

Da Vinci EMC Analysis – Interference Study

Da Vinci Overview

Da Vinci is a 3U Cubesat, with one ground station in Post Falls, Idaho. It is a STEM Education Project. It will launch around June 1, 2018 when it will be inserted into an orbit at 500 km apogee and 500 km perigee, on an inclination from the equator of 85 degrees. Transmission will begin 15 minutes after launch, and cease 24 months after launch.

The downlink is 432.5 MHz, and the uplink is 144.5 MHz. To demonstrate compliance with an experimental systems obligation to operate on a non-interference basis with other authorized operators in the bands, this report provides an electromagnetic compatibility study with the existing authorized users. Specifically, it 1) reviews the services and footnotes cited in the frequency allocation table for services in this frequency; 2) reviews operator registrations in this frequency range and the geographic operating range; 3) provides coordination confirmation from the American Radio Relay League; 4 estimates the probability of interference with an amateur operator.

It shows that no interference is expected to occur, based on any of these considerations.

1) Frequency Allocations and Footnotes 432.5 MHz

A review of the FCC Online Table of Frequency Allocations shows the following:

For International Region 1, the range of 432 to 438 MHz is allocated to Amateur, Radiolocation and Earth Exploration Satellite (active). The following footnotes apply:

5.279A The use of this band by sensors in the Earth exploration-satellite service (active) shall be in accordance with Recommendation ITU-R RS.1260-1.

Additionally, the Earth exploration-satellite service (active) in the band 432-438 MHz shall not cause harmful interference to the aeronautical radionavigation service in China. The provisions of this footnote in no way diminish the obligation of the Earth exploration satellite service (active) to operate as a secondary service in accordance with Nos. 5.29 and 5.30.

Comment: We will not be operating in view of China.

5.138 The following bands:

6765-6795 kHz (centre frequency 6780 kHz),

433.05-434.79 MHz (centre frequency 433.92 MHz) in Region 1 except in the countries mentioned in No. 5.280,

61-61.5 GHz (centre frequency 61.25 GHz),

122-123 GHz (centre frequency 122.5 GHz), and 244-246 GHz (centre frequency 245 GHz)

are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations.

Comment: Our frequency is not one of those mentioned.

5.271 *Additional allocation:* in Belarus, China, India, Kyrgyzstan and Turkmenistan, the band 420-460 MHz is also allocated to the aeronautical radionavigation service (radio altimeters) on a secondary basis. (WRC-07)

Comment: We will not operate in view of any of the nations mentioned.

5.276 in Afghanistan, Algeria, Saudi Arabia, Bahrain, Bangladesh, Brunei, Darussalam, Burkina Faso, Djibouti, Egypt, the United Arab Emirates, Ecuador, Eritrea, Ethiopia, Greece, Guinea, India, Indonesia, Iran (Islamic Republic of), Iraq, Israel, Italy, Jordan, Kenya, Kuwait, Libya, Malaysia, Niger, Nigeria, Oman, Pakistan, the Philippines, Qatar, the Syrian Arab Republic, the Dem. People's Rep. of Korea, Singapore, Somalia, Sudan, Switzerland, Tanzania, Thailand, Togo, Turkey and Yemen, the band 430-440 MHz is also allocated to the fixed service on a primary basis and the bands 430-435 MHz and 438-440 MHz are also allocated to the mobile, except aeronautical mobile, service on a primary basis. (WRC-12)

Comment: We will not operate in view of any of the nations mentioned.

5.277 *Additional allocation:* in Angola, Armenia, Azerbaijan, Belarus, Cameroon, Congo (Rep. of the), Djibouti, the Russian Federation, Georgia, Hungary, Israel, Kazakhstan, Mali, Mongolia, Uzbekistan, Poland, the Dem. Rep. of the Congo, Kyrgyzstan, Slovakia, Romania, Rwanda, Tajikistan, Chad, Turkmenistan and Ukraine, the band 430-440 MHz is also allocated to the fixed service on a primary basis. (WRC-12)

Comment: We will not operate in view of any of the nations mentioned.

5.280 In Germany, Austria, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Montenegro, Portugal, Serbia, Slovenia and Switzerland, the band 433.05-434.79 MHz (centre frequency 433.92 MHz) is designated for industrial, scientific and medical (ISM) applications.

Radiocommunication services of these countries operating within this band must accept harmful interference which may be caused by these applications. ISM equipment operating in this band is subject to the provisions of No. 15.13. (WRC-07)

Comment: We will not operate in view of any of the nations mentioned.

5.281 *Additional allocation:* in the French overseas departments and communities in Region 2 and India, the band 433.75-434.25 MHz is also allocated to the space operation service (Earth-to-space) on a primary basis. In France and in Brazil, the band is allocated to the same service on a secondary basis.

Comment: We will not operate in view of any of the departments, communities or nations mentioned.

5.282 In the bands 435-438 MHz, 1260-1270 MHz, 2400-2450 MHz, 3400-3410 MHz (in Regions 2 and 3 only) and 5650-5670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. 5.43). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. 25.11. The use of the bands 1260-1270 MHz and 5650-5670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

Comment: Our frequency is not within any of the frequency ranges specified.

For International Regions 2 and 3, the range of 432 to 438 MHz is allocated to Amateur, Radiolocation and Earth Exploration Satellite (active). The following footnotes apply:

5.271, 5.276, 5.277, 5.281, 5.282

Comment: All of these footnotes were addressed in the previous section.

5.279 *Additional allocation:* in Mexico, the bands 430-435 MHz and 438-440 MHz are also allocated on a primary basis to the land mobile service, subject to agreement obtained under No. 9.21.

Comment: We will not operate in view of Mexico.

For Federal use, the range of 420 to 450 MHz is allocated for Radiolocation, with the following footnotes:

G2 In the bands 216.965-216.995 MHz, 420-450 MHz (except as provided for in G129), 890-902 MHz, 928-942 MHz, 1300-1390 MHz, 2310-2390 MHz, 2417-2450 MHz, 2700-2900 MHz, 3300-3500 MHz (except as provided for in US108), 5650-5925 MHz, and 9000-9200 MHz, use of the Federal radiolocation service is restricted to the military services.

Comment: We will not use the Federal radiolocation services.

G129 Federal wind profilers are authorized to operate on a primary basis in the radiolocation service in the frequency band 448-450 MHz with an authorized bandwidth of no more than 2 MHz centered on 449 MHz, subject to the following conditions: 1) wind profiler locations must be pre-coordinated with the military services to protect fixed military radars; and 2) wind profiler operations shall not cause harmful interference to, nor claim protection from, military mobile radiolocation stations that are engaged in critical national defense operations.

Comment: Our frequency is not within any of the frequency ranges mentioned.

For non Federal use, the range of 420 to 450 MHz is allocated for Amateur, with the following footnotes:

5.282

Comment: this footnote was addressed in a previous section above.

5.286 The band 449.75-450.25 MHz may be used for the space operation service (Earth-to-space) and the space research service (Earth-to-space), subject to agreement obtained under No. 9.21.

Comment: Our frequency is not within the range specified.

US64 (a) In the band 401-406 MHz, the mobile, except aeronautical mobile, service is allocated on a secondary basis and is limited to, with the exception of military tactical mobile stations, Medical Device Radiocommunication Service (MedRadio) operations. MedRadio stations are authorized by rule on the condition that harmful interference is not caused to stations in the meteorological aids, meteorological satellite, and Earth exploration-satellite services, and that MedRadio stations accept interference from stations in the meteorological aids, meteorological-satellite, and Earth exploration-satellite services.

(b) The bands 413-419 MHz, 426-432 MHz, 438-444 MHz, and 451-457 MHz are also allocated on a secondary basis to the mobile, except aeronautical mobile, service. The use of this allocation is limited to MedRadio operations. MedRadio stations are authorized by rule and operate in accordance with 47 CFR part 95.

Comment: Our frequency does not lie within any of the frequency ranges stated.

US87 The band 449.75-450.25 MHz may be used by Federal and non-Federal stations for space telecommand (Earth-to-space) at specific locations, subject to such conditions as may be applied on a caseby-case basis. Operators shall take all practical steps to keep the carrier frequency close to 450 MHz.

Comment: Our frequency does not lie within the frequency range stated.

US230 The bands 422.1875-425.4875 MHz and 427.1875-429.9875 MHz are allocated to the land mobile service on a primary basis for non-Federal use within 80.5 kilometers (50 miles) of Cleveland, OH (41° 29' 51.2" N, 81° 41' 49.5" W) and Detroit, MI (42° 19' 48.1" N, 83° 02' 56.7" W). The bands 423.8125-425.4875 MHz

and 428.8125-429.9875 MHz are allocated to the land mobile service on a primary basis for nonFederal use within 80.5 kilometers of Buffalo, NY (42° 52' 52.2" N, 78° 52' 20.1" W).

Comment: Our frequency does not lie within any of the frequency ranges stated.

US269 In the band 420-450 MHz, the following provisions shall apply to the non-Federal radiolocation service:

- (a) Pulse-ranging radiolocation systems may be authorized for use along the shoreline of the conterminous United States and Alaska.
- (b) In the sub-band 420-435 MHz, spread spectrum radiolocation systems may be authorized within the conterminous United States and Alaska.
- (c) All stations operating in accordance with this provision shall be secondary to stations operating in accordance with the Table of Frequency Allocations.
- (d) Authorizations shall be granted on a case-by-case basis; however, operations proposed to be located within the areas listed in paragraph (a) of US270 should not expect to be accommodated.

Comment: We are not doing radiolocation service.

US397 In the band 432-438 MHz, the Earth exploration-satellite service (active) is allocated on a secondary basis for Federal use. Stations in the Earth exploration-satellite service (active) shall not be operated within line-of-sight of the United States except for the purpose of short duration pre-operational testing. Operations under this allocation shall not cause harmful interference to, nor claim protection from, any other services allocated in the band 432-438 MHz in the United States, including secondary services and the amateur-satellite service.

Comment: We are not performing active sensing.

3. Compatibility with Amateur Radio Operators

Because the operating frequency is in the amateur frequency range, we coordinated with the local amateur radio club. They provided a letter, in Appendix 1 of this report, stating that the Da Vinci operation will not cause unacceptable interference with local operations.

2. Compatibility with Registered Users the Operating Range of the Satellite

The area of coverage of the satellite, while transmitting to the ground station, includes the US and Canada. A search for users in this frequency range was made, as follows.

- The ITU Master International Frequency Register (MIFR) database was searched for the US and Canada. The criteria were: MIFR Broadcasting or FXM (All), US and Canada administrations and geographic areas; all notice types; all classes of station; status recorded, pending or not published; 432.3 to 432.7 MHz. No registrants were found in this frequency range. See Figure 1.




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MIFR (Terrestrial Services) on-line query (BETA2 release)

☐ MIFR (Broadcasting)
☐ MIFR (FXM)
☒ MIFR (all)

MIFR (ALL): Selection Criteria

Administration	Geographic Area	Notice Type	Class of Station
AFG AFS AGL ALB ALG ARG ARM > >> < << CAN USA	ABW AFG AFS AGL AIA ALB ALC > >> < << CAN USA	> >> < << 1A1 1A2 1A4 1A5 1A7 1B1 1C1	> >> < << AL AM BC BT FA FB FC

Status
☒ Recorded
☒ Pending
☒ Not published

Assigned Frequency

MHz ▾

f_{mi}432.3

f_{mi}432.7

☒ f_{min} ≤ Assigned Frequency ≤ f_{max} only

Unique Id. code given by Administration

Identifier assigned by the BR
from to

Date of Receipt (from)

Date of Receipt (to)

Site Name

MIFR (All)

No records

Figure 1 ITU Database Search Results Screen

- An FCC Site / Market / Frequency inquiry was made. The geographic area in a box including from Puerto Rico to Point Barrow AK, was searched, with the following criteria: Services Cellular, FRC, Land Mobile Commercial, MDS/ITFS Radio Services, PCS, Aviation, Coast and Ground, General Mobile Radio, Land Mobile – Private, Ship, Cable Operations and Licensing System, Experimental database, International Bureau, Mass Media and Paging; All

states; Currently Licensed and Pending Facilities; frequency range 432.3 to 432.7 MHz (+/- 200 kHz around our center frequency); All dates. No licensees or applicants were found. See Figure 2.

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FCC Federal Communications Commission

REBOOT FCC.GOV

[Site / Frequency / Market Search Results](#)
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Site / Frequency / Market Search Results

Search Criteria: Frequency Range = 432.3 MHz through 432.7 MHz, Box Search:
Start Coordinates = 18° 12' 0" N 66° 39' 52" W End coordinates=71° 28' 0" N 158°
30' 30" W, Currently Licensed and Pending Facilities

No Records found for this search criteria

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Federal Communications Commission 445 12th Street SW Washington, DC 20554 More FCC Contact Information...	Phone: 1-888-CALL-FCC (1-888-225-5322) TTY: 1-888-TELL-FCC (1-888-835-5322) Fax: 1-866-418-0232 E-mail: fccinfo@fcc.gov	- Privacy Policy - Website Policies & Notices - Required Browser Plug-ins - Freedom of Information Act
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FCC General Menu Reports 3.1.14 October 7, 2010

Figure 2: FCC Database Search

3. Compatibility with Amateur Radio Operators

Because the operating frequency is in the amateur frequency range, we coordinated with the local amateur radio club. They provided a letter, in Appendix 1 of this report, stating that the Da Vinci operation will not cause interference with local operations. Also in Appendix 1, is a letter from an official of the American Radio Relay League (ARRL), similarly stating that the Da Vinci operation will not cause interference to amateurs, and indicating support for the project.

4. Probability of Interference with an Amateur Radio Operator

The main allocated use in this frequency range as discussed earlier, is amateur operation. The following considers the elements that contribute to the probability of detection of the satellite signal by an amateur operator.

Period of Operation: The downlink will transmit for a total of 15 minutes per day, during the time it is visible from the ground station.

Number of Days of Operation: The plan is to operate for 2 years, or 730 days.

Number of amateur operators in the US: < 810,000

Number of amateur operators in Canada: <70,000

Total number of amateur operators in US and Canada: < 1 million

Percent of US and Canada population in sight of the satellite when it is transmitting: <15

Assumption: Amateur radio operator are distributed demographically, similarly to the overall population.

Percent of amateurs operating on UHF: <30

Number of hours a UHF operator is operating: Average, <2

Frequency range of amateur allocation, UHF: 420 to 450 MHz (30 MHz)

Bandwidth of DaVinci transmission: 25 kHz.

Appendix 1: ARRL Support



Section Manager

2300 W Polo Green Ave
Post Falls, ID 83854-9680
March 26, 2018

Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Subject: Support for Proposed Experimental License 0216-EX-CN-2017

I was recently contacted by LCF Enterprises, the "Industry Mentor" for a North Idaho STEM Charter Academy Project that involves flying a Cube-Sat ("Project DaVinci Cube-Sat"). This vehicle will utilize low-power RF uplink and downlink in the Amateur Radio 2-Meter and 70-CM bands.

The frequencies chosen (144.500 Up, 432.500 Down) are positioned correctly in the ARRL Band Plan, and monitoring of both frequencies indicate that there is no current activity in the local area.

In my opinion the uplink and downlink radio transmissions for Project DaVinci will not result in interference to the Amateur Radio community. I recommend approval of the Experimental License for this project.

Regards,

A handwritten signature in black ink, appearing to read "Edward Stuckey", is written over a horizontal line.

Edward Stuckey

Edward Stuckey, AI7H
Idaho Section Manager

ARRL, the national association for Amateur Radio™

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