HCT Co., Ltd.
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Tel. +82 31 634 6300   Fax. +82 31 645 6401

PART 0 POWER DENSITY CHAR REPORT

Applicant Name: SAMSUNG Electronics Co., Ltd. 129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677 Rep. of Korea	Date of Issue: Aug. 18, 2020 Test Report No.: HCT-SR-2007-FC002-R1 Test Site: HCT CO., LTD.

Applicant Name:
SAMSUNG Electronics Co., Ltd.
129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do,
16677 Rep. of Korea

Date of Issue: Aug. 18, 2020
Test Report No.: HCT-SR-2007-FC002-R1
Test Site: HCT CO., LTD.

FCC ID: A3LSMT878U

Report Type:	**Part 0 Power Density Characterization**
Equipment Type:	**Tablet**
Application Type	**Certification**
FCC Rule Part(s):	**CFR §2.1093**
Model Name:	**SM-T878U**

.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By	Reviewed By
Bong-Kyun Park Test Engineer SAR Team Certification Division	Yun-jeang, Heo Technical Manager SAR Team Certification Division

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	Jul. 16, 2020	Initial Release
R1	Aug. 18, 2020	Revised table 4-1

This test results were applied only to the test methods required by the standard.

The above Test Report is not related to the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA.

Table of Contents

1. Test Location 4
2. Information of the EUT 4
3. DEVICE UNDER TEST 5
4. POWER DENSITY CHARACTERIZATION 7
5 PD Char 22

1. Test Location

1.1 Test Laboratory

Company Name	HCT Co., Ltd.
Address	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Telephone	031-645-6300
Fax.	031-645-6401

1.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

Korea	National Radio Research Agency (Designation No. KR0032)
	KOLAS (Testing No. KT197)

2. Information of the EUT

2.1 General Information of the EUT

Model Name	SM-T878U
Equipment Type	Tablet
FCC ID	A3LSMT878U
Application Type	Certification
Applicant	SAMSUNG Electronics Co., Ltd.

3. DEVICE UNDER TEST

3.1 Device Overview

This device uses the Qualcomm® Smart Transmit feature to control and manage transmitting power in real time and to ensure the time-averaged RF exposure is in compliance with the FCC requirement at all times for 2G/3G/4G/5G WWAN operations. Additionally, this device supports WLAN/BT/NFC/ANT+/MST technologies, but the output power of these modems is not controlled by the Smart Transmit algorithm.

3.2 Time-Averaging for SAR and Power Density

This device is enabled with Qualcomm® Smart Transmit algorithm to control and manage transmitting power in real time and to ensure that the time-averaged RF exposure from 2G/3G/4G/5G NR WWAN is in compliance with FCC requirements.

This Part 0 report shows SAR and Power Density characterization of WWAN radios for 2G/3G/4G/5G Sub-6 NR and 5G mmW NR respectively.
Characterization is achieved by determining P_{Limit} for 2G/3G/4G/5G Sub 6 NR and input.power.limit for 5G mmW NR that correspond to the exposure design targets. 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 in this report. Section 3.3 includes a nomenclature of the specific terms
used in this report
.
The compliance test under the static transmission scenario and simultaneous transmission analysis are reported in Part 1 report. The validation of the time-averaging algorithm and compliance under the dynamic (time- varying) transmission scenario for WWAN technologies are reported in Part 2 report

3.3 Nomenclature for Part 0 Report

Technology	Term	Description
5G mmW NR	*input.power.limit*	Power level at antenna element for each beam corresponding to the exposure design target (*PD_design_target)*
	PD_design_target	Target PD level < FCC PD limit after accounting for all device design related uncertainties
	Δmin	Housing material influence
	PD Char	Table containing *input.power.limit* for all beams and bands

4. POWER DENSITY CHARACTERIZATION

4.1 Exposure Scenarios in Power Density Evaluation

At frequencies > 6 GHz, the total peak spatial averaged power density (psPD) is required to be assessed for all antenna configurations (beams) from all mmW antenna modules installed inside the device. This device has 2 patch antenna arrays (Module 0, Module 1) antenna array .

As showed in Figure 4-1, the surfaces near-by each mmW antenna module for PD characterization are identified and listed in Table 4-1.

Note: The J Patch antenna, located on the back surface, is constructed with its dedicated ground plane behind the entire patch array and can only propagate outward.

Table 4-1 Evaluation Surfaces for PD Characterization

Band	Antenna	Rear(S2)	Front(S1)	Left(S3)	Right(S4)	Bottom	Top(S5)
5G NR Band n261	Module 0	No	Yes	No	Yes	No	No
	Module 1	Yes	No	No	Yes	No	No
5G NR Band n260	Module 0	No	Yes	No	Yes	No	No
	Module 1	Yes	No	No	Yes	No	No

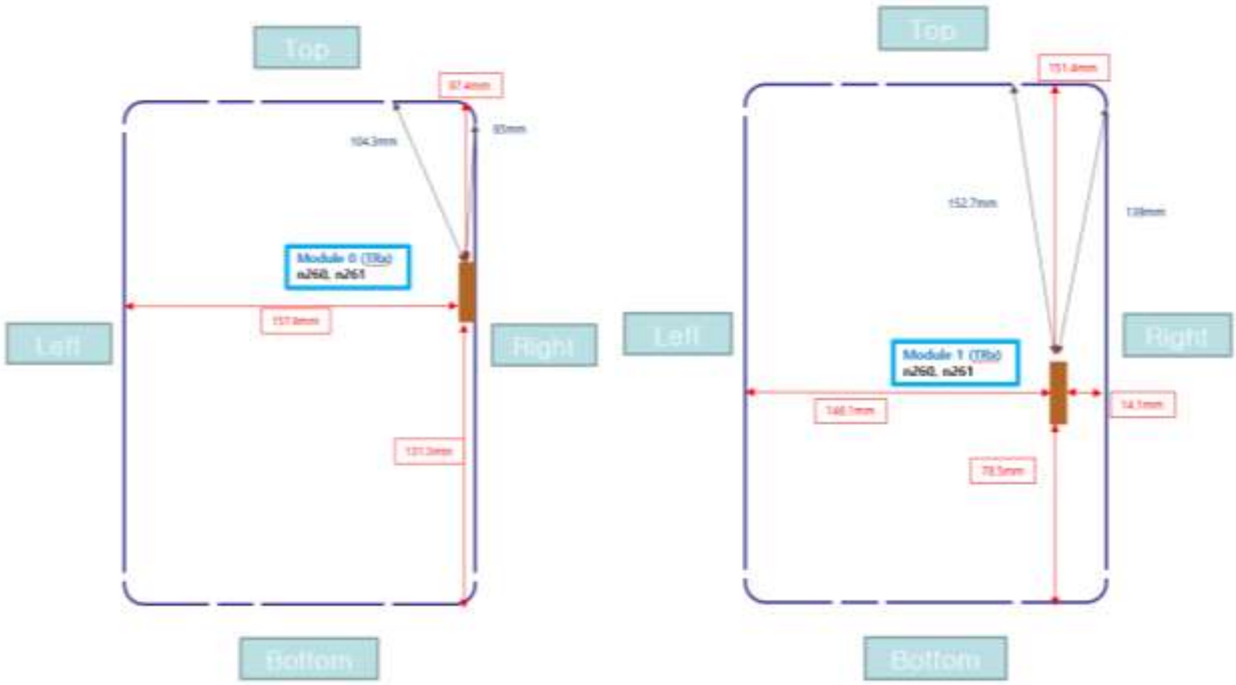

Figure 4-1: Location of mmW antenna modules looking from front of the DUT

Particular DUT edges were not required to be evaluated for power density if the edges were greater than 2.5 cm from the transmitting antenna according to FCC KDB Publication 941225 D06v02r01 Section III and FCC KDB Publication 648474 D04v01r03. The distances between the transmit antennas and the edges of the device are included in the filing. Per FCC guidance, additional edges with negligible psPD results could be excluded from testing towards Δ_{min} calculations.

4.2 Power Density Characterization Method

An overview of power density characterization method could be found in Figure 4-2 below.

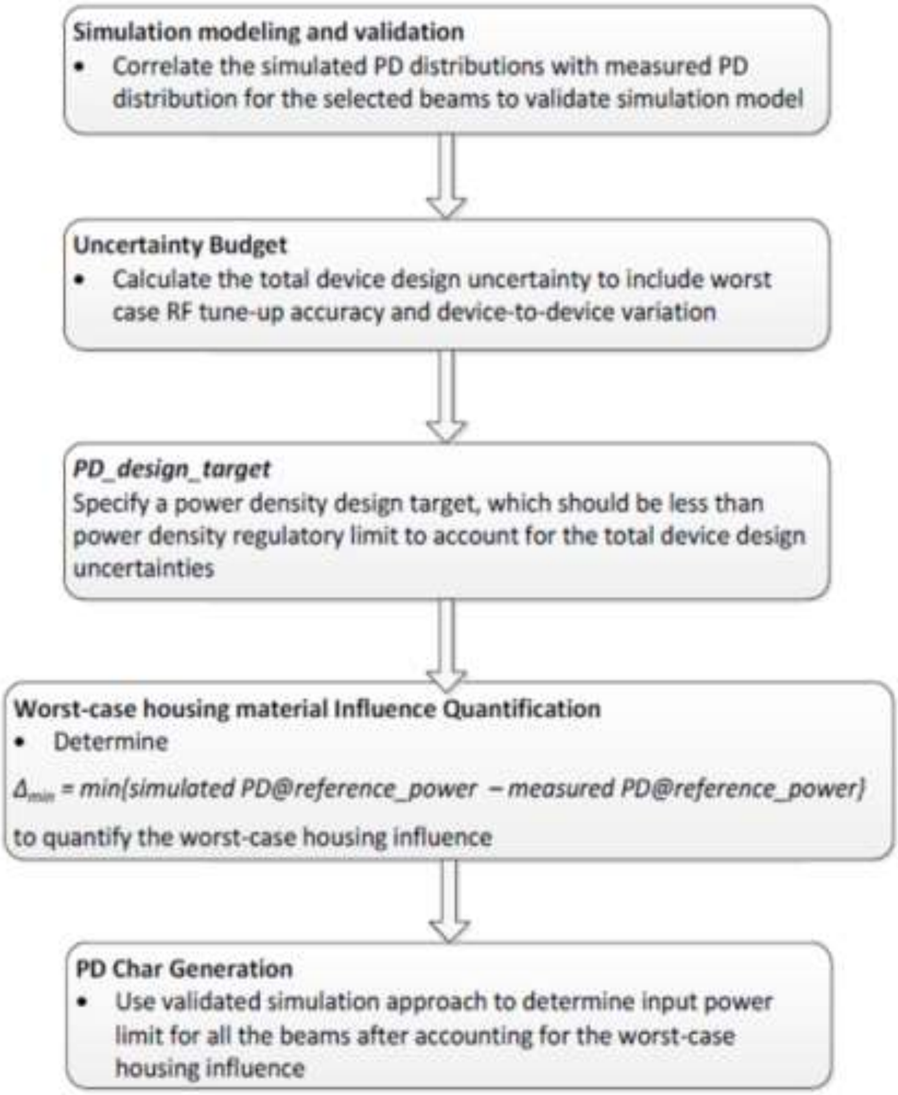

Figure 4-2: Flow chart for Power deisity characterization

4.3 Codebook for all supported beams

All the beams that the DUT supports are specified in the pre-defined codebook. The codebook for this device is specified as below.

Table 4-2 5G mmW NR Band n261 Ante K(Module 0) Codebook

Band	Beam ID	Module	Paired_With	# of Antenna Feed
n261	0	Module 0	128	1
n261	2	Module 0	130	2
n261	3	Module 0	131	2
n261	4	Module 0	132	2
n261	8	Module 0	136	2
n261	9	Module 0	137	2
n261	12	Module 0	140	4
n261	13	Module 0	141	4
n261	14	Module 0	142	4
n261	15	Module 0	143	4
n261	16	Module 0	144	4
n261	22	Module 0	150	4
n261	23	Module 0	151	4
n261	24	Module 0	152	4
n261	25	Module 0	153	4
n261	128	Module 0	0	1
n261	130	Module 0	2	2
n261	131	Module 0	3	2
n261	132	Module 0	4	2
n261	136	Module 0	8	2
n261	137	Module 0	9	2
n261	140	Module 0	12	4
n261	141	Module 0	13	4
n261	142	Module 0	14	4
n261	143	Module 0	15	4
n261	144	Module 0	16	4
n261	150	Module 0	22	4
n261	151	Module 0	23	4
n261	152	Module 0	24	4
n261	153	Module 0	25	4

Table 4-3 5G mmW NR Band n260 Codebook

Band	Beam ID	Module	Paired_With	# of Antenna Feed
n260	0	Module 0	128	1
n260	2	Module 0	130	2
n260	3	Module 0	131	2
n260	4	Module 0	132	2
n260	8	Module 0	136	2
n260	9	Module 0	137	2
n260	12	Module 0	140	4
n260	13	Module 0	141	4
n260	14	Module 0	142	4
n260	15	Module 0	143	4
n260	16	Module 0	144	4
n260	22	Module 0	150	4
n260	23	Module 0	151	4
n260	24	Module 0	152	4
n260	25	Module 0	153	4
n260	128	Module 0	0	1
n260	130	Module 0	2	2
n260	131	Module 0	3	2
n260	132	Module 0	4	2
n260	136	Module 0	8	2
n260	137	Module 0	9	2
n260	140	Module 0	12	4
n260	141	Module 0	13	4
n260	142	Module 0	14	4
n260	143	Module 0	15	4
n260	144	Module 0	16	4
n260	150	Module 0	22	4
n260	151	Module 0	23	4
n260	152	Module 0	24	4
n260	153	Module 0	25	4

Table 4-4 5G mmW NR Band n261 Module 1 Codebook

Band	Beam ID	Module	Paired_With	# of Antenna Feed
n261	1	Module 1	129	1
n261	5	Module 1	133	2
n261	6	Module 1	134	2
n261	7	Module 1	135	2
n261	10	Module 1	138	2
n261	11	Module 1	139	2
n261	17	Module 1	145	4
n261	18	Module 1	146	4
n261	19	Module 1	147	4
n261	20	Module 1	148	4
n261	21	Module 1	149	4
n261	26	Module 1	154	4
n261	27	Module 1	155	4
n261	28	Module 1	156	4
n261	29	Module 1	157	4
n261	129	Module 1	1	1
n261	133	Module 1	5	2
n261	134	Module 1	6	2
n261	135	Module 1	7	2
n261	138	Module 1	10	2
n261	139	Module 1	11	2
n261	145	Module 1	17	4
n261	146	Module 1	18	4
n261	147	Module 1	19	4
n261	148	Module 1	20	4
n261	149	Module 1	21	4
n261	154	Module 1	26	4
n261	155	Module 1	27	4
n261	156	Module 1	28	4
n261	157	Module 1	29	4

Table 4-5 5G mmW NR Band n260 Module 1 Codebook

Band	Beam ID	Module	Paired_With	# of Antenna Feed
n260	1	Module 1	129	1
n260	5	Module 1	133	2
n260	6	Module 1	134	2
n260	7	Module 1	135	2
n260	10	Module 1	138	2
n260	11	Module 1	139	2
n260	17	Module 1	145	4
n260	18	Module 1	146	4
n260	19	Module 1	147	4
n260	20	Module 1	148	4
n260	21	Module 1	149	4
n260	26	Module 1	154	4
n260	27	Module 1	155	4
n260	28	Module 1	156	4
n260	29	Module 1	157	4
n260	129	Module 1	1	1
n260	133	Module 1	5	2
n260	134	Module 1	6	2
n260	135	Module 1	7	2
n260	138	Module 1	10	2
n260	139	Module 1	11	2
n260	145	Module 1	17	4
n260	146	Module 1	18	4
n260	147	Module 1	19	4
n260	148	Module 1	20	4
n260	149	Module 1	21	4
n260	154	Module 1	26	4
n260	155	Module 1	27	4
n260	156	Module 1	28	4
n260	157	Module 1	29	4

4.4 Simulation and modeling validation

Power density simulations of all 13 beams and surfaces were performed by the manufacturer. Details of these simulations and modeling validatio0n can be found in the Power Density Simulation Report (Power Density Simulation Report Revision A). Table below includes a summary of the validation results to support worst-case housing influence quantification in power density characterization for this model.

With an input power of 6 dBm for n261 band and 6 dBm for n260 band, PD measurements are conducted for at least one single beam per antenna type and per antenna module (K, L) on worst-surface(s)

PD measurements are performed at mid channel of each mmW band and with CW modulation. All measured PD values are listed in table below along with corresponding simulated PD values for the same configuration. PD value will be used to determine worst-case housing influence for conservative assessment.

PD value will be used to determine worst-case housing influence for conservative assessment.

Table 4-6

5G NR band n261						
PD part 0 : input power limit 6dBm						
Module	Antenna pole	Channel	Beam ID	Simulation PD [mW/cm²]	measured PD [mW/cm²]	"Delta_Min (dB)"
0	V pole	Middle	16	1.988	0.675	4.69
	H pole	Middle	152	1.76	1.08	1.50
1	V pole	Middle	29	1.611	0.835	2.85
	H pole	Middle	149	2.467	0.829	4.74

5G NR band n260						
PD part 0 : input power limit 6dBm						
Module	Antenna pole	Channel	Beam ID	Simulation PD [mW/cm²]	measured PD [mW/cm²]	"Delta_Min (dB)"
0	V pole	Middle	12	2.017	0.988	3.10
	H pole	Middle	144	1.968	0.83	3.78
1	V pole	Middle	21	1.692	0.841	3.04
	H pole	Middle	149	1.722	0.68	4.05

4.5 *PD_design_target*

PD_design_target is determined by ensuring that it is less than FCC PD limit after accounting for total device design uncertainties including TxAGC and device-to-device variation, specified by the manufacturer

PD_design_target Calculations

PD_design_target	
$PD\_design\_target < PD\_regulatory\_limit \times 10^{\frac{-Total\ Uncertainty}{10}}$	
psPD over 4 cm² Averaging Area (mW/cm²)	
Total Uncertainty	2.1 dB
PD_regulatory_limit	1.0 mW/cm²
PD_design_target	0.6166 mW/cm²

PD_design_target Calculations

4.6 Worst-case Housing Influence Determination: *Δmin*

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 surfac e
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 Figure 4-1, only surrounding material/housing has impact on EM field propagation, and in turn 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 DUT, the below procedure was used to determine worst-case housing influence, *Δmin*:

1.Based on PD simulation, for each module and antenna type, determine one or more worst-surface(s) that has highest $4cm^2$ PD for all the single beams per antenna module and per antenna type in the mid channel of each band.

2.For identified worst surface(s) per antenna module and per antenna type group,

a. First determine Δ_{min} based on identified worst surface(s), and derive *input.power.limit*

b.Then prove all other near-by surface(s), i.e., non-selected surface(s), is not required for housing material loss quantification (in other words, these non-evaluated surfaces have no influence on the determined *input.power.limit*) by:

i. re-scale all simulated $4cm^2$PD values to *input.power.limit* to identify the worst-PD beam per each non-evaluated surface

ii. Measure $4cm^2$PD at *input.power.limit* on identified worst-PD beam per each non- evaluated surface

iii. Demonstrate all measured $4cm^2$PD values are below *PD_design_target.*

3.If any of the above surface(s) in Step (2.b.iii) have measured $4cm^2$ PD ≥ *PD_design_target*, then those surfaces must be included in the Δ_{min} determination in Step (2.a), and re-evaluate *input.power.limit* with these added surfaces.

Following above procedure, based on Table 4-2 ~ Table 4-5 in Samsung PD simulation report, the worst-surface(s)having highest $4cm^2$PD for all the single beams per each antenna type and each antenna module group in the mid channel of n261 and n260 bands are identified as:

a. for Module 0 : Front (S1)
b. for Module 1: Back (S2)

Thus, when comparing a simulated 4cm2averaged PD and measured 4 cm2averaged PD for the identified worstsurface(s), the worst error introduced for each antenna type and each antenna module group when using theestimated material property in the simulation is highlighted in bold numbers in Table 4-6.
Thus, the worst-case housing influence, denoted as Δmin = Sim. PD − Meas. PD , is determined as

Table 4-7.
Table Δmin for Ant K, Ant L

Band	Ant	*Δmin* (dB)
n261	K (patch) Module 0	1.50
	L (patch) Module 1	2.85
n260	K (patch) Module 0	3.10
	L (patch) Module 1	3.04

Δmin represents the worst case where RF exposure is underestimated the most in simulation when using the estimated material property of the housing. For conservative assessment, the *Δmin* is used as the worst-case factor and applied to all the beams in the corresponding antenna type and antenna module group to determine input power limits in PD char for compliance.

The detail *input.power.limit* derivation is described in Section 5-1 Simulated 4cm2 PD values in Table 4 ~ Table 5 in Power Density Simulation Report are scaled to input.power.limit and are listed in Tables 4-8 ~ 4-11 for all single beams for all identified surfaces (shown in Table 4-1), when assuming the simulation is performed with correct housing influence. Determine the worst beam for each of non-selected surface(s), i.e.,

a. for L patch(Module 1): Right Side (S4)
b. for K patch(Module 0): Right Side (S4)

Then perform PD measurement for all determined worst-case beams, in Tables 4-8 ~4- 11 on the corresponding surface. Measurement is performed in the mid channel of each band with CW modulation.The evaluation distance is at 2 mm.

The test results in Table 4-12 shows that the all measured 4cm^2 PD values are less than *PD_design_target* of 0.6166 mW/cm^2, thus, the non- selected surfaces have no influence on the determined Δmin and input.power.limit in Section 5

Table 4-8
N261/mid channel, Module 0 simulates 4cm² PD at PD_Design_Target
(If simulation performed with correct housing material properties) Δmin

n261, Module 0						
Beam ID	4cm2 PD(mW/cm2)					
	S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
0	0.207	0.017	0.017	0.027	0.574	0.016
2	0.188	0.014	0.032	0.035	0.612	0.022
3	0.225	0.014	0.017	0.017	0.524	0.012
4	0.187	0.024	0.022	0.020	0.617	0.012
8	0.224	0.015	0.017	0.023	0.555	0.012
9	0.199	0.011	0.018	0.013	0.509	0.010
12	0.244	0.013	0.020	0.033	0.518	0.025
13	0.270	0.021	0.016	0.021	0.602	0.016
14	0.221	0.027	0.015	0.010	0.523	0.008
15	0.216	0.023	0.012	0.014	0.552	0.009
16	0.171	0.032	0.019	0.032	0.617	0.009
22	0.264	0.018	0.016	0.022	0.551	0.021
23	0.236	0.024	0.018	0.017	0.572	0.013
24	0.220	0.024	0.012	0.011	0.530	0.008
25	0.213	0.034	0.014	0.026	0.617	0.010
128	0.162	0.018	0.042	0.020	0.561	0.020
130	0.159	0.026	0.045	0.023	0.587	0.014
131	0.246	0.014	0.007	0.011	0.603	0.007
132	0.141	0.017	0.056	0.019	0.596	0.020
136	0.189	0.020	0.025	0.019	0.602	0.010
137	0.266	0.010	0.027	0.011	0.582	0.014
140	0.183	0.029	0.018	0.021	0.560	0.009
141	0.198	0.032	0.021	0.023	0.572	0.016
142	0.238	0.026	0.013	0.011	0.578	0.009
143	0.264	0.015	0.029	0.013	0.580	0.017
144	0.163	0.013	0.098	0.024	0.520	0.025
150	0.185	0.034	0.017	0.019	0.552	0.011
151	0.224	0.028	0.019	0.022	0.610	0.019
152	0.233	0.020	0.013	0.010	0.534	0.009
153	0.276	0.014	0.075	0.017	0.617	0.022

Note: Even though the worst surface having the highest 4cm^2 PD values is right surface (S3), as shown in Table 5-3, the back surface (S2) was also selected for *Δmin* determination. Therefore, the worst- case beam for remaining non-selected surfaces (identified in Table 4-1) is from front surface (S1) only.
Please note the above scaled simulation values correspond to PD_design_target if the simulation was performed with correct housing material properties.

Table 4-9
N261/mid channel, Module 1 simulates 4cm² PD at PD_Design_Target
(If simulation performed with correct housing material properties) Δmin

n261, Module 1						
Beam ID	4cm2 PD(mW/cm2)					
	S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
1	0.038	0.015	0.022	0.005	0.018	0.578
5	0.029	0.012	0.056	0.013	0.021	0.578
6	0.058	0.022	0.011	0.006	0.015	0.601
7	0.047	0.015	0.058	0.017	0.015	0.615
10	0.053	0.016	0.027	0.006	0.013	0.570
11	0.030	0.009	0.046	0.013	0.024	0.598
17	0.028	0.017	0.112	0.023	0.024	0.617
18	0.067	0.028	0.007	0.006	0.012	0.610
19	0.088	0.027	0.005	0.003	0.009	0.588
20	0.061	0.022	0.027	0.016	0.018	0.589
21	0.033	0.008	0.096	0.026	0.022	0.617
26	0.041	0.031	0.040	0.011	0.023	0.608
27	0.083	0.029	0.005	0.004	0.010	0.588
28	0.055	0.025	0.021	0.005	0.018	0.508
29	0.052	0.011	0.102	0.033	0.025	0.613
129	0.039	0.012	0.006	0.021	0.006	0.575
133	0.044	0.017	0.010	0.040	0.013	0.561
134	0.046	0.020	0.004	0.013	0.008	0.581
135	0.034	0.017	0.011	0.046	0.014	0.559
138	0.049	0.015	0.005	0.010	0.009	0.572
139	0.028	0.015	0.010	0.044	0.014	0.559
145	0.082	0.020	0.014	0.037	0.010	0.617
146	0.078	0.026	0.002	0.009	0.010	0.572
147	0.047	0.027	0.004	0.005	0.011	0.563
148	0.025	0.023	0.022	0.112	0.015	0.617
149	0.057	0.016	0.017	0.068	0.009	0.617
154	0.090	0.021	0.010	0.028	0.014	0.593
155	0.085	0.027	0.003	0.005	0.010	0.602
156	0.038	0.032	0.009	0.020	0.013	0.615
157	0.050	0.015	0.018	0.080	0.010	0.617

Table 4-10
N260/mid channel, Module 0 simulates 4cm² PD at PD_Design_Target
(If simulation performed with correct housing material properties) Δmin

Beam ID	n260, Module 0					
	4cm2 PD(mW/cm2)					
	S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
0	0.222	0.016	0.038	0.009	0.581	0.013
2	0.240	0.011	0.018	0.013	0.608	0.013
3	0.286	0.011	0.010	0.026	0.611	0.010
4	0.201	0.009	0.015	0.011	0.617	0.011
8	0.304	0.010	0.007	0.019	0.610	0.010
9	0.233	0.008	0.017	0.011	0.617	0.009
12	0.267	0.022	0.019	0.018	0.617	0.020
13	0.354	0.019	0.009	0.020	0.607	0.015
14	0.275	0.022	0.038	0.046	0.540	0.013
15	0.288	0.017	0.056	0.009	0.580	0.022
16	0.217	0.018	0.031	0.011	0.617	0.018
22	0.287	0.022	0.015	0.021	0.617	0.020
23	0.370	0.015	0.011	0.014	0.617	0.009
24	0.288	0.021	0.065	0.025	0.582	0.023
25	0.261	0.016	0.035	0.006	0.581	0.016
128	0.238	0.009	0.009	0.010	0.617	0.006
130	0.262	0.009	0.008	0.014	0.617	0.009
131	0.325	0.013	0.019	0.016	0.617	0.012
132	0.195	0.017	0.014	0.013	0.617	0.011
136	0.309	0.013	0.011	0.013	0.617	0.007
137	0.271	0.014	0.016	0.009	0.617	0.008
140	0.250	0.022	0.019	0.015	0.617	0.016
141	0.281	0.023	0.006	0.018	0.608	0.009
142	0.351	0.020	0.047	0.019	0.617	0.015
143	0.365	0.028	0.020	0.013	0.617	0.013
144	0.252	0.022	0.022	0.013	0.617	0.016
150	0.238	0.016	0.006	0.026	0.598	0.014
151	0.288	0.022	0.021	0.012	0.617	0.010
152	0.384	0.020	0.039	0.015	0.617	0.014
153	0.314	0.029	0.029	0.007	0.617	0.015

Table 4-11
N260/mid channel, Module 1 simulates 4cm² PD at PD_Design_Target
(If simulation performed with correct housing material properties) Δmin

n260, Module 1						
Beam ID	4cm2 PD(mW/cm2)					
	S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
1	0.060	0.016	0.011	0.024	0.054	0.541
5	0.059	0.022	0.015	0.013	0.014	0.617
6	0.078	0.025	0.018	0.003	0.021	0.612
7	0.062	0.021	0.010	0.022	0.023	0.561
10	0.085	0.023	0.017	0.005	0.013	0.617
11	0.082	0.024	0.006	0.017	0.018	0.596
17	0.080	0.034	0.012	0.021	0.023	0.569
18	0.135	0.029	0.023	0.013	0.031	0.617
19	0.105	0.057	0.013	0.016	0.040	0.600
20	0.115	0.045	0.011	0.025	0.034	0.599
21	0.082	0.033	0.015	0.021	0.024	0.587
26	0.128	0.035	0.036	0.023	0.027	0.617
27	0.135	0.029	0.023	0.012	0.034	0.617
28	0.104	0.057	0.014	0.016	0.039	0.587
29	0.095	0.041	0.007	0.034	0.031	0.548
129	0.072	0.011	0.011	0.011	0.013	0.617
133	0.063	0.024	0.020	0.010	0.018	0.572
134	0.083	0.024	0.038	0.011	0.030	0.589
135	0.082	0.019	0.017	0.014	0.025	0.588
138	0.081	0.025	0.036	0.007	0.021	0.570
139	0.086	0.023	0.016	0.015	0.028	0.592
145	0.099	0.037	0.032	0.016	0.021	0.564
146	0.081	0.047	0.033	0.006	0.029	0.578
147	0.077	0.037	0.034	0.015	0.031	0.495
148	0.128	0.035	0.008	0.015	0.028	0.617
149	0.123	0.031	0.030	0.022	0.023	0.592
154	0.082	0.043	0.032	0.008	0.025	0.561
155	0.093	0.048	0.039	0.011	0.031	0.571
156	0.128	0.038	0.008	0.009	0.019	0.617
157	0.136	0.032	0.012	0.020	0.027	0.617

Table 4-12
4cm² PD of the selected Beam ids measured on the corresponding surfaces that
are not selected for Δ_{min} determination

Band	Antenna	Beam ID_1	Surface	Input.power.limit (dBm)	Meas.4 c ㎠ cm PD(Mw/㎠)
n261	Module 0	153	Right	4.7	0.275
	Module 1	154	Right	3.1	0.174
n260	Module 0	152	Right	4.8	0.380
	Module 1	157	Right	4.3	0.213

5 PD Char

5.1 Scaling Factor for Single Beams

To determine the input power limit at each antenna port, simulation was performed at low, mid, and high channel for each mmW band supported, with 6 dBm input power per active port for n261 band and 6 dBm input power per active port for n260 band:

1 .Obtained $PD_{surface}$ value (the worst PD among all identified surfaces of the DUT) at all three channels for all single beams specified in the codebook.

2.Derived a scaling factor at low, mid and high channel, $s(i)_{low\ or\ mid\ or\ high}$, by:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)},\ i \in single\ beams \qquad (1)$$

3. Determined the worst-case scaling factor, $s(i)$, among low, mid and high channels:

$$\boldsymbol{s(i)} = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ i \in single\ beams \qquad (2)$$

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

5.2 Scaling Factor for Beam Pairs

Per the manufacturer, the relative phase between beam pair is not controlled in the chipset design and could vary from run to run. Therefore, for each beam pair, based on the simulation results, the worst case scaling factor was determined mathematically to ensure the compliance. The worst-case PD for MIMO operations was found by sweeping the relative phase for all possible angles to ensure a conservative assessment. The power density simulation report contains the worst-case power density for each surface after sweeping through all relative phases between beams.

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{total\ PD\ (\emptyset(i)_{worstcase})},\ i \in beam\ pairs \qquad (3)$$

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

$$\boldsymbol{s(i)} = min\{s_{low}(i), s_{mid}(i), s_{high}(i)\},\ i \in beam\ pairs \qquad (4)$$

5.3 *Input.Power.Limit* Calculations

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 (Δmin) determined in Table 4-7, given by:

For n260 and n261

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big) +\ \Delta_{min},\ i \in all\ beams \qquad (5)$$

where 6 *dBm* is the input power used in simulation for n261 and n260, respectively;s(i) is the scaling factor obtained from Eq. (2) or Eq. (4) for beam *i*; Δmin is the worst- case housing influence factor

If simulation overestimates the housing influence, then Δmin (= 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 Δmin 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. The device design related uncertainty is embedded in the process of [illegible] determination. Since the device uncertainty is already accounted for in *PD_design_target*, it needs to be removed to avoid double counting this uncertainty.

Thus, Equation 5 is modified to:

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

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big),\ i \in all\ beams, \text{ for n260 and n261} \qquad (6)$$

else if Δ_{min} < -TxAGC uncertainty,

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big) +\ (\Delta_{min} + \text{TxAGC uncertainty}),$$
$$i \in all\ beams, \text{ for n260 and n261} \qquad (7)$$

else if Δ_{min} > TxAGC uncertainty,

$$input.power.limit(i) = 6\ dBm + 10 * \log\big(s(i)\big) + (\Delta_{min} - \text{TxAGC uncertainty}),$$
$$i \in all\ beams, \text{ for n260 and n261} \qquad (8)$$

Following above logic, the *input.power.limit* for this DUT can be calculated using Equations (6), (7), and (8), i.e.,

Input.power.limit Calculation

Band	Antenna	Δmin (dB)	TxAGC Uncertainty (dB)	*input.power.limit* *(dBm)*	Notes
n261	Module 0	1.50	0.5	input.power.limit (i)=6dB+10*log(s(i)+1.0	Using Eq. 8
	Module 1	2.85	0.5	input.power.limit (i)=6dB+10*log(s(i)+2.35	Using Eq. 8
n261	Module 0	3.10	0.5	input.power.limit (i)=6dB+10*log(s(i)+2.6	Using Eq. 8
	Module 1	3.04	0.5	input.power.limit (i)=6dB+10*log(s(i)+2.54	Using Eq. 8

Table 5-1 5G NR n261 Module 0 *input.power.limit*

Antenna	Beam ID_1	Beam ID_2	Input.power.limit (dBm)
Module 0	0		8.6
	2		6.0
	3		5.5
	4		5.1
	8		5.6
	9		5.5
	12		2.7
	13		2.9
	14		2.4
	15		2.7
	16		2.0
	22		2.4
	23		3.0
	24		2.4
	25		2.7
	128		9.7
	130		5.7
	131		6.0
	132		7.4
	136		5.8
	137		6.1
	140		2.7
	141		3.6
	142		4.0
	143		4.1
	144		4.0
	150		3.1
	151		4.0
	152		2.5
	153		4.7
	0	128	5.5
	2	130	1.4
	3	131	1.2
	4	132	1.5
	8	136	1.1
	9	137	1.5
	12	140	-1.7
	13	141	-1.6
	14	142	-1.3
	15	143	-1.5
	16	144	-1.0
	22	150	-1.7
	23	151	-1.3
	24	152	-1.4
	25	153	-1.4

Table 5-2 5G NR n261 Module 1 *input.power.limit*

Antenna	Beam ID_1	Beam ID_2	Input.power.limit (dBm)
Module 1	1		11.0
	5		8.5
	6		7.8
	7		7.5
	10		8.3
	11		8.2
	17		5.3
	18		5.6
	19		4.7
	20		4.7
	21		4.6
	26		5.9
	27		5.3
	28		4.5
	29		4.2
	129		8.5
	133		5.3
	134		5.8
	135		5.5
	138		5.3
	139		5.5
	145		2.5
	146		3.3
	147		3.5
	148		4.4
	149		2.4
	154		3.1
	155		3.9
	156		4.0
	157		2.5
	1	129	5.8
	5	133	2.7
	6	134	2.8
	7	135	2.6
	10	138	2.8
	11	139	2.7
	17	145	-0.2
	18	146	0.5
	19	147	0.4
	20	148	-0.1
	21	149	-0.3
	26	154	0.1
	27	155	0.6
	28	156	0.5
	29	157	0.0

Table 5-3 5G NR n260 Module 0 *input.power.limit*

Antenna	Beam ID_1	Beam ID_2	Input.power.limit (dBm)
Module 0	0		9.8
	2		5.8
	3		7.1
	4		6.1
	8		6.5
	9		6.4
	12		3.5
	13		4.0
	14		4.9
	15		4.1
	16		3.5
	22		3.5
	23		4.1
	24		4.6
	25		3.8
	128		9.6
	130		6.0
	131		6.8
	132		5.3
	136		6.4
	137		6.2
	140		3.6
	141		4.0
	142		5.0
	143		4.3
	144		3.6
	150		3.7
	151		4.6
	152		4.8
	153		3.9
	0	128	7.6
	2	130	3.6
	3	131	3.4
	4	132	2.5
	8	136	2.9
	9	137	2.8
	12	140	0.0
	13	141	0.5
	14	142	1.2
	15	143	0.7
	16	144	0.1
	22	150	0.3
	23	151	0.8
	24	152	0.8
	0	153	0.4

Table 5-4 5G NR n260 Module 1 *input.power.limit*

Antenna	Beam ID_1	Beam ID_2	Input.power.limit (dBm)
Module 1	1		10.9
	5		6.5
	6		7.9
	7		6.6
	10		7.3
	11		6.8
	17		3.9
	18		4.7
	19		6.3
	20		5.5
	21		4.0
	26		4.5
	27		4.8
	28		6.2
	29		4.3
	129		10.9
	133		7.1
	134		8.0
	135		6.4
	138		7.4
	139		6.9
	145		3.8
	146		4.8
	147		5.9
	148		4.9
	149		3.9
	154		4.0
	155		5.3
	156		5.6
	157		4.3
	1	129	6.5
	5	133	2.9
	6	134	4.0
	7	135	3.7
	10	138	4.0
	11	139	2.9
	17	145	0.5
	18	146	1.9
	19	147	2.4
	20	148	0.7
	21	149	0.5
	26	154	0.9
	27	155	2.6
	28	156	1.7
	29	157	0.4