The International Amateur Radio Union

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

AMATEUR SATELLITE FREQUENCY COORDINATION REQUEST

(Make a separate request for each space station to be operated in the amateur-satellite service.)

Have you read the instructions? Here is the link http://www.iaru.org/uploads/1/3/0/7/13073366/instructions_iaru_amateur_satellite_coordination_request.doc

Administrative information:

0	**DOCUMENT CONTROL**	
0a	Date submitted	**1/16/2018**
0b	Document revision number	**0**
1	**SPACECRAFT (published)**	
1a	Name	Phoenix CubeSat
1b	Notifying administration	FCC
1c	API/A number. If the API number is not known yet, provide the date on which the information was submitted to the notifying administration.	The FCC has not yet granted an API, but they were contacted on 12/21/2017 to begin the process.
2	**LICENSEE OF THE SPACE STATION (published) or responsible amateur in case of educational mission**	
2a	First (given) name	Sarah
2b	Last (family) name	Rogers
2c	Call sign	KI7OOY
2d	Postal address	
2e	Telephone number (including country code)	
2f	E-mail address (licensee will be our point of contact and receive all correspondence)	sarahsrogers@gmail.com
2g	Licensee's position in any organization referenced in item 3a.	Project Manager, Undergraduate Student
3	**ORGANISATIONS (published) — complete this section for EACH participating organization**	
3a	Name of organization and/or educational institution	Arizona State University

3b	Physical address	
3c	Postal address	
3d	Telephone number (including country code)	
3e	E-mail address	
3f	Web site URL	phxcubesat@asu.edu
3g	National Amateur Radio Society (including contact information)	AMSAT-NA
3h	National Amateur Satellite organization (including contact information)	ARRL
3i	Does your National Amateur Satellite organization and/or National Amateur Radio Society supports this request?	National AMSAT Organization ☐yes ☒ no National Amateur Radio Society ☐yes ☒no

Space station information:

4	**SPACE STATION (published)**	
4a	Type of mission *Tick applicable box(es)*	☐Amateur ☒Amateur combined with Educational ☐Amateur combined with other mission(s)
4b	Mission(s) and frequency band(s*)*	**Mission** This voluntary project consists entirely of undergraduate students at Arizona State University, including the project manager, KI7OOY. There are no paid employees. Its primary objective is self-training, i.e., learning by doing. The students are learning about satellites and space communication by designing, building, launching (by NASA through its ELaNa program) and operating a 3U Cubesat. It carries an earth-imaging system to study urban heat islands such as Phoenix, Arizona -- the project's secondary objective. Command, control and telemetry are in the 435 MHz band and the earth-imaging data are downlinked in the 2.4 GHz band. **Frequency** **UHF:** 435-438 MHz **S-Band:** 2.4-2.45 GHz

4c	Planned duration of each part of the mission.	Phoenix will orbit the earth for a period of 2 years before it reenters the atmosphere
4d	Proposed space station **transmitting** frequency plan. List for each frequency or frequency band:	
4d1	requested frequency and function	**Requested Frequencies** **UHF:** 435-438 MHz **S-Band:** 2.4-2.45 GHz UHF amateur bands will be used for downlinking satellite housekeeping data and for receiving mission operations schedules as often as needed. S Amateur frequencies will be used for downlinking all thermal images and associated spacecraft health data captured throughout the week.
4d2	tuning range of transmitter and step increment	**UHF** **Tuning Range:** 430-440 MHz **Step Increment**: 1 Hz **S-Band** **Tuning Range:** 2.4-2.45 GHz **Step Increment**: 500 kHz
4d3	EIRP	**UHF:** 3.01 dBW **S-Band**: 4.0 dBW
4d4	ITU emission designator	**UHF Frequency:** 20K0F1D **S-Band Frequency:** 1M35G1DDN
4d5	common description of the emission including modulation type AND data rate	**UHF Frequencies** Modulation Type: FSK Data Rate: 9600 bps **S-Band Frequencies** Modulation Type: QPSK Data Rate: 2 Mbps
4d6	Type of antenna, antenna gain and pattern	**UHF** **Antenna Pattern:** Omnidirectional **Antenna gain**: 0 dB **S-Band** **Gain**: 8 dBi Max **Pattern**: Left hand polarization
4d7	attitude stabilization, if used	Attitude stabilization is only required for transmitting science data over S amateur bands. The satellite will orient parallel to the earth and track the satellite dish at Arizona State University to transmit information.
4d8	Service Area	**ASU Earth Station**: 33.41, -111.93
4e	Proposed space station **receiving** frequency plan. List for each frequency or frequency range:	
4e1	requested frequency and function	**UHF**: 435-438 MHz UHF amateur frequencies will be used for up linking regular operations schedules to the satellite along with

		command codes as necessary.
4e2	tuning range of receiver and step increment	**Tuning Range:** 430-440 MHz **Step Increment:** 1 Hz
4e3	ITU emission designator	50K0F1D
4e4	common description of the emission including modulation type AND data rate	 **Data Rate:** 9600 bps **Modulation Type:** FSK
4e5	noise temperature	298 K
4e6	associated antenna gain and pattern	**UHF antenna gain:** 0 dB **Antenna pattern**: Omnidirectional No attitude stabilization is necessary for receiving commands over UHF amateur frequencies.
4f	Physical structure.	**Receiver Dimensions**: 40mm x 65mm x 1.6mm (Link to receiver drawing)
4g	*Functional Description.*	The AX-100 UHF Transceiver will relay all mission operation schedules and control commands from the Earth Station to the satellite's on board computer.
4h	*Satellite Power budget.*	 Satellite Power Budget
5	**TELECOMMAND (NOT published)**	
5a	Telecommand frequency plan.	
5a1	Proposed space station telecommand frequencies,	**UHF**: 435-438 MHz
5a2	ITU emission designator(s)	20K0F1D
5a3	common description of the emission including modulation type AND data rate	 **Modulation Type:** FSK **Data Rate:** 9600 bps
5a4	link budget(s)	 **ASU Ground Station** UHF DC Power: 2208W RF Power: 50W **Phoenix CubeSat** UHF: DC Power: 2.64 W (transmit) 0.182W (receive) RF Power: 30 dBm (transmit) 44 dBm (receive) Link Budget (UHF Uplink/Downlink) Link Budget (S-Band Downlink)
5a5	a general description of any cipher system	all command codes for spacecraft attitude control, tracking, image capture, and other mission critical operations will be implemented along with a rotating one-time use cipher key using a simple substitution scheme to maintain operation integrity. The cipher

		system will be stored as part of a private GitHub repository, to which only the Phoenix team has access, and it will be protected with gpg public/private key pairs. This allows the flight software to be shared and support other CubeSat projects in the future, yet allow control over the satellite's operations to remain within the command of the student team.
5b	Positive space station transmitter control. 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 system failure	*The UHF receiver will always be on so the spacecraft can listen for commands at any given time. When the satellite is over the ASU ground station, it can accept individual commands sent by the student team only.* *The AX-100 UHF transceiver can set a max transmit time as well as a maximum transmit inhibit time. These are both settings on the hardware and therefore operate independently of the satellite's on-board computer. These will be set to only transmit short heartbeat messages to the ASU ground station, with a buffer of 30 seconds in between, which will cover one downlink opportunity to the ASU Earth Station* *The S-Band transmitter will only transmit when its buffer is populated and there is data to send. Data is pulled into the buffer by the satellite computer. In the event of an on-board computer failure, the transmitter would stop receiving data, and therefore, it would be incapable of sending telemetry to the Earth Station. In this state, the transmitter would simply remain on. In addition, the transmitter is designed to power off automatically after 15 minutes if it is let on.*
5c	Telecommand stations. List telecommand station(s)	
	Callsign	KI7OOY For operating in amateur bands, the call sign for transmitting to the satellite must be through the individual call sign of each mission operator. The ASU ground station will not have its own registered license.
	Physical location	Arizona State University 781 S. Terrace Rd. Tempe, AZ 85287
5d	Optional: Give the complete space station turn off procedure.	
6	**Telemetry (published)**	
6a	**Telemetry frequencies**	
6a1	all telemetry frequencies or frequency bands,	**UHF**: 435-438 MHz **S-Band**: 2.4-2.45 GHz
6a2	ITU emission designator	**UHF Frequency:** 20K0F1D **S-Band Frequency:** 1M35G1DDN

6a3	common description of the emission including modulation type AND data rate	**UHF Frequencies** Modulation Type: FSK Data Rate: 9600 bps **S-Band Frequencies** Modulation Type: QPSK Data Rate: 2 Mbps
6a4	link budgets	**ASU Ground Station** UHF DC Power: 2208W RF Power: 50W S-Band: DC Power: 1764W RF Power: 30W **Phoenix CubeSat** UHF: DC Power: 2.64 W (transmit) 0.182W (receive) RF Power: 1W ~ 30 dBm (transmit) 44 dBm (receive) S-Band: DC Power: 2.7W (transmit only) RF Power: 1W ~ 24 dBm (transmit only)
6b	Transmission formats	**UHF:** Ax25/g3ruh. Plain text beacon with binary health data and CCSDS File Delivery **S-Band:** QPSK modulation with Intelsat IESS-308 based encoding. Data is downlinked as plain text file and .TIFF image data through CCSDS File Downlink
7	**Launch plans (published)**	
7a	Launch agency	Nanoracks
7b	Launch location	Wallops Flight Facility, VA
7c	Expected launch date	11/08/2018
7d	**Planned orbit.**	
7d1	planned orbit apogee	409 km
7d2	planned orbit perigee	401 km
7d3	planned orbit inclination	51.6°
7d4	planned orbit period	90 minutes
7e	List other amateur satellites expected to share the same launch.	Phoenix will launch as part of the ELaNa-21 mission with the following CubeSats on November 8, 2018 CapSat, TJREVERB, CySat1, TechEdSat-8, Virginia CC (three 1Us), SPACE HAUC, SPOC, and RadSat-u

Earth station information:

8	**Typical Earth station — transmitting**	
8a	Describe a typical Earth station used to transmit signals to the planned space station.	The transmitting earth station delivers all operations schedules and control commands to the satellite. All schedules are sent during times when the satellite is scheduled to pass over the Earth Station. The Earth Station will track the satellite and propagate its orbit to verify when it is overhead and establish a link between the satellite and the Earth Station. Those operating the Earth Station must be licensed to transmit to the satellite.
8b	Link budget. *Show complete link budgets for all Earth station transmitting frequencies, except telecommand.*	**ASU Ground Station** UHF DC Power: 2208W RF Power: 50W S-Band: DC Power: 1764W RF Power: 30W
9	**Typical Earth station — receiving**	
9a	Describe a typical Earth station to receive signals from the planned satellite.	Earth Stations which receives signals from the spacecraft have an antenna and a radio which are tuned to the satellite's frequency band and intercept signals over the air. The receiving station will demodulate the data for it to be processed and decrypt it if necessary. This allows the Earth Station operator to receive data from the spacecraft on its health and science data.
9b	Link budget. *Show complete link budgets for all Earth station receiving frequencies.*	**ASU Ground Station** UHF DC Power: 2208W RF Power: 50W

Additional information:

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

10	Please, supply any additional information that may assist the Satellite Advisor to coordinate your request(s). N/A

Certification:

11*	☒The licensee of the planned space station has reviewed all relevant laws, rules, and regulations, and certifies that this request complies with all requirements as understood by IARU to the best of his/her knowledge and confirms to meet the requirements of RR 1.56 and RR 1.57 in that the proposed satellite will operate without pecuniary interest. Please list any commercial interests. If none, please state none.
	☐The licensee of the planned space station has reviewed all relevant laws, rules, and regulations and disagrees with IARU interpretations of Treaty requirements. The IARU Satellite Advisor is asked to consider the following interpretation. Explanation follows.

- Please tick ONE appropriate box.

Signature:

12	(REQUIRED!)	
		1/16/2018
	Signature of space station licensee.	Date submitted for coordination.