ATTACHMENT A

Technical Information to Supplement Schedule S

A.1 SCOPE AND PURPOSE

Viasat, Inc. ("Viasat") has U.S. market access to operate the VIASAT-3 satellite at 88.9° W.L. under authority of the United Kingdom. Specifically, Viasat has been granted U.S. market access to provide FSS services using the 28.1-29.1 GHz and 29.5-30 GHz band segments (Earth-to-space) and the 18.3-19.3 GHz and 19.7-20.2 GHz band segments (space-to-Earth). Viasat now seeks U.S. market access for that spacecraft in the 27.5-28.1 GHz and 29.1-29.5 GHz band segments (Earth-to-space) and the 17.7-18.3 GHz and 19.3-19.7 GHz band segments (space-to-Earth).

In addition, Viasat seeks to modify its existing VIASAT-3 U.S. market access for the 29.5-30 GHz and 19.7-20.2 GHz bands so that Viasat instead may be licensed in those band segments as a U.S. operator at 88.9° W.L. and implement VIASAT-3 under the USASAT-31S ITU satellite network currently implemented through the Ka band payload on Galaxy 28. For purposes of this attachment, the 29.5-30 GHz band and 19.7-20.2 GHz payload will be known as "VIASAT-89US". The remainder of the satellite's payload, including that portion used for TT&C, will be known as "VIASAT-3 (89W)." Both payloads will be on the same spacecraft.

There is no change to the coverage of the United States underlying the current U.S. market access grant, but the satellite's coverage area now includes visible earth. Viasat will now use portions of the conventional Ku-band for TT&C and conduct TT&C operations from outside the United States. The coverage of the United States does not change, nor are there changes in any of the fundamental RF characteristics that would affect the operating environment with other spectrum users.[1]

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[1] Although not directly related to the existing terms of the market access grant for 88.9º W.L., Viasat notes that the satellite to be deployed will now provide near-hemispheric coverage.

The purpose of this Attachment is to provide the Commission with the technical characteristics of the VIASAT-3 (89W) payload, as modified to include the 27.5-28.1 GHz and 29.1-29.5 GHz band segments (Earth-to-space) and the 17.7-18.3 GHz and 19.3-19.7 GHz bands (space-to-Earth), as well as those of the VIASAT-89US payload for the 29.5-30 GHz (Earth-to-space) and 19.7-20.2 GHz (space-to-Earth) band segments.[2]

A.2 GENERAL DESCRIPTION

The satellite will provide a variety of Ka-band satellite services from the nominal 89º W.L. orbital location, with an offset of 0.1° and the station-keeping box centered at 88.9° W.L.

The satellite network will provide service to small, fixed and temporary-fixed user antennas as well as to very small antennas for earth stations in motion (ESIM) applications. In addition, gateway-type antennas called satellite access nodes (SANs) will be employed.

The satellite's beam coverage, both transmit and receive, consists of multiple spot beams that collectively are capable of providing service to virtually all parts of the Earth visible from 88.9° W.L. This application seeks authority with respect to CONUS, Hawaii, Puerto Rico, the U.S. Virgin Islands and parts of Alaska (*i.e.,* all portions of the United States and its territories that are visible from 88.9° W.L.).

The satellite typically uses asymmetric forward (SAN-to-subscriber) and return (subscriber-to-SAN) links. The network uses adaptive coding and modulation to combat rain fades. That is, the

[2] The spacecraft will be capable of operating across the 27.5-31.0 GHz band (Earth-to-space) and the 17.7-21.2 GHz band (space-to-Earth), but this application seeks Commission authority only with respect to the 27.5-28.1 GHz, 29.1-29.5 GHz, 17.7-18.3 GHz, and 19.3-19.7 GHz band segments, which represent the additional bands being added to the existing Commission authority, and the request to operate in the 19.7-20.2 GHz and 29.5-30 GHz band segments under a U.S. license instead of under the current U.S. market access grant. The technical information being provided in this application relates only to these bands.

modulation type, amount of coding and/or user data rate will be dynamically varied to meet the link requirements during rain events (in addition to employing uplink power control).

As noted above, TT&C operations will be conducted from outside the United States in the Ku-band and thus are not the subject of this application.

A.3 FREQUENCY AND POLARIZATION PLAN

The satellite's frequency plan for which Commission authorization is sought is given in Table A.3-1, indicating channel center, polarization and bandwidth. The table also shows the connectivity between each uplink and downlink band. Circular polarization is used on both the uplink and downlink with the downlink polarization being orthogonal to the uplink polarization. The satellite re-uses the spectrum such that any channel is re-used multiple times by a combination of polarization and spatial isolation. This satisfies the requirements of §25.210(f) of the FCC's Part 25 rules (the "Rules").

Table A.3-1. Satellite's Frequency Plan for Additional Frequencies and VIASAT-US89

Payload	Uplink Band Center Frequency (MHz)	Uplink Polarization	Downlink Band Center Frequency (MHz)	Downlink Polarization	Bandwidth (MHz)
VIASAT-3 (89W)	27,800	RHCP, LHCP	18,000	LHCP, RHCP	600
VIASAT-3 (89W)	29,300	RHCP, LHCP	19,500	LHCP, RHCP	400
VIASAT-US89	29,750	RHCP, LHCP	19,950	LHCP, RHCP	500

A.4 SATELLITE ANTENNA BEAMS AND ANTENNA GAIN CONTOURS

The satellite's antenna gain contours are being provided to the Commission in a GIMS container file; one file for each of the two payloads.

Each payload employs multiple spot beams in both the uplink and downlink directions. There are two types of spot beams: small beams ("A"-type beams) and larger beams ("B"-type beams). For each beam-type, the beams are nominally identical.

Viasat is providing the Commission with an isoline gain contour, in both uplink and downlink directions, that depict, on a composite basis across the entire coverage area, the -2 dB relative gain contour of all spot beams that may be operated within that area. In addition, the predicted antenna gain contours for one transmit and receive representative spot beam for each of the two beam types, and in both polarizations, is included in the two GIMS files associated with the individual VIASAT-3 (89W) and VIASAT-89US payloads.

The following beams have been included in the GIMS file associated with the VIASAT-3 (89W) payload:

1) RAR1, RAR2, RAL1 and RAL2. Representative spot beam contours for the uplink A-type beams, in both polarizations, and for each uplink band.
2) TAR1, TAR2, TAL1 and TAL2. Representative spot beam contours for the downlink A-type beams, in both polarizations, and for each downlink band.
3) RBR1, RBR2, RBL1 and RBL2. Representative spot beam contours for the uplink B-type beams, in both polarizations, and for each uplink band.
4) TBR1, TBR2, TBL1 and TBL2. Representative spot beam contours for the downlink B-type beams, in both polarizations, and for each downlink band.
5) RXAR_ISO and RXAL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the uplink A-type beams; applicable to both uplink bands.
6) TXAR_ISO and TXAL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the downlink A-type beams; applicable to both downlink bands.
7) RXBR_ISO and RXBL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the uplink B-type beams; applicable to both uplink bands.
8) TXBR_ISO and TXBL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the downlink B-type beams; applicable to both downlink bands.

The following beams have been included in the GIMS file associated with the VIASAT-89US payload:

1) RAR1 and RAL1. Representative spot beam contours for the uplink A-type beams in both polarizations.
2) TAR1and TAL1. Representative spot beam contours for the downlink A-type beams in both polarizations.
3) RBR1 and RBL1. Representative spot beam contours for the uplink B-type beams in both polarizations.
4) TBR1 and TBL1. Representative spot beam contours for the downlink B-type beams in both polarizations.
5) RXAR_ISO and RXAL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the uplink A-type beams.
6) TXAR_ISO and TXAL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the downlink A-type beams.
7) RXBR_ISO and RXBL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the uplink B-type beams.
8) TXBR_ISO and TXBL_ISO. These contain a -2 dB relative gain isoline contour, in both polarizations, for the downlink B-type beams.

A.5 TT&C CHARACTERISTICS

TT&C operations will be conducted from outside the United States in the conventional Ku-band and thus are not the subject of this application. As information, the TT&C center frequencies available to be used by the spacecraft are given in Table A.5-1.

Table A.5-1. Summary of the TT&C Subsystem Characteristics

Usage	Frequency (MHz)	Polarization
Command	14000.3	Vertical
	14001.0	Vertical
	14498.5	Horizontal
	14499.0	Horizontal

Telemetry	11700.25	Horizontal or Vertical
	11701.75	Horizontal or Vertical
	12197.5	Horizontal or Vertical
	12199.5	Horizontal or Vertical

Intelsat operates the C-/Ku-/Ka-band GALAXY 28 satellite at 89° W.L. Viasat has coordinated its proposed use of these TT&C frequencies with Intelsat.

A.6 MAXIMUM KA-BAND TRANSMISSION LEVELS

The satellite network will be operated such that the maximum uplink and downlink transmissions, from and to the United States, will not exceed the transmission levels contained in §25.138, regardless of the Ka-band frequency band segment. Authorized uplink transmissions to the satellite will not exceed the applicable EIRP density envelopes of §25.138(a). The satellite's downlink transmissions will not exceed a PFD level of -118 dBW/m^2/MHz. Because PFD is dependent on the slant path and hence spreading loss, the maximum EIRP density from the satellite can vary accordingly. For example, for a spreading loss of 162.8 dB (25° elevation angle), the satellite's transmissions would not exceed an EIRP density of 44.8 dBW/MHz.

A.7 POWER FLUX DENSITY AT THE EARTH'S SURFACE (17.7-18.3 GHZ AND 19.3-19.7 GHZ BANDS)

The maximum PFD transmitted towards U.S. territory by the VIASAT-3 (89W) payload will be compliant with the §25.208(c) PFD limits that apply to the 17.7-18.3 GHz and 19.3-19.7 GHz bands. The PFD limits of §25.208(c) are as follows:

- -115 dB(W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- -115+(δ-5)/2 dB(W/m^2) in any 1 MHz band for angles of arrival δ (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -105 dB(W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

As explained in section A.6, Viasat will operate the satellite such that no transmissions in any downlink Ka-band frequency band segment will exceed a PFD level of -118 $dBW/m^2/MHz$ towards U.S. territory. This PFD level is in compliance with §25.208(c).

A.8 TWO DEGREE COMPATIBILITY

A.8.1 Frequency Bands Subject to §25.138

Viasat certifies that authorized uplink transmissions to the VIASAT-89US payload will not exceed the applicable EIRP density envelopes of §25.138(a) and that payload's downlink transmissions will not exceed a PFD level of -118 $dBW/m^2/MHz$. Similarly, Viasat also certifies that authorized uplink transmissions to the VIASAT-3 (89W) payload will not exceed the applicable EIRP density envelopes of §25.138(a) and that the payload's downlink transmissions will not exceed a PFD level of -118 $dBW/m^2/MHz$. Accordingly, two-degree compatibility is ensured for the 29.25-30 GHz and 19.7-20.2 GHz band segments.

A.8.2 Frequency Bands Not Subject to §25.138

This section demonstrates that transmissions in the 27.5-28.1 GHz and 29.1-29.25 GHz band segments (Earth-to-space) and the 17.7-18.3 GHz and 19.3-19.7 GHz band segments (space-to-Earth) are two-degree compatible. Currently there are no operational GSO Ka-band satellites that use these bands at or within two degrees of the 88.9º W.L. location, nor are there any pending applications before the Commission for use of these bands by a GSO satellite at or within two degrees of 88.9° W.L. Therefore, in order to demonstrate two-degree compatibility, the transmission parameters of the VIASAT-3 (89W) payload have been assumed as both the wanted and victim transmissions.

Table A.8-2 provides a summary of the typical uplink and downlink transmission parameters of the VIASAT-3 (89W) payload and which were used in the interference analysis. The interference calculations assumed a 1 dB advantage for topocentric-to-geocentric conversion and that all wanted and interfering carriers are co-polarized. The C/I calculations were performed on a per Hz basis.

Table A.8-3 shows the results of the interference calculations in terms of the overall C/I margins. It can be seen that the C/I margins are positive in all cases, demonstrating that transmissions associated with the VIASAT-3 (89W) payload are two-degree compatible.

Table A.8-2. Typical VIASAT-3 payload transmission parameters.

Carrier ID	Emission Designator	Assigned Bandwidth (MHz)	Tx E/S Gain (dBi)	Uplink EIRP (dBW)	Downlink EIRP (dBW)	Rx E/S Gain (dBi)	C/I Criterion (dB)
1	600MG7D	600	65.0	75.0	70.8	49.3	19.7
2	500MG7D	500	65.0	75.0	70.0	49.3	20.5
3	500MG7D	500	65.0	75.0	70.0	40.7	13.8
4	500MG7D	500	65.0	75.0	70.0	33.7	9.3
5	400MG7D	400	65.0	75.0	69.0	40.7	14.7
6	300MG7D	300	65.0	75.0	67.8	40.7	9.6
7	200MG7D	200	44.3	58.3	63.0	61.4	14.0
8	100MG7D	100	44.3	57.7	60.0	61.4	13.3
9	50M0G7D	50	44.3	57.1	57.0	61.4	11.3
10	12M5G7D	12.5	44.3	55.4	51.0	61.4	11.9
11	6M25G7D	6.25	37.3	39.1	48.0	61.4	9.3

Table A.8-3. Summary of the overall C/I margins (dB).

		Interfering Carriers										
	Carrier ID	1	2	3	4	5	6	7	8	9	10	11
Wanted Carriers	1	9.0	9.0	9.0	9.0	9.0	8.9	10.7	9.9	8.7	5.8	5.6
	2	8.3	8.3	8.3	8.3	8.2	8.2	10.1	9.4	8.3	5.6	5.4
	3	6.5	6.5	6.5	6.5	6.4	6.4	9.3	9.1	8.9	8.1	8.0
	4	4.0	4.0	4.0	4.0	4.0	3.9	6.9	6.9	6.8	6.6	6.6
	5	5.5	5.5	5.5	5.5	5.5	5.5	8.3	8.2	8.0	7.3	7.3
	6	10.6	10.6	10.6	10.6	10.6	10.6	13.5	13.4	13.3	12.7	12.7
	7	17.5	16.9	16.9	16.9	16.1	15.0	9.8	7.3	5.0	0.6	0.3
	8	19.9	19.4	19.4	19.4	18.7	17.7	12.8	10.4	8.1	3.8	3.4
	9	23.3	22.9	22.9	22.9	22.3	21.5	17.1	14.7	12.4	8.1	7.8
	10	24.6	24.3	24.3	24.3	24.0	23.5	20.5	18.3	16.1	11.9	11.5
	11	16.5	16.0	16.0	16.0	15.4	14.6	10.2	7.8	5.5	1.2	0.8

A.9 SHARING WITH TERRESTRIAL SERVICES IN THE 27.5-28.35 GHZ BAND

In the U.S., the 27.5-28.35 GHz band is designated for the Upper Microwave Flexible Use (UMFU) Service and FSS is generally secondary to UMFUS, although a transmitting earth station in the 27.5-28.35 GHz band that meets the criteria in §25.136(a) may be authorized on an interference-protected basis.

Applications for earth station antennas communicating with the VIASAT-3 (89W) payload and using the 27.5-28.35 GHz band segment within the U.S. will include an appropriate demonstration that the proposed operations will be in compliance with §25.136, or otherwise would operate on a secondary basis.

A.10 SHARING WITH NGSO MSS FEEDER LINKS IN THE 29.1-29.3 GHZ AND 19.4-19.6 GHZ BANDS

Currently, Iridium is the only licensed MSS Feeder Link operator in the U.S. and is authorized to operate feeder links in the 29.1-29.3 GHz and 19.4-19.6 GHz bands. Viasat is seeking coordination with Iridium and has performed an interference analysis for operation of Earth-to-space and space-to-Earth links in the 29.1-29.3 GHz and 19.4-19.6 GHz bands which are shared with NGSO MSS Feeder Links. The analysis considers the Iridium system characteristics as Notified in the HIBLEO-2FL and HIBLEO-2FL2 ITU filings.

Table A.10-1 HIBLEO-2FL2 Parameters

Parameter / Description	Value
Satellites	66 with orbital characteristic per HIBLEO-2FL filing
Orbital planes / satellites per plane	6 planes / 11 satellites per plane
Orbital height	780 km
Orbital inclination	86.4°
Orbital period	100 min
Feeder link frequency (uplink)	29.1-29.3 GHz

Feeder link frequency (downlink)	19.4-19.6 GHz
Feeder link polarization (uplink)	RHCP
Feeder link polarization (downlink)	RHCP
Satellite FL beam receive antenna gain	30.1 dBi
Satellite FL beam antenna pattern	S.465
Satellite FL beam receive system noise	1295 K
Satellite FL beam G/T (calculated)	-1.02 dB/K
Feeder link emission designator	4M38Q7W
Earth station tracking scheme	Tracking based on longest hold time with 5° minimum elevation at earth station
Tracked earth station	Tempe, AZ
Earth station receive gain	53.2 dBi
Earth station receive system noise	731 K

The Iridium MSS Feeder Link uses right hand circular polarization (RHCP) for both the Earth-to-space and space-to-Earth links. VIASAT-3 (89W) uses both right hand circular and left hand circular polarization (LHCP) for its Earth-to-space and space-to-Earth beams.

Until coordination has been concluded with Iridium, in the downlink space-to-Earth direction (19.4-19.6 GHz band), Viasat will avoid co-frequency co-polar operations of Type A RHCP beams with boresights centered with an azimuth and/or elevation of less than 0.73 degrees from the azimuth and elevation of the Tempe, AZ gateway. In the case of RHCP Type B beams operating co-frequency with Iridium, the minimum offset for beam center azimuth and/or elevation will be 0.95 degrees the with respect to the boresight azimuth/elevation for the Tempe gateway.

Visualyse analyses were performed which show that the resulting I/N would be less than -12.2 dB more than 99.999% of the time in each of these scenarios.

Similar analyses were performed in the space-to-Earth direction for the left hand circular polarized beams which are operating cross-polarized from the Iridium system. In this case the required azimuth/elevation offset for beam center pointing of either the Type A beam or the Type B beam, with respect to the beam center pointing for the Tempe, AZ Feeder Link gateway, is less than for the co-polarized case. Any offset greater than 0.3 degrees for the Type A beam and 0.5 degrees for the Type B beam are sufficient to reduce the I/N at the Iridium gateway to less than -12.2 dB for more than 99.999% of the time.

This can also be easily calculated by working from the assumption that the maximum downlink pfd at Tempe is -118 dB(W/(m^2*MHz)) in the right hand polarization then applying the cross-pol isolation value between the RHC and LHC polarizations and then solving for downlink pfd. The resulting value is ~15 dB above the value that would result in a -12.2 dB I/N. The required offset can then be taken from the gain roll-off in the downlink beam pattern such that any pointing angle of beam center for the LHCP downlink beam greater than that value will reduce the downlink e.i.r.p. density by more than 15 dB.

Figure A.10-1 Type A beam interference into Feeder Link Rx (space-to-Earth)

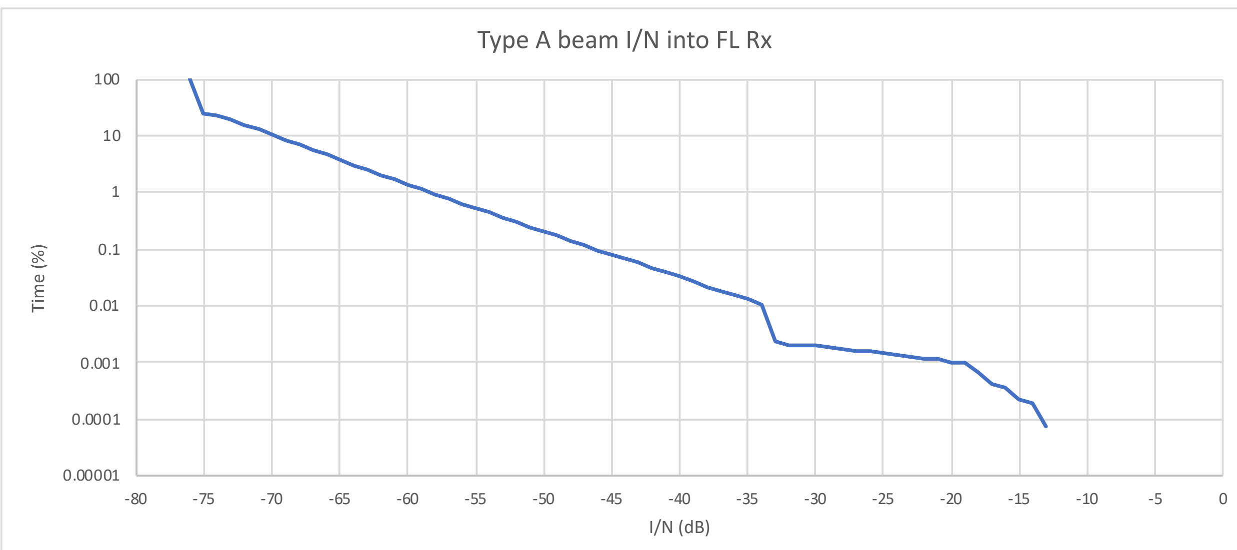
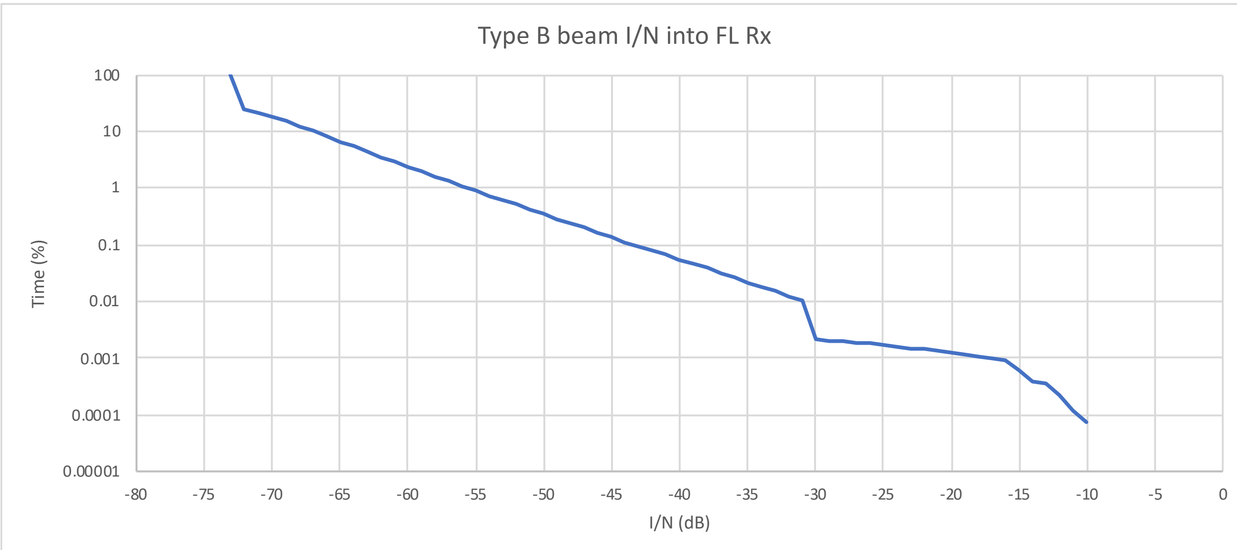


Figure A.10-2 Type B beam interference into Feeder Link Rx (space-to-Earth)



Applications for earth station antennas communicating with the VIASAT-3 (89W) payload and using the 29.1-29.25 GHz band segment within the U.S. will include an appropriate demonstration that the proposed operations, either have been coordinated with, or will otherwise be compatible with Iridium and will operate on a secondary basis.

A.11 SHARING WITH NGSO FSS IN THE 27.5-28.1 GHZ AND 17.8-18.3 GHZ BANDS

The Commission and the ITU have adopted identical epfd↑ and epfd↓ limits applicable to NGSO systems operating in the 27.5-28.1 GHz and 17.8-18.3 GHz bands, respectively. In the ITU regulatory regime, NGSO FSS systems are secondary to GSO FSS networks in these bands. The purpose for the development of the ITU epfd limits was to protect primary GSO networks, while increasing the use of the spectrum by allowing NGSO systems to use the same bands. The primary mechanism employed by NGSO systems in order to adhere to the epfd limits is to cease transmissions when some minimum separation angle towards the geostationary arc occurs (*i.e.*, an "exclusion zone"). The exclusion zone ensures protection to GSO networks, including Viasat's GSO network, from NGSO system interference, in both uplink and downlink directions, and simultaneously protects NGSO systems from interference due to GSO networks.

A.12 SHARING WITH LOCAL MULTIPOINT DISTRIBTION SERVICE IN THE 29.1-29.25 GHZ BAND

In the U.S., the 29.1-29.25 GHz band is designated for the Local Multipoint Distribution Service (LMDS) on a primary basis and FSS is secondary. The VIASAT-3 (89W) payload operates as a receiver in this frequency band and will not cause interference into LMDS.

Applications for earth station to transmit in the 29.1-29.25 GHz band within the U.S. will include an appropriate demonstration that the proposed operations will be compatible with LMDS in this band.

A.13 SHARING WITH FIXED SERVICE IN THE 17.7-18.3 GHZ BAND

Viasat seeks authority to operate in this band segment on a non-interference, unprotected basis.

A.13.1 Satellite to FS Receiver Interference

As discussed in Section A.7, the maximum PFD transmitted towards U.S. territory by the VIASAT-3 (89W) payload will be compliant with the §25.208(c) PFD limits that apply, in part, to the 17.7-18.3 GHz band segment thereby ensuring protection to FS stations using the band.

A.13.2 FS Transmitter to FSS Ground Antenna Interference

There exists the potential for interference caused by a transmitting FS station into a receiving FSS ground antenna if the FSS earth station is too close geographically to the FS station. Depending on the location of the FSS earth station relative to the FS antenna's main-beam axis direction, FSS earth stations need to be geographically separated from the FS transmitting station by an appropriate distance or adequately shielded. Given that Viasat's operations in the 17.7-18.3 GHz band segment would be on a non-conforming, unprotected basis, Viasat accepts the potential risk of FS station interference into Viasat's earth stations in this band segment.

A.14 SHARING WITH FSS SATELLITE NETWORKS (EARTH-TO-SPACE) IN THE 17.7-17.8 GHZ BAND SEGMENT

In the U.S., the 17.7-17.8 GHz band segment is allocated in the Earth-to-space direction to the FSS. In this band, FSS is limited to feeder links for the broadcasting-satellite service ("BSS").

A.14.1 Space Path Interference

A space station transmitting in the space-to-Earth direction in the 17.7-17.8 GHz band segment has the potential to cause interference into a space station receiving Earth-to-space transmissions in the same band (*i.e.,* space path interference due to bi-directional usage). The Commission has examined the potential for such interference in the context of sharing between 17/24 GHz BSS satellite networks and BSS feeder links.[3] The requirements to facilitate 17/24 GHz BSS operation anywhere within the 17.3-17.8 GHz band are codified in §25.264.

In accordance with §25.264(a), Annex 1 to this Attachment provides predicted off-axis gain information in the X-Z plane over a range of ± 30 degrees from the negative and positive X-axes, for both the A-type beams and B-type beams, in both polarizations, in planes rotated from the X-Z plane about the Z-axis over a range of ± 60 degrees relative to the equatorial plane, and at a center frequency of 17.775 GHz. §25.264(a)(4) seeks antenna off-axis gain information at three different frequencies: 17.735 GHz, 17.55 GHz and 17.775 GHz. The requirement to provide off-axis gain information at these three frequencies assumes the applicant transmits across the entire 17.3-17.8 GHz band, which is not the case for the VIASAT-3 (89W) payload, since it only transmits in the upper 17.7-17.8 GHz band. By providing predicted off-axis gain measurements

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[3] *See* Establishment of Policies and Service Rules for the Broadcasting-Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Satellite Services Operating Bi-directionally in the 17.3-17.8 GHz Frequency Band, Second Report and Order, 26 FCC Rcd 8927 (2011).

at a single frequency, Viasat believes it is in compliance with the intent of §25.264(a)(4), but nonetheless requests a waiver of §25.264(a)(4) to the extent necessary.

Viasat has performed PFD calculations at the orbital locations of all prior-filed U.S. DBS stations as required by §25.264(b)(1). These calculations show that the worst-case off-axis PFD at all of these orbital locations does not exceed a PFD level of -117 dBW/m^2/100 kHz.

In order to provide an example calculation, Viasat uses the nearest U.S.-licensed DBS space station, which is located at the nominal 85.4° W.L. location. EchoStar Satellite Operating Corporation has Commission authorization to operate the ECHOSTAR-12 satellite at 85.4° W.L.[4] This satellite provides service to Colombia, not the U.S., however it does have an uplink tracking beacon that transmits from U.S. soil on a center frequency of 17.798 GHz. The satellite network operates under a U.K. ITU filing.

Based on the off-axis gain information provided in Annex 1, the highest off-axis gain for any of the pattern cuts is 10.2 dBi, which corresponds to a worst-case off-axis EIRP density of -14 dBW/100 kHz. The worst-case spreading loss towards the ECHOSTAR-12 satellite is -135.5 dB. The PFD towards this satellite from the VIASAT-3 (89W) payload is therefore: -14 - 135.5 = -149.5 dBW/m^2/100 kHz; a value far below the coordination trigger threshold of -117 dBW/m^2/100 kHz. All other prior-filed U.S. DBS space stations have a larger orbital separation from the VIASAT-3 (89W) payload; hence the off-axis PFD levels at those space stations will be less than that calculated for the ECHOSTAR-12.

A.14.2 Ground Path Interference

There exists the potential for interference between a transmitting BSS feeder link station and a receiving FSS ground antenna if the FSS earth station is too close to the BSS feeder link station

4 *See* SAT-MOD-20170626-00099.

and not adequately shielded. Given that Viasat's operations in the 17.7-17.8 GHz band segment would be on a non-conforming, unprotected basis, Viasat accepts this risk.

A.15 ORBITAL DEBRIS MITIGATION PLAN

The VIASAT-3 (89W) payload and the VIASAT-US89 payload will be on the same spacecraft. For purposes of simplicity in describing Viasat's orbital debris mitigation plan, we refer generally to Viasat's satellite, or spacecraft, containing both payloads.

A.15.1 Spacecraft Hardware Design

The satellite is based on the flight proven Boeing 702 HP and MP heritage platform. The following updated orbital debris mitigation plan takes into account the selected spacecraft bus.

Viasat has assessed and limited the amount of debris released in a planned manner during normal operations. The satellite has been designed so as to not become a source of debris during launch, drift, or operating mode. All separation and deployment mechanisms, and any other potential source of debris, are expected to be retained by the spacecraft or launch vehicle.

In conjunction with the satellite manufacturer, Viasat has assessed and limited the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids of less than one centimeter in diameter that could cause loss of control and prevent post-mission disposal. Viasat and the satellite manufacturer have taken steps to limit the effects of such collisions through shielding, the placement of components, and the use of redundant systems.

The satellite includes redundant TT&C, bus control electronics and propulsion subsystems to ensure successful end-of-life disposal. The spacecraft TT&C system, vital for orbit raising, will be extremely rugged with regard to meteoroids smaller than 1 cm, by virtue of its redundancy, shielding, separation of components and physical characteristics. The TT&C subsystem will have no single points of failure. Near-omni-directional antenna coverage is provided through the use of a combination of independent bicone and forward/aft pipe antennas. These antenna feeds are extremely rugged and capable of providing adequate coverage even if struck, bent or otherwise damaged by a small or medium sized particle. The command receivers and decoders and telemetry encoders and transmitters will be located within a shielded area and will be totally redundant and physically separated. The Xenon tank, shielded in the spacecraft structure central cylinder, and a redundant pair of thrusters provide the energy for orbit-raising.

A.15.2 Minimizing Accidental Explosions

In conjunction with the satellite manufacturer, Viasat has assessed and limited the probability of accidental explosions during and after completion of mission operations through a failure mode verification analysis. The satellite manufacturer has taken 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. All vessel pressures and battery cell voltages will be monitored by telemetry. At end-of-life and once the satellite has been placed into its final disposal orbit, Viasat will remove all stored energy from the spacecraft by depleting any residual fuel and leaving the batteries in a permanent state of discharge. The xenon tank is vented by opening latch valves downstream of the tank to allow cold flow through the xenon ion thrusters, and the latch valve is open if negligible xenon remains. Otherwise, the xenon latch valves may remain closed. There is no liquid propulsion system on the spacecraft.

A.15.3 Safe Flight Profiles

Viasat's existing market access provides for the satellite to be located at 88.9º W.L. Viasat does not seek to change this location in this application.

A.15.4 Post-Mission Disposal

There is no change to the originally planned post-mission disposal orbit altitude of 300 km above the normal GSO operational orbit, which was based on the following analysis and calculation under §25.283:

Total Solar Pressure Area "A" = 220 m^2

"M" = Dry Mass of Satellite = 5000 kg

"C_R" = Solar Pressure Radiation Coefficient = 1.147

Therefore, the Minimum Disposal Orbit Perigee Altitude:

= 36,021 km + 1000 x C_R x A/m

= 36,021 km + 1000 x 1.147 x 220/5000

= 36,061 km

= 286 km above GSO (35,786 km)

To provide adequate margin, increasing the disposal orbit to 300 km will require 1.7 kg of xenon propellant, taking account of all fuel measurement uncertainties, which will be allocated and reserved in order to perform the final orbit raising maneuver.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

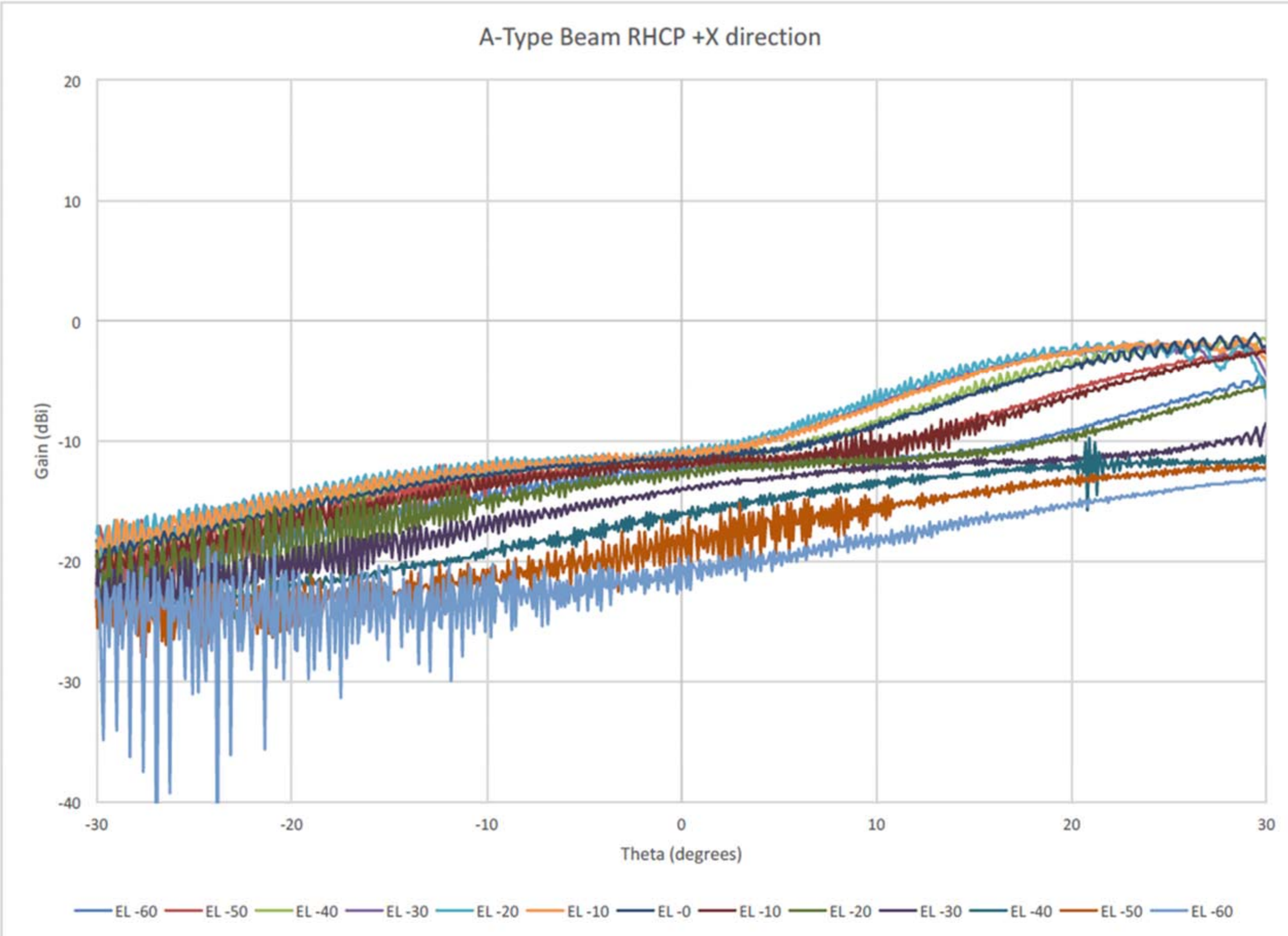
I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this pleading, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this pleading,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

/s/

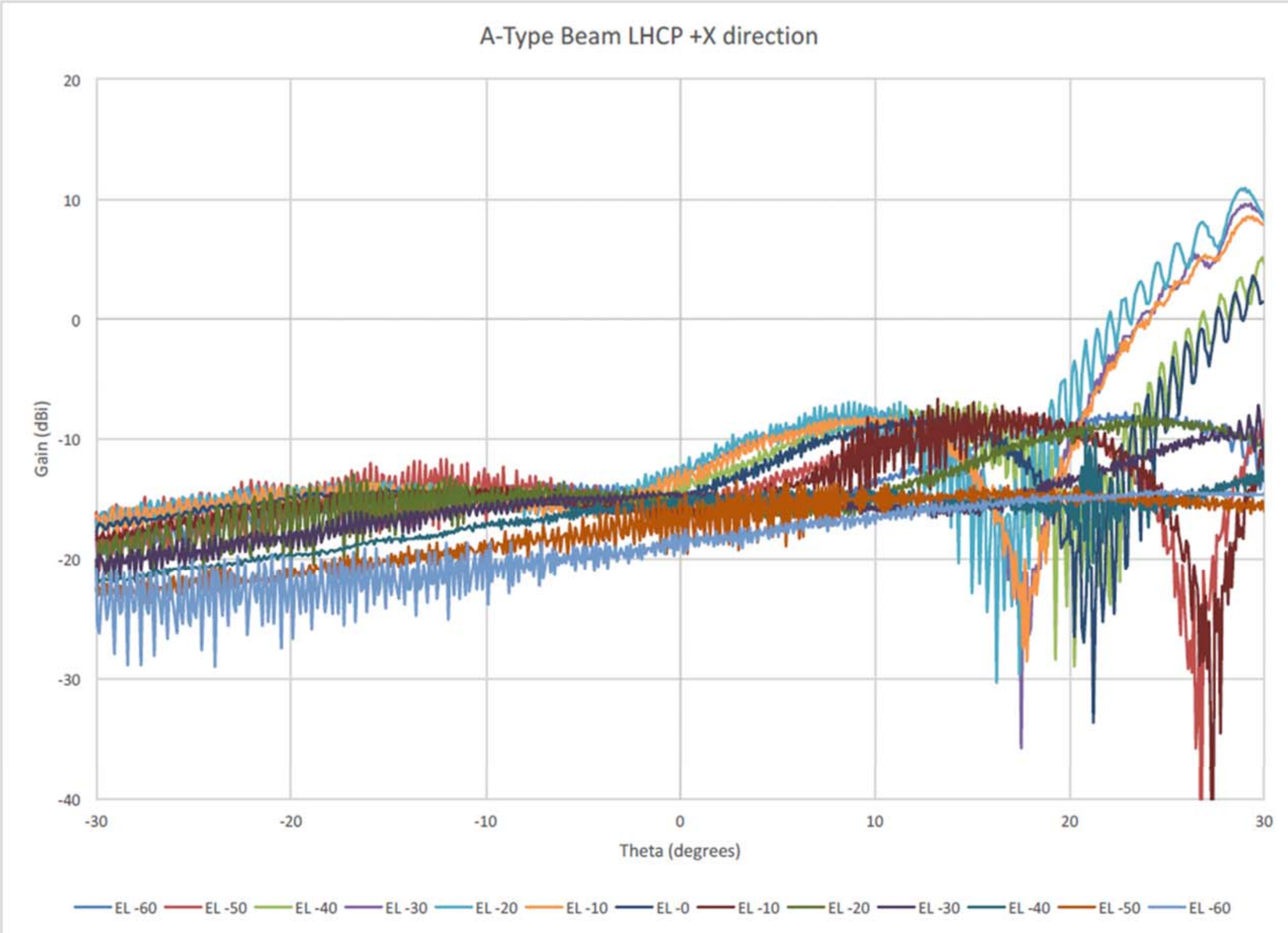
Stephen D. McNeil
TSCI
Ottawa, Ontario, Canada
(613) 270-1177

ANNEX 1

This annex provides eight predicted off-axis gain pattern cuts for the VIASAT-3 (89W) payload in the X-Z plane over a range of ± 30 degrees from the negative and positive X-axes, for both the A-type beams and B-type beams, in both polarizations, in planes rotated from the X-Z plane about the Z-axis over a range of ± 60 degrees relative to the equatorial plane, and at a center frequency of 17.775 GHz.



A-Type Beam RHCP +X direction
20
10
0
-10
-20
-30
-40
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60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Gain (dBi)
Theta (degrees)
20
10
0
-10
-20
-30
-40
-30
-20
-10
0
10
20
30
EL -60
EL -50
EL -40
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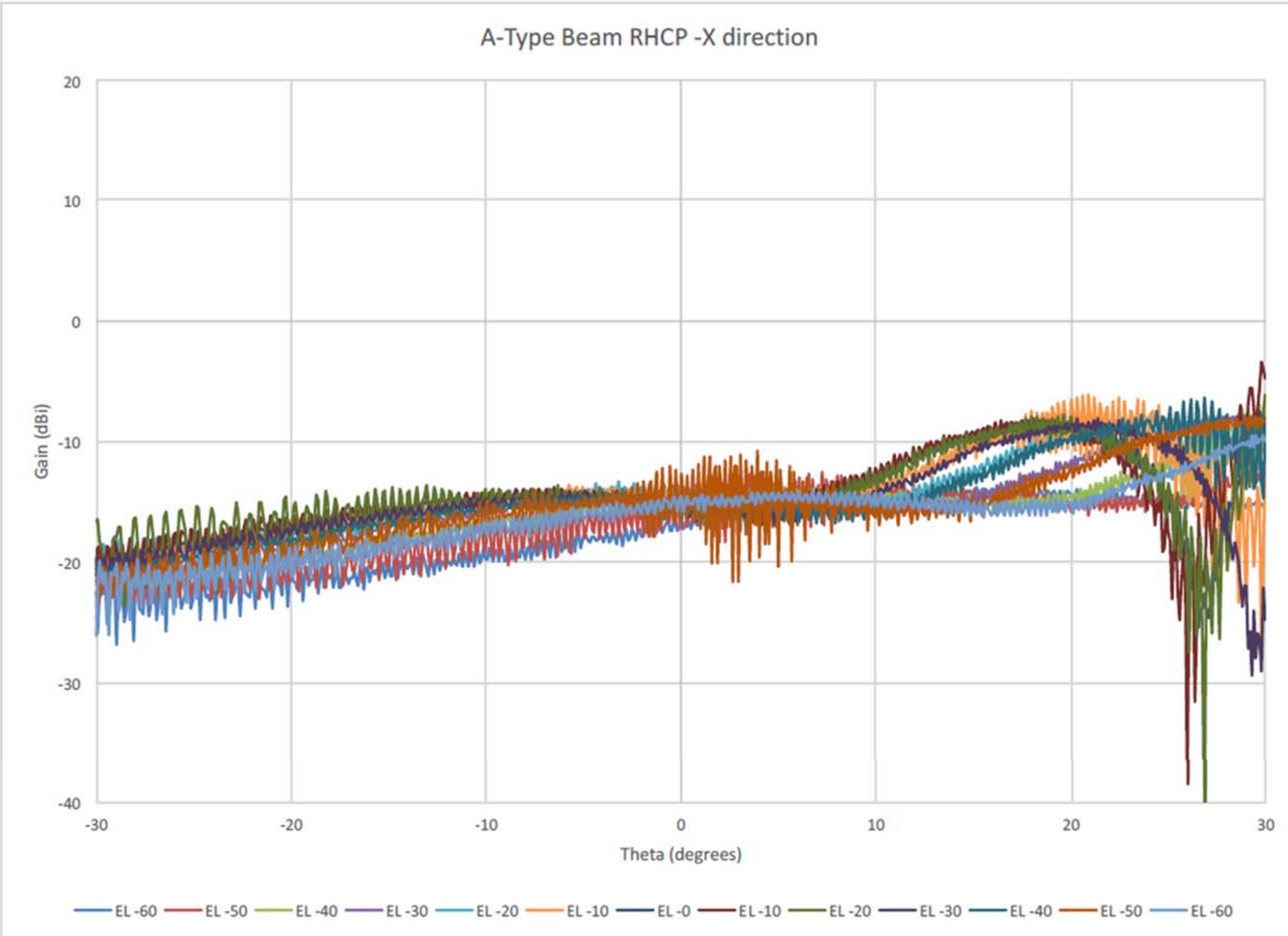
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60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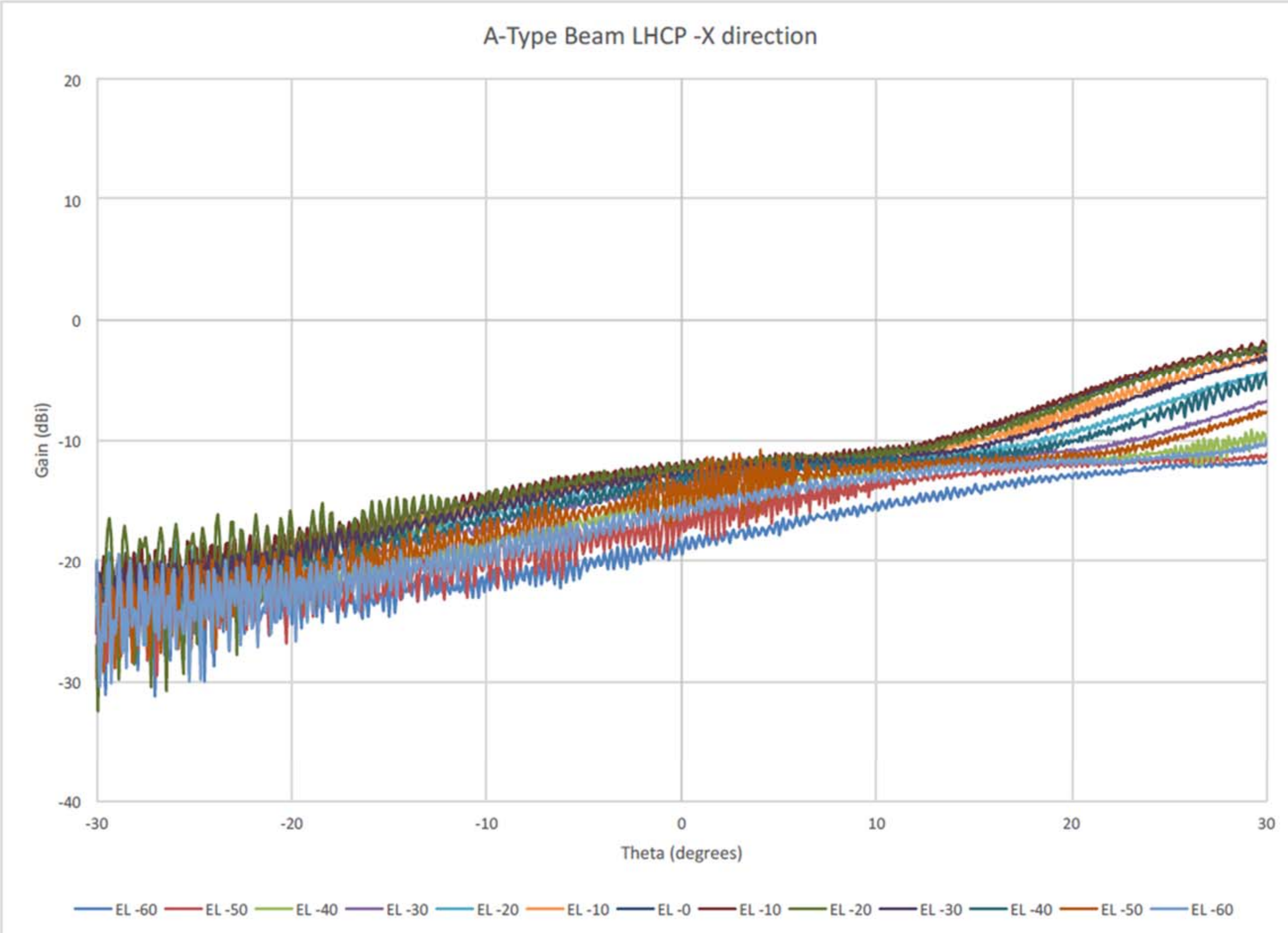
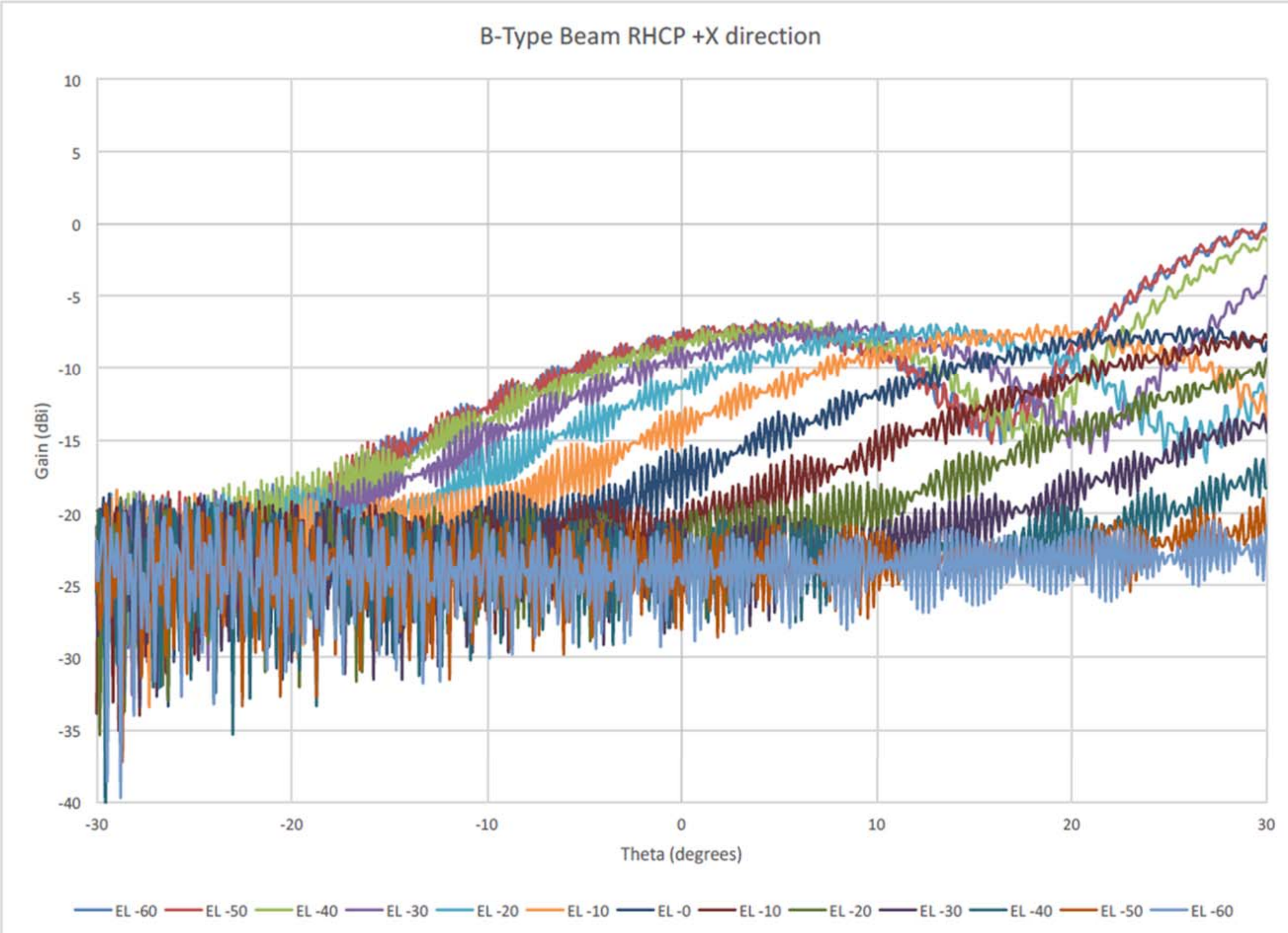
20
10
0
-10
-20
-30
-40
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60



A-Type Beam LHCP -X direction
20
10
0
-10
-20
-30
-40
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60


B-Type Beam RHCP +X direction
Gain (dBi)
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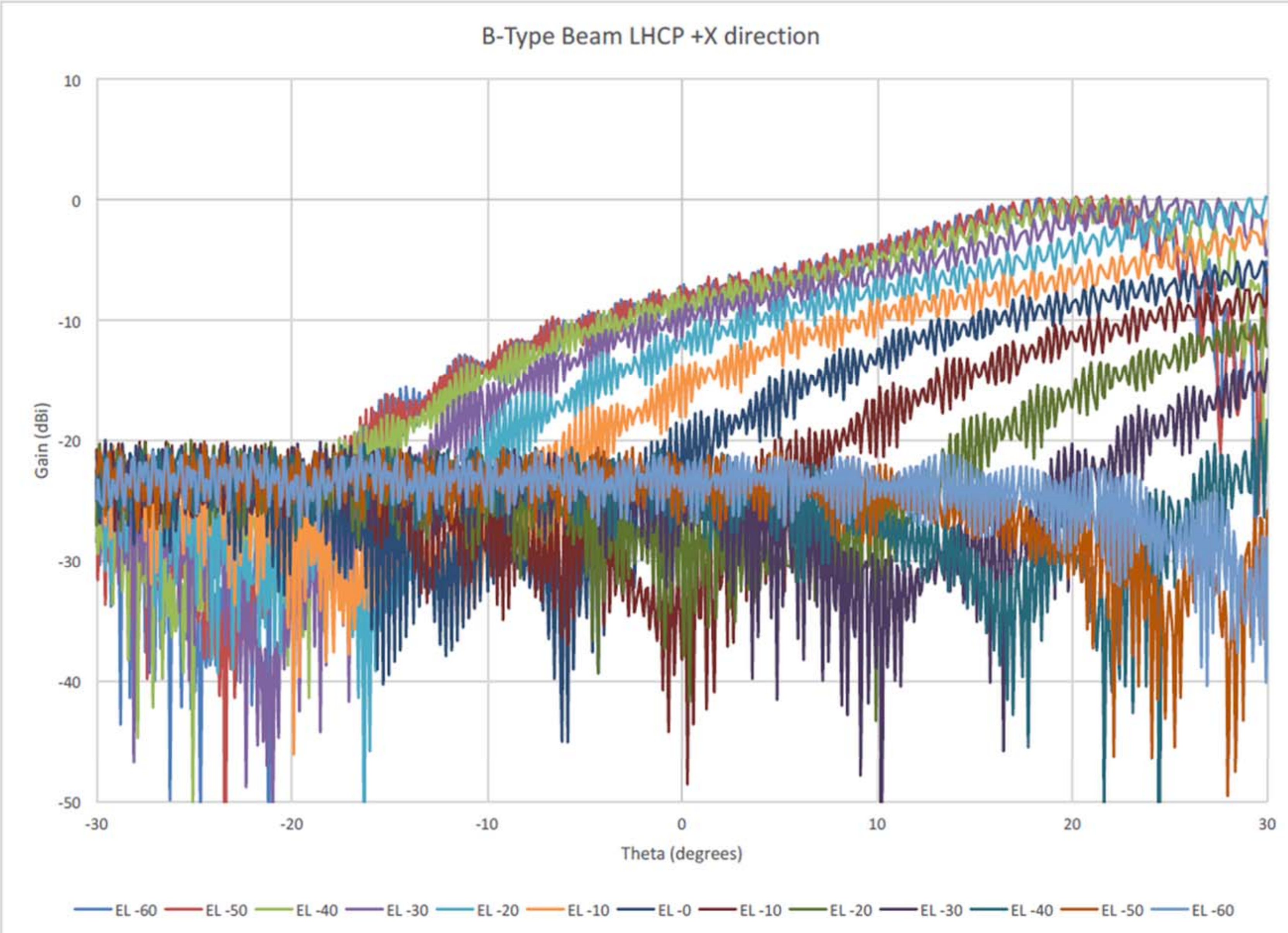
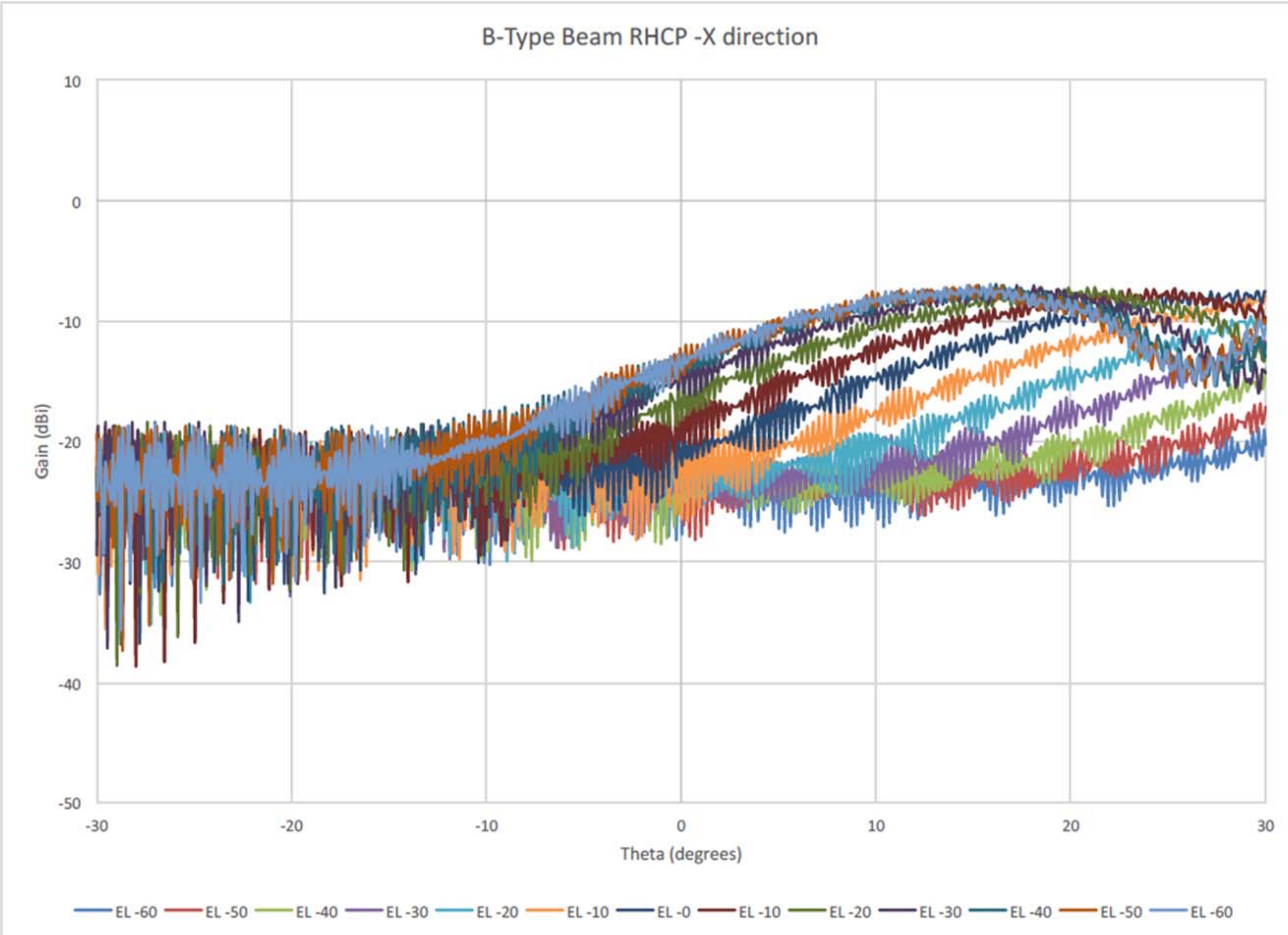
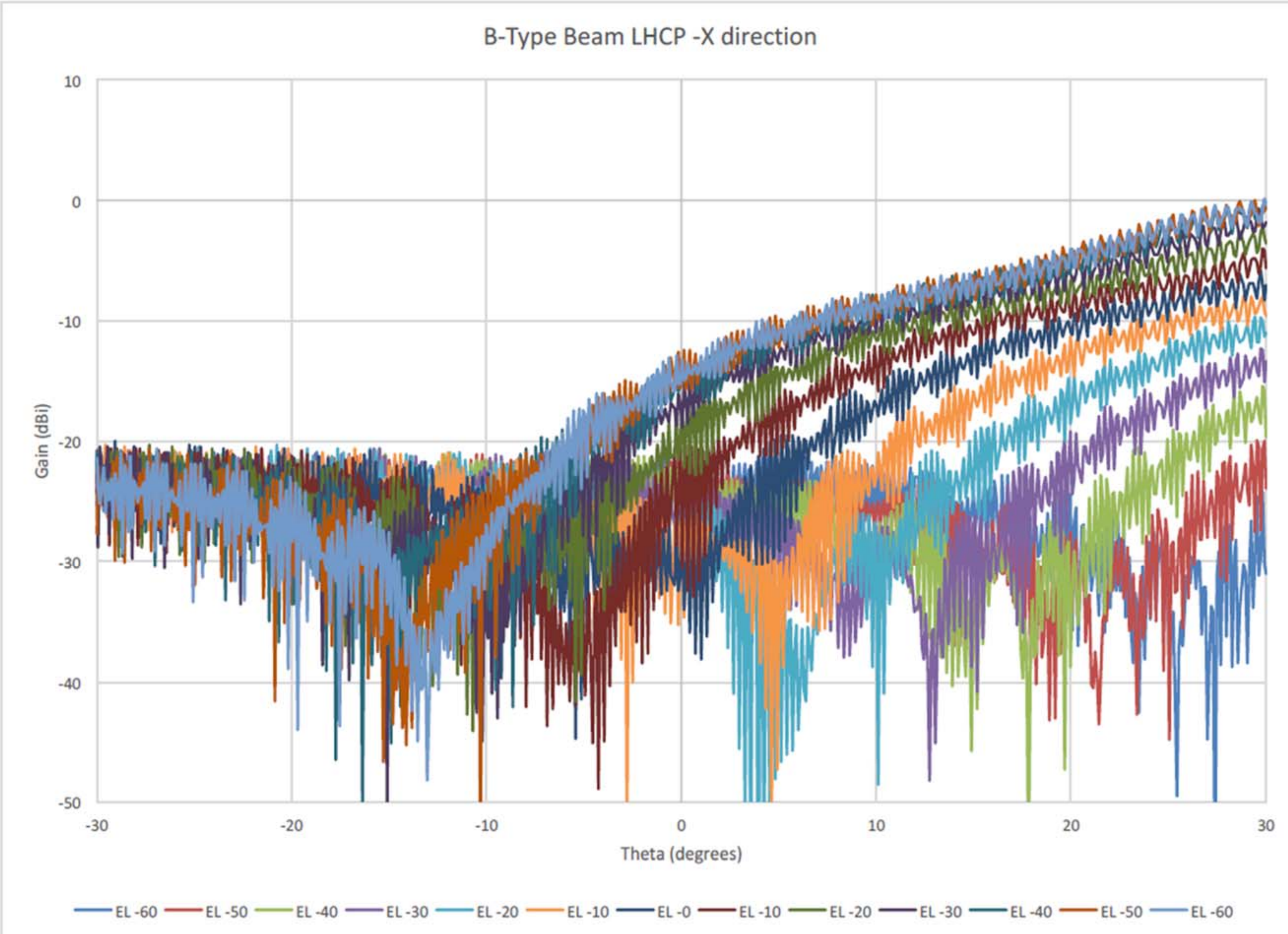
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60


B-Type Beam LHCP +X direction
10
0
-10
-20
-30
-40
-50
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60


B-Type Beam RHCP -X direction
10
0
-10
-20
-30
-40
-50
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60



B-Type Beam LHCP -X direction
10
0
-10
-20
-30
-40
-50
Gain (dBi)
-30
-20
-10
0
10
20
30
Theta (degrees)
EL -60
EL -50
EL -40
EL -30
EL -20
EL -10
EL -0
EL -10
EL -20
EL -30
EL -40
EL -50
EL -60