## REQUEST FOR SPECIAL TEMPORARY AUTHORITY

Pursuant to Section 25.120 of the Commission's rules, 47 C.F.R. §25.120, Harris CapRock Communications, Inc. ("Harris CapRock") respectfully requests special temporary authority ("STA") to operate a total of up to three (3) earth station terminals (Model ST5000-2.4) at a test location in Melbourne, Florida. Harris CapRock is developing and testing new earth station terminals to communicate with the Ka-band non-geostationary satellite orbit ("NGSO") fixed-satellite service ("FSS") system operated by O3b Limited ("O3b"), which has been previously authorized by the FCC to communicate with earth stations located in the United States.[1] Harris CapRock respectfully requests grant of STA authority at the earliest practicable time.

**Proposed Terminal Testing.** Harris CapRock seeks an STA for a period of 30 days, commencing on Monday, May 4, 2015, or the earliest practicable thereafter, to test terminal uplink transmissions in the 28.35-28.4 GHz band (part of O3b Channel 3 uplink band) and downlink receive operations in the 18.3-18.6 GHz band (together, "Channel 3 Spectrum"). O3b has already been granted an STA to operate in Channel 3 Spectrum at the very same location in Melbourne, Florida using similar 2.2m antenna terminals[2] and there have been no reported cases of interference in connection with O3b's use of this spectrum.

Harris CapRock's larger 2.4m antenna has essentially equivalent (if not superior) gain and off-axis discrimination as the smaller authorized antenna.[3] In addition, the terminal uses a well-proven positioner from Harris CapRock's SpaceTrack series of terminals that has pointing accuracy equivalent to that of the O3b terminal and other stabilized earth station onboard vessel

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[1] For example, in September 2012, the Commission granted O3b a license to operate a gateway earth station in Haleiwa, Hawaii, to communicate with its NGSO FSS system (see File No. SES-LIC- 20100723-00952, granted September 25, 2012). In June 2013, the Commission granted O3b a license to operate a second gateway in the United States, located in Vernon, Texas (see File No. SES LIC- 20130124-00089, granted June 20, 2013). In May 2014, the Commission granted O3b a blanket license to operate maritime earth stations (see File No. SES-LIC-20130528-00455, granted May 13, 2014).

[2] *See* File No. SES-STA-20141212- 00896 (granted April 14, 2015) ("*O3b STA*").

[3] *See* Technical Appendix at Annex 1 (attached hereto).

("ESV") terminals.[4] Thus, there is no material operational difference or increased interference risk from Harris CapRock's proposed temporary operations.

The Harris CapRock terminals will be mounted on a temporary fixed platform in a controlled test area where general public access is prohibited. Although the pointing angle of the antennas will change as O3b's in-orbit satellites are tracked, the platform will remain stationary during the demonstration. Only trained operators and technicians will be permitted to access the terminals, and specific instruction will be provided with respect to radiofrequency hazard characteristics of the antenna. As described in the attached narrative, the minimum elevation angle for the proposed operations during satellite tracking is 24° (towards the southwest on rising) and 28° (towards the southeast on setting).[5]

Harris CapRock seeks independent authority for temporary operation of this new terminal at the Melbourne site. The requested STA may be considered on an expedited basis because, among other things, the proposed operations are effectively equivalent to O3b's existing operations at the Melbourne site. Grant of the STA will further the public interest by facilitating Harris CapRock's intensive terminal development efforts, conducted in cooperation with O3b, and by allowing the new terminal to be expeditiously tested at a location where the subject frequencies have already been used without interference incident.

**Proposed Site.** Harris CapRock is proposes to test uplink transmission in the 28.35-28.4 GHz band and downlink receive operations in the 18.3-18.6 GHz band at the Melbourne, Florida location currently used by O3b for terminal operations (28°5'15.5" N, 80°38'10.2" W).[6] Harris CapRock was recently granted an experimental STA to test the subject terminals at a nearby site at 28°01'51" N, 80°35'56" W, and has actually completed coordination of the Channel 3 Spectrum and other bands at this location.[7]

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[4] *See* Technical Appendix at Annex 4.

[5] *See* Technical Appendix (Application Narrative).

[6] *See O3b STA.*

[7] *See* File No. 1105-EX-ST-2014; *see also* Technical Appendix (Comsearch Coordination Report).

Harris CapRock agrees to accept all interference from other authorized spectrum users and will immediately suspend operations in the event of interference to other systems and services. Harris CapRock also acknowledges and accepts the conditions imposed on O3b's grant of STA authority to conduct similar terminal operations at the Melbourne location.[8]

**Proposed Spectrum Use.** Harris CapRock's proposed earth station operations in Channel 3 Spectrum are consistent with the Commission's rules and policies. Harris CapRock first notes that O3b has completed all necessary coordination with U.S. government satellite networks operating in the Ka-band, including GSO and NGSO networks, as well as their associated specific earth stations filed under 9.7A and 9.7B of the ITU Radio Regulations through other administrations. O3b has also completed coordination, according to U.S. footnote 334 of the FCC Table of Frequency Allocations, with the U.S. government, and this US334 coordination agreement provides for additional earth stations in U.S. territory operating with O3b's satellites.

Under the Commission's Ka-band plan, the 28.35-28.4 GHz band may be used by NGSO FSS systems,[9] although Harris CapRock recognizes that operations under the brief, requested STA will be on a non-harmful interference basis vis-à-vis other spectrum users. The proposed operations will not cause any interference into or require protection from any co-frequency GSO satellites. O3b's prior use of the Channel 3 Spectrum at the same location and Harris CapRock's coordination efforts in the immediate area will ensure that its brief STA operations have no adverse impact on other spectrum users.

**Expedited Consideration under Section 25.120.** Harris CapRock respectfully requests expedited processing of this STA request under Section 25.120. Section 25.120(a) provides that STA requests should be filed at least three business days prior to commence of proposed

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[8] *See O3b STA* at Special Conditions (attached hereto).

[9] *See In the Matter of Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, 11 FCC Rcd. 19005, ¶¶ 59-62 and 79 (1996). *See also In the Matter of Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use*, 15 FCC Rcd. 13430, ¶ 28 (2000).

operations absent a finding of extraordinary reasons for the delay in submitting the request which could not have been earlier foreseen by the applicant. Harris CapRock received only yesterday confirmation of the specific frequency bands for testing and that O3b has moved a beam to Melbourne for testing purposes. As discussed more fully below, expedited consideration of this STA request is warranted given the unique circumstances of the present situation, including the Commission's prior consent for virtually identical operations by O3b and the benefits of allowing Harris CapRock to proceed expeditiously with its new antenna development program.

Section 25.120(b)(4) provides that the Commission may grant a temporary authorization for a period not to exceed 30 days, if the STA request has not been placed on public notice, and an application for regular authority is not contemplated. Harris CapRock does not contemplate filing an application for regulatory authority in connection with the proposed Melbourne test operations. Instead, Harris CapRock has filed a request for experimental STA for the Channel 3 Spectrum and other O3b bands, which it expects will be granted in due course.[10] Thus, this STA request is a unique, one-time request necessitated by late notice of final test parameters.

Unfortunately, the ordinary time frame for processing an experimental STA, including coordination with Commission Bureaus, will not permit commencement of operations in the required time frame. In addition, the International Bureau's extensive earth station engineering expertise and recent grant of virtually identical STA authority at the subject location make it the only potential source near-term authority for the subject testing. Harris CapRock anticipates that grant of a 30-day STA will afford sufficient time for testing and the requested experimental STA will cover future terminal testing.

Harris CapRock has expended considerable effort in preparing equipment and personnel for testing in Melbourne and will have its engineering team onsite for the commencement of testing on May 4th. Grant of the requested authority will serve the public interest by allowing continued development of a new line of antennas that could greatly benefit government and commercial customers and accelerate the expansion of Ka-band services. In addition, authorizing near-term development of this terminal will ensure that Harris CapRock (a U.S. equipment manufacturer and service provider) and other U.S. interests can participate more fully in the development of these important new services.

[10] *See* File No. 0454-EX-ST-2015.

Finally, the circumstances of the instant STA request are unique because the Commission has already authorized O3b to operate an antenna with essentially equivalent performance on the same frequencies at the same location as the instant request. However, Harris CapRock cannot rely on existing O3b authority in connection with the proposed antenna testing operations. Although the Harris CapRock terminal will operate within the same general envelope as the O3b terminal, independent authority for the new antenna is still required.

Harris CapRock respectfully submits that the public interest will be served by grant of the requested STA commencing May 4th. However, in the event that the Commission concludes that it is not possible to grant the STA in the requested time frame, Harris CapRock requests that the Commission grant the STA at the earliest practicable time.

**Conclusion.** The requested experimental STA will allow Harris CapRock, in partnership with O3b, to continue development of a new 2.4m terminal to communicate with the innovative O3b system, and will not result in harmful interference to or require protection from other authorized spectrum users. Therefore, the proposed operations are consistent with Commission's rules and policies, and with the public interest. Harris CapRock respectfully requests that the experimental STA be granted for a thirty (30) day period commencing on May 4, 2015 or as soon as practicable thereafter.

# HARRIS CAPROCK

# REQUEST FOR SPECIAL TEMPORARY AUTHORITY

# TECHNICAL APPENDIX

## REQUEST FOR EXPERIMENTAL SPECIAL TEMPORARY AUTHORITY

Harris CapRock Communications, Inc. ("Harris CapRock") hereby respectfully requests experimental special temporary authority ("STA") to operate a total of up to six (6) earth stations at two separate test sites located in Palm Bay (Melbourne), Florida and Houston, Texas, with a maximum of three (3) earth stations at each test site. Harris CapRock is developing and testing new earth stations to communicate with the Ka-band non-geostationary satellite orbit ("NGSO") fixed-satellite service ("FSS") system operated by O3b Limited ("O3b"), which has been previously authorized by the FCC to communicate with earth stations located in the United States. In this filing, Harris CapRock seeks an experimental STA for the period between January 6, 2015 and June 30, 2015.

Harris CapRock will operate the new circular 2.4m Ka-band terminal (Model ST5000-2.4) for non-commercial development, testing and demonstration purposes with the O3b system at the Melbourne and Houston test locations. Harris CapRock will evaluate antenna performance, including tracking characteristics, throughput, link analyses and potential applications of the antenna with the O3b system, including interactive video teleconferencing, interactive access to complex web content from the Internet and very large file transfers.

Grant of the requested authority would serve the public interest by allowing Harris CapRock to develop a new line of O3b antennas that could greatly benefit government and commercial customers. Moreover, the proposed experimental operations raise no concern regarding potential interference to co-frequency systems and services, will be conducted on an unprotected, non-interference basis and will otherwise comply with Part 5 of the FCC Rules.

### The O3b Satellite System

The new 2.4m earth stations will communicate with O3b's UK-authorized, Ka-band NGSO FSS system.[1] The Commission has granted O3b authority for gateway and other earth station operations in the United States.[2] O3b has filed a Letter of Intent ("LOI") to access the

[1] O3b's system includes four satellites launched on June 25, 2013, and a second tranche of four satellites launched on July 10, 2014. O3b's third tranche of satellites is scheduled for launch on December 18, 2014.

[2] For example, in September 2012, the Commission granted O3b a license to operate a gateway earth station in Haleiwa, Hawaii, to communicate with its NGSO FSS system. *See* FCC File No. SES-LIC-20100723-00952 (granted September 25, 2012). In June 2013, the Commission granted O3b a license to operate a second gateway in the United States, located in Vernon, Texas. *See* FCC File No. SES-LIC-20130124-00089 (granted June 20, 2013). In May 2014, the Commission granted O3b a blanket license to operate maritime earth stations. *See* FCC File No. SES-LIC-20130528-00455 (granted May 13, 2014).

U.S. market with its third tranche of satellites and to consolidate its market access authority.[3] O3b has also been granted numerous STAs for earth stations to communicate with the O3b system, including specifically in Houston, Texas, and Melbourne, Florida, using the frequencies requested herein.[4]

Because this application requests experimental authority for antenna development purposes only, Harris CapRock hereby incorporates by reference the relevant satellite and market access-related information supporting these prior grants.[5] As a result, although general background information is provided, this application focuses on the technical characteristics of the new ST5000-2.4 terminal and confirmation that the antenna will be operated for test purposes on an unprotected, non-interference basis under Part 5 of the Rules.

**Proposed Test Sites**

The Palm Bay (Melbourne), Florida, test site is located at N 28.0309° and W -80.5988°. The Houston, Texas, test site is located at N 29.5984° and W -95.3471°. As noted above, earth stations have been previously authorized to communicate with the O3b system at these locations. In addition, as discussed in the following section, no coordination with other co-frequency systems or services is required. Nonetheless, given the experimental nature of the operations proposed herein, Harris CapRock agrees to accept all interference from co-frequency operations and will immediately suspend operations in the event of interference to other systems and services.

The 2.4m antenna terminals will be mounted on a temporary fixed platform in a controlled test area where general public access is prohibited. Although the pointing angle of the antennas will change as O3b's in-orbit satellites are tracked, the platform will remain stationary during the demonstration. Only trained operators and technicians will be permitted to access the terminals, and specific instruction will be provided with respect to radiofrequency hazard characteristics of the antenna.

**Proposed Spectrum Use**

Harris CapRock's proposed earth station operations in shared bands are consistent with the Commission's rules and policies. Harris CapRock first notes that O3b has completed all necessary coordination with U.S. government satellite networks operating in the Ka-band, including GSO and NGSO networks, as well as their associated specific earth stations filed under

[3] *See* O3b Limited, Call Sign S2935, File No. SAT-LOI-20141029-00118.

[4] *See., e.g.,* O3b Limited, File Nos. SES-STA-20140819-00666 (Houston, TX), SES-STA-20140731-00627, SES-STA-20140429-00314 and SES-STA-20130620-00515 (Melbourne, FL).

[5] *See, e.g., id.* and related file numbers. Harris CapRock respectfully requests leave to supplement this filing with O3b satellite or market access information should the FCC deem such information necessary or appropriate to support grant of this experimental STA application.

9.7A and 9.7B of the ITU Radio Regulations through other administrations. O3b has also completed coordination, according to U.S. footnote 334 of the FCC Table of Frequency Allocations, with the U.S. government, and this US334 coordination agreement specifically provides for additional earth stations in U.S. territory operating with O3b's satellites.

Harris CapRock will limit terminal uplink transmission to the 28.6-29.1 GHz band. Under the Commission's Ka-band plan, this band may be used on a primary basis by NGSO FSS systems.[6] Harris CapRock recognizes, however, that operations under the requested STA will be on an unprotected, non-harmful interference basis. The experimental development, test and demonstration operations will adequately protect allocated services operating in this band.

The proposed demonstrations will not cause any interference into or require protection from any co-frequency GSO satellites. As previously shown by O3b,[7] there is an inherent angular separation between the O3b system orbit and the GSO arc from the perspective of earth stations located away from the equator. The Houston, Texas, and Melbourne, Florida, test sites are located further north in latitude than the O3b Hawaii gateway, which results in an even greater angular separation between the O3b and geostationary orbits as viewed from the Earth. This means that the angular separation between the O3b satellites and GSO arc from these locations will be greater than the 7° separation accepted by the Commission when it approved O3b's Hawaii gateway. This ensures that GSO FSS systems will be adequately protected.

Potential interference from the proposed operations into U.S. terrestrial fixed service ("FS") receivers in the 28.6-29.1 GHz band is a non-issue because there is no allocation in the Commission's Ka-band plan for FS stations operating in this band in the United States.

With respect to sharing with other Ka-band NGSO systems, Harris CapRock notes that there are no planned NGSO systems contemplated for deployment throughout the duration of the contemplated operations. Moreover, the O3b system is capable of sharing with future NGSO networks operating in the same frequency bands and, therefore, will not preclude additional entry by future NGSO licensees.[8] Thus, the proposed experimental operations can be authorized on an unprotected, non-interference basis under Part 5 of the Rules.

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[6] *See In the Matter of Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30.0 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, 11 FCC Rcd. 19005, ¶¶ 59-62 and 79 (1996). *See also In the Matter of Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast Satellite-Service Use*, 15 FCC Rcd. 13430, ¶ 28 (2000).

[7] *See* O3b Hawaii License Application, FCC File No. SES-LIC-20100723-00952, Technical Attachment at A.10.1.

[8] First, the entire O3b constellation will occupy a single circular orbit above the Earth's Equator, which enables an angular separation to be maintained between O3b communications links and the links of other NGSO systems using different orbits. Second, the O3b satellite system uses a

Although not part of the requested experimental authority, Harris CapRock notes that its proposed receive operations are also on an unprotected, non-interference basis only. Under the Commission's Ka-band plan, the 18.8-19.3 GHz band may be used on a primary basis by licensed NGSO FSS systems.[9] This band is not allocated for GSO FSS networks.[10] Nevertheless, the proposed demonstrations will not cause any interference into, or require protection from, any co-frequency GSO satellites. Furthermore, FS stations operating in the 18.8-19.3 GHz band are no longer co-primary with FSS users in this band.[11] However, because the experimental operations proposed herein will be conducted on an unprotected, non-interference basis, Harris CapRock agrees to accept any interference that its terminals may receive from FS transmissions in the 18.8-19.3 GHz band.

**Earth Station Technical Parameters**

The new ST5000-2.4 terminal is comprised of a 2.4m circular reflector antenna, an antenna positioner, and an antenna control module. The antenna positioner and control module are the same as those used in Harris CapRock's SpaceTrack 4000 series of stabilized antennas. The SpaceTrack 4000 has been previously licensed by the FCC in C-band and Ku-band ESV configurations and has years of proven experience in the field. Not only has the SpaceTrack 4000 been deployed in 2.4m configurations, but the operating environment in the ESV maritime context is far harsher than the proposed fixed temporary operations – with higher scan rates, torque, jarring, etc. – and there have been no reported cases of interference due to antenna misalignment or similar factors. Thus, the FCC can be assured that ST5000-2.4 will operate as designed to avoid potential interference to adjacent satellites.

Tracking the predictable O3b satellites as they fly in their equatorial path from fixed locations is quite straightforward. Although the ST5000-2.4 terminal is a full-motion stabilized antenna, the operational range for communications is towards the southern sky. For example, for the Melbourne, FL test site, the O3b satellites rise at approximately 240° azimuth and set at approximately 130° azimuth. The elevation angle for communications range from 24° on the rising satellite to 43.5° at zenith and then down to 28° for the setting satellite. Thus, a minimum elevation angle of 20° is a conservative assumption. The operational values for the Houston, Texas, test site are similar to those for the Melbourne, Florida, site.

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combination of multiple tracking antennas and satellite diversity to avoid interference from its system into other NGSO systems and from other NGSO systems into O3b. This further enables the use of angular discrimination to facilitate spectrum sharing, while providing a mechanism for interference avoidance in the rare event that an O3b earth station is pointed at an O3b satellite that is in-line with a satellite of another NGSO system.

[9] *See supra* n. 6.

[10] *See* id.

[11] *See* 47 C.F.R. § 101.85(b)(2).

Harris CapRock's ST5000-2.4 terminal is designed to meet the FCC's ESV operational requirements, which have been extended by analogy to full-motion antennas communicating with the O3b system. These parameters include: (i) maintaining off-axis EIRP to the levels set forth in the applicable FCC mask (in the case of Ka-band, Section 25.138); (ii) pointing accuracy of 0.2° or better; (iii) automatic cessation of emissions within 100 ms if pointing offset exceeds 0.5°; and (iv) transmissions will not resume until pointing accuracy is within 0.2°. The technical characteristics of the terminal are set forth in the follow tables.

**SUMMARY OF TECHNICAL PARAMETERS – ST5000-2.4**

| | |
|---|---|
| Antenna diameter | 2.4m |
| Type of Antenna | 2.4m circular reflector |
| Peak Power (SSPA) | 40 watts |
| Transmit Bandwidth | 1 MHz to 216 MHz |
| Transmit Gain | 54.7 dBi |
| EIRP | 68.9 dBW |
| Data Rate | 160 Mbps Tx/ 300 Mbps Rx |
| Emission Designators | 1M00G7D to 216MG7D |
| Transmit Polarization | Horizontal or Vertical |
| Transmit Max PSD | 46.4 dBW/4kHz |
| Transmit Beamwidth | .14 degrees |
| Receive G/T | 26.5 dB/K |
| Receive Bandwidth | Up to 216 MHz |
| Receive Polarization | LHCP and RHCP |

**ANTENNA CONTROL PARAMETERS - ST5000-2.4**

| | |
|---|---|
| Azimuth | Continuous coverage over 360º |
| Elevation | 0 to 90º antenna elevation |
| Position accuracy | 0.2º (auto-disable at 0.5 º offset) |
| Tracking capability | 8º/sec |

Additional information regarding the ST5000-2.4 terminal, including antenna performance plots (compliance with the FCC's off-axis EIRP mask), link budgets, and a radiofrequency hazard assessment are included as attachments hereto.

**Stop Buzzer Contact and Other Information**

Although Harris CapRock will coordinate closely with O3b in the context of antenna development, testing, and demonstration, the proposed experimental operations will be subject to the ultimate direction and control of Harris CapRock. The Harris CapRock point of contact with the authority to suspend immediately the proposed ST5000-2.4 terminal operations is:

Mike Horn
Harris CapRock Communications
1025 West NASA Blvd.
Melbourne, FL USA 32919
Phone: 321-724-3384
Mobile: 321-258-4414
Text: 3212584414@text.att.net
E-mail: mhorn01@harris.com

The secondary point of contact for the proposed experimental operations is:

Harris CapRock Network Control Center
Managed Network Services 24x7 support
4400 S. Sam Houston Pkwy, E.
Houston, Texas 77046
Office: (832) 668-2775
Fax: (713) 987-2894
Email Address: hcc-hou-csc@harris.com

The following annexes contain additional technical information relating to the proposed experimental operations:

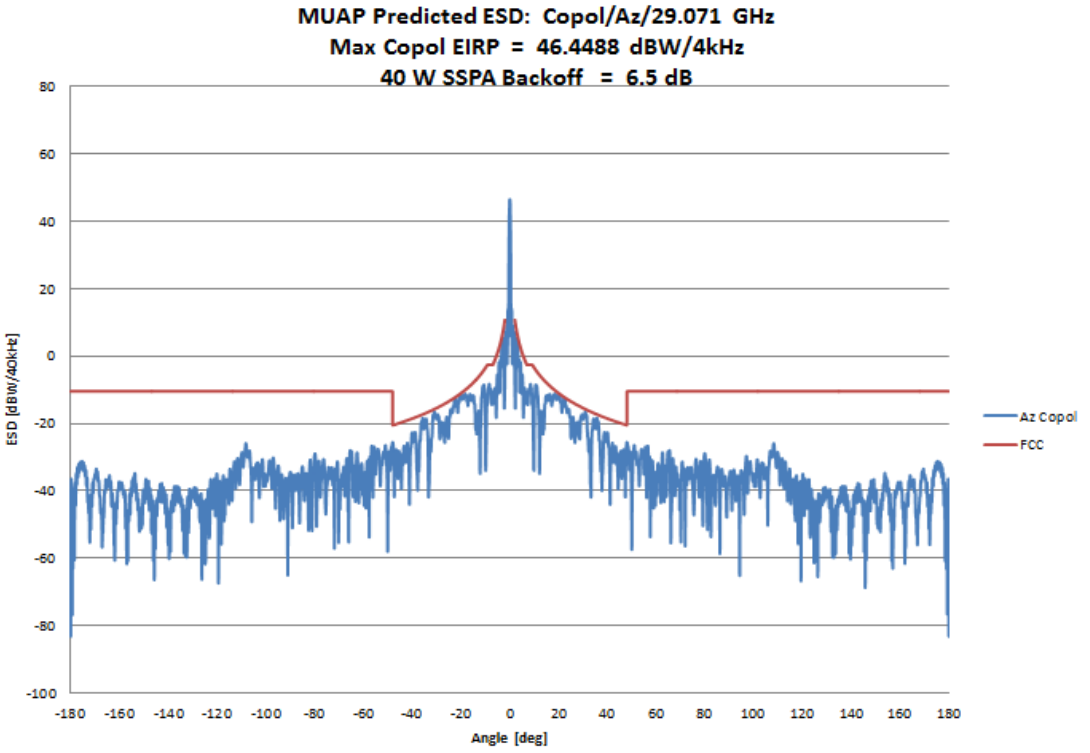
- Annex 1 – Antenna Performance Plots (demonstrating compliance with the FCC's Ka-band, off-axis EIRP spectral density mask, including co-pol and cross-pol at +/- 180º, +/-30º, +/-10º and various transmit frequencies).
- Annex 2 - Link Budgets (various forward and return link budgets for the ST5000-2.4 terminal).
- Annex 3: Radiation Hazard Study (establishing near-field and far-field region distances). Harris CapRock will follow standard industry procedures to mitigate potential radiation hazards to personnel in controlled environments. (The terminals do not transmit in uncontrolled areas at Harris CapRock test facilities.)
- Annex 4 – SpaceTrack 4000 Product Brochure (outlining technical characteristics of the proven 4000 series of stabilized antennas).

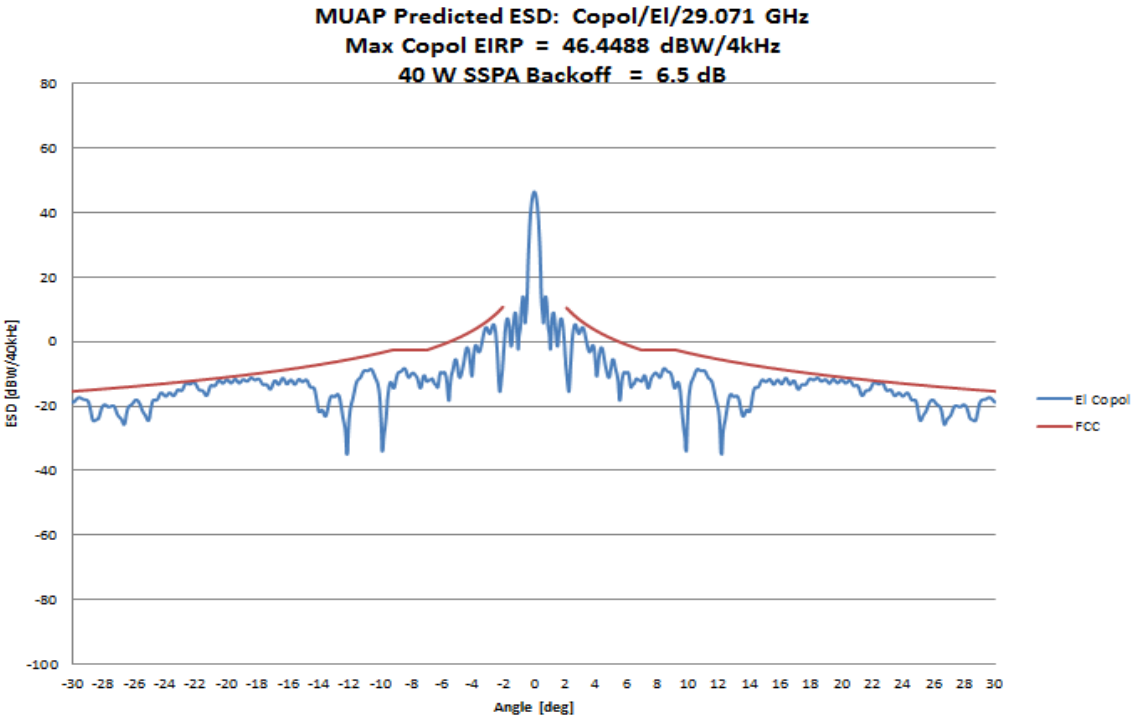
## Conclusion

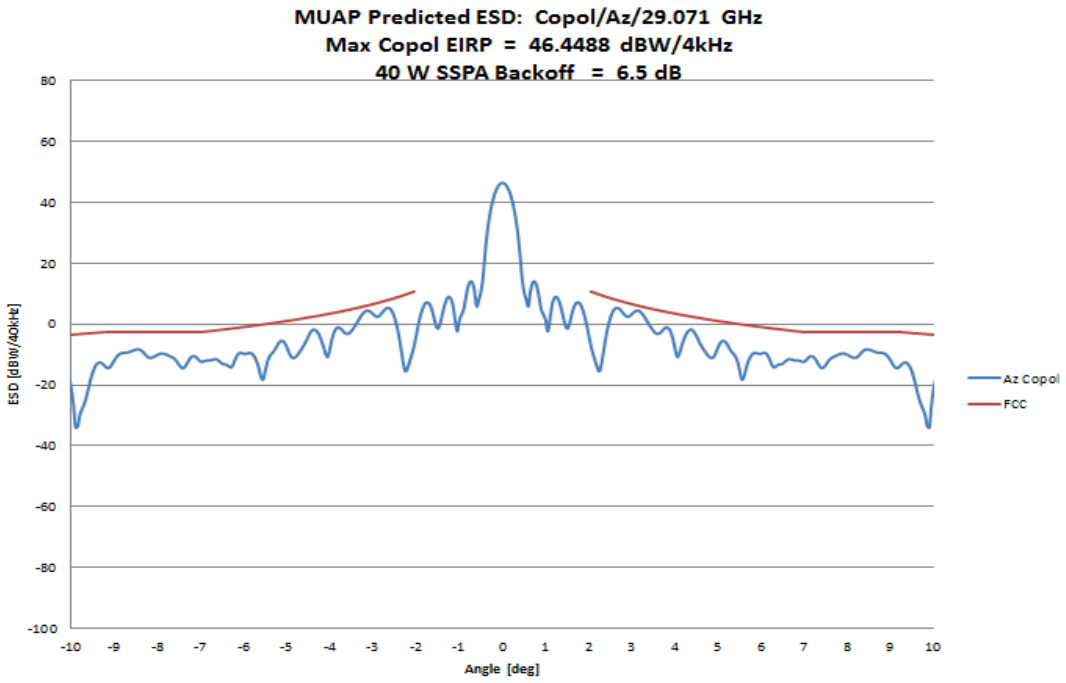
The requested experimental STA will allow Harris CapRock to develop, test and demonstrate the operational capabilities of its new 2.4m terminal with the O3b system, and will not result in harmful interference to or require protection from other authorized spectrum users. Accordingly, the proposed operations are consistent with Part 5 of the FCC's rules and within the public interest. Harris CapRock respectfully requests that the experimental STA be granted for the period from January 6, 2015 to June 30, 2015.

# Annex 1 – Antenna Performance Plots

# Demonstration of Compliance with FCC Ka-band Off-Axis EIRP Mask (Co-pol and Cross-pol)


MUAP Predicted ESD: Copol/Az/29.071 GHz
Max Copol EIRP = 46.4488 dBW/4kHz
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Angle [deg]
Az Copol
FCC


MUAP Predicted ESD: Copol/El/29.071 GHz
Max Copol EIRP = 46.4488 dBW/4kHz
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Angle [deg]
El Copol
FCC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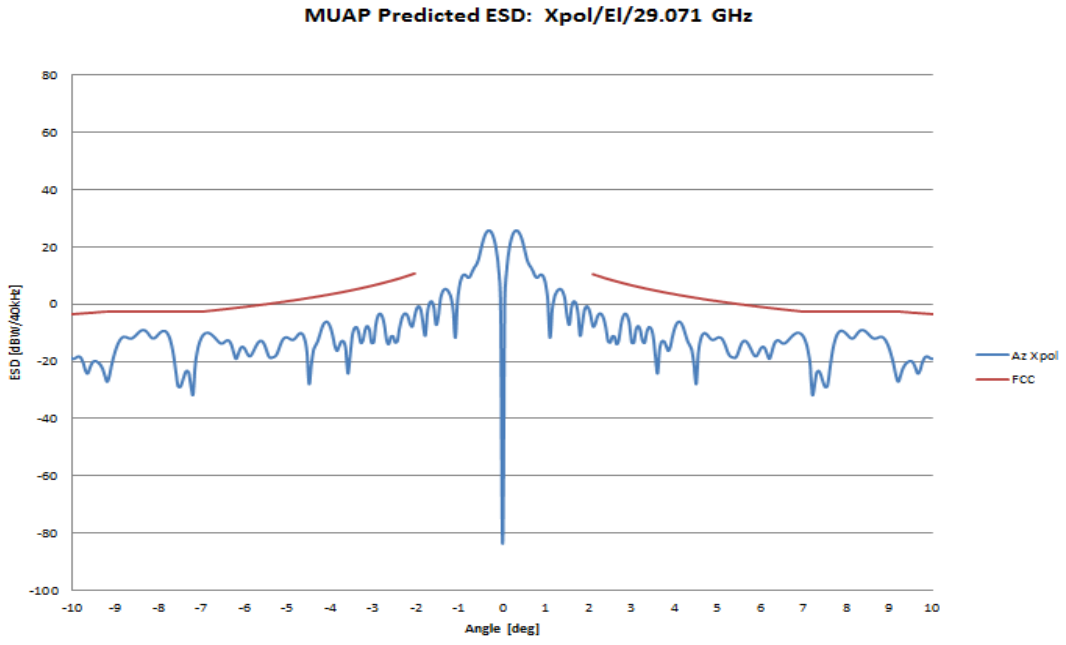
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
Angle [deg]
Az Copol
FCC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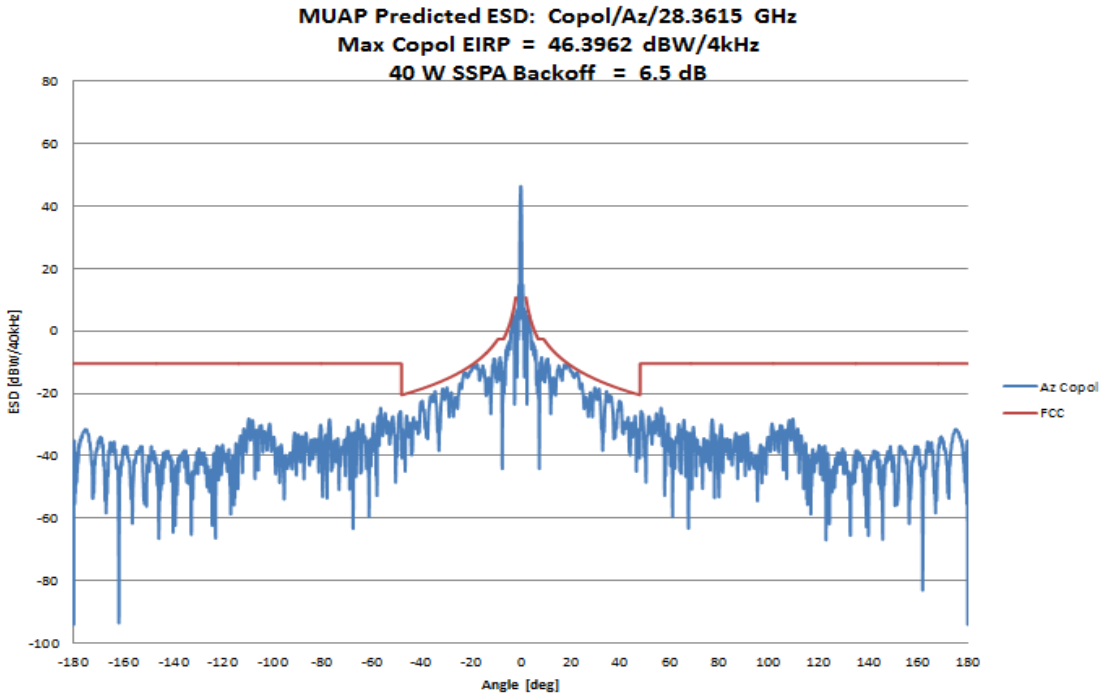
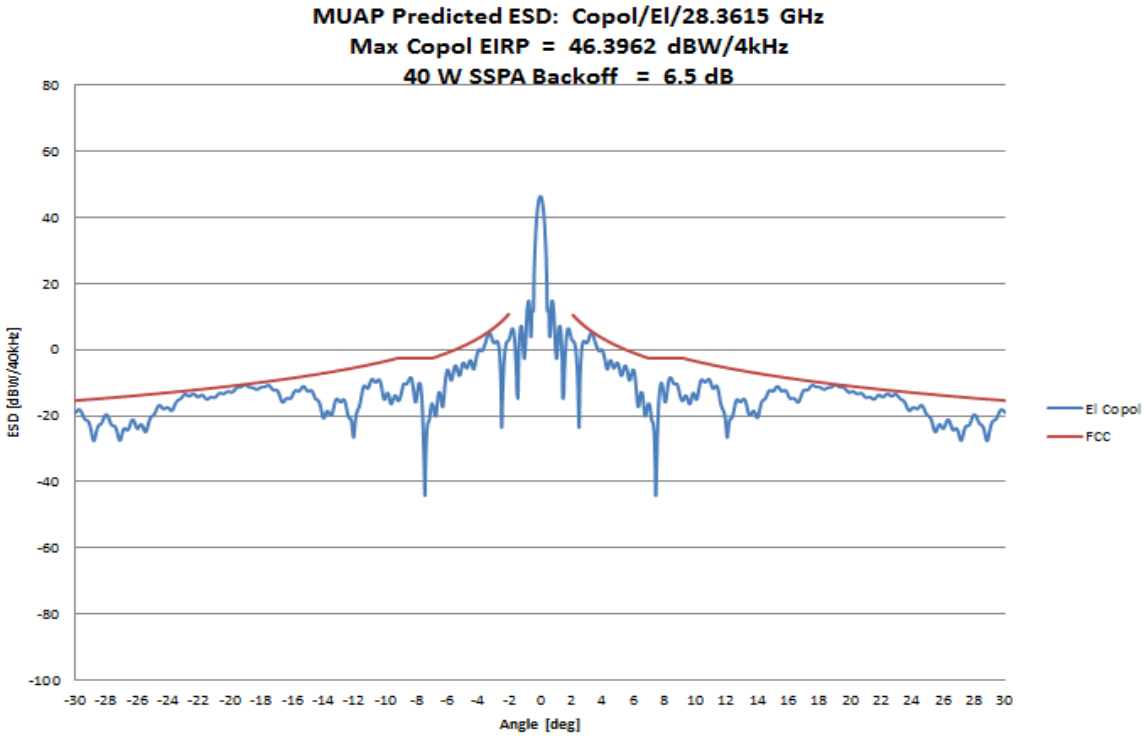
ESD [dBW/40kHz]
Angle [deg]
Az Xpol
FCC


MUAP Predicted ESD: Copol/Az/28.3615 GHz
Max Copol EIRP = 46.3962 dBW/4kHz
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Angle [deg]
Az Copol
FCC


MUAP Predicted ESD: Copol/El/28.3615 GHz
Max Copol EIRP = 46.3962 dBW/4kHz
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
80
60
40
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-20
-40
-60
-80
-100
-30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Angle [deg]
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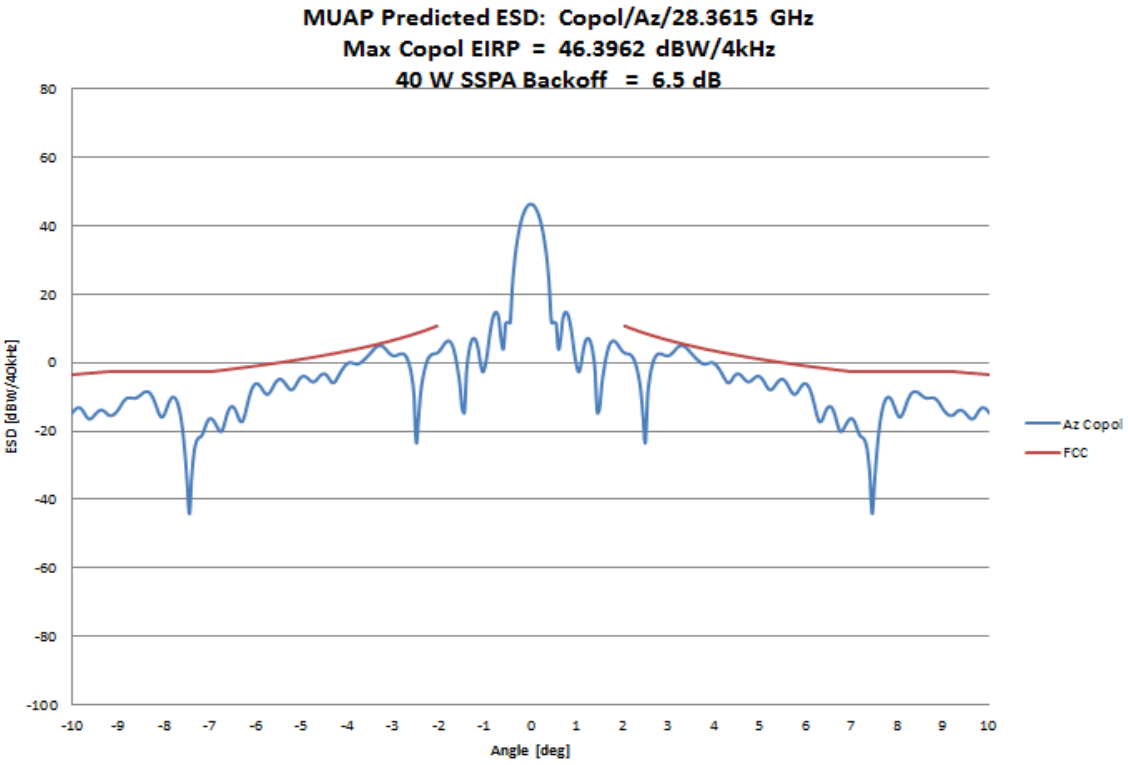
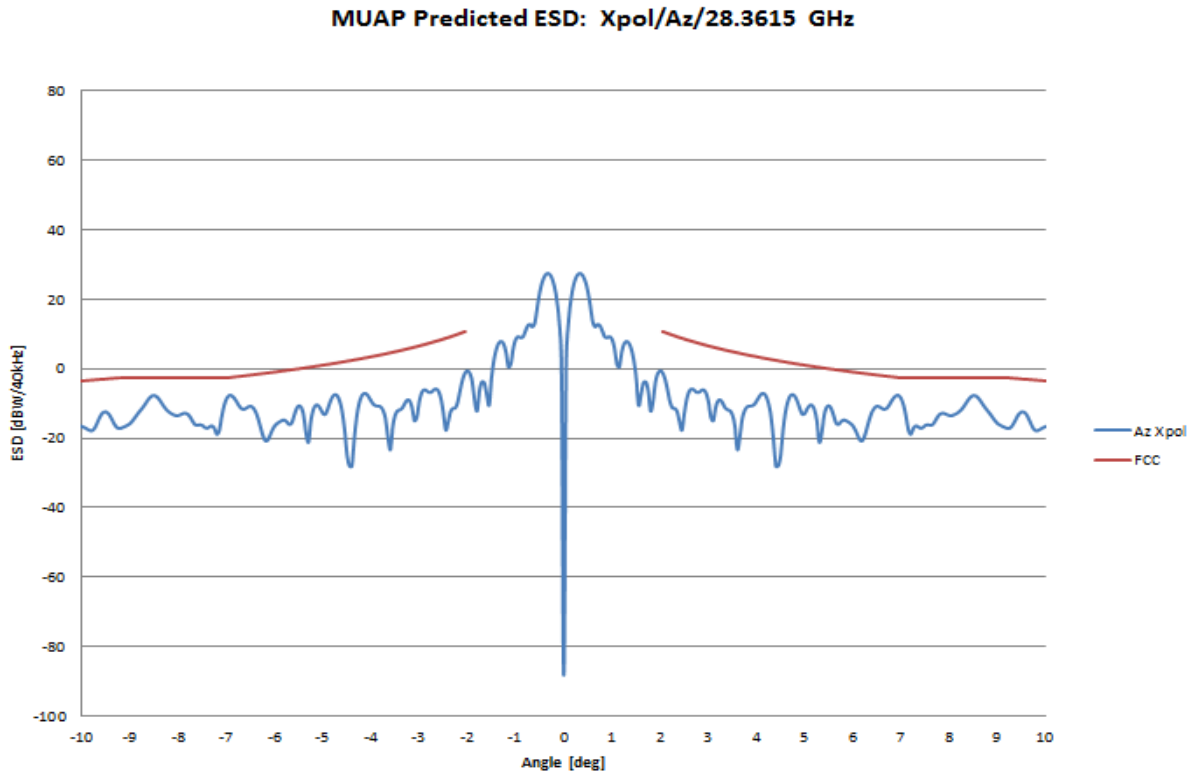
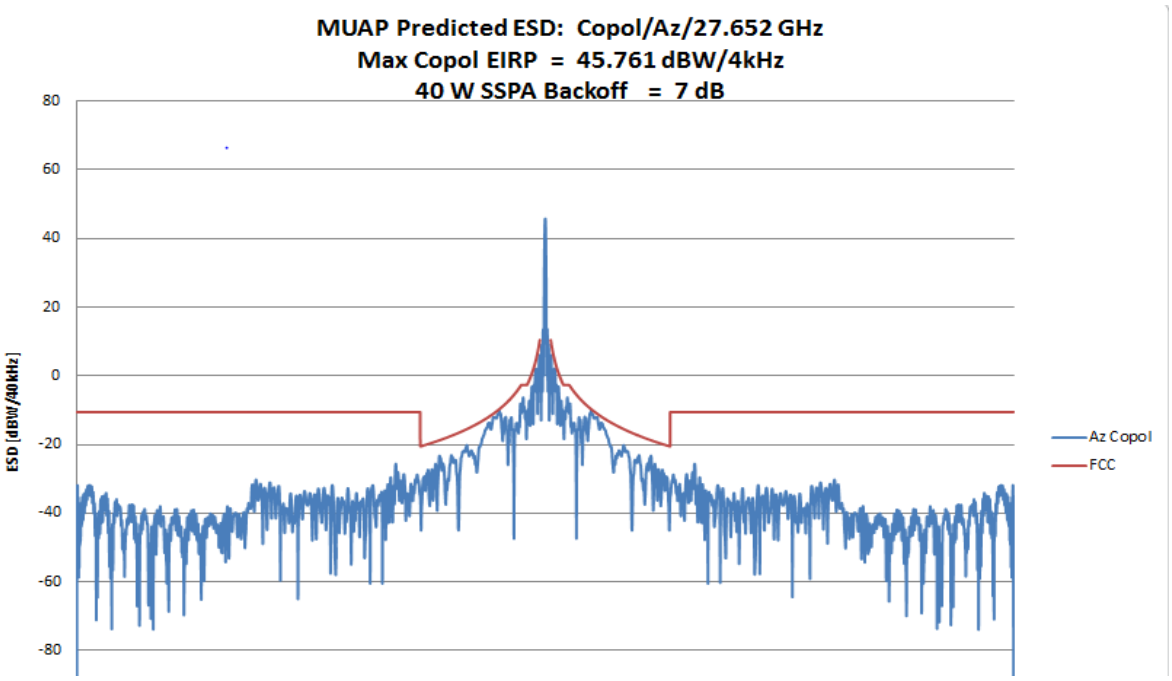
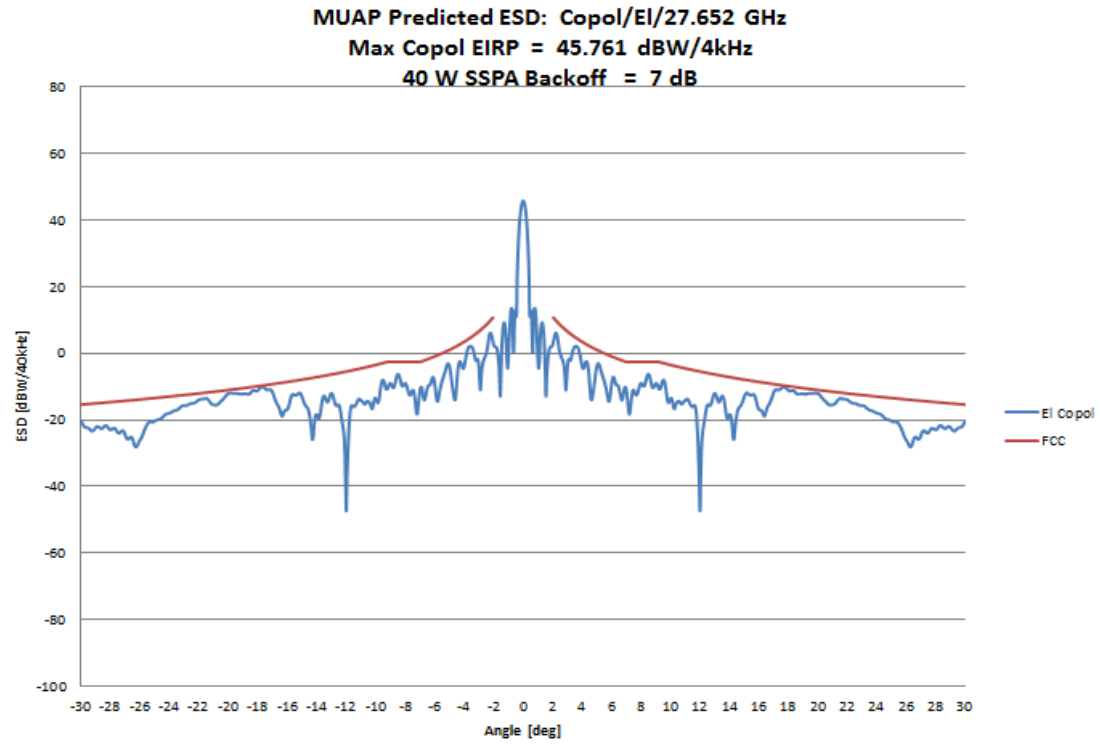
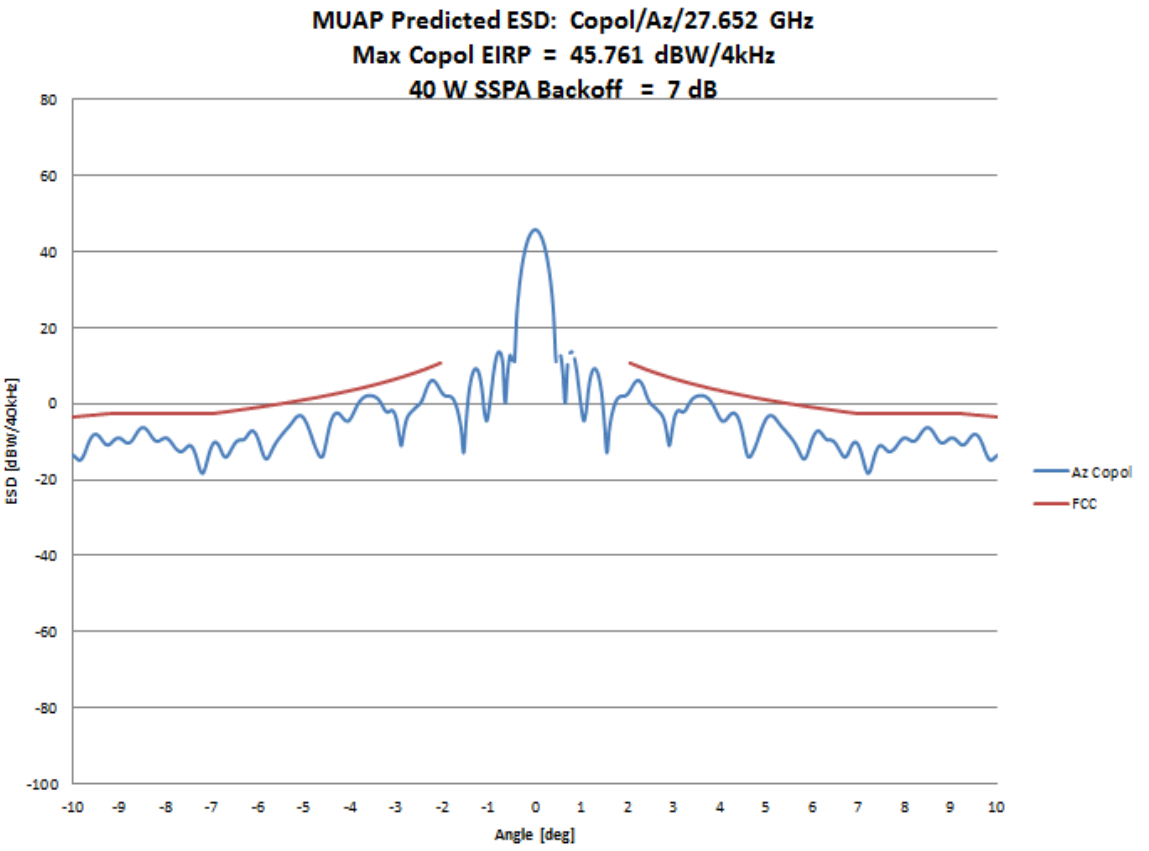
FCC

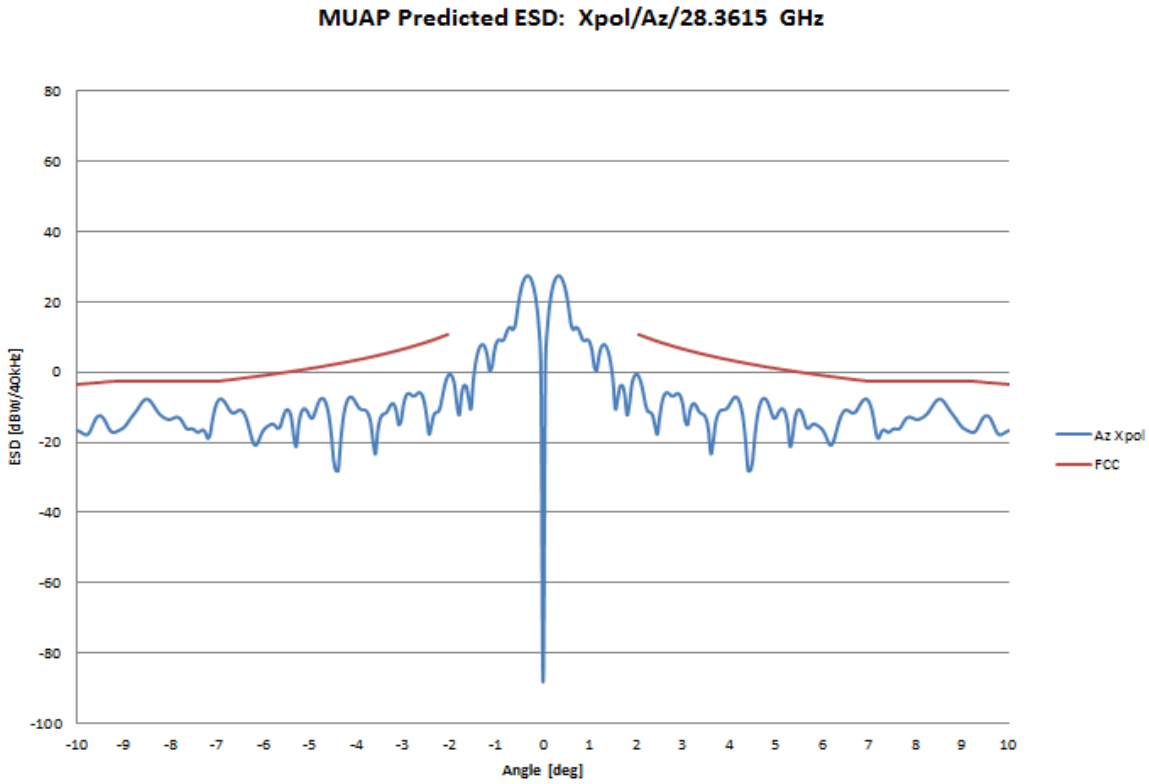

MUAP Predicted ESD: Copol/Az/28.3615 GHz
Max Copol EIRP = 46.3962 dBW/4kHz
40 W SSPA Backoff = 6.5 dB
ESD [dBW/40kHz]
Angle [deg]
Az Copol
FCC


MUAP Predicted ESD: Xpol/Az/28.3615 GHz
ESD [dBW/40kHz]
Angle [deg]
Az Xpol
FCC


MUAP Predicted ESD: Copol/Az/27.652 GHz
Max Copol EIRP = 45.761 dBW/4kHz
40 W SSPA Backoff = 7 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
Az Copol
FCC


MUAP Predicted ESD: Copol/El/27.652 GHz
Max Copol EIRP = 45.761 dBW/4kHz
40 W SSPA Backoff = 7 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Angle [deg]
El Copol
FCC


MUAP Predicted ESD: Copol/Az/27.652 GHz
Max Copol EIRP = 45.761 dBW/4kHz
40 W SSPA Backoff = 7 dB
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Angle [deg]
Az Copol
FCC


MUAP Predicted ESD: Xpol/Az/28.3615 GHz
ESD [dBW/40kHz]
80
60
40
20
0
-20
-40
-60
-80
-100
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Angle [deg]
Az Xpol
FCC

# ANNEX 2 – Link Budgets

## Link Budget: Return (Clear Sky)

| O3b Networks Link Analysis - Tier2 Service for Melbourne Beach/U.S.A. | | | |
|---|---|---|---|
| **ECM Link Budget Rpt - 11/19/2014** | | **Tier2** | **Tier2** |
| **Parameters** | Unit | **Clear Sky** | |
| **Ground parameters** | | **Teleport** | **Telco** |
| Location | | Vernon/U.S.A. | Melbourne Beach/U.S.A. |
| Latitude | (deg) | 34.16 | 28.09 |
| Longitude (East) | (deg) | 260.71 | 279.39 |
| E/S Range to SV | (km) | 10166.69 | 9311.20 |
| E/S Elevation to SV | (deg) | 29.99 | 43.30 |
| E/S Altitude | (km) | 0.00 | 0.00 |
| SV Beam Identifier | (#) | 12 | |
| Telco Offset to Beam Center | (km) | 0.27 | |
| **Modulation Parameters** | | **Return** | |
| Enter Reciever | Type | MEOLink | |
| Percentage of Bandwidth | (%) | 50% | |
| Allocated Bandwidth | (MHz) | 108 | |
| Channel Symbol Rate | (Msps) | 90 | |
| Channel Modulation Type | | 8PSK | |
| Channel FEC Rate | | 0.60 | |
| Channel Throughput | (Mbps) | 159.60 | |
| **Uplink** | | **Return** | |
| E/S Carrier Frequencies | (MHz) | 28020 | |
| E/S Tx HPA Power Level | (W) | 40 | |
| E/S Tx OBO | (dB) | -9 | |
| E/S Tx Antenna Gain (2.4m) | (dB) | 54.67 | |
| E/S Tx EIRP Per Channel | (dBW) | 58.80 | |
| E/S Tx RF Link Availability | (%) | Clear | |
| E/S Tx Spreading Loss | (dB) | -151.13 | |
| **Satellite** | | **Return** | |
| SV Rx G/T | (dB/K) | 5.57 | |
| SV Tx OBO | (dB) | -15.81 | |
| SV Tx EIRP Per Channel/Carrier | dBW | 32.44 | |
| **Downlink** | | **Return** | |
| E/S Rx Carrier Frequency | (MHz) | 18220 | |
| E/S Rx Rf Link Availability | (%) | Clear | |
| E/S Rx Antenna Gain (7.3m) | (dBi) | 61.91 | |
| E/S Rx Effective G/T | (dB/K) | 40.44 | |
| **Total Link** | | **Return** | |
| Carrier/Noise Bandwidth | (dB) | 45.00 | |
| Carrier/Noise Uplink | (dB) | 11.19 | |
| Carrier/Noise Downlink | (dB) | 23.08 | |
| Carrier/Intermodulation Im (C/Im) | (dB) | 25.00 | |
| (C/N)- Total Actual (Es/No) | (dB) | 10.39 | |
| (C/N)-Total Required | (dB) | 6.89 | |
| (Eb/No)-Total Actual | (dB) | 8.48 | |
| (Eb/No)-Total Required | (dB) | 8.48 | |
| **Excess Margin** | (dB) | **3.50** | |
| **Fade Margin** | (dB) | **12.65** | |

## Link Budget: Return (Rain)

| O3b Networks Link Analysis - Tier2 Service for Melbourne Beach/U.S.A. | | | |
|---|---|---|---|
| **ECM Link Budget Rpt - 11/19/2014** | | **Tier2** | **Tier2** |
| **Parameters** | Unit | **Rain Up** | |
| **Ground parameters** | | **Teleport** | **Telco** |
| Location | | Vernon/U.S.A. | Melbourne Beach/U.S.A. |
| Latitude | (deg) | 34.16 | 28.09 |
| Longitude (East) | (deg) | 260.71 | 279.39 |
| E/S Range to SV | (km) | 10166.69 | 9311.20 |
| E/S Elevation to SV | (deg) | 29.99 | 43.30 |
| E/S Altitude | (km) | 0.00 | 0.00 |
| SV Beam Identifier | (#) | 12 | |
| Telco Offset to Beam Center | (km) | 0.27 | |
| **Modulation Parameters** | | **Return** | |
| Enter Reciever | Type | MEOLink | |
| Percentage of Bandwidth | (%) | 50% | |
| Allocated Bandwidth | (MHz) | 108 | |
| Channel Symbol Rate | (Msps) | 90 | |
| Channel Modulation Type | | QPSK | |
| Channel FEC Rate | | 0.66 | |
| Channel Throughput | (Mbps) | 118.37 | |
| **Uplink** | | **Return** | |
| E/S Carrier Frequencies | (MHz) | 28020 | |
| E/S Tx HPA Power Level | (W) | 40 | |
| E/S Tx OBO | (dB) | -3 | |
| E/S Tx Antenna Gain (2.4m) | (dB) | 54.67 | |
| E/S Tx EIRP Per Channel | (dBW) | 64.80 | |
| E/S Tx RF Link Availability | (%) | 99.254% | |
| E/S Tx Spreading Loss | (dB) | -151.13 | |
| **Satellite** | | **Return** | |
| SV Rx G/T | (dB/K) | 5.57 | |
| SV Tx OBO | (dB) | -19.42 | |
| SV Tx EIRP Per Channel/Carrier | dBW | 28.83 | |
| **Downlink** | | **Return** | |
| E/S Rx Carrier Frequency | (MHz) | 18220 | |
| E/S Rx Rf Link Availability | (%) | Clear | |
| E/S Rx Antenna Gain (7.3m) | (dBi) | 61.91 | |
| E/S Rx Effective G/T | (dB/K) | 40.44 | |
| **Total Link** | | **Return** | |
| Carrier/Noise Bandwidth | (dB) | 45.00 | |
| Carrier/Noise Uplink | (dB) | 7.59 | |
| Carrier/Noise Downlink | (dB) | 19.48 | |
| Carrier/Intermodulation Im (C/Im) | (dB) | 21.39 | |
| (C/N)- Total Actual (Es/No) | (dB) | 6.87 | |
| (C/N)-Total Required | (dB) | 4.34 | |
| (Eb/No)-Total Actual | (dB) | 6.38 | |
| (Eb/No)-Total Required | (dB) | 6.38 | |
| **Excess Margin** | (dB) | **2.53** | |
| **Fade Margin** | (dB) | **9.13** | |

## Link Budget: Forward (1)

| O3b Networks Link Analysis - Tier2 Service for Melbourne Beach/U.S.A. | | | |
|---|---|---|---|
| **ECM Link Budget Rpt - 11/19/2014** | | **Tier2** | **Tier2** |
| **Parameters** | Unit | **Rain Up** | |
| **Ground parameters** | | **Teleport** | **Telco** |
| Location | | Vernon/U.S.A. | Melbourne Beach/U.S.A. |
| Latitude | (deg) | 34.16 | 28.09 |
| Longitude (East) | (deg) | 260.71 | 279.39 |
| E/S Range to SV | (km) | 10166.69 | 9311.20 |
| E/S Elevation to SV | (deg) | 29.99 | 43.30 |
| E/S Altitude | (km) | 0.00 | 0.00 |
| SV Beam Identifier | (#) | 15 | |
| Telco Offset to Beam Center | (km) | 0.27 | |
| **Modulation Parameters** | | **Forward** | |
| Enter Reciever | Type | MEOLink | |
| Percentage of Bandwidth | (%) | 100% | |
| Allocated Bandwidth | (MHz) | 216 | |
| Channel Symbol Rate | (Msps) | 180 | |
| Channel Modulation Type | | QPSK | |
| Channel FEC Rate | | 0.83 | |
| Channel Throughput | (Mbps) | 296.15 | |
| **Uplink** | | **Forward** | |
| E/S Carrier Frequencies | (MHz) | 28963 | |
| E/S Tx HPA Power Level | (W) | 500 | |
| E/S Tx OBO | (dB) | -4 | |
| E/S Tx Antenna Gain (7.3m) | (dB) | 65.60 | |
| E/S Tx EIRP Per Channel | (dBW) | 81.40 | |
| E/S Tx RF Link Availability | (%) | 99.856% | |
| E/S Tx Spreading Loss | (dB) | -151.13 | |
| **Satellite** | | **Forward** | |
| SV Rx G/T | (dB/K) | 5.54 | |
| SV Tx OBO | (dB) | -3.80 | |
| SV Tx EIRP Per Channel/Carrier | dBW | 45.45 | |
| **Downlink** | | **Forward** | |
| E/S Rx Carrier Frequency | (MHz) | 19163 | |
| E/S Rx Rf Link Availability | (%) | Clear | |
| E/S Rx Antenna Gain (2.4m) | (dBi) | 51.65 | |
| E/S Rx Effective G/T | (dB/K) | 26.49 | |
| **Total Link** | | **Forward** | |
| Carrier/Noise Bandwidth | (dB) | 51.93 | |
| Carrier/Noise Uplink | (dB) | 11.86 | |
| Carrier/Noise Downlink | (dB) | 19.48 | |
| Carrier/Intermodulation Im (C/Im) | (dB) | 30.00 | |
| (C/N)- Total Actual (Es/No) | (dB) | 10.58 | |
| (C/N)-Total Required | (dB) | 6.33 | |
| (Eb/No)-Total Actual | (dB) | 10.08 | |
| (Eb/No)-Total Required | (dB) | 10.08 | |
| **Excess Margin** | (dB) | **4.24** | |
| **Fade Margin** | (dB) | **12.83** | |

## Link Budget: Forward (2)

| O3b Networks Link Analysis - Tier2 Service for Melbourne Beach/U.S.A. | | | |
|---|---|---|---|
| **ECM Link Budget Rpt - 11/19/2014** | | **Tier2** | **Tier2** |
| **Parameters** | Unit | **Clear Sky** | |
| **Ground parameters** | | **Teleport** | **Telco** |
| Location | | Vernon/U.S.A. | Melbourne Beach/U.S.A. |
| Latitude | (deg) | 34.16 | 28.09 |
| Longitude (East) | (deg) | 260.71 | 279.39 |
| E/S Range to SV | (km) | 10166.69 | 9311.20 |
| E/S Elevation to SV | (deg) | 29.99 | 43.30 |
| E/S Altitude | (km) | 0.00 | 0.00 |
| SV Beam Identifier | (#) | 15 | |
| Telco Offset to Beam Center | (km) | 0.27 | |
| **Modulation Parameters** | | **Forward** | |
| Enter Reciever | Type | MEOLink | |
| Percentage of Bandwidth | (%) | 100% | |
| Allocated Bandwidth | (MHz) | 216 | |
| Channel Symbol Rate | (Msps) | 180 | |
| Channel Modulation Type | | 16APSK | |
| Channel FEC Rate | | 0.66 | |
| Channel Throughput | (Mbps) | 473.49 | |
| **Uplink** | | **Forward** | |
| E/S Carrier Frequencies | (MHz) | 28963 | |
| E/S Tx HPA Power Level | (W) | 500 | |
| E/S Tx OBO | (dB) | -10 | |
| E/S Tx Antenna Gain (7.3m) | (dB) | 65.60 | |
| E/S Tx EIRP Per Channel | (dBW) | 75.40 | |
| E/S Tx RF Link Availability | (%) | Clear | |
| E/S Tx Spreading Loss | (dB) | -151.13 | |
| **Satellite** | | **Forward** | |
| SV Rx G/T | (dB/K) | 5.54 | |
| SV Tx OBO | (dB) | -3.80 | |
| SV Tx EIRP Per Channel/Carrier | dBW | 45.45 | |
| **Downlink** | | **Forward** | |
| E/S Rx Carrier Frequency | (MHz) | 19163 | |
| E/S Rx Rf Link Availability | (%) | Clear | |
| E/S Rx Antenna Gain (2.4m) | (dBi) | 51.65 | |
| E/S Rx Effective G/T | (dB/K) | 26.49 | |
| **Total Link** | | **Forward** | |
| Carrier/Noise Bandwidth | (dB) | 51.93 | |
| Carrier/Noise Uplink | (dB) | 23.74 | |
| Carrier/Noise Downlink | (dB) | 19.48 | |
| Carrier/Intermodulation Im (C/Im) | (dB) | 25.00 | |
| (C/N)- Total Actual (Es/No) | (dB) | 16.56 | |
| (C/N)-Total Required | (dB) | 11.01 | |
| (Eb/No)-Total Actual | (dB) | 14.19 | |
| (Eb/No)-Total Required | (dB) | 14.19 | |
| **Excess Margin** | (dB) | **5.55** | |
| **Fade Margin** | (dB) | **18.81** | |

# Annex 3 – Radiation Hazard Study

# Radiation Hazard Study

ST5000-2.4m

This study analyzes the potential Radio Frequency (RF) human exposure levels caused by the Electro Magnetic (EM) fields of the above-captioned antenna. The mathematical analysis performed below complies with the methods described in the Federal Communications Commission Office of Engineering and Technology Bulletin No. 65 (1985 rev. 1997) R&O 96-326.

***Maximum Permisible Exposure***

There are two separate levels of exposure limits. The first applies to persons in the general population who are in an uncontrolled environment. The second applies to trained personnel in a controlled environment. According to 47 C.F.R. § 1.1310, the Maximum Permissible Exposure (MPE) limits for frequencies above 1.5 GHz are as follows:

- General Population / Uncontrolled Exposure 1.0 mW/cm2
- Occupational / Controlled Exposure 5.0 mW/cm2

The purpose of this study is to determine the power flux density levels for the earth station under study as compared with the MPE limits. This comparison is done in each of the following regions:

1. Far-field region
2. Near-field region
3. Transition region
4. The region between the feed and the antenna surface
5. The main reflector region
6. The region between the antenna edge and the ground

***Input Parameters***

The following input parameters were used in the calculations:

| Parameter | Value | Unit | Symbol |
|---|---|---|---|
| Atenna Diameter: | 2.4 | m | $D$ |
| Antenna Transmit Gain: | 54.67 | dBi | $G$ |
| Trasmit Frequency: | 28360 | MHz | $f$ |
| Feed Flange Diameter: | 6.00 | cm | $d$ |
| Power Input to the Antenna: | 40.00 | W | $P$ |

***Calculated Parameters***

The following values were calculated using the above input parameters and the corresponding formulas.

| Parameter | Value | Unit | Symbol | Formula |
|---|---|---|---|---|
| Anenna Surface Area: | 4.52 | $m^2$ | $A$ | $\pi D^2/4$ |
| Area of Feed Flange: | 28.27 | $cm^2$ | $a$ | $\pi d^2/4$ |
| Antenna Efficiency: | 0.58 | | $\eta$ | $G\lambda^2/(\pi^2 D^2)$ |
| Gain Factor: | 293001.00 | | $g$ | $10^{G/10}$ |
| Wavelength: | 0.0106 | m | $\lambda$ | $300/f$ |

***Behavior of EM Fields as a Function of Distance***

The behavior of the characteristics of EM fields varies depending on the distance from the radiating antenna. These characteristics are analyzed in three primary regions: the near-field region, the far-field region and the transition region. Of interest also are the region between the antenna main reflector and the subreflector, the region of the main reflector area and the region between the main reflector and ground.

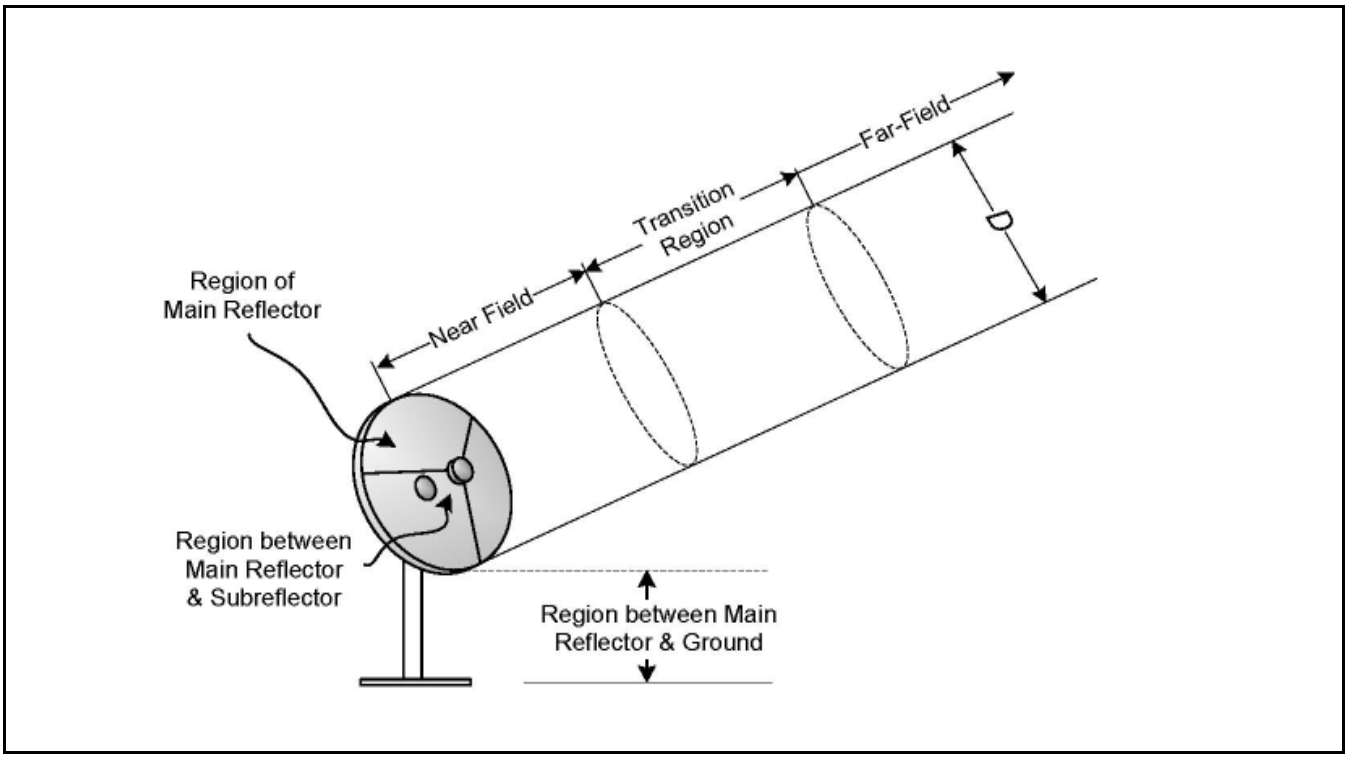



*Figure 1. EM Fields as a Function of Distance*

For parabolic aperture antennas with circular cross sections, such as the antenna under study, the near-field, far-field and transition region distances are calculated as follows:

| Parameter | Value | Unit | Formula |
|---|---|---|---|
| Near Field Distance: | 136.128 | m | $R_{nf} = D^2/(4\lambda)$ |
| Distance to Far Field: | 326.707 | m | Rff = 0.60D2/(λ) |
| Distance of Trasition Region | 136.128 | m | Rt = Rnf |

The distance in the transition region is between the near and far fields. Thus, Rnf ≤ Rt ≤ Rff . However, the power density in the transition region will not exceed the power density in the near-field. Therefore, for purposes of the present analysis, the distance of the transition region can equate the distance to the near-field.

***Power Flux Density Calculations***

The power flux density is considered to be at a maximum through the entire length of the near-field. This region is contained within a cylindrical volume with a diameter, D, equal to the diameter of the antenna. In the transition region and the far-field, the power density decreases inversely with the square of the distance. The following equations are used to calculate power density in these regions.

| Parameter | Value | Unit | Symbol | Formula |
|---|---|---|---|---|
| Power Density in the Near-Field | 2.040 | $mW/cm^2$ | $S_{nf}$ | $16.0\ \eta\ P/(\pi D^2)$ |
| Power Density in the Far-Field | 0.874 | $mW/cm^2$ | $S_{ff}$ | $GP/(4\pi R_{ff}^2)$ |
| Power Density in the Trans. Region | 2.040 | $mW/cm^2$ | $S_t$ | $S_{nf} R_{nf} /(R_t)$ |

The region between the main reflector and the subreflector is confined within a conical shape defined by the feed assembly. The most common feed assemblies are waveguide flanges. This energy is determined as follows:

| Parameter | Value | Unit | Symbol | Formula |
|---|---|---|---|---|
| Power Density at the Feed Flange | 5658.8 | $mW/cm^2$ | $S_{fa}$ | $4P / a$ |

The power density in the main reflector is determined similarly to the power density at the feed flange; except that the area of the reflector is used.

| Parameter | Value | Unit | Symbol | Formula |
|---|---|---|---|---|
| Power Density at Main Reflector | 3.537 | $mW/cm^2$ | $S_{surface}$ | $4P / A$ |

The power density between the reflector and ground, assuming uniform illumination of the reflector surface, is calculated as follows:

| Parameter | Value | Unit | Symbol | Formula |
|---|---|---|---|---|
| Power Density between Reflector and Ground | 0.884 | $mW/cm^2$ | $S_g$ | $P / A$ |

Table 1 summarizes the calculated power flux density values for each region. In a controlled environment, the only regions that exceed FCC limitations are shown below. These regions are only accessible by trained technicians who, as a matter of procedure, turn off transmit power before performing any work in these areas.

| **Power Densities** | **mW/cm2** | **Controlled Environment (5 mW/cm2)** |
|---|---|---|
| Far Field Calculation | 0.874 | Satisfies FCC Requirements |
| Near Field Calculation | 2.040 | Satisfies FCC Requirements |
| Transition Region | 2.040 | Satisfies FCC Requirements |
| Region between Main and Subreflector | 5658.8 | Exceeds Limitations |
| Main Reflector Region | 3.537 | Satisfies FCC Requirements |
| Region between Main Reflector and Ground | 0.884 | Satisfies FCC Requirements |

*Table 1. Power Flux Density for Each Region*

In conclusion, the results show that the antenna, in a controlled environment, and under the proper mitigation procedures, meets the guidelines specified in 47 C.F.R. § 1.1310.

# Annex 4 – SpaceTrack 4000 Product Brochure

# SpaceTrack 4000

Reliability Never Reached So Far™

Designed to meet the communications requirements of at-sea operations, Harris CapRock's SpaceTrack 4000 stabilized antennas are specifically engineered for offshore platforms, FPSOs, semisubmersibles and survey and seismic vessels. The SpaceTrack 4000 range of antennas support both C and Ku-band coverage, delivering the most reliable communications for global operations.

## BENEFITS

> Guaranteed pointing accuracy

> Secure and reliable transmission

> Cost-efficient, high-performance networks

### Certifications and Approvals

CE certified
Brazil Anatel certified
Compliant with MIL-STD 167-1A
Compliant with FCC 25.221 and FCC 25.222
Compliant with ITU and ETSI ESV specifications
Approved by Intelsat
Meets Eutelsat standards
Meets MIL-STD901 and MIL-STD461 standards

## FEATURES

> Automatic satellite acquisition

> Quick and easy conversion between C and Ku-band footprints

> Supports standard GPS and Compass interfaces

> Remote diagnostics and built-in tests

> Radome air conditioning optional

**Advanced Satellite Technology**

The satellite technology used in SpaceTrack 4000 results in the optimum pointing of the antenna. This feature ensures that the signal is maintained despite conditions at sea and the location and direction of the vessel. Once the system is deployed, the antenna automatically locks on the appropriate signal, guaranteeing continuous and reliable transmission.

# SpaceTrack 4000

Reliability Never Reached So Far™

SpaceTrack 4000 technology supports all types of seagoing vessels, resolving the challenges of geography and distance.

| Technical specifications | | | |
|---|---|---|---|
| **Antenna** | | | |
| 4012K | 1.2 m diameter, Ku band, symmetrical, prime focus | | |
| | Tx 13.75–14.5 GHz | Midband gain | Tx ~43.0 dBi |
| | Rx 10.95–12.75 GHz | Midband gain | Rx ~41.2 dBi |
| | | G/T (typical) | 20.0 dB/k |
| 4012C | 1.2 m diameter, C band, symmetrical, prime focus | | |
| | Tx 5850–6425 MHz | Midband gain | Tx ~35.2 dBi |
| | Rx 3625–4200 MHz | Midband gain | Rx ~31.7 dBi |
| | | G/T (typical) | 11.5 dB/k |
| 4018K | 1.8 m diameter, Ku band, symmetrical, prime focus | | |
| | Tx 13.75–14.5 GHz | Midband gain | Tx ~45.5 dBi |
| | Rx 10.95–12.75 GHz | Midband gain | Rx ~44.2 dBi |
| | | G/T (typical) | 22.4 dB/k |
| 4024K | 2.4 m diameter, Ku band, symmetrical, prime focus | | |
| | Tx 13.75–14.5 GHz | Midband gain | Tx ~50.1 dBi |
| | Rx 10.95–12.75 GHz | Midband gain | Rx ~47.7 dBi |
| | | G/T (typical) | 25.5 dB/k |
| 4024C | 2.4 m diameter, C band, symmetrical, prime focus | | |
| | Tx 5850–6425 MHz | Midband gain | Tx~ 42.1 dBi |
| | Rx 3625–4200 MHz | Midband gain | Rx ~38.2 dBi |
| | | G/T (typical) | 18.5 dB/k |
| **Pointing accuracy** | | | |
| For all systems | ≤ 0.2° peak | | |
| Max. vessel motion roll/pitch/ yaw | 8°/sec | | |
| **Dimensions and weights** | | | |
| 4012K | Radome size 1.8 m (H) x 1.8 m (D) | | Antenna weight 230 kg |
| 4012C Linear feed | Radome size 1.9 m (H) x 1.9 m (D) | | Antenna weight 400 kg |
| 4012C Circular feed | Radome size 2.7 m (H) x 2.55 m (D) | | Antenna weight 400 kg |
| 4018K | Radome size 2.7 m (H) x 2.55 m (D) | | Antenna weight 450 kg |
| 4024K | Radome size 3.75 m (H) x 3.6 m (D) | | Antenna weight 750 kg |
| 4024C | Radome size 3.75 m (H) x 3.6 m (D) | | Antenna weight 750 kg |
| **Application notes** | | | |
| 4012K | Typical data rates†: 9.6–512 Kbit/sec | - Suitable for small vessels with space constraints<br>- Minimal equipment costs<br>- Rapid deployment version: SpaceTrack FR | |
| 4012C | Typical data rates†: 9.6–512 Kbit/sec | - Suitable for small vessels with space constraints<br>- C-band operation provides global service options | |
| 4018K | Typical data rates†: 9.6–1024 Kbit/sec | - Suitable for small- to medium-sized vessels<br>- Higher data rate | |
| 4024K | Typical data rates†: 9.6–4096 Kbit/sec | - Suitable for medium to large vessels<br>- Large antenna size supports highest potential bit rates while minimizing space segment costs | |
| 4024C | Typical data rates†: 9.6–4096 Kbit/sec | - Suitable for medium to large vessels<br>- C-band operation provides global service options<br>- Linear or circular polarization options available | |

# Ka-Band Earth Station – Melbourne, FL

# Frequency Coordination Report

## 28 GHz


Prepared on Behalf of
Harris CapRock
Communications

January 7, 2015

COMSEARCH®
A CommScope Company

# Table of Contents

# 1. Summary of Results

On behalf of Harris CapRock Communications, Comsearch performed a coordination notice for all existing and proposed terrestrial licenses within the coordination contours of their proposed Ka-Band earth station in Melbourne, Florida, which will transmit at 28 GHz[1]. Prior-notification letters were sent to the licensees and a copy of the notification data is provided in section four of this report. The earth station coordination was finalized on January 5, 2015.

No objections were received from any of the incumbent 28 GHz licensees. Our notification to the LMDS incumbents was performed under the assumption that the earth station would be operating on a secondary basis to LMDS Block A operations and a contact at Harris CapRock Communications has been provided in case any concerns may arise in the future.

# 2. 28 GHz Common Carrier and LTTS Coordination

In accordance with FCC Rules and Regulations, the Ka-Band earth station in Melbourne, Florida was prior-coordinated by Comsearch. A notification letter and datasheets for this earth station were sent to the following 28 GHz common carrier fixed microwave licensee on December 5, 2014. This licensee is authorized to operate temporary fixed operations from 27.5 to 29.5 GHz on a nationwide basis.

| Licensee | Authorized Geographic Area |
|---|---|
| Verizon | Continental US |

A notification letter and datasheets for the Ka-Band earth station in Melbourne, Florida were also sent to the following 28 GHz local television transmission licensee on December 5, 2014. This licensee is authorized to operate temporary fixed operations from 27.5 to 29.5 GHz on a nationwide basis.

| Licensee | Authorized Geographic Area |
|---|---|
| Information Super Station, LLC | Continental US |

No objections were received from the common carrier or local television transmission service incumbents.

[1] The proposed earth station will operate in the 27.6 – 29.1 GHz portion of the Ka-Band.

# 3. 28 GHz LMDS Coordination

A Notification letter was sent to the following 28 GHz LMDS licensees on December 5, 2014. The proposed earth station will operate on frequencies that overlap Block A of the LMDS service. The total frequency allocation for Block A of the LMDS spectrum appears below.

**Block A**: 27.500-28.350 GHz
29.100-29.250 GHz
31.075-31.225 GHz

| Licensee | Market | Market Name |
|---|---|---|
| Wireless Distribution Services | BTA239 | Lakeland-Winter Haven, FL |
| Rainier Connect | BTA326 | Ocala, FL |
| Straight Path Spectrum | BTA336 | Orlando, FL |
| T-Mobile[2] | BTA336 | Orlando, FL |
| Nextlink/XO | BTA440 | Tampa-St. Petersburg-Clearwater, FL |
| T-Mobile[3] | BTA440 | Tampa-St. Petersburg-Clearwater, FL |
| Nextlink/XO | BTA469 | West Palm Beach-Boca Raton, FL |
| T-Mobile[4] | BTA469 | West Palm Beach-Boca Raton, FL |

No objections were received from the LMDS incumbents.

[2] T-Mobile has acquired LMDS spectrum from Straight Path in the Orlando, FL Basic Trading Area (BTA).

[3] T-Mobile has acquired LMDS spectrum from Nextlink Wireless / XO in the Tampa-St. Petersburg-Clearwater, FL BTA.

[4] T-Mobile has acquired LMDS spectrum from Nextlink Wireless / XO in the West Palm Beach-Boca Raton, FL BTA.

# 4. Earth Station Coordination Data

This section presents the data pertinent to the proposed Ka-Band earth station in Melbourne, Florida. This data was circulated to all incumbent licensees in the shared 28 GHz frequency ranges.

# COMSEARCH

## Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5662 http://www.comsearch.com

| | |
|---|---|
| Date: | 12/01/2014 |
| Job Number: | <PCNJobCode> |

### Administrative Information

| | |
|---|---|
| Status | ENGINEER PROPOSAL |
| Call Sign | <PCNCallSign> |
| Licensee Code | SPACLK |
| Licensee Name | Harris CapRock Communications |

### Site Information — MELBOURNE, FL

| | |
|---|---|
| Venue Name | |
| Latitude (NAD 83) | 28° 1' 51.2" N |
| Longitude (NAD 83) | 80° 35' 55.7" W |
| Climate Zone | B |
| Rain Zone | 1 |
| Ground Elevation (AMSL) | 5.76 m / 18.9 ft |

### Link Information

| | |
|---|---|
| Satellite Type | Medium Earth Orbit |
| Mode | TO - Transmit-Only |
| Modulation | Digital |
| Minimum Elevation Angle | 10.0° |
| Azimuth Range | 0.0° to 360° |
| Antenna Centerline (AGL) | 2.74 m / 9.0 ft |

### Antenna Information — Transmit - FCC32

| | | |
|---|---|---|
| Manufacturer | | Harris |
| Model | | ST5000-2.4 |
| Gain / Diameter | | 54.7 dBi / 2.4 m |
| 3-dB / 15-dB Beamwidth | | 0.14° / 0.32° |
| Max Available RF Power | (dBW/4 kHz) | -9.8 |
| | (dBW/MHz) | 14.2 |
| Maximum EIRP | (dBW/4 kHz) | 44.9 |
| | (dBW/MHz) | 68.9 |
| Interference Objectives: | Long Term | -151.0 dBW/4 kHz 20% |
| | Short Term | -128.0 dBW/4 kHz 0.0025% |

### Frequency Information — Transmit 28.0 GHz

Emission / Frequency Range (MHz)

1M00G7D - 216MG7D / 27652.0 - 27868.0
1M00G7D - 216MG7D / 27912.0 - 28128.0
1M00G7D - 216MG7D / 28172.0 - 28388.0
1M00G7D - 216MG7D / 28601.0 - 28817.0
1M00G7D - 216MG7D / 28855.0 - 29071.0

| | |
|---|---|
| Max Great Circle Coordination Distance | 168.6 km / 104.8 mi |
| Precipitation Scatter Contour Radius | 100.0 km / 62.1 mi |

# COMSEARCH

## Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5662 http://www.comsearch.com

| **Coordination Values** | **MELBOURNE, FL** |
|---|---|
| Licensee Name | Harris CapRock Communications |
| Latitude (NAD 83) | 28° 1' 51.2" N |
| Longitude (NAD 83) | 80° 35' 55.7" W |
| Ground Elevation (AMSL) | 5.76 m / 18.9 ft |
| Antenna Centerline (AGL) | 2.74 m / 9.0 ft |
| Antenna Model | Harris 2.4 Meter |
| Antenna Mode | Transmit 28.0 GHz |
| Interference Objectives: Long Term | -151.0 dBW/4 kHz 20% |
| Short Term | -128.0 dBW/4 kHz 0.0025% |
| Max Available RF Power | -9.8 (dBW/4 kHz) |

Transmit 28.0 GHz

| Azimuth (°) | Horizon Elevation (°) | Antenna Discrimination (°) | Horizon Gain (dBi) | Coordination Distance (km) |
|---|---|---|---|---|
| 0 | 0.00 | 94.45 | -10.00 | 112.26 |
| 5 | 0.00 | 89.45 | -10.00 | 112.26 |
| 10 | 0.00 | 84.45 | -10.00 | 112.26 |
| 15 | 0.00 | 79.45 | -10.00 | 112.26 |
| 20 | 0.00 | 74.45 | -10.00 | 112.26 |
| 25 | 0.00 | 69.45 | -10.00 | 112.26 |
| 30 | 0.00 | 64.45 | -10.00 | 112.26 |
| 35 | 0.00 | 59.45 | -10.00 | 112.26 |
| 40 | 0.00 | 54.45 | -10.00 | 112.26 |
| 45 | 0.00 | 49.45 | -10.00 | 112.26 |
| 50 | 0.00 | 44.45 | -10.00 | 112.26 |
| 55 | 0.00 | 39.45 | -9.65 | 113.45 |
| 60 | 0.00 | 34.45 | -8.45 | 117.36 |
| 65 | 0.00 | 29.45 | -7.12 | 121.56 |
| 70 | 0.00 | 24.45 | -5.61 | 126.08 |
| 75 | 0.00 | 19.46 | -3.90 | 130.96 |
| 80 | 0.00 | 14.46 | -1.93 | 133.35 |
| 85 | 0.00 | 9.46 | 0.35 | 139.71 |
| 90 | 0.00 | 4.47 | 2.91 | 147.68 |
| 95 | 0.00 | 0.68 | 5.41 | 156.29 |
| 100 | 0.00 | 5.56 | 6.74 | 163.72 |
| 105 | 0.00 | 10.56 | 5.78 | 157.61 |
| 110 | 0.00 | 15.55 | 3.37 | 149.20 |
| 115 | 0.00 | 20.55 | 0.78 | 141.00 |
| 120 | 0.00 | 25.55 | -1.53 | 134.41 |
| 125 | 0.00 | 30.55 | -3.43 | 132.24 |
| 130 | 0.00 | 35.55 | -5.02 | 127.80 |
| 135 | 0.00 | 40.55 | -6.37 | 123.82 |
| 140 | 0.00 | 45.55 | -7.54 | 120.24 |
| 145 | 0.00 | 50.55 | -8.55 | 117.04 |
| 150 | 0.00 | 55.55 | -9.42 | 114.18 |
| 155 | 0.00 | 60.55 | -10.00 | 112.26 |
| 160 | 0.00 | 65.55 | -10.00 | 112.26 |
| 165 | 0.00 | 70.55 | -10.00 | 112.26 |
| 170 | 0.00 | 75.55 | -10.00 | 112.26 |
| 175 | 0.00 | 80.55 | -10.00 | 112.26 |
| 180 | 0.00 | 85.55 | -10.00 | 112.26 |
| 185 | 0.00 | 90.55 | -10.00 | 112.26 |

# COMSEARCH

## Earth Station Data Sheet

19700 Janelia Farm Boulevard, Ashburn, VA 20147
(703)726-5662 http://www.comsearch.com

| **Coordination Values** | **MELBOURNE, FL** |
|---|---|
| Licensee Name | Harris CapRock Communications |
| Latitude (NAD 83) | 28° 1' 51.2" N |
| Longitude (NAD 83) | 80° 35' 55.7" W |
| Ground Elevation (AMSL) | 5.76 m / 18.9 ft |
| Antenna Centerline (AGL) | 2.74 m / 9.0 ft |
| Antenna Model | Harris 2.4 Meter |
| Antenna Mode | Transmit 28.0 GHz |
| Interference Objectives: Long Term | -151.0 dBW/4 kHz 20% |
| Short Term | -128.0 dBW/4 kHz 0.0025% |
| Max Available RF Power | -9.8 (dBW/4 kHz) |

Transmit 28.0 GHz

| Azimuth (°) | Horizon Elevation (°) | Antenna Discrimination (°) | Horizon Gain (dBi) | Coordination Distance (km) |
|---|---|---|---|---|
| 190 | 0.00 | 95.55 | -10.00 | 112.26 |
| 195 | 0.00 | 100.55 | -10.00 | 112.26 |
| 200 | 0.00 | 105.55 | -10.00 | 112.26 |
| 205 | 0.00 | 110.55 | -10.00 | 112.26 |
| 210 | 0.00 | 115.55 | -9.42 | 114.18 |
| 215 | 0.00 | 120.55 | -8.55 | 117.04 |
| 220 | 0.00 | 125.55 | -7.54 | 120.24 |
| 225 | 0.00 | 130.55 | -6.37 | 123.82 |
| 230 | 0.00 | 135.55 | -5.02 | 127.80 |
| 235 | 0.00 | 140.55 | -3.43 | 132.24 |
| 240 | 0.00 | 145.55 | -1.53 | 134.41 |
| 245 | 0.00 | 150.55 | 0.81 | 141.08 |
| 250 | 0.00 | 155.55 | 3.54 | 149.76 |
| 255 | 0.00 | 160.54 | 6.24 | 159.30 |
| 260 | 0.00 | 165.54 | 7.54 | 168.61 |
| 265 | 0.00 | 170.54 | 6.22 | 159.23 |
| 270 | 0.00 | 175.53 | 3.52 | 149.69 |
| 275 | 0.00 | 179.32 | 0.79 | 141.02 |
| 280 | 0.00 | 174.44 | -1.60 | 134.22 |
| 285 | 0.00 | 169.44 | -3.65 | 131.66 |
| 290 | 0.00 | 164.45 | -5.41 | 126.68 |
| 295 | 0.00 | 159.45 | -6.95 | 122.08 |
| 300 | 0.00 | 154.45 | -8.31 | 117.82 |
| 305 | 0.00 | 149.45 | -9.52 | 113.86 |
| 310 | 0.00 | 144.45 | -10.00 | 112.26 |
| 315 | 0.00 | 139.45 | -10.00 | 112.26 |
| 320 | 0.00 | 134.45 | -10.00 | 112.26 |
| 325 | 0.00 | 129.45 | -10.00 | 112.26 |
| 330 | 0.00 | 124.45 | -10.00 | 112.26 |
| 335 | 0.00 | 119.45 | -10.00 | 112.26 |
| 340 | 0.00 | 114.45 | -10.00 | 112.26 |
| 345 | 0.00 | 109.45 | -10.00 | 112.26 |
| 350 | 0.00 | 104.45 | -10.00 | 112.26 |
| 355 | 0.00 | 99.45 | -10.00 | 112.26 |

# 5. Contact Information

For questions or information regarding the 28 GHz Frequency Coordination Report, please contact:


| | |
|---|---|
| Contact person: | Joanna Lynch |
| Title: | Manager, Spectrum & Data Solutions |
| Company: | Comsearch |
| Address: | 19700 Janelia Farm Blvd., Ashburn, VA 20147 |
| Telephone: | 703-726-5711 |
| Fax: | 703-726-5599 |
| Email: | jlynch@comsearch.com |
| Web site: | www.comsearch.com |

Approved by OMB
3060−0678

# APPLICATION FOR EARTH STATION SPECIAL TEMPORARY AUTHORITY

APPLICANT INFORMATIONEnter a description of this application to identify it on the main menu:
O3b STA to operate at Melbourne to include GSO frequencies (Dec 2014) − 180 days

**1. Applicant**

| | | | |
|---|---|---|---|
| **Name:** | O3b Limited | **Phone Number:** | 202−813−4026 |
| **DBA Name:** | | **Fax Number:** | |
| **Street:** | 900 17th Street, NW, #300 | **E−Mail:** | suzanne.malloy@o3bnetworks.com |
| City: | Washington | **State:** | |
| **Country:** | USA | **Zipcode:** | − |
| **Attention:** | Ms Suzanne Malloy | | |

180 dAYS

FEDERAL COMMUNICATIONS

GRANTED
International Bureau

File# SES-STA-20141212-00896

Call Sign N/A Grant Date 04/14/2015
(or other identifier)

Term Dates
From 04/14/2015 To: 10/12/2015

Approved: Paul E Blais

Applicant: O3b Limited
Call Sign: None
File No. SES-STA-20141212-00896
Special Temporary Authority (STA)

O3b Limited (O3b) is granted an extension Special Temporary Authority (STA) for 180 days, to continue testing three 2.2 meter antennas in Melbourne, FL, as described in its application. Operations under this STA must be in accordance with the terms and conditions contained in O3b's application, the Federal Communication Commission's rules not waived herein, and are subject to the following conditions.

1) *Operations under this STA shall not cause harmful interference to, and shall not claim protection from, interference caused to it by any other lawfully operating station and it shall cease transmission(s) immediately upon notice of such interference.*

2) *Grant of this STA is without prejudice to any determination that the Commission may make regarding other pending applications or future STA requests.*

3) *Any action taken or expense incurred as a result of operations pursuant to this STA is solely at the applicant's risk.*

4) *This action is issued pursuant to Section 0.261 of the Commission's rules on delegated authority, 47 C.F.R. §0.261, and is effective immediately.*

"Extension with conditions"

180 days

FEDERAL COMMUNICATIONS

GRANTED
International Bureau

File # SES-STA-20141212-00896

Call Sign N/A (or other identifier) Grant Date 04/14/2015

Term Dates
From 04/14/2015 To: 10/12/2015

Approved: [signature]

5) Operations of this station during the period from expiration of SES-STA-20140429-00314 to the grant of this special temporary authority was authorized pursuant to Section 1.62 of the Commission's rules, 47 C.F.R. § ~~1.62~~ 1.62. [signature]

**2. Contact**

| | | | |
|---|---|---|---|
| **Name:** | Joseph A. Godles | **Phone Number:** | 202–429–4900 |
| **Company:** | Goldberg Godles Wiener & Wright LLP | **Fax Number:** | 202–429–4912 |
| **Street:** | 1229 19th St., NW | E–Mail: | jgodles@g2w2.com |
| **City:** | Washington | **State:** | DC |
| **Country:** | USA | **Zipcode:** | 20036 –2413 |
| **Attention:** | | **Relationship:** | Legal Counsel |

(If your application is related to an application filed with the Commission, enter either the file number or the IB Submission ID of the related application. Please enter only one.)
3. Reference File Number SESSTA2014042900314 or Submission ID

4a. 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):

4b. Fee Classification CGX – Fixed Satellite Transmit/Receive Earth Station

5. Type Request

○ Use Prior to Grant ○ Change Station Location ◉ Other

6. Requested Use Prior Date
12/31/2014

| | |
|---|---|
| 7. CityMelbourne | 8. Latitude<br>(dd mm ss.s h) 28 5 15.5 N 28.0876° |
| 9. State FL | 10. Longitude<br>(dd mm ss.s h) 80 38 10.2 W 80.6028° |

11. Please supply any need attachments.

Attachment 1: STA extension Attachment 2: Attachment 3:

12. Description. (If the complete description does not appear in this box, please go to the end of the form to view it in its entirety.)

Pursuant to Section 25.120 of the Commission's rules, O3b hereby requests an STA extension enabling it to continue testing during the 180-day period between December 31, 2014, and June 29, 2015, in accordance with the attached description.

13. 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

| | |
|---|---|
| 14. Name of Person Signing<br>Suzanne Malloy | 15. Title of Person Signing<br>Vice–President, Regulatory Affairs |

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).

**FCC NOTICE REQUIRED BY THE PAPERWORK REDUCTION ACT**

The public reporting for this collection of information is estimated to average 2 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.

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**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.**

**Request for Extension of Special Temporary Authority**

The International Bureau previously granted the request filed by O3b Limited ("O3b") for special temporary authority ("STA") to conduct earth station antenna tests via the O3b satellite system using up to three 2.2m earth station antennas at a facility in Melbourne, Florida[1] and extended the STA through December 30, 2014.[2]

Pursuant to Section 25.120 of the Commission's rules,[3] O3b hereby requests an STA extension enabling it to continue the earth station antenna tests during the 180-day period between December 31, 2014, and June 29, 2015.

O3b's extension request is supported by good cause. An extension will enable O3b to continue its testing so that it may establish performance standards and operational requirements for its earth stations. By granting O3b's prior STA requests, the Bureau already has found that facilitating these activities is in the public interest.

Accordingly, and for good cause shown, O3b respectfully requests that its STA extension request be granted.

---

[1] See FCC File No. SES-STA-20140403-00233.
[2] See FCC File No. SES-STA-20140429-00314.
[3] 47 C.F.R. § 25.120.