

Cislunar explorers Purpose of License Amendment Statement

File Number: 0295-EX-CR-2018

The request to amend the details of Cislunar Explorer's license is due to the addition of a small self-contained femtosatellite, known as a ChipSat, that will be secured to the outside surface of each Cislunar Explorer spacecraft.

At 5cm by 5cm and 2.5 grams, ChipSats represent the current state-of-the-art in small spacecraft. Each ChipSat is simply a Kapton printed circuit board that is outfitted with a suite of surface-mounted sensors, a solar cell, and a low-power transceiver.

The purpose of attaching these devices is to perform a technical demonstration of the ChipSats beyond low-Earth orbit (LEO). Though they have flown multiple times in LEO (on the KickSat I, KickSat II, and Venta I missions), they have never operated at altitudes above 400 km. By attaching these ChipSats to the Cislunar CubeSats, we will prove that the ChipSats can operate in the increased radiation environment of cislunar space and that they can still communicate over the increased distance. This is a critical demonstration on the path to large-scale planetary science missions involving ChipSats.

The ChipSats each have their own independent communications system. The ChipSat uses a CC1310 SimpleLink™ Ultra-Low-Power Sub-1 GHz Wireless MCU in the RGZ48 package as both its flight computer (microcontroller) and radio. It takes the data from the onboard sensors and transmits to ground stations through the embedded ISM-band antenna.

The ChipSats will not begin transmitting until given a command from Cislunar's flight computer. The ChipSats can also cease transmissions at any time when commanded by or if it ceases to receive regular status updates from Cislunar's flight computer. Data will also be communicated to the Cislunar's flight computer over a serial data line. The Cislunar spacecraft will transmit this information through its higher-power radio and higher-gain antenna. The data received from the ChipSats themselves and from the Cislunar CubeSats will be compared to prove that all data has been received correctly from the ChipSats. The ChipSats employ low-density parity checking and to achieve the necessary coding gain for receiving low-power transmissions.

The transmissions from the ChipSats will also be received from the same ground station used by the main Cislunar comms system and was approved in the initial license. The primary ground station is located on Rhodes Hall at Cornell University.

Table 1: ChipSats Telecom Data

ChipSats Telecom Data	ChipSats	
Uplink Frequency	N/A	MHz
Downlink Frequency	915	MHz
Power	0.25	W

Table 2: ChipSats Transmission Specifications

Transmission Specifications		
Name	Value	Unit
Transmitter Power (P)	0.25	W
Transmission Line Loss (TI)	negligible	dB
Transmit Antenna Gain (Gt)	0 (isotropic)	dBi
Antenna Half-Power Beam Width Angle (theta)	See datasheet	Deg
Carrier Frequency (f)	915	MHz

Table 3: ChipSats Path Parameters

Path Parameters		
Name	Value	Unit
Downlink Data Rate	0.05035	Bps
Bit Error Rate (BER)	Negligible at above downlink data rate (Shannon limit)	N/A
Modulation	GPSK	N/A
Coding	LDPC+CDMA	N/A



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Date