

Overview of the NASA Dragonfly Antenna System

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NASA's Dragonfly mission, led by the Johns Hopkins University Applied Physics Laboratory (JHU/APL), will study the geology, atmosphere and chemistry of Saturn's moon Titan to advance our understanding of life's chemical origins (<https://dragonfly.jhuapl.edu/>). The Dragonfly mission is a rotorcraft-lander which will explore the moon, performing scientific assessments at several landing locations. The extreme cold and unique environment poses several challenges in the design and testing of the lander and its sub-systems including antennas. In terms of telecommunications, the Dragonfly mission can be divided into three basic phases. After launch, the cruise stage will transfer the lander to Titan. Upon reaching Titan, the cruise stage will separate and the Entry, Descent and Landing (EDL) stage will transport the vehicle through the atmosphere to a safe landing. During surface operations, the rotorcraft-lander will fly to several sites performing its scientific observations.

There is a total of 7 antennas on the Dragonfly spacecraft with 3 antennas operating through the cruise stage, one Low Gain Antenna (LGA) communicating during EDL and a separate 3 antennas which will be used for telecom during the surface phase. The cruise stage antenna system consists of two antipodal LGAs which each cover a hemisphere of space. The Forward LGA (FLGA) is deployed on a boom after launch. The Aft LGA (ALGA) is rigidly mounted opposite the feed of a Medium Gain Antenna (MGA). The LGA antennas and MGA feed are simple choke ring horns fed by a septum polarizer. All of the antennas are designed to operate at right hand circular polarization (RHCP) with a Deep Space Network (DSN) uplink of 7.156 GHz and a downlink of 8.408 GHz. The MGA is a 0.4 m prime focus parabolic reflector with the feed supported by 3 struts, the ALGA mounted in a mirror position above the MGA feed, and antennas both fed by WR112 waveguide. The LHCP port of the septum polarizer is shorted to reduce blockage of the reflector which may occur with a load. The EDL stage uses the same LGA geometry as the cruise stage, except it is under a rigid radome which serves as a thermal protective shield during atmospheric entry.

The rotorcraft-lander antenna system consists of a LGA, a 1-axis gimbaled MGA and a 2-axis gimbaled High Gain Antenna (HGA). The ambient temperature on Titan is approximately 94°K, so the lander is covered in a thick thermal protective layer of foam to separate the relatively warm interior from the cold atmosphere. The LGA uses the same septum polarizer as the cruise stage antenna under foam with a long circular waveguide rising above the foam to a circular waveguide opening. At the lander thermal boundary there is a Kapton gasket and foam plug inside the waveguide to prevent gas exchange. The aperture of the horn is covered in a Teflon radome to prevent precipitation and dust from entering the antenna. The lander MGA is a 4 circularly element horn array fed by a corporate waveguide feed on a 1-axis gimbal. The array forms a sectoral beam with the wide plane covering from horizon to zenith and a narrow plane in the gimbal axis direction which is perpendicular to the top of the rotorcraft. The HGA is a Radial Line Slot Array (RLSA) with a 2-axis gimbal. The pencil beam of the HGA is designed to track the Earth and is used as the primary science downlink. The MGA nominally serves as a backup to the HGA. Both of these gimbaled antennas only operate when the lander is at rest on the surface and not in flight. The LGA is used for emergency communicates and is used to transmit status tones during flight.