

Part-0 Power Density Characterization Report

Report No. : PFBFLF-WTW-P21010278

Applicant : ASUSTeK COMPUTER INC.

Address : 1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan

Product : EXP21 Smartphone

FCC ID : MSQI007D

Brand : ASUS

Model No. : ASUS_I007D

Sample Received Date : Jan. 12, 2021

Lab Address : No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan

Test Location : No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch-Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

Prepared By :



Gina Liu / Specialist

Approved By :



Roy Wu / Senior Manager



FCC Accredited No.: TW0003

This report is for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us. You have 60 days from date of issuance of this report to notify us of any material error or omission caused by our negligence, provided, however, that such notice shall be in writing and shall specifically address the issue you wish to raise. A failure to raise such issue within the prescribed time shall constitute your unqualified acceptance of the completeness of this report, the tests conducted and the correctness of the report contents. Unless specific mention, the uncertainty of measurement has been explicitly taken into account to declare the compliance or non-compliance to the specification.

Table of Contents

Release Control Record	3
1. Description of Equipment Under Test	4
2. Power Density Characterization	6
2.1. Exposure Scenarios in Power Density Evaluation	6
2.2. Power Density Characterization Overview	7
2.3. Codebook for All Supported Beams	8
2.4. Simulation and Modeling Validation	13
2.5. <i>PD_design_target</i>	14
2.6. Worst-case Housing Influence Determination	14
3. PD Characterization of the DUT	22
3.1. Scaling Factor for Single Beams	22
3.2. Scaling Factor for Beam Pairs	22
3.3. <i>input.power.limit</i> Calculation	23
4. Information of the Testing Laboratories	34

Part-0 Power Density Characterization Report

Release Control Record

Report No.	Reason for Change	Date Issued
PFBFLF-WTW-P21010278	Initial release	Apr. 01, 2021

Part-0 Power Density Characterization Report

1. Description of Equipment Under Test

EUT Type	EXP21 Smartphone
FCC ID	MSQI007D
Brand Name	ASUS
Model Name	ASUS_I007D
Tx Frequency Bands (Unit: MHz)	GSM850 : 824.2 ~ 848.8 GSM1900 : 1850.2 ~ 1909.8 WCDMA Band II : 1852.4 ~ 1907.6 WCDMA Band IV : 1712.4 ~ 1752.6 WCDMA Band V : 826.4 ~ 846.6 CDMA BC0 : 824.7 ~ 848.31 CDMA BC1 : 1851.25 ~ 1908.75 CDMA BC10 : 817.9 ~ 823.1 LTE Band 2 : 1850.7 ~ 1909.3 LTE Band 4 : 1710.7 ~ 1754.3 LTE Band 5 : 824.7 ~ 848.3 LTE Band 7 : 2502.5 ~ 2567.5 LTE Band 12 : 699.7 ~ 715.3 LTE Band 13 : 779.5 ~ 784.5 LTE Band 14 : 790.5 ~ 795.5 LTE Band 17 : 706.5 ~ 713.5 LTE Band 25 : 1850.7 ~ 1914.3 LTE Band 26 : 814.7 ~ 848.3 LTE Band 30 : 2307.5 ~ 2312.5 LTE Band 38 : 2572.5 ~ 2617.5 LTE Band 40 : 2302.5 ~ 2397.5 LTE Band 41 : 2498.5 ~ 2687.5 LTE Band 42 : 3552.5 ~ 3597.5 LTE Band 43 : 3652.5 ~ 3672.5 LTE Band 48 : 3552.5 ~ 3697.5 LTE Band 66 : 1710.7 ~ 1779.3 LTE Band 71 : 665.5 ~ 695.5 5G NR n2 : 1852.5 ~ 1907.5 5G NR n5 : 826.5 ~ 846.5 5G NR n7 : 2502.5 ~ 2567.5 5G NR n12 : 701.5 ~ 713.5 5G NR n14 : 790.5 ~ 795.5 5G NR n25 : 1852.5 ~ 1912.5 5G NR n26 : 816.5 ~ 846.5 5G NR n30 : 2307.5 ~ 2312.5 5G NR n38 : 2572.5 ~ 2617.5 5G NR n41 : 2506.02 ~ 2679.99 5G NR n66 : 1712.5 ~ 1777.5 5G NR n71 : 665.5 ~ 695.5 5G NR n77 : 3710.01 ~ 3969.99 5G NR n78 : 3305 ~ 3795 5G NR n258 : 24250 ~ 27500 5G NR n260 : 37000 ~ 40000 5G NR n261 : 27500 ~ 28350 WLAN : 2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5720, 5745 ~ 5825, 5925 ~ 6425, 6425 ~ 6525, 6525 ~ 6875, 6875 ~ 7125 Bluetooth : 2402 ~ 2480

Note:

- The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

Part-0 Power Density Characterization Report

Time-Averaging for 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/LTE/5G NR WWAN is in compliance with FCC requirements. This Part-0 report shows power density characterization of WWAN radios for 5G NR FR2 mm-Wave. The characterization is achieved by determining *input.power.limit* for 5G NR FR2 mm-Wave that corresponds to the exposure design targets after accounting for all device design related uncertainties. The power density characterization is denoted as PD Char 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.

Nomenclature for Part-0 Report

Technology	Term	Description
5G NR FR2 mm-Wave	<i>Input.power.limit</i>	Power level at antenna element for each beam that corresponds to the exposure design target (<i>PD_design_target</i>)
	<i>PD_design_target</i>	Target power density level < FCC PD limit after accounting for all device design related uncertainties
	Δ_{min}	Housing material influence
	<i>PD Char</i>	Table containing <i>input.power.limit</i> for all beams and bands

Part-0 Power Density Characterization Report

2. Power Density Characterization

2.1. Exposure Scenarios in Power Density Evaluation

At frequency > 6 GHz, the total peak spatial averaged power density (psPD) is required to be assessed for all antenna configurations (beams) from all mm-Wave antenna modules installed inside the device. This device has 3 patch antenna arrays (Ant 0, Ant 1 and Ant 2).

As showed in Figure-2.1, the surfaces near-by each mm-Wave antenna module for power density characterization are identified and listed in Table 2-1.

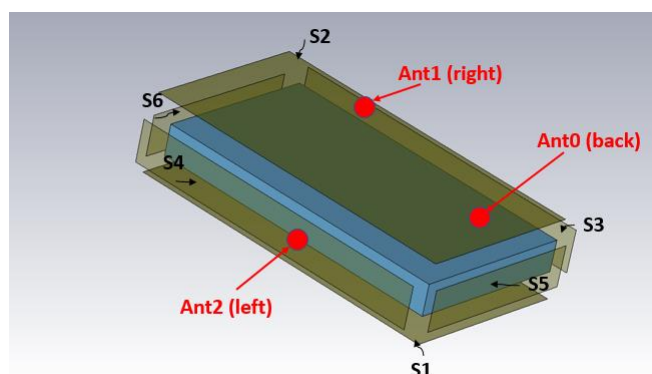


Figure-2.1 Location of mm-Wave antenna modules of the DUT

Band	Antenna	Front	Back	Right	Left	Top	Bottom
5G NR n258	Ant 0 Patch	No	Yes	Yes	Yes	Yes	No
	Ant 1 Patch	Yes	Yes	Yes	No	No	Yes
	Ant 2 Patch	Yes	Yes	No	Yes	Yes	No
5G NR n260	Ant 0 Patch	No	Yes	Yes	Yes	Yes	No
	Ant 1 Patch	Yes	Yes	Yes	No	No	Yes
	Ant 2 Patch	Yes	Yes	No	Yes	Yes	No
5G NR n261	Ant 0 Patch	No	Yes	Yes	Yes	Yes	No
	Ant 1 Patch	Yes	Yes	Yes	No	No	Yes
	Ant 2 Patch	Yes	Yes	No	Yes	Yes	No

Table-2.1 Evaluation surfaces of mm-Wave 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 941225 D06 v02r01 section III and KDB 648474 D04 v01r03. 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.

2.2. Power Density Characterization Overview

The parameters used in power density characterization :

1. The DUT supports total 132 beams for n261 and 144 beams for n258 and n260, where 88 and 96 beams are single beams (SISO), and 44 and 48 are beam pairs (MIMO) where 2 single beams are excited at the same time.
2. **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.
3. **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*.
4. **PD Char** : The table that contains *input.power.limit* fed to antenna port(s) for all supported beams.

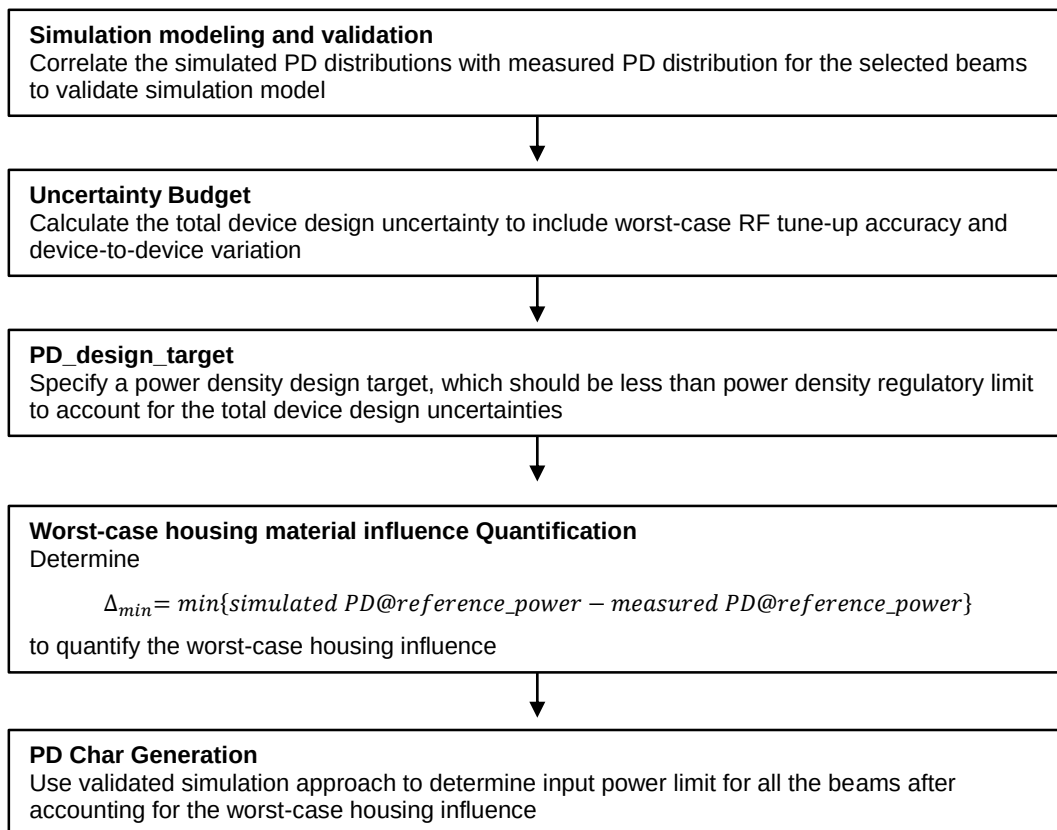


Figure-2.2 Flow chart for power density characterization

Part-0 Power Density Characterization Report

2.3. 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.

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
258	0	PATCH	4	132	1
258	0	PATCH	5	133	1
258	0	PATCH	12	140	2
258	0	PATCH	13	141	2
258	0	PATCH	14	142	2
258	0	PATCH	19	147	2
258	0	PATCH	20	148	2
258	0	PATCH	31	159	4
258	0	PATCH	32	160	4
258	0	PATCH	33	161	4
258	0	PATCH	34	162	4
258	0	PATCH	35	163	4
258	0	PATCH	44	172	4
258	0	PATCH	45	173	4
258	0	PATCH	46	174	4
258	0	PATCH	47	175	4
258	0	PATCH	132	4	1
258	0	PATCH	133	5	1
258	0	PATCH	140	12	2
258	0	PATCH	141	13	2
258	0	PATCH	142	14	2
258	0	PATCH	147	19	2
258	0	PATCH	148	20	2
258	0	PATCH	159	31	4
258	0	PATCH	160	32	4
258	0	PATCH	161	33	4
258	0	PATCH	162	34	4
258	0	PATCH	163	35	4
258	0	PATCH	172	44	4
258	0	PATCH	173	45	4
258	0	PATCH	174	46	4
258	0	PATCH	175	47	4

Table-2.5 Codebook for 5G NR n258 Ant-0

Part-0 Power Density Characterization Report

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
258	1	PATCH	2	130	1
258	1	PATCH	3	131	1
258	1	PATCH	9	137	2
258	1	PATCH	10	138	2
258	1	PATCH	11	139	2
258	1	PATCH	17	145	2
258	1	PATCH	18	146	2
258	1	PATCH	26	154	4
258	1	PATCH	27	155	4
258	1	PATCH	28	156	4
258	1	PATCH	29	157	4
258	1	PATCH	30	158	4
258	1	PATCH	40	168	4
258	1	PATCH	41	169	4
258	1	PATCH	42	170	4
258	1	PATCH	43	171	4
258	1	PATCH	130	2	1
258	1	PATCH	131	3	1
258	1	PATCH	137	9	2
258	1	PATCH	138	10	2
258	1	PATCH	139	11	2
258	1	PATCH	145	17	2
258	1	PATCH	146	18	2
258	1	PATCH	154	26	4
258	1	PATCH	155	27	4
258	1	PATCH	156	28	4
258	1	PATCH	157	29	4
258	1	PATCH	158	30	4
258	1	PATCH	168	40	4
258	1	PATCH	169	41	4
258	1	PATCH	170	42	4
258	1	PATCH	171	43	4

Table-2.6 Codebook for 5G NR n258 Ant-1

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
258	2	PATCH	0	128	1
258	2	PATCH	1	129	1
258	2	PATCH	6	134	2
258	2	PATCH	7	135	2
258	2	PATCH	8	136	2
258	2	PATCH	15	143	2
258	2	PATCH	16	144	2
258	2	PATCH	21	149	4
258	2	PATCH	22	150	4
258	2	PATCH	23	151	4
258	2	PATCH	24	152	4
258	2	PATCH	25	153	4
258	2	PATCH	36	164	4
258	2	PATCH	37	165	4
258	2	PATCH	38	166	4
258	2	PATCH	39	167	4
258	2	PATCH	128	0	1
258	2	PATCH	129	1	1
258	2	PATCH	134	6	2
258	2	PATCH	135	7	2
258	2	PATCH	136	8	2
258	2	PATCH	143	15	2
258	2	PATCH	144	16	2
258	2	PATCH	149	21	4
258	2	PATCH	150	22	4
258	2	PATCH	151	23	4
258	2	PATCH	152	24	4
258	2	PATCH	153	25	4
258	2	PATCH	164	36	4
258	2	PATCH	165	37	4
258	2	PATCH	166	38	4
258	2	PATCH	167	39	4

Table-2.7 Codebook for 5G NR n258 Ant-2

Part-0 Power Density Characterization Report

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
260	0	PATCH	4	132	1
260	0	PATCH	5	133	1
260	0	PATCH	12	140	2
260	0	PATCH	13	141	2
260	0	PATCH	14	142	2
260	0	PATCH	19	147	2
260	0	PATCH	20	148	2
260	0	PATCH	31	159	4
260	0	PATCH	32	160	4
260	0	PATCH	33	161	4
260	0	PATCH	34	162	4
260	0	PATCH	35	163	4
260	0	PATCH	44	172	4
260	0	PATCH	45	173	4
260	0	PATCH	46	174	4
260	0	PATCH	47	175	4
260	0	PATCH	132	4	1
260	0	PATCH	133	5	1
260	0	PATCH	140	12	2
260	0	PATCH	141	13	2
260	0	PATCH	142	14	2
260	0	PATCH	147	19	2
260	0	PATCH	148	20	2
260	0	PATCH	159	31	4
260	0	PATCH	160	32	4
260	0	PATCH	161	33	4
260	0	PATCH	162	34	4
260	0	PATCH	163	35	4
260	0	PATCH	172	44	4
260	0	PATCH	173	45	4
260	0	PATCH	174	46	4
260	0	PATCH	175	47	4

Table-2.8 Codebook for 5G NR n260 Ant-0

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
260	1	PATCH	2	130	1
260	1	PATCH	3	131	1
260	1	PATCH	9	137	2
260	1	PATCH	10	138	2
260	1	PATCH	11	139	2
260	1	PATCH	17	145	2
260	1	PATCH	18	146	2
260	1	PATCH	26	154	4
260	1	PATCH	27	155	4
260	1	PATCH	28	156	4
260	1	PATCH	29	157	4
260	1	PATCH	30	158	4
260	1	PATCH	40	168	4
260	1	PATCH	41	169	4
260	1	PATCH	42	170	4
260	1	PATCH	43	171	4
260	1	PATCH	130	2	1
260	1	PATCH	131	3	1
260	1	PATCH	137	9	2
260	1	PATCH	138	10	2
260	1	PATCH	139	11	2
260	1	PATCH	145	17	2
260	1	PATCH	146	18	2
260	1	PATCH	154	26	4
260	1	PATCH	155	27	4
260	1	PATCH	156	28	4
260	1	PATCH	157	29	4
260	1	PATCH	158	30	4
260	1	PATCH	168	40	4
260	1	PATCH	169	41	4
260	1	PATCH	170	42	4
260	1	PATCH	171	43	4

Table-2.9 Codebook for 5G NR n260 Ant-1

Part-0 Power Density Characterization Report

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
260	2	PATCH	0	128	1
260	2	PATCH	1	129	1
260	2	PATCH	6	134	2
260	2	PATCH	7	135	2
260	2	PATCH	8	136	2
260	2	PATCH	15	143	2
260	2	PATCH	16	144	2
260	2	PATCH	21	149	4
260	2	PATCH	22	150	4
260	2	PATCH	23	151	4
260	2	PATCH	24	152	4
260	2	PATCH	25	153	4
260	2	PATCH	36	164	4
260	2	PATCH	37	165	4
260	2	PATCH	38	166	4
260	2	PATCH	39	167	4
260	2	PATCH	128	0	1
260	2	PATCH	129	1	1
260	2	PATCH	134	6	2
260	2	PATCH	135	7	2
260	2	PATCH	136	8	2
260	2	PATCH	143	15	2
260	2	PATCH	144	16	2
260	2	PATCH	149	21	4
260	2	PATCH	150	22	4
260	2	PATCH	151	23	4
260	2	PATCH	152	24	4
260	2	PATCH	153	25	4
260	2	PATCH	164	36	4
260	2	PATCH	165	37	4
260	2	PATCH	166	38	4
260	2	PATCH	167	39	4

Table-2.10 Codebook for 5G NR n260 Ant-2

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
261	0	PATCH	4	132	1
261	0	PATCH	5	133	1
261	0	PATCH	12	140	2
261	0	PATCH	13	141	2
261	0	PATCH	14	142	2
261	0	PATCH	19	147	2
261	0	PATCH	20	148	2
261	0	PATCH	29	157	4
261	0	PATCH	30	158	4
261	0	PATCH	31	159	4
261	0	PATCH	32	160	4
261	0	PATCH	33	161	4
261	0	PATCH	40	168	4
261	0	PATCH	41	169	4
261	0	PATCH	42	170	4
261	0	PATCH	43	171	4
261	0	PATCH	132	4	1
261	0	PATCH	133	5	1
261	0	PATCH	140	12	2
261	0	PATCH	141	13	2
261	0	PATCH	142	14	2
261	0	PATCH	147	19	2
261	0	PATCH	148	20	2
261	0	PATCH	157	29	4
261	0	PATCH	158	30	4
261	0	PATCH	159	31	4
261	0	PATCH	160	32	4
261	0	PATCH	161	33	4
261	0	PATCH	168	40	4
261	0	PATCH	169	41	4
261	0	PATCH	170	42	4
261	0	PATCH	171	43	4

Table-2.11 Codebook for 5G NR n261 Ant-0

Part-0 Power Density Characterization Report

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
261	1	PATCH	2	130	1
261	1	PATCH	3	131	1
261	1	PATCH	9	137	2
261	1	PATCH	10	138	2
261	1	PATCH	11	139	2
261	1	PATCH	17	145	2
261	1	PATCH	18	146	2
261	1	PATCH	25	153	4
261	1	PATCH	26	154	4
261	1	PATCH	27	155	4
261	1	PATCH	28	156	4
261	1	PATCH	37	165	4
261	1	PATCH	38	166	4
261	1	PATCH	39	167	4
261	1	PATCH	130	2	1
261	1	PATCH	131	3	1
261	1	PATCH	137	9	2
261	1	PATCH	138	10	2
261	1	PATCH	139	11	2
261	1	PATCH	145	17	2
261	1	PATCH	146	18	2
261	1	PATCH	153	25	4
261	1	PATCH	154	26	4
261	1	PATCH	155	27	4
261	1	PATCH	156	28	4
261	1	PATCH	165	37	4
261	1	PATCH	166	38	4
261	1	PATCH	167	39	4

Table-2.12 Codebook for 5G NR n261 Ant-1

Band	Module	Antenna Type	Beam ID	Paired With	Feed no.
261	2	PATCH	0	128	1
261	2	PATCH	1	129	1
261	2	PATCH	6	134	2
261	2	PATCH	7	135	2
261	2	PATCH	8	136	2
261	2	PATCH	15	143	2
261	2	PATCH	16	144	2
261	2	PATCH	21	149	4
261	2	PATCH	22	150	4
261	2	PATCH	23	151	4
261	2	PATCH	24	152	4
261	2	PATCH	34	162	4
261	2	PATCH	35	163	4
261	2	PATCH	36	164	4
261	2	PATCH	128	0	1
261	2	PATCH	129	1	1
261	2	PATCH	134	6	2
261	2	PATCH	135	7	2
261	2	PATCH	136	8	2
261	2	PATCH	143	15	2
261	2	PATCH	144	16	2
261	2	PATCH	149	21	4
261	2	PATCH	150	22	4
261	2	PATCH	151	23	4
261	2	PATCH	152	24	4
261	2	PATCH	162	34	4
261	2	PATCH	163	35	4
261	2	PATCH	164	36	4

Table-2.13 Codebook for 5G NR n261 Ant-2

Part-0 Power Density Characterization Report

2.4. Simulation and Modeling Validation

Power density simulations of all beams and surfaces were performed by the manufacturer. Details of these simulations and modeling validation can be found in the Power Density Simulation Report. 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, power density measurements are conducted for two single beams per antenna module on worst-surface(s). Power density measurements are performed at mid channel of each mm-Wave band and with CW modulation. All measured power density values are listed in table below along with corresponding simulated power density values for the same configuration.

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

Band	Antenna Module	Ant Group	Beam ID	Surface	Simulated PD (W/m ²)	Measured PD (W/m ²)	Delta = Sim. - Mea. (dB)
n258	0	Vertical (AG0)	47	Back Side	16.24	7.39	3.42
		Horizontal (AG1)	175	Back Side	18.09	9.17	2.95
	1	Vertical (AG0)	28	Right Side	15.33	9.97	1.87
		Horizontal (AG1)	170	Right Side	13.45	7.39	2.60
	2	Vertical (AG0)	37	Left Side	14.49	9.78	1.71
		Horizontal (AG1)	165	Left Side	14.03	8.02	2.43
n260	0	Vertical (AG0)	32	Back Side	3.12	3.17	-0.07
		Horizontal (AG1)	161	Back Side	2.42	3.97	-2.15
	1	Vertical (AG0)	30	Right Side	6.02	7.59	-1.01
		Horizontal (AG1)	154	Right Side	8.01	6.97	0.60
	2	Vertical (AG0)	22	Left Side	3.46	7.36	-3.28
		Horizontal (AG1)	153	Left Side	3.04	7.32	-3.82
n261	0	Vertical (AG0)	42	Back Side	12.44	6.32	2.94
		Horizontal (AG1)	157	Back Side	8.64	3.61	3.79
	1	Vertical (AG0)	38	Right Side	10.82	6.61	2.14
		Horizontal (AG1)	166	Right Side	9.29	7.27	1.06
	2	Vertical (AG0)	22	Left Side	6.72	7.34	-0.38
		Horizontal (AG1)	163	Left Side	8.89	8.42	0.24

Part-0 Power Density Characterization Report

2.5. PD design target

The PD_{design_target} is determined by ensuring that it is less than FCC PD limit after accounting for total device designed related uncertainties specified by the manufacturer. The total uncertainties for this device is 2.1 dB. To account for total uncertainty, PD_{design_target} is determined as below.

$$PD_{design_target} < PD_{regulatory\ limit} \times 10^{\frac{-Total\ Uncertainty}{10}}$$

For power density, the $PD_{regulatory\ limit}$ is 1.0 mW/cm², and the PD_{design_target} is 0.6 mW/cm².

2.6. Worst-case Housing Influence Determination

For non-metal material, the material property cannot be accurately characterized at mm-Wave 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 power density amplitude quantification. Since the housing influence on power density 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 mm-Wave 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 DUT, the below procedure was used to determine worst-case housing influence, Δ_{min} :

1. Based on PD simulation, for each module and antenna type, determine one or more worst-surface(s) that has highest 4 cm² 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 4 cm² PD values to *input.power.limit* to identify the worst-PD beam per each non-evaluated surface.
 - ii. Measure 4 cm² PD at *input.power.limit* on identified worst-PD beam per each non-evaluated surface.
 - iii. Demonstrate all measured 4 cm² PD values are below PD_{design_target} .
3. If any of the above surface(s) in step (2.b.iii) have measured 4 cm² PD $\geq PD_{design_target}$, 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.

Part-0 Power Density Characterization Report

Following above procedure, based on Table 3-1 ~ Table 3-4 in PD simulation report, the worst-surface(s) having highest 4 cm² PD for all the single beams per each antenna type and each antenna module group in the mid channel are identified as:

- for Antenna 0 patch : Back (S2)
- for Antenna 1 patch : Right (S3)
- for Antenna 2 patch : Left (S4)

Thus, when comparing a simulated 4 cm²-averaged PD and measured 4 cm²-averaged PD for the identified worst surface(s), the worst error introduced for each antenna type and each antenna module group when using the estimated material property in the simulation is highlighted in bold numbers in below. Thus, the worst-case housing influence, denoted as $\Delta_{min} = \text{Sim. PD} - \text{Meas. PD}$, is determined as:

Band	Antenna Module	Δ_{min} (dB)
n258	0	2.95
	1	1.87
	2	1.71
n260	0	-2.15
	1	-1.01
	2	-3.82
n261	0	2.94
	1	1.06
	2	-0.38

The Δ_{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 Δ_{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 power density characterization for compliance.

The detail *input.power.limit* derivation is described in section 3.3. Simulated 4 cm² PD values in Table 3-1 ~ Table 3-4 in Power Density Simulation Report are scaled to *input.power.limit* and are listed in Table-3.2 ~ Table-3.13 for all single beams for all identified surfaces, when assuming the simulation is performed with correct housing influence.

Part-0 Power Density Characterization Report

Determine the worst beam for each of non-selected surface(s), i.e.,

- for n258 Ant-0 patch : Right & Top
- for n258 Ant-1 patch : Back
- for n258 Ant-2 patch : Back
- for n260 Ant-0 patch : Top
- for n260 Ant-1 patch : Front & Back
- for n260 Ant-2 patch : Front & Back
- for n261 Ant-0 patch : Right & Top
- for n261 Ant-1 patch : Back
- for n261 Ant-2 patch : Front & Back

Then perform PD measurement for all determined worst-case beams, highlighted in orange in Table-2.14 ~ Table-2.25, on the corresponding surface. Measurement is performed in the min channel of each band with CW modulation. The evaluation distance is at 2 mm.

The test result in Table-2.26 shows that the all measured 4 cm² PD values are less than *PD_design_target* of 0.6 mW/cm², thus, the non-selected surfaces have no influence on the determined Δ_{min} and *input.power.limit* in section 3.3.

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
0		4	0.66	4.69	0.22	0.29	0.90	0.02
0		5	0.36	4.65	0.13	0.33	0.64	0.01
0		12	0.45	5.73	0.27	0.67	0.89	0.01
0		13	0.29	5.72	0.03	0.69	0.26	0.01
0		14	0.55	4.04	0.08	0.12	0.84	0.02
0		19	0.39	5.47	0.24	0.59	0.79	0.01
0		20	0.37	5.70	0.09	0.18	0.35	0.01
0		31	0.33	4.34	0.15	1.22	0.85	0.01
0		32	0.29	5.59	0.07	1.12	0.52	0.02
0		33	0.37	4.46	0.11	0.30	0.47	0.02
0		34	0.35	4.90	0.09	0.16	0.55	0.02
0		35	0.35	5.73	0.12	0.13	0.64	0.01
0		44	0.31	4.87	0.11	1.22	0.70	0.01
0		45	0.37	5.55	0.09	0.80	0.46	0.02
0		46	0.36	4.34	0.09	0.18	0.50	0.02
0		47	0.33	5.66	0.10	0.16	0.58	0.02
0	132		0.24	5.56	0.24	0.20	1.54	0.00
0	133		0.26	5.38	0.23	0.28	1.56	0.00
0	140		0.43	5.30	0.48	0.54	1.51	0.01
0	141		0.33	5.33	0.06	0.19	1.79	0.01
0	142		0.26	5.62	0.28	0.21	2.23	0.00
0	147		0.35	5.07	0.22	0.32	1.73	0.01
0	148		0.26	5.69	0.10	0.06	1.95	0.01
0	159		0.36	5.04	0.42	1.33	1.61	0.00
0	160		0.41	5.73	0.07	0.57	2.18	0.00
0	161		0.49	5.71	0.06	0.08	2.33	0.00
0	162		0.31	5.54	0.05	0.05	2.32	0.00
0	163		0.32	5.73	0.34	0.09	2.55	0.00
0	172		0.35	5.30	0.15	1.02	1.81	0.00
0	173		0.47	5.72	0.09	0.32	2.33	0.01
0	174		0.46	5.71	0.03	0.08	2.35	0.00
0	175		0.26	5.58	0.21	0.07	2.32	0.00

Table-2.17 n258/mid channel, Ant-0 simulated 4 cm² PD at *PD_design_target* (if simulation performed with correct housing material properties) Δ_{min}

Part-0 Power Density Characterization Report

Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
1		2	2.01	2.03	0.04	5.44	0.02	0.06
1		3	1.94	2.32	0.03	5.73	0.03	0.10
1		9	1.83	1.50	0.07	5.61	0.06	0.17
1		10	2.23	2.83	0.01	5.74	0.00	0.02
1		11	1.62	2.00	0.03	5.73	0.04	0.41
1		17	2.16	2.50	0.03	5.73	0.03	0.06
1		18	2.13	2.51	0.02	5.73	0.02	0.07
1		26	1.49	2.02	0.08	4.58	0.06	0.20
1		27	2.14	3.17	0.02	5.73	0.01	0.04
1		28	2.04	3.03	0.01	5.72	0.00	0.02
1		29	2.09	2.54	0.03	5.72	0.02	0.33
1		30	1.59	2.18	0.06	4.51	0.09	0.62
1		40	2.21	2.95	0.03	5.73	0.01	0.04
1		41	2.14	3.18	0.02	5.74	0.00	0.02
1		42	2.04	2.90	0.02	5.73	0.01	0.07
1		43	1.70	1.87	0.04	4.94	0.07	0.58
1	130		0.52	3.57	0.04	5.73	0.05	0.20
1	131		0.61	3.25	0.01	5.36	0.03	0.07
1	137		0.76	3.88	0.03	5.73	0.05	0.16
1	138		0.73	4.12	0.02	5.74	0.01	0.06
1	139		0.75	3.70	0.05	5.66	0.10	0.30
1	145		0.75	4.02	0.02	5.73	0.02	0.07
1	146		0.70	4.12	0.04	5.72	0.07	0.22
1	154		1.02	4.22	0.03	5.73	0.05	0.25
1	155		0.90	3.82	0.03	5.49	0.01	0.04
1	156		0.98	3.97	0.02	5.73	0.01	0.03
1	157		0.91	4.12	0.03	5.74	0.04	0.09
1	158		1.11	3.73	0.04	5.72	0.13	0.38
1	168		0.95	4.03	0.02	5.72	0.00	0.05
1	169		0.93	3.72	0.03	5.47	0.01	0.03
1	170		0.93	4.11	0.02	5.72	0.01	0.03
1	171		0.98	3.92	0.03	5.73	0.09	0.22

**Table-2.18 n258/mid channel, Ant-1 simulated 4 cm² PD at *PD_design_target*
(if simulation performed with correct housing material properties) Δ_{min}**

Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
2		0	1.78	2.45	5.58	0.05	0.16	0.03
2		1	2.02	2.48	5.31	0.02	0.14	0.03
2		6	2.03	1.82	5.74	0.04	0.20	0.08
2		7	2.39	2.59	5.73	0.03	0.06	0.01
2		8	1.52	2.93	5.00	0.04	0.35	0.06
2		15	2.50	2.28	5.74	0.03	0.05	0.02
2		16	1.69	2.49	5.73	0.04	0.25	0.09
2		21	1.80	3.21	4.26	0.05	0.40	0.13
2		22	2.23	2.53	5.42	0.02	0.05	0.00
2		23	2.34	2.42	5.44	0.03	0.02	0.01
2		24	2.15	3.27	5.73	0.03	0.11	0.03
2		25	1.62	4.13	5.19	0.06	0.49	0.13
2		36	2.06	2.42	5.08	0.04	0.15	0.03
2		37	2.49	2.48	5.61	0.03	0.01	0.01
2		38	2.39	2.82	5.73	0.03	0.03	0.02
2		39	1.43	4.06	5.48	0.05	0.39	0.08
2	128		0.78	3.09	5.36	0.04	0.06	0.03
2	129		0.74	2.96	5.13	0.03	0.07	0.03
2	134		0.79	3.76	5.64	0.07	0.11	0.06
2	135		0.91	3.87	5.73	0.03	0.04	0.01
2	136		0.77	3.61	5.64	0.07	0.11	0.06
2	143		0.83	3.88	5.73	0.05	0.07	0.03
2	144		0.86	3.72	5.74	0.06	0.12	0.05
2	149		1.30	3.74	5.71	0.07	0.29	0.15
2	150		1.07	4.00	5.73	0.04	0.01	0.01
2	151		1.06	3.79	5.72	0.05	0.02	0.00
2	152		1.04	3.97	5.73	0.04	0.09	0.00
2	153		1.17	3.12	5.26	0.10	0.28	0.15
2	164		1.18	3.97	5.65	0.03	0.17	0.08
2	165		1.06	3.83	5.73	0.04	0.02	0.01
2	166		1.09	3.84	5.73	0.05	0.01	0.02
2	167		1.12	3.62	5.66	0.08	0.27	0.07

**Table-2.19 n258/mid channel, Ant-2 simulated 4 cm² PD at *PD_design_target*
(if simulation performed with correct housing material properties) Δ_{min}**

Part-0 Power Density Characterization Report

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
0		4	0.16	4.03	0.41	0.45	1.10	0.00
0		5	0.16	4.83	0.48	0.97	1.29	0.00
0		12	0.19	5.74	0.12	0.94	1.45	0.00
0		13	0.21	5.35	0.61	1.03	1.75	0.00
0		14	0.06	1.65	0.21	0.27	0.48	0.00
0		19	0.13	5.75	0.26	0.91	1.58	0.00
0		20	0.09	2.17	0.17	0.27	0.57	0.00
0		31	0.12	3.10	0.21	0.60	1.00	0.01
0		32	0.16	5.03	0.37	0.82	1.74	0.02
0		33	0.13	3.99	0.36	0.66	1.03	0.00
0		34	0.20	3.01	0.26	0.42	1.06	0.01
0		35	0.13	3.08	0.27	0.69	1.11	0.01
0		44	0.17	3.72	0.40	0.49	1.39	0.00
0		45	0.14	3.54	0.52	0.68	1.08	0.02
0		46	0.17	3.42	0.30	0.82	1.21	0.01
0		47	0.19	2.99	0.19	0.44	0.96	0.01
0	132		0.14	5.07	0.25	0.18	1.14	0.00
0	133		0.18	5.64	0.18	0.55	1.09	0.00
0	140		0.12	4.63	0.30	0.30	1.04	0.00
0	141		0.18	3.88	0.22	0.44	0.98	0.00
0	142		0.12	4.60	0.29	0.38	1.01	0.00
0	147		0.12	4.91	0.30	0.18	1.18	0.00
0	148		0.11	4.76	0.32	0.43	0.83	0.00
0	159		0.13	4.22	0.32	0.55	0.99	0.00
0	160		0.17	4.07	0.34	0.54	1.12	0.00
0	161		0.19	5.73	0.26	0.57	1.54	0.00
0	162		0.12	4.71	0.33	0.57	0.94	0.00
0	163		0.13	4.26	0.31	0.57	0.94	0.00
0	172		0.12	4.38	0.21	0.77	1.00	0.00
0	173		0.20	4.67	0.35	0.52	1.20	0.00
0	174		0.15	5.20	0.32	0.54	1.27	0.00
0	175		0.13	4.43	0.30	0.63	1.00	0.00

**Table-2.20 n260/mid channel, Ant-0 simulated 4 cm² PD at PD_design_target
(if simulation performed with correct housing material properties) Δ_{min}**

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
1		2	0.85	0.95	0.02	2.81	0.02	0.04
1		3	0.68	0.76	0.02	2.62	0.02	0.06
1		9	1.08	1.21	0.02	3.69	0.02	0.07
1		10	0.99	0.97	0.02	2.89	0.02	0.04
1		11	0.57	0.93	0.01	2.70	0.02	0.02
1		17	0.67	0.87	0.02	2.52	0.02	0.03
1		18	0.81	0.88	0.01	2.50	0.01	0.03
1		26	1.02	1.23	0.01	3.21	0.01	0.08
1		27	1.08	1.27	0.02	3.50	0.07	0.03
1		28	2.33	1.38	0.05	4.75	0.01	0.05
1		29	1.20	1.28	0.02	3.33	0.01	0.09
1		30	0.79	1.39	0.01	3.36	0.04	0.03
1		40	0.86	1.22	0.01	3.19	0.02	0.05
1		41	2.31	1.43	0.05	4.68	0.03	0.02
1		42	1.72	1.32	0.04	3.84	0.02	0.10
1		43	0.90	1.22	0.01	3.18	0.01	0.06
1	130		0.57	2.41	0.00	4.18	0.00	0.07
1	131		0.93	3.04	0.04	5.50	0.02	0.04
1	137		0.53	2.32	0.02	4.65	0.04	0.03
1	138		0.63	2.75	0.02	4.79	0.02	0.03
1	139		0.58	2.46	0.03	4.72	0.04	0.02
1	145		0.66	2.74	0.03	4.83	0.03	0.01
1	146		0.49	2.40	0.02	4.61	0.03	0.03
1	154		0.83	2.90	0.03	4.92	0.02	0.06
1	155		0.81	2.79	0.04	5.20	0.05	0.04
1	156		0.71	2.41	0.04	4.96	0.01	0.02
1	157		0.76	2.54	0.04	4.56	0.04	0.04
1	158		0.88	3.03	0.04	5.15	0.01	0.07
1	168		0.83	2.93	0.03	4.97	0.01	0.07
1	169		0.61	2.53	0.04	5.21	0.04	0.04
1	170		0.72	2.40	0.04	4.53	0.02	0.02
1	171		0.79	2.93	0.03	4.89	0.03	0.08

**Table-2.21 n260/mid channel, Ant-1 simulated 4 cm² PD at PD_design_target
(if simulation performed with correct housing material properties) Δ_{min}**

Part-0 Power Density Characterization Report

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
2		0	0.83	0.80	2.53	0.00	0.03	0.03
2		1	0.70	0.85	2.87	0.02	0.06	0.02
2		6	0.65	0.69	2.09	0.02	0.04	0.02
2		7	1.01	0.86	2.70	0.00	0.07	0.04
2		8	0.39	0.71	2.31	0.02	0.04	0.02
2		15	0.77	0.80	2.57	0.00	0.06	0.03
2		16	0.76	0.86	2.58	0.02	0.02	0.02
2		21	0.52	0.67	2.09	0.02	0.01	0.02
2		22	0.55	0.99	2.62	0.01	0.09	0.01
2		23	0.87	0.76	2.47	0.02	0.11	0.01
2		24	0.52	0.65	2.07	0.02	0.01	0.02
2		25	0.51	0.71	2.16	0.02	0.03	0.02
2		36	0.51	0.71	2.16	0.02	0.03	0.02
2		37	0.67	0.94	2.65	0.01	0.10	0.01
2		38	0.79	0.78	1.99	0.02	0.04	0.03
2		39	0.48	0.64	2.05	0.02	0.01	0.02
2	128		0.57	1.55	2.98	0.00	0.04	0.00
2	129		0.50	1.68	2.73	0.04	0.02	0.00
2	134		0.29	0.96	1.99	0.01	0.01	0.01
2	135		0.33	1.04	1.79	0.01	0.01	0.00
2	136		0.28	0.97	1.99	0.01	0.01	0.01
2	143		0.32	1.07	1.84	0.01	0.01	0.00
2	144		0.32	0.98	1.95	0.01	0.01	0.01
2	149		0.47	1.45	2.54	0.02	0.02	0.01
2	150		0.40	1.31	2.33	0.02	0.01	0.01
2	151		0.41	1.36	2.32	0.02	0.02	0.01
2	152		0.40	1.28	2.21	0.03	0.02	0.01
2	153		0.46	1.38	2.51	0.02	0.01	0.01
2	164		0.43	1.29	2.41	0.02	0.01	0.01
2	165		0.40	1.35	2.37	0.03	0.01	0.01
2	166		0.40	1.27	2.17	0.03	0.01	0.01
2	167		0.39	1.42	2.39	0.03	0.02	0.01

**Table-2.22 n260/mid channel, Ant-2 simulated 4 cm² PD at PD_design_target
(if simulation performed with correct housing material properties) Δ_{min}**

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
0		4	0.04	5.73	0.22	0.31	0.37	0.01
0		5	0.08	5.13	0.15	0.58	0.56	0.01
0		12	0.19	5.04	0.30	1.56	0.58	0.01
0		13	0.12	5.20	0.07	0.47	0.59	0.02
0		14	0.04	5.73	0.22	0.31	0.36	0.01
0		19	0.04	5.73	0.22	0.30	0.39	0.01
0		20	0.07	5.69	0.24	0.56	0.64	0.01
0		29	0.14	4.82	0.53	1.61	0.54	0.01
0		30	0.04	5.32	0.21	1.17	0.38	0.01
0		31	0.10	5.35	0.05	0.34	0.57	0.03
0		32	0.08	5.68	0.16	0.49	0.57	0.01
0		33	0.22	5.67	0.30	1.26	0.79	0.01
0		40	0.07	5.11	0.35	1.33	0.43	0.01
0		41	0.08	5.40	0.05	0.79	0.50	0.02
0		42	0.08	5.47	0.08	0.16	0.55	0.03
0		43	0.16	5.70	0.24	0.89	0.70	0.01
0	132		0.00	4.28	0.00	0.36	1.07	0.00
0	133		0.11	5.71	0.10	0.49	1.72	0.00
0	140		0.07	5.39	0.16	0.20	1.23	0.00
0	141		0.10	5.39	0.12	0.10	1.43	0.00
0	142		0.10	5.59	0.11	0.64	1.58	0.00
0	147		0.08	5.35	0.12	0.10	1.34	0.00
0	148		0.11	5.42	0.16	0.18	1.42	0.00
0	157		0.19	5.39	0.17	0.31	1.94	0.01
0	158		0.12	5.72	0.27	0.86	1.77	0.01
0	159		0.22	5.58	0.15	1.29	1.70	0.01
0	160		0.10	5.72	0.24	0.79	1.96	0.01
0	161		0.09	5.60	0.14	0.70	1.73	0.01
0	168		0.16	5.57	0.23	0.40	1.65	0.01
0	169		0.21	5.62	0.24	1.25	1.87	0.01
0	170		0.18	5.70	0.19	1.02	1.51	0.01
0	171		0.09	5.58	0.18	0.76	1.87	0.01

**Table-2.23 n261/mid channel, Ant-0 simulated 4 cm² PD at PD_design_target
(if simulation performed with correct housing material properties) Δ_{min}**

Part-0 Power Density Characterization Report

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
1		2	1.79	1.76	0.03	5.78	0.03	0.07
1		3	1.91	1.64	0.06	5.69	0.02	0.06
1		9	1.79	1.71	0.03	5.86	0.05	0.12
1		10	2.27	2.43	0.03	5.52	0.00	0.03
1		11	1.61	1.51	0.06	5.65	0.06	0.16
1		17	2.23	2.06	0.05	5.67	0.01	0.04
1		18	1.79	1.76	0.03	5.78	0.03	0.07
1		25	1.76	1.87	0.02	5.85	0.07	0.18
1		26	2.14	2.02	0.03	5.62	0.01	0.05
1		27	2.32	2.29	0.06	5.51	0.01	0.02
1		28	1.88	1.88	0.09	5.48	0.05	0.11
1		37	1.98	1.95	0.03	5.75	0.02	0.11
1		38	2.31	2.44	0.05	5.59	0.01	0.01
1		39	2.13	2.07	0.09	5.40	0.02	0.05
1	130		0.69	3.34	0.05	5.86	0.03	0.06
1	131		0.71	3.27	0.02	5.70	0.02	0.07
1	137		0.78	3.77	0.07	5.72	0.01	0.06
1	138		0.74	3.84	0.04	5.76	0.04	0.07
1	139		0.66	2.89	0.06	5.63	0.08	0.15
1	145		0.78	3.98	0.05	5.79	0.02	0.03
1	146		0.71	3.27	0.02	5.70	0.02	0.07
1	153		0.82	3.94	0.04	5.55	0.02	0.09
1	154		0.90	4.00	0.05	5.80	0.03	0.05
1	155		0.95	3.98	0.04	5.81	0.02	0.04
1	156		0.91	3.60	0.06	5.87	0.08	0.21
1	165		0.83	3.96	0.05	5.53	0.01	0.07
1	166		0.97	4.01	0.03	5.86	0.03	0.03
1	167		0.91	3.90	0.05	5.85	0.04	0.12

**Table-2.24 n261/mid channel, Ant-1 simulated 4 cm² PD at *PD_design_target*
(if simulation performed with correct housing material properties) Δ_{min}**

Part-0 Power Density Characterization Report

Antenna Module	Beam ID 2	Beam ID 1	Front	Back	Left	Right	Top	Bottom
2		0	1.66	1.66	4.79	0.00	0.00	0.00
2		1	1.78	1.54	5.52	0.02	0.09	0.03
2		6	1.63	1.98	5.68	0.03	0.16	0.05
2		7	1.99	1.85	5.42	0.02	0.07	0.03
2		8	2.30	1.57	5.73	0.04	0.06	0.04
2		15	2.06	1.76	5.31	0.02	0.05	0.02
2		16	1.58	1.67	5.60	0.03	0.10	0.03
2		21	1.52	1.95	5.54	0.03	0.15	0.05
2		22	2.66	1.92	5.53	0.02	0.02	0.01
2		23	2.41	2.15	5.50	0.03	0.02	0.02
2		24	1.79	2.19	5.62	0.03	0.09	0.04
2		34	2.21	1.94	5.47	0.03	0.07	0.03
2		35	2.66	1.97	5.52	0.03	0.02	0.01
2		36	2.14	2.27	5.55	0.03	0.04	0.03
2	128		0.61	3.23	5.47	0.04	0.06	0.04
2	129		0.77	3.05	5.74	0.03	0.08	0.03
2	134		0.96	2.98	5.65	0.03	0.15	0.06
2	135		0.95	3.68	5.60	0.03	0.04	0.03
2	136		0.70	2.94	5.49	0.03	0.06	0.03
2	143		0.90	3.72	5.63	0.02	0.03	0.01
2	144		0.83	3.09	5.72	0.04	0.09	0.07
2	149		0.91	3.40	5.49	0.03	0.14	0.05
2	150		1.08	3.86	5.72	0.03	0.01	0.01
2	151		1.01	3.73	5.62	0.04	0.03	0.03
2	152		0.95	3.34	5.68	0.05	0.15	0.11
2	162		1.02	3.65	5.57	0.03	0.05	0.01
2	163		1.07	3.86	5.73	0.03	0.01	0.02
2	164		0.96	3.63	5.70	0.04	0.08	0.06

Table-2.25 n261/mid channel, Ant-2 simulated 4 cm² PD at PD_design_target (if simulation performed with correct housing material properties) Δ_{min}

Band	Antenna	Beam ID	Surface	Tested Power Level (dBm)	input.power.limit (dBm)	Measured 4 cm ² PD (mW/cm ²)
n258	0	44	Right	1.8	1.77	0.049
n258	0	163	Top	1.3	1.21	0.144
n258	1	41	Back	2.0	2.00	0.185
n258	1	154	Back	3.1	3.10	0.170
n258	2	25	Back	4.1	4.02	0.131
n258	2	150	Back	2.2	2.15	0.192
n260	0	13	Top	11.6	11.52	0.231
n260	0	161	Top	9.8	9.74	0.525
n260	1	28	Front	6.0	5.97	0.470
n260	1	131	Back	8.7	8.63	0.245
n260	2	7	Front	11.8	11.74	0.504
n260	2	129	Back	9.4	9.33	0.263
n261	0	29	Right	4.4	4.33	0.069
n261	0	160	Top	5.5	5.41	0.128
n261	1	38	Back	3.2	3.13	0.101
n261	1	166	Back	4.0	4.00	0.392
n261	2	35	Front	5.4	5.39	0.313
n261	2	150	Back	4.2	4.14	0.334

Table-2.26 4 cm² PD of the selected beams measured on the corresponding surfaces that are not selected for Δ_{min} determination

3. PD Characterization of the DUT

3.1. 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 mm-Wave 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 DUT) at all three channels for all single beams specified in the codebook.
2. Derive a scaling factor at low, mid and high channel, $S(i)_{low \text{ or mid or high}}$, by:

$$S(i)_{low \text{ or mid or high}} = \frac{PD \text{ design target}}{sim. PD_{surface}(i)}, i \in \text{single beams} \quad (1)$$

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

$$S(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, i \in \text{single beams} \quad (2)$$

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

For 2nd generation of Smart Transmit, "Qualcomm MG Script" prints the $sim.power_{limit}$ for all three channels, denoted as $sim.power_{limit_L}$, $sim.power_{limit_M}$, and $sim.power_{limit_H}$. The $sim.power_{limit}$ is determined by:

$$sim. power_{limit} = \min\{sim. power_{limit_L}, sim. power_{limit_M}, sim. power_{limit_H}\}$$

3.2. Scaling Factor for Beam Pairs

The relative phase between beam pair is not controlled in the DUT 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.

The worst-case power density 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.

Once the power density was determined for the worst-case $\emptyset$, the scaling factor was obtained by the below equation for low, mid and high channels:

$$S(i)_{low \text{ or mid or high}} = \frac{PD \text{ design target}}{total PD(\phi(i)_{worst-case})}, i \in \text{beam pairs} \quad (3)$$

The $total PD(\emptyset_{worst-case})$ varies with channel and beam pair, the lowest scaling factor among all three channels, $S(i)$, is determined for the beam pair i :

$$S(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, i \in \text{beam pairs} \quad (4)$$

Part-0 Power Density Characterization Report

For 2nd generation of Smart Transmit, “Qualcomm MG Script” prints the $sim.power_{limit}$ for all three channels, denoted as $sim.power_{limit_L}$, $sim.power_{limit_M}$, and $sim.power_{limit_H}$. The $sim.power_{limit}$ is determined by:

$$sim.power_{limit} = \min\{sim.power_{limit_L}, sim.power_{limit_M}, sim.power_{limit_H}\}$$

3.3. input.power.limit Calculation

The power density 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 8, given by:

$$input.power.limit(i) = sim.power_{limit} + 10 * \log(s(i)) + \Delta_{min}, i \in all\ beams \quad (5)$$

Where 6 dBm is the input power used in simulation; $s(i)$ is the scaling factor obtained from Eq. (2) or Eq. (4) from beam i ; Δ_{min} is the worst-case housing influence factor (determined in table 10) from 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. The device design related uncertainty is embedded in the process of Δ_{min} 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 $-TxAGC\ uncertainty < \Delta_{min} < TxAGC\ uncertainty$,

$$input.power.limit(i) = sim.power_{limit}(i), i \in all\ beams \quad (6)$$

else if $\Delta_{min} < -TxAGC\ uncertainty$,

$$input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} + TxAGC\ uncertainty), i \in all\ beams \quad (7)$$

else if $\Delta_{min} > TxAGC\ uncertainty$,

$$input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} - TxAGC\ uncertainty), i \in all\ beams \quad (8)$$

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

Part-0 Power Density Characterization Report

Band	Antenna	Δ_{min} (dB)	TxAGC Uncertainty (dB)	<i>input.power.limit</i> (dBm)	Notes
n258	0 (Patch)	2.95	0.5	$input.power.limit(i) = sim.power_{limit} + 2.45$	Using Eq.8
	1 (Patch)	1.87	0.5	$input.power.limit(i) = sim.power_{limit} + 1.37$	Using Eq.8
	2 (Patch)	1.71	0.5	$input.power.limit(i) = sim.power_{limit} + 1.21$	Using Eq.8
n260	0 (Patch)	-2.15	0.5	$input.power.limit(i) = sim.power_{limit} + -1.65$	Using Eq.7
	1 (Patch)	-1.01	0.5	$input.power.limit(i) = sim.power_{limit} + -0.51$	Using Eq.7
	2 (Patch)	-3.82	0.5	$input.power.limit(i) = sim.power_{limit} + -3.32$	Using Eq.7
n261	0 (Patch)	2.94	0.5	$input.power.limit(i) = sim.power_{limit} + 2.44$	Using Eq.8
	1 (Patch)	1.06	0.5	$input.power.limit(i) = sim.power_{limit} + 0.56$	Using Eq.8
	2 (Patch)	-0.38	0.5	$input.power.limit(i) = sim.power_{limit}$	Using Eq.6

Table-3.1 *input.power.limit* Calculation

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n258	0		4	12.3
n258	0		5	10.0
n258	0		12	9.1
n258	0		13	6.3
n258	0		14	7.5
n258	0		19	8.7
n258	0		20	6.4
n258	0		31	4.5
n258	0		32	4.1
n258	0		33	4.3
n258	0		34	3.8
n258	0		35	4.0
n258	0		44	4.2
n258	0		45	4.3
n258	0		46	3.9
n258	0		47	3.9
n258	0		132	10.0
n258	0		133	9.5
n258	0		140	7.6
n258	0		141	6.1
n258	0		142	6.9
n258	0		147	6.6
n258	0		148	6.3
n258	0		159	5.0
n258	0		160	4.0
n258	0		161	3.9
n258	0		162	3.6
n258	0		163	3.7
n258	0		172	4.3
n258	0		173	3.9
n258	0		174	3.8
n258	0		175	3.2
n258	0	132	4	7.9
n258	0	133	5	6.9
n258	0	140	12	4.9
n258	0	141	13	4.1
n258	0	142	14	3.9
n258	0	147	19	4.2
n258	0	148	20	3.9
n258	0	159	31	1.3
n258	0	160	32	1.2
n258	0	161	33	1.5
n258	0	162	34	0.9
n258	0	163	35	0.7
n258	0	172	44	1.0
n258	0	173	45	1.5
n258	0	174	46	1.3
n258	0	175	47	0.5

Table-3.5 input.power.limit for 5G NR n258 Ant-0

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n258	1		2	10.6
n258	1		3	8.9
n258	1		9	7.8
n258	1		10	6.0
n258	1		11	7.4
n258	1		17	7.0
n258	1		18	6.3
n258	1		26	4.8
n258	1		27	3.4
n258	1		28	3.1
n258	1		29	4.7
n258	1		30	5.3
n258	1		40	4.0
n258	1		41	3.4
n258	1		42	3.4
n258	1		43	5.1
n258	1		130	9.9
n258	1		131	9.0
n258	1		137	6.9
n258	1		138	6.1
n258	1		139	7.5
n258	1		145	6.3
n258	1		146	6.9
n258	1		154	4.5
n258	1		155	3.6
n258	1		156	3.7
n258	1		157	3.7
n258	1		158	4.6
n258	1		168	3.8
n258	1		169	3.7
n258	1		170	3.7
n258	1		171	3.9
n258	1	130	2	6.2
n258	1	131	3	5.9
n258	1	137	9	3.9
n258	1	138	10	2.7
n258	1	139	11	4.8
n258	1	145	17	3.1
n258	1	146	18	3.0
n258	1	154	26	0.9
n258	1	155	27	0.1
n258	1	156	28	0.2
n258	1	157	29	0.5
n258	1	158	30	1.0
n258	1	168	40	0.4
n258	1	169	41	0.3
n258	1	170	42	0.0
n258	1	171	43	0.9

Table-3.6 input.power.limit for 5G NR n258 Ant-1

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n258	2		0	9.2
n258	2		1	9.2
n258	2		6	7.4
n258	2		7	7.0
n258	2		8	7.3
n258	2		15	6.9
n258	2		16	7.7
n258	2		21	4.8
n258	2		22	3.5
n258	2		23	3.1
n258	2		24	4.4
n258	2		25	5.2
n258	2		36	4.7
n258	2		37	3.1
n258	2		38	3.5
n258	2		39	5.3
n258	2		128	8.8
n258	2		129	9.5
n258	2		134	6.7
n258	2		135	5.7
n258	2		136	6.8
n258	2		143	6.0
n258	2		144	6.4
n258	2		149	4.7
n258	2		150	3.4
n258	2		151	3.4
n258	2		152	3.5
n258	2		153	5.2
n258	2		164	3.9
n258	2		165	3.3
n258	2		166	3.4
n258	2		167	4.6
n258	2	128	0	5.7
n258	2	129	1	6.1
n258	2	134	6	3.5
n258	2	135	7	3.0
n258	2	136	8	3.5
n258	2	143	15	2.9
n258	2	144	16	3.3
n258	2	149	21	0.4
n258	2	150	22	0.0
n258	2	151	23	0.1
n258	2	152	24	0.2
n258	2	153	25	0.8
n258	2	164	36	0.3
n258	2	165	37	-0.1
n258	2	166	38	0.1
n258	2	167	39	0.7

Table-3.7 input.power.limit for 5G NR n258 Ant-2

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n260	0		4	10.5
n260	0		5	16.4
n260	0		12	8.2
n260	0		13	9.9
n260	0		14	9.1
n260	0		19	8.5
n260	0		20	6.1
n260	0		31	4.8
n260	0		32	6.4
n260	0		33	6.3
n260	0		34	5.1
n260	0		35	5.0
n260	0		44	5.5
n260	0		45	6.4
n260	0		46	5.3
n260	0		47	5.2
n260	0		132	9.9
n260	0		133	17.0
n260	0		140	9.1
n260	0		141	10.0
n260	0		142	9.0
n260	0		147	9.1
n260	0		148	8.6
n260	0		159	7.6
n260	0		160	7.7
n260	0		161	8.1
n260	0		162	7.4
n260	0		163	7.6
n260	0		172	7.5
n260	0		173	7.7
n260	0		174	7.7
n260	0		175	7.7
n260	0	132	4	6.7
n260	0	133	5	12.4
n260	0	140	12	6.8
n260	0	141	13	6.4
n260	0	142	14	5.6
n260	0	147	19	6.7
n260	0	148	20	3.7
n260	0	159	31	2.6
n260	0	160	32	3.6
n260	0	161	33	3.7
n260	0	162	34	2.8
n260	0	163	35	2.8
n260	0	172	44	2.8
n260	0	173	45	3.5
n260	0	174	46	3.0
n260	0	175	47	2.9

Table-3.8 input.power.limit for 5G NR n260 Ant-0

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n260	1		2	8.2
n260	1		3	8.3
n260	1		9	4.9
n260	1		10	8.4
n260	1		11	4.6
n260	1		17	7.4
n260	1		18	7.2
n260	1		26	3.2
n260	1		27	3.9
n260	1		28	5.5
n260	1		29	3.7
n260	1		30	3.0
n260	1		40	2.8
n260	1		41	5.6
n260	1		42	4.6
n260	1		43	2.9
n260	1		130	14.0
n260	1		131	8.1
n260	1		137	5.5
n260	1		138	5.3
n260	1		139	5.4
n260	1		145	5.2
n260	1		146	5.5
n260	1		154	3.4
n260	1		155	4.3
n260	1		156	3.5
n260	1		157	3.2
n260	1		158	4.0
n260	1		168	3.8
n260	1		169	4.1
n260	1		170	3.1
n260	1		171	3.7
n260	1	130	2	6.5
n260	1	131	3	4.6
n260	1	137	9	3.2
n260	1	138	10	2.9
n260	1	139	11	2.1
n260	1	145	17	2.9
n260	1	146	18	2.8
n260	1	154	26	-0.1
n260	1	155	27	0.4
n260	1	156	28	1.2
n260	1	157	29	0.1
n260	1	158	30	0.1
n260	1	168	40	-0.1
n260	1	169	41	1.0
n260	1	170	42	0.5
n260	1	171	43	-0.1

Table-3.9 input.power.limit for 5G NR n260 Ant-1

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	input.power.limit (dBm)
n260	2		0	8.1
n260	2		1	5.6
n260	2		6	2.8
n260	2		7	8.4
n260	2		8	1.9
n260	2		15	7.8
n260	2		16	3.1
n260	2		21	1.2
n260	2		22	1.5
n260	2		23	2.6
n260	2		24	1.5
n260	2		25	0.8
n260	2		36	0.8
n260	2		37	2.1
n260	2		38	2.5
n260	2		39	1.0
n260	2		128	8.8
n260	2		129	6.0
n260	2		134	3.5
n260	2		135	2.8
n260	2		136	3.5
n260	2		143	3.3
n260	2		144	3.1
n260	2		149	1.9
n260	2		150	1.9
n260	2		151	1.9
n260	2		152	2.3
n260	2		153	1.8
n260	2		164	1.8
n260	2		165	1.9
n260	2		166	2.2
n260	2		167	2.2
n260	2	128	0	4.7
n260	2	129	1	2.5
n260	2	134	6	0.3
n260	2	135	7	1.0
n260	2	136	8	0.7
n260	2	143	15	1.1
n260	2	144	16	0.6
n260	2	149	21	-1.2
n260	2	150	22	-1.0
n260	2	151	23	0.1
n260	2	152	24	-1.6
n260	2	153	25	-1.5
n260	2	164	36	-1.4
n260	2	165	37	-0.6
n260	2	166	38	-0.5
n260	2	167	39	-1.5

Table-3.10 input.power.limit for 5G NR n260 Ant-2

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	<i>input.power.limit</i> (dBm)
n261	0		4	9.5
n261	0		5	9.8
n261	0		12	8.5
n261	0		13	6.8
n261	0		14	9.5
n261	0		19	9.5
n261	0		20	7.1
n261	0		29	6.8
n261	0		30	5.2
n261	0		31	5.0
n261	0		32	5.2
n261	0		33	6.5
n261	0		40	5.9
n261	0		41	4.9
n261	0		42	4.9
n261	0		43	5.9
n261	0		132	24.0
n261	0		133	10.5
n261	0		140	11.1
n261	0		141	10.6
n261	0		142	10.6
n261	0		147	10.7
n261	0		148	10.9
n261	0		157	6.4
n261	0		158	7.5
n261	0		159	7.6
n261	0		160	7.9
n261	0		161	7.0
n261	0		168	6.6
n261	0		169	7.8
n261	0		170	7.5
n261	0		171	7.4
n261	0	132	4	9.1
n261	0	133	5	7.0
n261	0	140	12	7.6
n261	0	141	13	6.2
n261	0	142	14	7.3
n261	0	147	19	7.3
n261	0	148	20	5.9
n261	0	157	29	3.9
n261	0	158	30	3.3
n261	0	159	31	3.1
n261	0	160	32	3.2
n261	0	161	33	3.5
n261	0	168	40	3.7
n261	0	169	41	1.3
n261	0	170	42	3.1
n261	0	171	43	3.3

Table-3.11 *input.power.limit* for 5G NR n261 Ant-0

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	<i>input.power.limit</i> (dBm)
n261	1		2	8.8
n261	1		3	9.5
n261	1		9	6.5
n261	1		10	5.6
n261	1		11	7.4
n261	1		17	6.0
n261	1		18	8.8
n261	1		25	5.3
n261	1		26	4.2
n261	1		27	3.8
n261	1		28	5.6
n261	1		37	4.7
n261	1		38	3.7
n261	1		39	4.6
n261	1		130	8.3
n261	1		131	9.3
n261	1		137	6.6
n261	1		138	6.4
n261	1		139	7.3
n261	1		145	6.4
n261	1		146	9.3
n261	1		153	5.2
n261	1		154	4.7
n261	1		155	4.6
n261	1		156	5.6
n261	1		165	4.8
n261	1		166	4.0
n261	1		167	4.8
n261	1	130	2	5.3
n261	1	131	3	6.0
n261	1	137	9	3.4
n261	1	138	10	2.8
n261	1	139	11	4.8
n261	1	145	17	3.4
n261	1	146	18	6.0
n261	1	153	25	1.8
n261	1	154	26	1.3
n261	1	155	27	0.9
n261	1	156	28	2.4
n261	1	165	37	1.8
n261	1	166	38	0.9
n261	1	167	39	1.4

Table-3.12 *input.power.limit* for 5G NR n261 Ant-1

Part-0 Power Density Characterization Report

Band	Antenna Module	Paired With ID (For Beam Pair)	Beam ID	<i>input.power.limit</i> (dBm)
n261	2		0	18.7
n261	2		1	8.4
n261	2		6	6.3
n261	2		7	8.2
n261	2		8	9.3
n261	2		15	7.8
n261	2		16	8.4
n261	2		21	6.0
n261	2		22	4.3
n261	2		23	5.8
n261	2		24	6.4
n261	2		34	5.6
n261	2		35	5.4
n261	2		36	6.2
n261	2		128	8.7
n261	2		129	7.9
n261	2		134	6.5
n261	2		135	5.4
n261	2		136	10.5
n261	2		143	5.2
n261	2		144	5.9
n261	2		149	4.4
n261	2		150	4.1
n261	2		151	4.2
n261	2		152	5.6
n261	2		162	4.3
n261	2		163	4.0
n261	2		164	5.0
n261	2	128	0	7.8
n261	2	129	1	4.8
n261	2	134	6	2.5
n261	2	135	7	3.1
n261	2	136	8	6.5
n261	2	143	15	3.0
n261	2	144	16	3.6
n261	2	149	21	1.3
n261	2	150	22	1.4
n261	2	151	23	1.4
n261	2	152	24	2.1
n261	2	162	34	1.6
n261	2	163	35	1.4
n261	2	164	36	2.0

Table-3.13 *input.power.limit* for 5G NR n261 Ant-2

Part-0 Power Density Characterization Report

4. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Taiwan Huaya Lab:

Add: No. 19, Huaya 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan

Tel: +886-(0)3-318-3232

Fax: +886-(0)3-211-5834

Taiwan Linkou Lab:

Add: No. 47-2, Baodoucuokeng, Linkou Dist., New Taipei City 244, Taiwan

Tel: +886-(0)2-2605-2180

Fax: +886-(0)2-2605-2943

Taiwan Hsinchu Lab1:

Add: E-2, No. 1, Lixing 1st Rd., East Dist., Hsinchu City 300, Taiwan

Tel: +886-(0)3-666-8565

Fax: +886-(0)3-666-8323

Taiwan Hsinchu Lab2:

Add: No. 49, Ln. 206, Wende Rd., Qionglin Township, Hsinchu County 307, Taiwan

Tel: +886-(0)3-512-0595

Fax: +886-(0)3-512-0568

Taiwan Xindian Lab:

Add: B2F., No. 215, Sec. 3, Beixin Rd., Xindian Dist., New Taipei City 231, Taiwan

Tel: +886-(0)2-8914-5882

Fax: +886-(0)2-8914-5840

Email: service.adt@tw.bureauveritas.com

Web Site: <https://ee.bureauveritas.com.tw/BVInternet/Default>

The road map of all our labs can be found in our web site also.

---END---