

## **MICROWAVE PATH SURVEY REPORT**

## RADIO FREQUENCY INTERFERENCE (RFI) MEASUREMENT REPORT

**Prepared For** 

ViaSat

Virginia Beach, VA

**Transmit and Receive Earth Station** 17-21 GHz and 27-31 GHz

May 7, 2015

19700 Janelia Farm Boulevard. - Ashburn, Virginia 20147, USA - 703.726.5500 - Fax 703.726.5597

#### **TABLE OF CONTENTS**

#### **<u>SECTION 1</u>** Introduction and Background

- **1.1 Introduction**
- 1.2 Background
- **1.3 Constraints**

#### **SECTION 2** Test Procedure

- 2.1 Calibration
- 2.2 Methodology

#### **SECTION 3** Data Presentation

#### **SECTION 4** Summary of Results

#### **<u>SECTION 5</u>** Conclusions and Recommendations

- 5.1 Conclusions
- 5.2 Recommendations

#### Addendum 1

Addendum 1 not applicable to this report

**ONE** 

#### **INTRODUCTION AND BACKGROUND**

#### 1.1 Introduction

On-site Radio Frequency Interference (RFI) measurements were performed on behalf of ViaSat, Inc. on May 7, 2015 at their proposed site in Virginia Beach, VA. The purpose of these measurements was to determine the relative RFI levels in the 17-21 and 27-31 GHz common carrier frequency band and their impact on digital down-link satellite reception. Measurements were performed at one designated location. The purpose of this report is to document the results of these measurements and to present recommendations.

The analysis in this report is based upon the following:

- Andrew 4.1 Meter Antenna
- Satellite Arc: 55 to 115 Degrees West Longitude
- Frequency Range Considered: 17 to 21 GHz and 27-31 GHz
- Interference Objective: -156 dBW/1 MHz
- Type of Reception: Digital
- Measured Antenna Center Line: 6.5 Feet Above Ground Level

#### 1.2 Background

ViaSat, Inc is proposing to locate a new transmit/receive antenna at an existing location of  $39^{\circ}$  37' 01.9" N and  $74^{\circ}$  49' 20.5" W ViaSat, Inc had requested that Comsearch conduct RFI measurements at the facility to assess the interference potential. This facility is currently nonoperational and measurements were done at a point near the proposed antenna locations.

The measured site is identified on a portion of a topographic map shown in Figure 1.2-1. An aerial photo of the site location is shown in Figure 1.2-2. A photo of the measurement using a GPS is shown in Figure 1.2-3.

#### 1.3 Constraints

The analysis in this report is based upon the following assumptions and constraints.

- The antenna selected will conform to the FCC reference pattern 32-25 Log $\theta$  as specified in 47CFR 25.209(a)(2).
- It is assumed that during the measurement period all of the terrestrial transmitters were active and operating at full transmit power for the licensed frequencies unless otherwise noted.
- The signal identification and frequencies analyzed are based upon information obtained from the various common carriers as to what frequencies were active at the time of the measurements and the traffic these frequencies were supposed to be carrying.
- The actual ground elevation of the site is based on the data from the topographic map.
- The interference objective of -156 dBW/1 MHz used throughout this report is based upon estimated link budget parameters and is subject to change. ViaSat, Inc should review the system parameters for this down-link in order to verify the viability of this objective.

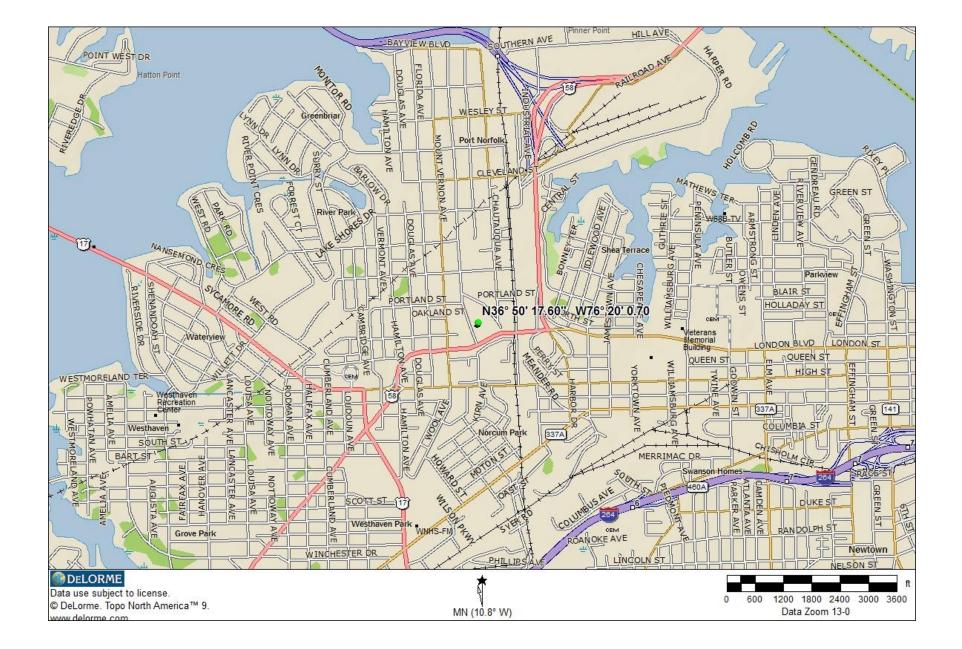


Figure 1.2-1 – Topographic Map

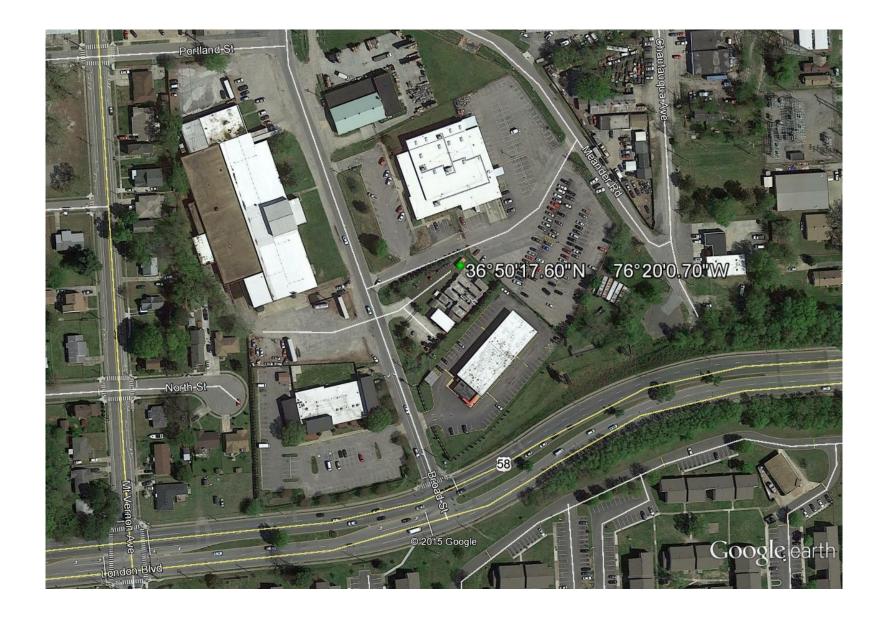


Figure 1.2-2 – Aerial Photograph

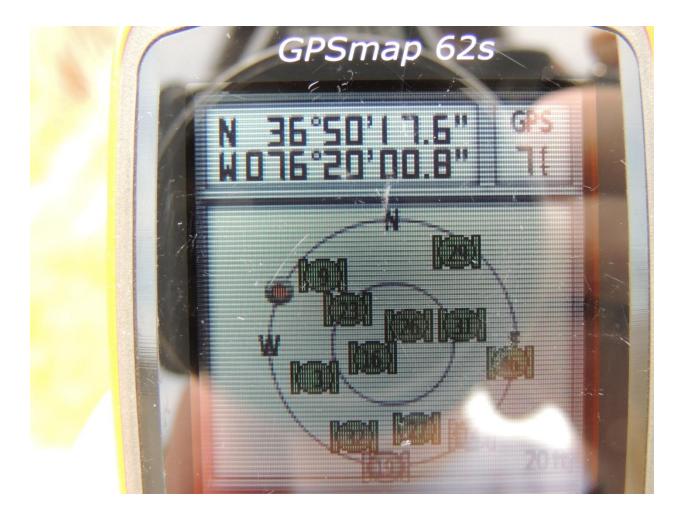


Figure 1.2-3 – GPS Photograph

TWO

#### **TEST PROCEDURE**

#### 2.1 Calibration

Figures 2.1-1 is the block diagram of the test set for all bands to be tested. All test equipment used was allowed a proper warm-up period prior to calibration. The test set was calibrated by the signal substitution method, as recommended by NSMA, utilizing a synthesized signal generator. The reference signal from the signal generator was adjusted for the center frequency of each band to be tested and measured with a thermal power meter for calibrated reference test level (-60 dBm). This calibrated reference signal from the signal generator was then injected into the end of the coaxial cable of the test set at the point, which normally connects to the test antenna. A spectrum analyzer then measured the reference test signal level after passing through the test set. At this point, the spectrum analyzer was calibrated reference signal (-60 dBm) by utilizing the reference level offset function of the Anritsu –M52720T spectrum analyzer. Upon completion of the calibration process, a known reference level was obtained for the measured in analyzer display readings.

The following formula is used to transform the measured signal level as read on the spectrum analyzer display (dBm) to an isotropic reference signal level (dBW<sub>I</sub>) as seen at the point of test:

 $dBW_I = LI - GA - 30$ 

Where:  $dBW_I = Isotropic level in dBW$ 

LI = Level (dBm) of injected signal

GA = Test antenna gain

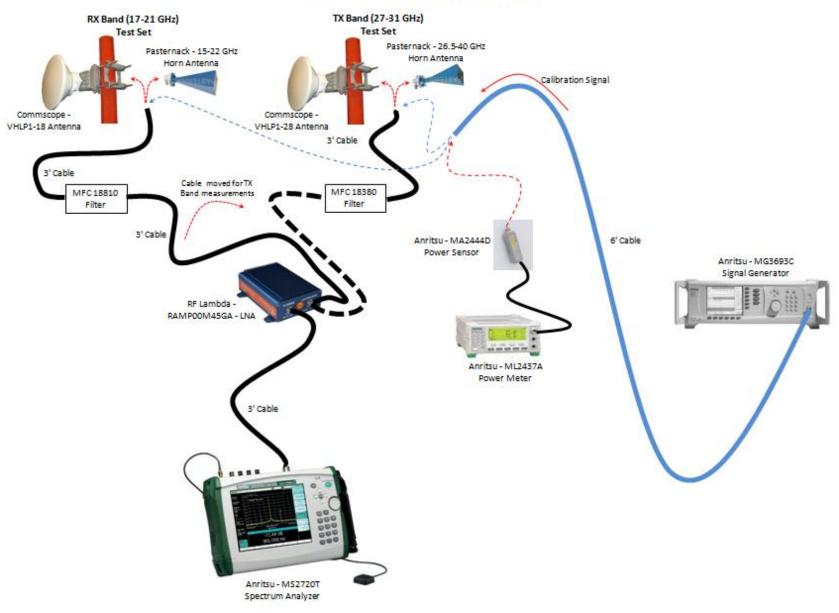
-30 =Conversion factor from dBm to dBW

at 19.5 GHz:  $dBW_I = -60 dBm - 30 dB - 30 dB$ 

 $= -120 \text{ dBW}_{\text{I}}$ 

In this instance, the spectrum analyzer displayed measured signal level of -60 dBm equates to an isotropic signal level of -120 dBW<sub>I</sub>.

Figures 2.1-2(A-H) displays the spectrum photographs of the described calibration procedure employed during these measurement.



#### **Test Set Equipment Diagram**



**Figure 2.1-1 Receive Test Equipment Block** 

<b>/Inritsu</b> 05/03	7/2015 08:06:3	7 am			4	-	Save
	M1 100.07	JD- @17 500 CH-			Spectrum	Analyzer	
<b>Ref Lvl</b> ·120.0 dBm I0.0 dB Ext Gain	-120.0 dBm	dBm @17.500 GHz	4				
n <b>put Atten</b> 1.0 dB	-130.0						
<b>)etection</b> 'eak	-140.0						
<b>RBW</b> MHz	-150.0						
<b>/BW</b> 300 kHz	-160.0	warden warden han war	man and and and and and and and and and a	nontransi	man makers	any aktories	
<b>Sweep Time</b> 50 ms	-170.0			-			
<b>Fraces</b> A: Max Hold							
	-180.0					r	Change
	-190.0						Quick Name
Sweep (Fast) Continuous	-200.0					ſ	Change Save Location
req Ref	-210.0 dBm						Change Type
nt Std Accy	17.000 GHz		Center 17.500 G Span 1.000 GH		18	3.000 GHz	Setup/JPEG/
Freq		Amplitude	Span		BW		Marker

Figure 2.1-2 (A) Calibration Spectrum Photo 17.5 GHz

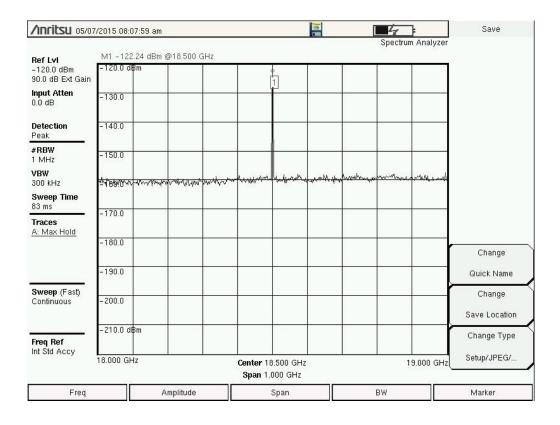


Figure 2.1-2 (B) Calibration Spectrum Photo 18.5 GHz

<b>/Inritsu</b> 05/03	7/2015 08:08:	57 am						Save
						Spe	ectrum Analyzer	
<b>Ref Lvi</b> -120.0 dBm 90.0 dB Ext Gain	M1 -121.5 -120.0 dBm	9 dBm @19.5	i00 GHz	¢ 1				C.
<b>nput Atten</b> ).0 dB	-130.0							
Detection Peak	-140.0							
<b>≭RBW</b> I MHz	-150.0							
<b>VBW</b> 300 kHz	-160.0	HARA AND AND	werenand	human	www.massal.com	unana Amuda	performant with which the	
<b>Sweep Time</b> 37 ms	-170.0		27			6 <u>.</u>		
<b>Traces</b> A: Max Hold	-180.0							
	0.000							Change
	-190.0							Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0							Change Save Location
Freq Ref	-210.0 dBm	1						Change Type
nt Std Accy	19.000 GHz			Center 19.500 Span 1.000			20.000 GHz	Setup/JPEG/
Freq		Amplitu	Ide	Spar	n ][	BW		Marker

Figure 2.1-2 (C) Calibration Spectrum Photo 19.5 GHz

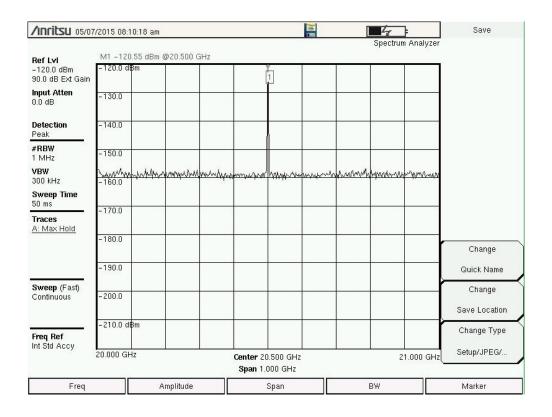
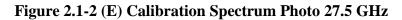


Figure 2.1-2 (D) Calibration Spectrum Photo 20.5 GHz

<b>/INFILSU</b> 05/0	7/2015 08:13:57 ar	n			Spectrum Ana	Save
Ref Lvl	M1 -121.52 dBr	n @27.500 GHz			Spectrum Ana	ayzer
-120.0 dBm 90.0 dB Ext Gain	–120.0 dBm		1			
<b>nput Atten</b> ).0 dB	-130.0					
<b>Detection</b> Peak	-140.0					
<b>≭RBW</b> IMHz	-150.0					
<b>/BW</b> 300 kHz	apres of the second	and of the constraints and	hold and the second second	manapatritation	www.www.www.www.	and the second se
<b>Sweep Time</b> 50 ms	-170.0					
Fraces A: Max Hold						
	-180.0					Change
	-190.0					Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0					Change
	-210.0 dBm					Save Location
F <b>req Ref</b> nt Std Accy						Change Type
	27.000 GHz		<b>Center</b> 27.500 C <b>Span</b> 1.000 GF		28.000	) GHz Setup/JPEG/
Freq		Amplitude	Span		BW	Marker



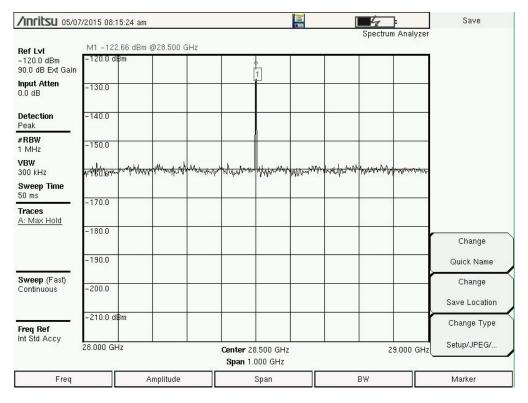


Figure 2.1-2 (F) Calibration Spectrum Photo 28.5 GHz

<b>/INFILSU</b> 05/07	72015-08:1	6:56 am					[	4	ŧ	Save
Ref Lvl	M1 -121.	35 dBm @i	29.500 GHz					Spectrum	n Analyzer	
120.0 dBm 10.0 dB Ext Gain	–120.0 dB	m			¢ [1]					
<b>nput Atten</b> 1.0 dB	-130.0				F		- ( -			
<b>etection</b> 'eak	-140.0							à		
RBW MHz	-150.0						8	isii		
<b>/BW</b> 300 kHz	-160.0	all an and a	VmVI mm	www.hund	w warmer	man hall	harrow	ann ann ann	<sub>የ</sub> ልላሳትነ <sub>ው የ</sub> ለቅን	
<b>Sweep Time</b> 13 ms	-170.0						-			
Fraces A: Max Hold										
	-180.0								r	Change
	-190.0									Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0								ſ	Change Save Location
req Ref nt Std Accy	-210.0 dB	m								Change Type
n olu Accy	29.000 GH	z	I		.000 GHz	z		3	0.000 GHz	Setup/JPEG/
Freq		Am	plitude		Span		2	BW		Marker

Figure 2.1-2 (G) Calibration Spectrum Photo 29.5 GHz

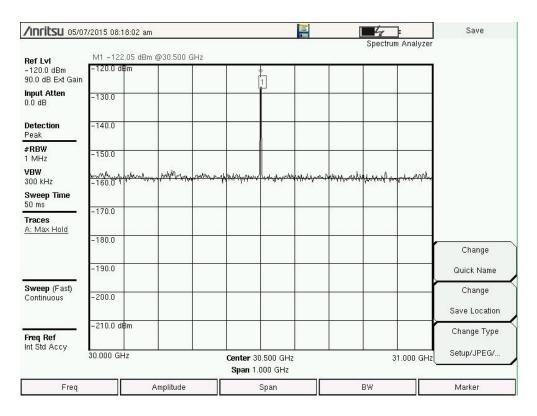


Figure 2.1-2 (H) Calibration Spectrum Photo 30.5 GHz

#### 2.2 Methodology

Upon arriving at the existing earth station site, azimuth and horizon elevation measurements were performed to evaluate if any satellite arc obstructions exist. The coordinates of the existing earth station site were verified on the DeLorme topographic map. Photographs were taken to document the satellite arc (clearance) and are included in this report.

After site coordinates and horizon elevations were verified, the test equipment was set up and calibrated to measure the RF environment. Measurements were conducted at the proposed earth station location for the 17-21 and 27-31 GHz band. After the equipment calibration was completed, the test antenna was mounted on an extendable tower and elevated to a height of 6.5 feet. This height is greater than the centerline of the earth station antenna. The antenna was rotated 360 degrees (scanning), once in each polarization, while activating the peak hold function of the spectrum analyzer. This enabled the analyzer to maintain and display the maximum signal level received for all frequencies under consideration. After the initial documentation of interference, all interference conflicts if observed were peaked on to determine the azimuth and the level of the interference source.

Upon completion of the RF testing, the measured signal levels were transposed to earth station interference levels after accounting for the addition of the corresponding earth station antenna gain.

THREE

### **DATA PRESENTATION**

The following section contains the tables and spectrum photos pertaining to the site location measured.

#### 3.1 Virginia Beach, VA

- Table 3.1-1 presents a site data sheet including all pertinent site information.
- Figures 3.1-1 and 3.1-2 are the photographs depicting the existing earth station site and satellite arc.
- Figures 3.1-3 through 3.1-10 are the RF spectrum photographs depicting the interference environment at the test site.

### **TABLE 3.1-1**

### MEASUREMENT SITE DATA SHEET

1.	SYSTEM NAME:	ViaSat, Inc
2.	CITY AND STATE:	Virginia Beach, VA
3.	SITE IDENTIFICATION:	Virginia Bearch
4.	COORDINATES: (NAD 1983)	LATITUDE: 36° 50' 17.6" N LONGITUDE: 76° 20' 00.7" W
5.	GROUND ELEVATION:	10.21 feet AMSL
6.	MEASUREMENT DATE AND TIMES:	May 7, 2015
7.	GEOSTATIONARY ARC RANGE: SATELLITE POSITIONS: AZIMUTH: ELEVATION:	55.0 W – 115.0 W 146.9° – 233.2° 41.7° / 31.2°

8. GEOSTATIONARY ARC VISIBILITY: Satellite arc has no blockage at this time



North



East



South



West

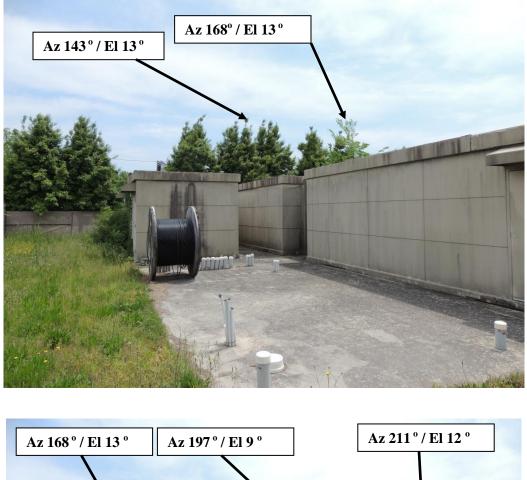
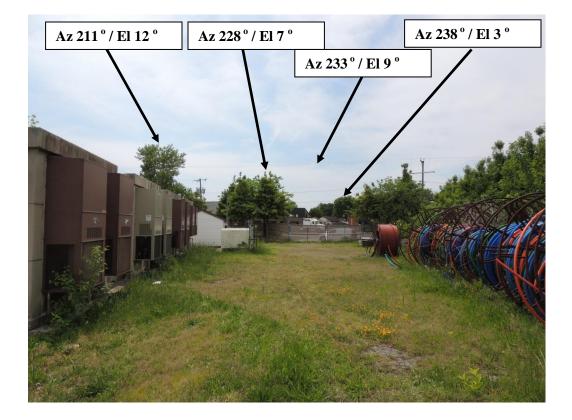


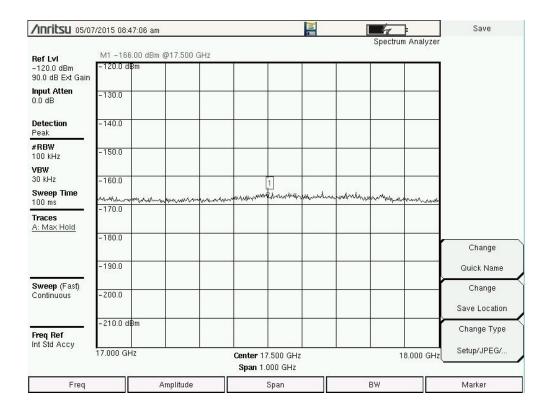


Figure 3.1-2 Horizon Photographs of Earth Station Site



<b>/INFILSU</b> 05/0	07/2015 08:38:4	15 am			1	1	⊒:	Save
						Spect	rum Analyzer	
<b>Ref Lvi</b> •120.0 dBm 90.0 dB Ext Gain	-120.0 dBm	dBm @17.500	GHz					
n <b>put Atten</b> .0 dB	-130.0							
etection eak	-140.0					8	- c - c	
<b>RBW</b> MHz	-150.0			1				
<b>'BW</b> 00 kHz	-160.0	alout all all and a second	hanna	your hander	montemp	washingt and yours	and the providence	
<b>weep Time</b> O ms	-170.0							
<b>races</b> A: Max Hold		8.						
	-180.0						r	Change
	-190.0							Quick Name
weep (Fast) ontinuous	-200.0						ſ	Change Save Location
req Ref t Std Accy	-210.0 dBm							Change Type
	17.000 GHz		(	Center 17.500 GH Span 1.000 GHz			18.000 GHz	Setup/JPEG/
Freq		Amplitude		Span		BW		Marker

Figure 3.1-3 (A) Spectrum Photos 17-18 GHz 1MHz Res BW Horizontal Pol 360<sup>0</sup>



<b>/INFILSU</b> 05/07	/2015 09:55:4	3 am			1	F	Save
lef Lvl	M1 -158.84	dBm @17.500 GHz			Spe	ctrum Analyzer	
120.0 dBm 0.0 dB Ext Gain	-120.0 dBm						
n <b>put Atten</b> 1.0 dB	-130.0						
<b>Detection</b> Peak	-140.0						
* <b>RBW</b> MHz	-150.0						
<b>/BW</b> 300 kHz	-160.0	munner	have when my	nither the nation that	monter	mounder	
<b>Sweep Time</b> 50 ms	-170.0						
Fraces A: Max Hold							
	-180.0					r	Change
	-190.0						Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0					ſ	Change Save Location
Freq Ref nt Std Accy	-210.0 dBm						Change Type
	17.000 GHz		<b>Center</b> 17.5 <b>Span</b> 1.00			18.000 GHz	Setup/JPEG/
Freq		Amplitude		Dan	BW		Marker

Figure 3.1-3 (C) Spectrum Photos 17-18 GHz 1 MHz Res BW Horizontal Pol Worst Case

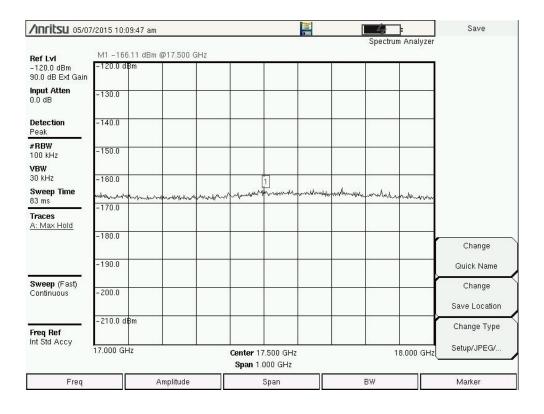


Figure 3.1-3 (D) Spectrum Photos 17-18 GHz 100 kHz Res BW Horizontal Pol Worst Case

: Max Hold	-180.0						+ r	Change
JU KHZ weep Time ) ms races	-160:0							
RBW MHz BW J0 kHz	-150.0	understanderstanderstanderstanderstanderstanderstanderstanderstanderstanderstanderstanderstanderstanderstanders	mannon	1 Marina	m.	and the second	manna	
o dB etection eak	-130.0							
20.0 dBm .0 dB Ext Gair out Atten	-120.0 dBm	18m @17.500 G	14					

Figure 3.1-3 (E) Spectrum Photos 17-18 GHz 1MHz Res BW Vertical Pol 360<sup>0</sup>

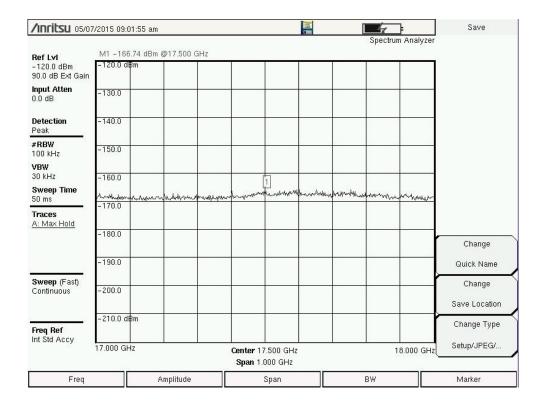


Figure 3.1-3 (F) Spectrum Photos 17-18 GHz 100 kHz Res BW Vertical Pol 360<sup>0</sup>

<b>/Inritsu</b> 05/03	7/2015 09:19	):35 am						0	4	}	Save
Ref Lvi	M1 -158.		17.500 GI	Hz				75 12	Spectrun	n Analyzer	
-120.0 dBm 90.0 dB Ext Gain	-120.0 dB	n									
<b>Input Atten</b> 0.0 dB	-130.0						7				
<b>Detection</b> Peak	-140.0										
# <b>RBW</b> 1 MHz	-150.0				[	1			2		
<b>VBW</b> 300 kHz	<u>www.</u> -160.0	mann	man	walnulawalnu	nonnandy	an walk	mahan	makundhad	www.www.	mm your	
Sweep Time 67 ms	-170.0						1	6			
Traces A: Max Hold											
	-180.0									r	Change
	-190.0							-			Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0						7			ſ	Change Save Location
Freq Ref Int Std Accy	-210.0 dB	n									Change Type
	17.000 GH				Center 17 Span 1.0	.500 GHz 000 GHz	1944		1	8.000 GHz	Setup/JPEG/
Freq		An	nplitude			Span		I	ЗW		Marker

Figure 3.1-3 (G) Spectrum Photos 17-18 GHz 1 MHz Res BW Vertical Pol Worst Case

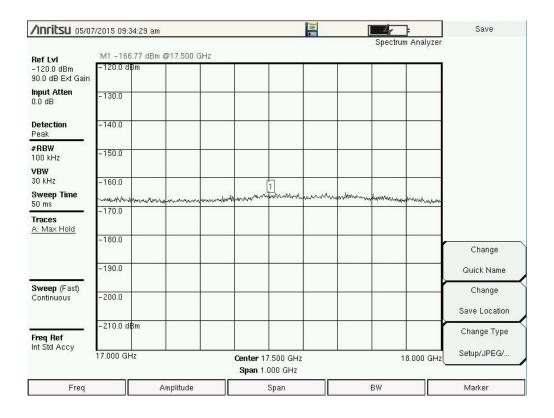


Figure 3.1-3 (H) Spectrum Photos 17-18 GHz 100 kHz Res BW Vertical Pol Worst Case

<b>/Inritsu</b> 05/07	7/2015 08:4	0:19 am					1	[	<b>1</b> 7	}-	Save
Ref Lvl			018.500 G⊦	łz				95 92	Spectrum	n Analyzer	
-120.0 dBm 90.0 dB Ext Gain	-120.0 dB	m									
Input Atten 0.0 dB	-130.0										
Detection Peak	-140.0							8	s		
# <b>RBW</b> 1 MHz	-150.0					1					
<b>VBW</b> 300 kHz	44 - 160:0000	althe and	Mr. marker	And And	when		www.hww	rown	Munipapa	Whater	
Sweep Time 50 ms	-170.0							5			
Traces <u>A: Max Hold</u>											
	-180.0									ľ	Change
	-190.0										Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0						·				Change Save Location
Freq Ref Int Std Accy	-210.0 dB	m									Change Type
	18.000 GH	z			enter 18 Span 1.0	.500 GHz 100 GHz	174.2		1	9.000 GHz	Setup/JPEG/
Freq		A	nplitude		3	Span		1	BW		Marker

Figure 3.1-4 (A) Spectrum Photos 18-19 GHz 1 MHz Res BW Horizontal Pol  $360^{\circ}$ 

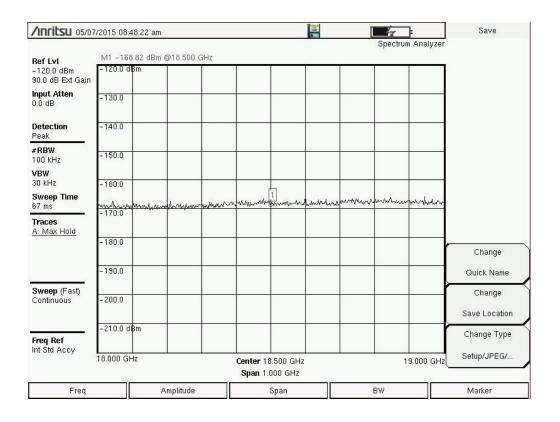


Figure 3.1-4 (B) Spectrum Photos 18-19 GHz 100 kHz Res BW Horizontal Pol 360<sup>0</sup>

<b>/Inritsu</b> 05/07	7/2015 09:59:08	am				Save
<b>Ref L∨I</b> -120.0 dBm 90.0 dB Ext Gain	M1 -158.45 c	18m @18.500 GHz			Spectrum Analy	izer
Input Atten 0.0 dB	-130.0					-
Detection Peak	-140.0					
#RBW 1 MHz	-150.0		. j]			
VBW 300 kHz Sweep Time	-160.0	man and a state of the second s	when hid water no	hour have been and have an	wwwwwwwwwwwwwwwww	
50 ms Traces A: Max Hold	-170.0					-
	-180.0					Change
	-190.0					Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0					Change Save Location
Freq Ref Int Std Accy	-210.0 dBm					Change Type Setup/JPEG/
	18.000 GHz		<b>Center</b> 18.500 G <b>Span</b> 1.000 GH		19.000 (	GHz
Freq		Amplitude	Span		BW	Marker

Figure 3.1-4 (C) Spectrum Photos 18-19 GHz 1 MHz Res BW Horizontal Pol Worst Case

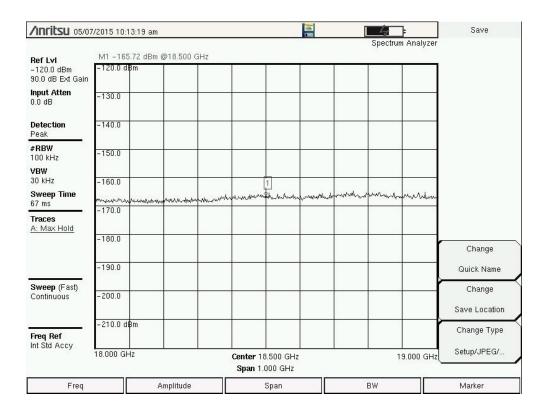
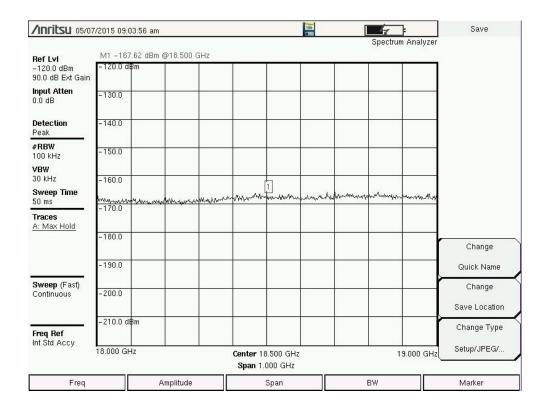


Figure 3.1-4 (D) Spectrum Photos 18-19 GHz 100 kHz Res BW Horizontal Pol Worst Case

/Inritsu 05/03	7/2015 08:57:	24 am					1	}	Save
					464-3		Spectrur	n Analyzer	
lef Lvl		4 dBm @18.500	GHz						
120.0 dBm 0.0 dB Ext Gain	-120.0 dBm								
n <b>put Atten</b> .0 dB	-130.0								
etection eak	-140.0								
<b>RBW</b> MHz	-150.0		<u></u>						
' <b>BW</b> 00 kHz	<u>~480.6~~</u> **	man with the second states	www.www.	www.m.m.	ano ano ante	antrashandraam	derport depart	Murhum	
<b>weep Time</b> O ms	-170.0								
races : Max Hold	-170.0								
	-180.0							r	Change
	-190.0								Quick Name
weep (Fast)								l P	Change
ontinuous	-200.0								Save Location
	-210.0 dBm	1							Change Tune
req Ref t Std Accy									Change Type
	18.000 GHz			Center 18.5 Span 1.00			1	9.000 GHz	Setup/JPEG/
Freq		Amplitude		Sp	an		BW		Marker

Figure 3.1-4 (E) Spectrum Photos 18-19 GHz 1 MHz Res BW Vertical Pol 360<sup>0</sup>



<b>/INFILSU</b> 05/0	07/2015 09:22	2:34 am					[	-47	}	Save
ef Lvi	M1 -158.	31 dBm @18	.500 GHz				7.5	Spectrur	n Analyzer	
120.0 dBm 0.0 dB Ext Gair	-120.0 dB	m								
<b>put Atten</b> .0 dB	-130.0					7				
etection eak	-140.0									
<b>RBW</b> MHz	-150.0				<b>E</b>					
<b>BW</b> 00 kHz	-160.0	a who a who a	n the second	when when when	norman	yerneth-new	white	other half and	mahappana	
<b>weep Time</b> O ms	-170.0		2-		7.42	-	-			
races : Max Hold	100.0									
	-180.0								r	Change
	-190.0									Quick Name
<b>weep</b> (Fast) ontinuous	-200.0					7				Change Save Location
req Ref	-210.0 dB	m								Change Type
t Std Accy	18.000 GHz	2			18.500 GH .000 GHz	z		1	9.000 GHz	Setup/JPEG/
Freq		Ampl	itude		Span		2		Marker	

Figure 3.1-5 (G) Spectrum Photos 18-19 GHz 1 MHz Res BW Vertical Pol Worst Case

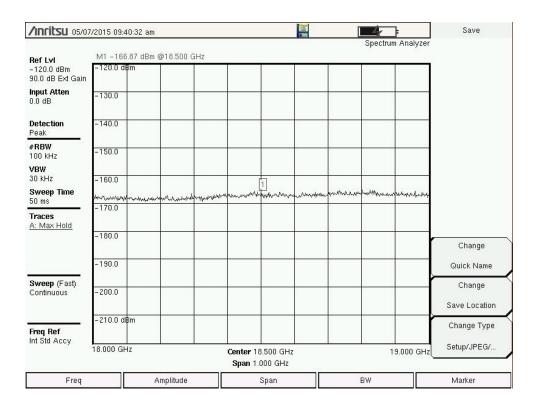


Figure 3.1-4 (H) Spectrum Photos 18-19 GHz 100 kHz Res BW Vertical Worst Case

<b>/INCITSU</b> 05/0	7/2015 08:41	:44 am						17	3	Save
							1.1	Spectru	m Analyzer	
Ref Lvl		37 dBm @19.	500 GHz							
120.0 dBm	-120.0 dBi	n								
10.0 dB Ext Gain										
<b>nput Atten</b> ).0 dB	-130.0					7				
<b>Detection</b> Peak	-140.0							÷		
<b>≭RBW</b> MHz	-150.0				1					
<b>/BW</b> 300 kHz	<u>ოოიაკაკი</u> -160.0	adjourner way	munina	mathathat	-	www.hump	Multim	Annow	per manual de la coma de	
Sweep Time i0 ms	-170.0									
F <b>races</b> A: Max Hold	-170.0									
	-180.0								r	Change
	-190.0									Quick Name
weep (Fast)									P	Change
continuous (	-200.0									Save Location
	-210.0 dBr	n					1	3		Ohanna Tura
req Ref nt Std Accy										Change Type
	19.000 GHz			Center 19 Span 1.	9.500 GHz 000 GHz			i	20.000 GHz(	Setup/JPEG/
Freq		Amplit	ude		Span			BW		Marker

Figure 3.1-5 (A) Spectrum Photos 19-20 GHz 1MHz Res BW Horizontal Pol  $360^{\circ}$ 

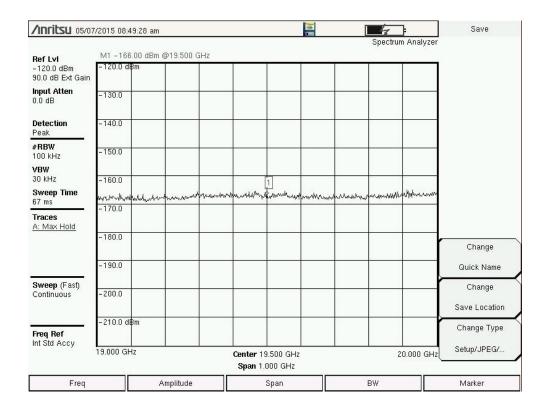


Figure 3.1-5 (B) Spectrum Photos 19-20 GHz 100 kHz Res BW Horizontal Pol  $360^{\circ}$ 

/Inritsu 05/07	7/2015 10:02:5	7 am			4	3	Save							
Ref Lvl	M1 -156.91	M1 -156.91 dBm @19.500 GHz												
-120.0 dBm 90.0 dB Ext Gain	-120.0 dBm													
<b>Input Atten</b> 0.0 dB	-130.0													
<b>Detection</b> Peak	-140.0													
#RBW 1 MHz	-150.0			1										
<b>VBW</b> 300 kHz	мллимпимил -160.0	en service de la constance de la	Anna Alleman and an and an and an and an	about the second	warm ward when	hamadalaan waar								
Sweep Time 67 ms	-170.0			-										
Traces A: Max Hold														
	-180.0					l r	Change							
	-190.0						Quick Name							
<b>Sweep</b> (Fast) Continuous	-200.0					<u> </u>	Change Save Location							
Freq Ref Int Std Accy	-210.0 dBm						Change Type							
	19.000 GHz			9.500 GHz 000 GHz		20.000 GHz	Setup/JPEG/							
Freq		Amplitude		Span	BW		Marker							

Figure 3.1-5 (C) Spectrum Photos 19-20 GHz 1 MHz Res BW Horizontal Pol Worst Case

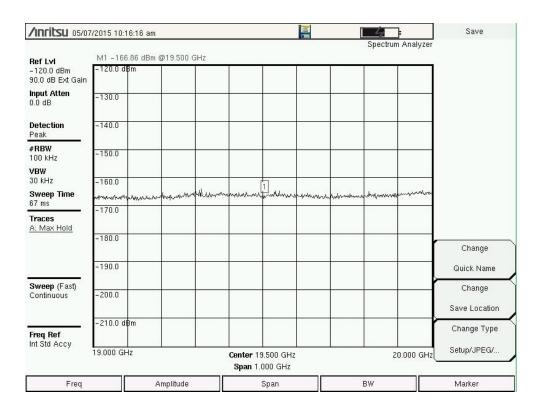


Figure 3.1-5 (D) Spectrum Photos 19-20 GHz 100 kHz Res BW Horizontal Pol Worst Case

<b>/Inritsu</b> 05/07	7/2015 09:2	.6:19 am						I	14	}	Save	
Ref Lvl	M1 -157	n Analyzer										
-120.0 dBm 90.0 dB Ext Gain	-120.0 dBm											
Input Atten 0.0 dB	-130.0								(			
Detection Peak	-140.0						-		*******			
#RBW 1 MHz	-150.0				[	1						
<b>VBW</b> 300 kHz	-160.0	get mar have get and	mwMM	whilling	www.~de	in addition to the	Mana	www.any	www	and production of the second		
Sweep Time 33 ms	-170.0					-		6				
Traces A: Max Hold	-180.0											
										ľ	Change	
	-190.0										Quick Name	
<b>Sweep</b> (Fast) Continuous	-200.0										Change Save Location	
Freq Ref Int Std Accy	-210.0 dB										Change Type	
	19.000 GH	Jz			Center 19 Span 1.1				2	0.000 GHz	Setup/JPEG/	
Freq Amplitude					Span			BW			Marker	

Figure 3.1-5 (E) Spectrum Photos 19-20 GHz 1MHz Res BW Vertical Pol  $360^{\circ}$ 

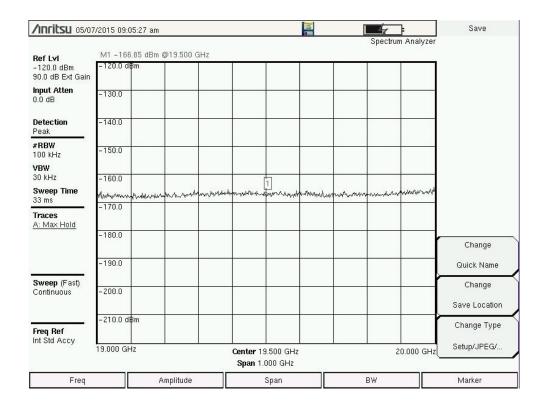


Figure 3.1-5 (F) Spectrum Photos 19-20 GHz 100 kHz Res BW Vertical Pol 360<sup>0</sup>

<b>/INCIESU 05/07</b>	/2015 09:26:1	9 am				ctrum Analyzer	Save
Ref Lvl	M1 -157.09						
-120.0 dBm 90.0 dB Ext Gain	-120.0 dBm						
<b>nput Atten</b> 1.0 dB	-130.0						
<b>Detection</b> Peak	-140.0						
<b>≉RBW</b> MHz	-150.0		1				
<b>/BW</b> 100 kHz	441.00.0	monten	undurunda	Alladerations	manna	mundharraden	
<b>Sweep Time</b> 13 ms	-170.0						
Fraces A: Max Hold							
	-180.0					r	Change
	-190.0						Quick Name
Sweep (Fast) Continuous	- 200.0					- ſ	Change Save Location
req Ref	-210.0 dBm						Change Type
Int Std Accy	19.000 GHz	20.000 GHz	Setup/JPEG/				
Freq		Amplitude	<b>Span</b> 1.00 Sp	an	BW		Marker

Figure 3.1-5 (G) Spectrum Photos 19-20 GHz 1MHz Res BW Vertical Pol Worst Case

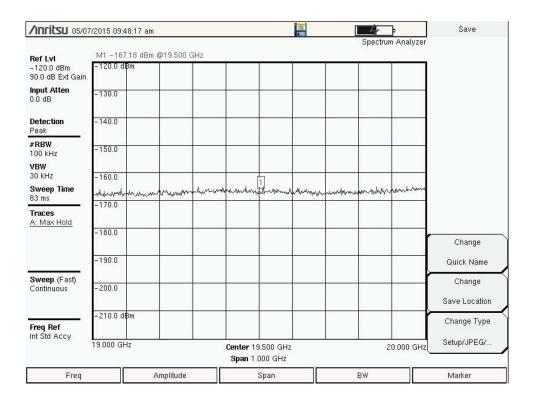
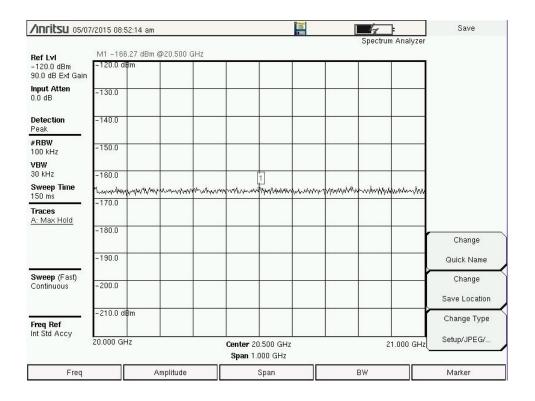


Figure 3.1-5 (H) Spectrum Photos 19-20 GHz 100 kHz Res BW Vertical Pol Worst Case

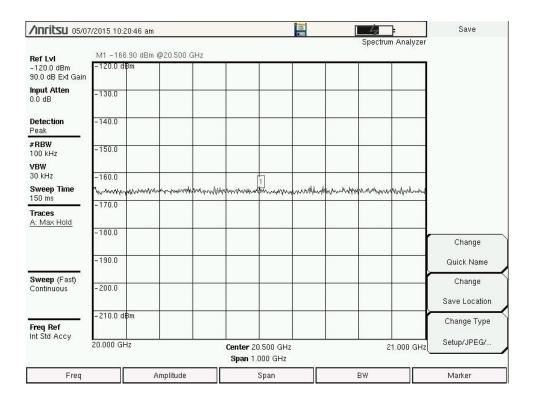
<b>/Inritsu</b> 05/07	}	Save									
<b>Ref L∨I</b> -120.0 dBm 90.0 dB Ext Gain	M1 -158 -120.0 di		@20.500 G	iHz				20	Spectrur	n Analyzer	
Input Atten 0.0 dB	-130.0										
Detection Peak	-140.0										
#RBW 1 MHz VBW	-150.0				LM1M	1		all office a state	. h	Mahmhagan	
300 kHz Sweep Time	-160.0	Arren Inn Nur	and a state of the	h	<u>44.360 564</u>	anner (never	<u>ryrwnyiuu</u>	AUX1 MANUA	www.enyoy.or.ev	e waarna wayaa	
50 ms Traces A: Max Hold	-170.0							5			
	-180.0									r	Change
	-190.0										Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0										Change Save Location
Freq Ref Int Std Accy	-210.0 dl										Change Type Setup/JPEG/
	20.000 GF	12			Center 20 Span 1.1				2	1.000 GHz	Compros Lorm
Freq		Span			BW			Marker			

Figure 3.1-6 (A) Spectrum Photos 20-21 GHz 1MHz Res BW Horizontal Pol  $360^{\circ}$ 



<b>/Inritsu</b> 05/07	7/2015 10:0	6:28 am					]		}	Save	
Ref Lvl			@20.500 G	iHz				94	Spectrur	n Analyzer	
-120.0 dBm 90.0 dB Ext Gain	-120.0 dB	3m									
Input Atten 0.0 dB	-130.0										
Detection Peak	-140.0								s		
#RBW 1 MHz	-150.0					1		-			
<b>VBW</b> 300 kHz	hybranting -160.0	www.	mmyhmy	www.yw	vythyronoi	an www.	matura	enderna and	www.www.ww	Warnaria	
Sweep Time 67 ms	-170.0					1.					
Traces A: Max Hold											
	-180.0									r	Change
	-190.0								-		Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0						9			ſ	Change Save Location
Freq Ref Int Std Accy	-210.0 de										Change Type
	20.000 GH	lz			Center 20 Span 1.1	).500 GHz 300 GHz	679.7		2	1.000 GHz	Setup/JPEG/
Freq Amplitude Span BW											Marker

Figure 3.1-6 (C) Spectrum Photos 20-21 GHz 1 MHz Res BW Horizontal Pol Worst Case



<b>/Inritsu</b> 05/07	7/2015 09:0	0:30 am						[	<b>1</b> 7	}	Save
Ref Lvl	M1 -158	.75 dBm @	₽20.500 G	iHz					Spectrur	n Analyzer	
-120.0 dBm 90.0 dB Ext Gain	-120.0 di	3m									
Input Atten 0.0 dB	-130.0						-				
Detection Peak	-140.0										
#RBW 1 MHz	-150.0					1					
<b>VBW</b> 300 kHz	Wumhuu -160.0	4.44.1447044	nndryww.rnh	.hapapanah	Vinneyryyyy	anthe may a	wathing	www.www.	Munichard	www.ywym	
Sweep Time 50 ms	-170.0					-		5			
Traces A: Max Hold	-180.0										
	-100.0									ľ	Change
	-190.0										Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0										Change Save Location
Freq Ref Int Std Accy	-210.0 dl									ľ	Change Type
	20.000 GH	Iz			Center 20 Span 1.1		12.4		2	1.000 GHz	Setup/JPEG/
Freq		A	mplitude			Span		1	BW		Marker

Figure 3.1-6 (E) Spectrum Photos 20-21 GHz 1MHz Res BW Vertical Pol  $360^{\circ}$ 

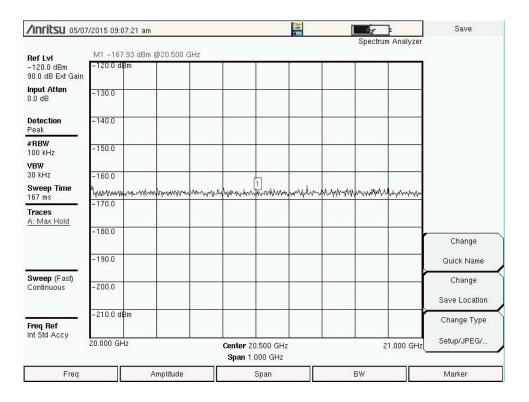


Figure 3.1-6 (F) Spectrum Photos 20-21 GHz 100 kHz Res BW Vertical Pol 360<sup>0</sup>

<b>/Inritsu</b> 05/07	1nritsu 05/07/2015 09:30:51 am 📔												
<b>Ref L∨I</b> -120.0 dBm 90.0 dB Ext Gain	M1 -157 -120.0 di		@20.500 C	âHz					Spectrun	1 Analyzer			
<b>Input Atten</b> 0.0 dB	-130.0												
<b>Detection</b> Peak	-140.0						ç	8					
#RBW 1 MHz	-150.0					1		-					
<b>VBW</b> 300 kHz	цитрация -160.0	ynnadara	hundradenskinger	glithanglathar	www.where	kuhnun	nwww.npm	hadagh de mer ya	nununun	nannanna			
Sweep Time 50 ms Traces A: Max Hold	-170.0												
	-180.0									r	Change		
	-190.0										Quick Name		
<b>Sweep</b> (Fast) Continuous	-200.0						а.				Change Save Location		
Freq Ref Int Std Accy	-210.0 dl										Change Type Setup/JPEG/		
	20.000 GH	łZ			Center 20 Span 1.	).500 GHz 000 GHz			2	1.000 GHz	oempror Edr		
Freq		A	mplitude			Span		1	BW		Marker		

Figure 3.1-6 (G) Spectrum Photos 20-21 GHz 1MHz Res BW Vertical Pol Worst Case

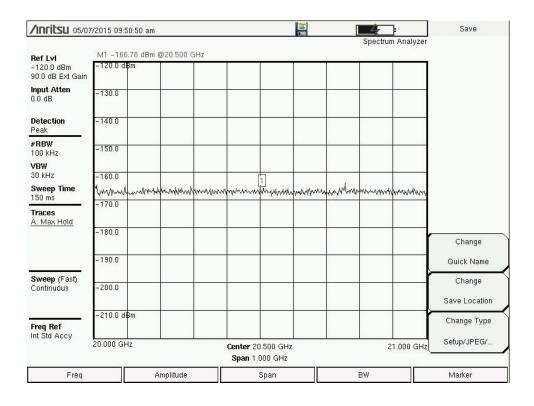


Figure 3.1-6 (H) Spectrum Photos 20-21 GHz 100 kHz Res BW Vertical Pol Worst Case

/Inritsu 05/07	/2015 10:33:41	am			4		Save
					Spec	ctrum Analyzer	
<b>Ref Lvi</b> -120.0 dBm 90.0 dB Ext Gain	M1 -158.60 ( -120.0 dBm	dBm @27.500 GHz					
<b>Input Atten</b> D.0 dB	-130.0						
<b>Detection</b> Peak	-140.0						
<b>#RBW</b> 1 MHz	-150.0						
<b>VBW</b> 300 kHz	#95000000000000000000000000000000000000	www.	and the second	wyohan have generally	an allow many during	and a gradie	
Sweep Time 50 ms	-170.0						
<b>Traces</b> A: Max Hold							
	-180.0					l l	Change
	-190.0						Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0						Change Save Location
Freq Ref Int Std Accy	-210.0 dBm						Change Type
nii olu Acty	27.000 GHz	- I - I	Center 27.50 Span 1.000			28.000 GHz	Setup/JPEG/
Freq		Amplitude	Spi	an	BW		Marker

Figure 3.1-7 (A) Spectrum Photos 27-28 GHz 1MHz Res BW Horizontal Pol  $360^{\circ}$ 

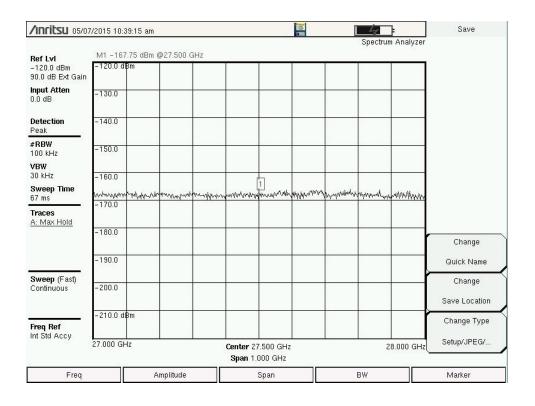


Figure 3.1-7 (B) Spectrum Photos 27-28 GHz 100 kHz Res BW Horizontal Pol 360<sup>0</sup>

<b>/INCITESU</b> 05/01	7/2015 10:40	6:19 am				-		4	}	Save
Ref Lvl	M1 -158.	90 dBm @27	.500 GHz				- 024	Spectrur	n Analyzer	
120.0 dBm 10.0 dB Ext Gain	-120.0 dB	m								
<b>nput Atten</b> 1.0 dB	-130.0					7				
<b>Detection</b> Peak	-140.0							· · · · · · · · · · · · · · · · · · ·		
<b>RBW</b> MHz	-150.0				1					
<b>/BW</b> 300 kHz	<u>whw/w/w</u> / -160.0	And makes have been been been been been been been be	and man	mound	almonth h	May May	alper and a start and a	enterna a	window and	
Sweep Time i0 ms	-170.0				1		-			
Fraces A: Max Hold						_				
	-180.0								r	Change
	-190.0									Quick Name
Sweep (Fast) Continuous	-200.0					-			ſ	Change Save Location
req Ref nt Std Accy	-210.0 dB	m								Change Type
n olu noby	27.000 GH	2		Center 27 Span 1.0			1	2	8.000 GHz	Setup/JPEG/
Freq		Ampli	tude		Span		0	BW		Marker

Figure 3.1-7 (C) Spectrum Photos 27-28 GHz 1MHz Res BW Vertical Pol 360<sup>0</sup>

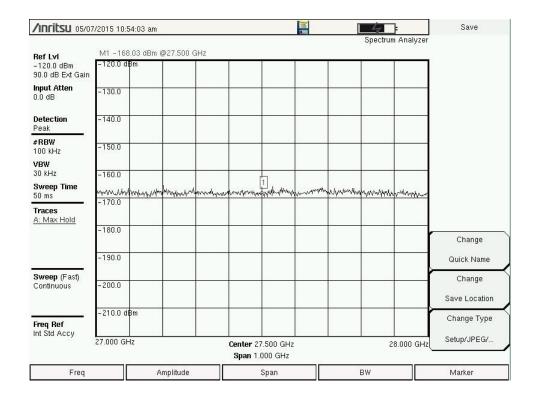


Figure 3.1-7 (D) Spectrum Photos 27-28 GHz 100 kHz Res BW Vertical Pol  $360^{\circ}$ 

/Inritsu 05/03	7/2015 10:3	14:54 am						0	4	}	Save
Ref Lvi	M1 -159	1.54 dBm @	028.500 G	iHz					Spectrur	n Analyzer	
-120.0 dBm 90.0 dB Ext Gain	-120.0 dl	3m									
Input Atten 0.0 dB	-130.0										
Detection Peak	-140.0							8			
#RBW 1 MHz	-150.0					<u></u>					
<b>VBW</b> 300 kHz	-160.0	Harring Ann	mondigos	uhanyan	anther provide	- Addrew Mar	www.	waylawa 4124-14-14-14-14-14-14-14-14-14-14-14-14-14	yanatumhun.	monorph	
Sweep Time 67 ms Traces	-170.0					s		5			
<u>A: Max Hold</u>	-180.0							<u>.</u>	<u></u>	r	Change
	-190.0										Quick Name
<b>Sweep</b> (Fast) Continuous	-200.0									ſ	Change Save Location
Freq Ref Int Std Accy	-210.0 dl	8m									Change Type
,	28.000 GH	Iz				3.500 GHz 300 GHz			2	9.000 GHz	Setup/JPEG/
Freq		A	mplitude			Span		1	BW		Marker

Figure 3.1-8 (A) Spectrum Photos 28-29 GHz 1MHz Res BW Horizontal Pol  $360^{\circ}$ 

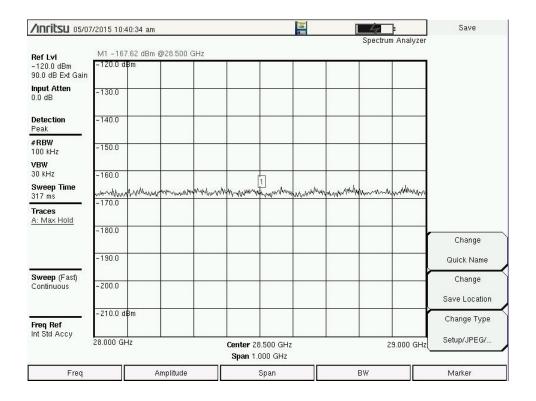


Figure 3.1-8 (B) Spectrum Photos 28-29 GHz 100 kHz Res BW Horizontal Pol 360<sup>0</sup>

<b>/Inritsu</b> 05/07	7/2015 10:48	:07 am					4		Save
lef Lvl	M1 -158.2	4 dBm @28.500	GHz				Spectrum	Analyzer	
120.0 dBm 10.0 dB Ext Gain	-120.0 dBn	n							
n <b>put Atten</b> .0 dB	-130.0								
etection 'eak	-140.0								
<b>RBW</b> MHz	-150.0					-		¢ē.	
<b>/BW</b> 100 kHz	-160.0	Manapatra Manapatra	monter	mmty	mannon	munun	untury	phandaga	
<b>Sweep Time</b> O ms	-170.0					6			
Fraces A: Max Hold									
	-180.0							r	Change
	-190.0								Quick Name
weep (Fast) ontinuous	-200.0							-r	Change Save Location
req Ref t Std Accy	-210.0 dBn	n							Change Type
	28.000 GHz			nter 28.500 GF pan 1.000 GHa			29.	000 GHz	Setup/JPEG/
Freq		Amplitude		Span		В	W		Marker

Figure 3.1-8 (C) Spectrum Photos 28-29 GHz 1MHz Res BW Vertical Pol  $360^{0}$ 

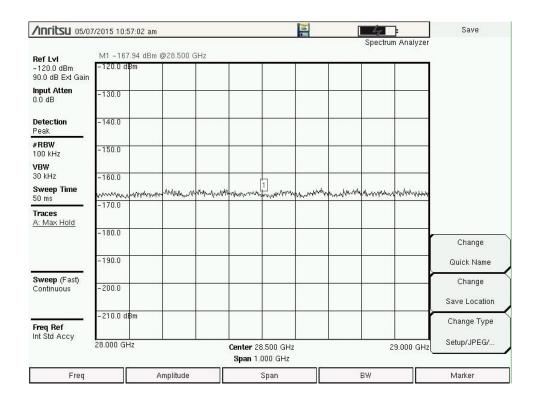
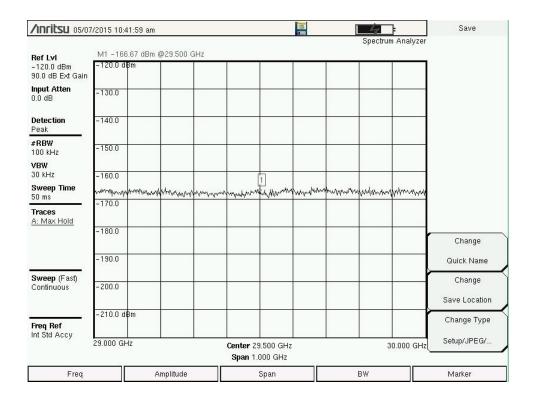


Figure 3.1-8 (D) Spectrum Photos 28-29 GHz 100 kHz Res BW Vertical Pol 360<sup>0</sup>

/Inritsu 05/03	1nritsu 05/07/2015 10:36:15 am												
Ref Lvi	M1 -159	.03 dBm @	@29.500 G	ίΗz					Spectrun	n Analyzer			
-120.0 dBm 90.0 dB Ext Gain	-120.0 dł	3m											
<b>Input Atten</b> 0.0 dB	-130.0												
<b>Detection</b> Peak	-140.0							e.	2)				
# <b>RBW</b> 1 MHz	-150.0					1							
<b>VBW</b> 300 kHz	<mark>₩₩₩₩₩₩</mark> -160.0	where we have a second s	Manhaberry	hhuspation	maynut	- munany Mrv	Wyngpron darchartha	northy	www.ad	entronyted			
Sweep Time 50 ms	-170.0							8					
Traces <u>A: Max Hold</u>													
	-180.0									l ľ	Change		
	-190.0										Quick Name		
<b>Sweep</b> (Fast) Continuous	-200.0						7				Change Save Location		
Freq Ref Int Std Accy	-210.0 dB										Change Type		
	29.000 GH	lz			Center 29 Span 1.1	9.500 GHz 000 GHz			3	0.000 GHz(	Setup/JPEG/		
Freq Amplitude Span BW										Marker			

Figure 3.1-9 (A) Spectrum Photos 29-30 GHz 1MHz Res BW Horizontal Pol 360<sup>0</sup>



<b>/INFILSU</b> 05/07	/2015 10:50:	20 am					47	} I	Save
							Spectrun	n Analyzer	
Ref Lvl		6 dBm @29.500	I GHz						
-120.0 dBm 30.0 dB Ext Gain	-120.0 dBm	×							
<b>nput Atten</b> ).0 dB	-130.0								
<b>Detection</b> Peak	-140.0						-		
<b>#RBW</b> 1 MHz	-150.0					÷			
<b>VBW</b> 300 kHz	лттүүнчим -160.0	divery many	mannam	marmin	www.www.ww	and the second sec	ahaamaaya	wahaman	
<b>Sweep Time</b> 50 ms	-170.0								
Traces A: Max Hold	- 170.0								
	-180.0							r	Change
	-190.0								Quick Name
Sweep (Fast)								r	Change
Continuous	-200.0								Save Location
Freq Ref	-210.0 dBm							ľ	Change Type
Int Std Accy	29.000 GHz			Center 29.50 Span 1.000			3	0.000 GHz	Setup/JPEG/
Freq		Amplitude		Spa			BW		Marker

Figure 3.1-9 (C) Spectrum Photos 29-30 GHz 1MHz Res BW Vertical Pol 360<sup>0</sup>

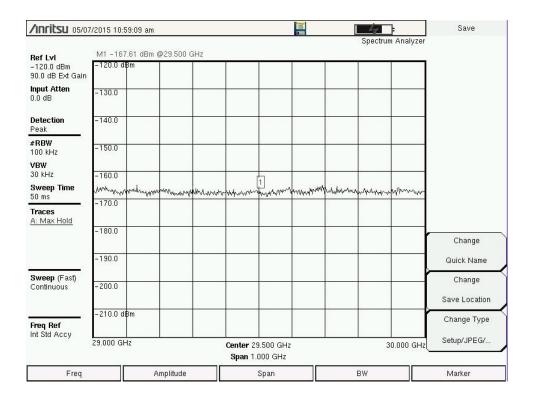


Figure 3.1-9 (D) Spectrum Photos 29-30 GHz 100 kHz Res BW Vertical Pol 360<sup>0</sup>

/Inritsu 05/03	1nritsu 05/07/2015 10:37:24 am												
Ref Lvi	M1 -158	3.02 dBm @	@30.500 (	GHz					Spectrun	n Analyzer			
-120.0 dBm 90.0 dB Ext Gain	–120.0 d	Bm											
<b>Input Atten</b> 0.0 dB	-130.0												
<b>Detection</b> Peak	-140.0								8				
<b>#RBW</b> 1 MHz	-150.0					1		-					
<b>VBW</b> 300 kHz	<u>vhhlydra</u> -160.0	minimultingly	harderday	many	manyapant	ammon	man	Valuation of the party of	mound	william			
Sweep Time 67 ms	-170.0					-	12						
Traces A: Max Hold													
	-180.0									l r	Change		
·	-190.0										Quick Name		
<b>Sweep</b> (Fast) Continuous	-200.0						1			ſ	Change Save Location		
Freq Ref Int Std Accy	-210.0 d										Change Type		
	30.000 GH	łz			Center 30 Span 1.4	).500 GHz 000 GHz	624		3	1.000 GHz	Setup/JPEG/		
Freq Amplitude Span BW										Marker			

Figure 3.1-10 (A) Spectrum Photos 30-31 GHz 1MHz Res BW Horizontal Pol  $360^{0}$ 

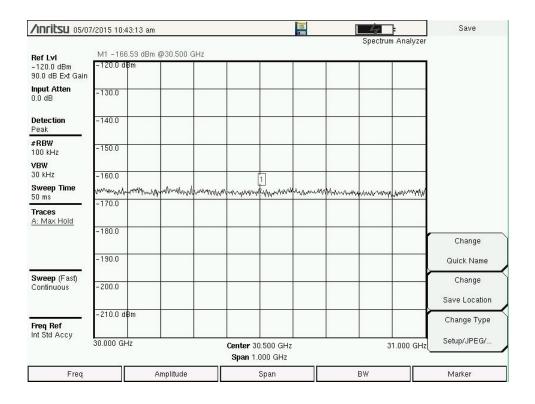


Figure 3.1-10 (B) Spectrum Photos 30-31 GHz 100 kHz Res BW Horizontal Pol 360<sup>0</sup>

<b>/Inritsu</b> 05/07	nritsu 05/07/2015 10:52:01 am 📔												
Ref Lvl			@30.500 G	iHz					Spectrun	n Analyzer			
-120.0 dBm 90.0 dB Ext Gain	-120.0 dł	3m											
Input Atten 0.0 dB	-130.0												
Detection Peak	-140.0							ej.					
#RBW 1 MHz	-150.0				[	1							
<b>VBW</b> 300 kHz	лифицуул -160.0	whenny	nathword	hornorphy	mmm	ennowlow	yhunnayha	hannyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyy	manna	Marinahar			
Sweep Time 83 ms	-170.0							-					
Traces <u>A: Max Hold</u>								-					
	-180.0									ľ	Change		
	-190.0										Quick Name		
<b>Sweep</b> (Fast) Continuous	-200.0						-				Change Save Location		
Freq Ref Int Std Accy	-210.0 di										Change Type		
	30.000 GH	Iz			Center 30 Span 1.4		19472		3	1.000 GHz	Setup/JPEG/		
Freq		A	mplitude			Span		9	BW		Marker		

Figure 3.1-10 (C) Spectrum Photos 30-31 GHz 1 GHz Res BW Vertical Pol 360<sup>0</sup>

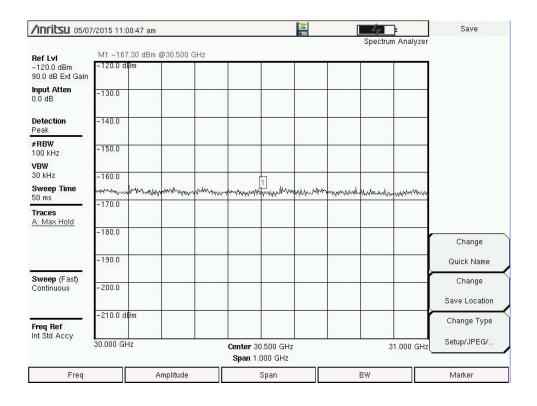


Figure 3.1-10 (D) Spectrum Photos 30-31 GHz 100 kHz Res BW Vertical Pol  $360^{\circ}$ 

FOUR

# **SUMMARY OF RESULTS**

The results of the measurements conducted at the proposed ViaSat, Inc site in Virginia Beach, VA are presented in this section.

## Arc Clearance:

There is no potential satellite arc blockage at this site. Final arc clearance will depend on antenna placement.

#### **Ku-Band Measurements:**

There was no radio frequency interference cases measured at this site above the noise floor of the test equipment.

**FIVE** 

### CONCLUSIONS AND RECOMMENDATIONS

# 5.1 <u>Conclusions</u>

There were no signals measured above the -156 dBW/ 1 MHz interference objective for digital reception at this site.

The satellite arc has no potential blockage from 55W through 115W.

## 5.2 <u>Recommendations</u>

.

It is recommended that frequency coordination of this site be initiated to protect this location at the more stringent digital receive interference objective.