

Antenna Test Report

November 7, 2025

FCC ID:	SBVRM058
IC:	5373A-RM058
Model:	S58
Product Description:	802.11 a/b/g/n/ac/ax 2x2 Client Device with BT/BLE

1. Measurement Method

Antenna Measurements in Anechoic Chambers

The influence of atmospheric conditions and surrounding objects are non-ideal for accurate antenna measurements. An anechoic chamber offers a non-reflective, no-echo room for performing the antenna measurements. The anechoic chamber can simulate outer space, which is the most ideal location for antenna measurements. All gain measurements were performed in accordance with IEEE Std. 149 (IEEE Standard Procedures for Antenna Measurements). Losses of any test cables were calibrated out post-measurement. Please refer to Figure 1 as the measurement chamber diagram

1. Perform chamber calibration using reference antennas.
2. Center the EUT in the chamber using the laser alignment system.
3. Connect the antenna micro-coax cable to the mast cable.
4. Capture antenna gain pattern using the automated measurement software.
5. Export the measurement data.
6. De-embed any additional cable losses in the setup (i.e., losses of any test cables that are not present in the actual product assembly).
7. Post-process the measured data to extract the peak gain.

2. Antenna Information

Antenna Name (Cable Color)	Antenna Type	Location	Primary Polarization	Operating Bands (GHz)	Operation
ANT1	PCB Antenna	Rear, Left	Vertical	2.4 & 5	WiFi
ANT2	PCB Antenna	Rear, Center	Vertical	2.4 & 5	WiFi
ANT3 (Y)	PCB Antenna	Top, Right	Horizontal	2.4 & 5	WiFi
ANT4 (R)	PCB Antenna	Left	Vertical	2.4 & 5	WiFi
ANT5 (BLK)	PCB Antenna	Front, Center	Horizontal	2.4	BT

3. Antenna Gain

S58 WiFi ANTENNA GAINS (All Antennas and Combinations)											
Band	SISO Gain				MIMO Correlated Gain				MIMO Uncorrelated Gain		
	Antenna	Max Peak (dBi)	Pol. (θ=V, φ=H)	Location (θ°, φ°)	Antenna Pairing	Max Peak (dBi)	Pol. (θ=V, φ=H)	Location (θ°, φ°)	Max Peak (dBi)	Pol. (θ=V, φ=H)	Location (θ°, φ°)
2.4G 2400 - 2483 MHz	Ant1	2.1	V	(135°, 93°)	Ant1 + Ant3	3.5	V	(138°, 103°)	1.0	H	(156°, 45°)
	Ant2	2.7	V	(135°, 99°)	Ant1 + Ant4	3.4	V	(141°, 104°)	1.0	H	(156°, 45°)
	Ant3	3.3	H	(72°, 242°)	Ant2 + Ant3	4.8	H	(52°, 245°)	1.9	H	(63°, 244°)
	Ant4	1.8	V	(95°, 128°)	Ant2 + Ant4	3.4	V	(101°, 115°)	0.6	V	(118°, 107°)
5G U-NII 1 5150-5250 MHz	Ant1	2.1	H	(87°, 201°)	Ant1 + Ant3	5.3	H	(106°, 225°)	2.5	H	(110°, 286°)
	Ant2	3.3	V	(93°, 72°)	Ant1 + Ant4	4.9	V	(69°, 338°)	2.4	V	(82°, 340°)
	Ant3	4.6	H	(105°, 281°)	Ant2 + Ant3	4.6	H	(78°, 39°)	2.1	H	(91°, 189°)
	Ant4	4.9	V	(93°, 344°)	Ant2 + Ant4	6.4	V	(93°, 344°)	3.5	V	(93°, 344°)
5G U-NII 2A 5250-5350 MHz	Ant1	2.4	V	(67°, 249°)	Ant1 + Ant3	5.4	H	(135°, 286°)	2.5	H	(132°, 286°)
	Ant2	3.3	V	(82°, 112°)	Ant1 + Ant4	5.5	V	(48°, 326°)	2.5	V	(48°, 326°)
	Ant3	4.3	H	(101°, 278°)	Ant2 + Ant3	4.3	V	(63°, 153°)	1.7	H	(115°, 276°)
	Ant4	4.1	V	(108°, 344°)	Ant2 + Ant4	5.2	V	(95°, 342°)	2.4	V	(95°, 341°)
5G U-NII 2C 5470-5725 MHz	Ant1	3.3	V	(55°, 311°)	Ant1 + Ant3	4.5	H	(127°, 281°)	2.0	H	(112°, 272°)
	Ant2	3.8	V	(70°, 136°)	Ant1 + Ant4	5.4	V	(48°, 317°)	2.4	V	(48°, 316°)
	Ant3	4.7	H	(98°, 275°)	Ant2 + Ant3	5.4	V	(18°, 38°)	2.4	V	(18°, 37°)
	Ant4	3.2	V	(86°, 331°)	Ant2 + Ant4	4.1	V	(67°, 46°)	1.4	V	(73°, 113°)
5G U-NII 3 5725-5850 MHz	Ant1	2.1	V	(121°, 138°)	Ant1 + Ant3	3.3	H	(117°, 157°)	0.6	H	(116°, 178°)
	Ant2	4.0	V	(67°, 108°)	Ant1 + Ant4	4.4	V	(68°, 32°)	1.6	V	(72°, 31°)
	Ant3	3.0	H	(99°, 274°)	Ant2 + Ant3	4.7	H	(18°, 102°)	1.7	H	(18°, 102°)
	Ant4	3.5	V	(100°, 259°)	Ant2 + Ant4	4.6	V	(65°, 30°)	1.9	V	(68°, 52°)

Notes:

- All WiFi antennas can operate in 1SS and 2SS modes.
- Individual SISO gains patterns can be seen in the Appendix: SISO Antenna Gains section.

S58 BT ANTENNA GAINS					
Band	Type	Peak (dBi)	DUT Orientation	Antenna Combination	Polarization
BLE 2.4G	SISO Min	3.1	Upright	BT	H
	SISO Max	3.2	Upright	BT	H

DG composite gain formulas to be used, justification, calculations and summary tables for each in- band RF Chain or Operating Mode

The following formulas will be used but rather than applying the peak gain for each antenna we will be using the spatial antenna gains at each azimuth/elevation angle to calculate the gain pattern. The gain to be used in the test report for a given frequency will be the maximum composite gain across all azimuth/elevation angles. Essentially, the equations are applied to the full 3-D measured gains, and the peak of the aggregate patterns are presented per frequency.

For additional information, refer to the Appendix: MIMO Antenna Gains section.

For total power:

- (ii) If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream:
- Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain; or,

$$DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

For PSD:

(iii) If antenna gains are not equal and each transmit antenna can be driven by more than one spatial stream:

- Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain; or,

$$\bullet \quad DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \sqrt{P_{j,k}} \right\}^2}{N_{ANT}} \right]$$

where

N_{SS} = the number of independent spatial streams of data;

N_{ANT} = the total number of antennas;

$g_{j,k} = 10^{G_k/20}$ if the k th antenna is being fed by spatial stream j , or zero if it is not;

G_k is the gain in dBi of the k th antenna;

$P_{j,k}$ is the relative normalized power (in linear terms, not decibels) of spatial stream j feeding the k th antenna, normalized such that

$$\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} P_{j,k} \right\} = N_{ANT}$$

Note: $P_{j,k} = 0$ if spatial stream j does not feed the k th antenna.

4. Antenna Test Setup

The test setup for the S58 antenna gain measurements is shown below:

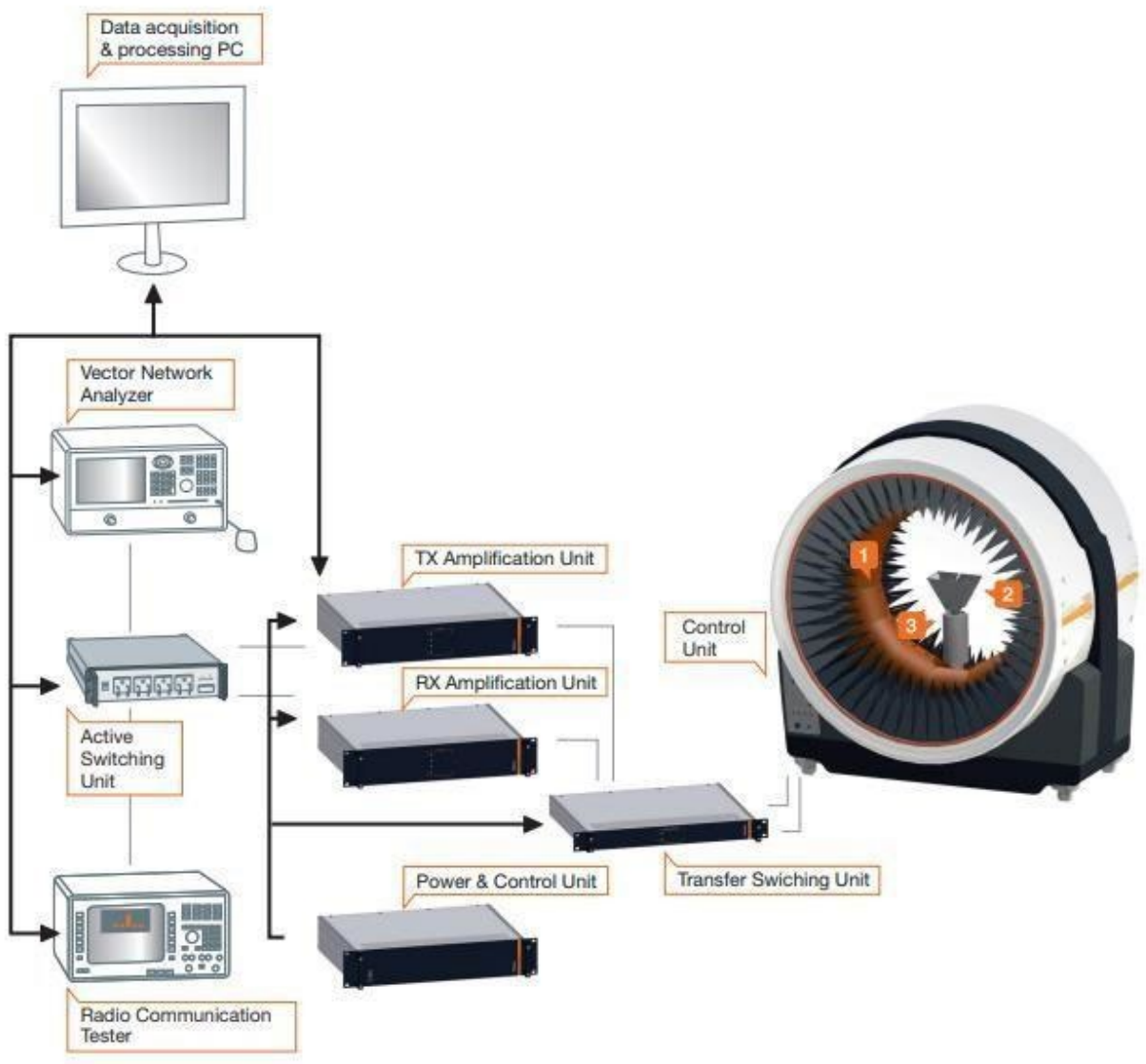


Figure 1 - Measurement Chamber Diagram

5. Test location

GGEC Antenna Chamber.

Peak Gain was measured using the antenna test chamber. The antennas for S58 were measured in the full product assembly.

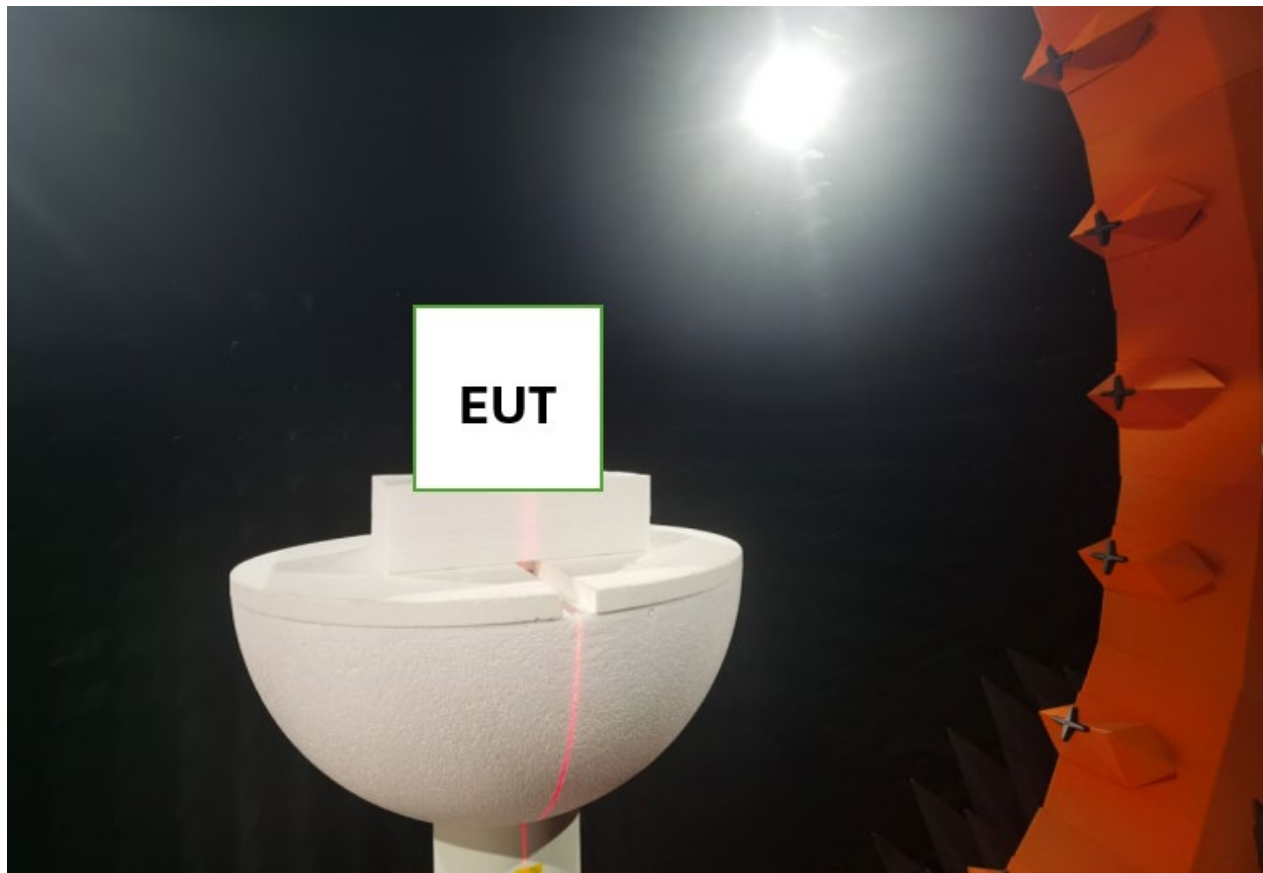


Figure 2 - EUT in the test chamber

Notes:

- Test Method and Environment – Gain Substitution Method in an Anechoic Environment
- Resolution – 3° in both azimuth and elevation
- Calibration Method – Efficiency Calibration using Standard Reference Dipoles
- Additional corrections – Gains compensated for setup/jumper cables, when applicable.

6. Test Equipment list

Description	Manufacturer	ID number
Antenna measurement system	MVG	1102805-0014

Calibrated test equipment:

MVG SG24

E5061A VNA

MVG Standard Reference Dipoles

1. SD2450

2. SD5150

3. SD5650

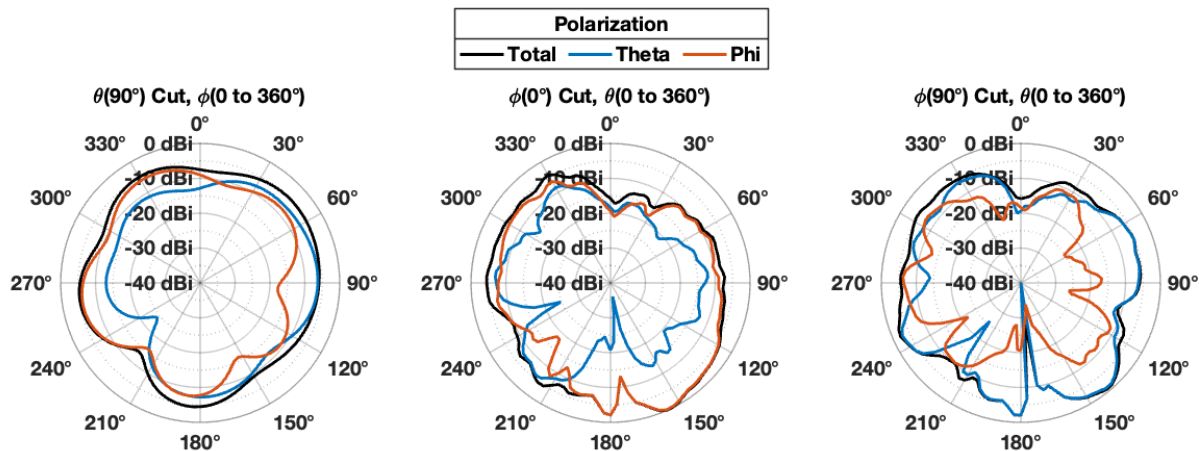
The chamber is calibrated annually by the vendor. Latest calibration: 28-Oct-2024.

7. Test Personnel

Test Engineer(s)	Test Date
Lijun Zhou (GGEC) Welkis Rodriguez (Sonos)	June 9-20, 2025

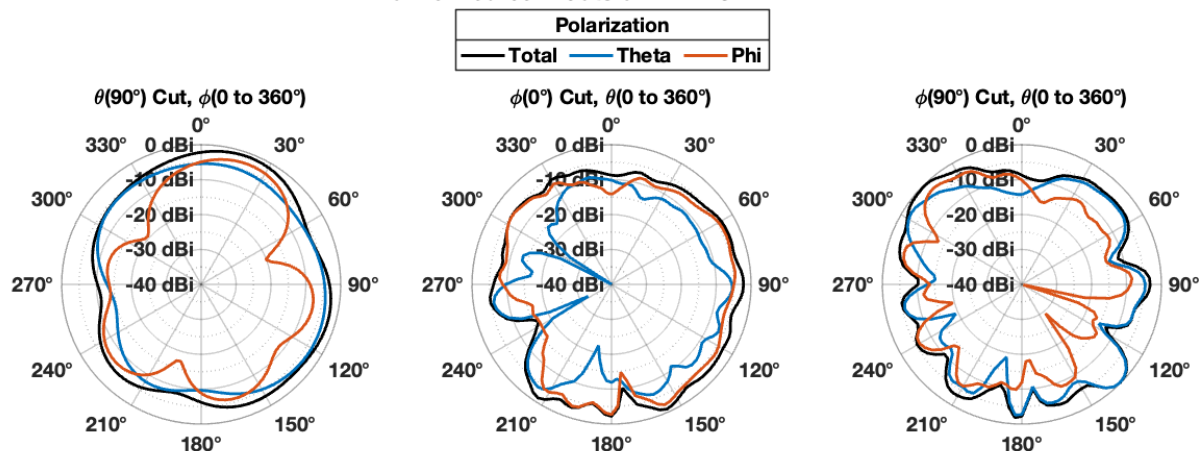
Appendix: SISO Antenna Gains

Normalized Gain Cuts of ANT1 @ 2412-MHz



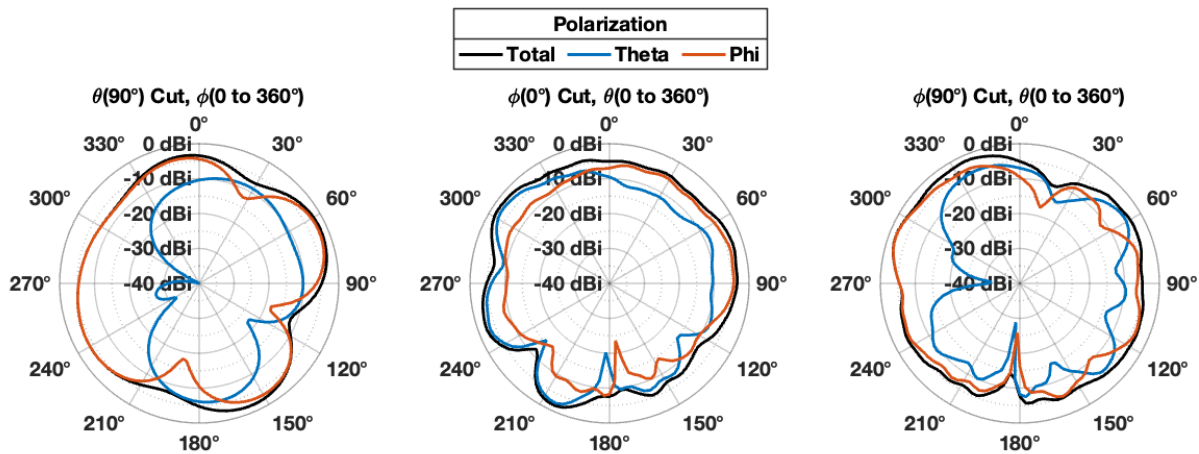
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.9	H	(135°, 348°)	1SS / 2SS
SISO Max	2.1	V	(135°, 93°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 2412-MHz



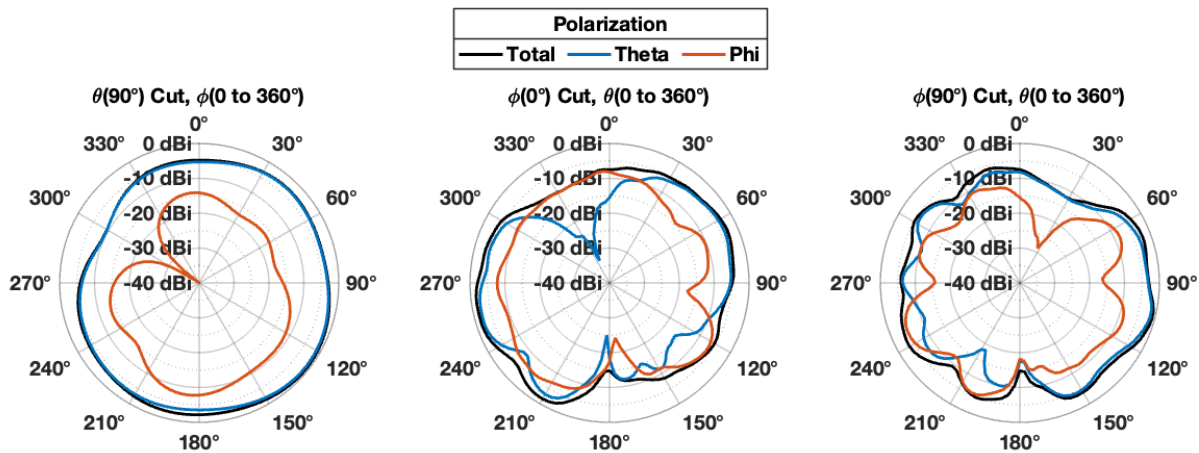
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.0	H	(60°, 110°)	1SS / 2SS
SISO Max	2.6	V	(135°, 98°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 2412-MHz



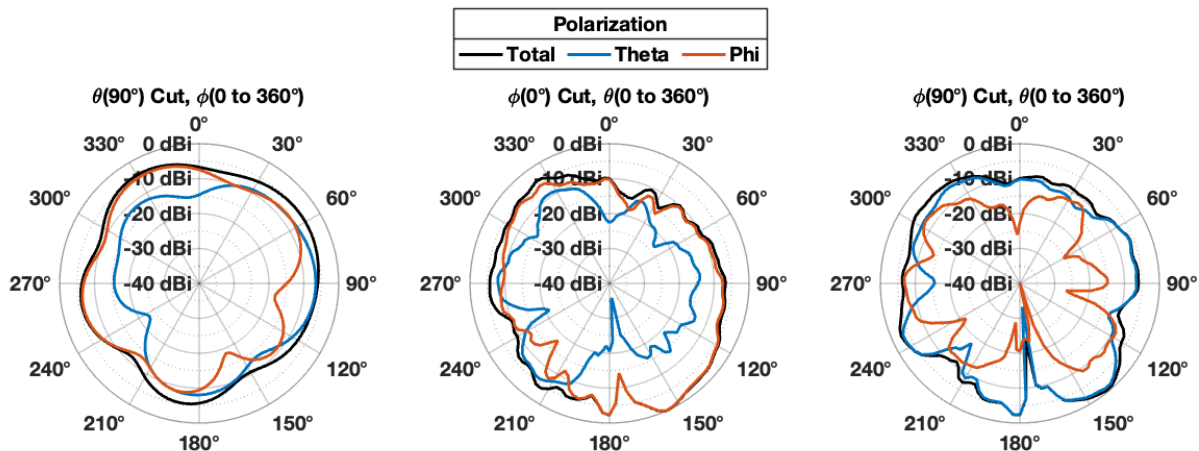
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	-0.1	V	(55°, 202°)	1SS / 2SS
SISO Max	2.4	H	(68°, 243°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 2412-MHz



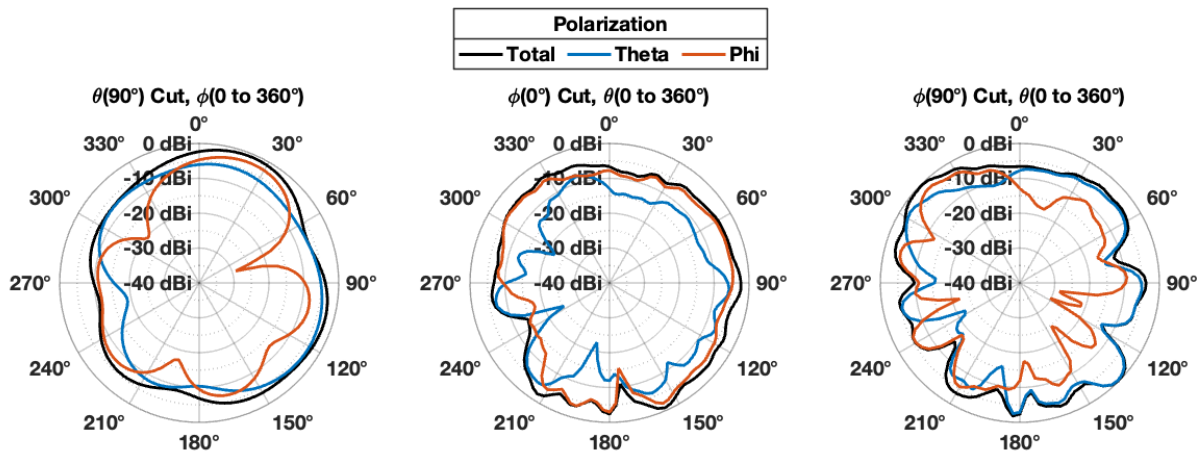
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	-2.3	H	(107°, 243°)	1SS / 2SS
SISO Max	1.8	V	(96°, 128°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 2442-MHz



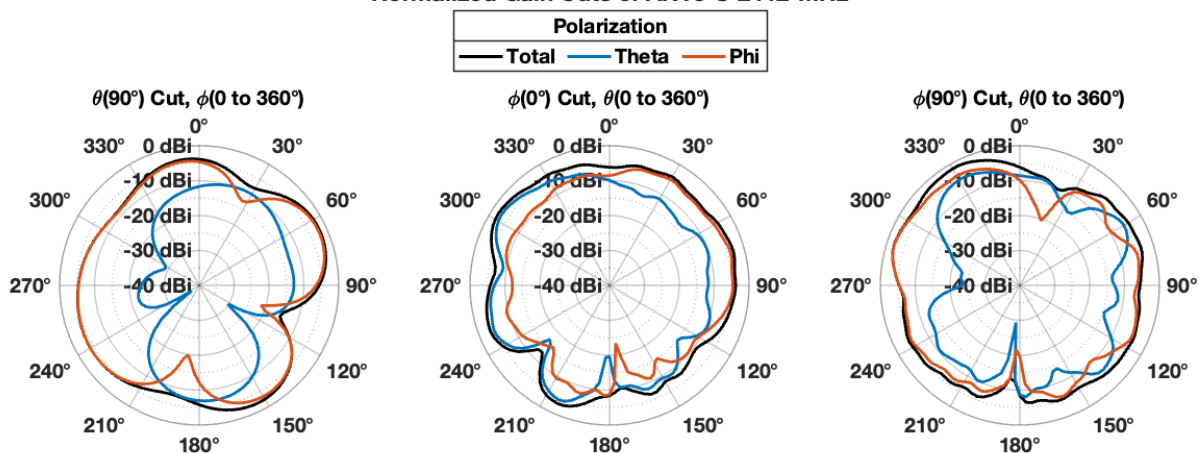
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.2	H	(135°, 345°)	1SS / 2SS
SISO Max	2.1	V	(135°, 94°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 2442-MHz



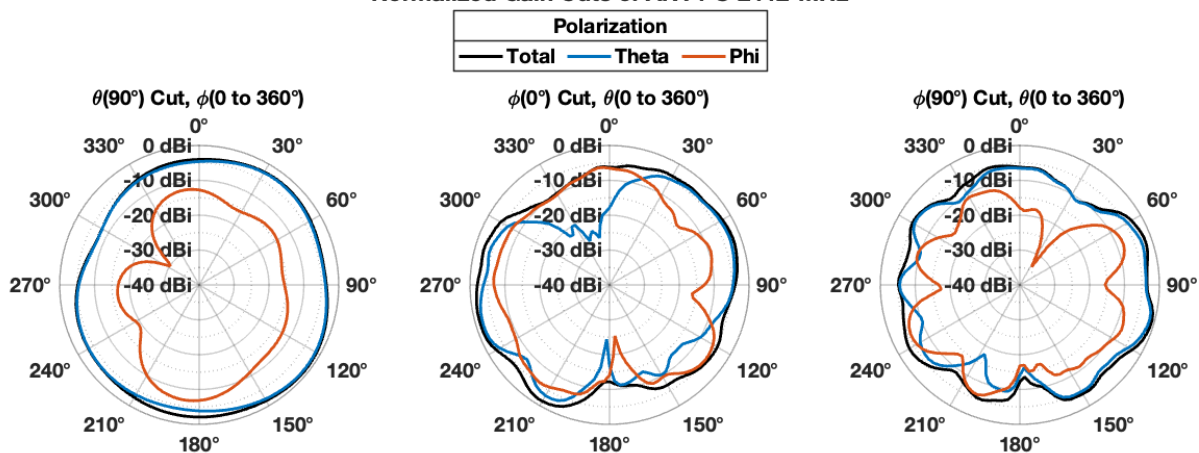
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.6	H	(45°, 251°)	1SS / 2SS
SISO Max	2.5	V	(135°, 99°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 2442-MHz



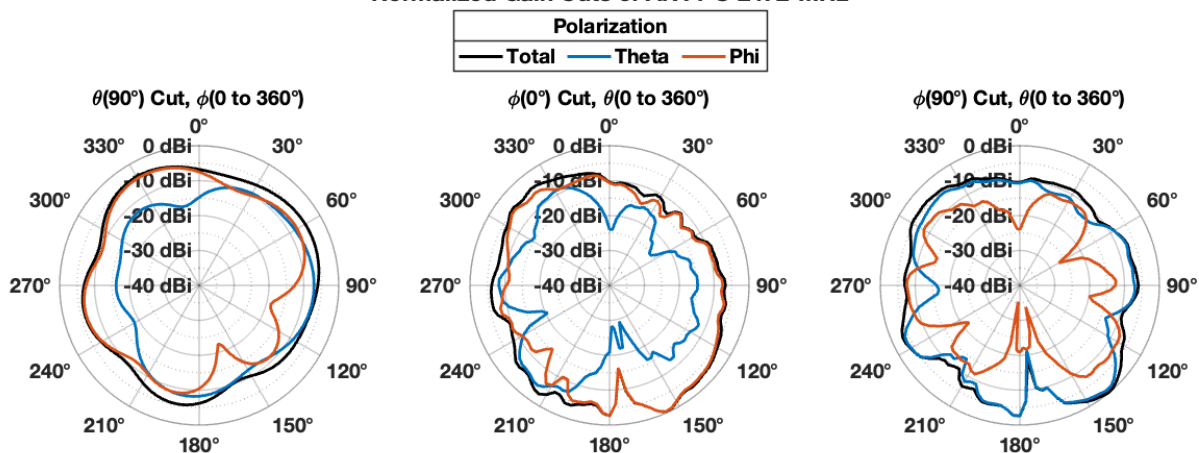
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.2	V	(54°, 214°)	1SS / 2SS
SISO Max	2.9	H	(70°, 243°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 2442-MHz



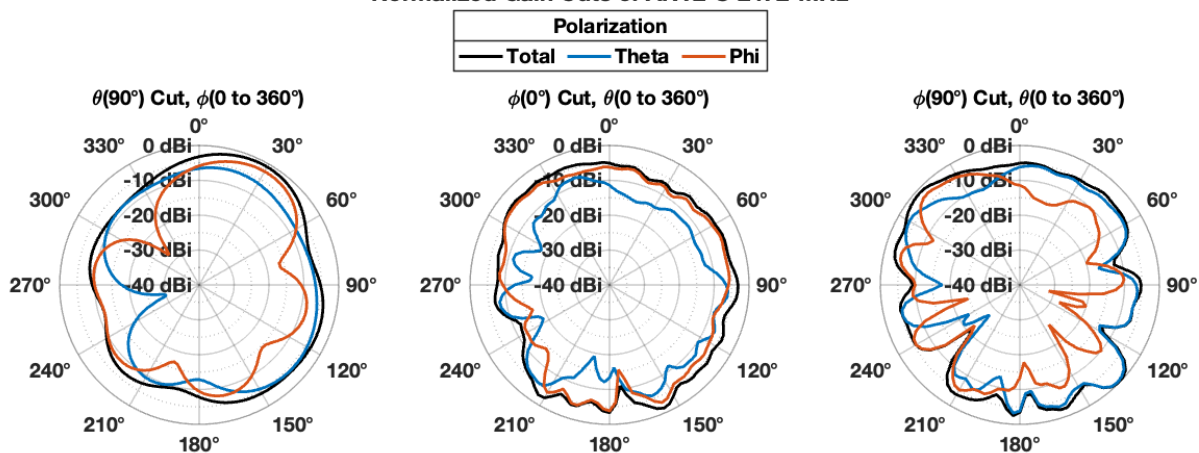
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	-2.7	H	(120°, 106°)	1SS / 2SS
SISO Max	1.5	V	(97°, 117°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 2472-MHz



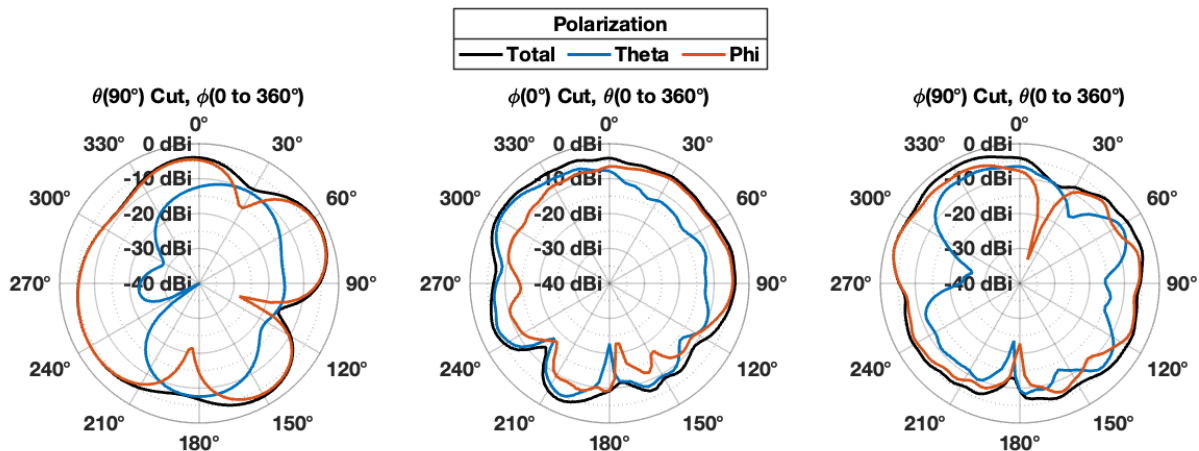
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.8	H	(130°, 340°)	1SS / 2SS
SISO Max	2.0	V	(135°, 93°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 2472-MHz



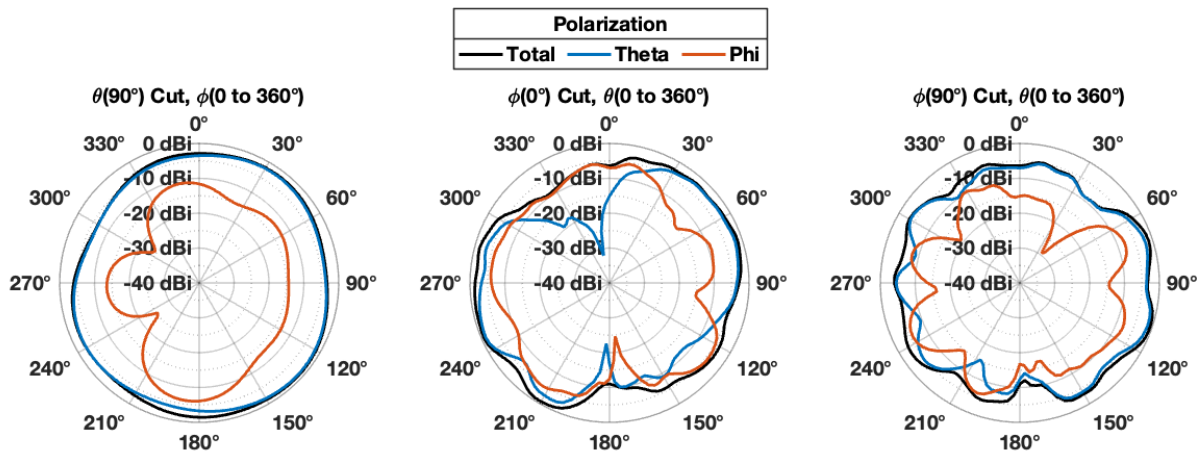
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.5	H	(57°, 168°)	1SS / 2SS
SISO Max	2.7	V	(135°, 99°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 2472-MHz



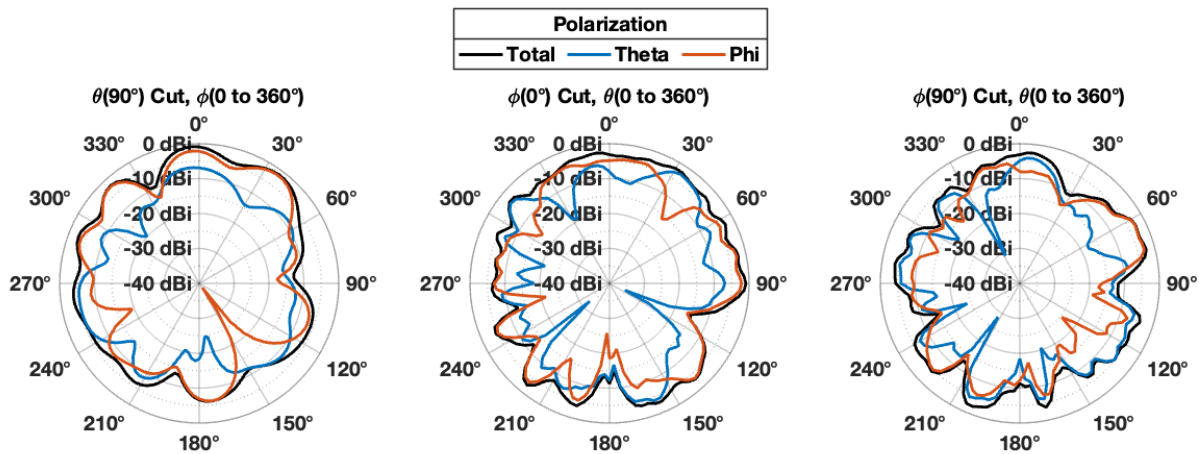
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.3	V	(53°, 213°)	1SS / 2SS
SISO Max	3.3	H	(72°, 242°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 2472-MHz



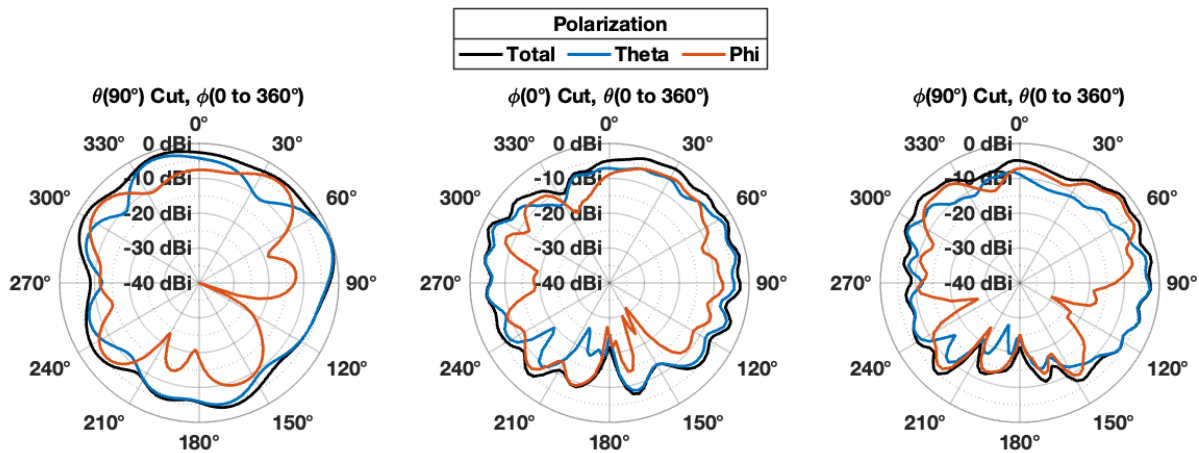
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	-2.6	H	(129°, 162°)	1SS / 2SS
SISO Max	1.2	V	(106°, 149°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5180-MHz



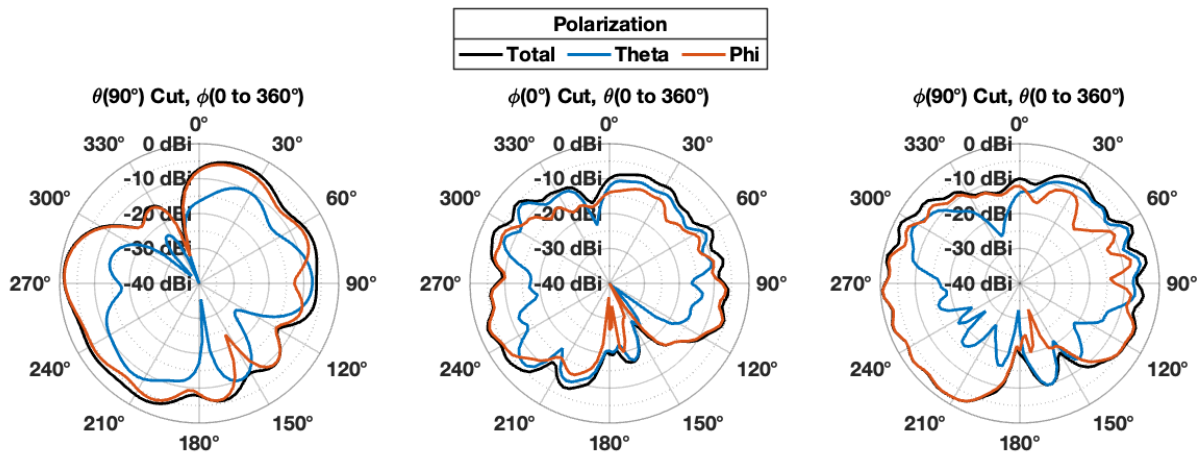
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.1	V	(87°, 208°)	1SS / 2SS
SISO Max	2.1	H	(87°, 201°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5180-MHz



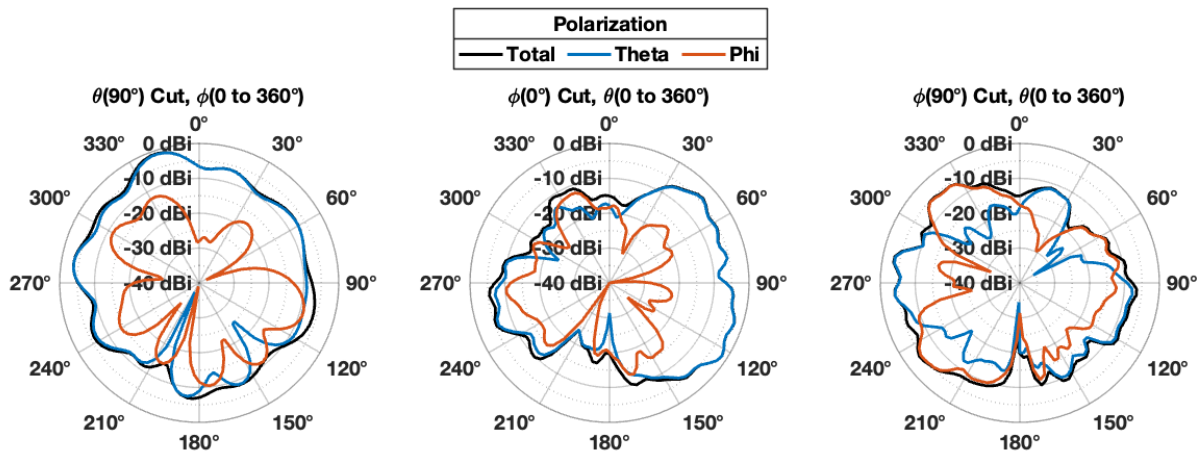
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.6	H	(71°, 82°)	1SS / 2SS
SISO Max	3.3	V	(93°, 72°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5180-MHz



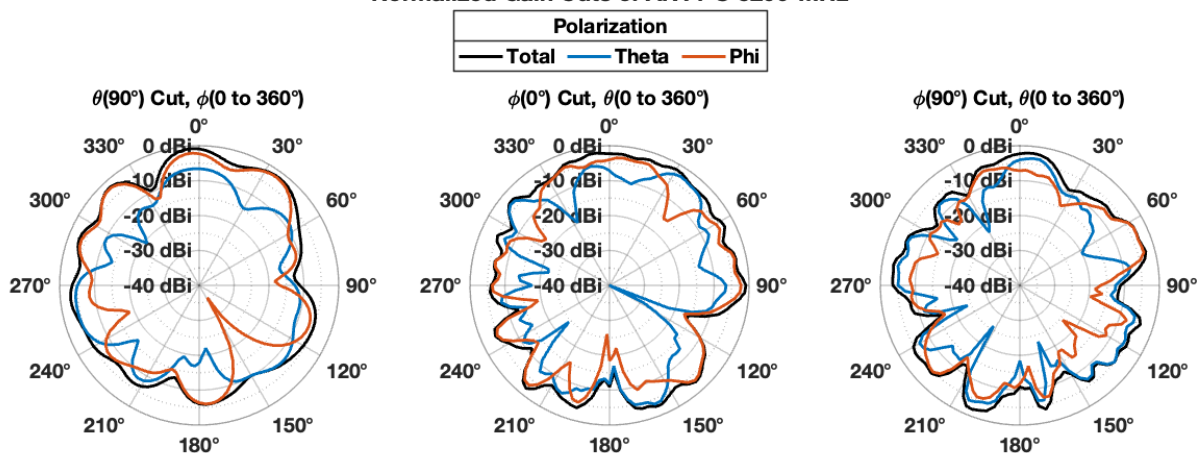
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.9	V	(63°, 148°)	1SS / 2SS
SISO Max	4.6	H	(105°, 281°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5180-MHz



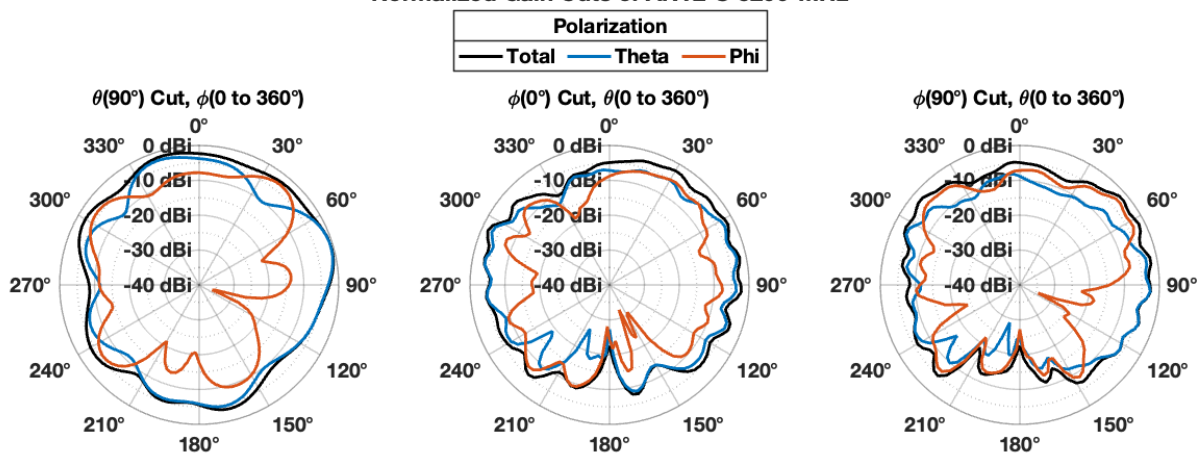
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.6	H	(70°, 290°)	1SS / 2SS
SISO Max	4.9	V	(93°, 344°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5200-MHz



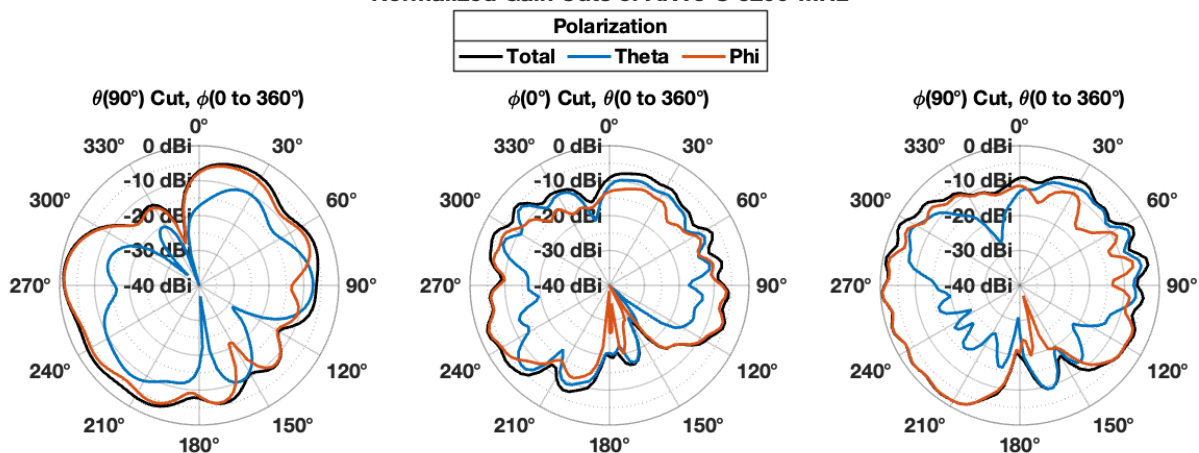
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.2	V	(85°, 187°)	1SS / 2SS
SISO Max	1.9	H	(91°, 210°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5200-MHz



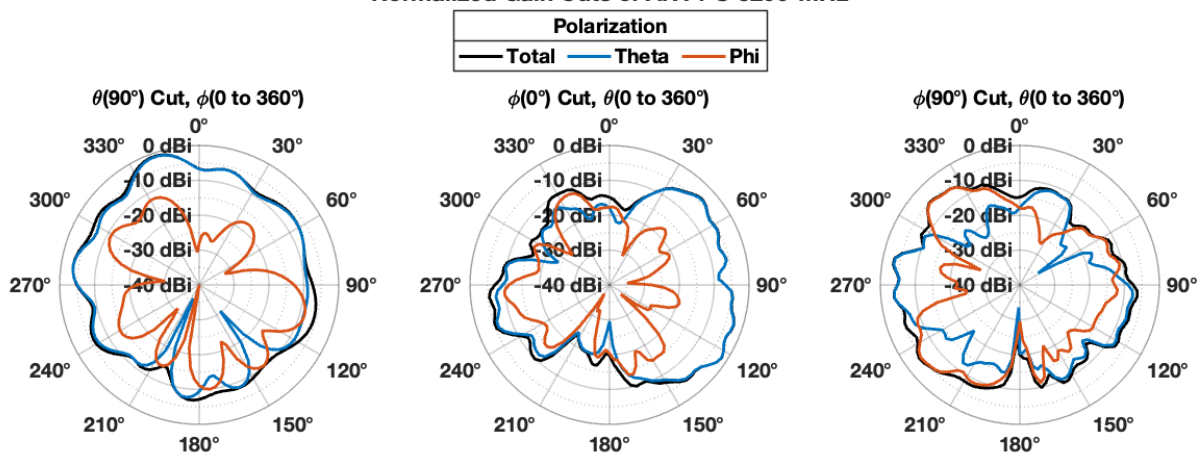
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.5	H	(73°, 132°)	1SS / 2SS
SISO Max	3.3	V	(93°, 72°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5200-MHz



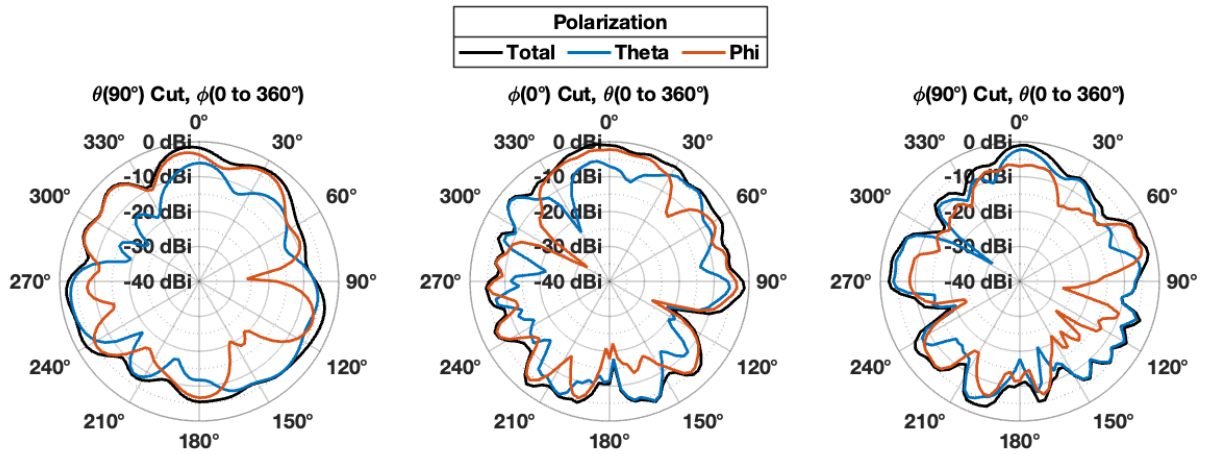
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	2.0	V	(63°, 148°)	1SS / 2SS
SISO Max	4.5	H	(105°, 280°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5200-MHz



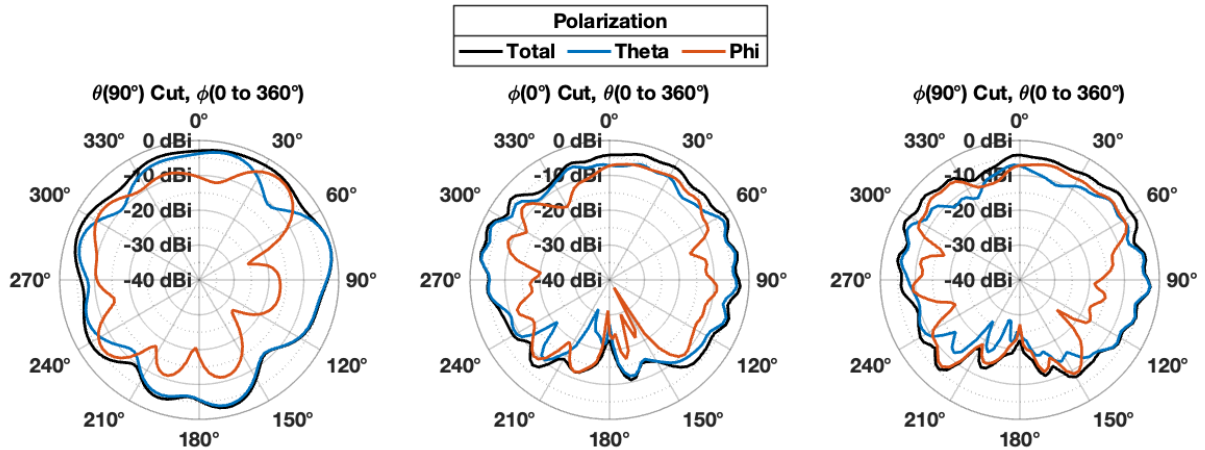
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.7	H	(70°, 290°)	1SS / 2SS
SISO Max	4.8	V	(97°, 344°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5300-MHz



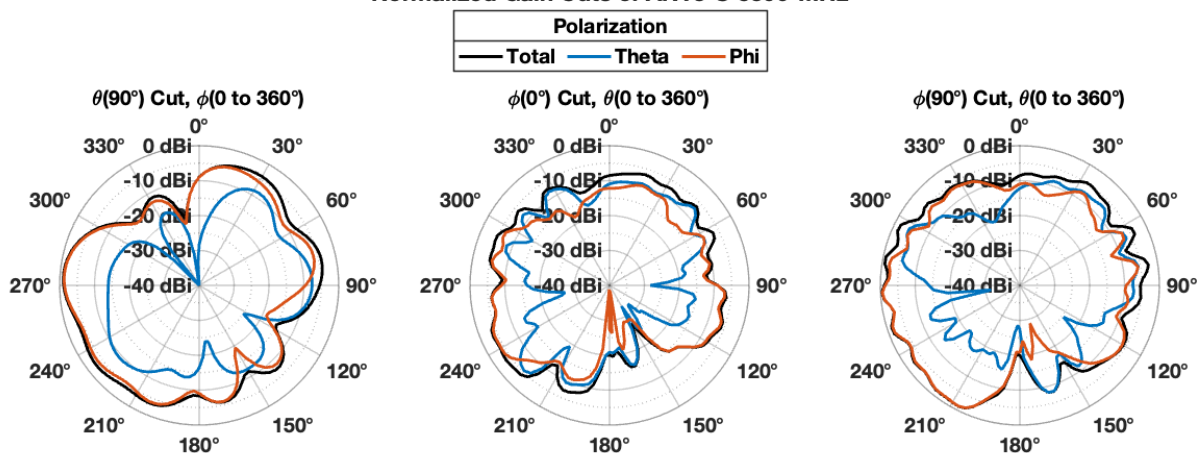
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.8	H	(100°, 206°)	1SS / 2SS
SISO Max	2.4	V	(67°, 249°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5300-MHz



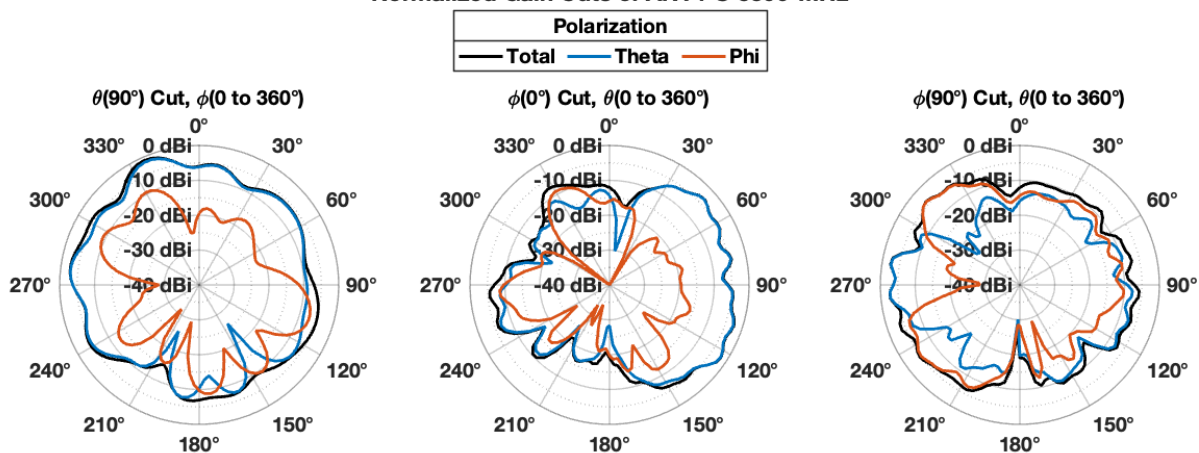
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.5	H	(78°, 41°)	1SS / 2SS
SISO Max	3.3	V	(82°, 112°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5300-MHz



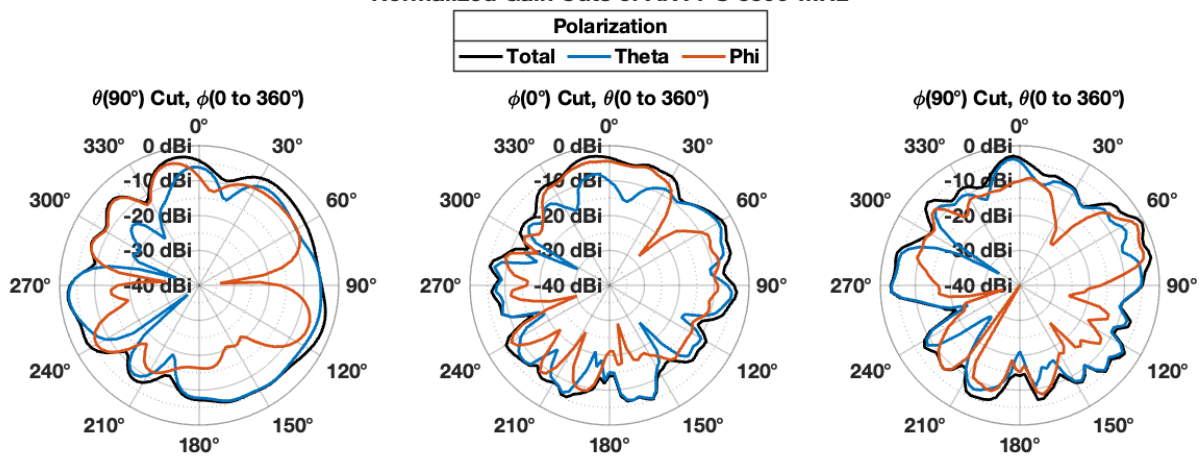
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.7	V	(63°, 146°)	1SS / 2SS
SISO Max	4.3	H	(101°, 278°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5300-MHz



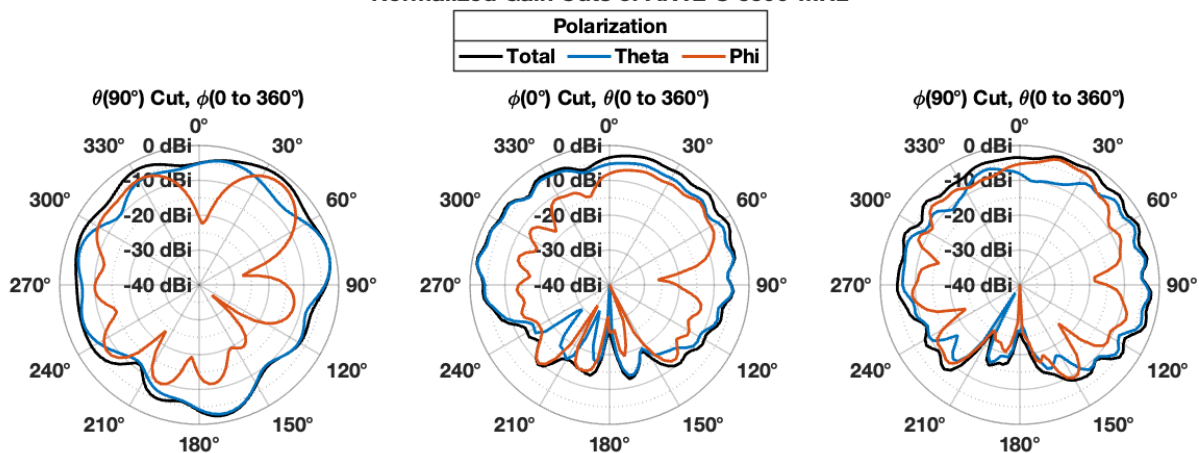
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.1	H	(59°, 286°)	1SS / 2SS
SISO Max	4.1	V	(108°, 344°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5500-MHz



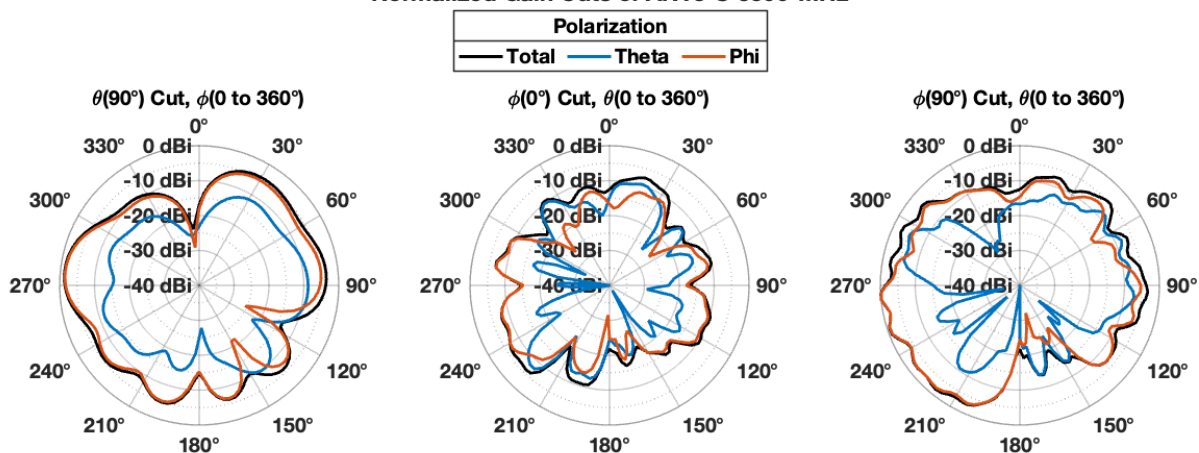
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	2.2	H	(79°, 206°)	1SS / 2SS
SISO Max	3.3	V	(55°, 311°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5500-MHz



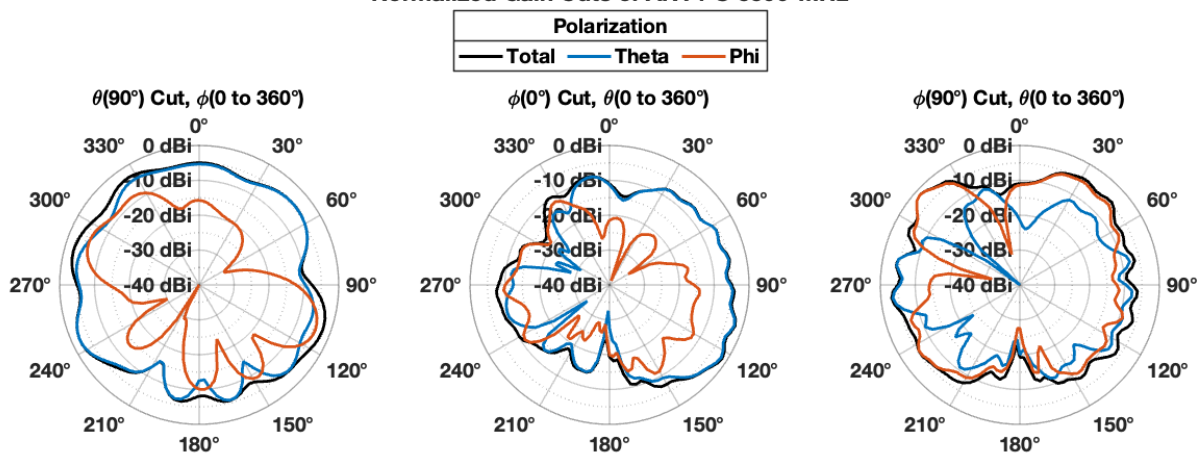
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.9	H	(74°, 212°)	1SS / 2SS
SISO Max	3.5	V	(79°, 168°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5500-MHz



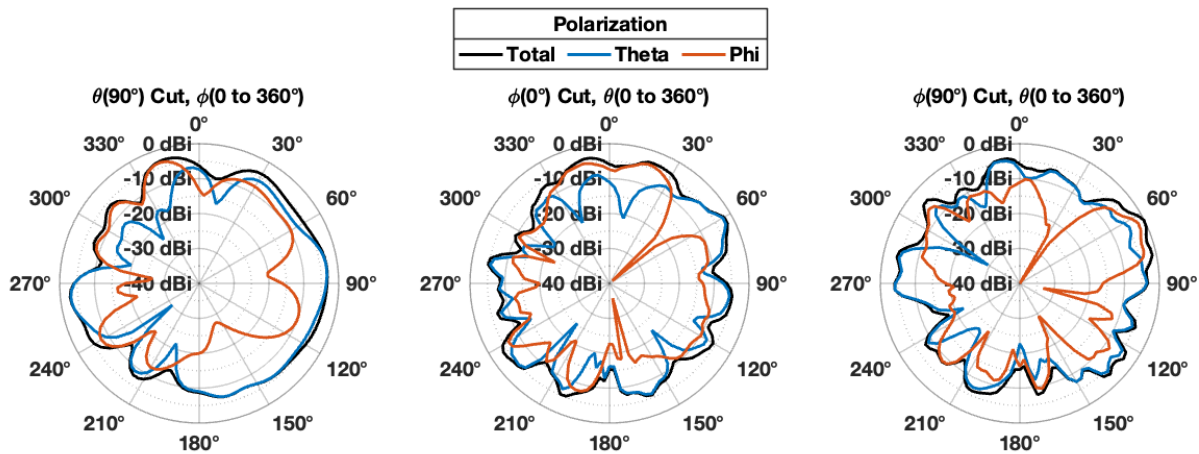
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.0	V	(100°, 214°)	1SS / 2SS
SISO Max	4.7	H	(98°, 275°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5500-MHz



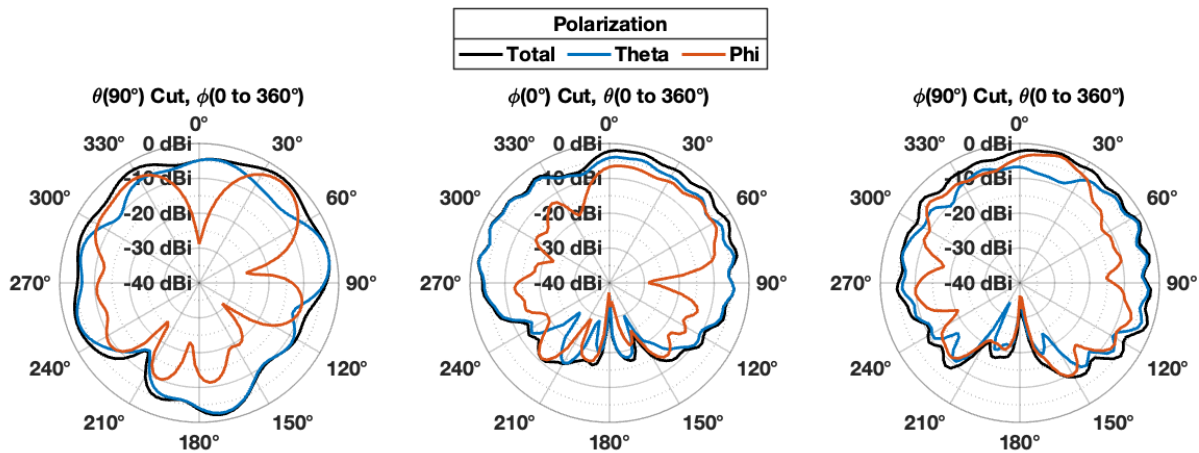
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	2.4	H	(48°, 280°)	1SS / 2SS
SISO Max	3.2	V	(86°, 331°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5600-MHz



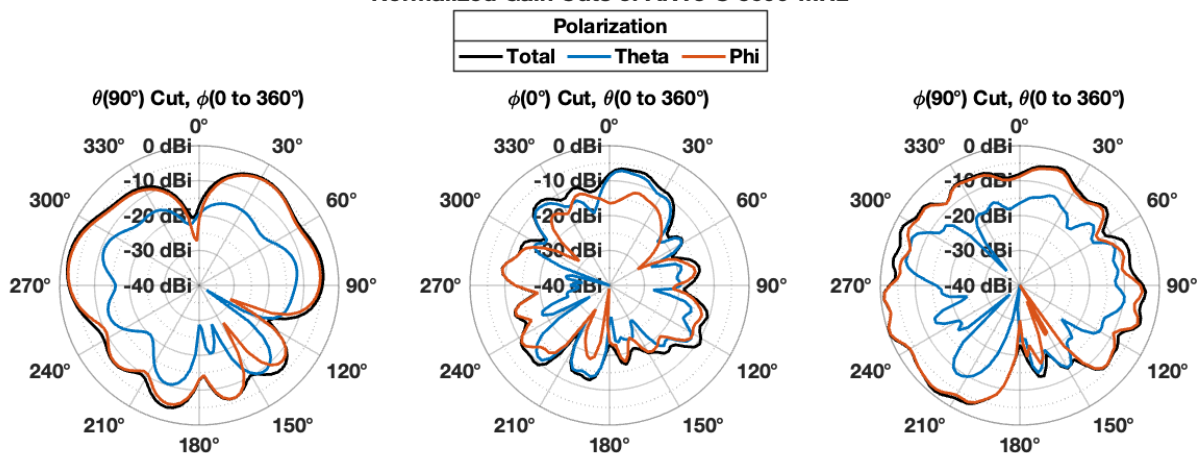
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.8	H	(75°, 155°)	1SS / 2SS
SISO Max	2.5	V	(94°, 215°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5600-MHz



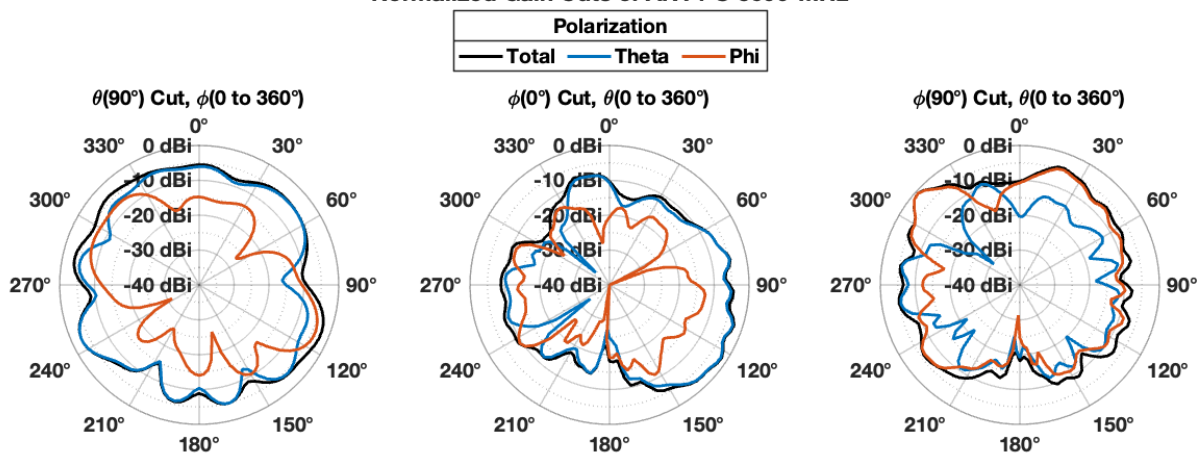
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	2.0	H	(70°, 320°)	1SS / 2SS
SISO Max	3.7	V	(79°, 169°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5600-MHz



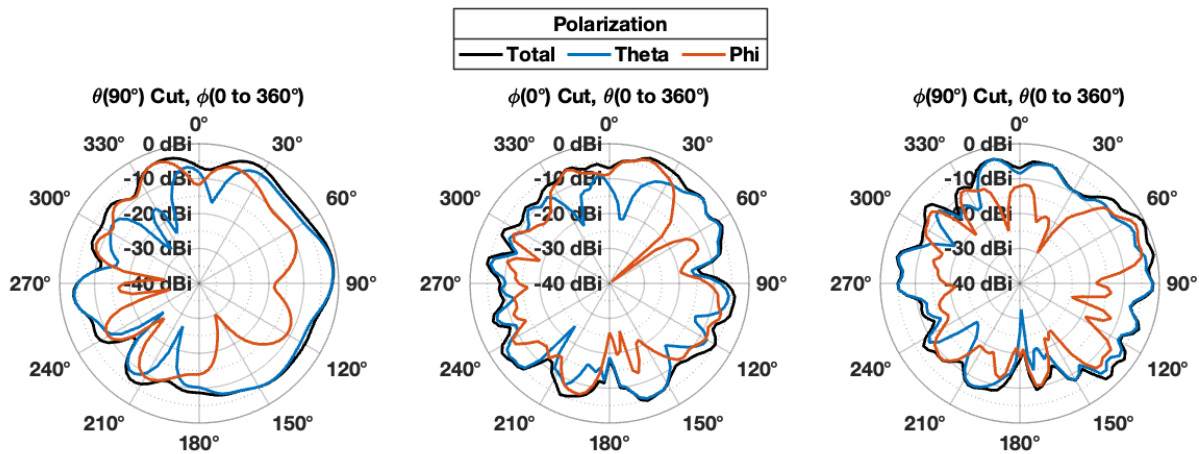
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	-0.7	V	(90°, 166°)	1SS / 2SS
SISO Max	4.4	H	(107°, 276°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5600-MHz



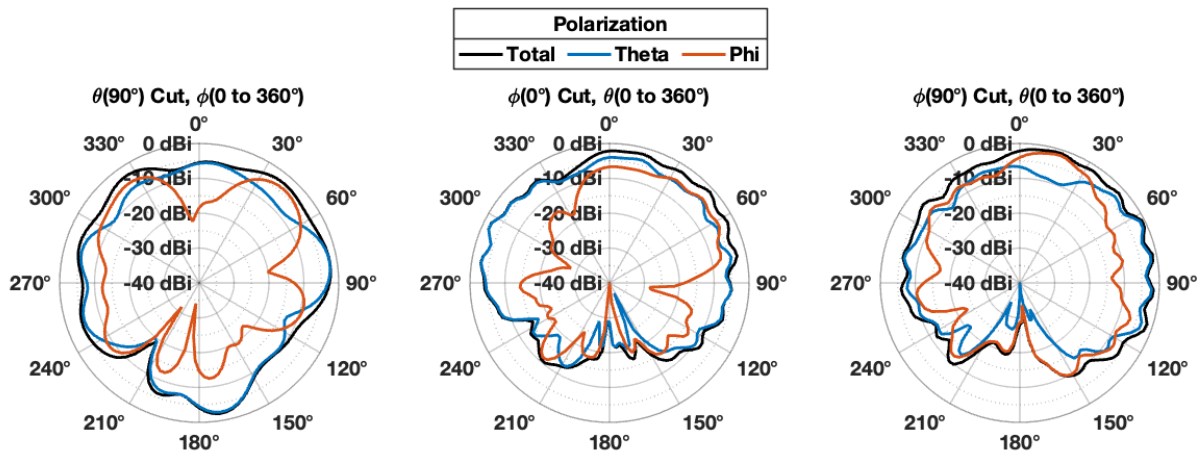
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	3.0	H	(48°, 275°)	1SS / 2SS
SISO Max	3.1	V	(114°, 339°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5700-MHz



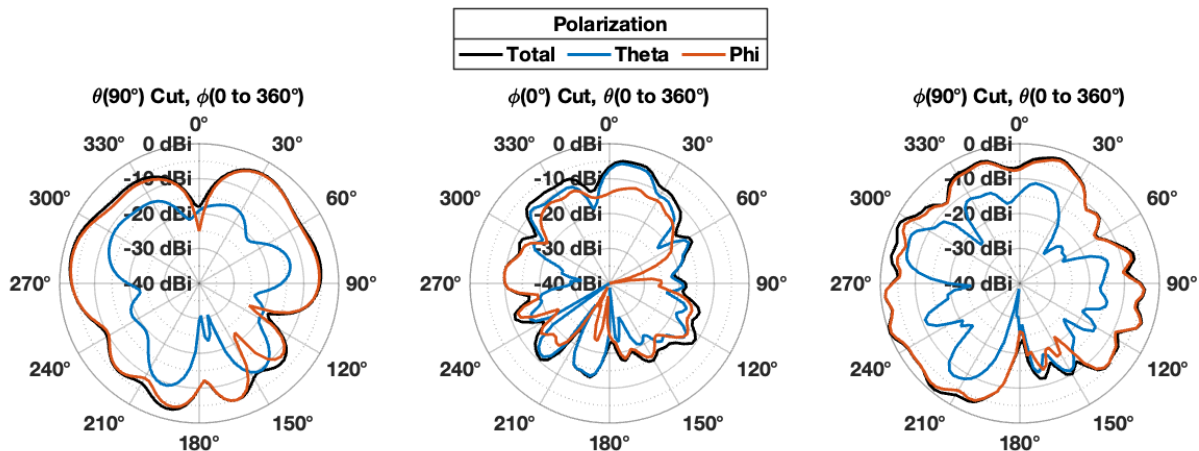
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.6	H	(112°, 321°)	1SS / 2SS
SISO Max	2.5	V	(102°, 176°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5700-MHz



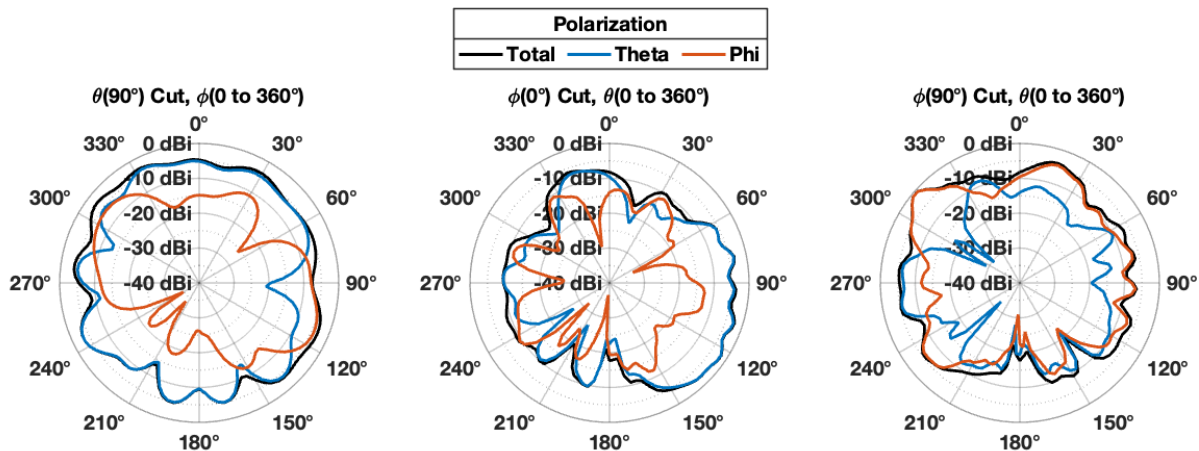
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.5	H	(69°, 320°)	1SS / 2SS
SISO Max	3.8	V	(70°, 136°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5700-MHz



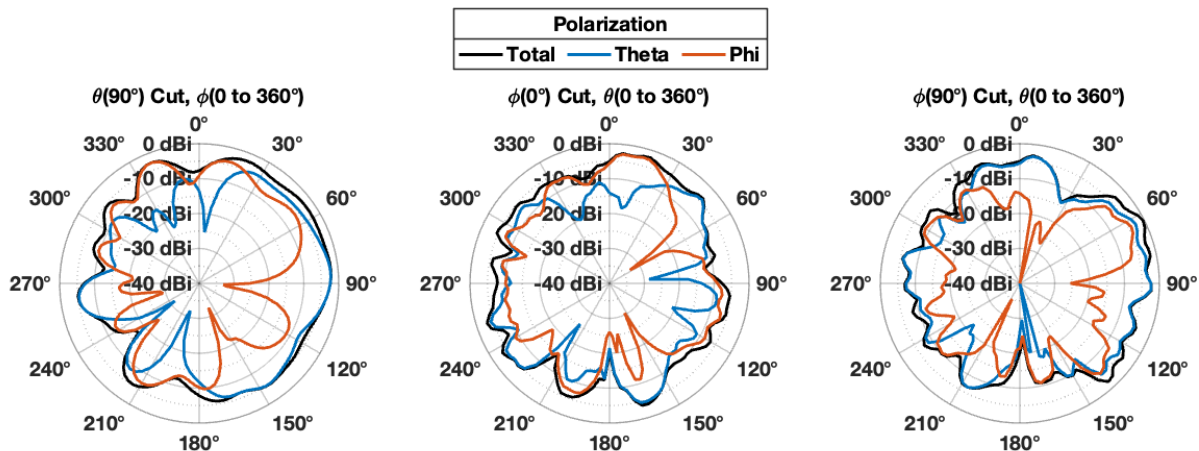
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	0.3	V	(51°, 134°)	1SS / 2SS
SISO Max	4.1	H	(107°, 275°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5700-MHz



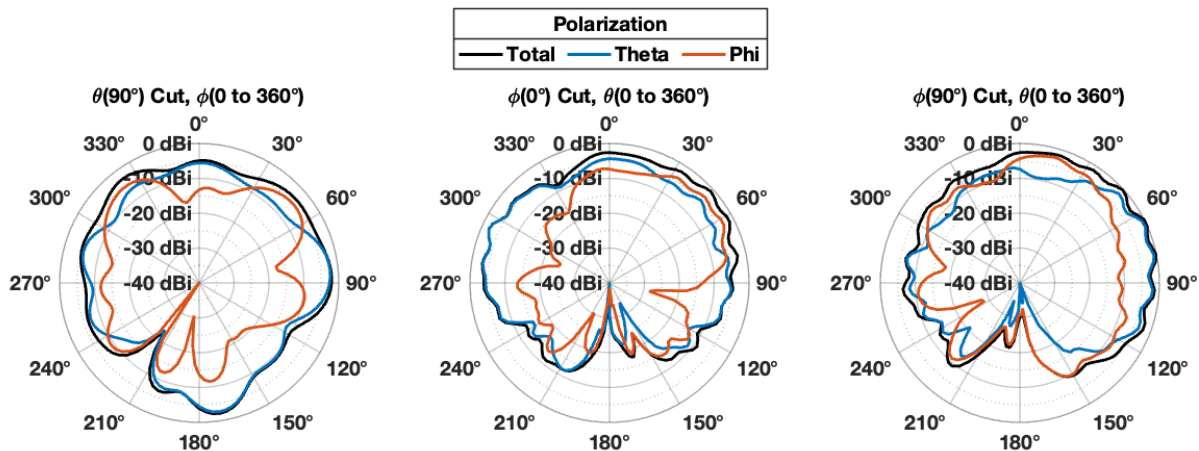
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	2.9	H	(49°, 272°)	1SS / 2SS
SISO Max	3.1	V	(110°, 338°)	1SS / 2SS

Normalized Gain Cuts of ANT1 @ 5800-MHz



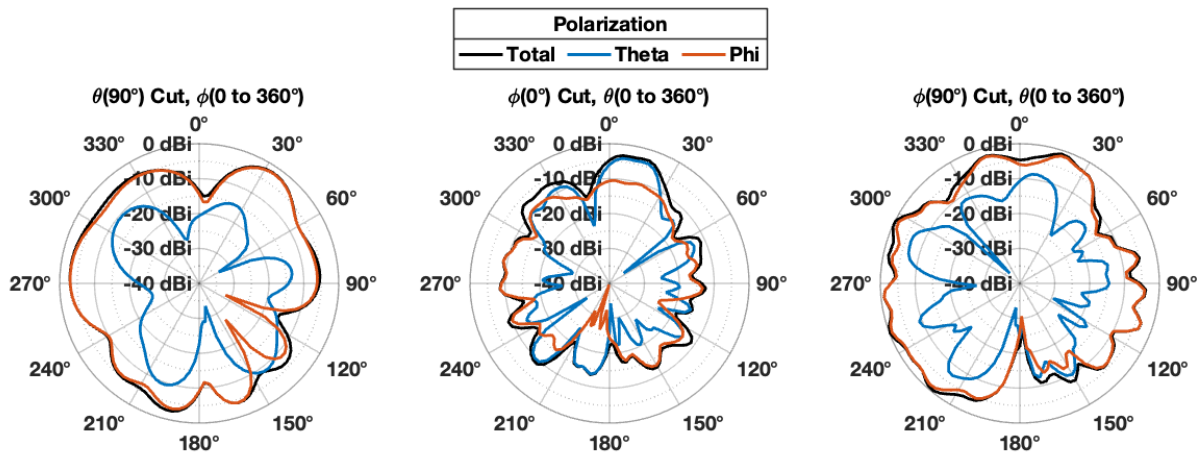
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.6	H	(102°, 328°)	1SS / 2SS
SISO Max	2.1	V	(121°, 138°)	1SS / 2SS

Normalized Gain Cuts of ANT2 @ 5800-MHz



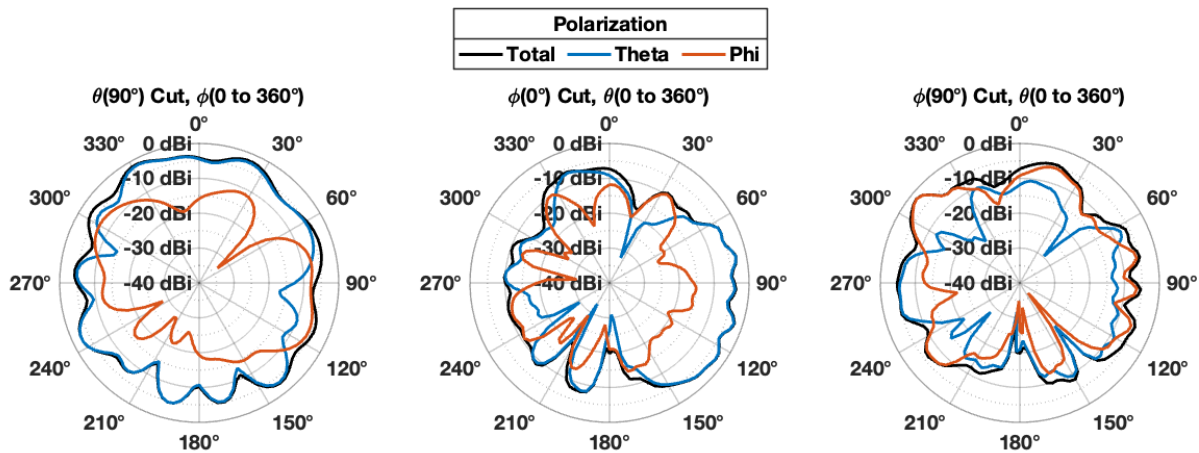
	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.5	H	(61°, 214°)	1SS / 2SS
SISO Max	4.0	V	(67°, 108°)	1SS / 2SS

Normalized Gain Cuts of ANT3 @ 5800-MHz



	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.2	V	(51°, 130°)	1SS / 2SS
SISO Max	3.0	H	(99°, 274°)	1SS / 2SS

Normalized Gain Cuts of ANT4 @ 5800-MHz



	Peak Gain [dBi]	Polarization	Direction (θ, ϕ)	Op. Mode
SISO Min	1.9	H	(51°, 270°)	1SS / 2SS
SISO Max	3.5	V	(100°, 259°)	1SS / 2SS

Appendix: MIMO Antenna Gains

Complex composite antenna gain systems require detail description and justification for an alternative DG determination method for consideration

S58 aims to have low gain antennas with omnidirectional system coverage. This requires that peak gains of different antennas do not overlap. Determining the worst-case system antenna gain by adding the individual peaks cannot apply here, as real-world peak total antenna gain is less than this.

We are proposing this plan to combine the gains on a spatial basis over an azimuth/elevation grid of 3° to determine the effective gain at the frequencies of interest.

Example Correlated Directional Gain Result:

This section aims to clarify why MIMO gains are usually not be the simple sum of peak gains between two antennas.

Consider two antennas, ANT2 and ANT4, they are on different chains so they can be active at the same time. [2442 MHz] The passive, individual antenna measurements show peak antenna gains of:

- ANT2 $G_\theta = +0.9$ dBi @ ($\theta=139^\circ$, $\varphi=99^\circ$),
- ANT2 $G_\varphi = +1.3$ dBi @ ($\theta=42^\circ$, $\varphi=252^\circ$),
- ANT4 $G_\theta = +1.8$ @ ($\theta=93^\circ$, $\varphi=129^\circ$),
- and ANT4 $G_\varphi = -1.1$ dBi @ ($\theta=159^\circ$, $\varphi=219^\circ$) for one of the measured units.

These gains would not directionally combine [at their specific peak gain locations] as they occur in different angular directions. To determine the peak correlated directional gain for these two antennas, one must calculate the directional gain at all 3D points, then find the max.

At this frequency point, for these two antennas, the peak aggregate gain is:

- ANT2-ANT4 $G_\theta = +3.4$ dBi @ ($\theta=93^\circ$, $\varphi=126^\circ$),
- and ANT2-ANT4 $G_\varphi = +1.2$ dBi @ ($\theta=156^\circ$, $\varphi=3^\circ$).

Since $G_\theta > G_\varphi$, the peak gain would be +3.4 dBi with a polarization of "V."