Part 0: SAR and Power Density Characterization
EUT RF Exposure Compliance Test Report

For
SMARTPHONE

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Model Name: A2341

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Revision History

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1 Introduction

The equipment under test (EUT) is a smart phone. It contains the Qualcomm modem supporting 2G/3G/4G WWAN technologies and mmW 5G NR bands. These WWAN modems enable Qualcomm Smart Transmit feature to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is in compliance with the FCC requirement.

In the Part 0 report, the EUT SAR and power density (PD) are characterized for WWAN radios (2G/3G/4G/5G mmW NR) to determine the power limit that corresponds to the exposure design target after accounting for all device design related uncertainties, i.e., *SAR_design_target* (< FCC SAR limit) for sub-6 radio and *PD_design_target* (< FCC PD limit) for mmW radio. The SAR characterization and PD characterization are denoted as SAR Char and PD Char.

SAR Char and PD Char will be used as input for Qualcomm Smart Transmit to operate. Both SAR Char and PD Char will be loaded and store in the EUT via the Embedded File System (EFS).

The EUT supports WLAN/BT radio as well but WLAN/BT modem is not enabled with Smart Transmit.

2 SAR Characterization

SAR Char is generated to cover all radio configurations and usage scenarios that are reported in the initial FCC submission.

2.1 Worst-case SAR determination

Based on FCC KDBs, in general, for a smartphone, the SAR evaluation is required for the exposure scenarios shown in Figure 2-1.

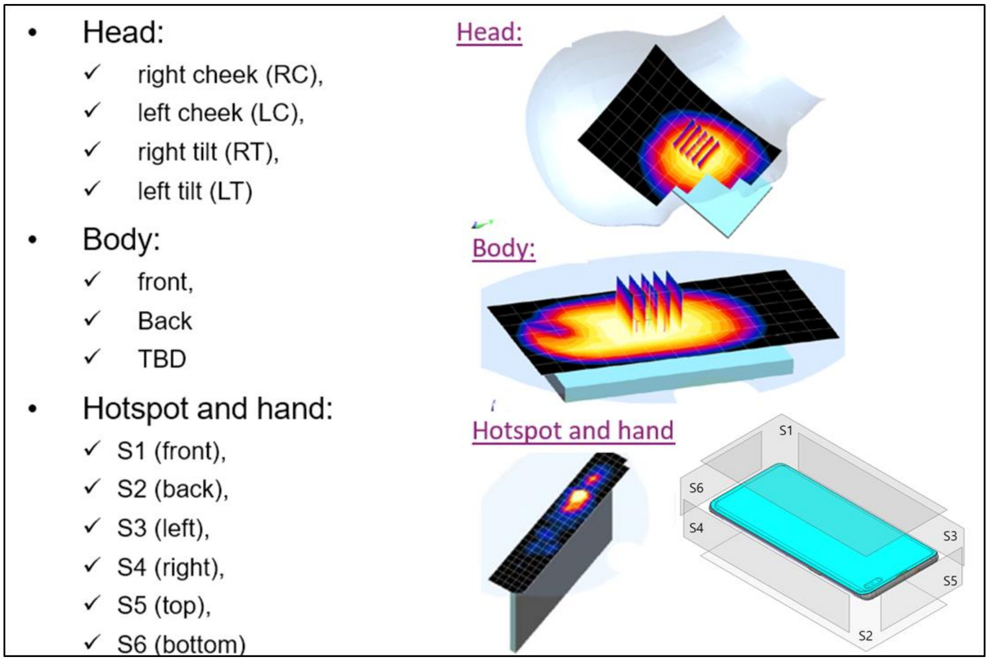

Figure 2-1: SAR evaluation for smartphone application

The device state index (DSI) used in Figure 2-2 represents each exposure scenario. Depending on the detection scheme implemented in the smartphone, the worst-case SAR is further grouped and determined for each or combined exposure scenario(s). Note for the 1g SAR versus 10g SAR exposure scenario, the worst-case is determined in term of exposure ratio (i.e., exposure level relative to the corresponding 1g- or 10g-SAR limit).

- If the device does not have any detection mechanism (**all "no"** in Figure 2-2), then the worst-case SAR is determined by taking the maximum SAR value among all exposure scenarios, i.e., worst-case SAR = $max\{SAR_{head}, SAR_{body}, SAR_{hotspot/extremity}\}$
- If the device can distinguish each of the above scenarios (**all "yes"** in Figure 2-2), then the worst-case SAR for each individual exposure scenario is given by corresponding SAR_{head}, SAR_{body}, and $SAR_{hotspot/extremity}$
- If the device can only distinguish a subset of the scenarios (**some "yes", some "no"** in Figure 2-2), then the worst-case SAR is given by:
  - Corresponding SAR for each exposure scenario that can be distinguished (DSI=yes)
  - Worst-case SAR among all other exposure scenario(s) that cannot be distinguished (DSI=no)

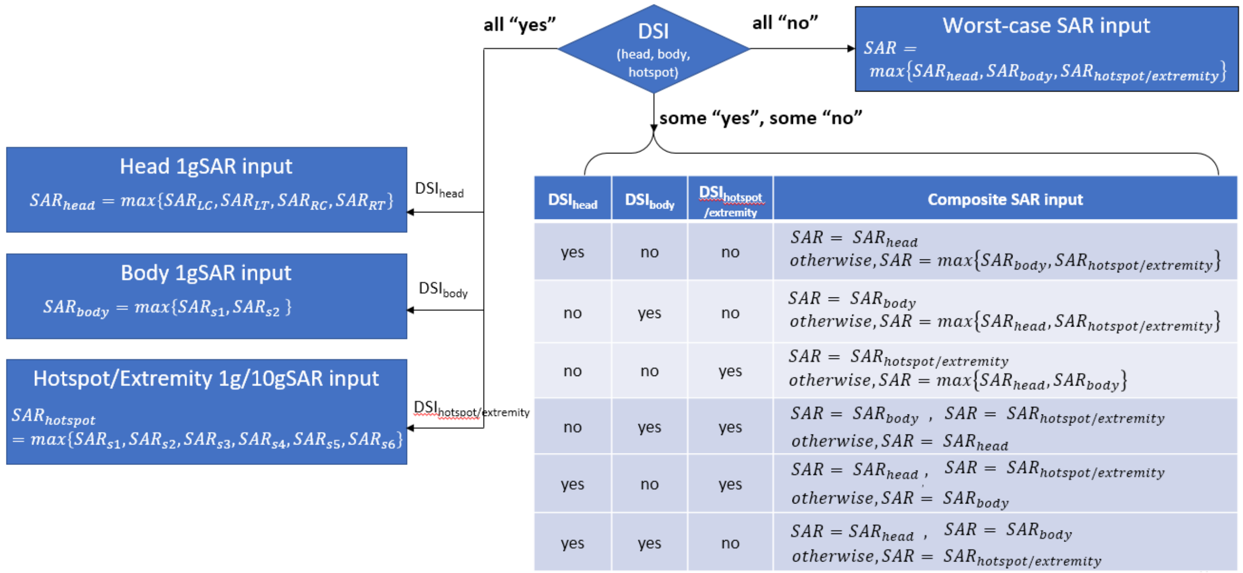

Figure 2-2: Worst-case SAR determination based on DSI

2.2 Usage Scenarios in SAR Evaluation

The EUT has a detection mechanism to distinguish head/body-worn/hotspot exposure, which is represented using DSI = 0 or DSI = 1. These two DSI states were used to determine power limit for Smart Transmit to operate.

The corresponding usage scenarios supported by EUT are summarized in Table 2-1:

Table 2-1: Usage/Exposure Scenario

Scenario	Description	SAR Definition	Worst-case SAR
Head (DSI = 0)	▪ Device positioned next to head ▪ 1g SAR evaluated in four positions (left/right cheek/tilt)	$SAR_{head} = max\{SAR_{LC}, SAR_{LT}, SAR_{RC}, SAR_{RT}\}$	SAR_{head}
Body worn/Hotspot (DSI = 1)	▪ Device state is either body worn or Hotspot at 5mm ▪ 1g SAR evaluated at all surfaces (S_1-S_6 as shown in Figure 2-1) of the EUT with 5 mm test separation distance relative to the flat phantom for body worn exposure	$SAR_{body\_DSI=1} = max\{SAR_{s1\_DSI=1}, SAR_{s2\ DSI=1}, SAR_{s3\ DSI=1}, SAR_{s4\ DSI=1}, SAR_{s5\ DSI=1}, SAR_{s6\ DSI=1}\}$	$SAR_{body\_DSI=1}$

2.3 SAR design target

The total device design related uncertainties of EUT is 1dB (k=2), which includes TxAGC and device to device variation.

To account for the total uncertainty, *SAR_design_target* needs to be:

$$SAR\_design\_target < SAR_{regulatory\_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$

For FCC SAR requirement of 1.6 W/kg for 1g SAR the *SAR_design_target* for EUT is determined as

$SAR\_design\_target\ = 0.8\ W/kg\ for\ 1gSAR.$

2.4 SAR Char of EUT

Referring to the initial FCC submission, the worst-case *reported* SAR for each antenna/technology/band/DSI is summarized in Table 2-2:

Table 2-2: Worst-case reported SAR (extracted from UL report 13259315-S1)

Tech/Band	Port		Worst-case SAR (W/kg)		P_{max} Max Tune-up Power (dBm)	
	DSI: 0	DSI: 1	DSI: 0	DSI: 1	DSI: 0	DSI: 1
GSM850	B	A	0.445	0.995	31.00	31.50
GSM1900	B	C	**0.997**	0.988	26.25	25.50
W-CDMA B2	B	A	0.994	0.972	20.25	17.00
W-CDMA B4	B	D	0.951	0.982	21.00	21.75
W-CDMA B5	B	A	0.647	0.717	23.90	25.70
CDMA BC0	B	A	0.945	0.776	23.90	25.70
CDMA BC1	B	B	0.988	0.989	20.25	20.00
CDMA BC10	B	A	0.871	0.748	23.90	25.70
LTE B5	B	A	0.634	0.789	24.50	25.70
LTE B7	B	C	0.976	0.984	17.00	18.50
LTE B12	B	A	0.627	0.720	23.90	25.70
LTE B13	B	A	0.676	0.660	23.90	25.70
LTE B14	B	A	0.520	0.608	23.90	25.70
LTE B25	B	D	0.985	0.989	20.25	19.25
LTE B26	B	A	0.687	0.751	24.50	25.70
LTE B30	D	C	0.921	0.987	17.50	20.50
LTE B41	D	A	0.990	**0.996**	20.00	21.75
LTE B48	B	A	0.993	0.991	21.75	22.00
LTE B66	B	C	0.982	0.996	21.00	20.25
LTE B71	B	B	0.557	0.569	24.50	24.50
FR1 n5	B	A	0.442	0.541	24.50	25.70
FR1 n12	B	A	0.377	0.436	23.90	25.70
FR1 n25	D	D	0.756	0.915	18.50	19.25
FR1 n41	D	A	0.882	0.994	18.00	19.75
FR1 n66	B	C	0.719	0.768	21.00	20.25
FR1 n71	B	A	0.499	0.446	24.50	25.70
FR1 n77	B	B	0.880	0.975	19.00	19.25

Using the reported SAR listed in Table 2-2, and following the procedure described in Section 2.1, the SAR Char of this EUT, i.e., P_{limit} corresponding to *SAR_design_target*, is determined for each supported antenna/technology/band/DSI as:

1. for DSI = 0, P_{limit} is calculated based on 1gSAR head exposure evaluation
2. for DSI = 1, P_{limit} is calculated based on body-worn/hotspot 1gSAR evaluation at 5 mm spacing

P_{limit} = min { P_{limit} corresponding to body worn 1gSAR evaluation at 5mm spacing,
P_{limit} corresponding to 1g SAR extremity evaluation at 5mm spacing,
P_{max} maximum RF tuneup power for the case that the SAR test is excluded}

The SAR Char is listed in Table 2-3.

Table 2-3: SAR Char of EUT

Exposure Scenario		Head		Body-worn & Hotspot		P_{max} (dBm) Tune-up power table
Spatial-average		1g		1g		
Test Distance		0 mm		5 mm		
Power Mode (DSI)		Mode A (DSI=0)		Mode B (DSI=1)		
Antenna	Tech/Band	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	Burst Average		Burst Average		Burst Average
A	GSM 850 2 slots	38.72	32.50	31.52	31.50	32.50
	GSM 1900 2 slots	37.55	31.00	23.79	23.50	31.00
	W-CDMA B2	28.78	25.70	17.12	17.00	25.70
	W-CDMA B4	33.76	25.70	17.96	17.25	25.70
	W-CDMA B5	31.78	25.70	27.14	25.70	25.70
	CDMA BC0	31.62	25.70	26.80	25.70	25.70
	CDMA BC1	33.03	25.70	17.37	17.00	25.70
	CDMA BC10	32.10	25.70	26.96	25.70	25.70
	LTE Band 5	31.92	25.70	26.73	25.70	25.70
	LTE Band 7	29.38	25.70	19.85	19.75	25.70
	LTE Band 12/17	32.38	25.70	27.12	25.70	25.70
	LTE Band 13	31.90	25.70	27.51	25.70	25.70
	LTE Band 25/2	29.23	25.70	17.10	17.00	25.70
	LTE Band 26	32.27	25.70	26.94	25.70	25.70
	LTE Band 30	29.26	25.70	20.53	20.25	25.70
	LTE Band 41	30.92	25.70	21.77	21.75	25.70
	LTE Band 48	30.51	25.70	22.04	22.00	22.80
	LTE Band 66/4	30.23	25.70	17.69	17.25	25.70
	LTE Band 71	32.28	25.70	28.50	25.70	25.70
	NR n5	32.56	25.70	28.37	25.70	25.70
	NR n12	35.21	25.70	29.31	25.70	25.70
	NR n25/2	34.12	25.70	17.52	17.00	25.70
	NR n41	34.63	25.70	19.78	19.75	25.70
	NR n66	31.92	25.70	18.69	17.25	25.70
	NR n71	34.73	25.70	29.21	25.70	25.70
	NR n77	30.76	25.70	19.34	19.00	25.70

Exposure Scenario		Head		Body-worn & Hotspot		P_{max} (dBm) Tune-up power table
Spatial-average		1g		1g		
Test Distance		0 mm		5 mm		
Power Mode (DSI)		Mode A (DSI=0)		Mode B (DSI=1)		
Antenna	Tech/Band	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	Burst Average		Burst Average		Burst Average
B	GSM 850 2 slots	34.52	31.00	34.04	31.00	31.00
	GSM 1900 2 slots	26.26	26.25	26.19	26.00	28.50
	W-CDMA B2	20.28	20.25	20.26	20.00	23.10
	W-CDMA B4	21.22	21.00	19.83	19.75	23.10
	W-CDMA B5	25.79	23.90	26.83	23.90	23.90
	CDMA BC0	24.15	23.90	26.70	23.90	23.90
	CDMA BC1	20.30	20.25	20.05	20.00	23.10
	CDMA BC10	24.50	23.90	27.04	23.90	23.90
	LTE Band 5	26.48	24.50	27.16	24.50	24.50
	LTE Band 7	17.11	17.00	18.47	18.25	22.80
	LTE Band 12/17	25.93	23.90	27.95	23.90	23.90
	LTE Band 13	25.60	23.90	27.52	23.90	23.90
	LTE Band 25/2	20.32	20.25	20.50	20.00	23.10
	LTE Band 26	26.13	24.50	27.17	24.50	24.50
	LTE Band 30	18.98	18.50	20.09	20.00	22.80
	LTE Band 41	19.05	19.00	21.04	21.00	22.80
	LTE Band 48	21.78	21.75	23.57	22.70	23.50
	LTE Band 66/4	21.08	21.00	20.33	20.25	23.10
	NR n5	28.05	24.50	29.50	24.50	24.50
	NR n12	28.14	23.90	30.87	23.90	23.90
	NR n25/2	21.49	20.25	20.67	20.00	23.10
	NR n41	17.96	17.00	20.59	19.00	23.70
	NR n66	22.43	21.00	21.68	20.25	23.10
	NR n71	27.52	24.50	29.71	24.50	24.50
	NR n77	19.56	19.00	19.36	19.25	22.70

Exposure Scenario		Head		Body-worn & Hotspot		P_{max} (dBm) Tune-up power table
Spatial-average		1g		1g		
Test Distance		0 mm		5 mm		
Power Mode (DSI)		Mode A (DSI=0)		Mode B (DSI=1)		
Antenna	Tech/Band	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	P_{design} (dBm) corresponding to 1.0 W/kg (SAR_design_target)	P_{limit} (dBm) Tune-up power table	
	Transmit Average	Burst Average		Burst Average		Burst Average
C	GSM 1900 2 slots	35.77	30.00	25.55	25.50	30.00
	W-CDMA B2	28.18	24.70	19.87	19.50	24.70
	W-CDMA B4	32.12	24.70	21.16	20.25	24.70
	LTE Band 7	25.98	24.70	18.57	18.50	25.00
	LTE Band 25/2	29.78	24.70	19.95	19.50	25.00
	LTE Band 30	28.06	24.70	20.56	20.50	25.00
	LTE Band 41	27.81	24.70	20.03	20.00	25.00
	LTE Band 48	28.86	25.20	22.51	22.00	23.70
	LTE Band 66/4	29.47	24.70	20.27	20.25	25.00
	NR n25/2	31.10	24.70	21.16	19.50	25.00
	NR n41	31.52	25.00	18.53	18.00	25.50
	NR n66	31.22	24.70	21.40	20.25	25.00
	NR n77	31.88	25.20	19.77	19.00	25.50
D	GSM 1900 2 slots	24.71	24.50	26.00	25.50	28.00
	W-CDMA B2	18.31	18.25	19.61	19.25	22.70
	W-CDMA B4	20.30	20.00	21.83	21.75	22.70
	LTE Band 7	17.74	17.50	21.34	21.25	23.00
	LTE Band 25/2	18.72	18.50	19.30	19.25	23.00
	LTE Band 30	17.86	17.50	20.34	20.25	22.50
	LTE Band 41	20.04	20.00	23.00	22.20	22.50
	LTE Band 48	23.88	22.25	19.57	19.50	22.70
	LTE Band 66/4	20.74	20.00	21.88	21.75	23.00
	NR n25/2	19.71	18.50	19.64	19.25	23.00
	NR n41	18.55	18.00	22.86	20.25	23.00
	NR n66	22.13	20.00	24.50	21.75	23.00
	NR n77	20.61	19.00	19.66	19.25	23.50

3 Power Density Characterization

EUT 5G mmW NR contains three mmW antenna modules (module 0, 1 and 2), denoted as ANT M0, ANT M1, ANT M2, which are installed at three different locations as shown in the operational description. A Total of 117 antenna array configurations per band are supported. In this chapter, a hybrid approach using electromagnetic (EM) simulation in combination with measurement is used to efficiently and conservatively characterize power density profile for the EUT.

3.1 Exposure scenarios in PD evaluation

In general, for a smartphone operating at frequencies > 6 GHz, the PD is required to be assessed for all antenna configurations (beams) from all mmW antenna modules installed inside the device. Furthermore, this PD evaluation should be performed at low, mid, and high channels for each supported mmW band.

For this EUT, the 4cm^2 spatially-averaged PD is evaluated along the surfaces (*S1, S2, S3, S4, S5, S6* as shown in Figure 3-2) of the EUT, and the worst-case PD is determined by taking the maximum PD among all PD at the evaluated surfaces for each beam/band.

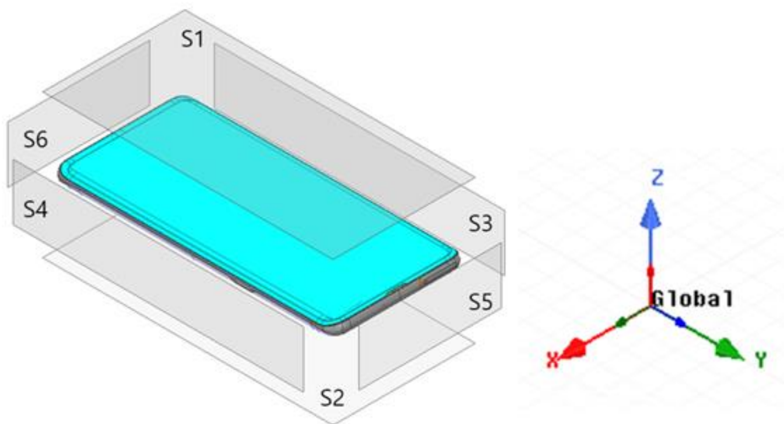

Figure 3-1: EUT surface definition: S1=Front, S2=Rear, S3=Edge 4, S4=Edge 2, S5=Edge 1, S6=Edge 3

3.2 PD characterization overview

Parameters used in PD characterization:

- The EUT supports total 117 beams per band, where 78 beams are single beams (SISO) and 39 are beam pairs (MIMO) where 2 single beams are excited at the same time.
- ***PD_design_target***: The design target for PD compliance as defined in the summary report. It should be less than FCC PD limit to account for all device design related uncertainties.
- ***input.power.limit***: For a PD characterized wireless device, the input power level at antenna port(s) for each beam corresponding to *PD_design_target*.
- **PD Char**: the table that contains *input.power.limit* fed to antenna port(s) for all supported beams.
-
- Figure 3-3 outlines the PD Char process.

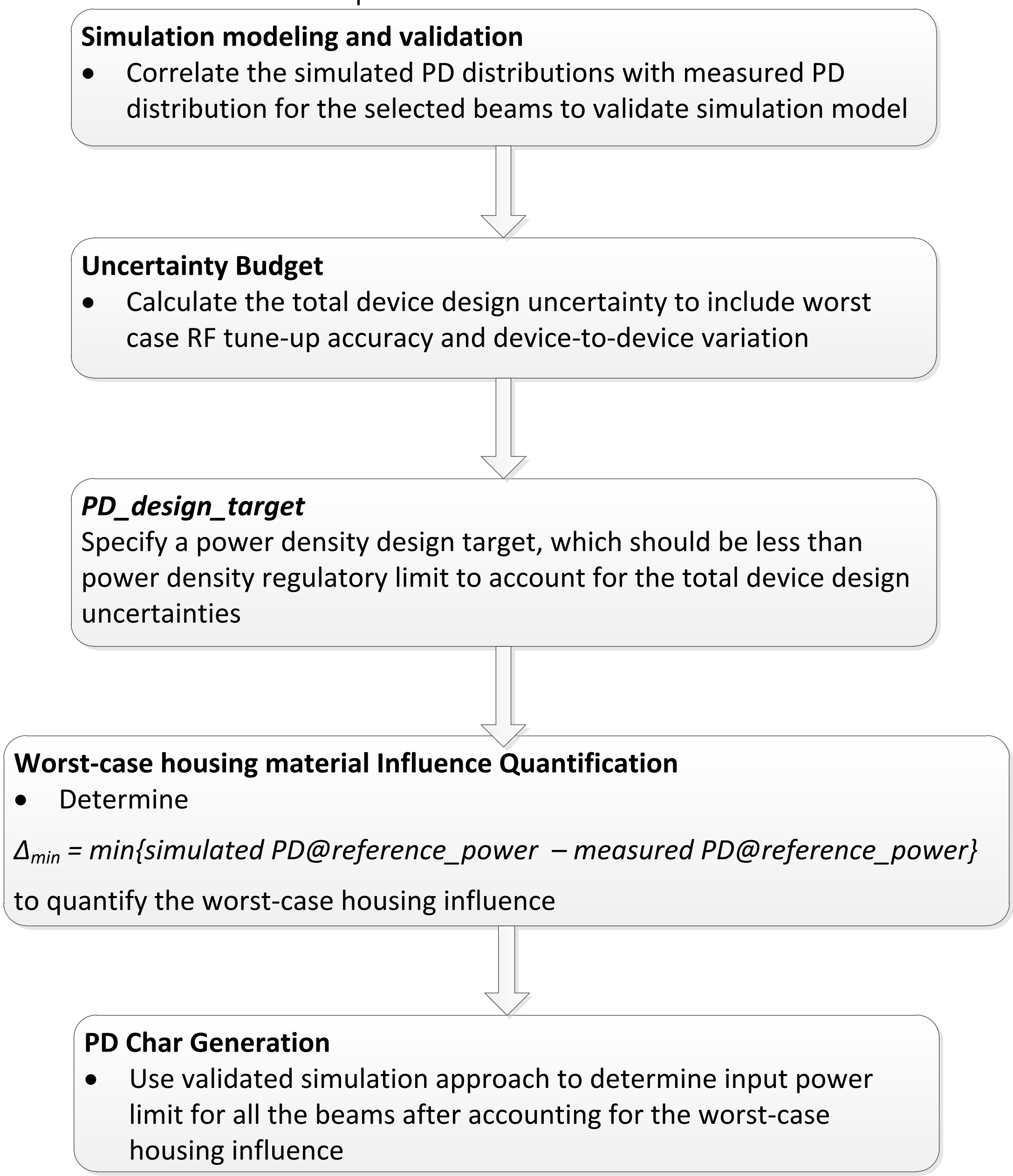

Figure 3-2 High level flow chart for power density characterization

3.3 Codebook for EUT

In general, all the beams that the EUT supports are specified in the pre-defined codebook. The codebook is device design specific and generated after evaluating radiation coverage from this specific device.

Table 3-1 shows all the beams and their relevant information in the codebook of the EUT. Note modules ANT M0, M1 and M2, respectively, in Figure 3-1.

The PD evaluation needs to be performed for all the beams listed in Table 3-1.

Table 3-1: Codebook of EUT

Band	Beam ID	Paired With	Module	Ant Type	# of Elements
260	0	128	ANT M1	PATCH	1
	1	129	ANT M1	PATCH	1
	2	130	ANT M0	PATCH	1
	3	131	ANT M0	PATCH	1
	4	132	ANT M2	PATCH	1
	5	133	ANT M2	PATCH	1
	6	134	ANT M1	PATCH	2
	7	135	ANT M1	PATCH	2
	8	136	ANT M1	PATCH	2
	9	137	ANT M0	PATCH	2
	10	138	ANT M0	PATCH	2
	11	139	ANT M0	PATCH	2
	12	140	ANT M2	PATCH	2
	13	141	ANT M2	PATCH	2
	14	142	ANT M2	PATCH	2
	15	143	ANT M1	PATCH	2
	16	144	ANT M1	PATCH	2
	17	145	ANT M0	PATCH	2
	18	146	ANT M0	PATCH	2
	19	147	ANT M2	PATCH	2
	20	148	ANT M2	PATCH	2
	21	149	ANT M1	PATCH	4
	22	150	ANT M1	PATCH	4
	23	151	ANT M1	PATCH	4
	24	152	ANT M1	PATCH	4
	25	153	ANT M1	PATCH	4
	26	154	ANT M2	PATCH	4
	27	155	ANT M2	PATCH	4
	28	156	ANT M2	PATCH	4
	29	157	ANT M2	PATCH	4
	30	158	ANT M2	PATCH	4

Band	Beam ID	Paired With	Module	Ant Type	# of Elements
260	31	159	ANT M1	PATCH	4
	32	160	ANT M1	PATCH	4
	33	161	ANT M1	PATCH	4
	34	162	ANT M1	PATCH	4
	35	163	ANT M2	PATCH	4
	36	164	ANT M2	PATCH	4
	37	165	ANT M2	PATCH	4
	38	166	ANT M2	PATCH	4
	128	0	ANT M1	PATCH	1
	129	1	ANT M1	PATCH	1
	130	2	ANT M0	PATCH	1
	131	3	ANT M0	PATCH	1
	132	4	ANT M2	PATCH	1
	133	5	ANT M2	PATCH	1
	134	6	ANT M1	PATCH	2
	135	7	ANT M1	PATCH	2
	136	8	ANT M1	PATCH	2
	137	9	ANT M0	PATCH	2
	138	10	ANT M0	PATCH	2
	139	11	ANT M0	PATCH	2
	140	12	ANT M2	PATCH	2
	141	13	ANT M2	PATCH	2
	142	14	ANT M2	PATCH	2
	143	15	ANT M1	PATCH	2
	144	16	ANT M1	PATCH	2
	145	17	ANT M0	PATCH	2
	146	18	ANT M0	PATCH	2
	147	19	ANT M2	PATCH	2
	148	20	ANT M2	PATCH	2
	149	21	ANT M1	PATCH	4
	150	22	ANT M1	PATCH	4
	151	23	ANT M1	PATCH	4
	152	24	ANT M1	PATCH	4
	153	25	ANT M1	PATCH	4
	154	26	ANT M2	PATCH	4
	155	27	ANT M2	PATCH	4
	156	28	ANT M2	PATCH	4
	157	29	ANT M2	PATCH	4
	158	30	ANT M2	PATCH	4
	159	31	ANT M1	PATCH	4
	160	32	ANT M1	PATCH	4

Band	Beam ID	Paired With	Module	Ant Type	# of Elements
260	161	33	ANT M1	PATCH	4
	162	34	ANT M1	PATCH	4
	163	35	ANT M2	PATCH	4
	164	36	ANT M2	PATCH	4
	165	37	ANT M2	PATCH	4
	166	38	ANT M2	PATCH	4
261	0	128	ANT M1	PATCH	1
	1	129	ANT M1	PATCH	1
	2	130	ANT M0	PATCH	1
	3	131	ANT M0	PATCH	1
	4	132	ANT M2	PATCH	1
	5	133	ANT M2	PATCH	1
	6	134	ANT M1	PATCH	2
	7	135	ANT M1	PATCH	2
	8	136	ANT M1	PATCH	2
	9	137	ANT M0	PATCH	2
	10	138	ANT M0	PATCH	2
	11	139	ANT M0	PATCH	2
	12	140	ANT M2	PATCH	2
	13	141	ANT M2	PATCH	2
	14	142	ANT M2	PATCH	2
	15	143	ANT M1	PATCH	2
	16	144	ANT M1	PATCH	2
	17	145	ANT M0	PATCH	2
	18	146	ANT M0	PATCH	2
	19	147	ANT M2	PATCH	2
	20	148	ANT M2	PATCH	2
	21	149	ANT M1	PATCH	4
	22	150	ANT M1	PATCH	4
	23	151	ANT M1	PATCH	4
	24	152	ANT M1	PATCH	4
	25	153	ANT M1	PATCH	4
	26	154	ANT M2	PATCH	4
	27	155	ANT M2	PATCH	4
	28	156	ANT M2	PATCH	4
	29	157	ANT M2	PATCH	4
	30	158	ANT M2	PATCH	4
	31	159	ANT M1	PATCH	4
	32	160	ANT M1	PATCH	4
	33	161	ANT M1	PATCH	4
	34	162	ANT M1	PATCH	4
	35	163	ANT M2	PATCH	4
	36	164	ANT M2	PATCH	4
	37	165	ANT M2	PATCH	4
	38	166	ANT M2	PATCH	4

Band	Beam ID	Paired With	Module	Ant Type	# of Elements
261	128	0	ANT M1	PATCH	1
	129	1	ANT M1	PATCH	1
	130	2	ANT M0	PATCH	1
	131	3	ANT M0	PATCH	1
	132	4	ANT M2	PATCH	1
	133	5	ANT M2	PATCH	1
	134	6	ANT M1	PATCH	2
	135	7	ANT M1	PATCH	2
	136	8	ANT M1	PATCH	2
	137	9	ANT M0	PATCH	2
	138	10	ANT M0	PATCH	2
	139	11	ANT M0	PATCH	2
	140	12	ANT M2	PATCH	2
	141	13	ANT M2	PATCH	2
	142	14	ANT M2	PATCH	2
	143	15	ANT M1	PATCH	2
	144	16	ANT M1	PATCH	2
	145	17	ANT M0	PATCH	2
	146	18	ANT M0	PATCH	2
	147	19	ANT M2	PATCH	2
	148	20	ANT M2	PATCH	2
	149	21	ANT M1	PATCH	4
	150	22	ANT M1	PATCH	4
	151	23	ANT M1	PATCH	4
	152	24	ANT M1	PATCH	4
	153	25	ANT M1	PATCH	4
	154	26	ANT M2	PATCH	4
	155	27	ANT M2	PATCH	4
	156	28	ANT M2	PATCH	4
	157	29	ANT M2	PATCH	4
	158	30	ANT M2	PATCH	4
	159	31	ANT M1	PATCH	4
	160	32	ANT M1	PATCH	4
	161	33	ANT M1	PATCH	4
	162	34	ANT M1	PATCH	4
	163	35	ANT M2	PATCH	4
	164	36	ANT M2	PATCH	4
	165	37	ANT M2	PATCH	4
	166	38	ANT M2	PATCH	4

3.4 Simulation and modeling validation

3.4.1 Modeling for simulation

Device modeling is described in the operational description.

3.4.2 Modeling validation

To validate modeling and simulation:

1. Select one beam (i.e., antenna array configuration) per antenna type (patch) and per antenna module. All three antenna modules contain only patch arrays. Therefore, the beam selection criteria for each mmW antenna are:
    a) Two beams from each of ANT M0, M1, and M2 (module 1)

       Note: Since the relative phase between two single beams in a beam pair is uncontrolled and could vary from run to run, for the validation purpose, the selection is limited to the single beam antenna array configuration. Additionally, single beam containing a higher number of active antenna elements is selected. For example, a single beam with four active patches should be selected over beam with a single active patch antenna beam.
2. The beams selected for modeling validation are highlighted in grey in Table 3-1.
3. For a given input power, perform both PD simulation and PD measurement to obtain the simulated PD distributions and measured PD distributions on the surface in front of the antenna array.
4. Validate modeling and simulation by correlating the simulated PD distribution and measured PD distribution for all antenna array configurations selected in Step 1.
5. The modeling validation is performed through correlating the simulated 4cm^2-avg PD distribution to measured 4cm^2-avg PD distribution.
6. These discrepancies in PD magnitude will be used to determine the worst-case housing influence (due to non-metal material property uncertainty) in Section 3.6. The worst-case housing influence will be accounted for in PD Char generation for conservative RF exposure assessment, see Section 3.7 for details.

Based on the selection criteria described in Step 1 and Step 2, the beams and surfaces selected for modeling validation of the EUT are listed in Table 3-2.

Table 3-2: Beams and surfaces selection for PD correlation

Band	Beam ID	Antenna	Pol	Surface
n261	33	M1	V	S2
	152		H	S2
	35	M2	V	S4
	166		H	S4
	17	M0	V	S1
	146		H	S1
n260	33	M1	V	S2
	161		H	S2
	36	M2	V	S4
	155		H	S4
	18	M0	V	S1
	137		H	S1

With an input power of 12 dBm for n261 band and 11 dBm for n260 band, PD measurement and PD simulation are conducted for all beams and surfaces listed in Table 3-2. Both PD measurement and PD simulation are performed at mid channel of each mmW beam, PD measurement is conducted with CW modulation.

- PD distribution

  Refer to the operational description

- 4cm^2-averaged PD value

Table 3-3 lists the measured 4cm^2-averaged PD and simulated 4cm^2-averaged PD for all selected beams and surfaces for both n261 and n260 bands. The discrepancy between simulated and measured PD value will be used to determine worst-case housing influence for conservative assessment (see Section 3.6).

Table 3-3: Measured and simulated 4cm^2 averaged PD for selected beams with 12 dBm input power for n261 and 11 dBm input power for n260

Band	Beam ID	Antenna	Pol	Surface	4cm2 avg. PD (W/m^2)		Delta[1]
					Meas.	Sim	
n261	33	M1	V	S2	60.80	68.00	**0.49**
	152		H	S2	96.00	71.10	**-1.30**
	35	M2	V	S4	100.00	72.30	**-1.40**
	166		H	S4	66.60	74.70	**0.50**
	17	M0	V	S1	6.19	4.50	**-1.39**
	146		H	S1	7.69	5.30	**-1.62**
n260	33	M1	V	S2	27.00	40.20	**1.73**
	161		H	S2	27.10	52.30	**2.87**
	36	M2	V	S4	45.20	66.80	**1.70**
	155		H	S4	37.00	56.30	**1.82**
	18	M0	V	S1	2.26	10.50	**6.67**
	137		H	S1	5.75	13.30	**3.64**

3.4.3 Simulation for power density

The model is validated in Section 3.4.3, the PD exposure of EUT can be reliably assessed using the validated simulation approach.
In general, all six surfaces of wireless device as shown in Figure 3-2 should be assessed for RF exposure from mmW radio, and the worst-case PD should be determined by:

$\mathbf{PD}_{\mathbf{worst\text{-}case}} = \max\{PD_{s1}, PD_{s2}, PD_{s3}, PD_{s4}, PD_{s5}, PD_{s6}\}$ (1)

where $PD_{s1}, PD_{s2}, PD_{s3}, PD_{s4}, PD_{s5}, PD_{s6}$ are the highest $4cm^2$-avgeraged PD on surface S1, S2, S3, S4, S5 and S6 of the device. respectively.

However, depending on the location of the mmW module and the antenna array orientation relative to the surface of the device, one or more surface(s) can be excluded for PD calculation as the PD value(s) on the excluded surface(s) will be undoubtedly lower when comparing to other surfaces, thus, the exclusion will have no impact for the worst-case PD determined using Equation 1.
For this EUT, based on the location of ANT M0, ANT M1 and ANT M2 shown in the operational description, and type of antenna array (containing in each mmW Ant), the surface planes identified for PD evaluation to determine the worst-case PD are selected and listed in Table 3-4.

Table 3-4: PD evaluation plane

ANT	Front	Back	Left	Right	Top	Bottom
	S1	S2	S3	S4	S5	S6
M1	No	Yes	Yes	No	No	No
M2	Yes	Yes	No	Yes	No	No
M0	Yes	Yes	No	No	Yes	No

The EM simulation is performed to characterize PD at low, mid, and high channels for each supported band. The simulation setup (mesh, convergence criteria and radiation boundary settings) as described in the operational description, ensures the accurate and reliable result for PD simulation on the planes identified. Both point PD and 4cm2-averaged PD distributions on the worst surface plane (i.e., the surface having highest PD value for the beam tested) are plotted and provided in the operational description to show that the PD hotspots are captured in this analysis.

3.5 *PD_design_target*

A2172 has their own internal controls for managing uncertainty and declared 2.2 dB uncertainty for use in determining the PD_design_target for the EUT using Qualcomm SDX50.

To account for the total design related uncertainty, PD_design_target needs to be:

$$PD\_design\_target < PD_{regulatory\_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$

With FCC $4cm^2$-averaged PD requirement of 10 W/m^2 and OEM declared 2.2 dB device design related uncertainty, the PD_design_target for the EUT is determined as:

$$PD\_design\_target = 7.5\ {}^{W}/{}_{m^2}$$

3.6 Worst-case housing influence determination

For non-metal material, the material property cannot be accurately characterized at mmW frequencies to date. The estimated material property for the device housing is used in the simulation model, which could influence the accuracy in simulation for PD amplitude quantification. Since the housing influence on PD could vary from surface to surface where the EM field propagates through, the most underestimated surface is used to quantify the worst-case housing influence for conservative assessment.

Since the mmW antenna modules are placed at different location as shown in the operational description only material/housing surrounded has impact on EM field propagation, in turn impact on power density. Furthermore, depending on the type of antenna array, i.e., dipole antenna array or patch antenna array, the nature of EM field propagation in the near field is different. Therefore, the worst-case housing influence is determined per antenna module and per antenna type.

For this EUT, when comparing a simulated 4cm^2-avgeraged PD and measured 4 cm^2-avgerated PD, the worst error introduced for each type of antenna array and antenna module when using the estimated material property in the simulation is highlighted in bold numbers in Table 3-5. Thus, the worst-case housing influence, denoted as $\mathit{\Delta}_{min} = \text{Sim. PD} - \text{Meas. PD}$, is determined as:

Table 3-5: $\mathit{\Delta}_{min}$ for ANT M0, ANT M1 and ANT M2

Band	Ant	Pol	$\mathit{\Delta}_{min}$ (dB)
n261	M1 (Patch Beam)	V	**0.49**
		H	**-1.30**
	M2 (Patch Beam)	V	**-1.40**
		H	**0.50**
	M0 (Patch Beam)	V	**-1.39**
		H	**-1.62**
n260	M1 (Patch Beam)	V	**1.73**
		H	**2.87**
	M2 (Patch Beam)	V	**1.70**
		H	**1.82**
	M0 (Patch Beam)	V	**6.67**
		H	**3.64**

$\mathit{\Delta}_{min}$ represents the worst case where RF exposure is underestimated the most in simulation when using the estimated material property for glass/plastics of the housing. For conservative assessment, the $\mathit{\Delta}_{min}$ is used as the worst-case factor and applied to all the beams in the corresponding beam group to determine input power limits in PD char for compliance (see Section 3.7.3 for details).

3.7 PD Char of the EUT

This section describes the PD Char generation that complies with the *PD_design_target* determined in Section 3.5 and is in compliance with the regulatory power density limit.

3.7.1 Scaling factor for single beams

To determine the input power limit at each antenna port, perform simulation at low, mid and high channel for each mmW band supported, with a given input power per active port (P_{ref}):

1. Obtain $PD_{surface}$ value (the worst PD among all identified surfaces of the EUT) at all three channels for all single beams specified in the codebook of Table 3-1.
2. Derive a scaling factor at low, mid and high channel, $s(i)_{low\_or\_mid\_or\_high}$, by:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)},\ i \in single\ beams \quad (2)$$

3. Determine the worst-case scaling factor, $\boldsymbol{s(i)}$**,** among low, mid and high channels:

$$s(i) = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ i \in single\ beams \quad (3)$$

and this scaling factor applies to the input power at each antenna port.

3.7.2 Scaling factor for beam pairs

The relative phase between beam pair is not controlled in the EUT and could vary from run to run. Therefore, for beam pair, based on the simulation results, the worst-case scaling factor needs to be determined mathematically to ensure the compliance.

For beam pair, extract the E-fields and H-fields from the corresponding single beams at low, mid and high channel for each supported band and for all identified surfaces of the EUT.

For a given beam pair containing *beam_a* and *beam_b*, and for a given channel, let relative phase between *beam_a* and *beam_b* = ∅, and the total PD of the beam pair can be expressed as:

$$total\ PD\ (\emptyset) = \frac{1}{2}\sqrt{Re\{PD_x(\emptyset)\}^2 + Re\{PD_y(\emptyset)\}^2 + Re\{PD_z(\emptyset)\}^2}$$
$$= \frac{1}{2} Re\left\{\left(\overrightarrow{E_a} + \overrightarrow{E_b e^{j\omega\emptyset}}\right) \times \left(\overrightarrow{H_a} + \overrightarrow{H_b e^{j\omega\emptyset}}\right)^*\right\} \quad (4)$$

where, *$PD_x(\emptyset)$*, *$PD_y(\emptyset)$* and *$PD_z(\emptyset)$* are the three components of the $total\ PD$ (∅); E_a and H_a are the extracted E-fields and H-fields of *beam_a*, while E_b and H_b are the extracted E-fields and H-fields of *beam_b*.

Sweep ∅ with a 5° step from 0° to 360° to determine the worst-case, $\emptyset_{worstcase}$, which results in the highest $total\ PD$ (∅) among all identified surfaces for this beam pair at this channel. For details on worst case $total\ PD$ (∅) derivation, see Appendix A.

Follow the above procedure to determine $\emptyset_{worstcase}$ for all three channels, and obtain the scaling factor given by the below equation for low, mid and high channels:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{total\ PD\ (\emptyset(i)_{worstcase})}, i \in beam\ pairs \quad (5)$$

The $\emptyset_{worstcase}$ varies with channel and beam pair, the lowest scaling factor among all three channels, $s(i)$, is determined for the beam pair *i*:

$$s(i) = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ i \in beam\ pairs \quad (6)$$

3.7.3 Input power limit

The PD Char specifies the limit of input power at antenna port that corresponds to *PD_design_target* for all the beams.

Ideally, if there is no uncertainty associated with hardware design, the input power limit, denoted as $input.power.limit(i)$, for beam *i* can be obtained after accounting for the housing influence (Δ_{min}) determined in Table 3-6 of Section 3.7.3, given by:

$$input.power.limit(i) = P_{\mathrm{ref}} + 10 * \log\big(s(i)\big) + \ \Delta_{min},\ i \in all\ beams \qquad (7)$$

where $8\ dBm$ is the input power using in simulation; $s(i)$ is the scaling factor obtained from Eq. (3) or Eq. (6) for beam *i*; Δ_{min} is the worst-case housing influence factor (determined in Table 3-8) for beam *i*.

If simulation overestimates the housing influence, then Δ_{min} (= simulated PD – measured PD) is negative, which means that the measured PD would be higher than the simulated PD. The input power to antenna elements determined via simulation must be decreased for compliance.
Similarly, if simulation underestimates the loss, then Δ_{min} is positive (measured PD would be lower than the simulated value). Input power to antenna elements determined via simulation can be increased and still be PD compliant.

In reality, the hardware design has uncertainty which must be properly considered. In Section 3.6, the TxAGC uncertainty is embedded in the process of Δ_{min} determination. Since TxAGC uncertainty is already accounted for in *PD_design_target* (see Section 3.5), it needs to be removed to avoid double counting this uncertainty.

Thus, Equation 7 is modified to:

If -TxAGC uncertainty < Δ_{min} < TxAGC uncertainty,

$$input.power.limit(i) = P_{\mathrm{ref}} + 10 * \log\big(s(i)\big),\ i \in all\ beams \quad (8)$$

else if Δ_{min} < -TxAGC uncertainty,

$$input.power.limit(i) = P_{\mathrm{ref}} + 10 * \log\big(s(i)\big) + \ (\Delta_{min} + \text{TxAGC uncertainty}), i \in all\ beams \quad (9)$$

else if Δ_{min} > TxAGC uncertainty,

$$input.power.limit(i) = P_{ref} + 10 * \log\big(s(i)\big) + (\Delta_{min} - \text{TxAGC uncertainty}), i \in all\ beams \quad (10)$$

Following above logic, the *input.power.limit* for this EUT can be calculated using Equations (8), (9) and (10), i.e.,

Table 3-6: *input.power.limit* calculation

Band	Ant	Pol	Δ_{min} (dB)	*Input.power.limit* (dBm) =	Notes
n261	M1 (Patch Beam)	V	**0.49**	12 dBm + 10 * log(s(i))	Using Eq. 8
		H	**-1.30**	12 dBm + 10 * log(s(i)) - 1.30	Using Eq. 9
	M2 (Patch Beam)	V	**-1.40**	12 dBm + 10 * log(s(i)) - 1.40	Using Eq. 9
		H	**0.50**	12 dBm + 10 * log(s(i))	Using Eq. 8
	M0 (Patch Beam)	V	**-1.39**	12 dBm + 10 * log(s(i)) - 1.39	Using Eq. 9
		H	**-1.62**	12 dBm + 10 * log(s(i)) - 1.62	Using Eq. 9
n260	M1 (Patch Beam)	V	**1.73**	12 dBm + 10 * log(s(i)) + 0.73	Using Eq. 10
		H	**2.87**	11 dBm + 10 * log(s(i)) + 1.87	Using Eq. 10
	M2 (Patch Beam)	V	**1.70**	11 dBm + 10 * log(s(i)) + 0.70	Using Eq. 10
		H	**1.82**	11 dBm + 10 * log(s(i)) + 0.82	Using Eq. 10
	M0 (Patch Beam)	V	**6.67**	11 dBm + 10 * log(s(i)) + 5.67	Using Eq. 10
		H	**3.64**	11 dBm + 10 * log(s(i)) + 2.64	Using Eq. 10

Thus, the EUT PD Char for n261 and n260 bands is as shown in Table 3-7.

Table 3-7: PD Char of the EUT

n261			n260		
Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)	Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)
N/A	0	7.3	N/A	0	7.2
	1	7.3		1	7.2
	2	14.8		2	17.9
	3	14.8		3	17.9
	4	6.0		4	6.9
	5	6.0		5	6.9
	6	4.2		6	4.7
	7	4.1		7	4.9
	8	3.7		8	5.2
	9	11.0		9	14.0
	10	12.0		10	15.0
	11	11.1		11	14.2
	12	2.8		12	5.0
	13	2.7		13	3.8
	14	2.8		14	4.3
	15	4.5		15	4.4
	16	4.2		16	5.2
	17	11.9		17	14.9
	18	11.2		18	14.2
	19	2.7		19	4.3
	20	2.8		20	3.5
	21	2.3		21	2.8
	22	3.4		22	2.3
	23	1.8		23	3.0
	24	1.4		24	2.5
	25	1.3		25	2.7
	26	-0.5		26	2.6
	27	-0.1		27	2.1
	28	0.1		28	0.8
	29	-0.3		29	1.1
	30	-0.3		30	2.1
	31	2.6		31	2.2
	32	2.6		32	2.5
	33	1.5		33	3.5
	34	1.2		34	2.5
	35	-0.2		35	2.2
	36	0.0		36	1.2
	37	-0.1		37	0.8
	38	-0.5		38	1.7

n261			n260		
Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)	Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)
N/A	128	6.0	N/A	128	7.3
	129	6.0		129	7.3
	130	13.0		130	12.2
	131	13.0		131	12.2
	132	6.8		132	7.0
	133	6.8		133	7.0
	134	2.9		134	4.9
	135	2.7		135	4.6
	136	2.7		136	4.4
	137	9.5		137	8.8
	138	9.9		138	9.2
	139	9.4		139	8.7
	140	3.6		140	4.3
	141	4.0		141	4.1
	142	3.6		142	4.1
	143	2.6		143	4.3
	144	2.9		144	4.5
	145	9.5		145	8.8
	146	10.5		146	9.7
	147	4.0		147	4.0
	148	3.7		148	4.5
	149	1.1		149	2.3
	150	1.0		150	2.3
	151	0.0		151	2.0
	152	0.0		152	2.3
	153	0.5		153	2.9
	154	1.2		154	1.8
	155	1.0		155	1.6
	156	1.3		156	1.2
	157	1.0		157	1.8
	158	1.6		158	1.7
	159	1.0		159	2.3
	160	0.1		160	2.1
	161	0.9		161	2.3
	162	-0.1		162	2.9
	163	0.9		163	2.3
	164	1.2		164	1.3
	165	1.3		165	1.1
	166	1.0		166	2.4

n261			n260		
Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)	Paired ID (Beam Pair)	Beam ID	Input Power Limit (dBm)
128	0	2.7	128	0	4.1
129	1	2.7	129	1	4.1
130	2	8.8	130	2	13.6
131	3	8.8	131	3	13.6
132	4	2.9	132	4	4.5
133	5	2.9	133	5	4.5
134	6	-1.0	134	6	1.6
135	7	-1.1	135	7	1.3
136	8	-1.0	136	8	1.6
137	9	4.8	137	9	10.2
138	10	6.1	138	10	10.6
139	11	4.8	139	11	10.1
140	12	-0.7	140	12	1.7
141	13	-0.4	141	13	1.3
142	14	-0.7	142	14	1.7
143	15	-0.6	143	15	1.3
144	16	-0.6	144	16	1.3
145	17	6.4	145	17	10.2
146	18	5.4	146	18	11.2
147	19	-0.7	147	19	1.9
148	20	-0.7	148	20	1.9
149	21	-3.4	149	21	-1.0
150	22	-3.0	150	22	-1.1
151	23	-3.0	151	23	-1.1
152	24	-3.7	152	24	-1.0
153	25	-3.7	153	25	-0.2
154	26	-3.3	154	26	-0.7
155	27	-3.1	155	27	-0.4
156	28	-3.1	156	28	-0.8
157	29	-3.2	157	29	-0.4
158	30	-3.3	158	30	-0.7
159	31	-3.3	159	31	-1.2
160	32	-3.1	160	32	-1.1
161	33	-3.3	161	33	-1.2
162	34	-3.3	162	34	0.0
163	35	-3.4	163	35	-0.3
164	36	-3.0	164	36	-0.7
165	37	-3.4	165	37	-0.7
166	38	-3.2	166	38	-0.3

A Worst Phase Derivation for Beam Pair

For beam pairs, since the relative phase between two beams is unknown – finding the worst-case PD by sweeping the relative phase for all possible angles is required for conservative assessment.
Assuming E-field and H-field of *beam_a* are {$Ex_{\_a}$, $Ey_{\_a}$, $Ez_{\_a}$} and {$Hx_{\_a}$, $Hy_{\_a}$, $Hz_{\_a}$}, respectively; E-field and H-field of *beam_b* are {$Ex_{\_b}$, $Ey_{\_b}$, $Ez_{\_b}$} and {$Hx_{\_b}$, $Hy_{\_b}$, $Hz_{\_b}$}, respectively; and the relative phase is ∅, for beam pair consisting of *beam_a* and *beam_b*, the combined E and H, {$Ex_{\_pair\_i}$, $Ey_{\_pair\_i}$, $Ez_{\_pair\_i}$} and {$Hx_{\_pair\_i}$, $Hy_{\_pair\_i}$, $Hz_{\_pair\_i}$}, can be expressed as:

$$Ex(\emptyset)_{\_pair\_i} = E_{x\_a} + E_{x\_b} \times e^{-j\omega\emptyset}$$
$$Ey(\emptyset)_{\_pair\_i} = E_{y\_a} + E_{y\_b} \times e^{-j\omega\emptyset}$$
$$Ez(\emptyset)_{\_pair\_i} = E_{z\_a} + E_{z\_b} \times e^{-j\omega\emptyset}$$

$$Hx(\emptyset)_{\_pair\_i} = H_{x\_a} + H_{x\_b} \times e^{-j\omega\emptyset}$$
$$Hy(\emptyset)_{\_pair\_i} = H_{y\_a} + H_{y\_b} \times e^{-j\omega\emptyset}$$
$$Hz(\emptyset)_{\_pair\_i} = H_{z\_a} + H_{z\_b} \times e^{-j\omega\emptyset}$$

The combined PD can then be calculated:

$$PDx(\emptyset)_{pair\_i} = Ey(\emptyset)_{\_pair\_i} \times Hz(\emptyset)^{*}_{pair\_i} - Ez(\emptyset)_{\_pair\_i} \times Hy(\emptyset)^{*}_{\_pair\_i}$$
$$PDy(\emptyset)_{\_pair\_i} = Ez(\emptyset)_{\_pair\_i} \times Hx(\emptyset)^{*}_{\_pair\_i} - Ex(\emptyset)_{\_pair\_i} \times Hz(\emptyset)^{*}_{\_pair\_i}$$
$$PDz(\emptyset)_{\_pair\_i} = Ex(\emptyset)_{\_pair\_i} \times Hy(\emptyset)^{*}_{\_pair\_i} - Ey(\emptyset)_{\_pair\_i} \times Hx(\emptyset)^{*}_{\_pair\_i}$$

$$PD(\emptyset) = \frac{1}{2}\sqrt{Re\{PDx(\emptyset)\}^{2}_{\_pair\_i} + Re\{PDy(\emptyset)\}^{2}_{\_pair\_i} + Re\{PDz(\emptyset)\}^{2}_{\_pair\_i}}$$

Sweep ∅ from 0 degree to 360 degree to find the highest PD (out of low, mid and high channel) and its corresponding ∅, $\emptyset_{worstcase}$, for all the beam pairs specified in the *codebook_sim*. The worst-case scaling factor *s(i)* for beam pair should be determined with $\emptyset(i)_{worstcase}$.

B Simulated input.power.limit

Table B-1: Lists input power limit per channel per band for all the beams that EUT supports.

n261					n260				
Paired ID (Beam Pair)	Beam ID	Low	Mid	High	Paired ID (Beam Pair)	Beam ID	Low	Mid	High
N/A	0	16.1	17.9	14.5	N/A	0	15.2	16.9	15.6
	1	12.3	14.6	12.0		1	12.3	13.7	15.6
	2	2.3	2.0	2.3		2	4.5	4.1	4.5
	3	2.3	3.0	2.3		3	4.5	4.1	4.5
	4	16.7	15.0	17.4		4	16.7	17.4	18.3
	5	16.7	17.2	17.4		5	16.7	11.9	18.3
	6	34.7	36.3	27.6		6	30.2	30.1	26.4
	7	32.2	36.7	36.3		7	28.8	29.1	26.5
	8	38.4	40.4	39.6		8	26.7	26.3	26.0
	9	4.8	5.5	4.3		9	9.6	11.0	8.6
	10	4.4	4.3	3.9		10	8.9	8.7	7.9
	11	5.4	5.2	4.5		11	10.7	10.4	9.0
	12	32.3	32.6	36.1		12	28.2	22.8	27.2
	13	31.8	37.0	33.9		13	32.9	36.8	37.2
	14	34.1	34.1	35.8		14	31.9	32.0	33.0
	15	31.9	33.5	26.3		15	32.6	31.7	26.3
	16	34.7	35.9	32.0		16	26.4	27.0	26.6
	17	4.3	4.5	4.0		17	8.7	9.0	7.9
	18	5.2	5.0	4.4		18	10.5	9.9	8.8
	19	33.6	36.0	36.9		19	32.9	30.7	31.4
	20	34.1	36.3	35.4		20	32.2	35.4	39.3
	21	46.1	49.9	55.6		21	37.9	36.9	47.2
	22	34.1	43.2	41.2		22	53.0	51.9	46.6
	23	62.8	63.3	59.9		23	44.9	45.1	40.7
	24	68.2	68.4	60.9		24	50.4	47.4	46.1
	25	58.4	70.0	56.2		25	36.4	48.2	40.3
	26	73.8	66.8	76.3		26	48.5	39.4	46.0
	27	62.1	69.9	67.7		27	55.2	54.9	50.7
	28	58.6	67.9	64.2		28	68.0	69.8	74.4
	29	69.9	73.3	72.7		29	60.7	68.3	66.4
	30	70.1	72.9	73.2		30	54.4	43.7	47.2
	31	42.2	46.8	51.7		31	41.9	54.1	45.7
	32	50.4	51.7	50.8		32	48.4	49.9	48.7
	33	68.0	66.7	58.8		33	37.8	40.2	39.6
	34	63.8	71.8	57.8		34	50.7	47.9	46.0
	35	67.7	71.8	72.3		35	53.5	42.4	46.5
	36	58.8	68.4	64.8		36	61.3	66.8	61.0
	37	64.4	70.5	68.6		37	64.9	73.6	74.4
	38	75.5	74.2	77.3		38	56.7	60.6	60.4

n261					n260				
Paired ID (Beam Pair)	Beam ID	Low	Mid	High	Paired ID (Beam Pair)	Beam ID	Low	Mid	High
N/A	128	17.7	16.2	16.7	N/A	128	16.6	16.4	15.1
	129	17.8	16.9	11.9		129	16.6	16.4	15.1
	130	2.7	2.7	3.0		130	5.3	5.5	6.0
	131	2.7	3.4	3.0		131	5.3	5.5	6.0
	132	13.9	18.4	19.9		132	16.5	15.9	13.8
	133	13.9	15.5	19.9		133	16.5	10.6	13.8
	134	31.0	33.8	36.5		134	28.8	26.3	24.0
	135	31.0	36.5	38.0		135	31.2	29.8	27.1
	136	35.3	37.5	33.8		136	32.7	31.5	28.0
	137	5.8	4.8	6.6		137	11.6	9.5	13.3
	138	4.0	5.3	6.0		138	8.0	10.6	12.0
	139	6.8	4.0	4.6		139	13.5	7.9	9.1
	140	28.0	31.1	41.2		140	30.5	25.9	25.1
	141	19.1	38.0	34.2		141	30.1	31.9	30.0
	142	30.2	33.7	41.3		142	32.1	25.2	24.7
	143	30.1	33.9	38.3		143	33.3	32.4	31.8
	144	31.2	34.3	35.8		144	32.1	30.9	26.8
	145	3.7	5.5	6.6		145	7.4	11.0	13.3
	146	4.5	5.0	5.3		146	9.0	9.9	10.6
	147	23.9	36.9	38.1		147	32.6	28.2	30.4
	148	27.0	38.1	40.8		148	29.0	28.9	28.6
	149	40.9	44.0	54.4		149	52.8	53.3	49.4
	150	51.4	54.4	55.9		150	53.4	51.0	48.1
	151	70.2	44.5	49.6		151	57.2	42.9	42.6
	152	68.6	71.1	55.6		152	42.8	52.7	46.9
	153	61.0	62.6	51.2		153	45.6	42.4	37.0
	154	60.4	59.5	72.7		154	54.8	49.5	48.0
	155	42.2	75.8	72.7		155	56.3	50.9	48.0
	156	36.7	70.0	61.9		156	60.3	62.6	59.3
	157	52.9	73.0	76.3		157	48.1	54.2	44.1
	158	55.6	65.1	66.5		158	54.2	48.9	55.5
	159	45.2	48.2	56.1		159	53.2	50.8	46.7
	160	62.9	68.7	54.3		160	55.4	44.1	45.7
	161	47.5	56.8	56.3		161	52.3	45.6	40.6
	162	72.5	65.3	53.8		162	43.5	41.0	46.4
	163	57.3	76.5	77.8		163	48.7	45.3	41.8
	164	37.9	72.9	62.3		164	61.6	59.4	56.1
	165	40.2	69.2	70.1		165	55.9	63.8	53.8
	166	58.8	74.7	71.1		166	47.8	43.0	40.8

n261			n260		
Paired ID (Beam Pair)	Beam ID	Worst Case Sim Beam Pair	Paired ID (Beam Pair)	Beam ID	Worst Case Sim Beam Pair
128	0	38.0	128	0	34.9
129	1	38.0	129	1	34.9
130	2	8.6	130	2	5.0
131	3	8.6	131	3	5.0
132	4	35.6	132	4	31.4
133	5	35.6	133	5	31.4
134	6	86.8	134	6	58.8
135	7	91.4	135	7	66.7
136	8	86.8	136	8	58.8
137	9	14.4	137	9	11.8
138	10	14.4	138	10	8.9
139	11	16.2	139	11	10.7
140	12	74.6	140	12	54.2
141	13	74.7	141	13	65.1
142	14	74.6	142	14	54.2
143	15	77.2	143	15	63.9
144	16	77.2	144	16	63.9
145	17	15.0	145	17	11.5
146	18	19.0	146	18	10.5
147	19	79.5	147	19	46.8
148	20	79.5	148	20	46.8
149	21	145.8	149	21	108.6
150	22	109.3	150	22	109.2
151	23	109.3	151	23	109.2
152	24	145.8	152	24	108.6
153	25	152.4	153	25	92.6
154	26	143.6	154	26	68.7
155	27	136.1	155	27	90.5
156	28	129.7	156	28	105.8
157	29	136.1	157	29	90.5
158	30	129.7	158	30	68.7
159	31	123.2	159	31	116.5
160	32	144.4	160	32	114.0
161	33	123.2	161	33	116.5
162	34	150.1	162	34	89.4
163	35	145.0	163	35	89.9
164	36	118.9	164	36	88.8
165	37	118.9	165	37	88.8
166	38	136.2	166	38	89.9