Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

6a. Description of Research Project:

Mission Overview: DOGE-1 is a Distributed Ledger Technology and Imaging mission, consisting of one 13.8 kg 12U class satellite intended reach a stable lunar orbit and operate for up to two years.

- DOGE-1 is a Geometric Mission on SpaceX's Falcon 9 2023 Launch paid for entirely in Dogecoin
- First mission to demonstrate Blockchain Technology beyond LEO.
- Unique Marketing Opportunity to display media inside the satellite to be down-linked back to Earth

The DOGE-1 mission entails the design, integration, launch, deployment to a stable lunar orbit, and operation of a 12U CubeSat spacecraft bus and accompanying payloads. DOGE-1 is manifested on the Falcon 9 Intuitive Machines IM-1 Launch as a rideshare mission offering deployment on a Trans Lunar Injection (TLI) trajectory. Once DOGE-1 is deployed it will transition via a minimum energy ballistic trajectory using its electric propulsion system to the most stable elliptical lunar orbit achievable.

The DOGE-1 payloads consist of:
(1) Distributed Public Ledger Technology Development & related imaging, authorization and authentication services (i.e., communications, control, on board transaction processing, public ledger management, monetizable display imaging overlay experiment).
(2) Interoperable Network Communication Architecture applications development including correlateable range, rate, and attitude data for performance analysis (i.e., GNSS above constellation navigation data acquisition, cooperative laser retroreflector target, cooperative relay target).

The DOGE-1 spacecraft is intended to demonstrate technologies that enable ancillary services (Comm, Data, Time, Nav) relay nodes between Earth satellites, constellations, ground stations, as well as other lunar orbiting and landed devices.

DOGE-1 is intended to serve as an infrastructure testbed for precursors to enable our envisioned commercial IoT network based on Interoperable Network Communication Architectures.

A space plaque will also be included, integrated with BETA, RHO, GAMMA, KAPPA, XI utility tokens for space advertising for a limited period of time.

Schedule of Upcoming Mission Milestones: The launch of DOGE-1 spacecraft is manifested as a lunar Rideshare payload on the SpaceX Falcon 9 launch vehicle IM-1 flight. The launch is scheduled for No Earlier Than (NET) January 1, 2023.

Launch Vehicle and Launch Site: The DOGE-1 spacecraft will be launched as a Surfboard payload using a SpaceX Falcon 9 from Cape Canaveral, FL.

Mission Duration: Nominal operations for the DOGE-1 spacecraft is planned for up to 2 years, assuming stable lunar orbit and make-up propellant requirement minimization objectives are achieved. A post-operations orbital lifetime of less than 3 months is anticipated, during which the spacecraft will use its remaining propulsion capabilities to execute a controlled impact on the Moon's surface due to gravitational variation driven orbital decay.

Launch and Deployment Profile: The DOGE-1 spacecraft will be integrated and launched on a SpaceX Falcon 9 vehicle, using the Surfboard adapter. The DOGE-1 spacecraft will be deployed after Trans Lunar

Injection, the accomplishment of the Lunar Injection Maneuver (LIM), and the deployment of the primary payload. The deployment time and coordinates will be at the discretion of the launch service provider. The LIM is being designed to minimize the delta-V required for the primary payload to reach a circularized 100 km Low Lunar Orbit (LLO). By delaying deployment of the DOGE-1 spacecraft until after the primary payload deployment, the delta-V required for DOGE-1 to reach a semi-circularized (elliptical) stable Lunar Orbit will likewise be minimized.

Communications Overview: All mission data is transmitted/received over links established between one of two identical S-Band command, telemetry, tracking, and payload radio transceivers accommodated on the DOGE-1 spacecraft and the baseline Goonhilly Earth Station a fixed ground station with a 32 m diameter dish (GHY-6, Merlin) located in Goonhilly Downs, United Kingdom.
A Global Navigation Satellite System (GNSS) receiver intended to experiment with how to correlate and make effective use of above constellation use of the Global Positioning System (GPS) orbital ephemeris data has been included as part of the Interoperable Network Communications Architecture (INCA) payload. The satellite bus uses reaction wheels, multiple star trackers, and sun sensors to enable precision 3-axis pointing. Telemetry & Tracking (TLM), Command (CMD), and Payload (PLD) data transmission from/to the spacecraft are proposed at S-band frequencies. The CMD and TLM links utilize a dual transceiver system, each of which operates in half-duplex mode (but, not on a common transmit/receive frequency). Accommodations have also been provided for an Endurosat X-Band radio transmitter for PLD and TLM downlink serving as a tertiary backup and additional testing resource.

The TLM & PLD S-Band downlink license authority requested utilizes allocated (space-to-Earth) spectrum in accordance with ITU Table of Frequency Allocations – within the frequency band 2200 to 2290 MHz. The applicable allocation is abstracted as the worksheet tab [FCC Regulations Abstract] in the DOGE-1 Radio License Reclama XISP-Inc Workbook. The TLM downlink data rate will vary for experimental purposes from 2.4 kbps (radio minimum bitrate) to 90 kbps (radio maximum bitrate). The requested Center Point Frequency is 2289.5 MHz, and the minimum operational bandwidth is 0.065 MHz. Accordingly, the Necessary Bandwidth of the radio system will vary for experimental purposes from 2.472 to 92.7 kHz, and will in all instances be enveloped by and well within the requested Necessary Bandwidth allocation of 1 MHz requested. See FCC Appendix J based calculations on the worksheet tab [Necessary Bandwidth] in the DOGE-1 Link Budgets, XISP-Inc Workbook. GMSK modulation is employed on the TLM downlink.

The CMD S-Band uplink license authority requested utilizes allocated (Earth-to-space) spectrum in accordance with ITU Table of Frequency Allocations – within the frequency band of 2025 to 2110 MHz. The applicable allocation is abstracted as the worksheet tab [FCC Regulations Abstract] in the DOGE-1 Radio License Reclama XISP-Inc Workbook. The CMD uplink data rate will vary for experimental purposes from 2.4 kbps (radio minimum bitrate) to 90 kbps (radio maximum bitrate). The requested Center Point Frequency is 2025.5 MHz, and the minimum operational bandwidth is 0.065 MHz. Accordingly, the Necessary Bandwidth of the radio system will vary for experimental purposes from 2.472 to 92.7 kHz, and will in all instances be enveloped by and well within the requested Necessary Bandwidth allocation of 1 MHz requested. See FCC Appendix J based calculations on the worksheet tab [Necessary Bandwidth] in the DOGE-1 Link Budgets, XISP-Inc Workbook. GMSK modulation is employed on the CMD uplink.

The PLD & TLM X-Band downlink license authority requested utilizes allocated (space-to-Earth) spectrum in accordance with ITU Table of Frequency Allocations – within the frequency band 2200 to 2290 MHz. The applicable allocation is abstracted as the worksheet tab [FCC Regulations Abstract] in the DOGE-1

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

Radio License Reclama XISP-Inc Workbook. The TLM downlink data rate will vary for experimental purposes from 2000 kbps (radio minimum bitrate) to 125000 kbps (radio maximum bitrate). The requested Center Point Frequency is 8262.5 MHz, and the minimum operational bandwidth is 60 MHz. Accordingly, the Necessary Bandwidth of the radio system will vary for experimental purposes from 0.65 to 97.5 MHz, and will in all instances be enveloped by and well within the requested Necessary Bandwidth allocation of 375 MHz requested. See FCC Appendix J based calculations on the worksheet tab [Necessary Bandwidth] in the DOGE-1 Link Budgets, XISP-Inc Workbook. QPSK 1/4 modulation is employed on the X-band PLD and TLM downlink.

FCC ONLINE TABLE OF FREQUENCY ALLOCATIONS Exceptions/Coordination/Special Requests

ITU Frequency Allocation: 2025-2110 MHz
– Goonhilly Earth Station S-Band Uplink to DOGE-1 (Earth-to-Space)
FIXED NG118 – Does not conflict and requested allocation is consistent with Region 1 (Goonhilly Earth Station is in Region 1) SPACE OPERATION, EARTH EXPLORATION SATELLITE, SPACE RESEARCH, and FIXED frequency allocations.
5.392 – Compliant
US90 – Compliant
US92 – Compliant, coordination initiated through NASA
US222 – Not Applicable
US346 – Compliant, coordination initiated through NASA
US347 – Special Request for Allocation is hereby made, coordination initiated through NASA

ITU Frequency Allocation: 2200-2290 MHz
– DOGE-1 S-Band Downlink to Goonhilly Earth Station (space-to-Earth)
5.392 – Does not conflict and requested allocation is consistent with Region 1 (Goonhilly Earth Station is in Region 1) SPACE OPERATION, EARTH EXPLORATION SATELLITE, SPACE RESEARCH, and FIXED frequency allocations.
US303 – Special Request for Allocation is hereby made for potential transmission to the Tracking and Data Relay Satellite System, coordination initiated through NASA.

ITU Frequency Allocation: 8025-8400 MHz
– DOGE-1 X-Band Downlink to Goonhilly Earth Station (space-to-Earth)
5.462A – Compliant. However, Special Request for Authorization to make use of the Region 1 EARTH EXPLORATION-SATELLITE (space-to-Earth) Allocation is hereby requested.
US258 – Special Request for Authorization to make use of the EARTH EXPLORATION-SATELLITE (space-to-Earth) Allocation is hereby requested subject to satisfactory resolution of electromagnetic compatibility analysis. Coordination has been initiated through NASA.

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

FEDERAL COMMUNICATIONS COMMISSION OFFICE OF ENGINEERING AND TECHNOLOGY POLICY AND RULES DIVISION

FCC ONLINE TABLE OF FREQUENCY ALLOCATIONS

47 C.F.R. § 2.106

Revised on February 1, 2021

Table of Frequency Allocations			1626.5-2110 MHz (UHF)		Page 36
International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
2025-2110			2025-2110	2025-2110	
SPACE OPERATION			SPACE OPERATION	FIXED NG118	TV Auxiliary Broadcasting (74F)
(Earth-to-space) (space-to-space)			(Earth-to-space) (space-to-space)	MOBILE 5.391	Cable TV Relay (78)
EARTH EXPLORATION-SATELLITE			EARTH EXPLORATION-SATELLITE		Local TV Transmission (101J)
(Earth-to-space) (space-to-space)			(Earth-to-space) (space-to-space)		
SPACE RESEARCH			SPACE RESEARCH		
(Earth-to-space) (space-to-space)			(Earth-to-space) (space-to-space)		
FIXED			FIXED		
MOBILE 5.391			MOBILE 5.391		
				5.392 US90 US92 US222	
5.392			5.392 US90 US92 US222 US346 US347	US346 US347	

NOTES:

This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for S-Band uplink services, with anticipated operations for less than two years.

NG118 In the bands 2025-2110 MHz, 6875-7125 MHz, and 12.7-13.25 GHz, television translator relay stations may be authorized to use frequencies on a secondary basis to other stations in the Television Broadcast Auxiliary Service that are operating in accordance with the Table of Frequency Allocations.

5.392 Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites, in the space research, space operations and Earth exploration-satellite services in the bands **2025-2110 MHz** and 2200-2290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

US90 In the band **2025-2110 MHz**, the power flux-density at the Earth's surface produced by emissions from a space station in the space operation, Earth exploration-satellite, or space research service that is transmitting in the space-to-space direction, for all conditions and all methods of modulation, shall not exceed the following values in any 4 kHz sub-band:

(a) −154 dBW/m^2 for angles of arrival above the horizontal plane (δ) of 0° to 5°,

(b) −154 + 0.5(δ-5) dBW/m^2 for δ of 5° to 25°, and

(c) −144 dBW/m^2 for δ of 25° to 90°.

US92 In the band **2025-2110 MHz**, Federal use of the co-primary fixed and mobile services is restricted to the military services and the following provisions apply:
(a) Federal use shall not cause harmful interference to, nor constrain the deployment and use of the band by, the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service. ***To facilitate compatible operations, coordination is required in accordance with a Memorandum of Understanding between Federal and non-Federal fixed and mobile operations.*** Non-Federal licensees shall make all reasonable efforts to accommodate military mobile and fixed operations; however, the use of the band 2025-2110 MHz by the non-Federal fixed and mobile services has priority over military fixed and mobile operations.
(b) Military stations should, to the extent practicable, employ frequency agile technologies and techniques, including the capability to tune to other frequencies and the use of a modular retrofit capability, to facilitate sharing of this band with incumbent Federal and non-Federal operations.

US222 In the band **2025-2035 MHz**, geostationary operational environmental satellite (GOES) earth stations in the space research and Earth exploration-satellite services may be authorized on a coequal basis for Earth-to-space transmissions for tracking, telemetry, and telecommand at Honolulu, HI (21° 21' 12" N, 36" W); Seattle, WA (47° 34' 15" N, 122° 33' 10" W); and Wallops Island, VA (37° 56' 44" N, 75° 27' 42" W).

US346 Except as provided for below and by US222, Federal use of the band **2025-2110 MHz** by the space operation service (Earth-to-space), Earth exploration-satellite service (Earth-to-space), and space research service (Earth-to-space) shall not constrain the deployment of the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service.
To facilitate compatible operations between non-Federal terrestrial receiving stations at fixed sites and Federal earth station transmitters, ***coordination is required*** .
To facilitate compatible operations between non-Federal terrestrial transmitting stations and Federal spacecraft receivers, the terrestrial transmitters in the band 2025-2110 MHz shall not be high-density systems (see Recommendations ITU-R SA.1154 and litary satellite control stations at the following sites shall operate on a co-equal, primary basis with non-Federal operations:

Facility	Coordinates	
Naval Satellite Control Network, Prospect Harbor, ME	44° 24' 16" N	068° 00' 46" W
New Hampshire Tracking Station, New Boston AFS, NH	42° 56' 52" N	071° 37' 36" W
Eastern Vehicle Check-out Facility & GPS Ground Antenna & Monitoring Station, Cape Canaveral, FL	28° 29' 09" N	080° 34' 33" W
Buckley AFB, CO	39° 42' 55" N	104° 46' 36" W
Colorado Tracking Station, Schriever AFB, CO	38° 48' 21" N	104° 31' 43" W
Kirtland AFB, NM	34° 59' 46" N	106° 30' 28" W
Camp Parks Communications Annex, Pleasanton, CA	37° 43' 51" N	121° 52' 50" W
Naval Satellite Control Network, Laguna Peak, CA	34° 06' 31" N	119° 03' 53" W
Vandenberg Tracking Station, Vandenberg AFB, CA	34° 49' 21" N	120° 30' 07" W
Hawaii Tracking Station, Kaena Pt, Oahu, HI	21° 33' 44" N	158° 14' 31" W
Guam Tracking Stations, Anderson AFB, and Naval CTS, Guam	13° 36' 54" N	144° 51' 18" E

US347 In the band **2025-2110 MHz**, non-Federal Earth-to-space and space-to-space transmissions may be authorized in the space research and Earth exploration-satellite services subject to such conditions as may be applied on a case-by-case basis. Such transmissions shall not cause harmful interference to Federal and non-Federal stations operating in accordance with the Table of Frequency Allocations.

NG118 In the bands **2025-2110 MHz**, 6875-7125 MHz, and 12.7-13.25 GHz, television translator relay stations may be authorized to use frequencies on a secondary basis to other stations in the Television Broadcast Auxiliary Service that are operating in accordance with the Table of Frequency Allocations.

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

Table of Frequency Allocations			2110-2483.5 MHz (UHF)		Page 37
International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
2200-2290			**2200-2290**	**2200-2290**	
SPACE OPERATION			SPACE OPERATION		
(space-to-Earth) (space-to-space)			(space-to-Earth) (space-to-space)		
EARTH EXPLORATION-SATELLITE			EARTH EXPLORATION-SATELLITE		
(space-to-Earth) (space-to-space)			(space-to-Earth) (space-to-space)		
FIXED			FIXED (line-of-sight only)		
MOBILE 5.391			MOBILE (line-of-sight only including aeronautical telemetry, but excluding flight testing of manned aircraft) 5.391		
SPACE RESEARCH			SPACE RESEARCH		
(space-to-Earth) (space-to-space)			(space-to-Earth) (space-to-space)		
5.392			5.392 US303	US303	

NOTES:

This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for S-Band downlink services, with anticipated operations for less than two years.

5.392 Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites, in the space research, space operations and Earth exploration-satellite services in the bands 2025-2110 MHz and **2200-2290 MHz**, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

US303 In the band **2285-2290 MHz**, non-Federal space stations in the space research, space operations and Earth exploration-satellite services may be authorized to transmit to the Tracking and Data Relay Satellite System subject to such conditions as may be applied on a case-by-case basis. Such transmissions shall not cause harmful interference to authorized Federal stations. The power flux-density at the Earth's surface from such non-Federal stations shall not exceed -144 to -154 dBW/m^2/4 kHz, depending on angle of arrival, in accordance with ITU Radio Regulation 21.16.
Authorization to make use of this allocation to transmit to the Tracking and Data Relay Satellite System as an alternate communication path to Earth subject to such conditions as may be applied is hereby requested.

Table of Frequency Allocations			7145-8650 MHz (SHF)		Page 45
International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
7900-8025			**7900-8025**	**7900-8025**	
FIXED			FIXED-SATELLITE (Earth-to-space)		
FIXED-SATELLITE (Earth-to-space)			MOBILE (Earth-to-space)		
MOBILE			FIXED-SATELLITE (Earth-to-space)		
5.461			G117		

NOTES:

This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for X-Band uplink services, with anticipated operations for less than two years. Use of this capability is not acticipated at this time but the capability to support the same at some level is anticipated to be extant.

5.461 Additional allocation: the bands 7250-7375 MHz (space-to-Earth) and **7900-8025 MHz** (Earth-to-space) are also allocated to the mobile-satellite service on a primary basis, subject to agreement obtained under No. 9.21.

G117 In the bands 7.25-7.75 GHz, **7.9-8.4 GHz**, 17.375-17.475 GHz, 17.6-21.2 GHz, 30-31 GHz, 33-36 GHz, 39.5-41 GHz, 43.5-45.5 GHz and 50.4-51.4 GHz, the Federal fixed-satellite and mobile-satellite services are limited to military systems.

8025-8175	**8025-8175**	**8025-8400**	
EARTH EXPLORATION-SATELLITE (space-to-Earth)	EARTH EXPLORATION-SATELLITE (space-to-Earth)		
FIXED	FIXED		
FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space)		
	Mobile-satellite (Earth-to-space)(no airborne transmissions)		
MOBILE 5.463	US258 G117		

NOTES:

This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for X-Band downlink services, with anticipated operations for less than two years. Use of this capability is not anticipated at this time but the capability to support the same at some level is expected to be extant.

5.463 Aircraft stations are not permitted to transmit in the band **8025-8400 MHz**.

US258 In the bands **8025-8400 MHz** and 25.5-27 GHz, the Earth exploration-satellite service (space-to-Earth) is allocated on a primary basis for non-Federal use. Authorizations are subject to a case-by-case electromagnetic compatibility analysis. ***Authorization to make use of this allocation is hereby requested subject to satisfactory resolution of electromagnetic compatibility analysis.***

G117 In the bands 7.25-7.75 GHz, **7.9-8.4 GHz**, 17.375-17.475 GHz, 17.6-21.2 GHz, 30-31 GHz, 33-36 GHz, 39.5-41 GHz, 43.5-45.5 GHz and 50.4-51.4 GHz, the Federal fixed-satellite and mobile-satellite services are limited to military systems.

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

8175-8215	**8175-8215**		
EARTH EXPLORATION-SATELLITE (space-to-Earth)	EARTH EXPLORATION-SATELLITE (space-to-Earth)		
FIXED	FIXED		
FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space)		
METEOROLOGICAL-SATELLITE (Earth-to-space)	METEOROLOGICAL-SATELLITE (Earth-to-space)		
	Mobile-satellite (Earth-to-space)(no airborne transmissions)		
MOBILE 5.463	US258 G104 G117		
NOTES:			
This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for X-Band downlink services, with anticipated operations for less than two years. Use of this capability is not acticipated at this time but the capability to support the same at some level is anticipated to be extant.			
5.463 Aircraft stations are not permitted to transmit in the band **8025-8400 MHz**.			
US258 In the bands **8025-8400 MHz** and 25.5-27 GHz, the Earth exploration-satellite service (space-to-Earth) is allocated on a primary basis for non-Federal use. Authorizations are subject to a case-by-case electromagnetic compatibility analysis. ***Authorization to make use of this allocation is hereby requested subject to satisfactory resolution of electromagnetic compatibility analysis.***			
G104 In the bands 7450-7550 and **8175-8215 MHz**, it is agreed that although the military space radio communication systems, which include earth stations near the proposed meteorological-satellite installations will precede the meteorological-satellite installations, engineering adjustments to either the military or the meteorological-satellite systems or both will be made as mutually required to assure compatible operations of the systems concerned.			
G117 In the bands 7.25-7.75 GHz, **7.9-8.4 GHz**, 17.375-17.475 GHz, 17.6-21.2 GHz, 30-31 GHz, 33-36 GHz, 39.5-41 GHz, 43.5-45.5 GHz and 50.4-51.4 GHz, the Federal fixed-satellite and mobile-satellite services are limited to military systems.			

8215-8400	**8215-8400**		
EARTH EXPLORATION-SATELLITE (space-to-Earth)	EARTH EXPLORATION-SATELLITE (space-to-Earth)		
FIXED	FIXED		
FIXED-SATELLITE (Earth-to-space)	FIXED-SATELLITE (Earth-to-space)		
MOBILE 5.463	Mobile-satellite (Earth-to-space)(no airborne transmissions)		
5.462A	US258 G117	US258	
NOTES:			
This FCC Regulations Abstract applies to the DOGE-1 12U lunar orbiting cubesat applying for an Experimental Operators License in conjunction with Goonhilly Earth Station for X-Band downlink services, with anticipated operations for less than two years. Use of this capability is not anticipated at this time but the capability to support the same at some level is anticipated to be extant.			
5.462A In Regions 1 and 3 (except for Japan), in the band **8025-8400 MHz**, the Earth exploration-satellite service using geostationary satellites shall not produce a power flux-density in excess of the following values for angles of arrival (θ), without the consent of the affected administration: −135 dB(W/m²) in a 1 MHz band for $0 \leq \theta \leq 5°$ $-135 + 0.5\ (\theta - 5)$ dB(W/m²) in a 1 MHz band for $5 \leq \theta \leq 25°$ −125 dB(W/m²) in a 1 MHz band for $25 \leq \theta \leq 90°$ (WRC-12)			
US258 In the bands **8025-8400 MHz** and 25.5-27 GHz, the Earth exploration-satellite service (space-to-Earth) is allocated on a primary basis for non-Federal use. Authorizations are subject to a case-by-case electromagnetic compatibility analysis. ***Authorization to make use of this allocation is hereby requested subject to satisfactory resolution of electromagnetic compatibility analysis.***			
G117 In the bands 7.25-7.75 GHz, **7.9-8.4 GHz**, 17.375-17.475 GHz, 17.6-21.2 GHz, 30-31 GHz, 33-36 GHz, 39.5-41 GHz, 43.5-45.5 GHz and 50.4-51.4 GHz, the Federal fixed-satellite and mobile-satellite services are limited to military systems.			

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

1. SPACECRAFT DESCRIPTION

Physical Description of the Spacecraft: The exterior dimensions of the satellite are shown in Table 2-1 Spacecraft Physical Description. The available rideshare payload envelope and the Mercury 12T dispenser are show in Figure 2-1 Mercury-12T Dispenser within SpaceX Surfboard Volume Envelope. Figure 2-2 Mercury-12T Dispenser shows the dispenser alone. Figure 2-3 Surfboard illustrates the SpaceX Surfboard. Figure 2-4 Rideshare Payload Volume and Surfboard and Figure 2-5 DOGE-1 SpaceX Surfboard Location provides other views.

Deploy Order		1
Payload Constituent		DOGE-1 CubeSat
SpaceX Internal Name		payload_DOGE-1_2
Separation System		Mercury-12T
Quantity of Deployables in this deploy		1.00
Deployable Type(s)		12U CubeSat
Separation Plane Origin (mm)	X_{PL}	578.87
	Y_{PL}	0.00
	Z_{PL}	177.90
Deploy Vector (unit vector)	X_{PL}	1.00
	Y_{PL}	0.00
	Z_{PL}	0.00
Deployable Dimensions (mm) Width x Height is parallel to separation plane	Width	240.40
	Height (in Zpl)	224.90
	Length (along deploy axis)	366.00
Total Deploy Mass	Nominal (kg)	13.80
	+ Tolerance (kg)	1.50
	- Tolerance (kg)	1.50
Total Separation Energy	Nominal (J)	11.07
	+ Tolerance (%)	20
	- Tolerance (%)	20
Time delay from initiation of electrical signal until first movement of Payload Constituent	Nominal Delay (s)	0.02
	+ Tolerance (s)	0.03
	- Tolerance (s)	0.015
Nominal Deploy Velocity [m/sec]		1.267

Table 2-1 Spacecraft Physical Description

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

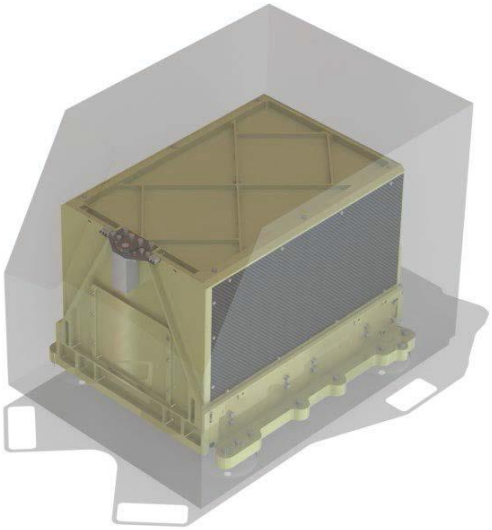

Figure 2-1 Mercury-12T Dispenser within SpaceX Surfboard Volume Envelope

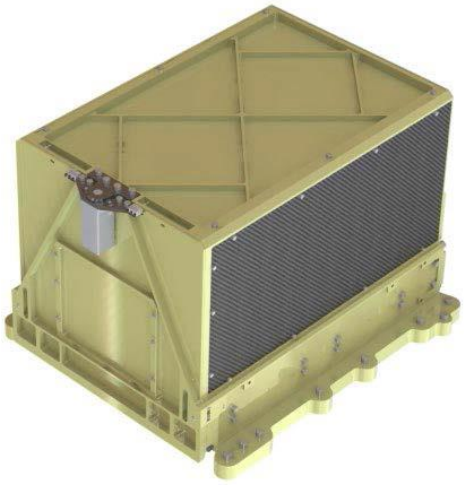

Figure 2-2 Mercury-12T Dispenser

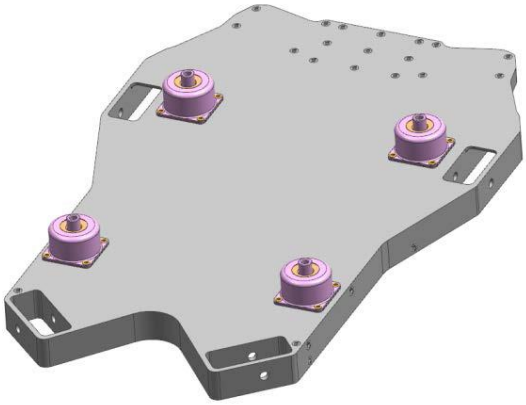

Figure 2-3 SpaceX Surfboard

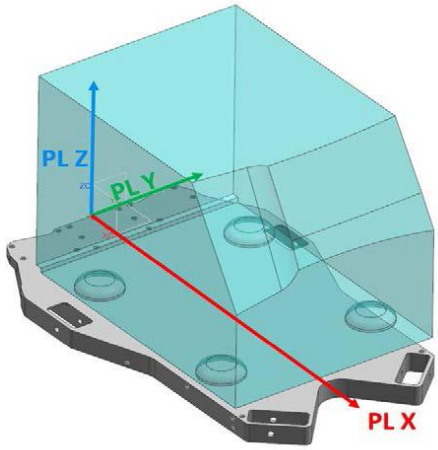

Figure 2-4 Rideshare Payload Volume and Surfboard

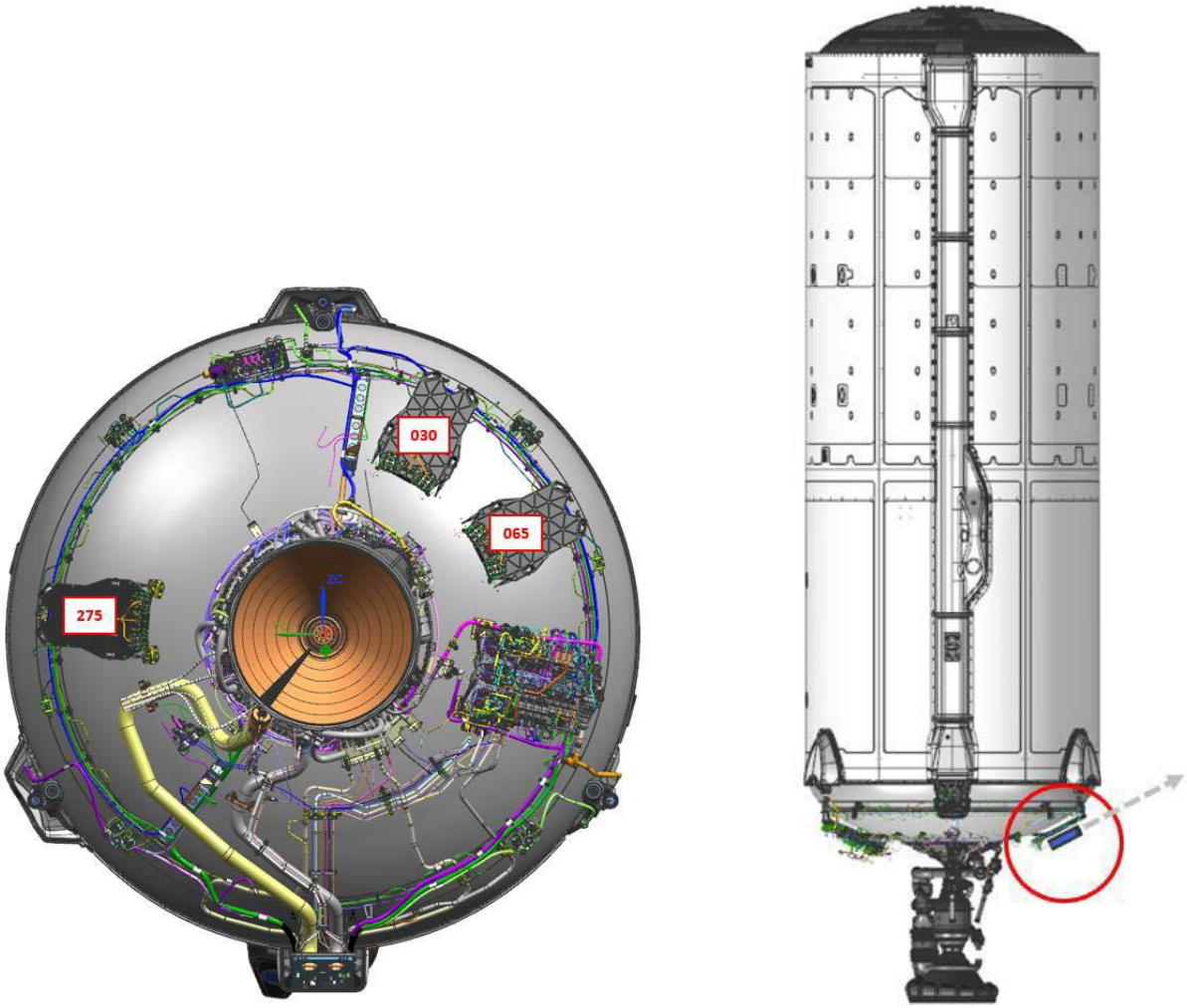

Figure 2-5 DOGE-1 SpaceX Surfboard Location

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

DOGE-1 Spacecraft Bus & Payloads consist of the following elements:

- 12U tabulated CubeSat structure – Exobotics Ltd
- A3200 On Board Computer – GOMSpace A/S (flight heritage)
- Attitude Determination & Control System (ADCS)
    - Reaction wheels + sun sensors – GOMSpace A/S (flight heritage)
    - Star trackers – CubeSpace SA (flight heritage)
- P31U Electrical Power System (EPS) – GOMSpace A/S (flight heritage)
    - BPX batteries (3x 75 Wh packs) – GOMSpace A/S (flight heritage)
    - Solar panels (8x 8W XY panels + 1x 2.3W Z panel) – Exobotics Ltd
- NanoCom AX2150 S-band radio system – GOMSpace A/S (flight heritage)
- NanoCom AM2150-P S-band antenna – GOMSpace A/S (flight heritage)
- X-Band Transmitter – Endurosat (flight heritage) [Radio Experiment QoS for location]
- X-Band Patch Antenna – Endurosat (flight heritage) [Radio Experiment QoS for location]
- Enpulsion NANO Electric Propulsion (2x) – Enpulsion GmbH (flight heritage)
- Payload 1, Distributed Ledger Technology (DLT) (imaging system + display) – Exobotics Ltd
- Payload 2, Geospatial Navigation Satellite System (GNSS) Multi-channel Receiver & Antenna – Novatel (flight heritage).[Radio Experiment QoS for location]
- Payload 3 (aspirational), Passive Retroreflectors (up to four) – Exobotics Ltd.

The nominal mass of the deployed satellite is 13.8 kg.

The DOGE-1 spacecraft has no deployable and is shown in Figure 2-6 DOGE-1 Spacecraft Isometric Renderings.

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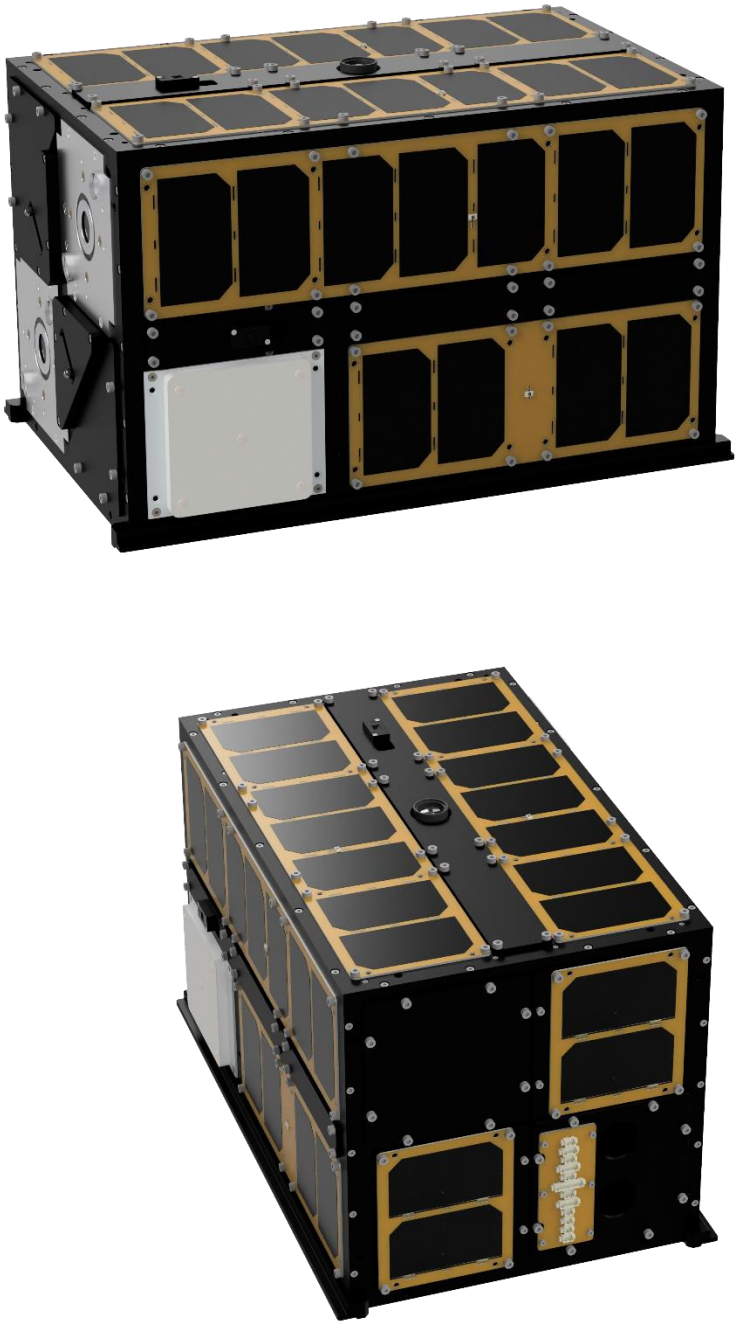

Figure 2-6 DOGE-1 Spacecraft Isometric Renderings

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

Total Mass of Satellite at Launch, Including All Propellants and Fluids: 13.8 kg.

Dry Mass of the Satellite: 13.8 kg.

payload__1			
Name	Deployable Identifier	Coordinate System	Separation Plane Distance [mm]
payload__1	1	Payload	0.00
Mass			
	Nominal [kg]	Plus Tolerance [+]	Minus Tolerance [-]
Mass	13.8000	1.5000	1.5000
Center of Gravity			
	Nominal [mm]	Plus Tolerance [+]	Minus Tolerance [-]
X_{PL}	372.4000	25.0000	25.0000
Y_{PL}	-1.5000	25.0000	25.0000
Z_{PL}	200.1000	25.0000	25.0000
Moment of Inertia			
	Nominal [millimeters ** 2 * kg]	Plus Tolerance [+]	Minus Tolerance [-]
Ixx	160000.0000	24000.00	24000.00
Iyy	234000.0000	35100.00	35100.00
Izz	236000.0000	35400.00	35400.00
Product of Inertia			
	Nominal [millimeters ** 2 * kg]	Plus Tolerance [+]	Minus Tolerance [-]
Ixy	2420.0000	9440.00	9440.00
Iyz	4470.0000	9440.00	9440.00
Izx	2000.0000	9440.00	9440.00

Table 2-2 DOGE-1 Mass Properties

Identification of All Fluids On-Board: No fluids are on-board.

Description of Propulsion System: The DOGE-1 spacecraft will be equipped with dual Enpulsion FEEP Nano electric propulsion system as previously noted.

Description of Attitude Determination and Control System: Following separation from the launch vehicle, the DOGE-1 spacecraft will autonomously de-tumble and be oriented into sun-pointing mode. The following chart describes the attitude determination and control system ("ADCS") modes that will be employed, using a combination of sun sensors, reaction wheels, star trackers, and if necessary, the electric propulsion system to orient the DOGE-1 spacecraft.

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

The spacecraft is three axis stabilized using its ADCS. The anticipated spacecraft bus and payload pointing objectives (ADCS modes) are outlined in Table 2-2 DOGE-1 Anticipated ADCS modes.

ADCS Mode	Description
Safe Mode	Coarse pointing of Z+ face NADIR with low-rate Z axis roll for detumbling with minimum power requirements.
Sun Pointing	Optimized sun pointing for power generation.
Low-rate Comms Pointing (TT&C)	Optimized Earth station pointing for S-Band Tracking, Telemetry & Command (TTC) communications uplink and downlink.
Image Pointing	Optimized pointing for Distributed Ledger Technology (DLT) image acquisition and display.
Navigation Pointing	Optimized GNSS pointing for above constellation multi-satellite fixes.
High-rate Comms Pointing (Payload)	Optimized Earth station pointing for X-Band payload high-rate data downlink (aspirational).
Relay Comms Pointing	Optimized pointing for space-to-space data relay communication (aspirational).
Retroreflector Pointing	Optimized pointing for Earth-to-space, and space-to-space passive laser retroreflector acquisition (aspirational).
Sun Clocking	To generate additional power, this mode permits the satellite to rotate around its fixed inertial axis towards the sun, while also operating in the Pointing modes.

Table 2-2 DOGE-1 Anticipated ADCS modes

Fluids in Pressurized Batteries: None. The DOGE-1 spacecraft employ unpressurized standard lithium-ion battery cells.

Description of Pyrotechnic Devices: None.

Form 442, Technical Question 6 Response
DOGE-1 Mission Experimental Program – Spectrum Utilization Details
(Revision 1.0)

Description of Electrical and Power System:

The P31U Electrical Power System (EPS) provided by GOMSpace A/S is flight heritage equipment which supplies power to the spacecraft bus and payload. The EPS includes:

- BPX batteries (3x 75 Wh packs = 225 Wh total) – GOMSpace A/S (flight heritage)
- Solar panels (8x 8W XY panels + 1x 2.3W Z panel = 66.3 W total) – Exobotics Ltd

The spacecraft bus and payloads can draw power from both the batteries and the solar arrays individually or simultaneously as needed to support operations.

The battery packs are all equipped with power regulation ICs which regulate the discharge state of the individual battery cells. All of the battery packs are charged by the solar panels.

The satellite bus nominally consumes less than 20 W of power, with certain modes reducing or increasing the load. The payload maximum available power (solar array + batteries) is 100 W. The charge/discharge cycle is managed by a power management system overseen by the On-Board Computer (OBC) and the Electrical Power System (EPS).

Identification of Other Stored Energy: None.

Identification of Any Radioactive Materials: None.