

FCC ID: A3LSMF946U

# Power Density Simulation Report

Revision A

May 11, 2023

SAMSUNG ELECTRONICS

## 1. Simulation methodology for Power Density (PD)

### 1.1 Simulation tool

#### 1.1.1 Tool description

For the simulation approach to calculating power density (PD) evaluation for mobile phone with mmWave antenna modules, ANSYS Electromagnetics suite version 2022.R2 (HFSS) is used. ANSYS HFSS is one of several commercial tools for 3D full-wave electromagnetic simulation used for antenna and RF structure design of high frequency component. ANSYS Electromagnetics suite version 2021.R2 (HFSS) is implemented based on Finite Element Method (FEM), which operates in the frequency domain.

#### 1.1.2 Mesh and Convergence criteria

To solve the PD analysis using FEM, volume area containing simulated objects should be subdivided into electrically small parts that are called finite elements as the unknown functions. To subdivide system, the adaptive mesh technique in ANSYS Electromagnetics suite version 2021.R2 (HFSS) is used. ANSYS Electromagnetics suite version 2021.R2 (HFSS) starts to refine the initial mesh based on wavelength and calculate the error to iterative process for adaptive mesh refinement. The determination parameter of the number of iteration in ANSYS Electromagnetics suite version 2021.R2 (HFSS) is defined as convergence criteria, delta S, and the iterative adaptive mesh process repeats until the delta S is met. In ANSYS Electromagnetics suite version 2021.R2 (HFSS), the accuracy of converged results depends on the delta S. Figure 1 is an example of final adaptive mesh of the device (cross-section of top view).

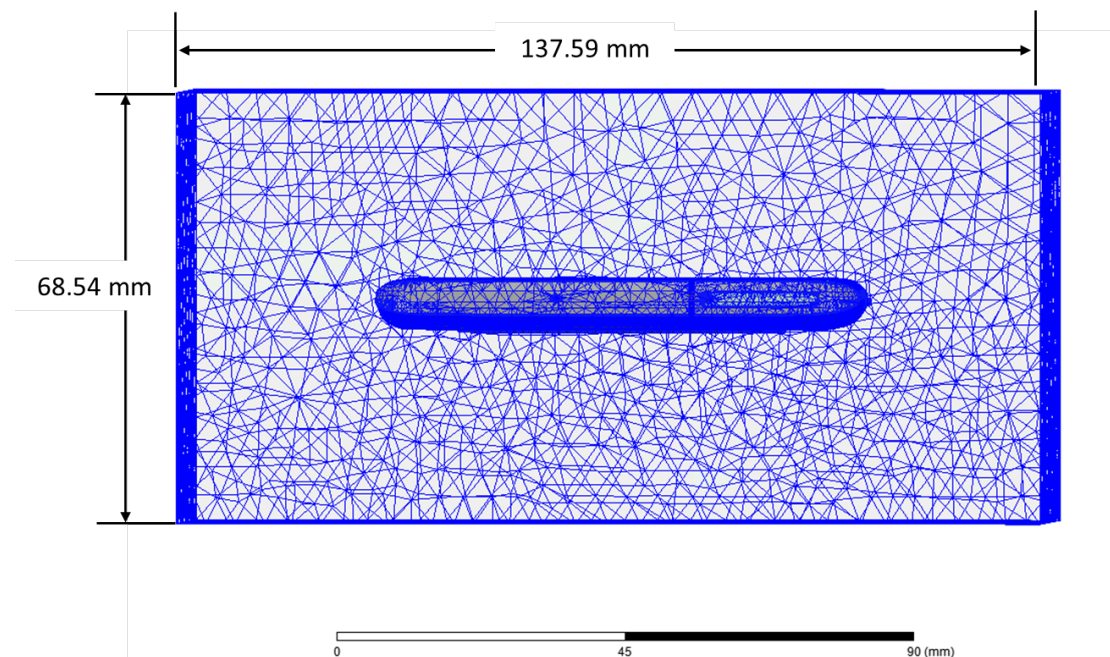


Figure 1 Example of the adaptive mesh technique (Top view)

### 1.1.3 Power density calculation

After solving 3D full-wave electromagnetic simulation, various kinds of physical quantities can be obtained. To calculate PD evaluation, two physical quantities, an electric field ( $\vec{E}$ ) and a magnetic field ( $\vec{H}$ ) are needed. The actual consumption power can be expressed as the real term of the Poynting vector ( $\vec{S}$ ) from the cross product of  $\vec{E}$  and complex conjugation of  $\vec{H}$  as shown below:

$$\langle \vec{S} \rangle = \text{Re} \left( \frac{1}{2} \vec{E} \times \vec{H}^* \right)$$

$\langle \vec{S} \rangle$  can be expressed as point power density based on a peak value of each spatial point on mesh grids, and obtained directly from ANSYS Electromagnetics suite version 2020.R1 (HFSS).

From the point power density  $\langle \vec{S} \rangle$ , the spatial-averaged power density ( $PD_{av}$ ) on an evaluated area ( $A$ ) can be derived as shown below:

$$PD_{av} = \frac{1}{A} \int_A \langle \vec{S} \rangle \cdot ds = \frac{1}{2A_{av}} \iint_{A_{av}} \| \text{Re}\{E \times H^*\} \| dA$$

, where the spatial-averaged power density ( $PD_{av}$ ) is total power density value considering on x, y and z components of point power density  $\langle \vec{S} \rangle$  and the evaluated area ( $A$ ) is  $4\text{cm}^2$ .

## 1.2 Simulation setup

### 1.2.1 3D modeling

Figure 2 shows the simulation model which is mounted two mmWave antenna modules. The simulation modeling includes most of the entire structure of device itself such as PCB, metal frame, battery, cables, and legacy antennas as well as mmWave antenna modules called as Ant K and Ant M. For a folder open status (Fig. 2-1), Ant M is placed on the right side and antennas are facing the right side, and Ant K is placed on the back side and antennas are facing the back side of the device. For a folder close status (Fig. 2-2), Ant K and Ant M are placed same of the folder open status.

### Folder Open

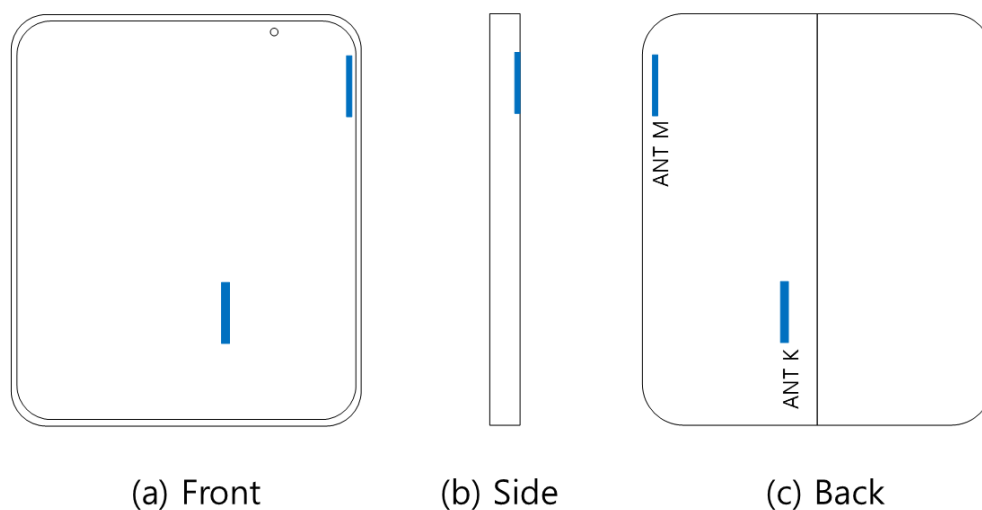


Figure 2-1. Simulation model which is mounted two mmWave antenna modules (Folder Open Status)

### Folder Closed

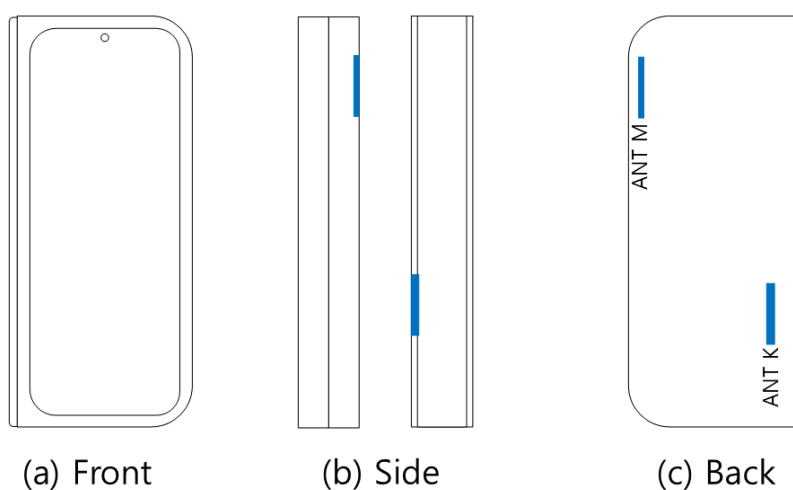


Figure 3-2. Simulation model which is mounted two mmWave antenna modules (Folder Closed Status)

#### 1.2.2 PD evaluation planes

Table 1 shows the PD evaluation planes for each mmWave antenna module and Figure 3 shows the PD evaluation planes and whole area of the simulation model to find worst case of beamforming cases.

Please note that the “right” and “left” edge of mentioned in this report are defined from the perspective

of looking at the device from the front side.

Table 1. PD evaluation planes

Module	Front	Back	Left From Front View	Right From Front View	Top	Bottom
	S1	S2	S3	S4	S5	S6
Ant K	O	O	O	O	O	O
Ant M	O	O	O	O	O	O

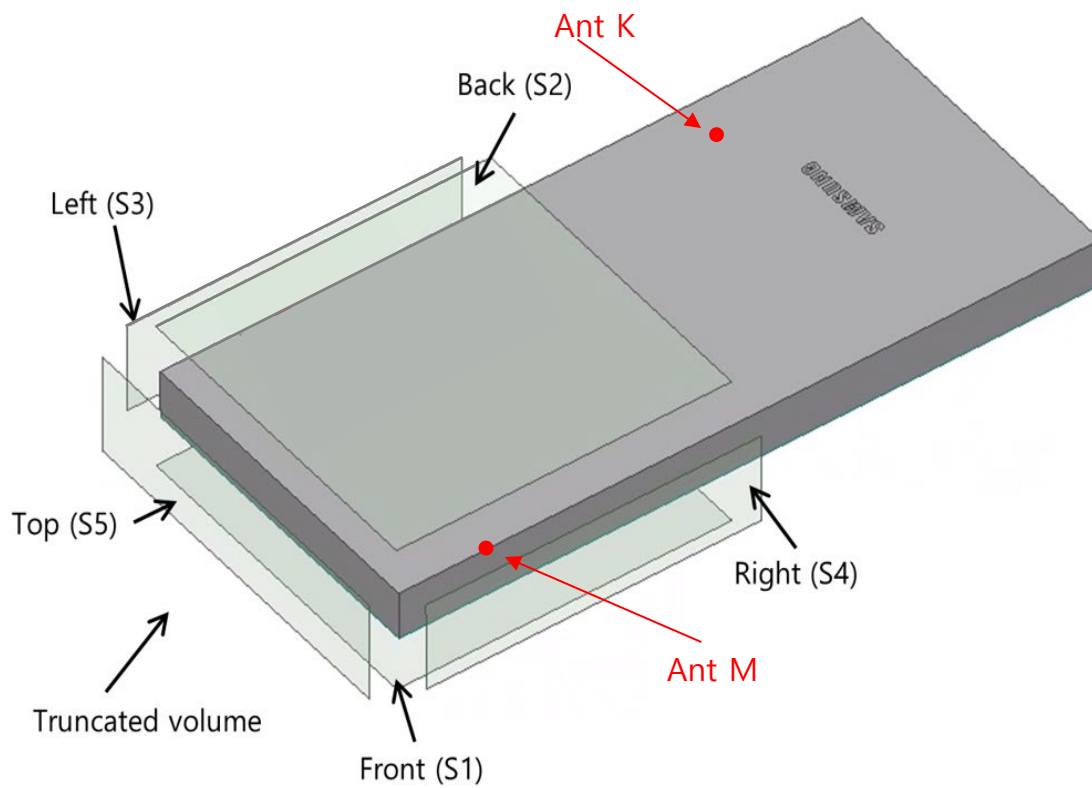


Figure 4. PD evaluation planes

### 1.2.3 Boundary condition

To simulate electromagnetic tool based on FEM, the boundary condition allows electromagnetic waves to be electrically open at the boundary and radiated far away without reflection. ANSYS

Electromagnetics suite version 2022.R2 (HFSS) can support the absorbing boundary condition (ABC) for radiation boundary and make normally a quarter wave length from the radiating structure. In this report, to cover all beamforming cases of mmWave antenna modules, 40 mm spacing from each surfaces of the device were used.

#### 1.2.4 Source excitation condition

The number of antenna ports of ANT K and ANT M for source excitation are the same. The antenna port of ANT K and M is divided into 10 ports for n261 1 x 5 patch array antennas, 10 ports for n260 1 x 5 patch array antennas. In the 10 ports included in each patch antenna, 5 ports are divided into vertical polarization feeding, and the other 5 ports are divided into horizontal polarization feeding.

Figure 4 shows the ANT K module structure and surrounding structure. The ANT K module is encrypted in the ANSYS Electromagnetics suite (HFSS) and can only check the feeding position.

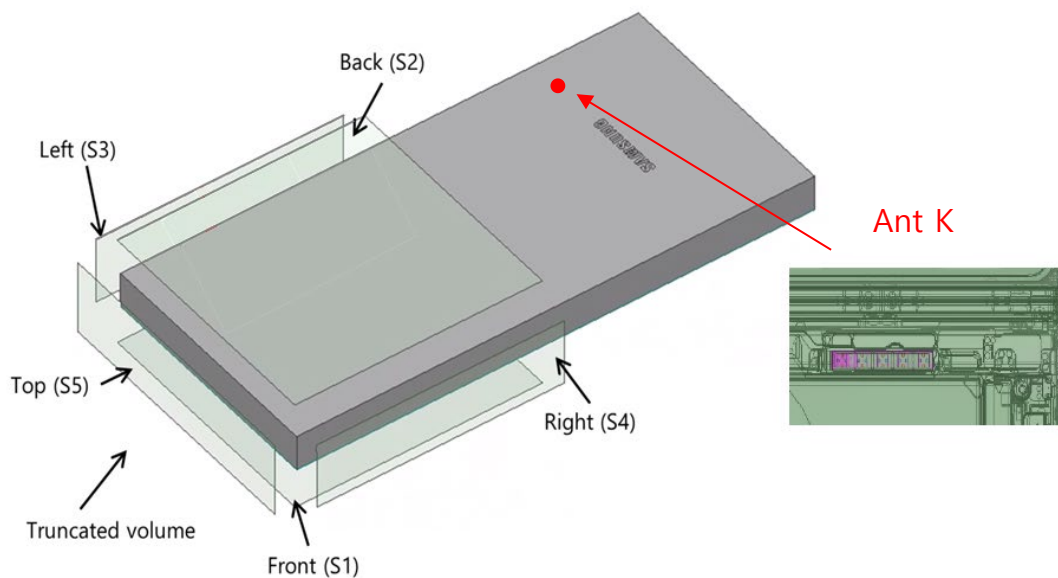


Figure 5. mmWave module (ANT K)

After finishing 3D full wave electromagnetic simulation of modeling structure, the magnitude and phase information can be loaded for each port by using “Edit Sources” function in ANSYS Electromagnetics suite (HFSS). Figure 5 shows an example of antenna port excitations.

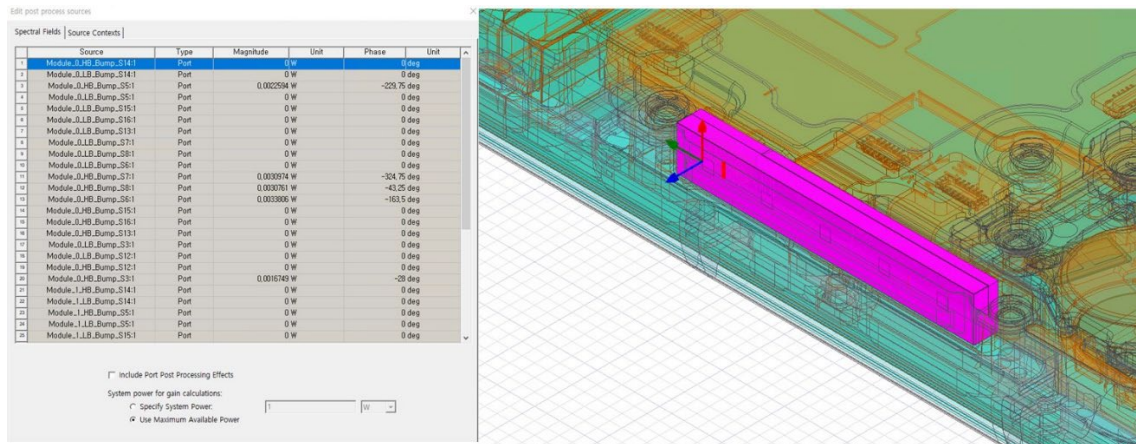


Figure 6. An example of port excitation (ANT M)

Since ANSYS Electromagnetics suite (HFSS) uses FEM solver based on frequency domain analysis method, the input source for the port excitation applies sinusoidal waveform for each frequency.

### 1.2.5 Condition of simulation completion

The simulation completion condition of ANSYS Electromagnetics suite (HFSS) is defined as delta S. The ANSYS Electromagnetics suite (HFSS) calculates the S-parameter for the mesh conditions of each step and determines whether to proceed with the operation of the next step by comparing the difference between the S-parameters in the previous step. A difference between the previous step and the current step of S-parameter is expressed as delta S, and the delta S generally sets 0.02. The simulation result of this report is the result of setting delta S to 0.02.

## 2. Simulation verification

### 2.1 Spatial-averaged power density

As mentioned in the previous chapter, the Poynting vector ( $\vec{S}$ ) can be obtained through cross product of an electric field ( $\vec{E}$ ) and complex conjugate of a magnetic field ( $\vec{H}$ ). The real term of the Poynting vector can be described as the point power density or peak power density. Using the point power density, the spatial-averaged power density can be obtained by the integral of  $4 \text{ cm}^2$  at 2.5 mm intervals of the point power density result. Figure 6 shows examples of the distribution plot of point power density and the averaged power density.

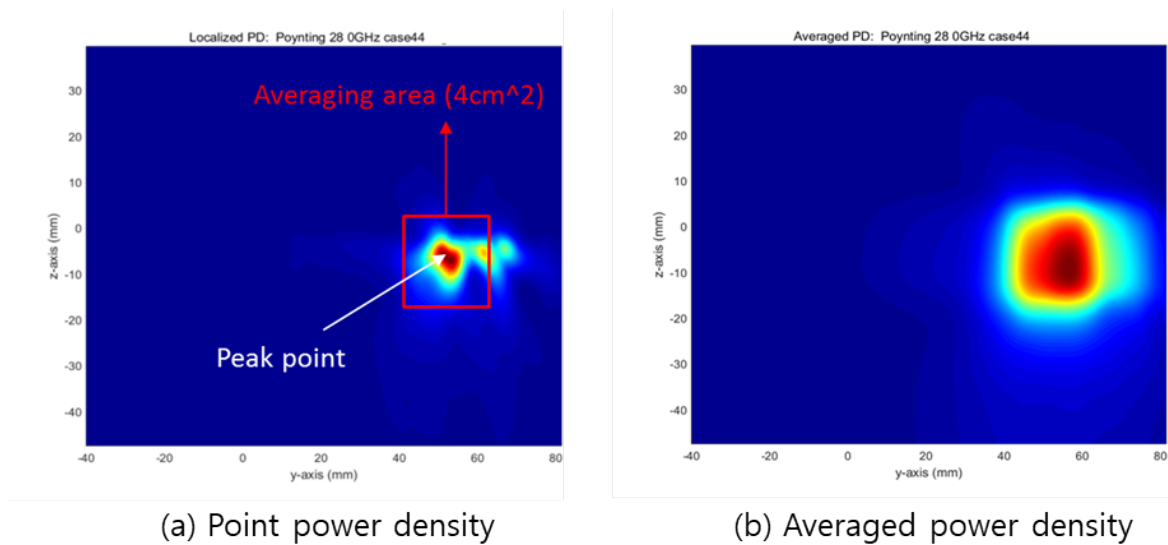


Figure 7. Power density distribution (Example)

## 2.2 Comparison between simulation and measurement

In this section, the simulated-power density distributions and measured-power density distributions are compared to each mmWave antenna.

Based on comparison of power density distributions, simulated power density and measured power density have a good correlation. The discrepancy in amplitude between simulated  $4\text{cm}^2$  averaged power density and measured  $4\text{cm}^2$  averaged power density is considered as housing influence and used in determining input power limit for each beam for RF exposure compliance.

The input powers per each active port are listed below for both Simulation and Measurement validation and power density characterization. For Simulation, these values were entered directly into HFSS model. For measurement, FTM S/W was used to input these values for each active port also.

Mode/Band	Antenna	Input Power (dBm)	
		SISO	MIMO
5G NR n261	K Patch	6.0	6.0
	M Patch	6.0	6.0
5G NR n260	K Patch	6.0	6.0
	M Patch	6.0	6.0
5G NR n258	K Patch	6.0	6.0
	M Patch	6.0	6.0

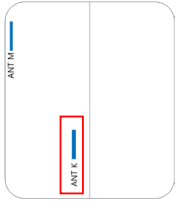
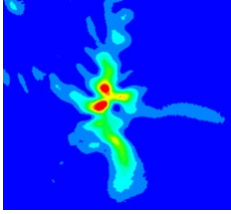
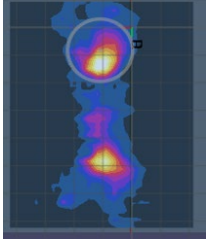
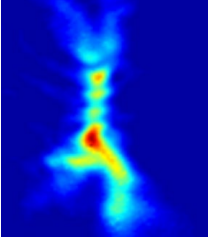
\* The below simulation and measurement result were performed at 2mm evaluation distance and 28GHz / 38.5GHz. The *input.power.limit* was determined based on below results in RF Exposure Part 0 Report.



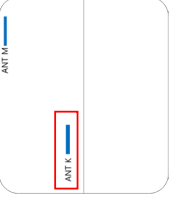
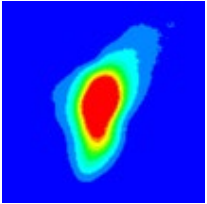
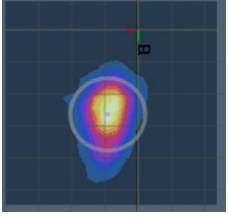
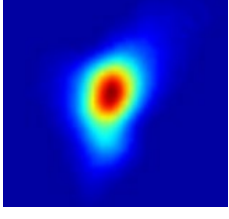
Condition	Band	Channel	Module	Side	Beam ID	Sim. PD (mW/cm <sup>2</sup> )	Meas. PD (mW/cm <sup>2</sup> )
Folder Closed	n261	Mid Ch. 2077915 (27924.96 MHz)	K	Rear	26	1.06	0.682
					165	2.12	1.65
			M	Right	41	1.17	0.572
				Rear		0.92	0.253
				Right	166	2.06	0.642
	Rear	1.38	0.609				
	n260	Mid Ch. 2254165 (38499.96 MHz)	K	Rear	34	1.00	0.623
					154	0.87	0.721
			M	Right	31	1.95	0.708
				Rear	40	1.25	0.403
	n258	Mid Ch. 2025833 (24800.04 MHz)	K	Left	26	0.46	0.306
				Rear	26	0.87	0.686
					165	1.75	1.51
			M	Right	29	1.10	0.631
				Rear	169	2.31	0.519
Rear	169	1.91	0.653				
Condition	Band	Channel	Module	Side	Beam ID	Sim. PD (mW/cm <sup>2</sup> )	Meas. PD (mW/cm <sup>2</sup> )
Folder Open	n261	Mid Ch. 2077915 (27924.96 MHz)	K	Rear	26	1.03	0.582
					165	2.16	1.48
			M	Front	31	0.92	0.61
				Right	33	1.31	0.523
				Right	159	1.02	0.718
	Rear	169		1.41	0.923		
	n260	Mid Ch. 2254165 (38499.96 MHz)	K	Rear	34	1.00	0.683
					154	0.86	0.676
			M	Rear	38	0.75	0.295
				Right	39	1.46	0.745
				Front		0.77	0.241
				Right	160	1.75	0.851
	Front	0.91	0.241				
	Rear	0.89	0.303				
	n258	Mid Ch. 2025833 (24800.04 MHz)	K	Rear	34	0.76	0.522
					165	1.79	1.36
			M	Rear	39	0.75	0.329
				Front	40	0.88	0.492
Right				41	1.14	0.965	
Rear	169	1.21	0.649				
		1.04	0.411				

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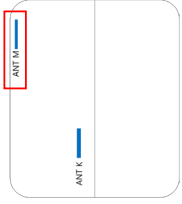
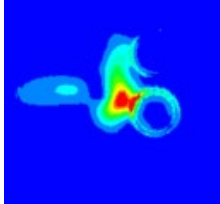
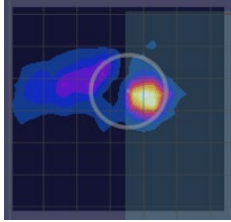
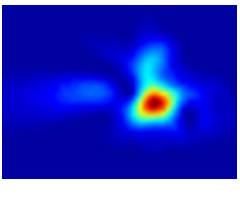

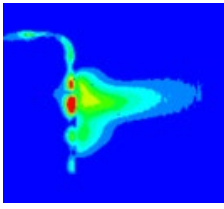
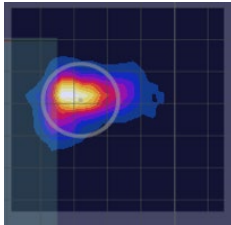
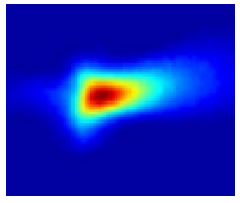
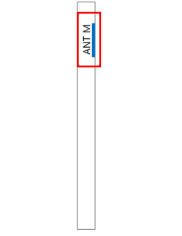
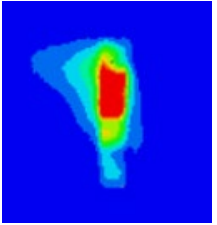
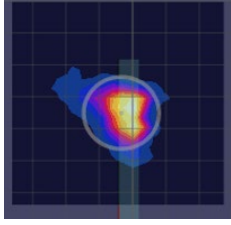
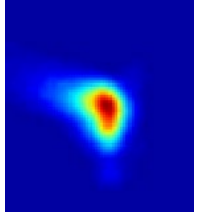
- Table 2-1, n258 ANT K-Patch: Mid Channel, Beam ID 34 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
34	S2 (Rear)				

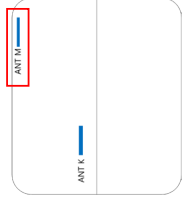
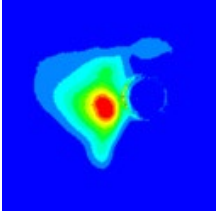
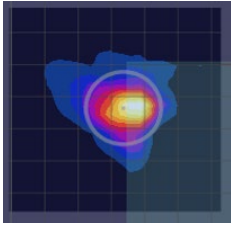
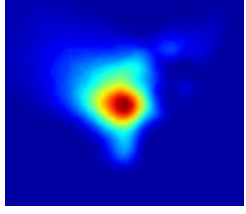
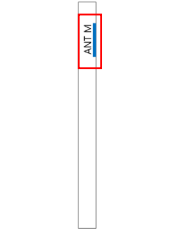
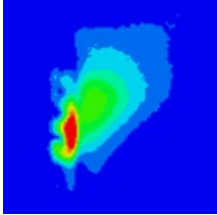
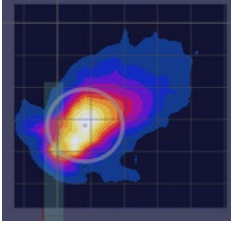
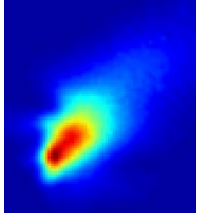
- Table 2-2, n258 ANT K-Patch: Mid Channel, Beam ID 165 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
165	S2 (Rear)				


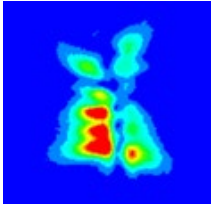
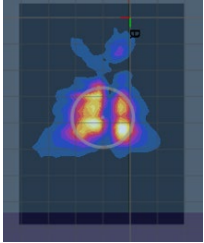
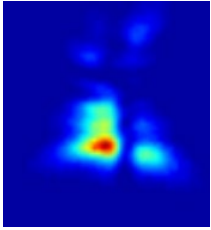
● Table 2-3, n258 ANT M-Patch: Mid Channel, Beam ID 39,40,41 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
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	S1 (Front)				
	S4 (Right)				

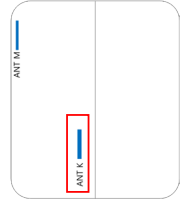
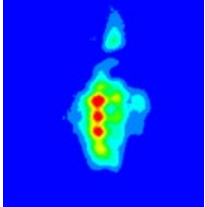
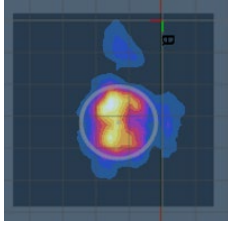
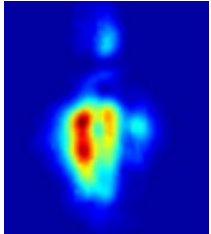
● Table 2-4, n258 ANT M-Patch: Mid Channel, Beam ID 169 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
169	S2 (Rear)				
	S4 (Right)				

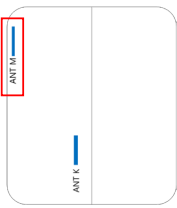
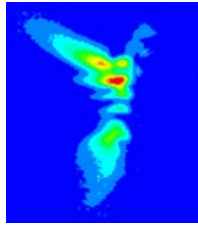
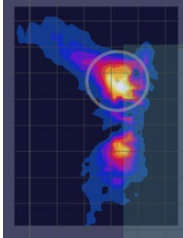
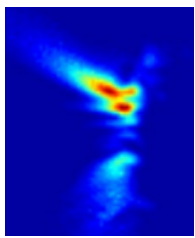
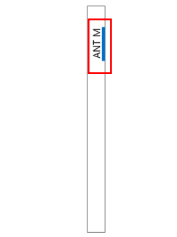
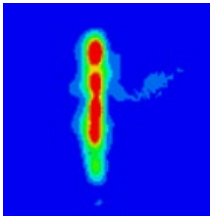
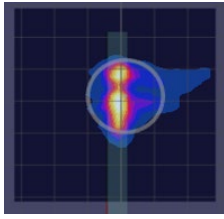
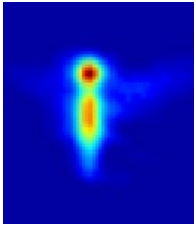

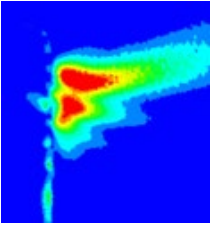
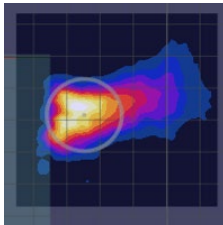
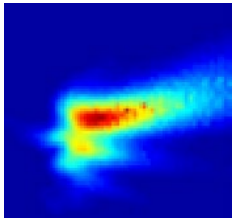
- Table 2-5, n260 ANT K-Patch: Mid Channel, Beam ID 34 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
34	S2 (Rear)				


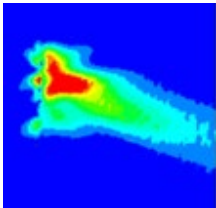
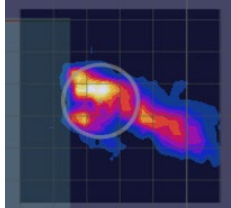
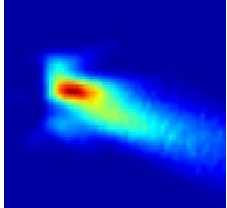
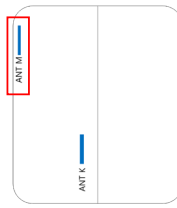
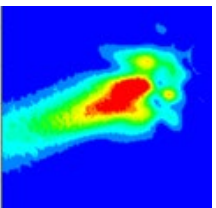
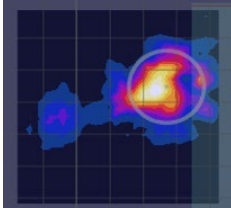
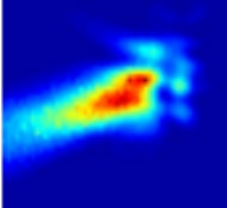
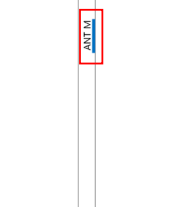
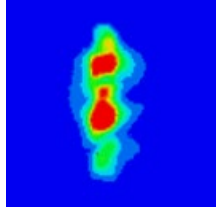
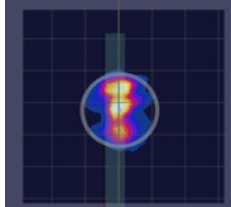
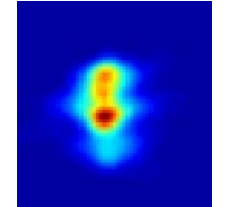
- Table 2-6, n260 ANT K-Patch: Mid Channel, Beam ID 154 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
154	S2 (Rear)				

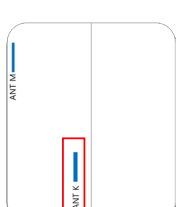
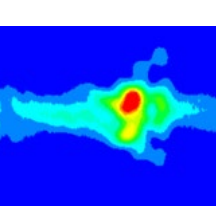
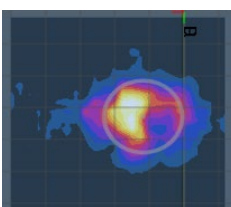
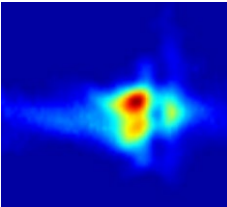
● Table 2-7, n260 ANT M-Patch: Mid Channel, Beam ID 38,39 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
38	S2 (Rear)				
	S4 (Right)				
39	S1 (Front)				

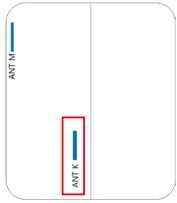
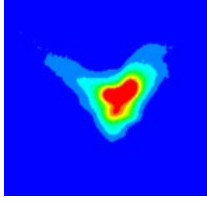

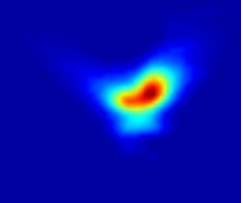
● Table 2-8, n260 ANT M-Patch: Mid Channel, Beam ID 160 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
160	S1 (Front)				
	S2 (Rear)				
	S4 (Right)				


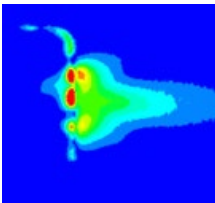
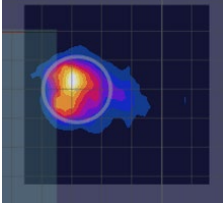
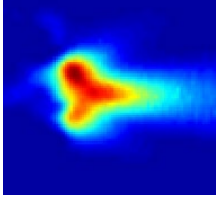

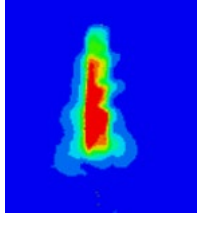
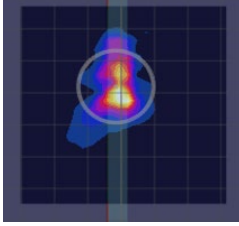
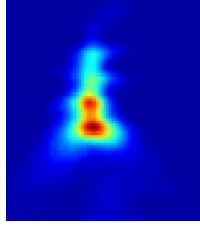
● Table 2-9, n261 ANT K-Patch: Mid Channel, Beam ID 26 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
26	S2 (Rear)				

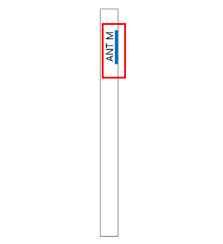
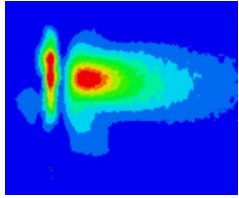
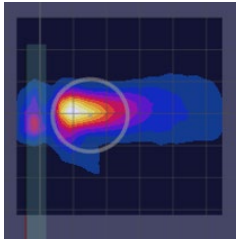
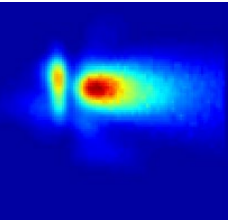
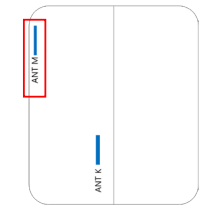
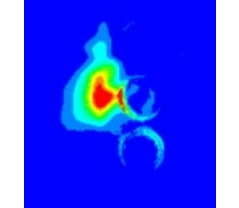
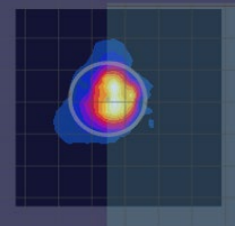
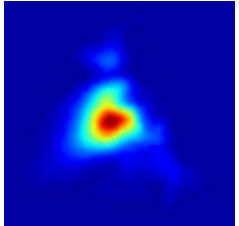
- Table 2-10, n261 ANT K-Patch: Mid Channel, Beam ID 165 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
165	S2 (Rear)				

- Table 2-11, n261 ANT M-Patch: Mid Channel, Beam ID 31,33 for selected surfaces

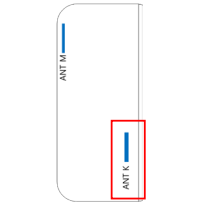
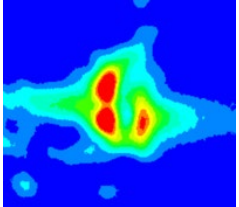
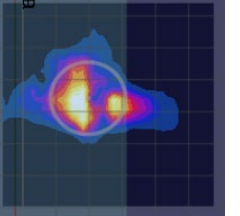
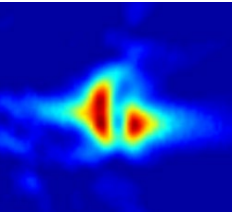
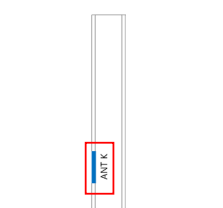
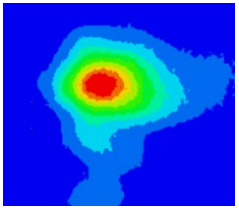
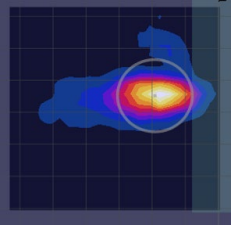
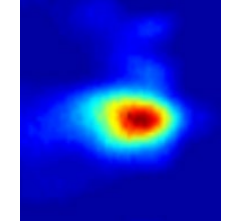
Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
31	S1 (Front)				
33	S4 (Right)				

- Table 2-12, n261 ANT M-Patch: Mid Channel, Beam ID 159,169 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
159	S4 (Right)				
	S2 (Rear)				

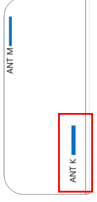
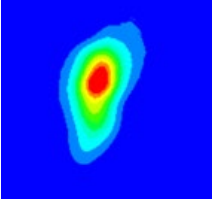

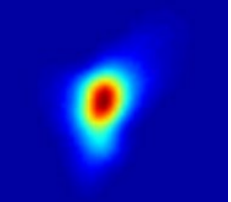
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- Table 2-13, n258 ANT K-Patch: Mid Channel, Beam ID 26 for selected surfaces


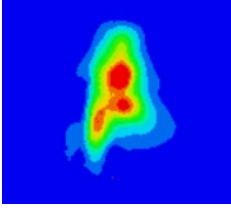
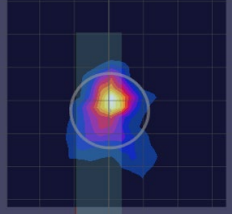
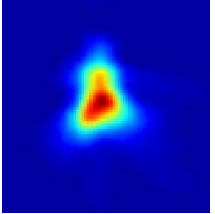
Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
26	S2 (Rear)				
	S3 (Left)				



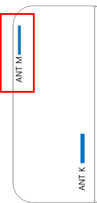
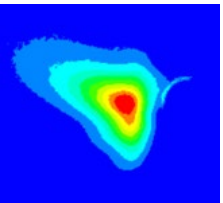
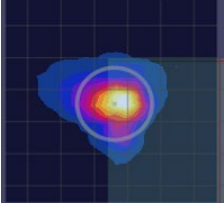
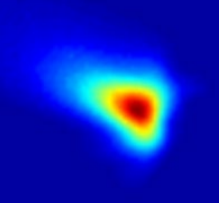

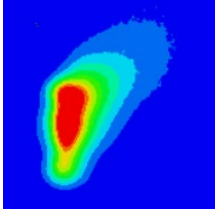
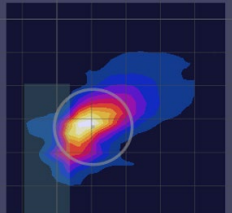
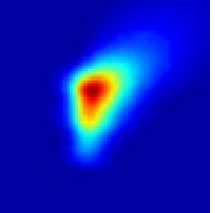
- Table 2-14, n258 ANT K-Patch: Mid Channel, Beam ID 165 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
165	S2 (Rear)				

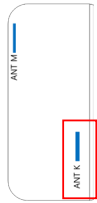
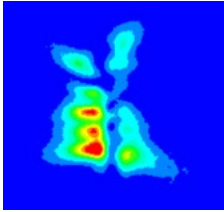
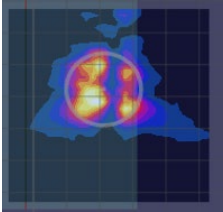
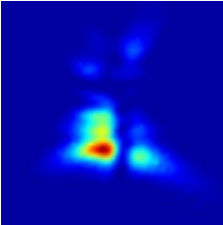
- Table 2-15, n258 ANT M-Patch: Mid Channel, Beam ID 29 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
29	S4 (Right)				

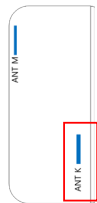
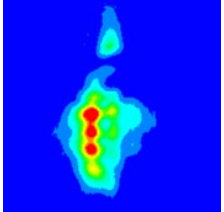
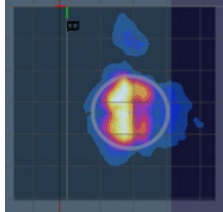
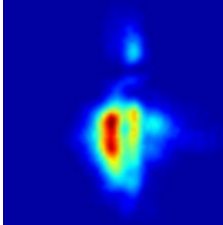
- Table 2-16, n258 ANT M-Patch: Mid Channel, Beam ID 169 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
169	S2 (Rear)				
	S4 (Right)				


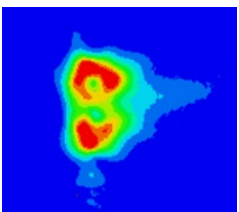
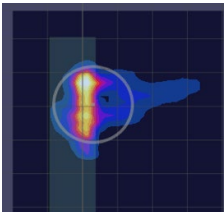
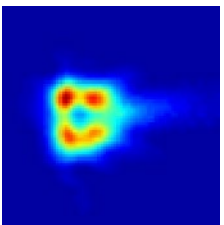
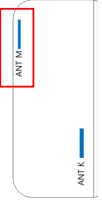
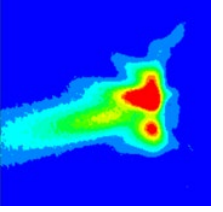
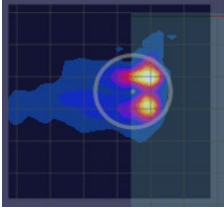
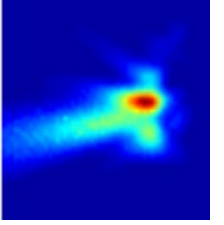
● Table 2-17, n260 ANT K-Patch: Mid Channel, Beam ID 34 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
34	S2 (Rear)				


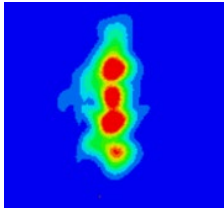
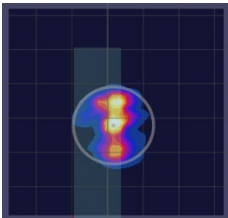
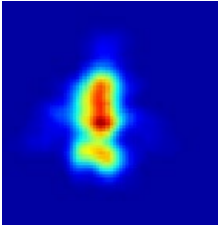
● Table 2-18, n260 ANT K-Patch: Mid Channel, Beam ID 154 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
154	S2 (Rear)				

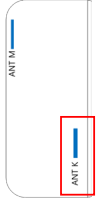
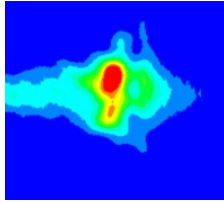
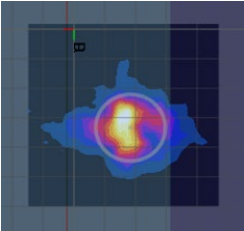
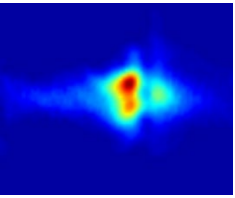
● Table 2-19, n260 ANT M-Patch: Mid Channel, Beam ID 31,40 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
31	S4 (Right)				
40	S2 (Rear)				

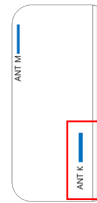
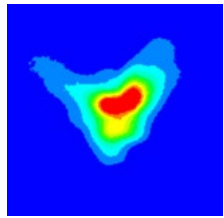
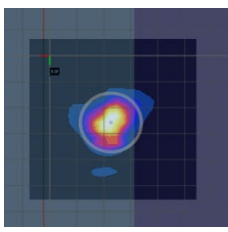
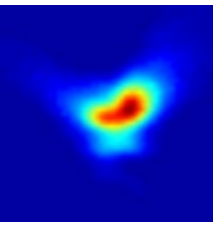
- Table 2-20, n260 ANT M-Patch: Mid Channel, Beam ID 160 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
160	S4 (Right)				

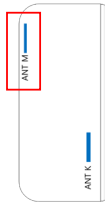
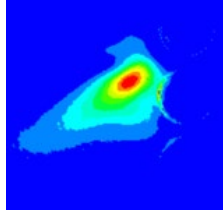
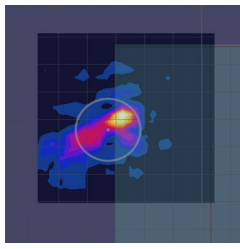
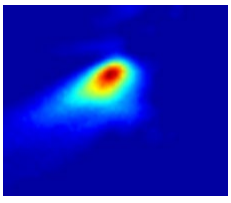

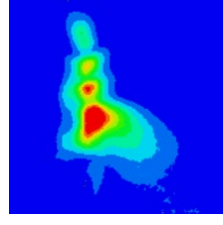
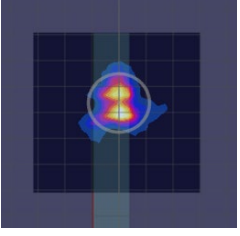
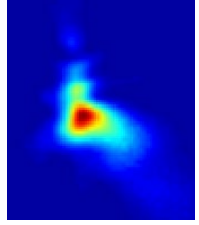
- Table 2-21, n261 ANT K-Patch: Mid Channel, Beam ID 26 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
26	S2 (Rear)				

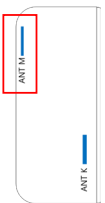
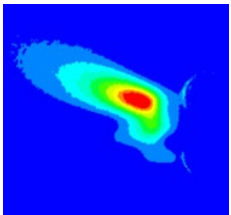
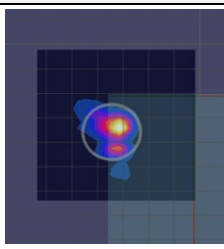
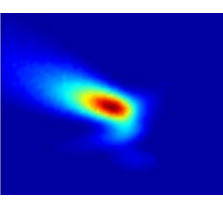

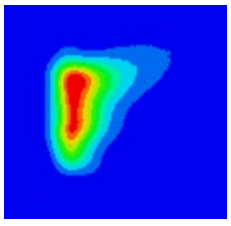
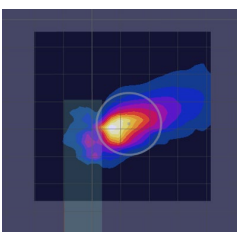
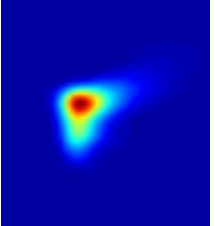
- Table 2-22, n261 ANT K-Patch: Mid Channel, Beam ID 165 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
165	S2 (Rear)				

● Table 2-23, n261 ANT M-Patch: Mid Channel, Beam ID 41 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
41	S2 (Rear)				
41	S4 (Right)				

● Table 2-24, n261 ANT M-Patch: Mid Channel, Beam ID 166 for selected surfaces

Beam ID	Surface	View	Simulated PD	Measured PD	Print out from Qualcomm MG Script
166	S2 (Rear)				
166	S4 (Right)				

### 3 Simulation results

This section shows the PD simulation results of Ant K and Ant M at 24GHz, 28GHz and 39GHz for each evaluation plane specified in Table 1 at two separation distances of 2mm and 10mm for open condition and for closed conditions. The ratio of PD exposure from front surface to the worst surface at 2mm, and the ratio of PD exposure from 2mm to 10mm (open and closed) evaluation distance for each beam are also reported in this section to support RF exposure analysis for simultaneous transmission scenarios performed in the Part 1 Near Field PD report.

The relative phase between beam pairs is not controlled in the chipset design. Therefore, the relative phase between each beam pair was considered mathematically to identify the worst case conditions. The below MIMO results represent the highest reported MIMO simulation results after sweeping across the relative phase between beams a 5° step interval from 0° to 360°,

The worst-case simulated PD determined from the tables in this section were used for conservativeness in *input.power.limit* determination in RF Exposure Part 0 Report.

#### 3.1 PD for Low/Mid/High Channel at 24GHz / 28GHz / 39GHz

##### 3.1.1 Ant K– Patch Antenna

Table 3 & Table 4 & Table 5 show the PD simulation evaluation of Ant K patch antenna at 24GHz / 28GHz / 39GHz for the corresponding evaluation planes specified in Table 1.



- K-patch High CH

No.	Module	Type	Beam D1	Beam D2	Feed no.	4-w/2 FDM(West)							max ratio out of all beams					4-w/2 FDM(West) at 30mm evaluation distance					max ratio out of all beams																									
						54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)															
						Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain															
1	1	1	50	50	1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

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- K-patch Low CH

No.	Module	Type	Beam D1	Beam D2	Feed no.	4-w/2 FDM(West)							max ratio out of all beams					4-w/2 FDM(West) at 30mm evaluation distance					max ratio out of all beams																					
						54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)	54(Slight)	53(L)	52(S)	51(Slight)	50(Mid)	49(Slight)	48(R)											
						Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain	Gain
1	1	1	50	50	1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50







- K-patch High CH

No.	Module	Type	Beam D1	Beam D2	Feed no.	4x42 PDM(Worst)						max ratio out of all beams						4x42 PDM(Best)						max ratio out of all beams					
						45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide
						dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm
1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

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- K-patch Low CH

No.	Module	Type	Beam D1	Beam D2	Feed no.	4x42 PDM(Worst)						max ratio out of all beams						4x42 PDM(Best)						max ratio out of all beams					
						45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide	45Klight	13kTail	15kTail	16kBottom	15kFront	20kSide
						dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm	dBm
1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	









3.1.2 Ant M – Patch Antenna

Table 5 & Table 6 & Table 7 show the PD simulation evaluation of Ant M patch antenna at 24GHz / 28GHz / 39GHz for the corresponding evaluation planes specified in Table 1. As shown, a per beam back-off for TER analysis is added to Table 5 (28 GHz Ant. M). This back-off is originated by the 2mm/10mm PD worst ratio which is used for TER calculation of ‘Hotspot’ condition of folder closed status. If the ratio is large, the input.power.limit of this model should be decreased large enough to meet the TER analysis. To avoid the large back-off, therefore, the per beam back-off is adopted and the back-off are applied to several beam IDs in Table 5 to meet the worst surface conditions that satisfying the ‘Hotspot’ TER analysis.

Table 5. PD of Ant M – patch antenna (24GHz – n258)

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- M\_patch Low CH

Table with multiple columns: No., Model, Type, Beam ID, Beam ID, Feed No., Frequency (GHz), and various surface area metrics (100.0%, 1.6%, etc.). It contains a large grid of data for different beam configurations and frequencies.





[Folder Closed Status]

- M-patch Low CH

Table with columns for No., Module, Type, Beam ID, Item No., and various performance metrics including ratio and ratio (2.0%, 4.0%, 8.0%, 16.0%) for different beam positions.

- M-patch Mid CH

Table with columns for No., Module, Type, Beam ID, Item No., and various performance metrics including ratio and ratio (2.0%, 4.0%, 8.0%, 16.0%) for different beam positions.

M\_patch High CH

No.	Module	Type	Beam ID 1	Beam ID 2	Wind Dir	# of PFDs (Waves)						min ratio out of all beams					min ratio out of all beams																					
						045Deg	135Deg	225Deg	315Deg	360Deg	045Deg	135Deg	225Deg	315Deg	360Deg	045Deg	135Deg	225Deg	315Deg	360Deg	045Deg	135Deg	225Deg	315Deg	360Deg													
						(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)	(kN/m)											
1	1	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6. PD of Ant M – patch antenna (28GHz – n261)

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- M-patch Low CH

Table with columns for No, Module, Type, Beam ID, Beam ID, Feed no, 4x4 PD (dBm/20), and various ratio/loss columns for 100.0%, 94.5%, 94.5%, 94.5%, 74.4%, 100.0% and 71.4%, 94.5%, 94.5%, 94.5%, 94.5%, 94.5%.

- K-patch Mid CH

Table with columns for No, Module, Type, Beam ID, Beam ID, Feed no, 4x4 PD (dBm/20), and various ratio/loss columns for 100.0%, 94.5%, 94.5%, 94.5%, 71.4%, 100.0% and 71.4%, 94.5%, 94.5%, 94.5%, 94.5%, 94.5%.







- M\_patch High CH

Table with columns for No., Module, Type, Beam ID, Beam CL, Beam CR, Head no., and various ratio and dBm values. The table is divided into two main sections: 'near ratio out of all beams' and 'near ratio out of all beams'.

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- M\_patch Low CH

Table with columns for No., Module, Type, Beam ID, Beam CL, Beam CR, Head no., and various ratio and dBm values. The table is divided into two main sections: 'near ratio out of all beams' and 'near ratio out of all beams'.

