Quub QAC-1 Flock Technical Description

The overall goal of the QAC-1 Flock mission is to launch four of Quub's Aurora-Class (QAC) satellites in order to test the satellite bus design for commercial application, as well as to perform a radio experiment. The satellites will endeavor to capture and downlink images of the Earth, as well as to assess and measure the radio frequency communications between the satellites and the ground station.

The satellites will be launched as secondary payloads aboard SpaceX's Falcon 9 rocket as part of the Transporter-11 rideshare mission, from Cape Canaveral, Florida, NET 1 June 2024.   It will be inserted into a circular sun-synchronous orbit at 500km, on an inclination from the equator of 97.4 degrees. Communication will continue for the two-year life of the mission. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs between 3 and 5 years after launch. See the Orbital Debris Assessment Report for details.

The flock is composed of 4 units with the dimensions of six 5 cm X 5 cm X 5 cm PocketQube modules plus standard tab spacing (giving an overall dimension of 74 mm x 192 mm x 143.2 mm with solar panels in their stowed configuration.) The total mass of one satellite is about 1.75 Kg.

Figure 1: Aurora Satellite Nadir Facing Antennas

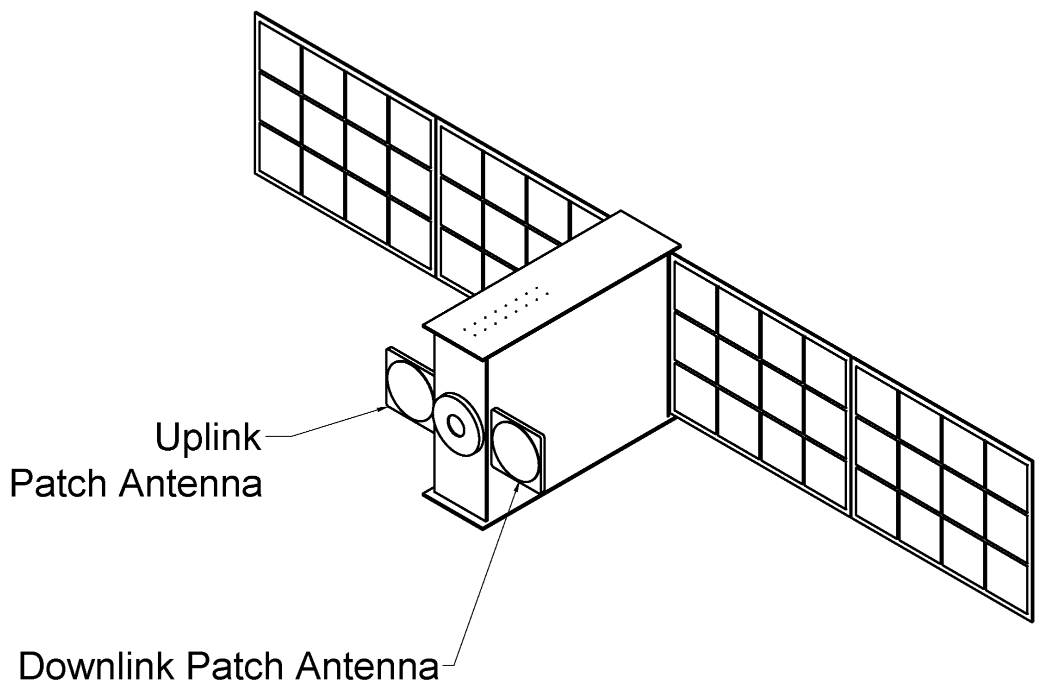
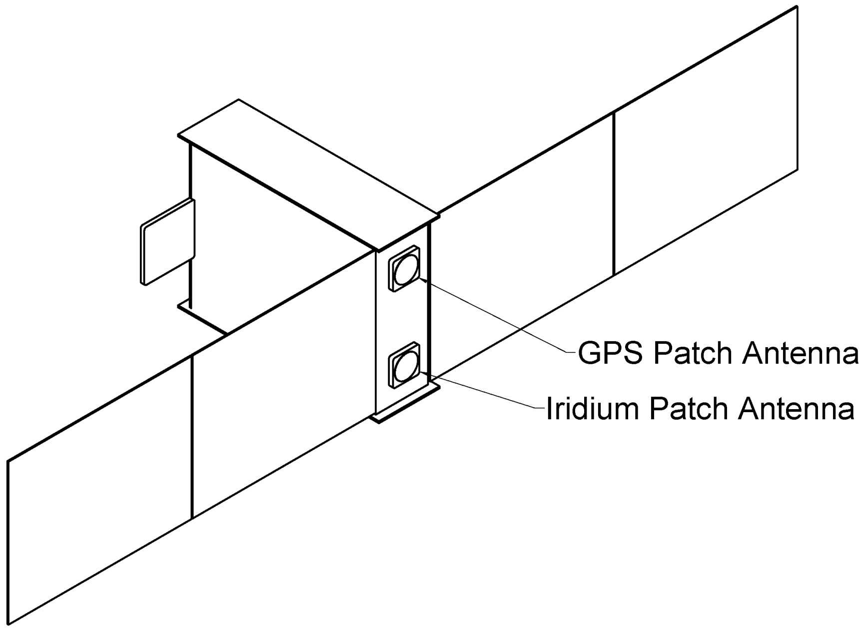


Figure 2: Aurora Satellite Zenith Facing Antennas



Each satellite contains the following systems:

Main Computing Subsystem: The primary computer onboard is a Raspberry Pi CM4 mounted on a custom printed carrier board which also comprises the back exterior panel of the spacecraft. This computer handles the main control loop for the satellite, and supports experimental image processing software. It also collects data from the sensor array subsystem.

Sensor Array Subsystem: This subsystem includes multiple instruments, each of which is mounted on a microcontroller board which reads data from the instrument, transmits data to the main computer, and receives commands from the main computer. The sensor instruments onboard are a Global Positioning System (GPS) chip and a Real-Time Clock (RTC).

Camera Subsystem: This system includes a Sony IMX283CQJ image sensor with a custom monolithic telescope seated in a mounting bracket. The camera is connected directly to the main computer.

Attitude Determination and Control System (ADCS) subsystem: Aurora's ADCS measures and controls the spacecraft's physical orientation relative to the Earth and Sun. This subsystem is composed of 3 reaction wheels and 2 copper coil magnetorquers for adjusting position, as well as 5 photo sensors and a 9-axis Inertial Measurement Unit (IMU) for attitude measurement, and 2 dedicated microcontroller boards which record instrument measurements and manage reaction wheel and magnetorquer actions.

Communications Subsystem (COMMS): The COMMS includes one S-Band LimeSDR software defined radio, and one RockBlock 9603N Iridium radio, and two antennas, one S-Band Printech 55mm S-Band patch antenna and one Taoglas Limited CGIP.25.4.A.02 Iridium patch antenna.

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All transmissions are controlled using Quub's API software, and in conformance with § 5.107 Transmitter control requirements, all transmission from the satellite can be terminated by using several standard commands, by activating an emergency override command, or by the satellite's onboard watchdog processes. The ground station antenna and mission operations center handling communications to/from the Aurora satellites, includes a 1.9m dish antenna, a LimeSDR radio, and RF Hamdesign MD-02 controller located at Quub's facilities in Lancaster, Pennsylvania.

The Aurora satellites will begin transmitting a beacon thirty minutes after deployment, and cease beaconing when communication with a groundstation is achieved, or after 72 hours if communication is not possible.

Electrical Power Subsystem (EPS): The EPS is a direct energy transfer system using a solar array producing approximately 26W of orbit average power to charge the 28 A-hr battery system (includes 8 battery cells). The solar arrays utilize Gran Systems photovoltaic cells; the batteries are Samsung INR18650 cells. Power levels and use are monitored by the main computer system, and subsystems are tasked or throttled based on real-time readings.

Structure/Frame Subsystem: The satellite's frame is fabricated of Windform and FR4 printed circuit board to hold components in place and protect subsystems from damage. The main frame of the spacecraft also includes a copper heatsink that passively dissipates heat from the main computer and radio and transfers it to the battery mount assembly to keep the batteries from freezing.

Propulsion Subsystem: The satellites include one bismuth solid-fuel vacuum arc thruster each. This thruster system may be used to support conjunction mitigation maneuvers.