

Exhibit 1

V11 ESV Terminal Technical Appendix

1. Introduction

KVH Industries, Inc. (“KVH”) has developed a small aperture, broadband, highly efficient and affordable earth stations onboard vessels (“ESV”) terminal for use with its global maritime communications network. This ESV – the KVH V11 terminal – operates in Ku-band FSS frequencies (14.0-14.5 GHz transmit, 11.7-12.2 GHz receive, 10.95-11.2 GHz and 11.45-11.7 GHz receive). The V11 terminal will automatically search for and acquire the designated satellite, and maintain precise pointing via automatic control of the azimuth, elevation and polarization angles.

The antenna being used in this ESV terminal is 1 meter in diameter, and its main lobe does not conform to the standards specified in Section §25.209(a) and (b). In order to compensate for this performance, KVH will operate with a spread spectrum modulation technique that will bring the off-axis EIRP spectral density of the terminal well within the spectral density limits specified in Section §25.222 of the Commission’s rules. This technical exhibit provides the showing required pursuant to Section §25.222, including detailed information regarding the ESV antenna patterns and off-axis emissions, and a summary of the remote ESV to hub link analysis.

2. Description of Antenna

KVH has developed the small aperture, broadband, highly efficient and affordable V11 ESV terminal for use with its global ESV network. The ESV terminal operates in the Ku FSS frequency band, 14.0-14.5 GHz transmit and 10.95-11.2 GHz, 11.45-11.7 GHz and 11.7-12.2 GHz receive. The antenna is a 1 meter parabolic reflector with a rear-fed sub-reflector feed assembly design. The ESV terminal will automatically search for and acquire the designated satellite and maintain precise pointing via automatic control of the azimuth, elevation and polarization angles. The RF equipment is integrated into the base of the terminal and includes a 3 watt block upconverter.

The proposed ESV uplink return transmission (inbound) channel supports data rates of 32 kbit/s, 64 kbit/s, 128 kbit/s, 256 kbit/s, and 512 kbit/s. The ESV uplink transmission utilizes a spread spectrum modulation. This authorization will require channel bandwidths of 18 MHz, 27MHz, and 36 MHz. The forward channel (outbound from the hub earth station to the ESV) will be between 3-10 Mbits/s aggregate with individual end user rates at 0.5-2Mbit/s. The forward channel is also spread over the 18 MHz, 27 MHz, or 36 MHz channel and is overlaid onto the same transponder spectrum using a technique called PCMA.¹

¹ Paired Carrier Multiple Access is a proprietary technique developed by ViaSat for their spread spectrum ArcLight service.

KVH TracPhone V11 Technical Parameters

Antenna Diameter	1	meter			
Antenna Centerline (typical)	10	m, AMSL			
Antenna Gain	42.2	dBi	14.25	GHz	
	40.4	dBi	11.85	GHz	
RF Power Max	3	Watts			
LL	0.65	dB			
Power at FF	4.12	dBW			
	2.583	Watts			
Maximum EIRP	46.3	dBW			
Data Rates	32 to 512	kbits/s Tx			
	to 1000	kbits/s Rx			
Emission Designators	1	2	3		
	36M0G7D	27M0G7D	18M0G7D		
Bandwidth	36000	27000	18000	kHz	
RF Power/4kHz	-35.4	-34.2	-32.4	dBW/4kHz	
EIRP/4kHz	6.8	-61.6	-58.6	dBW/4kHz	
Worst Case Hor EIRP	-23.3	-22.1	-20.3	dBW/4kHz	
Minimum Elevation	5	degrees			

3. Description of Service

As is shown in Figure 1 below, the V11 terminal will be operated within KVH's existing broadband mobile maritime service network, authorized by the Commission.² KVH is seeking authorization to operate within the continental United States (CONUS), Alaska and Hawaii, as well as U.S. territories and possessions, and adjacent waters within the satellite coverage zones.

KVH would like to primarily operate the terminals with the following satellites: AMC-15 @ 105° W.L., AMC-21 @ 125° W.L., TelStar 11N at 37.5° W.L., and GE-23 @ 172° E.L. The ESVs will communicate with existing hub earth stations in Miami, Florida, Carlsbad, California, and Kapolei, Hawaii.³ KVH will control all V11 operations using its standard network control capabilities and network management services. Additionally, since this service will operate under the control of the KVH ESV network operations center there will be a record of the ESV's location and operating parameters as specified in Section 25.222(a)(4). The service is designed as a regional service, covering the North American continent and its coastal waters, Central America, the Gulf of Mexico and the Caribbean, as well as the Pacific Ocean region, as shown in blue shade in Figure 2 below.

² See File No. SES-LIC-20060824-01502 (Call Sign E060335); File No. SES-LIC-20070504-00563 (Call Sign E070085); and File No. SES-LIC-20081104-01450 (Call Sign E090001).

³ Call Signs E040267, E030131 and E010236, respectively.

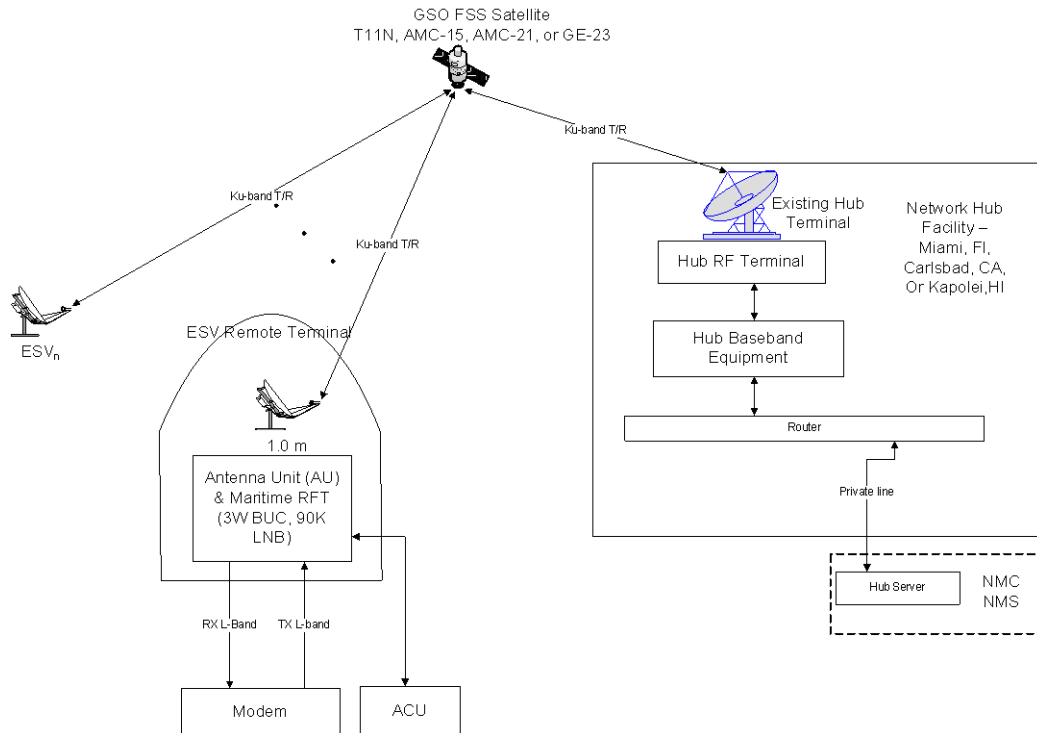


Figure 1 – ESV Network Architecture



Figure 2 – ESV Coverage Area

The ESV terminal will operate in compliance with KVH’s coordination agreement with the National Science Foundation with respect to Radio Astronomy Service (“RAS”) sites

and will not operate within 125 km of the Tracking and Data Relay Satellite System (TDRSS) sites for space research conducted at White Sands, New Mexico and the U.S. Naval Research Lab at Blossom Point, Maryland.⁴

4. Off-Axis EIRP Analysis

The data rates transmitted from the terminal will vary from 32 kbits/s to 512 kbits/s. Additionally, the ESVs will transmit using CRMA spreading⁵ over either an 18 MHz, 27 MHz, or 36 MHz channel bandwidth. KVH acknowledges that the small diameter V11 antenna does not meet the FCC 25.209 antenna pattern. However, KVH certifies that the aggregate EIRP levels do not exceed the limits specified for Ku-band ESVs in Section 25.222 of the Commission's rules. The co-pol off-axis EIRP spectral density levels of the KVH ESV terminal are shown in Figures 3 through 6 below. Note that a calculated worst case aggregate EIRP occurs when N=16 users for the 36 MHz channel and when N=8 users for the 18 MHz channel.

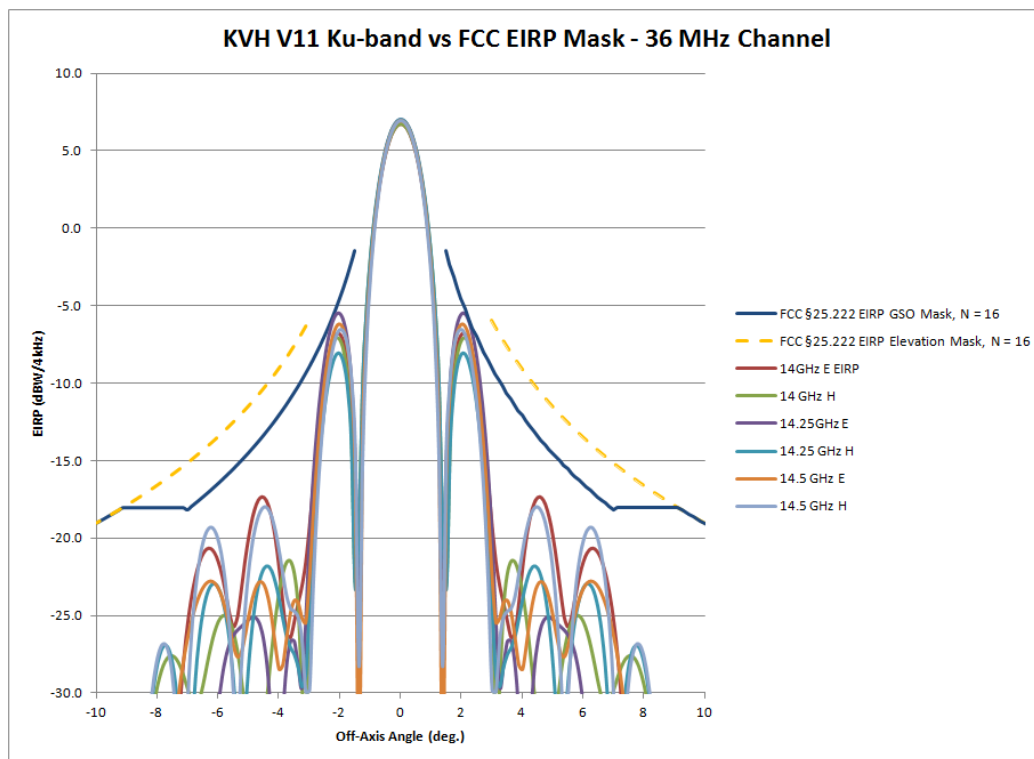


Figure 3 - V11 Off-Axis EIRP Spectral Density – 36 MHz Channel

⁴ See Coordination Agreement with the National Science Foundation, submitted with a letter dated November 20, 2008 in IBFS File No. SES-LIC-20081104-01450. KVH will accept technical limitations imposed on other Ku-band ESV operations necessary to protect TDRSS operations. See 47 C.F.R. § 25.222(c).

⁵ CRMA, or Code Reuse Multiple Access, is a ViaSat proprietary spread spectrum technique, similar to CDMA, used in the ArcLight satellite system.

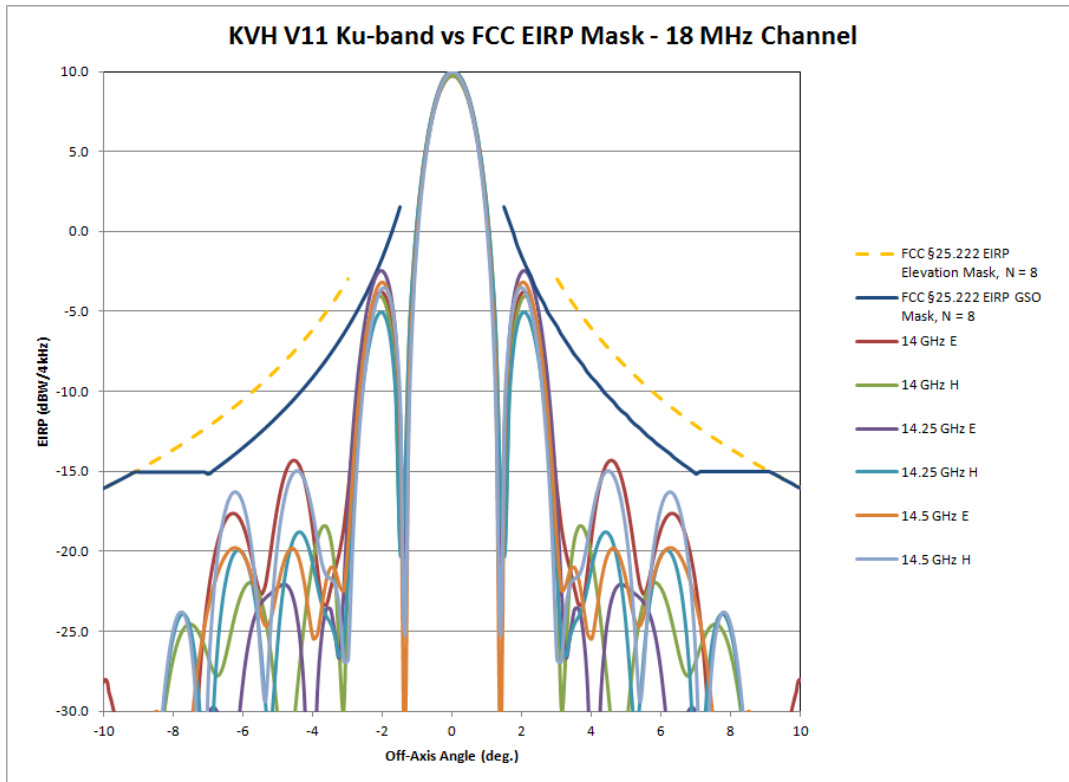


Figure 4 - V11 Off-Axis EIRP Spectral Density – 18 MHz Channel

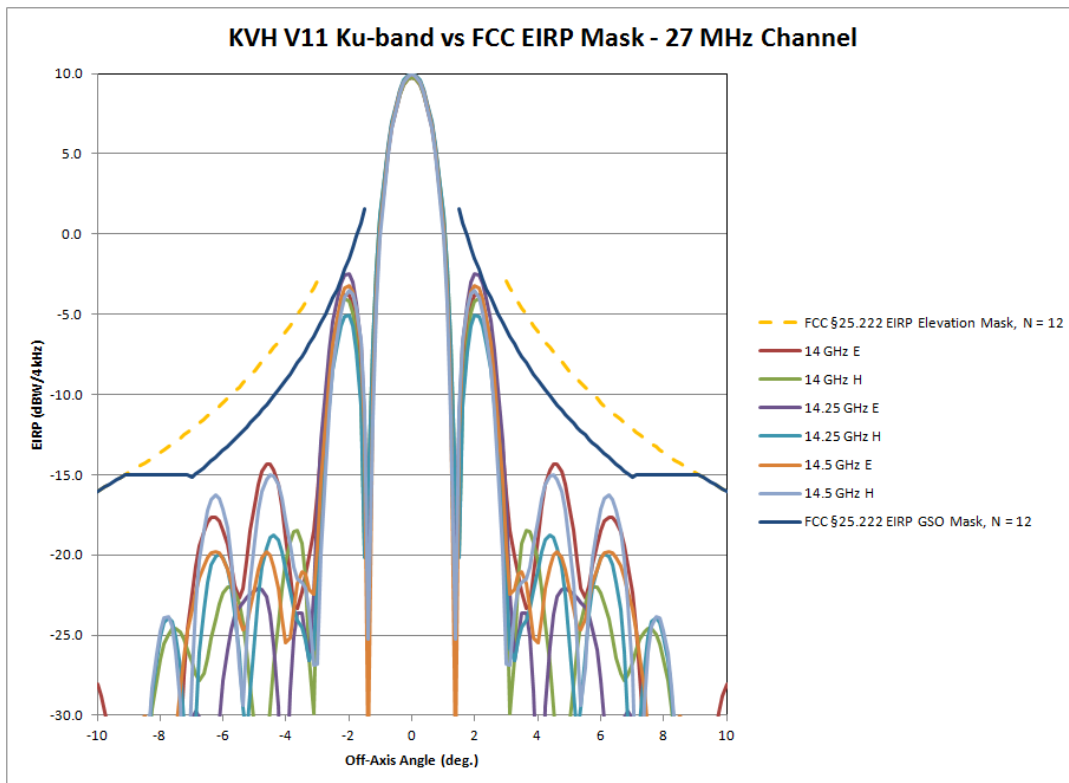


Figure 5 - V11 Off-Axis EIRP Spectral Density – 27MHz Channel

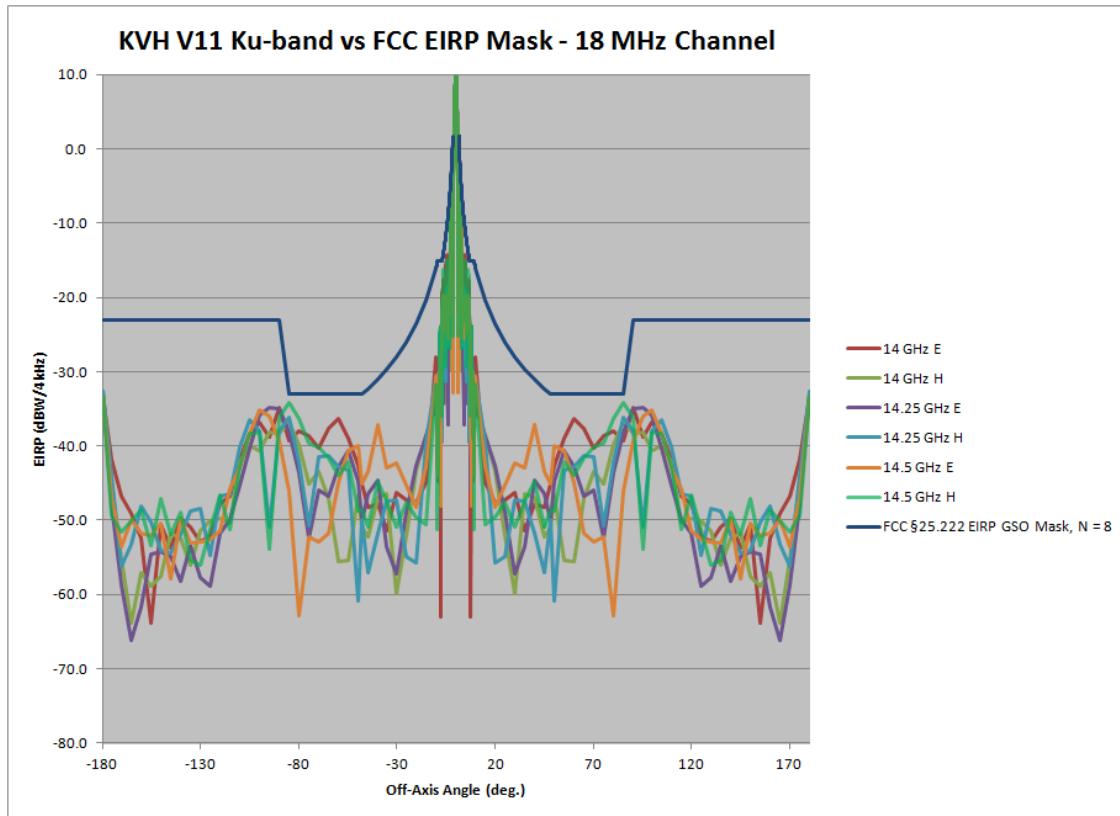


Figure 6 – 18 MHz Off-Axis EIRP Spectral Density +/- 180 degrees

Summary of Worst Case EIRP Density Performance Parameters

18 MHz Channel Calculations (Worst Case)		
Power a feed Flange	2.58	W
Channel; Bandwidth	18	MHz
RF Power Density at Flange	-32.4	dBW/4,kHz
Maximum Horizon EIRP Density (6.25° Elevation Angle)	3.67	dBW/MHz*
Maximum Horizon EIRP at 6.25°	16.22	dBW*
Maximum Number Simultaneous Users N	8	
Worst Case Main Beam Gain Exceedance between -7 and +7 degrees	-9.16	dB
at angle	-2.25	degree

Per § 25.222(b)(1)(i), Table 1 below provides the co-pol the E and H plane antenna patterns for the parabolic antenna, as well as the E and H plane EIRP charts for the worst scenario 18 MHz channel operation, and the FCC GSO and Elevation masks.

Table 1 – V11 ESV Off-Axis EIRP vs FCC §25.222 Masks

Table 1	Antenna Gain (dBi)									ESV EIRP (dBW/4 kHz)								
Off-Axis Angle	14 GHz E	14 GHz H	14.25 GHz E	14.25 GHz H	14.5 GHz E	14.5 GHz H	Off-Axis Angle	FCC §25.209	FCC §25.222 EIRP GSO Mask, N = 8	FCC §25.222 EIRP Elevation Mask, N = 8	14 GHz E	14 GHz H	14.25 GHz E	14.25 GHz H	14.5 GHz E	14.5 GHz H	Meets Mask	
-180	-0.97	-0.97	-0.23	-0.23	-1.00	-1.00	-180	0.0	-23.0	-23.0	-33.4	-33.4	-32.6	-32.6	-33.4	-33.4	Y	
-175	-9.44	-12.61	-15.57	-11.53	-14.54	-17.07	-175	0.0	-23.0	-23.0	-41.9	-45.0	-48.0	-43.9	-47.0	-49.5	Y	
-170	-14.42	-22.89	-26.22	-23.87	-21.13	-19.22	-170	0.0	-23.0	-23.0	-46.8	-55.3	-58.6	-56.3	-53.5	-51.6	Y	
-165	-16.61	-31.36	-33.68	-20.88	-17.56	-17.70	-165	0.0	-23.0	-23.0	-49.0	-63.8	-66.1	-53.3	-50.0	-50.1	Y	
-160	-20.00	-24.67	-29.29	-15.74	-19.28	-16.24	-160	0.0	-23.0	-23.0	-52.4	-57.1	-61.7	-48.2	-51.7	-48.7	Y	
-155	-31.36	-26.50	-22.18	-17.88	-19.67	-21.01	-155	0.0	-23.0	-23.0	-63.8	-58.9	-54.6	-50.3	-52.1	-53.4	Y	
-150	-18.21	-25.15	-21.89	-21.61	-18.05	-14.74	-150	0.0	-23.0	-23.0	-50.6	-57.6	-54.3	-54.0	-50.5	-47.2	Y	
-145	-21.29	-19.34	-22.44	-22.04	-25.52	-19.53	-145	0.0	-23.0	-23.0	-53.7	-51.8	-54.9	-54.5	-57.9	-51.9	Y	
-140	-17.32	-20.04	-25.76	-19.51	-17.34	-16.45	-140	0.0	-23.0	-23.0	-49.7	-52.5	-58.2	-51.9	-49.8	-48.9	Y	
-135	-18.58	-23.59	-21.03	-16.32	-20.74	-23.03	-135	0.0	-23.0	-23.0	-51.0	-56.0	-53.5	-48.7	-53.2	-55.4	Y	
-130	-20.43	-19.08	-25.35	-15.96	-20.57	-23.67	-130	0.0	-23.0	-23.0	-52.9	-51.5	-57.8	-48.4	-53.0	-56.1	Y	
-125	-19.59	-17.69	-26.45	-22.24	-20.08	-18.86	-125	0.0	-23.0	-23.0	-52.0	-50.1	-58.9	-54.7	-52.5	-51.3	Y	
-120	-15.34	-17.36	-19.28	-14.38	-18.99	-14.15	-120	0.0	-23.0	-23.0	-47.8	-49.8	-51.7	-46.8	-51.4	-46.6	Y	
-115	-14.34	-17.95	-17.49	-14.06	-13.37	-18.81	-115	0.0	-23.0	-23.0	-46.8	-50.4	-49.9	-46.5	-45.8	-51.2	Y	
-110	-9.43	-9.72	-12.83	-7.69	-10.61	-10.36	-110	0.0	-23.0	-23.0	-41.8	-42.1	-45.2	-40.1	-43.0	-42.8	Y	
-105	-5.83	-7.52	-7.93	-4.10	-5.93	-5.90	-105	0.0	-23.0	-23.0	-38.2	-39.9	-40.3	-36.5	-38.3	-38.3	Y	
-100	-4.33	-8.27	-3.37	-5.54	-2.72	-5.74	-100	0.0	-23.0	-23.0	-36.7	-40.7	-35.8	-38.0	-35.1	-38.2	Y	
-95	-6.32	-5.76	-2.46	-18.51	-3.61	-21.41	-95	0.0	-23.0	-23.0	-38.7	-38.2	-34.9	-50.9	-36.0	-53.8	Y	
-90	-2.38	-5.96	-2.61	-5.58	-6.83	-3.77	-90	0.0	-23.0	-23.0	-34.8	-38.4	-35.0	-38.0	-39.2	-36.2	Y	
-85	-6.83	-4.40	-5.67	-3.79	-13.67	-1.71	-85	-10.0	-33.0	-33.0	-39.2	-36.8	-38.1	-36.2	-46.1	-34.1	Y	
-80	-5.60	-7.42	-11.27	-9.69	-30.47	-3.83	-80	-10.0	-33.0	-33.0	-38.0	-39.8	-43.7	-42.1	-62.9	-36.2	Y	
-75	-6.21	-12.64	-20.00	-18.32	-19.84	-7.26	-75	-10.0	-33.0	-33.0	-38.6	-45.1	-52.4	-50.7	-52.3	-39.7	Y	
-70	-7.83	-11.10	-13.48	-9.10	-20.51	-7.78	-70	-10.0	-33.0	-33.0	-40.2	-43.5	-45.9	-41.5	-52.9	-40.2	Y	
-65	-5.23	-14.61	-14.36	-8.91	-19.37	-9.26	-65	-10.0	-33.0	-33.0	-37.6	-47.0	-46.8	-41.3	-51.8	-41.7	Y	

-60	-3.90	-23.15	-10.30	-10.44	-12.57	-11.61	-60	-10.0	-33.0	-33.0	-36.3	-55.6	-42.7	-42.9	-45.0	-44.0	Y
-55	-6.58	-22.93	-8.30	-10.91	-8.19	-9.63	-55	-10.0	-33.0	-33.0	-39.0	-55.3	-40.7	-43.3	-40.6	-42.0	Y
-50	-10.18	-14.15	-12.37	-28.46	-7.56	-16.32	-50	-10.0	-33.0	-33.0	-42.6	-46.6	-44.8	-60.9	-40.0	-48.7	Y
-48	-12.72	-18.43	-17.71	-17.46	-12.74	-16.15	-48	-10.0	-33.1	-33.1	-45.1	-50.8	-50.1	-49.9	-45.2	-48.6	Y
-45	-15.77	-19.78	-14.07	-24.60	-11.07	-18.56	-45	-9.3	-32.4	-32.4	-48.2	-52.2	-46.5	-57.0	-43.5	-51.0	Y
-40	-15.28	-14.52	-12.16	-19.40	-4.74	-12.40	-40	-8.1	-31.1	-31.1	-47.7	-46.9	-44.6	-51.8	-37.2	-44.8	Y
-35	-19.00	-14.07	-21.18	-14.94	-10.62	-14.95	-35	-6.6	-29.6	-29.6	-51.4	-46.5	-53.6	-47.4	-43.0	-47.4	Y
-30	-13.86	-27.44	-24.79	-14.81	-9.92	-18.44	-30	-4.9	-28.0	-28.0	-46.3	-59.9	-57.2	-47.2	-42.3	-50.9	Y
-25	-14.92	-19.62	-16.53	-22.55	-12.90	-15.11	-25	-2.9	-26.0	-26.0	-47.3	-52.0	-48.9	-55.0	-45.3	-47.5	Y
-20	-15.10	-10.92	-10.27	-23.27	-15.88	-17.23	-20	-0.5	-23.6	-23.6	-47.5	-43.3	-42.7	-55.7	-48.3	-49.6	Y
-15	-12.60	-6.20	-6.28	-7.11	-10.43	-18.10	-15	2.6	-20.4	-20.4	-45.0	-38.6	-38.7	-39.5	-42.8	-50.5	Y
-10	4.33	-2.19	-1.97	1.54	1.20	0.75	-10	7.0	-16.0	-16.0	-28.1	-34.6	-34.4	-30.9	-31.2	-31.7	Y
-9.875	3.65	-0.40	-3.20	1.93	1.77	0.54	-9.875	7.1	-15.9	-15.9	-28.8	-32.8	-35.6	-30.5	-30.7	-31.9	Y
-9.75	2.61	0.75	-3.65	1.69	1.66	-0.51	-9.75	7.3	-15.8	-15.8	-29.8	-31.7	-36.1	-30.7	-30.8	-32.9	Y
-9.625	1.28	1.47	-2.93	0.93	0.79	-2.61	-9.625	7.4	-15.6	-15.6	-31.1	-31.0	-35.3	-31.5	-31.6	-35.0	Y
-9.5	-0.15	1.82	-1.64	-0.20	-1.04	-6.33	-9.5	7.6	-15.5	-15.5	-32.6	-30.6	-34.1	-32.6	-33.5	-38.8	Y
-9.375	-1.42	1.86	-0.46	-1.43	-4.36	-13.62	-9.375	7.7	-15.3	-15.3	-33.8	-30.6	-32.9	-33.9	-36.8	-46.0	Y
-9.25	-2.36	1.57	0.33	-2.41	-10.29	-18.77	-9.25	7.8	-15.2	-15.2	-34.8	-30.8	-32.1	-34.8	-42.7	-51.2	Y
-9.125	-3.11	0.92	0.68	-2.98	-11.47	-10.17	-9.125	8.0	-15.0	-15.0	-35.5	-31.5	-31.7	-35.4	-43.9	-42.6	Y
-9	-4.11	-0.10	0.60	-3.47	-4.99	-6.99	-9	8.0	-15.0	-14.9	-36.5	-32.5	-31.8	-35.9	-37.4	-39.4	Y
-8.875	-5.80	-1.49	0.18	-4.31	-1.23	-6.06	-8.875	8.0	-15.0	-14.7	-38.2	-33.9	-32.2	-36.7	-33.6	-38.5	Y
-8.75	-8.69	-2.85	-0.46	-5.44	0.92	-6.15	-8.75	8.0	-15.0	-14.6	-41.1	-35.3	-32.9	-37.9	-31.5	-38.6	Y
-8.625	-12.37	-3.11	-1.07	-5.29	2.05	-5.27	-8.625	8.0	-15.0	-14.4	-44.8	-35.5	-33.5	-37.7	-30.4	-37.7	Y
-8.5	-11.08	-1.58	-1.43	-2.52	2.39	-2.19	-8.5	8.0	-15.0	-14.3	-43.5	-34.0	-33.8	-34.9	-30.0	-34.6	Y
-8.375	-6.91	0.71	-1.47	0.88	1.99	1.30	-8.375	8.0	-15.0	-14.1	-39.3	-31.7	-33.9	-31.5	-30.4	-31.1	Y
-8.25	-4.12	2.84	-1.42	3.70	0.79	4.16	-8.25	8.0	-15.0	-13.9	-36.5	-29.6	-33.8	-28.7	-31.6	-28.3	Y
-8.125	-2.71	4.58	-1.62	5.82	-1.49	6.26	-8.125	8.0	-15.0	-13.8	-35.1	-27.8	-34.0	-26.6	-33.9	-26.2	Y
-8	-2.54	5.90	-2.40	7.29	-5.71	7.69	-8	8.0	-15.0	-13.6	-35.0	-26.5	-34.8	-25.1	-38.1	-24.7	Y
-7.875	-3.86	6.85	-4.14	8.18	-15.69	8.47	-7.875	8.0	-15.0	-13.4	-36.3	-25.6	-36.6	-24.2	-48.1	-23.9	Y
-7.75	-7.91	7.48	-7.53	8.51	-10.21	8.59	-7.75	8.0	-15.0	-13.3	-40.3	-24.9	-39.9	-23.9	-42.6	-23.8	Y
-7.625	-30.63	7.80	-13.53	8.24	-2.75	7.97	-7.625	8.0	-15.0	-13.1	-63.0	-24.6	-45.9	-24.2	-35.2	-24.4	Y
-7.5	-6.57	7.85	-10.87	7.28	1.30	6.36	-7.5	8.0	-15.0	-12.9	-39.0	-24.6	-43.3	-25.1	-31.1	-26.1	Y

-7.375	0.60	7.63	-4.74	5.38	4.04	3.12	-7.375	8.0	-15.0	-12.7	-31.8	-24.8	-37.2	-27.0	-28.4	-29.3	Y
-7.25	4.85	7.16	-1.13	1.88	6.08	-3.63	-7.25	8.0	-15.0	-12.5	-27.6	-25.3	-33.5	-30.5	-26.3	-36.0	Y
-7.125	7.83	6.48	1.05	-5.62	7.70	-2.69	-7.125	8.0	-15.0	-12.4	-24.6	-25.9	-31.4	-38.0	-24.7	-35.1	Y
-7	10.04	5.67	2.24	-7.13	9.03	5.00	-7	7.9	-15.2	-12.2	-22.4	-26.7	-30.2	-39.5	-23.4	-27.4	Y
-6.875	11.71	4.93	2.64	1.96	10.12	9.32	-6.875	8.1	-15.0	-12.0	-20.7	-27.5	-29.8	-30.5	-22.3	-23.1	Y
-6.75	12.96	4.61	2.27	6.34	11.01	12.09	-6.75	8.3	-14.8	-11.8	-19.5	-27.8	-30.1	-26.1	-21.4	-20.3	Y
-6.625	13.86	4.99	1.14	9.00	11.70	13.95	-6.625	8.5	-14.6	-11.6	-18.6	-27.4	-31.3	-23.4	-20.7	-18.5	Y
-6.5	14.45	5.98	-0.63	10.71	12.21	15.17	-6.5	8.7	-14.4	-11.4	-18.0	-26.4	-33.0	-21.7	-20.2	-17.2	Y
-6.375	14.75	7.22	-1.96	11.78	12.52	15.88	-6.375	8.9	-14.1	-11.1	-17.7	-25.2	-34.4	-20.6	-19.9	-16.5	Y
-6.25	14.77	8.41	-0.71	12.35	12.63	16.13	-6.25	9.1	-13.9	-10.9	-17.6	-24.0	-33.1	-20.1	-19.8	-16.3	Y
-6.125	14.50	9.37	2.08	12.49	12.51	15.94	-6.125	9.3	-13.7	-10.7	-17.9	-23.0	-30.3	-19.9	-19.9	-16.5	Y
-6	13.93	10.05	4.59	12.22	12.16	15.28	-6	9.5	-13.5	-10.5	-18.5	-22.4	-27.8	-20.2	-20.3	-17.1	Y
-5.875	13.03	10.41	6.46	11.54	11.55	14.09	-5.875	9.8	-13.3	-10.3	-19.4	-22.0	-26.0	-20.9	-20.9	-18.3	Y
-5.75	11.82	10.43	7.77	10.40	10.67	12.23	-5.75	10.0	-13.0	-10.0	-20.6	-22.0	-24.6	-22.0	-21.7	-20.2	Y
-5.625	10.50	10.09	8.63	8.67	9.57	9.43	-5.625	10.2	-12.8	-9.8	-21.9	-22.3	-23.8	-23.7	-22.8	-23.0	Y
-5.5	9.72	9.36	9.15	6.19	8.44	5.42	-5.5	10.5	-12.5	-9.5	-22.7	-23.1	-23.3	-26.2	-24.0	-27.0	Y
-5.375	10.31	8.18	9.48	2.90	7.74	3.03	-5.375	10.7	-12.3	-9.3	-22.1	-24.2	-22.9	-29.5	-24.7	-29.4	Y
-5.25	12.00	6.51	9.71	1.02	7.98	6.85	-5.25	11.0	-12.0	-9.0	-20.4	-25.9	-22.7	-31.4	-24.4	-25.6	Y
-5.125	13.91	4.29	9.93	3.81	9.06	10.68	-5.125	11.3	-11.8	-8.8	-18.5	-28.1	-22.5	-28.6	-23.4	-21.7	Y
-5	15.55	1.52	10.16	7.28	10.38	13.34	-5	11.5	-11.5	-8.5	-16.9	-30.9	-22.3	-25.1	-22.0	-19.1	Y
-4.875	16.79	-1.21	10.31	9.87	11.52	15.16	-4.875	11.8	-11.2	-8.2	-15.6	-33.6	-22.1	-22.6	-20.9	-17.3	Y
-4.75	17.63	-1.90	10.25	11.66	12.28	16.39	-4.75	12.1	-10.9	-7.9	-14.8	-34.3	-22.2	-20.8	-20.1	-16.0	Y
-4.625	18.06	0.10	9.79	12.83	12.59	17.13	-4.625	12.4	-10.7	-7.7	-14.4	-32.3	-22.6	-19.6	-19.8	-15.3	Y
-4.5	18.08	2.90	8.72	13.46	12.40	17.44	-4.5	12.7	-10.4	-7.4	-14.3	-29.5	-23.7	-19.0	-20.0	-15.0	Y
-4.375	17.67	5.62	6.71	13.62	11.66	17.34	-4.375	13.0	-10.1	-7.1	-14.7	-26.8	-25.7	-18.8	-20.8	-15.1	Y
-4.25	16.80	8.10	2.99	13.32	10.32	16.84	-4.25	13.3	-9.7	-6.7	-15.6	-24.3	-29.4	-19.1	-22.1	-15.6	Y
-4.125	15.42	10.23	-4.69	12.59	8.48	15.92	-4.125	13.6	-9.4	-6.4	-17.0	-22.2	-37.1	-19.8	-23.9	-16.5	Y
-4	13.50	11.95	-3.15	11.48	6.94	14.61	-4	13.9	-9.1	-6.1	-18.9	-20.5	-35.6	-20.9	-25.5	-17.8	Y
-3.875	11.20	13.20	3.92	10.19	7.25	13.06	-3.875	14.3	-8.7	-5.7	-21.2	-19.2	-28.5	-22.2	-25.2	-19.4	Y
-3.75	9.29	13.90	7.29	9.05	9.01	11.65	-3.75	14.6	-8.4	-5.4	-23.1	-18.5	-25.1	-23.4	-23.4	-20.8	Y
-3.625	9.04	13.96	8.77	8.36	10.59	10.89	-3.625	15.0	-8.0	-5.0	-23.4	-18.5	-23.6	-24.1	-21.8	-21.5	Y
-3.5	10.09	13.15	8.75	7.89	11.38	10.70	-3.5	15.4	-7.6	-4.6	-22.3	-19.3	-23.7	-24.5	-21.0	-21.7	Y

-3.375	11.25	10.98	7.20	7.08	11.23	10.32	-3.375	15.8	-7.2	-4.2	-21.2	-21.4	-25.2	-25.3	-21.2	-22.1	Y
-3.25	12.36	5.98	5.81	5.83	10.25	8.85	-3.25	16.2	-6.8	-3.8	-20.1	-26.4	-26.6	-26.6	-22.2	-23.6	Y
-3.125	13.92	2.54	10.04	6.59	9.96	5.51	-3.125	16.6	-6.4	-3.4	-18.5	-29.9	-22.4	-25.8	-22.5	-26.9	Y
-3	16.25	11.90	15.40	10.91	12.89	5.63	-3	17.1	-6.0	-3.0	-16.2	-20.5	-17.0	-21.5	-19.5	-26.8	Y
-2.875	18.96	17.41	19.54	15.38	17.04	12.47	-2.875	17.5	-5.5		-13.5	-15.0	-12.9	-17.0	-15.4	-19.9	Y
-2.75	21.56	21.08	22.69	18.97	20.60	17.62	-2.75	18.0	-5.0		-10.9	-11.3	-9.7	-13.4	-11.8	-14.8	Y
-2.625	23.82	23.72	25.13	21.78	23.41	21.31	-2.625	18.5	-4.5		-8.6	-8.7	-7.3	-10.6	-9.0	-11.1	Y
-2.5	25.65	25.67	27.00	23.94	25.58	24.04	-2.5	19.1	-4.0		-6.8	-6.7	-5.4	-8.5	-6.8	-8.4	Y
-2.375	27.06	27.06	28.40	25.55	27.22	26.07	-2.375	19.6	-3.4		-5.4	-5.4	-4.0	-6.9	-5.2	-6.3	Y
-2.25	28.04	27.96	29.36	26.66	28.37	27.53	-2.25	20.2	-2.8		-4.4	-4.5	-3.1	-5.8	-4.1	-4.9	Y
-2.125	28.57	28.38	29.87	27.27	29.04	28.47	-2.125	20.8	-2.2		-3.8	-4.0	-2.5	-5.1	-3.4	-3.9	Y
-2	28.61	28.25	29.91	27.32	29.23	28.88	-2	21.5	-1.6		-3.8	-4.2	-2.5	-5.1	-3.2	-3.5	Y
-1.875	28.04	27.47	29.39	26.69	28.83	28.71	-1.875	22.2	-0.9		-4.4	-4.9	-3.0	-5.7	-3.6	-3.7	Y
-1.75	26.62	25.73	28.11	25.09	27.66	27.80	-1.75	22.9	-0.1		-5.8	-6.7	-4.3	-7.3	-4.8	-4.6	Y
-1.625	23.75	22.20	25.61	21.66	25.25	25.76	-1.625	23.7	0.7		-8.7	-10.2	-6.8	-10.8	-7.2	-6.7	Y
-1.5	17.05	12.54	20.45	12.22	20.03	21.43	-1.5	24.6	1.6		-15.4	-19.9	-12.0	-20.2	-12.4	-11.0	Y
-1.375	11.10	16.20	11.94	16.41	-0.37	7.14	-1.375				-21.3	-16.2	-20.5	-16.0	-32.8	-25.3	Y
-1.25	24.02	25.54	23.46	25.51	22.50	20.85	-1.25				-8.4	-6.9	-9.0	-6.9	-9.9	-11.6	Y
-1.125	29.50	30.31	29.36	30.31	28.86	28.05	-1.125				-2.9	-2.1	-3.1	-2.1	-3.6	-4.4	Y
-1	33.04	33.55	33.09	33.60	32.73	32.24	-1				0.6	1.1	0.7	1.2	0.3	-0.2	Y
-0.875	35.62	35.95	35.75	36.05	35.49	35.16	-0.875				3.2	3.5	3.3	3.6	3.1	2.7	Y
-0.75	37.58	37.80	37.77	37.94	37.56	37.34	-0.75				5.2	5.4	5.4	5.5	5.1	4.9	Y
-0.625	39.10	39.24	39.32	39.42	39.15	39.01	-0.625				6.7	6.8	6.9	7.0	6.7	6.6	Y
-0.5	40.26	40.34	40.50	40.56	40.37	40.28	-0.5				7.8	7.9	8.1	8.1	7.9	7.9	Y
-0.375	41.12	41.17	41.38	41.40	41.26	41.22	-0.375				8.7	8.8	9.0	9.0	8.8	8.8	Y
-0.25	41.72	41.74	41.98	41.99	41.88	41.86	-0.25				9.3	9.3	9.6	9.6	9.5	9.4	Y
-0.125	42.07	42.07	42.34	42.34	42.25	42.24	-0.125				9.7	9.7	9.9	9.9	9.8	9.8	Y
0	42.18	42.18	42.45	42.45	42.37	42.37	0				9.8	9.8	10.0	10.0	10.0	10.0	Y
0.125	42.07	42.07	42.34	42.34	42.25	42.24	0.125				9.7	9.7	9.9	9.9	9.8	9.8	Y
0.25	41.72	41.74	41.98	41.99	41.88	41.86	0.25				9.3	9.3	9.6	9.6	9.5	9.4	Y
0.375	41.12	41.17	41.38	41.40	41.26	41.22	0.375				8.7	8.8	9.0	9.0	8.8	8.8	Y
0.5	40.26	40.34	40.50	40.56	40.37	40.28	0.5				7.8	7.9	8.1	8.1	7.9	7.9	Y

0.625	39.10	39.24	39.32	39.42	39.15	39.01	0.625				6.7	6.8	6.9	7.0	6.7	6.6	Y
0.75	37.58	37.80	37.77	37.94	37.56	37.34	0.75				5.2	5.4	5.4	5.5	5.1	4.9	Y
0.875	35.62	35.95	35.75	36.05	35.49	35.16	0.875				3.2	3.5	3.3	3.6	3.1	2.7	Y
1	33.04	33.55	33.09	33.60	32.73	32.24	1				0.6	1.1	0.7	1.2	0.3	-0.2	Y
1.125	29.50	30.31	29.36	30.31	28.86	28.05	1.125				-2.9	-2.1	-3.1	-2.1	-3.6	-4.4	Y
1.25	24.02	25.54	23.46	25.51	22.50	20.85	1.25				-8.4	-6.9	-9.0	-6.9	-9.9	-11.6	Y
1.375	11.10	16.20	11.94	16.41	-0.37	7.14	1.375				-21.3	-16.2	-20.5	-16.0	-32.8	-25.3	Y
1.5	17.05	12.54	20.45	12.22	20.03	21.43	1.5	24.6	1.6		-15.4	-19.9	-12.0	-20.2	-12.4	-11.0	Y
1.625	23.75	22.20	25.61	21.66	25.25	25.76	1.625	23.7	0.7		-8.7	-10.2	-6.8	-10.8	-7.2	-6.7	Y
1.75	26.62	25.73	28.11	25.09	27.66	27.80	1.75	22.9	-0.1		-5.8	-6.7	-4.3	-7.3	-4.8	-4.6	Y
1.875	28.04	27.47	29.39	26.69	28.83	28.71	1.875	22.2	-0.9		-4.4	-4.9	-3.0	-5.7	-3.6	-3.7	Y
2	28.61	28.25	29.91	27.32	29.23	28.88	2	21.5	-1.6		-3.8	-4.2	-2.5	-5.1	-3.2	-3.5	Y
2.125	28.57	28.38	29.87	27.27	29.04	28.47	2.125	20.8	-2.2		-3.8	-4.0	-2.5	-5.1	-3.4	-3.9	Y
2.25	28.04	27.96	29.36	26.66	28.37	27.53	2.25	20.2	-2.8		-4.4	-4.5	-3.1	-5.8	-4.1	-4.9	Y
2.375	27.06	27.06	28.40	25.55	27.22	26.07	2.375	19.6	-3.4		-5.4	-5.4	-4.0	-6.9	-5.2	-6.3	Y
2.5	25.65	25.67	27.00	23.94	25.58	24.04	2.5	19.1	-4.0		-6.8	-6.7	-5.4	-8.5	-6.8	-8.4	Y
2.625	23.82	23.72	25.13	21.78	23.41	21.31	2.625	18.5	-4.5		-8.6	-8.7	-7.3	-10.6	-9.0	-11.1	Y
2.75	21.56	21.08	22.69	18.97	20.60	17.62	2.75	18.0	-5.0		-10.9	-11.3	-9.7	-13.4	-11.8	-14.8	Y
2.875	18.96	17.41	19.54	15.38	17.04	12.47	2.875	17.5	-5.5		-13.5	-15.0	-12.9	-17.0	-15.4	-19.9	Y
3	16.25	11.90	15.40	10.91	12.89	5.63	3	17.1	-6.0	-3.0	-16.2	-20.5	-17.0	-21.5	-19.5	-26.8	Y
3.125	13.92	2.54	10.04	6.59	9.96	5.51	3.125	16.6	-6.4	-3.4	-18.5	-29.9	-22.4	-25.8	-22.5	-26.9	Y
3.25	12.36	5.98	5.81	5.83	10.25	8.85	3.25	16.2	-6.8	-3.8	-20.1	-26.4	-26.6	-26.6	-22.2	-23.6	Y
3.375	11.25	10.98	7.20	7.08	11.23	10.32	3.375	15.8	-7.2	-4.2	-21.2	-21.4	-25.2	-25.3	-21.2	-22.1	Y
3.5	10.09	13.15	8.75	7.89	11.38	10.70	3.5	15.4	-7.6	-4.6	-22.3	-19.3	-23.7	-24.5	-21.0	-21.7	Y
3.625	9.04	13.96	8.77	8.36	10.59	10.89	3.625	15.0	-8.0	-5.0	-23.4	-18.5	-23.6	-24.1	-21.8	-21.5	Y
3.75	9.29	13.90	7.29	9.05	9.01	11.65	3.75	14.6	-8.4	-5.4	-23.1	-18.5	-25.1	-23.4	-23.4	-20.8	Y
3.875	11.20	13.20	3.92	10.19	7.25	13.06	3.875	14.3	-8.7	-5.7	-21.2	-19.2	-28.5	-22.2	-25.2	-19.4	Y
4	13.50	11.95	-3.15	11.48	6.94	14.61	4	13.9	-9.1	-6.1	-18.9	-20.5	-35.6	-20.9	-25.5	-17.8	Y
4.125	15.42	10.23	-4.69	12.59	8.48	15.92	4.125	13.6	-9.4	-6.4	-17.0	-22.2	-37.1	-19.8	-23.9	-16.5	Y
4.25	16.80	8.10	2.99	13.32	10.32	16.84	4.25	13.3	-9.7	-6.7	-15.6	-24.3	-29.4	-19.1	-22.1	-15.6	Y
4.375	17.67	5.62	6.71	13.62	11.66	17.34	4.375	13.0	-10.1	-7.1	-14.7	-26.8	-25.7	-18.8	-20.8	-15.1	Y
4.5	18.08	2.90	8.72	13.46	12.40	17.44	4.5	12.7	-10.4	-7.4	-14.3	-29.5	-23.7	-19.0	-20.0	-15.0	Y

4.625	18.06	0.10	9.79	12.83	12.59	17.13	4.625	12.4	-10.7	-7.7	-14.4	-32.3	-22.6	-19.6	-19.8	-15.3	Y
4.75	17.63	-1.90	10.25	11.66	12.28	16.39	4.75	12.1	-10.9	-7.9	-14.8	-34.3	-22.2	-20.8	-20.1	-16.0	Y
4.875	16.79	-1.21	10.31	9.87	11.52	15.16	4.875	11.8	-11.2	-8.2	-15.6	-33.6	-22.1	-22.6	-20.9	-17.3	Y
5	15.55	1.52	10.16	7.28	10.38	13.34	5	11.5	-11.5	-8.5	-16.9	-30.9	-22.3	-25.1	-22.0	-19.1	Y
5.125	13.91	4.29	9.93	3.81	9.06	10.68	5.125	11.3	-11.8	-8.8	-18.5	-28.1	-22.5	-28.6	-23.4	-21.7	Y
5.25	12.00	6.51	9.71	1.02	7.98	6.85	5.25	11.0	-12.0	-9.0	-20.4	-25.9	-22.7	-31.4	-24.4	-25.6	Y
5.375	10.31	8.18	9.48	2.90	7.74	3.03	5.375	10.7	-12.3	-9.3	-22.1	-24.2	-22.9	-29.5	-24.7	-29.4	Y
5.5	9.72	9.36	9.15	6.19	8.44	5.42	5.5	10.5	-12.5	-9.5	-22.7	-23.1	-23.3	-26.2	-24.0	-27.0	Y
5.625	10.50	10.09	8.63	8.67	9.57	9.43	5.625	10.2	-12.8	-9.8	-21.9	-22.3	-23.8	-23.7	-22.8	-23.0	Y
5.75	11.82	10.43	7.77	10.40	10.67	12.23	5.75	10.0	-13.0	-10.0	-20.6	-22.0	-24.6	-22.0	-21.7	-20.2	Y
5.875	13.03	10.41	6.46	11.54	11.55	14.09	5.875	9.8	-13.3	-10.3	-19.4	-22.0	-26.0	-20.9	-20.9	-18.3	Y
6	13.93	10.05	4.59	12.22	12.16	15.28	6	9.5	-13.5	-10.5	-18.5	-22.4	-27.8	-20.2	-20.3	-17.1	Y
6.125	14.50	9.37	2.08	12.49	12.51	15.94	6.125	9.3	-13.7	-10.7	-17.9	-23.0	-30.3	-19.9	-19.9	-16.5	Y
6.25	14.77	8.41	-0.71	12.35	12.63	16.13	6.25	9.1	-13.9	-10.9	-17.6	-24.0	-33.1	-20.1	-19.8	-16.3	Y
6.375	14.75	7.22	-1.96	11.78	12.52	15.88	6.375	8.9	-14.1	-11.1	-17.7	-25.2	-34.4	-20.6	-19.9	-16.5	Y
6.5	14.45	5.98	-0.63	10.71	12.21	15.17	6.5	8.7	-14.4	-11.4	-18.0	-26.4	-33.0	-21.7	-20.2	-17.2	Y
6.625	13.86	4.99	1.14	9.00	11.70	13.95	6.625	8.5	-14.6	-11.6	-18.6	-27.4	-31.3	-23.4	-20.7	-18.5	Y
6.75	12.96	4.61	2.27	6.34	11.01	12.09	6.75	8.3	-14.8	-11.8	-19.5	-27.8	-30.1	-26.1	-21.4	-20.3	Y
6.875	11.71	4.93	2.64	1.96	10.12	9.32	6.875	8.1	-15.0	-12.0	-20.7	-27.5	-29.8	-30.5	-22.3	-23.1	Y
7	10.04	5.67	2.24	-7.13	9.03	5.00	7	7.9	-15.2	-12.2	-22.4	-26.7	-30.2	-39.5	-23.4	-27.4	Y
7.125	7.83	6.48	1.05	-5.62	7.70	-2.69	7.125	8.0	-15.0	-12.4	-24.6	-25.9	-31.4	-38.0	-24.7	-35.1	Y
7.25	4.85	7.16	-1.13	1.88	6.08	-3.63	7.25	8.0	-15.0	-12.5	-27.6	-25.3	-33.5	-30.5	-26.3	-36.0	Y
7.375	0.60	7.63	-4.74	5.38	4.04	3.12	7.375	8.0	-15.0	-12.7	-31.8	-24.8	-37.2	-27.0	-28.4	-29.3	Y
7.5	-6.57	7.85	-10.87	7.28	1.30	6.36	7.5	8.0	-15.0	-12.9	-39.0	-24.6	-43.3	-25.1	-31.1	-26.1	Y
7.625	-30.63	7.80	-13.53	8.24	-2.75	7.97	7.625	8.0	-15.0	-13.1	-63.0	-24.6	-45.9	-24.2	-35.2	-24.4	Y
7.75	-7.91	7.48	-7.53	8.51	-10.21	8.59	7.75	8.0	-15.0	-13.3	-40.3	-24.9	-39.9	-23.9	-42.6	-23.8	Y
7.875	-3.86	6.85	-4.14	8.18	-15.69	8.47	7.875	8.0	-15.0	-13.4	-36.3	-25.6	-36.6	-24.2	-48.1	-23.9	Y
8	-2.54	5.90	-2.40	7.29	-5.71	7.69	8	8.0	-15.0	-13.6	-35.0	-26.5	-34.8	-25.1	-38.1	-24.7	Y
8.125	-2.71	4.58	-1.62	5.82	-1.49	6.26	8.125	8.0	-15.0	-13.8	-35.1	-27.8	-34.0	-26.6	-33.9	-26.2	Y
8.25	-4.12	2.84	-1.42	3.70	0.79	4.16	8.25	8.0	-15.0	-13.9	-36.5	-29.6	-33.8	-28.7	-31.6	-28.3	Y
8.375	-6.91	0.71	-1.47	0.88	1.99	1.30	8.375	8.0	-15.0	-14.1	-39.3	-31.7	-33.9	-31.5	-30.4	-31.1	Y
8.5	-11.08	-1.58	-1.43	-2.52	2.39	-2.19	8.5	8.0	-15.0	-14.3	-43.5	-34.0	-33.8	-34.9	-30.0	-34.6	Y

8.625	-12.37	-3.11	-1.07	-5.29	2.05	-5.27	8.625	8.0	-15.0	-14.4	-44.8	-35.5	-33.5	-37.7	-30.4	-37.7	Y
8.75	-8.69	-2.85	-0.46	-5.44	0.92	-6.15	8.75	8.0	-15.0	-14.6	-41.1	-35.3	-32.9	-37.9	-31.5	-38.6	Y
8.875	-5.80	-1.49	0.18	-4.31	-1.23	-6.06	8.875	8.0	-15.0	-14.7	-38.2	-33.9	-32.2	-36.7	-33.6	-38.5	Y
9	-4.11	-0.10	0.60	-3.47	-4.99	-6.99	9	8.0	-15.0	-14.9	-36.5	-32.5	-31.8	-35.9	-37.4	-39.4	Y
9.125	-3.11	0.92	0.68	-2.98	-11.47	-10.17	9.125	8.0	-15.0	-15.0	-35.5	-31.5	-31.7	-35.4	-43.9	-42.6	Y
9.25	-2.36	1.57	0.33	-2.41	-10.29	-18.77	9.25	7.8	-15.2	-15.2	-34.8	-30.8	-32.1	-34.8	-42.7	-51.2	Y
9.375	-1.42	1.86	-0.46	-1.43	-4.36	-13.62	9.375	7.7	-15.3	-15.3	-33.8	-30.6	-32.9	-33.9	-36.8	-46.0	Y
9.5	-0.15	1.82	-1.64	-0.20	-1.04	-6.33	9.5	7.6	-15.5	-15.5	-32.6	-30.6	-34.1	-32.6	-33.5	-38.8	Y
9.625	1.28	1.47	-2.93	0.93	0.79	-2.61	9.625	7.4	-15.6	-15.6	-31.1	-31.0	-35.3	-31.5	-31.6	-35.0	Y
9.75	2.61	0.75	-3.65	1.69	1.66	-0.51	9.75	7.3	-15.8	-15.8	-29.8	-31.7	-36.1	-30.7	-30.8	-32.9	Y
9.875	3.65	-0.40	-3.20	1.93	1.77	0.54	9.875	7.1	-15.9	-15.9	-28.8	-32.8	-35.6	-30.5	-30.7	-31.9	Y
10	4.33	-2.19	-1.97	1.54	1.20	0.75	10	7.0	-16.0	-16.0	-28.1	-34.6	-34.4	-30.9	-31.2	-31.7	Y
15	-12.60	-6.20	-6.28	-7.11	-10.43	-18.10	15	2.6	-20.4	-20.4	-45.0	-38.6	-38.7	-39.5	-42.8	-50.5	Y
20	-15.10	-10.92	-10.27	-23.27	-15.88	-17.23	20	-0.5	-23.6	-23.6	-47.5	-43.3	-42.7	-55.7	-48.3	-49.6	Y
25	-14.92	-19.62	-16.53	-22.55	-12.90	-15.11	25	-2.9	-26.0	-26.0	-47.3	-52.0	-48.9	-55.0	-45.3	-47.5	Y
30	-13.86	-27.44	-24.79	-14.81	-9.92	-18.44	30	-4.9	-28.0	-28.0	-46.3	-59.9	-57.2	-47.2	-42.3	-50.9	Y
35	-19.00	-14.07	-21.18	-14.94	-10.62	-14.95	35	-6.6	-29.6	-29.6	-51.4	-46.5	-53.6	-47.4	-43.0	-47.4	Y
40	-15.28	-14.52	-12.16	-19.40	-4.74	-12.40	40	-8.1	-31.1	-31.1	-47.7	-46.9	-44.6	-51.8	-37.2	-44.8	Y
45	-15.77	-19.78	-14.07	-24.60	-11.07	-18.56	45	-9.3	-32.4	-32.4	-48.2	-52.2	-46.5	-57.0	-43.5	-51.0	Y
48	-12.72	-18.43	-17.71	-17.46	-12.74	-16.15	48	-10.0	-33.1	-33.1	-45.1	-50.8	-50.1	-49.9	-45.2	-48.6	Y
50	-10.18	-14.15	-12.37	-28.46	-7.56	-16.32	50	-10.0	-33.0	-33.0	-42.6	-46.6	-44.8	-60.9	-40.0	-48.7	Y
55	-6.58	-22.93	-8.30	-10.91	-8.19	-9.63	55	-10.0	-33.0	-33.0	-39.0	-55.3	-40.7	-43.3	-40.6	-42.0	Y
60	-3.90	-23.15	-10.30	-10.44	-12.57	-11.61	60	-10.0	-33.0	-33.0	-36.3	-55.6	-42.7	-42.9	-45.0	-44.0	Y
65	-5.23	-14.61	-14.36	-8.91	-19.37	-9.26	65	-10.0	-33.0	-33.0	-37.6	-47.0	-46.8	-41.3	-51.8	-41.7	Y
70	-7.83	-11.10	-13.48	-9.10	-20.51	-7.78	70	-10.0	-33.0	-33.0	-40.2	-43.5	-45.9	-41.5	-52.9	-40.2	Y
75	-6.21	-12.64	-20.00	-18.32	-19.84	-7.26	75	-10.0	-33.0	-33.0	-38.6	-45.1	-52.4	-50.7	-52.3	-39.7	Y
80	-5.60	-7.42	-11.27	-9.69	-30.47	-3.83	80	-10.0	-33.0	-33.0	-38.0	-39.8	-43.7	-42.1	-62.9	-36.2	Y
85	-6.83	-4.40	-5.67	-3.79	-13.67	-1.71	85	-10.0	-33.0	-33.0	-39.2	-36.8	-38.1	-36.2	-46.1	-34.1	Y
90	-2.38	-5.96	-2.61	-5.58	-6.83	-3.77	90	0.0	-23.0	-23.0	-34.8	-38.4	-35.0	-38.0	-39.2	-36.2	Y
95	-6.32	-5.76	-2.46	-18.51	-3.61	-21.41	95	0.0	-23.0	-23.0	-38.7	-38.2	-34.9	-50.9	-36.0	-53.8	Y
100	-4.33	-8.27	-3.37	-5.54	-2.72	-5.74	100	0.0	-23.0	-23.0	-36.7	-40.7	-35.8	-38.0	-35.1	-38.2	Y
105	-5.83	-7.52	-7.93	-4.10	-5.93	-5.90	105	0.0	-23.0	-23.0	-38.2	-39.9	-40.3	-36.5	-38.3	-38.3	Y

110	-9.43	-9.72	-12.83	-7.69	-10.61	-10.36	110	0.0	-23.0	-23.0	-41.8	-42.1	-45.2	-40.1	-43.0	-42.8	Y
115	-14.34	-17.95	-17.49	-14.06	-13.37	-18.81	115	0.0	-23.0	-23.0	-46.8	-50.4	-49.9	-46.5	-45.8	-51.2	Y
120	-15.34	-17.36	-19.28	-14.38	-18.99	-14.15	120	0.0	-23.0	-23.0	-47.8	-49.8	-51.7	-46.8	-51.4	-46.6	Y
125	-19.59	-17.69	-26.45	-22.24	-20.08	-18.86	125	0.0	-23.0	-23.0	-52.0	-50.1	-58.9	-54.7	-52.5	-51.3	Y
130	-20.43	-19.08	-25.35	-15.96	-20.57	-23.67	130	0.0	-23.0	-23.0	-52.9	-51.5	-57.8	-48.4	-53.0	-56.1	Y
135	-18.58	-23.59	-21.03	-16.32	-20.74	-23.03	135	0.0	-23.0	-23.0	-51.0	-56.0	-53.5	-48.7	-53.2	-55.4	Y
140	-17.32	-20.04	-25.76	-19.51	-17.34	-16.45	140	0.0	-23.0	-23.0	-49.7	-52.5	-58.2	-51.9	-49.8	-48.9	Y
145	-21.29	-19.34	-22.44	-22.04	-25.52	-19.53	145	0.0	-23.0	-23.0	-53.7	-51.8	-54.9	-54.5	-57.9	-51.9	Y
150	-18.21	-25.15	-21.89	-21.61	-18.05	-14.74	150	0.0	-23.0	-23.0	-50.6	-57.6	-54.3	-54.0	-50.5	-47.2	Y
155	-31.36	-26.50	-22.18	-17.88	-19.67	-21.01	155	0.0	-23.0	-23.0	-63.8	-58.9	-54.6	-50.3	-52.1	-53.4	Y
160	-20.00	-24.67	-29.29	-15.74	-19.28	-16.24	160	0.0	-23.0	-23.0	-52.4	-57.1	-61.7	-48.2	-51.7	-48.7	Y
165	-16.61	-31.36	-33.68	-20.88	-17.56	-17.70	165	0.0	-23.0	-23.0	-49.0	-63.8	-66.1	-53.3	-50.0	-50.1	Y
170	-14.42	-22.89	-26.22	-23.87	-21.13	-19.22	170	0.0	-23.0	-23.0	-46.8	-55.3	-58.6	-56.3	-53.5	-51.6	Y
175	-9.44	-12.61	-15.57	-11.53	-14.54	-17.07	175	0.0	-23.0	-23.0	-41.9	-45.0	-48.0	-43.9	-47.0	-49.5	Y
180	-0.97	-0.97	-0.23	-0.23	-1.00	-1.00	180	0.0	-23.0	-23.0	-33.4	-33.4	-32.6	-32.6	-33.4	-33.4	Y

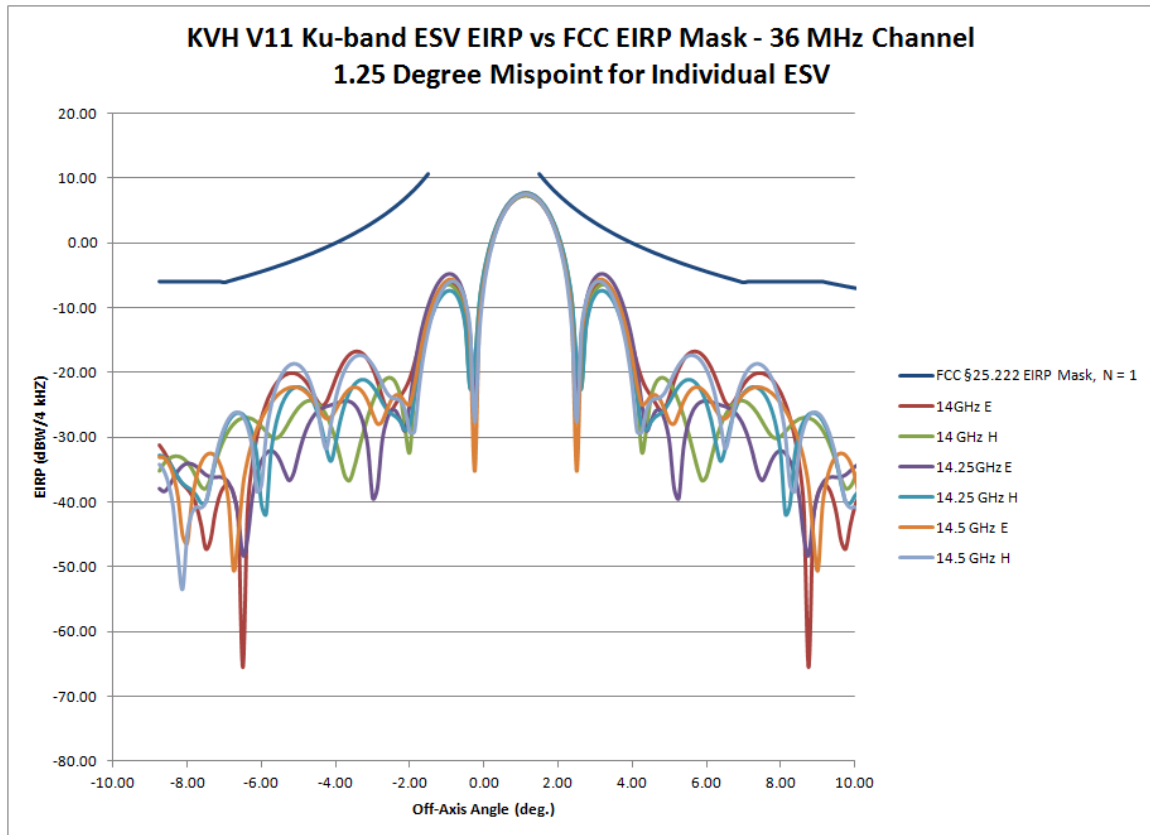
5. Pointing Accuracy

The ESV V11 terminal will utilize a motion stabilized tracking antenna and a direct sequence spread spectrum (DSSS) burst modem manufactured by ViaSat to access the satellite. The ESV terminal uses a common spreading code and a random access method called code reuse multiple access (“CRMA”) to access the satellite. CRMA is closely analogous to the more generally understood code division multiple access (CDMA) multiple access method, but differs in that all terminals use a common spreading code rather than a number of individual codes for each transmitter. Individual bursts are distinguished by time difference of arrival. The use of this spreading technique allows the RF spectral density for each ESV to be significantly lower than typical TDMA systems operating at Ku-band.

The antenna system utilizes a conical scanning function and rate gyros to stabilize the antenna and keep it pointed properly at the desired satellite. The conscan is currently set to worst case 0.15° from boresight. The dynamic pointing error for the vessel accelerations expected during testing operation is expected to be less than 1.0°. Thus the total expected mean pointing error for each vessel while under way, including both conscan and dynamic error, is 1.15°, this is the declared maximum pointing error.

During the small percentage of time when conditions cause the antenna pointing error to exceed the specified maximum pointing error limit of 1.15°, the antenna system will send a message to the modem, and the modem will inhibit transmission until the aggregate conscan plus dynamic pointing error value is back to within 1.0°. The time lag from detection of exceedance of mispointing to time when transmit is inhibited will be less than 100 ms. This error limit of 1.15° is the declared maximum antenna pointing error as described in §25.222(b)(1)(iv)(A).

As described above, the Ku-band ESV terminals use a spread spectrum multiple access technique whereby the individual off-axis EIRP density of each ESV terminal is well below the maximum aggregate network limit. Thus, each antenna individually will not generate harmful levels of interference. Figure 7 below shows the ESV off-axis EIRP considering a more than worst case 1.25 degree pointing error. As can be seen the EIRP density complies with the Section 25.222 mask for an individual ESV terminal.



**Figure 7 - Ku-Band ESV Terminal Off-axis EIRP
with 1.25 degree pointing error vs §25.222 limit**

6. FCC §25.222 Compliance Matrix for the V11 Terminal

	FCC Part 25 Earth Station on Vessels (ESV) Rules for Ku-Band	Complies	Comments
§ 25.222	§ 25.222 Blanket Licensing provisions for Earth Stations on Vessels (ESVs) receiving in the 10.95–11.2 GHz (space-to- Earth), 11.45–11.7 GHz (space-to-Earth), 11.7–12.2 GHz (space-to-Earth) frequency bands and transmitting in the 14.0–14.5 GHz (Earth-to-space) frequency band, operating with Geostationary Orbit (GSO) Satellites in the Fixed-Satellite Service.		
§ 25.222(a)	(a) The following ongoing requirements govern all ESV licensees and operations in the 10.95–11.2 GHz (space-to-Earth), 11.45–11.7 GHz (space-to-Earth), 11.7–12.2 GHz (space-to- Earth) frequency bands and 14.0–14.5 GHz (Earth-to-space) bands transmitting to GSO satellites in the fixed-satellite service. ESV licensees must comply with the requirements in either paragraph (a)(1) or (a)(2) of this section and all of the requirements set forth in paragraphs (a)(3) through (a)(7) of this section. Paragraph (b) of this section identifies items that must be included in the application for ESV operations to demonstrate that these ongoing requirements will be met.	Complies	Complies with (a)(1) and remaining provisions
§ 25.222(a)(1)	(1) The following requirements shall apply to an ESV that uses transmitters with off axis effective isotropically radiated power (EIRP) spectral-densities lower than or equal to the levels in paragraph (a)(1)(i)(A) of this section. An ESV, or ESV system, operating under this section shall provide a detailed demonstration as described in paragraph (b)(1) of this section. The ESV transmitter also must comply with the antenna pointing and cessation of emission requirements in paragraphs (a)(1)(ii) and (a)(1)(iii) of this section.		
§ 25.222(a)(1)(i)	(i) An ESV system shall not exceed the off axis EIRP spectral-density limits and conditions defined in paragraphs (a)(1)(i)(A) through (a)(1)(i)(D) of this section.		
§ 25.222(a)(1)(i)(A)	(A) The off-axis EIRP spectral-density emitted from the ESV, in the plane of the GSO as it appears at the particular earth station location, shall not exceed the following values:	Complies	Narrative I.B.1, Tech Exhibit 1, Section 4
	15-10log(N)-25logq dBW/4 kHz for $1.5^{\circ} \leq q \leq 7^{\circ}$		
	-6 -10log(N) dBW/4 kHz for $7^{\circ} < q \leq 9.2^{\circ}$		
	18 -10log(N)-25logq dBW/4 kHz for $9.2^{\circ} < q \leq 48^{\circ}$		

	-24 -10log(N) dBW/4 kHz for $48^\circ < q \leq 85^\circ$		
	-14 -10log(N) dBW/4 kHz for $85^\circ < q \leq 180^\circ$		
	Where theta (q) is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital location of the target satellite. For ESV networks using frequency division multiple access (FDMA) or time division multiple access (TDMA) techniques, N is equal to one. For ESV networks using multiple co-frequency transmitters that have the same EIRP, N is the maximum expected number of co-frequency simultaneously transmitting ESV earth stations in the same satellite receiving beam. For the purpose of this section, the peak EIRP of an individual sidelobe may not exceed the envelope defined above for q between 1.5° and 7.0° . For q greater than 7.0° , the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.		
§ 25.222(a)(1)(i)(B)	(B) In all directions other than along the GSO, the off-axis EIRP spectral-density for co-polarized signals emitted from the ESV shall not exceed the following values:	Complies	Exhibit 1, Section 4
	18-10log(N)-25logq dBW/4 kHz for $3.0^\circ \leq q \leq 48^\circ$		
	-24-10log(N) dBW/4 kHz for $48^\circ < q \leq 85^\circ$		
	-14-10log(N) dBW/4 kHz for $85^\circ < q \leq 180^\circ$		
	Where q and N are defined in paragraph (a)(1)(i)(A) of this section. This off-axis EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the orbital location of the target satellite with the exception of the plane of the GSO as defined in paragraph (a)(1)(i)(A) of this section. For the purpose of this section, the envelope may be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.	Complies	Exhibit 1, Section 4
§ 25.222(a)(1)(i)(C)	(C) In all directions, the off-axis EIRP spectral-density for cross-polarized signals emitted from the ESV shall not exceed the following values:	Complies	
	5-10log(N)-25logq dBW/4 kHz for $1.8^\circ \leq q \leq 7.0^\circ$		
	-16-10log(N) dBW/4 kHz for $7.0^\circ < q \leq 9.2^\circ$		

	Where q and N are defined as set forth in paragraph (a)(1)(i)(A) of this section. This EIRP spectral-density applies in any plane that includes the line connecting the focal point of the antenna to the target satellite.		
§ 25.222(a)(1)(i)(D)	(D) For non-circular ESV antennas, the major axis of the antenna will be aligned with the tangent to the arc of the GSO at the orbital location of the target satellite, to the extent required to meet the specified off-axis EIRP spectral-density criteria.	N/A	
§ 25.222(a)(1)(ii)	(ii) Each ESV transmitter must meet one of the following antenna pointing requirements:		
§ 25.222(a)(1)(ii)(A)	(A) Each ESV transmitter shall maintain a pointing error of less than or equal to 0.2° between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna, or		
§ 25.222(a)(1)(ii)(B)	(B) Each ESV transmitter shall declare a maximum antenna pointing error that may be greater than 0.2° provided that the ESV does not exceed the off-axis EIRP spectral density limits in paragraph (a)(1)(i) of this section, taking into account the antenna pointing error.	Complies	Narrative I.B.2, Exhibit 1, Section 5
§ 25.222(a)(1)(iii)	(iii) Each ESV transmitter must meet one of the following cessation of emission requirements:		
§ 25.222(a)(1)(iii)(A)	(A) For ESVs operating under paragraph (a)(1)(ii)(A) of this section, all emissions from the ESV shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna exceeds 0.5°, and transmission will not resume until such angle is less than or equal to 0.2°, or		
§ 25.222(a)(1)(iii)(B)	(B) For ESV transmitters operating under paragraph (a)(1)(ii)(B) of this section, all emissions from the ESV shall automatically cease within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna exceeds the declared maximum antenna pointing error and shall not resume transmissions until such angle is less than or equal to the declared maximum antenna pointing error.	Complies	Narrative, I.B.2, Exhibit 1, Section 5; resumes transmissions at 1.0 deg offset even though declared maximum point error is 1.15 deg
§ 25.222(a)(2)	(2) The following requirements shall apply to an ESV that uses off-axis EIRP spectral densities in excess of the levels in paragraph (a)(1)(i) of this section. An ESV, or ESV system, operating under this section shall file certifications and provide a detailed demonstration as described in paragraph (b)(2) of this section.	N/A	
§ 25.222(a)(2)(i)	(i) The ESV shall transmit only to the target satellite system(s) referred to in the certifications required by paragraph (b)(2) of this section.		
§ 25.222(a)(2)(ii)	(ii) If a good faith agreement cannot be reached between the target satellite operator and the operator of a future satellite that is located within 6 degrees longitude of the target satellite, the ESV operator shall accept the power-density levels that would accommodate that adjacent satellite.		

§ 25.222(a)(2)(iii)	(iii) The ESV shall operate in accordance with the off-axis EIRP spectral-densities that the ESV supplied to the target satellite operator in order to obtain the certifications listed in paragraph (b)(2) of this section. The ESV shall automatically cease emissions within 100 milliseconds if the ESV transmitter exceeds the off-axis EIRP spectral densities supplied to the target satellite operator.		
§ 25.222(a)(3)	(3) There shall be a point of contact in the United States, with phone number and address, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the ESVs, either directly or through the facilities of a U.S. Hub or a Hub located in another country with which the United States has a bilateral agreement that enables such cessation of emissions.	Complies	
§ 25.222(a)(4)	(4) For each ESV transmitter, a record of the ship location (<i>i.e.</i> , latitude/longitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than 1 year. Records will be recorded at time intervals no greater than every 20 minutes while the ESV is transmitting. The ESV operator will make this data available upon request to a coordinator, fixed system operator, fixed-satellite system operator, NTIA, or the Commission within 24 hours of the request.	Complies	Narrative I.B.3, Exhibit 1, Section 3
§ 25.222(a)(5)	(5) ESV operators communicating with vessels of foreign registry must maintain detailed information on each vessel's country of registry and a point of contact for the relevant administration responsible for licensing ESVs.	Complies	
§ 25.222(a)(6)	(6) ESV operators shall control all ESVs by a Hub earth station located in the United States, except that an ESV on U.S.-registered vessels may operate under control of a Hub earth station location outside the United States provided the ESV operator maintains a point of contact within the United States that will have the capability and authority to cause an ESV on a U.S.-registered vessel to cease transmitting if necessary.	Complies	
§ 25.222(a)(7)	(7) In the 10.95–11.2 GHz (space-to-Earth) and 11.45–11.7 GHz (space-to-Earth) frequency bands ESVs shall not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned, or may be assigned in the future.	Complies	
§ 25.222(b)	(b) Applications for ESV operation in the 14.0–14.5 GHz (Earth-to-space) band to GSO satellites in the fixed-satellite service must include, in addition to the particulars of operation identified on Form 312, and associated Schedule B, the applicable technical demonstrations in paragraphs (b)(1) or (b)(2) of this section and the documentation identified in paragraphs (b)(3) through (b)(5) of this section.		

§ 25.222(b)(1)	(1) An ESV applicant proposing to implement a transmitter under paragraph (a)(1) of this section must demonstrate that the transmitter meets the off-axis EIRP spectral- density limits contained in paragraph (a)(1)(i) of this section. To provide this demonstration, the application shall include the tables described in paragraph (b)(1)(i) of this section or the certification described in paragraph (b)(1)(ii) of this section. The ESV applicant also must provide the value N described in paragraph (a)(1)(i)(A) of this section. An ESV applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section must provide the certifications identified in paragraph (b)(1)(iii) of this section. An ESV applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section must provide the demonstrations identified in paragraph (b)(1)(iv) of this section.	Complies	Exhibit 1, Section 4
§ 25.222(b)(1)(i)	(i) Any ESV applicant filing an application pursuant to paragraph (a)(1) of this section must file three tables showing the off-axis EIRP level of the proposed earth station antenna in the direction of the plane of the GSO; the co-polarized EIRP in the elevation plane, that is, the plane perpendicular to the plane of the GSO; and cross polarized EIRP. In each table, the EIRP level must be provided at increments of 0.1° for angles between 0° and 10° off-axis, and at increments of 5° for angles between 10° and 180° off-axis.	Complies	Exhibit 1, Section 4
§ 25.222(b)(1)(i)(A)	(A) For purposes of the off-axis EIRP table in the plane of the GSO, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the plane of the GSO is determined by the focal point of the antenna and the line tangent to the arc of the GSO at the orbital position of the target satellite.		
§ 25.222(b)(1)(i)(B)	(B) For purposes of the off-axis co-polarized EIRP table in the elevation plane, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite, and the elevation plane is defined as the plane perpendicular to the plane of the GSO defined in paragraph (b)(1)(i)(A) of this section.		
§ 25.222(b)(1)(i)(C)	(C) For purposes of the cross-polarized EIRP table, the off-axis angle is the angle in degrees from the line connecting the focal point of the antenna to the orbital location of the target satellite and the plane of the GSO as defined in paragraph (b)(1)(i)(A) of this section will be used.		
§ 25.222(b)(1)(ii)	(ii) A certification, in Schedule B, that the ESV antenna conforms to the gain pattern criteria of § 25.209(a) and (b), that, combined with the maximum input power density calculated from the EIRP density less the antenna gain, which is entered in Schedule B, demonstrates that the off-axis EIRP spectral density envelope set forth in paragraphs (a)(1)(i)(A) through (a)(1)(i)(C) of this section will be met under the assumption that the antenna is pointed at the target satellite.	N/A	Demonstration provided under § 25.222(b)(1)(i)

§ 25.222(b)(1)(iii)	(iii) An ESV applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section, must provide a certification from the equipment manufacturer stating that the antenna tracking system will maintain a pointing error of less than or equal to 0.2 between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna and that the antenna tracking system is capable of ceasing emissions within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna exceeds 0.5°.		
§ 25.222(b)(1)(iv)	(iv) An ESV applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section must:		
§ 25.222(b)(1)(iv)(A)	(A) Declare, in their application, a maximum antenna pointing error and demonstrate that the maximum antenna pointing error can be achieved without exceeding the off-axis EIRP spectral-density limits in paragraph (a)(1)(A) of this section; and	Complies	Narrative I.B.2, Exhibit 1, Section 5
§ 25.222(b)(1)(iv)(B)	(B) Demonstrate that the ESV transmitter can detect if the transmitter exceeds the declared maximum antenna pointing error and can cease transmission within 100 milliseconds if the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna exceeds the declared maximum antenna pointing error, and will not resume transmissions until the angle between the orbital location of the target satellite and the axis of the main lobe of the ESV antenna is less than or equal to the declared maximum antenna pointing error.	Complies	Narrative I.B.2, Exhibit 1, Section 5
§ 25.222(b)(2)	(2) An ESV applicant proposing to implement a transmitter under paragraph (a)(2) of this section and using off-axis EIRP spectral densities in excess of the levels in paragraph (a)(1)(i) of this section shall provide the following certifications and demonstration as exhibits to its earth station application:	N/A	
§ 25.222(b)(2)(i)	(i) A statement from the target satellite operator certifying that the proposed operation of the ESV has the potential to create harmful interference to satellite networks adjacent to the target satellite(s) that may be unacceptable.		
§ 25.222(b)(2)(ii)	(ii) A statement from the target satellite operator certifying that the power-density levels that the ESV applicant provided to the target satellite operator are consistent with the existing coordination agreements between its satellite(s) and the adjacent satellite systems within 6° of orbital separation from its satellite(s).		
§ 25.222(b)(2)(iii)	(iii) A statement from the target satellite operator certifying that it will include the power-density levels of the ESV applicant in all future coordination agreements.		
§ 25.222(b)(2)(iv)	(iv) A demonstration from the ESV operator that the ESV system is capable of detecting and automatically ceasing emissions within 100 milliseconds when the transmitter exceeds the off-axis EIRP spectral-densities supplied to the target satellite operator.		

§ 25.222(b)(3)	(3) There shall be an exhibit included with the application describing the geographic area(s) in which the ESVs will operate.	Complies	Narrative I.B.3, Exhibit 1, Section 3
§ 25.222(b)(4)	(4) The point of contact referred to in paragraph (a)(3) of this section and, if applicable paragraph (a)(6) of this section, must be included in the application.	Complies	
§ 25.222(b)(5)	(5) ESVs that exceed the radiation guidelines of § 1.1310 of this chapter, Radiofrequency radiation exposure limits, must provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines.	Complies	Exhibit 2, Radiation Hazard Study
§ 25.222(c)	(c) Operations of ESVs in the 14.0–14.2 GHz (Earth-to-space) frequency band within 125 km of the NASA TDRSS facilities on Guam (located at latitude: 13°36'55" N, longitude 144°51'22" E) or White Sands, New Mexico (latitude: 32°20'59" N, longitude 106°36'31" W and latitude: 32°32'40" N, longitude 106°36'48" W) are subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). When NTIA seeks to provide similar protection to future TDRSS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission that the site is nearing operational status. Upon public notice from the Commission, all Ku-band ESV operators must cease operations in the 14.0–14.2 GHz band within 125 km of the new TDRSS site until after NTIA/IRAC coordination for the new TDRSS facility is complete. ESV operations will then again be permitted to operate in the 14.0–14.2 GHz band within 125 km of the new TDRSS site, subject to any operational constraints developed in the coordination process.	Complies	
§ 25.222(d)	(d) Operations of ESVs in the 14.47–14.5 GHz (Earth-to-space) frequency band within (a) 45 km of the radio observatory on St. Croix, Virgin Islands (latitude 17°46' N, longitude 64°35' W); (b) 125 km of the radio observatory on Mauna Kea, Hawaii (at latitude 19°48' N, longitude 155°28' W); and (c) 90 km of the Arecibo Observatory on Puerto Rico (latitude 18°20'46" W, longitude 66°45'11" N) are subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC).	Complies	

7. Antenna Gain Data

Pattern data is simulated.

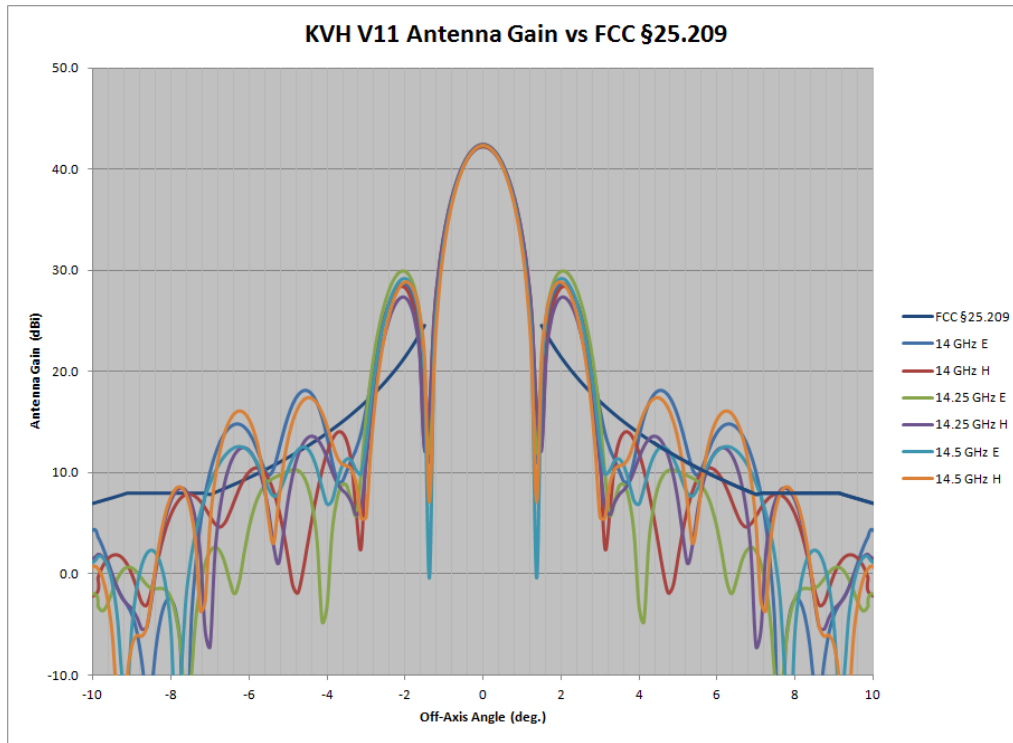


Figure 10 – Co-Pol Gain +/- 10 degrees

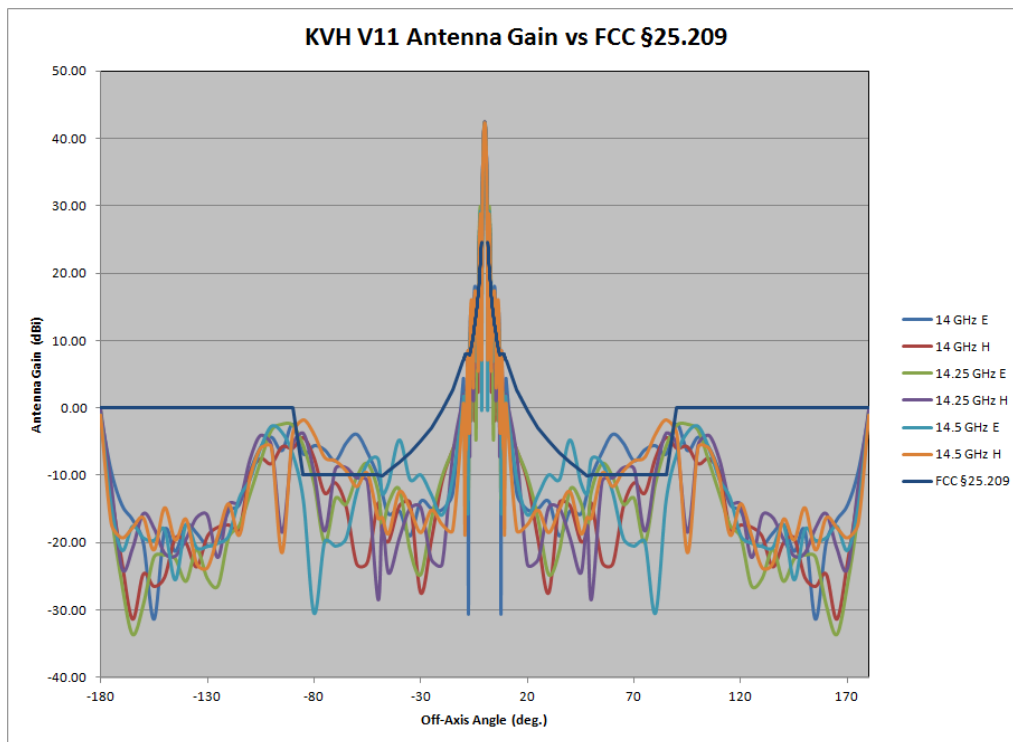


Figure 11 – Co-Pol Gain +/- 180 degrees