Part #0 Power Density Report
Power Density Characterization

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SAMSUNG ELECTRONICS

Power Density Characterization

1. Exposure Scenarios

At frequencies > 6 GHz, the total peak spatial averaged power density (psPD) is required to be assessed for all antenna configurations (beams) from all mmWave antenna modules installed inside the device. This device has a patch antenna arrays (K,M Patch).

As showed in Figure 1 and 2, the surfaces near-by each mmW antenna module for PD characterization are identified and listed in Table 1.

Table 1. Evaluation Surfaces for PD Characterization

Band/Mode	Antenna Module	condition	Back	Front	Top	Bottom	Right	Left
NR n258	K	Closed	Yes	No	No	No	No	No
NR n258	M	Closed	Yes	No	No	No	Yes	No
NR n260	K	Closed	Yes	No	No	No	No	No
NR n260	M	Closed	Yes	No	No	No	Yes	No
NR n261	K	Closed	Yes	No	No	No	No	Yes
NR n261	M	Closed	Yes	No	No	No	Yes	No
NR n258	K	Open	Yes	No	No	No	No	No
NR n258	M	Open	Yes	Yes	No	No	Yes	No
NR n260	K	Open	Yes	No	No	No	No	No
NR n260	M	Open	Yes	Yes	No	No	Yes	No
NR n261	K	Open	Yes	No	No	No	No	No
NR n261	M	Open	Yes	Yes	No	No	Yes	No

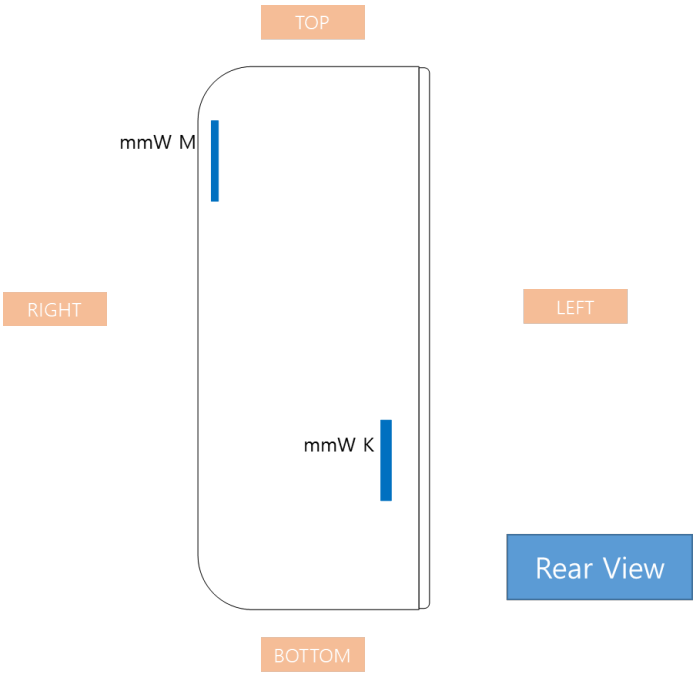


Figure 1: Location of mmW antenna modules looking from back of the DUT - Closed

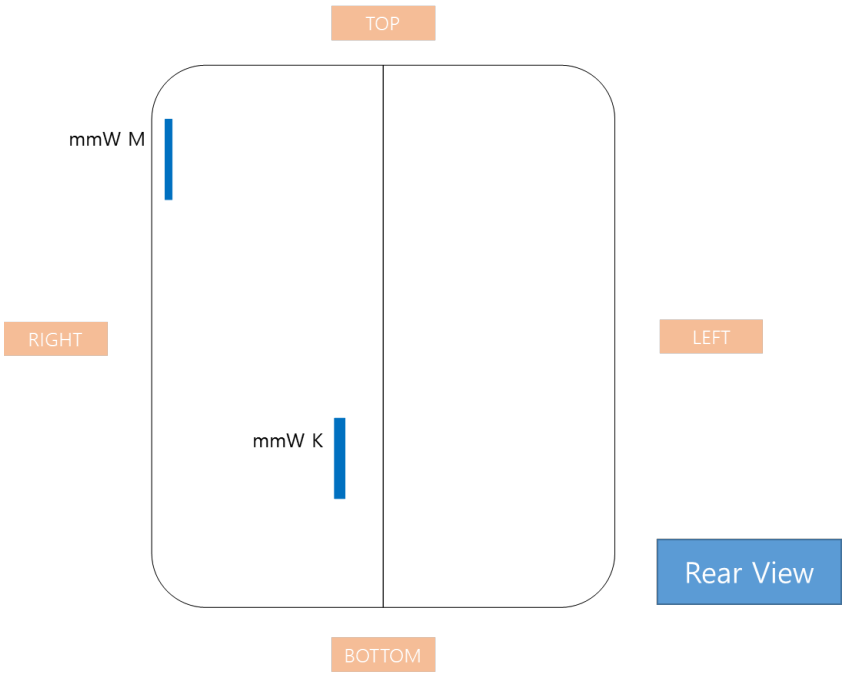
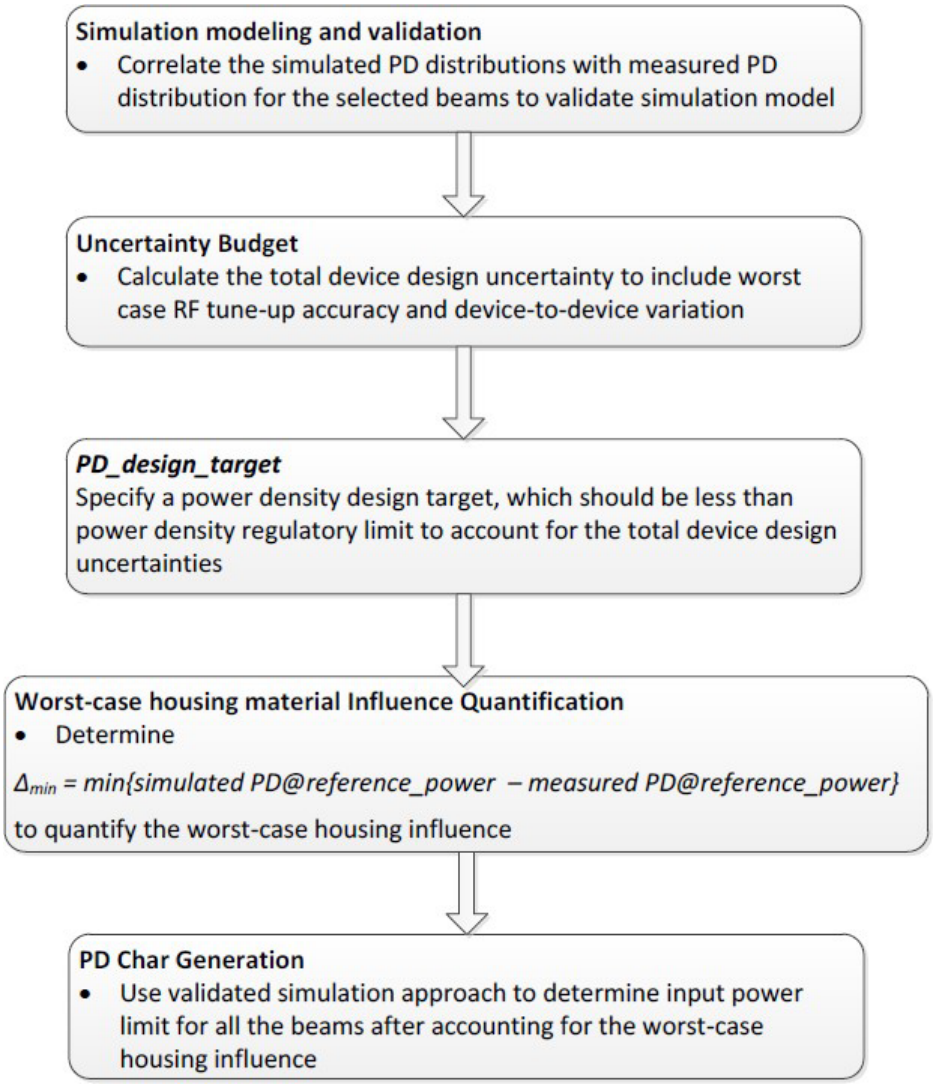


Figure 2: Location of mmW antenna modules looking from back of the DUT – Open

2. Power Density Characterization Method



3. Codebook for all supported beams

Table 2. 5G mmW NR Band n258 Ant K/M Codebook

Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.
n258	K	Patch	0		1	n258	M	Patch	1		1
			2		1				3		1
			4		1				5		1
			6		1				7		1
			8		1				9		1
			10		2				14		2
			11		2				15		2
			12		2				16		2
			13		2				17		2
			18		2				21		2
			19		2				22		2
			20		2				23		2
			24		5				29		5
			25		5				30		5
			26		5				31		5
			27		5				32		5
			28		5				33		5
			34		5				38		5
			35		5				39		5
			36		5				40		5
			37		5				41		5
			128		1				129		1
			130		1				131		1
			132		1				133		1
			134		1				135		1
			136		1				137		1
			138		2				142		2
			139		2				143		2
			140		2				144		2
			141		2				145		2
			146		2				149		2
			147		2				150		2
			148		2				151		2
			152		5				157		5
			153		5				158		5
			154		5				159		5
			155		5				160		5
			156		5				161		5
			162		5				166		5
			163		5				167		5
			164		5				168		5
			165		5				169		5
			0	128	2				1	129	2
			2	130	2				3	131	2
			4	132	2				5	133	2
			6	134	2				7	135	2
			8	136	2				9	137	2
			10	138	4				14	142	4
			11	139	4				15	143	4
			12	140	4				16	144	4
			13	141	4				17	145	4
			18	146	4				21	149	4
			19	147	4				22	150	4
			20	148	4				23	151	4
			24	152	10				29	157	10
			25	153	10				30	158	10
			26	154	10				31	159	10
			27	155	10				32	160	10
			28	156	10				33	161	10
			34	162	10				38	166	10
			35	163	10				39	167	10
			36	164	10				40	168	10
			37	165	10				41	169	10

Table 3. 5G mmW NR Band n260 Ant K/M Codebook

Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.	Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.
n260	K	Patch	0		1	n260	M	Patch	1		1
			2		1				3		1
			4		1				5		1
			6		1				7		1
			8		1				9		1
			10		2				14		2
			11		2				15		2
			12		2				16		2
			13		2				17		2
			18		2				21		2
			19		2				22		2
			20		2				23		2
			24		5				29		5
			25		5				30		5
			26		5				31		5
			27		5				32		5
			28		5				33		5
			34		5				38		5
			35		5				39		5
			36		5				40		5
			37		5				41		5
			128		1				129		1
			130		1				131		1
			132		1				133		1
			134		1				135		1
			136		1				137		1
			138		2				142		2
			139		2				143		2
			140		2				144		2
			141		2				145		2
			146		2				149		2
			147		2				150		2
			148		2				151		2
			152		5				157		5
			153		5				158		5
			154		5				159		5
			155		5				160		5
			156		5				161		5
			162		5				166		5
			163		5				167		5
			164		5				168		5
			165		5				169		5
			0	128	2				1	129	2
			2	130	2				3	131	2
			4	132	2				5	133	2
			6	134	2				7	135	2
			8	136	2				9	137	2
			10	138	4				14	142	4
			11	139	4				15	143	4
			12	140	4				16	144	4
			13	141	4				17	145	4
			18	146	4				21	149	4
			19	147	4				22	150	4
			20	148	4				23	151	4
			24	152	10				29	157	10
			25	153	10				30	158	10
			26	154	10				31	159	10
			27	155	10				32	160	10
			28	156	10				33	161	10
			34	162	10				38	166	10
			35	163	10				39	167	10
			36	164	10				40	168	10
			37	165	10				41	169	10

Table 4. 5G mmW NR Band n261 Ant K/M Codebook

Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.
n261	K	Patch	0		1
			2		1
			4		1
			6		1
			8		1
			10		2
			11		2
			12		2
			13		2
			18		2
			19		2
			20		2
			24		5
			25		5
			26		5
			27		5
			28		5
			34		5
			35		5
			36		5
			37		5
			128		1
			130		1
			132		1
			134		1
			136		1
			138		2
			139		2
			140		2
			141		2
			146		2
			147		2
			148		2
			152		5
			153		5
			154		5
			155		5
			156		5
			162		5
			163		5
			164		5
			165		5
			0	128	2
			2	130	2
			4	132	2
			6	134	2
			8	136	2
			10	138	4
			11	139	4
			12	140	4
			13	141	4
			18	146	4
			19	147	4
			20	148	4
			24	152	10
			25	153	10
			26	154	10
			27	155	10
			28	156	10
			34	162	10
			35	163	10
			36	164	10
			37	165	10

Band	Module	Type(P or D)	Beam ID_1	Bema ID_2	Feed no.
n261	M	Patch	1		1
			3		1
			5		1
			7		1
			9		1
			14		2
			15		2
			16		2
			17		2
			21		2
			22		2
			23		2
			29		5
			30		5
			31		5
			32		5
			33		5
			38		5
			39		5
			40		5
			41		5
			129		1
			131		1
			133		1
			135		1
			137		1
			142		2
			143		2
			144		2
			145		2
			149		2
			150		2
			151		2
			157		5
			158		5
			159		5
			160		5
			161		5
			166		5
			167		5
			168		5
			169		5
			1	129	2
			3	131	2
			5	133	2
			7	135	2
			9	137	2
			14	142	4
			15	143	4
			16	144	4
			17	145	4
			21	149	4
			22	150	4
			23	151	4
			29	157	10
			30	158	10
			31	159	10
			32	160	10
			33	161	10
			38	166	10
			39	167	10
			40	168	10
			41	169	10

4. Simulation and Modeling Validation

Power density simulations of all beams and surfaces were performed. 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 18 dBm for n261 band and 18 dBm for n260 band, PD measurements are conducted for at least one single beam per antenna module (L) on worst-surface(s). PD measurements are performed at mid cannel 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.

Table 5. Simulated and Measure PD

Condition	Band	Channel	Module	Side	Beam ID	Sim. PD (mW/cm2)	Meas. PD (mW/cm2)	Delta=Sim. - Meas. (dB)
Folder Closed	n261	Mid Ch. 2077915 (27924.96 MHz)	K	Rear	26	1.06	0.682	1.93
					165	2.12	1.65	**1.08**
			M	Right	41	1.17	0.572	**3.12**
				Rear		0.92	0.253	5.61
				Right	166	2.06	0.642	5.06
				Rear		1.38	0.609	3.55
	n260	Mid Ch. 2254165 (38499.96 MHz)	K	Rear	34	1.00	0.623	2.06
					154	0.87	0.721	**0.82**
			M	Right	31	1.95	0.708	4.40
				Rear	40	1.25	0.403	4.92
				Right	160	1.85	0.832	**3.46**
	n258	Mid Ch. 2025833 (24800.04 MHz)	K	Left	26	0.46	0.306	1.78
				Rear	26	0.87	0.686	1.03
					165	1.75	1.51	**0.65**
			M	Right	29	1.10	0.631	**2.40**
					169	2.31	0.519	6.48
				Rear	169	1.91	0.653	4.66
Condition	**Band**	**Channel**	**Module**	**Side**	**Beam ID**	**Sim. PD (mW/cm2)**	**Meas. PD (mW/cm2)**	**Delta=Sim. - Meas. (dB)**
Folder Open	n261	Mid Ch. 2077915 (27924.96 MHz)	K	Rear	26	1.03	0.582	2.48
					165	2.16	1.48	**1.64**
			M	Front	31	0.92	0.61	1.78
				Right	33	1.31	0.523	3.99
				Right	159	1.02	0.718	**1.51**
				Rear	169	1.41	0.923	1.84
	n260	Mid Ch. 2254165 (38499.96 MHz)	K	Rear	34	1.00	0.683	1.66
					154	0.86	0.676	**1.03**
			M	Rear	38	0.75	0.295	4.05
				Right	39	1.46	0.745	**2.91**
				Front		0.77	0.241	5.04
				Right	160	1.75	0.851	3.13
				Front		0.91	0.241	5.77
				Rear		0.89	0.303	4.68
	n258	Mid Ch. 2025833 (24800.04 MHz)	K	Rear	34	0.76	0.522	1.63
					165	1.79	1.36	**1.19**
			M	Rear	39	0.75	0.329	3.58
				Front	40	0.88	0.492	2.53
				Right	41	1.14	0.965	**0.73**
				Rear	169	1.21	0.649	2.71
				Right		1.04	0.411	4.03

5. PD design target

Table 6. PD design target

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	2.0 dB
PD_regulatory_limit	1.0 mW/cm²
PD_design_target	0.631 mW/cm²

6. 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 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 locations, 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 4cm² PD for all the single beams per antenna module and per antenna type in the mid cannel of each band.

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

   a. First determine 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 4cm² PD at input.power.limit to identify the worst-PD beam per each non-evaluated surface

      ii. Measure 4cm2 PD at input.power.limit on identified worst-PD beam per each

non-evaluated surface

iii. Demonstrated all measured 4cam2 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 min determination in Step(2.a), and re-evaluate input.power.limit with these added surfaces.

Following above procedure, based on Samsung PD simulation report, the worst- surface(s) having highest 4 cm^2 PD for all the single beams per each antenna type and each antenna module group in the mid cannel of n258, n260 and n261 bands are identified as in following table :

Table 7. Worst-surface(s) for ANT K, ANT M

Band/Mode	Antenna Module	condition	Back (S2)	Front (S1)	Top (S5)	Bottom (S6)	Right(S4)	Left (S3)
NR n258	K	Closed	Yes	No	No	No	No	No
NR n258	M	Closed	Yes	No	No	No	Yes	No
NR n260	K	Closed	Yes	No	No	No	No	No
NR n260	M	Closed	Yes	No	No	No	Yes	No
NR n261	K	Closed	Yes	No	No	No	No	Yes
NR n261	M	Closed	Yes	No	No	No	Yes	No
NR n258	K	Open	Yes	No	No	No	No	No
NR n258	M	Open	Yes	Yes	No	No	Yes	No
NR n260	K	Open	Yes	No	No	No	No	No
NR n260	M	Open	Yes	Yes	No	No	Yes	No
NR n261	K	Open	Yes	No	No	No	No	No
NR n261	M	Open	Yes	Yes	No	No	Yes	No

Thus, when comparing a simulated 4cm2--averaged PD and measured 4cm2-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 Table 8. Thus, the worst-case housing influence, denoted as $\Delta min = Sim.\ PD - Meas.\ PD$, is determined as

Table 8. Δmin for Ant K, Ant M

Condition	Band	Antenna	Δmin (dB)
Folder Closed	NR n258	K	0.65
	NR n258	M	2.40
	NR n260	K	0.82
	NR n260	M	3.46
	NR n261	K	1.08
	NR n261	M	3.12
Condition	**Band**	**Antenna**	**Δmin (dB)**
Folder Open	NR n258	K	1.19
	NR n258	M	0.73
	NR n260	K	1.03
	NR n260	M	2.91
	NR n261	K	1.64
	NR n261	M	1.51

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 7.

Simulated 4cm2 PD values in Power Density Simulation Report are scaled to input.power.limit and are listed in Tables blow for all single beams for all identified surfaces, when assuming the simulation is performed with correct housing influence.

Determine the worst beam for each of non-selected surface(s), identified in the table bleow:

Table 9. Non-Selected Surface(s) for Ant K, Ant M

Band/Mode	Antenna Module	condition	Back (S2)	Front (S1)	Top (S5)	Bottom (S6)	Right(S4)	Left (S3)
NR n258	K	Closed	No	Yes	No	No	No	No
NR n258	M	Closed	No	Yes	Yes	No	No	No
NR n260	K	Closed	No	Yes	No	No	No	Yes
NR n260	M	Closed	No	Yes	Yes	No	No	No
NR n261	K	Closed	No	Yes	No	No	No	Yes
NR n261	M	Closed	No	Yes	Yes	No	No	No
NR n258	K	Open	No	Yes	No	No	No	No
NR n258	M	Open	No	No	Yes	No	No	No
NR n260	K	Open	No	Yes	No	No	No	No
NR n260	M	Open	No	No	Yes	No	No	No
NR n261	K	Open	No	Yes	No	No	No	No
NR n261	M	Open	No	No	Yes	No	No	No

Then perform PD measurement for all determined worst-case beam, highlighted in orange in the tables blow, on the corresponding surface. Measurement is performed in the mid channel of each band with CW modulation. The evaluation distance is at 2mm.

Table 10. n258/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.011	0.057	0.002	0.027	0.004	0.155
K	2	0.011	0.049	0.004	0.016	0.003	0.146
K	4	0.013	0.043	0.007	0.012	0.003	0.133
K	6	0.010	0.045	0.003	0.012	0.003	0.149
K	8	0.013	0.047	0.004	0.009	0.003	0.136
K	10	0.015	0.042	0.014	0.039	0.004	0.199
K	11	0.021	0.131	0.004	0.043	0.008	0.310
K	12	0.023	0.117	0.009	0.008	0.008	0.330
K	13	0.013	0.072	0.007	0.069	0.007	0.267
K	18	0.021	0.131	0.004	0.043	0.008	0.310
K	19	0.025	0.156	0.004	0.013	0.008	0.302
K	20	0.016	0.068	0.010	0.025	0.004	0.240
K	24	0.044	0.251	0.009	0.134	0.019	0.623
K	25	0.041	0.305	0.009	0.078	0.013	0.634
K	26	0.086	0.461	0.005	0.037	0.039	0.868
K	27	0.080	0.269	0.014	0.029	0.021	0.736
K	28	0.051	0.177	0.037	0.043	0.012	0.530
K	34	0.029	0.218	0.024	0.251	0.026	0.721
K	35	0.058	0.393	0.007	0.054	0.028	0.723
K	36	0.074	0.426	0.006	0.023	0.034	0.867
K	37	0.049	0.173	0.015	0.076	0.011	0.511
K	128	0.003	0.041	0.002	0.017	0.001	0.202
K	130	0.003	0.057	0.002	0.022	0.002	0.250
K	132	0.002	0.060	0.002	0.016	0.001	0.260
K	134	0.001	0.078	0.003	0.010	0.001	0.246
K	136	0.004	0.046	0.003	0.004	0.002	0.171
K	138	0.006	0.129	0.004	0.071	0.006	0.448
K	139	0.004	0.180	0.002	0.038	0.003	0.507
K	140	0.004	0.166	0.003	0.006	0.002	0.568
K	141	0.007	0.083	0.006	0.049	0.003	0.416
K	146	0.008	0.101	0.003	0.061	0.005	0.465
K	147	0.003	0.171	0.001	0.024	0.002	0.549
K	148	0.006	0.149	0.008	0.023	0.003	0.598
K	152	0.024	0.326	0.004	0.168	0.016	1.225
K	153	0.022	0.364	0.002	0.152	0.011	1.259
K	154	0.012	0.639	0.003	0.025	0.004	1.183
K	155	0.008	0.646	0.001	0.012	0.010	1.421
K	156	0.023	0.454	0.028	0.013	0.017	1.711
K	162	0.023	0.320	0.003	0.169	0.016	1.198
K	163	0.021	0.523	0.004	0.036	0.005	1.105
K	164	0.009	0.684	0.001	0.015	0.004	1.283
K	165	0.016	0.592	0.013	0.011	0.016	1.754

Table 11. n258/mid channel, M Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.173	0.002	0.007	0.003	0.048	0.113
M	3	0.158	0.001	0.014	0.002	0.026	0.047
M	5	0.171	0.002	0.024	0.002	0.034	0.051
M	7	0.170	0.002	0.029	0.002	0.035	0.077
M	9	0.158	0.002	0.053	0.003	0.029	0.067
M	14	0.399	0.004	0.024	0.007	0.099	0.164
M	15	0.375	0.003	0.013	0.003	0.097	0.180
M	16	0.280	0.003	0.018	0.003	0.075	0.159
M	17	0.380	0.005	0.122	0.004	0.087	0.132
M	21	0.411	0.003	0.017	0.005	0.103	0.178
M	22	0.318	0.003	0.014	0.002	0.088	0.169
M	23	0.393	0.006	0.109	0.004	0.091	0.151
M	29	1.096	0.011	0.081	0.017	0.262	0.389
M	30	0.935	0.012	0.030	0.006	0.377	0.356
M	31	0.747	0.015	0.049	0.007	0.282	0.419
M	32	0.684	0.014	0.099	0.009	0.300	0.284
M	33	0.896	0.007	0.266	0.006	0.306	0.203
M	38	1.070	0.011	0.048	0.015	0.293	0.378
M	39	0.838	0.015	0.032	0.007	0.314	0.447
M	40	0.701	0.017	0.068	0.007	0.307	0.369
M	41	0.761	0.011	0.187	0.008	0.306	0.248
M	129	0.311	0.002	0.033	0.002	0.019	0.214
M	131	0.402	0.001	0.033	0.004	0.014	0.240
M	133	0.362	0.002	0.030	0.003	0.013	0.252
M	135	0.362	0.002	0.040	0.002	0.015	0.257
M	137	0.290	0.002	0.061	0.002	0.016	0.212
M	142	0.952	0.003	0.014	0.009	0.042	0.660
M	143	0.917	0.004	0.021	0.006	0.039	0.654
M	144	0.846	0.003	0.079	0.002	0.050	0.567
M	145	0.606	0.006	0.182	0.003	0.043	0.485
M	149	0.794	0.004	0.038	0.004	0.041	0.597
M	150	0.911	0.004	0.082	0.001	0.047	0.697
M	151	0.649	0.004	0.117	0.006	0.031	0.460
M	157	2.310	0.006	0.090	0.032	0.122	1.653
M	158	2.083	0.013	0.063	0.003	0.147	1.635
M	159	1.840	0.016	0.064	0.004	0.156	1.479
M	160	2.299	0.010	0.516	0.002	0.186	1.874
M	161	2.140	0.009	0.792	0.008	0.147	1.765
M	166	2.143	0.008	0.088	0.013	0.133	1.575
M	167	1.817	0.014	0.059	0.004	0.149	1.498
M	168	2.054	0.013	0.179	0.002	0.170	1.641
M	169	2.311	0.010	0.609	0.003	0.180	1.908

Table 12. n260/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.004	0.036	0.001	0.009	0.001	0.151
K	2	0.003	0.037	0.001	0.014	0.002	0.159
K	4	0.004	0.037	0.001	0.015	0.002	0.184
K	6	0.004	0.039	0.001	0.008	0.002	0.144
K	8	0.003	0.031	0.001	0.008	0.001	0.164
K	10	0.009	0.102	0.003	0.029	0.003	0.368
K	11	0.011	0.115	0.002	0.024	0.005	0.362
K	12	0.007	0.064	0.001	0.026	0.002	0.238
K	13	0.011	0.082	0.004	0.053	0.004	0.370
K	18	0.009	0.088	0.002	0.025	0.003	0.365
K	19	0.011	0.088	0.000	0.014	0.004	0.270
K	20	0.007	0.062	0.002	0.030	0.003	0.278
K	24	0.039	0.258	0.011	0.156	0.013	0.961
K	25	0.037	0.329	0.002	0.007	0.016	0.852
K	26	0.030	0.214	0.003	0.016	0.006	0.626
K	27	0.017	0.136	0.002	0.064	0.007	0.374
K	28	0.037	0.222	0.005	0.046	0.005	0.789
K	34	0.034	0.303	0.008	0.094	0.012	0.998
K	35	0.033	0.286	0.003	0.011	0.013	0.776
K	36	0.015	0.158	0.002	0.043	0.006	0.417
K	37	0.036	0.186	0.001	0.042	0.004	0.636
K	128	0.004	0.026	0.001	0.010	0.001	0.151
K	130	0.003	0.031	0.001	0.006	0.001	0.161
K	132	0.005	0.025	0.001	0.006	0.001	0.157
K	134	0.004	0.030	0.001	0.004	0.001	0.145
K	136	0.002	0.023	0.001	0.004	0.001	0.129
K	138	0.013	0.043	0.003	0.017	0.002	0.237
K	139	0.009	0.084	0.001	0.011	0.003	0.360
K	140	0.008	0.084	0.002	0.011	0.002	0.345
K	141	0.009	0.052	0.002	0.021	0.002	0.255
K	146	0.009	0.072	0.002	0.007	0.002	0.288
K	147	0.010	0.086	0.001	0.012	0.002	0.369
K	148	0.007	0.048	0.002	0.012	0.001	0.236
K	152	0.030	0.079	0.011	0.079	0.005	0.491
K	153	0.022	0.144	0.004	0.017	0.007	0.587
K	154	0.038	0.256	0.003	0.021	0.010	0.871
K	155	0.021	0.197	0.002	0.035	0.004	0.751
K	156	0.034	0.188	0.003	0.032	0.010	0.609
K	162	0.025	0.117	0.008	0.042	0.006	0.552
K	163	0.030	0.201	0.004	0.013	0.005	0.720
K	164	0.031	0.237	0.006	0.027	0.006	0.822
K	165	0.020	0.156	0.002	0.038	0.007	0.601

Table 13. n260/mid channel, M Patch simulated 4cm^2 PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.281	0.001	0.030	0.001	0.024	0.161
M	3	0.399	0.001	0.025	0.002	0.051	0.205
M	5	0.427	0.001	0.052	0.001	0.049	0.240
M	7	0.413	0.001	0.064	0.001	0.045	0.222
M	9	0.386	0.001	0.064	0.001	0.052	0.203
M	14	0.785	0.002	0.219	0.003	0.071	0.353
M	15	0.696	0.001	0.076	0.005	0.090	0.405
M	16	0.782	0.003	0.061	0.001	0.136	0.501
M	17	0.698	0.002	0.089	0.003	0.045	0.312
M	21	0.835	0.002	0.172	0.003	0.112	0.442
M	22	0.623	0.001	0.025	0.004	0.104	0.420
M	23	0.764	0.003	0.165	0.001	0.088	0.402
M	29	1.810	0.006	0.715	0.013	0.205	0.978
M	30	1.634	0.005	0.384	0.012	0.271	1.127
M	31	1.952	0.005	0.063	0.003	0.425	1.240
M	32	1.756	0.007	0.093	0.002	0.291	1.177
M	33	1.364	0.005	0.593	0.004	0.114	0.711
M	38	1.843	0.007	0.652	0.014	0.245	1.099
M	39	1.751	0.005	0.160	0.006	0.339	1.141
M	40	1.841	0.005	0.106	0.001	0.350	1.251
M	41	1.238	0.007	0.346	0.002	0.142	0.844
M	129	0.249	0.001	0.016	0.001	0.045	0.047
M	131	0.330	0.001	0.016	0.002	0.073	0.081
M	133	0.426	0.002	0.033	0.001	0.087	0.090
M	135	0.385	0.002	0.042	0.002	0.090	0.062
M	137	0.408	0.001	0.050	0.001	0.092	0.087
M	142	0.737	0.003	0.087	0.005	0.133	0.132
M	143	0.748	0.003	0.104	0.005	0.209	0.158
M	144	0.752	0.002	0.036	0.001	0.228	0.250
M	145	0.578	0.002	0.051	0.004	0.085	0.111
M	149	0.748	0.002	0.134	0.006	0.151	0.152
M	150	0.758	0.004	0.053	0.002	0.239	0.175
M	151	0.841	0.003	0.140	0.005	0.212	0.142
M	157	1.357	0.005	0.403	0.011	0.356	0.349
M	158	1.476	0.008	0.417	0.008	0.528	0.331
M	159	1.449	0.008	0.115	0.003	0.502	0.394
M	160	1.847	0.007	0.071	0.002	0.699	0.496
M	161	1.308	0.004	0.460	0.016	0.287	0.380
M	166	1.366	0.004	0.474	0.021	0.286	0.360
M	167	1.701	0.008	0.117	0.005	0.569	0.537
M	168	1.556	0.009	0.109	0.003	0.558	0.454
M	169	1.490	0.007	0.178	0.003	0.569	0.289

Table 14. n261/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.007	0.058	0.001	0.020	0.003	0.160
K	2	0.010	0.045	0.001	0.014	0.002	0.179
K	4	0.010	0.042	0.002	0.013	0.002	0.158
K	6	0.008	0.042	0.002	0.007	0.003	0.202
K	8	0.010	0.055	0.003	0.004	0.003	0.114
K	10	0.013	0.079	0.004	0.035	0.003	0.343
K	11	0.026	0.135	0.002	0.019	0.007	0.451
K	12	0.024	0.136	0.003	0.009	0.010	0.384
K	13	0.012	0.067	0.006	0.022	0.004	0.294
K	18	0.015	0.146	0.002	0.029	0.006	0.359
K	19	0.018	0.113	0.002	0.018	0.006	0.382
K	20	0.014	0.070	0.003	0.045	0.006	0.302
K	24	0.027	0.282	0.008	0.066	0.009	0.838
K	25	0.046	0.385	0.004	0.037	0.021	0.934
K	26	0.105	0.405	0.004	0.013	0.024	1.064
K	27	0.052	0.306	0.008	0.030	0.022	0.894
K	28	0.026	0.102	0.015	0.067	0.009	0.565
K	34	0.028	0.295	0.007	0.063	0.010	0.850
K	35	0.104	0.419	0.003	0.019	0.024	0.995
K	36	0.090	0.346	0.006	0.017	0.040	0.869
K	37	0.046	0.220	0.008	0.032	0.012	0.840
K	128	0.004	0.060	0.003	0.009	0.001	0.286
K	130	0.004	0.083	0.005	0.008	0.002	0.364
K	132	0.005	0.082	0.005	0.010	0.002	0.353
K	134	0.004	0.086	0.006	0.010	0.002	0.377
K	136	0.003	0.042	0.006	0.009	0.002	0.207
K	138	0.012	0.188	0.013	0.031	0.005	0.565
K	139	0.013	0.242	0.001	0.021	0.001	0.763
K	140	0.012	0.215	0.009	0.004	0.005	0.763
K	141	0.011	0.144	0.016	0.017	0.006	0.548
K	146	0.012	0.181	0.009	0.032	0.005	0.641
K	147	0.014	0.261	0.002	0.007	0.002	0.897
K	148	0.013	0.216	0.019	0.021	0.007	0.778
K	152	0.039	0.572	0.007	0.137	0.013	1.674
K	153	0.049	0.696	0.005	0.051	0.006	1.758
K	154	0.064	0.796	0.002	0.013	0.006	1.926
K	155	0.056	0.855	0.005	0.011	0.016	2.025
K	156	0.026	0.601	0.067	0.019	0.030	1.949
K	162	0.041	0.634	0.004	0.109	0.010	1.727
K	163	0.064	0.732	0.004	0.017	0.004	1.823
K	164	0.059	0.838	0.004	0.010	0.007	1.931
K	165	0.052	0.779	0.021	0.011	0.025	2.116

Table 15. n261/mid channel, M Patch simulated 4cm^2 PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - closed

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.266	0.002	0.011	0.001	0.059	0.103
M	3	0.227	0.003	0.019	0.002	0.035	0.116
M	5	0.134	0.004	0.049	0.001	0.029	0.105
M	7	0.137	0.003	0.029	0.003	0.036	0.115
M	9	0.192	0.003	0.062	0.003	0.030	0.089
M	14	0.414	0.007	0.038	0.005	0.064	0.202
M	15	0.487	0.006	0.029	0.002	0.123	0.204
M	16	0.533	0.004	0.028	0.002	0.125	0.244
M	17	0.268	0.006	0.119	0.006	0.043	0.167
M	21	0.437	0.007	0.036	0.004	0.083	0.208
M	22	0.558	0.003	0.019	0.002	0.140	0.254
M	23	0.515	0.004	0.033	0.003	0.118	0.237
M	29	0.446	0.011	0.252	0.018	0.102	0.475
M	30	0.892	0.025	0.155	0.005	0.281	0.719
M	31	1.080	0.025	0.063	0.006	0.327	0.533
M	32	1.036	0.018	0.086	0.004	0.279	0.638
M	33	0.921	0.017	0.269	0.018	0.096	0.602
M	38	0.702	0.019	0.200	0.008	0.182	0.712
M	39	1.070	0.025	0.075	0.006	0.361	0.619
M	40	0.998	0.016	0.097	0.005	0.311	0.499
M	41	1.173	0.012	0.179	0.011	0.148	0.923
M	129	0.289	0.001	0.020	0.002	0.016	0.190
M	131	0.388	0.001	0.025	0.002	0.020	0.194
M	133	0.359	0.001	0.028	0.002	0.019	0.197
M	135	0.346	0.001	0.039	0.001	0.021	0.188
M	137	0.284	0.001	0.051	0.001	0.018	0.165
M	142	0.670	0.002	0.117	0.002	0.049	0.426
M	143	0.813	0.001	0.049	0.001	0.063	0.515
M	144	0.833	0.001	0.014	0.002	0.066	0.541
M	145	0.581	0.002	0.052	0.007	0.035	0.353
M	149	0.718	0.001	0.088	0.003	0.046	0.443
M	150	0.816	0.001	0.030	0.002	0.065	0.522
M	151	0.613	0.002	0.066	0.005	0.041	0.378
M	157	1.951	0.004	0.551	0.003	0.147	1.279
M	158	1.936	0.006	0.212	0.001	0.230	1.347
M	159	1.720	0.003	0.024	0.002	0.231	1.180
M	160	1.735	0.003	0.030	0.002	0.198	1.258
M	161	1.809	0.006	0.118	0.027	0.119	1.097
M	166	2.064	0.005	0.382	0.002	0.200	1.381
M	167	1.793	0.005	0.084	0.001	0.224	1.223
M	168	1.651	0.002	0.054	0.006	0.216	1.170
M	169	1.829	0.003	0.085	0.009	0.160	1.250

Table 16. n258/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) – open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.007	0.005	0.001	0.028	0.006	0.139
K	2	0.012	0.009	0.003	0.016	0.006	0.151
K	4	0.010	0.006	0.005	0.015	0.005	0.126
K	6	0.009	0.008	0.005	0.011	0.004	0.133
K	8	0.008	0.006	0.007	0.007	0.005	0.145
K	10	0.009	0.010	0.016	0.040	0.008	0.217
K	11	0.020	0.016	0.002	0.041	0.007	0.274
K	12	0.023	0.023	0.006	0.006	0.016	0.326
K	13	0.014	0.010	0.007	0.073	0.010	0.291
K	18	0.020	0.016	0.002	0.041	0.007	0.274
K	19	0.020	0.024	0.007	0.012	0.014	0.295
K	20	0.014	0.013	0.013	0.021	0.005	0.242
K	24	0.041	0.023	0.007	0.128	0.017	0.671
K	25	0.052	0.030	0.007	0.082	0.015	0.665
K	26	0.088	0.088	0.016	0.030	0.042	0.678
K	27	0.074	0.050	0.011	0.044	0.039	0.681
K	28	0.031	0.058	0.042	0.045	0.016	0.616
K	34	0.022	0.011	0.022	0.248	0.039	0.755
K	35	0.048	0.059	0.020	0.038	0.034	0.604
K	36	0.064	0.115	0.008	0.024	0.046	0.738
K	37	0.051	0.033	0.017	0.069	0.028	0.537
K	128	0.003	0.002	0.001	0.017	0.002	0.204
K	130	0.002	0.002	0.002	0.020	0.003	0.245
K	132	0.002	0.003	0.002	0.014	0.002	0.259
K	134	0.001	0.002	0.003	0.009	0.002	0.250
K	136	0.003	0.006	0.004	0.004	0.002	0.170
K	138	0.005	0.005	0.003	0.064	0.009	0.434
K	139	0.004	0.006	0.002	0.033	0.005	0.507
K	140	0.003	0.006	0.004	0.006	0.002	0.578
K	141	0.003	0.007	0.005	0.049	0.006	0.435
K	146	0.007	0.003	0.002	0.059	0.007	0.445
K	147	0.004	0.005	0.002	0.025	0.001	0.545
K	148	0.005	0.006	0.007	0.021	0.003	0.602
K	152	0.022	0.016	0.002	0.164	0.022	1.186
K	153	0.023	0.019	0.004	0.162	0.013	1.228
K	154	0.011	0.026	0.003	0.028	0.004	1.179
K	155	0.007	0.027	0.003	0.013	0.008	1.439
K	156	0.017	0.049	0.037	0.016	0.019	1.763
K	162	0.023	0.015	0.002	0.165	0.022	1.159
K	163	0.022	0.021	0.004	0.039	0.007	1.117
K	164	0.010	0.029	0.004	0.016	0.005	1.268
K	165	0.014	0.040	0.023	0.011	0.013	1.788

Table 17. n258/mid channel, M Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (*Δmin*) - open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.124	0.001	0.011	0.000	0.066	0.130
M	3	0.172	0.001	0.015	0.001	0.114	0.065
M	5	0.201	0.001	0.015	0.000	0.136	0.090
M	7	0.144	0.001	0.016	0.000	0.114	0.089
M	9	0.156	0.001	0.018	0.001	0.112	0.078
M	14	0.256	0.001	0.022	0.001	0.137	0.115
M	15	0.359	0.002	0.026	0.001	0.231	0.226
M	16	0.333	0.002	0.036	0.001	0.238	0.290
M	17	0.366	0.002	0.053	0.001	0.273	0.104
M	21	0.316	0.001	0.020	0.001	0.187	0.159
M	22	0.363	0.002	0.033	0.001	0.249	0.280
M	23	0.417	0.002	0.050	0.001	0.319	0.129
M	29	0.659	0.005	0.070	0.005	0.430	0.450
M	30	0.920	0.006	0.035	0.002	0.721	0.656
M	31	1.047	0.012	0.045	0.001	0.879	0.695
M	32	1.099	0.006	0.134	0.002	0.806	0.508
M	33	1.090	0.004	0.222	0.002	0.755	0.315
M	38	0.796	0.005	0.064	0.004	0.536	0.515
M	39	0.983	0.010	0.033	0.001	0.817	0.748
M	40	1.077	0.009	0.057	0.001	0.882	0.629
M	41	1.141	0.005	0.187	0.002	0.829	0.421
M	129	0.165	0.001	0.021	0.002	0.027	0.195
M	131	0.139	0.001	0.020	0.001	0.024	0.182
M	133	0.163	0.000	0.017	0.001	0.020	0.211
M	135	0.173	0.000	0.039	0.001	0.025	0.207
M	137	0.077	0.000	0.064	0.001	0.011	0.142
M	142	0.350	0.002	0.017	0.003	0.044	0.422
M	143	0.387	0.001	0.015	0.003	0.045	0.482
M	144	0.365	0.001	0.027	0.001	0.076	0.408
M	145	0.242	0.001	0.184	0.001	0.038	0.390
M	149	0.343	0.001	0.037	0.002	0.031	0.416
M	150	0.432	0.001	0.053	0.000	0.037	0.561
M	151	0.348	0.001	0.062	0.001	0.057	0.405
M	157	0.940	0.004	0.078	0.012	0.117	1.026
M	158	1.011	0.003	0.040	0.002	0.139	1.190
M	159	0.885	0.002	0.068	0.002	0.059	1.138
M	160	1.020	0.003	0.287	0.001	0.156	1.176
M	161	1.032	0.002	0.458	0.002	0.159	1.204
M	166	0.950	0.003	0.075	0.005	0.141	1.066
M	167	0.989	0.002	0.058	0.003	0.080	1.204
M	168	0.894	0.002	0.092	0.002	0.113	1.119
M	169	1.043	0.003	0.347	0.002	0.160	1.213

Table 18. n260/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) – open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.004	0.036	0.001	0.009	0.001	0.151
K	2	0.003	0.037	0.001	0.014	0.002	0.159
K	4	0.004	0.037	0.001	0.015	0.002	0.184
K	6	0.004	0.039	0.001	0.008	0.002	0.144
K	8	0.003	0.031	0.001	0.008	0.001	0.164
K	10	0.009	0.102	0.003	0.029	0.003	0.368
K	11	0.011	0.115	0.002	0.024	0.005	0.362
K	12	0.007	0.064	0.001	0.026	0.002	0.238
K	13	0.011	0.082	0.004	0.053	0.004	0.370
K	18	0.009	0.088	0.002	0.025	0.003	0.365
K	19	0.011	0.088	0.000	0.014	0.004	0.270
K	20	0.007	0.062	0.002	0.030	0.003	0.278
K	24	0.039	0.258	0.011	0.156	0.013	0.961
K	25	0.037	0.329	0.002	0.007	0.016	0.852
K	26	0.030	0.214	0.003	0.016	0.006	0.626
K	27	0.017	0.136	0.002	0.064	0.007	0.374
K	28	0.037	0.222	0.005	0.046	0.005	0.789
K	34	0.034	0.303	0.008	0.094	0.012	0.998
K	35	0.033	0.286	0.003	0.011	0.013	0.776
K	36	0.015	0.158	0.002	0.043	0.006	0.417
K	37	0.036	0.186	0.001	0.042	0.004	0.636
K	128	0.004	0.026	0.001	0.010	0.001	0.151
K	130	0.003	0.031	0.001	0.006	0.001	0.161
K	132	0.005	0.025	0.001	0.006	0.001	0.157
K	134	0.004	0.030	0.001	0.004	0.001	0.145
K	136	0.002	0.023	0.001	0.004	0.001	0.129
K	138	0.013	0.043	0.003	0.017	0.002	0.237
K	139	0.009	0.084	0.001	0.011	0.003	0.360
K	140	0.008	0.084	0.002	0.011	0.002	0.345
K	141	0.009	0.052	0.002	0.021	0.002	0.255
K	146	0.009	0.072	0.002	0.007	0.002	0.288
K	147	0.010	0.086	0.001	0.012	0.002	0.369
K	148	0.007	0.048	0.002	0.012	0.001	0.236
K	152	0.030	0.079	0.011	0.079	0.005	0.491
K	153	0.022	0.144	0.004	0.017	0.007	0.587
K	154	0.038	0.256	0.003	0.021	0.010	0.871
K	155	0.021	0.197	0.002	0.035	0.004	0.751
K	156	0.034	0.188	0.003	0.032	0.010	0.609
K	162	0.025	0.117	0.008	0.042	0.006	0.552
K	163	0.030	0.201	0.004	0.013	0.005	0.720
K	164	0.031	0.237	0.006	0.027	0.006	0.822
K	165	0.020	0.156	0.002	0.038	0.007	0.601

Table 19. n260/mid channel, M Patch simulated 4cm^2 PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) - open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.281	0.001	0.030	0.001	0.024	0.161
M	3	0.399	0.001	0.025	0.002	0.051	0.205
M	5	0.427	0.001	0.052	0.001	0.049	0.240
M	7	0.413	0.001	0.064	0.001	0.045	0.222
M	9	0.386	0.001	0.064	0.001	0.052	0.203
M	14	0.785	0.002	0.219	0.003	0.071	0.353
M	15	0.696	0.001	0.076	0.005	0.090	0.405
M	16	0.782	0.003	0.061	0.001	0.136	0.501
M	17	0.698	0.002	0.089	0.003	0.045	0.312
M	21	0.835	0.002	0.172	0.003	0.112	0.442
M	22	0.623	0.001	0.025	0.004	0.104	0.420
M	23	0.764	0.003	0.165	0.001	0.088	0.402
M	29	1.810	0.006	0.715	0.013	0.205	0.978
M	30	1.634	0.005	0.384	0.012	0.271	1.127
M	31	1.952	0.005	0.063	0.003	0.425	1.240
M	32	1.756	0.007	0.093	0.002	0.291	1.177
M	33	1.364	0.005	0.593	0.004	0.114	0.711
M	38	1.843	0.007	0.652	0.014	0.245	1.099
M	39	1.751	0.005	0.160	0.006	0.339	1.141
M	40	1.841	0.005	0.106	0.001	0.350	1.251
M	41	1.238	0.007	0.346	0.002	0.142	0.844
M	129	0.249	0.001	0.016	0.001	0.045	0.047
M	131	0.330	0.001	0.016	0.002	0.073	0.081
M	133	0.426	0.002	0.033	0.001	0.087	0.090
M	135	0.385	0.002	0.042	0.002	0.090	0.062
M	137	0.408	0.001	0.050	0.001	0.092	0.087
M	142	0.737	0.003	0.087	0.005	0.133	0.132
M	143	0.748	0.003	0.104	0.005	0.209	0.158
M	144	0.752	0.002	0.036	0.001	0.228	0.250
M	145	0.578	0.002	0.051	0.004	0.085	0.111
M	149	0.748	0.002	0.134	0.006	0.151	0.152
M	150	0.758	0.004	0.053	0.002	0.239	0.175
M	151	0.841	0.003	0.140	0.005	0.212	0.142
M	157	1.357	0.005	0.403	0.011	0.356	0.349
M	158	1.476	0.008	0.417	0.008	0.528	0.331
M	159	1.449	0.008	0.115	0.003	0.502	0.394
M	160	1.847	0.007	0.071	0.002	0.699	0.496
M	161	1.308	0.004	0.460	0.016	0.287	0.380
M	166	1.366	0.004	0.474	0.021	0.286	0.360
M	167	1.701	0.008	0.117	0.005	0.569	0.537
M	168	1.556	0.009	0.109	0.003	0.558	0.454
M	169	1.490	0.007	0.178	0.003	0.569	0.289

Table 20. n261/mid channel, K Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (Δmin) – open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
K	0	0.007	0.058	0.001	0.020	0.003	0.160
K	2	0.010	0.045	0.001	0.014	0.002	0.179
K	4	0.010	0.042	0.002	0.013	0.002	0.158
K	6	0.008	0.042	0.002	0.007	0.003	0.202
K	8	0.010	0.055	0.003	0.004	0.003	0.114
K	10	0.013	0.079	0.004	0.035	0.003	0.343
K	11	0.026	0.135	0.002	0.019	0.007	0.451
K	12	0.024	0.136	0.003	0.009	0.010	0.384
K	13	0.012	0.067	0.006	0.022	0.004	0.294
K	18	0.015	0.146	0.002	0.029	0.006	0.359
K	19	0.018	0.113	0.002	0.018	0.006	0.382
K	20	0.014	0.070	0.003	0.045	0.006	0.302
K	24	0.027	0.282	0.008	0.066	0.009	0.838
K	25	0.046	0.385	0.004	0.037	0.021	0.934
K	26	0.105	0.405	0.004	0.013	0.024	1.064
K	27	0.052	0.306	0.008	0.030	0.022	0.894
K	28	0.026	0.102	0.015	0.067	0.009	0.565
K	34	0.028	0.295	0.007	0.063	0.010	0.850
K	35	0.104	0.419	0.003	0.019	0.024	0.995
K	36	0.090	0.346	0.006	0.017	0.040	0.869
K	37	0.046	0.220	0.008	0.032	0.012	0.840
K	128	0.004	0.060	0.003	0.009	0.001	0.286
K	130	0.004	0.083	0.005	0.008	0.002	0.364
K	132	0.005	0.082	0.005	0.010	0.002	0.353
K	134	0.004	0.086	0.006	0.010	0.002	0.377
K	136	0.003	0.042	0.006	0.009	0.002	0.207
K	138	0.012	0.188	0.013	0.031	0.005	0.565
K	139	0.013	0.242	0.001	0.021	0.001	0.763
K	140	0.012	0.215	0.009	0.004	0.005	0.763
K	141	0.011	0.144	0.016	0.017	0.006	0.548
K	146	0.012	0.181	0.009	0.032	0.005	0.641
K	147	0.014	0.261	0.002	0.007	0.002	0.897
K	148	0.013	0.216	0.019	0.021	0.007	0.778
K	152	0.039	0.572	0.007	0.137	0.013	1.674
K	153	0.049	0.696	0.005	0.051	0.006	1.758
K	154	0.064	0.796	0.002	0.013	0.006	1.926
K	155	0.056	0.855	0.005	0.011	0.016	2.025
K	156	0.026	0.601	0.067	0.019	0.030	1.949
K	162	0.041	0.634	0.004	0.109	0.010	1.727
K	163	0.064	0.732	0.004	0.017	0.004	1.823
K	164	0.059	0.838	0.004	0.010	0.007	1.931
K	165	0.052	0.779	0.021	0.011	0.025	2.116

Table 21. n261/mid channel, M Patch simulated 4cm² PD at PD_design_Target (if simulation performed with correct housing material properties) (*Δmin*) - open

Antenna	Beam ID_1	Simulated 4cm2 PD (mW/cm2) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties					
		S4(Right)	S3(Left)	S5(Top)	S6(Bottom)	S1(Front)	S2(Rear)
M	1	0.266	0.002	0.011	0.001	0.059	0.103
M	3	0.227	0.003	0.019	0.002	0.035	0.116
M	5	0.134	0.004	0.049	0.001	0.029	0.105
M	7	0.137	0.003	0.029	0.003	0.036	0.115
M	9	0.192	0.003	0.062	0.003	0.030	0.089
M	14	0.414	0.007	0.038	0.005	0.064	0.202
M	15	0.487	0.006	0.029	0.002	0.123	0.204
M	16	0.533	0.004	0.028	0.002	0.125	0.244
M	17	0.268	0.006	0.119	0.006	0.043	0.167
M	21	0.437	0.007	0.036	0.004	0.083	0.208
M	22	0.558	0.003	0.019	0.002	0.140	0.254
M	23	0.515	0.004	0.033	0.003	0.118	0.237
M	29	0.446	0.011	0.252	0.018	0.102	0.475
M	30	0.892	0.025	0.155	0.005	0.281	0.719
M	31	1.080	0.025	0.063	0.006	0.327	0.533
M	32	1.036	0.018	0.086	0.004	0.279	0.638
M	33	0.921	0.017	0.269	0.018	0.096	0.602
M	38	0.702	0.019	0.200	0.008	0.182	0.712
M	39	1.070	0.025	0.075	0.006	0.361	0.619
M	40	0.998	0.016	0.097	0.005	0.311	0.499
M	41	1.173	0.012	0.179	0.011	0.148	0.923
M	129	0.289	0.001	0.020	0.002	0.016	0.190
M	131	0.388	0.001	0.025	0.002	0.020	0.194
M	133	0.359	0.001	0.028	0.002	0.019	0.197
M	135	0.346	0.001	0.039	0.001	0.021	0.188
M	137	0.284	0.001	0.051	0.001	0.018	0.165
M	142	0.670	0.002	0.117	0.002	0.049	0.426
M	143	0.813	0.001	0.049	0.001	0.063	0.515
M	144	0.833	0.001	0.014	0.002	0.066	0.541
M	145	0.581	0.002	0.052	0.007	0.035	0.353
M	149	0.718	0.001	0.088	0.003	0.046	0.443
M	150	0.816	0.001	0.030	0.002	0.065	0.522
M	151	0.613	0.002	0.066	0.005	0.041	0.378
M	157	1.951	0.004	0.551	0.003	0.147	1.279
M	158	1.936	0.006	0.212	0.001	0.230	1.347
M	159	1.720	0.003	0.024	0.002	0.231	1.180
M	160	1.735	0.003	0.030	0.002	0.198	1.258
M	161	1.809	0.006	0.118	0.027	0.119	1.097
M	166	2.064	0.005	0.382	0.002	0.200	1.381
M	167	1.793	0.005	0.084	0.001	0.224	1.223
M	168	1.651	0.002	0.054	0.006	0.216	1.170
M	169	1.829	0.003	0.085	0.009	0.160	1.250

The test results in the table below shows that the all measured 4cm2 PD values are less than PD_design_target of 0.631 mW/cm2, thus, the non-selected surfaces have no influence on the determined Δmi and input.power.limit in Section 7.

Table 22. 4cm^2 PD of the selected beams measured on the corresponding surfaces that are not selected for Δmin determination – closed

Band	Antenna	Beam ID	Surface	Tested Power Level (dBm)	input.power.limit (dBm)	Meas. 4cm2 PD (mW/cm2)
n258	K	26	Front	4.5	4.5	0.0187
	M	30	Front	5.2	5.2	0.244
	M	161	Top	2.1	2.1	0.0753
n260	K	25	Front	4.0	4	0.0035
	K	25	Left	4.0	4	0.246
	M	29	Top	3.9	3.9	0.143
	M	160	Front	3.8	3.8	0.0893
n261	K	8	Left	13.5	13.5	0.127
	K	36	Front	5.0	5	0.0061
	M	29	Top	8.7	8.7	0.438
	M	39	Front	5.6	5.6	0.285

Table 23. 4cm^2 PD of the selected beams measured on the corresponding surfaces that are not selected for Δmin determination - open

Band	Antenna	Beam ID	Surface	Tested Power Level (dBm)	input.power.limit (dBm)	Meas. 4cm2 PD (mW/cm2)
n258	K	145	Front	6.9	6.9	0.093
	M	36	Top	5.7	5.7	0.0058
n260	K	165	Front	4.7	4.7	0.186
	M	29	Top	4.3	4.3	0.0041
n261	K	36	Front	3.5	3.5	0.149
	M	157	Top	5.1	5.1	0.0065

7 PD Char

7.1 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 n258 band and 6 dBm input power per active port for n260 band and 6 dBm input power per active port for n261 band:

Obtained PDsurface value (the worst PD among all identified surfaces of the DUT) at all three channels for all single beams specified in the codebook.

Derived a scaling factor at low, mid and high channel, $s(i)low\_or\_mid\_or\_high$, by:

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

Determined the worst-case scaling factor, $\boldsymbol{s(i)}$, 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.

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:

$$sim.power_{limit} = min\{sim.power_{limit}\_L, sim.power_{limit}\_M, sim.power_{limit\_H}\}$$

7.2 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.

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

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

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:

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

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:

$$sim.power_{limit} = min\{sim.power_{limit}\_L, sim.power_{limit}\_M, sim.power_{limit\_H}\}$$

7.3 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 $input.power.(i)$, for beam i can be obtained after accounting for the housing influence (Δmin) given by:

For n258,n260 and n261

$$input.power.limit(i) = 18\ dBm + 10 * \log(s(i)) + \triangle min,\ I \in all\ beams \qquad (5)$$

where 6 dBm is the input power used in simulation for n258,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 for beam i.

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 Δmin 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 < △min < TxAGC uncertainty,

input.power.limit(i) = 18 dBm + 10 * log(s(i)) + △min, I ∈ all beams (6)

else if △min < - TxAGC uncertainty,

input.power.limit(i) = 18 dBm + 10 * log(s(i)) + (△min + TxAGC uncertainty), I ∈ all beams (7)

else if △min > TxAGC uncertainty,

input.power.limit(i) = 18 dBm + 10 * log(s(i)) + (△min - TxAGC uncertainty), I ∈ all beams (8)

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

Table 24. *input. power. limit* Calculation – closed

Band	Antenna	Δmin	TxAGC Uncertainty	*input.power.limit*	Notes
		(dB)	(dB)	(dBm)	
n258	K	0.65	0.63	*input.power.limit(i) = sim.power_limit + 0.02*	Using Eq.8
	M	2.4	0.63	*input.power.limit(i) = sim.power_limit + 1.77*	Using Eq.8
n260	K	0.82	0.63	*input.power.limit(i) = sim.power_limit + 0.19*	Using Eq.8
	M	3.46	0.63	*input.power.limit(i) = sim.power_limit + 2.83*	Using Eq.8
n261	K	1.08	0.63	*input.power.limit(i) = sim.power_limit + 0.45*	Using Eq.8
	M	3.12	0.63	*input.power.limit(i) = sim.power_limit + 2.49*	Using Eq.8

Table 25. *input. power. limit* Calculation – open

Band	Antenna	Δmin	TxAGC Uncertainty	*input.power.limit*	Notes
		(dB)	(dB)	(dBm)	
n258	K	1.19	0.63	*input.power.limit(i) = sim.power_limit + 0.56*	Using Eq.8
	M	0.73	0.63	*input.power.limit(i) = sim.power_limit + 0.1*	Using Eq.8
n260	K	1.03	0.63	*input.power.limit(i) = sim.power_limit + 0.4*	Using Eq.8
	M	2.91	0.63	*input.power.limit(i) = sim.power_limit + 2.28*	Using Eq.8
n261	K	1.64	0.63	*input.power.limit(i) = sim.power_limit + 1.01*	Using Eq.8
	M	1.51	0.63	*input.power.limit(i) = sim.power_limit + 0.88*	Using Eq.8

Table 26. 5G NR n258 K Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n258	0		11.7
n258	2		11.7
n258	4		12.7
n258	6		12.1
n258	8		12.6
n258	10		10.4
n258	11		8.9
n258	12		8.8
n258	13		9.0
n258	18		8.9
n258	19		9.2
n258	20		9.7
n258	24		5.4
n258	25		5.0
n258	26		4.6
n258	27		5.3
n258	28		5.3
n258	34		5.1
n258	35		5.4
n258	36		4.6
n258	37		6.0
n258		128	10.2
n258		130	9.6
n258		132	9.5
n258		134	9.5
n258		136	11.6
n258		138	7.2
n258		139	6.5
n258		140	5.9
n258		141	7.0
n258		146	6.9
n258		147	6.1
n258		148	5.8
n258		152	2.8
n258		153	2.6
n258		154	2.8
n258		155	2.0
n258		156	1.2
n258		162	2.9
n258		163	3.0
n258		164	2.5
n258		165	1.2
n258	0	128	7.4
n258	2	130	6.8
n258	4	132	7.2
n258	6	134	7.1
n258	8	136	8.2
n258	10	138	4.2
n258	11	139	4.4
n258	12	140	3.5
n258	13	141	4.3
n258	18	146	3.8
n258	19	147	4.9
n258	20	148	3.7
n258	24	152	-0.8
n258	25	153	-0.8
n258	26	154	0.3
n258	27	155	-0.1
n258	28	156	-1.5
n258	34	162	-0.5
n258	35	163	0.3
n258	36	164	0.0
n258	37	165	-0.5

Table 27. 5G NR n258 M Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n258	1		11.0
n258	3		10.6
n258	5		9.9
n258	7		11.0
n258	9		10.4
n258	14		8.3
n258	15		7.2
n258	16		7.4
n258	17		6.9
n258	21		7.6
n258	22		7.2
n258	23		6.4
n258	29		3.8
n258	30		3.0
n258	31		2.5
n258	32		2.6
n258	33		2.3
n258	38		3.2
n258	39		2.9
n258	40		2.4
n258	41		2.2
n258		129	10.1
n258		131	9.1
n258		133	9.8
n258		135	9.8
n258		137	10.7
n258		142	5.6
n258		143	5.6
n258		144	5.9
n258		145	7.0
n258		149	6.3
n258		150	5.7
n258		151	6.5
n258		157	1.6
n258		158	2.1
n258		159	2.3
n258		160	1.8
n258		161	2.0
n258		166	1.9
n258		167	2.2
n258		168	2.3
n258		169	1.7
n258	1	129	6.4
n258	3	131	6.5
n258	5	133	6.6
n258	7	135	6.6
n258	9	137	7.6
n258	14	142	3.5
n258	15	143	2.9
n258	16	144	3.3
n258	17	145	4.0
n258	21	149	4.6
n258	22	150	3.7
n258	23	151	4.2
n258	29	157	-1.3
n258	30	158	-1.1
n258	31	159	-0.9
n258	32	160	-1.5
n258	33	161	-1.6
n258	38	166	-1.0
n258	39	167	-1.3
n258	40	168	-0.8
n258	41	169	-1.6

Table 28. 5G NR n260 K Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	0		11.4
n260	2		11.3
n260	4		10.7
n260	6		11.6
n260	8		11.4
n260	10		8.0
n260	11		7.3
n260	12		8.8
n260	13		8.2
n260	18		8.2
n260	19		8.2
n260	20		8.6
n260	24		3.7
n260	25		4.0
n260	26		4.3
n260	27		5.4
n260	28		5.2
n260	34		3.4
n260	35		4.3
n260	36		4.6
n260	37		5.4
n260		128	12.1
n260		130	11.1
n260		132	10.7
n260		134	11.2
n260		136	12.4
n260		138	7.9
n260		139	8.4
n260		140	8.4
n260		141	8.3
n260		146	8.7
n260		147	8.2
n260		148	8.7
n260		152	4.7
n260		153	4.7
n260		154	4.4
n260		155	5.3
n260		156	4.5
n260		162	4.3
n260		163	5.3
n260		164	4.4
n260		165	4.2
n260	0	128	8.3
n260	2	130	8.0
n260	4	132	7.5
n260	6	134	8.0
n260	8	136	8.5
n260	10	138	5.1
n260	11	139	4.8
n260	12	140	5.4
n260	13	141	4.9
n260	18	146	5.5
n260	19	147	5.2
n260	20	148	6.5
n260	24	152	1.1
n260	25	153	1.1
n260	26	154	1.2
n260	27	155	1.5
n260	28	156	1.2
n260	34	162	1.2
n260	35	163	1.4
n260	36	164	1.3
n260	37	165	1.0

Table 29. 5G NR n260 M Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n260	1		11.3
n260	3		10.4
n260	5		9.5
n260	7		10.1
n260	9		10.6
n260	14		6.9
n260	15		7.3
n260	16		7.6
n260	17		8.0
n260	21		6.7
n260	22		7.7
n260	23		7.7
n260	29		3.9
n260	30		3.8
n260	31		3.6
n260	32		4.0
n260	33		4.5
n260	38		3.8
n260	39		3.5
n260	40		3.4
n260	41		4.6
n260		129	11.7
n260		131	10.4
n260		133	9.5
n260		135	9.9
n260		137	10.3
n260		142	6.8
n260		143	6.8
n260		144	6.8
n260		145	8.0
n260		149	6.5
n260		150	7.4
n260		151	6.8
n260		157	3.5
n260		158	3.7
n260		159	4.1
n260		160	3.0
n260		161	3.6
n260		166	4.0
n260		167	3.6
n260		168	4.1
n260		169	3.7
n260	1	129	7.8
n260	3	131	7.2
n260	5	133	6.6
n260	7	135	7.0
n260	9	137	7.3
n260	14	142	3.7
n260	15	143	4.3
n260	16	144	4.3
n260	17	145	4.2
n260	21	149	3.5
n260	22	150	4.6
n260	23	151	3.6
n260	29	157	-0.2
n260	30	158	0.1
n260	31	159	0.8
n260	32	160	0.4
n260	33	161	0.0
n260	38	166	0.3
n260	39	167	0.2
n260	40	168	1.0
n260	41	169	0.3

Table 30. 5G NR n261 K Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	0		11.5
n261	2		11.9
n261	4		11.8
n261	6		11.3
n261	8		13.6
n261	10		8.9
n261	11		7.9
n261	12		8.6
n261	13		9.1
n261	18		8.5
n261	19		8.4
n261	20		9.2
n261	24		4.6
n261	25		4.2
n261	26		4.1
n261	27		4.5
n261	28		6.4
n261	34		4.6
n261	35		4.4
n261	36		5.0
n261	37		4.8
n261		128	9.6
n261		130	8.7
n261		132	8.9
n261		134	8.6
n261		136	11.3
n261		138	6.8
n261		139	5.5
n261		140	5.5
n261		141	7.0
n261		146	6.3
n261		147	4.9
n261		148	5.4
n261		152	2.1
n261		153	2.0
n261		154	1.5
n261		155	1.3
n261		156	1.5
n261		162	2.0
n261		163	1.8
n261		164	1.5
n261		165	1.2
n261	0	128	7.1
n261	2	130	6.6
n261	4	132	6.6
n261	6	134	6.5
n261	8	136	9.0
n261	10	138	4.0
n261	11	139	3.6
n261	12	140	3.8
n261	13	141	4.0
n261	18	146	3.9
n261	19	147	3.5
n261	20	148	4.3
n261	24	152	-0.6
n261	25	153	-0.4
n261	26	154	-0.5
n261	27	155	-1.1
n261	28	156	-0.8
n261	34	162	-0.6
n261	35	163	-0.2
n261	36	164	-0.5
n261	37	165	-1.4

Table 31. 5G NR n261 M Patch *input. power. limit*

Band	Beam ID 1	Beam ID 2	input.power.limit
n261	1		9.6
n261	3		9.3
n261	5		10.2
n261	7		10.4
n261	9		9.9
n261	14		6.8
n261	15		5.9
n261	16		6.8
n261	17		7.5
n261	21		6.1
n261	22		6.3
n261	23		7.1
n261	29		4.0
n261	30		3.4
n261	31		3.3
n261	32		3.5
n261	33		2.9
n261	38		3.6
n261	39		3.1
n261	40		3.2
n261	41		2.9
n261		129	11.3
n261		131	10.2
n261		133	9.9
n261		135	10.6
n261		137	11.4
n261		142	7.7
n261		143	6.3
n261		144	5.9
n261		145	8.0
n261		149	7.0
n261		150	6.2
n261		151	7.2
n261		157	3.2
n261		158	3.1
n261		159	2.7
n261		160	2.6
n261		161	2.9
n261		166	2.9
n261		167	3.0
n261		168	3.0
n261		169	2.5
n261	1	129	7.7
n261	3	131	7.3
n261	5	133	7.3
n261	7	135	7.3
n261	9	137	7.6
n261	14	142	4.8
n261	15	143	3.5
n261	16	144	3.9
n261	17	145	5.6
n261	21	149	3.9
n261	22	150	4.0
n261	23	151	4.4
n261	29	157	1.0
n261	30	158	0.3
n261	31	159	0.5
n261	32	160	-0.2
n261	33	161	-0.5
n261	38	166	0.3
n261	39	167	0.3
n261	40	168	0.3
n261	41	169	-0.8