mission Directorate.

For more information about the SSTP, visit:
https://www.nasa.gov/directorates/spacetech/small_spacecraft/

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