RF Exposure Report

(Part 0: SAR and PD Char Evaluation)

FCC ID	**: 2ACCJN042**
Equipment	**: 5G NR/ LTE/WCDMA/GSM Mobile Phone**
Brand Name	**: TCL**
Model Name	**: T790S**
Applicant	**: TCL Communication Ltd 5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT, Hong Kong**
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.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

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History of this test report

Report No.	Version	Description	Issued Date
FA062326D	01	Initial issue of report	Aug. 06, 2020
FA062326D	02	Update section3.2	Aug. 24, 2020

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 sto 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 operat 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 (reffered 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	5G NR/ LTE/WCDMA/GSM Mobile Phone
FCC ID	2ACCJN042
Wireless Technology and Frequency Range	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band IV: 1710 MHz ~ 1755 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 7: 2500 MHz ~ 2570 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 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 n260: 37GHz ~ 40GHz 5G NR n261: 27.5GHz ~ 28.35GHz WLAN 2.4GHz Band: 2412 MHz ~ 2483.5 MHz WLAN 5.2GHz Band: 5150 MHz ~ 5250 MHz WLAN 5.3GHz Band: 5250 MHz ~ 5350 MHz WLAN 5.6GHz Band: 5470 MHz ~ 5725 MHz WLAN 5.8GHz Band: 5725 MHz ~ 5825 MHz Bluetooth: 2400 MHz ~ 2483.5 MHz NFC: 13.56 MHz
Mode	GSM/GPRS/EGPRS RMC/AMR 12.2Kbps HSDPA HSUPA DC-HSDPA 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 HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE NFC: ASK
EUT Stage	Production Unit

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

Exposure conditions	Trigger Conditions	DSI	SAR design target	W/kg	Remark
Head	Earpiece on	3	1g SAR design target	0.50	Only for GSM850
Head	Earpiece on	3	1g SAR design target	0.79	
Body Worn	n/a	1	1g SAR design target	0.79	
Extremity	n/a	1	10g SAR design target	2.49	
Hotspot	Hotspot om	2	1g SAR design target	0.79	

	Uncertainty dB (k=2)
Total uncertainty	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

Band	Antenna	Head	Hotspot	Body-Worn	Extremity	Pmax*
		DSI 3	DSI 2	DSI 1	DSI 1	
GSM850 (4 Tx slots)**	1	19.5	24.8	27.9	27.9	23.5
GSM1900 (2 Tx slots)**	2	28.4	24.0	21.6	21.6	20.0
WCDMA II	2	30.0	19.9	21.5	21.5	24.0
WCDMA IV	2	30.9	20.6	21.4	21.4	24.0
WCDMA V	1	22.3	24.2	27.6	27.6	24.0
LTE Band 2	2	30.6	20.0	21.5	21.5	24.0
LTE Band 2(1)	3	19.0	20.0	20.5	20.5	22.5
LTE Band 66&4	2	31.2	20.4	21.4	21.4	24.0
LTE Band 66(1)	3	19.0	21.5	21.0	21.0	23.0
LTE Band 5	1	22.8	24.0	27.7	27.7	24.0
LTE Band 7	2	31.1	20.2	22.2	22.2	24.0
LTE Band 12	1	21.6	24.2	26.7	26.7	24.0
LTE Band 13	1	21.0	24.4	26.9	26.9	24.0
LTE Band 48**	2	35.1	20.6	20.6	20.6	21.3
FR1 N2	3	19.0	20.5	22.0	22.0	24.0
FR1 N5	1	21.8	24.9	28.2	28.2	24.0
FR1 N66	3	21.0	22.5	23.5	23.5	24.0

(1) Ant 3 of LTE Band 2 and LTE Band 66 are transmission only for 5GNR EN-DC combination.

*Pmax is used for RF tune up procedure. The maximum allowed output power is equal to Pmax + device uncertainty.

**All Plimit 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 & LTE TDD & NR TDD).

The Plimit values, corresponding to SAR_design_target.

Maximum target power, P_{max}, is configured in NV settings in EUT to limit maximum transmitting power. This power is converted into peak power in NV settings for TDD schemes. The EUT maximum allowed output power is equal to P_{max} + 1.0dB device uncertainty

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.

Simulation modeling and validation

- Correlate the simulated PD distributions with measured PD distribution for the selected beams to validate simulation model

↓

Uncertainty Budget

- Calculate the total device design uncertainty to include worst case RF tune-up accuracy and device-to-device variation

↓

PD_design_target

Specify a power density design target, which should be less than power density regulatory limit to account for the total device design uncertainties

↓

Worst-case housing material Influence Quantification

- Determine

$$\Delta_{min} = \min\{\textit{simulated PD@8dBm} - \textit{measured PD@8dBm}\}$$

to quantify the worst-case housing influence

↓

PD Char Generation

- Use validated simulation approach to determine input power limit for all the beams after accounting for the worst-case housing influence

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.

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed
n260	1		QTM0	PATCH	1
n260	5		QTM0	PATCH	2
n260	6		QTM0	PATCH	2
n260	7		QTM0	PATCH	2
n260	10		QTM0	PATCH	2
n260	11		QTM0	PATCH	2
n260	17		QTM0	PATCH	4
n260	18		QTM0	PATCH	4
n260	19		QTM0	PATCH	4
n260	20		QTM0	PATCH	4
n260	21		QTM0	PATCH	4
n260	26		QTM0	PATCH	4
n260	27		QTM0	PATCH	4
n260	28		QTM0	PATCH	4
n260	29		QTM0	PATCH	4
n260		129	QTM0	PATCH	1
n260		133	QTM0	PATCH	2
n260		134	QTM0	PATCH	2
n260		135	QTM0	PATCH	2
n260		138	QTM0	PATCH	2
n260		139	QTM0	PATCH	2
n260		145	QTM0	PATCH	4
n260		146	QTM0	PATCH	4
n260		147	QTM0	PATCH	4
n260		148	QTM0	PATCH	4
n260		149	QTM0	PATCH	4
n260		154	QTM0	PATCH	4
n260		155	QTM0	PATCH	4
n260		156	QTM0	PATCH	4
n260		157	QTM0	PATCH	4
n260	1	129	QTM0	PATCH	1
n260	5	133	QTM0	PATCH	2
n260	6	134	QTM0	PATCH	2
n260	7	135	QTM0	PATCH	2
n260	10	138	QTM0	PATCH	2
n260	11	139	QTM0	PATCH	2
n260	17	145	QTM0	PATCH	4
n260	18	146	QTM0	PATCH	4
n260	19	147	QTM0	PATCH	4
n260	20	148	QTM0	PATCH	4
n260	21	149	QTM0	PATCH	4
n260	26	154	QTM0	PATCH	4
n260	27	155	QTM0	PATCH	4
n260	28	156	QTM0	PATCH	4
n260	29	157	QTM0	PATCH	4

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed
n260	0		QTM1	PATCH	1
n260	2		QTM1	PATCH	2
n260	3		QTM1	PATCH	2
n260	4		QTM1	PATCH	2
n260	8		QTM1	PATCH	2
n260	9		QTM1	PATCH	2
n260	12		QTM1	PATCH	4
n260	13		QTM1	PATCH	4
n260	14		QTM1	PATCH	4
n260	15		QTM1	PATCH	4
n260	16		QTM1	PATCH	4
n260	22		QTM1	PATCH	4
n260	23		QTM1	PATCH	4
n260	24		QTM1	PATCH	4
n260	25		QTM1	PATCH	4
n260		128	QTM1	PATCH	1
n260		130	QTM1	PATCH	2
n260		131	QTM1	PATCH	2
n260		132	QTM1	PATCH	2
n260		136	QTM1	PATCH	2
n260		137	QTM1	PATCH	2
n260		140	QTM1	PATCH	4
n260		141	QTM1	PATCH	4
n260		142	QTM1	PATCH	4
n260		143	QTM1	PATCH	4
n260		144	QTM1	PATCH	4
n260		150	QTM1	PATCH	4
n260		151	QTM1	PATCH	4
n260		152	QTM1	PATCH	4
n260		153	QTM1	PATCH	4
n260	0	128	QTM1	PATCH	1
n260	2	130	QTM1	PATCH	2
n260	3	131	QTM1	PATCH	2
n260	4	132	QTM1	PATCH	2
n260	8	136	QTM1	PATCH	2
n260	9	137	QTM1	PATCH	2
n260	12	140	QTM1	PATCH	4
n260	13	141	QTM1	PATCH	4
n260	14	142	QTM1	PATCH	4
n260	15	143	QTM1	PATCH	4
n260	16	144	QTM1	PATCH	4
n260	22	150	QTM1	PATCH	4
n260	23	151	QTM1	PATCH	4
n260	24	152	QTM1	PATCH	4
n260	25	153	QTM1	PATCH	4

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed
n261	1		QTM0	PATCH	1
n261	5		QTM0	PATCH	2
n261	6		QTM0	PATCH	2
n261	7		QTM0	PATCH	2
n261	10		QTM0	PATCH	2
n261	11		QTM0	PATCH	2
n261	17		QTM0	PATCH	4
n261	18		QTM0	PATCH	4
n261	19		QTM0	PATCH	4
n261	20		QTM0	PATCH	4
n261	21		QTM0	PATCH	4
n261	26		QTM0	PATCH	4
n261	27		QTM0	PATCH	4
n261	28		QTM0	PATCH	4
n261	29		QTM0	PATCH	4
n261		129	QTM0	PATCH	1
n261		133	QTM0	PATCH	2
n261		134	QTM0	PATCH	2
n261		135	QTM0	PATCH	2
n261		138	QTM0	PATCH	2
n261		139	QTM0	PATCH	2
n261		145	QTM0	PATCH	4
n261		146	QTM0	PATCH	4
n261		147	QTM0	PATCH	4
n261		148	QTM0	PATCH	4
n261		149	QTM0	PATCH	4
n261		154	QTM0	PATCH	4
n261		155	QTM0	PATCH	4
n261		156	QTM0	PATCH	4
n261		157	QTM0	PATCH	4
n261	1	129	QTM0	PATCH	1
n261	5	133	QTM0	PATCH	2
n261	6	134	QTM0	PATCH	2
n261	7	135	QTM0	PATCH	2
n261	10	138	QTM0	PATCH	2
n261	11	139	QTM0	PATCH	2
n261	17	145	QTM0	PATCH	4
n261	18	146	QTM0	PATCH	4
n261	19	147	QTM0	PATCH	4
n261	20	148	QTM0	PATCH	4
n261	21	149	QTM0	PATCH	4
n261	26	154	QTM0	PATCH	4
n261	27	155	QTM0	PATCH	4
n261	28	156	QTM0	PATCH	4
n261	29	157	QTM0	PATCH	4

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed
261	0		QTM1	PATCH	1
261	2		QTM1	PATCH	2
261	3		QTM1	PATCH	2
261	4		QTM1	PATCH	2
261	8		QTM1	PATCH	2
261	9		QTM1	PATCH	2
261	12		QTM1	PATCH	4
261	13		QTM1	PATCH	4
261	14		QTM1	PATCH	4
261	15		QTM1	PATCH	4
261	16		QTM1	PATCH	4
261	22		QTM1	PATCH	4
261	23		QTM1	PATCH	4
261	24		QTM1	PATCH	4
261	25		QTM1	PATCH	4
261		128	QTM1	PATCH	1
261		130	QTM1	PATCH	2
261		131	QTM1	PATCH	2
261		132	QTM1	PATCH	2
261		136	QTM1	PATCH	2
261		137	QTM1	PATCH	2
261		140	QTM1	PATCH	4
261		141	QTM1	PATCH	4
261		142	QTM1	PATCH	4
261		143	QTM1	PATCH	4
261		144	QTM1	PATCH	4
261		150	QTM1	PATCH	4
261		151	QTM1	PATCH	4
261		152	QTM1	PATCH	4
261		153	QTM1	PATCH	4
261	0	128	QTM1	PATCH	1
261	2	130	QTM1	PATCH	2
261	3	131	QTM1	PATCH	2
261	4	132	QTM1	PATCH	2
261	8	136	QTM1	PATCH	2
261	9	137	QTM1	PATCH	2
261	12	140	QTM1	PATCH	4
261	13	141	QTM1	PATCH	4
261	14	142	QTM1	PATCH	4
261	15	143	QTM1	PATCH	4
261	16	144	QTM1	PATCH	4
261	22	150	QTM1	PATCH	4
261	23	151	QTM1	PATCH	4
261	24	152	QTM1	PATCH	4
261	25	153	QTM1	PATCH	4

4.3 PD_design_target determination

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

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

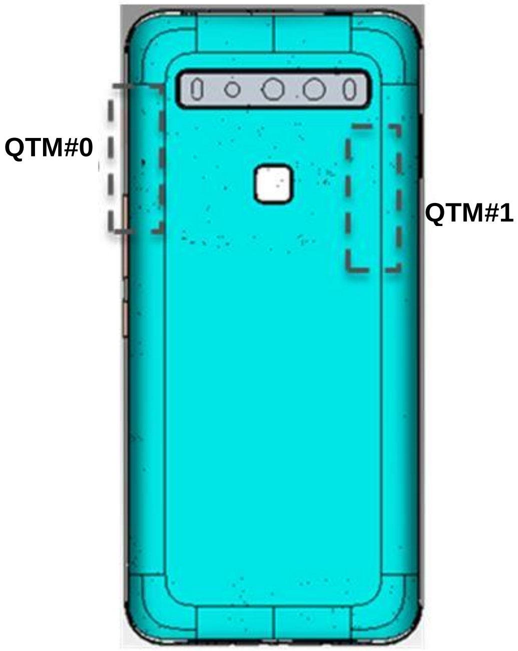
For this EUT, the PD design target and the uncertainty value are listed below

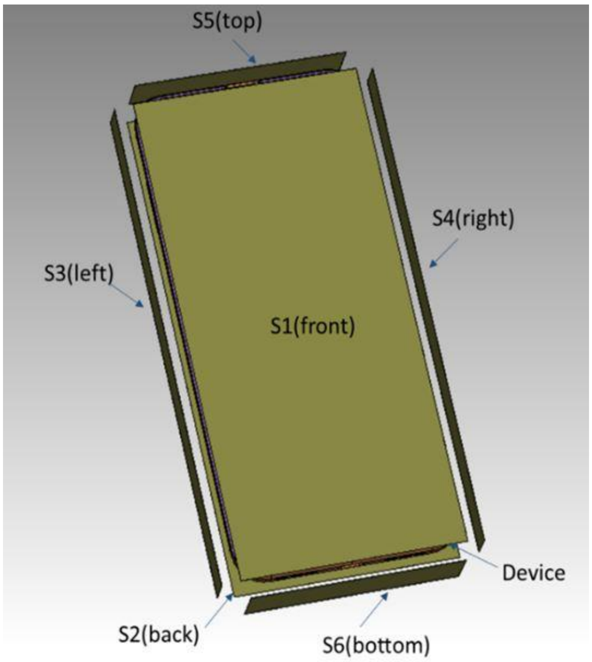
N260	PD design target	Antenna Module	W/m^2
		Antenna Module 0/1	4.6

N261	PD design target	Antenna Module	W/m^2
		Antenna Module 0/1	4.6

Item	Uncertainty dB (k=2)
Total uncertainty	2.1

4.4 Exposure positions for PD evaluation





Evaluation positions

Antenna Module	Front	Back	Left From Front View	Right From Front View	Top	Bottom
	S1	S2	S3	S4	S5	S6
QTM#0	O	O	O	O	O	X
QTM#1	O	O	O	O	O	X

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 (W/m^2), averaged over 4 cm2	Delta=Sim-Meas(dB)
n260	0	29	-	38.5	Right Side	2mm	CW	5.66	17.311	4.86
	0	29	-	38.5	Front	2mm	CW	4.51	9.333	3.16
	0	-	146	38.5	Right Side	2mm	CW	8.87	16.198	2.62
	0	-	146	38.5	Front	2mm	CW	4.91	9.165	2.71
	1	12	-	38.5	Left Side	2mm	CW	0.823	3.584	6.39
	1	12	-	38.5	Back	2mm	CW	4.73	14.04	4.73
	1	-	144	38.5	Left Side	2mm	CW	1.37	3.227	3.72
	1	-	140	38.5	Back	2mm	CW	4.32	13.527	4.96
n261	0	27	-	27.925	Right Side	2mm	CW	7.68	14.843	2.86
	0	28	-	27.925	Back	2mm	CW	2.86	8.036	4.49
	0	-	155	27.925	Right Side	2mm	CW	7.76	14.192	2.62
	0	-	155	27.925	Back	2mm	CW	3.86	7.885	3.10
	1	23	-	27.925	Left Side	2mm	CW	2.11	4.065	2.85
	1	15	-	27.925	Back	2mm	CW	6.52	17.051	4.18
	1	-	152	27.925	Left Side	2mm	CW	1.44	3.304	3.61
	1	-	152	27.925	Back	2mm	CW	5.21	15.924	4.85

4.6 PD Char

4.6.1 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:

$$s(i)_{low\_or\_mid\_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)},\ i = 1,2,\ldots M \qquad (4)$$

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

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

   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:

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

4.6.2 Simulated input power limit for beam pairs

The relative phase between single beams of a beam pair is sweeped to find the worst case PD for beam-pairs operation, and PD simulation data has taken this into considerationfor 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* $\emptyset$ and for a given channel, determine the worst-case $\emptyset_{worstcase}$ which results in the highest $t$otal PD ($\emptyset$) among all identified surfaces for this beam pair at this channel. When $\emptyset_{worstcase}$ is determined for all three channels, obtain the scaling factor given by the below equation for low, mid and high channels:

$$s(i)_{low\_or\_mid\_high} = \frac{PD\ design\ target}{total.PD(\emptyset(\mathrm{i})_{worstcase})},\ i = M+1,\ M+2,\ldots N \qquad (8)$$

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

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

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

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

4.6.3 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 $\Delta_{\min}$:

1. Based on PD simulation, determine one or more worst-surface(s) that contains all the highest 4cm^2-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 4cm^2-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 4cm^2-averaged PD at *input.power.limit* for the identified worst-PD beam at each non-selected surface
      iii. Demonstrate all measured 4cm^2-averaged PD values are below *PD_design_target*.
3. If any of the above surface(s) in Step (2.b.iii) have measured 4cm^2-averaged PD ≥ *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 4cm^2-avgeraged PD and measured 4cm^2-avgeraged 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 Module	Polarization	Delta Min
N260	0	AG0	3.16
		AG1	2.62
	1	AG0	4.73
		AG1	3.72
N261	0	AG0	2.86
		AG1	2.62
	1	AG0	2.85
		AG1	3.61

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 4cm^2-averaged PD at input.power.limit

Determine the worst beam for each of non-selected surface(s)

Band	Beam_ID 1	Beam_ID 2	Polarization	Ant module	Ant Type	Num. of Feed	top	left	right	back	front
n260	1		AG0	QTM0	PATCH	1	0.142	0.018	4.213	1.285	1.986
n260	5		AG0	QTM0	PATCH	2	0.260	0.010	4.443	1.514	2.065
n260	6		AG0	QTM0	PATCH	2	0.198	0.019	4.600	1.607	2.486
n260	7		AG0	QTM0	PATCH	2	0.262	0.008	4.336	1.284	1.697
n260	10		AG0	QTM0	PATCH	2	0.230	0.015	4.600	1.318	2.099
n260	11		AG0	QTM0	PATCH	2	0.226	0.010	4.158	1.182	1.663
n260	17		AG0	QTM0	PATCH	4	0.412	0.009	4.494	1.350	2.360
n260	18		AG0	QTM0	PATCH	4	0.381	0.017	4.600	1.593	2.357
n260	19		AG0	QTM0	PATCH	4	0.199	0.018	4.253	1.541	2.365
n260	20		AG0	QTM0	PATCH	4	0.227	0.014	4.600	1.714	2.469
n260	21		AG0	QTM0	PATCH	4	0.407	0.010	4.444	1.268	2.364
n260	26		AG0	QTM0	PATCH	4	0.511	0.018	4.555	1.541	2.169
n260	27		AG0	QTM0	PATCH	4	0.116	0.015	4.600	1.819	2.365
n260	28		AG0	QTM0	PATCH	4	0.209	0.019	4.600	1.710	2.536
n260	29		AG0	QTM0	PATCH	4	0.136	0.011	4.600	1.637	2.480
n260		129	AG1	QTM0	PATCH	1	0.226	0.010	4.600	1.123	2.299
n260		133	AG1	QTM0	PATCH	2	0.347	0.007	4.458	1.158	2.147
n260		134	AG1	QTM0	PATCH	2	0.223	0.017	4.477	1.061	2.887
n260		135	AG1	QTM0	PATCH	2	0.209	0.007	4.600	0.931	2.197
n260		138	AG1	QTM0	PATCH	2	0.317	0.013	4.600	1.166	2.797
n260		139	AG1	QTM0	PATCH	2	0.155	0.007	4.492	0.861	2.158
n260		145	AG1	QTM0	PATCH	4	0.377	0.011	4.519	1.595	2.038
n260		146	AG1	QTM0	PATCH	4	0.347	0.017	4.477	1.393	2.534
n260		147	AG1	QTM0	PATCH	4	0.136	0.016	4.352	1.497	2.650
n260		148	AG1	QTM0	PATCH	4	0.169	0.012	4.600	1.638	2.624
n260		149	AG1	QTM0	PATCH	4	0.310	0.009	4.600	1.625	1.996
n260		154	AG1	QTM0	PATCH	4	0.509	0.018	4.365	1.312	2.262
n260		155	AG1	QTM0	PATCH	4	0.198	0.016	4.458	1.444	2.576
n260		156	AG1	QTM0	PATCH	4	0.083	0.016	4.248	1.496	2.671
n260		157	AG1	QTM0	PATCH	4	0.260	0.010	4.600	1.652	2.400

Band	Beam_ID 1	Beam_ID 2	Polarization	Ant module	Ant Type	Num. of Feed	top	left	right	back	front
n260	0		AG0	QTM1	PATCH	1	0.177	0.558	0.116	4.600	0.129
n260	2		AG0	QTM1	PATCH	2	0.263	0.717	0.056	4.600	0.207
n260	3		AG0	QTM1	PATCH	2	0.411	1.049	0.150	4.592	0.269
n260	4		AG0	QTM1	PATCH	2	0.125	1.049	0.066	4.600	0.327
n260	8		AG0	QTM1	PATCH	2	0.236	0.666	0.068	4.600	0.219
n260	9		AG0	QTM1	PATCH	2	0.227	0.833	0.143	4.600	0.231
n260	12		AG0	QTM1	PATCH	4	0.311	1.174	0.059	4.600	0.341
n260	13		AG0	QTM1	PATCH	4	0.189	0.921	0.082	4.600	0.270
n260	14		AG0	QTM1	PATCH	4	0.504	0.899	0.127	4.269	0.214
n260	15		AG0	QTM1	PATCH	4	0.102	0.877	0.080	4.600	0.235
n260	16		AG0	QTM1	PATCH	4	0.198	1.193	0.065	4.600	0.368
n260	22		AG0	QTM1	PATCH	4	0.305	1.079	0.072	4.600	0.302
n260	23		AG0	QTM1	PATCH	4	0.247	0.996	0.140	4.385	0.228
n260	24		AG0	QTM1	PATCH	4	0.342	0.983	0.141	4.600	0.289
n260	25		AG0	QTM1	PATCH	4	0.150	1.111	0.077	4.600	0.335
n260		128	AG1	QTM1	PATCH	1	0.112	0.851	0.059	4.600	0.209
n260		130	AG1	QTM1	PATCH	2	0.188	0.644	0.062	4.600	0.129
n260		131	AG1	QTM1	PATCH	2	0.278	1.197	0.113	4.504	0.271
n260		132	AG1	QTM1	PATCH	2	0.179	0.750	0.067	4.600	0.149
n260		136	AG1	QTM1	PATCH	2	0.151	0.934	0.087	4.600	0.187
n260		137	AG1	QTM1	PATCH	2	0.189	0.767	0.110	4.600	0.153
n260		140	AG1	QTM1	PATCH	4	0.359	1.003	0.067	4.600	0.224
n260		141	AG1	QTM1	PATCH	4	0.305	1.040	0.099	4.600	0.218
n260		142	AG1	QTM1	PATCH	4	0.225	1.154	0.186	4.384	0.314
n260		143	AG1	QTM1	PATCH	4	0.123	0.939	0.129	4.600	0.368
n260		144	AG1	QTM1	PATCH	4	0.316	1.133	0.062	4.600	0.242
n260		150	AG1	QTM1	PATCH	4	0.360	0.928	0.089	4.600	0.222
n260		151	AG1	QTM1	PATCH	4	0.125	1.450	0.151	4.600	0.274
n260		152	AG1	QTM1	PATCH	4	0.317	1.242	0.131	4.600	0.425
n260		153	AG1	QTM1	PATCH	4	0.140	0.924	0.099	4.600	0.256

Band	Beam_ID 1	Beam_ID 2	Polarization	Ant module	Ant Type	Num. of Feed	top	left	right	back	front
n261	1		AG0	QTM0	PATCH	1	0.101	0.015	4.600	1.479	2.067
n261	5		AG0	QTM0	PATCH	2	0.311	0.024	4.333	2.067	1.812
n261	6		AG0	QTM0	PATCH	2	0.100	0.011	4.319	2.425	1.786
n261	7		AG0	QTM0	PATCH	2	0.610	0.029	4.364	1.657	1.427
n261	10		AG0	QTM0	PATCH	2	0.088	0.013	4.336	2.345	1.816
n261	11		AG0	QTM0	PATCH	2	0.335	0.018	4.301	2.128	1.729
n261	17		AG0	QTM0	PATCH	4	0.425	0.029	4.250	1.622	2.074
n261	18		AG0	QTM0	PATCH	4	0.053	0.019	4.520	2.331	2.066
n261	19		AG0	QTM0	PATCH	4	0.038	0.021	4.398	2.453	1.972
n261	20		AG0	QTM0	PATCH	4	0.237	0.019	4.204	2.403	1.916
n261	21		AG0	QTM0	PATCH	4	0.880	0.037	4.445	1.843	1.894
n261	26		AG0	QTM0	PATCH	4	0.078	0.019	4.452	2.182	1.990
n261	27		AG0	QTM0	PATCH	4	0.046	0.021	4.499	2.367	2.090
n261	28		AG0	QTM0	PATCH	4	0.092	0.015	4.315	2.540	1.885
n261	29		AG0	QTM0	PATCH	4	0.577	0.032	4.532	2.118	1.908
n261		129	AG1	QTM0	PATCH	1	0.060	0.013	4.446	2.002	1.791
n261		133	AG1	QTM0	PATCH	2	0.152	0.013	4.374	2.281	1.821
n261		134	AG1	QTM0	PATCH	2	0.084	0.020	4.315	1.950	2.308
n261		135	AG1	QTM0	PATCH	2	0.349	0.030	4.437	1.380	1.879
n261		138	AG1	QTM0	PATCH	2	0.045	0.026	4.263	1.994	2.269
n261		139	AG1	QTM0	PATCH	2	0.248	0.029	4.401	1.630	2.139
n261		145	AG1	QTM0	PATCH	4	0.186	0.019	4.333	2.199	1.908
n261		146	AG1	QTM0	PATCH	4	0.036	0.014	4.400	2.455	1.968
n261		147	AG1	QTM0	PATCH	4	0.026	0.014	4.400	2.357	2.081
n261		148	AG1	QTM0	PATCH	4	0.235	0.029	4.256	2.118	2.092
n261		149	AG1	QTM0	PATCH	4	0.473	0.029	4.506	2.121	1.857
n261		154	AG1	QTM0	PATCH	4	0.069	0.015	4.306	2.331	1.927
n261		155	AG1	QTM0	PATCH	4	0.025	0.015	4.461	2.478	2.031
n261		156	AG1	QTM0	PATCH	4	0.061	0.017	4.315	2.186	2.143
n261		157	AG1	QTM0	PATCH	4	0.367	0.032	4.135	1.936	1.969

Band	Beam_ID 1	Beam_ID 2	Polarization	Ant module	Ant Type	Num. of Feed	top	left	right	back	front
n261	0		AG0	QTM1	PATCH	1	0.129	0.715	0.079	4.262	0.067
n261	2		AG0	QTM1	PATCH	2	0.146	0.666	0.072	4.335	0.116
n261	3		AG0	QTM1	PATCH	2	0.033	0.811	0.097	4.397	0.061
n261	4		AG0	QTM1	PATCH	2	0.259	0.809	0.063	4.592	0.149
n261	8		AG0	QTM1	PATCH	2	0.069	0.716	0.089	4.324	0.093
n261	9		AG0	QTM1	PATCH	2	0.118	0.889	0.076	4.344	0.058
n261	12		AG0	QTM1	PATCH	4	0.128	0.612	0.156	3.996	0.179
n261	13		AG0	QTM1	PATCH	4	0.041	1.011	0.175	4.489	0.186
n261	14		AG0	QTM1	PATCH	4	0.021	0.999	0.156	4.295	0.084
n261	15		AG0	QTM1	PATCH	4	0.064	0.992	0.081	4.460	0.114
n261	16		AG0	QTM1	PATCH	4	0.312	0.804	0.088	4.588	0.116
n261	22		AG0	QTM1	PATCH	4	0.103	0.683	0.168	4.095	0.182
n261	23		AG0	QTM1	PATCH	4	0.017	1.066	0.178	4.455	0.123
n261	24		AG0	QTM1	PATCH	4	0.046	1.037	0.126	4.350	0.105
n261	25		AG0	QTM1	PATCH	4	0.246	0.826	0.080	4.599	0.105
n261		128	AG1	QTM1	PATCH	1	0.156	0.504	0.096	4.600	0.192
n261		130	AG1	QTM1	PATCH	2	0.141	0.464	0.067	4.210	0.079
n261		131	AG1	QTM1	PATCH	2	0.038	0.620	0.076	4.600	0.170
n261		132	AG1	QTM1	PATCH	2	0.204	0.498	0.109	4.498	0.128
n261		136	AG1	QTM1	PATCH	2	0.052	0.576	0.078	4.600	0.192
n261		137	AG1	QTM1	PATCH	2	0.118	0.625	0.092	4.549	0.141
n261		140	AG1	QTM1	PATCH	4	0.187	0.684	0.072	4.269	0.094
n261		141	AG1	QTM1	PATCH	4	0.052	0.784	0.134	4.566	0.197
n261		142	AG1	QTM1	PATCH	4	0.022	0.789	0.117	4.542	0.216
n261		143	AG1	QTM1	PATCH	4	0.060	0.855	0.105	4.476	0.220
n261		144	AG1	QTM1	PATCH	4	0.288	0.418	0.124	4.241	0.156
n261		150	AG1	QTM1	PATCH	4	0.101	0.713	0.106	4.450	0.131
n261		151	AG1	QTM1	PATCH	4	0.036	0.803	0.128	4.600	0.228
n261		152	AG1	QTM1	PATCH	4	0.057	0.930	0.105	4.482	0.248
n261		153	AG1	QTM1	PATCH	4	0.199	0.483	0.158	4.313	0.151

4cm^2-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 tot 4cm^2 (W/m2)
n260	0	26	-	38.5	Top Side	3.02	2mm	CW	0.234
	0	28	-	38.5	Left Side	3.45	2mm	CW	0.322
	0	27	-	38.5	Back	3.41	2mm	CW	1.18
	1	14	-	38.5	Top Side	7.46	2mm	CW	0.235
	1	-	142	38.5	Right Side	6.54	2mm	CW	0.326
	1	-	152	38.5	Front	6.62	2mm	CW	0.34
n261	0	21	-	27.925	Top Side	5.11	2mm	CW	0.456
	0	21	-	27.925	Left Side	5.11	2mm	CW	0.62
	0	-	134	27.925	Front	6.35	2mm	CW	1.69
	1	16	-	27.925	Top Side	3.73	2mm	CW	0.179
	1	23	-	27.925	Right Side	2.54	2mm	CW	0.542
	1	-	152	27.925	Front	3.6	2mm	CW	0.492

4.7 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.

4.7.1 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:

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

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 < *Δmin* < TxAGC uncertainty at reference power level,

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

else if Δmin < -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 Δmin > 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

Band	Antenna Module	Polarization	Δ_{min} (dB)	TxAGC uncertainty (dB)	Input.power.limit (dBm)
n260	0	AG0	3.16	0.5	6 +10* log(s(i))+2.66
		AG1	2.62	0.5	6 +10* log(s(i))+2.12
	1	AG0	4.73	0.5	6 +10* log(s(i))+4.23
		AG1	3.72	0.5	6 +10* log(s(i))+3.22
n261	0	AG0	2.86	0.5	6 +10* log(s(i))+2.36
		AG1	2.62	0.5	6 +10* log(s(i))+2.12
	1	AG0	2.85	0.5	6 +10* log(s(i))+2.35
		AG1	3.61	0.5	6 +10* log(s(i))+3.11

4.7.2 PD char Table

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

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed	Input Power limit
n260	1		QTM0	PATCH	1	9.08
n260	5		QTM0	PATCH	2	5.20
n260	6		QTM0	PATCH	2	5.75
n260	7		QTM0	PATCH	2	4.50
n260	10		QTM0	PATCH	2	5.09
n260	11		QTM0	PATCH	2	4.61
n260	17		QTM0	PATCH	4	2.90
n260	18		QTM0	PATCH	4	3.34
n260	19		QTM0	PATCH	4	3.40
n260	20		QTM0	PATCH	4	2.98
n260	21		QTM0	PATCH	4	2.87
n260	26		QTM0	PATCH	4	3.02
n260	27		QTM0	PATCH	4	3.41
n260	28		QTM0	PATCH	4	3.45
n260	29		QTM0	PATCH	4	2.90
n260		129	QTM0	PATCH	1	8.21
n260		133	QTM0	PATCH	2	5.12
n260		134	QTM0	PATCH	2	5.63
n260		135	QTM0	PATCH	2	4.69
n260		138	QTM0	PATCH	2	5.20
n260		139	QTM0	PATCH	2	5.01
n260		145	QTM0	PATCH	4	2.92
n260		146	QTM0	PATCH	4	2.54
n260		147	QTM0	PATCH	4	3.16
n260		148	QTM0	PATCH	4	2.83
n260		149	QTM0	PATCH	4	2.87
n260		154	QTM0	PATCH	4	2.63
n260		155	QTM0	PATCH	4	2.95
n260		156	QTM0	PATCH	4	3.06
n260		157	QTM0	PATCH	4	2.79
n260	1	129	QTM0	PATCH	1	6.54
n260	5	133	QTM0	PATCH	2	1.80
n260	6	134	QTM0	PATCH	2	2.35
n260	7	135	QTM0	PATCH	2	1.30
n260	10	138	QTM0	PATCH	2	2.09
n260	11	139	QTM0	PATCH	2	1.81
n260	17	145	QTM0	PATCH	4	-0.63
n260	18	146	QTM0	PATCH	4	-0.26
n260	19	147	QTM0	PATCH	4	0.35
n260	20	148	QTM0	PATCH	4	-0.42
n260	21	149	QTM0	PATCH	4	-0.68
n260	26	154	QTM0	PATCH	4	-0.30
n260	27	155	QTM0	PATCH	4	0.02
n260	28	156	QTM0	PATCH	4	0.10
n260	29	157	QTM0	PATCH	4	-0.72

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed	Input Power limit
n260	0		QTM1	PATCH	1	11.97
n260	2		QTM1	PATCH	2	8.06
n260	3		QTM1	PATCH	2	9.53
n260	4		QTM1	PATCH	2	8.33
n260	8		QTM1	PATCH	2	8.45
n260	9		QTM1	PATCH	2	8.81
n260	12		QTM1	PATCH	4	5.38
n260	13		QTM1	PATCH	4	6.74
n260	14		QTM1	PATCH	4	7.46
n260	15		QTM1	PATCH	4	6.49
n260	16		QTM1	PATCH	4	5.48
n260	22		QTM1	PATCH	4	5.79
n260	23		QTM1	PATCH	4	7.39
n260	24		QTM1	PATCH	4	7.21
n260	25		QTM1	PATCH	4	6.00
n260		128	QTM1	PATCH	1	11.81
n260		130	QTM1	PATCH	2	6.95
n260		131	QTM1	PATCH	2	8.36
n260		132	QTM1	PATCH	2	7.14
n260		136	QTM1	PATCH	2	7.55
n260		137	QTM1	PATCH	2	7.63
n260		140	QTM1	PATCH	4	4.54
n260		141	QTM1	PATCH	4	5.55
n260		142	QTM1	PATCH	4	6.54
n260		143	QTM1	PATCH	4	5.89
n260		144	QTM1	PATCH	4	4.68
n260		150	QTM1	PATCH	4	4.98
n260		151	QTM1	PATCH	4	6.46
n260		152	QTM1	PATCH	4	6.62
n260		153	QTM1	PATCH	4	5.26
n260	0	128	QTM1	PATCH	1	8.19
n260	2	130	QTM1	PATCH	2	4.51
n260	3	131	QTM1	PATCH	2	5.28
n260	4	132	QTM1	PATCH	2	4.00
n260	8	136	QTM1	PATCH	2	5.61
n260	9	137	QTM1	PATCH	2	4.86
n260	12	140	QTM1	PATCH	4	1.01
n260	13	141	QTM1	PATCH	4	2.40
n260	14	142	QTM1	PATCH	4	2.98
n260	15	143	QTM1	PATCH	4	2.42
n260	16	144	QTM1	PATCH	4	1.87
n260	22	150	QTM1	PATCH	4	1.68
n260	23	151	QTM1	PATCH	4	3.04
n260	24	152	QTM1	PATCH	4	3.03
n260	25	153	QTM1	PATCH	4	1.46

Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed	Input Power limit
n261	1		QTM0	PATCH	1	9.94
n261	5		QTM0	PATCH	2	6.15
n261	6		QTM0	PATCH	2	5.82
n261	7		QTM0	PATCH	2	7.01
n261	10		QTM0	PATCH	2	5.78
n261	11		QTM0	PATCH	2	6.54
n261	17		QTM0	PATCH	4	4.39
n261	18		QTM0	PATCH	4	3.25
n261	19		QTM0	PATCH	4	3.21
n261	20		QTM0	PATCH	4	3.92
n261	21		QTM0	PATCH	4	5.11
n261	26		QTM0	PATCH	4	3.45
n261	27		QTM0	PATCH	4	3.18
n261	28		QTM0	PATCH	4	3.36
n261	29		QTM0	PATCH	4	4.83
n261		129	QTM0	PATCH	1	8.60
n261		133	QTM0	PATCH	2	6.05
n261		134	QTM0	PATCH	2	6.35
n261		135	QTM0	PATCH	2	7.32
n261		138	QTM0	PATCH	2	6.35
n261		139	QTM0	PATCH	2	6.91
n261		145	QTM0	PATCH	4	3.86
n261		146	QTM0	PATCH	4	3.19
n261		147	QTM0	PATCH	4	3.14
n261		148	QTM0	PATCH	4	3.95
n261		149	QTM0	PATCH	4	5.25
n261		154	QTM0	PATCH	4	3.40
n261		155	QTM0	PATCH	4	3.09
n261		156	QTM0	PATCH	4	3.30
n261		157	QTM0	PATCH	4	4.95
n261	1	129	QTM0	PATCH	1	6.29
n261	5	133	QTM0	PATCH	2	2.76
n261	6	134	QTM0	PATCH	2	2.77
n261	7	135	QTM0	PATCH	2	3.58
n261	10	138	QTM0	PATCH	2	2.75
n261	11	139	QTM0	PATCH	2	3.02
n261	17	145	QTM0	PATCH	4	1.42
n261	18	146	QTM0	PATCH	4	-0.11
n261	19	147	QTM0	PATCH	4	0.01
n261	20	148	QTM0	PATCH	4	0.86
n261	21	149	QTM0	PATCH	4	2.33
n261	26	154	QTM0	PATCH	4	0.26
n261	27	155	QTM0	PATCH	4	-0.14
n261	28	156	QTM0	PATCH	4	0.15
n261	29	157	QTM0	PATCH	4	2.61

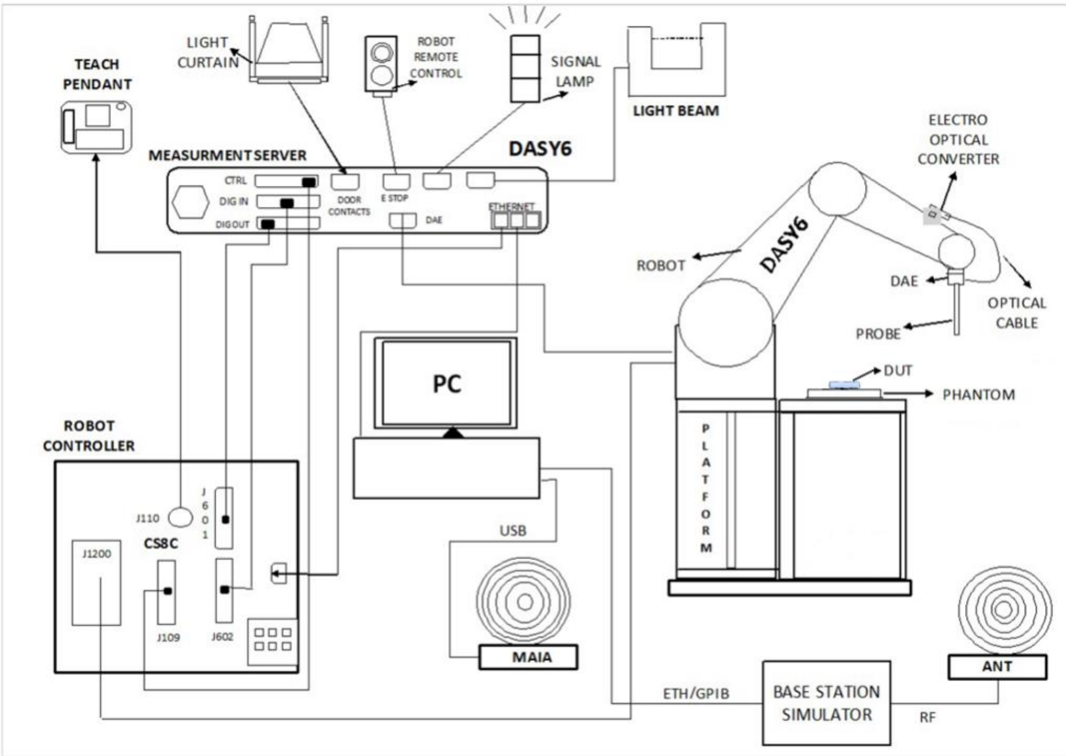
Band	Beam_ID 1	Beam_ID 2	Ant module	Ant Type	Num. of Feed	Input Power limit
261	0		QTM1	PATCH	1	7.67
261	2		QTM1	PATCH	2	5.62
261	3		QTM1	PATCH	2	5.06
261	4		QTM1	PATCH	2	5.53
261	8		QTM1	PATCH	2	5.35
261	9		QTM1	PATCH	2	4.97
261	12		QTM1	PATCH	4	3.64
261	13		QTM1	PATCH	4	2.78
261	14		QTM1	PATCH	4	2.39
261	15		QTM1	PATCH	4	2.53
261	16		QTM1	PATCH	4	3.73
261	22		QTM1	PATCH	4	3.25
261	23		QTM1	PATCH	4	2.54
261	24		QTM1	PATCH	4	2.43
261	25		QTM1	PATCH	4	3.19
261		128	QTM1	PATCH	1	9.45
261		130	QTM1	PATCH	2	6.29
261		131	QTM1	PATCH	2	5.86
261		132	QTM1	PATCH	2	6.00
261		136	QTM1	PATCH	2	6.06
261		137	QTM1	PATCH	2	5.75
261		140	QTM1	PATCH	4	4.57
261		141	QTM1	PATCH	4	3.94
261		142	QTM1	PATCH	4	3.68
261		143	QTM1	PATCH	4	3.74
261		144	QTM1	PATCH	4	4.76
261		150	QTM1	PATCH	4	4.28
261		151	QTM1	PATCH	4	3.82
261		152	QTM1	PATCH	4	3.60
261		153	QTM1	PATCH	4	4.53
261	0	128	QTM1	PATCH	1	5.22
261	2	130	QTM1	PATCH	2	3.99
261	3	131	QTM1	PATCH	2	2.41
261	4	132	QTM1	PATCH	2	3.07
261	8	136	QTM1	PATCH	2	2.43
261	9	137	QTM1	PATCH	2	1.89
261	12	140	QTM1	PATCH	4	-0.26
261	13	141	QTM1	PATCH	4	-0.22
261	14	142	QTM1	PATCH	4	-0.44
261	15	143	QTM1	PATCH	4	-0.72
261	16	144	QTM1	PATCH	4	0.07
261	22	150	QTM1	PATCH	4	-0.30
261	23	151	QTM1	PATCH	4	-0.29
261	24	152	QTM1	PATCH	4	-0.78
261	25	153	QTM1	PATCH	4	-0.21

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

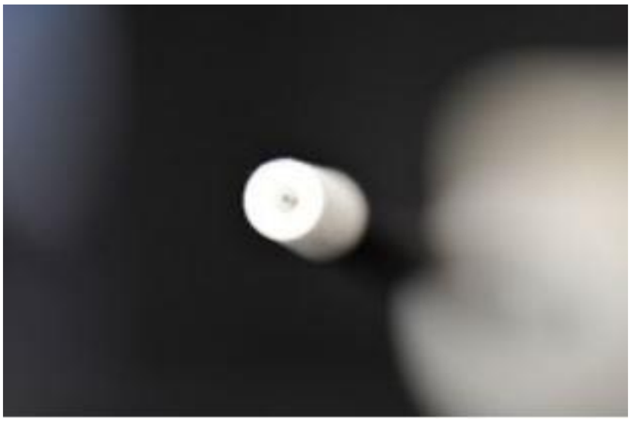
Sporton Lab and below test site location are accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

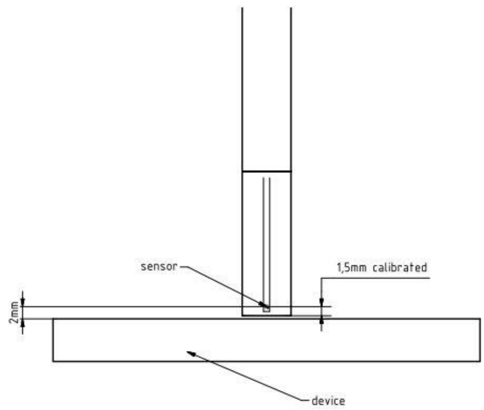
Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	TW1190 No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, CHINESE TAIPEI
Test Site No.	SAR06-HY

5.3 EUmmWave Probe / E-Field 5G Probe

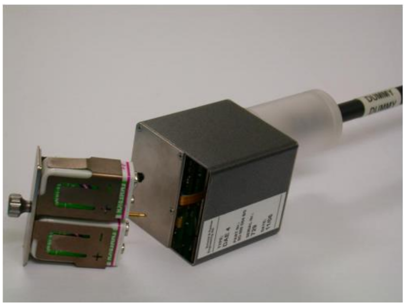
The probe design allows measurements at distances as small as 2 mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm.

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

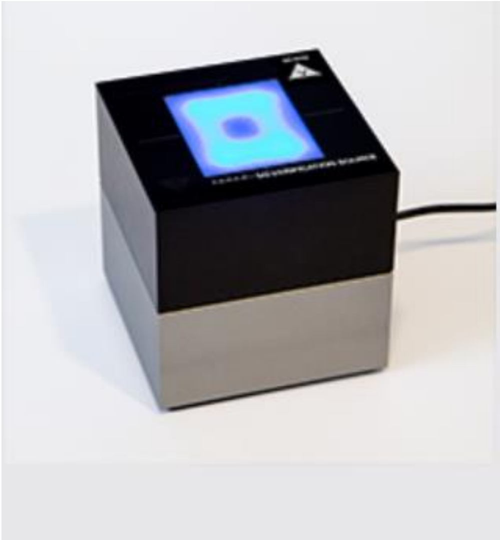
Fine-resolution scans on 2 different planes are performed to reconstruct the E- and H-fields as well as the power density; the z-distance between the 2 planes is set to λ/4.

The (x, y) grid step is also setλ/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

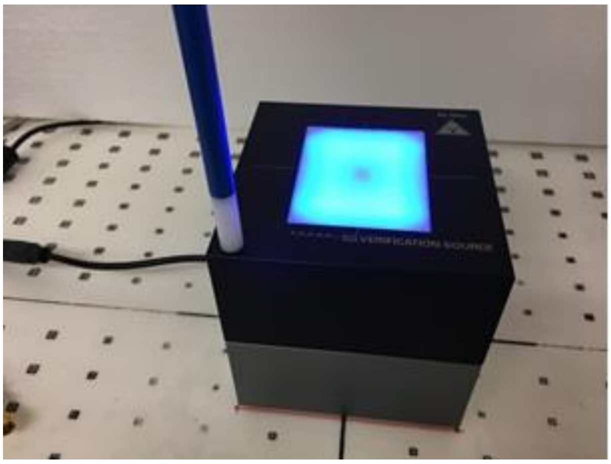
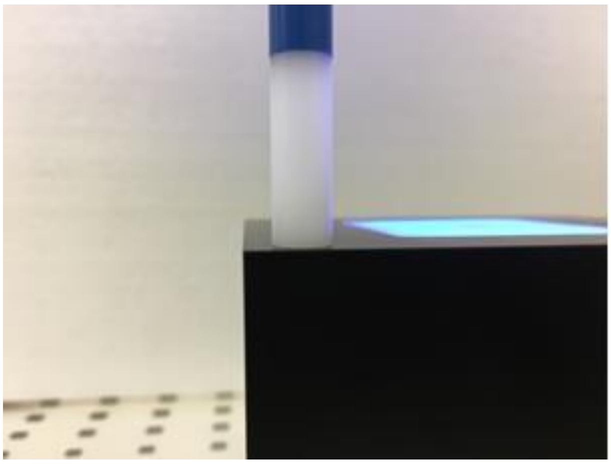


5.7 Power Density System Verification

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

System Verification								
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
30	30GHz_1007	9461	1424	5.5	31.4	34.1	-0.331	2020/7/7
30	30GHz_1007	9461	1424	5.5	31.8	34.1	-0.283	2020/7/25

6. Uncertainty Assessment

The budget is valid for evaluation distances > λ/2π. For specific tests and configurations, the Uncertainty could be considerably smaller.

Preliminary Module mmWave Uncertainty Budget Evaluation Distances to the Antennas > λ / 2π						
Error Description	**Uncertainty Value (± dB)**	**Probability**	**Divisor**	**(Ci)**	**Standard Uncertainty (±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	