UltiSat, Inc.
Six-Month Experimental Special Temporary Authorization ("STA")

Technical Appendix

I. BB45 Ka-band Radiation Hazard Analysis

II. BB45 X-band Radiation Hazard Analysis

III. BB45 EIRP Spectral Density Patterns

IV. BB45 Gain Patterns

I. Radiation Hazard Analysis

BB45 (Ka-band)

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	0.45m
Antenna Effective Diameter	0.45 m
Antenna Surface Area	0.159 sq. meters
Antenna Isotropic Gain	41.0 dBi
Number of Identical Adjacent Antennas	1
Nominal Antenna Efficiency (ε)	65%
Nominal Frequency	29.5 GHz
Nominal Wavelength (λ)	0.0102 meters
Maximum Transmit Power / Carrier	12.5 Watts
Number of Carriers	1
Total Transmit Power	25.0 Watts
W/G Loss from Transmitter to Feed	1.0 dB
Total Feed Input Power	9.93 Watts
Radome Losses	1.0 dB
Effective RF Power at radome	7.89 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda$ = 4.98 meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda$ = 11.95 meters
Transition Region	R_{nf} to R_{ff} = 4.98 meters to 11.95 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:

$PD_{as} = 4P/A =$ **24.97** 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:

$PD_{radome}=4P_{rad}/A$ = **19.8** 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:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **12.95** mW/cm² (3)
from 0 to 4.9 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} = **12.95** mW/cm²
For: 4.98 < R < 11.95 meters

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance, (meters), R_{safeu}: 64.5
.
Controlled Environment Safe Operating Distance, (meters), R_{safec}: 12.9

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: $R > R_{ff}$ = 9.23 meters
PD_{ff} = **5.55**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

$PD_{2\ deg\ off\text{-}axis} = PD_{ff} x\ 280.2/G$ = **0.13** 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:

$PD_{nf(off\text{-}axis)} = PD_{nf} /100 =$ **0.260** 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 =	0.569 meters
	h =	2.0 meters, delta between antenna and object >1 m
Then:		
	α	S
	10	1.7 meters
	15	1.1 meters
	20	0.9 meters
	25	0.7 meters
	30	0.6 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 top of an air vehicle. There will also be proper emission warning signs placed and all operating personnel will be aware of the human exposure levels at and around the earth station. The applicant agrees to abide by the conditions specified in Condition 18 provided below:

> *(18) – UltiSat Inc shall take all reasonable and customary measures to ensure that the MET does not create potential for harmful non-ionizing radiation to persons who may be in the vicinty of the MET when it is in operation. At a minimum, permanent warning label(s) shall be affixed to the MET warning of the radiation hazard and including a diagram showing the regions around the MET where the radiation levels could exceed 1.0mW/cm2. The operator of the MET shall be responsible for assuring that individuals do not stray into the region around the MET where there is a potential for exceeding the maximum permissible exposure limits required by Section 1.1310 of the Commission's rules 47 C.F.R § 1.1310. This shall be accomplished by means of signs, caution tape, verbal warnings, placement of the MET so as to minimize access to the hazardous region and/or any other appropriate means*

The table below summarizes all of the above calculations.

Parameter	Abbrevation	Value	Units	Formula
Antenna Diameter	D	0.45	meters	
Antenna Centerline	h	2	meters	
Antenna Surface Area	Sa	0.159	$meter^2$	
Antenna Ground Elevation	GE	2	meters	
Frequency of Operation	f	29.5	GHz	
Wavelength	λ	0.01017	meters	
HPA Output Power	P_{HPA}	12.5	Watts	
HPA to Antenna Loss	L_{Tx}	1	dB	
Radome Loss	L_{rad}	1	dB	
Transmit Power at Flange	P_F	9.93	Watts	$16\ PHPA / 10^{\frac{-L_{Tx}}{10}}$
Power After Radome	P_{Rad}	7.89	Watts	$16\ PF / 10^{\frac{-L_{Rad}}{10}}$
Antenna Gain	G_{es}	41.01	dBi	
Apeature Effeciency	η	0.65		
1. Reflector Calculations				
Antenna Surface Power Density	PD_{As}	249.72	W/m^2	$16\ PF / \pi D^2$
		24.97	mW/cm^2	
Radome Surface Power Density	PD_{Rad}	198.36	W/m^2	$16\ PRad / \pi D^2$
		19.84	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
2. On Axis Near Field Calculations				
Extent of Near Field	R_{NF}	4.98	meters	$D^2 / 4\lambda$
Near Field Power Density	P_{DNF}	129.52	W/m^2	$16\ PRad / \pi D^2$
		12.95	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
3. On Axis Transition Region Calculations				
Extent Of Transition Region, Minimum	R_{TR}	4.98	meters	$D^2 / 4\lambda$
Extent Of Transition Region, Maximum	R_{TR}	11.95	meters	$0.6\ D^2 / \lambda$
Worst Case Transition Region Power Density	P_{DTR}	12.95	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
Minimum Safe Distance, Uncontrolled Access	R_{SU}	64.46	meters	$P_{DNF}\ RN_F / 1mW/cm^2$
Minimum Safe Distance, Controlled Access	R_{SC}	12.89	meters	$P_{DNF}\ RN_F / 5mW/cm^2$
4. On Axis Far Field Calculations				
Distance to Far Field	R_{FF}	11.95	meters	$0.6\ D^2 / \lambda$
On Axis Power Density At Start of Far Field	P_{DFF}	55.48	W/m^2	$G_{ES}\ PR_{ad} / 4\lambda\ RF_F^2$
		5.55	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
5. Off-Axis Far Field Power Density Calculations				
Far Field Power Density at sampl 2˚ Off-Axis		0.12	mW/cm^2	$P_{DFF} / \lfloor G @ 2° / G_{es}$
				Meets Controlled Limits
				Meets Uncontrolled Limits
6. Off-Axis Power Density Calculations for the Near Field and Transitional Regions				
Power Density Off Main Beam Axis at 1 Antenna	$P_{DNF\text{-}off\text{-}axis}$	0.13	mW/cm^2	$16\ PRad / 100\ \pi D_{NF}^2$
Diameter Removed				Meets Controlled Limits
				Meets Uncontrolled Limits
7. Off-Axis Safe Distances From Earth Station				
Minimum Elevation Angle of Antenna	α_{min}	10	Degrees	
Height of Object to be Cleared	h	2	meters	
Height center of antenna is above the ground	G_E	2	meters	
	α	S		
	10˚	6.99 m		
	15˚	4.63 m		
	20˚	3.45 m		
	25˚	2.73 m		
	30˚	2.24 m		

II. Radiation Hazard Analysis

BB45 (X-band)

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	0.45m
Antenna Effective Diameter	0.45 m
Antenna Surface Area	0.159 sq. meters
Antenna Isotropic Gain	30.2 dBi
Number of Identical Adjacent Antennas	1
Nominal Antenna Efficiency (ε)	71%
Nominal Frequency	8.15 GHz
Nominal Wavelength (λ)	0.0368 meters
Maximum Transmit Power / Carrier	25 Watts
Number of Carriers	1
Total Transmit Power	25 Watts
W/G Loss from Transmitter to Feed	1.0 dB
Total Feed Input Power	19.9 Watts
Radome Losses	1.0 dB
Effective RF Power at radome	15.8 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda$ = 1.38 meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda$ = 3.30 meters
Transition Region	R_{nf} to R_{ff} = 1.38 meters to 3.3 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:

$PD_{as} = 4P/A =$ **49.9** 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:

$PD_{radome}=4P_{rad}/A$ = **39.7** 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:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **28.2** mW/cm² (3)
from 0 to 4.9 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} = **28.2** mW/cm²
For: $1.38 < R < 3.3$ meters

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance, (meters), R_{safeu}: 38.7

Controlled Environment Safe Operating Distance, (meters), R_{safec}: 7.8

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: $R > R_{ff}$ = 3.3 meters
PD_{ff} = **12.1** mW/cm^2 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

$PD_{2\ deg\ off\text{-}axis} = PD_{ff} x\ 280.2/G$ = **3.2** 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:

$PD_{nf(off\text{-}axis)} = PD_{nf}/100 =$ **0.28** 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 =	0.569 meters
	h =	2.0 meters, delta between antenna and object >1 m
Then:		
	α	S
	10	7.0 meters
	15	4.6 meters
	20	3.4 meters
	25	2.7 meters
	30	2.3 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 top of an air vehicle. There will also be proper emission warning signs placed and all operating personnel will be aware of the human exposure levels at and around the earth station. The applicant agrees to abide by the conditions specified in Condition 18 provided below:

> *(18) – UltiSat Inc shall take all reasonable and customary measures to ensure that the MET does not create potential for harmful non-ionizing radiation to persons who may be in the vicinty of the MET when it is in operation. At a minimum, permanent warning label(s) shall be affixed to the MET warning of the radiation hazard and including a diagram showing the regions around the MET so as to minimize access to the hazardous region and/or any other appropriate means.*

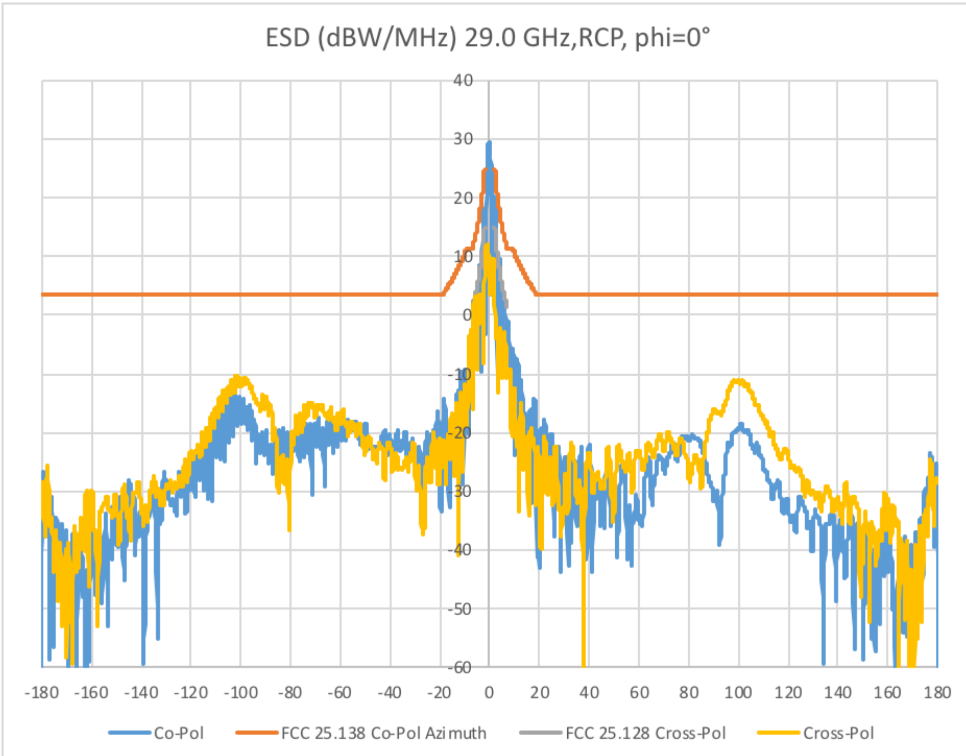
The table on the following page summarizes all of the above calculations.

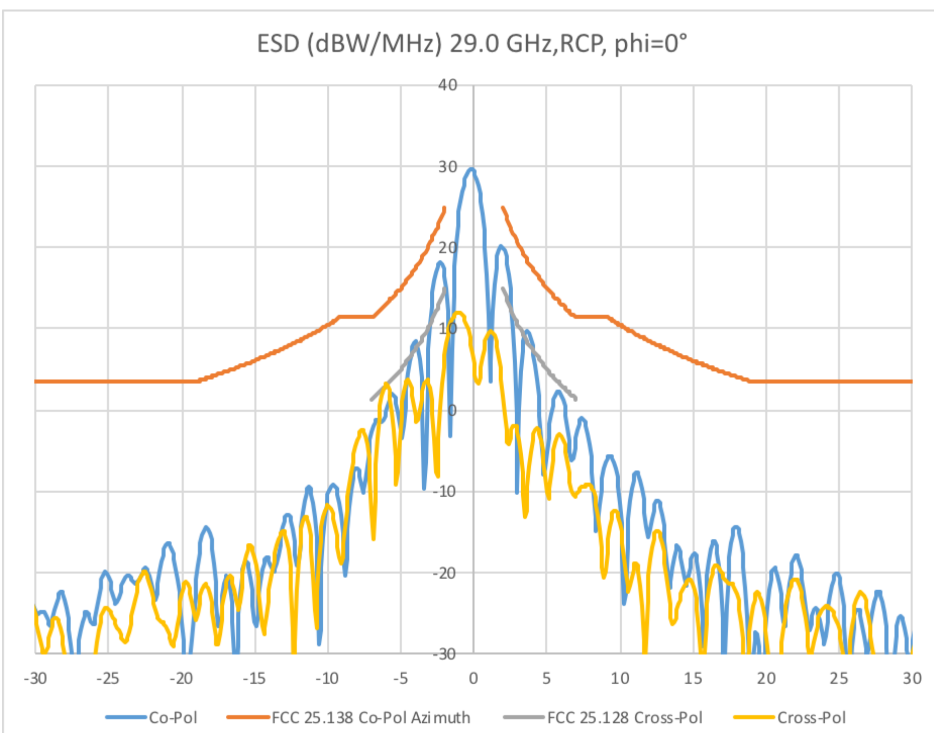
Parameter	Abbrevation	Value	Units	Formula
Antenna Diameter	D	0.45	meters	
Antenna Centerline	h	2	meters	
Antenna Surface Area	Sa	0.159	$meter^2$	
Antenna Ground Elevation	GE	2	meters	
Frequency of Operation	f	8.15	GHz	
Wavelength	λ	0.03681	meters	
HPA Output Power	P_{HPA}	25	Watts	
HPA to Antenna Loss	L_{Tx}	1	dB	
Radome Loss	L_{rad}	1	dB	
Transmit Power at Flange	P_F	19.86	Watts	$16\,PHPA / 10^{\frac{-L_{Tx}}{10}}$
Power After Radome	P_{Rad}	15.77	Watts	$16\,PF / 10^{\frac{-L_{Rad}}{10}}$
Antenna Gain	G_{es}	30.2	dBi	
Apeature Effeciency	η	0.71		
1. Reflector Calculations				
Antenna Surface Power Density	PD_{As}	499.44	W/m^2	$16\,PF / \pi D^2$
		49.94	mW/cm^2	
Radome Surface Power Density	PD_{Rad}	396.72	W/m^2	$16\,PRad / \pi D^2$
		39.67	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
2. On Axis Near Field Calculations				
Extent of Near Field	R_{NF}	1.38	meters	$D^2 / 4\lambda$
Near Field Power Density	P_{DNF}	281.64	W/m^2	$16\,PRad / \pi D^2$
		28.16	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
3. On Axis Transition Region Calculations				
Extent Of Transition Region, Minimum	R_{TR}	1.38	meters	$D^2 / 4\lambda$
Extent Of Transition Region, Maximum	R_{TR}	3.30	meters	$0.6\,D^2 / \lambda$
Worst Case Transition Region Power Density	P_{DTR}	28.16	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
Minimum Safe Distance, Uncontrolled Access	R_{SU}	38.74	meters	$P_{DNF}\,RNF / 1mW/cm^2$
Minimum Safe Distance, Controlled Access	R_{SC}	7.75	meters	$P_{DNF}\,RNF / 5mW/cm^2$
4. On Axis Far Field Calculations				
Distance to Far Field	R_{FF}	3.30	meters	$0.6\,D^2 / \lambda$
On Axis Power Density At Start of Far Field	P_{DFF}	120.64	W/m^2	$G_{ES}\,PRad / 4\lambda\,RFF^2$
		12.06	mW/cm^2	Does Not meet Controlled Limits
				Does Not meet Uncontrolled Limits
5. Off-Axis Far Field Power Density Calculations				
Far Field Power Density at sampl 2° Off-Axis		3.23	mW/cm^2	$P_{DFF} / [G @ 2^\circ / G_{es}]$
				Meets Controlled Limits
				Meets Uncontrolled Limits
6. Off-Axis Power Density Calculations for the Near Field and Transitional Regions				
Power Density Off Main Beam Axis at 1 Antenna	$P_{DNF\text{-}off\text{-}axis}$	0.28	mW/cm^2	$16\,PRad / 100\,\pi D_{NF}^2$
Diameter Removed				Meets Controlled Limits
				Does not meet Uncontrolled Limits
7. Off-Axis Safe Distances From Earth Station				
Minimum Elevation Angle of Antenna	α_{min}	10	Degrees	
Height of Object to be Cleared	h	3	meters	
Height center of antenna is above the ground	G_E	2	meters	
	α	S		
	10°	6.99 m		
	15°	4.63 m		
	20°	3.45 m		
	25°	2.73 m		
	30°	2.24 m		

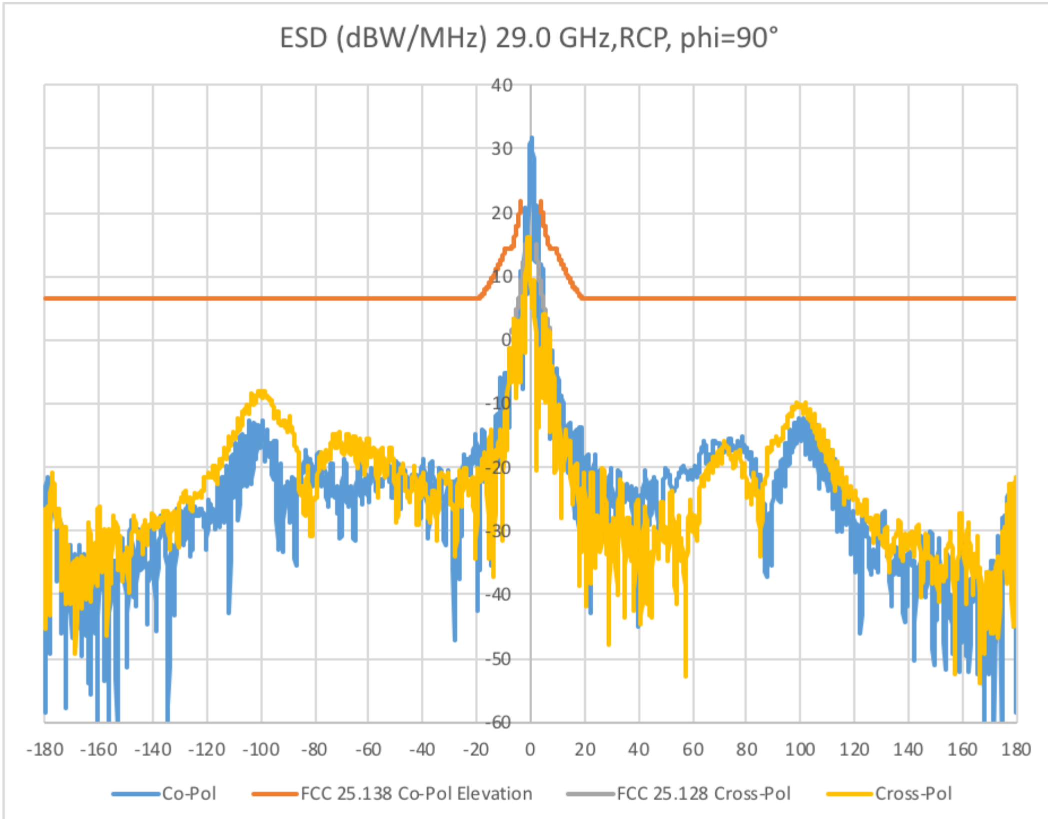
III. BB45 Off-Axis EIRP Spectral Density Patterns

A. Ka-band

1. 29.0 GHz



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20
10
0
-10
-20
-30
-40
-50
-60
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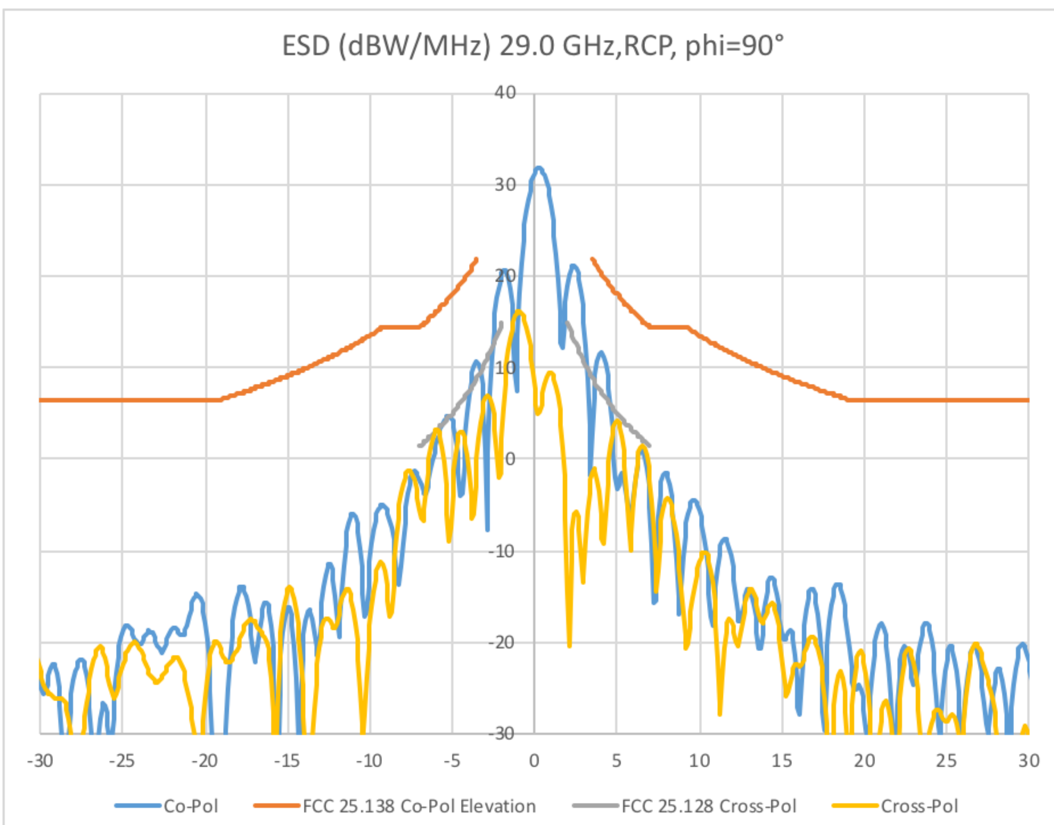
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol


ESD (dBW/MHz) 29.0 GHz,RCP, phi=90°
40
30
20
10
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-10
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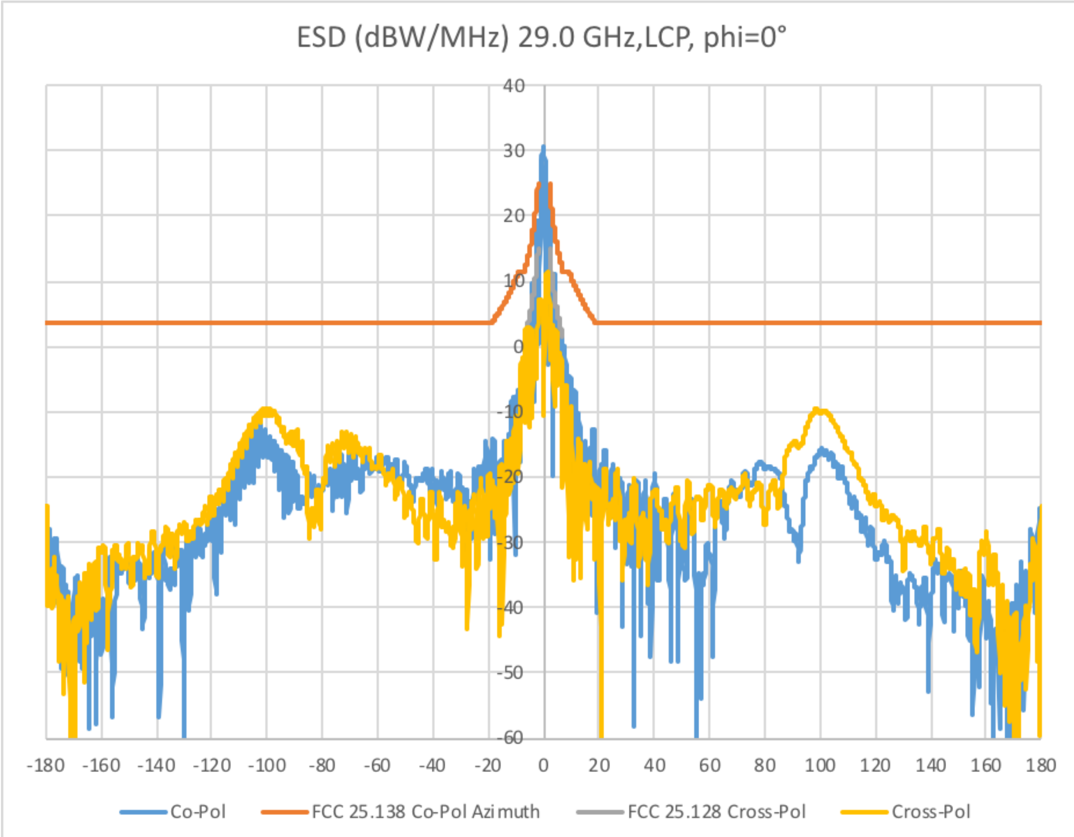
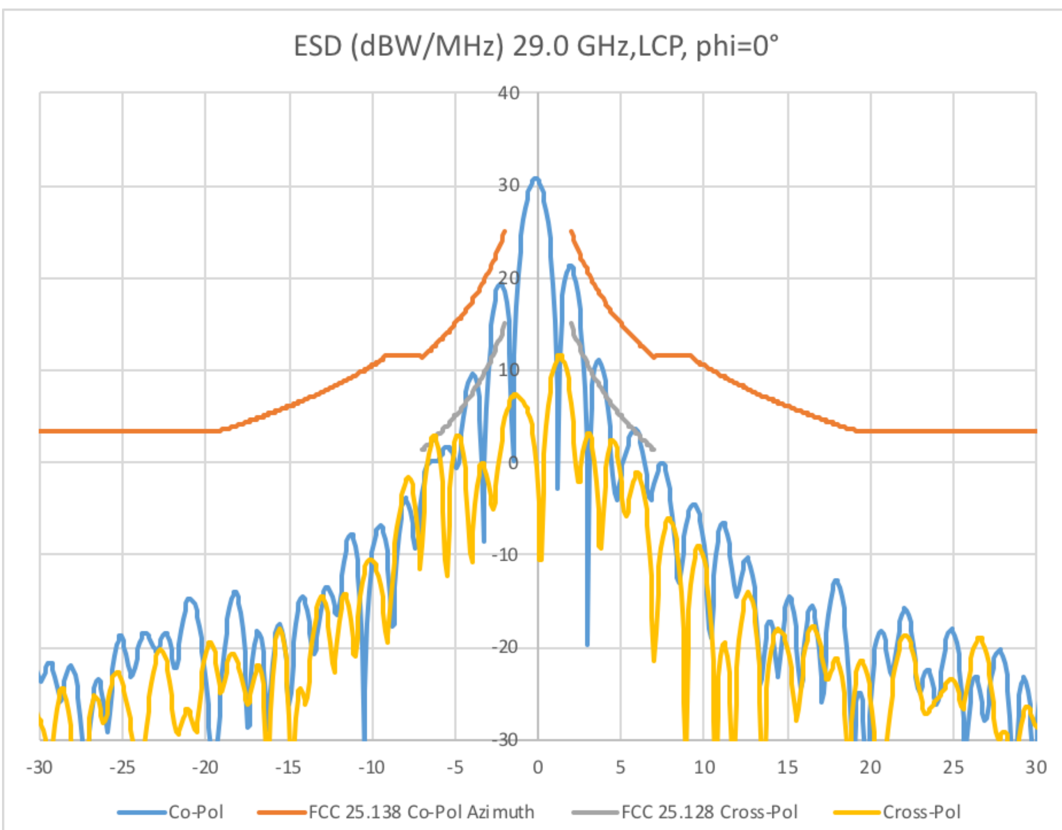
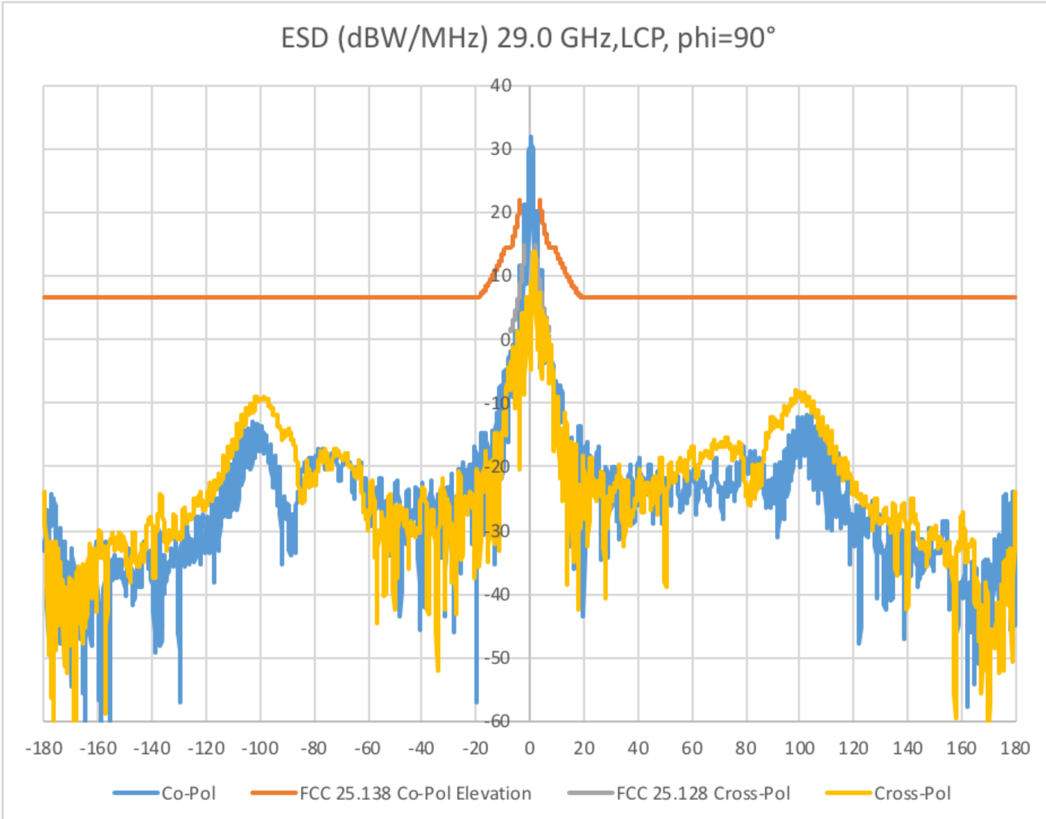
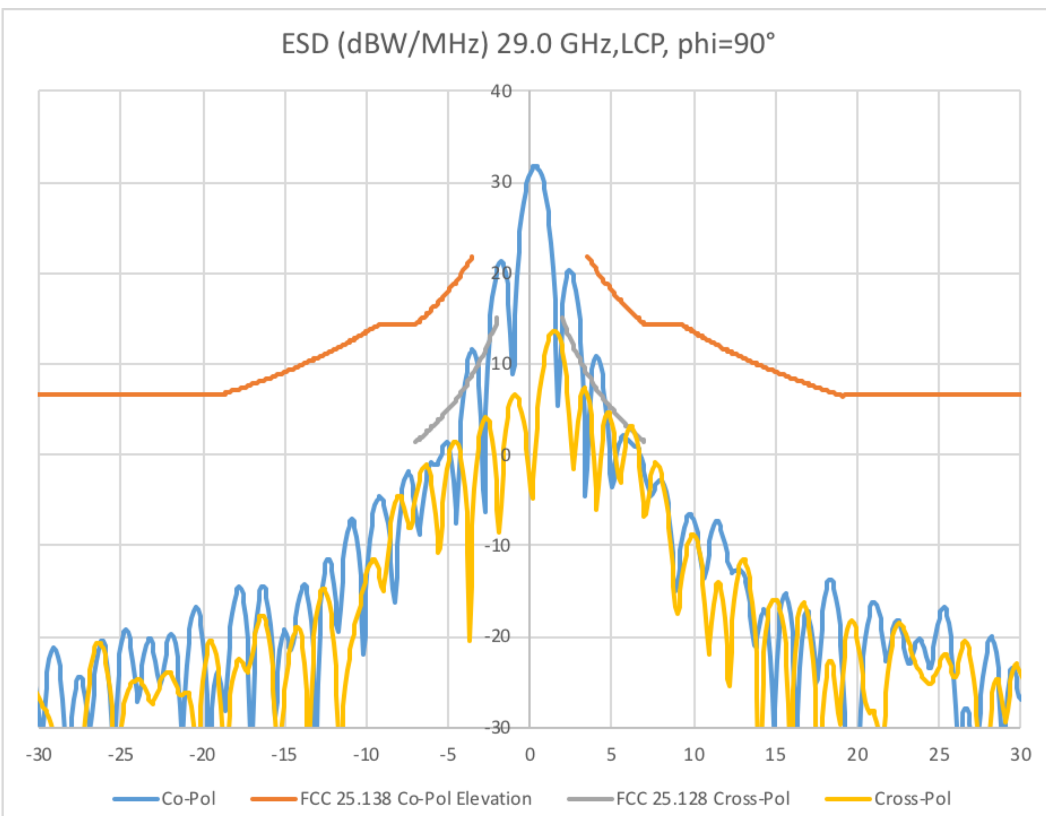
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

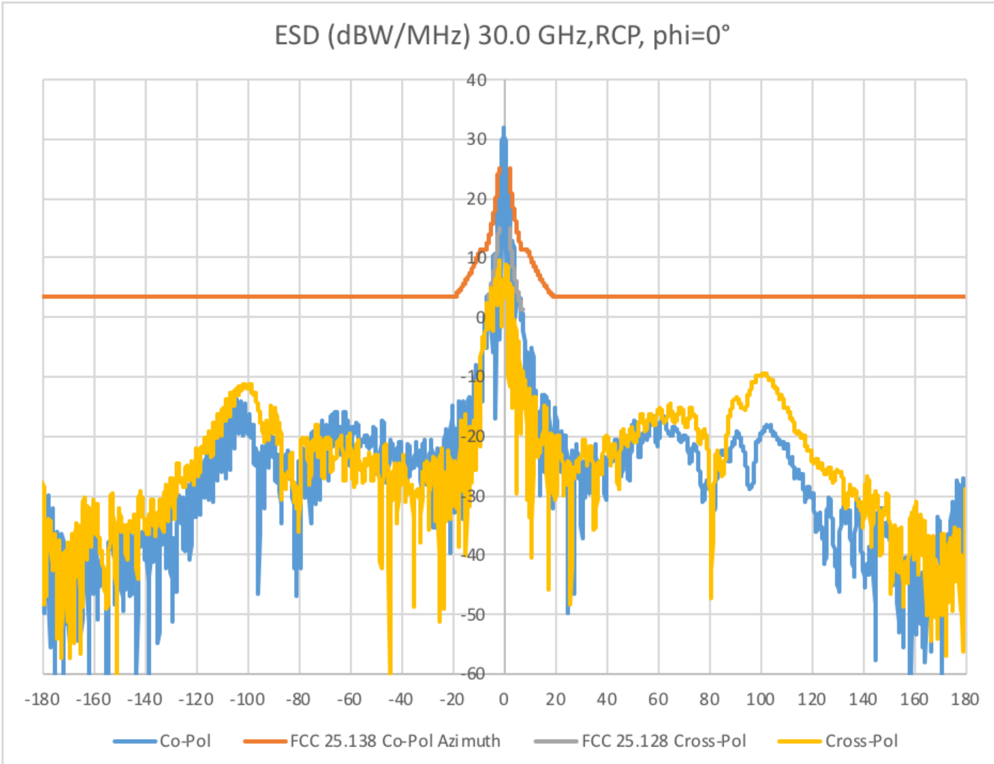

ESD (dBW/MHz) 29.0 GHz,LCP, phi=0°
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
Co-Pol
FCC 25.138 Co-Pol Azimuth
FCC 25.128 Cross-Pol
Cross-Pol

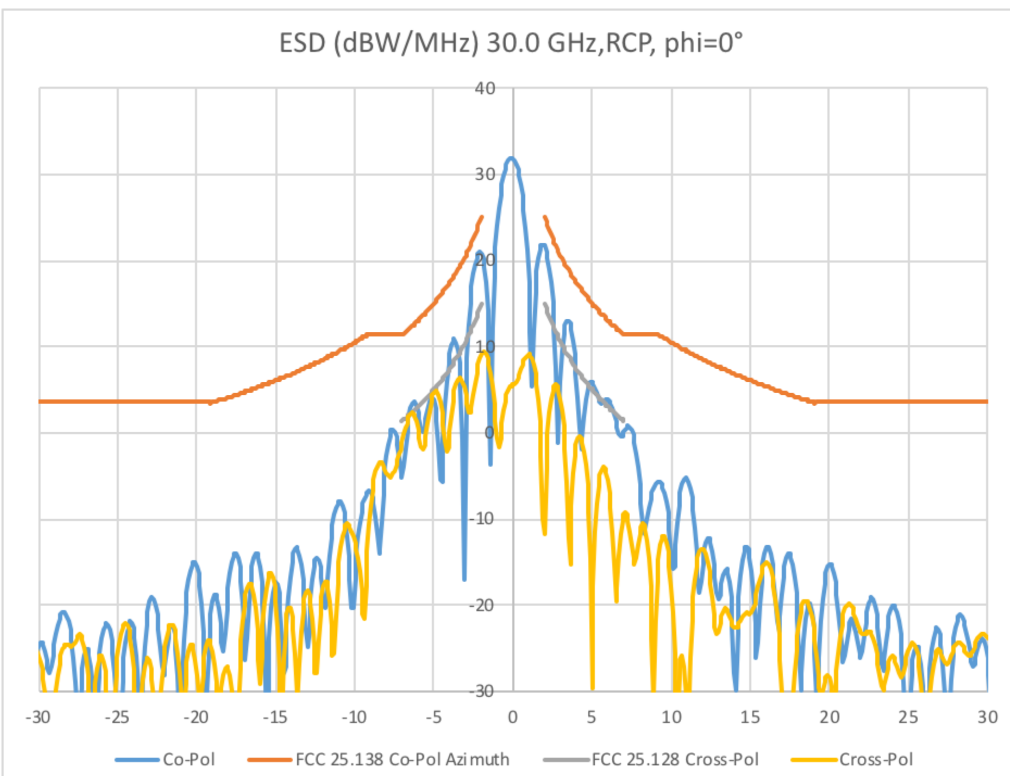

ESD (dBW/MHz) 29.0 GHz,LCP, phi=0°
40
30
20
10
0
-10
-20
-30
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Co-Pol
FCC 25.138 Co-Pol Azimuth
FCC 25.128 Cross-Pol
Cross-Pol

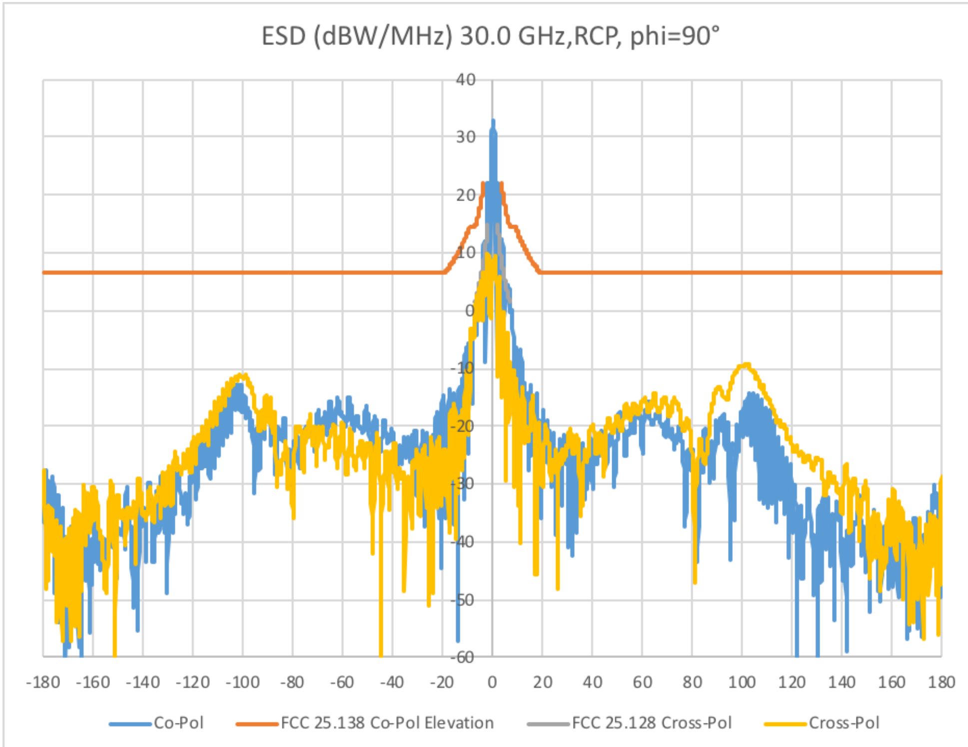

ESD (dBW/MHz) 29.0 GHz,LCP, phi=90°
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

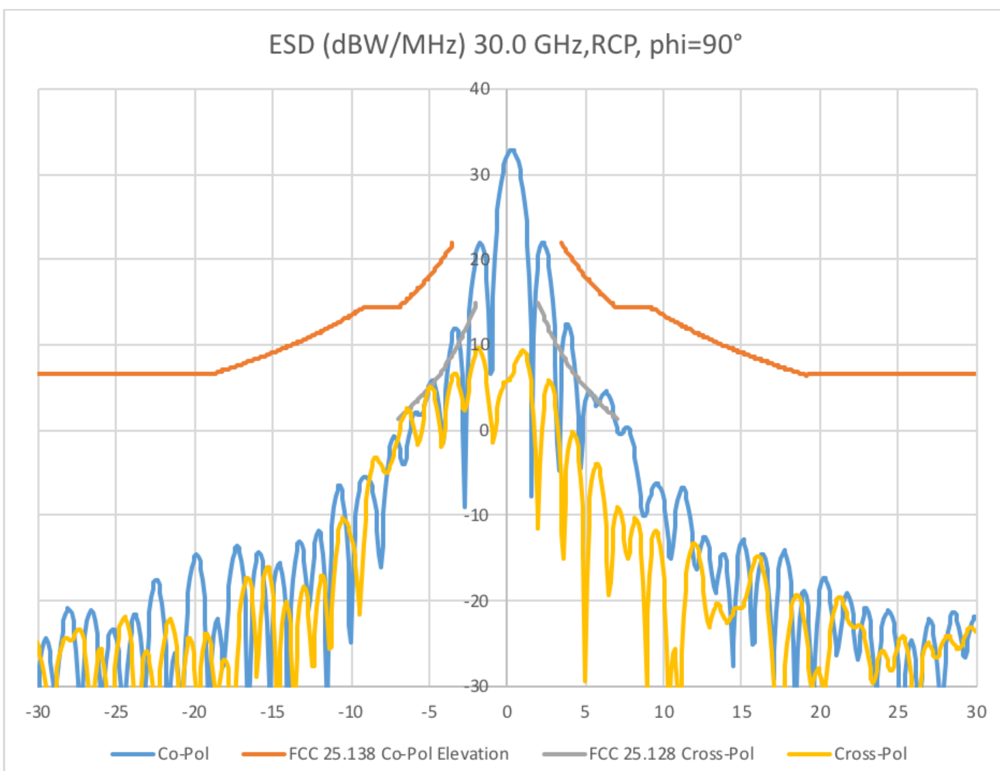

ESD (dBW/MHz) 29.0 GHz,LCP, phi=90°
40
30
20
10
0
-10
-20
-30
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

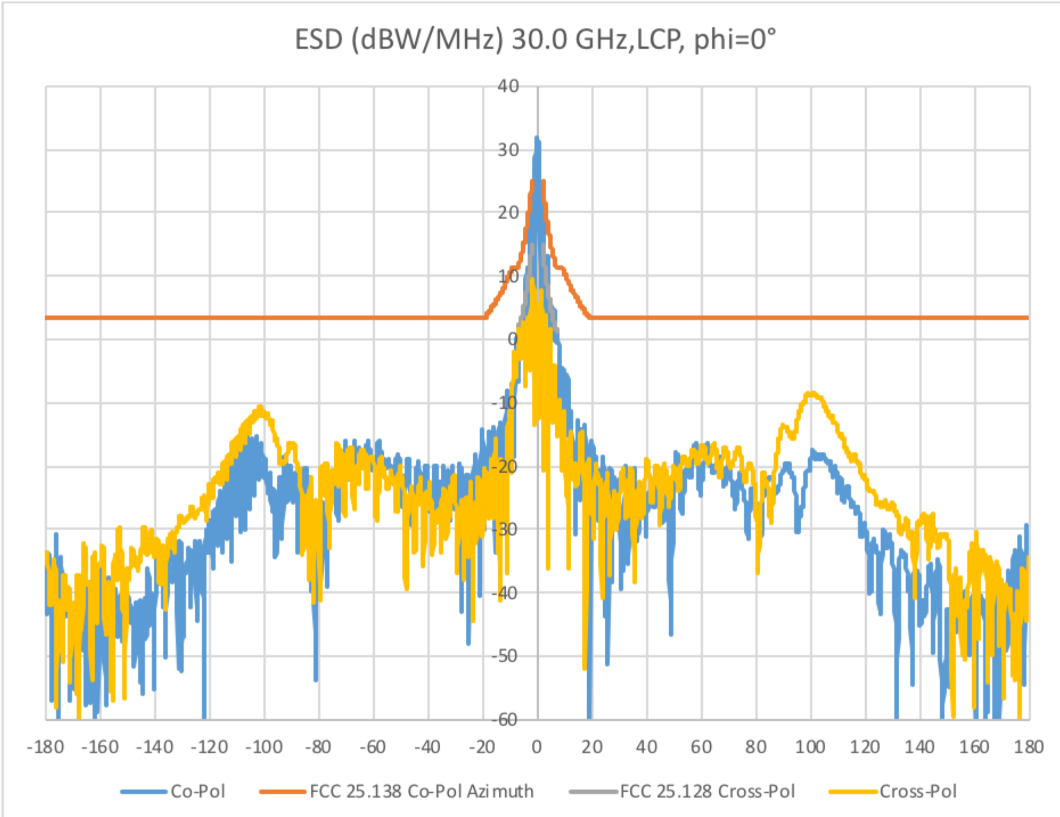
2. 30.0 GHz (Commercial)



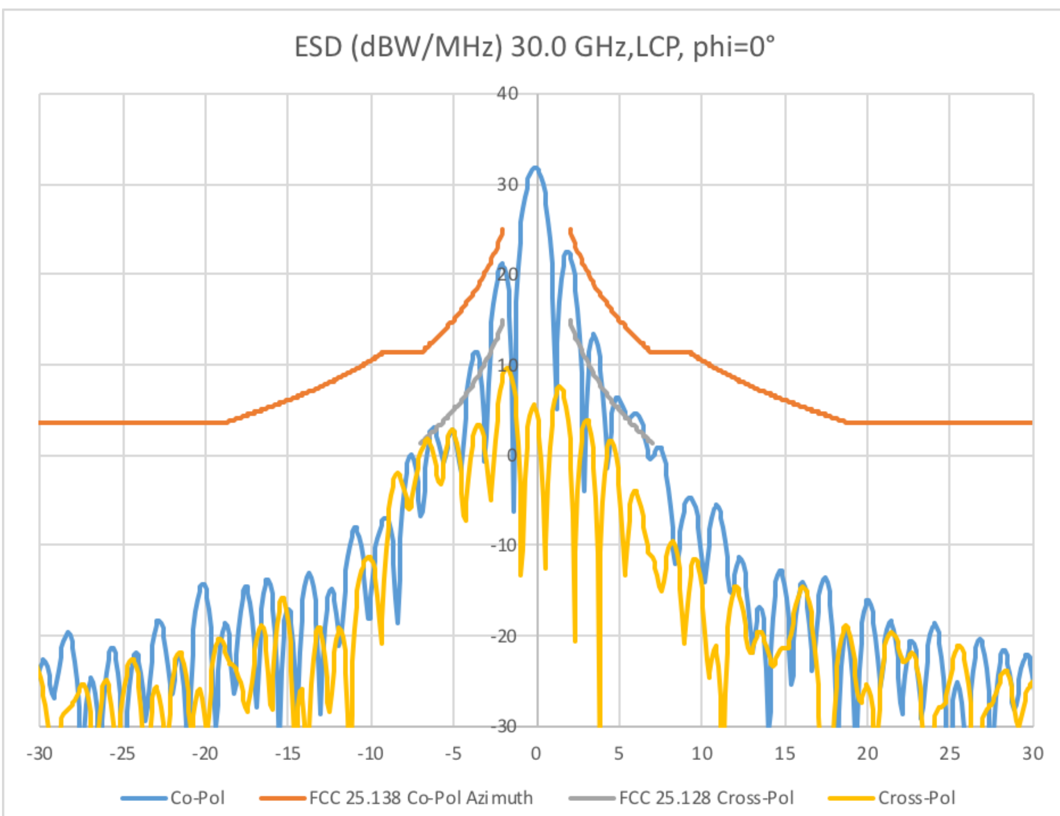



ESD (dBW/MHz) 30.0 GHz,RCP, phi=90°
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

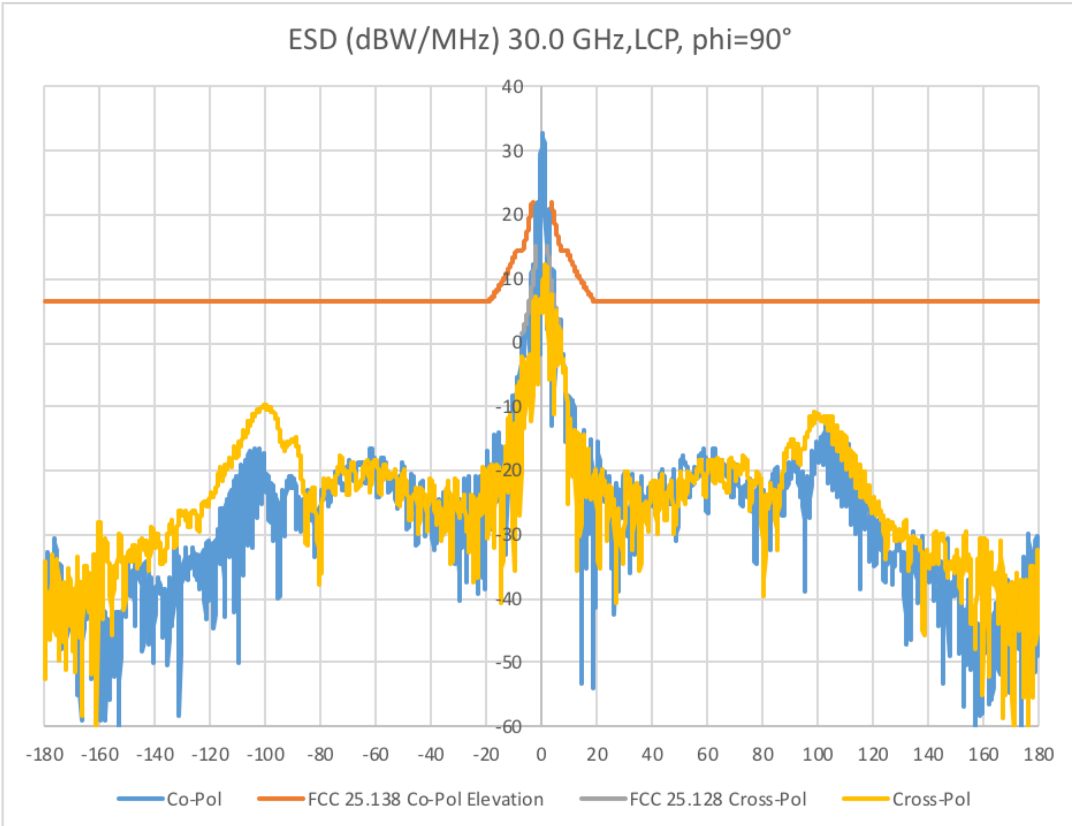

ESD (dBW/MHz) 30.0 GHz,RCP, phi=90°
40
30
20
10
0
-10
-20
-30
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

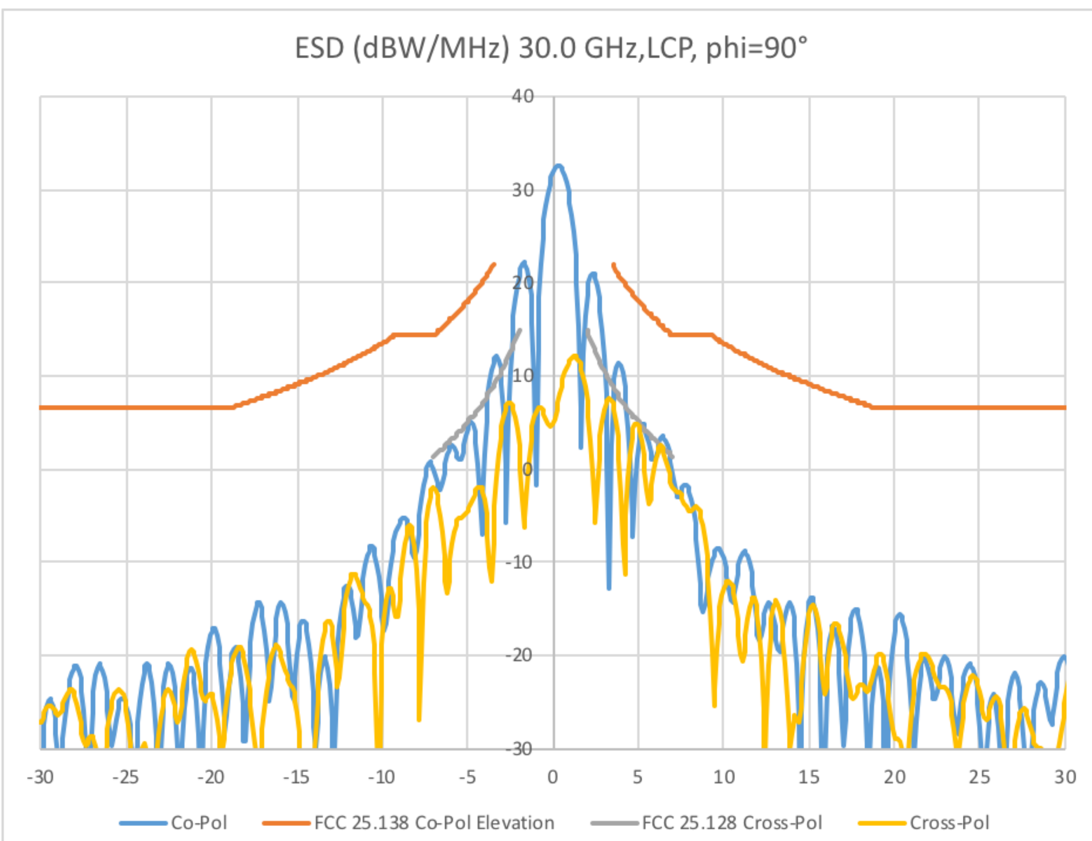


ESD (dBW/MHz) 30.0 GHz,LCP, phi=0°
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
FCC 25.138 Co-Pol Azimuth
FCC 25.128 Cross-Pol
Cross-Pol

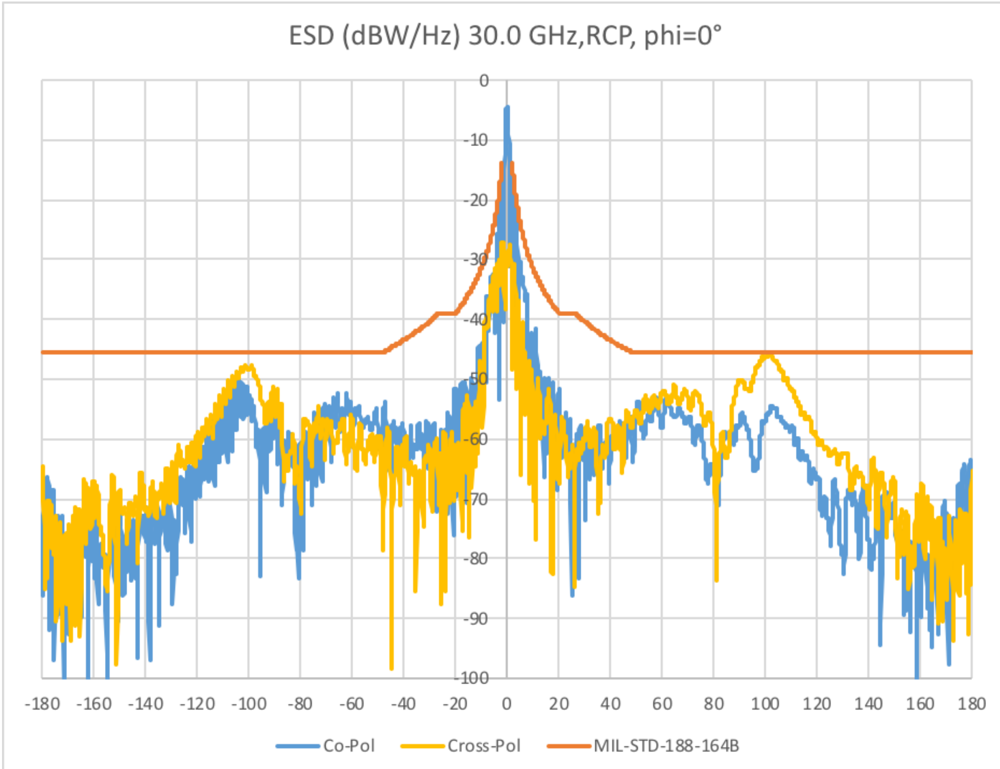


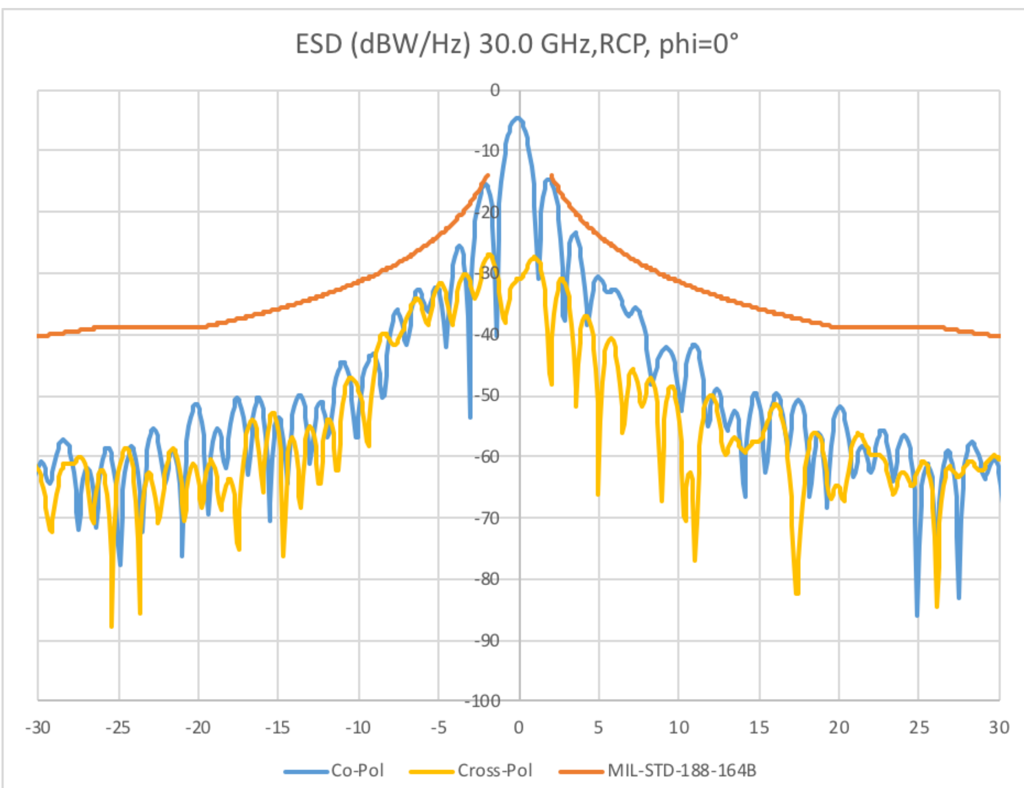
ESD (dBW/MHz) 30.0 GHz,LCP, phi=0°
40
30
20
10
0
-10
-20
-30
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
FCC 25.138 Co-Pol Azimuth
FCC 25.128 Cross-Pol
Cross-Pol

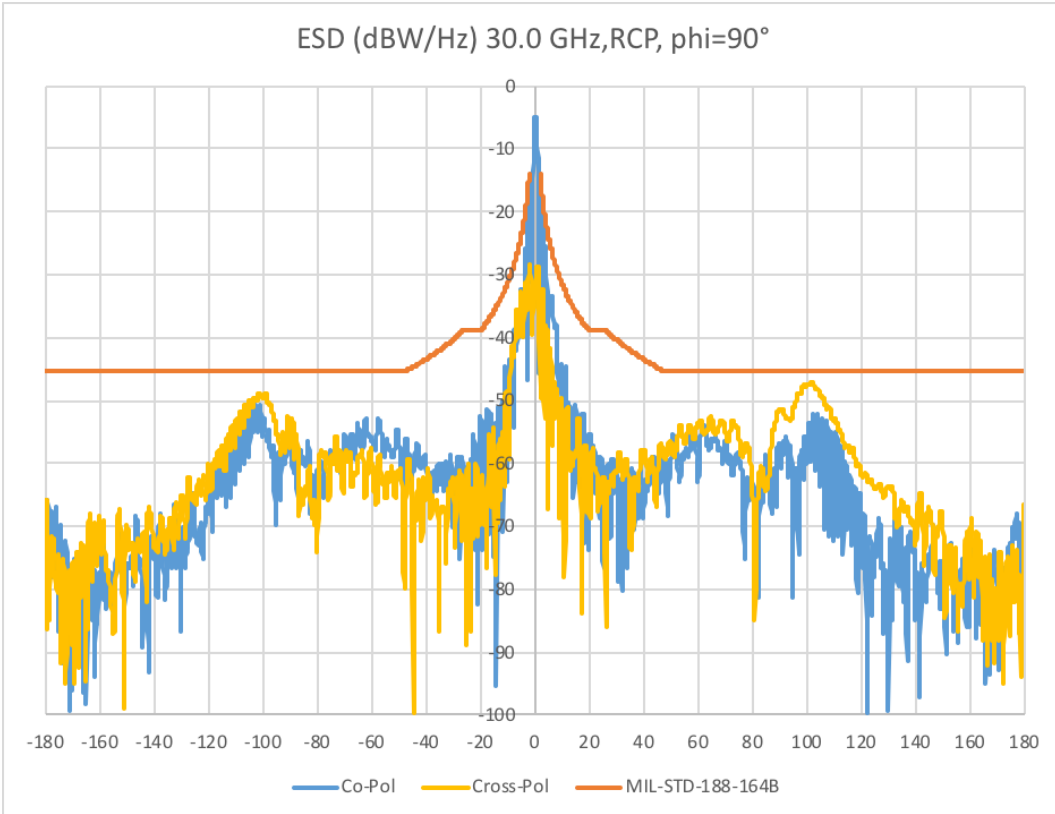

ESD (dBW/MHz) 30.0 GHz,LCP, phi=90°
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

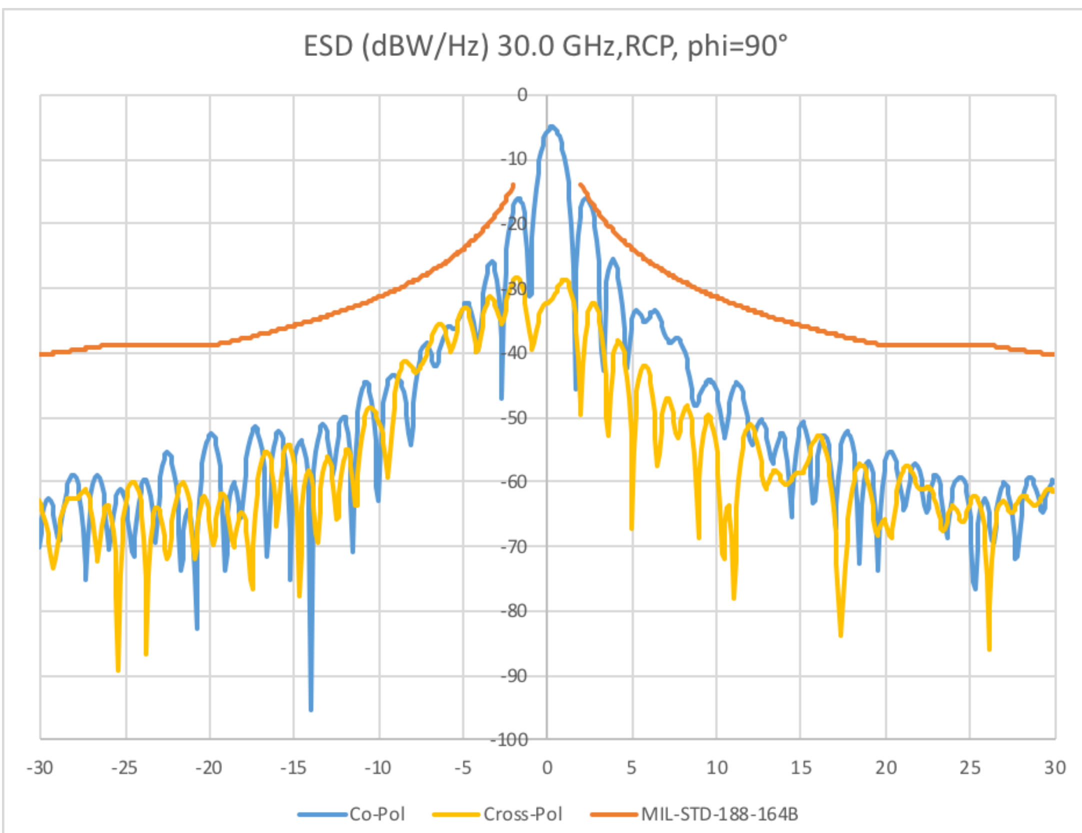

ESD (dBW/MHz) 30.0 GHz,LCP, phi=90°
40
30
20
10
0
-10
-20
-30
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
FCC 25.138 Co-Pol Elevation
FCC 25.128 Cross-Pol
Cross-Pol

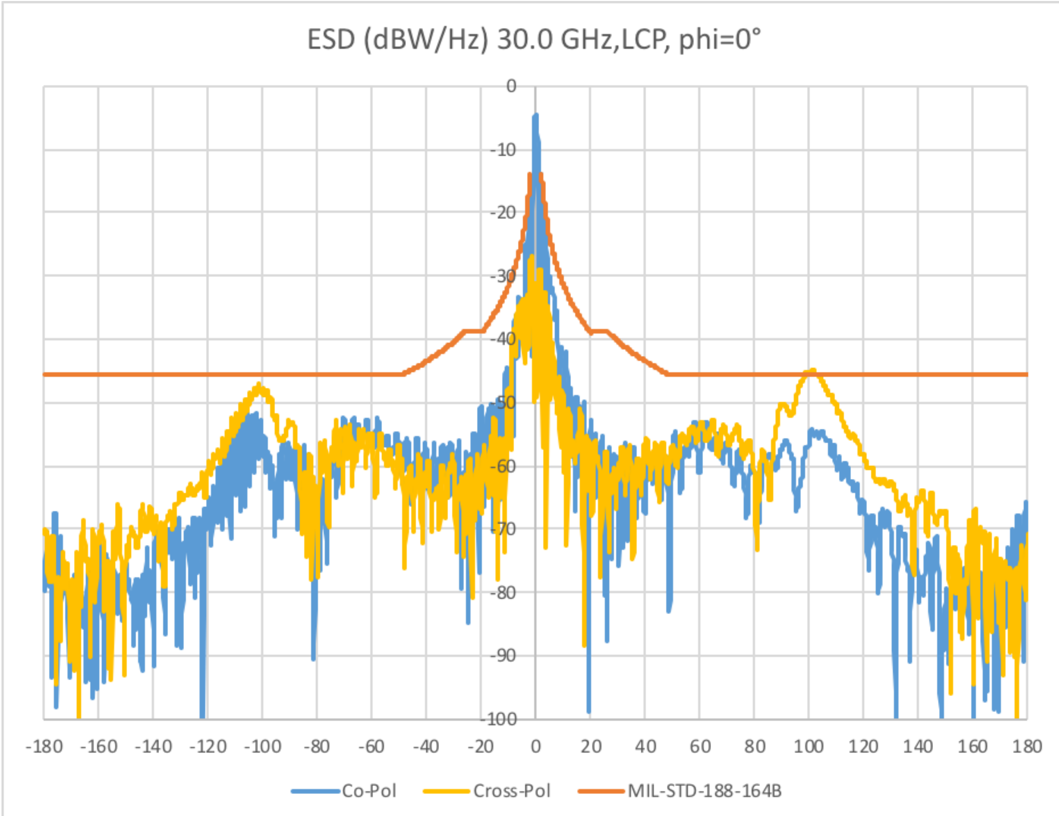
3. 30.0 GHz (Military)

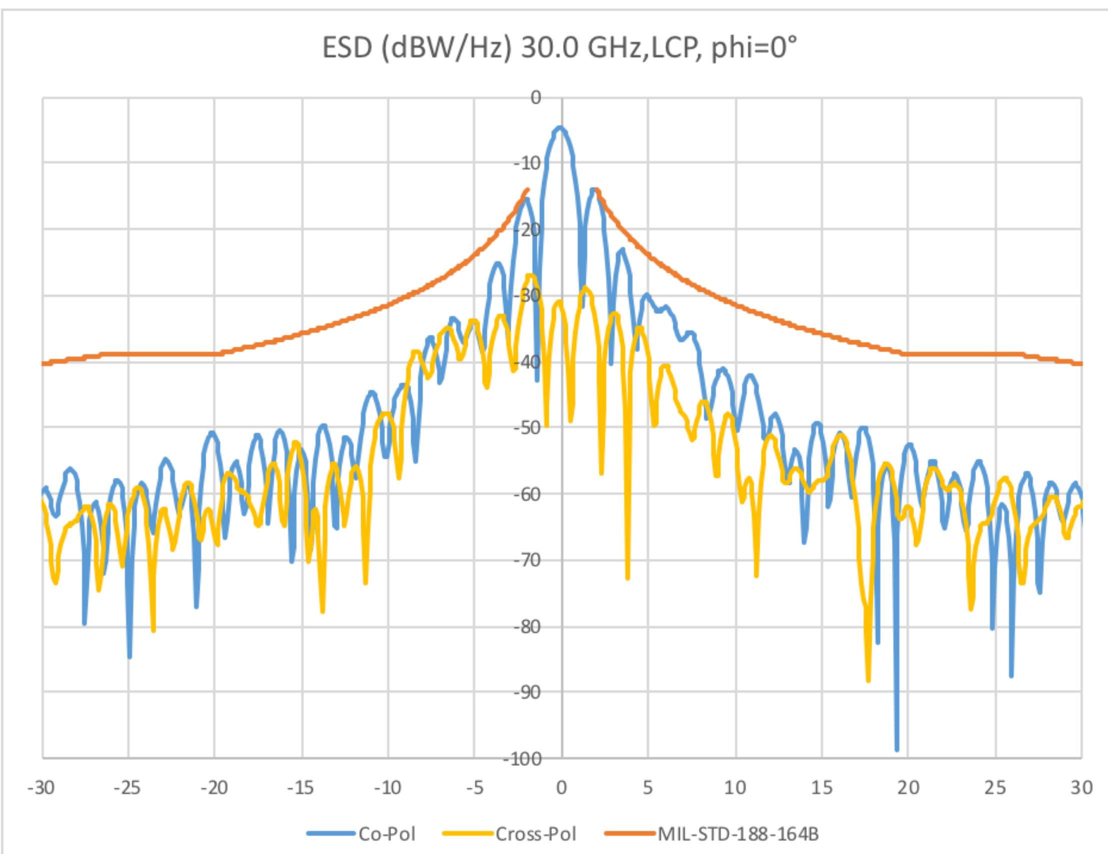


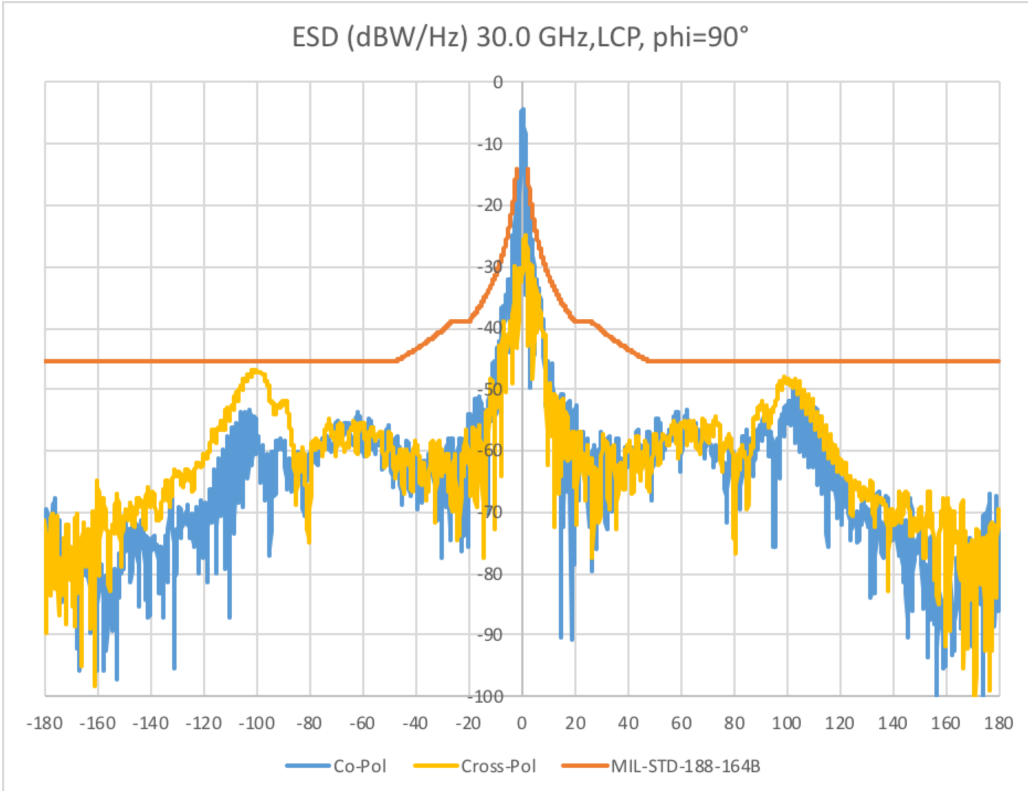


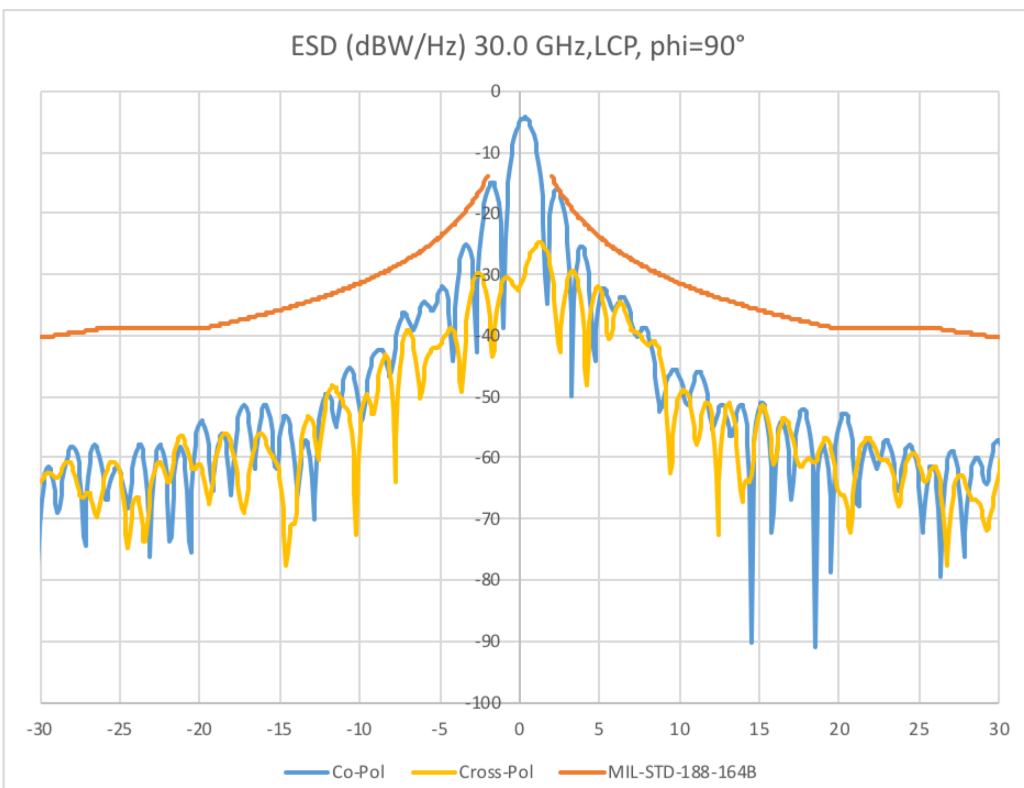

ESD (dBW/Hz) 30.0 GHz,RCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B


ESD (dBW/Hz) 30.0 GHz,RCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B

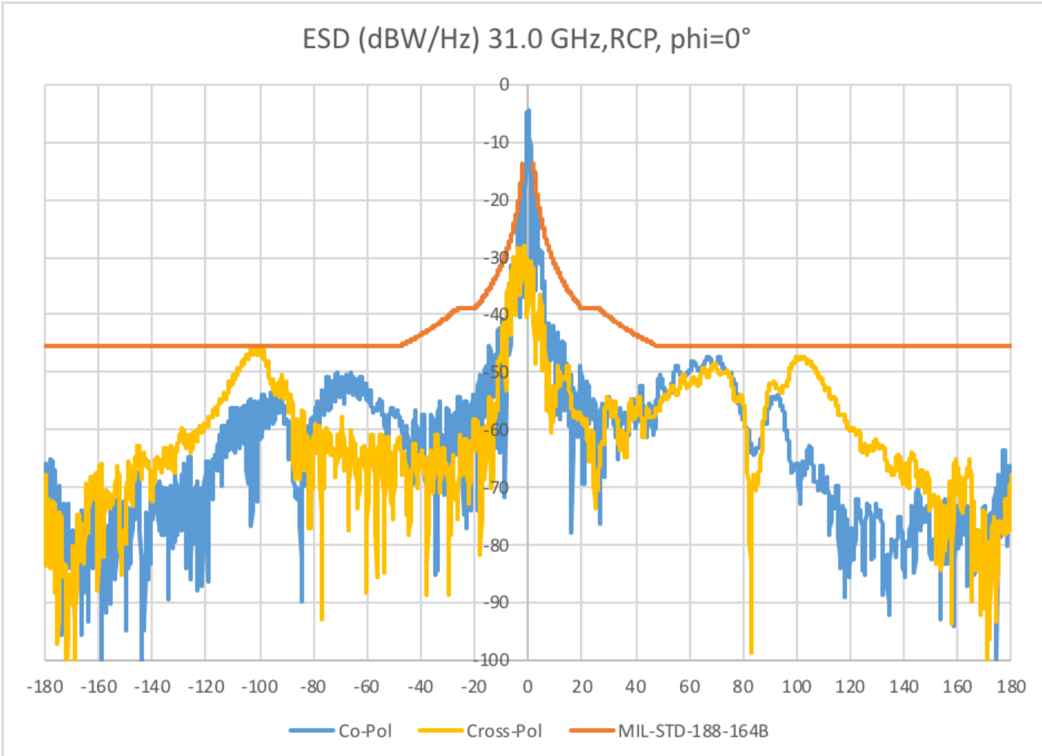

ESD (dBW/Hz) 30.0 GHz,LCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B

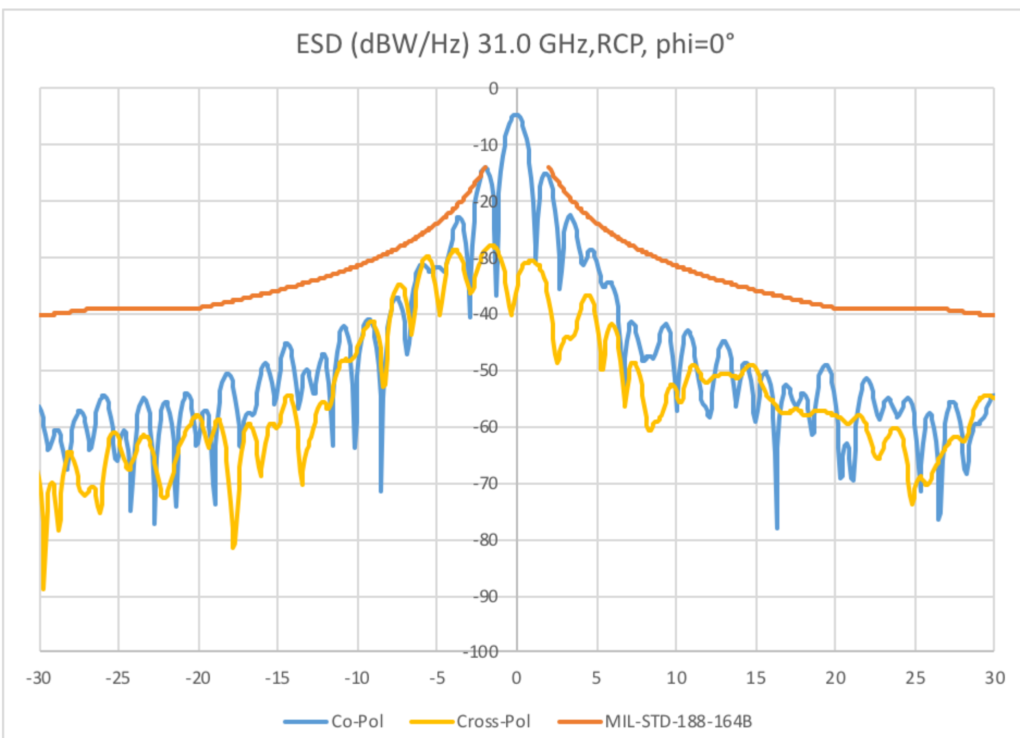

ESD (dBW/Hz) 30.0 GHz,LCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B

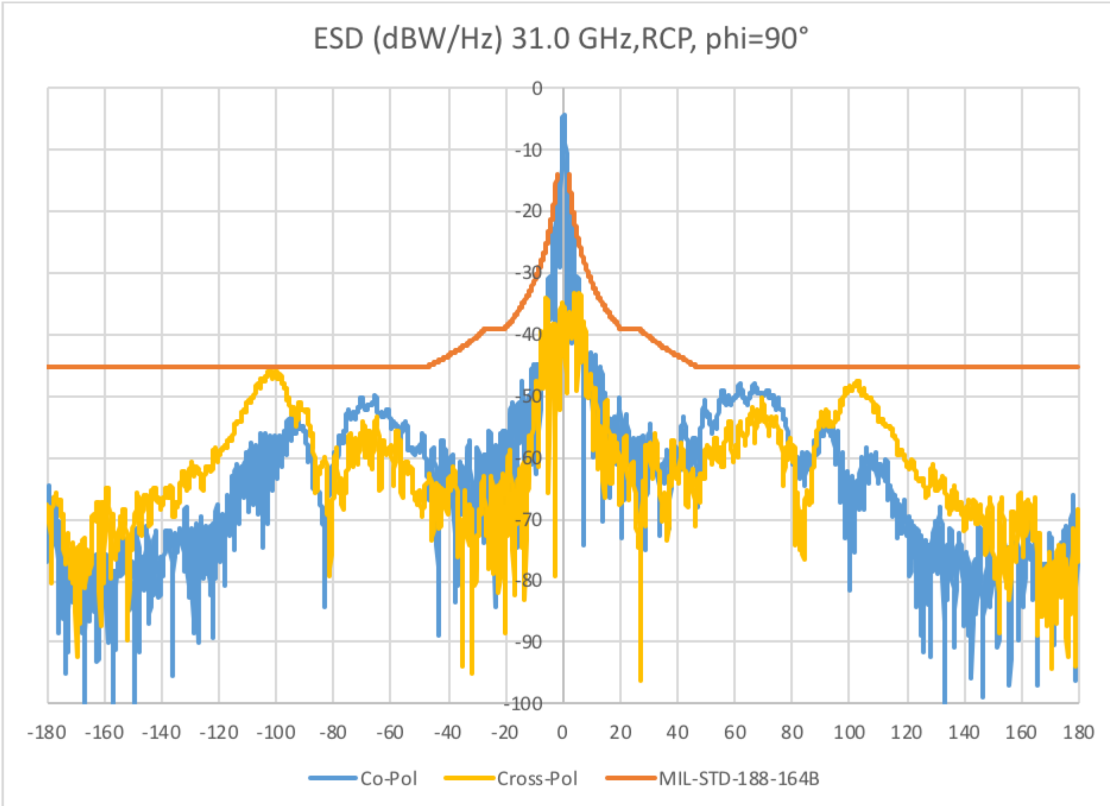

ESD (dBW/Hz) 30.0 GHz,LCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B

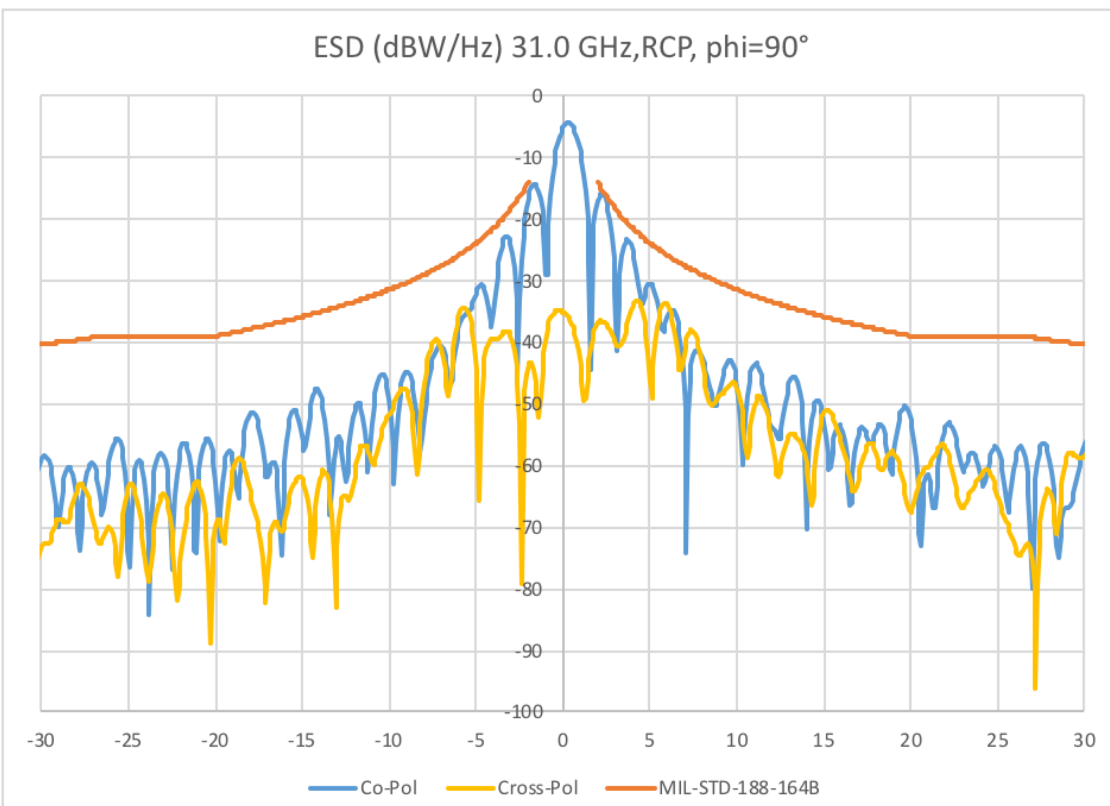

ESD (dBW/Hz) 30.0 GHz,LCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B

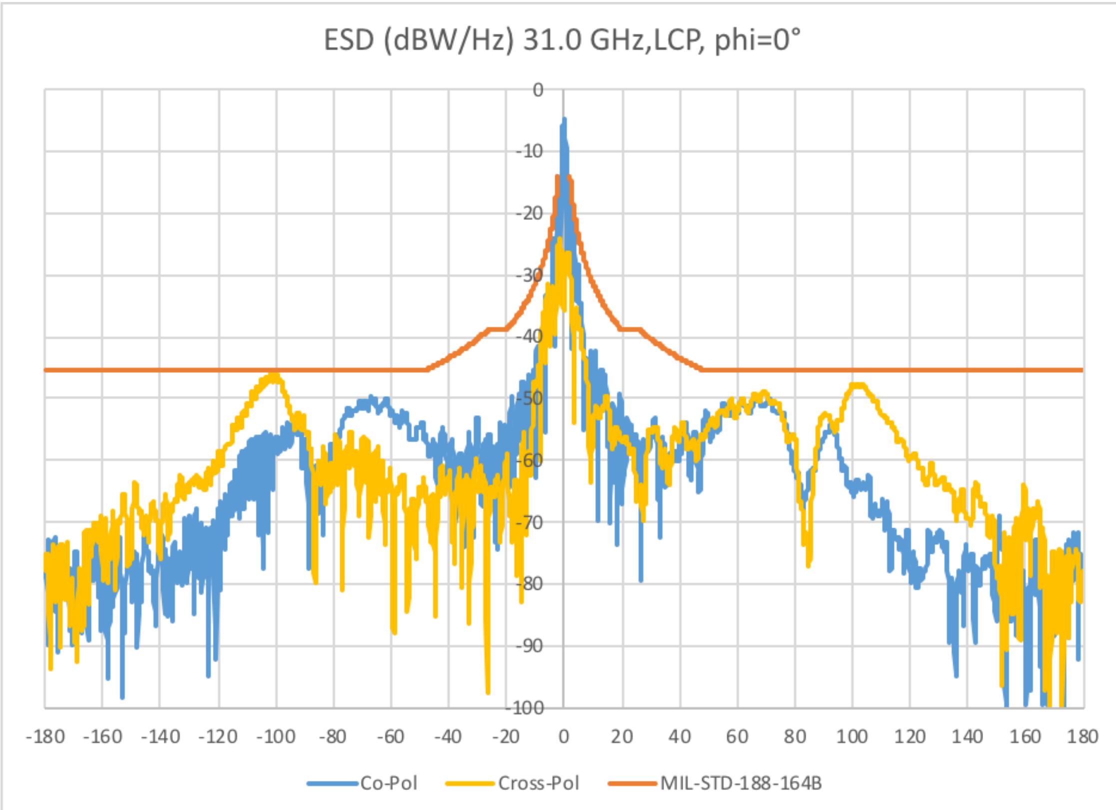
4. 31.0 GHz


ESD (dBW/Hz) 31.0 GHz,RCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B

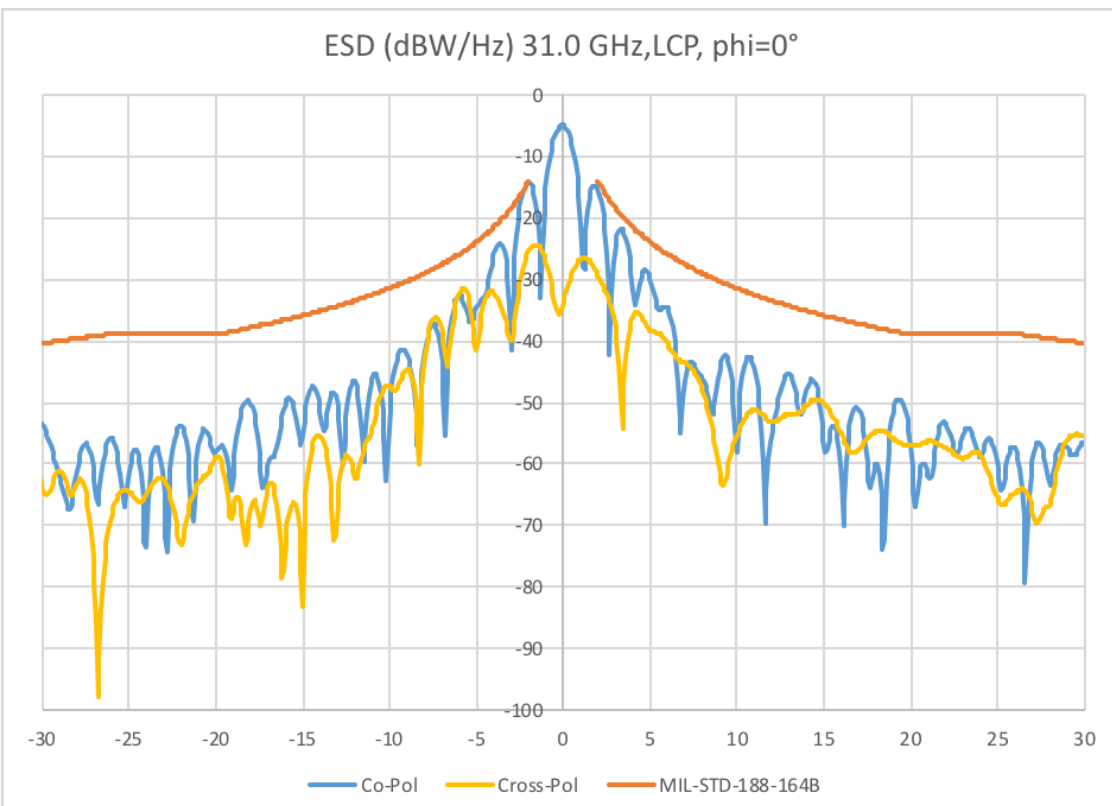

ESD (dBW/Hz) 31.0 GHz,RCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B


ESD (dBW/Hz) 31.0 GHz,RCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
Co-Pol
Cross-Pol
MIL-STD-188-164B

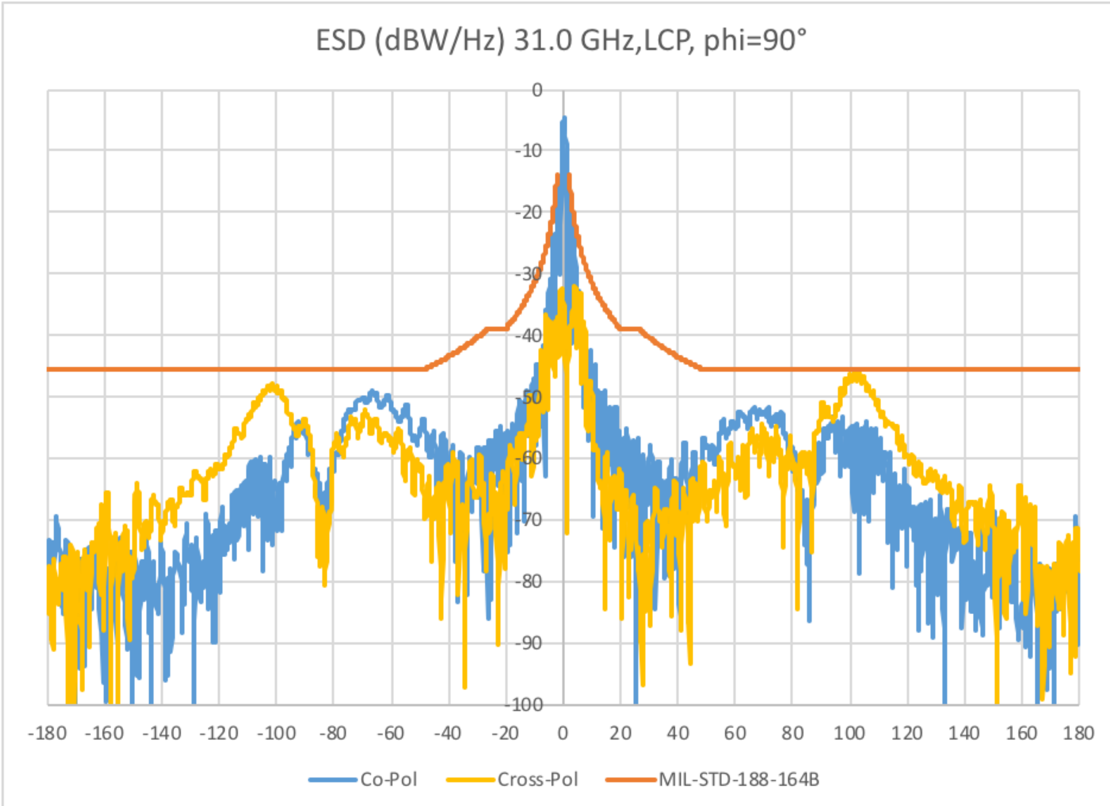

ESD (dBW/Hz) 31.0 GHz,RCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Co-Pol
Cross-Pol
MIL-STD-188-164B



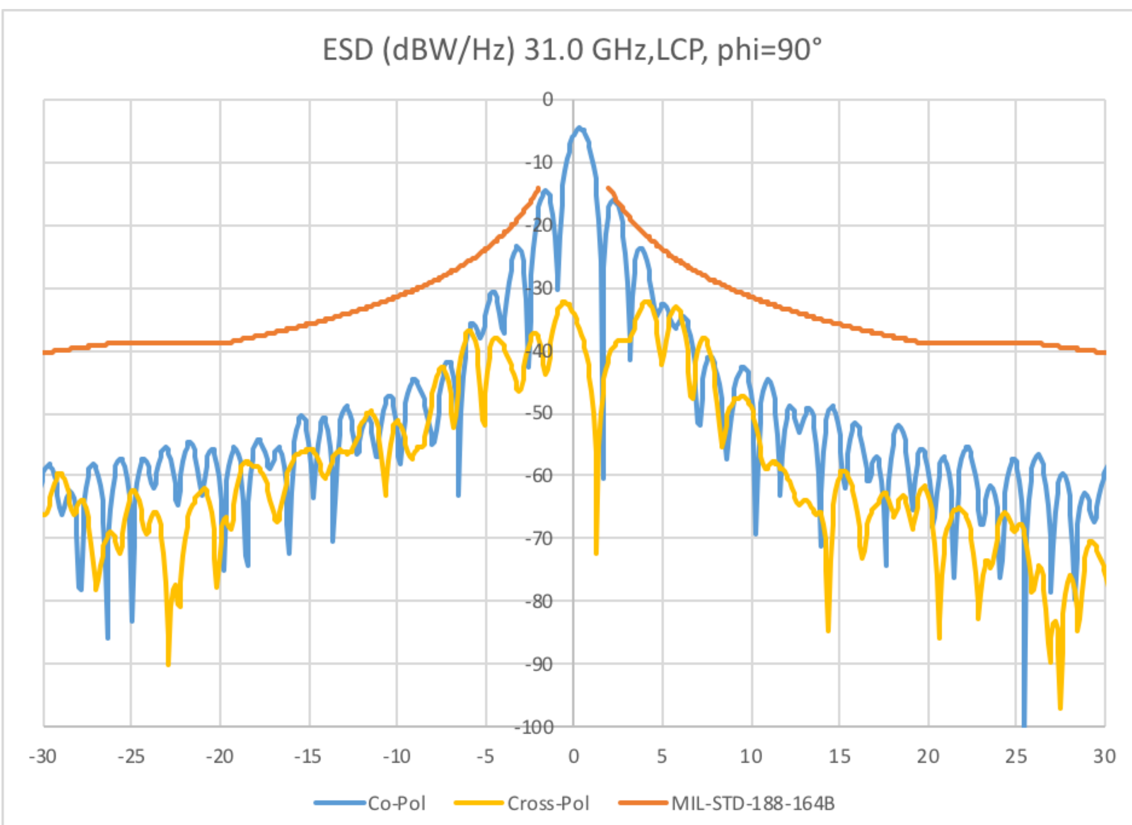
ESD (dBW/Hz) 31.0 GHz,LCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B



ESD (dBW/Hz) 31.0 GHz,LCP, phi=0°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B



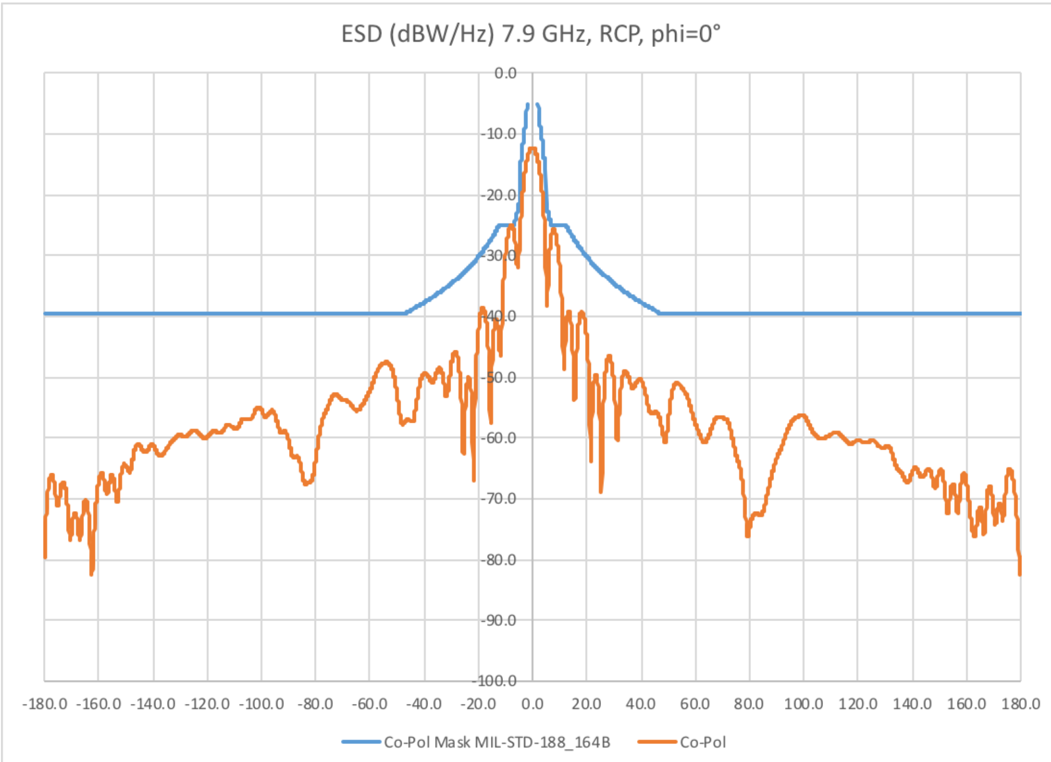
ESD (dBW/Hz) 31.0 GHz,LCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
Co-Pol
Cross-Pol
MIL-STD-188-164B

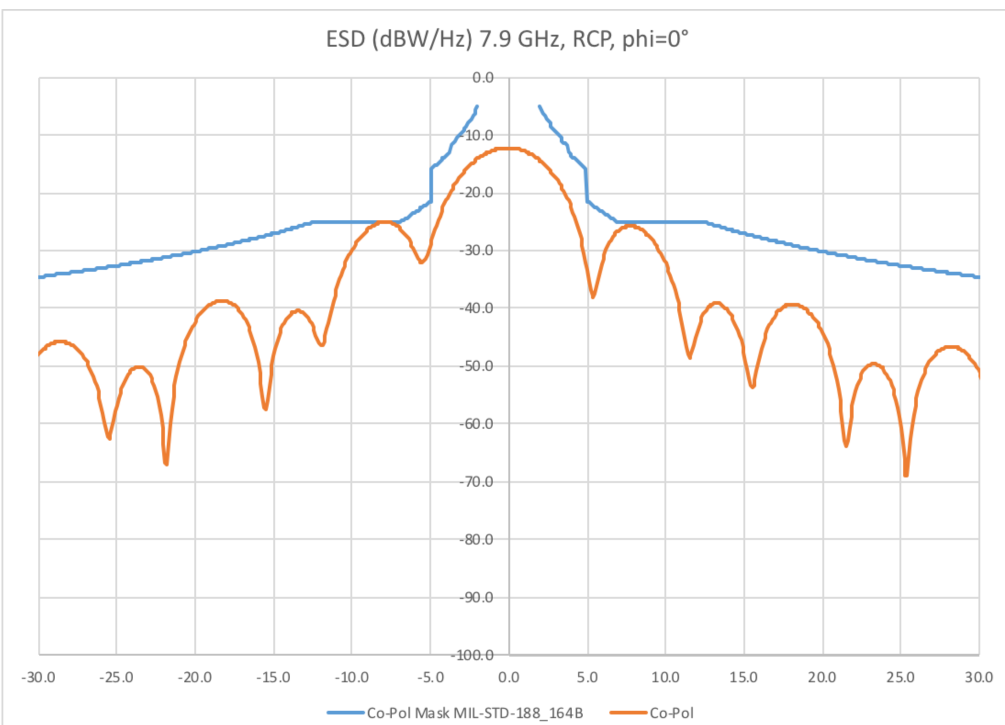


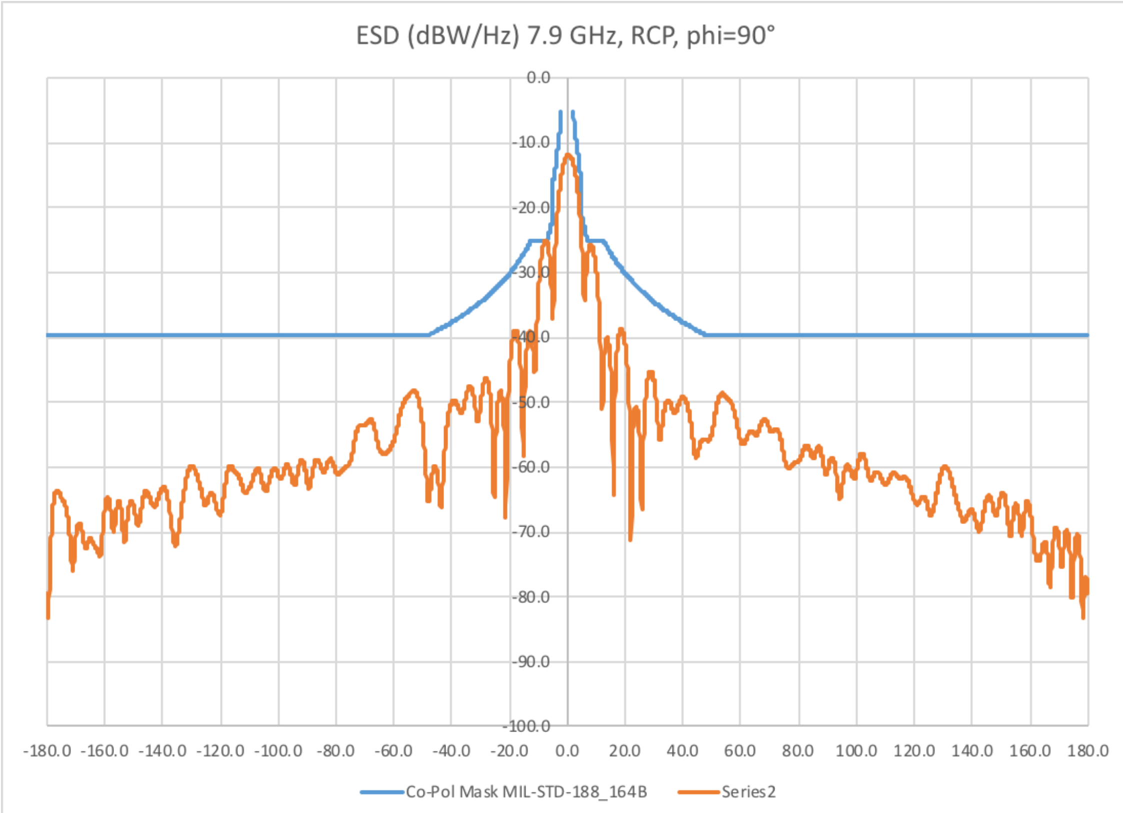
ESD (dBW/Hz) 31.0 GHz,LCP, phi=90°
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30
Co-Pol
Cross-Pol
MIL-STD-188-164B

A. X-band

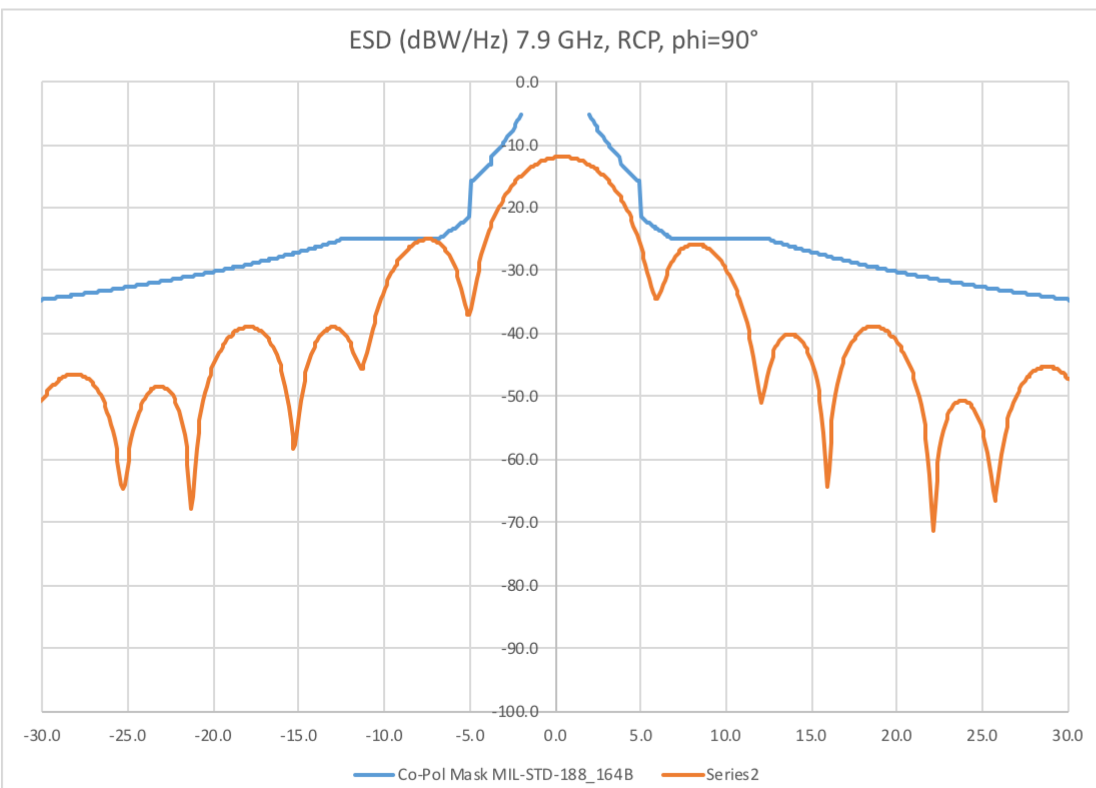
1. 7.90 GHz



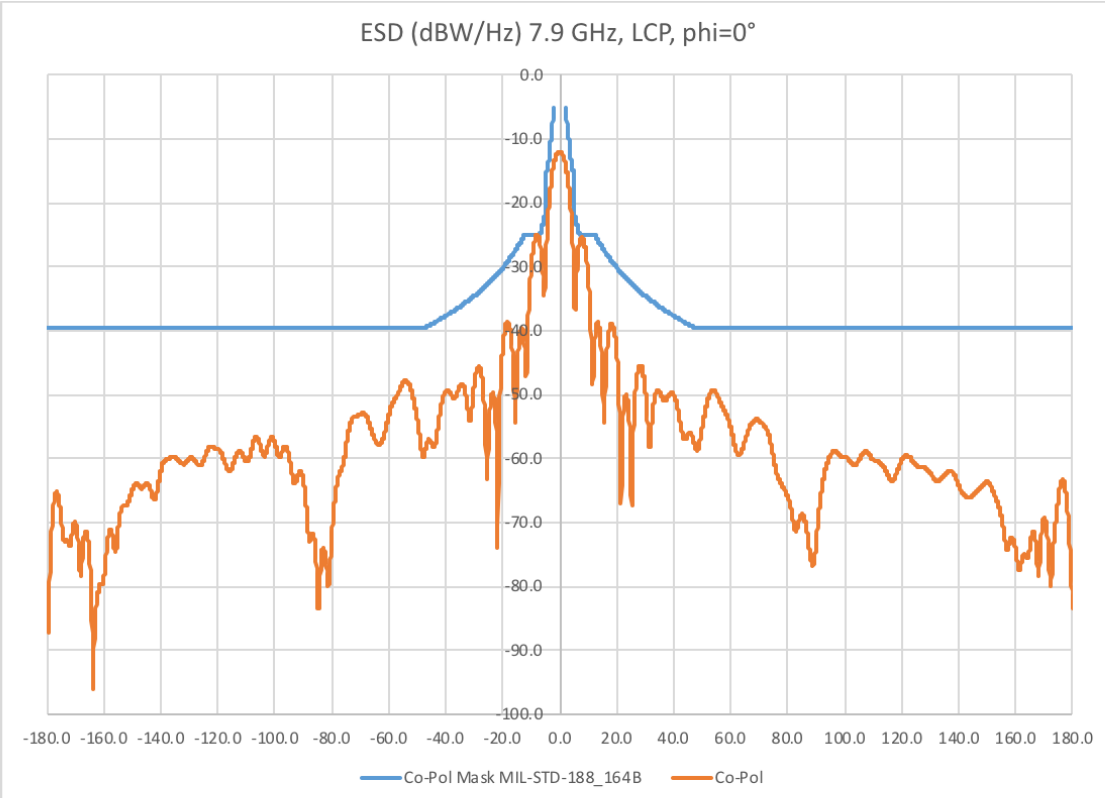


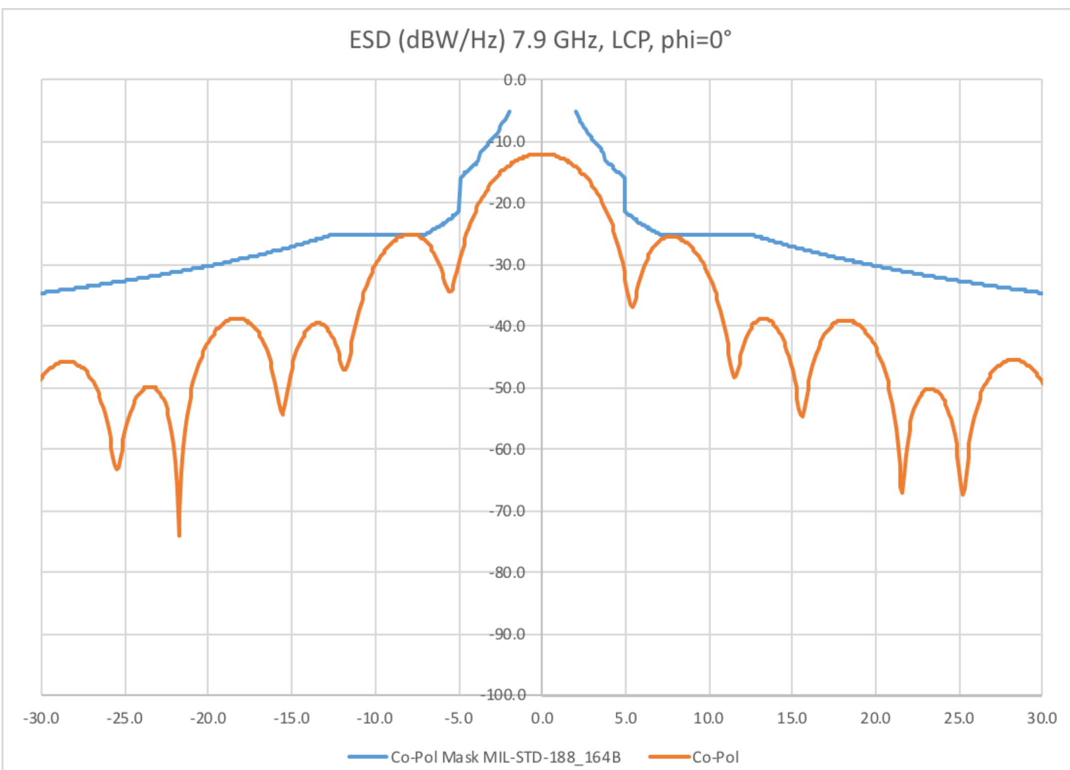


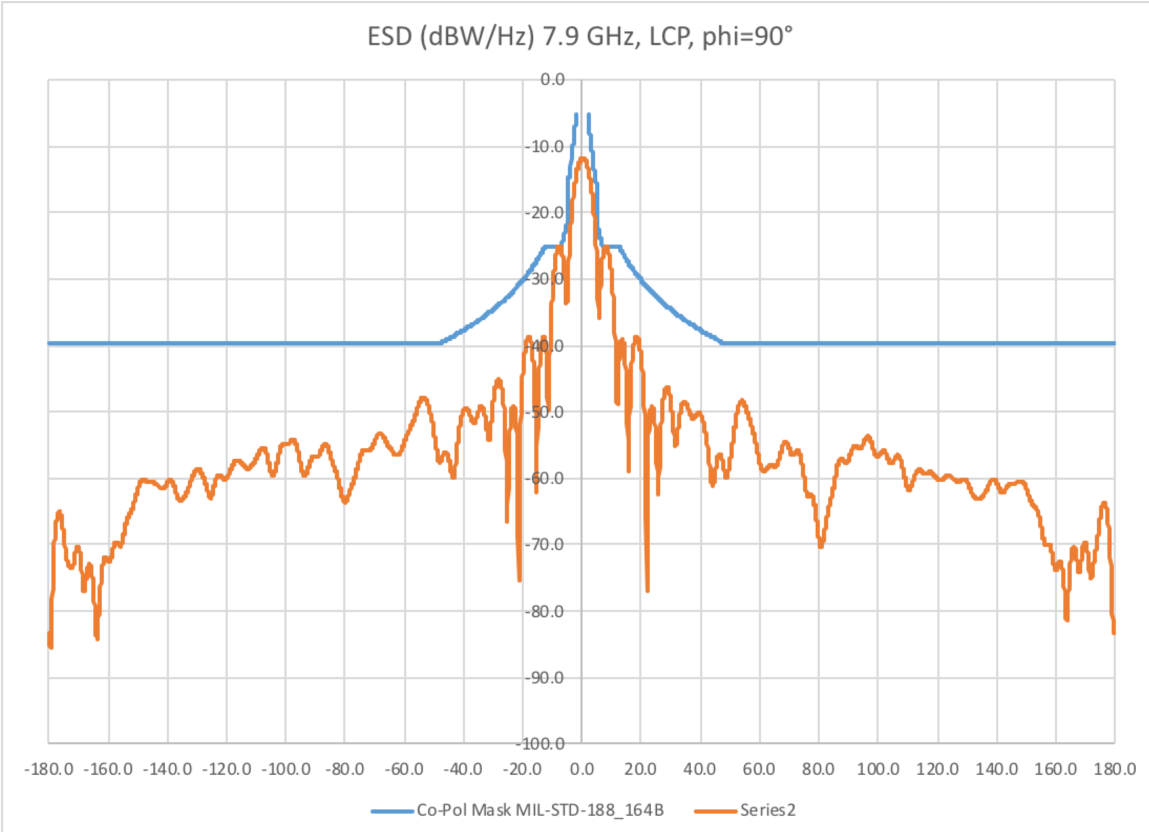
ESD (dBW/Hz) 7.9 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2

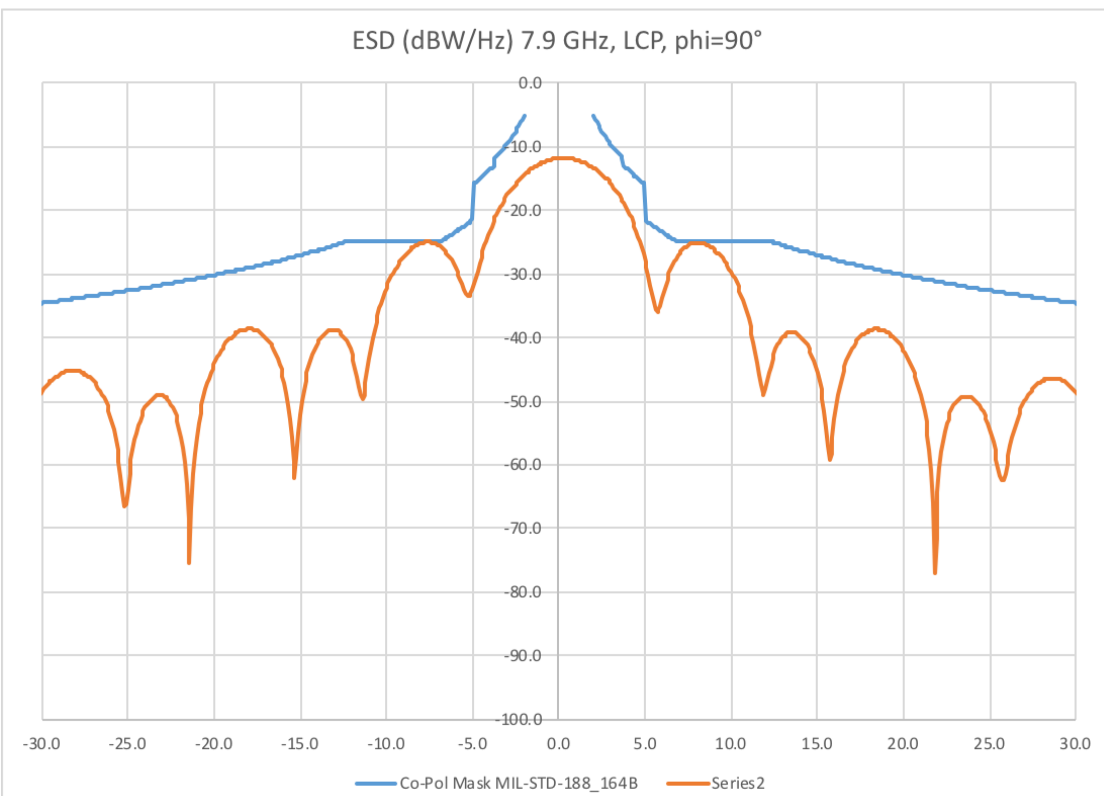


ESD (dBW/Hz) 7.9 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2

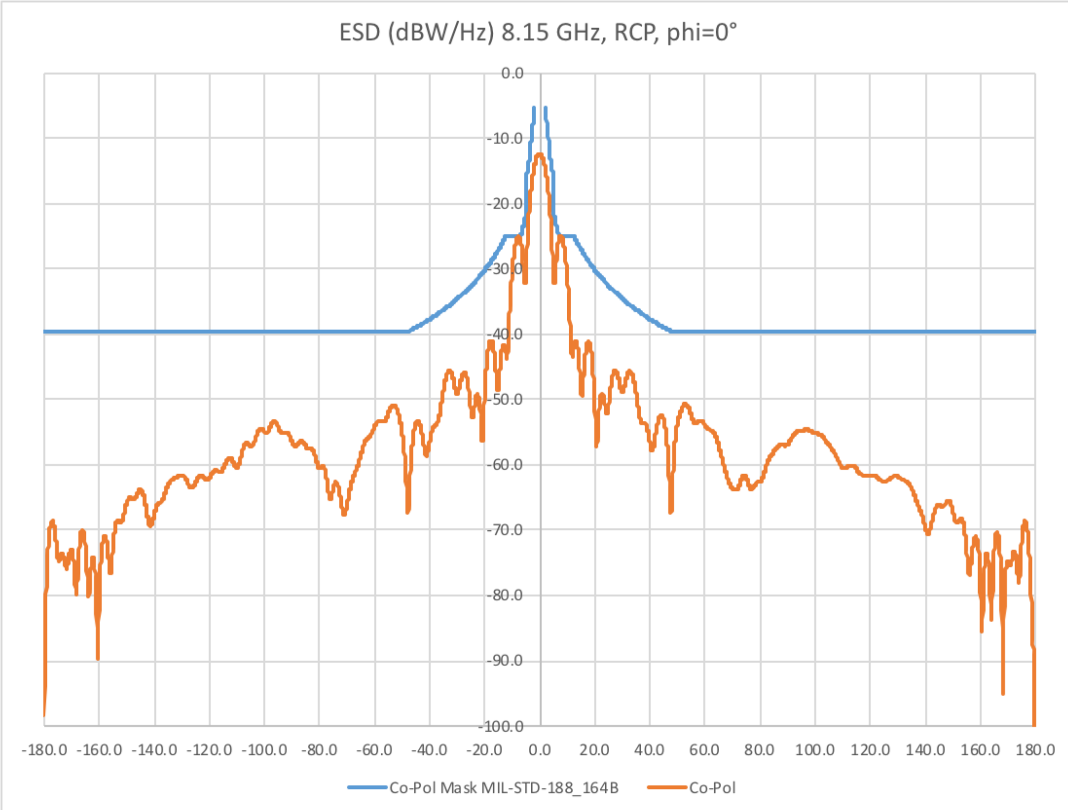

ESD (dBW/Hz) 7.9 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol


ESD (dBW/Hz) 7.9 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol

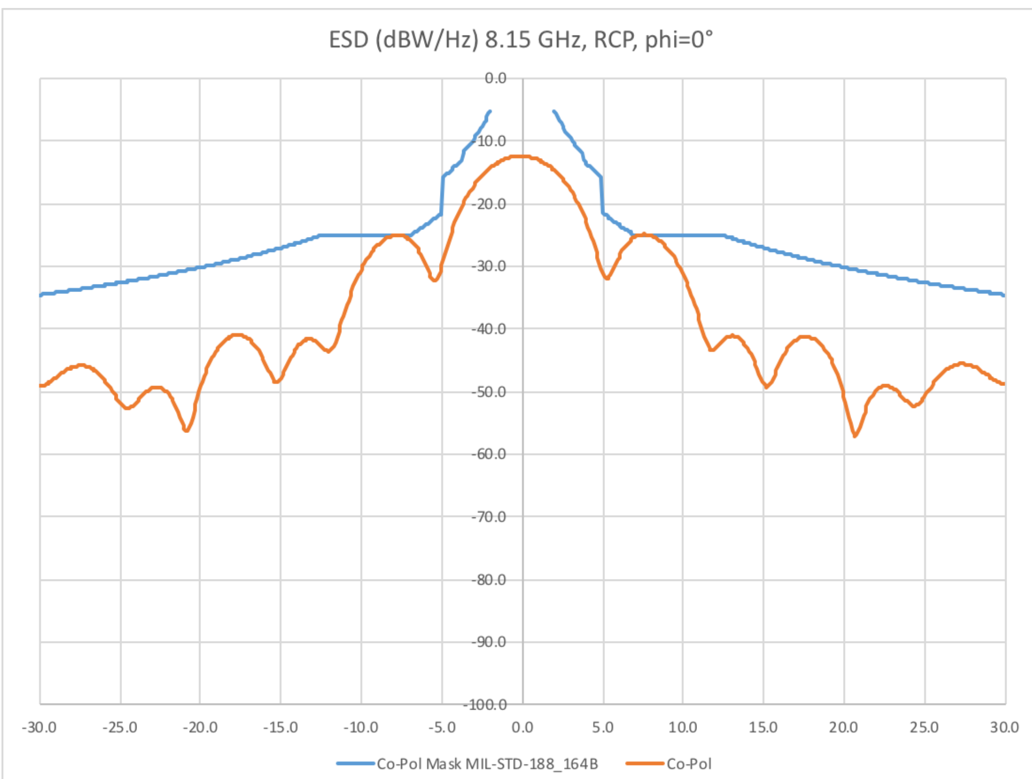

ESD (dBW/Hz) 7.9 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2


ESD (dBW/Hz) 7.9 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2

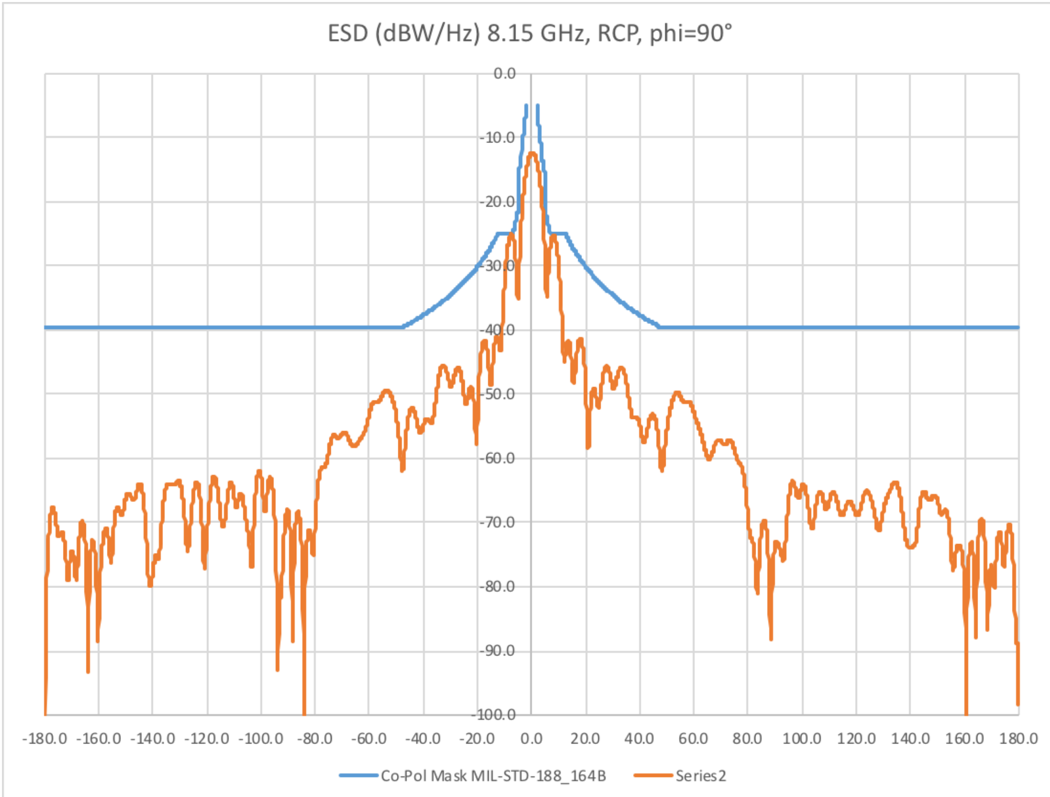
2. 8.15 GHz



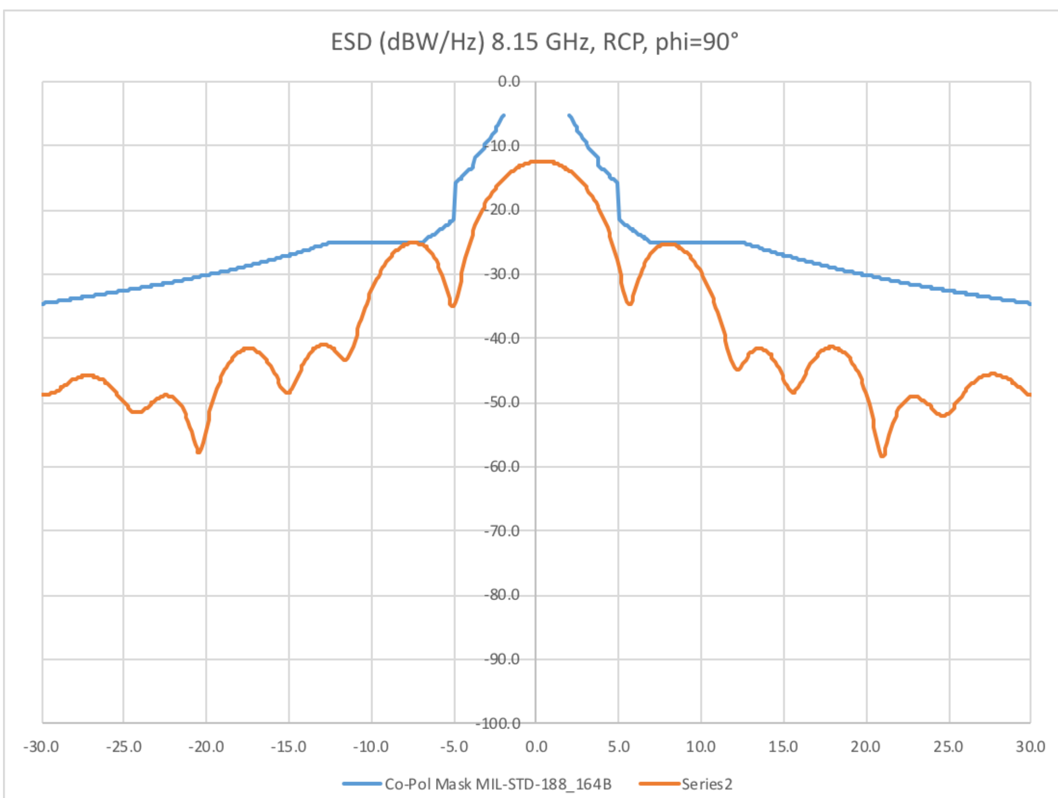
ESD (dBW/Hz) 8.15 GHz, RCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol



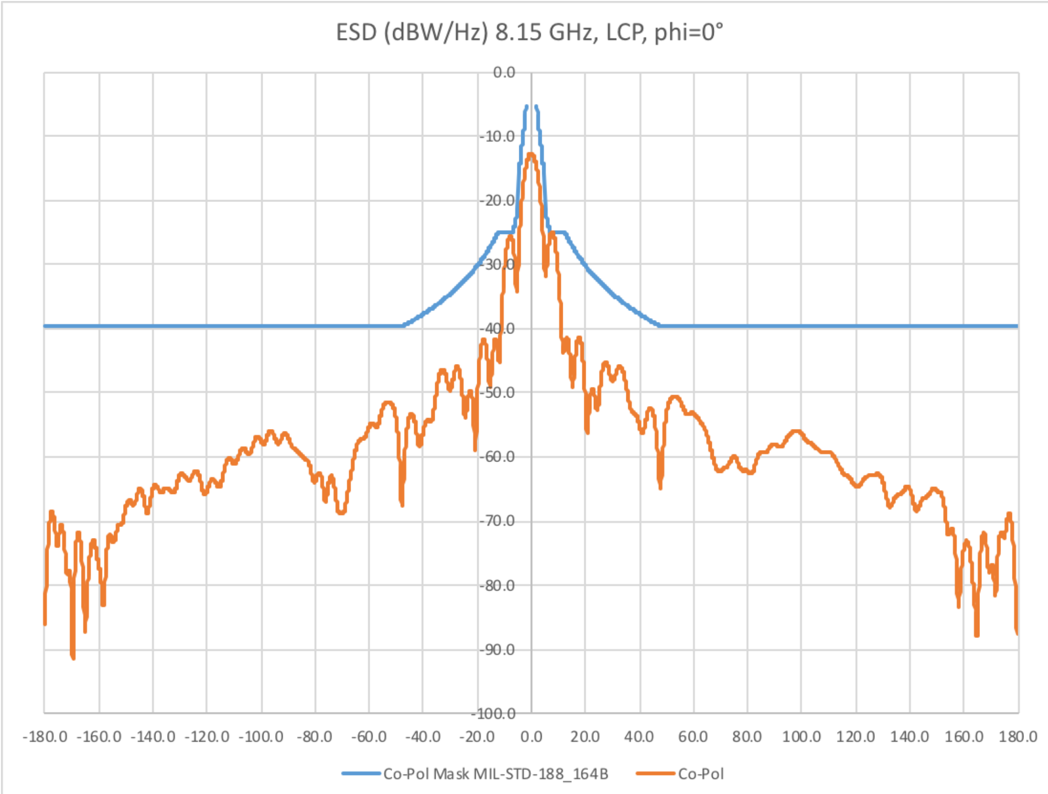
ESD (dBW/Hz) 8.15 GHz, RCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol

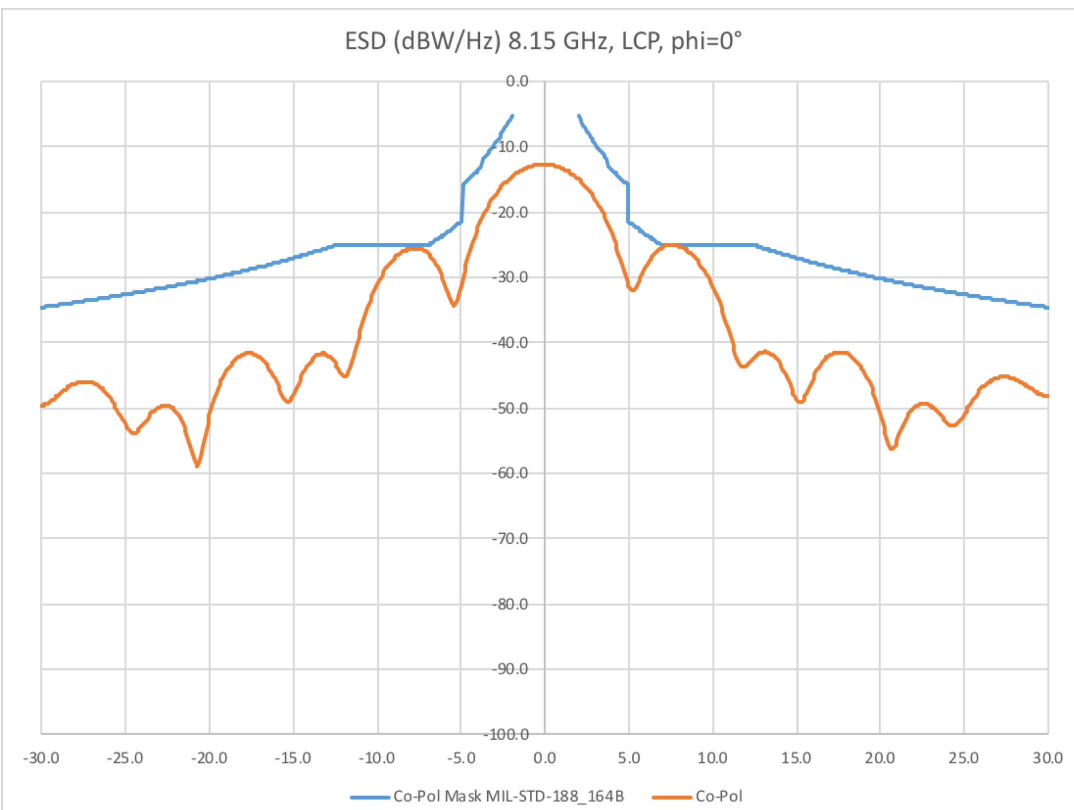


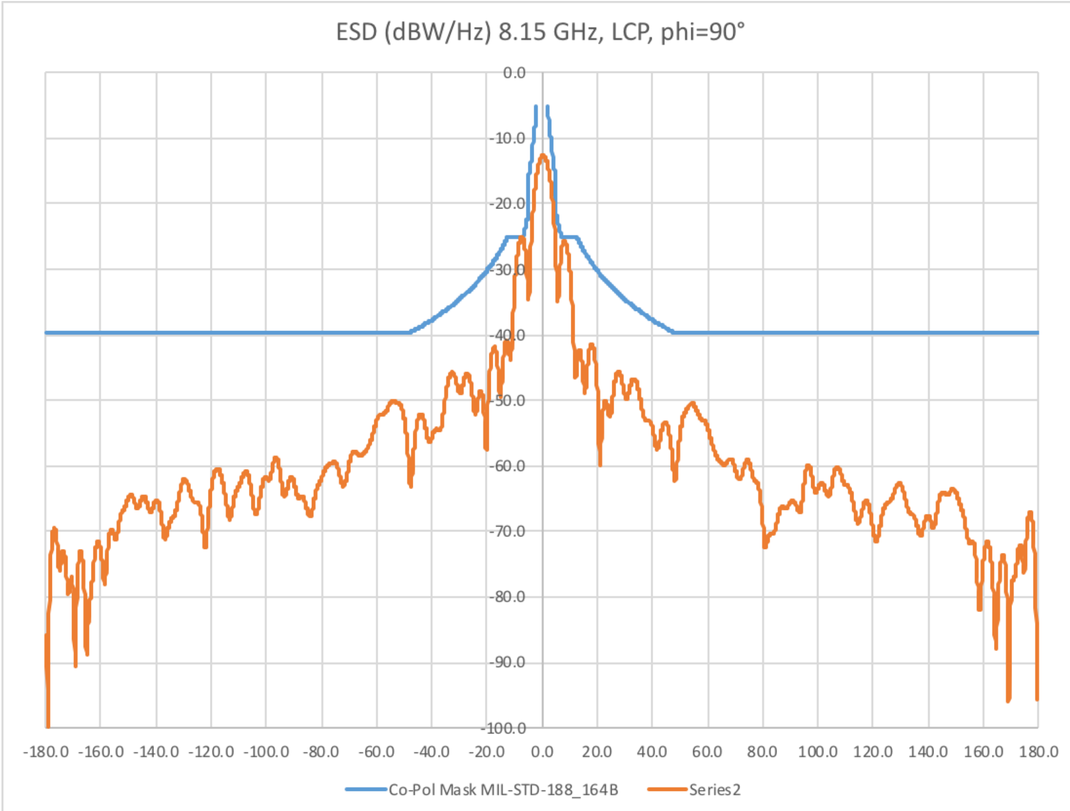
ESD (dBW/Hz) 8.15 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2



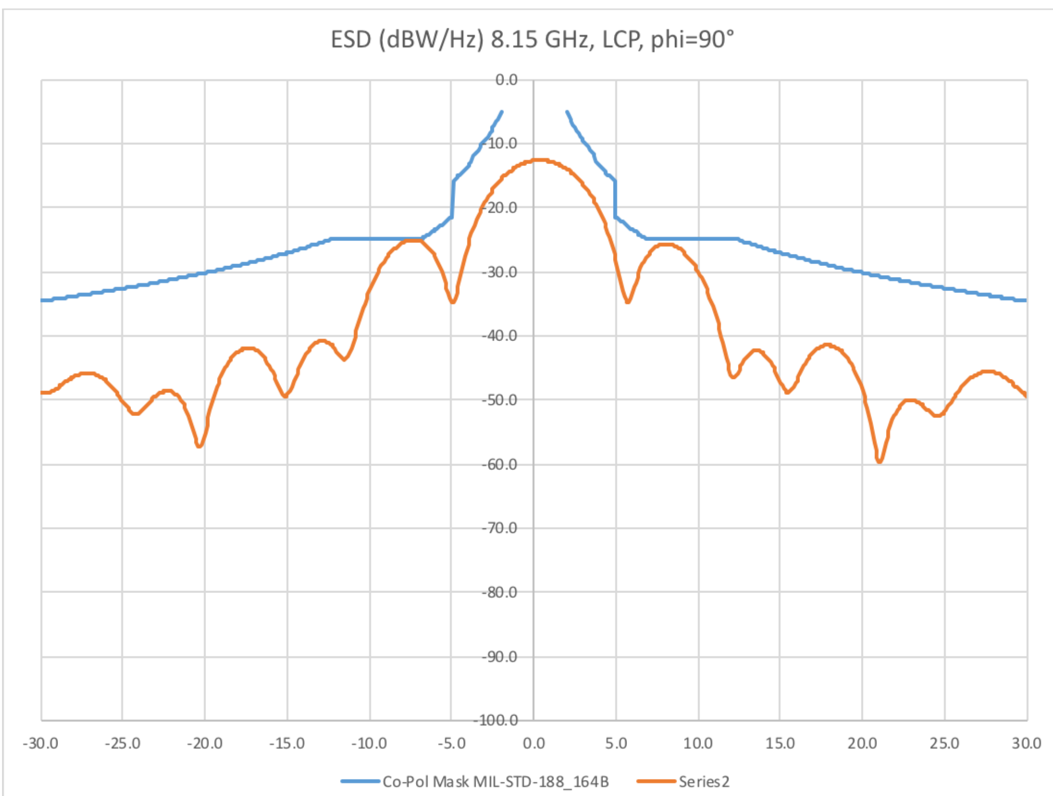
ESD (dBW/Hz) 8.15 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2


ESD (dBW/Hz) 8.15 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol


ESD (dBW/Hz) 8.15 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol

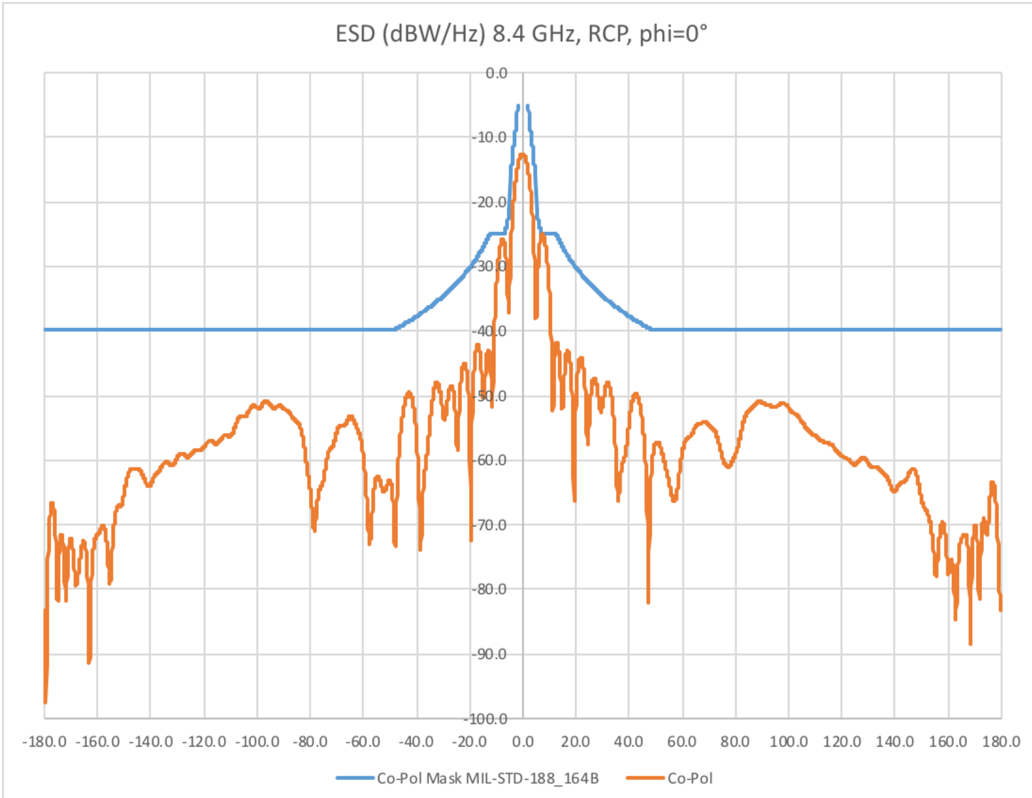


ESD (dBW/Hz) 8.15 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2

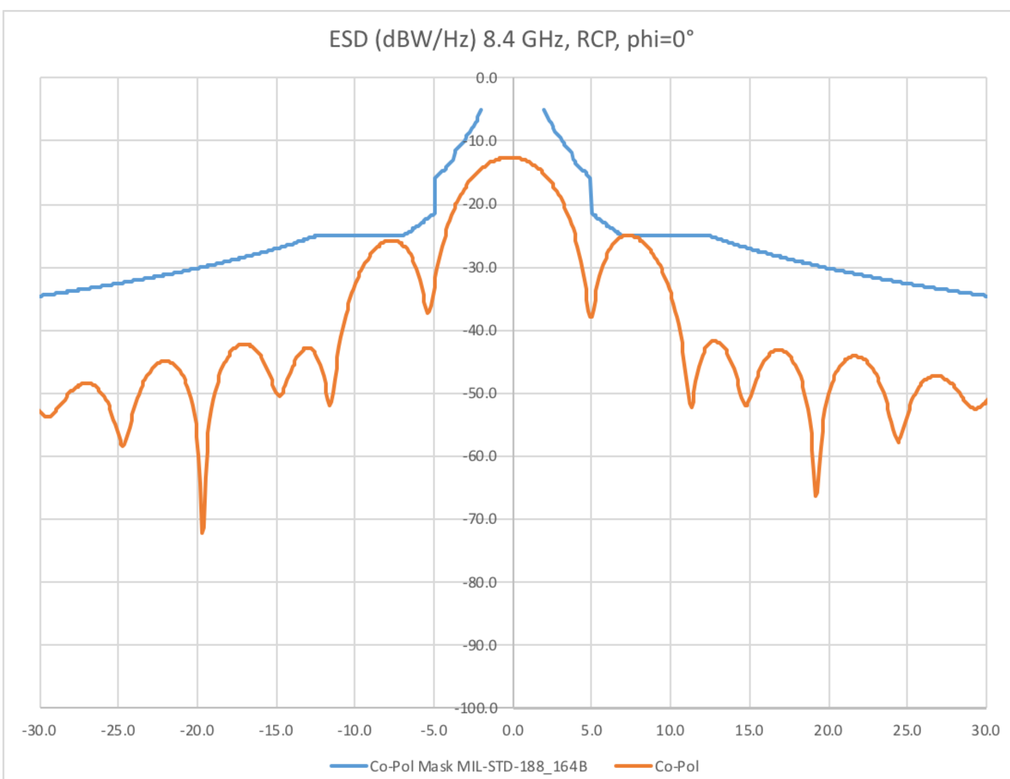


ESD (dBW/Hz) 8.15 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2

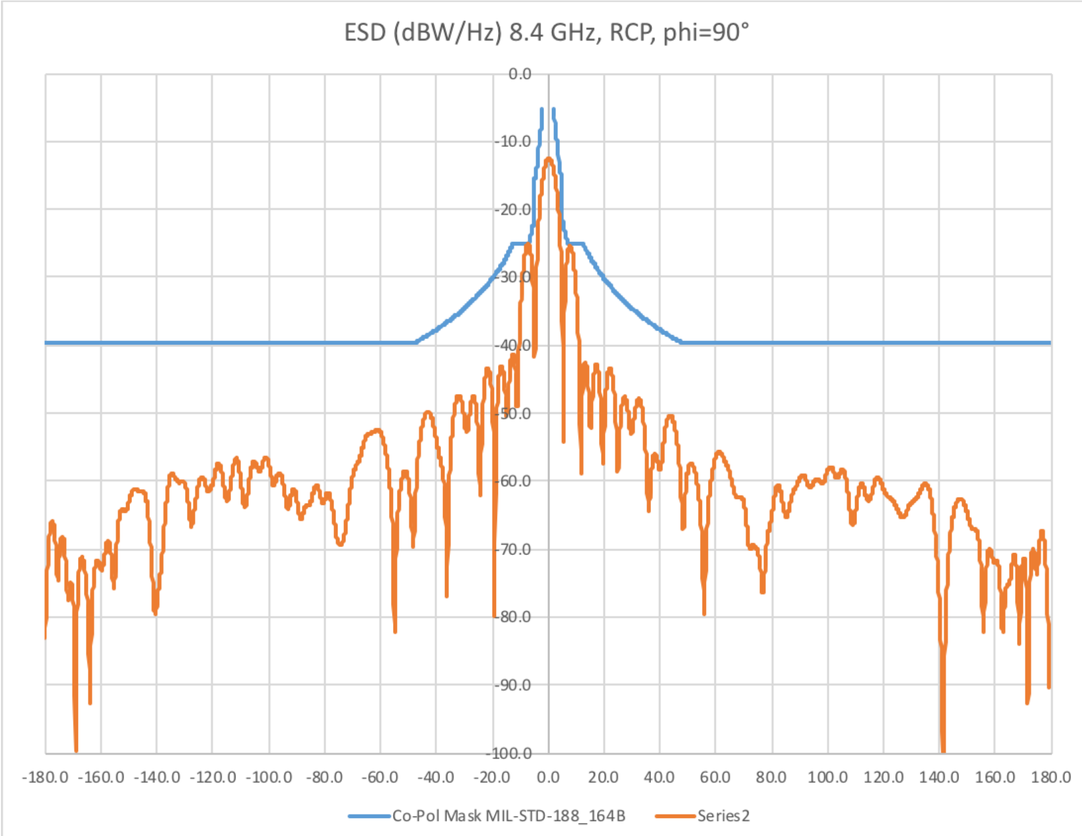
3. 8.40 GHz

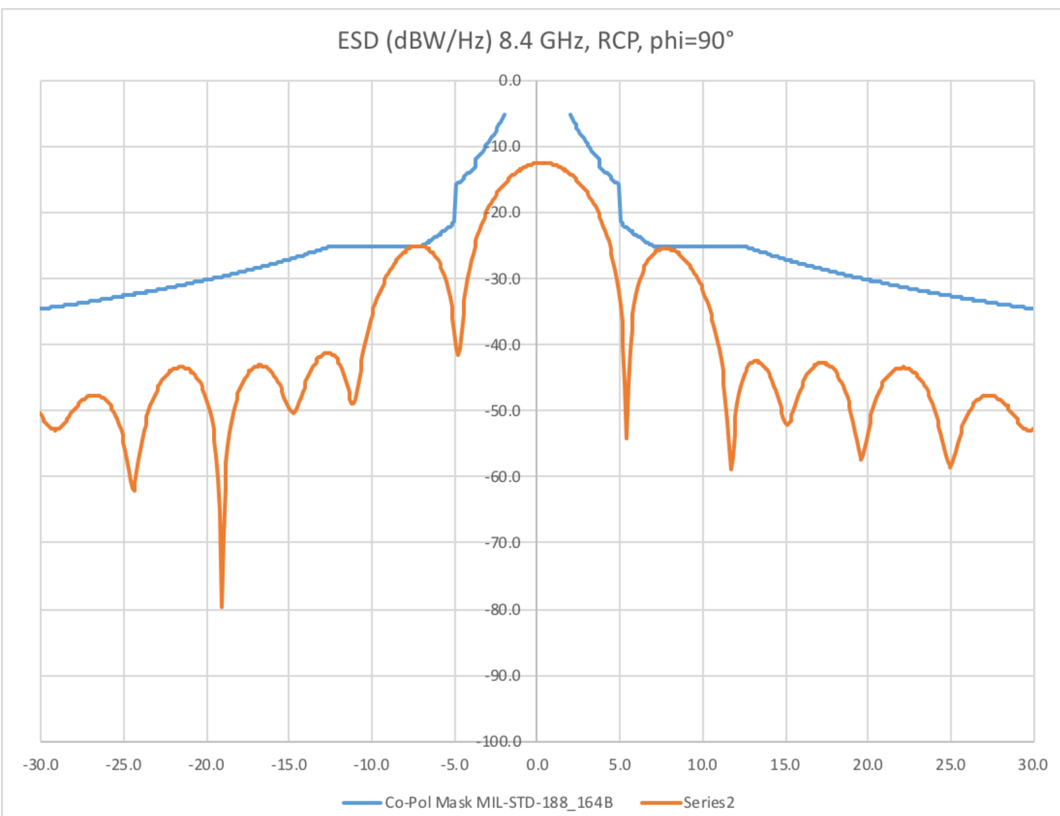


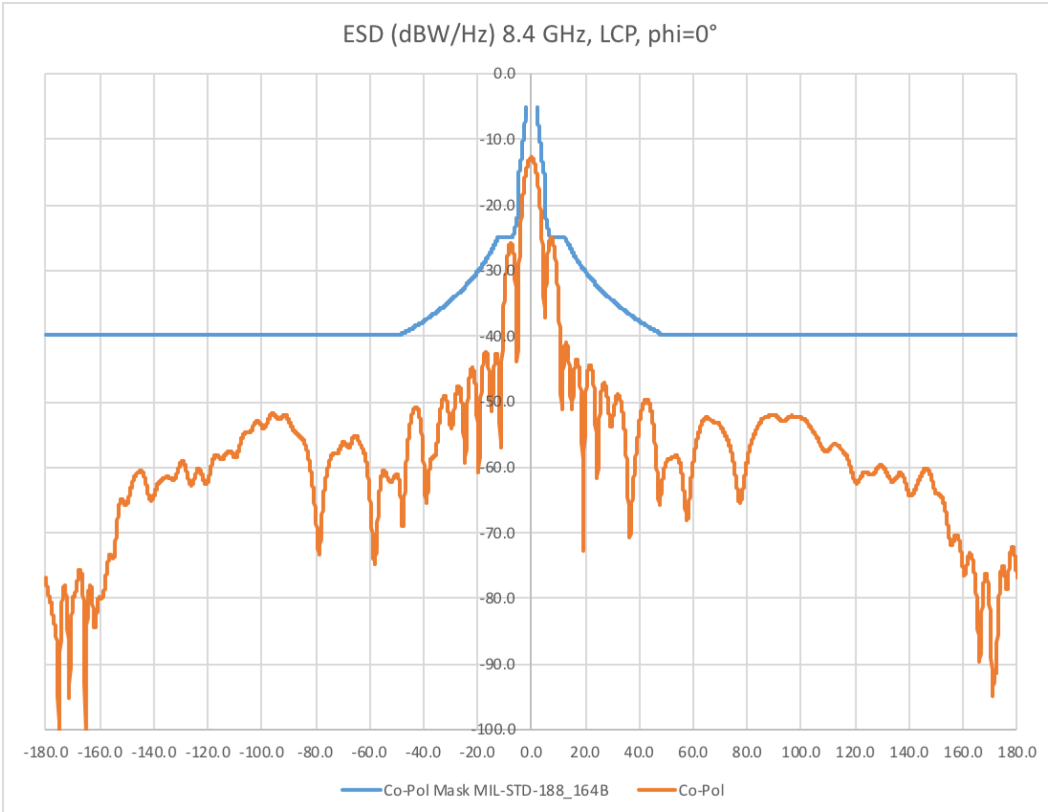
ESD (dBW/Hz) 8.4 GHz, RCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol

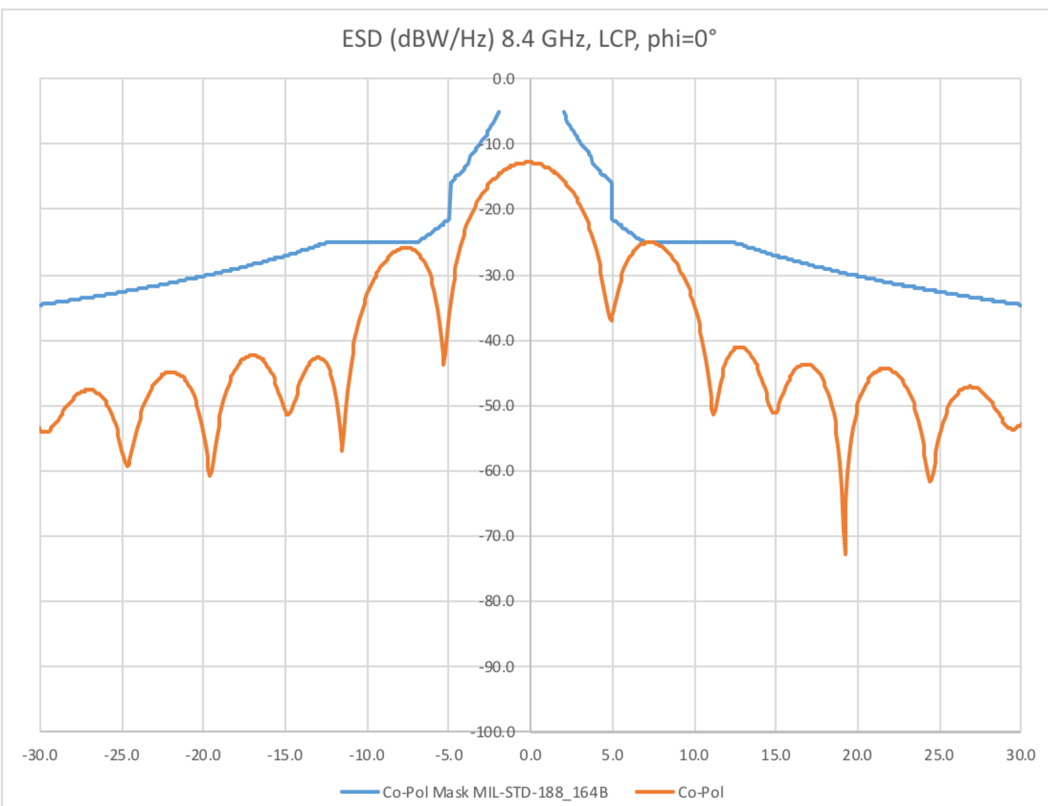


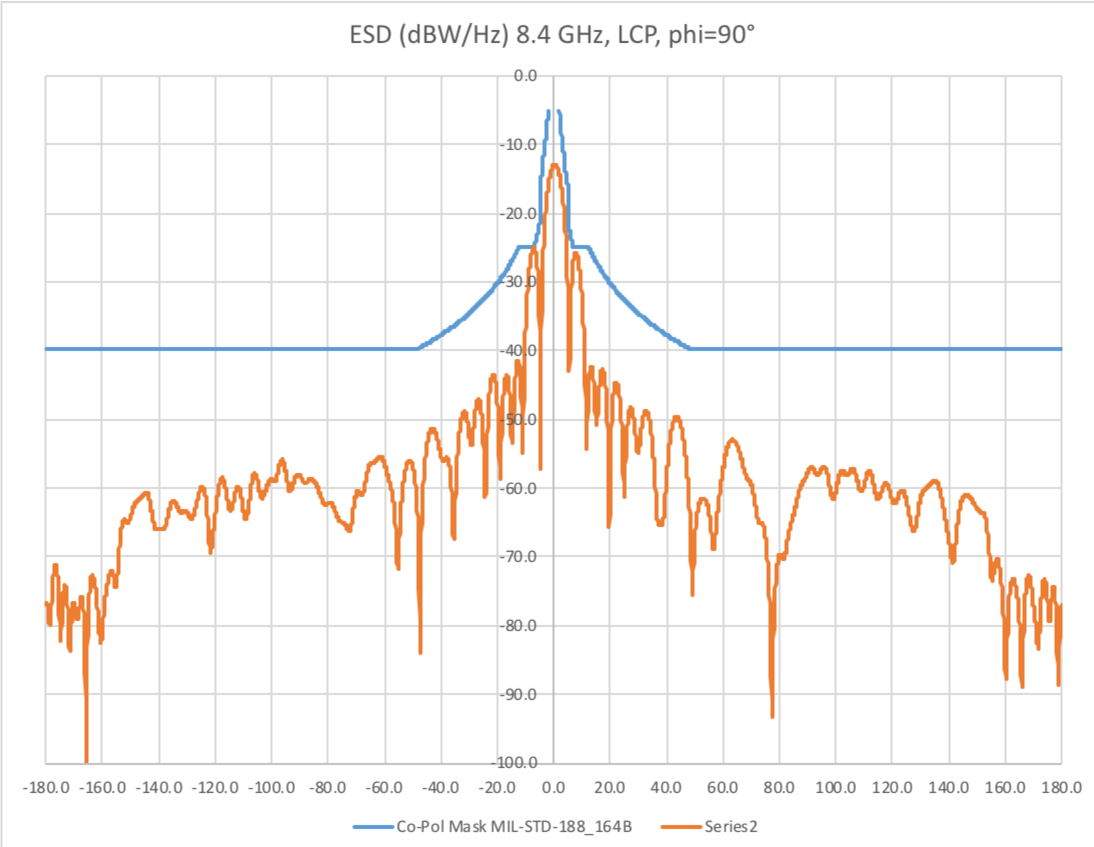
ESD (dBW/Hz) 8.4 GHz, RCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol


ESD (dBW/Hz) 8.4 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2

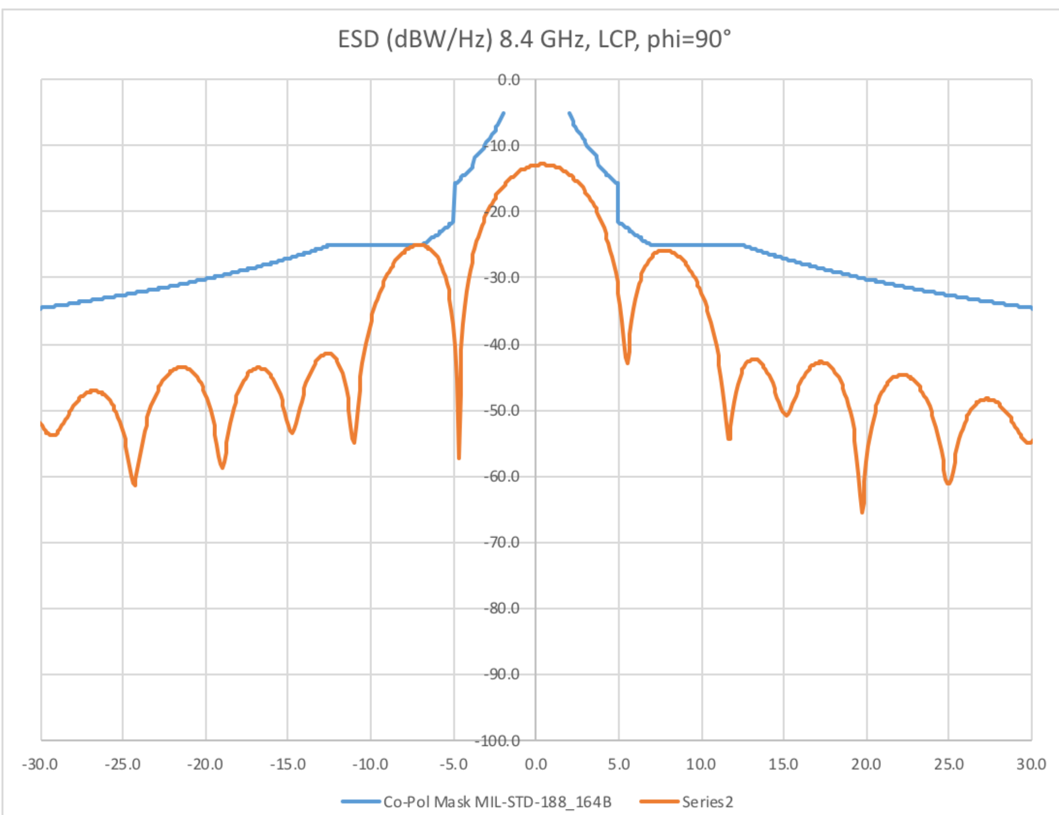

ESD (dBW/Hz) 8.4 GHz, RCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2


ESD (dBW/Hz) 8.4 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol


ESD (dBW/Hz) 8.4 GHz, LCP, phi=0°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Co-Pol



ESD (dBW/Hz) 8.4 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-180.0 -160.0 -140.0 -120.0 -100.0 -80.0 -60.0 -40.0 -20.0 0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0
Co-Pol Mask MIL-STD-188_164B
Series2

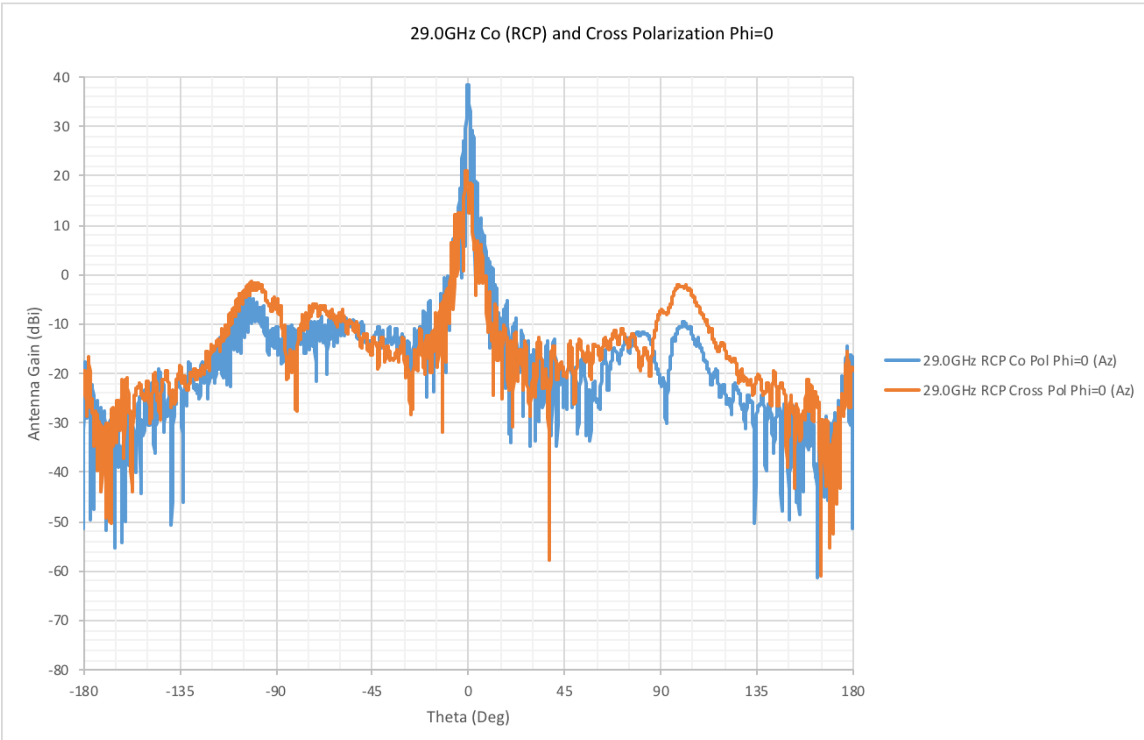


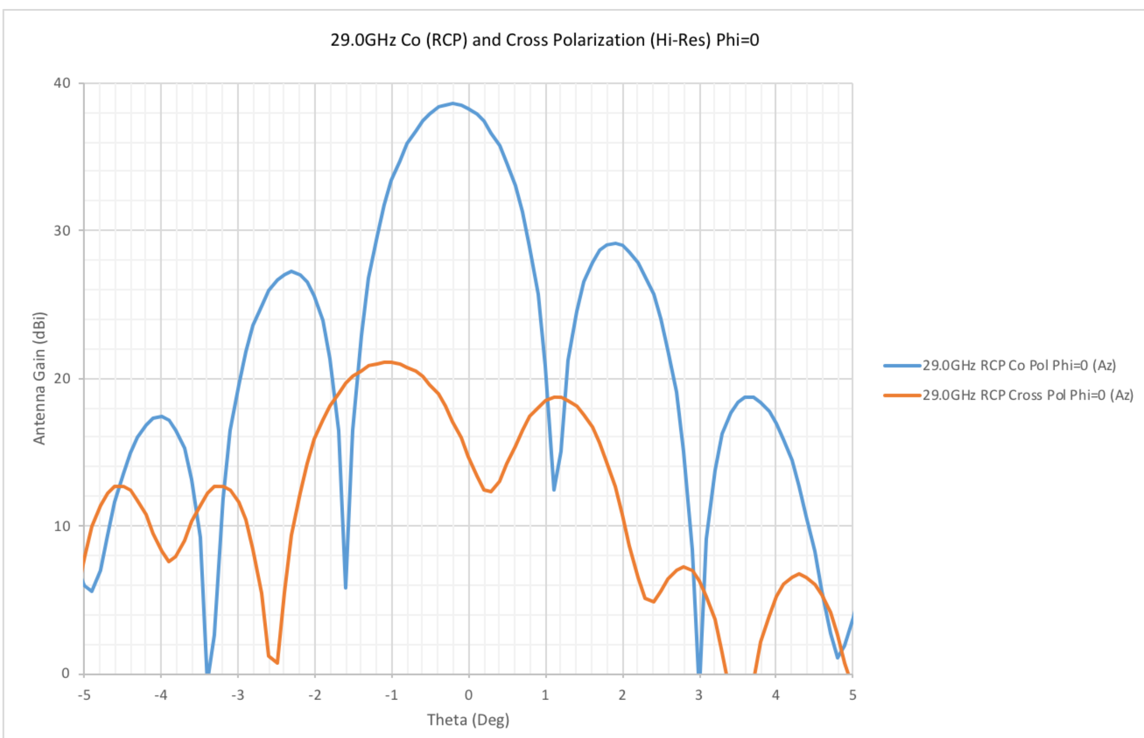
ESD (dBW/Hz) 8.4 GHz, LCP, phi=90°
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
-30.0 -25.0 -20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0
Co-Pol Mask MIL-STD-188_164B
Series2

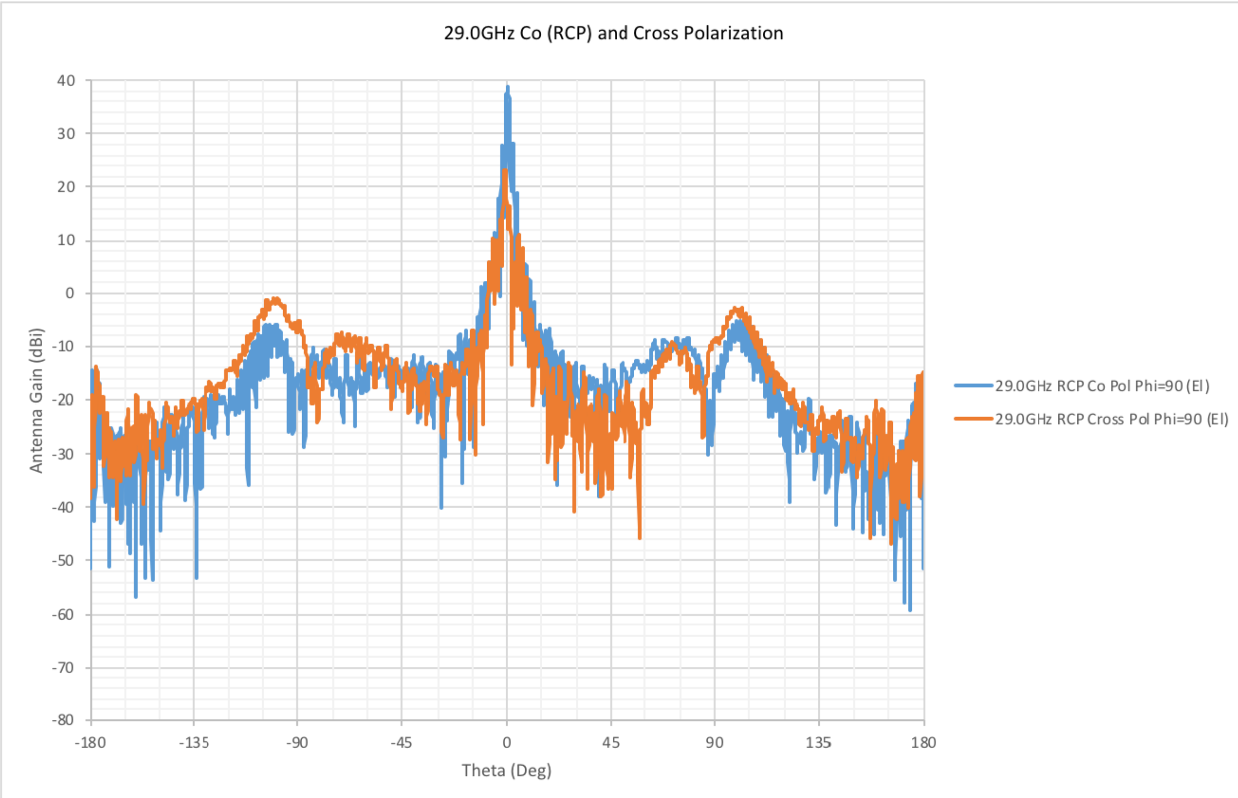
IV. BB45 Gain Patterns

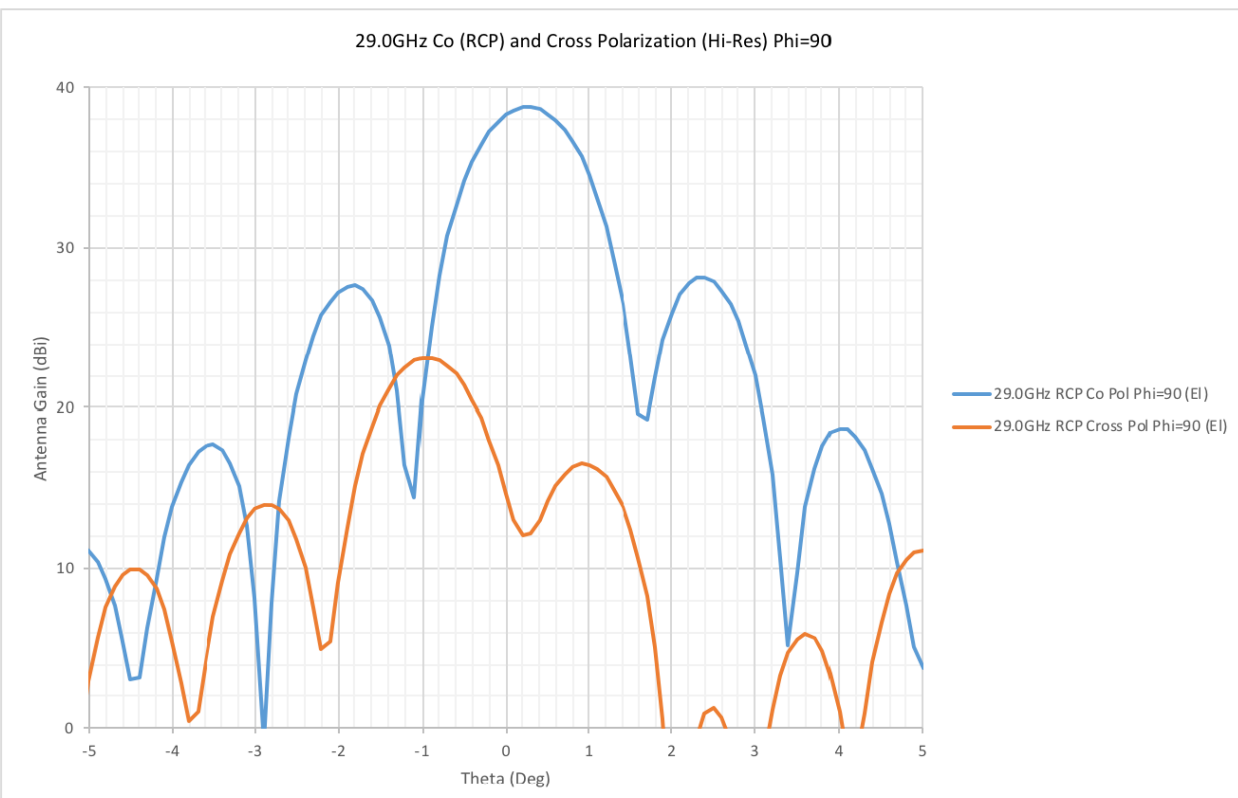
A. Ka-band

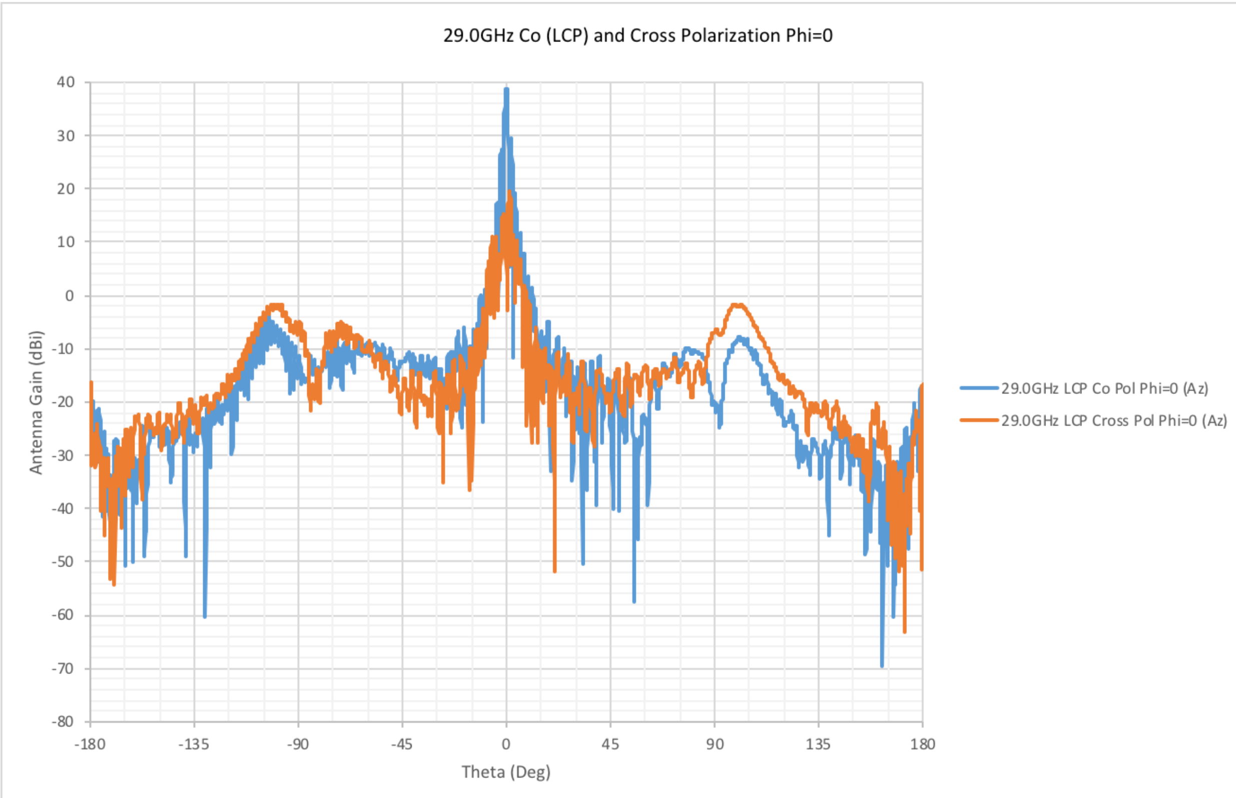
1. 29.0 GHz



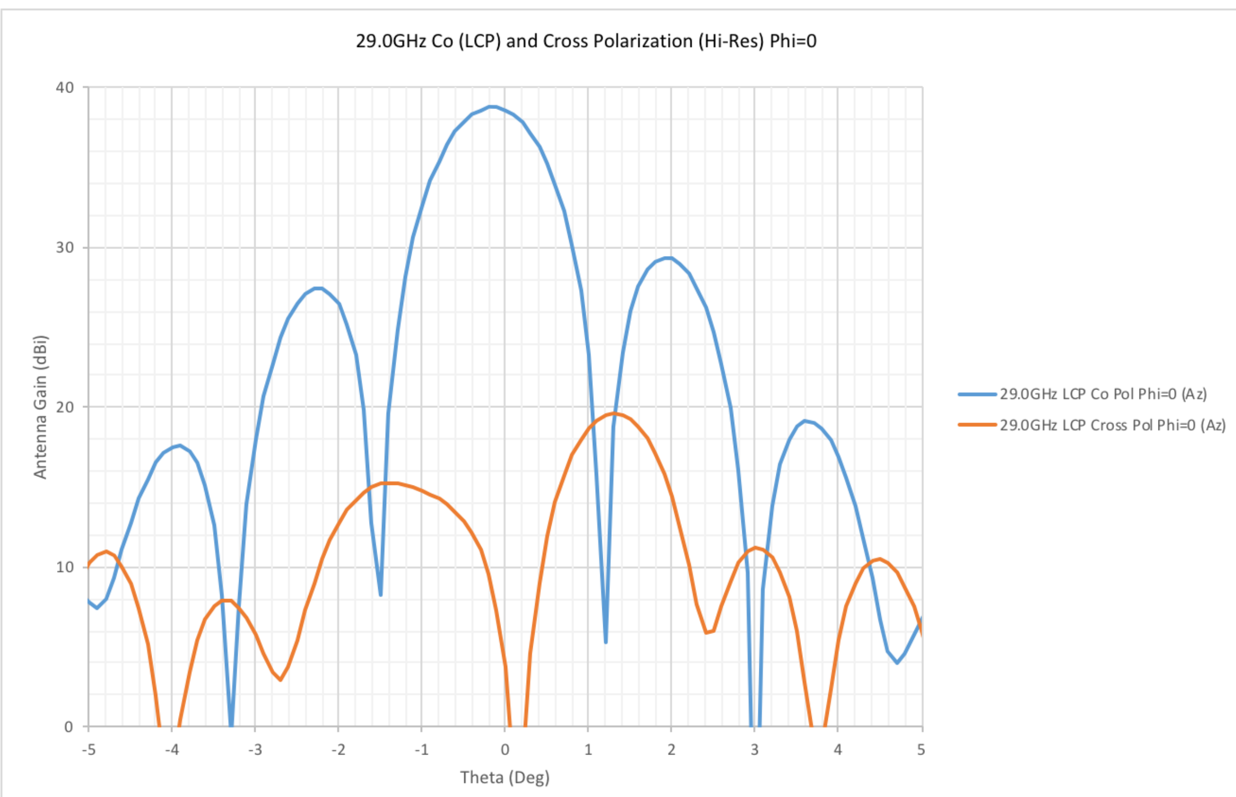



29.0GHz Co (RCP) and Cross Polarization
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Antenna Gain (dBi)
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
29.0GHz RCP Co Pol Phi=90 (El)
29.0GHz RCP Cross Pol Phi=90 (El)

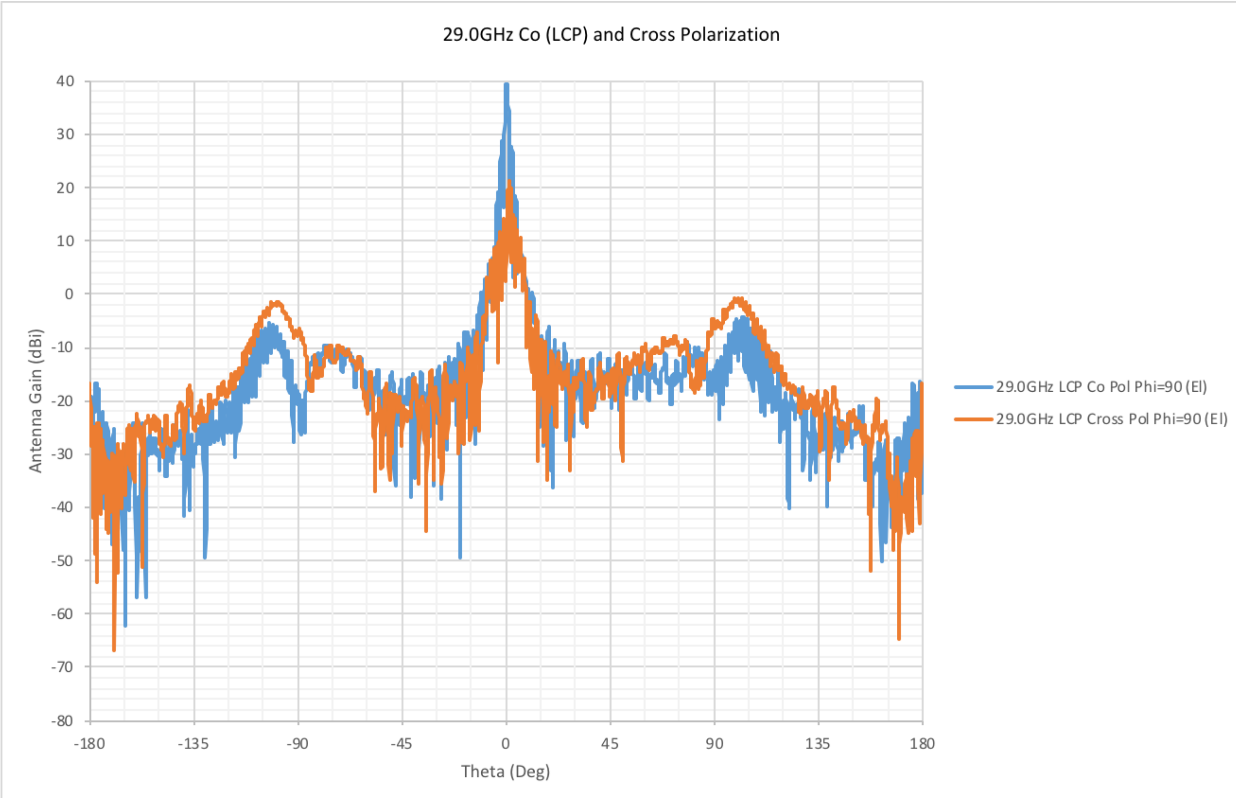

29.0GHz Co (RCP) and Cross Polarization (Hi-Res) Phi=90
40
30
20
10
0
Antenna Gain (dBi)
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
29.0GHz RCP Co Pol Phi=90 (El)
29.0GHz RCP Cross Pol Phi=90 (El)

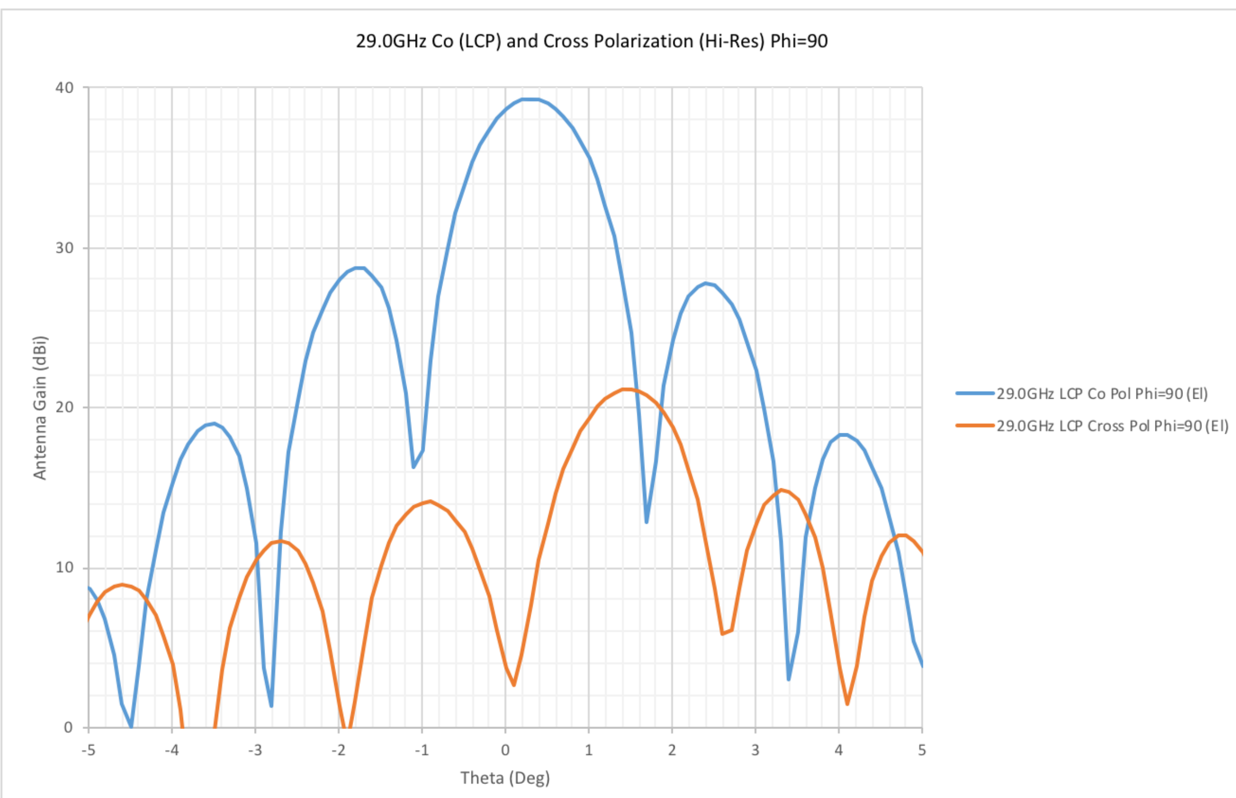


29.0GHz Co (LCP) and Cross Polarization Phi=0
Antenna Gain (dBi)
Theta (Deg)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
29.0GHz LCP Co Pol Phi=0 (Az)
29.0GHz LCP Cross Pol Phi=0 (Az)

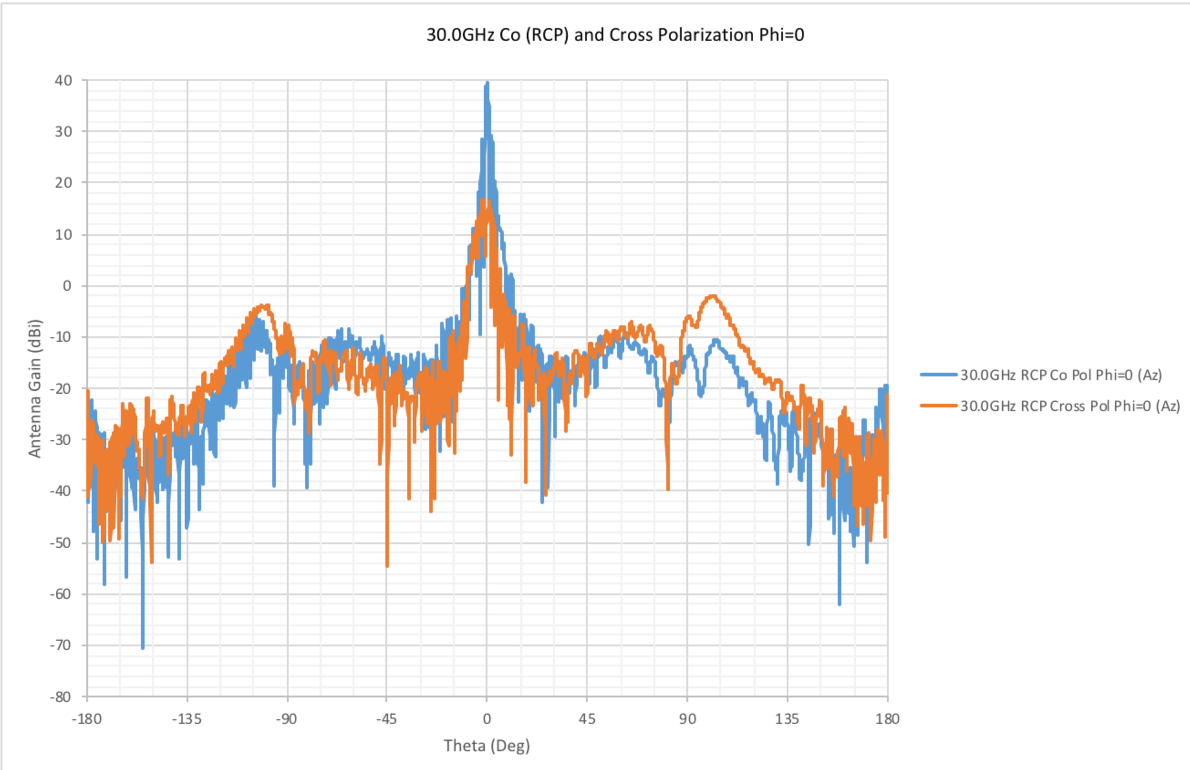


29.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=0
Antenna Gain (dBi)
Theta (Deg)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
29.0GHz LCP Co Pol Phi=0 (Az)
29.0GHz LCP Cross Pol Phi=0 (Az)

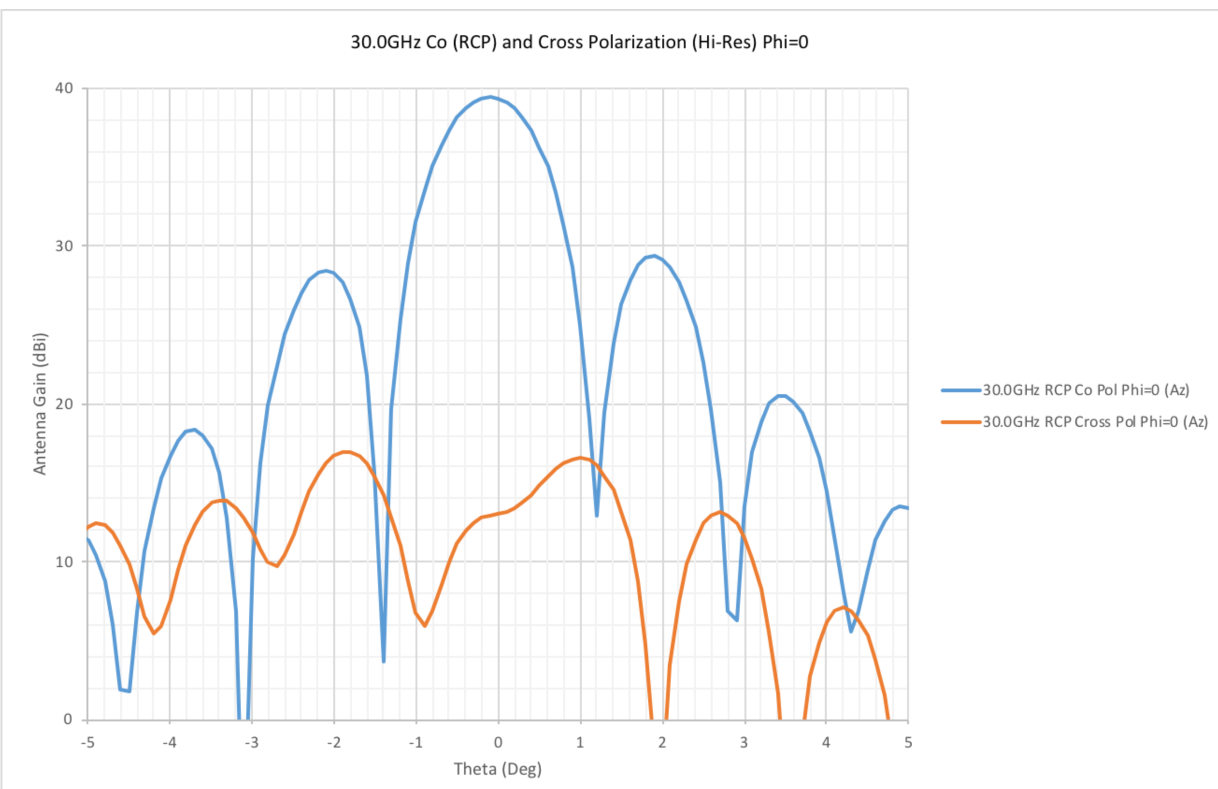

29.0GHz Co (LCP) and Cross Polarization
Antenna Gain (dBi)
Theta (Deg)
29.0GHz LCP Co Pol Phi=90 (El)
29.0GHz LCP Cross Pol Phi=90 (El)


29.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=90
Antenna Gain (dBi)
Theta (Deg)
29.0GHz LCP Co Pol Phi=90 (El)
29.0GHz LCP Cross Pol Phi=90 (El)

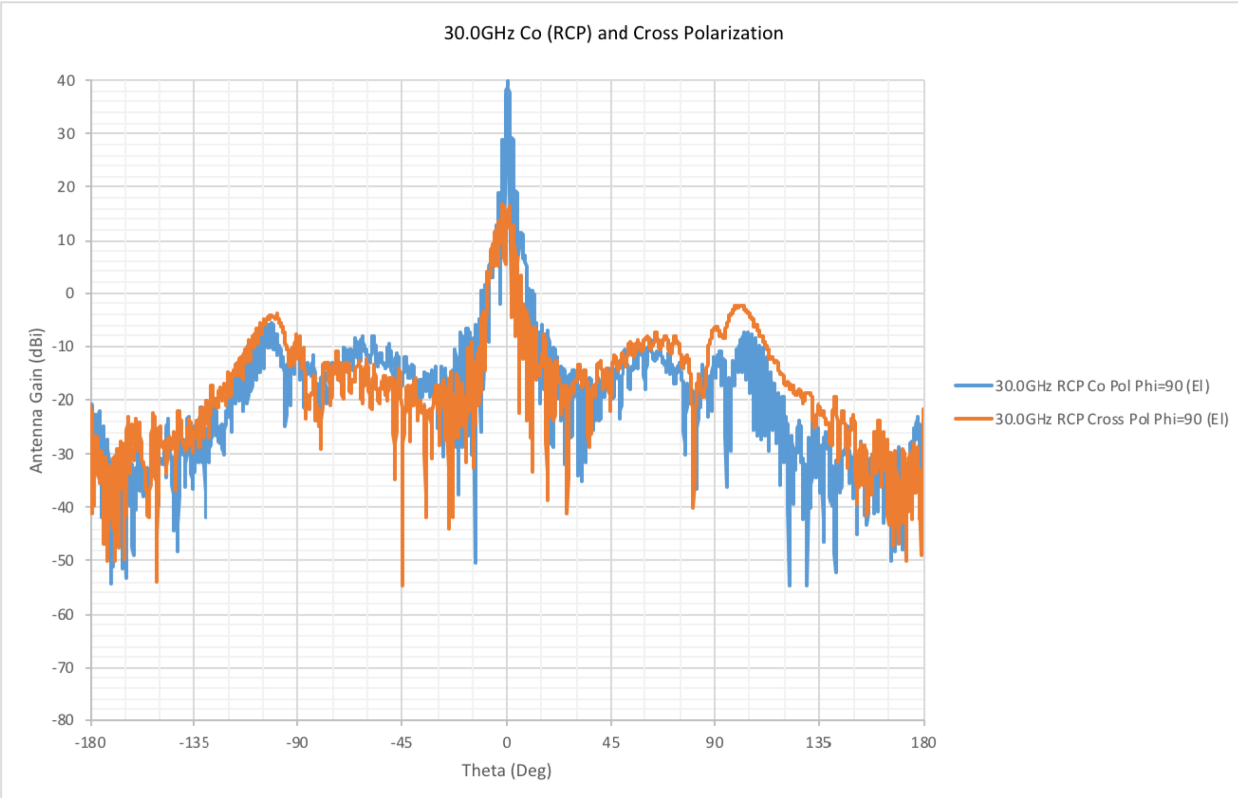
2. 30.0 GHz

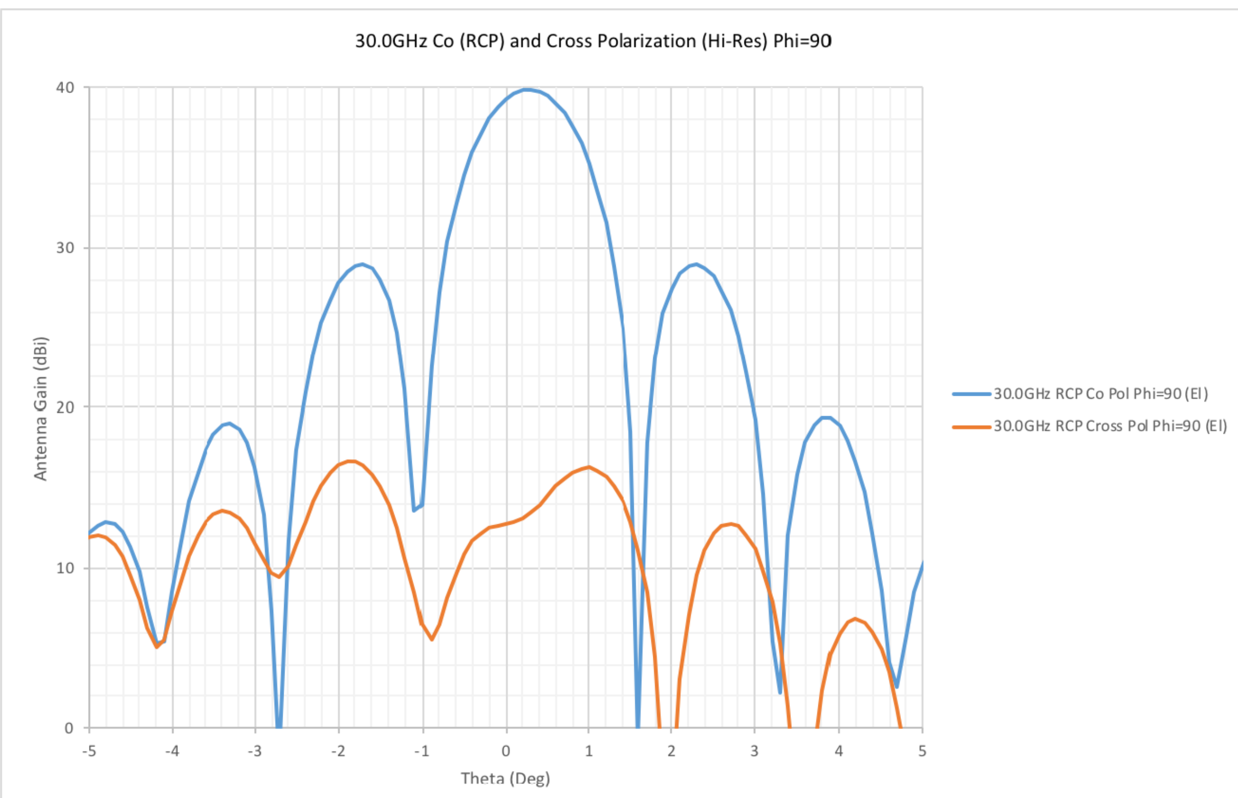


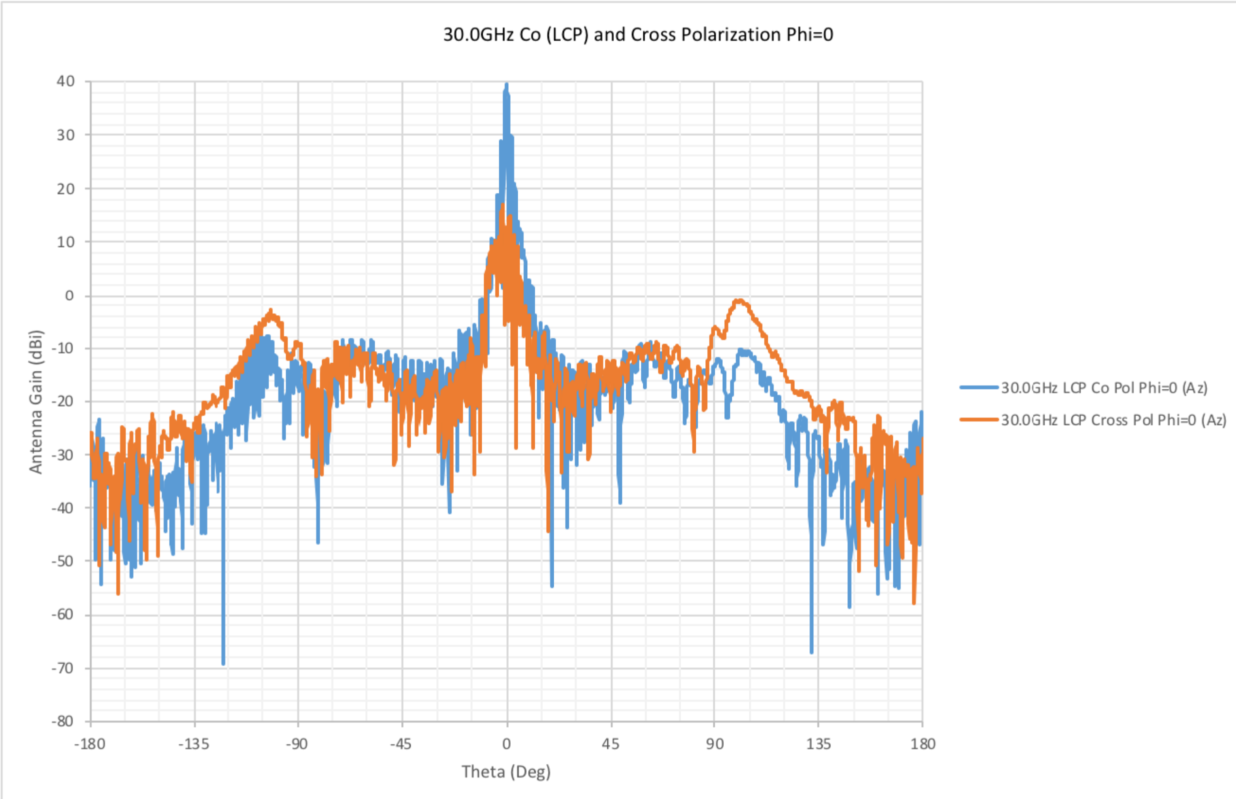
30.0GHz Co (RCP) and Cross Polarization Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
30.0GHz RCP Co Pol Phi=0 (Az)
30.0GHz RCP Cross Pol Phi=0 (Az)

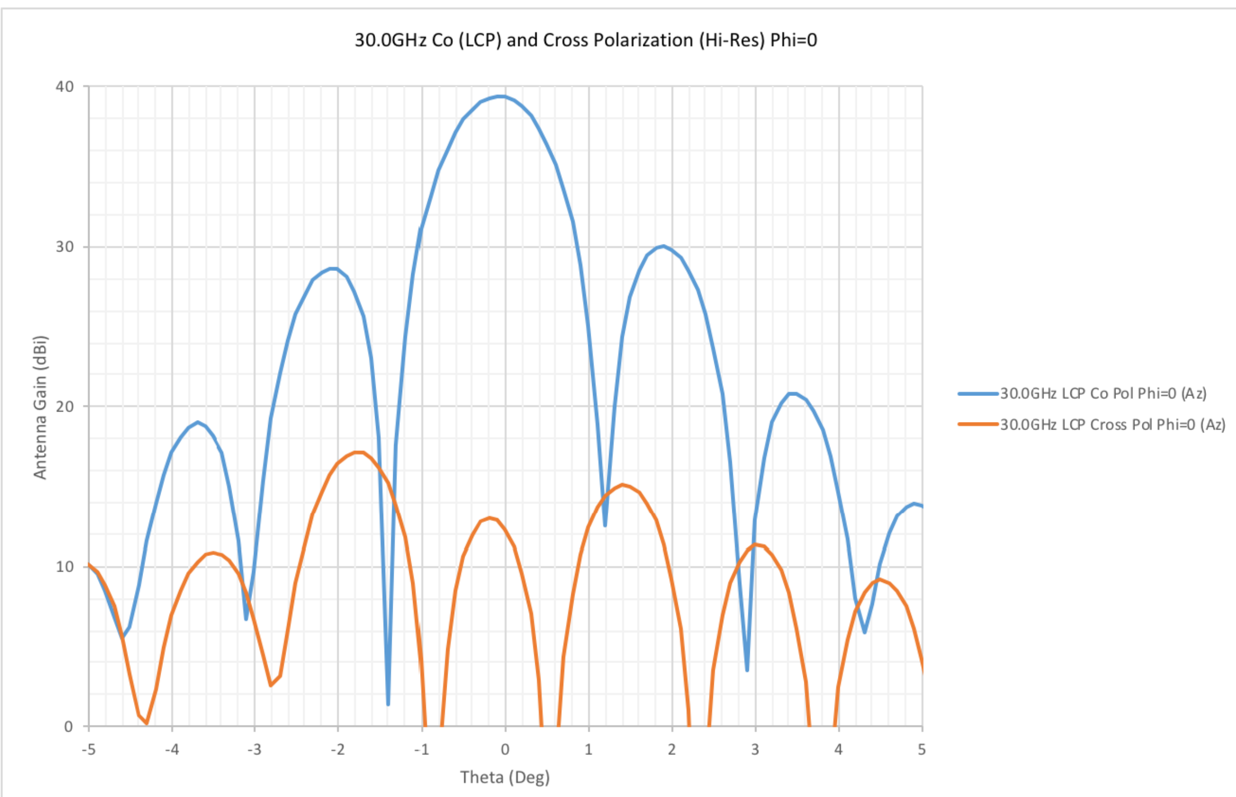


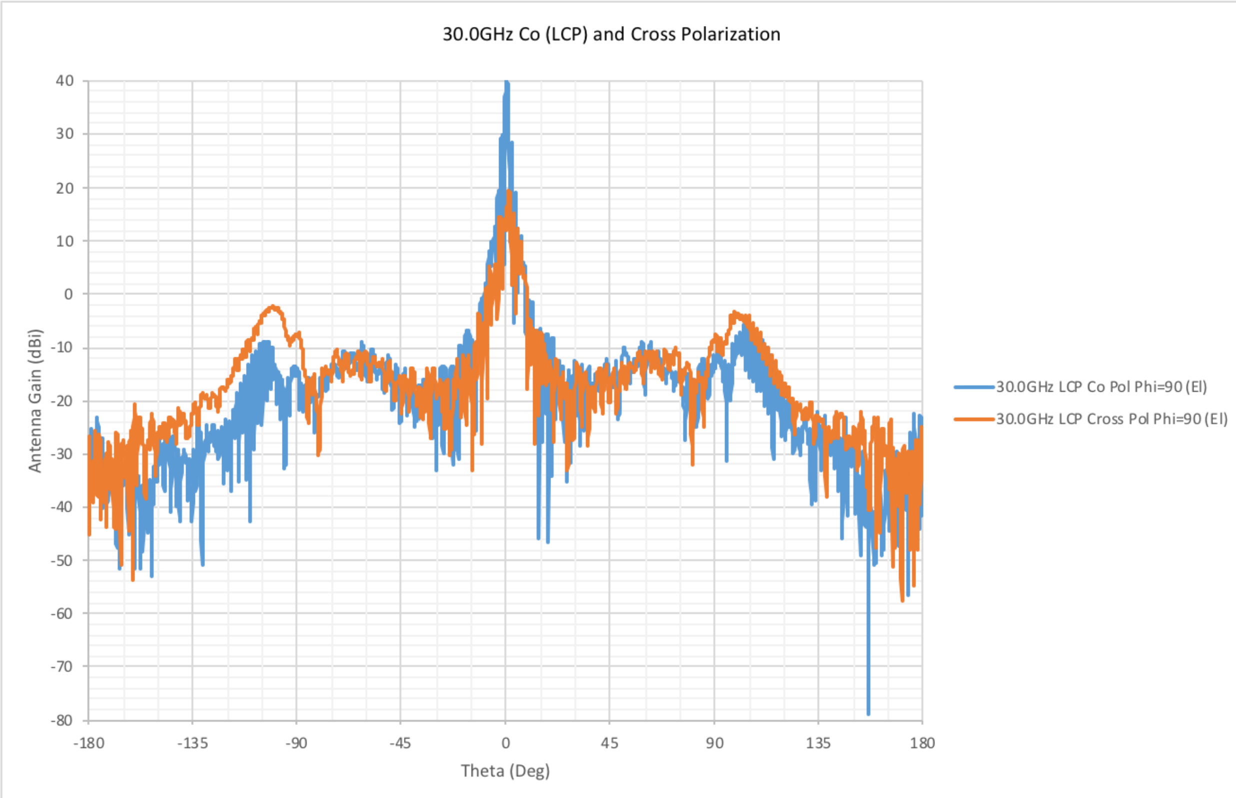
30.0GHz Co (RCP) and Cross Polarization (Hi-Res) Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
30.0GHz RCP Co Pol Phi=0 (Az)
30.0GHz RCP Cross Pol Phi=0 (Az)

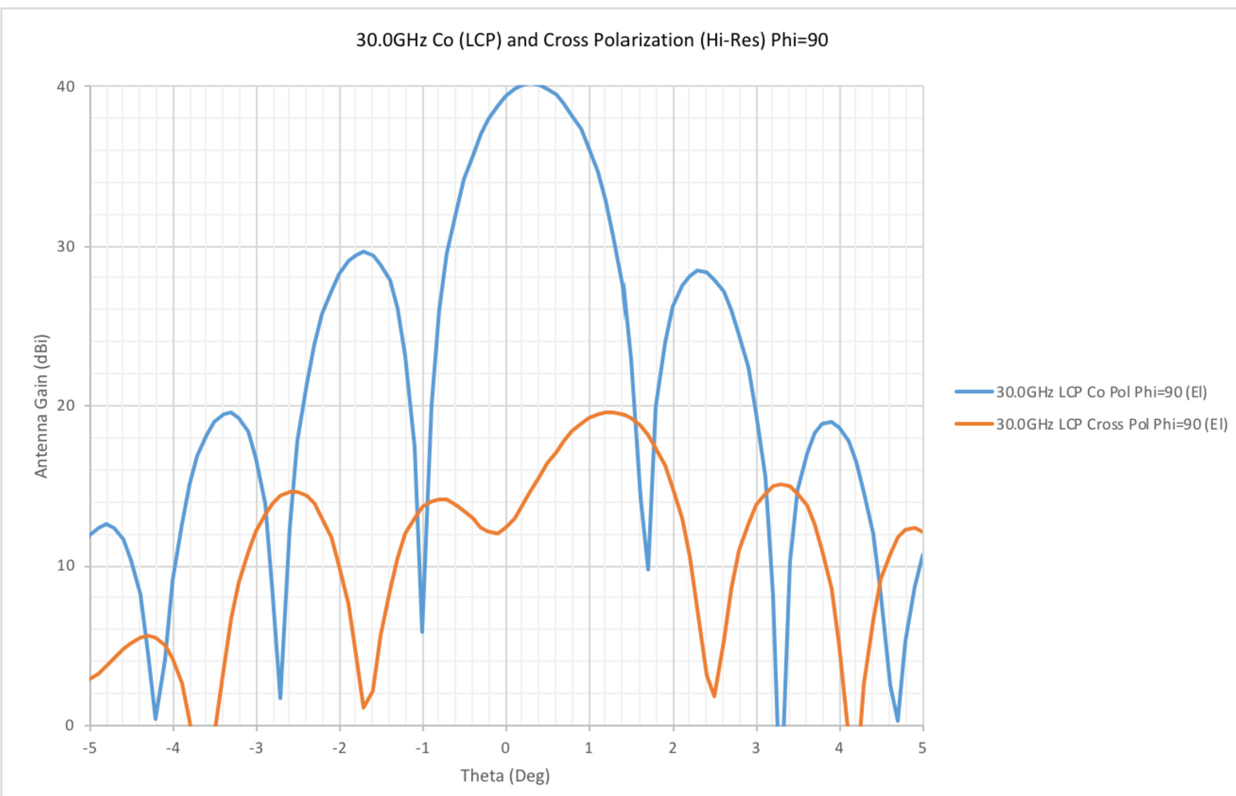

30.0GHz Co (RCP) and Cross Polarization
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Antenna Gain (dBi)
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
30.0GHz RCP Co Pol Phi=90 (El)
30.0GHz RCP Cross Pol Phi=90 (El)


30.0GHz Co (RCP) and Cross Polarization (Hi-Res) Phi=90
40
30
20
10
0
Antenna Gain (dBi)
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
30.0GHz RCP Co Pol Phi=90 (El)
30.0GHz RCP Cross Pol Phi=90 (El)

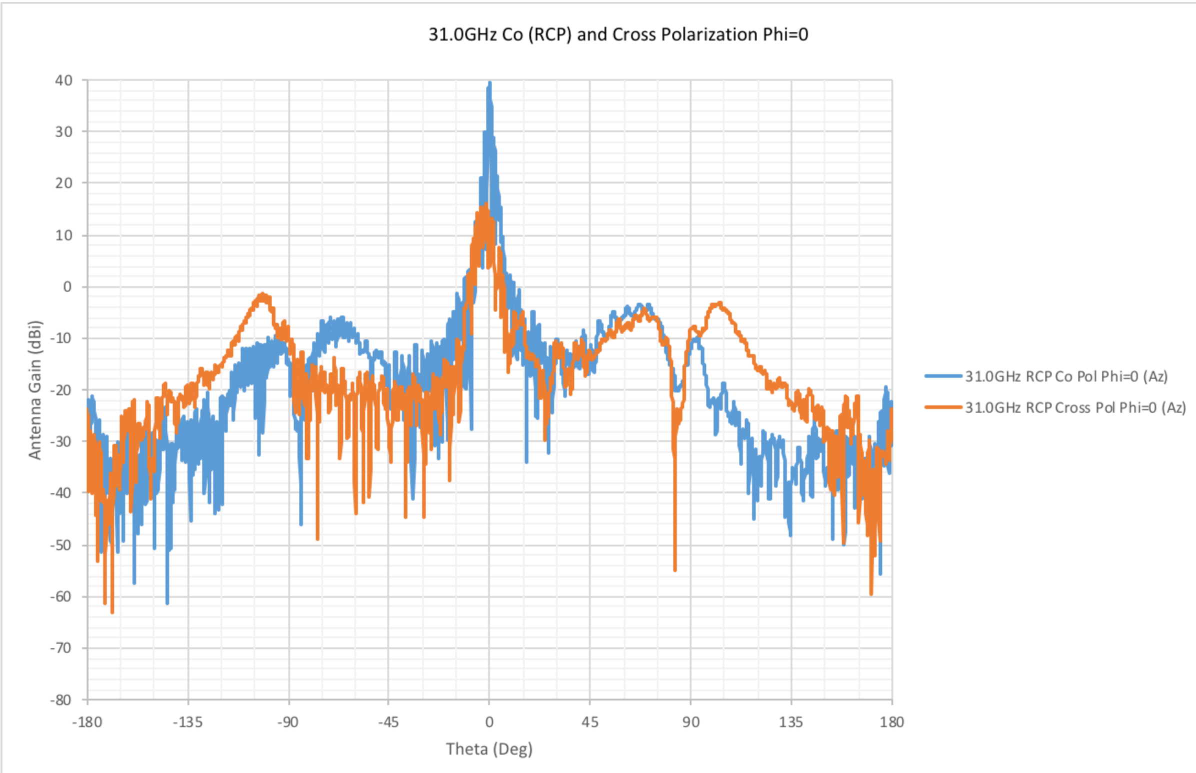

30.0GHz Co (LCP) and Cross Polarization Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
30.0GHz LCP Co Pol Phi=0 (Az)
30.0GHz LCP Cross Pol Phi=0 (Az)

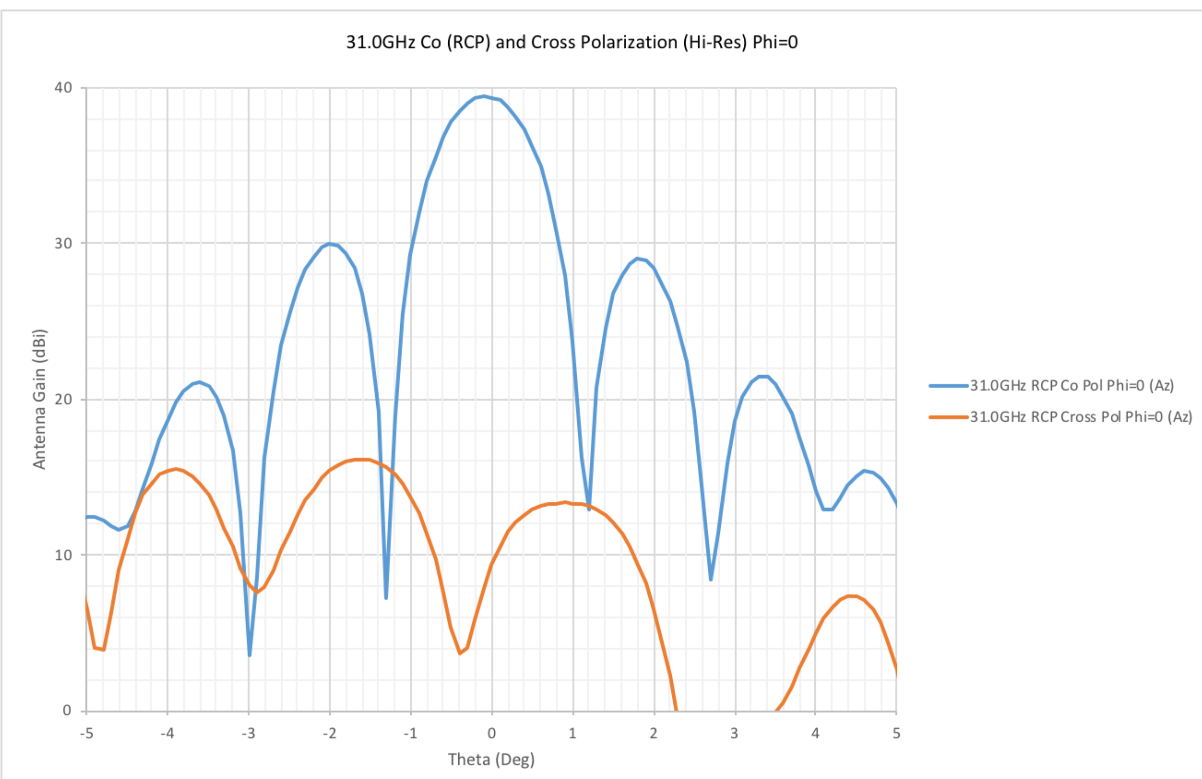

30.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
30.0GHz LCP Co Pol Phi=0 (Az)
30.0GHz LCP Cross Pol Phi=0 (Az)

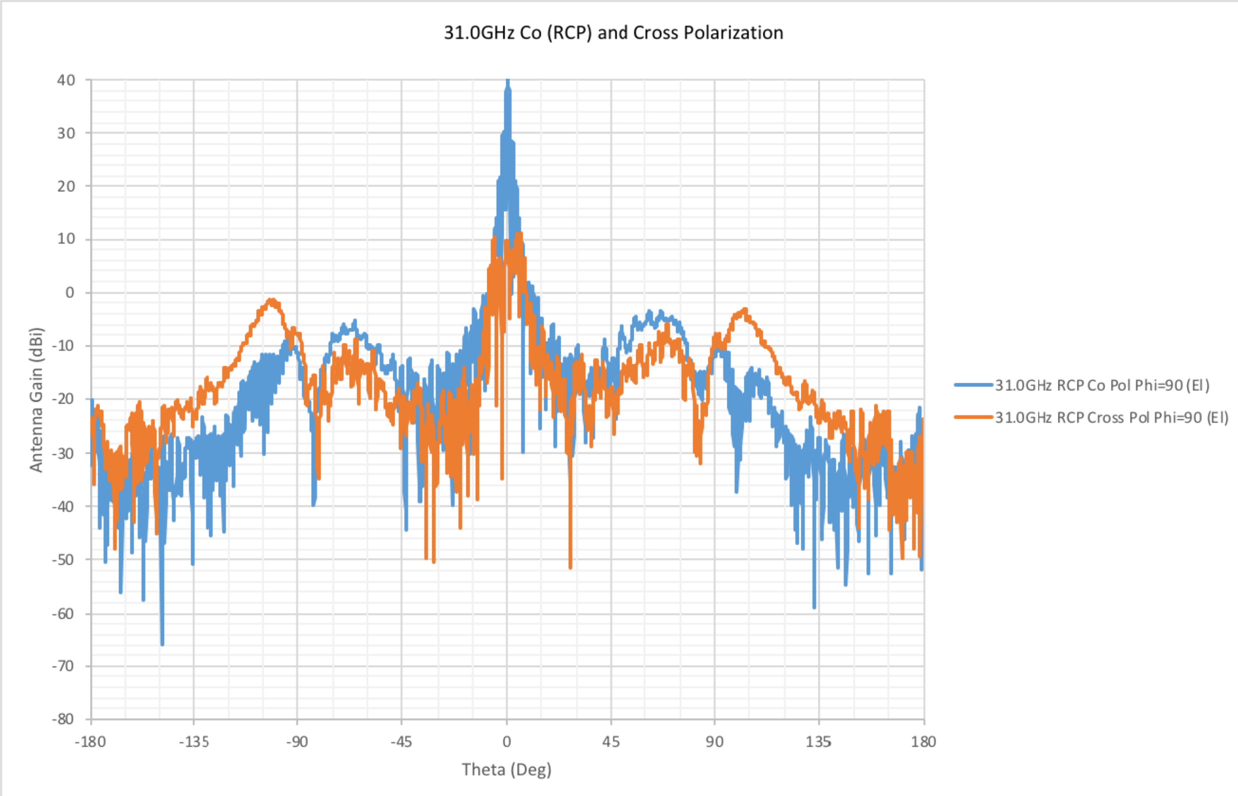

30.0GHz Co (LCP) and Cross Polarization
Antenna Gain (dBi)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
30.0GHz LCP Co Pol Phi=90 (El)
30.0GHz LCP Cross Pol Phi=90 (El)

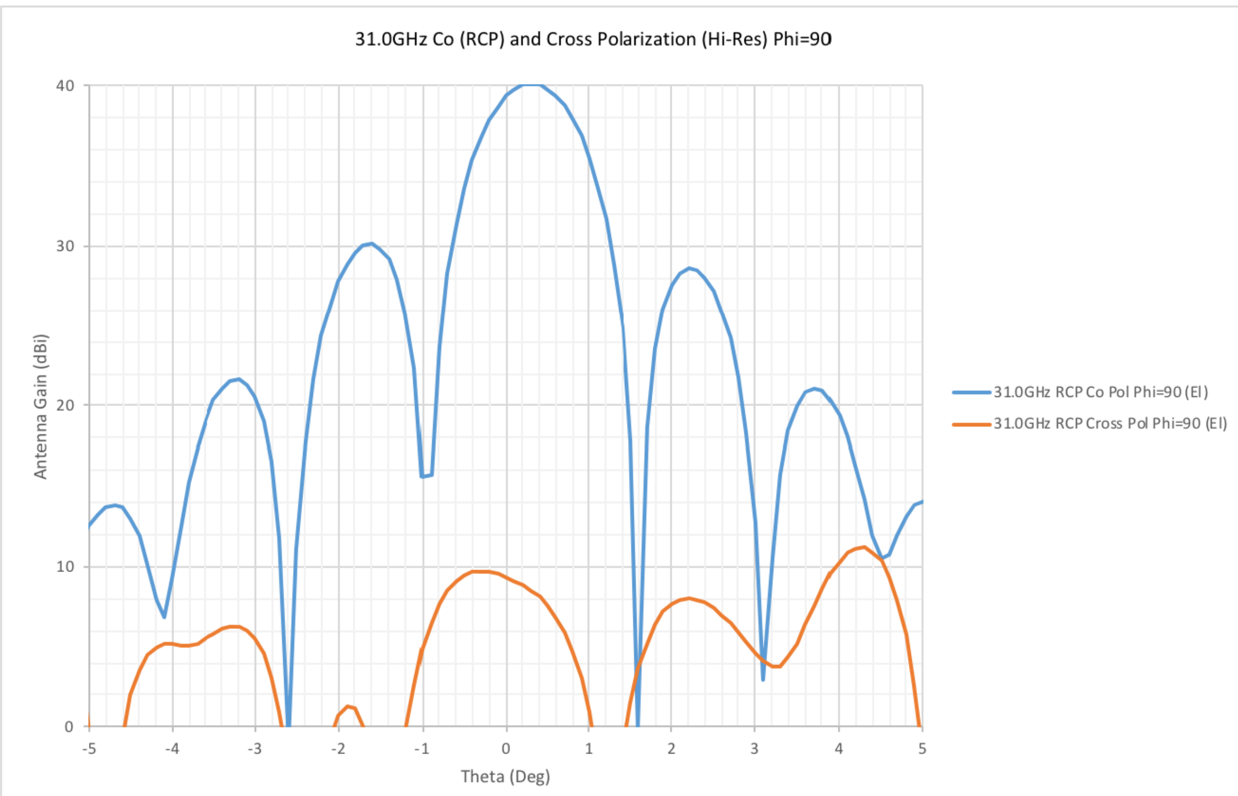

30.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=90
Antenna Gain (dBi)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
30.0GHz LCP Co Pol Phi=90 (El)
30.0GHz LCP Cross Pol Phi=90 (El)

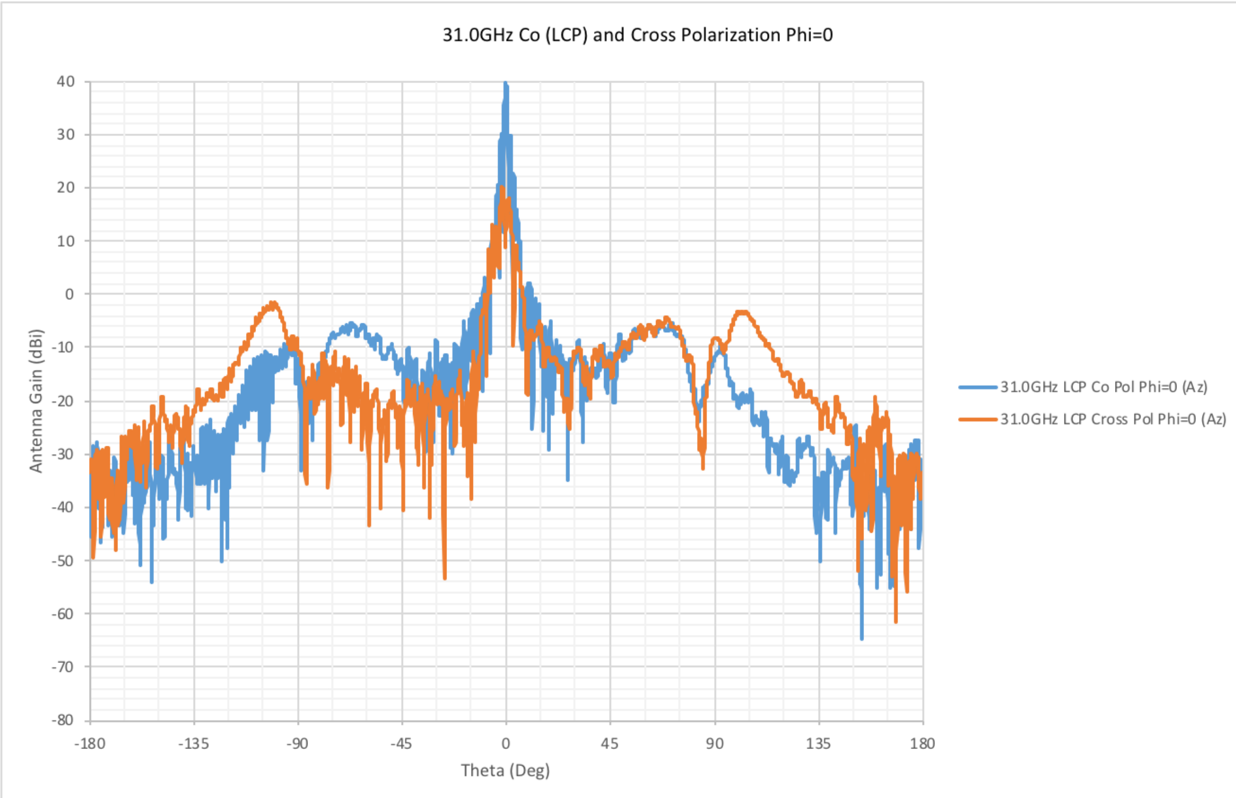
3. 31.0 GHz

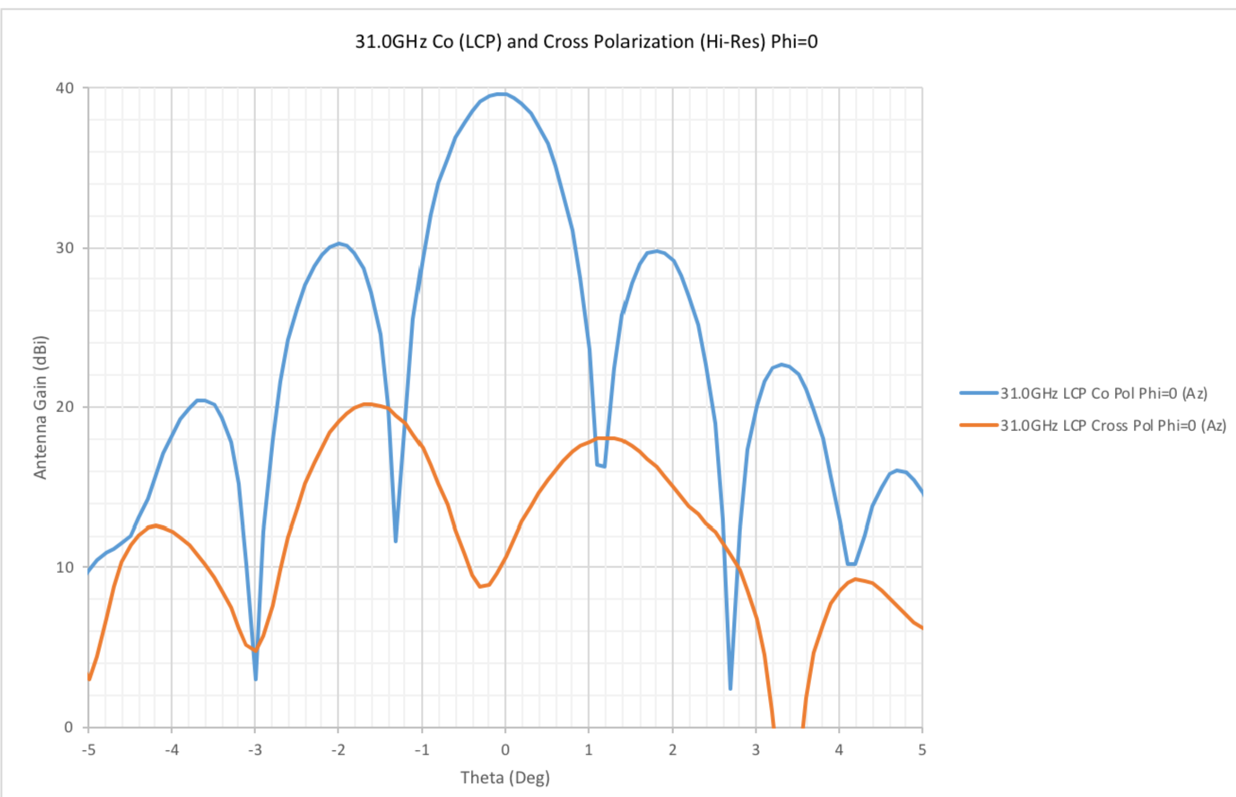

31.0GHz Co (RCP) and Cross Polarization Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
31.0GHz RCP Co Pol Phi=0 (Az)
31.0GHz RCP Cross Pol Phi=0 (Az)

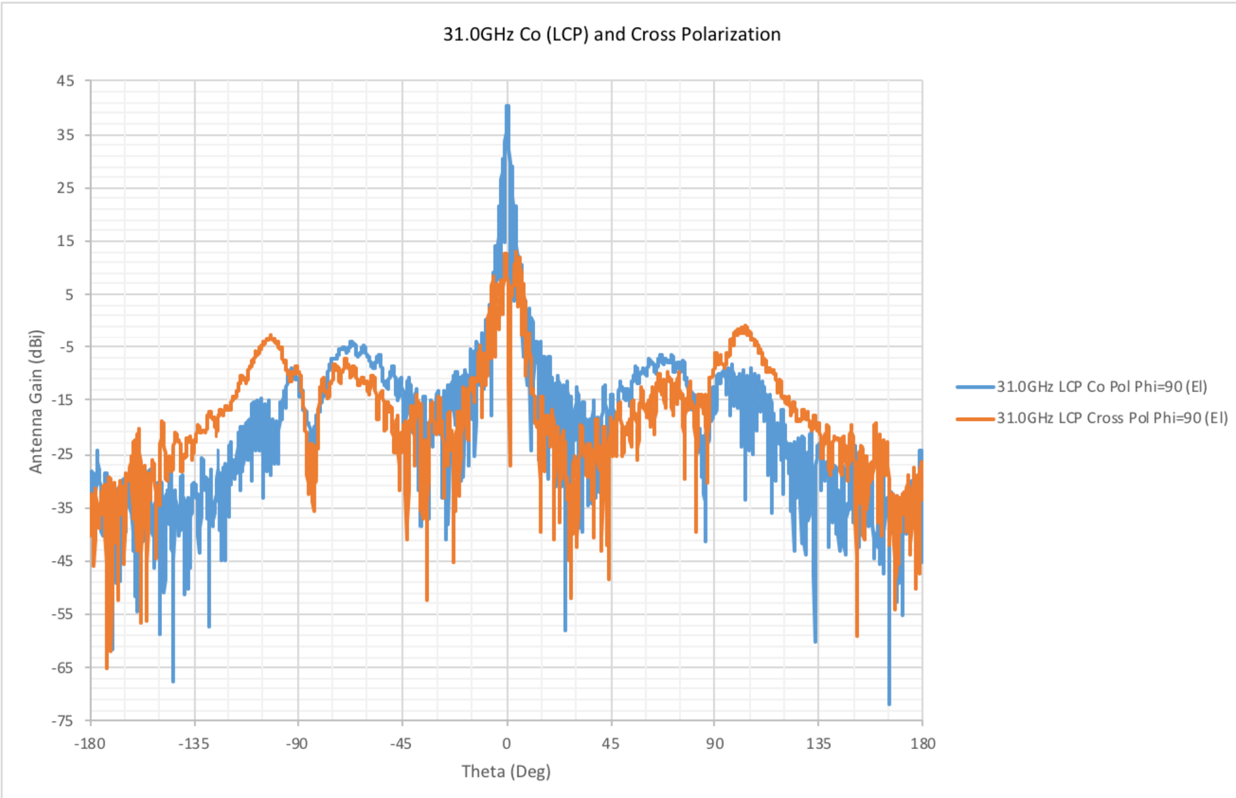

31.0GHz Co (RCP) and Cross Polarization (Hi-Res) Phi=0
Antenna Gain (dBi)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
31.0GHz RCP Co Pol Phi=0 (Az)
31.0GHz RCP Cross Pol Phi=0 (Az)

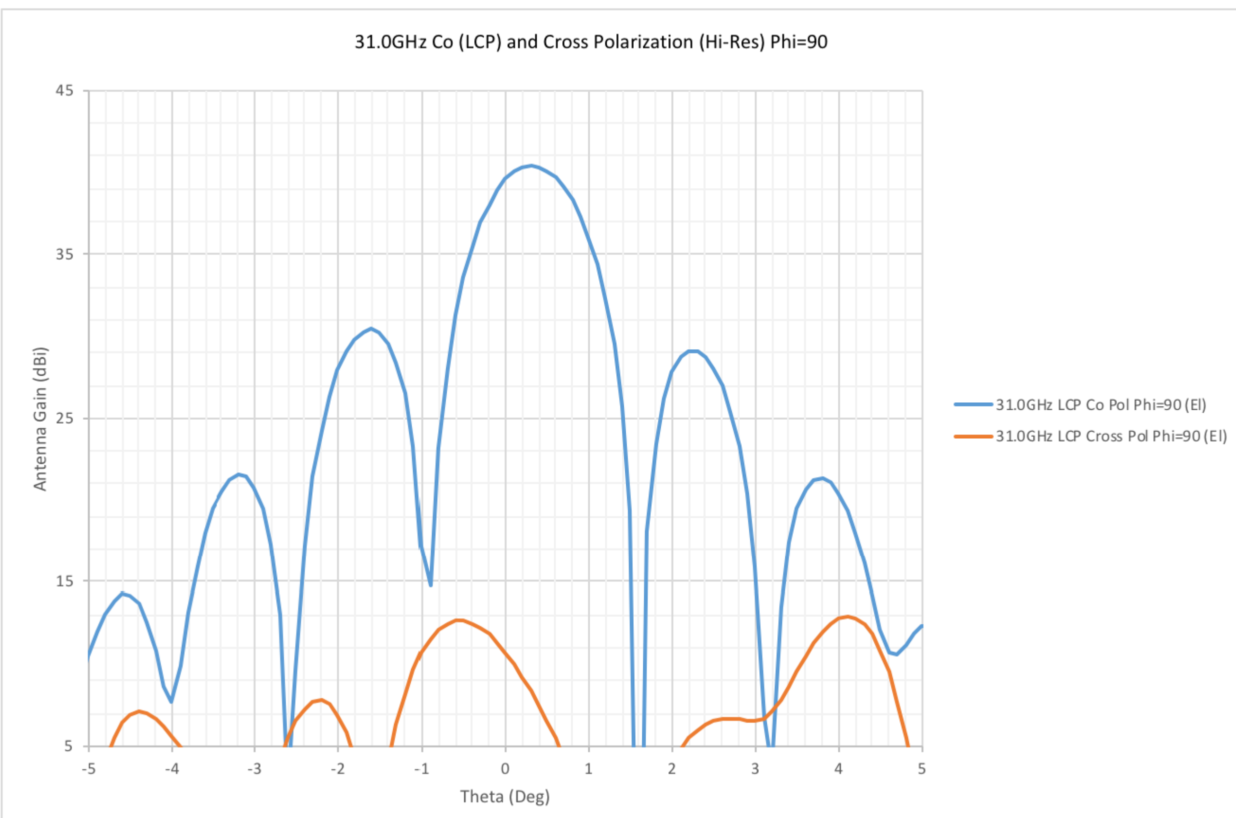

31.0GHz Co (RCP) and Cross Polarization
Antenna Gain (dBi)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
31.0GHz RCP Co Pol Phi=90 (El)
31.0GHz RCP Cross Pol Phi=90 (El)


31.0GHz Co (RCP) and Cross Polarization (Hi-Res) Phi=90
Antenna Gain (dBi)
40
30
20
10
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
31.0GHz RCP Co Pol Phi=90 (El)
31.0GHz RCP Cross Pol Phi=90 (El)


31.0GHz Co (LCP) and Cross Polarization Phi=0
Antenna Gain (dBi)
Theta (Deg)
31.0GHz LCP Co Pol Phi=0 (Az)
31.0GHz LCP Cross Pol Phi=0 (Az)


31.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=0
Antenna Gain (dBi)
Theta (Deg)
31.0GHz LCP Co Pol Phi=0 (Az)
31.0GHz LCP Cross Pol Phi=0 (Az)


31.0GHz Co (LCP) and Cross Polarization
Antenna Gain (dBi)
45
35
25
15
5
-5
-15
-25
-35
-45
-55
-65
-75
-180
-135
-90
-45
0
45
90
135
180
Theta (Deg)
31.0GHz LCP Co Pol Phi=90 (El)
31.0GHz LCP Cross Pol Phi=90 (El)


31.0GHz Co (LCP) and Cross Polarization (Hi-Res) Phi=90
Antenna Gain (dBi)
45
35
25
15
5
-5
-4
-3
-2
-1
0
1
2
3
4
5
Theta (Deg)
31.0GHz LCP Co Pol Phi=90 (El)
31.0GHz LCP Cross Pol Phi=90 (El)