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October 21, 2014

***By Electronic Filing***

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

**Re: Gogo LLC ESAA Modification, Call Sign E120106,
File No. SES-MFS-20140801-00625**

Dear Ms. Dortch:

Gogo LLC ("Gogo"), by its attorney, hereby updates the record with respect to Gogo's above-referenced application to modify its license to operate earth stations aboard aircraft (the "Gogo Modification") and responds to the Commission staff's request for additional information regarding the Gogo Modification.[1]

First, Gogo corrects, clarifies, or supplements the following items in the Gogo Modification, and requests that the Commission update its records to reflect the revised data:

- The antenna ID in item E28 of the Form 312, Schedule B for the Gogo Modification is incorrect for one of the carriers described in items E43-E49. Specifically, the antenna associated with the carrier with emission designator 1M40G7D should be the AES1 antenna, rather than the AES2 antenna.

- The response to items E33 and E34 of the Form 312, Schedule B for the Gogo Modification, which seeks information on the minor and major antenna axes, should be 0.33 and 0.66 meters, respectively, for the ThinKom antenna designated AES2 on the form. As discussed in more detail below, this data corresponds to the antenna parameters used in the Radiation Hazard Analysis.

- Gogo clarifies that the transmit antenna gain for the AES2 antenna specified in items E41/42 of the Form 312, Schedule B for the Gogo Modification (36.7 dBi) represents the gain at mid-band, 14.25 GHz, for a 40° elevation angle and 50° scan angle. The maximum transmit gain for the ThinKom antenna, as illustrated in Figure 1 of the Radiation Hazard Analysis, Annex 7 of the Gogo Modification, is 37.8 dBi at 14.5 GHz,

[1] *See* Letter of Paul E. Blais, Chief, Systems Analysis Branch, Satellite Division, International Bureau, to Karis Hastings, Counsel for Gogo LLC, File No. SES-MFS-20131114-01015, dated Oct. 9, 2014 (the "FCC Letter").

for an 80° elevation angle and 10° scan angle. The transmit antenna gain associated with the carrier for the ThinKom terminal that has the highest EIRP density (18.9 dBW/ 4 kHz) is 37.6 dBi at 14.274 GHz for a 57° elevation angle, 33° scan angle, and 45 degree skew angle. *See* Appendix B, B.2.3., first figure.

Because the antenna gain varies with elevation angle and the maximum allowable EIRP density values vary with scan and skew angles, the required radiofrequency ("RF") input power density at the flange associated with a specific antenna gain and EIRP will vary as well. For example, for the set of parameters Gogo originally provided in items E41/42 (14.25 GHz, 40°elevation angle, 50° scan angle), the gain is 36.7 dBi. This means that the maximum RF input power at the flange is 44.6 – 36.7 = 7.9 dBW or 6.2 Watts. The maximum operational input power at the flange specified in item E38 of the Schedule B, 26.8 W (14.3 dBW), would only be available at a main beam gain of 30.3 dBi (44.6-14.3), which corresponds to operation at 14.25 GHz with a 14° elevation angle and 76° scan angle. *See* Figure 1 of the Radiation Hazard Analysis, Annex 7 of the Gogo Modification. In order to operate with a lower main beam gain, the maximum EIRP would need to be lower than 44.6 dBW in order to meet the required off-axis emissions.

- The frequency and emission designator section of the Form 312, Schedule B for the Gogo Modification provides values for the maximum EIRP per carrier (E48) and the Maximum EIRP Density per Carrier (E49), which are based upon the values agreed upon in Gogo's coordination agreements with the satellite operators. They also conform to the values provided in items E38 and E40. Neither the EIRP nor the EIRP Density will result in values which exceed the maximum Total Input Power at the antenna flange (E38), and the maximum EIRP for any carrier does not exceed the value in E40.

- Gogo reiterates that it is seeking authority pursuant to Section 25.227(a)(2) of the Commission's rules.[2] The data presented in the Technical Annex (Annex 8) of the Gogo Modification demonstrates that the ThinKom terminal is capable of complying with the mask defined in Section 25.227(a)(1) of the Commission's rules. However, Gogo is seeking to operate carriers at higher power levels than those assumed in the Annex 8 data and has coordinated those proposed operations with satellite operators pursuant to Section 25.227(a)(2).

- In both the Narrative and the Form 312, Schedule B for the Gogo Modification, Gogo refers to the "Telstar 18" spacecraft.[3] Gogo hereby acknowledges that in prior decisions, the Commission has used the designation "Telstar 18" to refer only to the conventional C-band payload on that satellite, which is licensed by the Kingdom of Tonga. Gogo proposes to use the Ku-band payload on this spacecraft, which was licensed by the People's Republic of China under the name of "Apstar V." Gogo understands that in acting on the Gogo Modification the Commission may need to refer to the Ku-band capacity of the spacecraft by a different name than Telstar 18 in order to distinguish it from the C-band payload that has already been granted U.S. market access.

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[2] *See* Gogo Modification, Narrative at 2.

[3] *See id.*, Narrative at 1-6, and Form 312, Schedule B, items E21-24.

- Table 1 in the Radiation Hazard Analysis, Annex 7 of the Gogo Modification, contains a typographical error. The first value, for the Antenna Aperture major axis, should be 0.66 meters, rather than 0.62 meters.

- Gogo clarifies that in Section 1.5 of the Technical Annex (Annex 8) of the Gogo Modification, the acronym "VICTS" refers to a variable inclination continuous transverse stub antenna. In addition, the "scan" angle referred to in this section is determined by the following relationship: 90° - elevation angle = scan angle. For the Commission's convenience, Gogo provides the following revised version of Table 1 in this section, which has an added column to reflect the elevation angle. Gogo has also changed the title of the table to make clear that it is intended to demonstrate representative data for the ThinKom antenna, not the specifics of the proposed Gogo operations.

Table 1.
Representative Maximum EIRP PSD Levels [dBW/4kHz] vs. Scan/Skew for ThinKom Antenna over CONUS

| | | | Maximum EIRP PSD [dBW/4kHz] | | |
|---|---|---|---|---|---|
| freq [GHz] | elev [deg] | scan [deg] | skew=10° | skew=30° | skew=50° |
| 14.00 | 79.5 | 10.5 | 18.2 | 18.1 | 17.7 |
| 14.00 | 59.4 | 30.6 | 18.2 | 18.1 | 17.3 |
| 14.00 | 39.2 | 50.8 | 18.2 | 16.7 | 15.6 |
| 14.00 | 19.3 | 70.7 | 16.9 | 15.5 | 12.9 |
| 14.25 | 80.2 | 9.8 | 18.7 | 18.4 | 17.8 |
| 14.25 | 59.9 | 30.1 | 18.7 | 18.4 | 17.3 |
| 14.25 | 39.9 | 50.1 | 18.9 | 16.7 | 16.0 |
| 14.25 | 20.7 | 69.3 | 17.4 | 15.7 | 13.1 |
| 14.50 | 80.6 | 9.4 | 19.1 | 18.8 | 18.2 |
| 14.50 | 60.3 | 29.7 | 18.9 | 18.7 | 17.8 |
| 14.50 | 40.6 | 49.4 | 18.7 | 16.7 | 16.2 |
| 14.50 | 21.8 | 68.2 | 17.5 | 15.9 | 13.5 |

- Appendix B of the Technical Annex (Annex 8) of the Gogo Modification did not include information regarding the relevant input power density assumed for purposes of the antenna pattern information provided in those materials. For the Commission's convenience, a new set of Appendix B graphs that supplies this information is attached hereto.

- Appendix C of the Technical Annex (Annex 8) of the Gogo Modification provides information regarding the EIRP density for the ThinKom antenna designated as AES2. Accordingly, Gogo corrects the title of that appendix to read "Antenna EIRP Density Tables."

The questions posed in the FCC Letter and Gogo's answers are set forth below:

- *Gogo's radio frequency hazard analysis uses an antenna diameter of 0.662 and 0.66 meter but its Schedule B listed an antenna diameter of 0.74 meters. Please clarify or correct the antenna diameters used in the analysis and confirm that there are no discrepancies with respect to the antenna diameter specified in other parts of the application.*

Commission rules and policies suggest that for a non-circular antenna such as the ThinKom terminal, an applicant should report the "effective" or "equivalent" antenna diameter.[4] However, because the ThinKom antenna does not physically rotate, its gain and therefore its effective aperture size varies with the elevation angle.[5] Thus, there is no single set of values that can accurately describe the effective measurements of the ThinKom antenna. Instead, the values for antenna diameter provided in the Gogo Modification vary depending on the underlying assumptions and context.

The 0.74 meter diameter listed in item E32 of the Form 312 Schedule B included in the Gogo Modification reflects the actual physical size of the ThinKom antenna. In its promotional materials, ThinKom describes this antenna as a 0.74 meter terminal, so the information Gogo provided in Schedule B aligns with the way the antenna is characterized by the manufacturer.

The 0.662 meter diameter used in the radiation hazard analysis (in some cases rounded to 0.66 meters)[6] is the effective aperture area, which represents the illuminated active area on top of the aperture in the near-field. The relevant Commission reference[7] indicates that the "physical area of the aperture antenna" is to be used in calculations and also recognizes that the antenna's effective aperture area can be different from its physical area.[8] The 0.662 meter value was used to give a more accurate indicator of the radiation intensity in making the calculations in equations 11 and 12 of OET Bulletin 65.

In Section 7 of the radiation hazard analysis, the evaluation of the safe occupancy area in the front of the antenna, Gogo used an effective diameter of 0.53 meters.[9] This value assumed a

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[4] *See* 47 C.F.R. § 25.103 (defining the "equivalent diameter" of a non-circular-aperture antenna as "the diameter of a hypothetical circular-aperture antenna with the same aperture area as the actual antenna"); *see also* Instructions for 312 Main Form and Schedules A and B (for elliptical aperture antennas, "provide the major and minor axes diameters of the antenna and its equivalent circular electrical diameter").

[5] *See* Gogo Modification, Annex 7, Radiation Hazard Analysis for ThinKom Terminal, at 2 Figure 1 (comparison of the ThinKom antenna gain vs. elevation angle).

[6] *See* Gogo Modification, Annex 7, Radiation Hazard Analysis for ThinKom Terminal, at 8. As discussed above, in one location in the Radiation Hazard Analysis, the antenna aperture's major axis is identified as being 0.62 meters. *See id.* at 1. This is a typographical error in the document. The correct value that was used in the relevant calculations is 0.662 meters.

[7] OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Ed. 97-01, August 1997 ("OET Bulletin 65").

[8] *See id*. at 27-28.

[9] Gogo Modification, Annex 7, at 6.

10 degree elevation angle in order to provide a conservative, worst case calculation of the safe distance for personnel working near the antenna.[10]

Finally, the return link budgets for operation of the ThinKom antenna with the Telstar 18 and SES-1 satellites indicated an effective diameter of 0.3 meters.[11] This value reflects the antenna gain of the ThinKom antenna for the elevation angle representing the worst case return link scenario for each satellite beam and carrier. The value was shown for illustrative purposes and was not used in the link budget calculations.

- *Gogo' s application contained a certification of compliance with the requirements of Section 25.227(a)(6) of the Commission's rules to record the location of the ESAA. The description of the KANDU antenna control subsystem, which is a subcomponent of the ThinKom terminal, however, only discusses satellite tracking using the aircraft's inertial reference unit and the target satellite's orbital slot. We note that the description does not indicate that the location of the antenna is recorded. Please clarify how the ThinKom terminal complies with the requirements of Section 25.227(a)(6).*

In addition to its other functions, such as performing satellite acquisition and tracking, the KANDU antenna control subsystem records the location of the ESAA antenna (longitude, latitude, and altitude).

- *Gogo' s application contained a certification of compliance with the requirement of Section 25.227(a)(9) of the Commission's rules to automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal. The description of the KANDU component's fault management system indicates that it "is responsible for transitioning the system back into normal operation during soft (recoverable) faults and graceful transition to a non-operational mode for hard (unrecoverable) faults. In the case that the TX antenna pointing and or antenna pointing knowledge is compromised in any way, the fault management mutes the HPT [high power transmitter]." Please confirm that this process does not affect Gogo's statement in paragraph 1.3 of Annex 8, that, "[a]ll emissions automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the antenna exceeds 0.5°, and transmission is not resumed until the angle is verified to be less than 0.2°."*

Gogo hereby confirms that the KANDU's fault management autonomous responses do not compromise or in any way affect Gogo's compliance with the requirement to mute emissions

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[10] At elevation angles greater than 10 degrees, the effective aperture value would increase to the point that the effective major and minor axes would each be 0.66 meters, resulting in a 0.75 meter effective diameter. However, for the purposes of this section of the radiation hazard analysis the effective aperture was fixed at 0.53 meters in order to provide worst case power density values.

[11] Gogo Modification, Annex 5 at 2 and Annex 8, Appendix A. The antenna diameter on the SES-1 return link budget is a typographical error and should indicate 0.4 meters instead of 0.3 meters diameter.

automatically within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the antenna exceeds 0.5 degrees and not to resume transmission until the angle is verified to be less than 0.2 degrees.

- *Gogo's application contained a certification of compliance with Section 25.227(a)(10) of the Commission's rules to monitor and control ESAA terminals by a Network Control and Monitoring Center (NCMC) or an equivalent facility and that each terminal is able to receive at least "enable transmission" and "disable transmission" commands from the NCMC and must automatically cease transmissions immediately on receiving any "parameter change command," until it receives an "enable transmission" command. Please confirm that the NCMC Engineer on Duty and the Remote Control Points listed in the current authorization have the equipment and technical ability to command the ThinKom terminals.*

Gogo hereby confirms that the NCMC Engineer on Duty at the Gogo Systems Operation Center in Itasca, IL has the equipment and technical ability to command the ThinKom terminals, including by sending enable transmission, disable transmission, and parameter change commands to single terminals or to any group of terminals. The commands are relayed to the ESAA terminals via the teleport earth stations that have been identified in Gogo's ESAA applications.

With the exception of the Gogo Systems Operation Center, the other Remote Control Points currently listed on the Gogo ESAA license do not have the independent ability to command individual Gogo ESAA terminals. As discussed above, these teleport earth stations are able to relay commands from the Gogo Systems Operation Center. In addition, they have the physical ability to shut down Gogo ESAA network operations within an entire satellite beam, but have authority to do so only if they receive an instruction from Gogo.

Thus, any Commission directions requiring shut down of a terminal or terminals in the Gogo ESAA network should be communicated directly to the Gogo Systems Operation Center, using the contact information on file with the Commission and supplied again in the Gogo Modification.[12]

- *Section 25.227(a)(13) of the Conmiission's rules requires that ESAA providers operating in the international airspace within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in this band, the maximum power flux density (pfd) produced at the surface of the Earth by emissions from a single aircraft carrying an ESAA terminal should not exceed the following values unless the foreign Administration has imposed other conditions for protecting its fixed service stations:*

| | | | |
|---|---|---|---|
| -132 + 0.5 Theta | dB(W/(m$^2$ · MHz)) | For | Theta ≤40° |
| -112 | dB(W/(m$^2$ · MHz)) | For | 40° < Theta ≤90° |

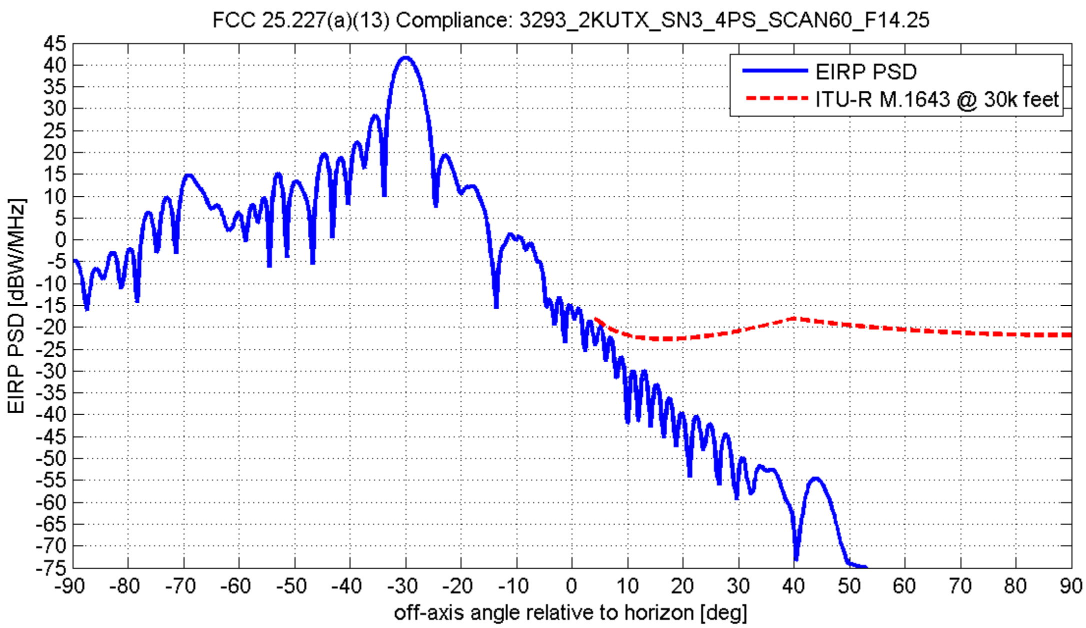
[12] Gogo Modification, Form 312 Schedule B Items E1-E9 and Annex 1.

*In Gogo's application, Technical Annex, Table 1, lists maximum EIRP power spectral densities. Please explain how the ThinKom system uses the following factors to ensure compliance with Section 25.227(a)(13) of the Commission's rules: EIRP, the plane's location, the direction and attitude of flight, and direction to a foreign administration.*

The Gogo ESAA network has been designed to ensure that operation of the ThinKom terminals complies with Section 25.227(a)(13). That provision sets maximum radiated power flux density (PFD) at the surface of the Earth when operating in the international airspace within line-of-sight (as determined by aircraft altitude and geographic location) of the territory of a foreign administration that has a primary allocation for terrestrial networks.

Gogo principally relies on frequency diversity to ensure compliance with this requirement. Specifically, when operating within line-of-sight of a foreign administration with primary terrestrial networks, Gogo selects operating frequencies to avoid channels used by the terrestrial systems.

In many operational scenarios, the ThinKom terminal will comply with the applicable mask, giving Gogo additional flexibility in frequency assignment. ThinKom has conducted an analysis based upon measured antenna pattern data and has determined a range of operating parameters for which the antenna maintains compliance to the PFD contour/mask prescribed in Section 25.227(a)(13). A representative example of this analysis is shown below with the antenna mainbeam commanded to an elevation of 30 degrees above the horizon and while operating at a peak power spectral density (PSD) of 18.5 dBW/4KHz (42.5 dBW/MHz.)




For that subset of geometries and aircraft attitudes for which restriction of peak PSD is insufficient or impractical to ensure compliance (generally when operating/radiating at very low elevation angles, while proximal to and in the direction of the territory of the foreign administration), Gogo will use frequency diversity as discussed above or will coordinate frequencies in advance as required with the relevant foreign administration.

- *Gogo provided letters from target satellite operators to demonstrate compliance with Section 25.227(a)(15) of the Commission's rules. In reviewing the satellite operator certifications in Annex 3, it was noted that the operators certified that the proposed use of the ESAA transit/receive terminals at the power density levels that Gogo provided to them were consistent with their existing coordination agreements. Please confirm that the power settings that Gogo provided to the satellite operators do not exceed the EIRP values in Gogo's FCC Form 312, Schedule B.*

The power levels Gogo provided to the satellite carriers for each satellite and beam were input directly into Gogo's FCC Form 312, Schedule B. Thus, Gogo hereby confirms that the power settings that Gogo provided to the satellite operators who supplied certifications in Annex 3 of the Gogo Modification do not exceed the EIRP values in Gogo's FCC Form 312, Schedule B. Nor do the Form 312, Schedule B EIRP values exceed those Gogo provided to the satellite carriers – the values are identical.

Please let me know if you have any questions regarding this matter.

Respectfully submitted,

*/s/ Karis A. Hastings*

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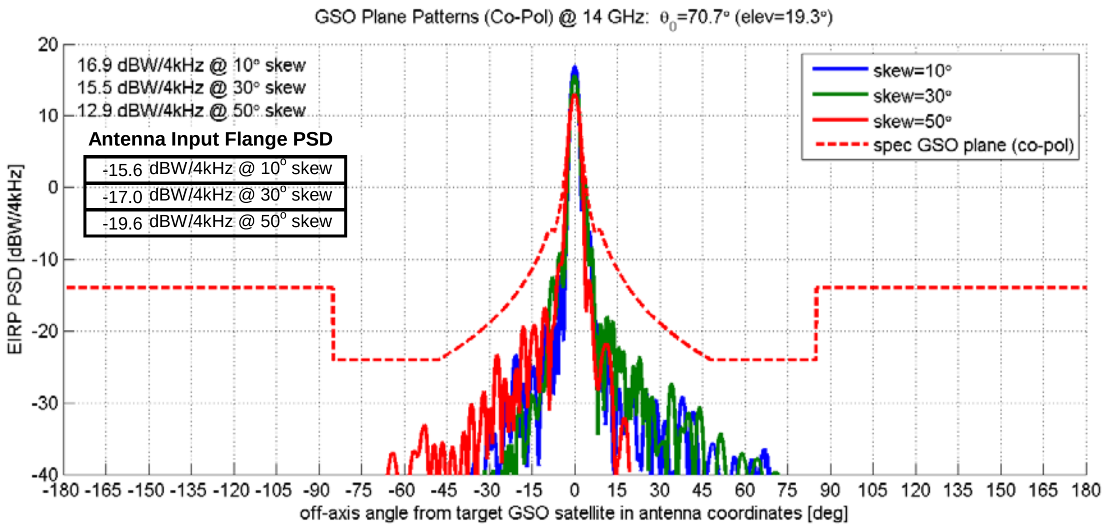
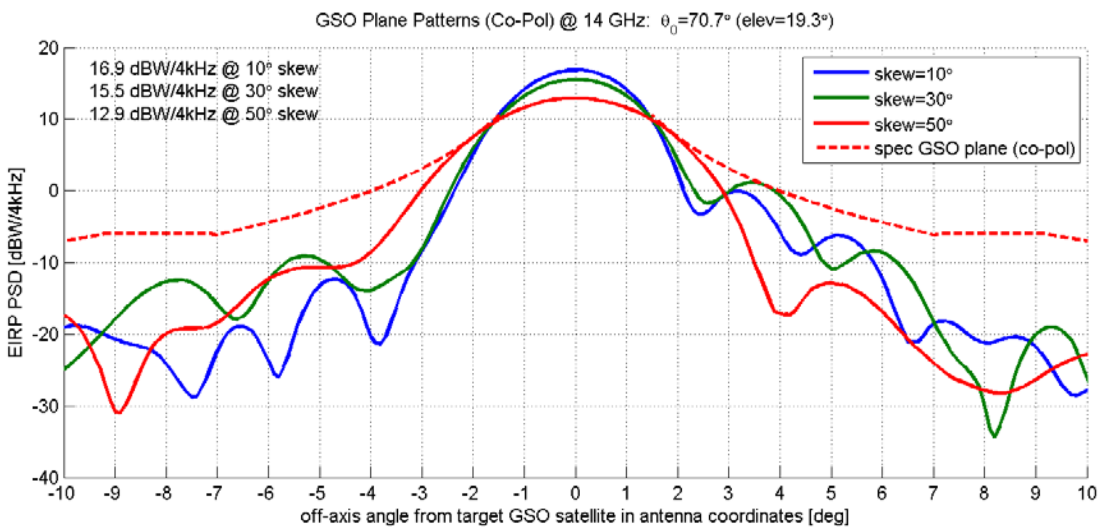
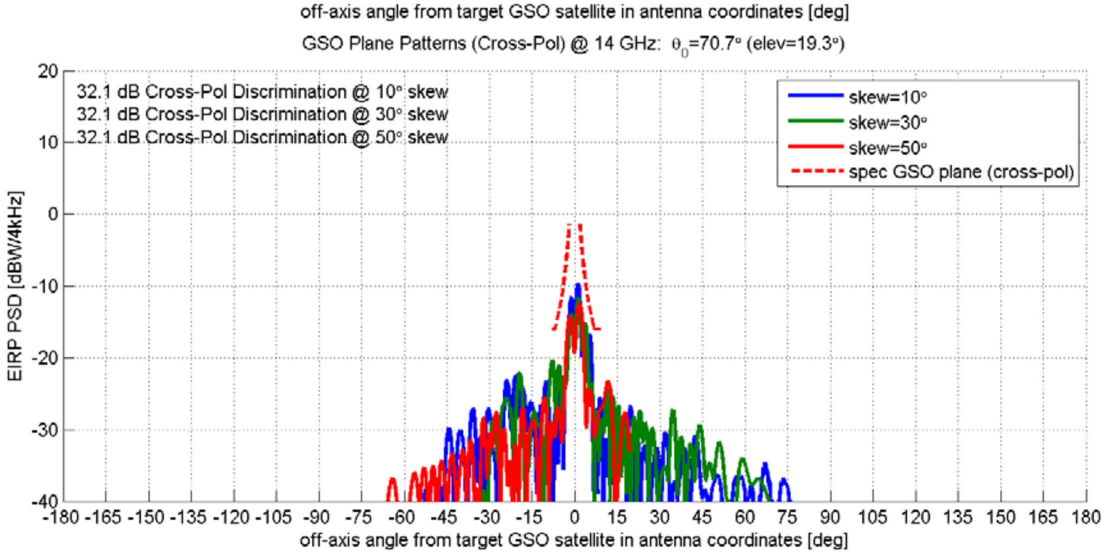
cc: Paul Blais
Andrea Kelly
Cindy Spiers
Trang Nguyen

**Attachment: Updated Appendix B to Technical Annex (Annex 8) of the Gogo Modification**

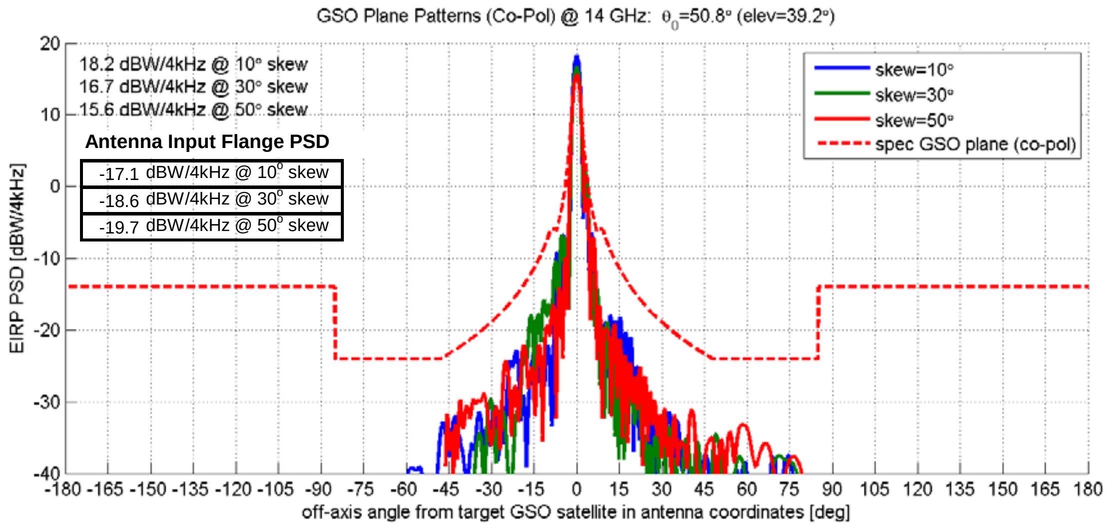
## B.1.1 Antenna Patterns, Mainbeam @ Elevation=20° (Scan=70°), 14.00 GHz

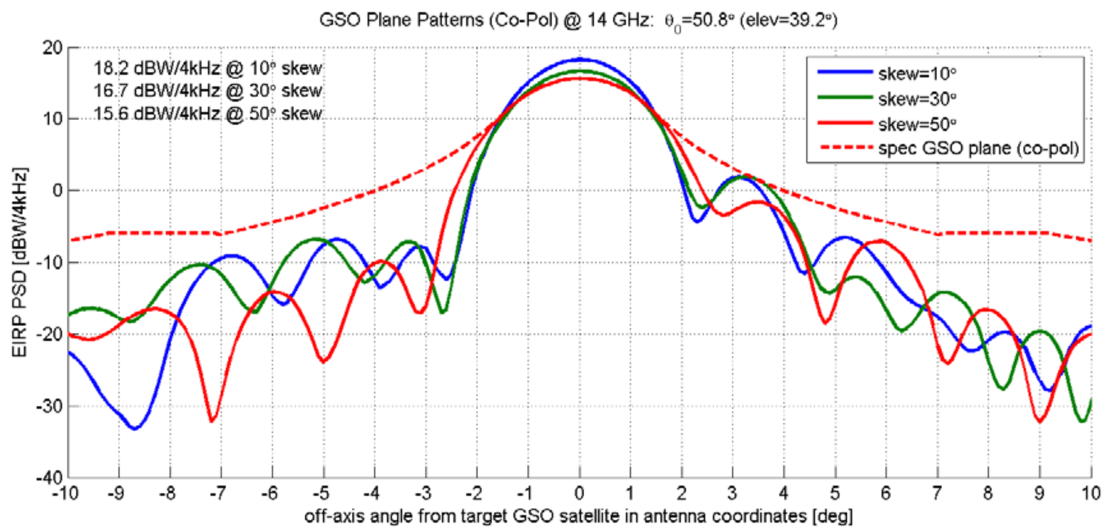


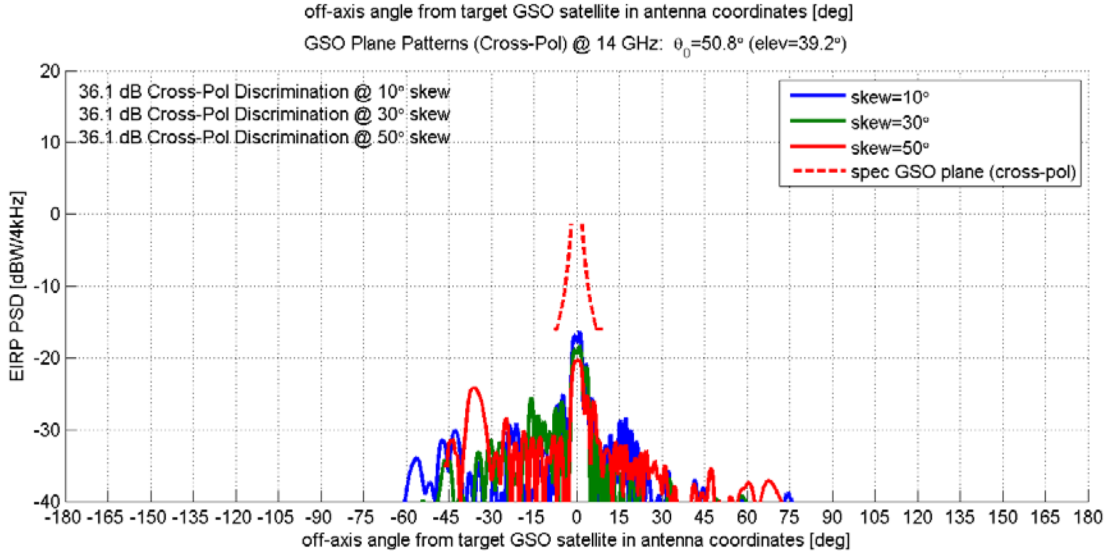



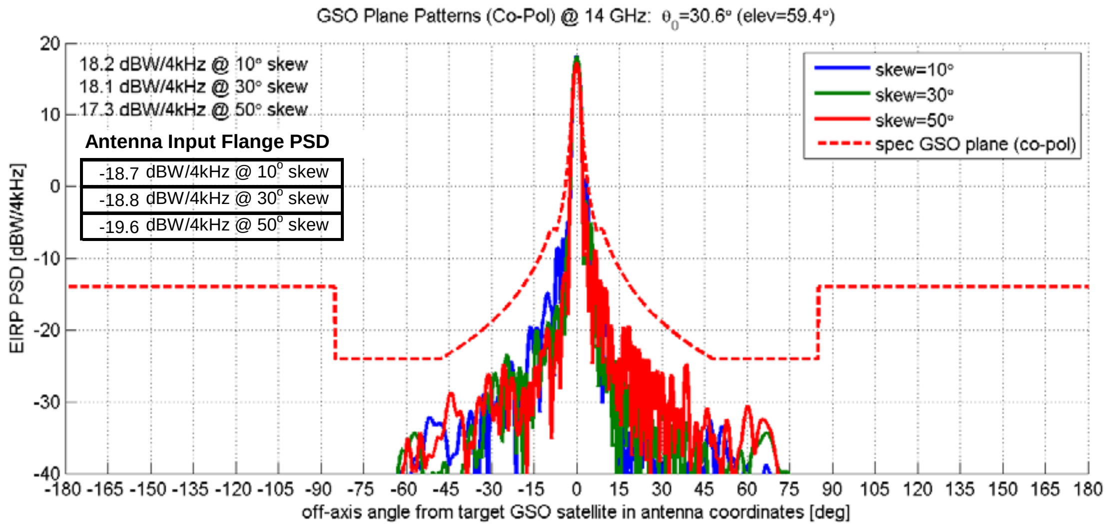
## B.1.2 Antenna Patterns, Mainbeam @ Elevation=40° (Scan=50°), 14.00 GHz

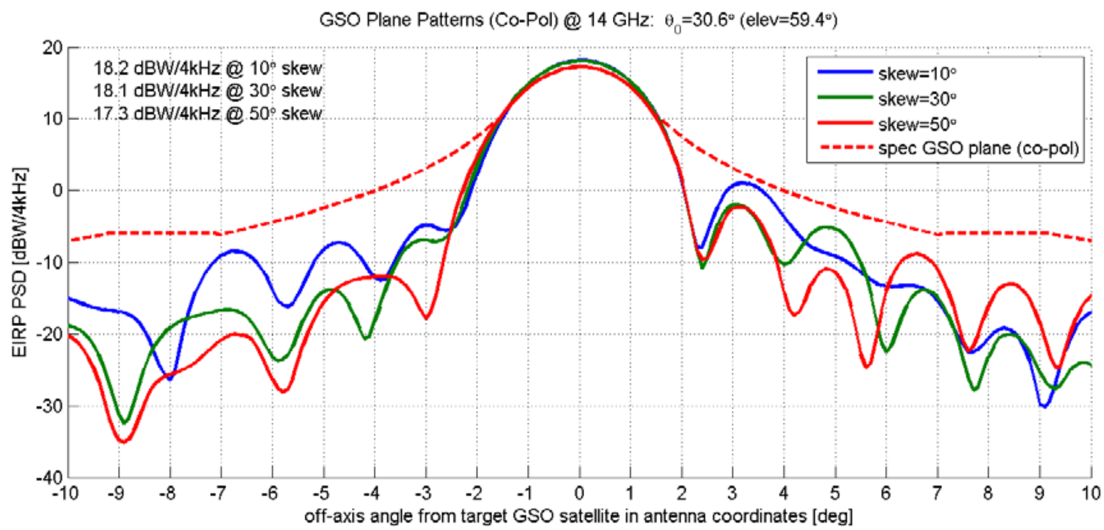


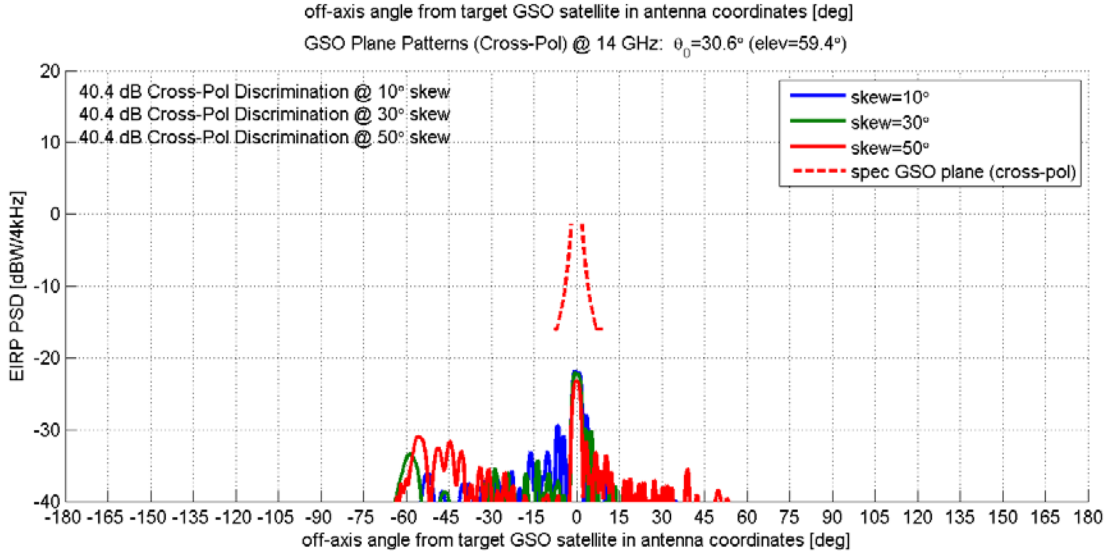



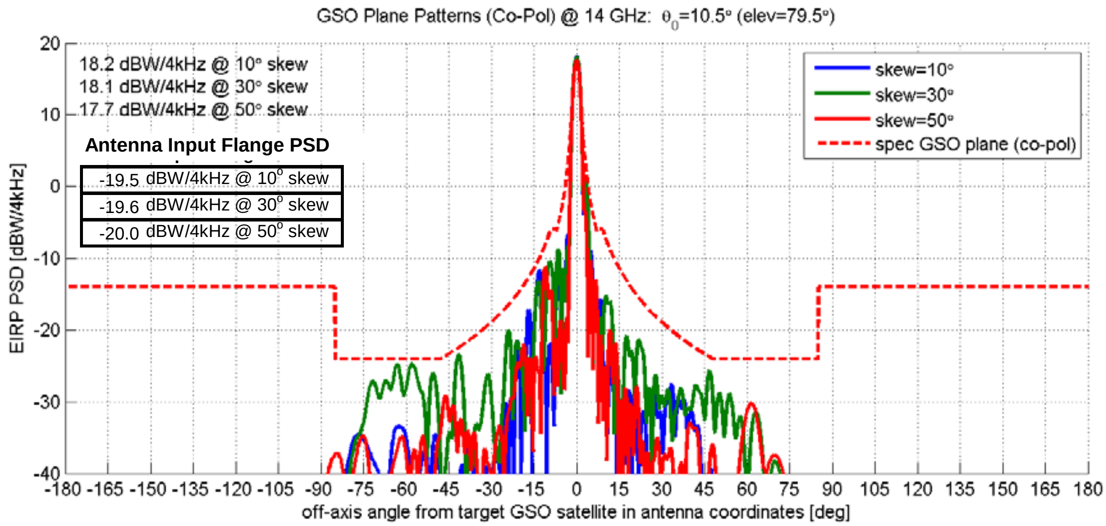
B.1.3 Antenna Patterns, Mainbeam @ Elevation=60° (Scan=30°), 14.00 GHz

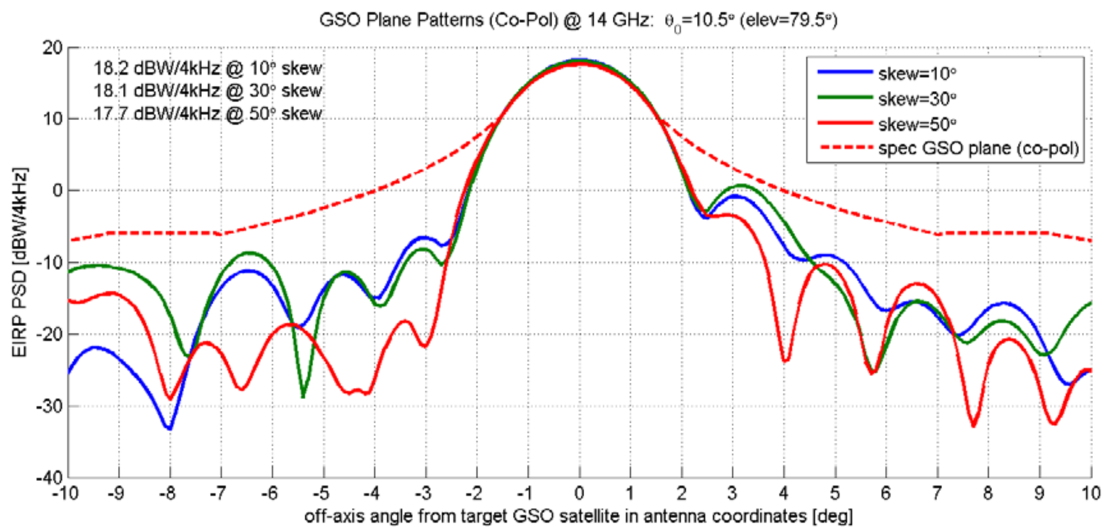


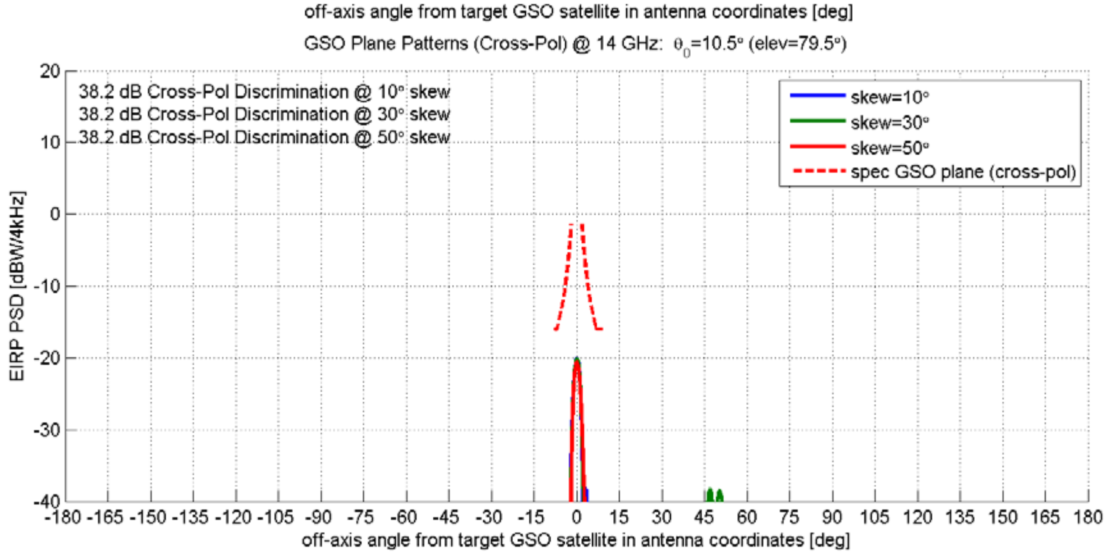



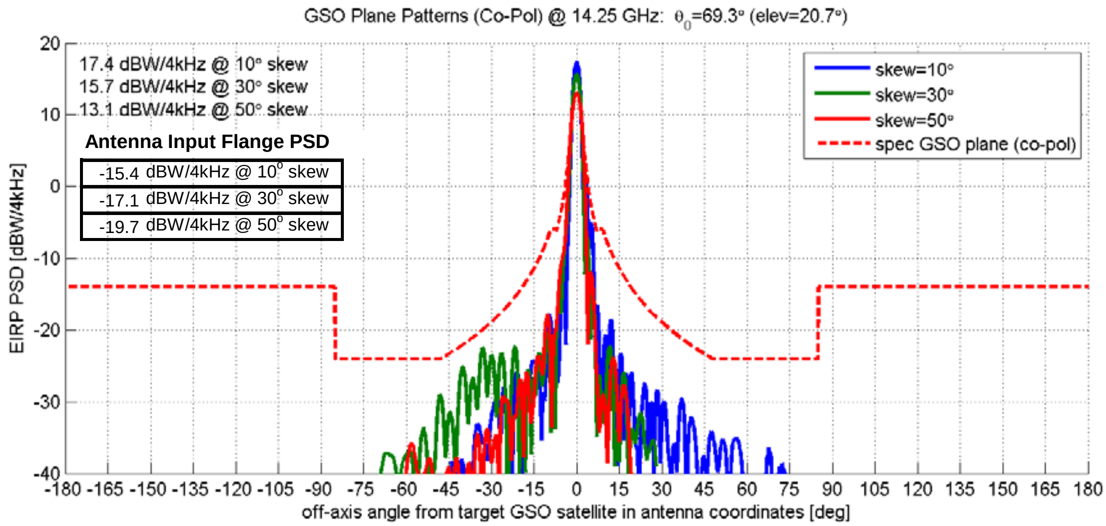
B.1.4 Antenna Patterns, Mainbeam @ Elevation=80° (Scan=10°), 14.00 GHz

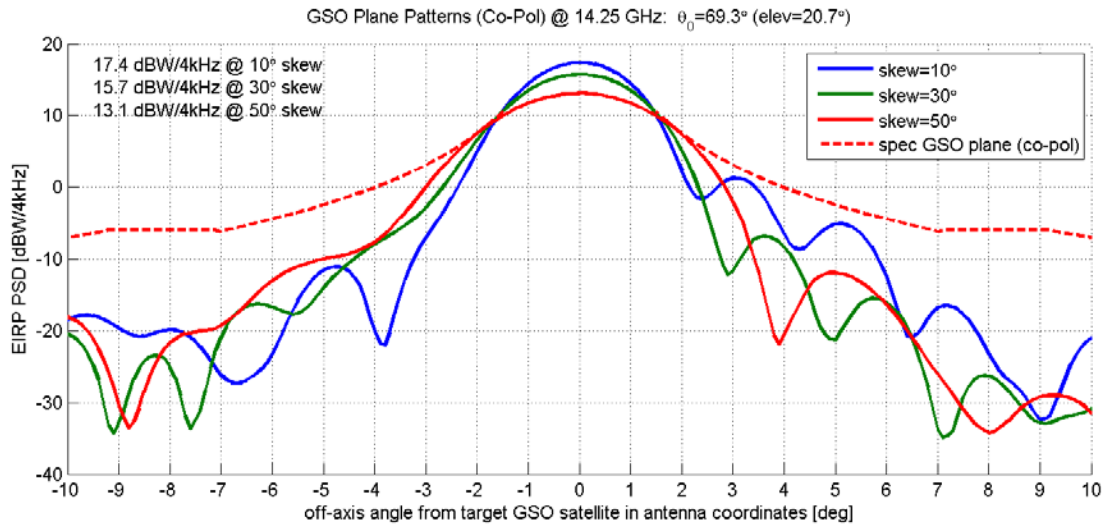


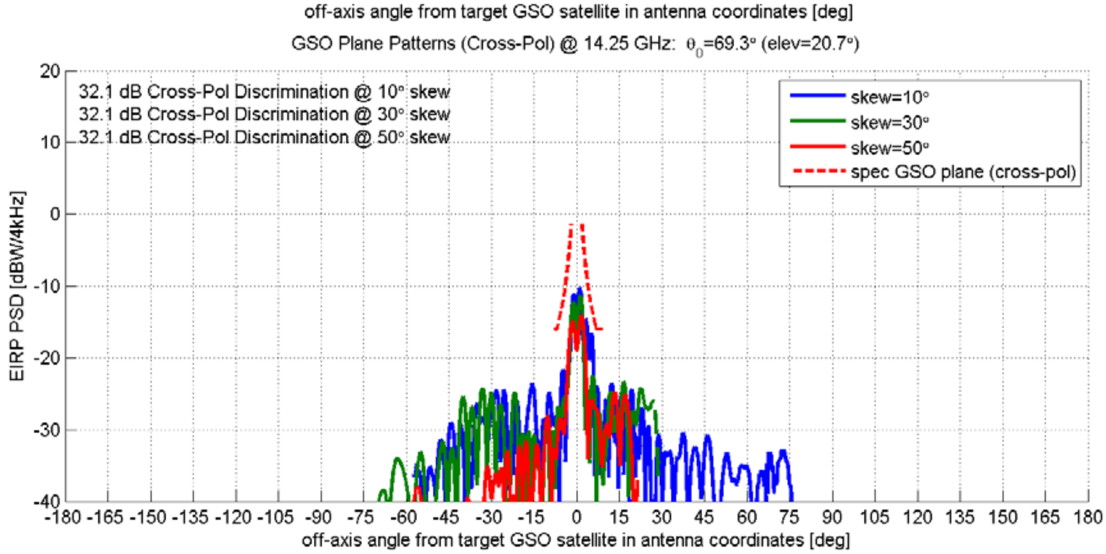



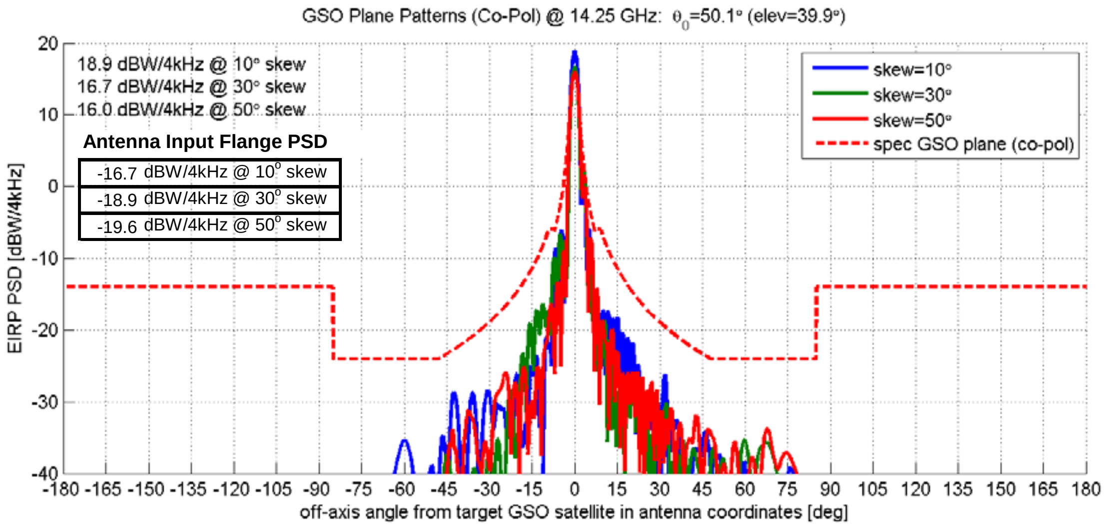
B.2.1 Antenna Patterns, Mainbeam @ Elevation=20° (Scan=70°), 14.25 GHz

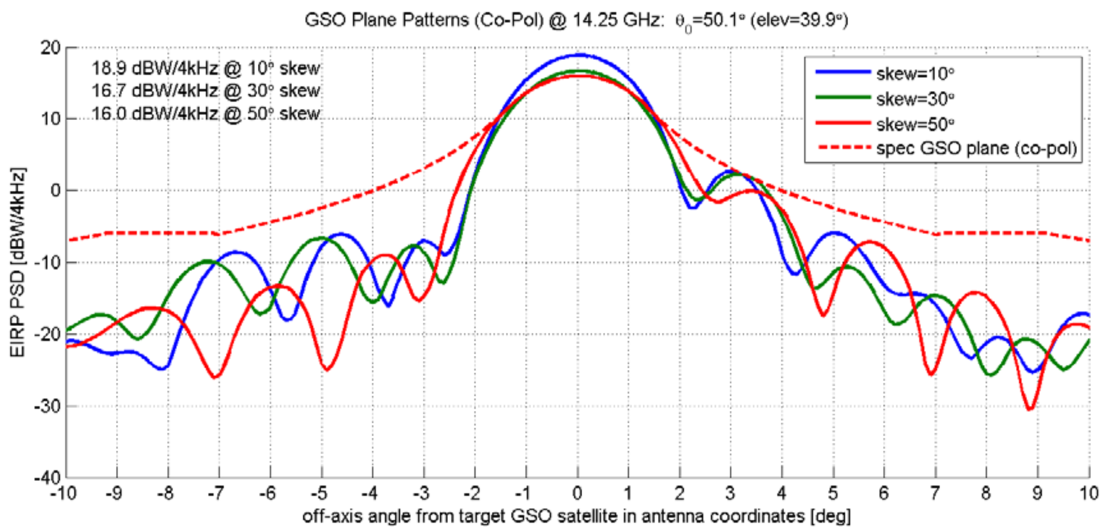


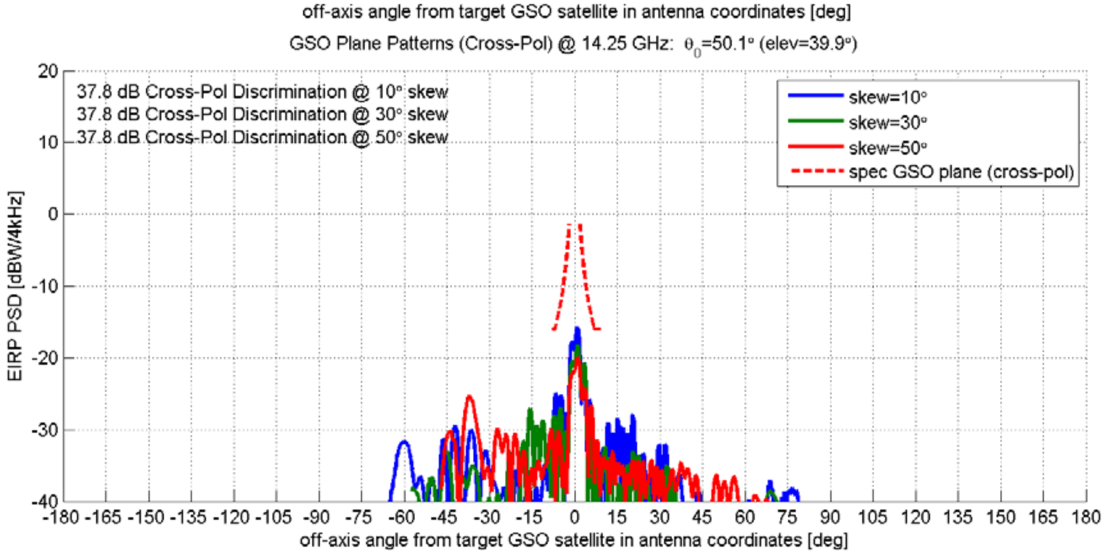



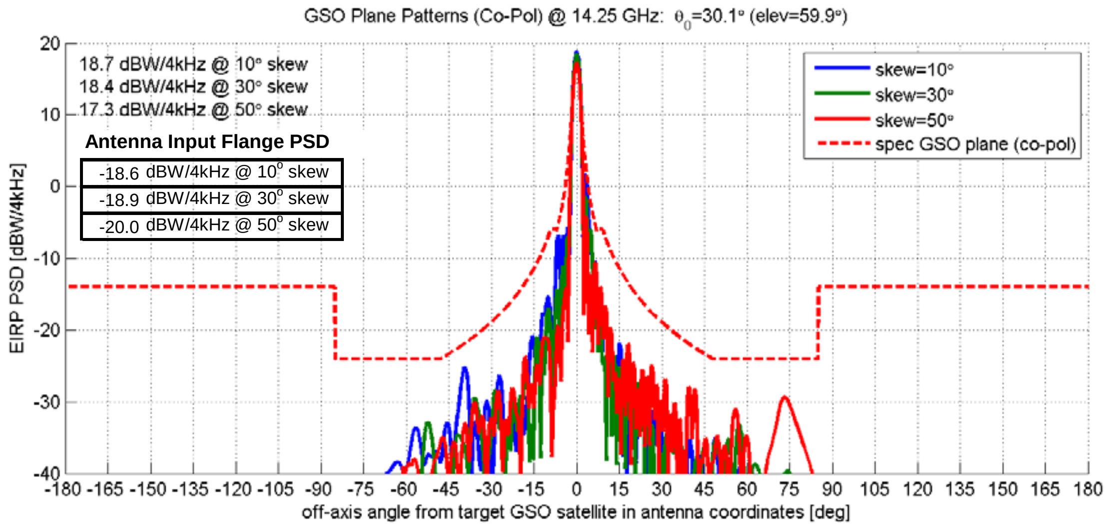
## B.2.2 Antenna Patterns, Mainbeam @ Elevation=40° (Scan=50°), 14.25 GHz

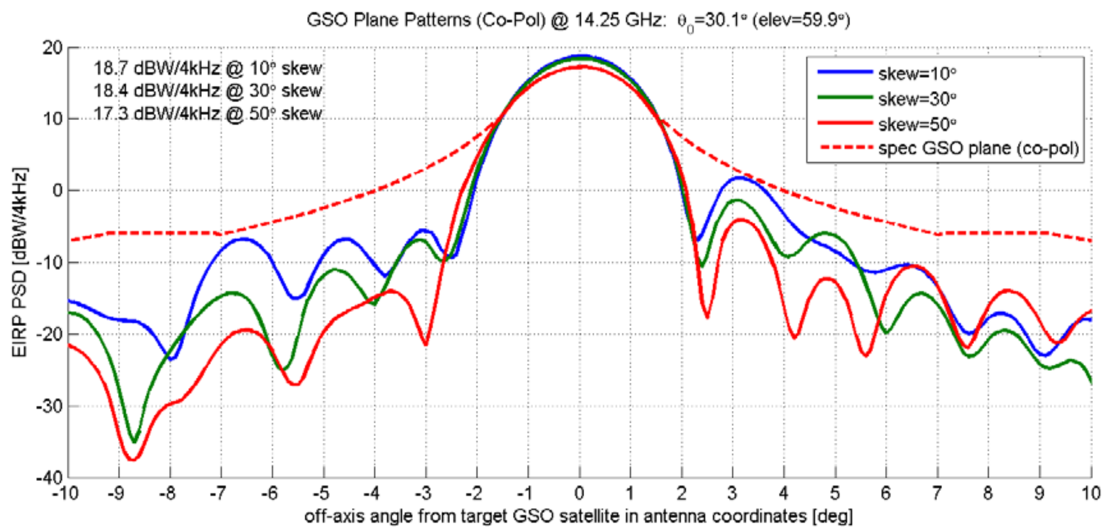


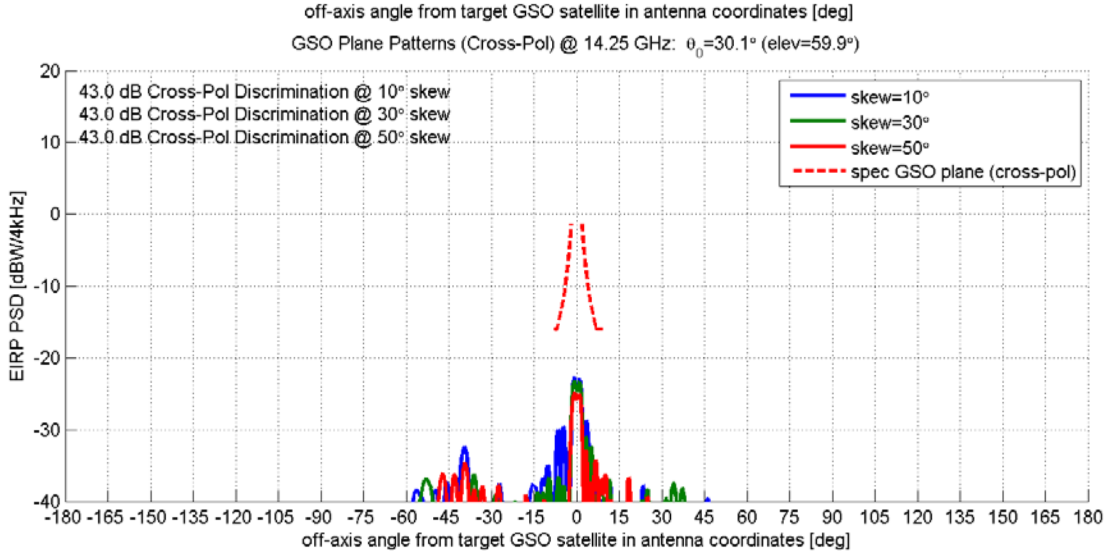



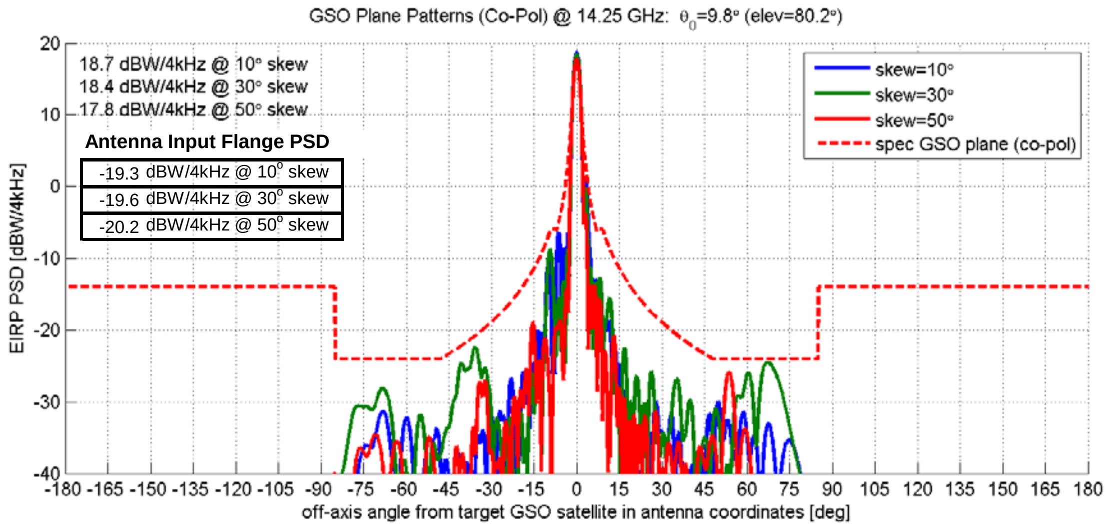
### B.2.3 Antenna Patterns, Mainbeam @ Elevation=60° (Scan=30°), 14.25 GHz

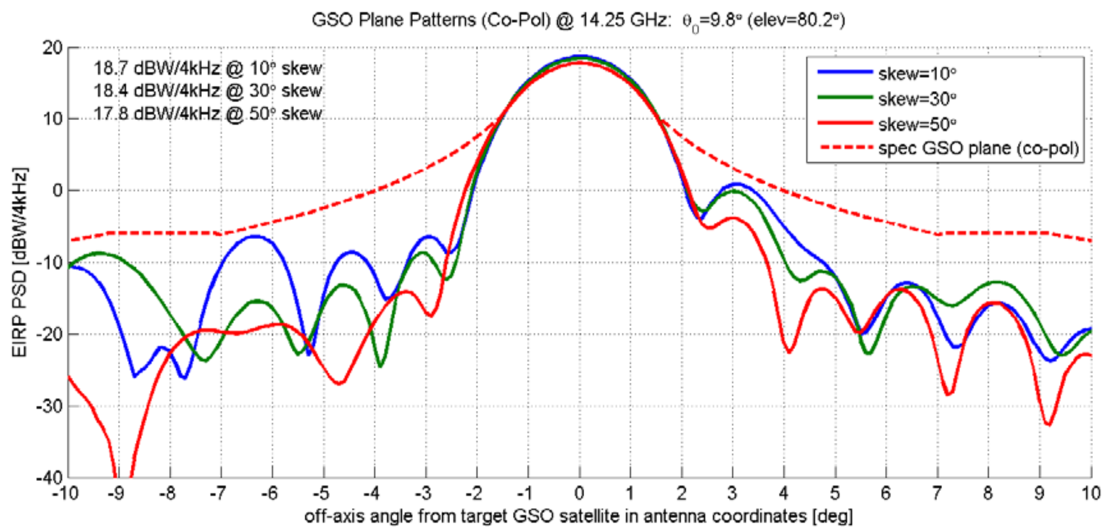


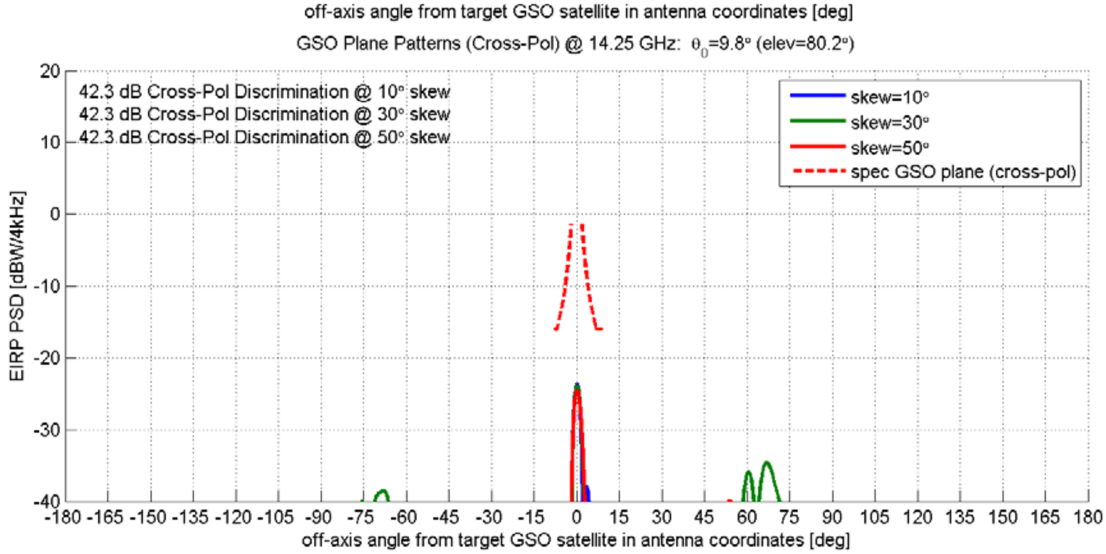



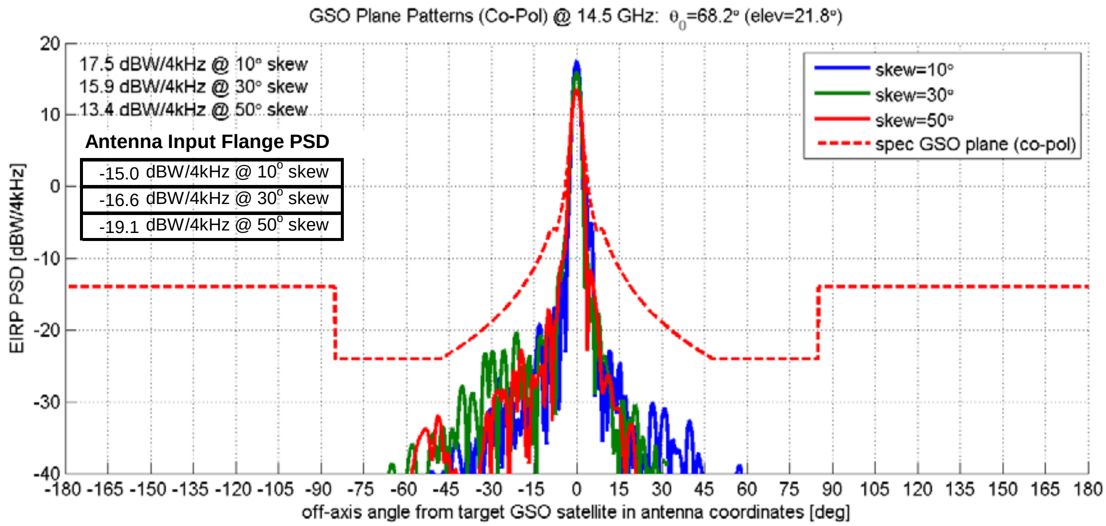
### B.2.4 Antenna Patterns, Mainbeam @ Elevation=80° (Scan=10°), 14.25 GHz

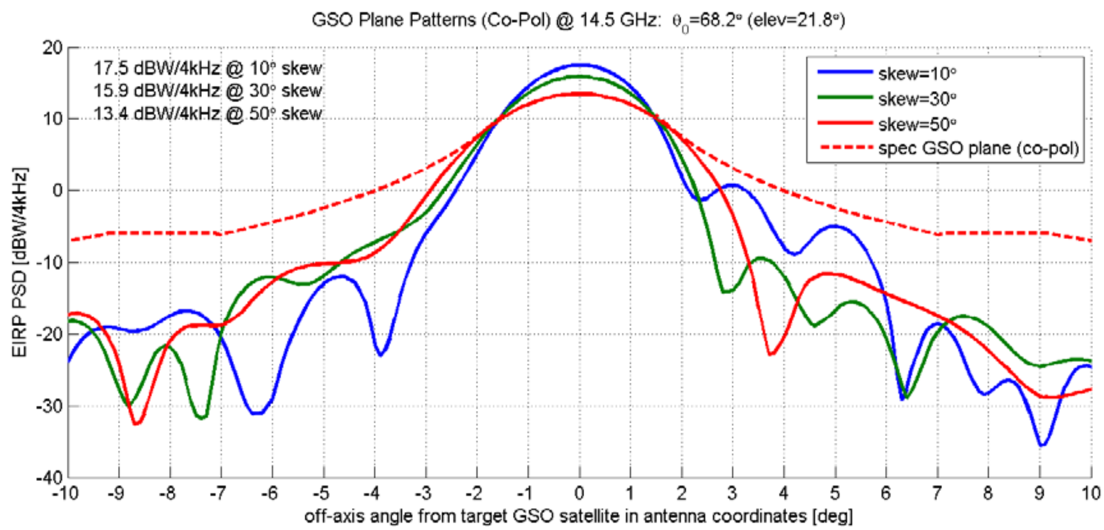


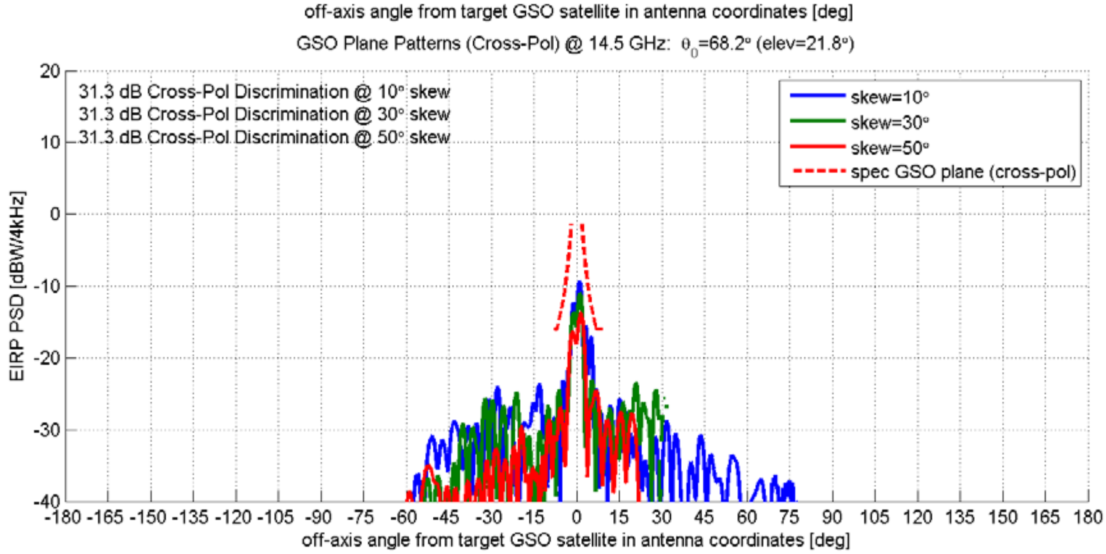



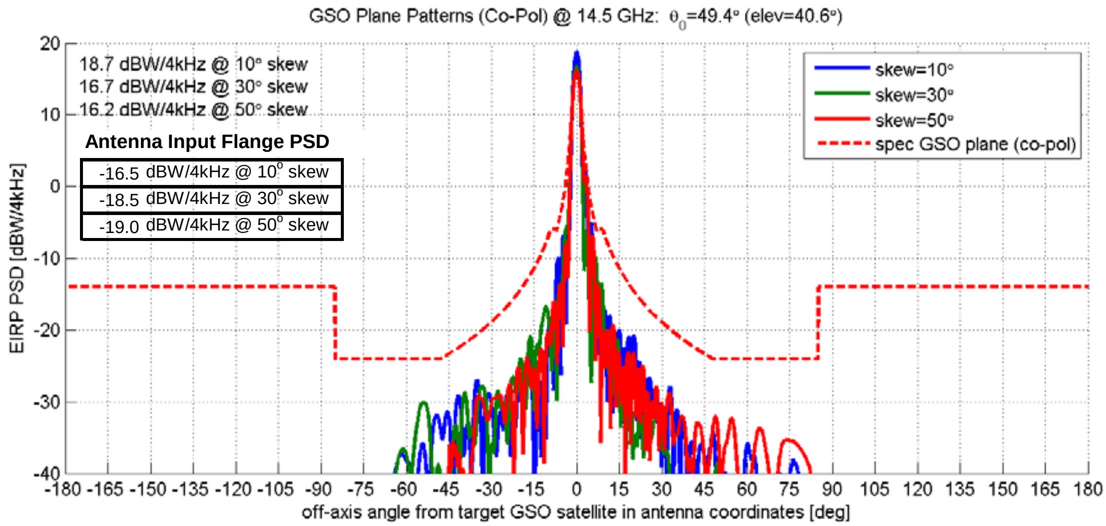
## B.3.1 Antenna Patterns, Mainbeam @ Elevation=20° (Scan=70°), 14.50 GHz

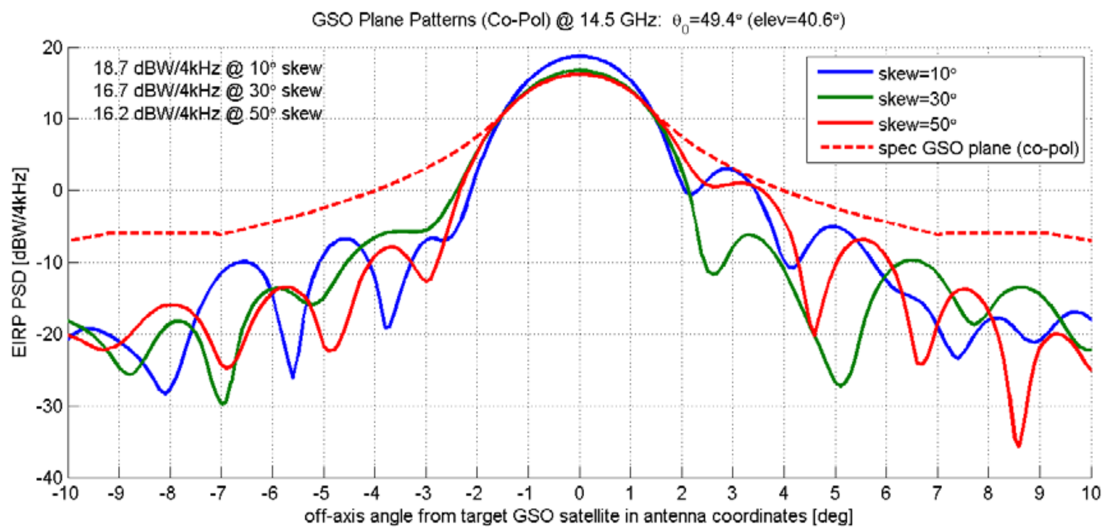


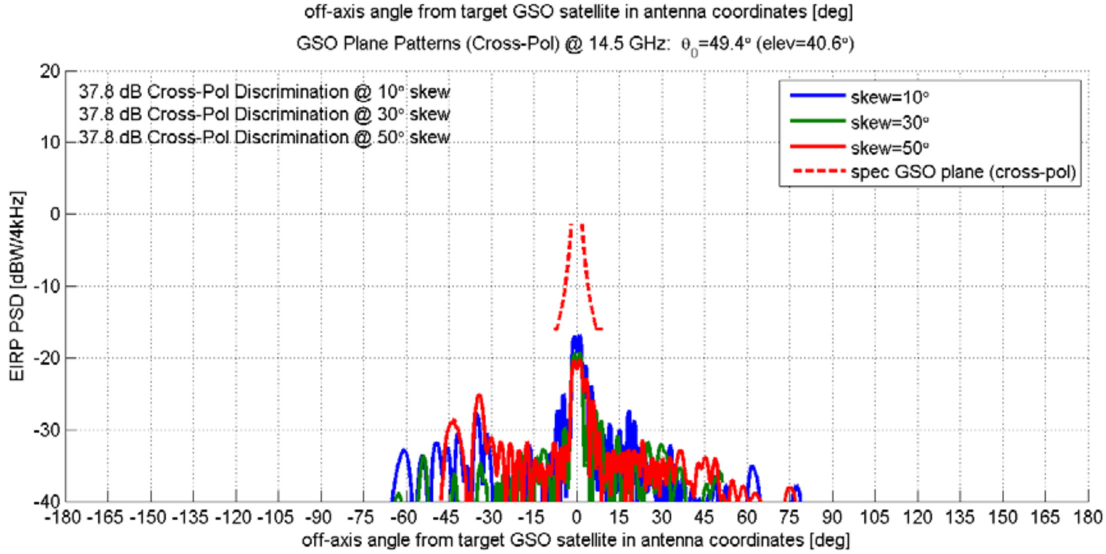



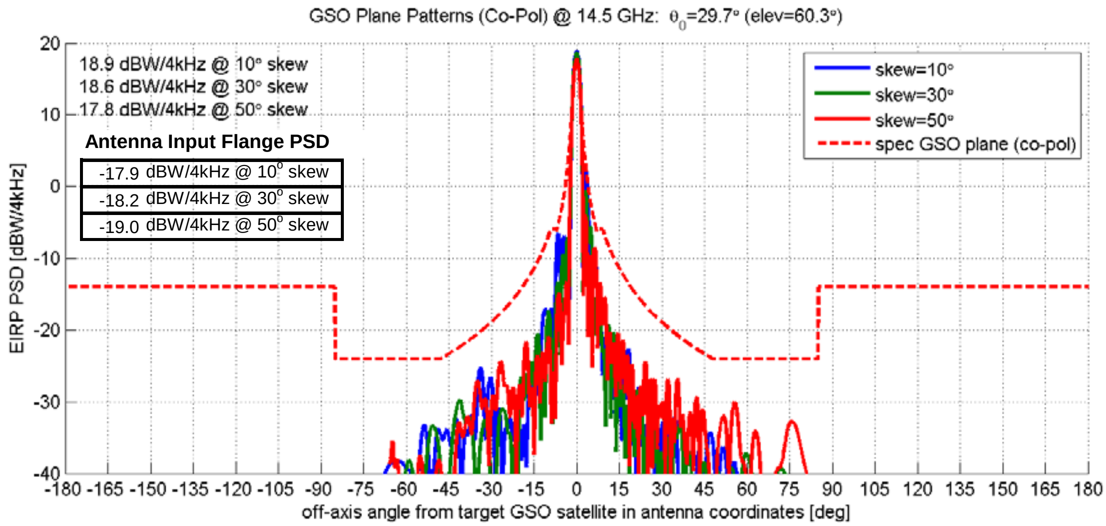
### B.3.2 Antenna Patterns, Mainbeam @ Elevation=40° (Scan=50°), 14.50 GHz

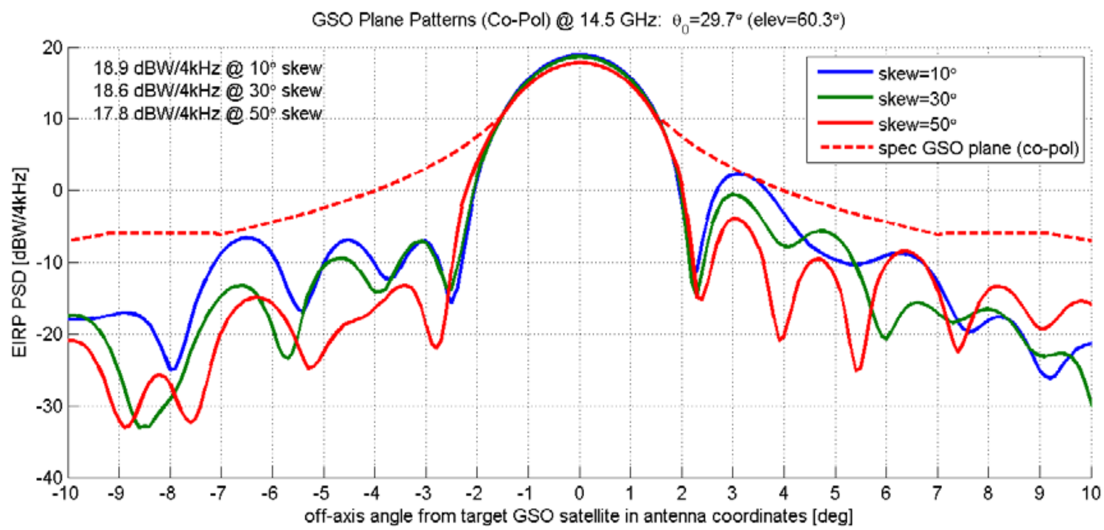


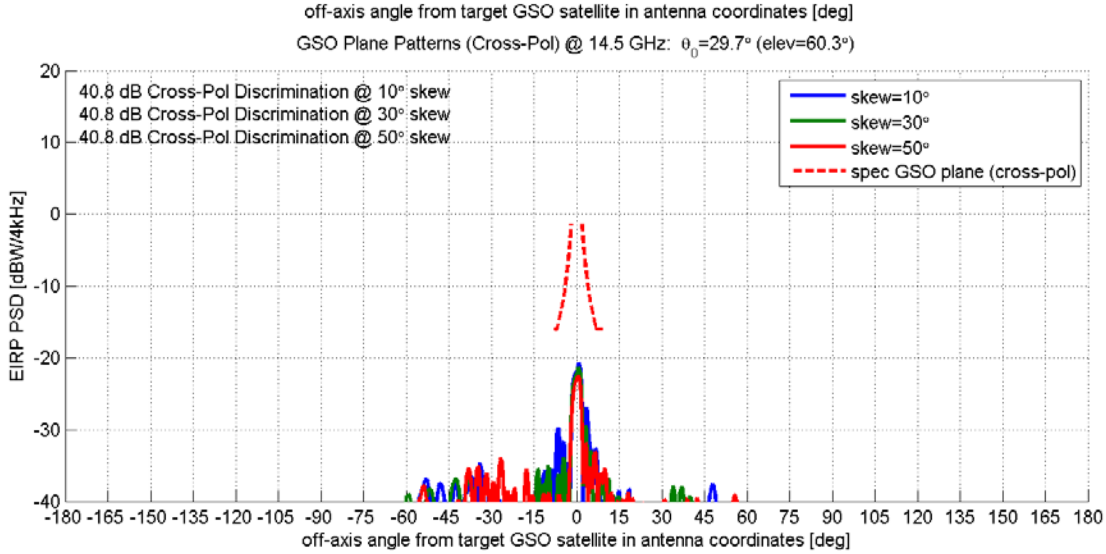



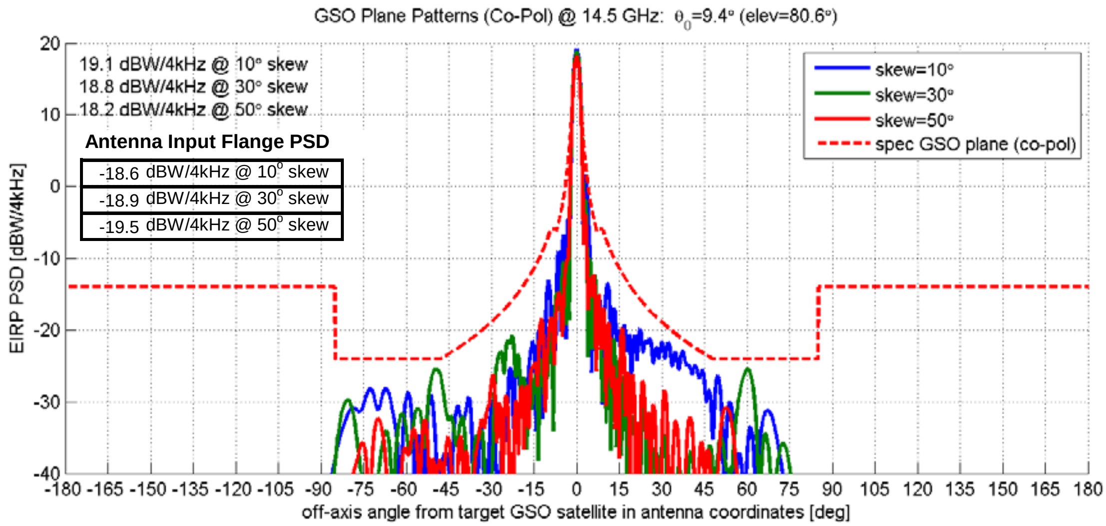
### B.3.3 Antenna Patterns, Mainbeam @ Elevation=60° (Scan=30°), 14.50 GHz

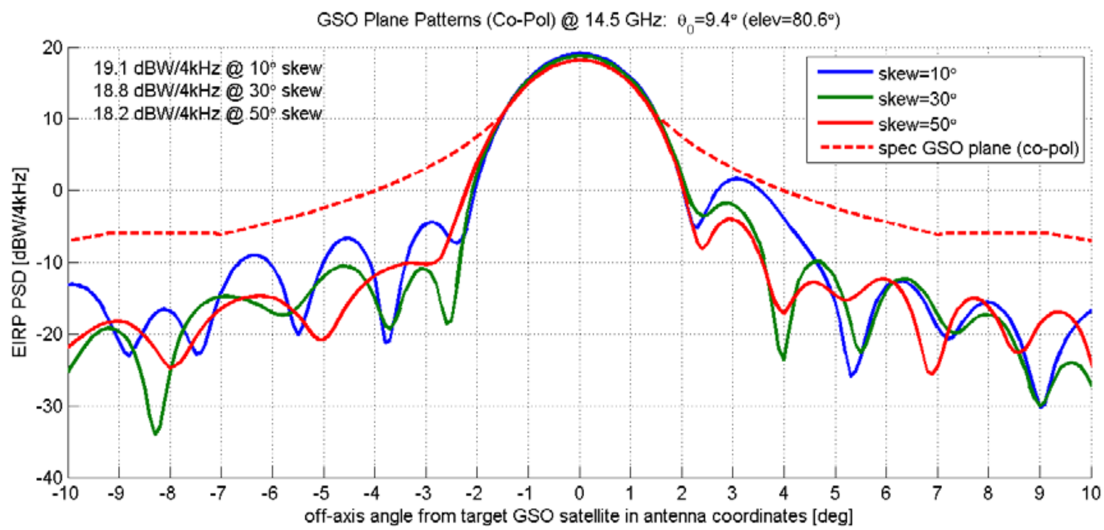


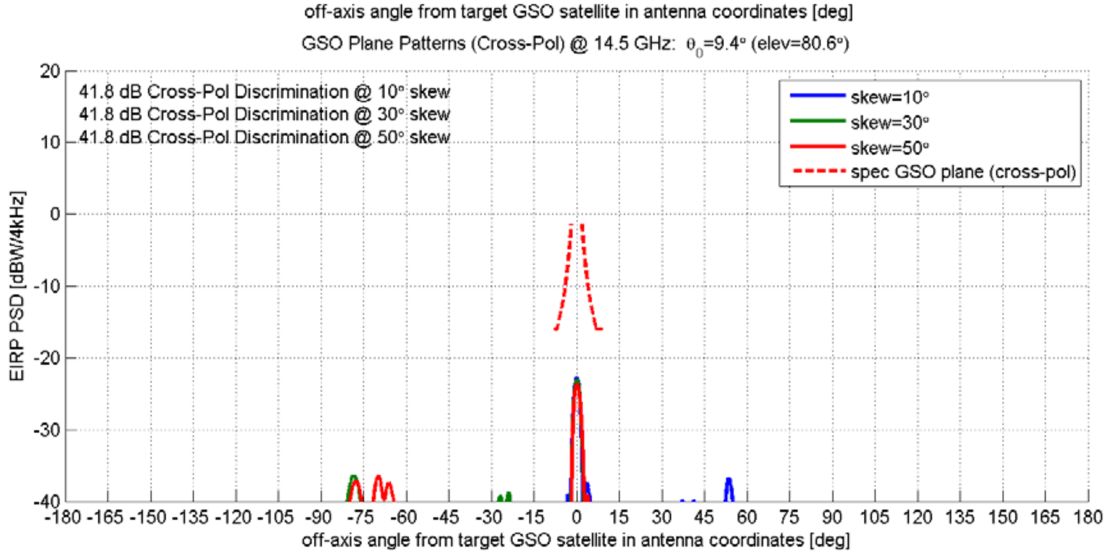



B.3.4 Antenna Patterns, Mainbeam @ Elevation=80° (Scan=10°), 14.50 GHz



**Engineering Declaration**

Declaration of Timothy Joyce

I, Timothy Joyce, hereby certify under penalty of perjury that I am the technically qualified person responsible for the technical materials contained in the foregoing letter, that I am familiar with Part 25 of the Commission's Rules (47 C.F.R. Part 25), and that I have either prepared or reviewed the technical information submitted in the letter and found it to be complete and accurate to the best of my knowledge and belief.

By: *_/s/ Timothy Joyce_*

Timothy Joyce
VP of RF Engineering
Gogo LLC

October 21, 2014