ATTACHMENT A
Technical Annex to Supplement Schedule S

A.1 SCOPE AND PURPOSE

This Attachment provides the technical characteristics of the 17/24 GHz Broadcasting-Satellite Service ("BSS") payload on the SES-3 satellite. This Canadian payload is referred to as the "Ciel-6i" satellite herein and in the associated Schedule S form. This attachment contains the information required by 47 C.F.R. §25.114 and other sections of the FCC's Part 25 rules that cannot be entered into the Schedule S submission. The information contained herein updates the information provided previously as part of the SES-3 Application filed by SES Americom, Inc. ("SES Americom").[1] Where information has changed, this is indicated in the text below.

A.2 General Description

The overall description of the SES-3 satellite (including the Ciel-6i payload) in Section 1 of the Technical Appendix to the SES-3 Application is unchanged. The Ciel-6i payload operates under the CAN-BSS19 ITU filing with a priority filing date of November 9, 2006 and was brought into use on September 24, 2012.

As previously indicated in the SES-3 Application, the Ciel-6i payload is capable of operating anywhere within the 24.75-25.25 GHz and 17.3-17.8 GHz bands, although U.S. market access is only being requested for the 24.75-25.15 GHz and 17.3-17.7 GHz bands.

The satellite uses a single wide-area beam on both the uplink and downlink. The downlink beam is capable of providing service to all of North America including Alaska and Hawaii.

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[1] *See* File Nos. SAT-RPL-20121228-00227 & SAT-AMD-20131113-00132, Technical Annex (the "SES-3 Application").

The satellite receives uplink transmissions in left-hand circular polarization ("LHCP") only and simultaneously downlinks in both left and right hand circular polarizations ("LHCP and RHCP"). Consequently, a waiver of §25.210(f) of the FCC's rules is being requested.

The payload uses a single travelling wave tube amplifier ("TWTA"). The input and output filters are both 500 MHz wide. The TWTA redundancy information for the Ciel-6i payload in Section 2.2.2 of the Technical Appendix to the SES-3 Application remains unchanged.

A.3 Services to be Provided

DISH intends to use the capacity from the Ciel-6i payload in the U.S. to support DISH's terrestrial wireless network.[2] Since this is the first generation of service, it will be demonstrated in different areas of the country to obtain appropriate information in order to expand service nationwide, then ultimately utilizing Ciel-6i's replacement payload and additional satellite capacity.

Updated representative link budgets, which include details of the 17/24 GHz BSS transmission characteristics, performance objectives and earth station characteristics that DISH intends to use, are provided in the associated Schedule S submission. The link budgets include aggregate interference effects from two adjacent satellite networks assumed to be located nominally at 99.235° W.L. and 107° W.L. Worst-case east-west station-keeping between satellites was also taken into account.

[2] The services to be provided using the Ciel-6i payload were not described as part of the SES-3 Application as FCC operating authority was not being sought for that payload at that time.

A.4 TT&C CHARACTERISTICS

There is no change to the TT&C characteristics described in Section 2.5 of the Technical Appendix to the SES-3 Application. The Commission has authorized SES Americom to provide TT&C operations for the SES-3 satellite at 103° W.L.[3]

A.5 SATELITE TRANSPONDER FREQUENCY RESPONSE

There is no change to the frequency response information provided for the Ciel-6i payload in Section 2.4 of the Technical Appendix to the SES-3 Application. The frequency tolerances of § 25.202(e) and the out-of-band emission limits of § 25.202(f) (1)-(3) will be met.

A.6 CESSATION OF EMISSIONS

There is no change to Section 6 of the Technical Appendix to the SES-3 Application. The Ciel-6i payload can be turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required.

A.7 OFF-AXIS EIRP DENSITY LEVELS

There is no change to the earth station off-axis density information provided in Annex 2 Section 2.1 of the Technical Appendix to the SES-3 Application, with one qualification. The off-axis EIRP spectral density levels of the earth station antennas transmitting to the Ciel-6i satellite will not exceed the limits of § 25.223 (*i.e.*, an uplink input power density of -56.5 dBW/Hz). In order to comply with § 25.262(d)(1), uplink transmissions will be limited to an uplink input power density of -57.2 dBW/Hz, unless the slightly higher level allowed by § 25.223 can be coordinated with the existing operator at 99.235° W.L.

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[3] *See SES Americom, Inc.*, Order, 29 FCC Rcd 3678 (IB 2014).

A.8 PFD ANALYSIS

The satellite's maximum downlink EIRP is 33.6 dBW. The downlink beam's peak occurs at a distance of 37,247 km from the spacecraft, corresponding to a spreading loss of 162.4 dB. Using a worst-case assumption that all of the satellite's EIRP is transmitted in a bandwidth of 1 MHz, the maximum possible PFD at the Earth's surface would therefore be: 33.6 - 162.4 = -128.8 dBW/m^2/MHz.[4] This value is lower than all of the PFD levels of § 25.208(w) and therefore demonstrates that the satellite's downlink transmissions comply with § 25.208(w).

A.9 FOUR-DEGREE COMPATIBILITY

This section replaces the four-degree interference analysis in Annex 2 Section 2.1 of the Technical Appendix to the SES-3 Application to take into account new carrier types that are more representative of the ones DISH would operate on the Ciel-6i payload and higher expected PFD levels from adjacent satellites. This section demonstrates that the proposed operations of the Ciel-6i satellite will continue to be compatible with adjacent 17/24 GHz BSS satellites, both operational and hypothetical.

To the east of 103° W.L., DIRECTV Enterprises, LLC ("DIRECTV") has Commission authorization to operate the DIRECTV RB-1 satellite at 99.235° W.L. As stated in DIRECTV's modification application for the DIRECTV RB-1 satellite, the satellite transmits with a maximum PFD level of -120 dBW/m^2/MHz.[5]

To the west of 103° W.L., there is no 17/24 GHz BSS satellite authorized to operate at 107° W.L., and no pending application before the Commission for authorization to use the 107° W.L. orbital slot.

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[4] The PFD analysis here differs slightly from the PFD analysis in the SES-3 Application as it is based on a different carrier bandwidth.

[5] *See* SAT-MOD-20110727-00135, Application for Minor Modification at 5 (filed Jul. 27, 2011).

A.9.1 Interference from the DIRECTV RB-1 Satellite Network

Table A.9-1 shows the representative link budgets for Ciel-6i assuming the adjacent DIRECTV RB-1 satellite network transmits with an uplink input power density of -56.5 dBW/Hz, the maximum allowed by §25.223, and with a PFD of -120 dBW/m^2/MHz towards the Ciel-6i earth station. Worst-case east-west station-keeping was taken into account. The link budgets demonstrate that the proposed services can successfully operate given the assumed interference environment.

Table A.9-1. Single-entry interference from the DIRECTV RB-1 satellite network.

Link Parameters	**3M75G7W**	**36M0G7W**	**390MG7W**
Uplink frequency	25.00	25.0	25.0
Downlink frequency	17.50	17.5	17.5
User data rate	1544	14820.0	160500.0
Modulation	QPSK	QPSK	QPSK
Total coding rate	0.247	0.247	0.247
Number of carriers per TXP	30	6	1
Carrier bandwidth	3751	36000	389879
Uplink:			
Nominal E/S e.i.r.p. per carrier	62.8	70.9	84.7
Earth station diameter	4.5	3.5	3.5
Earth station gain	59.6	57.4	57.4
Uplink input power per carrier	3.2	13.5	27.3
Uplink input power density	-62.0	-61.5	-58.0
Atmospheric loss	0.4	0.4	0.4
Free space path loss	211.9	211.9	211.9
G/T satellite	-8.0	-8.0	-8.0
C/N thermal uplink	6.1	4.4	7.9
C/I ASI	40.7	39.0	42.4
C/(N+I) uplink	6.1	4.4	7.9
Downlink:			
Satellite e.i.r.p. per carrier	16.0	23.1	33.3
Atmospheric loss	0.2	0.2	0.2
Free space path loss	208.7	208.7	208.7
Earth station mis-pointing loss	0.3	0.3	0.3
Earth station diameter	4.5	6.3	6.3
Earth station gain	56.5	59.4	59.4
Noise temperature	150.0	150.0	150.0
Earth station G/T	34.7	37.6	37.6
C/N thermal downlink	5.1	5.3	5.2
C/I XPOL, IM, ASI	10.5	10.6	10.9
C/(N+I) downlink	3.2	4.2	3.3
Overall:			
C/(N+I) overall	1.4	1.3	2.0
C/(N+I) required	-2.0	-2.0	-2.0
Margin	3.4	3.3	4.0

A.9.2 Interference from a Hypothetical Satellite Network at 107° W.L.

Table A.9-2 shows the representative link budgets for Ciel-6i assuming a hypothetical adjacent satellite network at 107° W.L. transmits with an uplink input power density of -56.5 dBW/Hz, the maximum allowed by §25.223, and with a PFD of -115 dBW/m^2/MHz towards the Ciel-6i ground station; the maximum PFD allowed by §25.208(w). Worst-case east-west station-keeping was taken into account. The link budgets demonstrate that the proposed services can successfully operate given the assumed interference environment.

Table A.9-2. Single-entry interference from a hypothetical satellite network at 107° W.L.

Link Parameters	**3M75G7W**	**36M0G7W**	**390MG7W**
Uplink frequency	25.00	25.0	25.0
Downlink frequency	17.50	17.5	17.5
User data rate	1544	14820.0	160500.0
Modulation	QPSK	QPSK	QPSK
Total coding rate	0.247	0.247	0.247
Number of carriers per TXP	30	6	1
Carrier bandwidth	3751	36000	389879
Uplink:			
Nominal E/S e.i.r.p. per carrier	62.8	70.9	84.7
Earth station diameter	4.5	3.5	3.5
Earth station gain	59.6	57.4	57.4
Uplink input power per carrier	3.2	13.5	27.3
Uplink input power density	-62.0	-61.5	-58.0
Atmospheric loss	0.4	0.4	0.4
Free space path loss	211.9	211.9	211.9
G/T satellite	-8.0	-8.0	-8.0
C/N thermal uplink	6.1	4.4	7.9
C/I ASI	41.4	39.6	43.1
C/(N+I) uplink	6.1	4.4	7.9
Downlink:			
Satellite e.i.r.p. per carrier	16.0	23.1	33.3
Atmospheric loss	0.2	0.2	0.2
Free space path loss	208.7	208.7	208.7
Earth station mis-pointing loss	0.3	0.3	0.3
Earth station diameter	4.5	6.3	6.3
Earth station gain	56.5	59.4	59.4
Noise temperature	150.0	150.0	150.0
Earth station G/T	34.7	37.6	37.6
C/N thermal downlink	5.1	5.3	5.2
C/I XPOL, IM, ASI	6.5	6.6	6.7
C/(N+I) downlink	1.3	2.9	1.3
Overall:			
C/(N+I) overall	0.0	0.6	0.5
C/(N+I) required	-2.0	-2.0	-2.0
Margin	2.0	2.6	2.5

A.9.3 Interference from the Ciel-6i Satellite Network into Adjacent Networks

The Commission's rules contained in §25.223 (uplink transmission levels) and §25.208(w) (downlink transmission levels) establish the "standard" interference environment for 17/24 GHz BSS satellite networks that are separated by a nominal four degrees. The DIRECTV RB-1 satellite is authorized to operate slightly "off-grid" from the 99.0° W.L. grid location specified in Appendix F of the Report and Order adopted May 2, 2007, IB Docket No. 06-123, FCC 07-76.

Section 25.140(b)(5) addresses the situation applicable to an applicant that seeks authorization to operate a 17/24 GHz BSS satellite that is "on-grid" but is less than four degrees away from a previously authorized 17/24 GHz BSS satellite that is off-grid. The rule requires the applicant to demonstrate that its proposed operations will not cause more interference to the off-grid satellite than if the two networks were separated by exactly four degrees.

The DIRECTV RB-1 satellite is slightly offset from a grid location by 0.235 degrees. Therefore, the corresponding reductions in both uplink and downlink power levels, relative to the allowable power levels of §25.223 and §25.208(w), and reductions that fully protect the DIRECTV RB-1 satellite network can be calculated as: 25*log(4/(4-0.235)) = 0.7 dB ("reduction factor").

As stated in section A.7 above, DISH will not transmit with an uplink input power density of greater than -57.2 dBW/Hz (*i.e.*, 0.7 dB lower than the maximum allowed by §25.223), unless the slightly higher level allowed by §25.223 can be coordinated with the existing operator at 99.235° W.L.

As demonstrated in section A.8 above, the maximum PFD on the Earth's surface in a 1 MHz bandwidth is -128.8 dBW/m^2/MHz. This level is 7.8 dB below the lowest level of §25.208(w), a difference that is much greater than the required 0.7 dB reduction factor calculated above.

The preceding demonstrates that Ciel-6i will not cause more interference to the off-grid DIRECTV RB-1 satellite network than if the two networks were separated by exactly four degrees. By extension, and due to the slightly larger orbital separation, it also demonstrates that

the Ciel-6i satellite network is compatible with any future 17/24 GHz BSS satellite authorized at the on-grid location of 107° W.L.

A.10 INTERFERENCE ANALYSIS WITH DIRECTV RB-2 AT 102.75° W.L.

The DIRECTV RB-2 satellite is planned to be operated at the 102.75° W.L. orbital location under a U.S. ITU satellite network filing that is lower in ITU date priority than the Canadian CAN-BSS19 filing under which the Ciel-6i payload will operate. Coordination of the RB-2 satellite with Ciel-6i is not complete. Accordingly, the RB-2 satellite is not entitled to protection from interference from the Ciel-6i satellite, nor can it cause harmful interference to Ciel-6i, until coordination is complete.

As DISH has previously demonstrated, the operation of the RB-2 satellite will cause harmful interference into DISH's proposed operations with Ciel-6i.[6] This is amply demonstrated in Table A.10.1 below for a representative 36 MHz carrier. The table demonstrates that the link's required C/(N+I) level is not met, and by a substantial deficit of 17.6 dB, when accounting for the additional interference that would be caused by the operations of the RB-2 satellite.

[6] See DISH Operating L.L.C. Petition to Condition at 6, 9, File Nos. SAT-MOD-20140612-00066 & SAT-MOD-20140624-00075 (Sept. 2, 2014).

Table A.10-1. Interference from RB-2 into Ciel-6i

Ciel-6i with interference from +/-4 deg neighbors		
Ciel-6i orbital location	°E	-103.0
Ciel-6i uplink frequency	GHz	25000
Ciel-6i user data rate	kbps	14820
Ciel-6i modulation		QPSK
Ciel-6i total coding rate		0.247
Ciel-6i number of carriers per txp		6
Ciel-6i carrier bandwidth	MHz	36
Ciel-6i uplink EIRP	dBW	70.9
Ciel-6i TX earth station gain	dBi	57.4
Ciel-6i uplink input power / carrier	dBW	13.5
Ciel-6i uplink input power density	dBW/Hz	-61.3
Ciel-6i RX G/T satellite	dB/K	-8
Ciel-6i uplink carrier thermal C/N	dB	4.4
Ciel-6i uplink ASI from +/-4 neighbors	dB	38.7
Ciel-6i C/(N+I) uplink	dB	4.4
Ciel-6i downlink frequency	MHz	17500
Ciel-6i downlink in EIRP / 36 MHz	dBW	23.1
Ciel-6i RX earth station location		Vancouver
Ciel-6i RX earth station on-axis gain	dBi	59.4
Ciel-6i RX earth station antenna pointing error	dB	0.3
Ciel-6i RX earth station noise temperature	K	150
Ciel-6i downlink carrier thermal C/N	dB	5.4
Ciel-6i downlink ASI from +/-4 degree neighbors	dB	7.0
Ciel-6i C/(N+I) downlink	dB	3.1
Ciel-6i C/(N+I) overall		0.7
Ciel-6i C/(N+I) required	dB	-2.0
Ciel-6i margin	dB	2.7

RB-2 impact into Ciel-6i		
RB-2 orbital location	°E	-102.75
Ciel-6i orbital location	°E	-103.0
RB-2 uplink EIRP / 36 MHz towards Ciel-6i	dBW	42.8
RB-2 peak downlink EIRP / 36 MHz	dBW	58.9
RB-2 downlink EIRP towards Ciel-6i earth station	dBW	52.90
Ciel-6i RX earth station antenna gain towards RB-2	dBi	47.2

Aggregate downlink interference into Ciel-6i with RB-2	dB	-17.6
Aggregate uplink interference into Ciel-6i with RB-2	dB	27.7
Aggregate Inteference into Ciel-6i with RB-2 included	**dB**	**-17.6**

A.11 ORBITAL DEBRIS MITIGATION PLAN

A complete orbital debris mitigation plan was submitted with the SES-3 Application and is incorporated by reference herein without change.[7]

A.12 SATELLITE TRANSMIT OFF-AXIS GAIN AND PFD ANALYSIS

This section replaces Annex 2 Section 2.2 of the Technical Appendix to the SES-3 Application. The predicted gain data shown below differs from the SES-3 application. The predicted gain used in the SES-3 Application used an incorrect phi value, while this data uses the correct phi value which aligns with the equatorial (X-Z) plane.

Section 25.264 of the Commission's rules was adopted to mitigate potential space-path interference between 17/24 GHz BSS satellites and 12/17 GHz BSS satellites. That is, there is a potential for space path (*i.e.*, satellite-to-satellite) interference between a 17/24 GHz BSS satellite transmitting in the 17 GHz band and a nearby 12/17 GHz BSS satellite receiving in the 17 GHz band.

Tables A.12-1 through A.12-4 provide the predicted transmit off-axis gain of the 17 GHz antenna as required by § 25.264(a). In partial response to the requirements of § 25.264(c), Tables A.12-5 and A.12-6 provide the measured transmit off-axis gain of the 17 GHz antenna, but only over a limited range of angles, in the non-rotated X-Z plane, and in one polarization (RHCP). Accordingly, DISH seeks a waiver of § 25.264(c) and, to the extent required, § 25.264(d).

Because the FCC had not yet released the space path interference rules when the Ciel-6i payload was being constructed, only partial measurements were made on the 17 GHz antenna. The only available measurements are provided in Tables A.12-5 and A.12-6. In further support of the waiver request, DISH notes that the nearest Commission-licensed 12/17 GHz BSS satellite is located at 101.2° W.L., or nominally 1.8 degrees away from the 103° W.L. location.

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[7] *See* SES-3 Application, Technical Appendix, Section 9 at 17-19.

Section 25.264 was developed for situations where a 17/24 GHz BSS satellite would be in close proximity (*e.g.*, less than 0.5 degrees) from a 12/17 GHz BSS satellite, which is not the case for Ciel-6i. Worst-case PFD calculations demonstrate this point.

The highest off-axis gain level between both the predicted and measured levels is -22.5 dBi. The nearest 12/17 GHz BSS satellite is nominally located 1.8 degrees away. Accounting for worst-case east-west station-keeping, the spreading loss between the two satellite locations can be calculated to be 132.94 dB. Assuming all of the 12/17 GHz BSS satellite's power were to be put into a 100 kHz bandwidth, which will not be the case, the resulting PFD at the nominal 101.2° W.L. location can be calculated to be -145.1 dBW/m^2/100 kHz; a level far lower than the -117 dBW/m^2/100 kHz PFD coordination threshold level. Using the worst-case assumption that all the power will be in the 100 kHz reference bandwidth, one can show that the PFD threshold level would not be exceeded even for a much smaller orbital separation of 0.1 degree. The preceding demonstrates that there is no potential interference issue with respect to any U.S.-licensed 12/17 GHz BSS satellite from the Ciel-6i satellite.

In addition, Ciel-6i is operated at 103° W.L. with a maximum orbital eccentricity of less than 4.7 $\times 10^{-4}$.

Table A.12-1. Predicted off-axis gain (dBi). ±30 degrees about the –X axis in the X-Z plane.

Off-Axis Angle (°)	17.305 GHz LHCP	17.305 GHz RHCP	17.550 GHz LHCP	17.550 GHz RHCP	17.795 GHz LHCP	17.795 GHz RHCP
30	-24.8	-28.0	-24.6	-40.8	-32.5	-25.7
25	-40.8	-28.8	-29.6	-35.8	-29.1	-37.8
20	-26.6	-32.1	-33.8	-27.6	-25.2	-40.7
15	-34.4	-25.5	-29.5	-29.0	-26.6	-32.2
10	-30.5	-44.4	-34.5	-41.7	-31.6	-32.4
5	-35.3	-41.4	-31.2	-45.2	-40.1	-40.8
0	-35.4	-42.0	-32.8	-39.9	-41.4	-34.7
-5	-40.8	-39.4	-35.9	-41.9	-36.5	-49.9
-10	-45.8	-36.3	-39.2	-38.6	-46.6	-37.4
-15	-41.6	-51.0	-41.9	-42.7	-45.3	-44.7
-20	-41.4	-55.6	-38.5	-47.5	-50.0	-41.9
-25	-42.7	-51.1	-48.8	-42.4	-42.6	-46.3
-30	-41.7	-47.4	-41.6	-60.8	-41.5	-44.0

Table A.12-2. Predicted off-axis gain (dBi). ±30 degrees about the +X axis in the X-Z plane.

Off-Axis Angle (°)	17.305 GHz LHCP	17.305 GHz RHCP	17.550 GHz LHCP	17.550 GHz RHCP	17.795 GHz LHCP	17.795 GHz RHCP
30	-31.1	-27.3	-32.6	-29.1	-39.4	-32.2
25	-37.4	-33.1	-35.8	-36.5	-32.0	-33.8
20	-34.2	-34.3	-35.8	-33.8	-32.9	-29.9
15	-32.1	-33.9	-31.5	-34.0	-32.4	-34.3
10	-34.4	-37.2	-31.8	-40.1	-39.9	-36.1
5	-36.0	-37.7	-33.3	-40.0	-41.4	-42.1
0	-39.8	-39.9	-43.9	-43.6	-41.7	-49.9
-5	-39.1	-48.5	-40.7	-47.1	-41.1	-46.2
-10	-43.9	-41.9	-42.5	-43.3	-50.4	-43.7
-15	-38.1	-44.9	-38.9	-49.6	-41.1	-39.2
-20	-49.7	-39.8	-54.8	-42.4	-48.7	-41.0
-25	-54.1	-51.5	-43.3	-57.8	-46.9	-55.3
-30	-42.0	-55.3	-42.7	-42.9	-48.3	-52.0

Table A.12-3. Predicted off-axis gain (dBi). –X Axis. X-Z plane rotated ±60 degrees about the Z axis.

Off-Axis Angle (°)	17.305 GHz LHCP	17.305 GHz RHCP	17.550 GHz LHCP	17.550 GHz RHCP	17.795 GHz LHCP	17.795 GHz RHCP
60	-32.4	-29.5	-26.5	-26.8	-23.3	-23.0
55	-34.7	-31.3	-28.5	-28.5	-24.1	-24.0
50	-34.9	-31.9	-29.2	-28.6	-24.3	-24.4
45	-33.9	-32.5	-29.4	-30.7	-24.7	-25.9
40	-40.2	-34.0	-29.9	-31.4	-25.6	-26.1
35	-44.7	-37.4	-30.4	-30.5	-25.6	-25.8
30	-39.3	-35.7	-30.3	-33.8	-28.3	-27.2
25	-37.5	-35.2	-33.0	-35.0	-29.2	-29.3
20	-40.0	-35.4	-30.1	-31.7	-32.1	-31.3
15	-38.5	-41.7	-32.7	-32.1	-35.5	-33.6
10	-35.4	-42.1	-31.9	-35.5	-46.0	-38.4
5	-38.2	-49.7	-33.9	-37.4	-39.2	-40.3
0	-35.4	-42.0	-32.8	-39.9	-41.4	-34.7
-5	-35.7	-34.5	-30.6	-34.5	-38.7	-31.4
-10	-39.2	-29.0	-28.1	-27.0	-39.7	-29.2
-15	-30.5	-28.5	-31.5	-26.3	-31.8	-31.6
-20	-27.2	-25.8	-26.0	-26.8	-26.0	-24.2
-25	-35.1	-28.1	-31.0	-25.0	-46.1	-29.1
-30	-37.4	-29.0	-27.0	-25.9	-29.2	-25.1
-35	-30.4	-25.6	-24.8	-26.5	-25.3	-22.5
-40	-36.0	-27.3	-26.3	-25.7	-27.7	-23.3
-45	-34.7	-37.1	-30.3	-25.6	-29.8	-27.6
-50	-29.6	-29.3	-30.6	-35.8	-25.8	-27.3
-55	-31.1	-31.0	-28.4	-26.7	-26.2	-24.9
-60	-28.7	-29.4	-28.4	-30.6	-24.4	-24.9

Table A.12-4. Predicted off-axis gain (dBi). +X Axis. X-Z plane rotated ±60 degrees about the Z axis.

Off-Axis Angle (°)	17.305 GHz LHCP	17.305 GHz RHCP	17.550 GHz LHCP	17.550 GHz RHCP	17.795 GHz LHCP	17.795 GHz RHCP
-60	-31.9	-30.1	-29.3	-29.5	-25.5	-25.8
-55	-31.7	-30.7	-28.1	-27.8	-25.1	-25.1
-50	-33.8	-31.8	-30.3	-29.9	-27.6	-27.4
-45	-26.4	-31.5	-26.4	-28.5	-26.5	-26.4
-40	-27.2	-31.1	-27.2	-30.0	-27.9	-27.2
-35	-28.3	-31.9	-28.3	-30.7	-29.9	-28.3
-30	-38.1	-32.6	-33.5	-33.2	-30.9	-28.7
-25	-35.6	-34.2	-33.6	-35.0	-31.7	-30.8
-20	-38.4	-36.1	-36.7	-36.7	-33.2	-32.3
-15	-42.8	-34.1	-41.1	-37.1	-35.0	-35.3
-10	-52.4	-37.8	-39.8	-39.7	-35.9	-37.4
-5	-42.3	-40.3	-50.5	-39.0	-42.1	-40.7
0	-39.8	-39.9	-43.9	-43.6	-41.7	-49.9
5	-35.9	-36.4	-39.1	-37.6	-38.0	-38.9
10	-36.1	-40.0	-40.2	-39.9	-36.9	-36.0
15	-37.7	-48.7	-36.1	-40.5	-31.1	-35.1
20	-53.2	-47.0	-45.0	-50.5	-29.9	-32.4
25	-49.0	-38.6	-38.0	-51.8	-30.1	-29.0
30	-56.7	-38.3	-40.6	-41.3	-28.7	-30.2
35	-36.1	-37.8	-35.3	-45.2	-25.9	-28.6
40	-41.6	-48.9	-51.1	-40.4	-28.8	-28.4
45	-39.1	-36.6	-36.6	-35.1	-24.4	-24.6
50	-39.5	-40.9	-49.0	-37.0	-23.6	-25.2
55	-40.7	-38.3	-40.6	-38.0	-24.7	-26.3
60	-56.0	-50.8	-46.4	-57.4	-23.2	-24.2

Table A.12-5. Measured off-axis gain (dBi). +10 to +30 degrees about the –X axis in the X-Z plane.

Off-Axis Angle (°)	17.305 GHz RHCP	17.550 GHz RHCP	17.795 GHz RHCP
30	-23.4	-25.0	-23.6
25	-23.4	-23.0	-26.6
20	-27.4	-27.0	-26.6
15	-27.4	-27.0	-26.6
10	-27.4	-27.0	-26.6

Table A.12-6. Measured off-axis gain (dBi). +10 to +30 degrees about the +X axis in the X-Z plane.

Off-Axis Angle (°)	17.305 GHz RHCP	17.550 GHz RHCP	17.795 GHz RHCP
30	-24.4	-24.0	-23.6
25	-23.4	-24.0	-23.6
20	-25.4	-27.0	-26.6
15	-27.4	-27.0	-26.6
10	-27.4	-27.0	-26.6

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.

/s/ Stephen D. McNeil
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