

ATTACHMENT A

Technical Annex to Supplement Schedule S

1. SCOPE

This attachment contains certain information required by 47 C.F.R. § 25.114 and other sections of the FCC's Part 25 rules that cannot be entered on Schedule S.

2. GENERAL DESCRIPTION

The ECHOSTAR-12 satellite will operate at the 86.4° W.L. orbital location on a regular basis in accordance with the United Kingdom's filings with the International Telecommunication Union ("ITU") for the IOMSAT-S21 network.

The ECHOSTAR-12 satellite will operate in the 17.3-17.8 GHz BSS feeder uplink band (ITU Appendix 30A) and the 12.2-12.7 GHz BSS downlink band (ITU Appendix 30). The satellite's frequency plan, including uplink and downlink connectivity, is identical to that prescribed in the ITU's Region 2 BSS and associated feeder link Plan. Full frequency re-use is achieved through the use of dual orthogonal polarizations. The cross-polar isolation of the satellite's receive and transmit antennas exceeds 27 dB.

The ECHOSTAR-12 satellite has the capability of transmitting and receiving via twenty-two circular spot beams. At the 86.4° W.L. orbital location, five uplink spot beams and eight downlink spot beams collectively will be used to provide service to Colombia. The satellite will transmit on channels 1, 5, 9, 13, 17 and 21. Table 1-1 provides the satellite's beam and channel strapping information. The channel numbering and associated center frequencies are identical to those contained in Appendices 30 and 30A of the ITU Radio Regulations for the ITU Region 2 Plan.

Table 1-1: ECHOSTAR-12 satellite’s beam and channel strapping to be used at 86.4°W.L.

Uplink Beam	Uplink Channel	Downlink Beam	Downlink Channel
RX1	5	TX2	5
RX1	9	TX2	9
RX1	13	TX2	13
RX1	21	TX2	21
RX2	1	TX4	1
RX2	17	TX4	17
RX2	5	TX3	5
RX2	9	TX3	9
RX2	13	TX3	13
RX2	21	TX3	21
RX3	5	TX7	5
RX3	9	TX7	9
RX3	13	TX7	13
RX3	21	TX7	21
RX3	1	TX8	1
RX3	17	TX8	17
RX4	5	TX5	5
RX4	9	TX5	9
RX4	13	TX5	13
RX4	21	TX5	21
RX4	1	TX6	1
RX4	17	TX6	17
RX5	17	TX1	17

3. TT&C

The telemetry, tracking and command (“TT&C”) earth stations will be located at EchoStar’s satellite control facilities in Mount Jackson, VA, and Blackhawk, South Dakota. The satellite’s near-omnidirectional beams will be used for TT&C purposes. A thorough analysis of TT&C frequency interference has been conducted, and there are no conflicts with adjacent satellite operators.

A summary of the TT&C subsystem performance is given in Table 3-1 below.

Table 3-1: Summary of the TT&C Subsystem Performance

Parameter	Performance
On-Station Command Frequency	17,304.0 MHz
Auto-Tracking Beacon	17,798.0 MHz
Uplink Flux Density	-60 to -80 dBW/m ²
Uplink Polarization	Linear (Vertical)
On-Station Telemetry Frequencies	12,205.0 MHz 12,697.0 MHz
Maximum Downlink EIRP	1.0 dBW
Downlink Polarization	Linear (Vertical)

4. ORBITAL DEBRIS MITIGATION PLAN

The Commission has reviewed and approved orbital debris mitigation information previously submitted for ECHOSTAR-12, subject to grant of limited waivers of 47 C.F.R. §§ 25.114(d)(14(ii) and 25.283(c) to allow residual amounts of oxidizer and helium to remain at the satellite’s end of life.¹ All such information remains materially the same, except as discussed below with respect to safe flight profiles.

4.1 Safe Flight Profiles

In considering current and planned satellites that may have a station-keeping volume that overlaps the ECHOSTAR-12 satellite, EchoStar has reviewed the lists of FCC-licensed satellite

¹ See EchoStar, IBFS File No. SAT-MOD-20130905-00113, Attachment to Grant at 1 (granted Feb. 27, 2014).

networks, as well as 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 $\pm 0.15^\circ$ of 86.4° W.L. have been reviewed.

Based on these reviews, EchoStar concludes that there are no operational or planned satellites that could have a station-keeping overlap with the ECHOSTAR-12 satellite. Telesat Canada operates the NIMIQ 1 satellite nominally at 86.5° W.L. with an east-west station-keeping tolerance of ± 0.05 degrees. EchoStar will maintain the ECHOSTAR-12 satellite at the 86.4° W.L. orbital location, with an east-west station-keeping tolerance of ± 0.05 degrees, thereby ensuring there is no possibility of station-keeping volume overlap between the two satellites.

Based on the preceding, EchoStar concludes that there is no requirement to physically coordinate the ECHOSTAR-12 satellite with another satellite operator at the present time.

5. INTERFERENCE ANALYSES

The ECHOSTAR-12 satellite at 86.4° W.L. will operate under the UK Administration's IOMSAT-S21 ITU filing. Accordingly, EchoStar, through the UK Administration, is responsible for coordination of the ECHOSTAR-12 satellite following the Appendix 30 and 30A coordination procedures.

The analyses of the ECHOSTAR-12 satellite network at 86.4° W.L. with respect to the limits in Annex 1 to Appendices 30 and 30A are given in Appendices 1 and 2 to this attachment. The results of these analyses are discussed below. Note that the analyses were performed against IFIC 2697; a rather old IFIC in which the IOMSAT-S21 network was published. Networks that have since expired and been suppressed by the ITU were ignored in the analyses.

The Appendices show that the ECHOSTAR-12 satellite network meets all the ITU criteria in Annex 1, except for § 4.2.3(c) of Article 4 of Appendices 30 and 30A. With respect to § 4.2.3(c), the MSPACE analysis shows that there are two adjacent Region 2 BSS networks that are deemed to be affected: Bahama's non-operational BAHIFRB1 Plan network and Mexico's operational QUETZSAT-77 network.

The Bahama's network was identified as being potentially affected when the IOMSAT-S21 network was published, but Bahama did not comment within the requisite four-month period, therefore coordination with the Bahamian network is not required. With respect to the Mexico's network at 77° W.L., EchoStar has an agreement with the operator of the QUETZSAT-77 satellite network.

Based on the preceding, EchoStar concludes that coordination of the ECHOSTAR-12 satellite network with another operator / administration is not required.

**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.

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June 26, 2017

Appendix 1 to Technical Annex:
Analysis of ANNEX 1 of Appendix 30

1 Limits for the interference into frequency assignments in conformity with the Regions 1 and 3 Plan or with the Regions 1 and 3 List or into new or modified assignments in the Regions 1 and 3 List

Not Applicable to Region 2.

2 Limits to the change in the overall equivalent protection margin for frequency assignments in conformity with the Region 2 plan

With respect to § 4.2.3 c) of Article 4, an administration in Region 2 is considered as being affected if the overall equivalent protection margin corresponding to a test point of its entry in the Region 2 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 Region 2 Plan as established by the 1983 Conference; or*
- a modification of the assignment in accordance with this Appendix; or*
- a new entry in the Region 2 Plan under Article 4; or*
- any agreement reached in accordance with this Appendix. (WRC-03)*

The MSPACE analysis was performed utilizing the Region 2 BSS Plan as contained in IFIC 2697. This is the IFIC in which the IOMSAT-S21 network was published. The results of the analysis are contained below in Annex 1 to this Appendix.

3 Limits to the change in the power flux-density to protect the broadcasting-satellite service in Regions 1 and 2 in the band 12.2-12.5 GHz and in Region 3 in the band 12.5-12.7 GHz

With respect to § 4.2.3 a), 4.2.3 b) or 4.2.3 f) of Article 4, as appropriate, an administration in Region 1 or 3 is considered as being affected if the proposed modification to the Region 2 Plan would result in exceeding the following power flux-density values, at any test point in the service area of its overlapping frequency assignments:

$-147 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$	$\text{for } 0^\circ \leq \theta < 0.23^\circ$
$-135.7 + 17.74 \log \theta \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$	$\text{for } 0.23^\circ \leq \theta < 2.0^\circ$
$-136.7 + 1.66 \theta^2 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$	$\text{for } 2.0^\circ \leq \theta < 3.59^\circ$
$-129.2 + 25 \log \theta \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$	$\text{for } 3.59^\circ \leq \theta < 10.57^\circ$
$-103.6 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$	$\text{for } 10.57^\circ \leq \theta$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies. (WRC-03)

The GIMS Appendix 30 PFD tool was used to assess compliance with this Section. Using the antenna gain contours and power levels of the beams of the ECHOSTAR-12 satellite, the GIMS PFD tool showed that no administrations are affected. Accordingly, the ECHOSTAR-12 satellite network is compliant with this Section.

4 Limits to the power flux-density to protect the terrestrial services of other administrations

With respect to § 4.1.1 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modified assignment in the Regions 1 and 3

List is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Plan or List for Regions 1 and 3 as established by WRC-2000. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the consequence of the proposed modification to an existing assignment in the Region 2 Plan is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference. The same administration is considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to § 4.1.1 d) or § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 is considered as being affected if the proposed new assignment in the Regions 1 and 3 List, or if the proposed new frequency assignment in the Region 2 Plan, would result in exceeding a power flux-density, for any angle of arrival, at any point on its territory, of:

$$\begin{array}{ll} -148 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))} & \text{for } \theta \leq 5^\circ \\ -148 + 0.5 (\theta - 5) \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))} & \text{for } 5^\circ < \theta \leq 25^\circ \\ -138 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))} & \text{for } 25^\circ < \theta \leq 90^\circ \end{array}$$

where θ represents the angle of arrival. (WRC-03)

The GIMS PFD tool was used to determine the administrations whose terrestrial services may be affected by the ECHOSTAR-12 satellite network. Using this tool, the results show that the PFD limits are not exceeded over the territory of any administration and therefore the ECHOSTAR-12 satellite is compliant with this Section.

5 Limits to the change in the power flux-density of assignments in the Regions 1 and 3 Plan or List to protect the fixed-satellite service (space-to-Earth) in the band 11.7-12.2 GHz in Region 2 or in the band 12.2-12.5 GHz in Region 3, and of assignments in the Region 2 Plan to protect the fixed-satellite service (space-to-Earth) in the band 12.5-12.7 GHz in Region 1 and in the band 12.2-12.7 GHz in Region 3

With respect to § 4.2.3 e), an administration is considered as being affected if the proposed modification to the Region 2 Plan would result in an increase in the power flux-density over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1 or 3 of 0.25 dB or more above that resulting from the frequency assignments in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference.

With respect to § 4.1.1 e) or 4.2.3 e) of Article 4, an administration is considered as not being affected if the proposed new or modified assignment in the Regions 1 and 3 List, or if a proposed modification to the Region 2 Plan, gives a power flux-density anywhere over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1, 2 or 3 of less than:

$$\begin{aligned} -186.5 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) & \quad \text{for } 0^\circ \leq \theta < 0.054^\circ \\ -164.0 + 17.74 \log \theta \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) & \quad \text{for } 0.054^\circ \leq \theta < 2.0^\circ \\ -165.0 + 1.66 \theta^2 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) & \quad \text{for } 2.0^\circ \leq \theta < 3.59^\circ \\ -157.5 + 25 \log \theta \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) & \quad \text{for } 3.59^\circ \leq \theta < 10.57^\circ \\ -131.9 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) & \quad \text{for } 10.57^\circ \leq \theta \end{aligned}$$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

The ITU's GIBC software tool was used to assess compliance with this Section. The results show that no administrations are affected and therefore the ECHOSTAR-12 satellite network is compliant with this Section.

6 Limits to the change in equivalent noise temperature to protect the fixed-satellite service (Earth-to-space) in Region 1 from modifications to the Region 2 Plan in the band 12.5-12.7 GHz

With respect to § 4.2.3 e) of Article 4, an administration of Region 1 is considered as being affected if the proposed modification to the Region 2 Plan would result in:

- the value of $\Delta T / T$ resulting from the proposed modification is greater than the value of $\Delta T / T$ resulting from the assignment in the Region 2 Plan as of the date of entry into force of the Final Acts of the 1985 Conference; and*

- *the value of $\Delta T / T$ resulting from the proposed modification exceeds 6%, using the method of Appendix 8 (Case II). (WRC-03)*

Based on a review of the available ITU space network databases, there are no assignments registered in the Earth-to-space direction in the frequency band 12.5-12.7 GHz. Accordingly, no Region 1 space stations can be affected and the ECHOSTAR-12 satellite network is compliant with this Section.

Annex 1 to Appendix 1 to Attachment A

ECHOSTAR-12 at 86.4° W.L. MSPACE Results

Admin	Orbital Position (°W)	Network	Max. OEPM Degradation (dB)
BAH	87.20	BAHIFRB1	1.232
MEX	77.00	QUETZSAT-77	1.242

Appendix 2 to Technical Annex:
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)*

See the results described under Section 2 of the Appendix 30 Annex 1 Analysis.

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 feederlink carriers. (WRC-03)

The analysis shows that there are no affected Region 1 or Region 3 networks.

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.
