Alpha Satellite Mission Technical Description

The overall goal of the Alpha mission is to serve as a technical demonstration of a light sail in orbit, verifying the mechanical properties of the polycarbonate material. Also, the sail architecture will demonstrate key functions of next-generation ChipSats.

Alpha comprises a 1U CubeSat capable of deploying a free-flying 1m x 1m light sail in response to ground commands. The sail has a sensor-equipped ChipSat attached to each of the 4 corners. These will transmit GPS data to the Cornell University ground station, enabling tracking of the sail to about 10 m accuracy.

The satellite will be launched in 2020, on the next available launch after NG-13. It will be inserted into orbit from the ISS via the NanoRacks CubeSat Deployer (NRCSD). Apogee and perigee will be approximately 400km, on an inclination of 51.6° from the equator.

Ground communication via Iridium will begin 2 to 3 hours after deployment of the CubeSat from the ISS. Atmospheric drag will lower the CubeSat's altitude until it de-orbits about 3 months after release from the deployer. Payload deployment will occur on command ~3 weeks after CubeSat deployment; exact timing dependent on TLE and verification that the spacecraft is over Region 2. The sail's orbit lifespan will be on the order of a few days after it is deployed from the CubeSat. The Orbital Debris Assessment Report provides more detail.

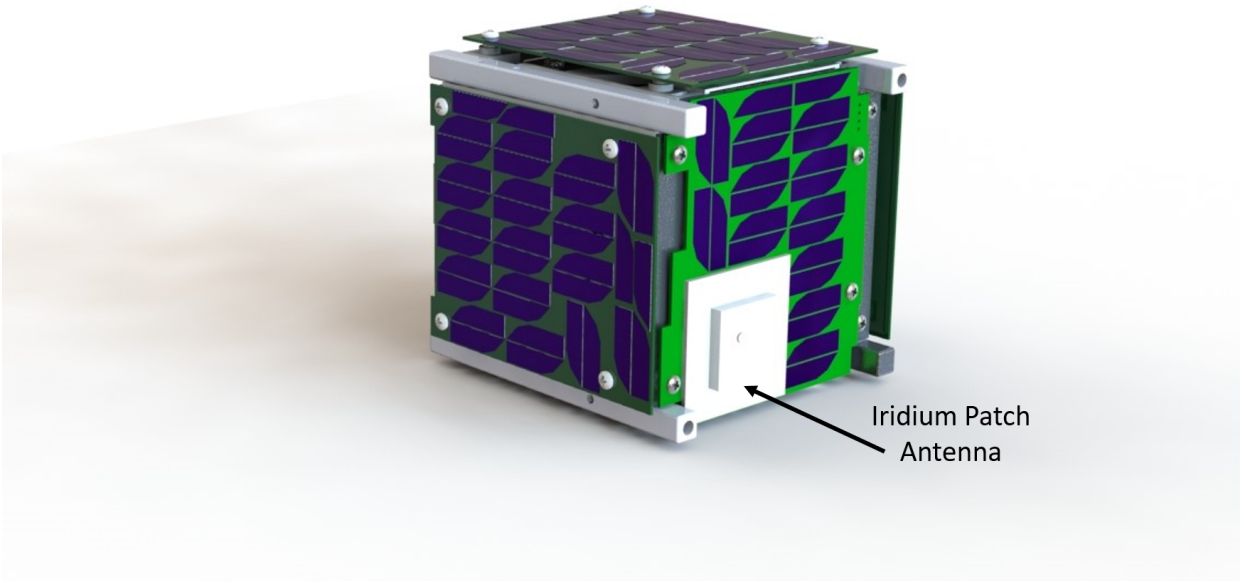

Figure 1: Alpha Spacecraft (View of Antenna)

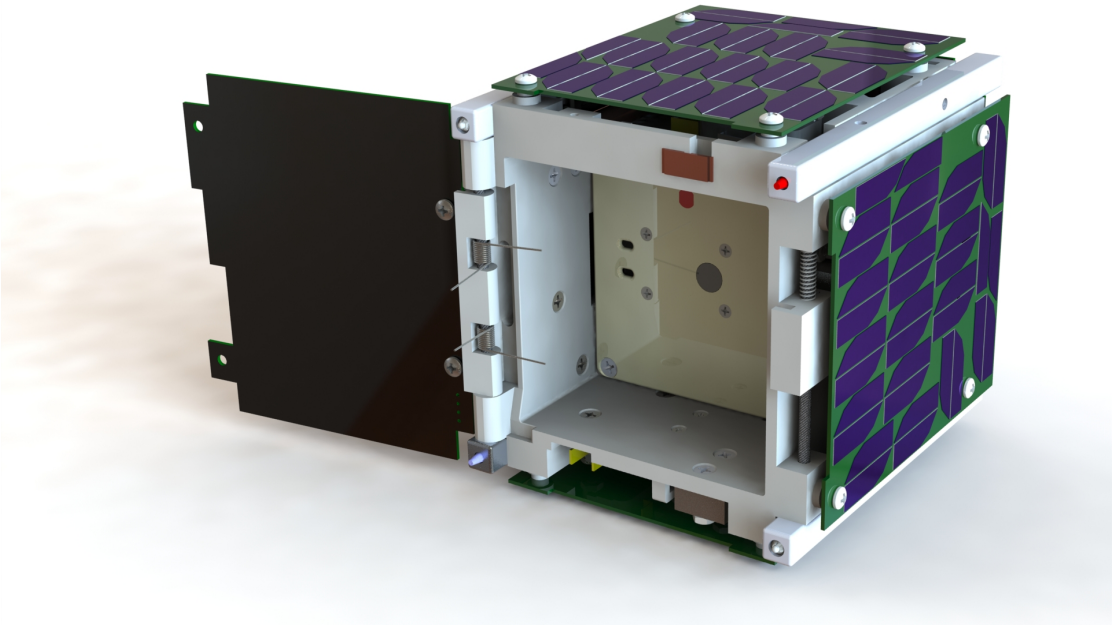

Figure 2: Alpha CubeSat (Payload Deployment)

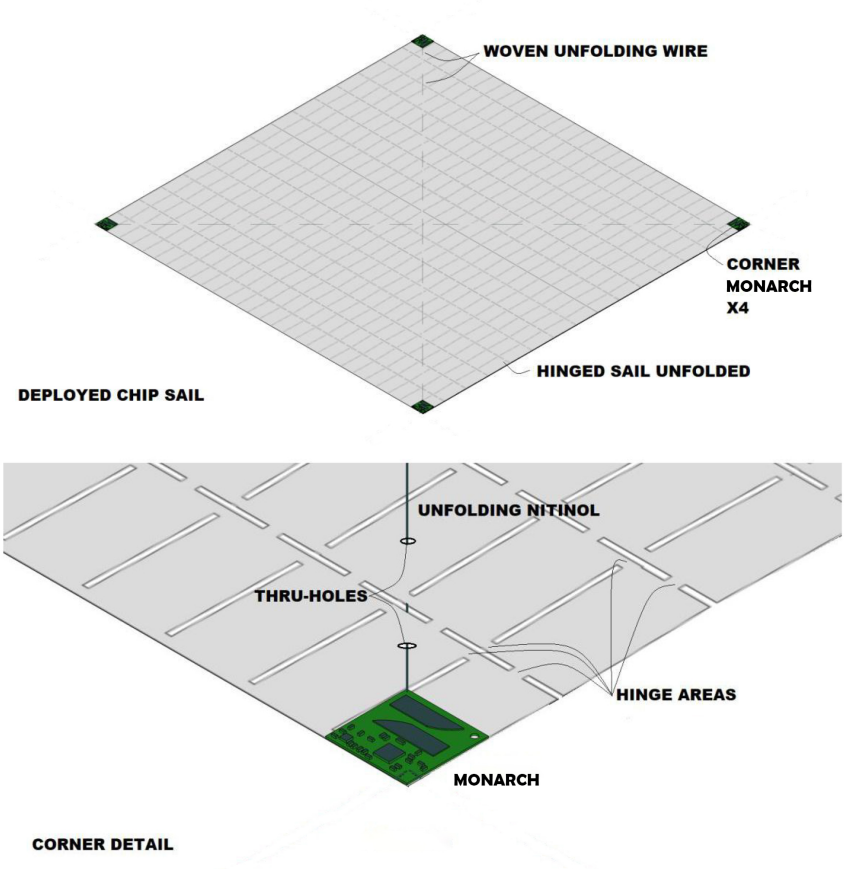

Figure 3: ChipSat Light Sail Deployment

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The CubeSat contains the following systems: Attitude Determination and Control, Command and Data Handling, Communications, Electrical Power, Structure and Payload.

Attitude Determination and Control Subsystem (ADCS): The CubeSat ADCS uses three magnetic torque rods for attitude control in three axes. Approximate tracking information is provided through the Iridium network.

Command and Data Handling (CDH) Subsystem: The spacecraft uses a Teensy 3.5 with Arduino IDE as its flight controller. The Teensy handles all operations of the spacecraft, such as health monitoring, ADCS, and Iridium RockBlock activities.

Communications Subsystem (COMMS): The Alpha CubeSat communicates with mission control via the Iridium constellation, using a RockBlock MK.II transceiver. The patch antenna is mounted externally on the face of the CubeSat that aligns roughly with magnetic south after the magnetic spin-up maneuver completes. This orientation directs most of the transmitter power into space, not at the Earth. The ChipSats attached to the sail use 10mW transmitters in the ISM band, transmitting only when they are within ITU region 2 (as determined by the onboard GPS). See the Communications Plan document for detains of communications operations.

Electrical Power Subsystem (EPS): The Alpha EPS consists of 6 solar panels assembled from TrisolX triple junction GaAs cells. The solar array provides 1.3W of electrical power on average. A COTS charge controller – Sparkfun Sunny Buddy – is used to charge the batteries. Two 2000mAh LiPo pouch cells are connected in parallel, to supply an operational power requirement of 122mW.

Structure Subsystem: The rails of the CubeSat are fabricated from 7075 Aluminum. The remainder of the structure is 3D-printed Accura® Bluestone™, a nano-composite with high stiffness and thermal resistance.

Propulsion Subsystem: The Alpha CubeSat does not contain a propulsion system.

Payload Subsystem: The payload is the 1m x 1m solar sail, and the four attached ChipSats containing GPS receiver, power, processor and radio transceiver. Drag is orders of magnitude greater than solar radiation pressure so, the sail's orbit is expected to drop rapidly. Due to the high ballistic coefficient of the sail, it will only remain in orbit on the order of a few days after it is deployed. See the Payload Description document for more details.