Rocket Lab Orbital Launch Vehicle
Iridium 9602 SBD (FCC ID: Q639602)
Implementation

Version 1.0

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Contents

1 MISSION OVERVIEW

The Electron launch vehicle is a 3-stage commercial launch vehicle manufactured and operated by Rocket Lab, launched from Rocket Lab's private orbital launch range in Mahia, New Zealand. The Electron launch vehicle is licensed by the Federal Aviation Authority (FAA).

The launch vehicle lifts off shortly after ignition of all Stage 1 motors. At T+150 seconds, the propellant in Stage 1 is exhausted and the motors cut off. Stage1/2 Separation occurs at T+153 seconds and the single Stage 2 motor ignites at T+157 seconds.

The vehicle achieves orbit at T+491 seconds (perigee altitude reaches 130 km). The Stage 2 motor cuts off at T+493 seconds, and Stage2/3 separation occurs shortly afterward.

Following separation from the rocket booster stage, Stage 3 completes a 45-minute coast, followed by an ignition, cutting off at T+3028 seconds. Payload separation occurs at T+3059 seconds.

Rocket Lab has implemented an experimental communications module using the Iridium 9602 transceiver for the upcoming experimental test launch. The Iridium 9602 transmitter is activated once the vehicle is in orbit, following Stage2/3 separation. The Iridium 9602 module continues transmit beacon data for the duration of the Stage 3 coast, burn, and payload separation, until the Stage 3 batteries deplete or the transmitter is commanded off.

There is no mechanism to charge the batteries on the spacecraft, therefore the duration of the Iridium 9602 transmission is limited by the life of the batteries, maximum 11 hours.

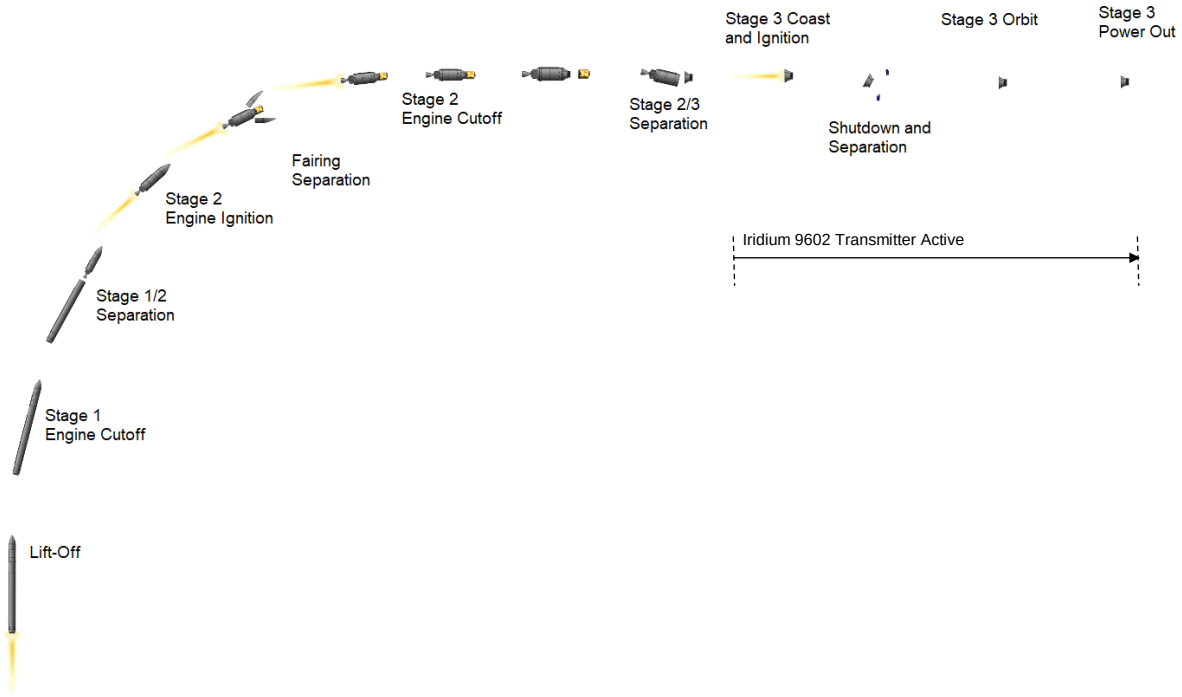


Figure 1 - Electron Launch Vehicle Mission Overview

2 IMPLEMENTATION

2.1 System Block Diagram

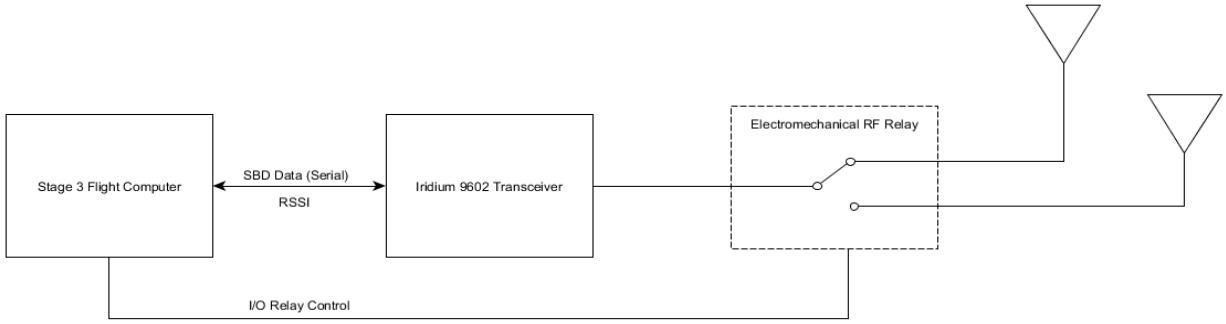


Figure 2 - Iridium 9602 System Block Diagram

2.2 System Description

The Iridium transmitter used on the vehicle upper stage is the Iridium 9602 (FCC ID: Q639602). The transmitter is used default configuration settings consistent with its existing FCC license for ground-to-space communications.

The transmitter is connected to the Stage 3 Flight Computer, which sends SBD messages to the module via serial communication. The Flight Computer interrogates the 9602 module for health and status and signal strength information.

The antennas used for the Iridium 9602 transceiver are L-Band rounded blade antennas. Polarization: Linear, predominantly vertical. An electromechanical RF relay is used to select the transmission path from the Iridium 9602 to either antenna.

2.3 Antenna Hardware

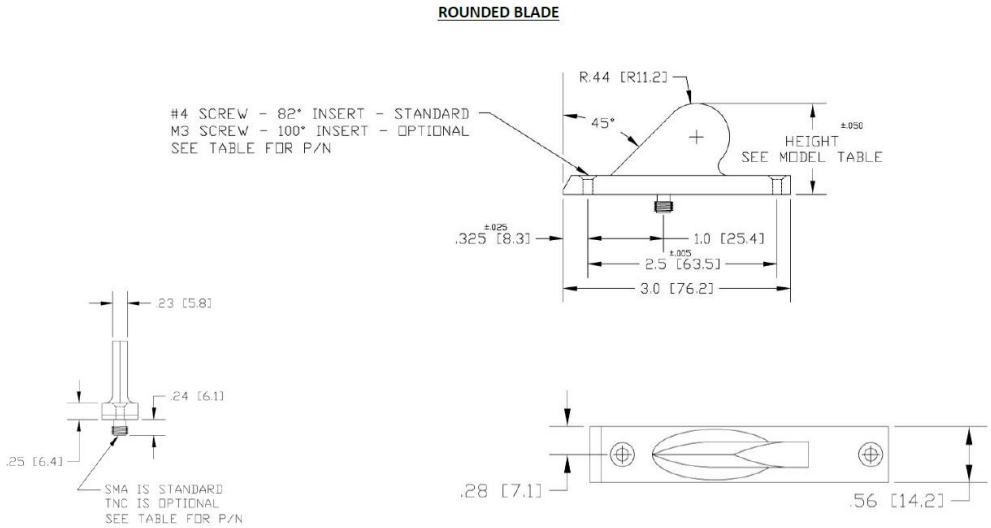


Figure 3 - Iridium 9602 Antenna

2.4 Antenna Locations

Two L-Band rounded blade antennas are located 180° apart on Stage 3. An electromechanical switch is used to control the direction of transmission.

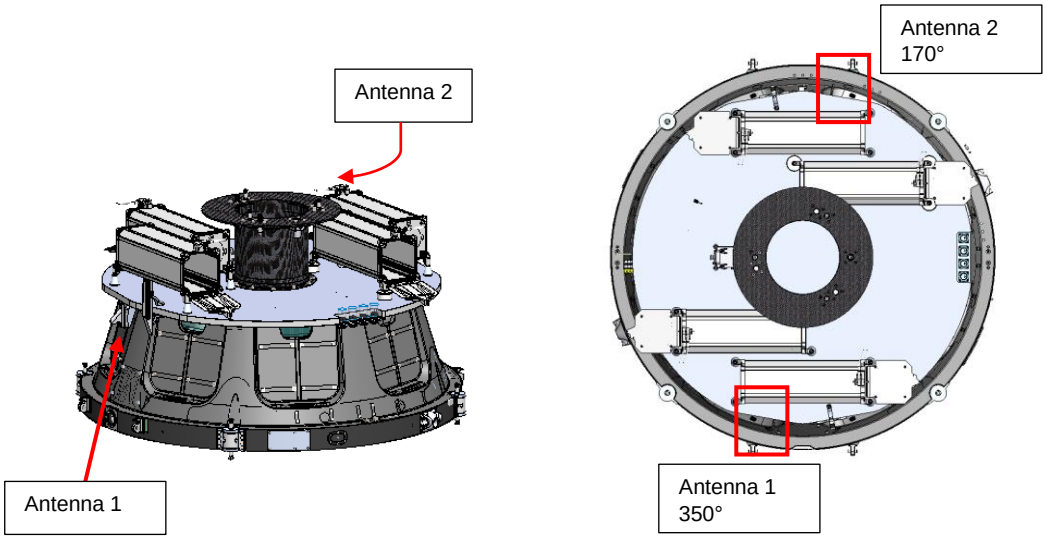
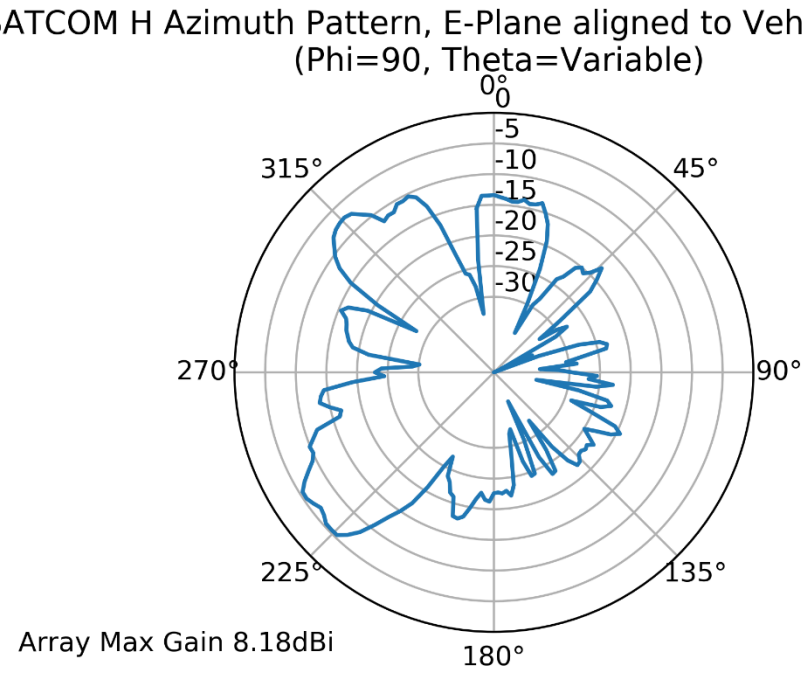


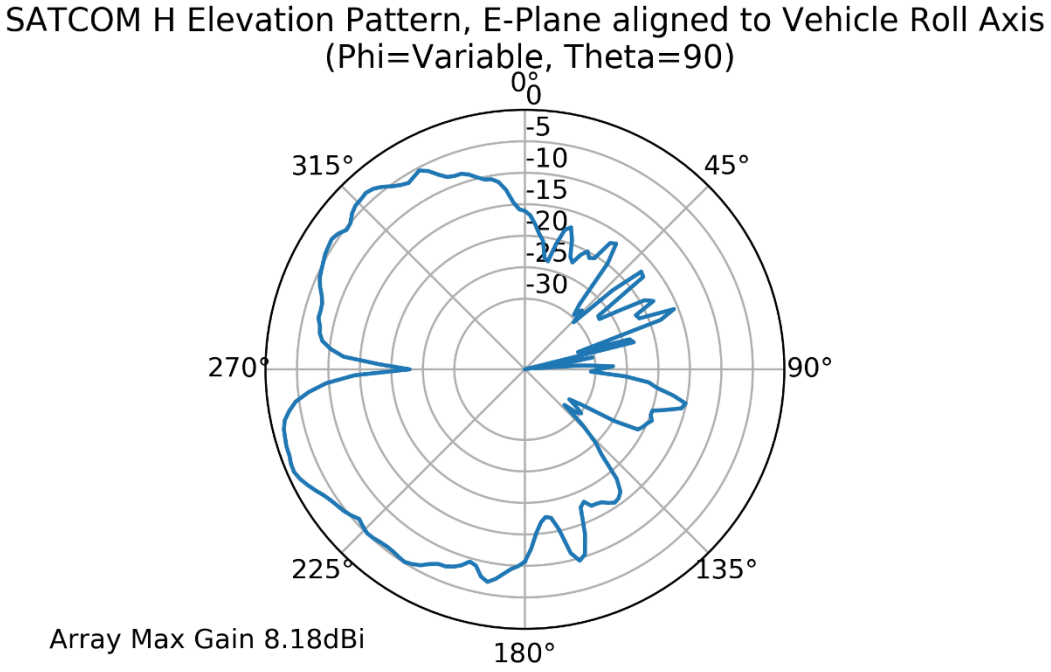
Figure 4 - Iridium 9602 Antenna Locations

3 ANTENNA PATTERNS

Test Frequency: 1616.25 MHz

Polarization: Vertical and Horizontal





4 OVER-THE-AIR TESTING

System-level tests were conducted during integrated stage testing on the combined Stage 2 / Stage 3 and Stage 3 live-sky test. Beacon messages were transmitted to the Iridium 9602 SBD transceiver with the stage placed outside with a view of the sky. Messages were received via the Rock-Block web-based portal. All messages were received.

Date Time (UTC)	Device	Direction	Payload	Length (Bytes)	Credits Used	Status	Actions
17/Nov/2017 00:15:24	RockBLOCK 12102	↑ MO	MAHIA_RF_TEST_-Z_20171117_1314	30	1	✓	View
17/Nov/2017 00:08:37	RockBLOCK 12102	↑ MO	MAHIA_RF_+Z_20171117_1308	25	1	✓	View
16/Nov/2017 23:55:53	RockBLOCK 12102	↑ MO	MAHIA_RFTEST_+Z_20171117_1255	29	1	✓	View
16/Nov/2017 23:52:08	RockBLOCK 12102	↑ MO	MAHIA_RFTEST_-Z_20171117_1250	29	1	✓	View

Message Details

Received At (UTC)	17/Nov/2017 00:15:24
Device	RockBLOCK 12102
Direction	↑ MO
Message Size	30 bytes (1 credit)

```
0000: 4d 41 48 49 41 5f 52 46 5f 54 45 53 54 5f 2d 5a |MAHIA_RF_TEST_-Z
0016: 5f 32 30 31 37 31 31 31 37 5f 31 33 31 34 .. .. |_20171117_1314' '
```

Copy

Plain Text	MAHIA_RF_TEST_-Z_20171117_1314
Status	✓
Location	
Approx Lat/Lng:	039° 15.043S 177° 52.013E 3KM ?

Delivery Details

Address	Last Attempt / Delivered At (UTC)	Status
e.mcquarrie@rocketlab.co.nz	17/Nov/2017 00:15:28	✓
j.lamorie@rocketlab.co.nz	17/Nov/2017 00:15:28	✓

Close

5 CONTROL OF TRANSMISSION DIRECTION

In order to prevent interference with Radio Astronomy, the Rocket Lab communications system ensures that transmissions will only occur on an Iridium 9602 antenna that is pointed away from the earth. This is implemented using the launch vehicle's navigation system and control of an electromechanical RF switch to select the desired antenna for transmission.

The Electron launch vehicle is equipped with a 6-degree-of-freedom navigation system based on an inertial measurement unit (IMU) and GPS. The navigation algorithm used to control the launch vehicle computes altitude, position, and velocity relative to the earth.

The Electron flight computer has data for the location of each antenna relative to the vehicle body axis. Using a combination of vehicle altitude, vehicle position, and antenna pointing direction, the angle between the nadir and axis of transmission of each antenna is computed.

The direction of transmission is selected such that (a) the transmission is directed towards the Iridium constellation, and (b) radio-frequency transmission is not directed towards earth. Since the Iridium constellation (780km) is higher altitude than the Electron orbit (500km), both conditions are met.

6 EMERGENCY SHUT-OFF

The Rocket Lab communications module shuts down transmissions from the Iridium 9602 if any errors are detected. Rocket Lab can shut down operation of one or all launch vehicle transmitters by sending commands through the vehicle's UHF telemetry link.