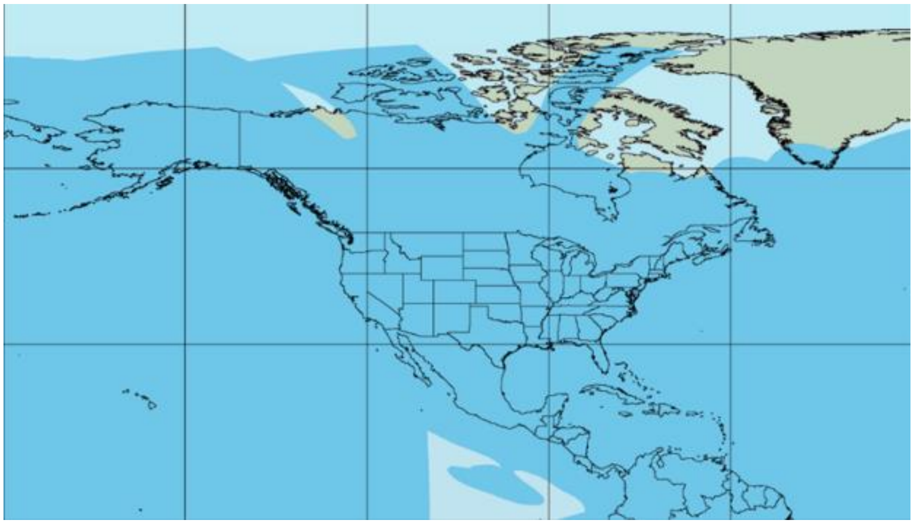
UltiSat, Inc.
ESAA Blanket License Application

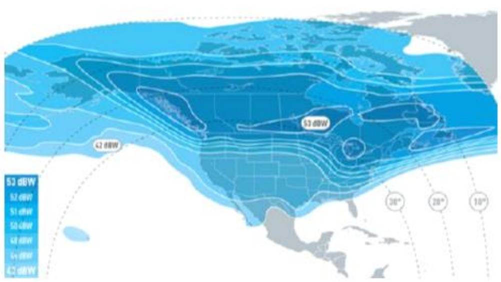
Technical Appendix

I. Coverage Maps

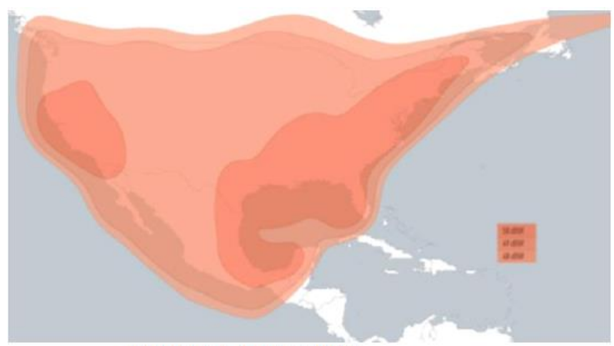
Consolidated Coverage Map



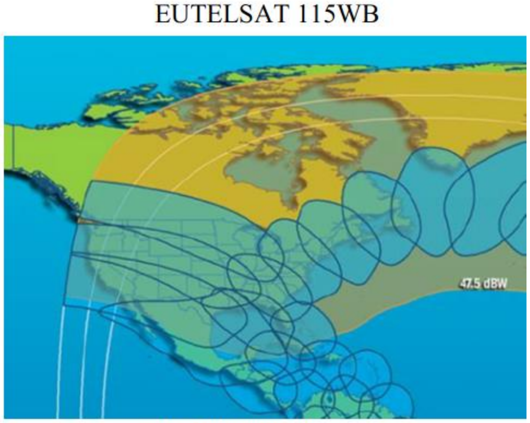
Representative Individual Satellite Coverage Maps



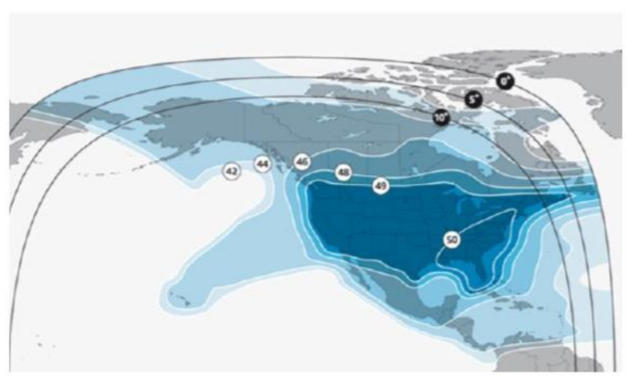
EUTELSAT 115WB



EUTELSAT 117WA



INTELSAT 29e



SES-15

II. Radiation Hazard Analysis

BB45Ku

This analysis predicts the radiation levels around a proposed earth station complex, comprised of a single panel type antenna. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01, pp 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a uncontrolled environment. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Aperture Size	0.45meters
Antenna Effective Diameter	0.45 meters
Antenna Surface Area	0.159 sq. meters
Antenna Isotropic Gain	34.6 dBi
Number of Identical Adjacent Antennas	1
Nominal Antenna Efficiency (ε)	70%
Nominal Frequency	14.25 GHz
Nominal Wavelength (λ)	0.0211 meters
Maximum Transmit Power / Carrier	40.0 Watts
Number of Carriers	1
Total Transmit Power	40.0 Watts
W/G Loss from Transmitter to Feed	4.0 dB
Total Feed Input Power	15.9 Watts
Radome Losses	1.0 dB
Effective RF Power at radome	12.7 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda$ = 2.4 meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda$ = 5.8 meters
Transition Region	R_{nf} to R_{ff} = 2.4 meters to 5.8 meters

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

PD_{as} = 4P/A = **40.1** mW/cm^2 (1)

Where: P = total power at feed, milliwatts

A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public.

This antenna will incorporate a radome which has 1.0 dB of loss. The worst case power density at the surface of the radome is shown below:

$PD_{radome}=4P_{rad}/A$ = **31.81** mW/cm² (2)

Where: Prad = total power at feed less radome losses, milliwatts

A = Total area of reflector, sq. cm (this would represent worst case)

Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, i.e., the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **22.3** mW/cm² (3)

from 0 to 2.4 meters

Evaluation

Uncontrolled Environment: **Does Not Meet Controlled Limits**

Controlled Environment: **Does Not Meet Uncontrolled Limits**

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

$PD_{tr} = (PD_{nf})(R_{nf})/R$ = dependent on R (4)

where: PD_{nf} = near field power density

R_{nf} = near field distance

R = distance to point of interest

PD_{tr} = **22.3** mW/cm²

For: 2.4 < R < 5.8 meters

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

PD_{ff} = $PG/(4\pi R^2)$ = dependent on R (5)
where: P = total power at feed
G = Numeric Antenna gain in the direction of interest relative to isotropic radiator
R = distance to the point of interest
For: $R > R_{ff}$ = 5.8 meters
PD_{ff} = **11.06** mW/cm² at R_{ff}

We use Eq (5) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} : See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} : See Section 3

5.0 Off-Axis Levels at the Far Field Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$
for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees
(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At two (2) degrees off axis At the far-field limit, we can calculate the power density as:

$G_{off} = 32 - 25\log(2) = 32 – 7.52$ dBi = 280.2 numeric

$PD_{2\ deg\ off\text{-}axis} = PD_{ff} x\ 280.2/G$ = **0.8** mW/cm^2 (6)

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$PD_{nf(off\text{-}axis)} = PD_{nf} / 100 =$ **0.22** mW/cm^2 at D off axis (7)

See Section 7 for the calculation of the distance vs. elevation angle required to achieve this rule for a given object height.

7.0 Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha)$ (8)

Where: α = minimum elevation angle of antenna
D = dish diameter in meters
h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (8), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	0.45 meters
	h =	2.0 meters, delta between antenna and object >1 m
Then:		
	α	S
	10	1.3 meters
	15	0.9 meters
	20	0.7 meters
	25	0.6 meters
	30	0.5 meters

8.0 Summary of Results

The earth station site will be protected from uncontrolled access by virtue of the fact that it will be mounted on the roof of an aircraft. There will be proper emission warning labels placed on the earth station and all operations/maintenance personnel will be made aware of the human exposure levels at and around the earth station. The earth station will not be operated during maintenance work and other operations where operations/maintenance personnel may be in the vicinity of the earth station.

The table below summarizes all of the above calculations.

Parameter	Abbr.		Units	Formula
Antenna Effective Diameter	Df	0.450	meters	
Antenna Centerline	h	2	meters	
Antenna Surface Area	Sa	0.159	$meter^2$	$(\pi*Df^2)/4$
Antenna Ground Elevation	GE	2	meters	
Frequency of Operation	f	14.25	GHz	
Wavelength	λ	0.0211	meters	
HPA Output Power	P_{HPA}	40	watts	
HPA to Antenna Loss	L_{Tx}	4	dB	
Radome Loss	L_{Rad}	1	dB	
Transmit Power at Flange	P	15.92	watts	$P/10Log^{-1}(L_{Tx}/10)$
Effective Power after Radome		12.65	watts	$P/10Log^{-1}$(Radome Loss/10)
Antenna Gain	G_{es}	35.64	dBi	does not include radome loss
Antenna Aperature Efficiency	η	70%	n/a	
1. Reflector Surface Region Calculations				
Antenna Surface Power Density	Pdas	400.5	W/m^2	$(16 * P)/(\pi * D^2)$
		40.05	mW/cm^2	
Power at Radome Surface	Pdrad	318.1	W/m^2	$(16 * P)/(\pi * D^2)$
(outside radome)		31.81	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
2. On Axis Near Field Calculations				
Extent of Near Field	Rn	2.40	meters	$D^2 / (4 * \lambda)$
		7.87	feet	
Near Field Power Density	PDnf	222.7	w/m^2	$(16 * \eta *P)/(\pi * D^2)$
		22.27	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
3. On Axis Transition Region Calculations				
Extent of Transition Region (min)	R_{Tr}	2.405	meters	$D^2 / (4 * \lambda)$
Extent of Transition Region (min)		7.890	feet	
Extent of Transition Region (max)	R_{Tr}	5.771	meters	$0.6 * D^2 / \lambda$
Extent of Transition Region (max)		18.934	feet	
Worst Case Transition Region Power Density	PD_{tr}	222.7	w/m^2	
		22.27	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
Uncontrolled enviorment safe operating distance	Rsu	53.6	meters	$(PD_{nf})/R_{nf})/Rsu$
Controlled enviorment safe operating distance	Rsc	10.7	meters	$(PD_{nf})/R_{nf})/Rsc$
4. On Axis Far Field Calculations				
Distance to Far Field Region	Rf	5.77	meters	$0.6 * D^2 / \lambda$
		18.93	feet	
On Axis Power Density in the Far Field	PD_{ff}	110.6	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2)$
		11.06	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
5. Off-axis Power Density in the Far Field Limit and Beyond				
Antenna Surface Power Density	PDs	8.5	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2) * (Goa/Ges)$
Goa/Ges at a sample angle of θ=2 degrees		0.077		Goa = 32 - 25*log(θ)
		0.8	mW/cm^2	
6. Off Axis Power Density in the Near Field and Transitional Region Calculations				
Power Density of Wn/100 for 1 diameter	PDs	2.23	W/m^2	$[(16 * \eta *P)/(\pi * D^2)] / 100$
removed		0.223	mW/cm^2	**Meets controlled limits**
				Meets Uncontrolled limits
7.0 Off-axis Safe Distances from Earth Station				
minimum elevation angle of antenna	α	10	degree	
hieght of object to be cleared	h	2	meter	
Groun elevation delta antenna-obstacle elevation ang	**GD**	**S**		
	10	1.3	meter	S=(D/sinα) + (2h - D- 2) / (2tanα)
	15	0.9	meter	
	20	0.7	meter	
	25	0.6	meter	
	30	0.5	meter	
Note: Maximum FCC power density limits for 6GHz is 1mW/cm2 for general population exposure as per FCC OS&T				

III. BBIG45Ku
EIRP Spectral Density (ESD) Data

PREPARED	APPROVED	AUTHORIZED
R. ELEUTERI Antenna Engineer	F. CIPOLLONI R&D Manager	F. ZARGHETTA Administrator

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REVISIONS LOG

REV	CHANGE ORDER	DATE	DESCRIPTION	AUTHOR
1.0	n/a	2017/11/30	First edition	R. Eleuteri

1 SCOPE

This document summarizes the BBIG45Ku performance in terms of maximum allowable EIRP Spectral Density (ESD) as per the applicable FCC regulations.

2 APPLICABLE DOCUMENTS

2.1 Customer documents

N/A

2.2 Applicable standards

[AD1] FCC 25.227 - Blanket licensing provisions for ESAAs operating with GSO FSS space stations in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz, and 14.0-14.5 GHz bands.

2.3 Skytech documents

N/A

3 ACRONYMS

Abbreviation	Meaning
AZ	Azimut
EIRP	Effective Isotropic Radiated Power
EL	Elevation
ESD	EIRP Spectral Density
Hpol	Horizontal Polarization
OMT	Ortho-Mode Transducer
Vpol	Vertical Polarization

4 ESD Data

The BBIG45Ku ESD performance has been assessed with respect to the FCC 25.227 standard considering the four transmitting frequencies 13.75 GHz, 14.00 GHz, 14.25 GHz and 14.50 GHz, in both the Horizontal and Vertical polarization. The antenna radiation patterns used for the ESD patterns calculation have been measured at the test facilities of "Politecnico di Torino" University.

The computed ESD patterns are reported in the following sections with the superimposition of the limit masks provided in Figure 1, Figure 2 and Figure 3 (applied to Azimut co-polar cuts, Elevation co-polar cuts and Azimut & Elevation cross-polar cuts, respectively).

$15-25 \log_{10}\theta$	dBW/4 kHz	for $1.5° \le \theta \le 7°$.
-6	dBW/4 kHz	for $7° < \theta \le 9.2°$.
$18-25 \log_{10}\theta$	dBW/4 kHz	for $9.2° < \theta \le 19.1°$.
-14	dBW/4 kHz	for $19.1° < \theta \le 180°$.

Figure 1: ESD limits superimposed to the Azimut co-polar cuts

$18-25 \log\theta$	dBW/4 kHz	for $3.0° \le \theta \le 19.1°$.
-14	dBW/4 kHz	for $19.1° < \theta \le 180°$.

Figure 2: ESD limits superimposed to the Elevation co-polar cuts

$5-25 \log_{10}\theta$	dBW/4 kHz	for $1.8° < \theta \le 7°$.

Figure 3: ESD limits superimposed to the cross-polar cuts

4.1 Horizontal polarization ESD

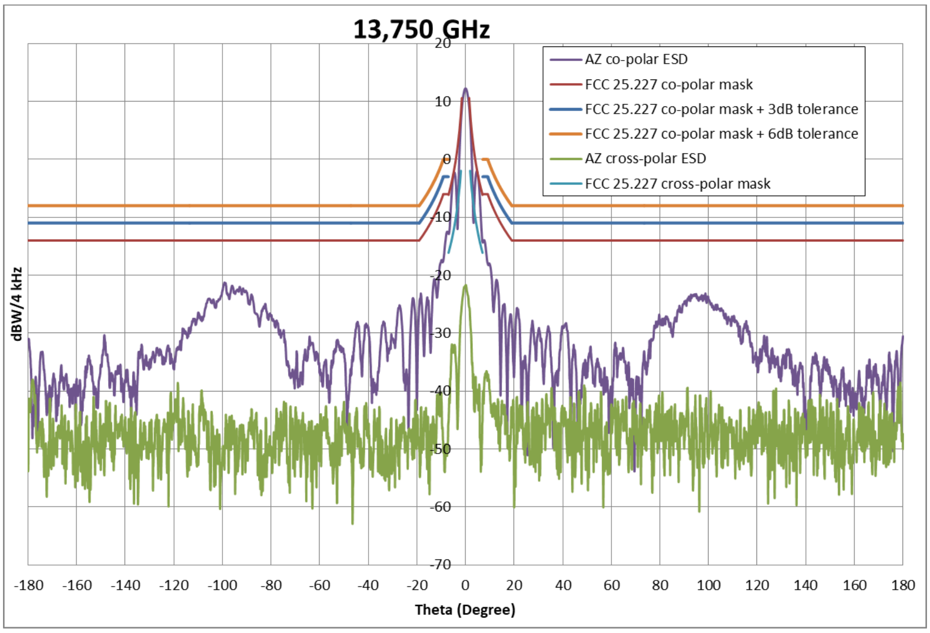

Figure 4: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Azimut cut)

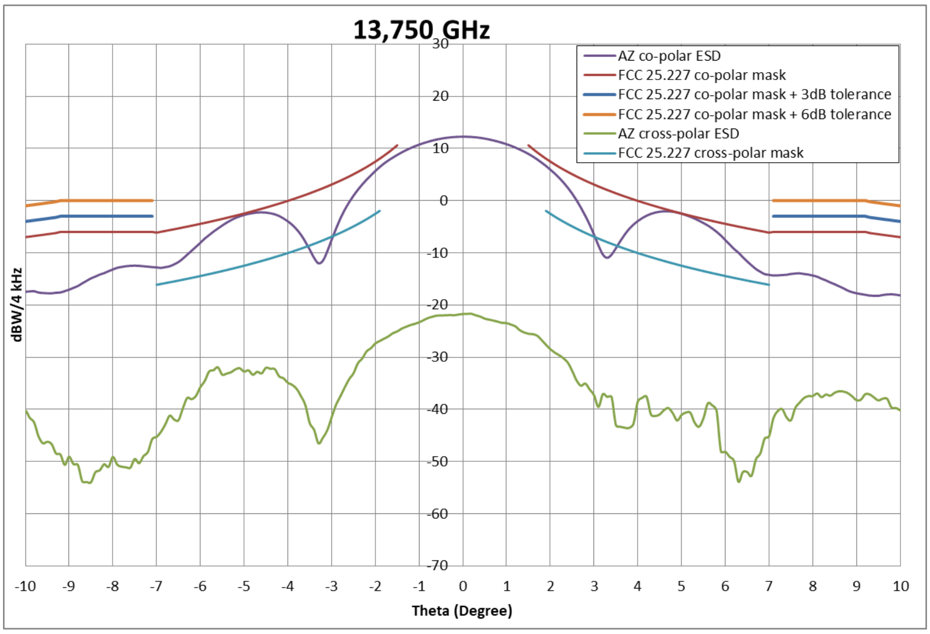

Figure 5: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Azimut cut) - zoom

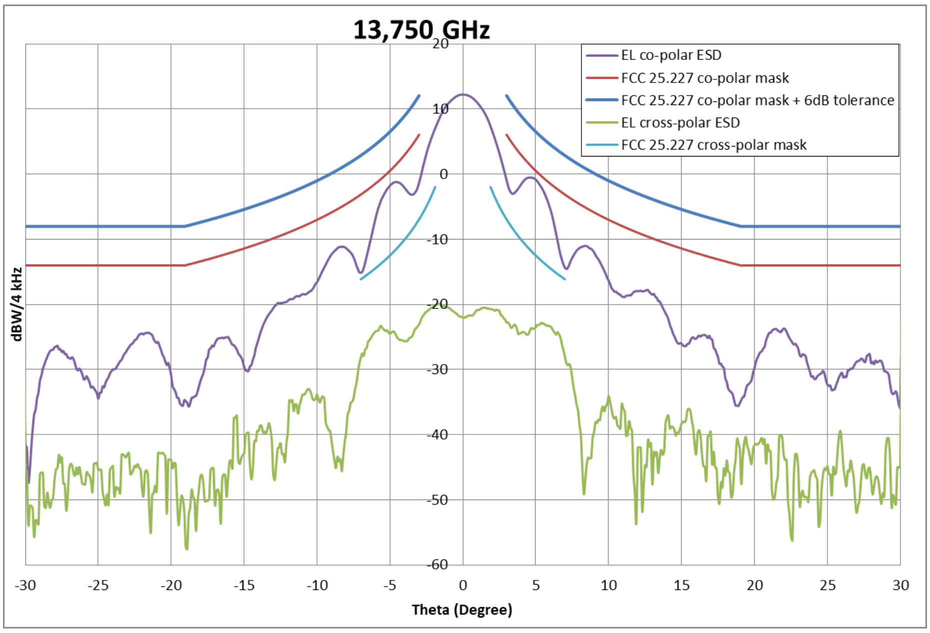

Figure 6: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Elevation cut)

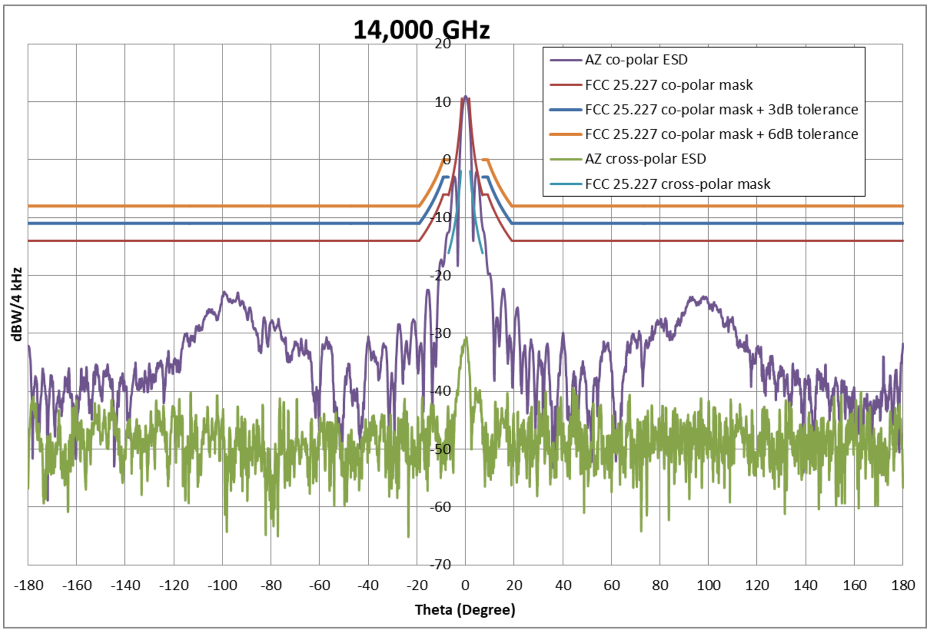

Figure 7: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Azimut cut)

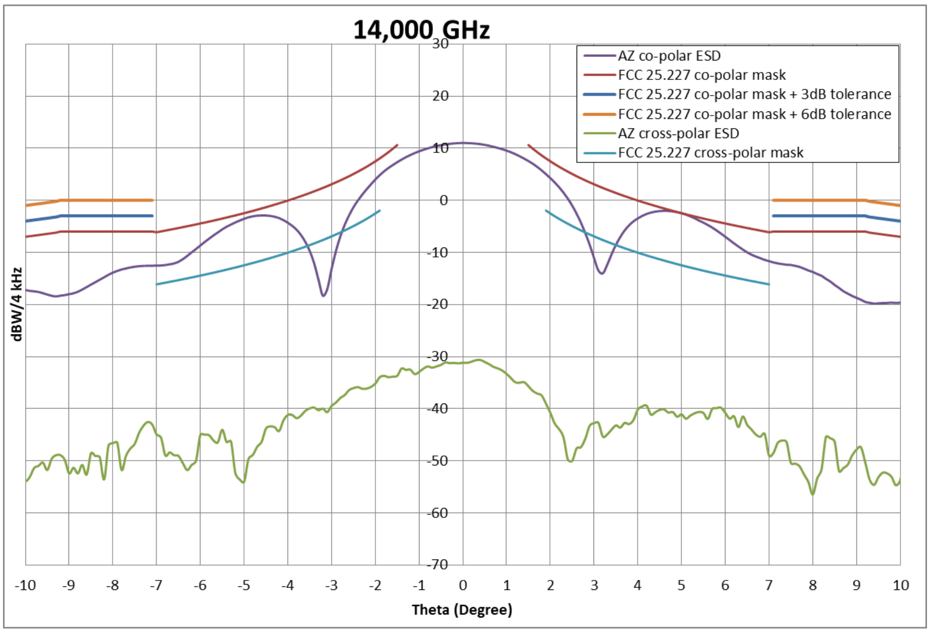

Figure 8: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Azimut cut) – zoom

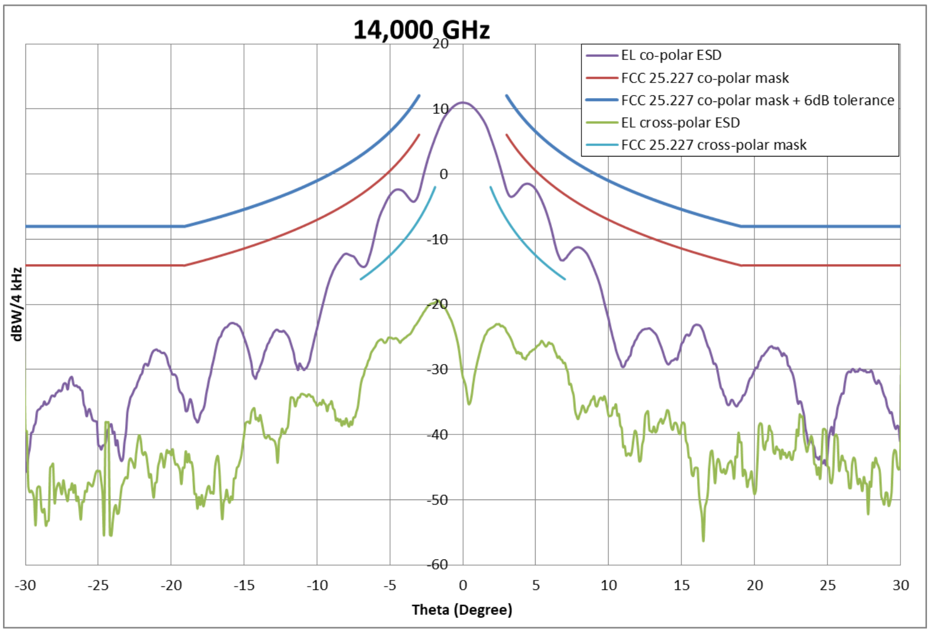

Figure 9: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Elevation cut)

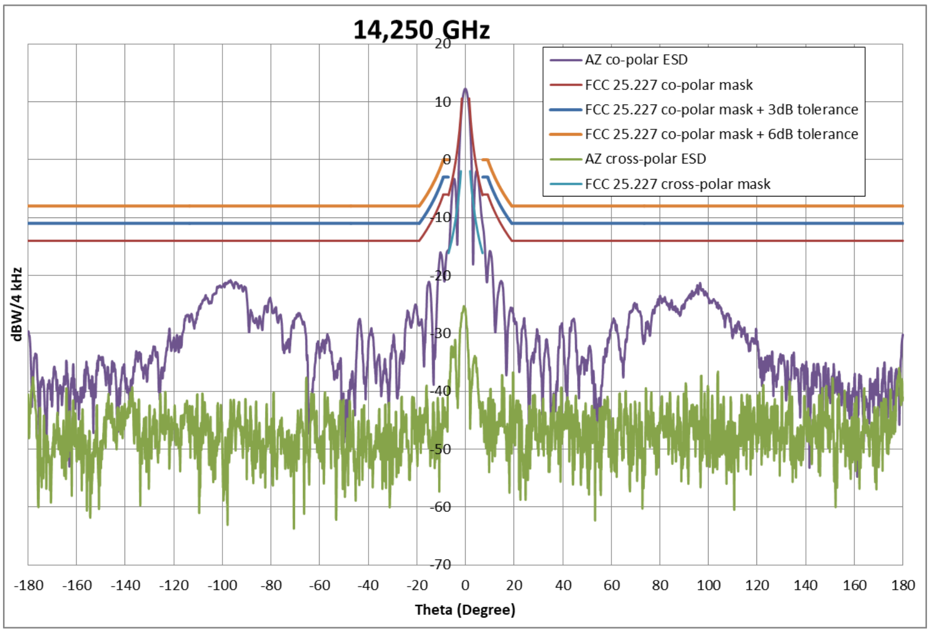

Figure 10: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Azimut cut)

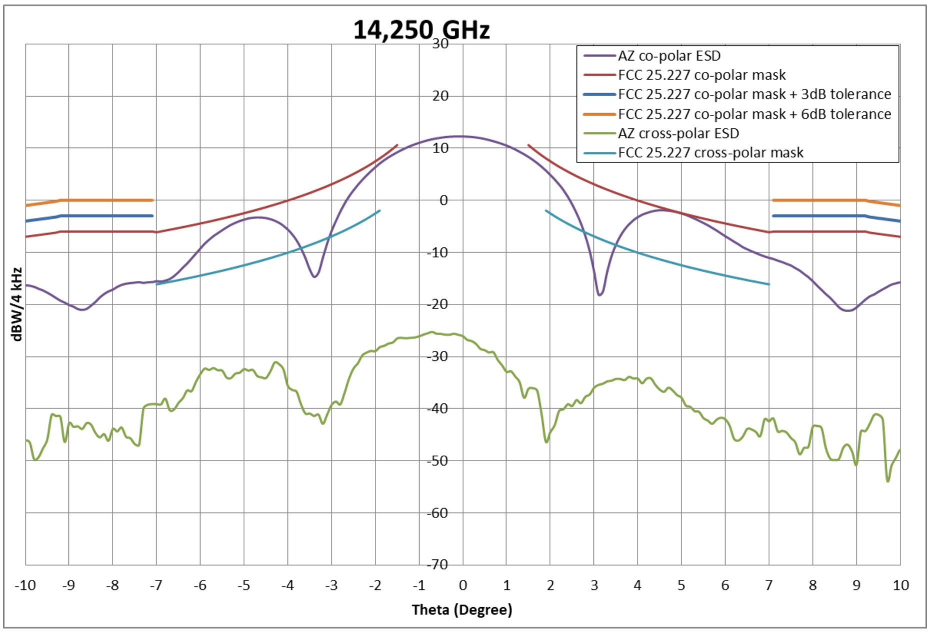

Figure 11: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Azimut cut) - zoom

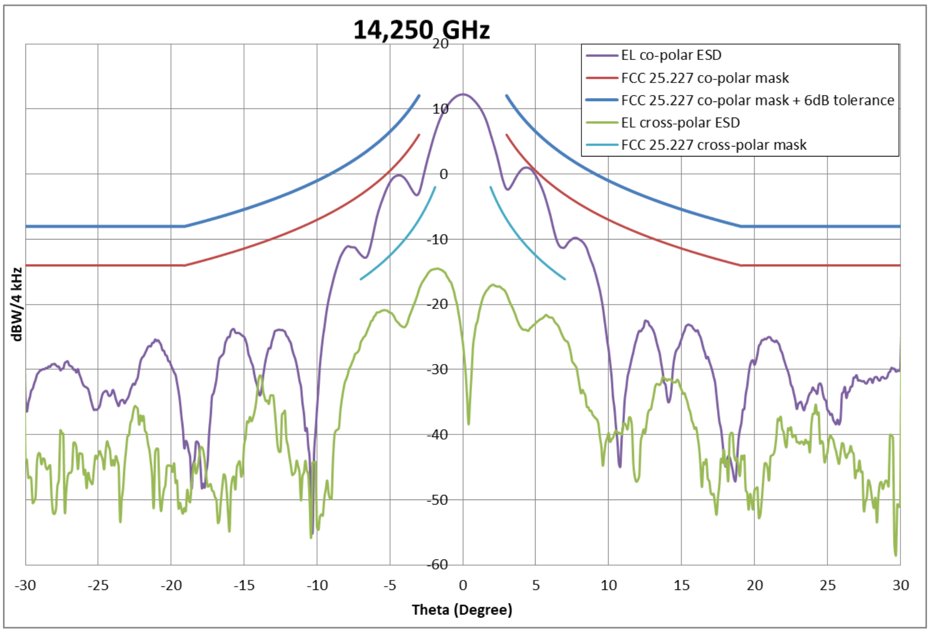

Figure 12: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Elevation cut)

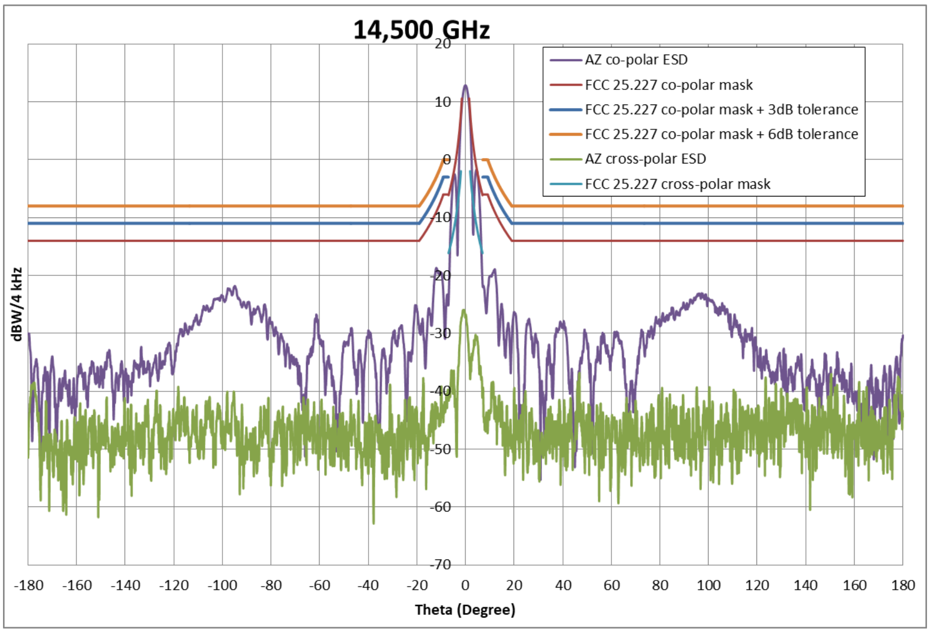

Figure 13: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Azimut cut)

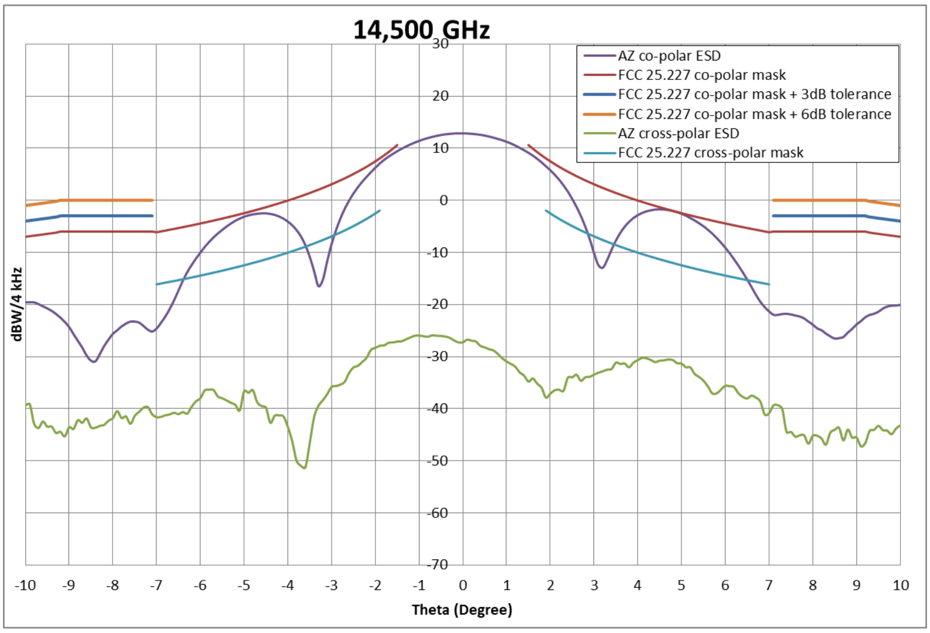

Figure 14: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Azimut cut) - zoom

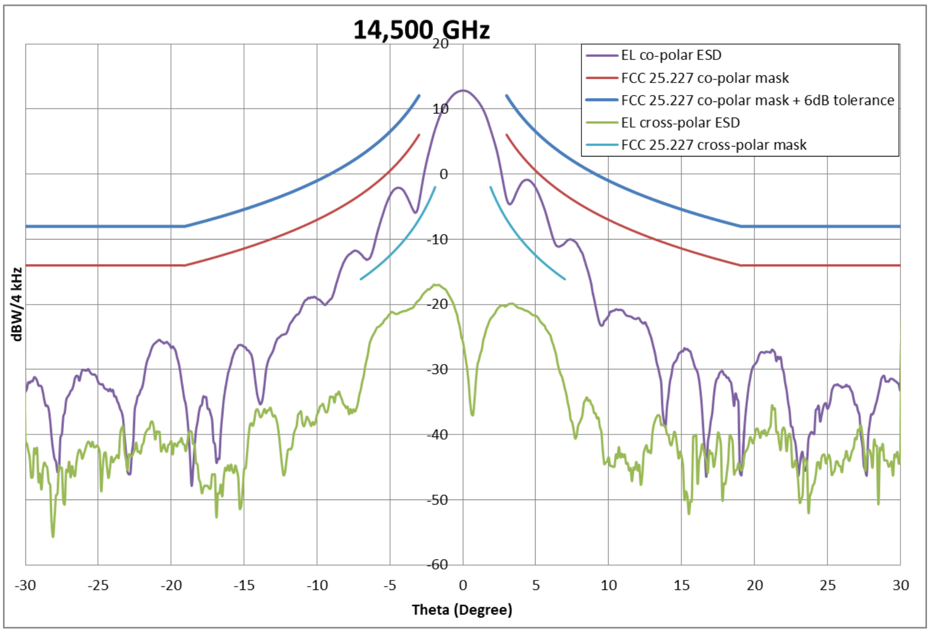

Figure 15: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Elevation cut)

4.2 Vertical Polarization ESD

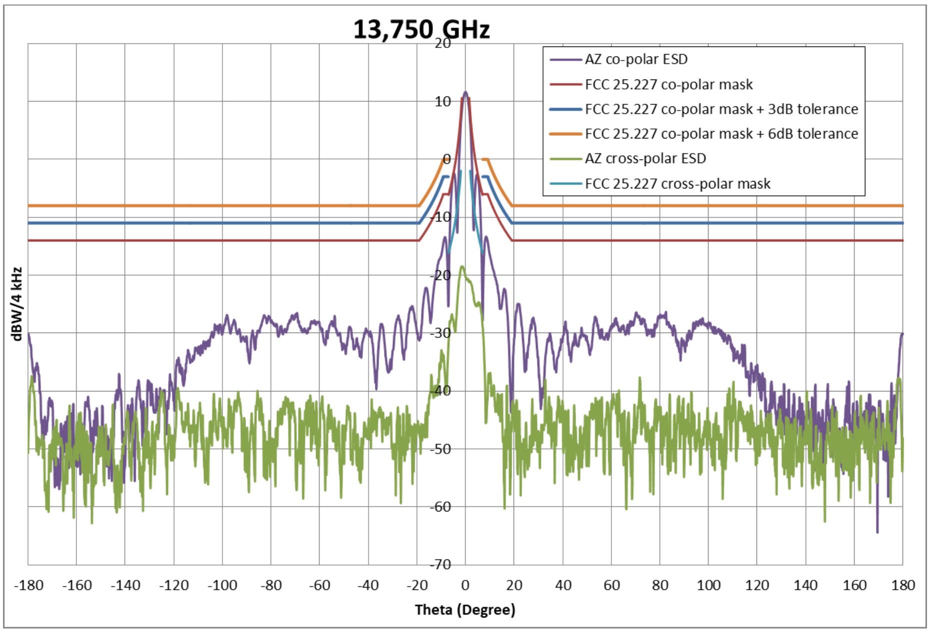

Figure 16: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Azimut cut)

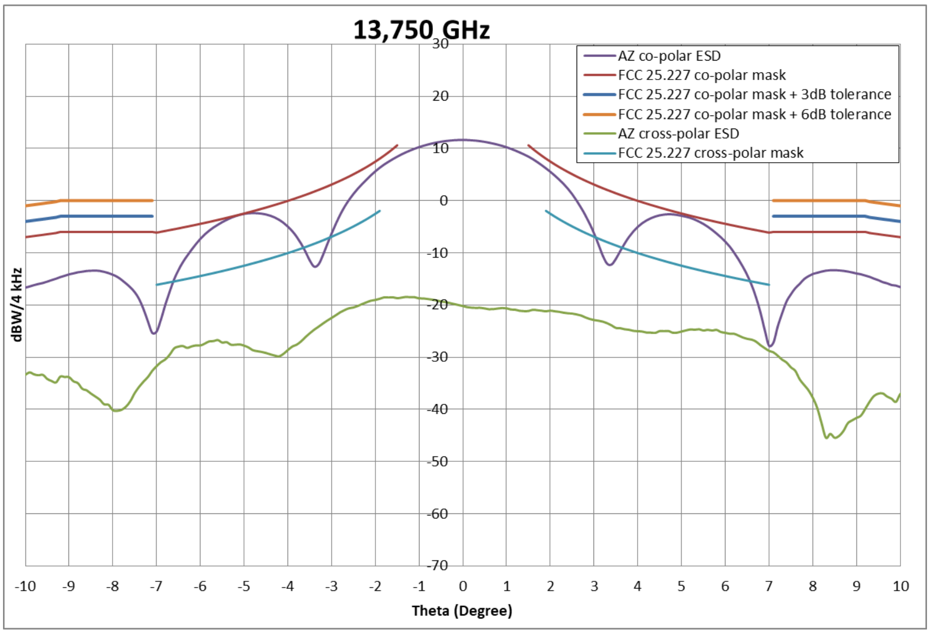

Figure 17: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Azimut cut) - zoom

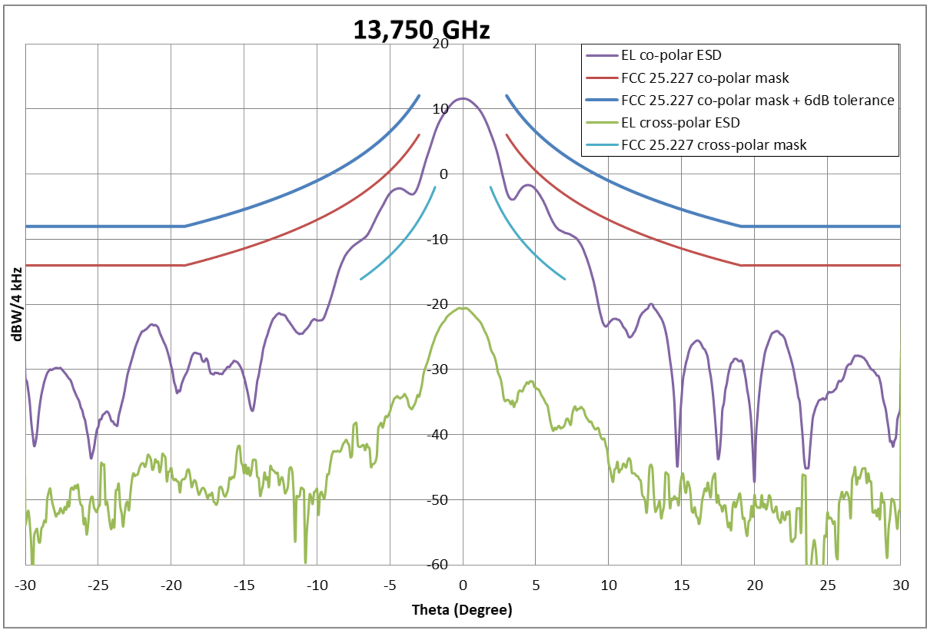

Figure 18: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Elevation cut)

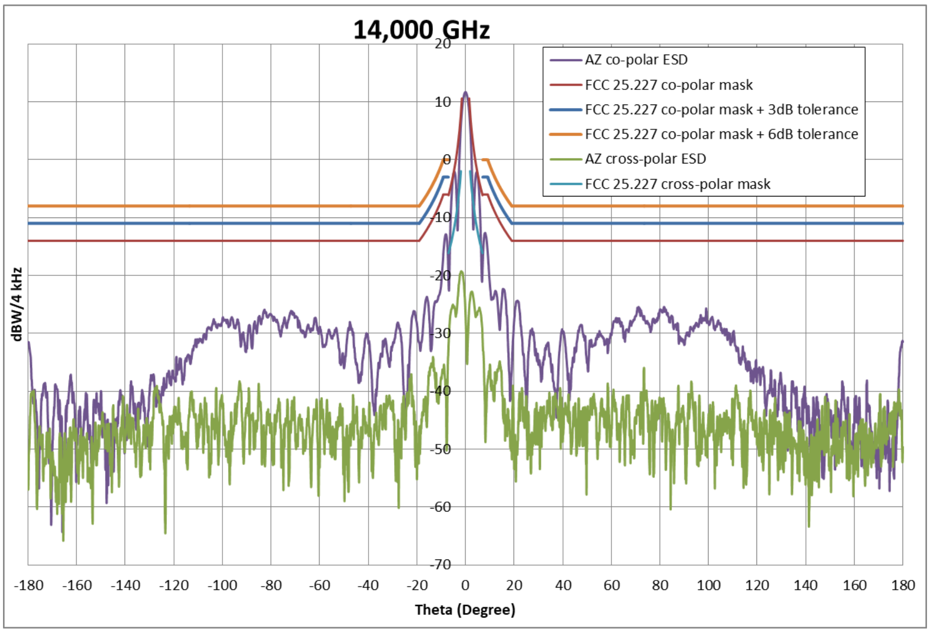

Figure 19: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Azimut cut)

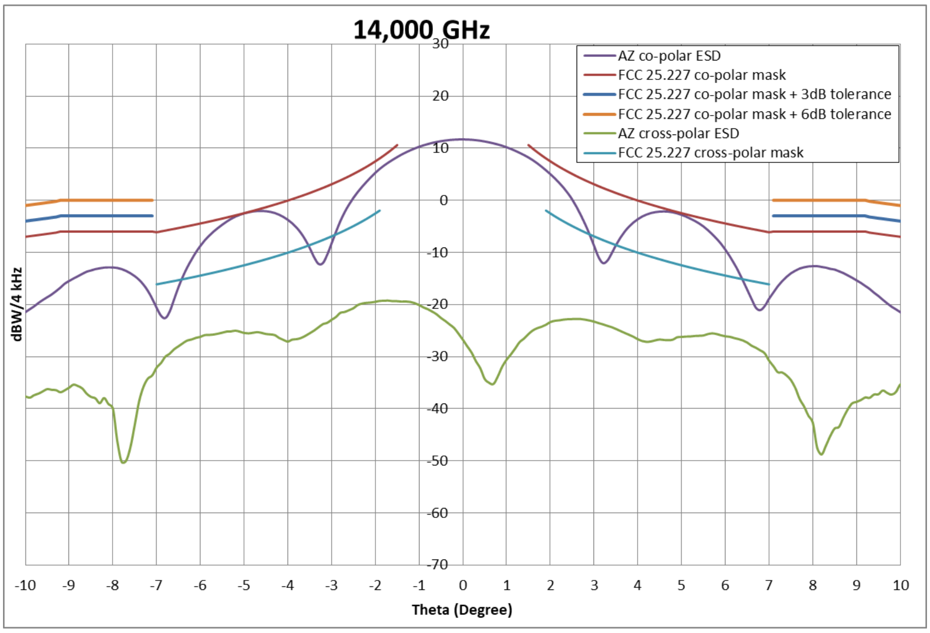

Figure 20: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Azimut cut) - zoom

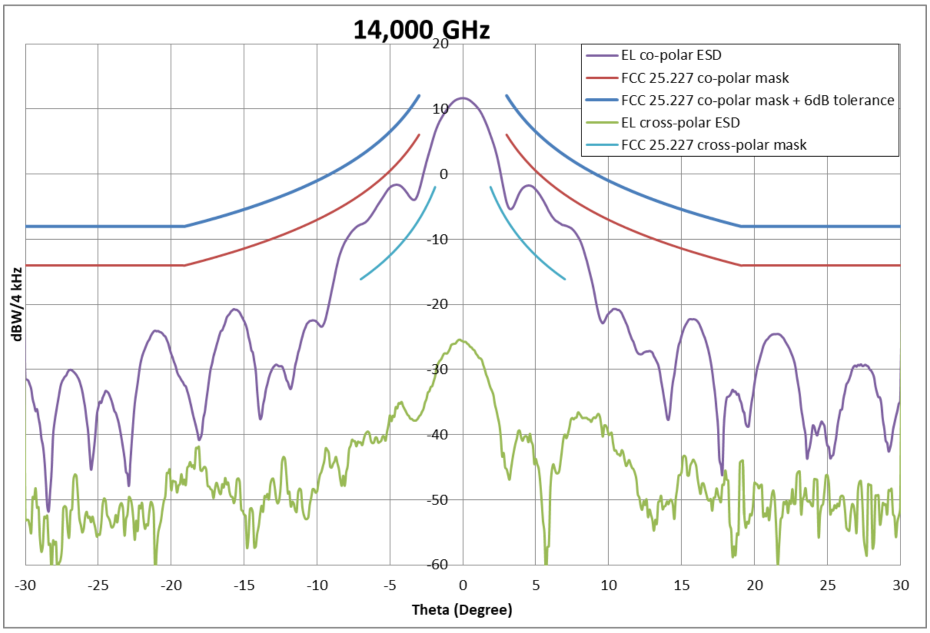

Figure 21: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Elevation cut)

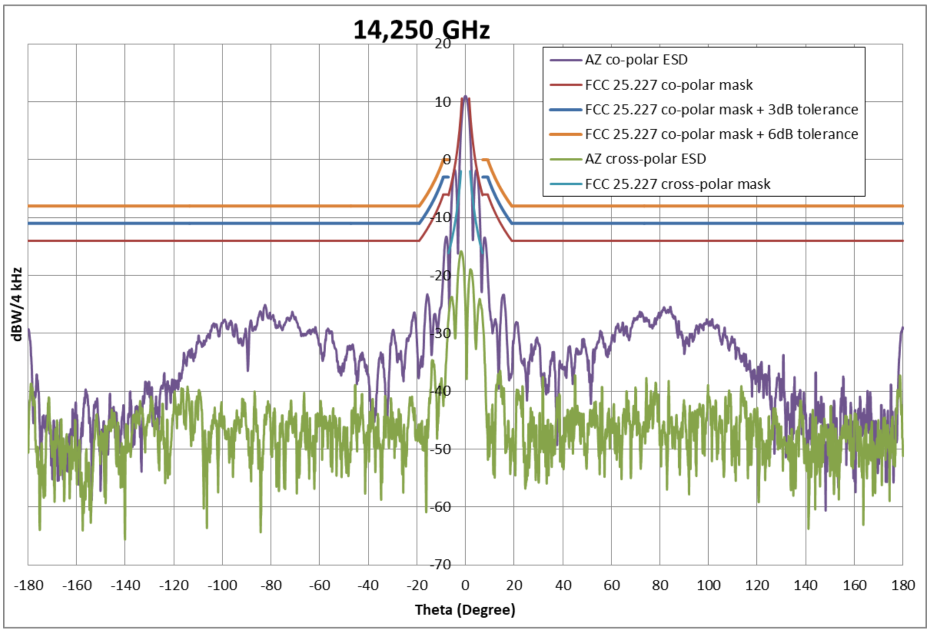

Figure 22: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Azimut cut)

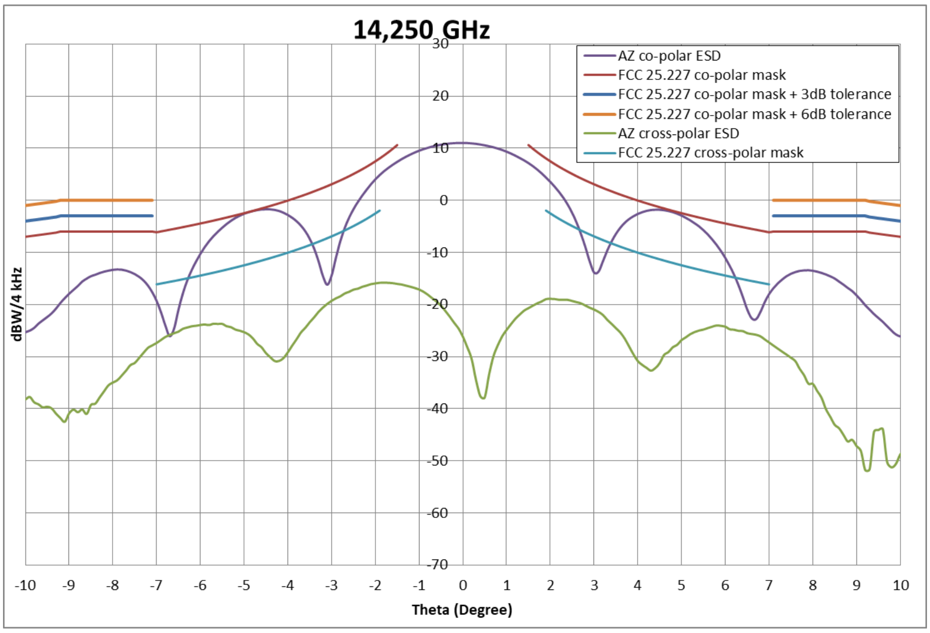

Figure 23: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Azimut cut) - zoom

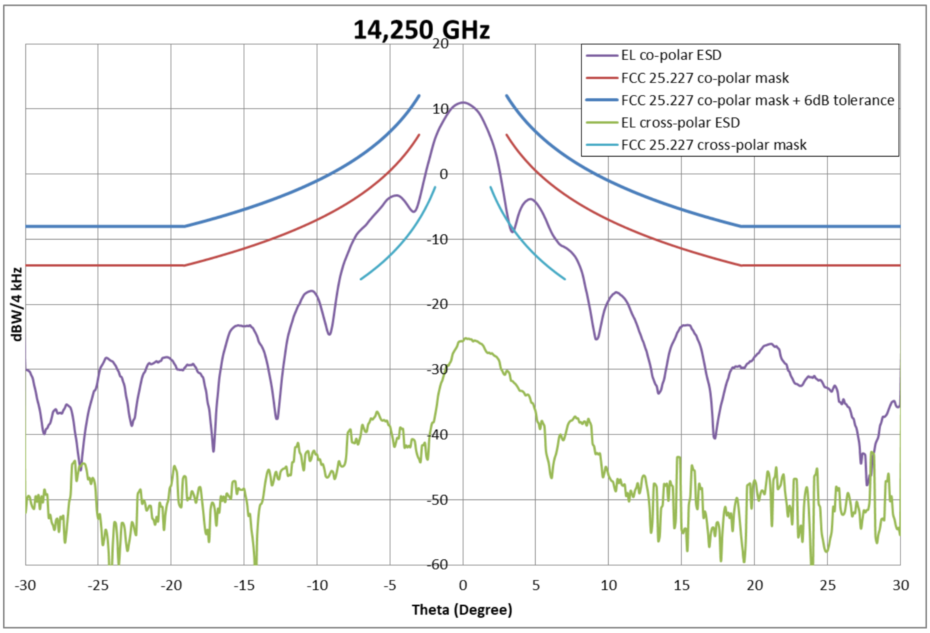

Figure 24: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Elevation cut)

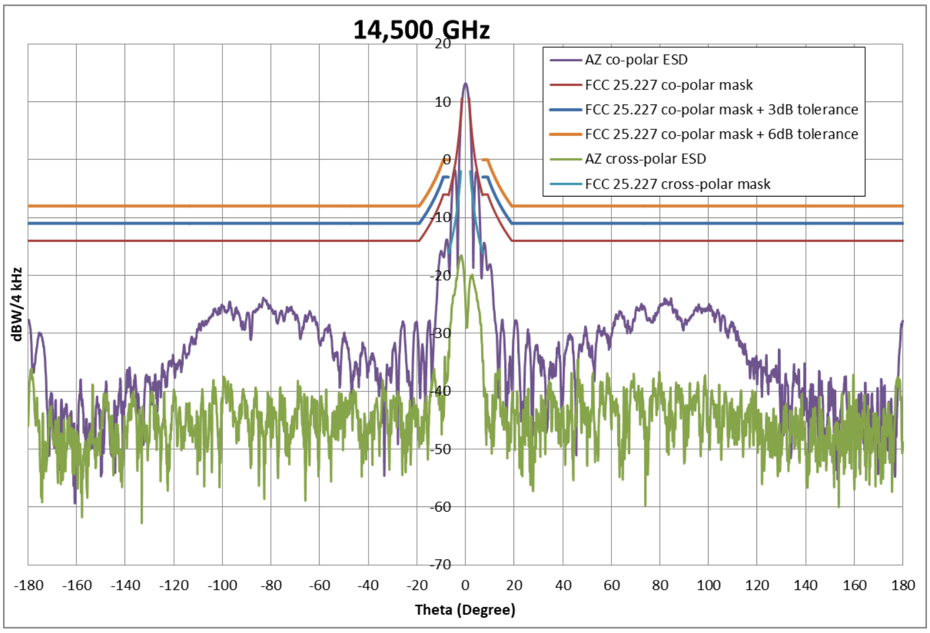

Figure 25: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Azimut cut)

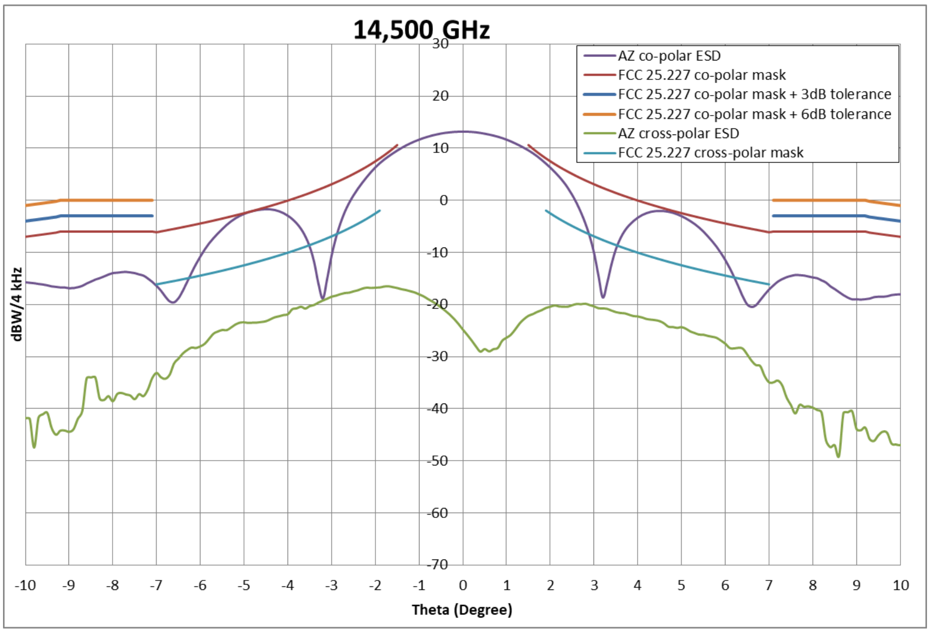

Figure 26: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Azimut cut) - zoom

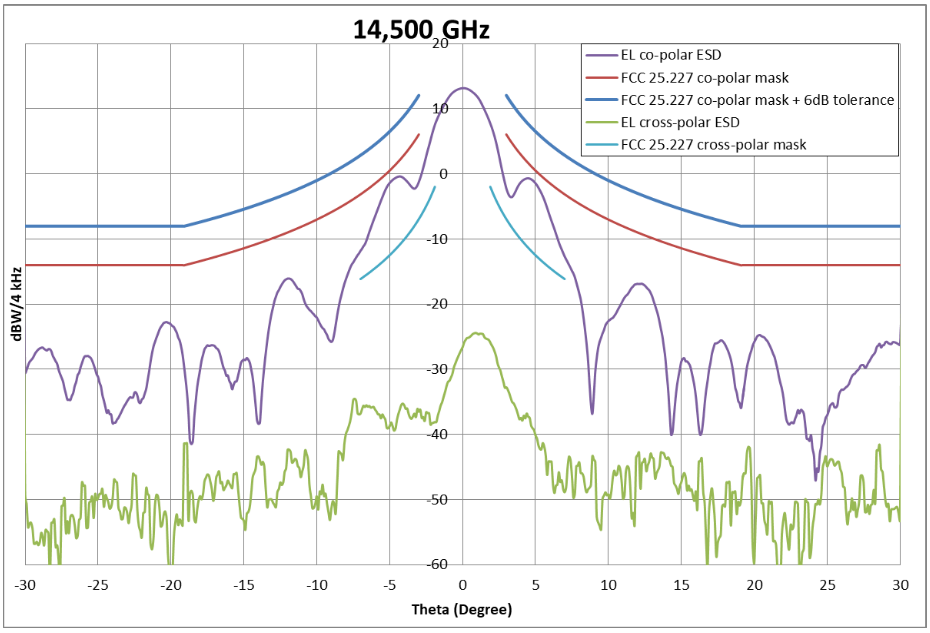

Figure 27: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Elevation cut)

4.3 Input and Output maximum ESD

Table 1 shows the maximum input and output ESD computed on the basis of the ESD patterns reported in the previous sections, highlighting the worst case. The input ESD is intended as applied to the coaxial port of the OMT.

Table 1: Recap of maximum input and output ESD

Frequency (GHz)	Polarization	Max Input ESD (dBW/4 kHz)	Max Output ESD (dBW/4 kHz)
13.75	H	-21.4	12.2
13.75	V	-21.7	11.6
14.00	H	-22.7	10.9
14.00	V	-21.7	11.6
14.25	H	-21.6	12.2
14.25	V	-22.7	11.0
14.50	H	-21.3	12.8
14.50	V	-20.8	13.2

IV. Gain Patterns of SkyTech BBIG45Ku antenna.

ID	*TRGD04_12/17*
Authors	*G. Dassano*
Date	*29/12/2017*
Version	*1*
Classification (*)	*CO*

Summary:

This report deals with the measurements of the radiation pattern of a sample of the parabolic reflector antenna BBIG45Ku manufactured by SkyTeck, operating in Ku band: The measurements were carried out in November 2017 in the Politecnico di Torino Antenna Laboratory (LACE). Measurements of radiation patterns have been carried out on the two transmission and the two reception antenna ports, for H and V polarizations, at two frequencies bands; in the frequency range 10.95-12.75 GHz (RX) and in the frequency range 13.75-14.5 GHz (TX).

**Classification: PU-Public, LI-Limited, CO-Company Confidential*

Document history

Version	*Date*	*Description*	*Authors*
1	December 29, 2017	Gain, XPD and patterns in RX and TX band for V and H polarizations (1st draft)	G. Dassano

Distribution list

Name	*Company*
R. Eleuteri	*SkyTech*
G. Dassano	*Politecnico di Torino*
R. Maggiora	*Politecnico di Torino*
M. Orefice	*Politecnico di Torino*

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1. INTRODUCTION

In this document are reported the results of the tests (carried out on November 2017) on a 30cm parabolic reflector antenna for Ku band satellite communication, indicated as **BBIG45Ku,** manufactured by SkyTech. The antenna has a circular aperture with a diameter of 45 cm.

For this antenna the results shown in this report are:

In the RX and TX bands: the frequency swept maximum gain for the co-polarization on axis, and the XPD factor evaluated on axis.

The radiation pattern cuts (co- and cross-polarization) in the principal (Azimuth and Elevation) planes:

- *in RX band, in the angular range ±180° for AZ and ±30° for EL planes, and both polarizations ports (H and V), at 3 frequencies: 10.95, 11.85 and 12.75 GHz;*
- *in TX band, in the angular range ±180° for AZ and ±30° for EL planes, and both polarizations ports (H and V), at 4 frequencies, 250MHz spaced, from 13.75 to 14.5 GHz;*

All the measurements were carried out in LACE's outdoor far field test range, with a distance SRC-AUT of 150 m.

2. MEASUREMENTS FACILITIES DESCRIPTION

2.1 Gain and pattern measurements

The measurements have been performed in the outdoor test range of the Laboratory (see fig.1).

The present test range, who has replaced the old one used since the early '60es for pioneering works on space antennas, has been supplied from MI Technologies (formerly Scientific Atlanta) and installed in February 2008.

In this test range the Antenna Under Test (AUT), used as receiver, and the Source (SRC) are placed on the roof of two different buildings, the Department of Electronics and Telecommunications and the Department of Control and Computer Engineering. The two buildings are far apart (more than 150 m) without obstacles in between, and the height of both AUT and SRC is 30 m above the ground; the range is schematically shown in fig.1 (plan and elevation). It is also possible to use a SRC at a slightly lower level, to reduce the scattering from the back of the range.

Due to the elevated range, there are many Fresnel zones without obstacles. The effects of the reflection on the ground can be removed by a time windowing, with some directivity of the source and also considering that the incidence angle on the ground is near to the Brewster angle.

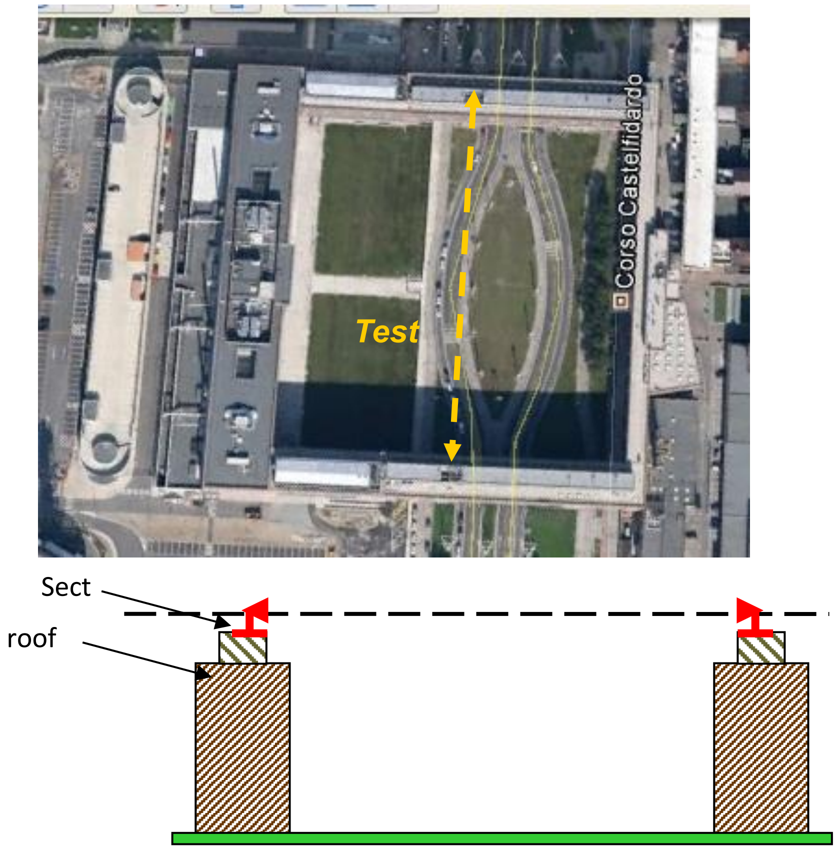


Fig.1: Plan view and vertical section of the outdoor test range

The design frequency interval is 100 MHz-50 GHz (the upgrade from 20 to 40 GHz has been added in 2011; from 40 to 50 GHz in 2015). The distance between SRC and AUT allows to test antennas up to 0.7m diameter at 40 GHz; at lower frequencies the maximum size in meters is given by $D \cong 4.7/f^{1/2}$, where f is the frequency in GHz. Corrections procedures are also available should the distance be less than $2D^2/\lambda$.

The dynamic range is around 90 dB (depending on the frequency). The receiver can handle up to 16 measurements channels, with external switching system, and 1 reference channel measured simultaneously with each signal channel, with 100 dB isolation Channel to Channel (110 dB . Reference Channel to Signal Channel). The accuracy in amplitude (Logarithmic mode) is ±.05 dB/10 dB over the full dynamic range (excluding effects of temperature, cross-talk and noise) and ±0.4 °/10 dB in phase over full dynamic range; the noise figure is 17 dB at 0.1 to 18 GHz. The most recent calibration of the whole system has been in June 2014.

The positioning system of the AUT is a 3-axis system (roll over azimuth over elevation), consisting of: MI53150 Az/El and MI6111 rotary positioner (see fig.2, left). The Az/El accuracies are respectively 0.03° and 0.05° with max load 1136 kg and bending moment 3390 N·m; the roll accuracy is 0.05° with max load 455 kg and bending moment 678 N·m. As a practical guideline, the system can measure antennas up to 2m in size and to 70 kg in weight: actual limits depend however on the shape of the antenna. This positioning system allows to take pattern cuts as well as raster scan of the pattern, and to measure circular and linear polarization.. Examples of measured radiation patterns are shown in fig. 3. The full system cabling diagram is shown in fig. 4.

As source antennas standard gain horns are used. Measurement accuracy for secondary lobe is estimated in about in ±1 dB; for gain in about ±0.5 dB

Fig.2: Outdoor test range: the AUT mount (left) and the upper SRC mount (right).

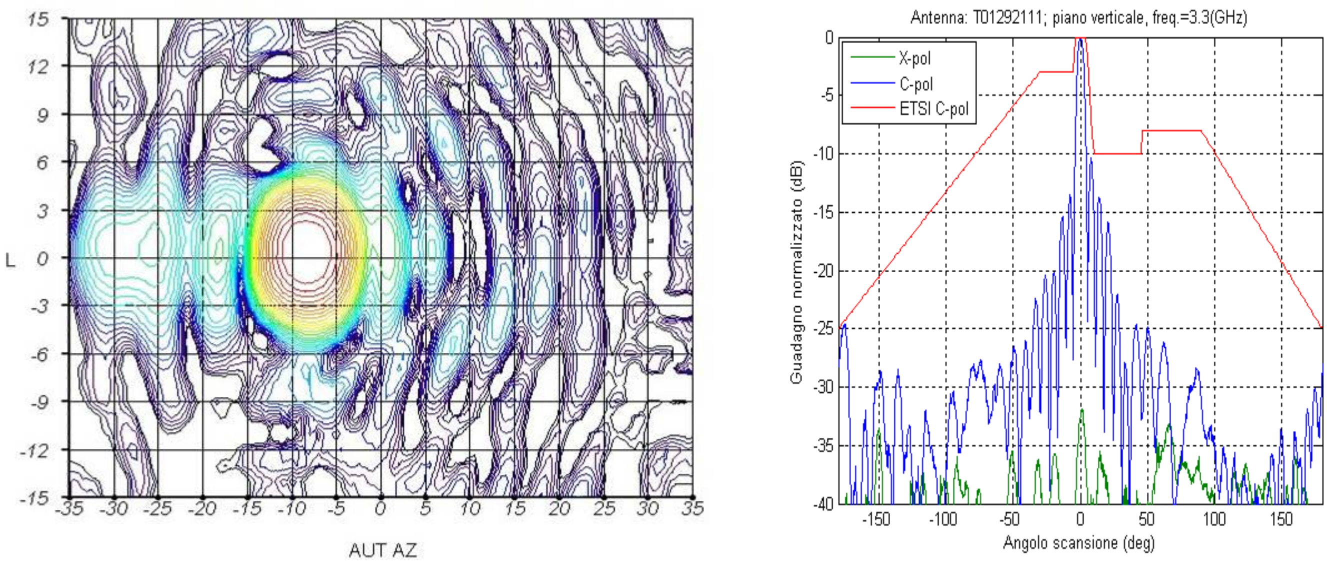
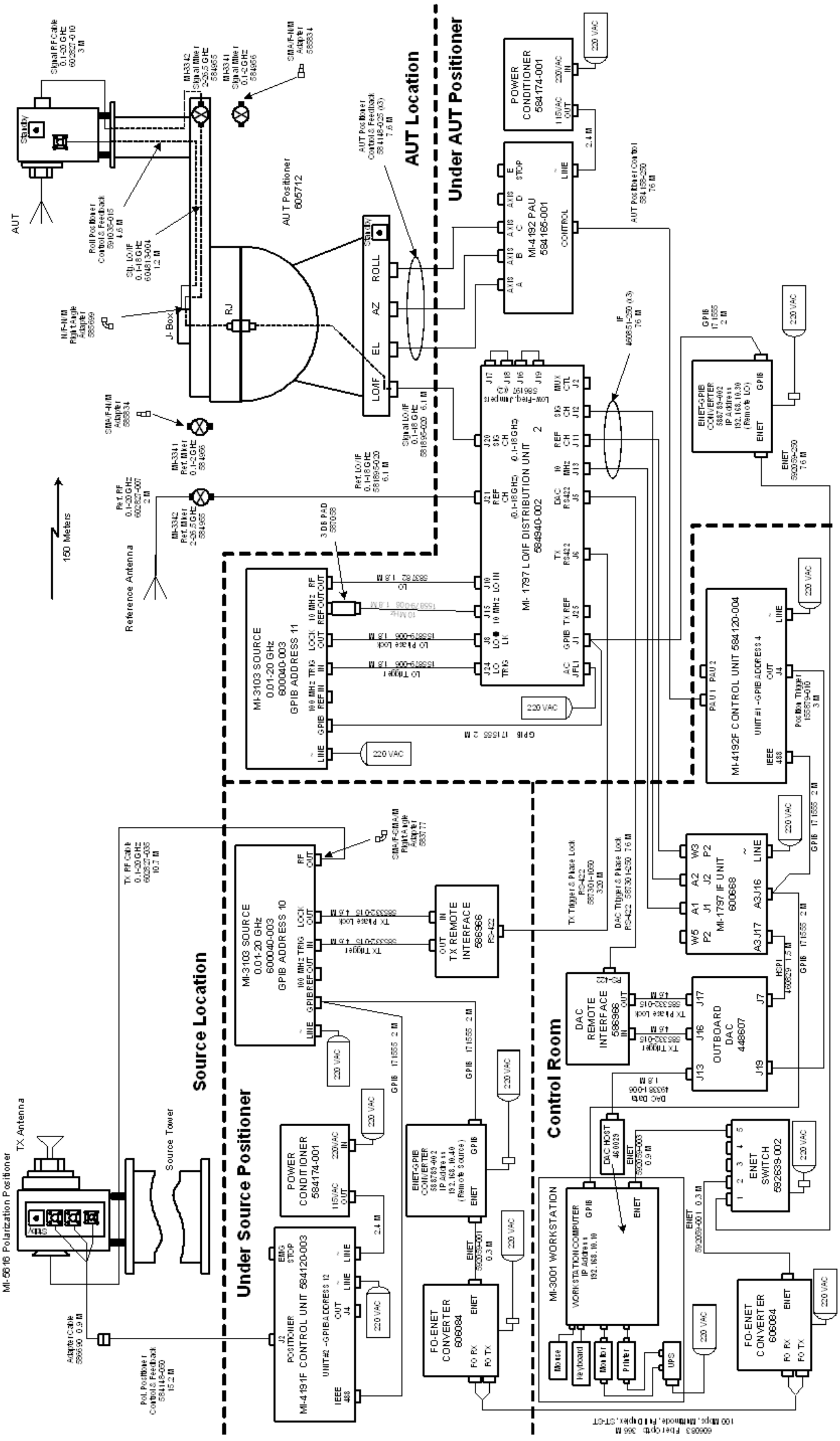


Fig.3: Examples of radiation patterns measured in the Outdoor Test Range.



. Fig.4: The full system cabling diagram.

3. MEASUREMENTS PROCEDURES

3.1 Gain measurement

The standard procedure for this type of measurement is the "substitution method". The Antenna Under Test (AUT) operates in reception. The maximum signal level received (at all ports) from the AUT, pointed with the maximum to the source antenna, is measured, with a frequency sweep in the required frequency band. Then the AUT is replaced by a Standard Gain Horn antenna (SGH) with known gain, with the maximum to the source antenna, and again the maximum signal level received from is recorded. The Gain of the AUT is derived from the simple formula (in dB)

$G_{AUT} = G_{SGH} + (P_{rAUT} - P_{rSGH})$

The gain vs frequency is plotted in Cartesian plot, in dB scale.

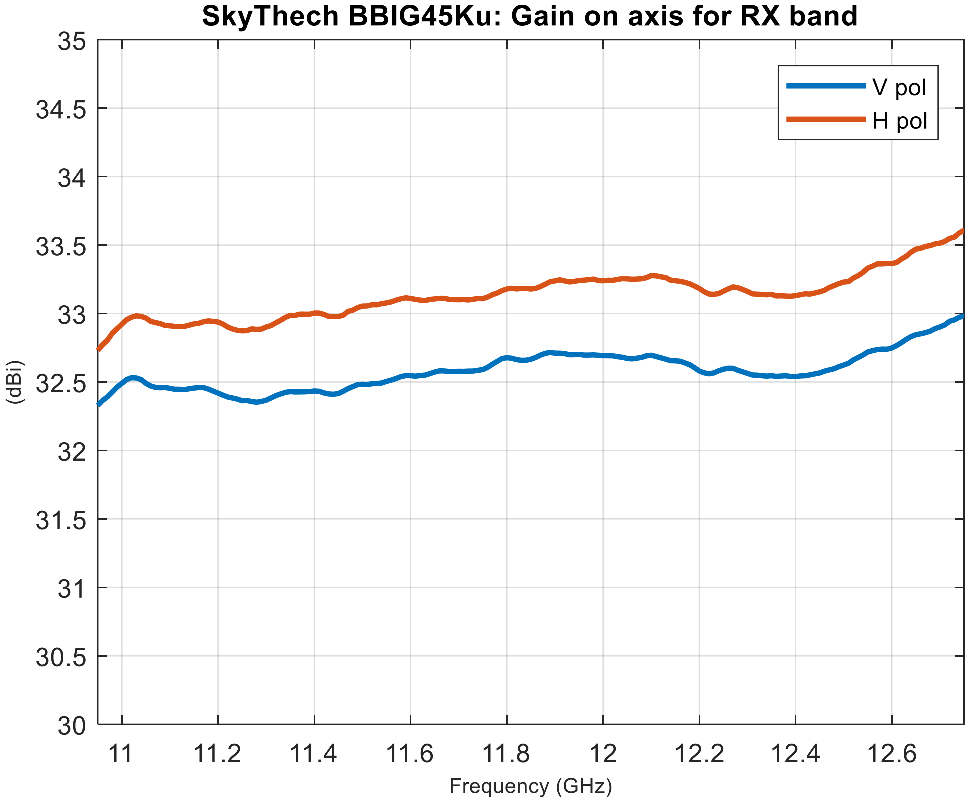
3.2. Radiation pattern measurements

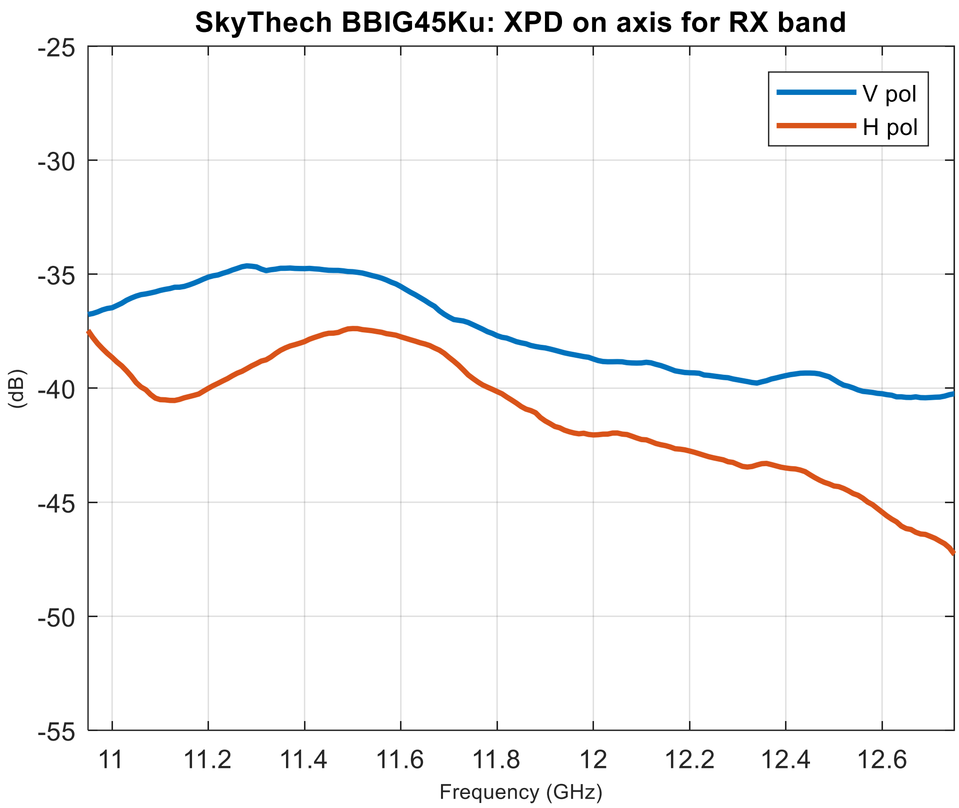
Since the patterns are required in various phi-cuts (azimuth, elevation) as well as in a raster scan around the main beam, the standard procedure is to measure, at discrete frequencies, the received power from the AUT from each port, when transmitting from the source three different linear polarizations (V and H). The radiation patterns are plotted in dB scale, in the desired angular range.

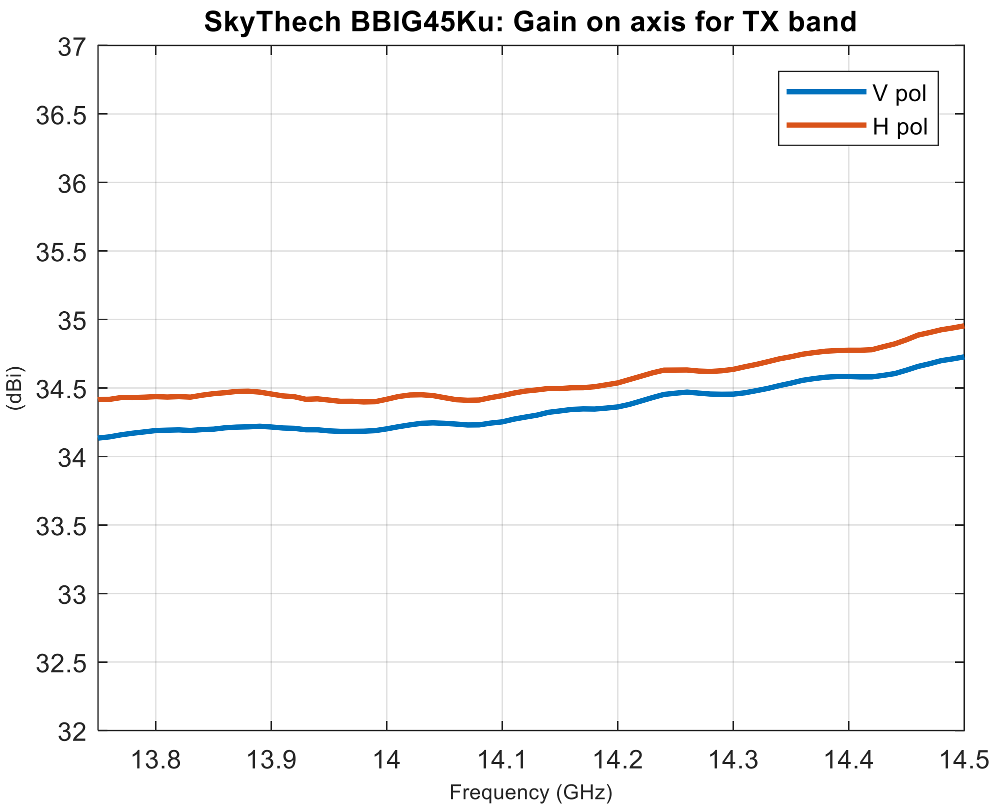
4. Pictures of the measurement campaign.

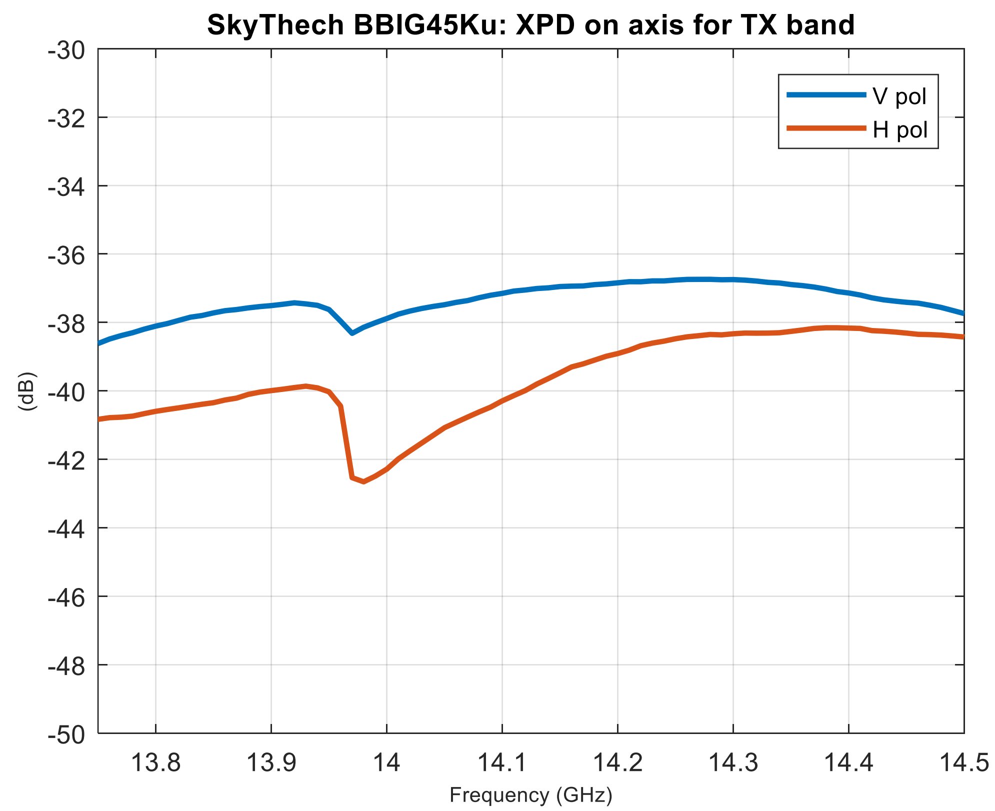
Fig.5: Antenna BBIG45Ku mounted on AUT positioner.

5. Gain and XPD measurements , TX / RX Bands.





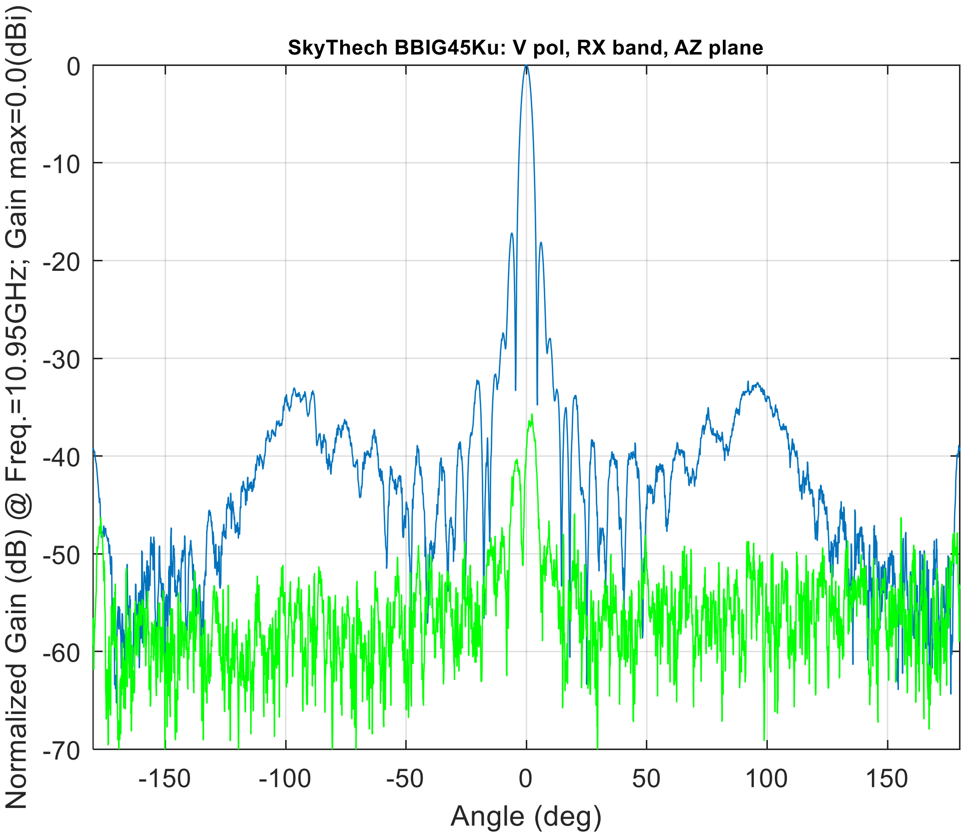

SkyThech BBIG45Ku: Gain on axis for TX band
V pol
H pol
(dBi)
37
36.5
36
35.5
35
34.5
34
33.5
33
32.5
32
13.8
13.9
14
14.1
14.2
14.3
14.4
14.5
Frequency (GHz)

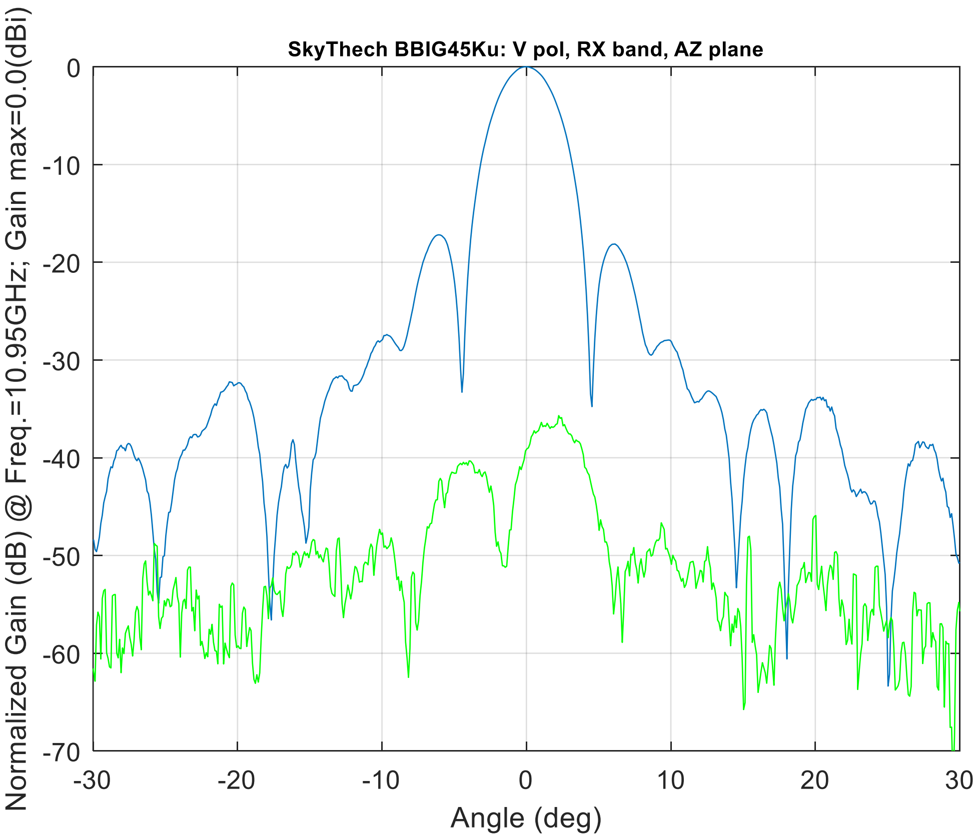

SkyThech BBIG45Ku: XPD on axis for TX band
V pol
H pol
(dB)
-30
-32
-34
-36
-38
-40
-42
-44
-46
-48
-50
13.8
13.9
14
14.1
14.2
14.3
14.4
14.5
Frequency (GHz)

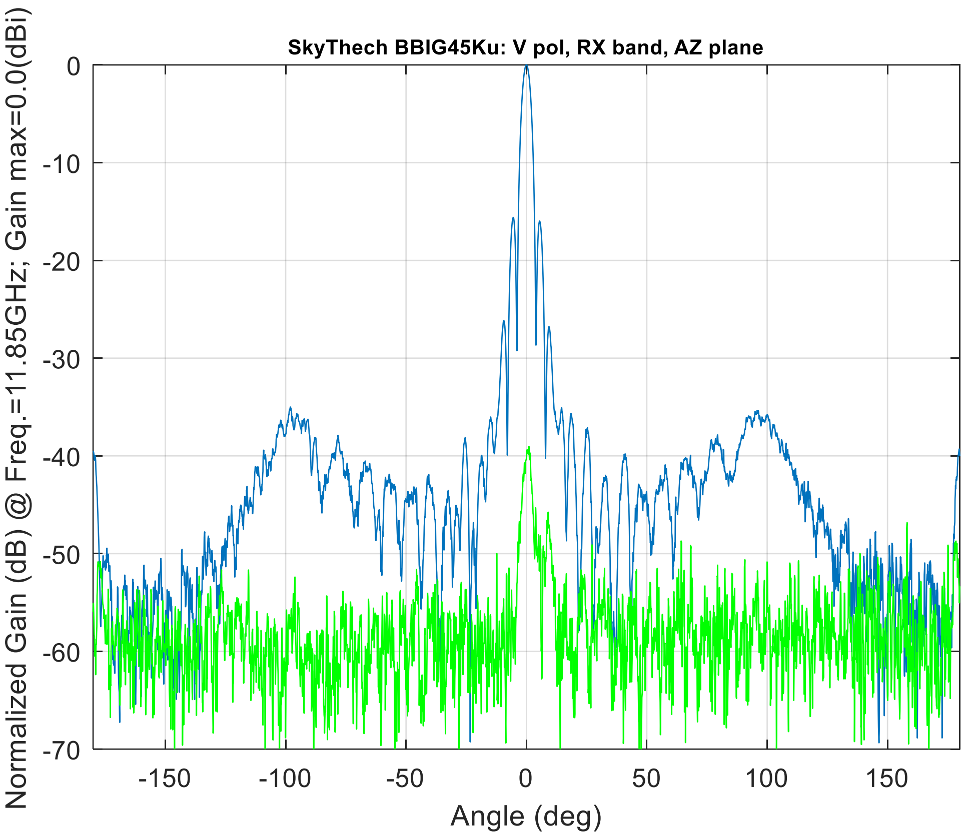
6. Radiation Pattern Measurements.

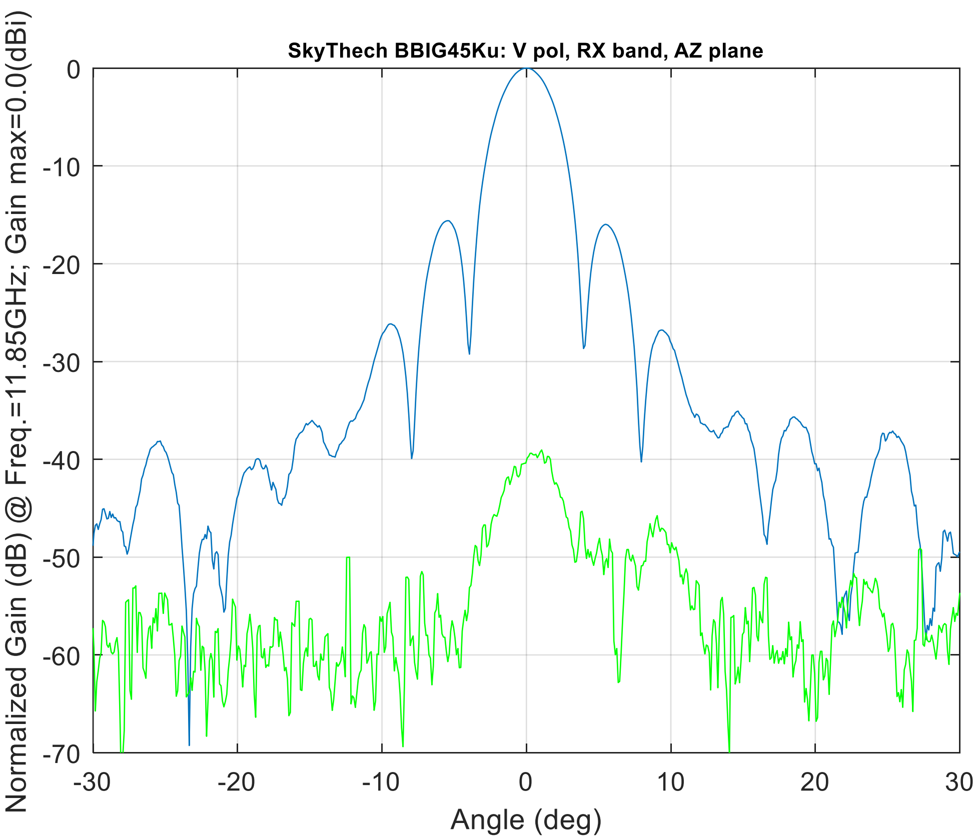
***6.1: Radiation patterns in RX band (10.95-12.75 GHz)*.**

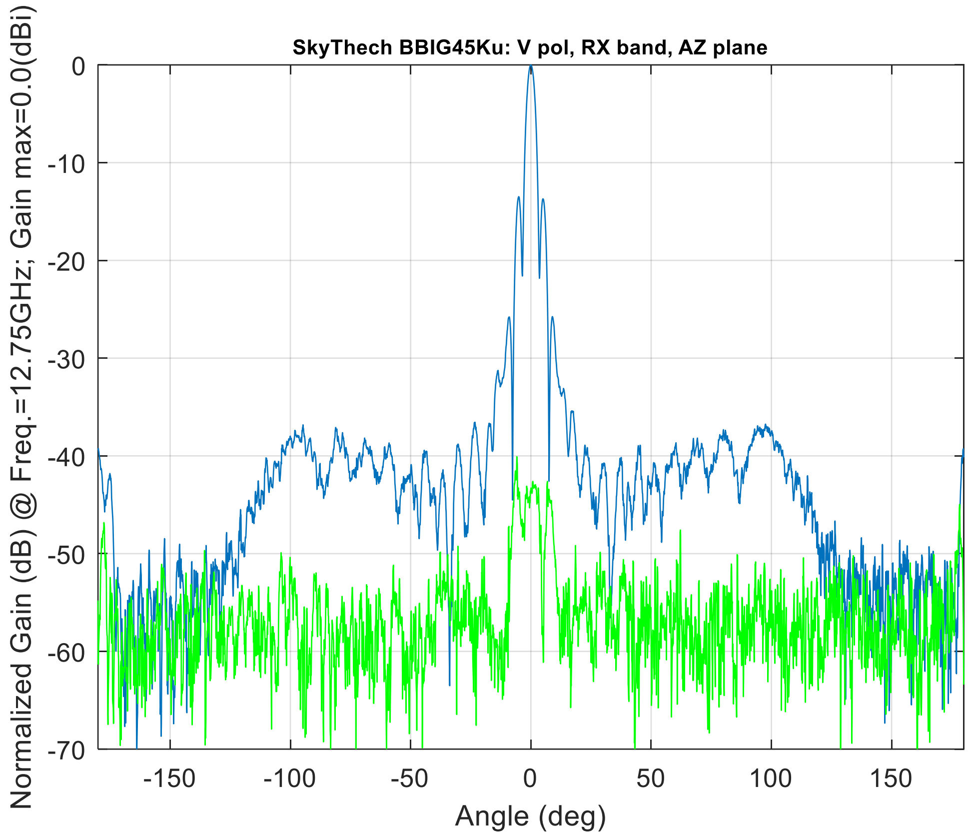
6.1.1: V-pol, AZ and EL plane plots.






SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150


SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
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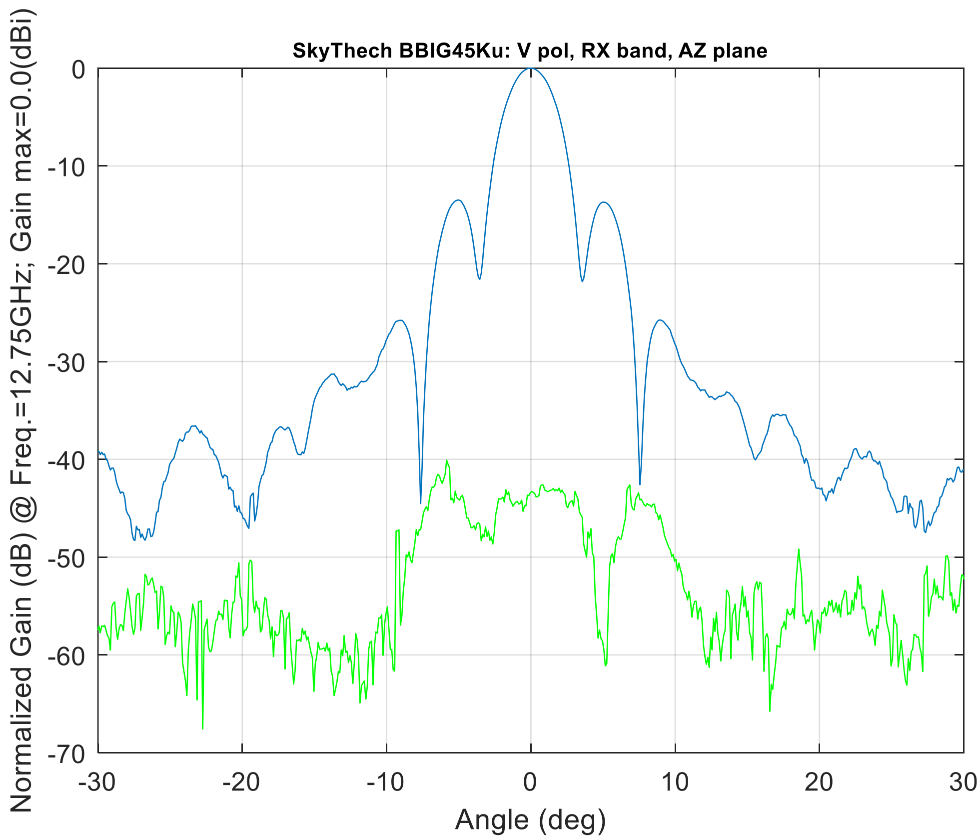
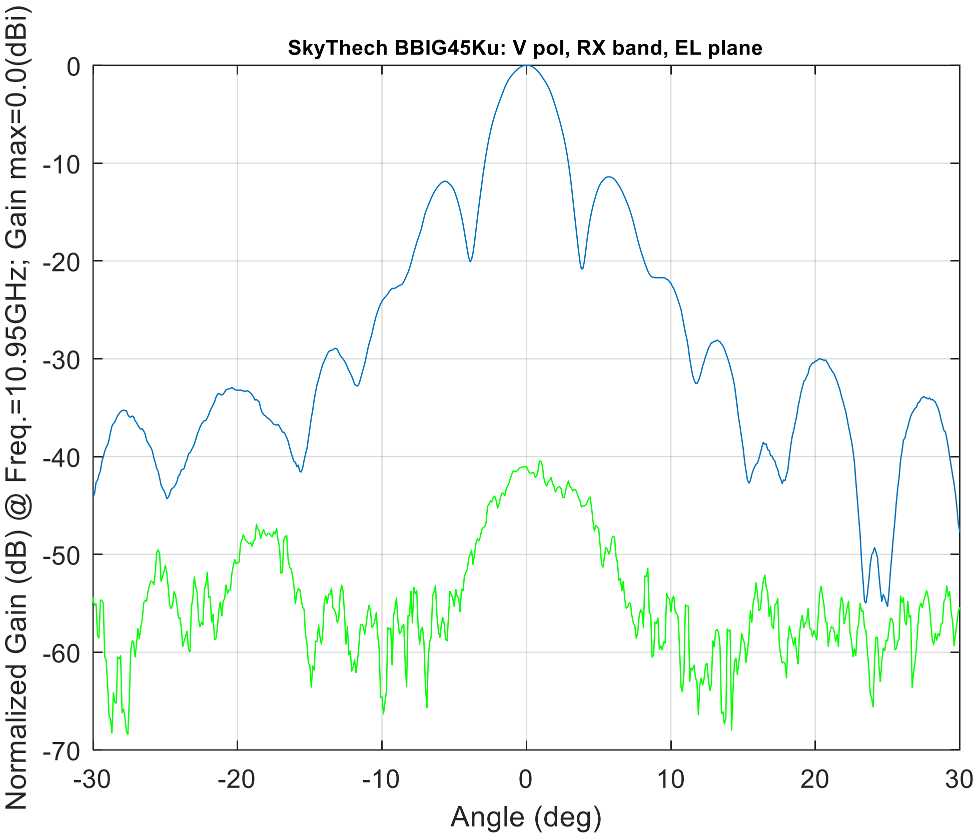
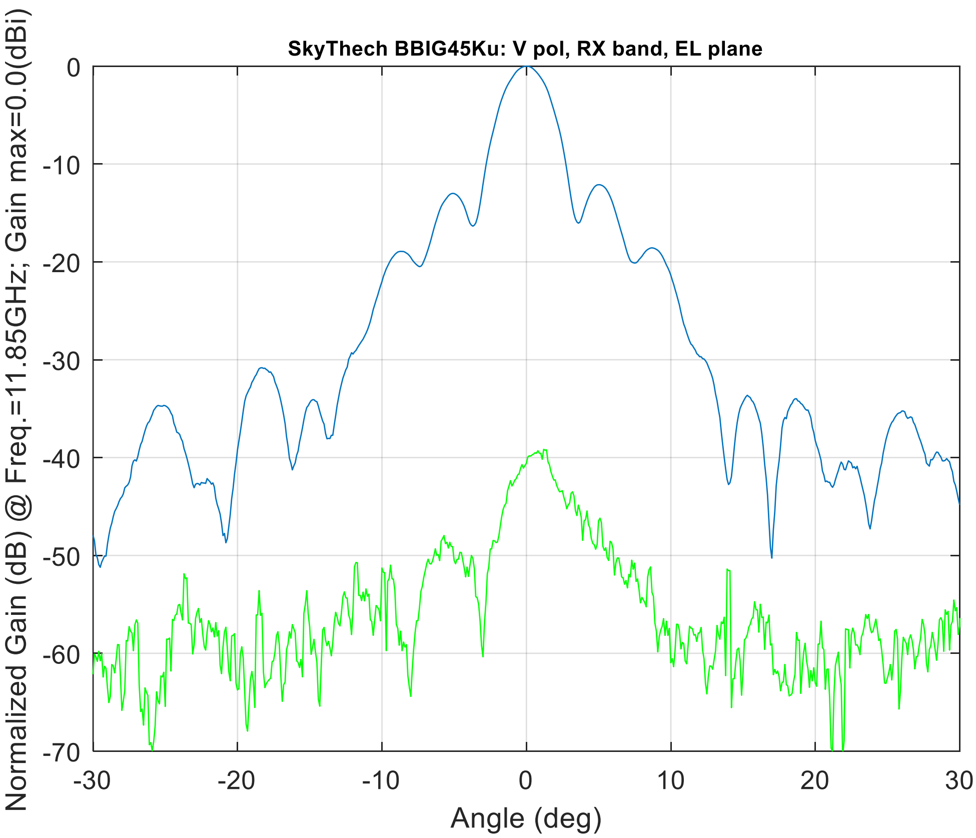
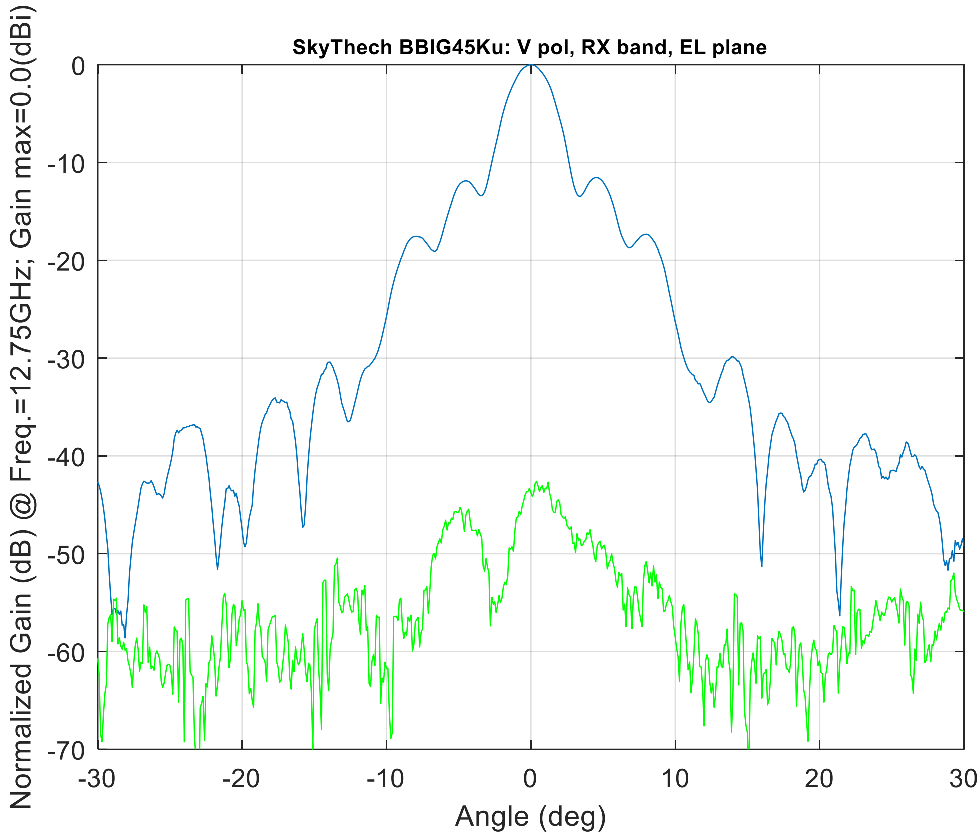
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

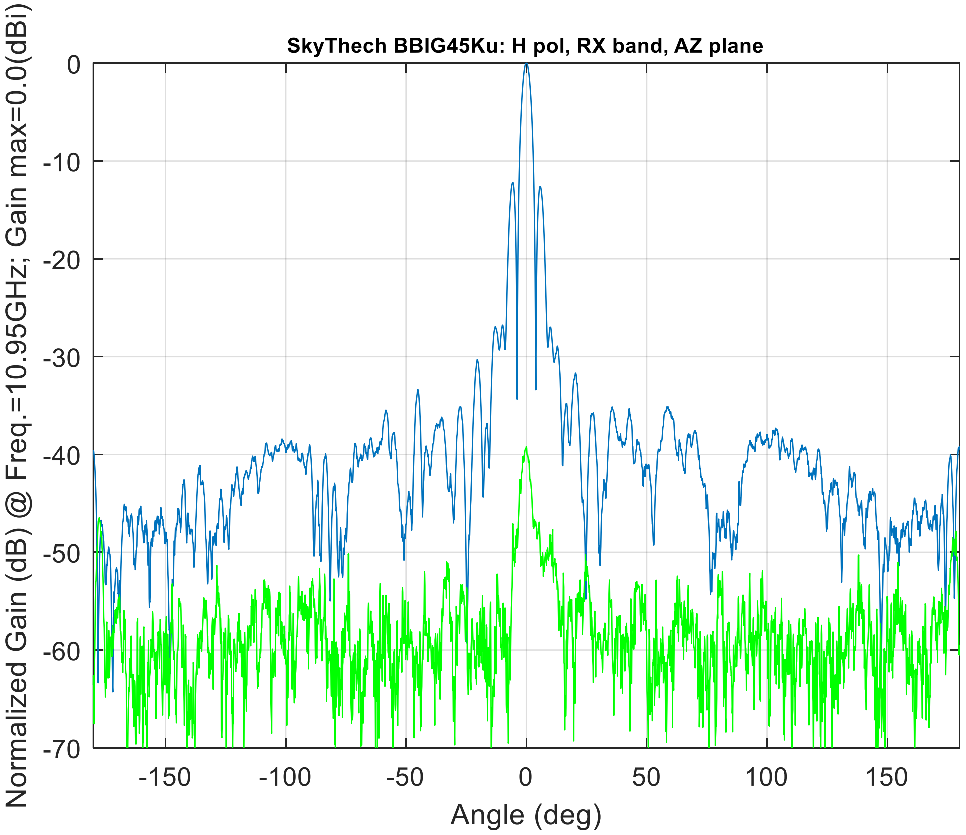

SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

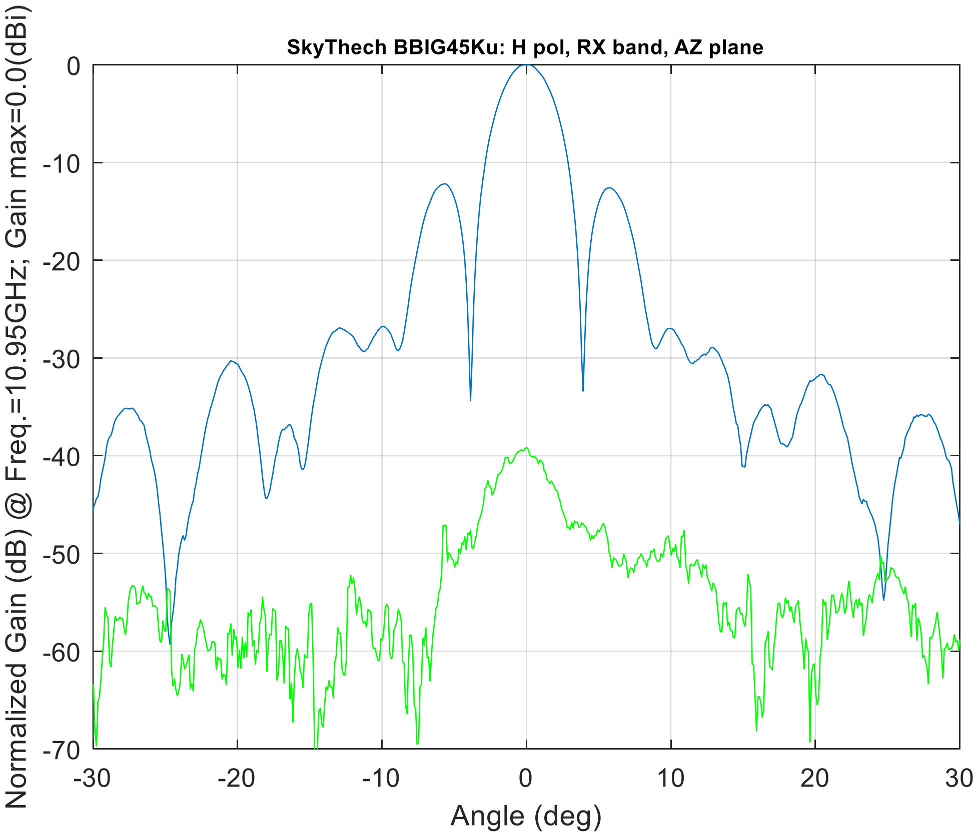

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=10.95GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

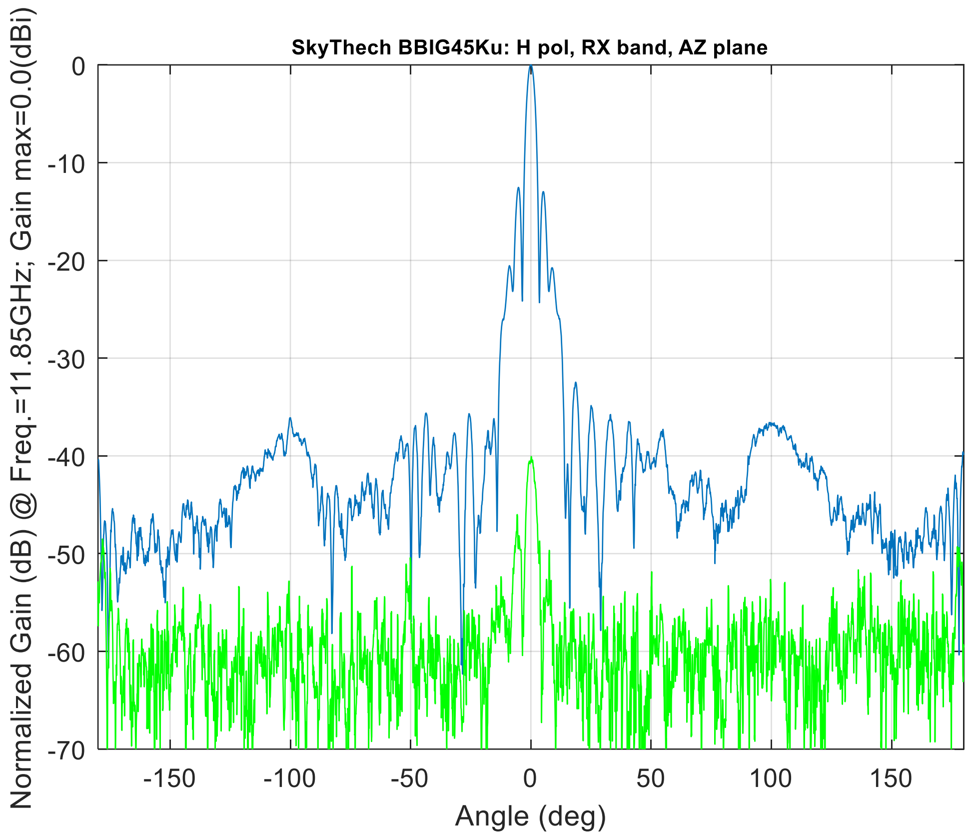

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

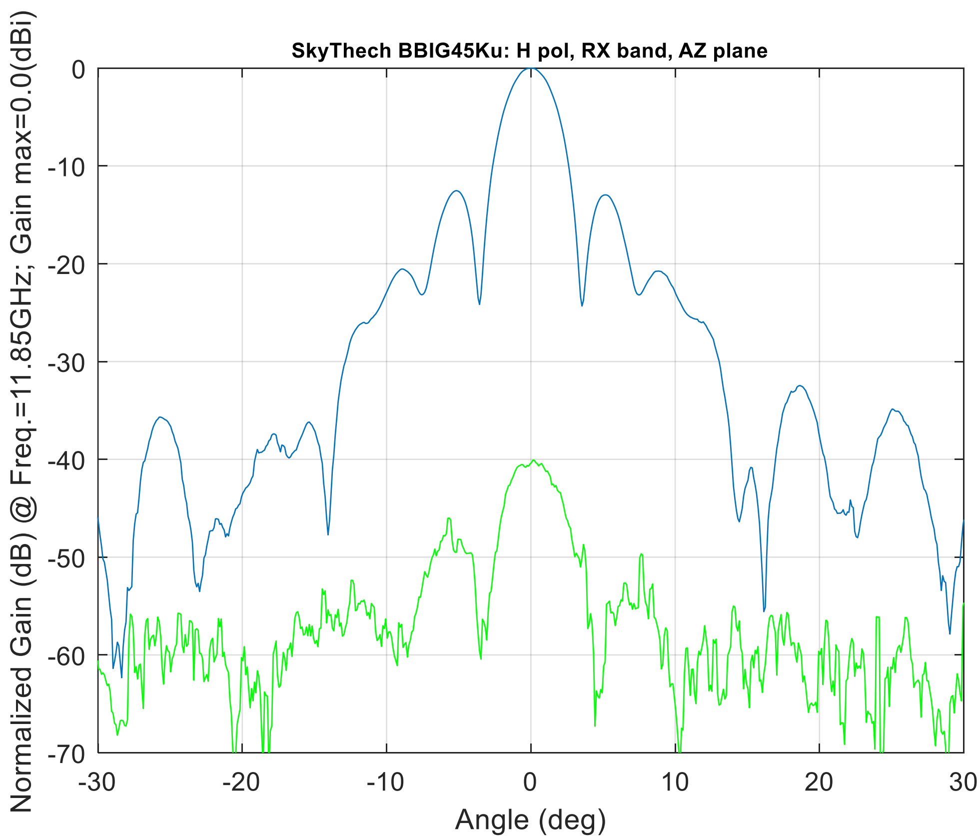

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

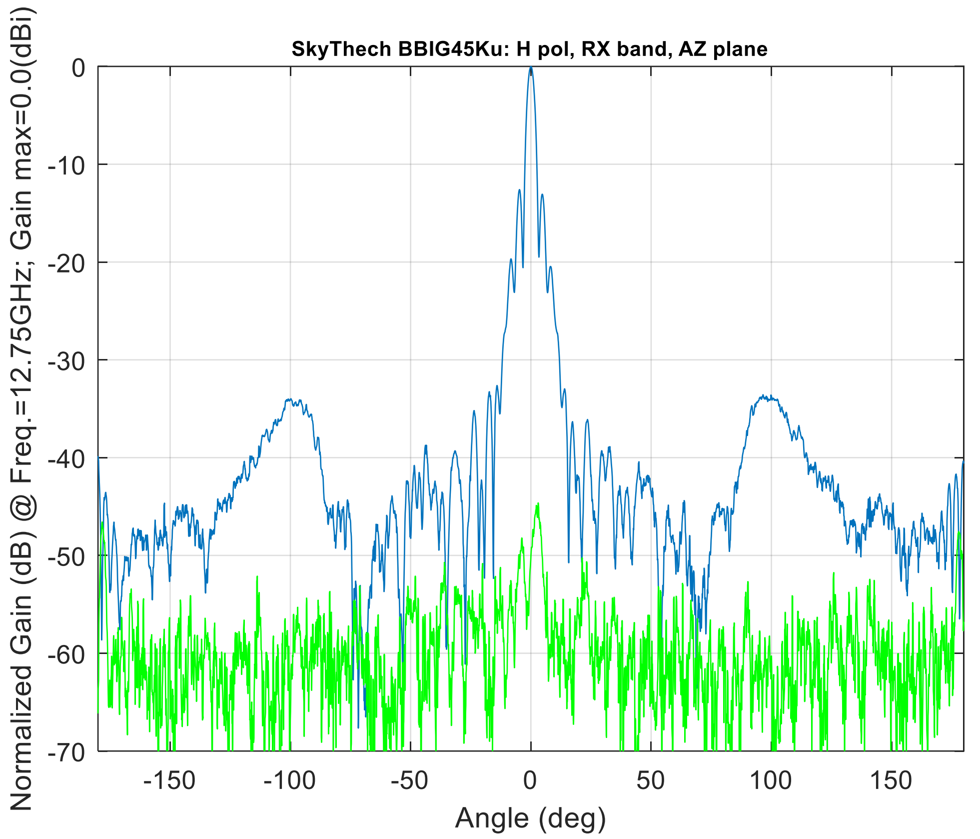
6.1.2: H-pol, AZ and EL plane plots.






SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150


SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
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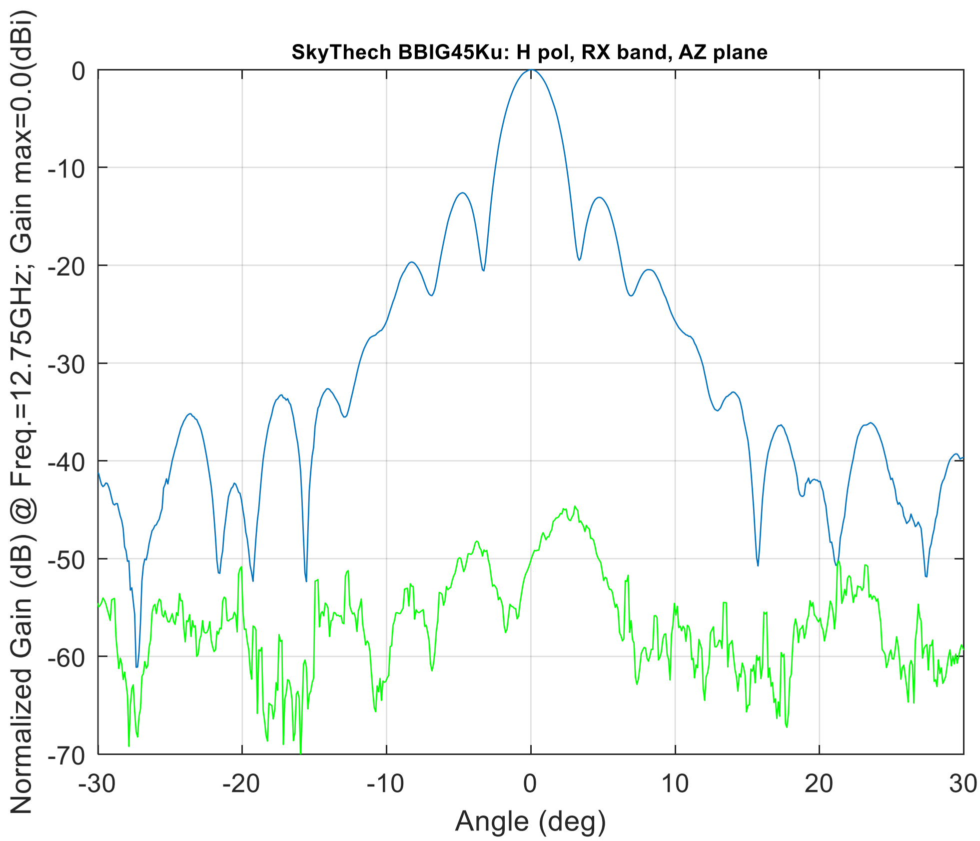
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150


SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
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-20
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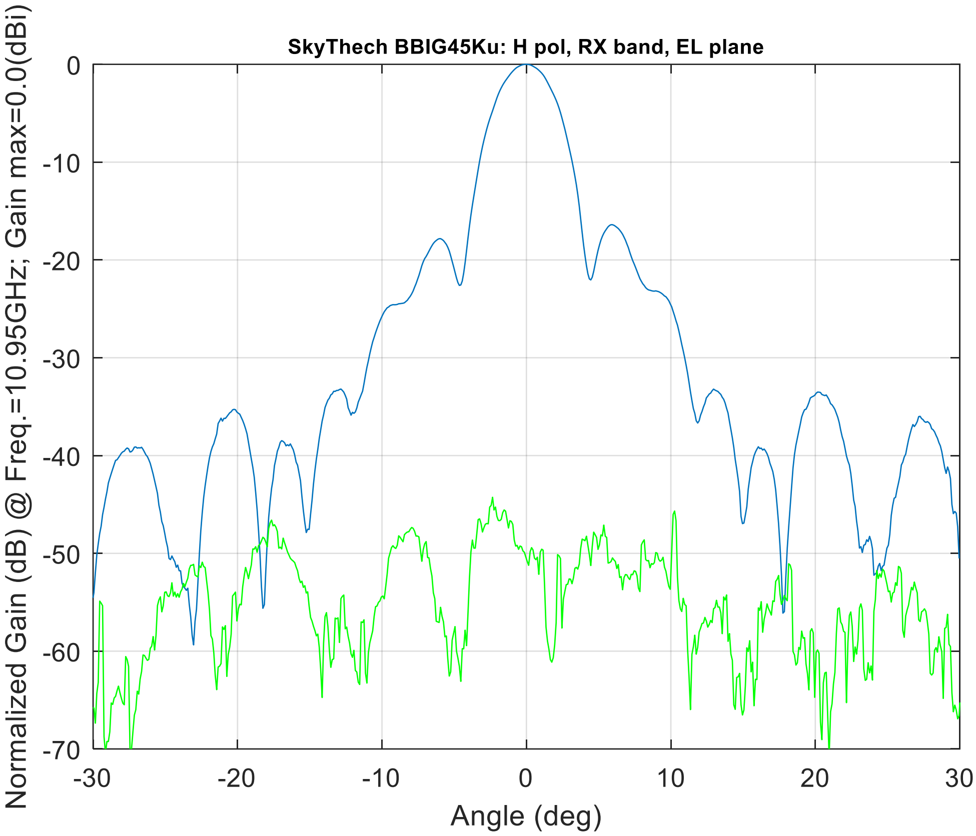
-40
-50
-60
-70
-30
-20
-10
0
10
20
30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Normalized Gain (dB) @ Freq.=10.95GHz; Gain max=0.0(dBi)
Angle (deg)
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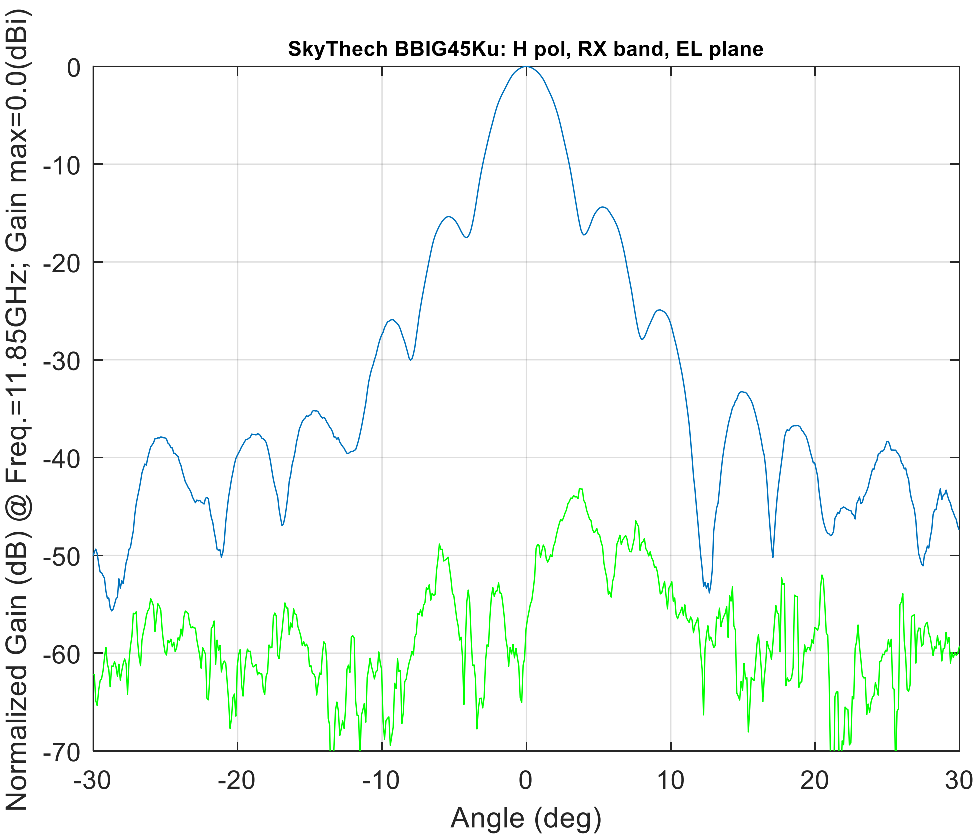
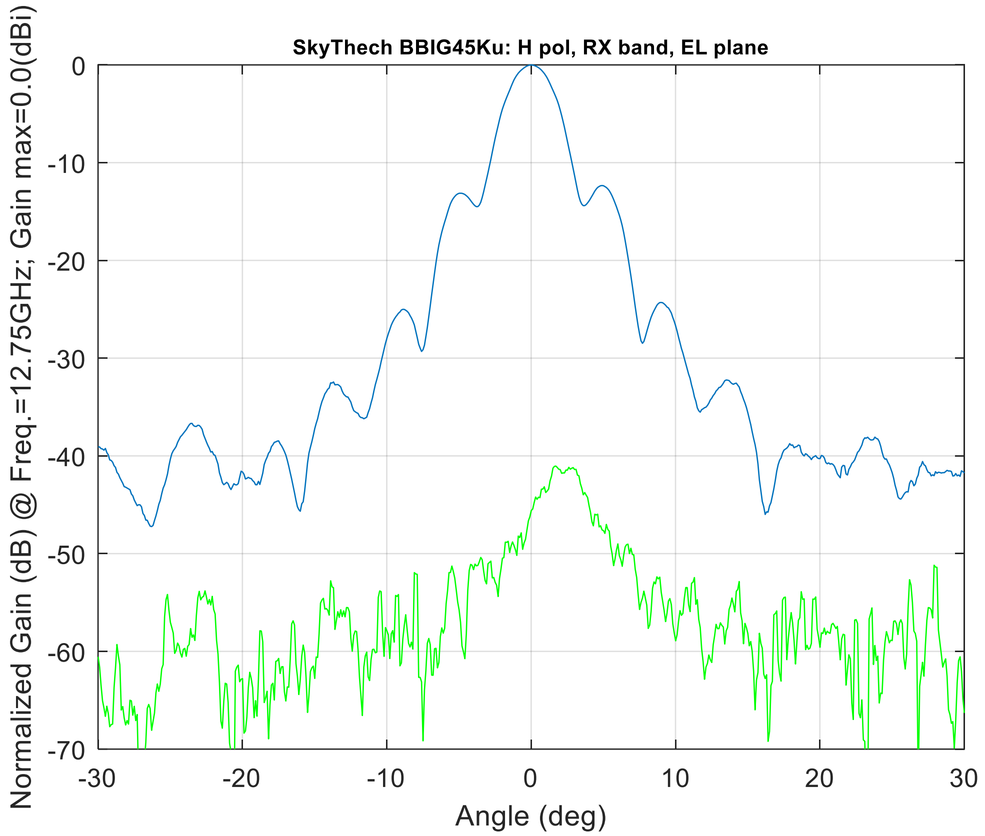
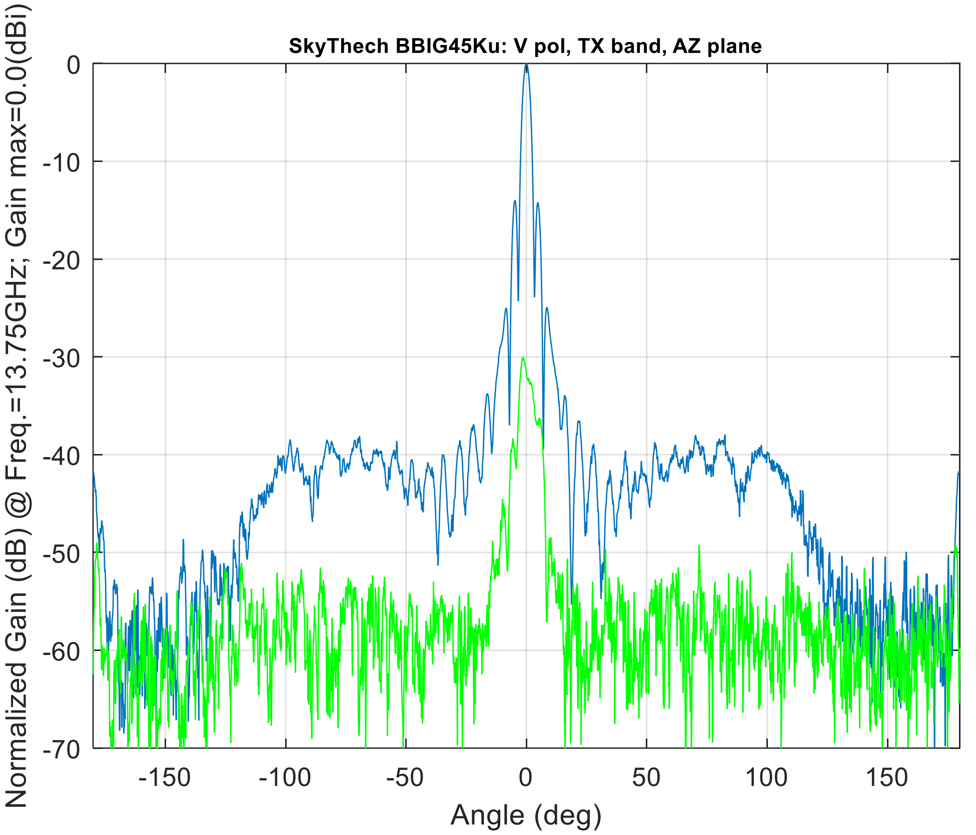
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

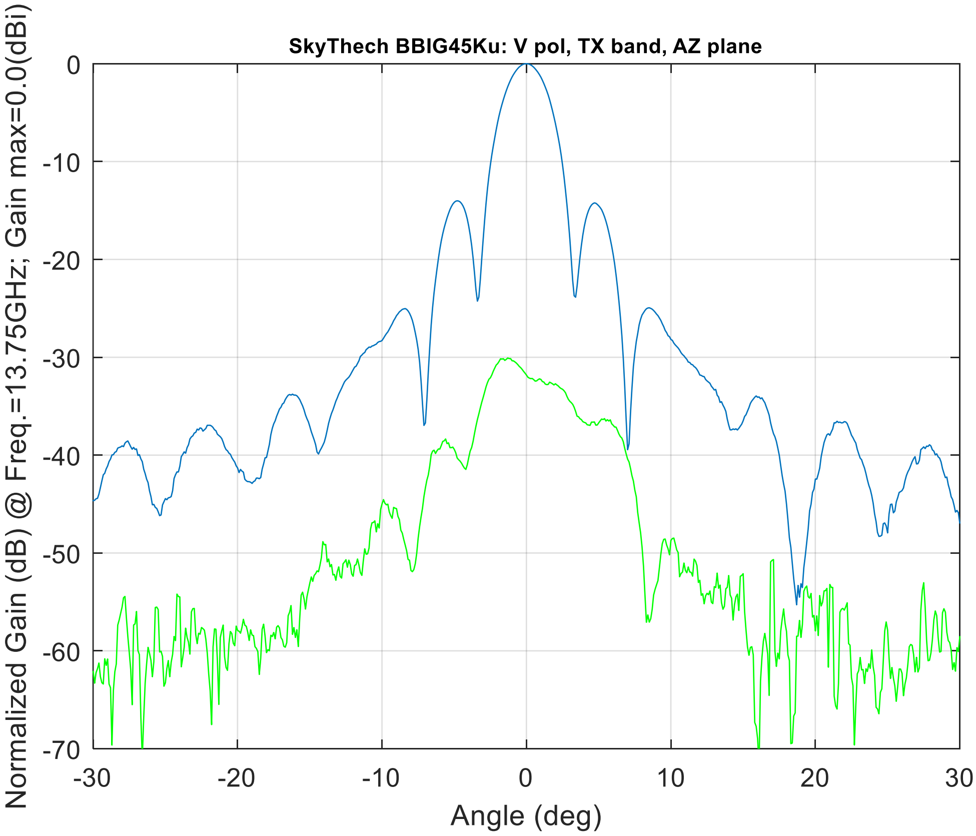

SkyThech BBIG45Ku: H pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

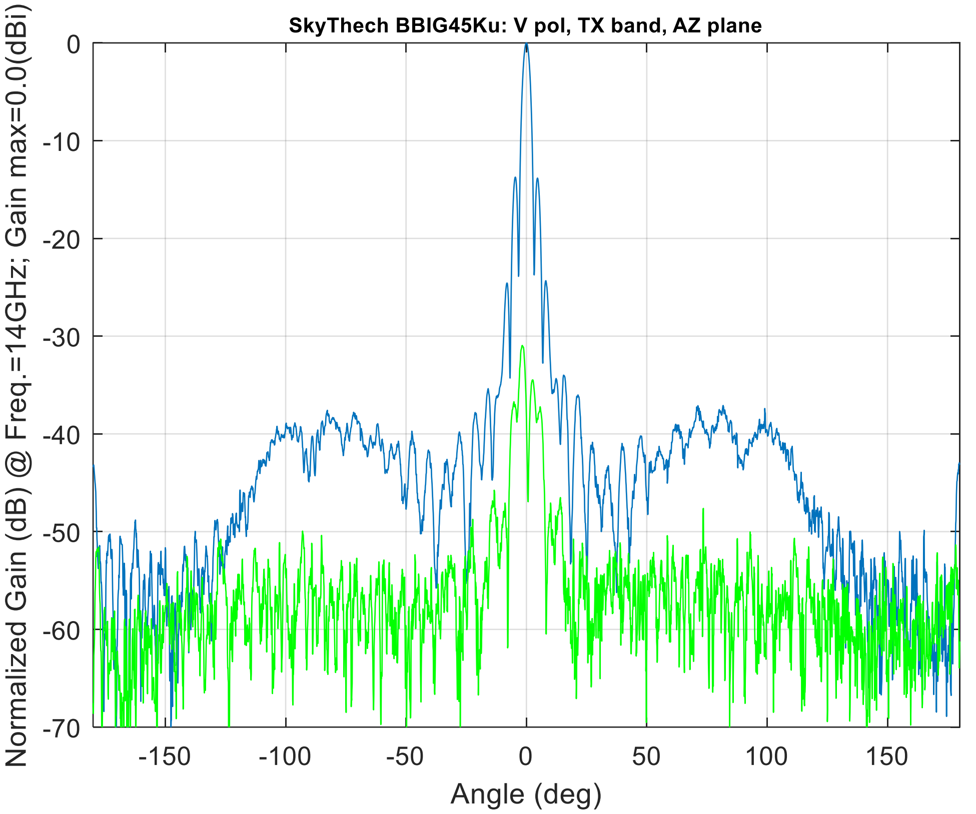

SkyThech BBIG45Ku: H pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

6.2: Radiation patterns in TX band (13.75-14.5 GHz) .

6.2.1: V-pol, AZ and EL plane plots.






SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
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-20
-30
-40
-50
-60
-70
-150
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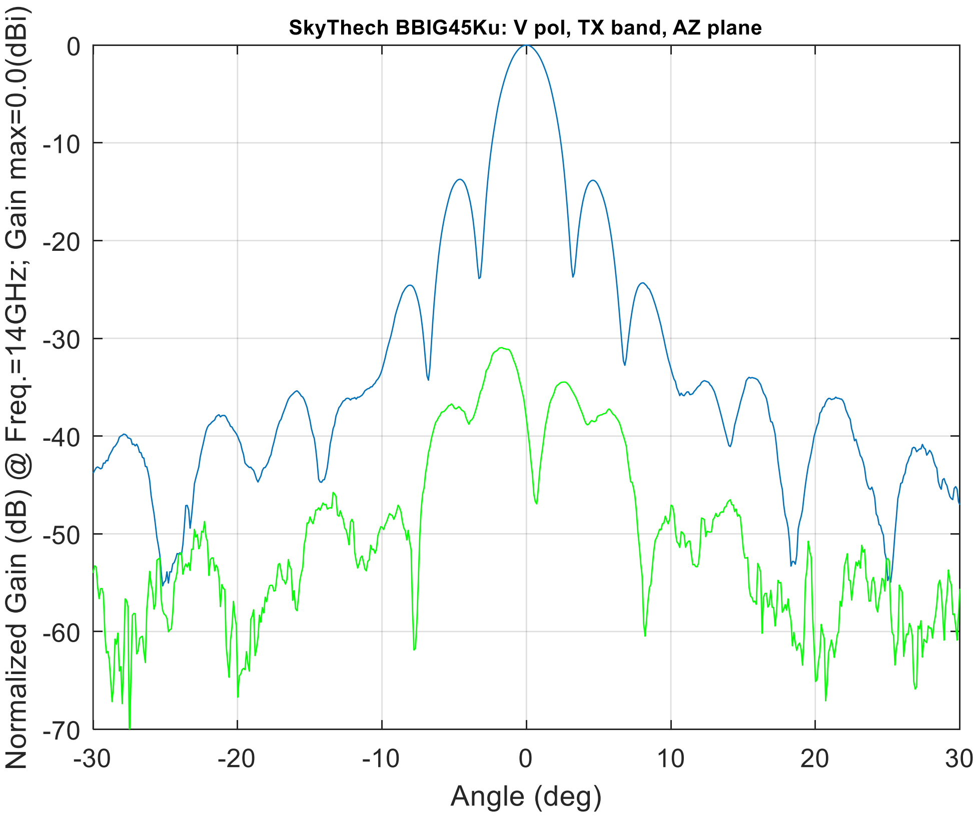
50
100
150


SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
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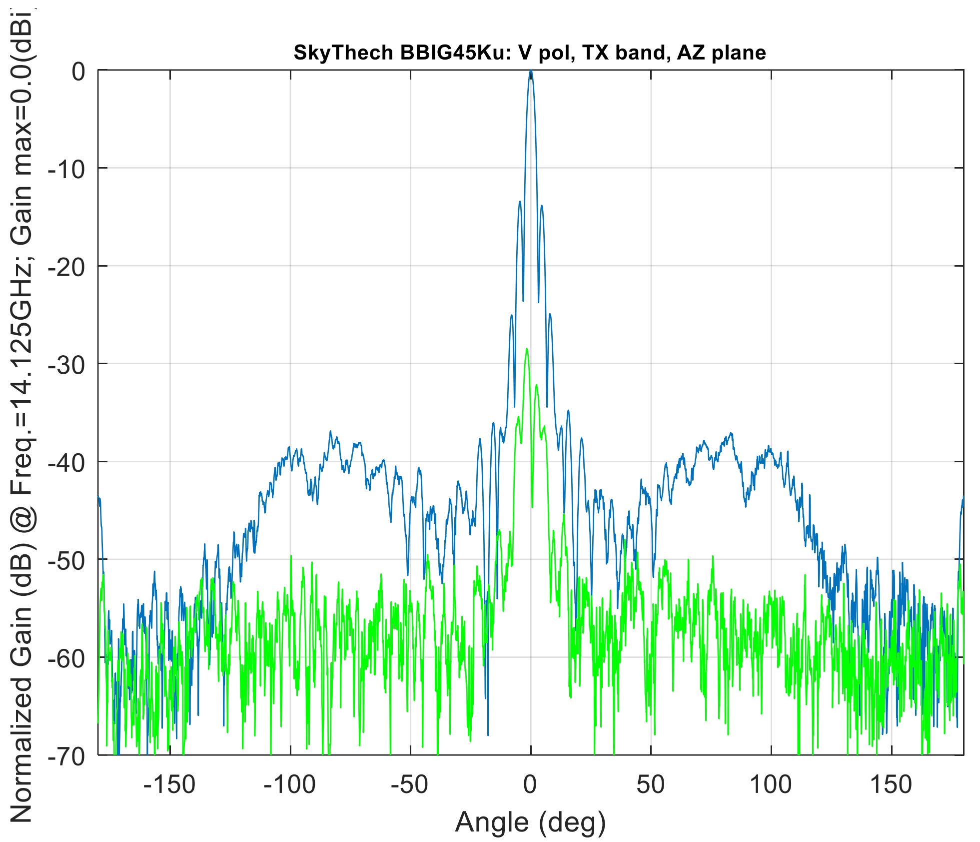
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
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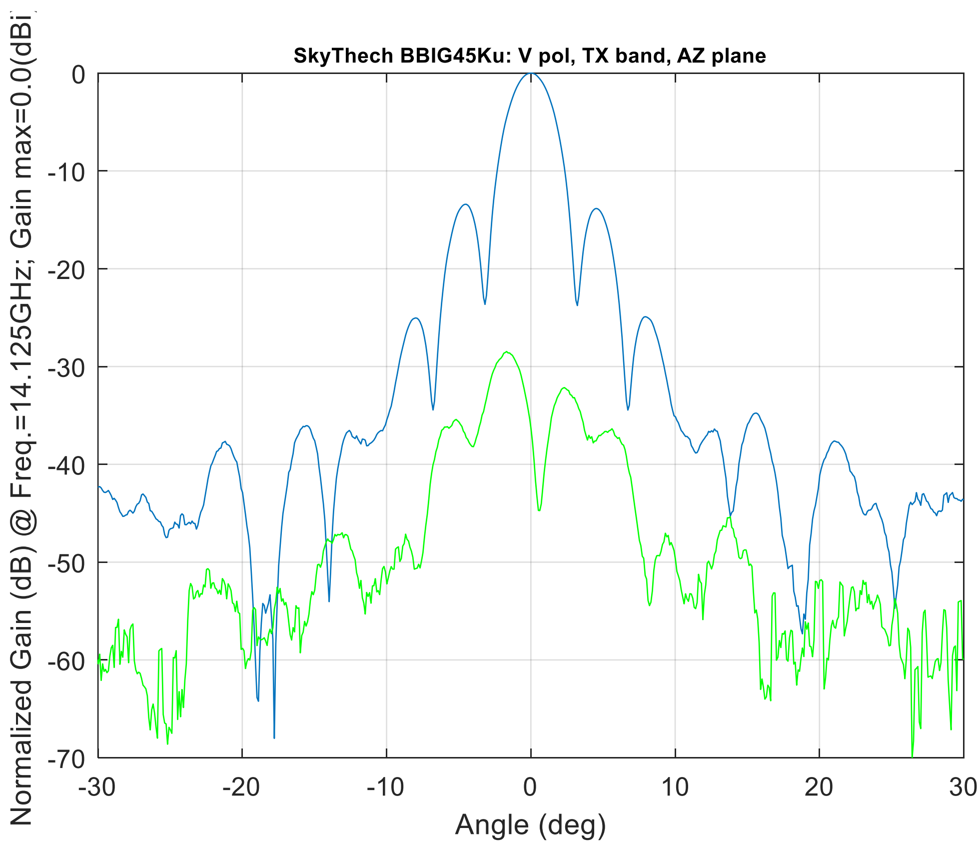
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150


SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
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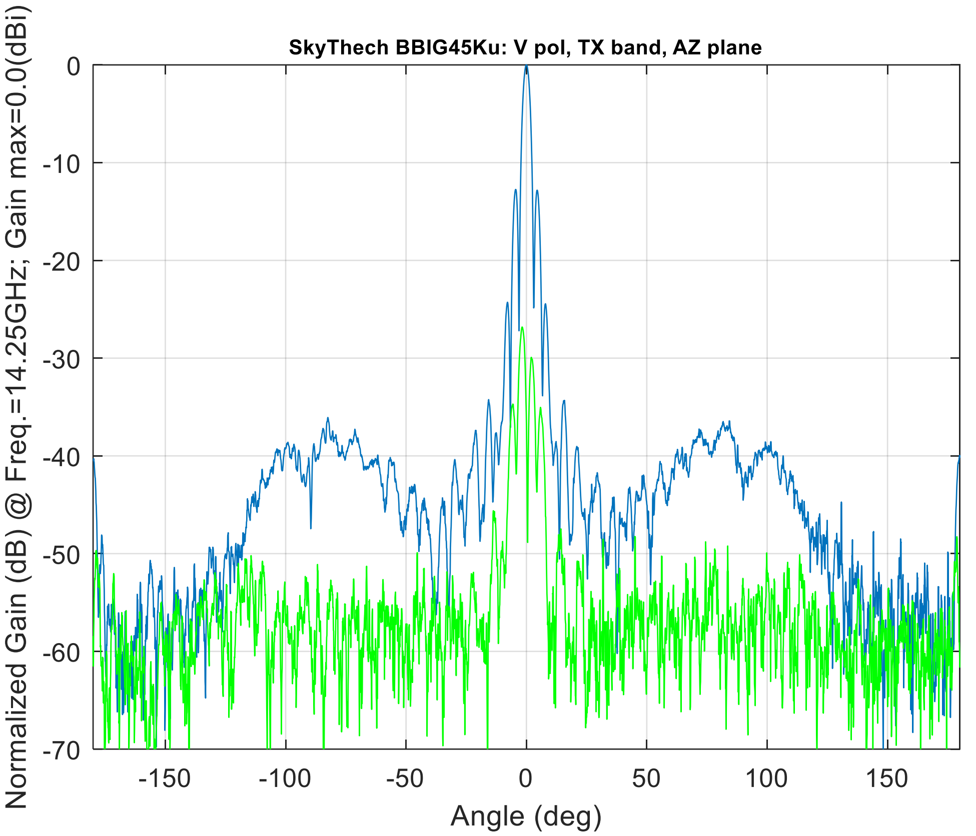
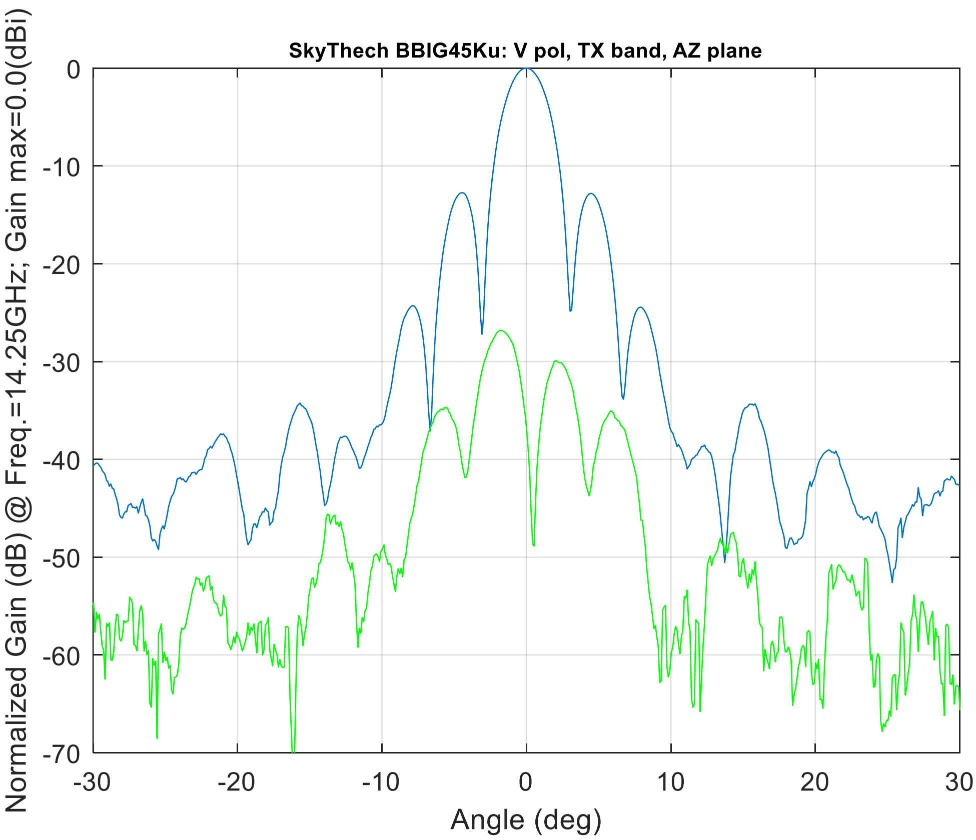
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150


SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
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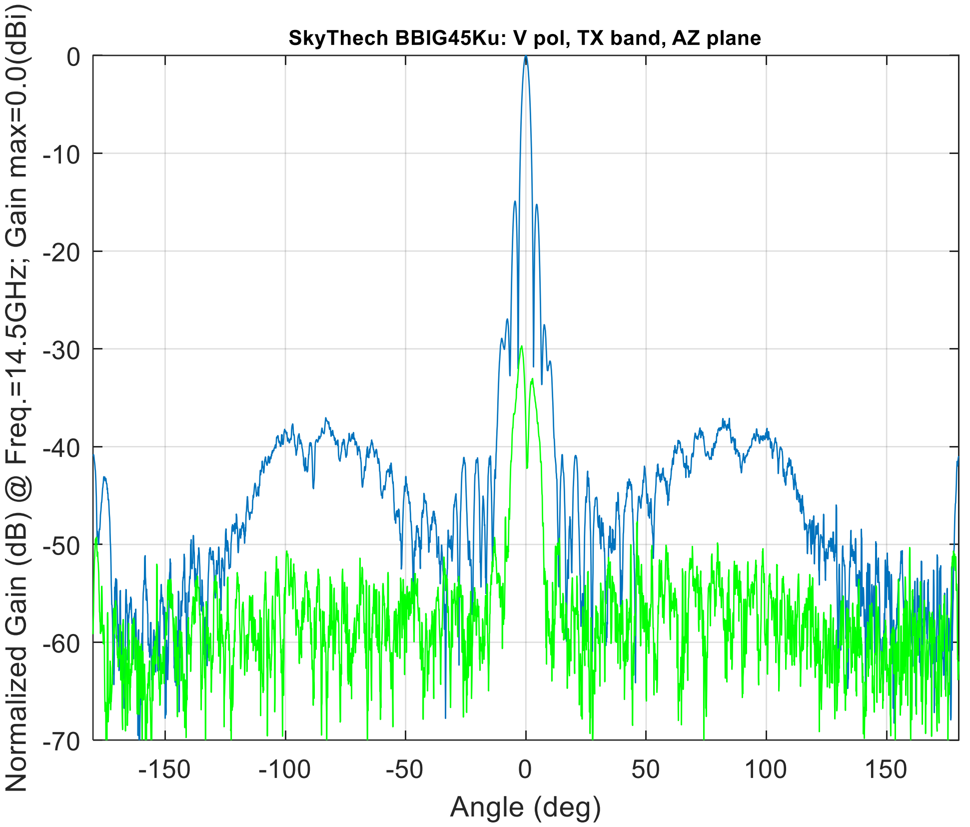
SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
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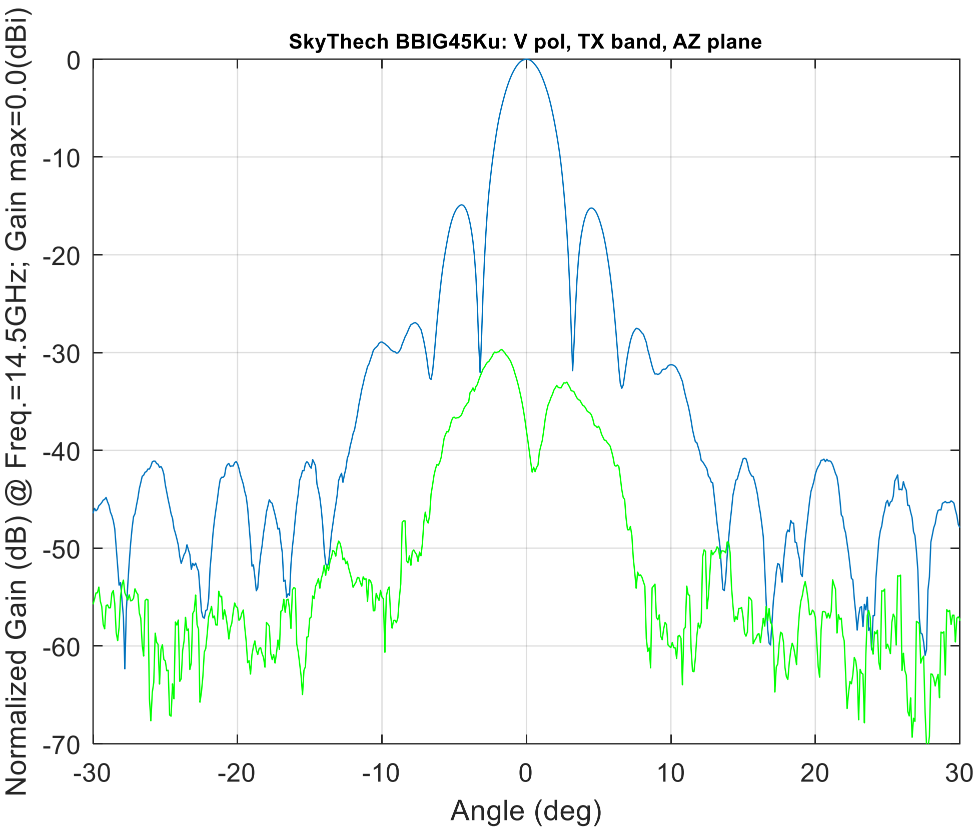
Angle (deg)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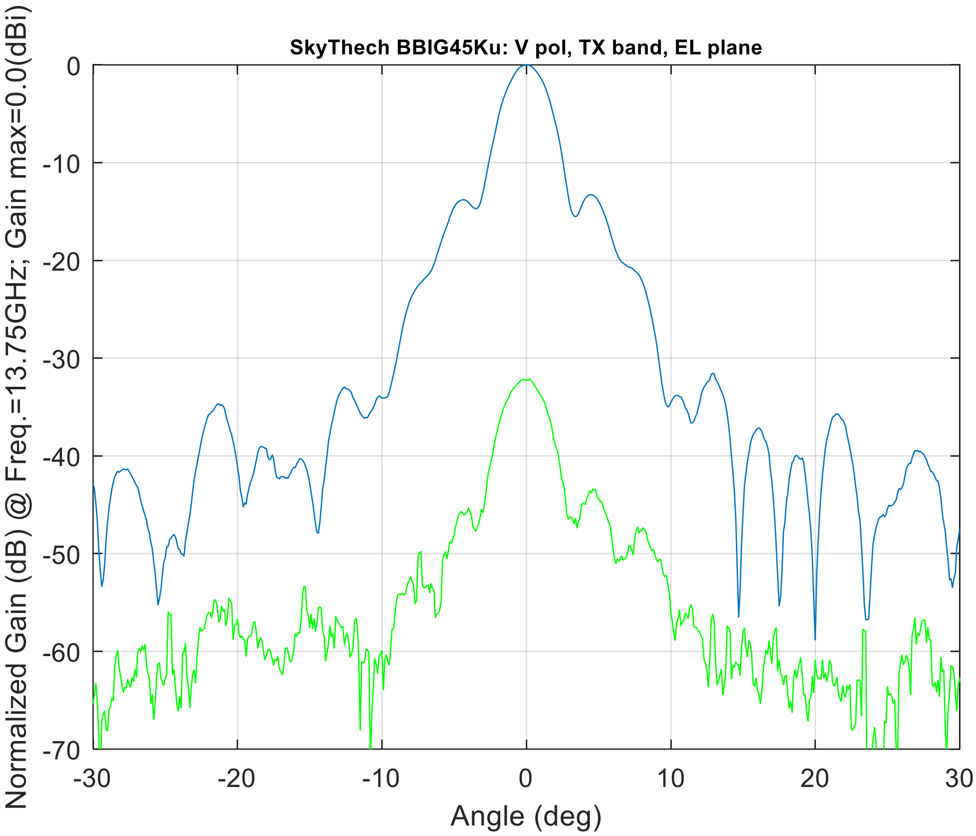
Angle (deg)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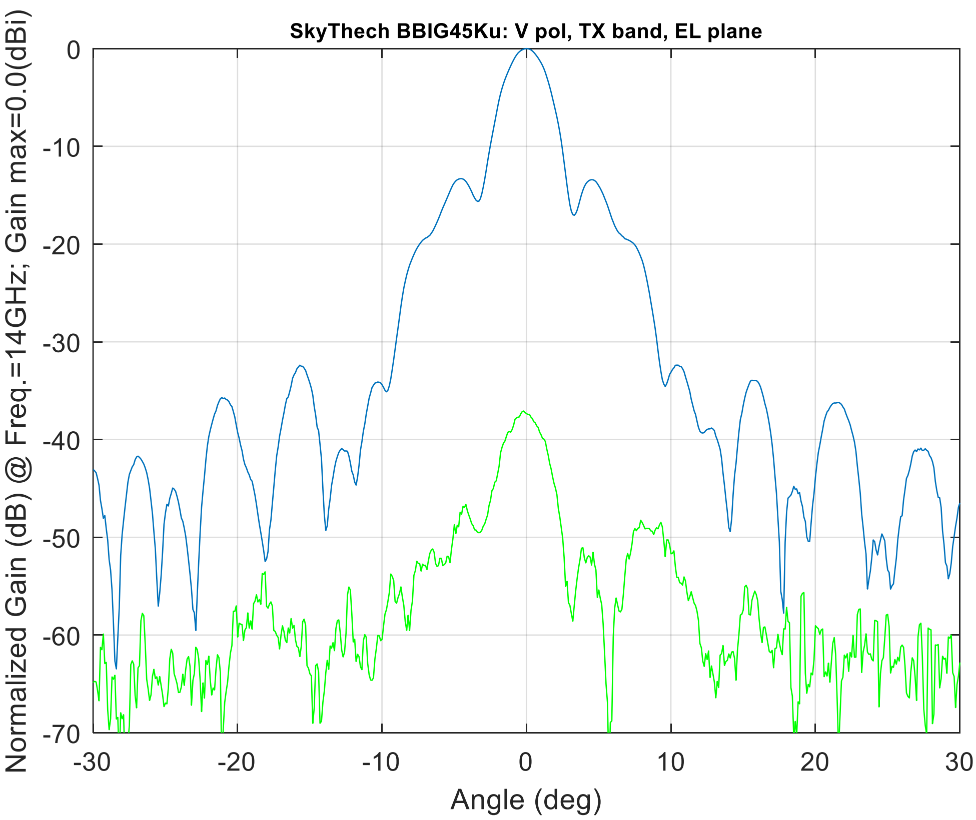
Angle (deg)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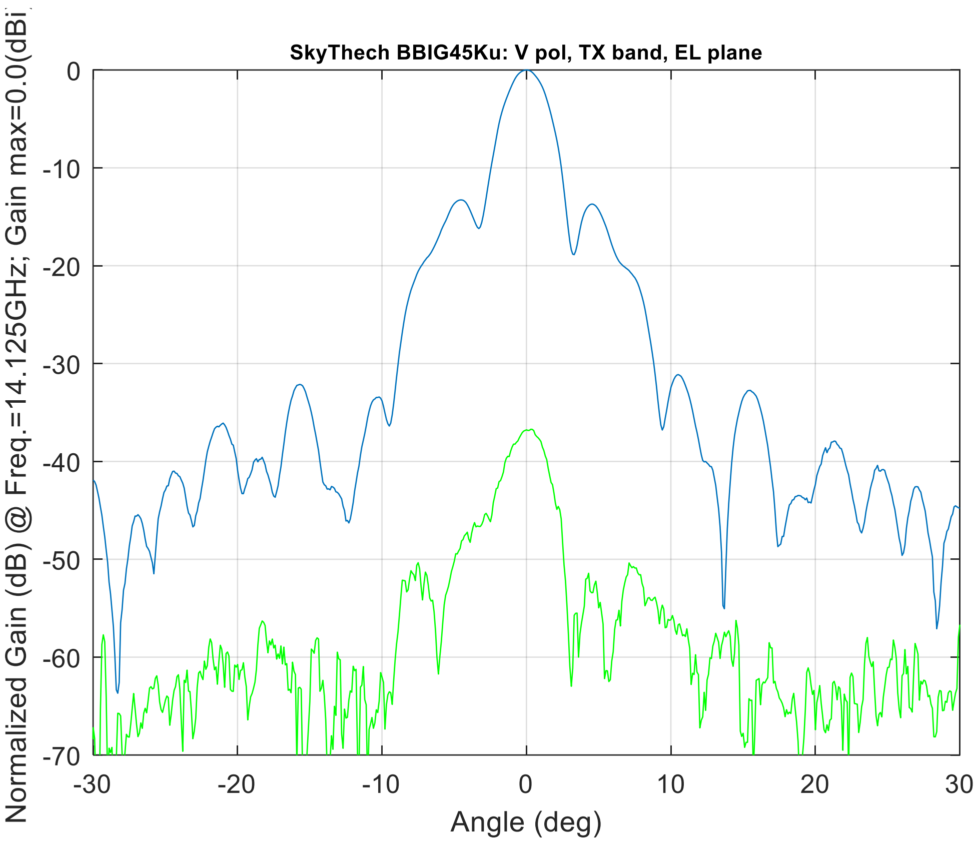
Angle (deg)



SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
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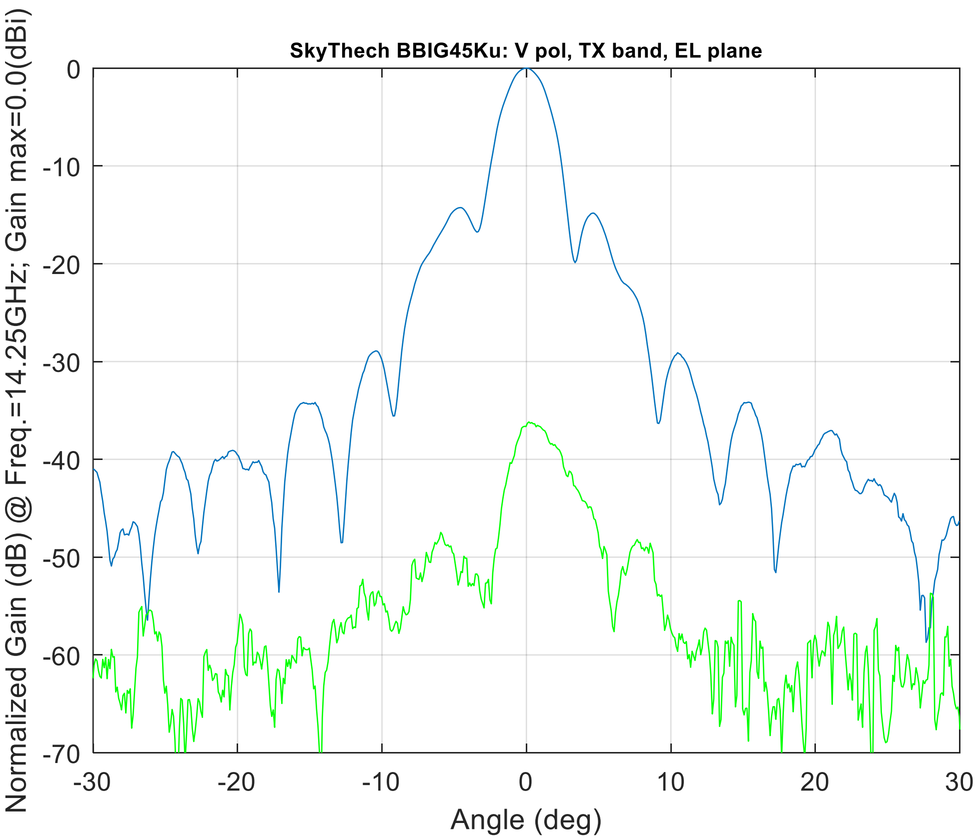
Angle (deg)



SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
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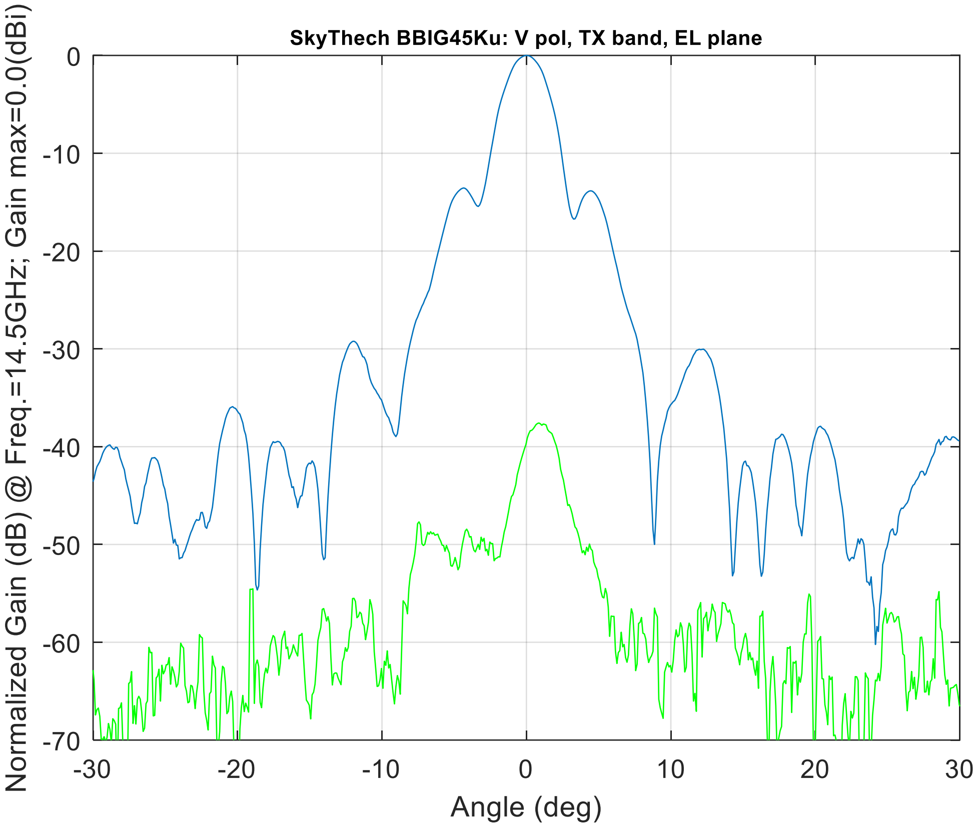
Angle (deg)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Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
Angle (deg)
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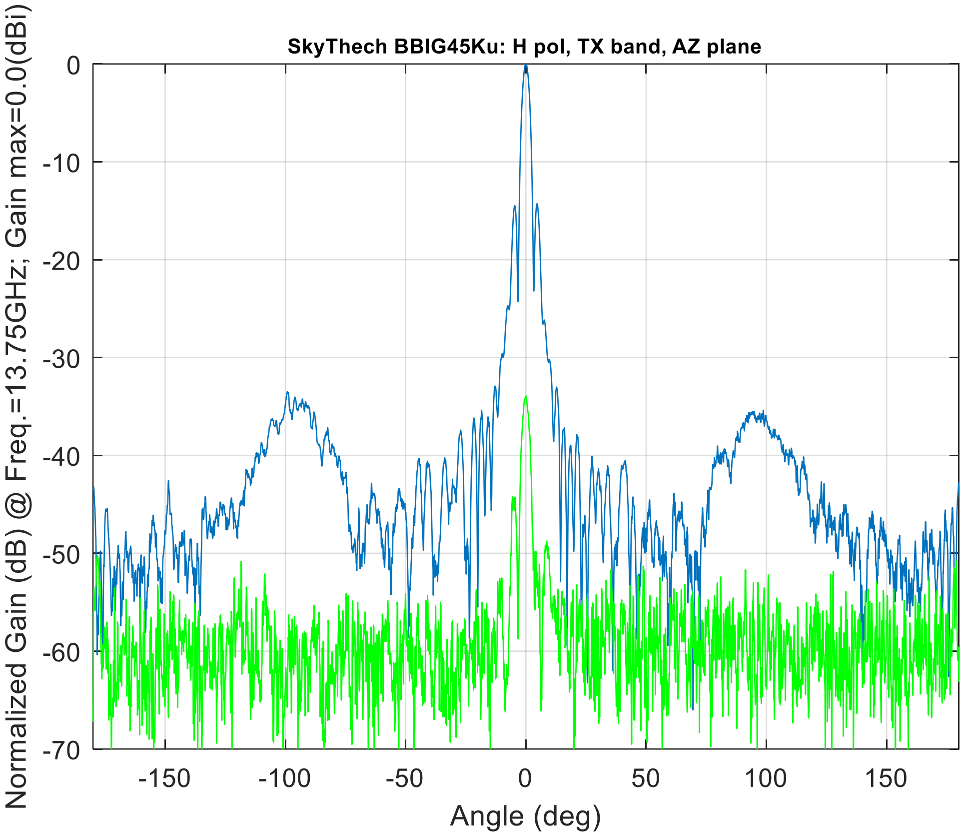
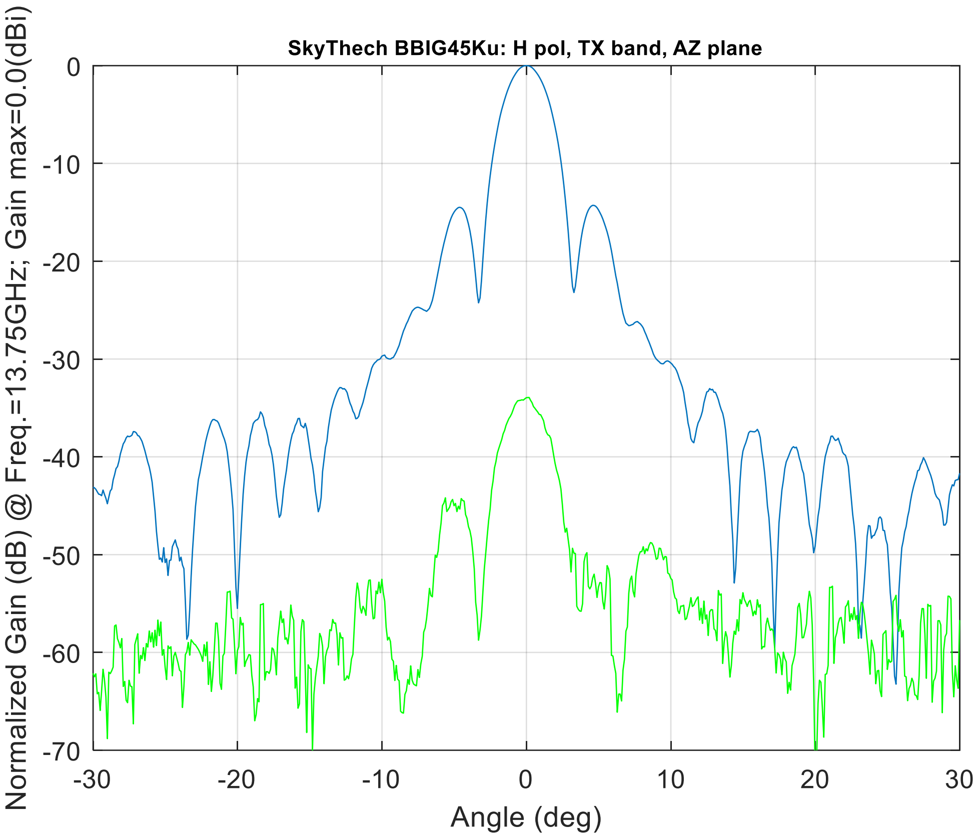
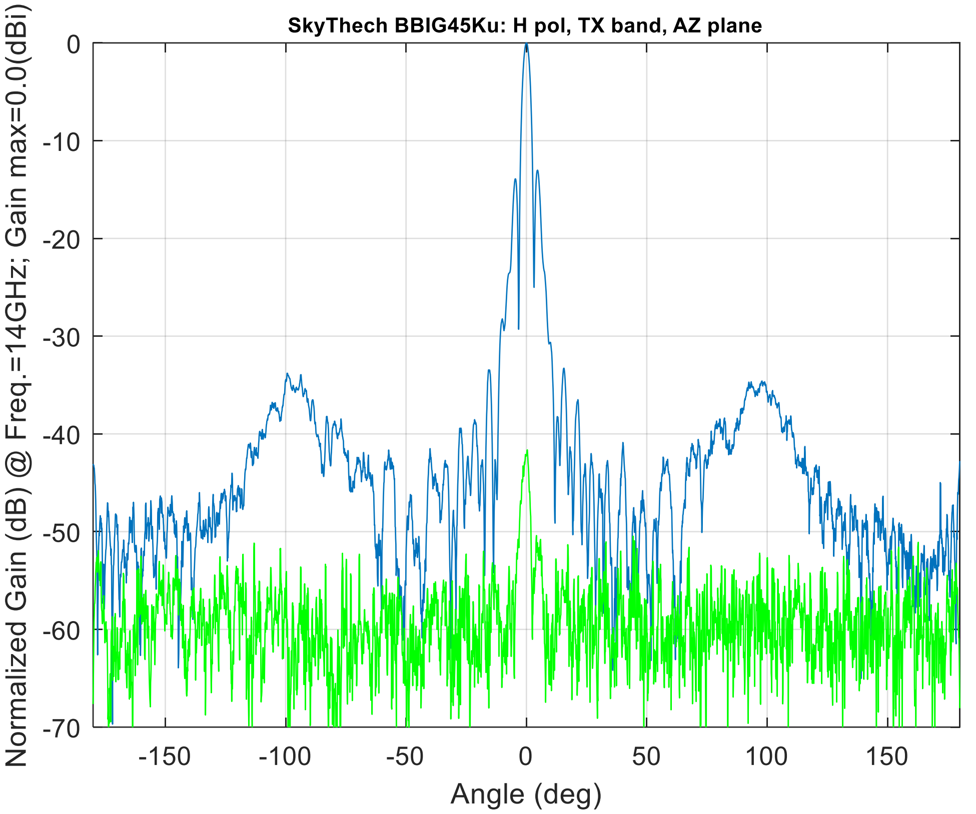
6.2.2: H-pol, AZ and EL plane plots.



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Angle (deg)
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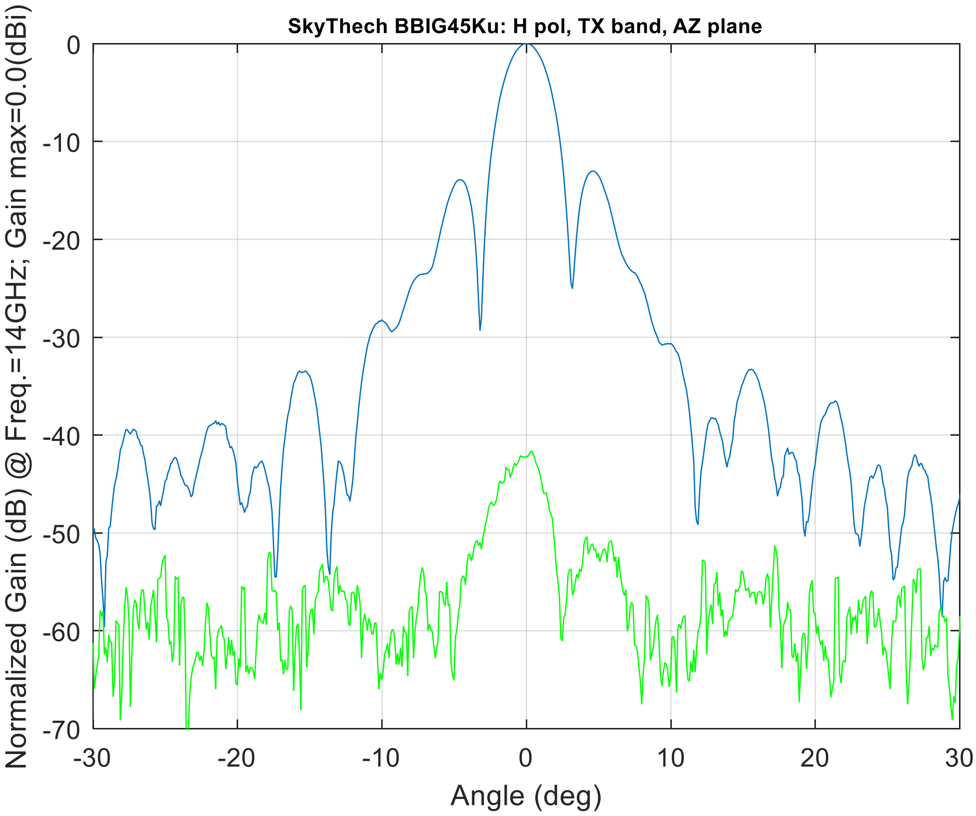
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Angle (deg)
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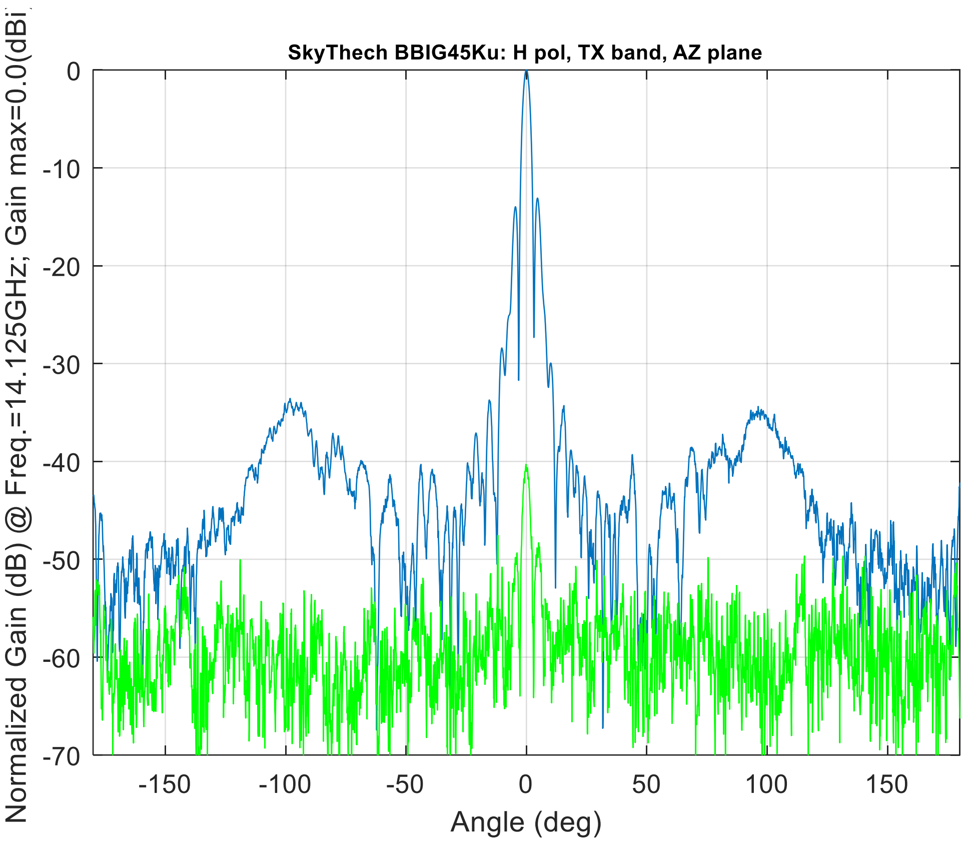
SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
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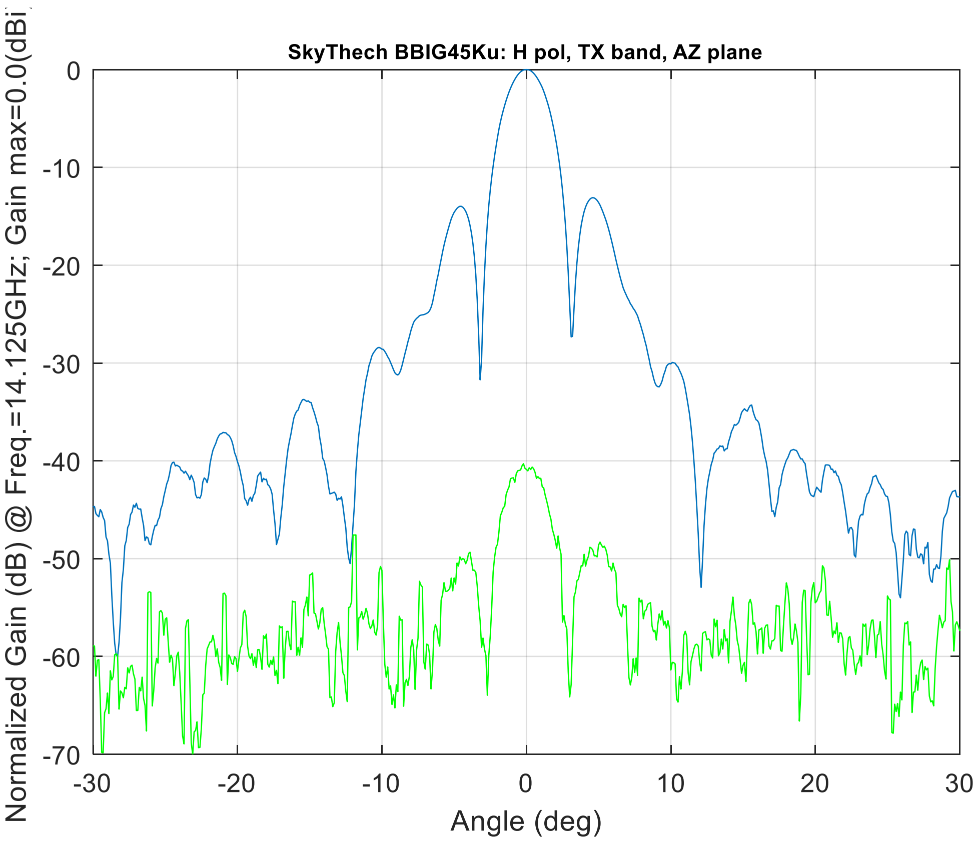
Angle (deg)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Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
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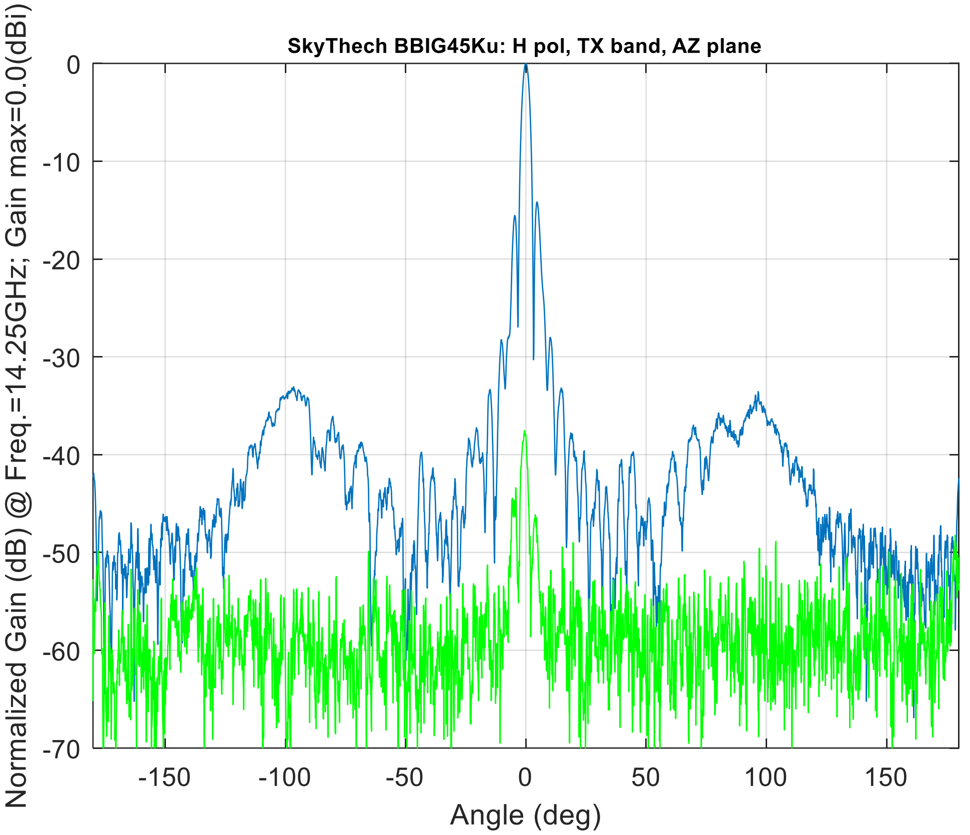
Angle (deg)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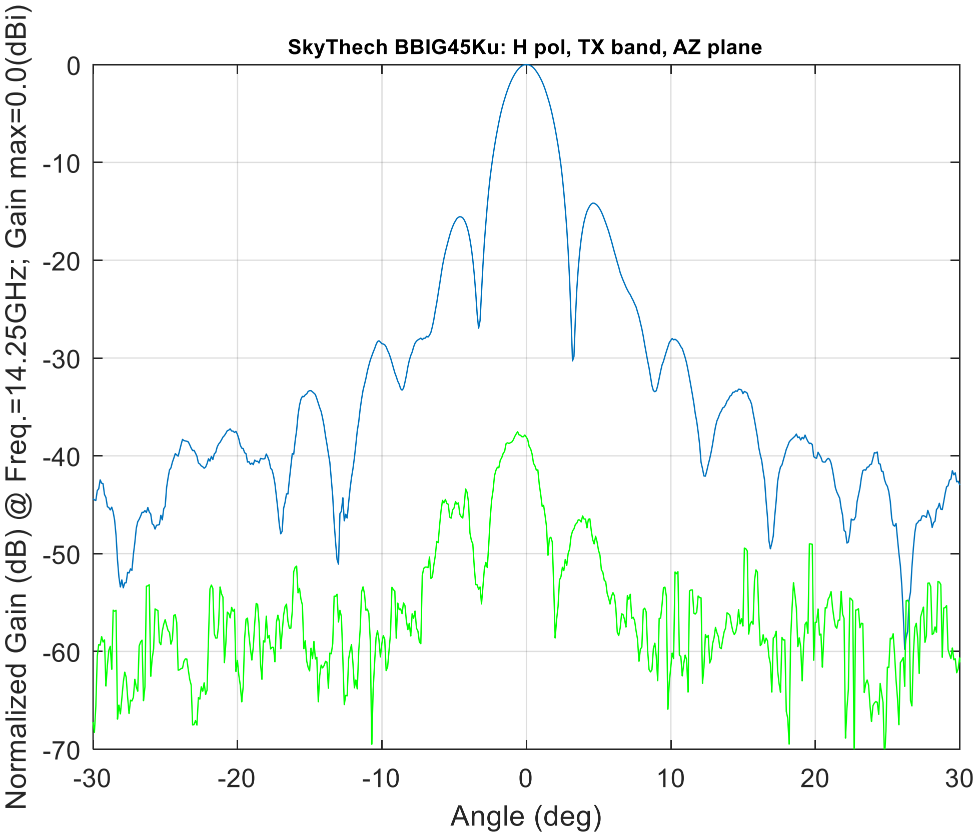
Angle (deg)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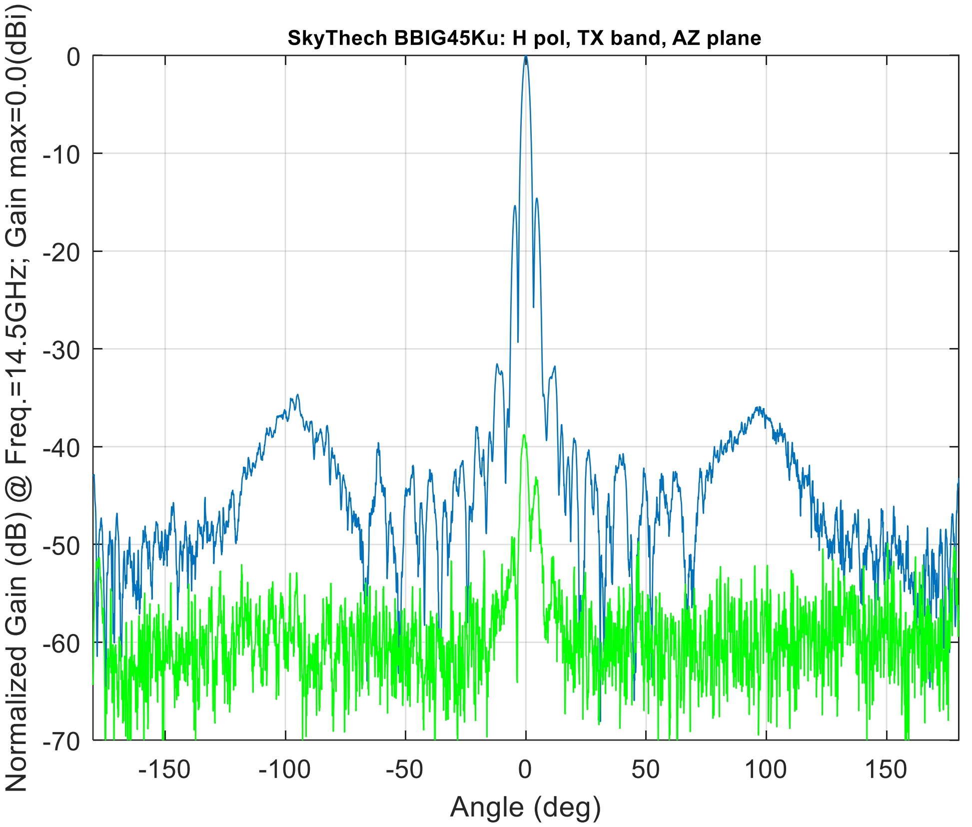
Angle (deg)


SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
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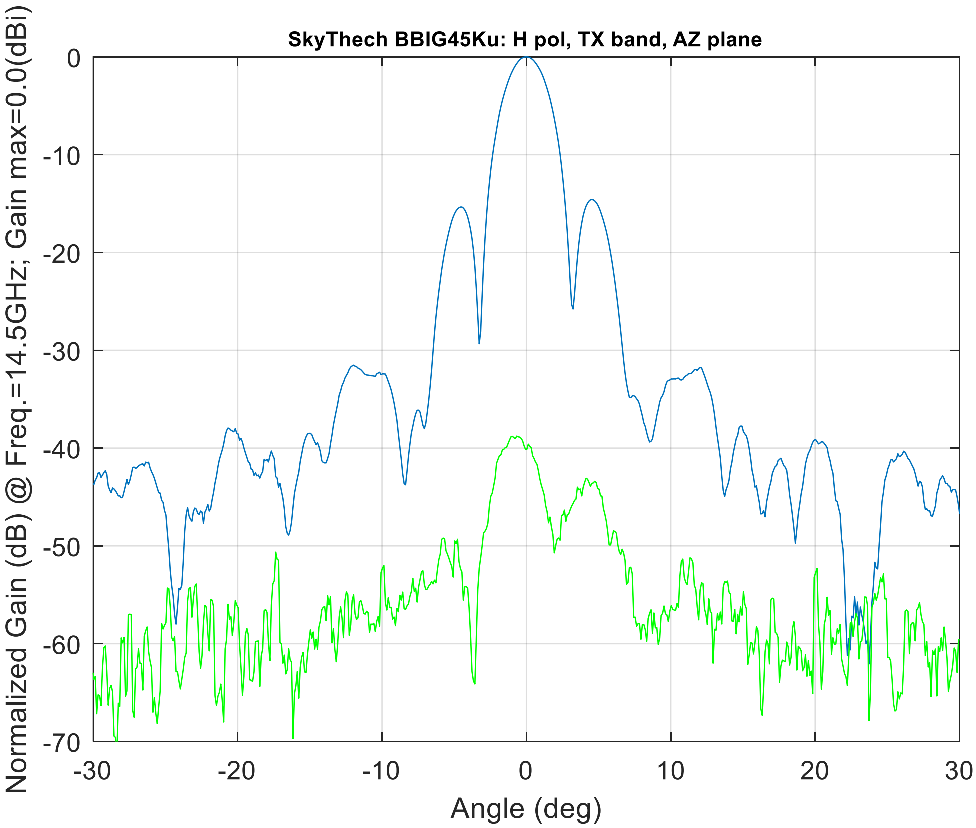
Angle (deg)


SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
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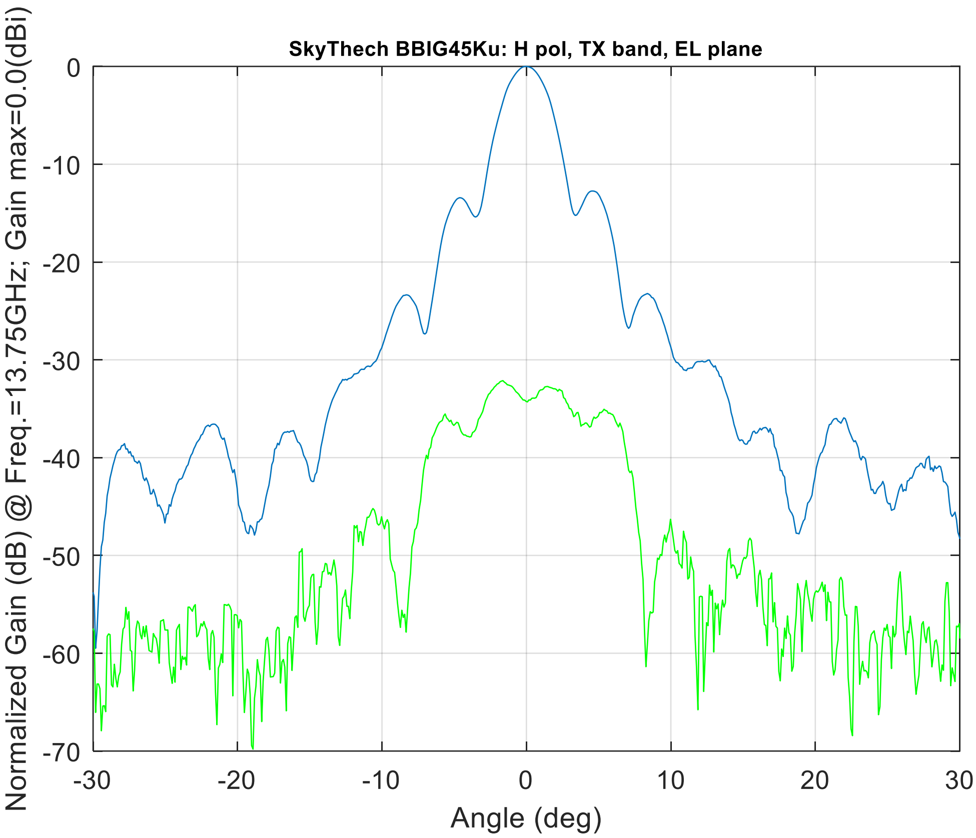
Angle (deg)


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=13.75GHz; Gain max=0.0(dBi)
Angle (deg)
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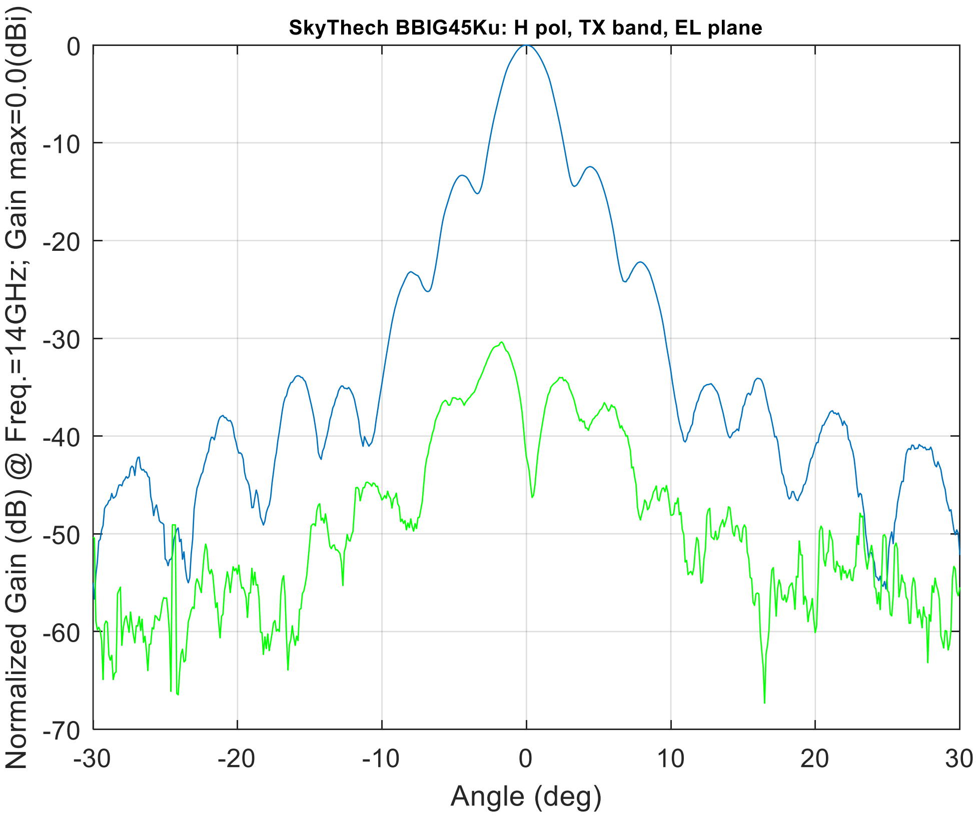
SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
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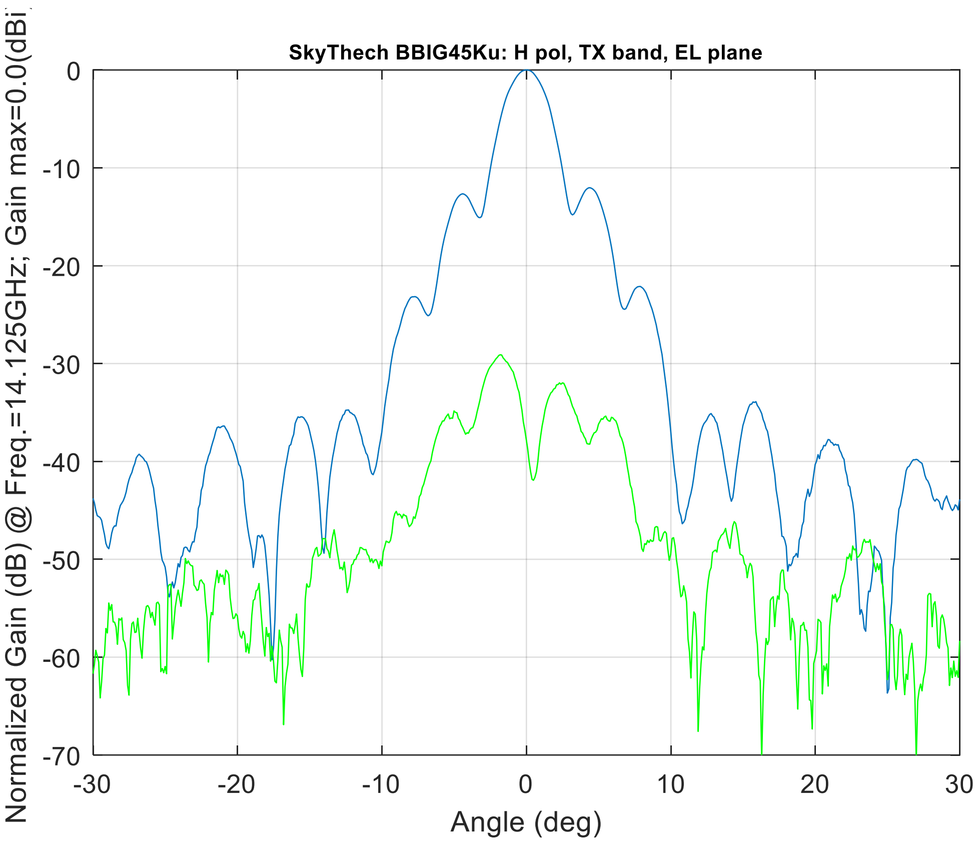
SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
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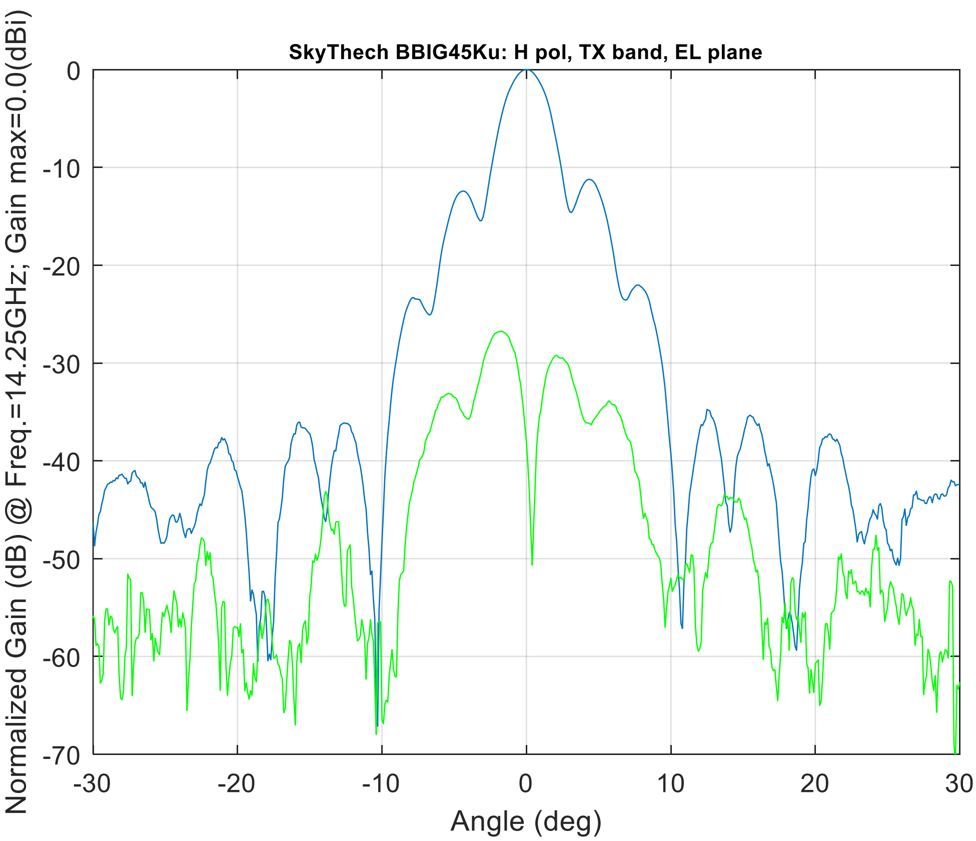
Angle (deg)


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
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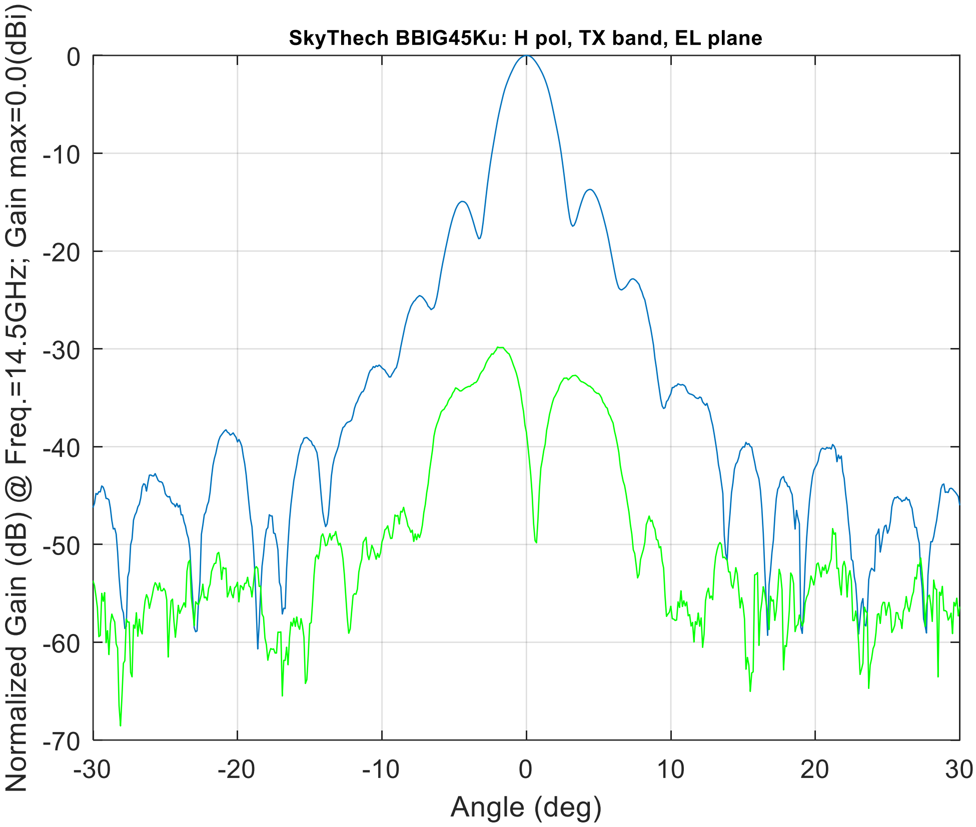
Angle (deg)


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
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Angle (deg)

CERTIFICATIONS

UltiSat Inc. ("UltiSat"), pursuant to Section 25.227 of the FCC's Rules, hereby certifies the following:

1. In accordance with Section 25.227(a)(15), as the operator of an ESAA system operating over international waters, UltiSat has confirmed with its target space station operators that its existing and proposed operations are within coordinated parameters for adjacent satellites up to six degrees away (+/- 6°) on the geostationary arc.

2. In accordance with Section 25.227(b)(7), UltiSat certifies that its existing and proposed operations comply with the following requirements of Section 25.227:

    - Per Section 25.227(a)(6), for each ESAA transmitter, UltiSat will time annotate and maintain a record for a period of not less than one year of the vehicle location (i.e., latitude/longitude/altitude), transmit frequency, channel bandwidth and satellite used. Records will be recorded at time intervals no greater than one (1) minute while the ESAA is transmitting. UltiSat will make this data available in the requisite format within 24 hours of a request from the Commission, NTIA, or a frequency coordinator for purposes of resolving harmful interference events.
    - Per Section 25.227(a)(9), each ESAA terminal will automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal or when it detects that unintended satellite tracking has happened or is about to happen.
    - Per Section 25.227(a)(10), each ESAA terminal will be subject to the monitoring and control by an NCMC. Each terminal will be able to receive "enable transmission" and "disable transmission" commands from the NCMC and must automatically cease transmissions immediately on receiving any "parameter change command", which may cause harmful interference during the change, until it receives an "enable transmission" command from its NCMC. In addition, the NCMC will be able to monitor the operation of an ESAA terminal to determine if it is malfunctioning.
    - Per Section 25.227(a)(11), each ESAA terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal will automatically cease transmissions.

By:

/s/ David Bryant
David Bryant
UltiSat Inc.

July 26, 2018

VI. Section 25.227 Compliance Matrix

Rule	Text	Application Citation
§ 25.227	**§25.227 Blanket licensing provisions for ESAAs operating with GSO FSS space stations in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz, and 14.0-14.5 GHz bands.**	
§ 25.227(a)	(a) The following ongoing requirements govern all ESAA 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) and 14.0-14.5 GHz (Earth-to-space) frequency bands receiving from and transmitting to geostationary orbit satellites in the Fixed-Satellite Service. ESAA licensees shall comply with the requirements in either paragraph (a)(1), (a)(2) or (a)(3) of this section and all of the requirements set forth in paragraphs (a)(4) through (a)(16) and paragraphs (c), (d), and (e) of this section. Paragraph (b) of this section identifies items that shall be included in the application for ESAA operations to demonstrate that these ongoing requirements will be met.	UltiSat complies for all ESAA terminal operations.
§ 25.227(a)(1)	(1) The following requirements shall apply to an ESAA that uses transmitters with off-axis EIRP spectral-densities lower than or equal to the levels in paragraph (a)(1)(i) of this section. ESAA licensees operating under this section shall provide a detailed demonstration as described in paragraph (b)(1) of this section. The ESAA transmitter also shall comply with the antenna pointing and cessation of emission requirements in paragraphs (a)(1)(ii) and (iii) of this section.	UltiSat complies for all ESAA terminal operations.
§ 25.227(a)(1)(i)(A)	(A) EIRP spectral density emitted in the plane tangent to the GSO arc, as defined in §25.103, must not exceed the following values: 15 - 25 log10(θ) dBW/4 kHz For 1.5° ≤ θ ≤ 7° -6 dBW/4 kHz For 7° < θ ≤ 9.2° 18 - 25 log10(θ) dBW/4 kHz For 9.2° < θ ≤ 19.1° -14 dBW/4 kHz For 19.1° < θ ≤ 180° Where theta (θ) is the angle in degrees from a line from the earth station antenna to the assigned orbital location of the target satellite. The EIRP density levels specified for θ > 7° may be exceeded by up to 3 dB in up to 10% of the range of theta (θ) angles from ±7-180°, and by up to 6 dB in the region of main reflector spillover energy.	*See* Technical Appendix, III.

§ 25.227(a)(1)(i)(B)	(B) The EIRP spectral density of co-polarized signals must not exceed the following values in the plane perpendicular to the GSO arc, as defined in §25.103: 18 - 25 log(θ) dBW/4 kHz For 3° ≤ θ ≤ 19.1° -14 dBW/4 kHz For 19.1° < θ ≤ 180° Where θ is as defined in paragraph (a)(1)(i)(A) of this section. These EIRP density levels may be exceeded by up to 6 dB in the region of main reflector spillover energy and in up to 10% of the range of θ angles not included in that region, on each side of the line from the earth station to the target satellite.	*Id.*
§ 25.227(a)(1)(i)(C)	(C) The off-axis EIRP spectral-density of cross-polarized signals must not exceed the following values in the plane tangent to the GSO arc or in the plane perpendicular to the GSO arc 5 - 25 log10(θ) dBW/4 kHz For 1.8° ≤ θ ≤ 7° Where θ is as defined in paragraph (a)(1)(i)(A) of this section.	*Id.*
§ 25.227(a)(1)(ii)	(ii) Each ESAA transmitter shall meet one of the following antenna pointing requirements: (A) Each ESAA 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 ESAA antenna; or (B) Each ESAA transmitter shall declare a maximum antenna pointing error that may be greater than 0.2° provided that the ESAA 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.	*See* Application Narrative, II.A.
§ 25.227(a)(1)(iii)	(iii) Each ESAA transmitter shall meet one of the following cessation of emission requirements: (A) For ESAAs operating under paragraph (a)(1)(ii)(A) of this section, all emissions from the ESAA 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 ESAA antenna exceeds 0.5°, and transmission shall not resume until such angle is less than or equal to 0.2°, or (B) For ESAA transmitters operating under paragraph (a)(1)(ii)(B) of this section, all emissions from the ESAA 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 ESAA 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.	*Id.*

25.227(a)(2)	(2) The following requirements apply to ESAA systems that operate with off-axis EIRP spectral-densities in excess of the levels in paragraph (a)(1)(i) or (a)(3)(i) of this section under licenses granted based on certifications filed pursuant to paragraph (b)(2) of this section. (i) An ESAA or ESAA system licensed based on certifications filed pursuant to paragraph (b)(2) of this section must operate in accordance with the off-axis EIRP density specifications provided to the target satellite operator in order to obtain the certifications. (ii) Any ESAA transmitter operating under a license granted based on certifications filed pursuant to paragraph (b)(2) of this section must be self-monitoring and capable of shutting itself off and must cease or reduce emissions within 100 milliseconds after generating off-axis EIRP-density in excess of the specifications supplied to the target satellite operator. (iii) A system with variable power control of individual ESAA transmitters must monitor the aggregate off-axis EIRP density from simultaneously transmitting ESAA transmitters at the system's network control and monitoring center. If simultaneous operation of two or more ESAA transmitters causes aggregate off-axis EIRP density to exceed the off-axis EIRP density specifications supplied to the target satellite operator, the network control and monitoring center must command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below those specifications, and the transmitters must comply within 100 milliseconds of receiving the command.	N/A
§ 25.227(a)(3)	(3) The following requirements apply to an ESAA system that uses variable power-density control of individual ESAA earth stations transmitting simultaneously in the same frequencies to the same target satellite, unless the system operates pursuant to paragraph (a)(2) of this section. (i) Aggregate EIRP density from co-frequency earth stations in each target satellite receiving beam, not resulting from colliding data bursts transmitted pursuant to a contention protocol, will not exceed the limits specified in paragraph (a)(1)(i) of this section. (ii) Each ESAA transmitter must be self-monitoring and capable of shutting itself off and must cease or reduce emissions within 100 milliseconds after generating off-axis EIRP density in excess of the limit in paragraph (a)(3)(i) of this section. (iii) A system with variable power control of individual ESAA transmitters must monitor aggregate power density from simultaneously transmitting ESAA transmitters at the network control and monitoring center. If simultaneous operation of two or more transmitters causes aggregate off-axis EIRP density to exceed the off-axis EIRP density limit in paragraph (a)(3)(i) of this section, the network control and monitoring center must command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below	N/A

	that limit, and those transmitters must comply within 100 milliseconds of receiving the command.	
§ 25.227(a)(4)	(4) An applicant filing to operate an ESAA terminal or system and planning to use a contention protocol shall certify that its contention protocol use will be reasonable.	N/A
§ 25.227(a)(5)	(5) 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 ESAA.	*See* Application Narrative, II.C.
§ 25.227(a)(6)	(6) For each ESAA transmitter, a record of the vehicle location (i.e., latitude/longitude/altitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than one year. Records shall be recorded at time intervals no greater than one (1) minute while the ESAA is transmitting. The ESAA operator shall make this data available, in the form of a comma delimited electronic spreadsheet, within 24 hours of a request from the Commission, NTIA, or a frequency coordinator for purposes of resolving harmful interference events. A description of the units (i.e., degrees, minutes, MHz ….) in which the records values are recorded will be supplied along with the records.	*See* Technical Appendix, V.
§ 25.227(a)(7)	(7) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands ESAAs 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.	N/A
§ 25.227(a)(8)	(8) An ESAA terminal receiving in the 11.7-12.2 GHz (space-to-Earth) bands shall receive protection from interference caused by space stations other than the target space station only to the degree to which harmful interference would not be expected to be caused to an earth station employing an antenna conforming to the referenced patterns defined in paragraphs (a) and (b) of section 25.209 and stationary at the location at which any interference occurred.	Applicable regulatory status and protection provision.
§ 25.227(a)(9)	(9) Each ESAA terminal shall automatically cease transmitting within 100 milliseconds upon loss of reception of the satellite downlink signal or when it detects that unintended satellite tracking has happened or is about to happen.	*See* Technical Appendix, V.
§ 25.227(a)(10)	(10) Each ESAA terminal should be subject to the monitoring and control by an NCMC or equivalent facility. Each terminal must be able to receive at least “enable transmission” and “disable transmission” commands from the NCMC and must automatically cease transmissions immediately on receiving any “parameter change command”, which may cause harmful interference during the change, until it receives an “enable transmission”	*Id.*

§ 25.227(a)(11)	(11) Each ESAA terminal shall be self-monitoring and, should a fault which can cause harmful interference to FSS networks be detected, the terminal must automatically cease transmissions.	*Id.*
§ 25.227(a)(12)	(12) Unless otherwise stated all ESAA system that comply with the off-axis EIRP spectral-density limits in paragraph (a)(1)(i) of this section may request Permitted List authority.	Applicable regulatory status and protection provision.
§ 25.227(a)(13)	(13) ESAA providers operating in the international airspace within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in this band, the maximum power flux density (pfd) produced at the surface of the Earth by emissions from a single aircraft carrying an ESAA terminal should not exceed the following values unless the foreign Administration has imposed other conditions for protecting its fixed service stations: $-132+0.5 \cdot \theta$ dB(W/(m2 · MHz)) For $\theta \leq 40°$ -112 dB(W/(m2 · MHz)) For $40° < \theta \leq 90°$ Where: θ is the angle of arrival of the radio-frequency wave (degrees above the horizontal) and the aforementioned limits relate to the pfd and angles of arrival would be obtained under free-space propagation conditions.	Applicable regulatory status and protection provision.
§ 25.227(a)(14)	(14) All ESAA terminals operated in U.S. airspace, whether on U.S.-registered civil aircraft or non-U.S.-registered civil aircraft, must be licensed by the Commission. All ESAA terminals on U.S.-registered civil aircraft operating outside of U.S. airspace must be licensed by the Commission, except as provided by Section 303(t) of the Communications Act.	Applicable regulatory status and protection provision.
§ 25.227(a)(15)	(15) For ESAA systems operating over international waters, ESAA operators will certify that their target space station operators have confirmed that proposed ESAA operations are within coordinated parameters for adjacent satellites up to 6 degrees away on the geostationary arc.	Applicable regulatory status and protection provision.
§ 25.227(a)(16)	(16) Prior to operations within the foreign nation's airspace, the ESAA operator will ascertain whether the relevant administration has operations that could be affected by ESAA terminals, and will determine whether that administration has adopted specific requirements concerning ESAA operations. When the aircraft enters foreign airspace, the ESAA terminal would be required to operate under the Commission's rules, or those of the foreign administration, whichever is more constraining. To the extent that all relevant administrations have identified geographic areas from which ESAA operations would not affect their radio operations, ESAA operators would be free to operate within those identified areas without further action. To the extent that the foreign administration has not adopted requirements regarding ESAA operations, ESAA operators would be required to coordinate their operations with any potentially affected operations.	UltiSat complies.

§ 25.227(b)	(b) Applications for ESAA operation in the 14.0-14.5 GHz (Earth-to-space) band to GSO satellites in the FSS shall include, in addition to the particulars of operation identified on FCC Form 312, and associated Schedule B, the applicable technical demonstrations in paragraphs (b)(1), (b)(2), or (b)(3), and the documentation identified in paragraphs (b)(4) through (b)(8) of this section.	
§ 25.227(b)(1)	(1) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1) of this section must	

	provide the information required by §25.115(g)(1). An applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section must also provide the certifications identified in paragraph (b)(1)(iii) of this section. An applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section must also provide the demonstrations identified in paragraph (b)(1)(iv) of this section. (i)-(ii) [Reserved] (iii) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(A) of this section shall: (A) Demonstrate that the total tracking error budget of their antenna is within 0.2° or less between the orbital location of the target satellite and the axis of the main lobe of the ESAA antenna. As part of the engineering analysis, the ESAA applicant must show that the antenna pointing error is within three sigma () from the mean value, *i.e.*, that there is a 0.997 probability the antenna maintains a pointing error within 0.2°; and (B) Demonstrate 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 ESAA antenna exceeds 0.5°. (iv) An ESAA applicant proposing to implement a transmitter under paragraph (a)(1)(ii)(B) of this section shall: (A) Declare, in its 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)(i) of this section; and (B) Demonstrate that the ESAA 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 ESAA 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 ESAA antenna is less than or equal to the declared maximum antenna pointing error.	*See* Technical Appendix, III; Application Narrative, II.A.

§ 25.227(b)(2)	(2) An ESAA applicant proposing to operate with off-axis EIRP density in excess of the levels in paragraph (a)(1)(i) or (a)(3)(i) of this section must provide the following in exhibits to its earth station application: (i) Off-axis EIRP density data pursuant to §25.115(g)(1); (ii) The certifications required by §25.220(d); and (iii) A detailed showing that each ESAA transmitter in the system will automatically cease or reduce emissions within 100 milliseconds after generating EIRP density exceeding specifications provided to the target satellite operator; and (iv) A detailed showing that the aggregate power density from simultaneously transmitting ESAA transmitters will be monitored at the system's network control and monitoring center; that if simultaneous operation of two or more ESAA transmitters causes the aggregate off-axis EIRP density to exceed the off-axis EIRP density specifications supplied to the target satellite operator, the network control and monitoring center will command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below those specifications; and that those transmitters will comply within 100 milliseconds of receiving the command.	N/A
§ 25.227(b)(3)	(3) An applicant proposing to implement an ESAA system subject to paragraph (a)(3) of this section must provide the following information in exhibits to its earth station application: (i) Off-axis EIRP density data pursuant to §25.115(g)(1); (ii) A detailed showing of the measures that will be employed to maintain aggregate EIRP density at or below the limit in paragraph (a)(3)(i) of this section; (iii) A detailed showing that each ESAA terminal will automatically cease or reduce emissions within 100 milliseconds after generating off-axis EIRP density exceeding the limit in paragraph (a)(3)(i) of this section; and (iv) A detailed showing that the aggregate power density from simultaneously transmitting ESAA transmitters will be monitored at the system's network control and monitoring center; that if simultaneous operation of two or more transmitters in the ESAA network causes aggregate off-axis EIRP density to exceed the off-axis density limit in paragraph (a)(3)(i) of this section, the network control and monitoring center will command those transmitters to cease emissions or reduce the aggregate EIRP density to a level at or below that limit; and that those transmitters will comply within 100 milliseconds of receiving the command.	N/A

§ 25.227(b)(4)	(4) There shall be an exhibit included with the application describing the geographic area(s) in which the ESAA will operate.	*See* Technical Appendix, I.
§ 25.227(b)(5)	(5) Any ESAA applicant filing for an ESAA terminal or system and planning to use a contention protocol shall include in its application a certification that will comply with the requirements of paragraph (a)(4) of this section.	N/A
§ 25.227(b)(6)	(6) The point of contact referred to in paragraph (a)(5) of this section shall be included in the application.	*See* Application Narrative, II.C.
§ 25.227(b)(7)	(7) Any ESAA applicant filing for an ESAA terminal or system shall include in its application a certification that will comply with the requirements of paragraph (a)(6), (a)(9), (a)(10), (a)(11) of this section.	*See* Technical Appendix, V.
§ 25.227(b)(8)	(8) All ESAA applicants shall submit a radio frequency hazard analysis determining via calculation, simulation, or field measurement whether ESAA terminals, or classes of terminals, will produce power densities that will exceed the Commission's radio frequency exposure criteria. ESAA applicants with ESAA terminals that will exceed the guidelines in Section 1.1310 for radio frequency radiation exposure shall provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines. All ESAA licensees shall ensure installation of ESAA terminals on aircraft by qualified installers who have an understanding of the antenna's radiation environment and the measures best suited to maximize protection of the general public and persons operating the vehicle and equipment. An ESAA terminal exhibiting radiation exposure levels exceeding 1.0 mW/cm^2 in accessible areas, such as at the exterior surface of the radome, shall have a label attached to the surface of the terminal warning about the radiation hazard and shall include thereon a diagram showing the regions around the terminal where the radiation levels could exceed 1.0 mW/cm^2.	*See* Technical Appendix, II.

§ 25.227(c)	(c)(1) Operations of ESAAs in the 14.0-14.2 GHz (Earth-to-space) frequency band in the radio line-of-sight of the NASA TDRSS facilities on Guam (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 with the National Aeronautics and Space Administration (NASA) through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. (2) 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's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band ESAA licensees shall cease operations in the 14.0-14.2 GHz band within radio line-of-sight of the new TDRSS site until the licensees complete coordination with NTIA/IRAC for the new TDRSS facility. Licensees shall notify the International Bureau once they have completed coordination for the new TDRSS site. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The ESAA licensee then will be permitted to commence operations in the 14.0-14.2 GHz band within radio line-of-sight of the new TDRSS site, subject to any operational constraints developed in the coordination process.	UltiSat will not transmit in the radio line-of-sight of the subject facilities. In the event UltiSat seeks to operate within the relevant zone, it will coordinate as necessary.
§ 25.227(d)	(d)(1) Operations of ESAA in the 14.47-14.5 GHz (Earth-to-space) frequency band in the radio line-of-sight of radio astronomy service (RAS) observatories observing in the 14.47-14.5 GHz band are subject to coordination with the National Science Foundation (NSF). The appropriate NSF contact point to initiate coordination is Electromagnetic Spectrum Manager, NSF, 4201 Wilson Blvd., Suite 1045, Arlington VA 22203, fax 703-292-9034, email esm@nsf.gov. Licensees shall notify the International Bureau once they have completed coordination. Upon receipt of the coordination agreement from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. (2) A list of applicable RAS sites and their locations can be found in 25.226(d)(2) Table 1. (3) When NTIA seeks to provide similar protection to future RAS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission's International Bureau that the site is nearing operational status. Upon public notice from the International Bureau, all Ku-band ESAA licensees shall cease operations in the 14.47-14.5 GHz band within the relevant geographic zone of the new RAS site until the licensees complete coordination for the new RAS facility. Licensees shall notify the International Bureau once they have completed coordination for the new RAS site and shall submit the coordination agreement to the Commission. Upon receipt of such notification from a licensee, the International Bureau will issue a public notice stating that the licensee may commence operations within the coordination zone in 30 days if no party has opposed the operations. The ESAA licensee then will be permitted to commence operations in the 14.47-14.5 GHz band within the relevant coordination distance around the new RAS site, subject to any operational constraints developed in the coordination process.	UltiSat will not transmit in the radio line-of-sight of the subject facilities. In the event UltiSat seeks to operate, it will coordinate as necessary.