



The International Amateur Radio Union

Since 1925, the Federation of National Amateur Radio Societies
Representing the Interests of Two-Way Amateur Radio Communication

FREQUENCY COORDINATION REQUEST

Tick here if this space station is also planned for amateur-satellite service operation.

Administrative information:

0	DOCUMENT CONTROL	
0a	Date submitted	14-MAR-17
0b	Document version number (start at zero and increment with each revised request)	0
1	SPACECRAFT (published)	
1a	Name before launch	RECONSO
1b	Proposed name after launch	RECONSO
1c	Country of license	USA
1d	Contact individual at your licensing authority and contact information	Douglas Young Federal Communications Commission Experimental Licensing Branch Phone: (202)481-2440 Fax: (202)418-1918 Email: Douglas.Young@fcc.gov
1e	API/A special section number	Will forward to the IARU Satellite Advisor when available.

2	SPACE STATION LICENSE (published)	
2a	Experimental station call sign(s)	Will furnish when issued.
2b	Licensee's name	
2c	Representative's first (given) name	Francis
2d	Representative's last (family) name	Park
2e	Postal address	Georgia Institute of Technology School of Aerospace Engineering 270 Ferst Drive SE Atlanta, GA 30332-0150
2f	Telephone number (including country code)	+1-973-820-3020
2g	Representative e-mail address: our single point of contact who will receive all correspondence	Fpark8@gatech.edu or francis.park1@gmail.com
2h	Skype name (if available)	Francis_prk
2i	List names and e-mail addresses of <i>additional</i> people (up to three) who should receive copies of correspondence	sterling.peet@gatech.edu

Space station information:

3	SPACE STATION (published)	
3a	Mission(s) <i>Describe in detail what the space station is planned to do. Use as much space as you need.</i>	The RECONSO mission is designed to demonstrate visual detection and tracking of space debris from a small Cubesat platform. The spacecraft has been designed, fabricated and tested by a team of Georgia Tech undergraduate and graduate students who will also be responsible for mission operations. Photographs of the sky regions of interest will be acquired during the sunlight portion of the orbit. Onboard processing will occur during the eclipse periods. Image processing will detect moving objects in the acquired series of images and assign orbital parameters to the detected objects. Downlinked data will be the estimated orbital elements for the debris, not raw images. RECONSO contains no propulsion system, and is pointed using a 3-axis magnetorquer system.
3b	Planned launch date	28-APR-2018
3c	Planned mission duration	~ 180 days
3d	Proposed space station uplink and downlink frequency ¹ plan <i>List for each frequency band:</i> → frequency band (e.g. 435-438 MHz) → indicate if operating frequency can be changed by telecommand and frequencies which may be used → output power → ITU emission designator ^{2,3} → common description of the emission including modulation type AND data rate ⁴	Uplink/Downlink Frequency: 437.325 MHz. Frequency cannot be modified in flight by telecommand. Output power: 1.5 W ITU Emission Designator: 12K5F2D Common Description: 9600, 19k2, 38k4 baud packets, G3RUH FSK Antenna Gain and Pattern: 2.15 dBi, Linear Attitude Stabilization: 3-axis stabilized; antenna in cross-track direction

¹ Show all frequencies **numerically** in MHz, or GHz. *Letter band designations are not used.*

² ITU emission designators are defined in Appendix I to the radio regulations. Effect of Doppler shift is NOT included when determining bandwidth.

³ If using a frequency changing transponder, indicate the transmitting bandwidth. Effect of Doppler shift is NOT included when determining bandwidth.

⁴ Common emission description means terms like transponder, NBFM, PSK31, 1200 baud packet (AFSK on FM), etc.

	<ul style="list-style-type: none"> → antenna gain and pattern⁵ → attitude stabilisation, if used⁶ 	
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4	INTERNATIONAL (published) Countries with international arrangements completed or anticipated.	NONE
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5	TELECOMMAND (NOT published)	
5a	Telecommand frequency plan. <i>List:</i> <ul style="list-style-type: none"> → space station telecommand frequency bands, → ITU emission designator(s) → common description of the emission including modulation type AND data rate → link power budget(s) → a very general description of any cipher system⁷ 	Telecommand Frequency: 437.325 MHz ITU Emission Designator: 11K4F2D Common Description: 1200 baud packets, AFSK Link Budget: Ground Station Transmitter Power Output: 35.0 W Ground Stn. Total Transmission Line Losses: 3.5 dB Antenna Gain: 18.9 dBi Ground Station EIRP: 30.8 dBW Ground Station Antenna Pointing Loss: 1.7 dB Gnd-to-S/C Antenna Polarization Losses: 3.0 dB Path Loss: 151.5 dB Atmospheric Losses: 1.1 dB Ionospheric Losses: 0.4 dB Rain Losses: 0.0 dB Isotropic Signal Level at Spacecraft: -126.8 dBW Spacecraft Antenna Pointing Loss: 0.4 dB Spacecraft Antenna Gain: 2.2 dBi Spacecraft Total Transmission Line Losses: 0.5 dB Spacecraft Effective Noise Temperature: 888 K Spacecraft Figure of Merit (G/T): -27.8 dB/K S/C Signal-to-Noise Power Density (S/No): 73.5 dBHz System Desired Data Rate: 9600 bps Command System Eb/No: 33.7 dB Demodulation Method Selected: AFSK/FM Forward Error Correction Coding Used: None System Allowed or Specified Bit-Error-Rate: 1.0E-05 Demodulator Implementation Loss: 1.0 dB Telemetry System Required Eb/No: 13.8 dB Eb/No Threshold: 14.8 dB System Link Margin: 18.9 dB

⁵ Common patterns include omnidirectional, unidirectional (with a pattern).

⁶ Unstabilized is a tumbler. Stabilized can be passive magnetic, spinner, three axis, gravity gradient, etc.

⁷ Any means of preventing unauthorized telecommand of the space station. Recommended, but not required.

		Encryption Protocol: AS256
5b	<p>Positive space station transmitter control. <i>Explain how telecommand stations will turn off the space station transmitter(s) immediately, even in the presence of user traffic and/or space station computer failure.</i></p> <p>NOTE: Transmitter turn off control from the ground is absolutely required. Software control is useful, but does not substitute for telecommand. <i>Good engineering practice is to make telecommand independent of all other systems.</i></p> <p>Be sure to read the paper: Controlling Space Station Transmitters.</p>	<p>The transmitter may be turned off via telecommand. If the flight computer is turned off or fails, transmission will cease. The RECONSO mission has an “End of Life” procedure, where all systems are shut down, including the transmitter.</p>
5c	<p>Telecommand stations. <i>List all telecommand stations. Sufficient Earth telecommand stations must be arranged before launch to insure that can be terminated immediately. See RR 22.1 and #3 of the terms and conditions above.</i></p>	<p>Georgia Institute of Technology Contact: sterling.peet@gatech.edu</p> <p>California Polytechnic State University Contact: bellardo@calpoly.edu</p>

6	Launch plans (published)	
6a	Launch agency	Space Test Program-2
6b	Launch location	Kennedy Space Center
6c	<p>Planned orbit <i>Include</i></p> <ul style="list-style-type: none"> ➔ <i>apogee</i> ➔ <i>perigee</i> ➔ <i>inclination</i> ➔ <i>period</i> <p><i>Include plans for orbit changes.</i></p>	<p>Apogee: 500 km</p> <p>Perigee: 800 km</p> <p>Inclination: 75 degrees</p> <p>Period: 97.728 minutes</p>
6d	List other satellites expected to share the same launch. Update	LightSail 2, Armadillo, others (not publicly available)

	when more information becomes available.	
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Earth station information:

7	Typical Earth station — transmitting (published)	
7a	Describe a typical telecommand station.	An Earth station must be equipped with a medium-gain antenna with a method of pointing and an FM radio with a broad enough filter to allow for 9600 baud data rates.
7b	Link power budget. <i>Show complete link budgets for each Earth station transmitting frequency band.</i>	Ground Station Transmitter Power Output: 35.0 W Ground Stn. Total Transmission Line Losses: 3.5 dB Antenna Gain: 18.9 dBi Ground Station EIRP: 30.8 dBW Ground Station Antenna Pointing Loss: 1.7 dB Gnd-to-S/C Antenna Polarization Losses: 3.0 dB Path Loss: 151.5 dB Atmospheric Losses: 1.1 dB Ionospheric Losses: 0.4 dB Rain Losses: 0.0 dB Isotropic Signal Level at Spacecraft: -126.8 dBW Spacecraft Antenna Pointing Loss: 0.4 dB Spacecraft Antenna Gain: 2.2 dBi Spacecraft Total Transmission Line Losses: 0.5 dB Spacecraft Effective Noise Temperature: 888 K Spacecraft Figure of Merit (G/T): -27.8 dB/K S/C Signal-to-Noise Power Density (S/No): 73.5 dBHz System Desired Data Rate: 9600 bps Command System Eb/No: 33.7 dB Demodulation Method Selected: AFSK/FM Forward Error Correction Coding Used: None System Allowed or Specified Bit-Error-Rate: 1.0E-05 Demodulator Implementation Loss: 1.0 dB Telemetry System Required Eb/No: 13.8 dB Eb/No Threshold: 14.8 dB System Link Margin: 18.9 dB

8	Typical Earth station — receiving (published)	
8a	Describe a typical Earth station to receive signals from the planned satellite.	An Earth station equipped with some circularly polarized UHF Yagi antennas for reception on a moveable mount for pointing.
8b	Link power budget. <i>Show complete link budgets for each Earth station receiving frequency band.</i>	Space Station Transmitter Power Output: 1.5 W Space Stn. Total Transmission Line Losses: 0.3 dB Antenna Gain: 0.0 dBi Space Station EIRP: 1.4 dBW Space Station Antenna Pointing Loss: 0.4 dB S/C-to-Ground Antenna Polarization Losses: 3.0 dB Path Loss: 151.5 dB Atmospheric Losses: 1.1 dB Ionospheric Losses: 0.4 dB Rain Losses: 0.0 dB Isotropic Signal Level at Spacecraft: -155.0 dBW Ground Station Antenna Pointing Loss: 1.7 dB


		Ground Station Antenna Gain: 18.9 dBi Ground Stn Total Transmission Line Losses: 7.6 dB Ground Stn Effective Noise Temperature: 633 K Ground Stn Figure of Merit (G/T): -16.7 dB/K Signal-to-Noise Power Density (S/No): 55.2 dBHz System Desired Data Rate: 9600 bps Command System Eb/No: 15.3 dB Demodulation Method Selected: GMSK Forward Error Correction Coding Used: None System Allowed or Specified Bit-Error-Rate: 1.0E-05 Demodulator Implementation Loss: 1.0 dB Telemetry System Required Eb/No: 13.8 dB Eb/No Threshold: 14.8 dB System Link Margin: 1.8 dB
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Additional information:

Do not attach large files. Indicate the URL where the information is available.

9	The space station telemetry will be transmitted for 1.0 sec every 20 sec.
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Signature: Licensee agrees to IARU terms and conditions for coordination and represents that all information provided is true and correct.

10		14-MAR-2017
	<hr style="width: 80%; margin: auto;"/> Signature of licensee	<hr style="width: 80%; margin: auto;"/> Date submitted for coordination