



RF Exposure Report

(Part 0: SAR and PD Char Evaluation)

FCC ID : XHG-RG1000
Equipment : Mobile Hotspot
Model Name : RG1000
Applicant : Franklin Technology Inc.
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Standard : FCC 47 CFR Part 2 (2.1093)

We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

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Table of Contents

- 1. Introduction 4**
- 2. Product Description 5**
- 3. SAR Characterization..... 6**
 - 3.1 SAR design target and uncertainty..... 6
 - 3.2 SAR Char Table 7
- 4. Power Density Characterization 8**
 - 4.1 PD Char Table..... 8
 - 4.2 Codebook for all beams 9
 - 4.3 PD_design_target determination.....13
 - 4.4 Exposure positions for PD evaluation14
 - 4.5 Simulation and modeling validation.....15
 - 4.6 PD Char16
 - 4.7 Simulated input power limit for single beams16
 - 4.8 Simulated input power limit for beam pairs17
 - 4.9 Worst-case housing influence determination.....18
 - 4.10 PD Char24
 - 4.11 PD char generation24
 - 4.12 PD char Table.....25
- 5. PD Test Setup.....29**
 - 5.1 PD Test – System Setup29
 - 5.2 Test Side Location.....29
 - 5.3 EUmmWave Probe / E-Field 5G Probe.....30
 - 5.4 Data Acquisition Electronics (DAE)31
 - 5.5 Scan configuration31
 - 5.6 System Verification Source31
 - 5.7 Power Density System Verification.....32
 - 5.8 System Verification Results.....32
- 6. Uncertainty Assessment33**



History of this test report

Report No.	Version	Description	Issued Date
FA140849A	01	Initial issue of report	Sep. 14, 2021



1. Introduction

The FCC RF exposure limit is defined based on time-averaged RF exposure. The product implements Qualcomm Smart Transmit feature which controls the instantaneous transmitting power for WWAN transmitter to ensure the product in compliance with FCC RF exposure limit over a defined time window, for SAR (transmit frequency ≤ 6GHz) and power density (transmit frequency > 6GHz) to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure is compliant to the regulation requirement. Cannot operate without SAR and PD characterization at the device level, beforehand.

This report describes the procedures for the SAR char and PD char generation, and the parameters obtained from SAR and PD characterization (referred to as SAR char and PD char, respectively) will be used as input for Smart Transmit. Both SAR char and PD char will be entered via the Embedded File System (EFS) to enable the Smart Transmit Feature.

Terminologies in this report

P _{limit}	The time-averaged RF power which corresponds to SAR_design_target.
P _{max}	Maximum target power level
SAR_design_target:	The design target for SAR compliance. It should be less than regulatory power density limit to account for all device design related uncertainties.
SAR char	P _{limit} for all the technologies/bands for all applicable DSI
PD_design_target:	The design target for PD compliance. It should be less than regulatory power density limit to account for all device design related uncertainties.
input.power.limit	For a PD characterized wireless device, the input power level at antenna port(s) for each beam corresponding to PD_design_target.
PD char	The table that contains input.power.limit fed to antenna port(s) for all supported beams.



2. Product Description

Product Feature & Specification	
Equipment Name	Mobile Hotspot
FCC ID	XHG-RG1000
Wireless Technology and Frequency Range	WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band V: 824 MHz ~ 849 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66: 1710 MHz ~ 1780 MHz 5G NR n2 : 1850 MHz ~ 1910 MHz 5G NR n5 : 824 MHz ~ 849 MHz 5G NR n66 : 1710 MHz ~ 1780 MHz 5G NR n77: 3700 MHz ~ 3980 MHz 5G NR n78: 3700 MHz ~ 3800 MHz 5G NR n260 : 37 GHz ~ 40 GHz 5G NR n261 : 27.5 GHz ~ 28.35 GHz WLAN 2.4 GHz Band: 2400 MHz ~ 2483.5 MHz WLAN 5.2 GHz Band: 5150 MHz ~ 5250 MHz WLAN 5.8 GHz Band: 5725 MHz ~ 5850 MHz
Mode	RMC/AMR 12.2Kbps HSDPA HSUPA LTE: QPSK, 16QAM, 64QAM 5G NR: DFT-s-OFDM/CP-OFDM, Pi/2 BPSK/QPSK/16QAM/64QAM/256QAM WLAN: 802.11a/b/g/n/ac/ax HT20/HT40/VHT20/VHT40/VHT80/HE20/HE40/HE80

3. SAR Characterization

SAR char must be generated to cover all radio configurations and usage scenarios that the wireless device supports for operating at 6 GHz or below. It will then be used as input for Smart Transmit to control and manage RF exposure for $f < 6$ GHz.

3.1 SAR design target and uncertainty

Band	Antenna	1g SAR design target (W/kg)
WCDMA II	TX0	0.95
WCDMA V	TX0	0.95
LTE B2	TX0	0.95
LTE B2	TX1	0.95
LTE B66/4	TX0	0.95
LTE B66	TX1	0.95
LTE B5	TX0	0.95
LTE B12/B17	TX0	0.95
LTE B13	TX0	0.95
LTE B41(PC3)**	TX0	0.95
LTE B48(PC3)**	TX0	0.95
n2	TX0	0.95
n2	TX1	0.95
n5	TX0	0.95
n66	TX0	0.95
n66	TX1	0.95
n77/n78(PC3)	TX0	0.55
n77(PC2)	TX0	0.55

Total uncertainty	Uncertainty dB (k=2)
	1.0

To account for total uncertainty, SAR_design_target should be determined as:

$$SAR_{design_target} < SAR_{regulatory_limit} \times 10^{\frac{-total\ uncertainty}{10}}$$



3.2 SAR Char Table

SAR char must be generated to cover all radio configurations and usage scenarios that the wireless device supports for operating at 6 GHz or below. It will then be used as input for Smart Transmit to control and manage RF exposure for $f < 6$ GHz.

<P_{limit} for supported technologies and bands (P_{limit} in EFS file)>

Band	Antenna	TDD duty cycle	P _{limit} *	P _{max} * (dBm)
			Body (DSI:1)	
WCDMA II	TX0	100.00%	21.9	23.0
WCDMA V	TX0	100.00%	25.2	23.0
LTE B2	TX0	100.00%	22.1	23.0
LTE B2	TX1	100.00%	25.6	23.0
LTE B66/4	TX0	100.00%	21.5	23.0
LTE B66	TX1	100.00%	22.9	23.0
LTE B5	TX0	100.00%	26.5	23.0
LTE B12/B17	TX0	100.00%	25.6	23.0
LTE B13	TX0	100.00%	24.2	23.0
LTE B41(PC3)**	TX0	63.30%	15.7	21.0
LTE B48(PC3)**	TX0	63.30%	25.7	21.0
n2	TX0	100.00%	22.8	23.0
n2	TX1	100.00%	24.8	23.0
n5	TX0	100.00%	25.5	23.0
n66	TX0	100.00%	22.8	23.0
n66	TX1	100.00%	23.8	23.0
n77/n78(PC3)	TX0	100.00%	22.0	23.0
n77(PC2)	TX0	100.00%		25.0

*P_{max} is used for RF tune up procedure. The maximum allowed output power is equal to P_{max} + 1.0 dB uncertainty.

**All P_{limit} power levels entered in the Table correspond to average power levels after accounting for duty cycle in the case TDD modulation schemes (for e.g., GSM).

The max allowed output power is the P_{limit} + 1.0 dB device uncertainty, and if P_{limit} is higher than P_{max}, the device output power will be P_{max} instead.

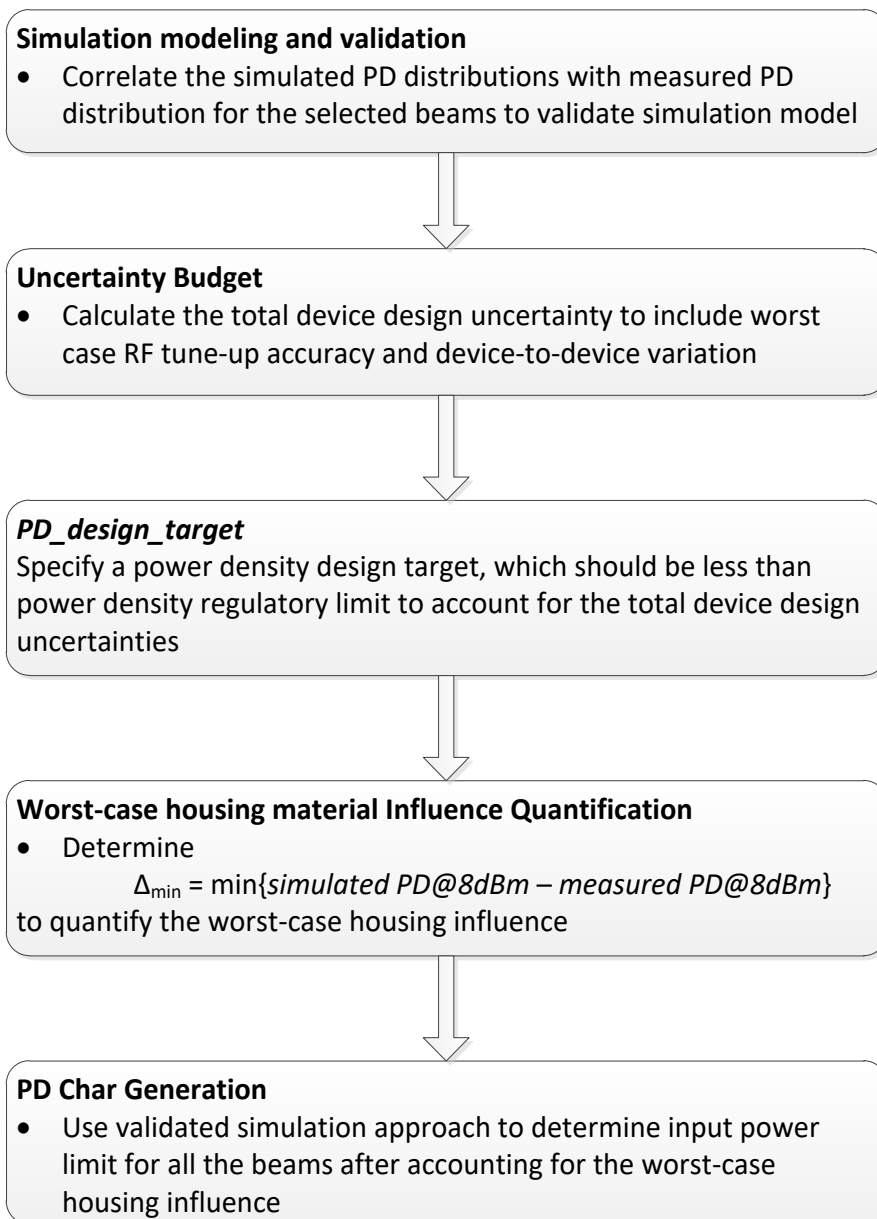
4. Power Density Characterization

The device with 5G mmW NR typically supports many beams and contains multiple mmW antenna arrays installed at different locations to achieve good coverage in the field. The power density (PD) measurement is a time-consuming test, and it is not practical to measure the power density for all the beams on all the surfaces of the device, thus a hybrid approach using electromagnetic (EM) simulation in combination with measurement is recommended for PD char generation

4.1 PD Char Table

The mmW device supports total N beams, where M out of N are single beams and the rest of (N-M) are beam pairs (where 2 single beams are excited at the same time).

The following figure outlines the PD char process.





4.2 Codebook for all beams

All the beams that the device supports are specified in the pre-defined codebook, and the codebook is device design specific and generated after evaluating radiation coverage from this particular device. In the field, a smartphone manages the beam selection and utilization based on this pre-defined codebook that is loaded and stored in the device.

n260				
Ant / Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID	
Module 0 / Patch	V	1	1	
		1	3	
		1	5	
		1	7	
		2	12	
		2	13	
		2	14	
		2	15	
		2	19	
		2	20	
		2	21	
		4	27	
		4	28	
		4	29	
		4	30	
		4	31	
		4	36	
		4	37	
	4	38		
	4	39		
	H	H	1	129
			1	131
			1	133
			1	135
			2	140
			2	141
			2	142
			2	143
			2	147
			2	148
			2	149
			4	155
			4	156
			4	157
			4	158
			4	159
			4	164
			4	165
	4	166		
4	167			
Paired	Paired	2	1	129
		2	3	131
		2	5	133
		2	7	135
		4	12	140
		4	13	141
		4	14	142
		4	15	143
		4	19	147
		4	20	148
		4	21	149
		8	27	155
		8	28	156
8	29	157		
8	30	158		
8	31	159		
8	36	164		
8	37	165		
8	38	166		
8	39	167		



n260				
Ant / Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID	
Module 1 / Patch	V	1	0	
		1	2	
		1	4	
		1	6	
		2	8	
		2	9	
		2	10	
		2	11	
		2	16	
		2	17	
		2	18	
		4	22	
		4	23	
		4	24	
		4	25	
		4	26	
		4	32	
	4	33		
	4	34		
	4	35		
	H	H	1	128
			1	130
			1	132
			1	134
			2	136
			2	137
			2	138
			2	139
			2	144
			2	145
			2	146
			4	150
			4	151
	4	152		
	4	153		
4	154			
4	160			
4	161			
4	162			
4	163			
Paired	Paired	2	0	
		2	2	
		2	4	
		2	6	
		4	8	
		4	9	
		4	10	
		4	11	
		4	16	
		4	17	
		4	18	
		8	22	
		8	23	
		8	24	
8	25			
8	26			
8	32			
8	33			
8	34			
8	35			



n261				
Ant / Module Type	SISO/MIMO	Feed no.	Beam ID	
	& Polarization			
L Patch	V	1	1	
		1	3	
		1	5	
		1	7	
		2	12	
		2	13	
		2	14	
		2	15	
		2	19	
		2	20	
		2	21	
		4	27	
		4	28	
		4	29	
		4	30	
		4	31	
		4	36	
		4	37	
		4	38	
	4	39		
	H	H	1	129
			1	131
			1	133
			1	135
			2	140
			2	141
			2	142
			2	143
			2	147
			2	148
			2	149
			4	155
			4	156
			4	157
			4	158
			4	159
			Paired	Paired
	2	3		
	2	5		
2	7			
4	12			
4	13			
4	14			
4	15			
4	19			
4	20			
4	21			
8	27			
8	28			
8	29			
8	30			
8	31			
8	36			
8	37			
8	38			
8	39			



n261				
Ant / Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID	
Module 1 / Patch	V	1	0	
		1	2	
		1	4	
		1	6	
		2	8	
		2	9	
		2	10	
		2	11	
		2	16	
		2	17	
		2	18	
		4	22	
		4	23	
		4	24	
		4	25	
		4	26	
		4	32	
	4	33		
	4	34		
	4	35		
	H	H	1	128
			1	130
			1	132
			1	134
			2	136
			2	137
			2	138
			2	139
			2	144
			2	145
			2	146
			4	150
			4	151
			4	152
	4	153		
4	154			
4	160			
4	161			
4	162			
4	163			
Paired	Paired	2	0	
		2	2	
		2	4	
		2	6	
		4	8	
		4	9	
		4	10	
		4	11	
		4	16	
		4	17	
		4	18	
		8	22	
		8	23	
		8	24	
8	25			
8	26			
8	32			
8	33			
8	34			
8	35			

4.3 PD design target determination

To account for total uncertainty, PD_design_target should meet the criteria:

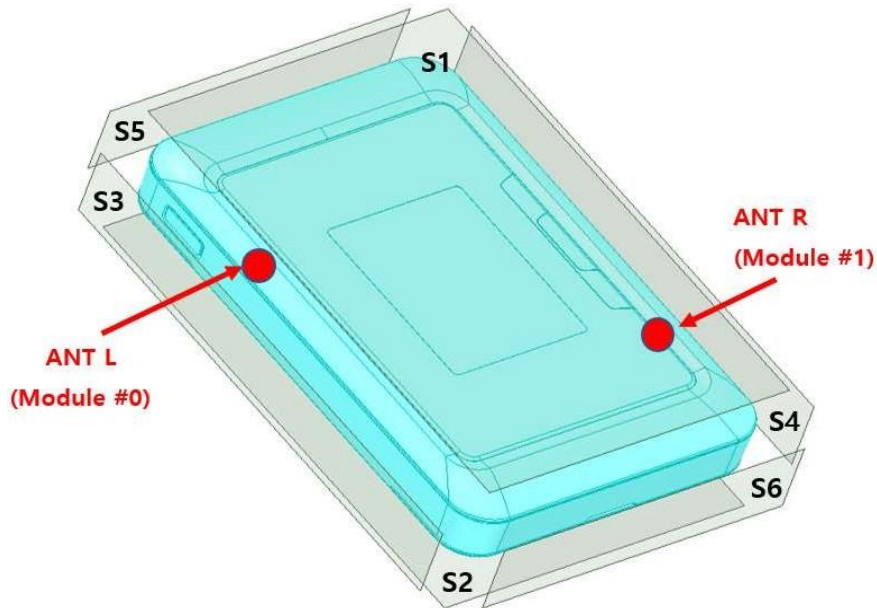
$$PD_design_target < PD_{regulatory_limit} \times 10^{\frac{-totaluncertainty}{10}}$$

For this EUT, the PD design target and the uncertainty value are listed below

n260 / n261	PD design target	Antenna Module	W/m ²
		Antenna Module 0/1	2.7

Item	Uncertainty dB (k=2)
Total uncertainty	2.1

4.4 Exposure positions for PD evaluation



Evaluation positions

Front view	Front	Back	Left side	Right side	Top side	Bottom side
	S1	S2	S3	S4	S5	S6
Module 0	V	V	-	V	-	-
Module 1	V	V	-	V	V	-

Remark:

1. Referring to the PD simulation report for the reason of selecting surfaces/edges.
2. The exposure positions selection is based on the all edges and surfaces of the device with a transmitting antenna located within 25 mm from that surface or edge.



4.5 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. Following Table includes a summary of the validation results to support worst-case housing influence quantification in power density characterization for this model With an input power of 6 dBm for n261 and n260 band, PD measurements are conducted for at least one single beam per antenna type and per antenna module (0,1) on worst-surface(s) . PD measurements are performed at mid channel of each mmW band and with CW modulation. PD value will be used to determine worst-case housing influence for conservative assessment

Band	Antenna Module	Beam ID 1	Beam ID 2	Frequency (GHz)	Exposure Surface	Test Separation	Modulation	Measured results Savg tot 4cm^2 (W/m2)	Simulated Pd averaged over 4cm^2 (W/m2)	Sim vs meas (dB)
n260	Module 0	36	-	38.5	Front (S1)	10mm	CW	3.59	7.58	3.246
n260	Module 0	36	-	38.5	Left (S3)	10mm	CW	1.55	4.24	4.370
n260	Module 0	-	157	38.5	Front (S1)	10mm	CW	2.12	7.49	5.481
n260	Module 0	-	164	38.5	Left (S3)	10mm	CW	3.04	5.06	2.213
n260	Module 1	22	-	38.5	Front (S1)	10mm	CW	2.38	7.42	4.938
n260	Module 1	32	-	38.5	Right (S4)	10mm	CW	1.9	4.1	3.340
n260	Module 1	-	161	38.5	Front (S1)	10mm	CW	1.41	7.77	7.412
n260	Module 1	-	160	38.5	Right (S4)	10mm	CW	2.32	5.35	3.629
n261	Module 0	28	-	27.925	Front (S1)	10mm	CW	2.61	5.54	3.269
n261	Module 0	28	-	27.925	Left (S3)	10mm	CW	2.39	4.18	2.428
n261	Module 0	-	159	27.925	Front (S1)	10mm	CW	3.23	6.69	3.162
n261	Module 0	-	159	27.925	Left (S3)	10mm	CW	2.98	5.68	2.801
n261	Module 1	23	-	27.925	Front (S1)	10mm	CW	3.76	4.95	1.194
n261	Module 1	23	-	27.925	Right (S4)	10mm	CW	3.05	4.19	1.379
n261	Module 1	-	161	27.925	Front (S1)	10mm	CW	1.18	6.48	7.397
n261	Module 1	-	161	27.925	Right (S4)	10mm	CW	1.04	5.82	7.479

4.6 PD Char

4.7 Simulated input power limit for single beams

Perform simulation at low, mid and high channel for each mmW band supported, with a given input power per active port, *sim.input.power.per.active.port* (6 dBm for this product):

1. Obtain $PD_{surface}$ value (the worst PD among all identified surfaces of the device) at all three channels for all single beams (1~M) specified in *codebook_sim*.
2. Adjust input power to determine a scaling factor at all three channels by:

$$s(i)_{low_or_mid_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)}, i = 1, 2, \dots, M \quad (4)$$

3. Determine the worst-case scaling factor among low, mid and high channels:

$$s(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, i = 1, 2, \dots, M \quad (5)$$

Note: This scaling factor applies to the input power at each antenna port

4. Determine the simulated input power limit, *sim.powerlimit*, for single beam *i* by:

$$sim.\ power_{limit.(i)}dBm = 10 * \log(s(i)) + sim.input.power.per.active.port, i = 1, 2, \dots, M \quad (6)$$

4.8 Simulated input power limit for beam pairs

The relative phase between single beams of a beam pair is swepted to find the worst case PD for beam-pairs operation, and PD simulation data has taken this into consideration for beam-pair operations take consideration of the variation relative phase was reported

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

For a given beam pair containing *beam_a* and *beam_b* with relative phase ϕ and for a given channel, determine the worst-case $\phi_{worstcase}$ which results in the highest total PD (ϕ) among all identified surfaces for this beam pair at this channel. When $\phi_{worstcase}$ is determined for all three channels, obtain the scaling factor given by the below equation for low, mid and high channels:

$$s(i)_{low_or_mid_high} = \frac{PD\ design\ target}{total.PD(\phi(i)_{worstcase})}, i = M+1, M+2, \dots N \quad (8)$$

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

$$s(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, i = M+1, M+2, \dots N \quad (9)$$

The simulated input power limit, $sim.power_{limit}$, for beam pair i can be determined by

$$sim.power_{limit}(i)dBm = 10 * \log(s(i)) + sim.input.power.per.active.port, i = M+1, M+2, \dots N \quad (10)$$

4.9 Worst-case housing influence determination

Referring to the PD simulation report for PD simulation data for all beams . For non-metal material, the material property cannot be accurately characterized at mmW frequencies. The estimated material property for the device housing is used in the simulation model, which could impact 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.

Referring to the PD simulation report for PD simulation data for all beams, and the worst beams are selected to be tested Power density simulation for all

The mmW antenna modules are placed at different locations and only surrounding material/housing has impact on EM field propagation and in turn power density, and depending on the type of 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 procedure to determine worst-case housing influence, denoted as Δ_{min} :

1. Based on PD simulation, determine one or more worst-surface(s) that contains all the highest 4cm²-averaged PD for each of the 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) in Step 1, and then follow the procedures described in Section 4.6 to derive *input.power.limit* corresponding to *PD_design_target* for all the beams
 - b. Then prove all other surface(s) near-by the mmW module, i.e., surface(s) not selected in Step 1, is not required for housing material loss quantification (in other words, these nonevaluated surfaces have no influence on the determined *input.power.limit*) by:
 - i. Scale the simulated 4cm²-averaged PD values for all single beams to correspond to their *sim.power.limit*, and identify the worst-PD beam per each non-selected surface.
 - ii. Measure 4cm²-averaged PD at *input.power.limit* for the identified worst-PD beam at each non-selected surface
 - iii. Demonstrate all measured 4cm²-averaged PD values are below *PD_design_target*.
3. If any of the above surface(s) in Step (2.b.iii) have measured 4cm²-averaged PD \geq *PD_design_target*, then those surfaces must be included in the Δ_{min} determination in Step (2.a), and follow the procedures in Section 4.6 to re-evaluate *input.power.limit* with these added surfaces.

Therefore, when comparing a simulated 4cm²-averaged PD and measured 4cm²-averaged PD for the above identified surfaces, the worst errors introduced when using the estimated material property in the simulation per module and per antenna type (worst out of both polarizations) is highlighted in bolded numbers in section 4.5. Thus, the worst-case housing influence, denoted as Δ_{min} (= minimum of (sim.PD – meas.PD) for the same antenna type of each module), is determined as:

Band	Antenna	Δ_{min} (dB)	
		AG0 Polarization	AG1 Polarization
n260	0	3.25	2.21
	1	3.34	3.63
n261	0	2.43	2.80
	1	1.19	7.40

Δ_{min} represents the worst case where RF exposure is underestimated the most by simulation upon using the estimated material property for glass/plastics of the housing. For conservative assessment, the Δ_{min} is used as the worst case correction and applied to each corresponding beam group to determine power limits in PD char for compliance. To ensure that condition described in Step (2.b.iii) is met, apply the correct *input.power.limit* to derive the PD simulated results for all beams, and select the worst beams (yellow highlighted in the PD table) for each of non-selected applicable surface(s).

The PD test results for non-selected surfaces are less than *PD_design_target*, and meets condition in Step (2.b.iii), thus performing Step (3) is not needed



Simulated 4cm²-averaged PD at input.power.limit
 Determine the worst beam for each of non-selected surface(s)

<n260>

n260										
Ant Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID		Simulated 4cm 2 SAPD (W/m 2) corresponding to PD_design_target_mid channel					
					(S1) Front Surface	(S2) Rear Surface	(S3) Left Surface	(S4) Right Surface	(S5) Top Surface	(S6) Bottom Surface
Module 0 / Patch	V	1	1		2.70	0.11	0.99	0.02	0.09	0.04
		1	3		2.60	0.09	1.56	0.02	0.15	0.03
		1	5		2.33	0.12	1.15	0.02	0.15	0.02
		1	7		2.70	0.09	1.45	0.03	0.10	0.03
		2	12		2.70	0.13	1.14	0.02	0.23	0.01
		2	13		2.70	0.12	1.66	0.01	0.11	0.05
		2	14		2.38	0.08	1.40	0.01	0.17	0.03
		2	15		2.70	0.12	1.65	0.02	0.27	0.01
		2	19		2.69	0.15	1.73	0.01	0.18	0.04
		2	20		2.62	0.11	1.55	0.01	0.05	0.04
		2	21		2.38	0.07	1.36	0.02	0.08	0.04
		4	27		2.70	0.16	1.43	0.02	0.09	0.02
		4	28		2.70	0.19	1.46	0.02	0.22	0.04
		4	29		2.68	0.16	1.75	0.02	0.06	0.04
		4	30		2.45	0.25	1.09	0.03	0.26	0.06
		4	31		2.62	0.09	1.10	0.03	0.12	0.01
		4	36		2.70	0.16	1.51	0.01	0.09	0.02
		4	37		2.51	0.13	1.71	0.03	0.14	0.05
		4	38		2.20	0.14	1.25	0.02	0.06	0.06
	4	39	2.70	0.13	1.14	0.03	0.17	0.03		
		H	1	129	2.52	0.13	1.58	0.02	0.04	0.04
			1	131	2.38	0.08	1.24	0.02	0.13	0.05
			1	133	2.49	0.09	1.52	0.02	0.16	0.05
			1	135	2.70	0.08	1.83	0.02	0.08	0.05
			2	140	2.70	0.13	2.12	0.02	0.17	0.02
			2	141	2.21	0.09	1.40	0.02	0.09	0.05
			2	142	2.53	0.16	1.12	0.02	0.05	0.07
			2	143	2.44	0.10	1.55	0.02	0.11	0.04
			2	147	2.38	0.10	1.93	0.02	0.17	0.02
			2	148	2.62	0.10	1.89	0.01	0.05	0.03
			2	149	2.47	0.18	1.69	0.02	0.05	0.12
			4	155	2.28	0.15	2.46	0.02	0.12	0.03
			4	156	2.62	0.12	1.77	0.02	0.16	0.02
			4	157	2.48	0.10	1.54	0.01	0.06	0.04
			4	158	2.46	0.21	1.66	0.01	0.04	0.09
			4	159	2.69	0.16	2.45	0.02	0.13	0.04
			4	164	2.57	0.13	2.07	0.01	0.18	0.02
			4	165	2.61	0.10	1.63	0.01	0.10	0.04
		4	166	2.54	0.14	1.65	0.01	0.04	0.05	
	4	167	2.41	0.22	1.54	0.02	0.10	0.10		



<n260>

n260											
Ant Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID		Simulated 4cm 2 SAPD (W/m 2) corresponding to PD_design_target_mid channel						
					(S1) Front Surface	(S2) Rear Surface	(S3) Left Surface	(S4) Right Surface	(S5) Top Surface	(S6) Bottom Surface	
Module 1 / Patch	V	1	0		2.70	0.06	0.03	1.31	0.02	0.27	
		1	2		2.44	0.14	0.05	1.16	0.02	0.54	
		1	4		2.70	0.09	0.04	1.62	0.02	0.36	
		1	6		2.70	0.08	0.02	1.11	0.02	0.13	
		2	8		2.69	0.17	0.03	1.11	0.01	0.59	
		2	9		2.69	0.09	0.03	1.69	0.02	0.17	
		2	10		2.38	0.08	0.03	1.71	0.04	0.38	
		2	11		2.70	0.17	0.04	1.21	0.01	0.78	
		2	16		2.68	0.08	0.03	1.77	0.01	0.29	
		2	17		2.28	0.06	0.03	1.49	0.04	0.10	
		2	18		2.46	0.08	0.04	1.51	0.02	0.25	
		4	22		2.70	0.09	0.04	1.48	0.01	0.26	
		4	23		2.44	0.09	0.03	1.50	0.02	0.49	
		4	24		2.45	0.07	0.03	1.50	0.02	0.09	
		4	25		2.70	0.18	0.03	1.07	0.04	0.47	
		4	26		2.66	0.11	0.03	1.29	0.01	0.42	
		4	32		2.70	0.15	0.03	1.60	0.01	0.42	
		4	33		2.44	0.09	0.03	1.52	0.02	0.44	
		4	34		1.92	0.08	0.03	1.29	0.05	0.25	
		4	35		2.70	0.15	0.04	0.96	0.01	0.55	
		H	1		128	2.70	0.08	0.03	1.32	0.05	0.29
			1		130	2.70	0.07	0.04	1.61	0.04	0.35
			1		132	2.28	0.10	0.05	1.18	0.03	0.10
			1		134	2.52	0.09	0.02	1.75	0.02	0.11
			2		136	2.31	0.19	0.04	2.05	0.01	0.22
			2		137	2.43	0.07	0.03	1.42	0.03	0.15
			2		138	2.70	0.09	0.02	1.76	0.07	0.12
			2		139	2.70	0.12	0.05	2.25	0.09	0.75
			2		144	2.25	0.08	0.04	1.93	0.04	0.22
			2		145	2.59	0.09	0.04	1.44	0.04	0.10
			2		146	2.70	0.11	0.03	1.93	0.10	0.53
			4		150	2.54	0.18	0.04	2.70	0.03	0.63
			4		151	2.70	0.13	0.03	1.69	0.02	0.25
			4		152	2.62	0.17	0.03	1.70	0.03	0.07
			4		153	2.55	0.18	0.03	1.30	0.09	0.09
	4		154	2.48	0.09	0.03	2.22	0.04	0.41		
	4		160	2.46	0.10	0.03	2.11	0.02	0.40		
	4		161	2.70	0.14	0.03	1.67	0.04	0.12		
	4		162	2.69	0.20	0.03	1.74	0.06	0.08		
	4		163	2.70	0.25	0.04	2.24	0.05	0.48		



<n261>

n261											
Ant. Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID		Simulated 4cm 2 SAPD (W/m 2) corresponding to PD_design_target_mid channel						
					(S1) Front Surface	(S2) Rear Surface	(S3) Left Surface	(S4) Right Surface	(S5) Top Surface	(S6) Bottom Surface	
Module 0 / Patch	V	1	1		2.70	0.27	1.71	0.03	0.07	0.03	
		1	3		2.66	0.48	1.83	0.02	0.07	0.04	
		1	5		2.57	0.22	1.55	0.02	0.15	0.04	
		1	7		2.64	0.28	1.61	0.04	0.09	0.04	
		2	12		2.66	0.19	1.81	0.05	0.19	0.09	
		2	13		2.61	0.32	1.84	0.01	0.06	0.01	
		2	14		2.54	0.67	1.67	0.04	0.16	0.04	
		2	15		2.63	0.22	1.76	0.03	0.05	0.03	
		2	19		2.64	0.50	1.85	0.04	0.05	0.02	
		2	20		2.64	0.67	1.67	0.03	0.31	0.07	
		2	21		2.70	0.29	2.04	0.03	0.05	0.03	
		4	27		2.28	0.33	2.16	0.04	0.30	0.05	
		4	28		2.70	0.33	2.04	0.02	0.04	0.02	
		4	29		2.67	0.75	1.84	0.04	0.19	0.07	
		4	30		2.60	0.65	1.30	0.07	0.32	0.07	
		4	31		2.56	0.36	1.78	0.03	0.12	0.03	
		4	36		2.64	0.36	1.82	0.05	0.11	0.06	
		4	37		2.67	0.31	1.92	0.02	0.05	0.02	
		4	38		2.59	0.70	1.53	0.08	0.29	0.09	
	4	39		2.68	0.48	1.56	0.04	0.23	0.05		
		H	1		129	2.48	0.33	1.75	0.03	0.08	0.06
			1		131	2.54	0.20	1.55	0.02	0.09	0.05
			1		133	2.58	0.40	2.13	0.02	0.09	0.02
			1		135	2.51	0.45	1.79	0.06	0.09	0.02
			2		140	2.63	0.74	1.47	0.05	0.10	0.08
			2		141	2.45	0.48	2.07	0.03	0.02	0.01
			2		142	2.49	0.73	1.31	0.05	0.13	0.09
			2		143	2.66	0.13	1.88	0.03	0.10	0.03
			2		147	2.53	0.41	1.99	0.03	0.05	0.05
			2		148	2.56	0.25	2.21	0.03	0.05	0.02
			2		149	2.57	0.31	1.91	0.05	0.17	0.08
			4		155	2.70	1.22	1.63	0.11	0.28	0.18
			4		156	2.60	0.91	2.57	0.05	0.08	0.01
			4		157	2.68	0.19	2.23	0.04	0.07	0.01
			4		158	2.70	0.16	2.32	0.03	0.14	0.02
			4		159	2.70	0.18	2.29	0.03	0.10	0.02
			4		164	2.55	0.97	1.75	0.04	0.08	0.07
			4		165	2.64	0.28	2.15	0.03	0.03	0.01
		4		166	2.69	0.20	2.49	0.06	0.15	0.06	
	4		167	2.70	0.16	2.31	0.03	0.16	0.03		



<n261>

n261 PD Simulation											
Ant Ant. Module Type	SISO/MIMO & Polarization	Feed no.	Beam ID		Simulated 4cm 2 SAPD (W/m 2) corresponding to PD_design_target_mid channel						
					(S1)	(S2)	(S3)	(S4)	(S5)	(S6)	
					Front Surface	Rear Surface	Left Surface	Right Surface	Top Surface	Bottom Surface	
R Patch	V	1	0		2.60	0.30	0.06	1.57	0.04	0.22	
		1	2		2.55	0.25	0.08	1.64	0.04	0.25	
		1	4		2.61	0.34	0.07	2.18	0.02	0.20	
		1	6		2.70	0.25	0.06	1.40	0.03	0.16	
		2	8		2.66	0.17	0.10	1.86	0.04	0.35	
		2	9		2.58	0.32	0.05	1.74	0.01	0.13	
		2	10		2.68	0.21	0.07	2.16	0.02	0.23	
		2	11		2.64	0.61	0.08	1.62	0.14	0.97	
		2	16		2.54	0.20	0.08	1.79	0.01	0.08	
		2	17		2.62	0.53	0.04	1.71	0.07	0.57	
		2	18		2.62	0.50	0.12	1.90	0.03	0.40	
		4	22		2.61	0.27	0.09	1.92	0.05	0.33	
		4	23		2.60	0.26	0.06	2.20	0.01	0.10	
		4	24		2.62	0.39	0.08	1.72	0.04	0.25	
		4	25		2.68	0.42	0.11	1.62	0.04	0.44	
		4	26		2.61	0.25	0.13	1.94	0.07	0.76	
		4	32		2.64	0.25	0.06	1.99	0.03	0.18	
		4	33		2.64	0.46	0.06	2.01	0.02	0.15	
		4	34		2.60	0.40	0.10	1.68	0.04	0.58	
	4	35		2.54	0.25	0.12	1.72	0.03	0.37		
		H	1		128	2.68	0.36	0.10	2.17	0.05	0.29
			1		130	2.63	0.37	0.12	2.53	0.02	0.30
			1		132	2.62	0.27	0.08	1.54	0.02	0.29
			1		134	2.67	0.28	0.03	1.63	0.03	0.18
			2		136	2.56	0.68	0.19	2.05	0.06	0.42
			2		137	2.51	0.28	0.04	2.20	0.01	0.19
			2		138	2.56	0.18	0.07	2.67	0.06	0.24
			2		139	2.63	0.32	0.03	1.70	0.05	0.45
			2		144	2.56	0.38	0.16	2.36	0.02	0.27
			2		145	2.65	0.21	0.07	2.56	0.04	0.17
			2		146	2.57	0.77	0.23	1.97	0.08	0.77
			4		150	2.64	0.83	0.22	1.79	0.09	0.45
			4		151	2.55	0.34	0.08	2.17	0.00	0.04
			4		152	2.65	0.21	0.04	2.32	0.01	0.25
			4		153	2.70	0.46	0.13	2.30	0.17	0.52
	4			154	2.65	0.20	0.04	2.39	0.02	0.35	
	4		160	2.56	0.66	0.17	1.98	0.02	0.26		
	4		161	2.65	0.23	0.06	2.38	0.01	0.09		
	4		162	2.70	0.20	0.04	2.35	0.06	0.35		
	4		163	2.70	0.53	0.11	2.07	0.15	0.52		



4cm²-averaged PD for the selected beams on non-selected surfaces for Δ_{min} determination

Band	Antenna Module	Beam ID 1	Beam ID 2	Frequency (GHz)	Exposure Surface	Input Power limit	Test Separation	Modulation	Measured results Savg inc 4cm ² (W/m ²)	Measured results Savg tot 4cm ² (W/m ²)	Epeak [V/m]	Hpeak [A/m]
n260	Module 0	-	158	38.5	Back (S2)	4.16	10mm	CW	0.168	0.182	10.4	0.031
n260	Module 0	-	164	38.5	Left (S3)	3.83	10mm	CW	2.08	2.23	40.6	0.111
n260	Module 0	31	-	38.5	Right (S4)	5.29	10mm	CW	0.084	0.118	12.8	0.037
n260	Module 0	-	164	38.5	Top (S5)	3.83	10mm	CW	0.055	0.063	8.13	0.027
n260	Module 0	-	158	38.5	Bottom (S6)	4.16	10mm	CW	0.074	0.081	8.77	0.027
n260	Module 1	-	162	38.5	Back (S2)	5.46	10mm	CW	0.044	0.049	7.07	0.019
n260	Module 1	22	-	38.5	Left (S3)	4.45	10mm	CW	0.058	0.065	8.56	0.027
n260	Module 1	-	160	38.5	Right (S4)	5.1	10mm	CW	2.19	2.36	44.1	0.105
n260	Module 1	-	153	38.5	Top (S5)	5.73	10mm	CW	0.04	0.046	6.85	0.023
n260	Module 1	35	-	38.5	Bottom (S6)	5.37	10mm	CW	0.077	0.09	14.1	0.037
n261	Module 0	-	164	27.925	Back (S2)	5.77	10mm	CW	0.594	0.632	0	0.059
n261	Module 0	-	159	27.925	Left (S3)	4.36	10mm	CW	2.15	2.25	39	0.103
n261	Module 0	-	155	27.925	Right (S4)	8.78	10mm	CW	0.182	0.208	14.6	0.037
n261	Module 0	27	-	27.925	Top (S5)	7.31	10mm	CW	0.301	0.315	16.7	0.051
n261	Module 0	-	155	27.925	Bottom (S6)	8.78	10mm	CW	0.06	0.064	8.84	0.024
n261	Module 1	-	160	27.925	Back (S2)	10.47	10mm	CW	1.29	1.43	31.9	0.084
n261	Module 1	-	150	27.925	Left (S3)	11.47	10mm	CW	0.354	0.373	19.2	0.055
n261	Module 1	-	161	27.925	Right (S4)	9.01	10mm	CW	3	3.3	45.2	0.123
n261	Module 1	-	163	27.925	Top (S5)	12.26	10mm	CW	0.043	0.059	8.92	0.037
n261	Module 1	26	-	27.925	Bottom (S6)	5.84	10mm	CW	0.57	0.603	19.3	0.055

4.10 PD Char

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

4.11 PD char generation

Ideally, if there is no uncertainty associated with hardware as described in Section 4.4, after accounting for the housing influence (Δ_{min}), *input.power.limit(i)*, for beam *i* can be obtained:

$$input.power.limit(i) = 6\text{ dBm} + 10 * \log(s(i)) + \Delta_{min}, i \in \text{all beams} \quad (11)$$

If simulation overestimates the housing influence, then Δ_{min} (= minimum {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 loss, then Δ_{min} is positive (measured PD would be lower than the simulated value). Input power to antenna elements determined via simulation can be increased and still be PD compliant.

In reality, the hardware design has uncertainty which must be properly considered in equation (11). In Section 4.7, the TxAGC uncertainty at reference power level (6dBm in report) is embedded in the process of Δ_{min} determination and should be removed to avoid double counting this uncertainty.

If -TxAGC uncertainty at reference power level < Δ_{min} < TxAGC uncertainty at reference power level,

$$Input.power.limit(i) = sim.power_{limit}(i), i = 1,2,...,N \quad (12)$$

else if Δ_{min} < -TxAGC uncertainty at reference power level,

$$Input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} + TxAGC\ uncertainty), i = 1,2,...,N \quad (13)$$

else if Δ_{min} > TxAGC uncertainty at reference power level,

$$Input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} - TxAGC\ uncertainty), i = 1,2,...,N \quad (14)$$

The input power limit is derived and listed in the table below

AG0 Polarization				
Band	Antenna Module	Δ_{min} (dB)	TxAGC uncertainty (dB)	Input.power.limit (dBm)
n260	0	3.26	0.5	$6 + 10^* \log(s(i)) + 2.76$
	1	3.34	0.5	$6 + 10^* \log(s(i)) + 2.84$
n261	0	2.43	0.5	$6 + 10^* \log(s(i)) + 1.93$
	1	1.19	0.5	$6 + 10^* \log(s(i)) + 0.69$

AG1 Polarization				
Band	Antenna Module	Δ_{min} (dB)	TxAGC uncertainty (dB)	Input.power.limit (dBm)
n260	0	2.21	0.5	$6 + 10^* \log(s(i)) + 1.71$
	1	3.63	0.5	$6 + 10^* \log(s(i)) + 3.13$
n261	0	2.80	0.5	$6 + 10^* \log(s(i)) + 2.30$
	1	7.40	0.5	$6 + 10^* \log(s(i)) + 6.90$



4.12 PD char Table

Combining the information in previous sections, PD char is derived and listed below

n260				
Ant / Module Type	SISO/MIMO & Polarization	Input Power Limit (dBm)	Feed no.	Beam ID
Module 0 / Patch	V	11.24	1	1
		11.10	1	3
		11.05	1	5
		10.46	1	7
		7.45	2	12
		7.35	2	13
		7.51	2	14
		8.71	2	15
		8.17	2	19
		7.24	2	20
		6.96	2	21
		4.64	4	27
		5.92	4	28
		6.22	4	29
		6.25	4	30
		5.29	4	31
		4.26	4	36
		5.81	4	37
		5.44	4	38
	5.31	4	39	
	11.20	1		129
	9.80	1		131
	10.24	1		133
	9.62	1		135
	8.33	2		140
	6.65	2		141
	7.14	2		142
	6.55	2		143
	7.57	2		147
	5.88	2		148
	7.48	2		149
	5.14	4		155
	3.61	4		156
	2.92	4		157
	4.16	4		158
	5.18	4		159
	3.83	4		164
	3.25	4		165
	3.20	4		166
	4.94	4		167
4.82	2	1	129	
4.39	2	3	131	
4.45	2	5	133	
4.08	2	7	135	
2.70	4	12	140	
1.16	4	13	141	
1.44	4	14	142	
1.28	4	15	143	
0.68	4	19	147	
0.99	4	20	148	
1.61	4	21	149	
-0.68	8	27	155	
-1.02	8	28	156	
-1.81	8	29	157	
-1.53	8	30	158	
-0.96	8	31	159	
-1.78	8	36	164	
-1.70	8	37	165	
-1.36	8	38	166	
-0.89	8	39	167	



n260						
Ant / Module Type	SISO/MIMO & Polarization	Input Power Limit (dBm)	Feed no.	Beam ID		
Module 1 / Patch	V	10.60	1	0		
		11.22	1	2		
		11.45	1	4		
		11.66	1	6		
		7.28	2	8		
		7.84	2	9		
		8.59	2	10		
		7.60	2	11		
		8.34	2	16		
		7.54	2	17		
		7.40	2	18		
		4.45	4	22		
		5.92	4	23		
		5.25	4	24		
		5.73	4	25		
		5.55	4	26		
		4.74	4	32		
		5.77	4	33		
	5.70	4	34			
	5.37	4	35			
		H	10.99	1	128	
			11.60	1	130	
			11.54	1	132	
			12.58	1	134	
			9.50	2	136	
			8.36	2	137	
			7.98	2	138	
			10.02	2	139	
			8.60	2	144	
			8.63	2	145	
			9.55	2	146	
			6.62	4	150	
			4.80	4	151	
			4.98	4	152	
		5.73	4	153		
		5.78	4	154		
		5.10	4	160		
		4.54	4	161		
		5.46	4	162		
		7.03	4	163		
		Paired	4.03	2	0	128
			4.45	2	2	130
			4.67	2	4	132
			5.16	2	6	134
			2.47	4	8	136
	1.16		4	9	137	
	0.56		4	10	138	
	1.29		4	11	139	
	2.19		4	16	144	
	2.54		4	17	145	
	1.55		4	18	146	
	-0.89		8	22	150	
	-1.95		8	23	151	
	-1.87	8	24	152		
	-1.63	8	25	153		
	-0.44	8	26	154		
	-1.59	8	32	160		
	-1.82	8	33	161		
	-1.91	8	34	162		
	-0.73	8	35	163		



n261					
Ant / Module Type	SISO/MIMO	Input Power Limit (dBm)	Feed no.	Beam ID	
	& Polarization				
L Patch	V	13.27	1	1	
		11.31	1	3	
		10.54	1	5	
		10.66	1	7	
		8.19	2	12	
		6.43	2	13	
		8.78	2	14	
		6.24	2	15	
		8.08	2	19	
		9.66	2	20	
		8.13	2	21	
		7.31	4	27	
		4.81	4	28	
		6.50	4	29	
		8.19	4	30	
		6.01	4	31	
		6.21	4	36	
		4.81	4	37	
		8.04	4	38	
	6.99	4	39		
	12.75	1		129	
	10.80	1		131	
	12.05	1		133	
	11.65	1		135	
	10.57	2		140	
	7.02	2		141	
	10.82	2		142	
	7.89	2		143	
	8.17	2		147	
	7.54	2		148	
	9.43	2		149	
	8.78	4		155	
	6.74	4		156	
	4.39	4		157	
	4.49	4		158	
	4.36	4		159	
	5.77	4		164	
	4.36	4		165	
	6.93	4		166	
	5.18	4		167	
	6.67	2	1	129	
	5.06	2	3	131	
	5.10	2	5	133	
	5.10	2	7	135	
	2.87	4	12	140	
	1.05	4	13	141	
3.54	4	14	142		
2.89	4	15	143		
3.17	4	19	147		
2.89	4	20	148		
3.86	4	21	149		
1.31	8	27	155		
-0.81	8	28	156		
-0.90	8	29	157		
0.30	8	30	158		
-0.49	8	31	159		
0.00	8	36	164		
-1.65	8	37	165		
2.00	8	38	166		
0.30	8	39	167		
	Paired				



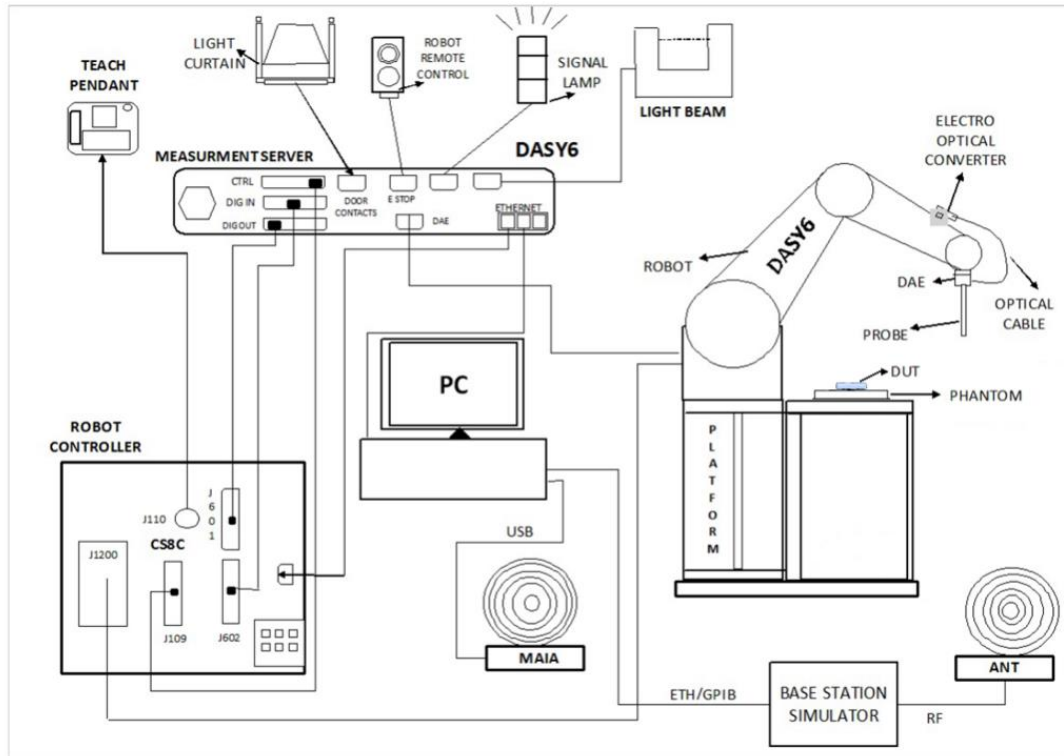
n261					
Ant / Module Type	SISO/MIMO & Polarization	Input Power Limit (dBm)	Feed no.	Beam ID	
Module 1 / Patch	V	9.74	1	0	
		9.48	1	2	
		10.25	1	4	
		11.61	1	6	
		6.15	2	8	
		5.47	2	9	
		7.33	2	10	
		9.77	2	11	
		5.03	2	16	
		7.95	2	17	
		7.85	2	18	
		5.00	4	22	
		3.89	4	23	
		4.52	4	24	
		5.55	4	25	
		5.84	4	26	
		4.36	4	32	
		3.97	4	33	
	5.52	4	34		
	4.52	4	35		
	16.68	1		128	
	16.84	1		130	
	15.69	1		132	
	17.77	1		134	
	14.49	2		136	
	11.96	2		137	
	13.50	2		138	
	14.20	2		139	
	12.51	2		144	
	12.80	2		145	
	15.72	2		146	
	11.47	4		150	
	9.18	4		151	
	9.39	4		152	
	13.50	4		153	
	10.00	4		154	
	10.47	4		160	
	9.01	4		161	
	10.65	4		162	
	12.26	4		163	
	5.53	2	0	128	
	5.31	2	2	130	
	5.44	2	4	132	
	6.85	2	6	134	
	2.45	4	8	136	
0.89	4	9	137		
3.35	4	10	138		
3.95	4	11	139		
0.82	4	16	144		
2.55	4	17	145		
3.49	4	18	146		
0.39	8	22	150		
-1.72	8	23	151		
-0.32	8	24	152		
1.36	8	25	153		
0.85	8	26	154		
-0.58	8	32	160		
-1.97	8	33	161		
0.87	8	34	162		
0.95	8	35	163		
	Paired				

5. PD Test Setup

5.1 PD Test – System Setup

The system to be used for the near field power density measurement

- SPEAG DASY6 system
 - SPEAG cDASY6 5G module software
 - EUmmWVx probe
- 5G Phantom cover



5.2 Test Side Location

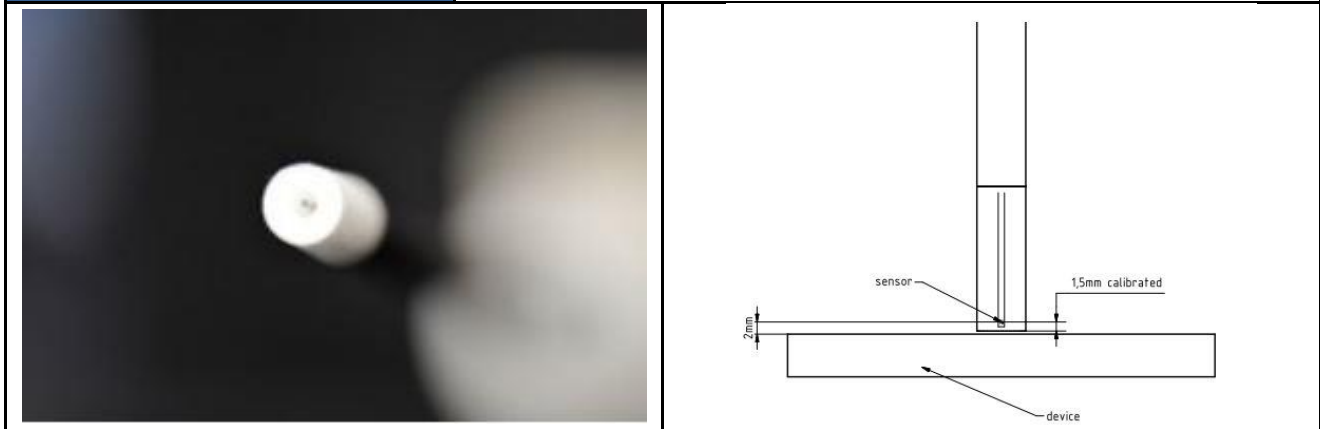
Sporton Lab and below test site location are accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory TW1190
Test Site Location	No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, CHINESE TAIPEI
Test Site No.	SAR06-HY

5.3 EUmmWave Probe / E-Field 5G Probe

The probe design allows measurements at distances as small as 2 mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm.

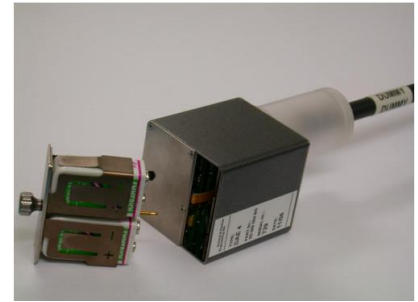
Frequency	750 MHz – 110 GHz
Probe Overall Length	320 mm
Probe Body Diameter	8.0 mm
Tip Length	23.0 mm
Tip Diameter	8.0 mm
Probe's two dipoles length	0.9 mm – Diode loaded
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Distance between diode sensors and probe's tip	1.5 mm
Minimum Mechanical separation between probe tip and a Surface	0.5 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction.
Compatibility	cDASY6 + 5G-Module SW1.0 and higher



5.4 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



5.5 Scan configuration

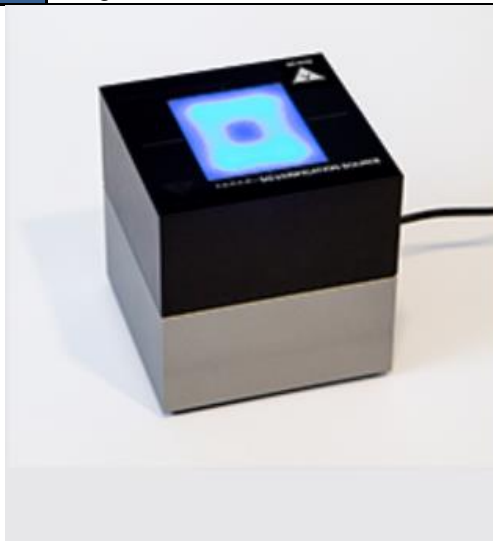
Fine-resolution scans on 2 different planes are performed to reconstruct the E- and H-fields as well as the power density; the z-distance between the 2 planes is set to $\lambda/4$.

The (x, y) grid step is also set $\lambda/4$, the grid extent is set to sufficiently large to identify the field pattern and the peak.

5.6 System Verification Source

The System Verification sources at 30 GHz and above comprise horn-antennas and very stable signal generators.

Model	Ka-band horn antenna
Calibrated frequency:	30 GHz at 10mm from the case surface
Frequency accuracy	± 100 MHz
E-field polarization	linear
Harmonics	-20 dBc
Total radiated power	14 dBm
Power stability	0.05 dB
Power consumption	5 W
Size	00 x 100 x 100 mm
Weight	1 kg

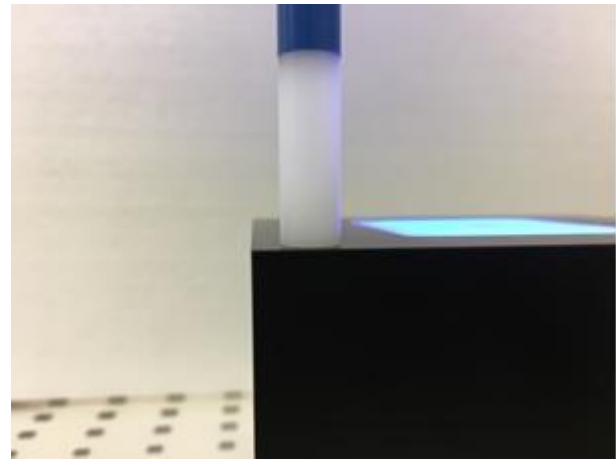
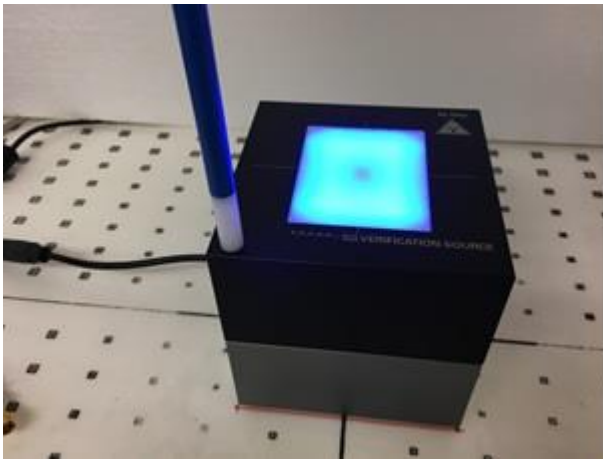


5.7 Power Density System Verification

The system performance check verifies that the system operates within its specifications. The EUT is replaced by a calibrated source, the same spatial resolution, measurement region and the test separation used in the calibration was applied to system check. Through visual inspection into the measured power density distribution, both spatially (shape) and numerically (level) have no noticeable difference. The measured results should be within 0.66B of the calibrated targets.

Frequency [GHz]	Grid step	Grid extent X/Y [mm]	Measurement points
10	0.25 ($\frac{\lambda}{4}$)	120/120	16 × 16
30	0.25 ($\frac{\lambda}{4}$)	60/60	24 × 24
60	0.25 ($\frac{\lambda}{4}$)	32.5/32.5	26 × 26
90	0.25 ($\frac{\lambda}{4}$)	30/30	36 × 36

Settings for measurement of verification sources



Verification Setup photo

5.8 System Verification Results

Frequency (GHz)	5G Verification Source	Probe S/N	DAE S/N	Distance (mm)	Measured 4 cm ² (W/m ²)	Targeted 4 cm ² (W/m ²)	Deviation (dB)	Date
30G	30GHz_1009	9441	656	10	26.7	25.9	0.13	2021/7/8
30G	30GHz_1009	9441	656	10	27.1	25.9	0.20	2021/7/17
30G	30GHz_1009	9441	656	10	27.2	25.9	0.21	2021/7/25
30G	30GHz_1009	9441	1311	10	26.5	25.9	0.10	2021/7/30
30G	30GHz_1009	9441	316	10	26.8	25.9	0.15	2021/9/3



6. Uncertainty Assessment

The budget is valid for evaluation distances $> \lambda/2\pi$. For specific tests and configurations, the Uncertainty could be considerably smaller.

Preliminary Module mmWave Uncertainty Budget Evaluation Distances to the Antennas $> \lambda / 2\pi$						
Error Description	Uncertainty Value (\pm dB)	Probability	Divisor	(Ci)	Standard Uncertainty (\pm dB)	(Vi) Veff
Measurement System						
Probe Calibration	0.49	N	1	1	0.49	∞
Hemispherical Isotropy	0.50	R	1.732	1	0.29	∞
Linearity	0.20	R	1.732	0	0.12	∞
System Detection Limits	0.04	R	1.732	1	0.02	∞
Modulation Response	0.40	R	1.732	1	0.23	∞
Readout Electronics	0.03	N	1	1	0.03	∞
Response Time	0.00	R	1.732	1	0.00	∞
Integration Time	0.00	R	1.732	1	0.00	∞
RF Ambient Noise	0.2	R	1.732	1	0.12	∞
RF Ambient Reflections	0.21	R	1.732	1	0.12	∞
Probe Positioner	0.04	R	1.732	1	0.02	∞
Probe Positioning	0.30	R	1.732	1	0.17	∞
S _{avg} Reconstruction	0.60	R	1.732	1	0.35	∞
Test Sample Related						
Power Drift	0.2	R	1.732	1	0.12	∞
Input Power	0	N	1	0	0.00	∞
Combined Std. Uncertainty					0.76 dB	∞
Coverage Factor for 95 %					K=2	
Expanded STD Uncertainty					1.52 dB	