EMC Analysis of CACTUS-1

Summary of CACTUS-1

CACTUS-1 is a 3U cubesat being launched into orbit at 500-km, and 90-degree inclination polar inclination. CACTUS-1 is operated from a single ground station location at Capitol Technology University in Laurel, MD. The frequency used for space to earth communication and earth to space communication is 434.031 MHz. This report reviews with other authorized operators in this frequency range and operating range. It shows that no interference is reasonably expected to occur with the local amateur radio club and no interference with any preexisting operators in our operating range.

Compliance with Local Amateur Radio Operators

Because the operating frequency is in the amateur frequency range, we coordinated with the local amateur radio club. The Goddard Amateur Radio Club near, has provided a letter, included in the Appendix A of this report, stating that the CACTUS ground station will not cause unacceptable interference with local operations.

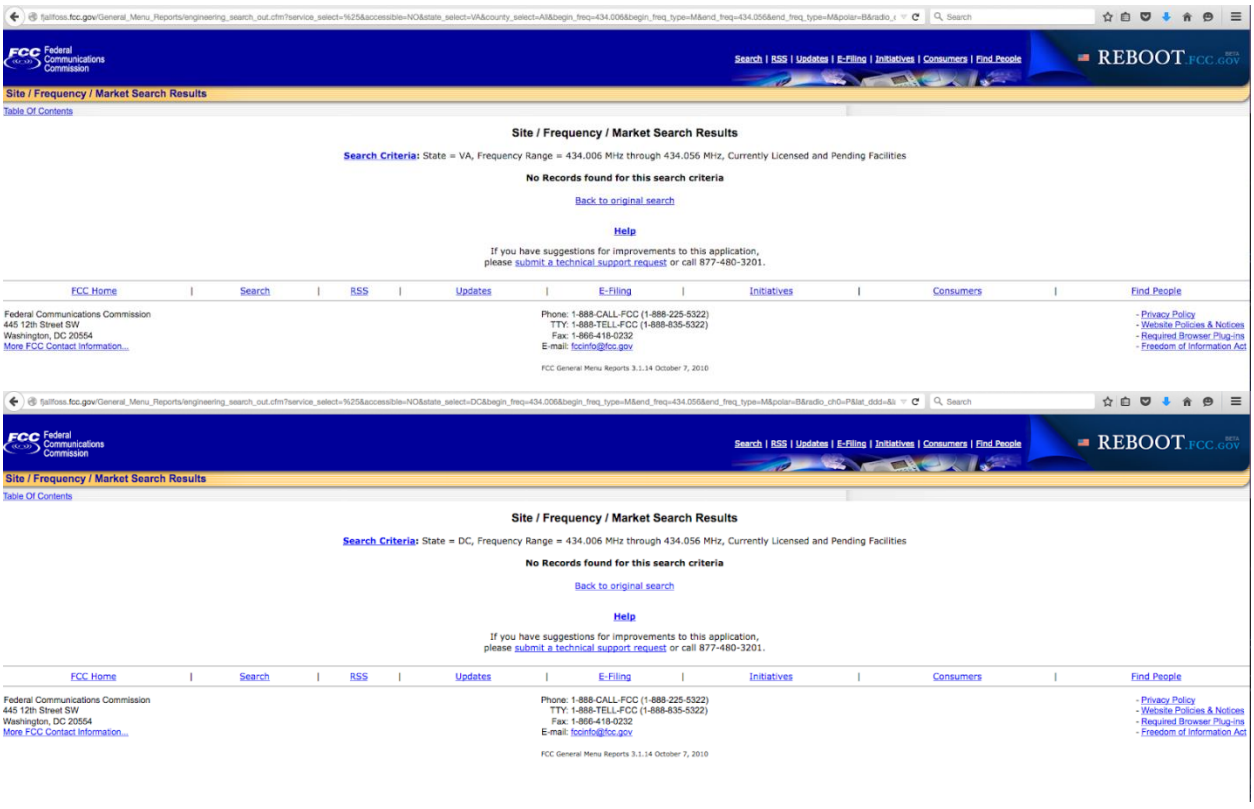
Compatibility within the Operating Range

CACTUS's orbit is expected to be full earth coverage (standard polar orbit). The frequency used with the 420-450 band for amateur satellites. Within this band we fall into 432- 438 amateur radiolocation exploration. Our transmissions are from the same location as our University's amateur radio station, call sign KB3KJI. Our transmission to CACTUS will be with a yagi directional antenna. The satellite is in a nearly polar orbit (assume 90 degrees) so we will track it as it passes horizon-to-horizon along the N-S or S-N line. Our ConOps is to expect at most 1-2 viable 10-minute contact windows per day as a maximum, of which up to the first two minutes will be our ground station transmitting (the rest will be receiving data).

Our frequency range does not conflict with terrestrial and aeronautical mobile system band allocations. Both our uplink and downlink are at 434MHz. Our peak power for our ground transmitter is 10 W (10dbW), and the ground station is using a Yagi and has a beam width of 24 degrees. The satellite transmits at 0.5 Watts (-3 dBW) with a dipole antenna. The typical PFD from the satellite at 500km is -107.46 dbW/m^2/4KHz.

FCU database searches were conducted to identify other users near our frequency. Using the FCC engineering search database, no results were returned for our frequency range of 434.031 +/- 25 KHz for the Maryland, DC and Virginia areas (http://fjallfoss.fcc.gov/General_Menu_Reports/engineering_search.cfm), see Figures 1a, 1b, 1c.

Figures 1 a,b, c: There are no entities in our 434.031 MHz range from the FCC engineering search for MD/DC/VA.



Downlink Compatibility

The Cactus-1 downlink at 434.031 MHz is a 500 mW transmitter using a short dipole (2.1 dB gain) with a roughly 25^{o} half-power beam width. This places the satellite footprint as a circle of radius 233km, and given we broadcast only when commanded while overhead our ground station, our operation fits neatly within MD, VA, DC, DE, PA, WV, NJ. Our power density peaks at -124.5 dBW/m^2/4kHz, which is at/below the Terrestrial Services (-125 dBW/m^2/4KHz) and Aeronautical Mobile (R) services (-125 dBW/m^2/4KHz). To ensure we do not interfere to Canada to the north, our frequency falls within their amateur range of 433.000 - 434.800 "Digital Modes (1) (7)" (wp.rac.ca) where 'digital operations may include repeater operation, crossband duplex operation, links or simplex' and as this is both a non-critical band and outside our half-power radius, we will not be interfering.

Appendix A: Letter from local Ham club indicating non-interference

Goddard Amateur Radio Club Letter in Experimental License Application

Capon, Thomas L. (GSFC-5440) <thomas.l.capon@nasa.gov>

Fri 3/30/2018 1:50 PM

Archive

To: Alex Antunes <aantunes@captechu.edu>;

Cc: Kilroy, Patrick L. (GSFC-5680) <patrick.l.kilroy@nasa.gov>; Ryan S <rmschrenk@gmail.com>; Bob McCown <bob.mccown@gmail.com>; ThomanBruce@gmail.com <ThomanBruce@gmail.com>; Schultz, Daniel J. (GSFC-441.0)[GODDARD AMATEUR RADIO CLUB] <n8fgv@usa.net>; Gary Chatters WA9ZZZ <gclistl@garychatters.com>;

I, Thomas Capon, AB3LN, as President of the Goddard Amateur Radio Club located in Greenbelt, MD, hereby recognize and have no objections to Capitol Technology University operating a satellite ground station at a frequency of 434.031 MHz under an experimental license on the Capitol Technology University campus. This ground station will not result in unacceptable interference to local amateur operations. The Goddard Amateur Radio Club is happy to support educational institutions experimenting with space communication.

Name: Thomas Capon (AB3LN)
Date: March 30 2018
Signed: email sent to serve as electronic signature