RBC Signals LLC
Application for Special Temporary Authorization

Technical Appendix

I. Technical Description

II. Antenna Patterns

III. Link Budgets

IV. Orbital Debris Assessment Report

V. Draft FCC Form 312 Schedule B

I. Technical Description

RBC Signals seeks to provide receive-only telemetry support to its customer, Spacety Co., Ltd. ("Spacety"), for series of Spacety spacecraft (the "TY Series"). The Spacety spacecraft that are the subject of this Technical Description include a total of six 6U cubesats. Three satellites will be launched on October 28, 2018 (the TY1-02, TY1-03 and TY4-02 satellites), and three satellites will be launched on December 7, 2018 (the TY1-05, TY3-01 and TY3-02 satellites).

RBC Signals seeks a 30-day special temporary authority ("STA") to communicate with the first three Spacety satellites, and a 180-day STA to communicate with all six Spacety spacecraft. For the sake of administrative convenience and to provide a comprehensive view of RBC Signals' proposed telemetry operations, a single Technical Description covering all six Spacety spacecraft has been prepared for FCC review.

The Spacety satellite technology demonstration missions include: Earth observation, astronomical observation, and optical communications. This Technical Description provides an overview of the VHF, UHF-band and X-band service links of the Spacety TY Series satellites, although the scope of RBC Signals' STA request is receive-only telemetry in UHF frequencies at its earth station facilities in Deadhorse, Alaska; Fairbanks, Alaska; and Windham, New York. A summary of the six individual Spacety satellites, missions, launch dates, and applicable ITU filings is provided in the table below.

Table 1 Spacety Satellite and Missions

Satellite	Mission	Launch	ITU Filing
TY1-02	Laser Projection Communications Testing	Oct. 28, 2018	TY2D
TY1-03	Optical Remote Sensing Payload Testing – 15m	Oct. 28, 2018	TY2D
TY1-05	Optical Remote Sensing Payload Testing – 5m	Dec. 7, 2018	TFStar
TY3-01	Optical Remote Sensing Payload Testing – 15m	Dec. 7, 2018	TY2D
TY3-02	Optical Remote Sensing Payload Testing – 15m	Dec. 7, 2018	TY2D
TY4-02	X-Ray Polarization Detection Payload Testing	Oct. 28, 2018	TY2D

RBC Signals is a U.S.-based, satellite communications services company headquartered in the state of Washington. RBC Signals operates a global network of satellite earth stations, providing satellite communications services in various frequency bands.

Spacety is a China-based, space technology company headquartered in Beijing, China. Spacety is developing and deploying a series of six 6U cubesats to demonstrate its TY Series product line and related services, and to conduct the missions described in Table 1.

To accomplish this mission, RBC Signals seeks to provide receive-only telemetry communication services to Spacety, enabling them to validate and demonstrate key technologies of their TY Series satellites to establish further space heritage of their product line and demonstrate payload services. Towards this end, the TY Series satellite operations will allow Spacety to test and demonstrate components, software design, and operational concepts that are integral to the planned satellite product line.

The tests and demonstrations planned by Spacety will be conducted intermittently over a one-year period commencing shortly after launch of the satellite. The TT&C and commercial payload communications frequencies, ground station location and operational constraints have been carefully identified to avoid the potential for interference to other spectrum users.

RBC Signals notes that the expected launch date for the first three satellites is expected to be October 28, 2018 and the launch date for the second three satellites is expected to be December 7, 2018. Therefore, RBC Signals respectfully requests that the Commission consider and authorize the proposed TT&C and mission data downlink satellite operations (as appropriately conditioned) as soon as practicable.

TY Series Satellites

The Spacety TY Series satellites conform to the form factor of a 6U cubesat (350 mm X 259 mm X 132 mm in the stowed configuration and 801 mm X 430 mm X 425 mm in the deployed configuration), with a total mass of approximately 10 kg. The maximum power generated by the solar panels is approximately 34 W (32 W at end-of-life ("EOL"), with a maximum transmitter output power of approximately 0 dBW in UHF frequencies and 2 dBW in X-band. The communications payload uses a directional antenna and the TT&C radio uses omnidirectional canted turnstile antennas, as indicated in Figure 1.

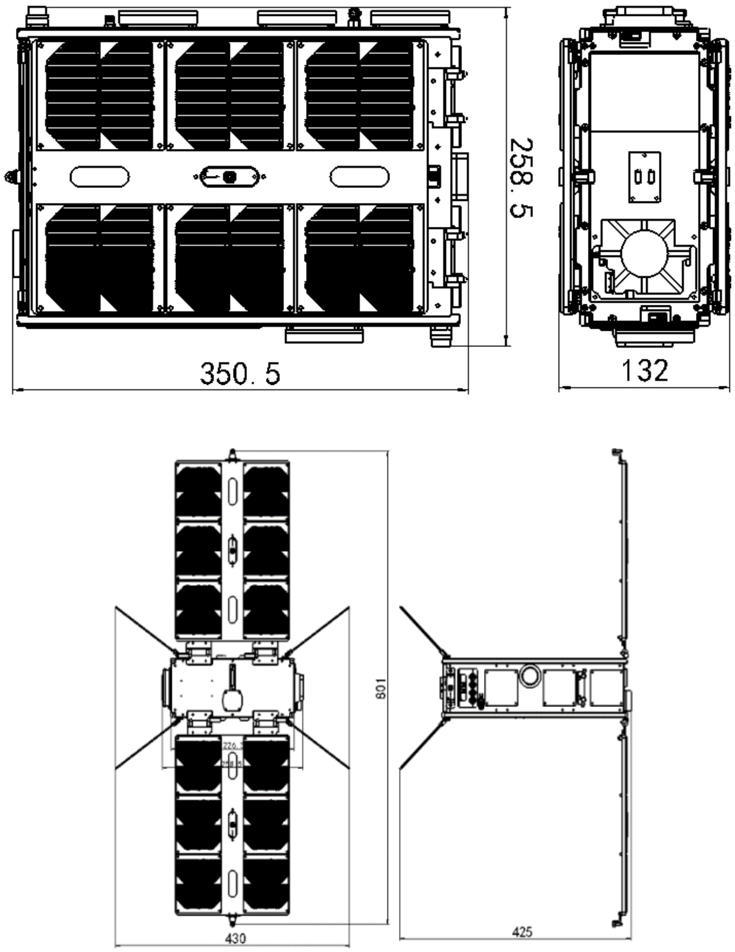

Figure 1 TY Stowed and Deployed Configurations

Orbits. The first three Spacety satellites will be launched as secondary payloads aboard a Long March CZ-2C launch vehicle from the JinQuan launch center in China on October 2018. The satellites will be launched into a nominal circular, sun-synchronous orbit at 528 km apogee and 528 km perigee with an inclination from the equator of 97.5°. An orbital lifetime calculation for this orbit estimates that the satellite will remain in orbit for approximately 5.5 years (under worst case conditions), well within the limits set by internationally accepted guidelines.[1]

The second three Spacety satellites will be launched as secondary payloads aboard a Long March CZ-2D launch vehicle from the JinQuan launch center in China on December 7, 2018. The satellites will be launched into a nominal circular, sun-synchronous orbit at 536 km apogee and 536 km perigee in with an inclination from the equator of 97.6°. An orbital lifetime calculation

[1] *See* Orbital Debris Assessment Report (attached).

for this orbit estimates that the satellite will remain in orbit for approximately 5.9 years (under worst case conditions), also well within the limits set by internationally accepted guidelines.[2]

Communications Payload. The TY Series communications payload consists of an X-band gateway downlink with modem, solid-state power amplifier ("SSPA") and directional antenna for transmit operations. Specific technical parameters include:

- Mission data downlink
    - X-band Transmit
    - 2.0 dBW spacecraft transmitter output power, 16.6 dBW Peak EIRP
    - TX in 8140 – 8365 MHz
    - Carrier Frequencies
        - 8145 MHz
        - 8360 MHz
    - Circularly polarized, QPSK modulation on downlink
    - 10, 20 Mbps

The communications payload will operate intermittently and on an as-needed basis to download mission data between one to six times per day while the satellites pass over the RBC Signals' earth stations located in Deadhorse, Alaska; Fairbanks, Alaska; and Windham, New York.

Telemetry Downlink. Telemetry reception of the TY Series satellites will be conducted using a AstroDev Lithium-1 UHF transceiver, with Yagi antennas, for receive operations. Telemetry downlink operations in the 401 MHz band will take place intermittently when the satellite is in view of the three earth station sites in Deadhorse, Alaska; Fairbanks, Alaska; and Windham, New York. Spacety and RBC Signals will coordinate the telemetry operations to ensure compatibility with any other co-frequency operations in the area. Particulars of the telemetry downlink operations include:

- 1 W spacecraft transmitter output power, 2.0 dBW EIRP
- Tx (downlink) at 401.5-401.9 MHz (12.5 kHz, 25 kHz bandwidth)
    - Carrier frequencies include:
    - 401.60625 MHz
    - 401.69375 MHz
    - 401.79250 MHz
    - 401.80000 MHz
- RHCP polarized, GFSK modulation
- 4800 bps

Satellite telemetry communications will begin once the Spacety spacecraft have been deployed into its intended orbit.

[2] *See* Orbital Debris Assessment Report (attached).

Command Uplink. Command uplink of the Spacety TY satellites will be conducted in the VHF band from China. Command uplink authority is not being requested in this filing and the information about the VHF command uplink in this section is provided for context and completeness. Particulars of the command uplink operations include:

- Tx (uplink) at 149.7875 – 149.8125 MHz (25 kHz bandwidth)
- RHCP polarized

Receive-Only Earth Station

Spacety/RBC Signals will utilize an AstroDev Lithium-1 radio and associated equipment, including two M2 Antenna Systems 400CP30A Yagi antennas (combined in a phased array configuration to increase the antenna gain from 16.2 dBi to 18 dBi), to conduct telemetry receive-only operations. The earth stations are located at the RBC Signals' facilities in Deadhorse, Alaska; Fairbanks, Alaska; and Windham, New York. The earth stations receive in the 401.5-401.9 MHz band (12.5 kHz and 25 kHz bandwidths). See draft FCC Form 312 Schedule B for overview of the propose earth station operations.

II. Antenna Patterns

The antenna patterns for the UHF monopole transmit antenna are provided in this section. For clarification, +Z is the Nadir pointing direction of the satellite.

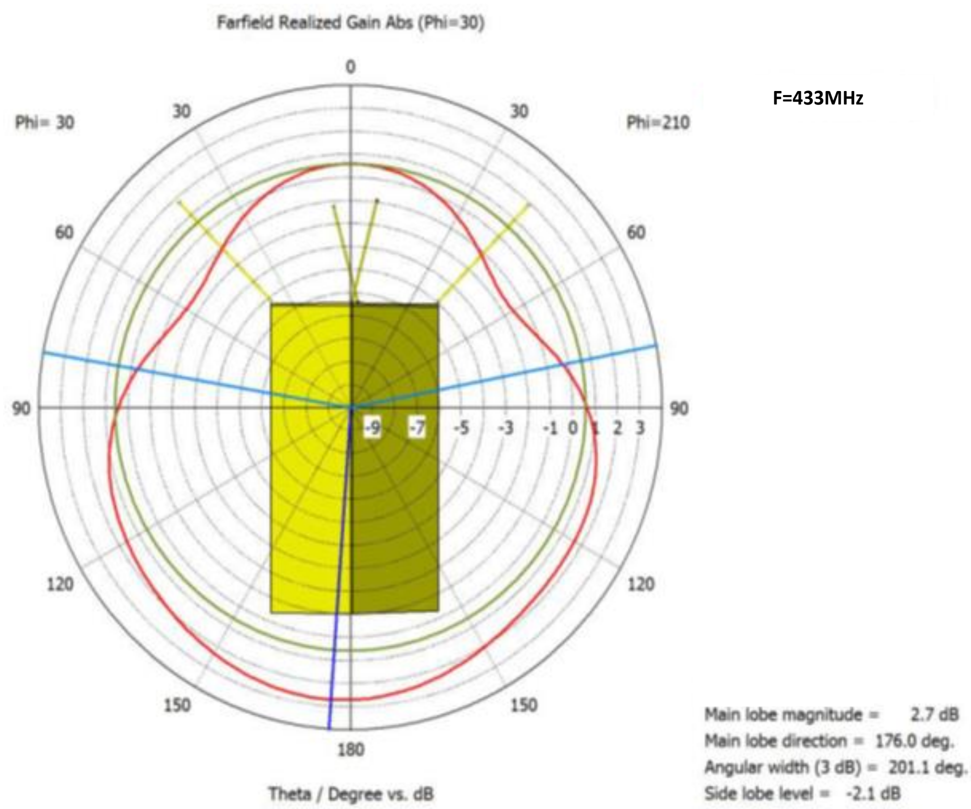

Figure 2 UHF Monopole TX Antenna Pattern

Satellite Payload Antenna Patterns

The antenna patterns for the X-band transmit antenna is provided in this section.

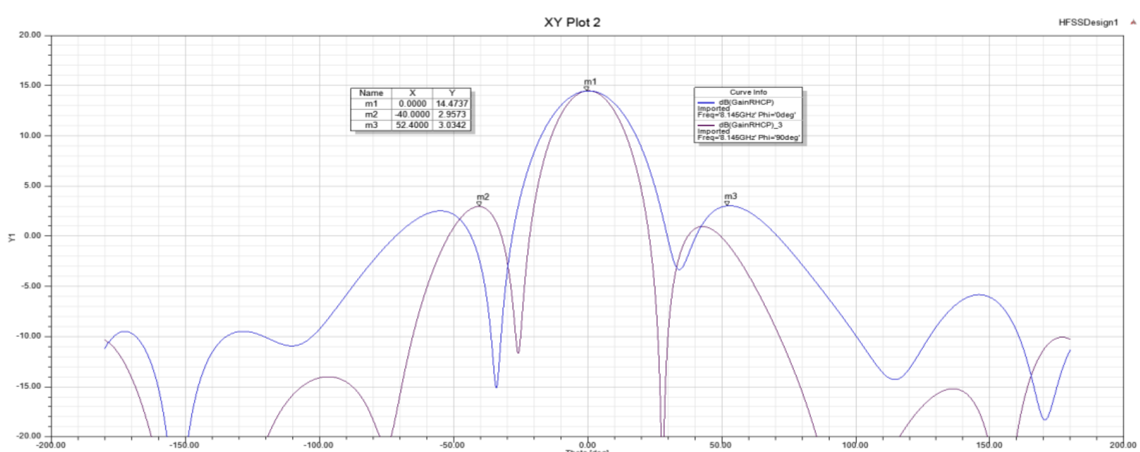

Figure 3 X-band Transmit Antenna Pattern

III. TT&C Link Budgets

The following figure illustrate representative link budgets for the UHF-band TT&C downlink.

UHF Telemetry Link Budgets		UHF-band	
		EOC	EOC
GEOMETRY, FREQUENCY, DATA RATES			
Orbit Altitude	km	528.00	536.00
Grazing (Elevation) Angle	deg	4.40	4.70
Nadir (Scan) Angle	deg	67.05	66.83
Earth Central Angle	deg	18.55	18.47
Slant Range	km	2203.91	2197.27
Link Frequency	GHz	0.40	0.40
Link Wavelength	cm	74.76	74.76
Channel Bandwidth	MHz	0.010	0.01
Excess Bandwidth		0.20	0.20
Channel Symbol Rate	Msps	0.008	0.008
Spreading		1.000	1.000
Spreading	dB	0.000	0.000
Bandwidth Efficiency (Coding)	bps/Hz	1.000	1.000
Bandwidth Efficiency (Total)	bps/Hz	1.000	1.000
Information Data Rate	Mbps	0.008	0.008
Target Propagation Link Margin	dB	18.30	18.30
Comparable DVB-S2X ModCod		QPSK 9/20	QPSK 9/20
SATELLITE TRANSMITER PARAMETERS			
Power per Channel	Watts	1.00	1.00
Power per Channel	dBW	0.00	0.00
TX Antenna Diameter	cm	37.00	37.00
TX Antenna Efficiency		0.65	0.65
TX Half Power Beamwidth	deg	141.44	141.44
TX Antenna Gain (B.3.a.1)	dBi	1.96	1.96
Maximum EIRP	dBW	2.0	1.96
Pointing Loss	dB	0.00	0.00
Effective EIRP	dBW	1.96	1.96
DOWNLINK PATH LOSSES			
Total Path Loss	dB	151.38	151.35
GATEWAY RECEIVER PARAMETERS			
Noise Figure	dB	2.3	2.3
Feed/Recv Noise Temperature	K	204.8	204.8
RX Clear Sky Antenna Temperature	K	25.00	25.00
System Noise Temperature at Antenna (C.10.d.6)	K	229.76	229.76
System Noise Temperature at Antenna	dB-K	23.61	23.61
RX Antenna Diameter	cm	210.00	210.00
RX Antenna Efficiency		0.65	0.65
RX Half Power Beamwidth (C.10.d.4)	deg	24.92	24.92
Peak Antenna Gain (C.10.d.3)	dBi	17.04	17.04
Pointing Loss	dB	0.00	0.00
Effective G/T	dBi/K	-9.72	-9.72
Link Summary			
Receive Power	dBW	-132.4	-132.3
Received C/N	dB	30.3	30.3
C/I	dB	18.00	18.00
Shannon Code C/(N+I)	dB	7.99	8.01
Implementation Loss	dB	3.00	3.00
Objective C/(N+I) (After Depspreading)	dB	10.99	11.01
Objective C/N (c.8.e.2)	dB	11.96	11.98
Link Margin	dB	18.30	18.30

Figure 4 Downlink TT&C Telemetry Link Budget

IV. Spacety TY Series Orbital Debris Assessment Report (ODAR)

Spacety-TY-Series-ODAR-1.0

This report is in compliance with NASA-STD-8719.14, APPENDIX A.

Spacety Co., Ltd.
No.9 Dengzhuang South Road
Haidian District
Beijing, China

Document Data is Not Restricted. This document contains no proprietary, ITAR, or export controlled information.

DAS Software Version Used In Analysis: v2.1.1

Contents

Self-assessment of the ODAR using the format in Appendix A.2 of NASA-STD-8719.14:

A self-assessment is provided below in accordance with the assessment format provided in Appendix A.2 of NASA-STD-8719.14.

Req		Launch Vehicle				Spacecraft			Comments
#	Description	Compliant	Not Compliant	Incomplete	Standard Non Compliant	Compliant or N/A	Not Compliant	Incomplete	No debris released in LEO.
4.3-1a	Debris-LEO			x		x			No debris released in LEO.
4.3-1b	Debris-LEO			x		x			No debris released in LEO.
4.3-2	Debris-GEO			x		x			No debris released near GEO.
4.4-1	Explosions			x		x			
4.4-2	Passivation			x		x			
4.4-3	Long-term risk			x		x			No planned breakups.
4.4-4	Short-term risk			x		x			No planned breakups.
4.5-1	Debris from collisions-large obj			x		x			
4.5-2	Debris from collisions-small obj			x		x			
4.6-1a	Disposal by re-entry			x		x			
4.6-1b	Disposal by maneuvers			x		x			No planned disposal maneuvers.
4.6-1c	Disposal by retrieval			x		x			No planned retrieval.
4.6-2	Disposal near GEO			x		x			LEO orbits only.
4.6-3	Disposal between LEO,GEO			x		x			LEO orbits only.
4.6-4	Reliability of disposal			x		x			No planned disposal operations.
4.7-1	Risk of human casualty			x		x			
4.8-1	Tethers			x		x			No Tethers used.

Assessment Report Format:

ODAR Technical Sections Format Requirements:

This ODAR follows the format in NASA-STD-8719.14, Appendix A.1 and includes the content indicated as a minimum, in each of sections 2 through 8 below for the TY SERIES satellites. Sections 9 through 14 apply to the launch vehicle ODAR and are not covered here.

ODAR Section 1: Program Management and Mission Overview

Program/project manager: Spacety Co., Ltd., a Chinese company, will launch six 6U cubesats – two sets of three satellites (in two launches) – pursuant to Chinese government authority. Thus, program control is vested in:

Spacety Co., Ltd.
No.9 Dengzhuang South Road
Haidian District
Beijing, China

Foreign government or space agency participation: None.

Summary of NASA's responsibility under the governing agreement(s): N/A

Mission Overview: The TY Series satellites that are the subject of this analysis consist of six 6U cubesats. They will be launched into a sun-synchronous, low-Earth orbit (LEO), with the first three satellites at 528km circular orbit and second three satellites at 536km circular orbit. The satellite bus used for the TY Series satellites uses an attitude measurement and control system to enable precision three-axis pointing without the use of propellant.

Proposed Launch Dates: October 28, 2018 (three satellites)
December 7, 2018 (three satellites)

Mission Duration: The anticipated operational lifetime of the TY Series satellites is one year.

Launch and deployment profile, including all parking, transfer, and operational orbits with apogee, perigee, and inclination: The Long March CZ-2 launch vehicle will transport multiple mission payloads to orbit. The six TY Series cubesats will be deployed, over the course of two launches, into approximately circular, LEO sun-synchronous orbits as described below.

Three satellites will be deployed into each of two orbits. The TY Series satellites will deploy UHF antennas and two solar panels once deployed from the launch vehicle. The spacecraft will decay naturally from an operational orbit defined as follows:

Launch #1

Long March CZ-2C
JiuQuan Launch Center
October 28, 2018
Apogee: 528 km
Perigee: 528 km
Inclination: 97.5°

Launch #12

Long March CZ-2D
JiuQuan Launch Center
December 7, 2018
Apogee: 536 km
Perigee: 536 km
Inclination: 97.6°

The TY Series satellites have no onboard propulsion and therefore do not actively change their orbit. There is no parking or transfer orbit.

ODAR Section 2: Spacecraft Description:

Physical description of the spacecraft: The TY Series satellites are based on the 6U cubesat form factor. The basic, pre-deployment physical dimensions are 350 mm x 259 mm x 132 mm with a mass of approximately 10kg. After solar array deployment, the SV physical dimensions grow to 801 mm x 430 mm x 425 mm.

The spacecraft include a 6U structure, thermal control subsystem, attitude measurement and control, electrical power, GNSS, TT&C, C&DH and payloads. RF communications include telemetry and commanding in the UHF band and mission data download at X-band. The six TY Series satellites, their payload missions, launch dates and their associated ITU filings are listed in Table 1.

Table 2 Spacety Satellite and Missions

Satellite	Mission	Launch	ITU Filing
TY1-02	**Laser Projection Communications**	**Oct. 28, 2018**	**TY2D**
TY1-03	**Optical Remote Sensing – 15m**	**Oct. 28, 2018**	**TY2D**
TY1-05	**Optical Remote Sensing – 5m**	**Dec. 7, 2018**	**TFStar**
TY3-01	**Optical Remote Sensing – 15m**	**Dec. 7, 2018**	**TY2D**
TY3-02	**Optical Remote Sensing – 15m**	**Dec. 7, 2018**	**TY2D**
TY4-02	**X-Ray Polarization Detection**	**Oct. 28, 2018**	**TY2D**

The TY Series satellite design includes a spring-loaded UHF and two solar panels that are deployed after jettison from the deployer by two independent burn wires controlled by software timers via the flight computer. The spacecraft is depicted in a pre-deployment configuration in Figure 5 and in a post-deployment configuration in Figure 6.

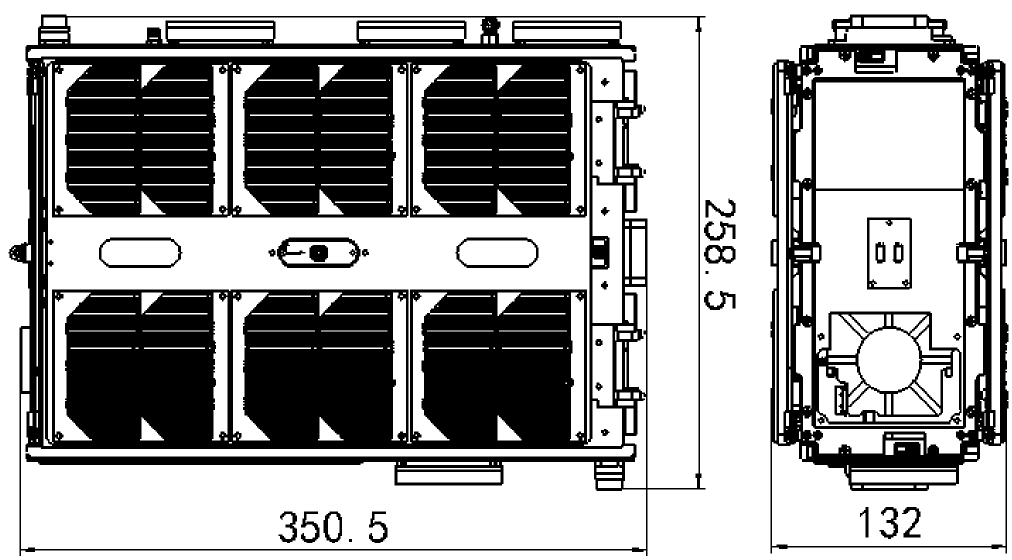

Figure 5 TY Series Spacecraft Configuration – Pre-Deployment

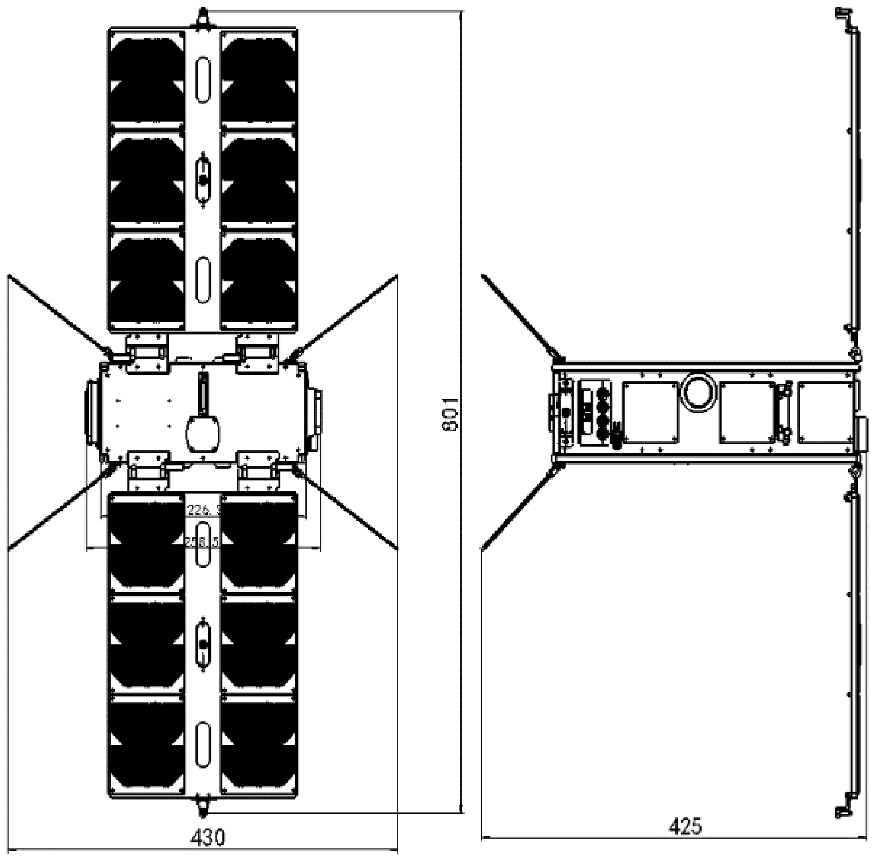

Figure 6 TY Series Spacecraft Configuration – Post-Deployment

Total satellite mass at launch, including all propellants and fluids: 10 kg.

Dry mass of satellites at launch: 10 kg. (No propellants exist)

Description of all propulsion systems (cold gas, mono-propellant, bi-propellant, electric, nuclear): None.

Identification, including mass and pressure, of all fluids (liquids and gases) planned to be on board and a description of the fluid loading plan or strategies, excluding fluids in sealed heat pipes: None

Fluids in Pressurized Batteries: None

The TY Series satellites use unpressurized standard COTS Lithium-Ion battery cells in each spacecraft. The total capacity energy capacity per spacecraft is 77 W-Hrs.

Description of attitude control system and indication of the normal attitude of the spacecraft with respect to the velocity vector: The TY Series spacecraft attitude control system consists of start trackers, momentum wheels, GPS and magnetic torquers.

- A *damping mode* used after initial satellite deployment or in response to an anomaly resulting in high angular velocity. This mode uses magnetometers and magnetic coils to reduce angular moment enough to enable transition to another control mode.
- A *safe hold mode* that is optimized for solar power generation from the satellite. The spacecraft's large fixed panel and deployable panel will be oriented towards the sun.
- A *3-axis stabilized mode*, which keeps the nadir panel of the satellites pointed toward the Earth and the +X panel facing towards the direction of motion. This mode is used for collecting imagery or other sensor data in a strip mode where constant satellite orientation is required.
- A *targeted tracking mode*, which will allow the payload (e.g. imager) or X-Band antenna to be directed at any location on the Earth's surface. This mode is used for collecting imagery or other sensor data where long term dwelling in upon a single point is required and for downlinking payload data to a X-band ground station.

Description of any range safety or other pyrotechnic devices: None. The spacecraft deploys its antenna and panels using a burn wire system. System power is locked off during launch. The antenna and solar panel spring constants are very low.

Description of the electrical generation and storage system: Standard commercial-off-the-shelf (COTS) Lithium-Ion battery cells are charged before payload integration and provide electrical energy during the eclipse portion of the satellites' orbit. The cells are recharged by triple-junction GaAs solar cells. The charge/discharge cycle is managed by a power management system with battery protection circuits to prevent against over-charging and under-charging conditions.

Identification of any other sources of stored energy not noted above: None

Identification of any radioactive materials on board: None

ODAR Section 3: Assessment of Spacecraft Debris Released during Normal Operations:

Identification of any object (>1 mm) expected to be released from the spacecraft any time after launch, including object dimensions, mass, and material: None.

Rationale/necessity for release of each object: N/A.

Time of release of each object, relative to launch time: N/A.

Release velocity of each object with respect to spacecraft: N/A.
Expected orbital parameters (apogee, perigee, and inclination) of each object after release: N/A.

Calculated orbital lifetime of each object, including time spent in Low Earth Orbit (LEO): N/A.

Assessment of spacecraft compliance with Requirements 4.3-1 and 4.3-2 (per DAS v2.1.1)
4.3-1, Mission Related Debris Passing Through LEO: COMPLIANT
4.3-2, Mission Related Debris Passing Near GEO: COMPLIANT

ODAR Section 4: Assessment of Spacecraft Intentional Breakups and Potential for Explosions.

Potential causes of spacecraft breakup during deployment and mission operations: There is no credible scenario that would result in spacecraft breakup during normal deployment and operations.

Summary of failure modes and effects analyses of all credible failure modes which may lead to an accidental explosion: The in-orbit failure of a battery cell protection circuit could lead to a short circuit resulting in overheating and a very remote possibility of battery cell explosion. The battery safety systems discussed in the FMEA (*see* requirement 4.4-1 below) describe the combined faults that must occur for any of seven (7) independent, mutually exclusive failure modes to lead to such an explosion.

Detailed plan for any designed spacecraft breakup, including explosions and intentional collisions: There are no planned breakups.

List of components which shall be passivated at End of Mission (EOM) including method of passivation and amount which cannot be passivated:
Momentum wheels – power removed and wheels spun down

Rationale for all items which are required to be passivated, but cannot be due to their design: Lithium Ion Battery Cells will not be passivated at end-of-mission due to the low risk and low impact of explosive rupturing, and the extremely short lifetime at mission conclusion. The battery charge circuits include overcharge protection to limit the risk of battery failure. However, in the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy, of these small batteries is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the vessel due to the lack of penetration energy.

Assessment of spacecraft compliance with Requirements 4.4-1 through 4.4-4:

Requirement 4.4-1: Limiting the risk to other space systems from accidental explosions during deployment and mission operations while in orbit about Earth or the Moon: *"For each spacecraft and launch vehicle orbital stage employed for a mission, the program or project shall demonstrate, via failure mode and effects analyses or equivalent analyses, that the integrated probability of explosion for all credible failure modes of each spacecraft and launch vehicle is less than 0.001 (excluding small particle impacts) (Requirement 56449)."*

Compliance statement:

Required Probability: 0.001.

Expected probability: 0.000.

Supporting Rationale and FMEA details:

Battery explosion:

Effect: All failure modes below might theoretically result in battery explosion with the possibility of orbital debris generation. However, in the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy, of these small batteries is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the spacecraft due to the lack of penetration energy to the multiple enclosures surrounding the batteries.

Probability: Extremely Low. It is believed to be much less than 0.1% given that multiple independent (not common mode) faults must occur for each failure mode to cause the ultimate effect (explosion).

Failure mode 1: Internal short circuit.

Mitigation 1: Protoflight level sine burst, sine and random vibration in three axes of both spacecraft, thermal vacuum cycling of both spacecraft and extensive functional testing followed by maximum system rate-limited charge and discharge cycles were performed to prove that no internal short circuit sensitivity exists. Additional environmental and functional testing of the batteries at the power subsystem vendor facilities were also conducted on the batteries at the component level.

Combined faults required for realized failure: Environmental testing **AND** functional charge/discharge tests must both be ineffective in discovery of the failure mode.

Failure Mode 2**:** Internal thermal rise due to high load discharge rate.

Mitigation 2: Battery cells were tested in lab for high load discharge rates in a variety of flight-like configurations to determine if the feasibility of an out-of-control thermal rise in the cell. Cells were also tested in a hot, thermal vacuum environment in order to test the upper limit of the cells capability. No failures were observed or identified via satellite telemetry or via external monitoring circuitry.

Combined faults required for realized failure: Spacecraft thermal design must be incorrect **AND** external over-current detection and disconnect function must fail to enable this failure mode.

***Failure Mode 3*:** Excessive discharge rate or short-circuit due to external device failure or terminal contact with conductors not at battery voltage levels (due to abrasion or inadequate proximity separation).

Mitigation 3: This failure mode is negated by:

a) qualification tested short circuit protection on each external circuit,

b) design of battery packs and insulators such that no contact with nearby board traces is possible without being caused by some other mechanical failure,

c) obviation of such other mechanical failures by protoflight level environmental tests (shock, random vibration, thermal cycling, and thermal-vacuum tests).

Combined faults required for realized failure: An external load must fail/short-circuit AND external over-current detection and disconnect function must all occur to enable this failure mode.

Failure Mode 4: Inoperable vents.

Mitigation 4: Battery venting is not inhibited by the battery holder design or the spacecraft design. The battery can vent gases to the external environment.

Combined effects required for realized failure: The cell manufacturer OR the satellite integrator fails to install proper venting.

Failure Mode 5: Crushing

Mitigation 5: This mode is negated by spacecraft design. There are no moving parts in the proximity of the batteries.

Combined faults required for realized failure: A catastrophic failure must occur in an external system **AND** the failure must cause a collision sufficient to crush the batteries leading to an internal short circuit **AND** the satellite must be in a naturally sustained orbit at the time the crushing occurs.

Failure Mode 6: Low level current leakage or short-circuit through battery pack case or due to moisture-based degradation of insulators.

Mitigation 6: These modes are negated by:

a) battery holder/case design made of non-conductive plastic, and

b) operation in vacuum such that no moisture can affect insulators.

Combined faults required for realized failure: Abrasion or piercing failure of circuit board coating or wire insulators **AND** dislocation of battery packs **AND** failure of battery terminal insulators **AND** failure to detect such failures in environmental tests must occur to result in this failure mode.

Failure Mode 7: Excess temperatures due to orbital environment and high discharge combined.

Mitigation 7: The spacecraft thermal design will negate this possibility. Thermal rise has been analyzed in combination with space environment temperatures showing that batteries do not exceed normal allowable operating temperatures under a variety of modeled cases, including worst case orbital scenarios. Analysis shows these temperatures to be well below temperatures of concern for explosions.

Combined faults required for realized failure: Thermal analysis **AND** thermal design **AND** mission simulations in thermal-vacuum chamber testing **AND** over-current monitoring and control must all fail for this failure mode to occur.

Requirement 4.4-2: **Design for passivation after completion of mission operations while in orbit about Earth or the Moon:**

'Design of all spacecraft and launch vehicle orbital stages shall include the ability to deplete all onboard sources of stored energy and disconnect all energy generation sources when they are no longer required for mission operations or post-mission disposal or control to a level which ca

not cause an explosion or deflagration large enough to release orbital debris or break up the spacecraft (Requirement 56450)."

Compliance statement: the TY Series spacecraft onboard sources of energy include onboard batteries for energy storage. The battery charge circuits include overcharge protection to limit the risk of battery failure. And as previously mentioned, the integrated burst disc should prevent any explosion altogether. In the unlikely event that a battery cell does explosively rupture, the small size, mass, and potential energy, of these small batteries is such that while the spacecraft could be expected to vent gases, most debris from the battery rupture should be contained within the spacecraft due to the lack of penetration energy to the multiple enclosures surrounding the batteries. In addition, the momentum wheels will be spun down and power removed, thus preventing the possibility of a cataphoric failure.

Requirement 4.4-3. Limiting the long-term risk to other space systems from planned breakups: Compliance statement: This requirement is not applicable. There are no planned breakups.

Requirement 4.4-4: Limiting the short-term risk to other space systems from planned breakups: Compliance statement: This requirement is not applicable. There are no planned breakups.

ODAR Section 5: Assessment of Spacecraft Potential for On-Orbit Collisions

Assessment of spacecraft compliance with Requirements 4.5-1 and 4.5-2 (per DAS v2.1.1, and calculation methods provided in NASA-STD-8719.14, section 4.5.4):

Requirement 4.5-1. Limiting debris generated by collisions with large objects when operating in Earth orbit:

"For each spacecraft and launch vehicle orbital stage in or passing through LEO, the program or project shall demonstrate that, during the orbital lifetime of each spacecraft and orbital stage, the probability of accidental collision with space objects larger than 10 cm in diameter is less than 0.001 (Requirement 56506)."

Large Object Impact and Debris Generation Probability: 0.00000; COMPLIANT.

Requirement 4.5-2. Limiting debris generated by collisions with small objects when operating in Earth or lunar orbit:

"For each spacecraft, the program or project shall demonstrate that, during the mission of the spacecraft, the probability of accidental collision with orbital debris and meteoroids sufficient to

prevent compliance with the applicable post-mission disposal requirements is less than 0.01 (Requirement 56507)."

Small Object Impact and Debris Generation Probability: Not applicable; the spacecraft is planned orbital disposal by atmospheric entry, and does not require a specific spacecraft orientation and drag state to meet the disposal requirements. Therefore, no element or component of the spacecraft system is required to complete post-mission operations.

Identification of all systems or components required to accomplish any post-mission disposal operation, including passivation and maneuvering: None

ODAR Section 6: Assessment of Spacecraft Post-Mission Disposal Plans and Procedures

6.1 Description of spacecraft disposal option selected: The satellite will de-orbit naturally by atmospheric re-entry. There is no propulsion system.

6.2 Plan for any spacecraft maneuvers required to accomplish post-mission disposal: None

6.3 Calculation of area-to-mass ratio after post-mission disposal, if the controlled reentry option is not selected:

Spacecraft Mass: 10 kg

Cross-sectional Area: 0.0855 m^2

Area to mass ratio: 0.0855/10 = 0.00855 m^2/kg

6.4 Assessment of spacecraft compliance with Requirements 4.6-1 through 4.6-5 (per DAS v 2.1.1 and NASA-STD-8719.14 section): Requirement 4.6-1. Disposal for space structures passing through LEO:

"A spacecraft or orbital stage with a perigee altitude below 2000 km shall be disposed of by one of three methods: (Requirement 56557)

a. Atmospheric reentry option: Leave the space structure in an orbit in which natural forces will lead to atmospheric reentry within 25 years after the completion of mission but no more than 30 years after launch; or Maneuver the space structure into a controlled de-orbit trajectory as soon as practical after completion of mission.

b. Storage orbit option: Maneuver the space structure into an orbit with perigee altitude greater than 2000 km and apogee less than GEO - 500 km.

c. Direct retrieval: Retrieve the space structure and remove it from orbit within 10 years after completion of mission."

Analysis: The TY Series satellite method of disposal is COMPLIANT using method "a." The spacecraft will be left in a 528 x 528 km or 536 x 536 km near-circular orbit, reentering in less than 6 years after launch with orbit history as shown in Figure 2 (analysis assumes an approximate random tumbling behavior from the 536 x 536 km orbit without solar array deployment, all other scenarios will reduce the deorbit time). If the solar arrays are successfully deployed, the passive deorbit time from orbit insertion drops to less than 3.6 years.

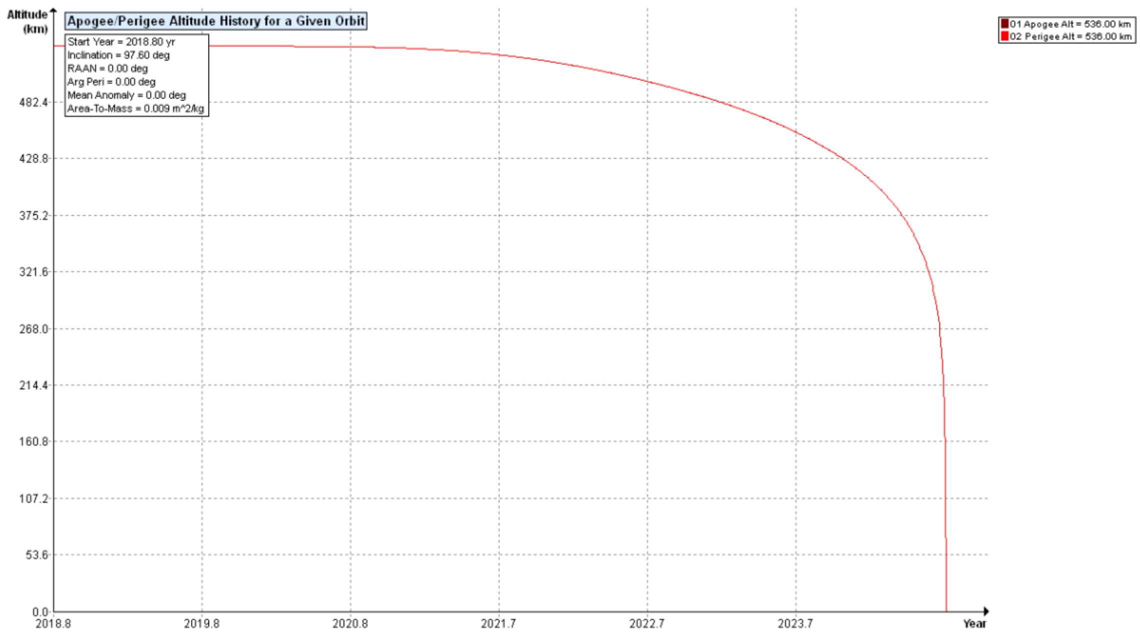

Figure 2: TY Series Satellite Worst-case Orbit History

Requirement 4.6-2. Disposal for space structures near GEO:
Analysis is not applicable.

Requirement 4.6-3. Disposal for space structures between LEO and GEO: Analysis is not applicable.

Requirement 4.6-4. Reliability of Post-mission Disposal Operations:
Analysis is not applicable. The satellite will reenter passively without post mission disposal operations within the allowable timeframe.

ODAR Section 7: Assessment of Spacecraft Reentry Hazards:

Assessment of spacecraft compliance with Requirement 4.7-1: Requirement 4.7-1. Limit the risk of human casualty:

"The potential for human casualty is assumed for any object with an impacting kinetic energy in excess of 15 joules:
a) For uncontrolled reentry, the risk of human casualty from surviving debris shall not exceed 0.0001 (1:10,000) (Requirement 56626)."
Summary Analysis Results: DAS v2.1.1 reports that the TY Series satellites are COMPLIANT with the requirement. The critical values reported by the DAS software are:

- Demise Altitude = 57.7 km
- Debris Casualty Area = 0.000000
- Impact Kinetic Energy = 0.000000

This is expected to represent the absolute maximum casualty risk, as calculated with DAS's limited modeling capability.

As a worst-case analysis, the Casualty Risk from Reentry Debris analysis was repeated assuming that the SV was constructed of stainless steel (generic) because it reflects what is expected to be the highest melting point material in the TY Series cubesats. Under these worst-case conditions, the risk of human casualty increases to 1:116,100. Even when considering the effects from all six SV in the filing, the combined risk is still only 1:19,350, safely below the requirement of 1:10,000.

The DAS Output Summary Follows:

```
10 10 2018; 08:43:31AM     Processing Requirement 4.3-2: Return Status
: Passed

=====================
No Project Data Available
=====================

=============== End of Requirement 4.3-2 ===============
10 10 2018; 08:43:35AM     Requirement 4.4-3:  Compliant

=============== End of Requirement 4.4-3 ===============
10 10 2018; 08:57:24AM     Processing Requirement 4.5-1:    Return
Status :  Passed

==============
Run Data
==============

**INPUT**

     Space Structure Name = TY Series
     Space Structure Type = Payload
     Perigee Altitude = 528.000000 (km)
     Apogee Altitude = 528.000000 (km)
     Inclination = 97.500000 (deg)
     RAAN = 0.000000 (deg)
     Argument of Perigee = 0.000000 (deg)
     Mean Anomaly = 0.000000 (deg)
     Final Area-To-Mass Ratio = 0.005500 (m^2/kg)
     Start Year = 2018.000000 (yr)
     Initial Mass = 10.000000 (kg)
     Final Mass = 10.000000 (kg)
     Duration = 1.000000 (yr)
     Station-Kept = False
     Abandoned = True
     PMD Perigee Altitude = -1.000000 (km)
     PMD Apogee Altitude = -1.000000 (km)
     PMD Inclination = 0.000000 (deg)
     PMD RAAN = 0.000000 (deg)
     PMD Argument of Perigee = 0.000000 (deg)
     PMD Mean Anomaly = 0.000000 (deg)

**OUTPUT**

     Collision Probability = 0.000001
     Returned Error Message: Normal Processing
     Date Range Error Message: Normal Date Range
     Status = Pass
```

==============

=============== End of Requirement 4.5-1 ===============
10 10 2018; 09:05:22AM   Requirement 4.5-2: Compliant
10 10 2018; 09:05:24AM   Processing Requirement 4.6 Return Status :
Passed

==============
Project Data
==============

INPUT

Space Structure Name = TY Series
Space Structure Type = Payload

Perigee Altitude = 528.000000 (km)
Apogee Altitude = 528.000000 (km)
Inclination = 97.500000 (deg)
RAAN = 0.000000 (deg)
Argument of Perigee = 0.000000 (deg)
Mean Anomaly = 0.000000 (deg)
Area-To-Mass Ratio = 0.005500 (m^2/kg)
Start Year = 2018.000000 (yr)
Initial Mass = 10.000000 (kg)
Final Mass = 10.000000 (kg)
Duration = 1.000000 (yr)
Station Kept = False
Abandoned = True
PMD Perigee Altitude = 527.400198 (km)
PMD Apogee Altitude = 527.400198 (km)
PMD Inclination = 97.517651 (deg)
PMD RAAN = 358.783991 (deg)
PMD Argument of Perigee = 4.342359 (deg)
PMD Mean Anomaly = 0.000000 (deg)

OUTPUT

Suggested Perigee Altitude = 527.400198 (km)
Suggested Apogee Altitude = 527.400198 (km)
Returned Error Message = Passes LEO reentry orbit criteria.

Released Year = 2026 (yr)
Requirement = 61
Compliance Status = Pass

==============

=============== End of Requirement 4.6 ===============
10 10 2018; 09:05:55AM   *********Processing Requirement 4.7-1
Return Status : Passed

```
***********INPUT****
 Item Number = 1

name = TY Series
quantity = 1
parent = 0
materialID = 8
type = Box
Aero Mass = 10.000000
Thermal Mass = 10.000000
Diameter/Width = 0.259000
Length = 0.350000
Height = 0.132000

name = S
quantity = 1
parent = 1
materialID = 8
type = Box
Aero Mass = 10.000000
Thermal Mass = 10.000000
Diameter/Width = 0.259000
Length = 0.350000
Height = 0.132000

**************OUTPUT****
Item Number = 1

name = TY Series
Demise Altitude = 77.997169
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

*************************************
name = S
Demise Altitude = 57.768135
Debris Casualty Area = 0.000000
Impact Kinetic Energy = 0.000000

*************************************

=============== End of Requirement 4.7-1 ===============
```

Requirements 4.7-1b, and 4.7-1c:
These requirements are non-applicable requirements because the TY Series satellites do not use controlled reentry.

4.7-1, b): *"For controlled reentry, the selected trajectory shall ensure that no surviving debris impact with a kinetic energy greater than 15 joules is closer than 370 km from foreign* *landmasses, or is within 50 km from the continental U.S., territories of the U.S., and the permanent ice pack of Antarctica (Requirement 56627)."*

Not applicable to the TY Series satellites. They do not use controlled reentry.

4.7-1 c): *"For controlled reentries, the product of the probability of failure of the reentry burn (from Requirement 4.6-4.b) and the risk of human casualty assuming uncontrolled reentry shall not exceed 0.0001 (1:10,000) (Requirement 56628)."*
Not applicable to the TY Series satellites. It does not use controlled reentry.

ODAR Section 8: Assessment for Tether Missions

Not applicable. There are no tethers used in the TY Series satellite missions.

END of ODAR for TY Series satellites.

Appendix A: Acronyms

Arg peri	Argument of Perigee
CDR	Critical Design Review
cm	centimeter
COTS	Commercial Off-The-Shelf (items)
DAS	Debris Assessment Software
EOM	End Of Mission
FRR	Flight Readiness Review
GEO	Geosynchronous Earth Orbit
ITAR	International Traffic In Arms Regulations
kg	kilogram
km	kilometer
LEO	Low Earth Orbit
Li-Ion	Lithium Ion
m^2	Meters squared
ml	milliliter
mm	millimeter
N/A	Not Applicable.
NET	Not Earlier Than
ODAR	Orbital Debris Assessment Report
OSMA	Office of Safety and Mission Assurance
PDR	Preliminary Design Review

PL	Payload
ISIPOD	ISIS CubeSat Deployer
PSIa	Pounds Per Square Inch, absolute
RAAN	Right Ascension of the Ascending Node
SMA	Safety and Mission Assurance
Ti	Titanium
Yr	year

Approved by OMB
3060-0678

V. Draft FCC Form 312 Schedule B

Date & Time Filed:
File Number: ---
Callsign/Satellite ID:

APPLICATION FOR EARTH STATION AUTHORIZATIONS FCC 312 MAIN FORM FOR OFFICIAL USE ONLY	FCC Use Only

APPLICANT INFORMATION

Enter a description of this application to identify it on the main menu:
Draft Form (STA for Windham-SpaceTy)

1-8. Legal Name of Applicant

Name:	RBC Signals, LLC	Phone Number:	404-803-7734
DBA Name:		Fax Number:	
Street:	2205 152nd Ave NE	E-Mail:	crichins@rbcsignals.com
City:	Redmond	State:	WA
Country:	USA	Zipcode:	98052 -
Attention:	Mr. Christopher Richins		

9-16. Name of Contact Representative

Name:	Jason Davila	Phone Number:	6099021670
Company:	LMI Advisors	Fax Number:	
Street:	2550 M Street NW Suite 344	E-Mail:	jdavila@lmiadvisors.com
City:	Washington	State:	DC
Country:	USA	Zipcode:	20037-
Attention:	Jason Davila	Relationship:	Other

CLASSIFICATION OF FILING

17. Choose the button next to the classification that applies to this filing for both questions a. and b. Choose only one for 17a and only one for 17b. a. (●) a1. Earth Station (N/A) a2. Space Station	b. (●) b1. Application for License of New Station (○) b2. Application for Registration of New Domestic Receive-Only Station (N/A) b3. Amendment to a Pending Application (N/A) b4. Modification of License or Registration (N/A) b5. Assignment of License or Registration (N/A) b6. Transfer of Control of License or Registration (N/A) b7. Notification of Minor Modification (N/A) b8. Application for License of New Receive-Only Station Using Non-U.S. Licensed Satellite (N/A) b9. Letter of Intent to Use Non-U.S. Licensed Satellite to Provide Service in the United States (○) b10. Other (Please specify) (○) b11. Application for Earth Station to Access a Non-U.S.satellite Not Currently Authorized to Provide the Proposed Service in the Proposed Frequencies in the United States.

17c. Is a fee submitted with this application?
(○) If Yes, complete and attach FCC Form 159.

If No, indicate reason for fee exemption (see 47 C.F.R.Section 1.1114).
(○) Governmental Entity (○) Noncommercial educational licensee

◉ Other(please explain): DRAFT FORM

17d.
Fee Classification

18. If this filing is in reference to an existing station, enter:	19. If this filing is an amendment to a pending application enter:	
(a) Call sign of station:	(a) Date pending application was filed:	(b) File number of pending application:
Not Applicable	Not Applicable	Not Applicable

TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Select all that apply:

☐ a. Fixed Satellite
☒ b. Mobile Satellite
☐ c. Radiodetermination Satellite
☐ d. Earth Exploration Satellite
☐ e. Direct to Home Fixed Satellite
☐ f. Digital Audio Radio Service
☒ g. Other (please specify)
NGSO

21. STATUS: Choose the button next to the applicable status. Choose only one.
○ Common Carrier ◉ Non-Common Carrier

22. If earth station applicant, check all that apply.
☐ Using U.S. licensed satellites
☒ Using Non-U.S. licensed satellites

23. If applicant is providng INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Choose one. Are these facilities:
○ Connected to a Public Switched Network ○ Not connected to a Public Switched Network ◉ N/A

24. FREQUENCY BAND(S): Place an "X" in the box(es) next to all applicable frequency band(s).
☐ a. C-Band (4/6 GHz) ☐ b. Ku-Band (12/14 GHz)
☒ c.Other (Please specify upper and lower frequencies in MHz.)
Frequency Lower: 401.5 Frequency Upper: 401.9

TYPE OF STATION

25. CLASS OF STATION: Choose the button next to the class of station that applies. Choose only one.
◉ a. Fixed Earth Station
○ b. Temporary-Fixed Earth Station
○ c. 12/14 GHz VSAT Network
○ d. Mobile Earth Station
(N/A) e. Geostationary Space Station
(N/A) f. Non-Geostationary Space Station
○ g. Other (please specify)

26. TYPE OF EARTH STATION FACILITY: Choose only one.
○ Transmit/Receive ○ Transmit-Only ◉ Receive-Only ○ N/A

PURPOSE OF MODIFICATION

27. The purpose of this proposed modification is to: (Place an 'X' in the box(es) next to all that apply.)
Not Applicable

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. §§ 1.1308 and 1.1311, as an exhibit to this application.A Radiation Hazard Study must accompany all applications for new transmitting facilities, major modifications, or major amendments. ○ **Yes** ◉ **No**

ALIEN OWNERSHIP Earth station applicants not proposing to provide broadcast, common carrier, aeronautical en route or aeronautical fixed radio station services are not required to respond to Items 30-34.

29. Is the applicant a foreign government or the representative of any foreign government?	○ Yes ◉ No
30. Is the applicant an alien or the representative of an alien?	○ Yes ○ No ◉ N/A
31. Is the applicant a corporation organized under the laws of any foreign government?	○ Yes ○ No ◉ N/A
32. Is the applicant a corporation of which more than one-fifth of the capital stock is owned of record or voted by aliens or their representatives or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	○ Yes ○ No ◉ N/A
33. Is the applicant a corporation directly or indirectly controlled by any other corporation of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	○ Yes ○ No ◉ N/A
34. If any answer to questions 29, 30, 31, 32 and/or 33 is Yes, attach as an exhibit an identification of the aliens or foreign entities, their nationality, their relationship to the applicant, and the percentage of stock they own or vote.	

BASIC QUALIFICATIONS

35. Does the Applicant request any waivers or exemptions from any of the Commission's Rules? If Yes, attach as an exhibit, copies of the requests for waivers or exceptions with supporting documents.	○ Yes ◉ No
36. Has the applicant or any party to this application or amendment had any FCC station authorization or license revoked or had any application for an initial, modification or renewal of FCC station authorization, license, or construction permit denied by the Commission? If Yes, attach as an exhibit, an explination of circumstances.	○ Yes ◉ No
37. Has the applicant, or any party to this application or amendment, or any party directly or indirectly controlling the applicant ever been convicted of a felony by any state or federal court? If Yes, attach as an exhibit, an explination of circumstances.	○ Yes ◉ No
38. Has any court finally adjudged the applicant, or any person directly or indirectly controlling the applicant, guilty of unlawfully monopolizing or attemptiing unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement or any other means or unfair methods of competition?If Yes, attach as an exhibit, an explanation of circumstances	○ Yes ◉ No
39. Is the applicant, or any person directly or indirectly controlling the applicant, currently a party in any pending matter referred to in the preceding two items? If yes, attach as an exhinit, an explanation of the circumstances.	◉ Yes ○ No
40. If the applicant is a corporation and is applying for a space station license, attach as an exhibit the names, address, and citizenship of those stockholders owning a record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries. Also list the names and addresses of the officers and directors of the Filer.	
41. By checking Yes, the undersigned certifies, that neither applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. *See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.*	◉ Yes ○ No
42a. Does the applicant intend to use a non-U.S. licensed satellite to provide service in the United States? If Yes, answer 42b and attach an exhibit providing the information specified in *47 C.F.R. 25.137, as appropriate*. If No, proceed to question 43.	◉ Yes ○ No
42b. What administration has licensed or is in the process of licensing the space station? If no license will be issued, what administration has coordinated or is in the process of coordinating the space station? China	

43. Description. (Summarize the nature of the application and the services to be provided). See Narrative.

43a. Geographic Service Rule Certification By selecting A, the undersigned certifies that the applicant is not subject to the geographic service or geographic coverage requirements specified in 47 C.F.R. Part 25.	◉ A
By selecting B, the undersigned certifies that the applicant is subject to the geographic service or geographic	○ B

coverage requirements specified in 47 C.F.R. Part 25 and will comply with such requirements.

By selecting C, the undersigned certifies that the applicant is subject to the geographic service or geographic coverage requirements specified in 47 C.F.R. Part 25 and will not comply with such requirements because it is not feasible as a technical matter to do so, or that, while technically feasible, such services would require so many compromises in satellite design and operation as to make it economically unreasonable. A narrative description and technical analysis demonstrating this claim are attached. ○ **C**

CERTIFICATION

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests an authorization in accordance with this application. The applicant certifies that grant of this application would not cause the applicant to be in violation of the spectrum aggregation limit in 47 CFR Part 20. All statements made in exhibits are a material part hereof and are incorporated herein as if set out in full in this application. The undersigned, individually and for the applicant, hereby certifies that all statements made in this application and in all attached exhibits are true, complete and correct to the best of his or her knowledge and belief, and are made in good faith.

44. Applicant is a (an): (Choose the button next to applicable response.)

○ Individual
○ Unincorporated Association
○ Partnership
○ Corporation
○ Governmental Entity
◉ Other (please specify)
LLC

45. Name of Person Signing	46. Title of Person Signing
Christopher Richins	CEO

47. Please supply any need attachments.

Attachment 1:	Attachment 2:	Attachment 3:

WILLFUL FALSE STATEMENTS MADE ON THIS FORM ARE PUNISHABLE BY FINE AND / OR IMPRISONMENT (U.S. Code, Title 18, Section 1001), AND/OR REVOCATION OF ANY STATION AUTHORIZATION (U.S. Code, Title 47, Section 312(a)(1)), AND/OR FORFEITURE (U.S. Code, Title 47, Section 503).

SATELLITE EARTH STATION AUTHORIZATIONS
FCC Form 312 - Schedule B:(Technical and Operational Description)

FOR OFFICIAL USE ONLY

Location of Earth Station Site

E1: Site Identifier:	Windham	E5. Call Sign:	
E2: Contact Name	Zachary Reich	E6. Phone Number:	415-622-5548
E3. Street:	County Road 10	E7. City:	Windham
		E8. County:	Greene
E4. State	NY	E9. Zip Code	12496
E10. Area of Operation:		Windham, NY	
E11. Latitude:	42 ° 20 ' 11.3 " N		
E12. Longitude:	74 ° 15 ' 37.4 " W		
E13. Lat/Lon Coordinates are:		○NAD-27	◉NAD-83 ○N/A
E14. Site Elevation (AMSL):		15.0 meters	

E15. If the proposed antenna(s) operate in the Fixed Satellite Service (FSS) with geostationary satellites, do(es) the proposed antenna(s) comply with the antenna gain patterns specified in Section 25.209(a) and (b) as demonstrated by the manufacturer's qualification measurement? If NO, provide asa technical analysis showing compliance with two-degree spacing policy.	○ Yes ○ No ◉ N/A
E16. If the proposed antenna(s) do not operate in the Fixed Satellite Service (FSS), or if they operate in the Fixed Satellite Service (FSS) with non-geostationary satellites, do(es) the proposed antenna(s) comply with the antenna gain patterns specified in Section 25.209(a2) and (b) as demonstrated by the manufacturer's qualification measurements?	◉ Yes ○ No ○ N/A
E17. Is the facility operated by remote control? If YES, provide the location and telephone number of the control point.	○ Yes ◉ No
E18. Is frequency coordination required? If YES, attach a frequency coordination report as	○ Yes ◉ No
E19. Is coordination with another country required? If YES, attach the name of the country(ies) and plot of coordination contours as	○ Yes ◉ No
E20. FAA Notification - (See 47 CFR Part 17 and 47 CFR part 25.113(c)) Where FAA notification is required, have you attached a copy of a completed FCC Form 854 and or the FAA's study regarding the potential hazard of the structure to aviation? **FAILURE TO COMPLY WITH 47 CFR PARTS 17 AND 25 WILL RESULT IN THE RETURN OF THIS APPLICATION.**	○ Yes ◉ No

POINTS OF COMMUNICATION

Satellite Name:OTHER | OTHER | If you selected OTHER, please enter the following:	
E21. Common Name: TY4-02	E22. ITU Name:
E23. Orbit Location: NGSO	E24. Country: China

Satellite Name:OTHER | OTHER | If you selected OTHER, please enter the following:	
E21. Common Name: TY1-02	E22. ITU Name:
E23. Orbit Location: NGSO	E24. Country: China

Satellite Name:OTHER | OTHER | If you selected OTHER, please enter the following:	
E21. Common Name: TY1-03	E22. ITU Name:
E23. Orbit Location: NGSO	E24. Country: China

POINTS OF COMMUNICATION (Destination Points)

E25. Site Identifier: Windham	
E26. Common Name:	E27. Country:USA

ANTENNA

Site ID	E28. Antenna Id	E29. Quantity	E30. Manufacturer	E31. Model	E32. Antenna Size	E41/42. Antenna GainTransmint and/or Recieve(____dBi at _____GHz)
Windham	Yagi	2	M2 Antenna Systems	400CP30A	3.57	18.0 dBi at 0.400

E28. Antenna Id	E33/34. Diameter Minor/Major(meters)	E35. Above Ground Level (meters)	E36. Above Sea Level (meters)	E37. Building Height Above Ground Level (meters)	E38. Total Input Power at antenna flange (Watts)	E39. Maximum Antenna Height Above Rooftop (meters)	E40. Total EIRP for al carriers (dBW)
Yagi	0.25/3.57	15.0	0.0	0.0	0.0	0.0	0.0

FREQUENCY

E28. Antenna	E43/44. Frequency	E45. T/R	E46. Antenna Polarization(H,V,L,R)	E47. Emission	E48. Maximum EIRP per	E49. Maximum ERIP Density per

Id	Bands(MHz)	Mode		Designator	Carrier(dBW)	Carrier(dBW/4kHz)
Yagi	401.5 401.9	R	Right Hand Circular	12K5G1D	0.0	0.0
E50. Modulation and Services GFSK						
Yagi	401.5 401.9	R	Right Hand Circular	25K0G1D	0.0	0.0
E50. Modulation and Services GFSK						

FREQUENCY COORDINATION

E28. Antenna Id	E51. Satellite Orbit Type	E52/53. Frequency Limits(MHz)	E54/55. Range of Satellite Arc E/W Limit	E56. Earth Station Azimuth Angle Eastern Limit	E57. Antenna Elevation Angle Eastern Limit	E58. Earth Station Azimuth Angle Western Limit	E59. Antenna Elevation Angle Western Limit	E60. Maximum EIRP Density toward the Horizon(dBW/4kHz)
Yagi	Non-Geostationary	401.5 401.9	0.0/ 0.0	0.0	5.0	360.0	5.0	-50.0

REMOTE CONTROL POINT LOCATION
REMOTE CONTROL POINT LOCATION

E61. Call Sign NOTE: Please enter the callsign of the controlling station, not the callsign for which this application is being filed.			E65. Phone Number
E62. Street Address			
E63. City	E67. County	E64/68. State/Country /	E66. Zip Code

FCC NOTICE REQUIRED BY THE PAPERWORK REDUCTION ACT

The public reporting for this collection of information is estimated to average 0.25 - 24 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the required data, and completing and reviewing the collection of information. If you have any comments on this burden estimate, or how we can improve the collection and reduce the burden it causes you, please write to the Federal Communications Commission, AMD-PERM, Paperwork Reduction Project (3060-0678), Washington, DC 20554. We will also accept your comments regarding the Paperwork Reduction Act aspects of this collection via the Internet if you send them to PRA@fcc.gov. PLEASE DO NOT SEND COMPLETED FORMS TO THIS ADDRESS.

Remember - You are not required to respond to a collection of information sponsored by the Federal government, and the government may not conduct or sponsor this collection, unless it displays a currently valid OMB control number or if we fail to provide you with this notice. This collection has been assigned an OMB control number of 3060-0678.

THE FOREGOING NOTICE IS REQUIRED BY THE PAPERWORK REDUCTION ACT OF 1995, PUBLIC LAW 104-13, OCTOBER 1, 1995, 44 U.S.C. SECTION 3507.