

Exhibit on Radix Wideband and Parabolic Antennas and Radio

Radix has a powered parabolic dish and wideband antennas (unpowered) that are connected to a software-defined radio (SDR). This system is not operable upon launch and includes multiple inhibits discussed below.

This software-defined radio is a commercial-off-the-shelf-part that can be programmed for either receive or transmit. In addition to laser downlink testing, the primary goal of the Radix mission is concerned with only the receive capability of the SDR and parabolic/wideband antennas.

The GomSpace SDR TR-600 transceiver module that operates the parabolic and wideband antennas will have several software and hardware controls that will inhibit them from all operation in transmit or receive capability. The transceiver will be unable to send or receive at any power level or frequency upon launch and initial deployment, as they will not be programmed for operation when launched. Furthermore, the SDR transceiver and the parabolic antenna are each powered from their own software-controlled power distribution unit (PDU) channel. These PDU channels, like all subsystem PDU channels, are controlled by the Radix flight computer. The initial flight computer image will not have code included to turn on the SDR or parabolic antenna PDU channels. It will be as if they do not exist according to the flight computer image.

In addition, at launch, the SDR itself will not have software pre-loaded to function at all. To enable the SDR, a transmission from the ground via our UHF TT&C link would be necessary to add the SDR and parabolic antenna PDU channel functionality to the flight computer image and upload code for the SDR to function.

The long-term goal of the company is to operate a data relay service for satellites. However, no beta testers for this flight have been found. The primary purpose of this flight is to act as tech demonstration to gain flight heritage and reduce risk of the Radix satellite design.

If potential testers are found before Radix de-orbits, we would want to discuss the possibility with the FCC and NASA Spectrum Office of amending the license to test before the end of Radix's flight. If concerns could not be addressed to the satisfaction of either FCC or the NASA Spectrum Office and the FCC or NASA Spectrum Office does not approve the license amendment, then the application for those testers would be pushed to a future satellite mission.

Summary of safety inhibits from unauthorized use:

- A. The software-defined radio is on a dedicated PDU channel to prevent any accidental power-on. The parabolic antenna is on a separate PDU channel to prevent any accidental power-on. The SDR and the parabolic antenna PDU channel functionality will not be included in the flight computer image at launch.

- B. The satellite will launch with no software to drive the software-defined radio
- C. Once software is put on the SDR via the UHF TT&C link, any operation of the SDR would require a command sent through our UHF TT&C link to initially power on the software-defined radio.
- D. Any operation of the parabolic antenna would require a command sent through our UHF TT&C link to initially power on that antenna.
- E. The wideband antenna is connected to a receive-only port on the SDR. There is no transmission path to this antenna.

At no point will software be uploaded or commands sent to operate the SDR without pre-coordination and confirmation with the FCC that the activity is authorized.

In absence of beta testers, we are proposing to do a receive-only test to validate the proper mechanical deployment and function of the wideband and parabolic antennas. By using the sun as a reference source and tuning in the range of 2655-2690 MHz we can assess performance of the wideband and parabolic antennas post-deployment compared to ideal conditions on the ground that we have already measured. This can be used to test the receive capabilities of both the wideband and parabolic antennas.

To accomplish this test, we would upload software via the UHF TT&C link to the flight computer to enable the PDU channels, upload software to the SDR to enable its receive-only functionality in the authorized band, and send commands to turn on the SDR and parabolic antenna to perform the receive-only test. As outlined above, the radio will still be inhibited from transmitting due to the lack of software to drive the transmit function, as well as the lack of transmit commands sent from the ground station via the UHF TT&C link.

This plan and included inhibits was discussed with Cathy Sham of the NASA Spectrum Office on Tuesday, March 20th. She communicated her approval of this approach to Thilini Schlesinger of NASA ISS Research Integration Office who then communicated it to the payload integrator (Nanoracks) on Thursday, March 22nd. Please see email chain below:

RE: OA-9 cubesats

2 messages

Conor Brown <cbrown@nanoracks.com>

Thu, Mar 22, 2018 at 6:58 PM

To: David Payne <david.payne@analyticalspace.com>, Justin Oliveira <justin.oliveira@analyticalspace.com>

Cc: Weston Marlow <weston.marlow@analyticalspace.com>

David and Justin,

Please see below email from Cathy Sham (JSC Spectrum Manager) capturing the fact that she agrees to progress with the JSC Radio Frequency Authorization (RFA) based on the discussed approach on the telecom held on March 20th.

Per direction of Thilini Schlesinger, our Research Integration Manager, I removed the rest of the email chains in this correspondence because other payloads were discussed and it was not relevant to the discussion.

Regards,

Conor Brown | External Payloads Manager
NanoRacks, LLC | nanoracks.com
P: 703.973.6821

From: Sham, Catherine C. (JSC-EV811)

Sent: Thursday, March 22, 2018 5:12 PM

To: Schlesinger, Thilini (JSC-OZ611) <thilini.schlesinger@nasa.gov>; Jih, Cindy T. (JSC-OD111) <cindy.t.jih@nasa.gov>

Cc: Chu, Alan H. (JSC-EV811) <alan.h.chu@nasa.gov>

Subject: RE: OA-9 cubesats

Thilini:

Thank you for your quick response. Please keep me posted on further distribution.

For Radix – yes, I am agreeable to progress with the RFA based on the UHF radio and closing the assessing provided the UHF license is approved and the precoord conditions documented for future operation of the SDR. Thank you for your offer to keep this satellite on the IPL.

Thanks
Cathy

Conor Brown <cbrown@nanoracks.com>

To: David Payne <david.payne@analyticalspace.com>, Justin Oliveira
<justin.oliveira@analyticalspace.com>

Cc: Weston Marlow <weston.marlow@analyticalspace.com>

Thu, Mar 22, 2018 at 7:02 PM

Oh and here is Thilini's information:

Thilini Schlesinger

Research Integration Manager

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International Space Station Program

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Conor