

TECHNICAL APPENDIX

SES-10 AT 67.0° W.L.

1.0 Overall Description (§25.114(d)(1))

This technical appendix is submitted in support of the New Skies Satellites BV (“SES”) petition for U.S. market access for the SES-10 spacecraft to be located at 67° W.L. SES hereby provides technical information relating to operation of SES-10 at 67° W.L.

SES-10 is equipped with fifty transponders (36 MHz or 54 MHz) in various segments of the Ku- and Ka-bands. The spacecraft’s transponders will provide coverage of the southern United States, Mexico, the Caribbean, Central America, and South America. Specifically, SES-10 operates in the following frequency bands in its Mexico, Central America and Caribbean (MCC) beam, which also covers the southern United States: 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz, 13.75-14 GHz, 14-14.5 GHz and 17.3-17.55 GHz; the following frequency bands in its Spanish-speaking Latin America (HSA) beam: 11.45-11.7 GHz, 11.7-12.2 GHz, 13.75-14 GHz and 14-14.5 GHz; the following frequency bands in its Brazil (B) beam: 11.45-11.7 GHz, 11.7-12.2 GHz, 13.75-14 GHz and 14-14.5 GHz; and the following frequency bands in its Lima (L) beam: 27.85-28.35 GHz. The TT&C frequencies of SES-10 are in the Ku-band.

2.0 Schedule S (§25.114(c))

The Schedule S database is included with this filing. As noted in the narrative section of this application, in preparing the Schedule S, SES relied on the most recent instructions.²

3.0 Telemetry and Telecommand (TT&C) frequencies and beams

The TT&C link budgets are included in the Schedule S. SES plans to use the following configuration of the TT&C carriers. The command horn will be used for receiving Ku-band

² Consistent with those instructions, in cases where the Schedule S software requests information that space station applicants are no longer required to provide, SES has omitted data elements, or where necessary to permit validation of the Schedule S file, has entered a “1” as a placeholder. SES specifies that these “1” data entries are outside the scope of the certifications herein regarding accuracy of the information provided with this petition.

telecommand carriers when SES-10 is on station. The horn will also be used for transmitting telemetry carriers when SES-10 is on station. Table 1 below shows the planned TT&C carrier center frequencies and bandwidths. Following Table 1 there is a description of the other possible TT&C configurations that could be implemented as necessary in case of relocation and/or emergency.

Table 1: TT&C Carrier Frequencies

	Frequency, MHz	Nominal polarization
Command carriers (bandwidth: 800 kHz, 1.2 MHz capture range)		
Ku-band	14005.0	V
	14499.0	H/V Flex
	13751.5	V/H Flex
Beacons/Telemetry (bandwidth: 300 kHz)		
Ku-band	11703.5	H
	12196.5	V
	11702.5	H
	12197.5	V

Telemetry signals will use circular polarization in case of transfer orbit or emergency.

Command signals will also use circular polarization in case of transfer orbit or emergency, via an omni-directional antenna.

A frequency designated as “Flex” above allows for the selection of three alternative modes: single frequency, dual frequency or frequency agility. Single frequency implies that the frequency in the table is the one used for command; dual frequency implies that the frequency in the table can be alternatively replaced by another optional frequency; frequency agility implies that the command frequency can be any frequency within the range 13.75-14.52 GHz.

4.0 Satellite Antenna Gain Contours (§25.114(c)(4))

Annex A shows the typical antenna gain contours for the SES-10 space station beams at 67° W.L. The peak EIRP and G/T values of the beams are shown in Table 2 and Table 2-a. The EIRP of the telemetry carrier is provided.

Table 2: Maximum EIRP and G/T for payload beams

Beam ID	Band	Pol	Link Direction	GXT filename	Max. EIRP (dBW)	Max. G/T (dB/K)
M-RH	Ku	H	Receive	MCC H GtoT (SES-10_GIMS).gxt	52.79 53.06	6.81
M-RV	Ku	V	Receive	MCC V GtoT (SES-10_GIMS).gxt		6.89
M-TH	Ku	H	Transmit	MCC H EIRP (SES-10_GIMS).gxt		
M-TV	Ku	V	Transmit	MCC V EIRP (SES-10_GIMS).gxt		
H-RH	Ku	H	Receive	HSA H GtoT (SES-10_GIMS).gxt	50.11 50.37	3.81
H-RV	Ku	V	Receive	HSA V GtoT (SES-10_GIMS).gxt		3.82
H-TH	Ku	H	Transmit	HSA H EIRP (SES-10_GIMS).gxt		
H-TV	Ku	V	Transmit	HSA V EIRP (SES-10_GIMS).gxt		
B-RH	Ku	H	Receive	BR H GtoT (SES-10_GIMS).gxt	52.65 52.14	7.78
B-RV	Ku	V	Receive	BR V GtoT (SES-10_GIMS).gxt		7.5
B-TH	Ku	H	Transmit	BR H EIRP (SES-10_GIMS).gxt		
B-TV	Ku	V	Transmit	BR V EIRP (SES-10_GIMS).gxt		
L-RCL	Ka	CL	Receive	LIM CL GtoT (SES-10_GIMS).gxt		15.12
L-RCR	Ka	CR	Receive	LIM CR GtoT (SES-10_GIMS).gxt		15.14

Table 2-a: Maximum EIRP and G/T for TT&C beams

Beam ID	Band	Pol	Link Direction	Max. EIRP (dBW)	Max. G/T (dB/K)
TM-GH	Ku	H/V	Transmit	18.1	-3.8 -25.16
TM-OM	Ku	CL/CR	Transmit	3.0	
TC-GH	Ku	H/V	Receive		
TC-OM	Ku	CL/CR	Receive		

Pursuant to 25.114(c)(4)(vi)(A), the gain characteristics for the TT&C beams (TM-GH, TM-OM, TC-GH, TC-OM) are not provided in a GIMS-readable format because the gain contour at 8 dB below peak falls entirely beyond the edge of the visible Earth.

5.0 Link Budgets (§25.140(a))

Typical link budgets, including emission designators, are in Annex B. TT&C link budgets are also provided.

6.0 Maximum Theoretical Operation Levels

SES-10 will be operated consistent with coordination agreements with adjacent satellites. In any case, in the Ku-band frequencies, the downlink EIRP density of the SES-10 digital carriers will not exceed -18 dBW/Hz; and the input power density of the uplink digital carriers of earth stations operating with SES-10 will not exceed -42 dBW/Hz. In the 17.3-17.55 GHz band, the input power density of the uplink digital carriers of earth stations operating with SES-10 will not exceed -48 dBW/Hz.

7.0 Two Degree Spacing Analysis (§25.114(d)(7) and §25.140(a))

Annex C provides analyses demonstrating the compatibility of SES-10 at 67° W.L. with respect to authorized space stations operating within two degrees.

8.0 Analysis for SES-10 satellite application in the Direct Broadcast Satellite Service (§25.114(d)(13))

SES-10 will operate in the 17.3-17.55 GHz portion of the feeder link band to the Direct Broadcast Satellite Service (DBS) in its MCC beam. As a result, information associated with Appendix 30A of the ITU Radio Regulations is provided below.

With respect to §25.114(d)(13)(i), the operation of SES-10 in 17.3-17.55 GHz will be under a Gibraltar ITU filing for which the information requested in Appendix 4 of the ITU Radio Regulations has already been submitted to, and published by, the ITU. The relevant publication is Special Section AP30-30A/E/598 and AP30-30A/E/598 MOD A and can be found in the ITU's BR IFIC 2723 dated July 10, 2012 and BR IFIC 2780 dated October 14, 2014, respectively. Further, under this rule section, applicants must provide sufficient technical information showing that the proposed system could operate satisfactorily if all assignments in the BSS and feeder link Plans were implemented. SES is planning to use the 17.3-17.55 GHz band in a manner consistent with usage for BSS feeder links. BSS feeder links operate under an FSS allocation. Considering the application of two degree spacing in many other FSS bands in

the United States, it would be reasonable to assume that such operations would be consistent with other Plan assignments with at least two degrees of orbital separation. A review of all Region 2 Appendix 30A Plan assignments within +/- 3 degrees shows the following:

PLAN ASSIGNMENT	CATEGORY	PLAN ID.	ADM	LONGITUDE
B CE311	B/Plan/List	30_2	B	-64.2
B CE411	B/Plan/List	30_2	B	-64.2
B CE511	B/Plan/List	30_2	B	-64.2
MEX01SUR	B/Plan/List	30_2	MEX	-69.2

There are no Plan assignments within two degrees of 67 W.L. and therefore SES-10 can be assumed to be able to operate satisfactorily should all Plan assignments be implemented.

With respect to §25.114(d)(13)(ii), analysis of the proposed system with respect to the limits in Annex 1 to Appendix 30A of the ITU Radio Regulations is provided in Annex D to this Technical Appendix. In order to ensure compatibility with the Plan, SES plans to conduct its operations in this frequency band in a manner similar to that of BSS feeder links. Specifically, SES plans to operate with a minimum earth station size of 3.7 meters and an input power density of -53.6 dBW/Hz. With these assumptions, the analysis in Annex D shows that no other Plan assignments or proposed modification to the Appendix 30A Plan are affected pursuant to Appendix 30A.

9.0 Mitigation of Orbital Debris (§25.114(d)(14))

1. *Spacecraft Hardware design.* SES has assessed and limited the amount of debris that will be released in a planned manner during normal operations of SES-10. During the satellite ascent, after separation from the launcher, no debris will be generated. As with all recent SES satellite launches, all deployments will be conducted using pyrotechnic devices designed to retain all physical debris. No debris is generated during normal on-station operations, and the spacecraft will be in a stable configuration.

SES has also assessed and limited the probability of the space station becoming a source of orbital debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal. The design of SES's recent spacecraft locates all sources of stored energy within the body of the structure, which provides protection from small orbital debris. SES requires that spacecraft manufacturers assess the probability of micrometeorite damage that can cause any loss of functionality. This probability is then factored into the ultimate spacecraft probability of success. Any significant probability of damage would need to be mitigated in order for the spacecraft design to meet SES's required probability of success of the mission. SES has taken the following steps to limit the effects of such collisions: (1) critical spacecraft components are located inside the protective body of the spacecraft and properly shielded; and (2) all spacecraft subsystems have redundant components to ensure no single-point failures. The spacecraft will not use any subsystems for end-of-life disposal that are not used for normal operations.

2. *Minimizing Accidental Explosions.* SES has assessed and limited the probability of accidental explosions during and after completion of mission operations. As part of the Safety Data Package submission for SES spacecraft, an extensive analysis is completed by the spacecraft manufacturer, reviewing each potential hazard relating to accidental explosions. A matrix is generated indicating the worst-case effect, the hazard cause, and the hazard controls available to minimize the severity and the probability of occurrence. Each subsystem is analyzed for potential hazards, and the Safety Design Package is provided for each phase of the program running from design phase, qualification, manufacturing and operational phase of the spacecraft. Also, the spacecraft manufacturer generates a Failure Mode Effects and Criticality Analysis for the spacecraft to identify all potential mission failures. The risk of accidental explosion is included as part of this analysis. This analysis

indicates failure modes, possible causes, methods of detection, and compensating features of the spacecraft design.

The design of the SES-10 spacecraft is such that the risk of explosion is minimized both during and after mission operations. In designing and building the spacecraft, the manufacturer took steps to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. Burst tests are performed on all pressure vessels during qualification testing to demonstrate a margin of safety against burst. Bipropellant mixing is prevented by the use of valves that prevent backwards flow in propellant and pressurization lines. All pressures, including those of the batteries, will be monitored by telemetry. At the end of operational life, after the satellite has reached its final disposal orbit, all on-board sources of stored energy will be depleted or secured, excess propellant remaining in the chemical propulsion tanks will be vented, excess pressurant remaining in the helium tanks will be vented, and the batteries will be discharged.

Safe Flight Profiles. SES has assessed and limited the probability of the space station becoming a source of debris by collisions with large debris or other operational space stations. Specifically, SES has assessed the possibility of collision with satellites located at, or reasonably expected to be located at, the requested orbital location or assigned in the vicinity of that location. Regarding avoidance of collisions with controlled objects, in general, if a geosynchronous satellite is controlled within its specified longitude and latitude station-keeping limits, collision with another controlled object (excluding where the satellite is collocated with another object) is the direct result of that object entering the allocated space.

SES-10 will be positioned at 67° W.L. In considering current and planned satellites that may have a station-keeping volume that overlaps the SES-10 satellite, SES has reviewed the FCC

databases for FCC licensed satellite networks and those that are currently under consideration by the FCC. In addition, networks for which a request for coordination has been published by the ITU within ± 0.15 degrees of 67° W.L. have also been reviewed. Only those networks that either operate, or are planned to operate, and have an overlapping station-keeping volume with the SES-10 satellite, have been taken into account in the analysis.

Based on these reviews, the satellites operating nominally at 67° W.L. are AMC-3 and AMC-4, which are also controlled and operated by SES. There are no pending applications before the Commission requesting authorization to use an orbital location within $\pm 0.15^\circ$ of 67° W.L., and within this sub-arc, there are no ITU networks other than those at 67° W.L., all of which were submitted on behalf of SES. Based on the preceding, it is concluded that physical coordination of the SES-10 satellite with another party is not required at the present time.

On-station operations require station-keeping within the ± 0.1 degree N-S and ± 0.05 degree E-W control box, thereby ensuring adequate collision avoidance distance from other satellites in geosynchronous orbit. SES-10 will be temporarily co-located with AMC-3 and AMC-4 as traffic is transferred to SES-10. After traffic transfer is complete, the AMC-3 and AMC-4 satellites will be relocated to another orbital location such that there will be no station-keeping volume overlap with SES-10.³ During the period of collocation, SES will use the proven inclination-eccentricity technique to ensure adequate separation between the satellites. This strategy is presently in use by SES at several orbital locations to ensure proper operation and safety of multiple satellites within one orbital box.

SES uses the Space Data Center (“SDC”) system from the Space Data Association to monitor the risk of close approach of its satellites with other objects. Any close encounters

³ SES will request the necessary Commission approval prior to any spacecraft relocation.

(separation of less than 10 km) are flagged and investigated in more detail. If required, avoidance maneuvers are performed to eliminate the possibility of collisions. During any relocation, the moving spacecraft is maneuvered such that it is at least 30 km away from the synchronous radius at all times. In most cases, much larger deviation from the synchronous radius is used. In addition, the SDC system is used to ensure no close encounter occurs during the move. When de-orbit of a spacecraft is required, the initial phase is treated as a satellite move, and the same precautions are used to ensure collision avoidance.

3. *Post-Mission Disposal.* Post-mission disposal of the satellite from operational orbit will be accomplished by carrying out maneuvers to a higher orbit. The upper stage engine remains part of the satellite, and there is no re-entry phase for either component. The fuel budget for elevating the satellite to a disposal orbit is included in the satellite design. SES plans to maneuver SES-10 to a disposal orbit with a minimum perigee of 260 km above the normal GSO operational orbit. This proposed disposal orbit altitude results from application of the IADC formula based on the following calculation:

$$\text{Total Solar Pressure Area "A"} = 61.2 \text{ m}^2$$

$$\text{"M"} = \text{Dry Mass of Satellite} = 2440 \text{ kg}$$

$$\text{"CR"} = \text{Solar Pressure Radiation Coefficient} = 1.00$$

Therefore the Minimum Disposal Orbit Perigee Altitude:

$$= 36,021 \text{ km} + 1000 \times \text{CR} \times \text{A} / \text{m}$$

$$= 36,021 \text{ km} + 1000 \times 1.00 \times 61.2 / 2440$$

$$= 36,046 \text{ km}$$

$$= 260 \text{ km above GSO (35,786 km)}$$

SES intends to reserve 30 kg of propellant in order to account for post-mission disposal of SES-

10. SES has assessed fuel-gauging uncertainty and has provided an adequate margin of fuel reserve to address the assessed uncertainty.

ANNEX A

Space Station Antenna Beam Diagrams

Figure A-1
BR Beam; H-Pol; EIRP Plot; Tx Direction (Downlink); 11.92 GHz; Peak: 52.65 dBW.

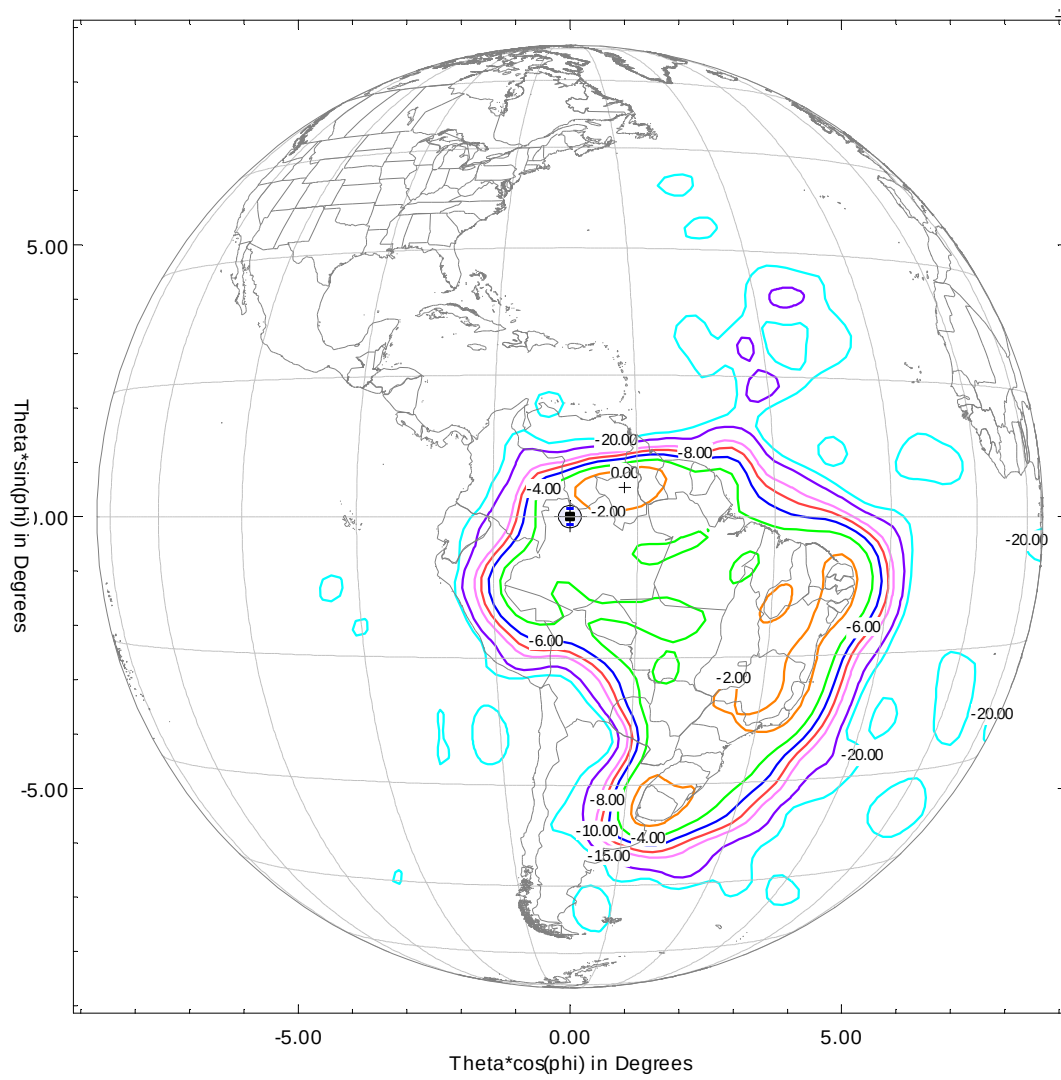


Figure A-2
BR Beam; V-Pol; G/T Plot; Rx Direction (Uplink); 14.22 GHz; Peak: 7.5 dB/K.

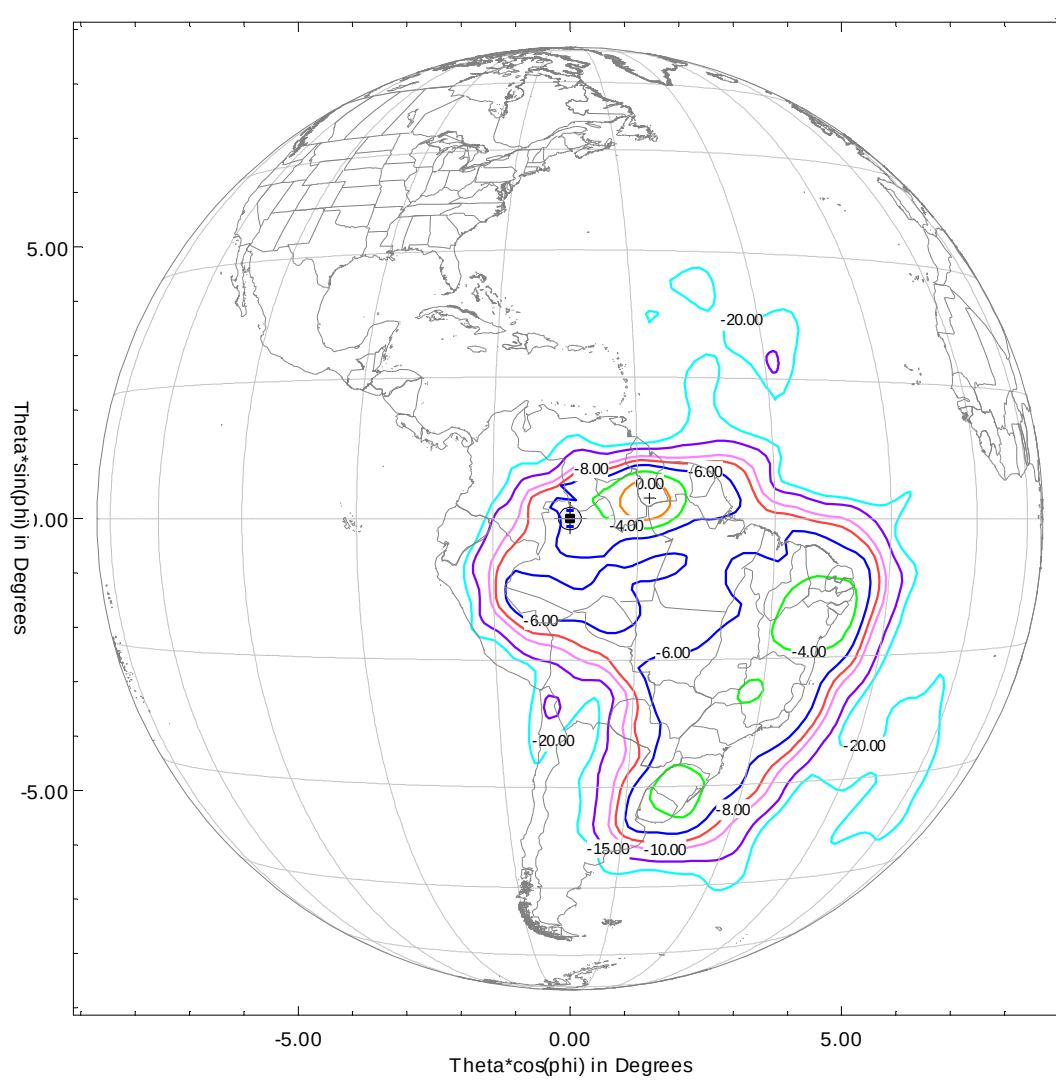


Figure A-3
BR Beam; V-Pol; EIRP Plot; Tx Direction (Downlink); 11.68 GHz; Peak: 52.14 dBW.

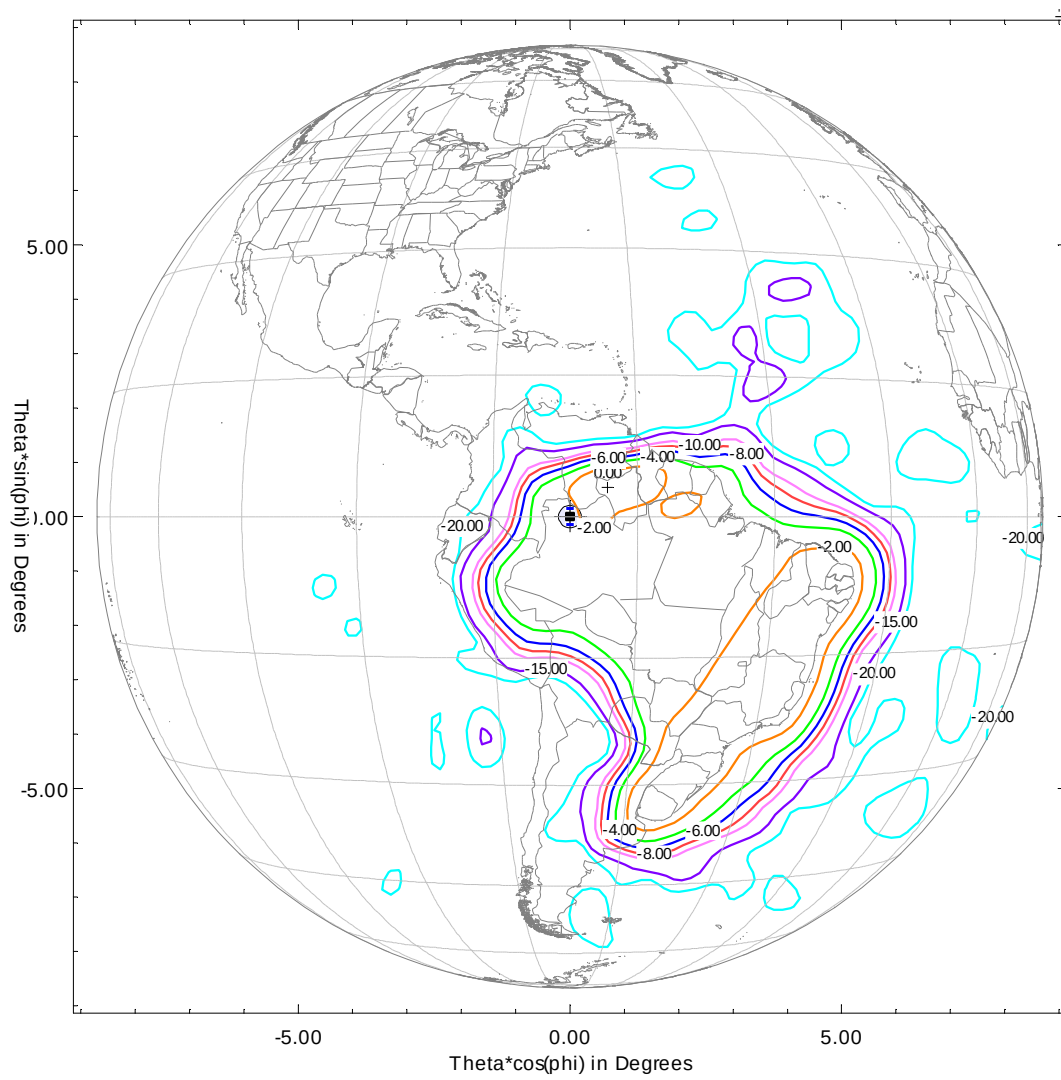


Figure A-4
BR Beam; H-Pol; G/T Plot; Rx Direction (Uplink); 13.98 GHz; Peak: 7.78 dB/K.

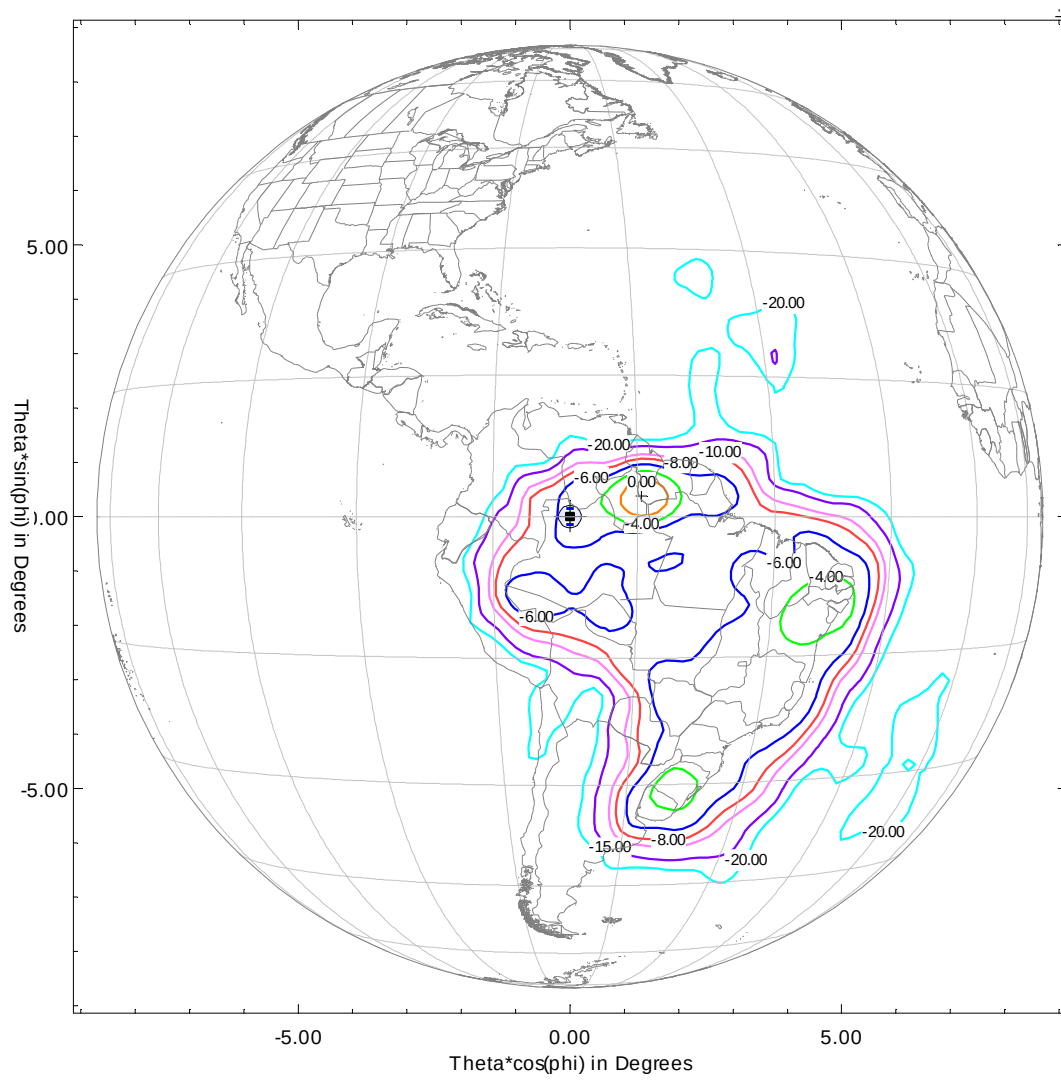


Figure A-5
HSA Beam; H-Pol; EIRP Plot; Tx Direction (Downlink); 11.80 GHz; Peak: 50.11 dBW.

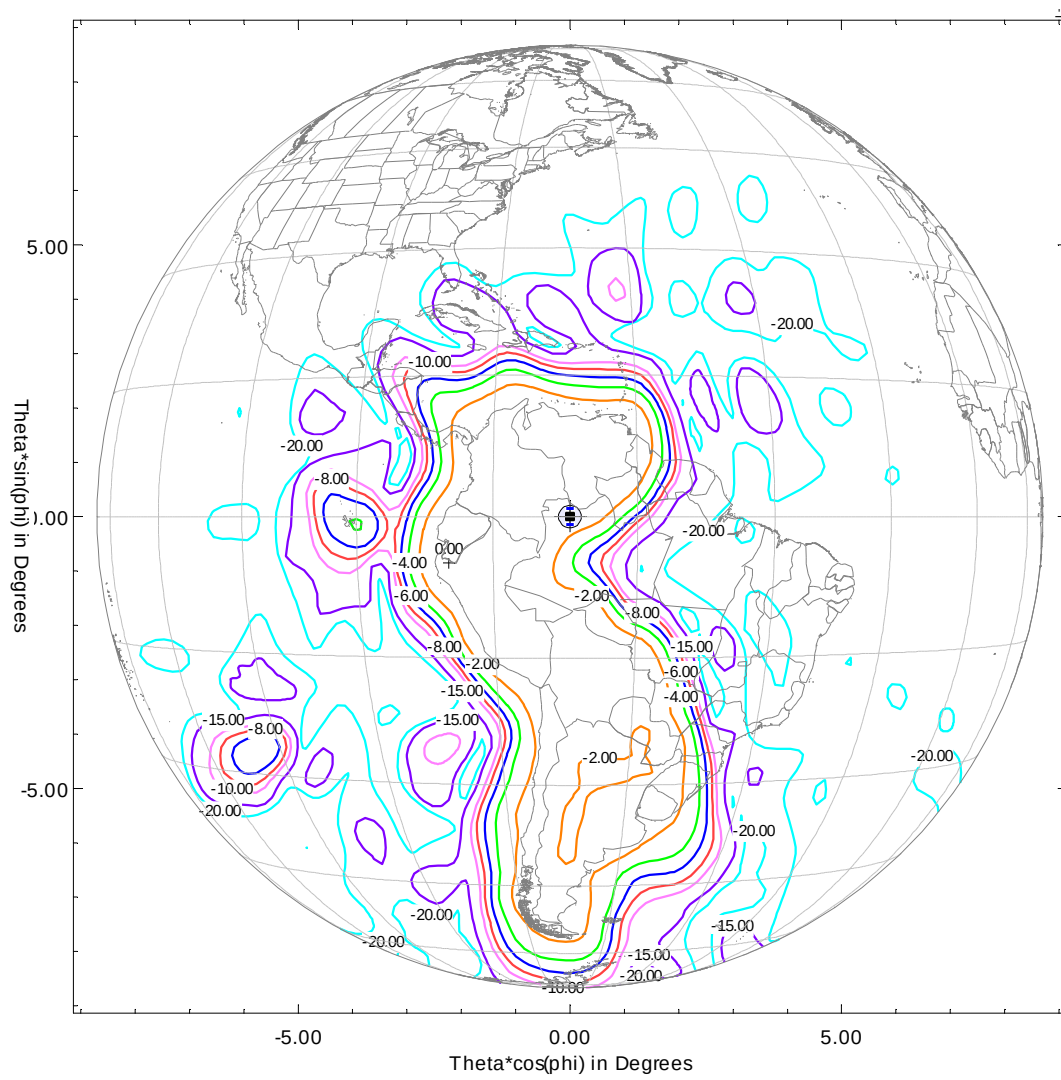


Figure A-6
HSA Beam; V-Pol; G/T Plot; Rx Direction (Uplink); 14.10 GHz; Peak: 3.82 dB/K.

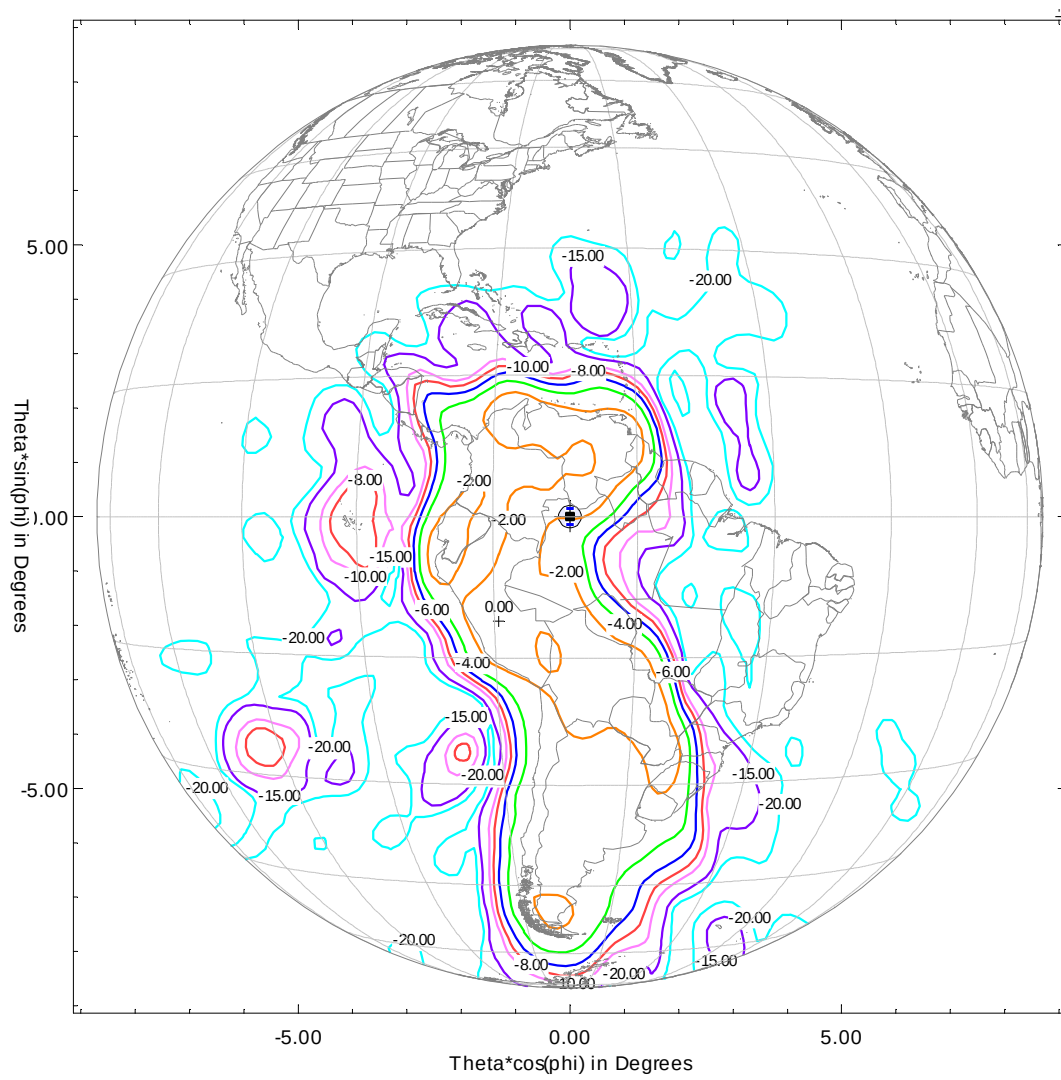


Figure A-7
HSA Beam; V-Pol; EIRP Plot; Tx Direction (Downlink); 11.81 GHz; Peak: 50.37 dBW.

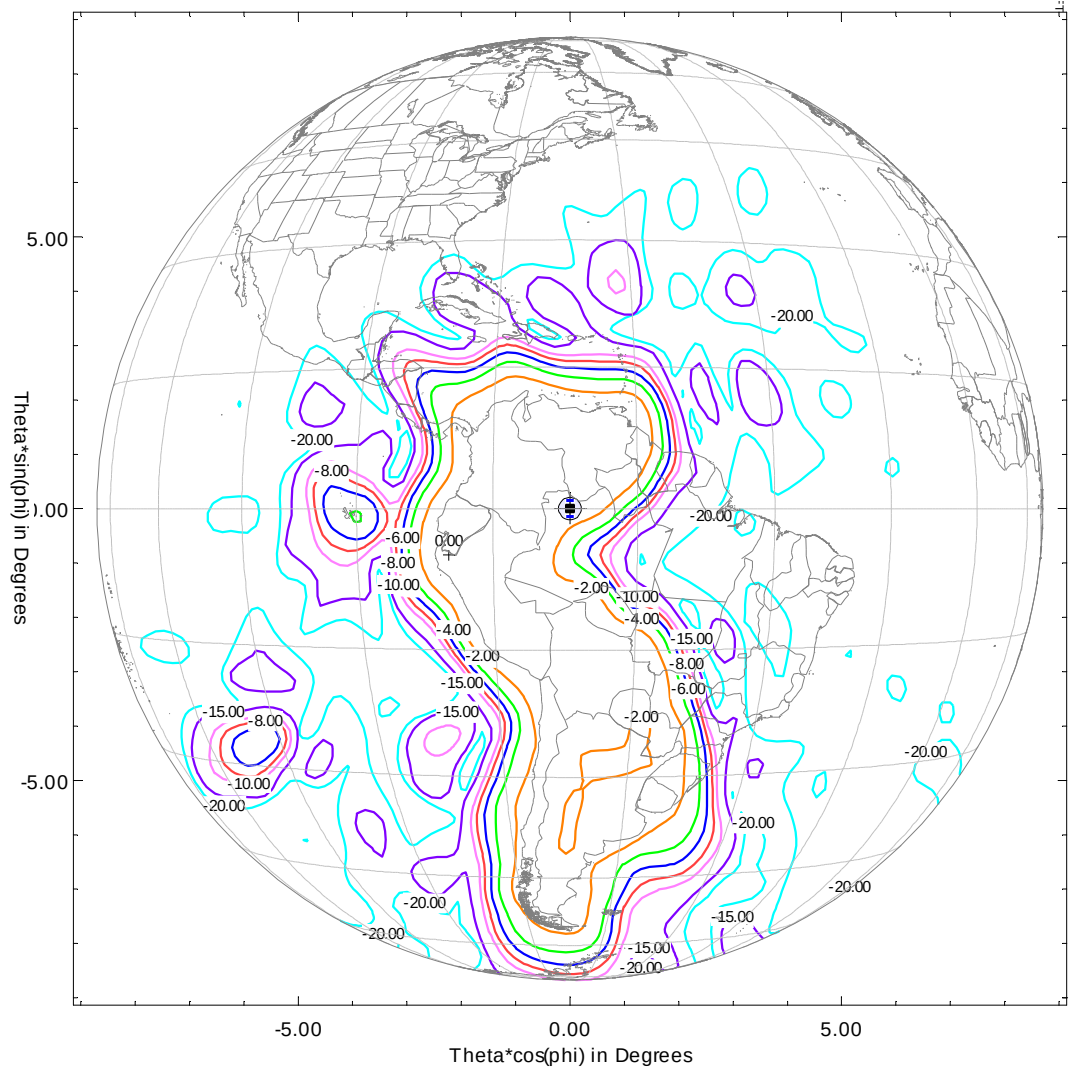


Figure A-8
HSA Beam; H-Pol; G/T Plot; Rx Direction (Uplink); 14.11 GHz; Peak: 3.81 dB/K.

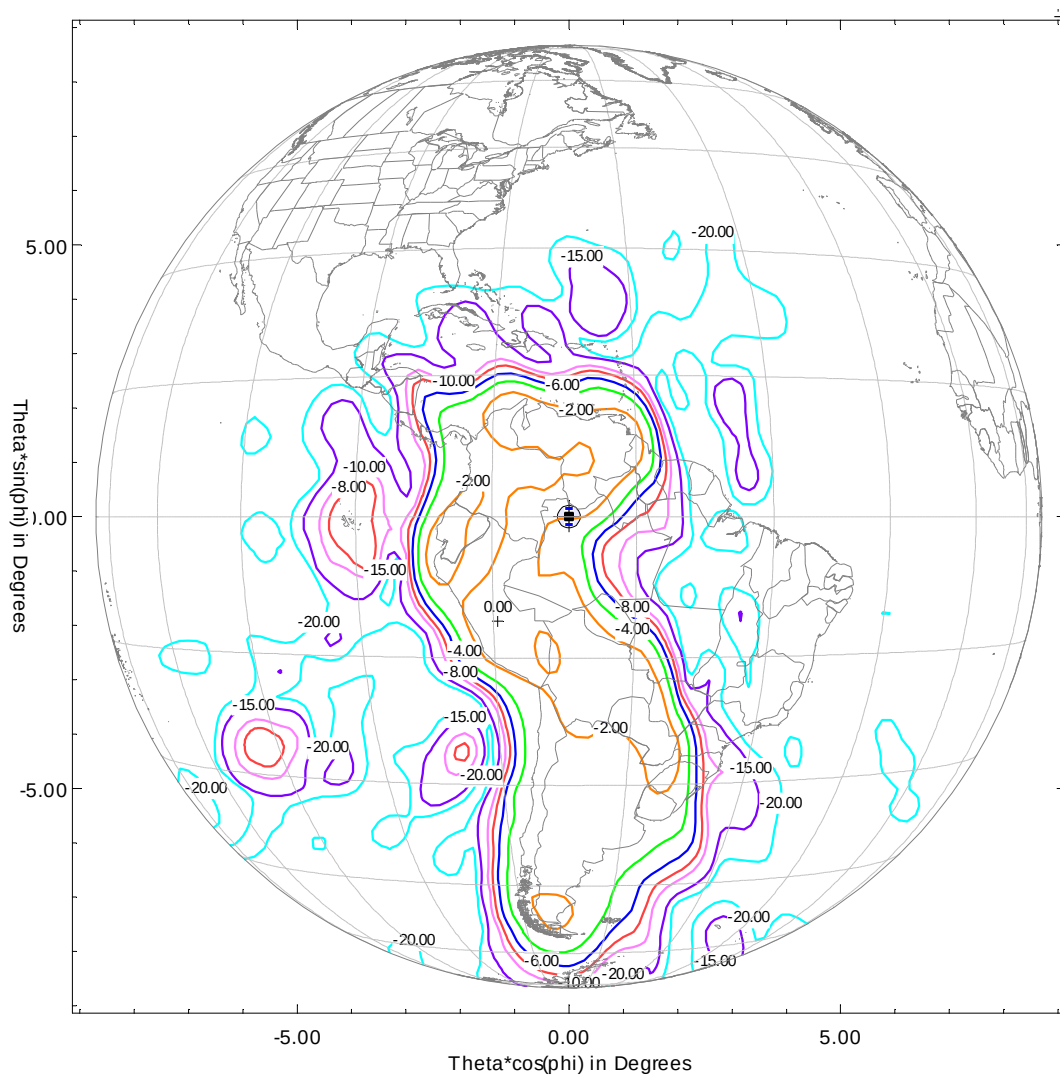


Figure A-9
LIM Beam; CL-Pol; G/T Plot; Rx Direction (Uplink); 27.96 GHz; Peak: 15.12 dB/K.

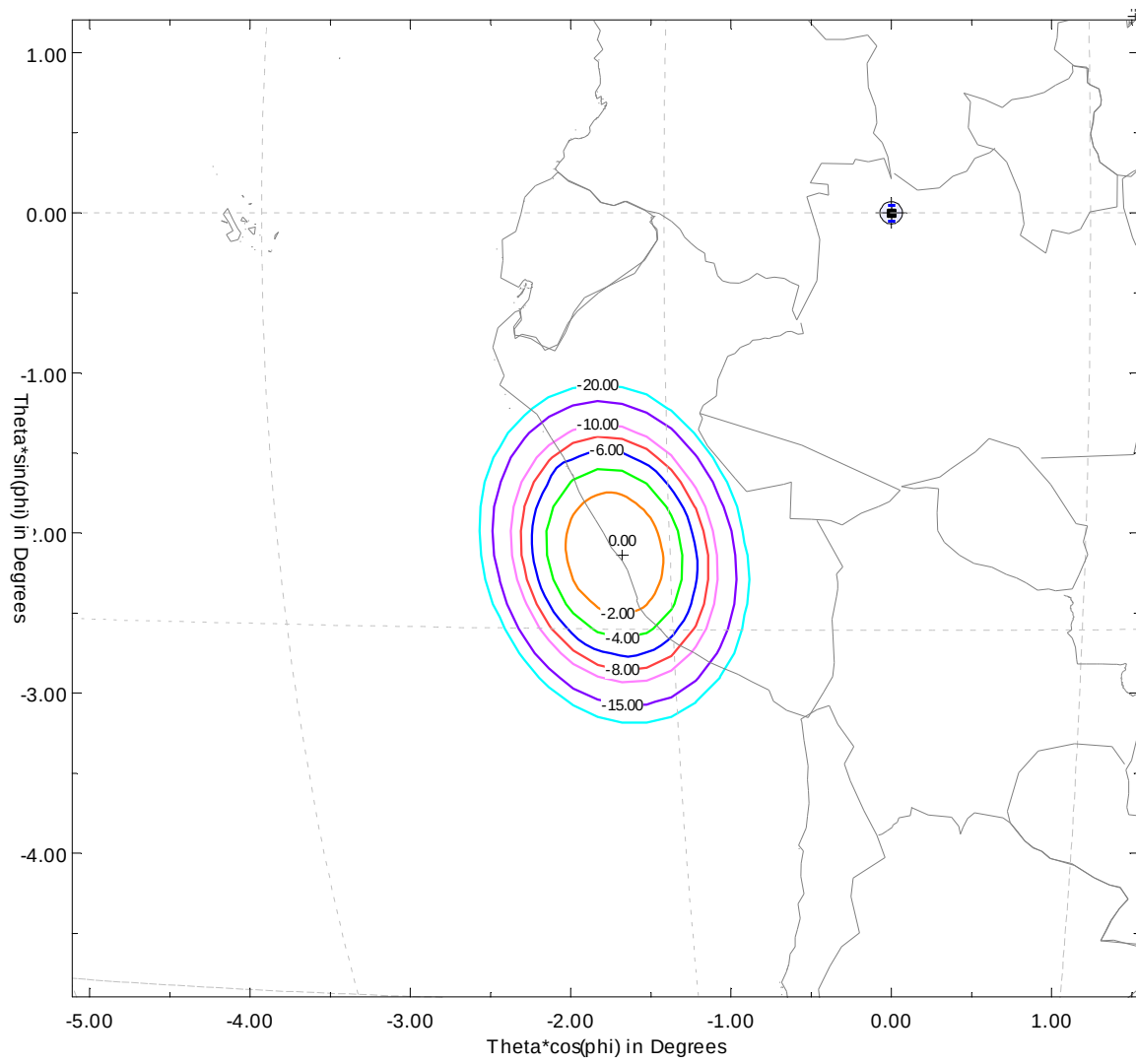


Figure A-10
LIM Beam; CR-Pol; G/T Plot; Rx Direction (Uplink); 28.08 GHz; Peak: 15.14 dB/K.

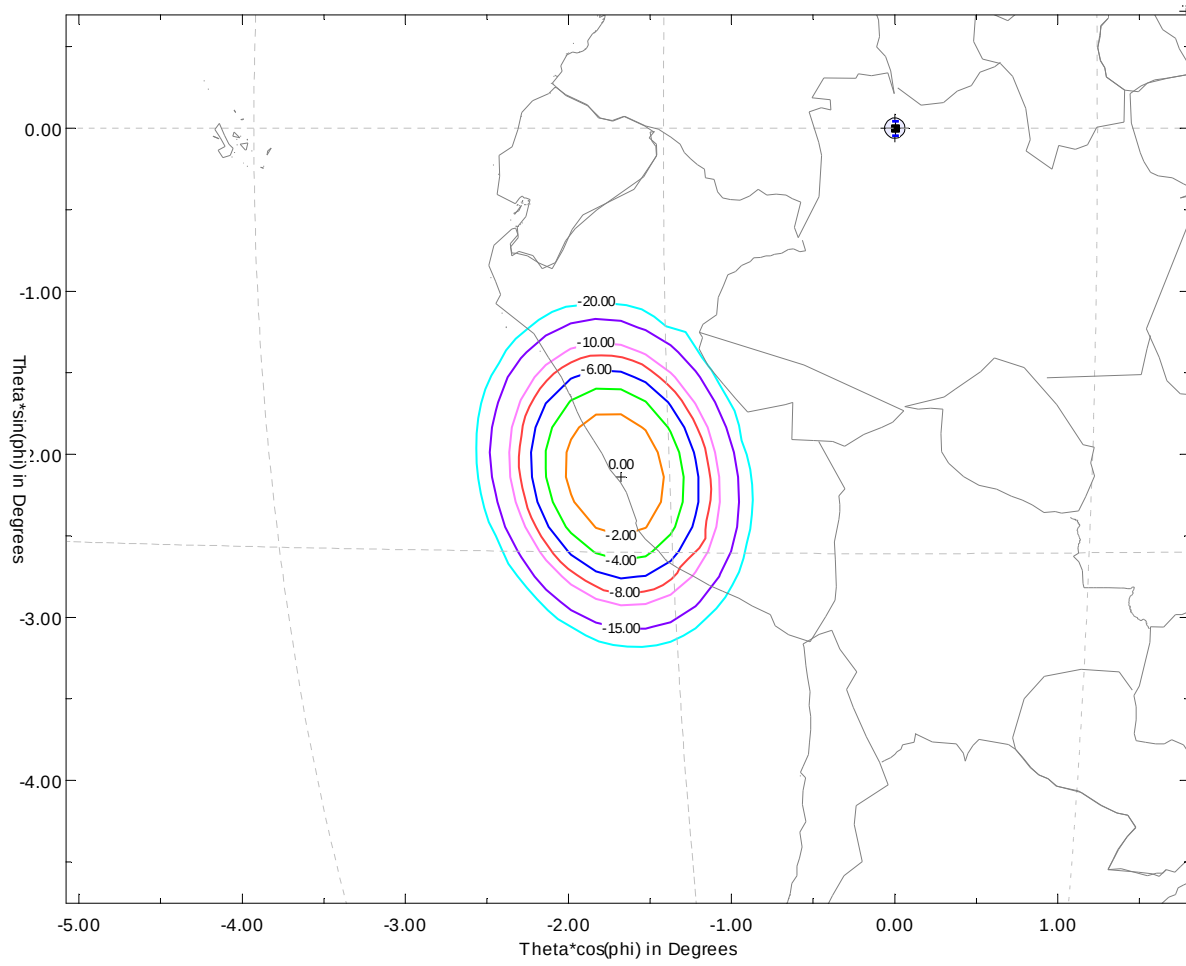


Figure A-11
MCC Beam; H-Pol; EIRP Plot; Tx Direction (Downlink); 11.80 GHz; Peak: 52.79 dBW.

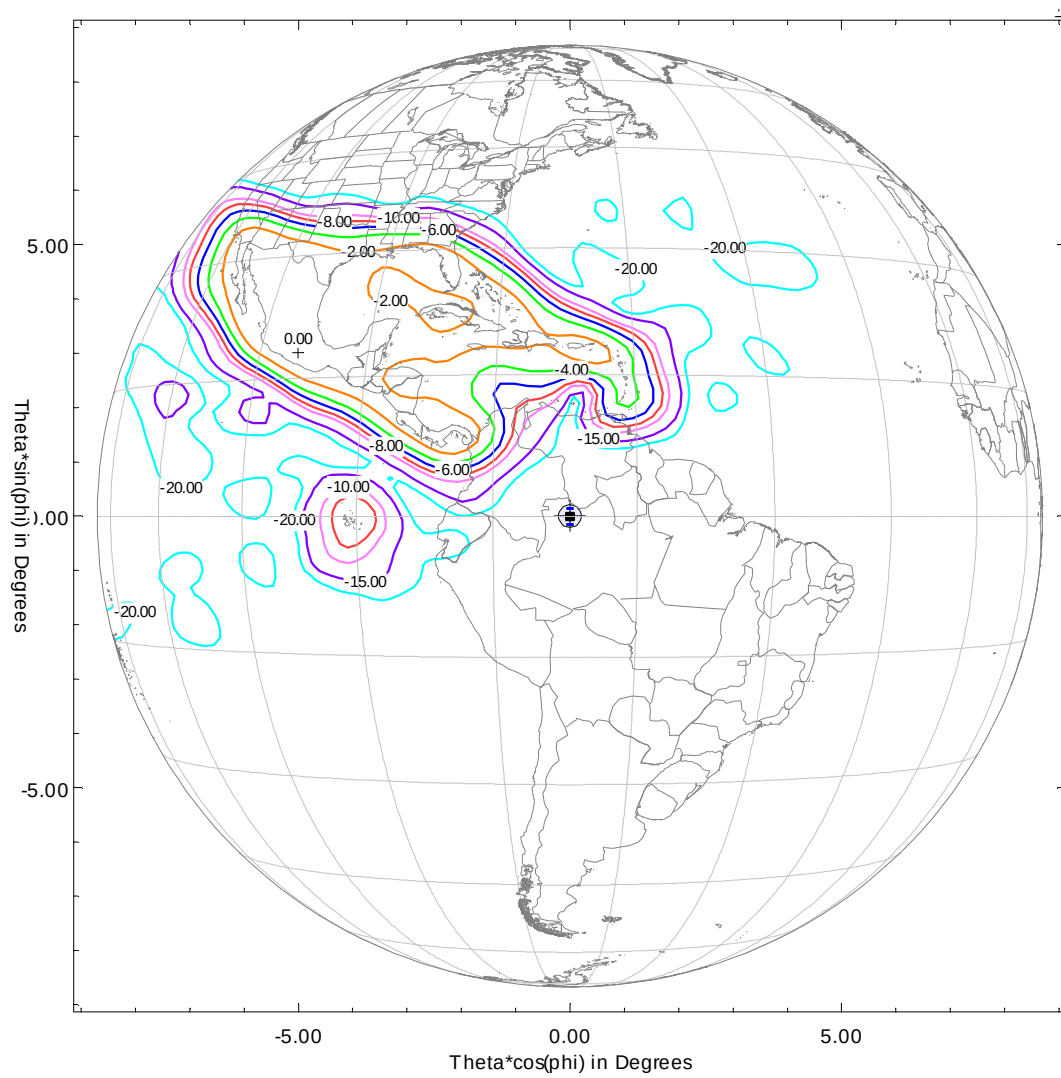


Figure A-12
MCC Beam; V-Pol; G/T Plot; Rx Direction (Uplink); 14.10 GHz; Peak: 6.89 dB/K.

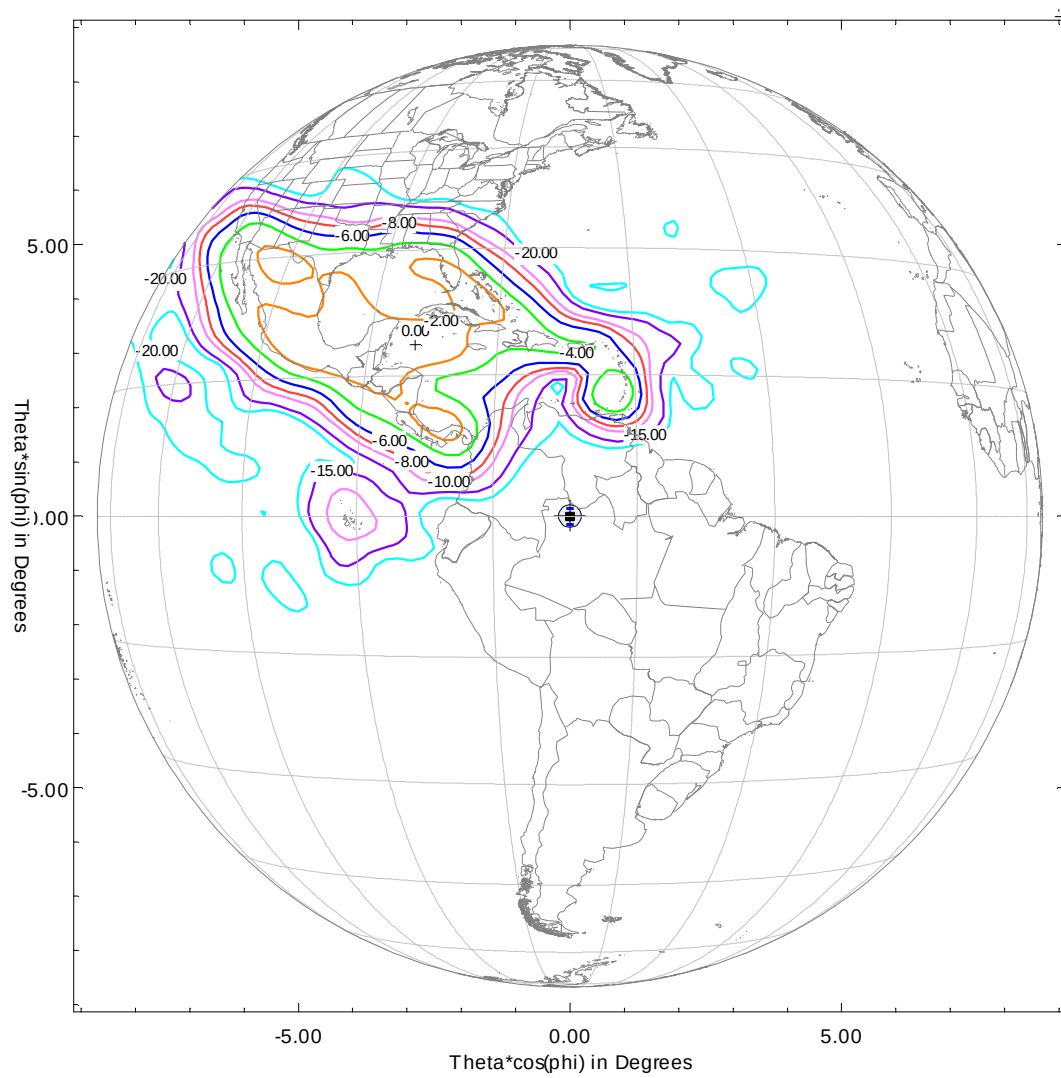


Figure A-13
MCC Beam; V-Pol; EIRP Plot; Tx Direction (Downlink); 11.68 GHz; Peak: 53.06 dBW.

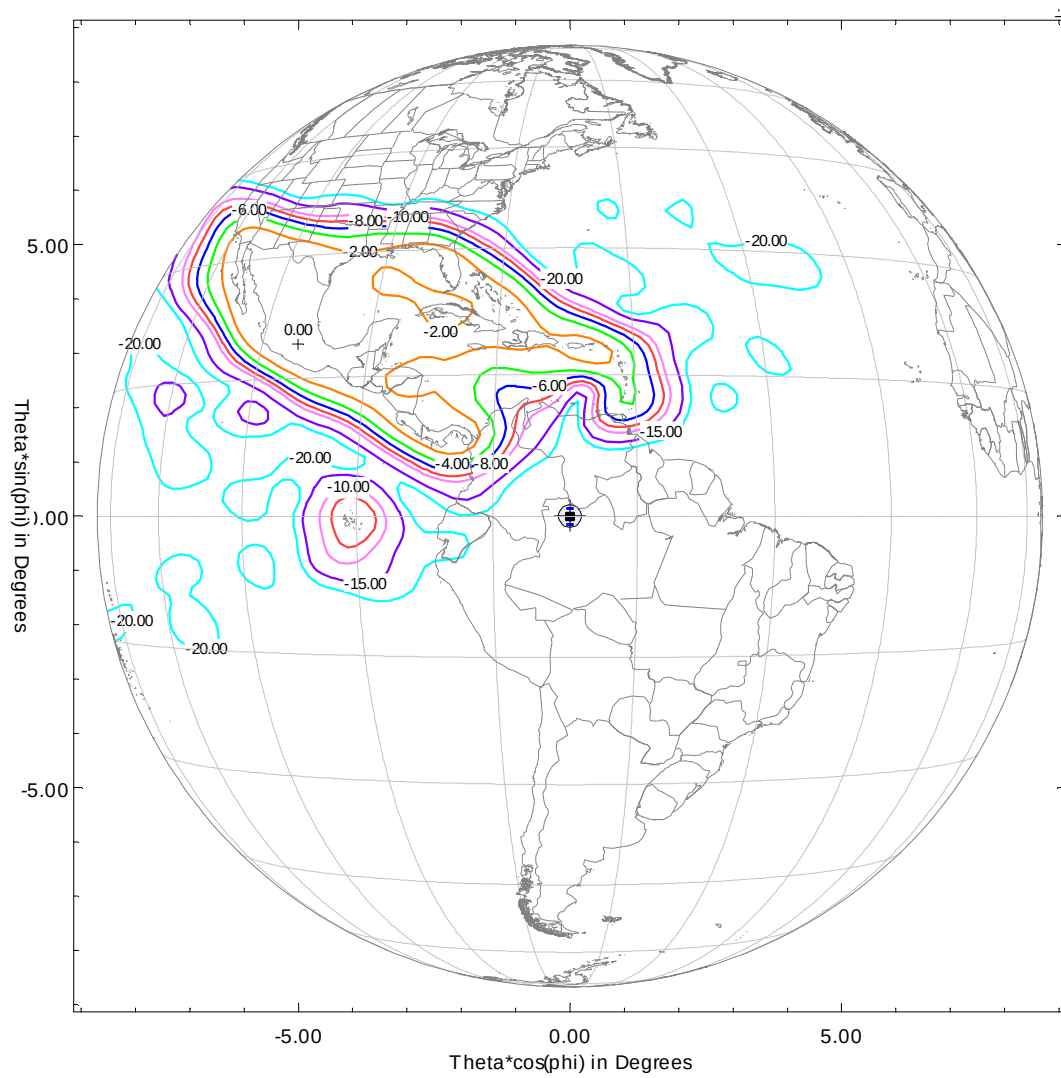
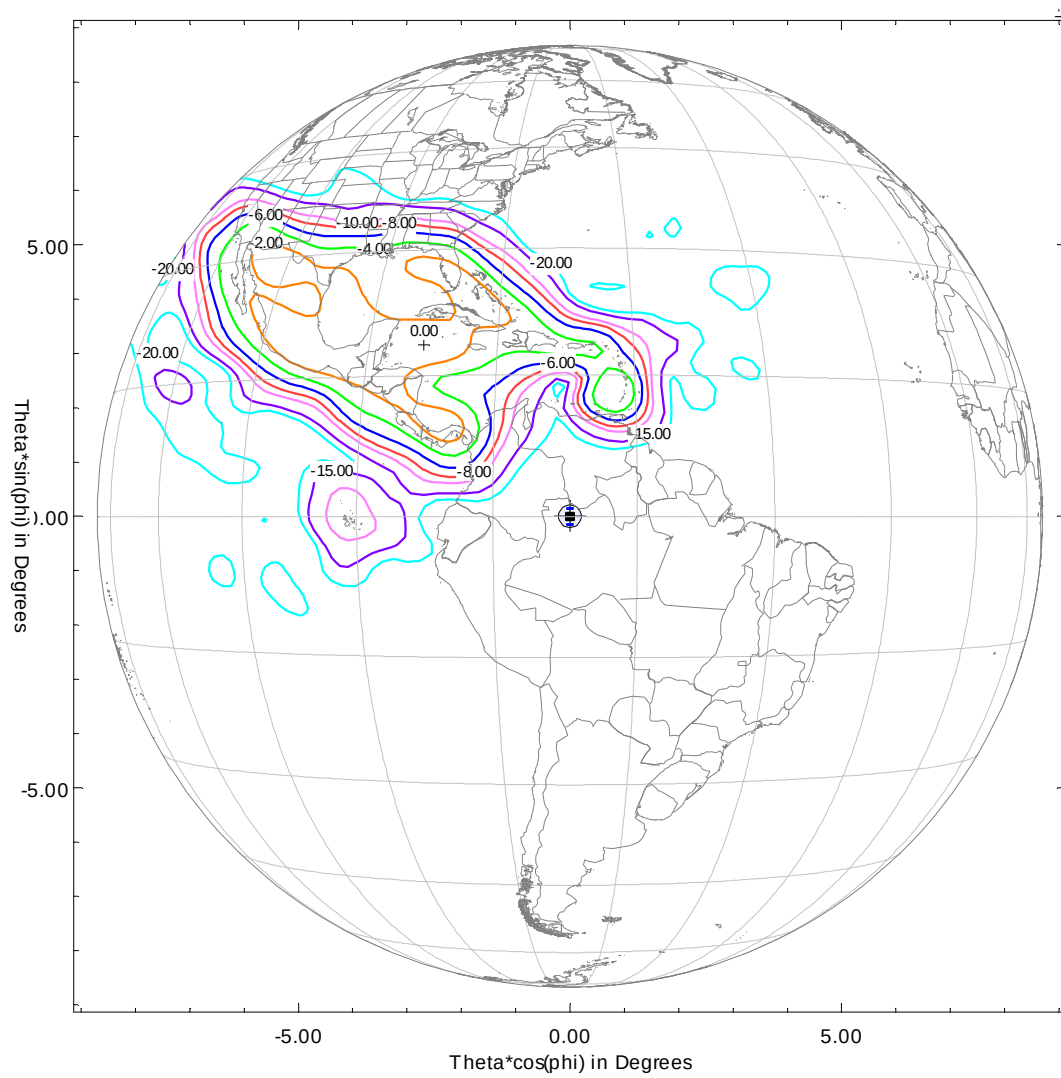


Figure A-14
MCC Beam; H-Pol; G/T Plot; Rx Direction (Uplink); 13.98 GHz; Peak: 6.81 dB/K.



ANNEX B

Link Budgets

Table B-1
Ku-Band Link Budgets

		100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
Uplink Frequency	GHz	14.220	14.280	14.110	14.220	14.220	14.220
Downlink Frequency	GHz	11.920	11.980	11.810	11.920	11.920	11.920
Carrier Allocated Bandwidth	kHz	100.0	54000.0	36000.0	750.0	9000.0	2000.0
Energy Dispersal	MHz	n/a	n/a	n/a	n/a	n/a	n/a
Uplink:							
Nominal E/S e.i.r.p. per carrier	dBW	40.2	76.7	76.7	46.0	61.7	47.8
Earth Station Diameter	m	0.76	7.60	7.60	0.45	6.30	0.45
Earth Station Gain	dBi	39.2	59.2	59.1	34.7	57.6	34.7
Uplink Input Power per Carrier	dBW	1.0	17.5	17.6	11.3	4.1	13.1
Free Space Loss	dB	207.0	207.4	207.3	207.0	207.0	207.0
G/T Satellite	dB/K	3.7	3.4	3.4	3.7	3.7	3.7
C/N Thermal Uplink	dB	16.5	24.7	26.6	13.5	18.4	11.1
C/I XPOL, ACI, IM, ASI	dB	15.2	24.2	26.0	12.3	17.1	9.8
C/(N+I) uplink	dB	12.8	21.5	23.3	9.8	14.7	7.4
Downlink:							
Satellite e.i.r.p. per carrier	dBW	18.6	50.8	51.0	22.8	40.1	25.4
Maximum e.i.r.p. density	dBW/4kHz	3.6	10.3	15.2	4.0	10.4	-0.6
Free Space Loss	dB	205.5	205.9	205.8	205.5	205.5	205.5
Earth Station Diameter	m	1.80	0.65	0.65	7.60	1.20	7.60
Earth Station Gain	dBi	45.2	36.4	36.2	57.7	41.6	57.7
Noise Temperature	K	118.2	120.3	120.2	118.2	118.2	118.2
Earth Station G/T	dB/K	24.4	15.6	15.4	36.9	20.9	36.9
C/N Thermal Downlink	dB	17.1	12.5	14.5	25.1	15.5	23.4
C/I XPOL, ACI, IM, ASI	dB	12.8	28.2	10.5	20.8	11.2	19.1
C/(N+I) downlink	dB	11.5	12.4	9.1	19.4	9.8	17.7
Adjacent Satellite Interference:							
Uplink Inp. Pwr. Dens. @ 2 degrees	dBW/Hz	-48	-48	-48	-48	-48	-48
Downlink e.i.r.p. Dens @ 2 degrees	dBW/Hz	-22	-22	-22	-22	-22	-22
C/I up (single satellite)	dB	18.2	27.2	29.0	15.3	20.1	12.8
C/I dn (single satellite)	dB	15.8	11.7	13.5	23.8	14.2	22.1
Aggregate C/I up	dB	15.2	24.2	26.0	12.3	17.1	9.8
Aggregate C/I down	dB	12.8	8.7	10.5	20.8	11.2	19.1
Overall:							
C/(N+I) overall	dB	9.1	11.9	8.9	9.4	8.6	7.0
C/(N+I) required	dB	-6.5	0.0	6.9	9.3	0.0	6.9
System Margin	dB	15.6	11.9	2.0	0.1	8.6	0.1

Table B-2
Ku-Band Link Budgets (with uplink in 17.3-17.55 GHz)

S13.c.	9M0G7W
Data Rate (dB-Hz)	71.08
Throughput rate (Mbps)	12.82
Symbol rate (Msps)	7.20
Modulation identifier	8PSK 3/5
Ku-band uplink frequency	17.5200
Ku-band downlink frequency	11.1700
Convolution FEC rate	N/A
Block FEC rate	0.5933
Rx ES temperature (K)	105.8092
Uplink:	
Transmit Power (dBW)	8.31
Transmit Loss (dB)	0.00
Antenna diameter	3.70
Antenna Gain (dBi)	54.77
Ground Station EIRP (dBW)	63.00
Uplink Atm. Loss (dB)	-4.40
Free Space Loss (dB)	-208.74
Satellite G/T (dB/K)	5.57
Boltzmann's Constant (dBW/K-Hz)	-228.60
C/N (dB)	19.68
C/I (dB)	26.15
C/(N+I)up (dB)	18.63
Downlink:	
Satellite Carrier EIRP (dBW)	6.00
Interference bandwidth (MHz)	7.20
Satellite EIRP density (dBW/4kHz)	36.02
Downlink Atm. Loss (dB)	-3.21
Free Space Loss (dB)	-204.84
Ground station antenna diam. (m)	0.90
Ground Station G/T (dB/K)	13.83
C/N (dB)	14.90
C/I (dB)	16.02
C/(N+I)dn (dB)	12.41
Overall:	13.65
C/IM (dB)	22.24
C/I - ASI (dB)	14.88
C(N+I) (ASI) (dB)	11.21
Total C/(N+I) (dB)	10.88
Required C/N (dB)	6.00
Margin (dB)	4.88

Table B-3
TT&C Link Budgets (nominal operations)

Link Parameters	Units	TT&C			
		800KF9D	300KF9D	300KF9D	300KF9D
Uplink Frequency	GHz	14005.0			
Downlink Frequency	GHz		11703.5	12196.5	12197.5
Carrier Allocated Bandwidth	kHz	800.0	300.0	300.0	300.0
Energy Dispersal	MHz	n/a	n/a	n/a	n/a
Uplink:					
Nominal E/S e.i.r.p. per carrier	dBW	76.29			
Earth Station Diameter	m	9.0			
Earth Station Gain	dB	60.5			
Input power density	dBW/4 kHz	-7.3			
Uplink Input Power per Carrier	dBW	15.7			
Free Space Loss	dB	206.4			
G/T Satellite towards E/S	dB/K	-12.6			
C/N Thermal Uplink	dB	26.8			
C/I XPOL, ACI, IM, ASI	dB	43.3			
C/(N+I) uplink	dB	26.7			
Downlink:					
Satellite e.i.r.p. per carrier	dBW		14.1	14.1	14.1
Maximum e.i.r.p. density	dBW/4kHz		-4.7	-4.7	-4.7
Free Space Loss	dB		204.9	205.2	205.2
Earth Station Diameter	m		9.0	9.0	9.0
Earth Station Gain	dB		59.0	59.3	59.3
Noise Temperature	K		120.0	120.0	120.0
Earth Station G/T	dB/K		38.2	38.5	38.5
C/N Thermal Downlink	dB		21.2	21.2	21.2
C/I XPOL, ACI, IM, ASI	dB		20.4	20.7	20.7
C/(N+I) downlink	dB		17.8	18.0	18.0
Adjacent Satellite Interference:					
Uplink Inp. Pwr. Dens. @ 2 degrees	dBW/Hz	-50	-50	-50	-50
Downlink e.i.r.p. Dens @ 2 degrees	dBW/Hz		-26	-26	-26
C/I up (single satellite)	dB	46.3			
C/I dn (single satellite)	dB		23.4	23.7	23.7
Aggregate C/I up	dB	43.3			
Aggregate C/I down	dB		20.4	20.7	20.7
Overall:					
C/(N+I) overall	dB	26.7	17.8	18.0	18.0
C/(N+I) required	dB	10.0	9.0	9.0	9.0
System Margin	dB	16.7	8.8	9.0	9.0

ANNEX C

Interference Analysis

Interference Analysis

SES provides below an analysis addressing the specific case of interference between SES-10 and adjacent systems.

For the TT&C frequencies, to ensure that the SES-10 TT&C operations do not cause harmful interference into, or receive harmful interference from, adjacent satellite networks, coordination of the TT&C channels will be completed with Embratel Star One, which operates Star One C1 at 65° W.L. This approach is consistent with industry practice, in which TT&C operations are typically addressed with adjacent satellite licensees on a case-by-case basis considering the actual characteristics of the respective networks. Further, it is worth noting that there is no frequency overlap between the SES-10 command carriers and Star One C1's TT&C carriers or communications payload at 65° W.L.; therefore specific carrier-to-interference (C/I) analysis of the SES-10 command carriers is not provided. Telemetry carriers are lower in EIRP density than the SES-10 communication payload and use large earth stations antennas; therefore, they are also not addressed separately from the communications payload analyses.

For the Ku-band, in the case of the AMC-3 and AMC-4 satellites at 67° W.L., both controlled by SES, operations will be managed to ensure that co-frequency beams do not interfere with each other. The only operational Ku-band satellite adjacent to the 67° W.L. position that is not controlled by SES is Star One C1 at 65° W.L. with 2° geocentric separation. Given that there is currently no Ku-band satellite at 69° W.L., a hypothetical satellite assumed to be transmitting at the same maximum uplink power density and downlink EIRP density levels as those being sought for the SES-10 spacecraft is used to estimate interference levels at that orbital location.

Specific C/I Analysis:

Two Degree Spacing Analysis

For this portion of the analysis, the C/I ratio between two adjacent systems is estimated for a set of competing emissions. The analysis methodology consists of defining the emission characteristics for each network and computing the interference levels resulting from co-channel operation. C/I levels are calculated for each combination of overlapping emissions (*i.e.*, the same frequency band and link direction). Results are presented in tables providing the interference levels for combinations of emissions pairs.

The worst-case geometry for the earth and space stations is assumed. The space stations are positioned closer to each other by their respective stationkeeping tolerances and the earth station is mispointed toward the interfering space station by an assumed pointing error.

The following equations can be used to express the uplink and downlink C/I:

$$C / I_{UP} = (PD_{ES,W} - PD_{ES,I}) + (G_{ES,W}(\theta_W) - G_{ES,I}(\theta_I)) + \Delta G / T$$

$$C / I_{DN} = (ED_{SS,W} - ED_{SS,I}) + (G_{ES,W}(\theta_W) - G_{ES,W}(\theta_I)) + \Delta GC$$

Here the uplink C/I is estimated using the emission power densities and gains of the earth stations, and an assumption defining the locations of the wanted and interfering earth stations relative to the wanted space station beam boresight. The downlink C/I is estimated using the wanted and interfering space station emission EIRP densities, the gain of the wanted earth station, and an assumption defining the location of the wanted earth station relative to the wanted and interfering space station beam boresights.

The off-axis performance of the earth station antenna is modeled using Section 25.209 of the Commission's rules. According to Section 29.209(c)(1), receiving earth stations are afforded protection to the extent that they meet the 25.209(a) and (b) masks at 1.5 degrees off-axis.

Therefore, all receiving earth stations are assumed to meet this mask in the interference analysis

contained herein. Note that this antenna pattern does not define gain values for angles less than 1.5 degrees. In order to account for earth station pointing errors, a parabolic main beam model is used for gain values at small off-axis angles ($G_{MAX} - 0.0025 * (D/\lambda * \phi)^2$).

Earth station topocentric off-axis angles are approximated by adding 10% to the geocentric angular separation, taking into account the satellite stationkeeping tolerance and earth station pointing error.

System characteristics used in the analysis are shown in the following tables. Three space stations are considered: SES-10 and two adjacent stations: Embratel's Star One C1 at 65.0° W.L., and a hypothetical satellite at 69.0° W.L. assumed to be transmitting at the same maximum uplink power density and downlink EIRP density levels as those for SES-10.

Table C-3 provides the space station name and orbital information, and assumed earth station parameters of the networks.

Table C-3: Station Parameters

Parameter	System 1	System 2	System 3
Space station name	Star One C1	SES-10	Hypothetical Satellite
Nominal orbit location (+E, -W)	-65	-67	-69
Station-keeping tolerance (deg)	0.05	0.05	0.05
Earth station pointing error (deg)	0.15	0.15	0.15
Earth station antenna efficiency (fraction)	0.65	0.65	0.65

This analysis considers the digital emissions signals of both networks. Analog TV/FM signals are coordinated on a case-by-case basis with nearby spacecraft, and are therefore not addressed in this analysis. Digital signals are more robust and operate typically down to much lower C/N ratios than analog signals, and therefore are more tolerant of interference.

Tables C-4a and C-4b show the emission characteristics considered here for Star One C1 at 65.0° W.L. and a hypothetical satellite at 69.0° W.L. (The emissions characteristics for Star One C1 have been derived from its Schedule S file). All off-axis EIRP densities and off-axis

gain values shown in Tables C-4a and C-4b were calculated with respect to the off-axis angle towards the adjacent satellite.

Table C-4a: Star One C1 Typical Emissions

UPLINK -- Star One C1 Carriers								
Emission	Bandwidth (MHz)		Uplink EIRP	Uplink Eirp density	Transm. Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Eirp density
36M0G7W	36.0		76.5	0.9	9	60.7	29	-38.7
17M9G7W	17.9		72.0	-0.5	9	60.7	29	-40.2
5M50G7W	5.5		65.0	-2.4	7.5	59.1	29	-40.5
1M64G7W	1.64		62.5	0.4	6	57.2	29	-35.8
614KG7W	0.614		61.5	3.6	4.5	54.7	29	-30.0
5K80G7W	0.0058		41.0	3.4	4.5	54.7	29	-30.3

DOWNLINK -- Star One C1 Carriers							
Emission	Satellite EIRP	Bandw. (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain
36M0G7W	40.7	36.0	-34.9	3	49.6	29	21.0
17M9G7W	33.0	17.9	-39.5	9	59.1	29	21.0
5M50G7W	27.5	5.5	-39.9	7.5	57.6	29	21.0
1M64G7W	22.0	1.64	-40.1	6	55.6	29	21.0
614KG7W	17.0	0.614	-40.9	4.5	53.1	29	21.0
5K80G7W	-3.5	0.0058	-41.1	4.5	53.1	29	21.0

Table C-4b: Hypothetical satellite at 69° W.L. Typical Emissions

UPLINK -- Hypothetical Satellite Carriers							
Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W	
Bandwidth (MHz)	0.1	54.0	36.0	0.75	9.0	2.0	
Uplink EIRP	40.2	76.7	76.7	46.0	61.7	47.8	
Uplink Power	1.0	17.5	17.5	11.3	4.1	13.1	
Uplink Power density	-49.0	-59.8	-58.1	-47.4	-65.4	-49.9	
Uplink Earth Station (m)	0.76	7.6	7.6	0.45	6.3	0.45	
Earth Station Gain	39.2	59.2	59.2	34.7	57.6	34.7	
Upl. EIRP density	-9.8	-0.6	1.1	-12.8	-7.8	-15.2	
Sidelobe Characteristic	29	29	29	29	29	29	
Off-axis Eirp density	-28.0	-38.8	-37.1	-26.4	-44.4	-28.9	

DOWNLINK -- Hypothetical Satellite Carriers						
Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
Bandwidth	0.1	54.0	36.0	0.75	9.0	2.0
Receive Earth Station (m)	1.8	0.65	0.65	7.6	1.2	7.6
Satellite EIRP	18.6	50.8	51.0	22.8	40.1	25.4
Downlink EIRP density	-31.4	-26.5	-24.6	-36.0	-29.4	-37.6
RX Earth Station Gain	45.2	36.3	36.3	57.7	41.6	57.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	21.0	21.0	21.0	21.0	21.0	21.0

Table C-5 shows the SES-10 emission characteristics considered here (derived from the Schedule S file). Similar to Tables C-4a and C-4b, all off-axis EIRP densities and off-axis gain values shown in Table C-5 were calculated with respect to the off-axis angle towards the adjacent satellite.

Table C-5: SES-10 Typical Emissions

UPLINK -- SES-10 Carriers						
Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
Bandwidth (MHz)	0.1	54.0	36.0	0.75	9.0	2.0
Uplink EIRP	40.2	76.7	76.7	46.0	61.7	47.8
Uplink Power	1.0	17.5	17.5	11.3	4.1	13.1
Uplink Power density	-49.0	-59.8	-58.1	-47.4	-65.4	-49.9
Uplink Earth Station (m)	0.76	7.6	7.6	0.45	6.3	0.45
Earth Station Gain	39.2	59.2	59.2	34.7	57.6	34.7
Upl. EIRP density	-9.8	-0.6	1.1	-12.8	-7.8	-15.2
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Eirp density	-28.0	-38.8	-37.1	-26.4	-44.4	-28.9

DOWNLINK -- SES-10 Carriers						
Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
Bandwidth	0.1	54.0	36.0	0.75	9.0	2.0
Receive Earth Station (m)	1.8	0.65	0.65	7.6	1.2	7.6
Satellite EIRP	18.6	50.8	51.0	22.8	40.1	25.4
Downlink EIRP density	-31.4	-26.5	-24.6	-36.0	-29.4	-37.6
RX Earth Station Gain	45.2	36.3	36.3	57.7	41.6	57.7
Sidelobe Characteristic	29	29	29	29	29	29
Off-axis Gain	21.0	21.0	21.0	21.0	21.0	21.0

Applying the methodology described above to the emission characteristics shown in Tables C-4 and C-5 results in the C/I levels shown in Appendix 1 to this Annex. A separate table is provided for each frequency band/link direction pair that shows the C/I level for each emission pair.

All the calculated C/I values, including the worst cases, are shown in Appendix 1.

APPENDIX 1

C/I CALCULATIONS

Table A1-1: SES-10 into Star One C1 Ku-Band Uplink C/I

Uplink C/I analysis			SES-10 into Star One C1			UPLINK -- SES-10 Carriers									
Frequency	Ku-band					Emission			100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W	
						Bandwidth (MHz)			0.1	54.0	36.0	0.75	9.0	2.0	
						Uplink EIRP			40.2	76.7	76.7	46.0	61.7	47.8	
						Uplink Power			1.0	17.5	17.5	11.3	4.1	13.1	
SES-10 Orbital Position	67.00	W				Uplink Power density			-49.0	-59.8	-58.1	-47.4	-65.4	-49.9	
Star One C1 Orbital Position	65.0	W				Uplink Earth Station (m)			0.76	7.6	7.6	0.45	6.3	0.45	
Geocentric Separation	1.9	degrees				Earth Station Gain			39.2	59.2	59.2	34.7	57.6	34.7	
Topocentric Separation	2.1	degrees				Upl. EIRP density			-9.8	-0.6	1.1	-12.8	-7.8	-15.2	
						Sidelobe Characteristic			29	29	29	29	29	29	
						Off-axis Eirp density			-28.0	-38.8	-37.1	-26.4	-44.4	-28.9	
UPLINK -- Star One C1 Carriers									UPLINK C/I - SES-10 into Star One C1						
Emission	Bandwidth (MHz)			Uplink EIRP	Uplink Eirp density	Transm. Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Eirp density	C/I	C/I	C/I	C/I	C/I	
36M0G7W	36.0			76.5	0.9	9	60.7	29	-38.7	28.9	39.8	38.0	27.3	45.4	29.8
17M9G7W	17.9			72.0	-0.5	9	60.7	29	-40.2	27.5	38.3	36.5	25.9	43.9	28.3
5M50G7W	5.5			65.0	-2.4	7.5	59.1	29	-40.5	25.6	36.4	34.7	24.0	42.0	26.5
1M64G7W	1.64			62.5	0.4	6	57.2	29	-35.8	28.4	39.2	37.4	26.8	44.8	29.2
614KG7W	0.614			61.5	3.6	4.5	54.7	29	-30.0	31.6	42.4	40.7	30.0	48.0	32.5
5K80G7W	0.0058			41.0	3.4	4.5	54.7	29	-30.3	31.4	42.2	40.4	29.8	47.8	32.2

Table A1-4: Star One C1 into SES-10 Ku-Band Downlink C/I

Downlink C/I analysis Star One C1 into SES-10				DOWNLINK -- SES-10 Carriers									
Frequency Ku-band				Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W			
				Bandwidth	0.1	54.0	36.0	0.75	9.0	2.0			
				Receive Earth Station (m)	1.8	0.65	0.65	7.6	1.2	7.6			
				Satellite EIRP	18.6	50.8	51.0	22.8	40.1	25.4			
SES-10 Orbital Position				67.0	W								
Star One C1 Orbital Position				65.0	W								
Geocentric Separation				1.9	degrees								
Topocentric Separation				2.1	degrees								
											</		

Table A1-5: SES-10 into Hypothetical satellite at 69° W.L. Ku-Band Uplink C/I

Uplink C/I analysis			SES-10 into Hypothetical Satellite				UPLINK -- SES-10 Carriers									
Frequency		Ku-band					Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W			
SES-10 Orbital Position		67.0	W				Bandwidth (MHz)	0.1	54.0	36.0	0.75	9.0	2.0			
Hypothetical Satellite Orbital Position		69.0	W				Uplink EIRP	40.2	76.7	76.7	46.0	61.7	47.8			
Geocentric Separation		1.9	degrees				Uplink Power	1.0	17.5	17.5	11.3	4.1	13.1			
Topocentric Separation		2.1	degrees				Uplink Power density	-49.0	-59.8	-58.1	-47.4	-65.4	-49.9			
							Uplink Earth Station (m)	0.76	7.6	7.6	0.45	6.3	0.45			
							Earth Station Gain	39.2	59.2	59.2	34.7	57.6	34.7			
							Upl. EIRP density	-9.8	-0.6	1.1	-12.8	-7.8	-15.2			
							Sidelobe Characteristic	29	29	29	29	29	29			
							Off-axis Eirp density	-28.0	-38.8	-37.1	-26.4	-44.4	-28.9			
UPLINK -- Hypothetical Satellite Carriers										UPLINK C/I - SES-10 into Hypothetical Satellite						
Emission	Occupied Bandwidth (MHz)			Uplink EIRP	Uplink Eirp density	Transm. Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Eirp density	C/I	C/I	C/I	C/I	C/I		
100KG7W	0.1			40.2	-9.8	0.76	39.2	29	-28.0	18.2	29.0	27.3	16.6	19.1		
54M0G7W	54.0			76.7	-0.6	7.6	59.2	29	-38.8	27.4	38.2	36.4	25.8	28.2		
36M0G7W	36.0			76.7	1.1	7.6	59.2	29	-37.1	29.1	40.0	38.2	27.5	30.0		
750KG7W	0.75			46.0	-12.8	0.45	34.7	29	-26.4	15.3	26.1	24.3	13.7	16.1		
9M0G7W	9.0			61.7	-7.8	6.3	57.6	29	-44.4	20.2	31.0	29.2	18.6	21.0		
2M0G7W	2.0			47.8	-15.2	0.45	34.7	29	-28.9	12.8	23.6	21.9	11.2	13.7		

Table A1-6: SES-10 into Hypothetical satellite at 69° W.L. Ku-Band Downlink C/I

Downlink C/I analysis Frequency Ku-band			SES-10 into Hypothetical Satellite						DOWNLINK -- SES-10 Carriers						
									Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
									Bandwidth	0.1	54.0	36.0	0.75	9.0	2.0
SES-10 Orbital Position			67.0	W					Receive Earth Station (m)	1.8	0.65	0.65	7.6	1.2	7.6
Hypothetical Satellite Orbital Position			69.0	W					Satellite EIRP	18.6	50.8	51.0	22.8	40.1	25.4
Geocentric Separation			1.9	degrees					Downlink EIRP density	-31.4	-26.5	-24.6	-36.0	-29.4	-37.6
Topocentric Separation			2.1	degrees					RX Earth Station Gain	45.2	36.3	36.3	57.7	41.6	57.7
									Sidelobe Characteristic	29	29	29	29	29	29
									Off-axis Gain	21.0	21.0	21.0	21.0	21.0	21.0
DOWNLINK -- Hypothetical Satellite Carriers									DOWNLINK C/I - SES-10 into Hypothetical Satellite						
Emission			Satellite EIRP	Bandw. (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I
100KG7W			18.6	0.1	-31.4	1.8	45.2	29	21.0	24.2	19.3	17.3	28.7	22.2	30.4
54M0G7W			50.8	54.0	-26.5	0.65	36.3	29	21.0	20.2	15.3	13.4	24.7	18.2	26.4
36M0G7W			51.0	36.0	-24.6	0.65	36.3	29	21.0	22.2	17.3	15.3	26.7	20.2	28.4
750KG7W			22.8	0.75	-36.0	7.6	57.7	29	21.0	32.1	27.2	25.3	36.7	30.2	38.3
9M0G7W			40.1	9.0	-29.4	1.2	41.6	29	21.0	22.6	17.7	15.8	27.2	20.6	28.8
2M0G7W			25.4	2.0	-37.6	7.6	57.7	29	21.0	30.5	25.6	23.6	35.0	28.5	36.7

Table A1-7: Hypothetical satellite at 69° W.L. into SES-10 Ku-Band Uplink C/I

Uplink C/I analysis Hypothetical Satellite into SES-10				UPLINK -- SES-10 Carriers											
Frequency		Ku-band		Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W					
				Bandwidth (MHz)	0.1	54.0	36.0	0.75	9.0	2.0					
				Uplink EIRP	40.2	76.7	76.7	46.0	61.7	47.8					
				Uplink Power	1.0	17.5	17.5	11.3	4.1	13.1					
SES-10 Orbital Position	67.0	W		Uplink Power density	-49.0	-59.8	-58.1	-47.4	-65.4	-49.9					
Hypothetical Satellite Orbital Position	69.0	W		Uplink Earth Station (m)	0.76	7.6	7.6	0.45	6.3	0.45					
Geocentric Separation	1.9	degrees		Earth Station Gain	39.2	59.2	59.2	34.7	57.6	34.7					
Topocentric Separation	2.1	degrees		Upl. EIRP density	-9.8	-0.6	1.1	-12.8	-7.8	-15.2					
				Sidelobe Characteristic	29.0	29.0	29.0	29.0	29.0	29.0					
				Off-axis Eirp density	-28.0	-38.8	-37.1	-26.4	-44.4	-28.9					
UPLINK -- Hypothetical Satellite Carriers								UPLINK C/I - Hypothetical Satellite into SES-10							
Emission	Occupied Bandwidth (MHz)		Uplink EIRP	Uplink Eirp density	Transm. Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Eirp density	C/I	C/I	C/I	C/I	C/I	C/I	
100KG7W	0.1		40.2	-9.8	0.76	39.2	29	-28.0	18.2	27.4	29.1	15.3	20.2	12.8	
54M0G7W	54.0		76.7	-0.6	7.6	59.2	29	-38.8	29.0	38.2	40.0	26.1	31.0	23.6	
36M0G7W	36.0		76.7	1.1	7.6	59.2	29	-37.1	27.3	36.4	38.2	24.3	29.2	21.9	
750KG7W	0.75		46.0	-12.8	0.45	34.7	29	-26.4	16.6	25.8	27.5	13.7	18.6	11.2	
9M0G7W	9.0		61.7	-7.8	6.3	57.6	29	-44.4	34.6	43.8	45.6	31.7	36.6	29.2	
2M0G7W	2.0		47.8	-15.2	0.45	34.7	29	-28.9	19.1	28.2	30.0	16.1	21.0	13.7	

Table A1-8: Hypothetical satellite at 69° W.L. into SES-10 Ku-Band Downlink C/I

Downlink C/I analysis		Hypothetical Satellite into SES-10						DOWNLINK -- SES-10 Carriers						
Frequency	Ku-band							Emission	100KG7W	54M0G7W	36M0G7W	750KG7W	9M0G7W	2M0G7W
								Bandwidth	0.1	54.0	36.0	0.75	9.0	2.0
SES-10 Orbital Position	67.0	W						Receive Earth Station (m)	1.8	0.65	0.65	7.6	1.2	7.6
Hypothetical Satellite Orbital Position	69.0	W						Satellite EIRP	18.6	50.8	51.0	22.8	40.1	25.4
Geocentric Separation	1.9	degrees						Downlink EIRP density	-31.4	-26.5	-24.6	-36.0	-29.4	-37.6
Topocentric Separation	2.1	degrees						RX Earth Station Gain	45.2	36.3	36.3	57.7	41.6	57.7
								Sidelobe Characteristic	29	29	29	29	29	29
								Off-axis Gain	21.0	21.0	21.0	21.0	21.0	21.0
DOWNLINK -- Hypothetical Satellite Carriers									DOWNLINK C/I - Hypothetical Satellite into SES-10					
Emission	Satellite EIRP	Bandw. (MHz)	Downlink EIRP density	Receive Ant. (m)	Earth Station Gain	Sidelobe Charact.	Off-axis Gain	C/I	C/I	C/I	C/I	C/I	C/I	
100KG7W	18.6	0.1	-31.4	1.8	45.2	29	21.0	24.2	20.2	22.2	32.1	22.6	30.5	
54M0G7W	50.8	54.0	-26.5	0.65	36.3	29	21.0	19.3	15.3	17.3	27.2	17.7	25.6	
36M0G7W	51.0	36.0	-24.6	0.65	36.3	29	21.0	17.3	13.4	15.3	25.3	15.8	23.6	
750KG7W	22.8	0.75	-36.0	7.6	57.7	29	21.0	28.7	24.7	26.7	36.7	27.2	35.0	
9M0G7W	40.1	9.0	-29.4	1.2	41.6	29	21.0	22.2	18.2	20.2	30.2	20.6	28.5	
2M0G7W	25.4	2.0	-37.6	7.6	57.7	29	21.0	30.4	26.4	28.4	38.3	28.8	36.7	

ANNEX D

Analysis of ANNEX 1 of Appendix 30A

Analysis of ANNEX 1 of Appendix 30A

1 Limits to the change in the overall equivalent protection margin with respect to frequency assignments in conformity with the Region 2 feeder-link Plan (WRC-2000)

With respect to the modification to the Region 2 feeder-link Plan and when it is necessary under this Appendix to seek the agreement of any other administration of Region 2, except in cases covered by Resolution **42 (Rev.WRC-03)**, an administration is considered as being affected if the overall equivalent protection margin corresponding to a test point of its entry in that Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

- the feeder-link Plan as established by the 1983 Conference; or
- a modification of the assignment in accordance with this Appendix; or
- a new entry in the feeder-link Plan under Article 4; or
- any agreement reached in accordance with this Appendix except for Resolution **42 (Rev.WRC-03)**. (WRC-03)

The BSS payload of the SES-10 satellite will operate under the UK's USAT-67W ITU network. Using the maximum uplink transmission parameters of the SES-10 satellite network, an MSPACE analysis was performed utilizing the Region 2 BSS Plan as contained in IFIC 2723. The results of the analysis are contained in Table A.1 below. As shown, there are four affected networks that were all filed on behalf of the UK, and further, all four networks were filed on behalf of SES. Therefore there are no interference issues because SES will be able to coordinate operations internally.

Table A.1. MSPACE Results

Admin	Orbital Position (°W)	Network	Max. OEPM Degradation (dB)
UK	66.3	USAT-S5	2.961
UK	66.3	USAT-S5 MOD-A	2.956
UK	68.5	USAT-S4 MOD-A	0.920
UK	68.5	USAT-S4 MOD-B	4.642

2 Limits to the interference into frequency assignments in conformity with the Regions 1 and 3 feeder-link Plan or with the Regions 1 and 3 feeder-link List or proposed new or modified assignments in the Regions 1 and 3 feeder-link List (WRC-03)

Not Applicable to Region 2.

3 Limits applicable to protect a frequency assignment in the bands 17.3-18.1 GHz (Regions 1 and 3) and 17.3-17.8 GHz (Region 2) to a receiving space station in the fixed-satellite service (Earth-to-space)

An administration in Region 1 or 3 is considered as being affected by a proposed modification in Region 2, with respect to § 4.2.2 a) or 4.2.2 b) of Article 4, or an administration in Region 2 is considered as being affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List, with respect to § 4.1.1 c) of Article 4, when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link would cause an increase in the noise temperature of the feeder-link space station which exceeds the threshold value of $\Delta T / T$ corresponding to 6%, where $\Delta T / T$ is calculated in accordance with the method given in Appendix 8, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)

Table A.2 shows the results of $\Delta T / T$ calculations for the closest Regions 1 and 3 feeder link space stations, based on the Region 1 and 3 Plan and List. As shown the $\Delta T / T$ values are well below the allowed 6% level. Therefore the SES-10 satellite network is in conformity with this Section.

Table A.2. Delta T/T Calculation Results.

Closest Region 1 or 3 Feeder Link Space Station			E/S Lat (°N)	E/S Long (°E)	Range (km)	E/S Gain towards Victim Satellite (dBi)	Victim Satellite Rx System Noise Temp (K)	Calculated $\Delta T/T$ (%)
Network Name	Orbital Position (°E)	Peak Receive Antenna Gain (dBi)						
INTERSPUTNIK-47.5W-B	-47.5	37	29.0	-99.0	39064	-4.2	600	0.12%
MCO-BSS-40.5W	-40.5	35.9	29.0	-99.0	39661	-7.5	600	0.04%
GMB30200	-37.2	47.69	29.0	-99.0	39956	-8.7	600	0.48%
IRL21100	-37.2	48.08	29.0	-99.0	39956	-8.7	600	0.53%
NGR11500	-37.2	38.47	29.0	-99.0	39956	-8.7	600	0.06%
DBL-G4-37.2W	-37.2	35	29.0	-99.0	39956	-8.7	330	0.05%
AND34100	-37	48.88	29.0	-99.0	39974	-8.8	600	0.63%
GUI19200	-37	42.29	29.0	-99.0	39974	-8.8	600	0.14%
POR_100	-37	47.17	29.0	-99.0	39974	-8.8	600	0.42%

4 Limits applicable to protect a frequency assignment in the band 17.8-18.1 GHz (Region 2) to a receiving feeder-link space station in the fixed-satellite service (Earth-to-space) (WRC-03)

With respect to § 4.1.1 d) of Article 4, an administration is considered affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link in Region 2 of that administration would cause an increase in the noise temperature of the receiving feeder-link space station which exceeds the threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix 8, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)

Not Applicable to Region 2.

DECLARATION

I, Simone La Torre, hereby certify under penalty of perjury that I am the technically qualified person responsible for preparation of the technical information contained in the foregoing exhibit; that I am familiar with the technical requirements of Part 25; and that I either prepared or reviewed the technical information contained in the exhibit and that it is complete and accurate to the best of my knowledge, information and belief.

/s/ Simone La Torre

Simone La Torre
Engineer, Spectrum Management and Development
SES Americom, Inc.

Dated: January 15, 2016