Part 1: Test Under Static Transmission Scenario

For
SMARTPHONE

FCC ID: BCG-E3994A
Model Name: A2481

Report Number: 13573777-S4V1
Issue Date: 8/5/2021

Prepared for
APPLE INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014-2084

Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 319-4000
FAX: (510) 661-0888

ACCREDITED
CERT #0751.05

Revision History

Rev.	Date	Revisions	Revised By
V1	8/5/2021	Initial Issue	--

Table of Contents

Figures

Tables

1. Introduction

The equipment under test (EUT) contains the Qualcomm modem supporting 2G/3G/4G/5G technologies and mmW 5G NR bands. Both WWAN modems are enabled with Qualcomm's Smart Transmit feature with algorithms to control and manage transmitting power in real time and to ensure the time-averaged RF exposure from the WWAN modems are always in compliance with FCC requirements.

In addition to these WWAN modems, the EUT contains a different modem to support WLAN.

The purpose of this Part 1 report is to demonstrate that this EUT complies with FCC RF exposure limits at maximum time-averaged transmit power limits for WWAN technologies, and at maximum transmit power limits for WLAN technologies. The specifics of this report are as listed:

- SAR and power density (PD) compliance for all WWAN radios (Sub-6 GHz + 5G mmW NR) is assessed based on maximum time-averaged transmit power (static transmission condition). Relevant FCC KDBs and exclusion criteria are applied on a time-average power basis for WWAN technologies. The maximum time-averaged transmit power limits for supported WWAN technologies, bands, and antennas in this report are derived in the Part 0 report. The validation of the Qualcomm's Smart Transmit time-averaging algorithm and compliance under the Tx varying transmission scenario for WWAN technologies are reported in the Part 2 report.
- SAR compliance for WLAN radios is assessed based on maximum transmit power as per relevant FCC KDBs.
- Demonstrated compliance in simultaneous transmission scenarios involving both WWAN and WLAN transmissions, where WWAN exposure is assessed based on time-averaged transmit power limits, and WLAN exposure is assessed based on maximum transmit power limits.

By following the above steps, this report demonstrates that this EUT complies with FCC RF exposure limits for FCC equipment authorization.

The P_{limit} and *input.power.limit* used in this report are determined and listed in the Part 0 report.

Refer to Compliance Summary report for product description and terminology used in this report.

2. Measurement Setup and General Information

The SAR measurement are recorded in UL's *FCC SAR Test Report* (Report No. 13573771-S1).

This section provides the details of the test setup used for PD measurement.

2.1. Test Environment

Test Location	UL Verification Services
Ambient Temperature	22±2^{0}C

2.2. Power Density Measurement System

The power density measurement system is constructed based on the DASY6 platform by SPEAG. The DASY6 with EUmmWv2 and 5G software module can measure the electromagnetic exposure (electromagnetic and power density) up to 110GHz as close as 2mm from any transmitter.

2.2.1. Power Density Probe

The novel EUmmWV3 & EUmmWV4 probe is used in the power density measurement. It is designed for precise near-field measurements in the mm-wave range by Schmid & Partner Engineering AG of Zurich, Switzerland. The specifications are:

- Frequency range: 0.75 ~ 110 GHz
- Dynamic range: <50 – 3000 V/m (up to 10000 V/m with additional PRE-10 voltage divider)
- Linearity: < ± 0.2 dB
- Supports sensor model calibration (SMC)
- ISO17025 accredited calibration

2.2.2. Power Density Measurement System Verification

The power density system verification is performed using the SPEAG verification device. It consists of a ka-band horn antenna with a corresponding gun oscillator packaged within a cube-shaped housing.

The specification of the verification device is:

- Calibrated frequency: 30 GHz at 10 mm from the case surface
- Frequency accuracy: ± 100 MHz
- E-field polarization: linear
- Harmonics: -20 dBc (typ)
- Total radiated power: 14 dBm (typ)
- Power stability: 0.05 dB
- Power consumption: 5 W (max)
- Size: 100 × 100 × 100 mm
- Weight: 1 kg

Tables 2-1 and 2-2 show the verification test results. The measured power density (PD) value is within ±10% of target level; for the 5G verification source's uncertainty, please refer to Appendix B.

Table 2-1: System Validation Results for SAR 1

SAR Lab	Date	Frequency (GHz)	5G Verification Probe SN	Probe Cal. Due Data	5G Verification Source SN	Source Cal. Due Data	Result Incident power (mW/cm2) over 4cm^2	Target$_n$ (Ref. Value)	Deviation (dB)	Result Total power (mW/cm2) over 4cm^2	Target$_{Tot}$ (Ref. Value)	Deviation (dB)
SAR 1	6/2/2021	30	9398	10/14/2021	1003	11/13/2021	39.4	33.5	0.70	39.9	33.9	0.71
SAR 1	6/2/2021	30	9398	10/14/2021	1003	11/13/2021	40.2	33.5	0.79	40.6	33.9	0.78
SAR 1	6/2/2021	30	9398	10/14/2021	1003	11/13/2021	40.5	33.5	0.82	40.9	33.9	0.82
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	40.8	33.5	0.86	41.2	33.9	0.85
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	40.9	33.5	0.87	41.3	33.9	0.86
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	40.3	33.5	0.80	40.7	33.9	0.79
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	39.3	33.5	0.69	39.6	33.9	0.67
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	39	33.5	0.66	39.4	33.9	0.65
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	38.5	33.5	0.60	38.9	33.9	0.60
SAR 1	6/3/2021	30	9398	10/14/2021	1003	11/13/2021	38.1	33.5	0.56	38.5	33.9	0.55
						Average	39.7		Average	40.1		

Table 2-2: System Validation Results for SAR 3

SAR Lab	Date	Frequency (GHz)	5G Verification Probe SN	Probe Cal. Due Data	5G Verification Source SN	Source Cal. Due Data	Result Incident power (mW/cm2) over 4cm2	Targetn (Ref. Value)	Deviation (dB)	Result Total power (mW/cm2) over 4cm2	TargetTot (Ref. Value)	Deviation (dB)
SAR 3	3/22/2021	30	9496	2/6/2022	1003	11/13/2021	30.7	33.5	-0.38	32.2	33.9	-0.22
SAR 3	3/22/2021	30	9496	2/6/2022	1003	11/13/2021	31.2	33.5	-0.31	32.4	33.9	-0.20
SAR 3	3/22/2021	30	9496	2/6/2022	1003	11/13/2021	31.7	33.5	-0.24	33	33.9	-0.12
SAR 3	3/22/2021	30	9496	2/6/2022	1003	11/13/2021	32.0	33.5	-0.20	33.2	33.9	-0.09
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	32.2	33.5	-0.17	33.3	33.9	-0.08
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	31.9	33.5	-0.21	33	33.9	-0.12
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	31.9	33.5	-0.21	33	33.9	-0.12
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	31.6	33.5	-0.25	32.8	33.9	-0.14
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	31.5	33.5	-0.27	32.7	33.9	-0.16
SAR 3	3/23/2021	30	9496	2/6/2022	1003	11/13/2021	31.2	33.5	-0.31	32.3	33.9	-0.21
						Average	31.6		Average	32.8		

Table 2-3: System Check Results

SAR Lab	Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Data	Result Incident power (mW/cm2) over 4cm^2	Target$_n$ (Ref. Value)	Delta ±10 %	Result Total power (mW/cm2) over 4cm^2	Target$_{Tot}$ (Ref. Value)	Delta ±10 %
SAR 1	6/3/2021	30	1003	11/13/2021	37.8	39.7	-5%	38.2	40.1	-5%
SAR 1	6/7/2021	30	1003	11/13/2021	39.2	39.7	-1%	39.8	40.1	-1%
SAR 1	6/11/2021	30	1003	11/13/2021	42	39.7	6%	42.4	40.1	6%
SAR 1	6/15/2021	30	1003	11/13/2021	43	39.7	8%	43.3	40.1	8%
SAR 1	6/19/2021	30	1003	11/13/2021	40.2	39.7	1%	40.8	40.1	2%
SAR 1	6/22/2021	30	1003	11/13/2021	43.3	39.7	9%	43.7	40.1	9%
SAR Lab	**Date**	**Frequency (GHz)**	**5G Verification Source SN**	**Source Cal. Due Data**	**Result Incident power (mW/cm2) over 4cm^2**	**Target$_n$ (Ref. Value)**	**Delta ±10 %**	**Result Total power (mW/cm2) over 4cm^2**	**Target$_{Tot}$ (Ref. Value)**	**Delta ±10 %**
SAR 3	6/21/2021	30	1003	11/13/2021	32.9	31.6	4%	35.1	32.8	7%
SAR 3	6/27/2021	30	1003	11/13/2021	33	31.6	4%	33.4	32.8	2%

SAR 1:

Device under Test Properties

Name, Manufacturer	Dimensions [mm]	S/N	DUT Type
, 5G Verification Source - 30GHz	100.0 x 100.0 x 100.0	1003	Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G Air	FRONT, 5.55	Validation band	CW, 0--	30000.0, 30000	1.0

Scan Setup

Medium	Probe, Calibration Date	DAE, Calibration Date
--Air-	EUmmWV3 - SN9398_F1-78GHz, 2020-10-14	DAE4 Sn1352, 2020-11-17

Scan Setup

	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55
MAIA	N/A

Measurement Results

	5G Scan
Date	2021-06-22, 01:16
Avg. Area [cm^2]	4.00
pS$_{tot}$ avg [W/m^2]	43.7
pS$_n$ avg [W/m^2]	43.3
E$_{peak}$ [V/m]	145
Power Drift [dB]	-0.01

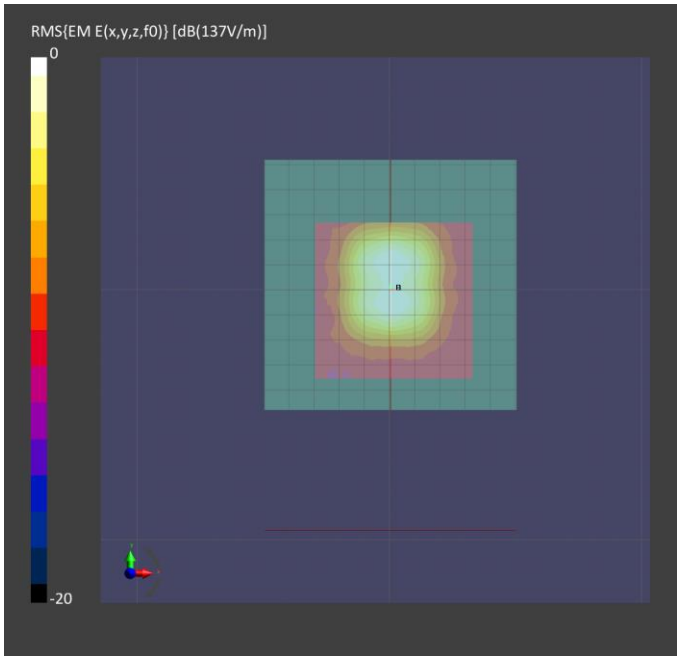

Figure 2-1: 4 cm^2 PD for source validation on 6/22/2021

SAR 3:

Device under Test Properties

Model, Manufacturer	Dimensions [mm]	S/N	DUT Type
, 5G Verification Source - 30GHz	100.0 x 100.0 x 100.0	1003	Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G -	FRONT, 5.55	Validation band	CW, 0--	30000.0, 30000	1.0

Hardware Setup

Medium	Probe, Calibration Date	DAE, Calibration Date	
--Air-	EUmmWV4 - SN9496_F1-78GHz, 2021-02-26	DAE4 Sn1548, 2021-02-22	

Scan Setup

	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	5.55
MAIA	N/A

Measurement Results

	5G Scan
Date	2021-06-27, 23:23
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	33.0
psPDtot+ [W/m^2]	33.4
psPDmod+ [W/m^2]	33.7
E_{max} [V/m]	132
Power Drift [dB]	0.21

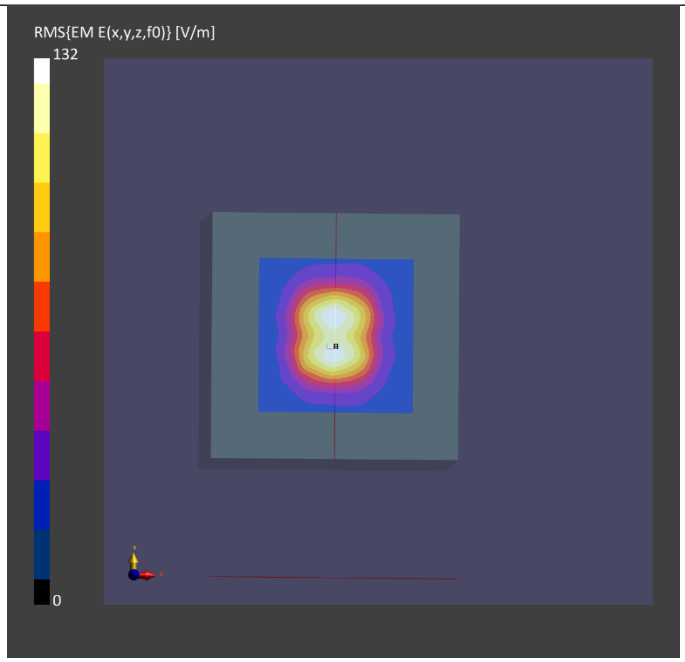

Figure 2-2: 4 cm^2 PD for source validation on 6/27/2021

3. Test Condition, Configuration, and Assessment

3.1. Qualcomm Smart Transmit Parameters

The input parameters described in §2.3 of the Compliance Summary report are required for functionality of Qualcomm's Smart Transmit algorithm.

These parameters are entered through the *Embedded File System* (EFS) and cannot be accessed by the end-user.

The Part 0 report documents the determination of P_{limit} for Sub-6 GHz WWAN bands (Part 0, §2.4) and the *input.power.limit* for 5G mmW NR bands using the design targets (Part 0, §3.7), and device related uncertainty listed below:

Total Uncertainty (dB)	$SAR_{Design\ Target}$ (1-g W/kg)	$SAR_{Design\ Target}$ (10-g W/kg)	$SAR_{Design\ Limit}$ (1-g W/kg)	$SAR_{Design\ Limit}$ (10-g W/kg)
1.00	0.8	2.0	1.0	2.5

Total Uncertainty (dB)	$PD_{Design\ Target}$ (W/m^2)
2.20	6.0

3.1.1. Qualcomm Smart Transmit Parameters for the Sub-6 Modem

For this EUT, the input parameters listed in §2.3 of the Part 0 report are populated via the EFS entry.

3.1.2. Qualcomm Smart Transmit parameters for the 5G modem

For this EUT, the *input.power.limit* parameters for the 5G mmW NR radio(s) are listed in §3.7.3 of the Part 0 report and are populated via EFS entry into the EUT.

3.2. Device Test Configuration for SAR Measurements

In summary, SAR is evaluated on this EUT in test configurations and test conditions listed below:

- Test configurations: Hotspot SAR exposure (1-g SAR) from all device surfaces/edges (front, back, left, right, top, bottom) having a transmitting antenna located ≤ 25mm from that device surface/edge when in direct contact with flat section of SAM phantom. Hotspot SAR is evaluated at 5mm separation distance for all selected device surfaces as per FCC KDB publication 648474 D04.
- Test condition: The SAR measurements on all supported Sub-6 WWAN technologies and bands are conducted with the EUT transmitting at maximum time-average transmit power (P_{limit}) or maximum RF tune-up power (P_{max}) if $P_{max} \leq P_{limit}$.

See UL's *FCC SAR Test Report* (Report No. 13573771-S1) for details

3.3. Device Test Configuration for PD Measurements

As can be seen in §3 of the Part 0 report, the PD exposure for this EUT has been assessed against the $PD_{Design\ Target}$ listed in §4.2 of this report using a validated simulation approach for the worst cases for all its beams. To further confirm the compliance, a subset of beams and test cases were selected for PD verification, see §4.2.

The following beam selection criteria for the PD verification test were used:

- Select one single beam (antenna array config) per polarization (vertical or horizontal) and per mmW antenna module
  - The single beam containing highest number of active antenna ports. For example, the single beam with 4 active patch ports should be selected over the beam with a single active patch port
- Select one beam per mmW antenna module
  - The beam pair containing the highest number of active antenna ports.

Additionally, since the worst-case surface dictates the compliance, the PD measurement is made on the worst channel and worst surface determined through the validated simulation approach, see Appendix B of the Part 0 report.

Based on the aforementioned criteria and the EUT codebook in §3.3 of the Part 0 report, Tables 3-1, 3-2, and 3-3 list the selected beams and test cases for PD verification measurement(s). The definition of the EUT surface is illustrated in Figure 3-1.

Table 3-1: PD verification test cases for n258

Module/Antenna	Ch.	Beam ID1	Beam ID2	BW	RB	DUT
		V	H	MHz	#	Surface
M1	2042915	31		100	1	Back
	2042915	28	156	100	1	Back
	2069160		156	100	1	Back
	2069160		156	100	1	Left
Module/Antenna	Ch.	Beam ID1	Beam ID2	BW	RB	DUT
		V	H	MHz	#	Surface
M0	2069160	12		100	1	Back
	2069160	11	139	100	1	Back
	2016667		140	100	66	Back
	2016667		140	100	66	Left
	2016667		140	100	66	Top
Module/Antenna	Ch.	Beam ID1	Beam ID2	BW	RB	DUT
		V	H	MHz	#	Surface
M2	2069160		160	100	1	Right
	2069160	32	160	100	1	Right
	2069160	32		100	66	Right
	2042915	32		100	66	Back
	2042915	32		100	66	Front

Table 3-2: PD verification test cases for n260

Module/Antenna	Ch.	Beam ID1	Beam ID2	BW	RB	DUT
		V	H	MHz	#	Surface
M1	2229167		168	100	1	Back
	2253330	27	155	100	1	Back
	2253330	37		100	66	Back
	2253330	37		100	66	Left
Module/Antenna	**Ch.**	**Beam ID1**	**Beam ID2**	**BW**	**RB**	**DUT**
		V	**H**	**MHz**	**#**	**Surface**
M0	2229167		141	100	1	Back
	2229167	12	141	100	1	Back
	2229167	12		100	66	Back
	2229167	12		100	66	Left
	2229167	12		100	66	Top
Module/Antenna	**Ch.**	**Beam ID1**	**Beam ID2**	**BW**	**RB**	**DUT**
		V	**H**	**MHz**	**#**	**Surface**
M2	2277500	42		100	1	Right
	2277500	42	170	100	1	Right
	2277500		162	50	33	Right
	2277500		162	50	33	Back
	2277500		162	50	33	Front

Table 3-3: PD verification test cases for n261

Module/Antenna	Ch.	Beam ID1	Beam ID2	BW	RB	DUT
		V	H	MHz	#	Surface
M1	2070833	27		100	1	Back
	2070833	40	168	100	1	Back
	2070833		157	100	66	Back
	2070833		157	100	66	Left
Module/Antenna	**Ch.**	**Beam ID1**	**Beam ID2**	**BW**	**RB**	**DUT**
		V	**H**	**MHz**	**#**	**Surface**
M0	2083330	23		100	1	Back
	2070833	10	138	100	1	Back
	2083330		150	100	1	Back
	2083330		150	100	1	Left
	2083330		150	100	1	Top
Module/Antenna	**Ch.**	**Beam ID1**	**Beam ID2**	**BW**	**RB**	**DUT**
		V	**H**	**MHz**	**#**	**Surface**
M2	2077084	44		100	1	Right
	2077084		164	100	1	Right
	2077084	36	164	50	1	Right
	2077084	36	164	50	1	Back
	2077084	36	164	50	1	Front

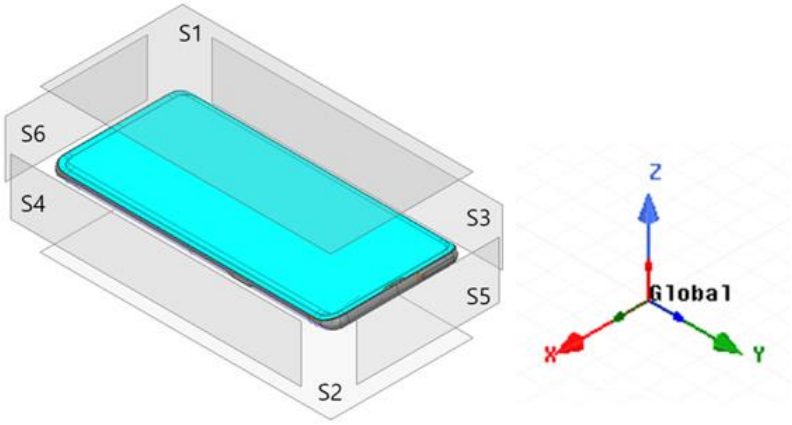

Figure 3-1: EUT surface definition (S1=Front, S2=Rear, S3=Edge 4, S4=Edge 2, S5=Edge 1, S6=Edge 3)

4. Summary of Results

4.1. SAR Measurement and Conducted Power Results at P_{limit}

The transmit power limit, P_{limit}, that corresponds to the $SAR_{Design\ Target}$, stated in §3.1 for all technologies and bands, was determined through the Part 0 report and are listed in EFS entries in §2.4 of the Part 0 report. For this EUT, the P_{max} (maximum RF tune-up power) for select Sub-6 GHz technologies is less than, or equal to, the corresponding P_{limit}, + tolerance, as summarized and shown in Table 4-1.

Table 4-1: Comparison of P_{limit} and P_{max}

Exposure Scenario		Duty Cycle	Head		Body-worn		Hotspot		P_{max} (dBm)
Spatial-average			1-g		1-g		1-g		
Test Distance			0 mm		5 mm		5 mm		
Power Mode (DSI)			DSI: 0		DSI: 1		DSI: 1		
Antenna	Tech/Band		P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	
			Burst Average		Burst Average		Burst Average		Burst Average
ANT1	GSM 850 2 slots	25.0%	37.50	32.50	33.51	32.50	33.51	32.50	32.50
	GSM 1900 2 slots	25.0%	34.15	30.50	26.44	24.30	24.71	24.30	31.00
	W-CDMA B2	100.0%	26.89	24.20	19.24	17.30	17.58	17.30	25.70
	W-CDMA B4	100.0%	27.20	25.00	20.78	20.50	20.78	20.50	25.70
	W-CDMA B5	100.0%	30.39	25.70	26.80	25.40	25.80	25.40	25.70
	CDMA BC0	100.0%	27.85	22.50	26.15	22.50	24.54	22.50	22.50
	CDMA BC1	100.0%	26.49	24.20	18.70	17.30	17.51	17.30	25.70
	CDMA BC10	100.0%	30.84	25.70	26.79	25.40	25.86	25.40	25.70
	LTE Band 5	100.0%	30.78	25.70	26.94	25.40	25.94	25.40	25.70
	LTE Band 7	100.0%	27.23	25.70	21.14	20.50	20.83	20.50	25.70
	LTE Band 12/17	100.0%	32.68	25.70	28.40	25.70	28.34	25.70	25.70
	LTE Band 13	100.0%	31.01	25.70	27.95	25.70	26.32	25.70	25.70
	LTE Band 14	100.0%	30.63	25.70	26.88	25.70	25.89	25.70	25.70
	LTE Band 25/2	100.0%	29.42	24.20	19.32	17.30	17.48	17.30	25.70
	LTE Band 26	100.0%	31.20	25.70	27.24	25.40	25.77	25.40	25.70
	LTE Band 30	100.0%	27.22	25.70	22.15	21.10	21.36	21.10	25.70
	LTE Band 41	63.3%	29.13	25.70	23.92	21.70	21.97	21.70	25.70
	LTE Band 66/4	100.0%	28.32	25.00	20.86	20.50	20.86	20.50	25.70
	LTE Band 71	100.0%	32.29	25.70	27.27	25.70	27.27	25.70	25.70
	NR n5	100.0%	33.06	25.70	28.80	25.40	28.07	25.40	25.70
	NR n7	100.0%	27.04	25.70	21.61	20.50	21.18	20.50	25.70
	NR n12	100.0%	33.96	25.70	28.93	25.70	28.53	25.70	25.70
	NR n25/2	100.0%	30.14	24.20	19.48	17.30	17.70	17.30	25.70
	NR n30	100.0%	28.93	25.70	23.09	21.10	21.67	21.10	25.70
	NR n41	63.3%	29.38	25.70	23.04	19.70	23.04	19.70	25.70
	NR n66	100.0%	29.89	25.00	20.77	20.50	20.77	20.50	25.70
	NR n71	100.0%	34.29	25.70	29.84	25.70	29.84	25.70	25.70

Exposure Scenario		Duty Cycle	Head		Body-worn		Hotspot		P_{max} (dBm)
Spatial-average			1-g		1-g		1-g		
Test Distance			0 mm		5 mm		5 mm		
Power Mode (DSI)			DSI: 0		DSI: 1		DSI: 1		
Antenna	Tech/Band		P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	
			Burst Average		Burst Average		Burst Average		Burst Average
ANT2	GSM 850 2 slots	25.0%	33.71	31.00	37.42	31.00	36.23	31.00	31.00
	GSM 1900 2 slots	25.0%	26.21	26.00	27.64	26.20	26.43	26.20	28.50
	W-CDMA B2	100.0%	19.95	19.50	19.96	19.20	19.60	19.20	23.20
	W-CDMA B4	100.0%	17.87	17.60	19.41	18.30	18.58	18.30	23.20
	W-CDMA B5	100.0%	24.97	24.70	29.45	24.70	29.45	24.70	24.70
	CDMA BC0	100.0%	23.17	22.00	26.67	22.00	26.67	22.00	22.00
	CDMA BC1	100.0%	19.94	19.50	20.73	19.20	19.63	19.20	23.20
	CDMA BC10	100.0%	25.03	24.70	27.38	24.70	27.38	24.70	24.70
	LTE Band 5	100.0%	25.42	24.70	27.00	24.70	27.00	24.70	24.70
	LTE Band 7	100.0%	18.58	18.20	19.44	19.00	19.44	19.00	22.70
	LTE Band 12/17	100.0%	25.02	24.70	26.73	24.70	26.73	24.70	24.70
	LTE Band 13	100.0%	25.82	24.70	27.90	24.70	27.90	24.70	24.70
	LTE Band 14	100.0%	25.78	24.70	28.05	24.70	28.05	24.70	24.70
	LTE Band 25/2	100.0%	19.83	19.50	20.97	19.20	19.68	19.20	23.20
	LTE Band 26	100.0%	25.28	24.70	27.02	24.70	27.02	24.70	24.70
	LTE Band 30	100.0%	19.79	19.60	21.70	20.50	20.74	20.50	22.70
	LTE Band 41	63.3%	19.48	18.70	21.55	20.80	21.55	20.80	24.50
	LTE Band 66/4	100.0%	17.89	17.60	19.54	18.30	18.62	18.30	23.20
	LTE Band 71	100.0%	26.10	24.70	27.75	24.70	27.75	24.70	24.70
	NR n5	100.0%	27.63	24.70	28.64	24.70	28.64	24.70	24.70
	NR n7	100.0%	19.05	18.20	19.56	19.00	19.56	19.00	22.70
	NR n12	100.0%	27.13	24.70	28.49	24.70	28.49	24.70	24.70
	NR n25/2	100.0%	20.53	19.50	21.45	19.20	20.09	19.20	23.20
	NR n30	100.0%	20.42	19.60	22.40	20.50	21.80	20.50	22.70
	NR n41	63.3%	18.23	16.70	20.24	18.80	20.24	18.80	25.70
	NR n66	100.0%	18.04	17.60	19.74	18.30	18.70	18.30	23.20
	NR n71	100.0%	28.90	24.70	29.13	24.70	29.13	24.70	24.70

Exposure Scenario		Duty Cycle	Head		Body-worn		Hotspot		P_{max} (dBm)
Spatial-average			1-g		1-g		1-g		
Test Distance			0 mm		5 mm		5 mm		
Power Mode (DSI)			DSI: 0		DSI: 1		DSI: 1		
Antenna	Tech/Band		P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	P_{design} (dBm)	P_{limit} + Tolerance (dBm)	
			Burst Average		Burst Average		Burst Average		Burst Average
ANT3	GSM 1900 2 slots	25.0%	32.19	30.00	27.88	26.90	27.13	26.90	30.00
	W-CDMA B2	100.0%	24.61	24.40	21.06	20.50	20.68	20.50	25.20
	W-CDMA B4	100.0%	28.39	25.20	21.90	21.50	21.73	21.50	25.20
	LTE Band 7	100.0%	24.09	23.70	21.24	18.90	19.33	18.90	25.20
	LTE Band 25/2	100.0%	25.77	24.40	20.85	20.50	20.70	20.50	25.20
	LTE Band 30	100.0%	25.05	22.30	19.91	19.70	19.91	19.70	22.30
	LTE Band 41	63.3%	25.49	25.20	21.10	20.80	21.10	20.80	25.20
	LTE Band 66/4	100.0%	27.63	25.20	23.23	21.50	21.72	21.50	25.20
	NR n7	100.0%	24.44	23.70	22.18	18.90	22.18	18.90	25.20
	NR n25/2	100.0%	26.00	24.40	21.59	20.50	20.92	20.50	25.20
	NR n30	100.0%	25.49	22.30	20.01	19.70	20.01	19.70	22.30
	NR n41	63.3%	24.13	23.30	20.01	18.80	20.01	18.80	24.70
	NR n66	100.0%	29.08	25.20	23.66	21.50	22.49	21.50	25.20
ANT4	GSM 1900 2 slots	25.0%	26.49	26.10	30.21	28.00	28.59	28.00	28.00
	W-CDMA B2	100.0%	20.25	19.60	23.16	22.00	22.21	22.00	23.20
	W-CDMA B4	100.0%	20.55	20.30	23.27	21.50	21.76	21.50	23.20
	LTE Band 7	100.0%	21.02	18.40	21.85	19.50	19.88	19.50	22.70
	LTE Band 25/2	100.0%	19.83	19.60	24.37	22.00	22.23	22.00	23.20
	LTE Band 30	100.0%	19.12	18.80	20.94	20.60	20.94	20.60	22.70
	LTE Band 41	63.3%	23.32	19.80	23.34	21.50	22.72	21.50	24.50
	LTE Band 48	63.3%	22.73	22.50	23.21	22.50	23.21	22.50	22.50
	LTE Band 66/4	100.0%	20.57	20.30	24.88	21.50	21.70	21.50	23.20
	NR n7	100.0%	21.26	18.40	22.62	19.50	20.80	19.50	22.70
	NR n25/2	100.0%	20.07	19.60	24.69	22.00	22.37	22.00	23.20
	NR n30	100.0%	19.32	18.80	21.85	20.60	21.85	20.60	22.70
	NR n41	63.3%	22.28	17.80	22.01	19.50	21.92	19.50	25.70
	NR n66	100.0%	21.18	20.30	25.22	21.50	22.27	21.50	23.20
	NR n77	63.3%	20.23	20.00	21.23	19.50	19.86	19.50	24.00
ANT7	LTE Band 48	63.3%	30.13	25.70	24.25	21.90	22.09	21.90	25.70
	NR n77	63.3%	27.27	25.70	20.98	19.30	19.50	19.30	25.70
ANT8	LTE Band 48	63.3%	21.69	21.50	23.20	23.00	23.20	23.00	23.00
	NR n77	63.3%	19.69	19.50	21.15	20.50	21.15	20.50	24.00
ANT9	LTE Band 48	63.3%	27.32	25.20	25.19	22.10	22.30	22.10	25.20
	NR n77	63.3%	25.97	25.70	20.20	20.00	20.20	20.00	25.70

Therefore, for this EUT, SAR and conducted power measurements at P_{limit} will be the same as those performed at P_{max}. SAR measured at P_{limit} (reported in UL's *FCC SAR Test Report*, 13573771-S1) can be leveraged in this section to avoid re-testing. The worst-case reported SAR values for Sub-6 GHz are listed in §2.4 of the Part 0 report and the worst-case reported WLAN SAR results are listed in Table 4-2.

Table 4-2: Worst-case reported WLAN SAR

Techonology	Freq (GHz)	ANT			Reported 1-g SAR (W/kg)			P_{max} Tune-up		
		Head	Body-worn	Hotspot	Head	Body-worn	Hotspot	Head	Body-worn	Hotspot
WLAN	2.4	ANT4	ANT3	ANT3	0.371	0.470	0.497	15.00	16.75	16.75
	5	ANT6	ANT5	ANT5	0.296	0.392	0.392	12.75	13.50	13.50

Note that WLAN SAR for each of the bands in the above table lists the worst-case SAR out of both WLAN antennas and WLAN MIMO.

4.2. PD Measurement Results at input.power.limit

Tables 3-1 to 3-3 list the beams selected for PD verification test for this EUT and Tables 4-3 to 4-5 list the corresponding PD measurement results at 2 mm spacing. Qualcomm's Smart Transmit algorithm operates based on time-averaged transmit power reported on a per symbol basis, which is independent of modulation, channel, and bandwidth (RBs). Therefore, PD measurements in Tables 4-3 to 4-5 were conducted with the EUT in *Factory Test Mode* (FTM), with CW modulation and on the worst-case channel determined through simulations (See Appendix B of the Part 0 report), with the EUT transmitting at *input.power.limit* (listed in Table 3-4 of the Part 0 report) corresponding to the tested beams.

All 4cm^2 PD values for the selected beams are listed in Tables 4-3 to 4-5. In addition to these selected beams, 4cm^2 PD for a few more beams (highlighted in Tables 4-3 to 4-5) were used in the Part 2 report.

Table 4-3: PD Measurement results for n258

Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M1	25.875	2042915	31		-0.3	1	100	1	Back	2.380	3.320
	24.300	2016667	28	156	-2.4	1	100	1	Back	2.110	2.520
	27.450	2069160		156	3.7	1	100	1	Back	**4.960**	**5.650**
	27.450	2069160		156	3.7	1	100	1	Left	0.130	0.134
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M0	27.450	2069160	12		6.0	1	100	1	Back	3.380	3.760
	27.450	2069160	11	139	2.5	1	100	1	Back	2.920	3.530
	24.300	2016667		140	7.0	1	100	66	Back	**4.960**	**6.170**
	24.300	2016667		140	7.0	1	100	66	Left	0.091	0.094
	24.300	2016667		140	7.0	1	100	66	Top	0.252	0.272
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M2	27.450	2069160		160	-0.1	1	100	1	Right	3.350	5.200
	27.450	2069160	32	160	-3.3	1	100	1	Right	3.720	4.810
	27.450	2069160	32		1.8	1	100	66	Right	**4.920**	**7.090**
	27.450	2069160	32		1.8	1	100	66	Back	0.102	0.104
	27.450	2069160	32		1.8	1	100	66	Front	1.490	2.190

n258	PD_Design_Target (W/m^2):		6				
	Total Uncertainty (dB):		2.2				
	Worst-case location (x,y,z) (m):		S4 (Edge Right) (0.03411, -0.00900, -0.00100)				
Module	Printed backoff Value bj (linear)	FCC PD Limit (W/m^2)	bj*PD_design_target + total uncertainty (W/m^2)	Beam/Beam-pair ID	Measured PD (W/m^2)	Surface	Contribution Factor c(i,j)
0	0.9772	10	9.730	140	6.170	S2	0.0236
1	0.955	10	9.509	32	7.090	S4	0.9994
Verfication:	(0.0236 x 6.17) + (0.9994 x 7.09) = 7.231358 < 9.509						

Note: Module 0 contains antennas M0 and M1, module 1 contains antenna M2

Table 4-4: PD Measurement results for 260

Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M1	37.050	2229167		168	-0.6	1	100	1	Back	1.500	1.940
	37.050	2229167	27	155	-3.7	1	100	1	Back	2.050	2.490
	38.500	2253330	37		1.0	1	100	66	Back	**4.230**	**4.800**
	38.300	2253330	37		1.0	1	100	66	Left	0.070	0.075
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M0	37.050	2229167		141	6.9	1	100	1	Back	2.490	3.020
	37.050	2229167	13	141	2.9	1	100	1	Back	1.930	2.450
	37.050	2229167	12		5.8	2	100	66	Back	**4.240**	**5.040**
	37.050	2229167	12		5.8	2	100	66	Left	0.042	0.045
	37.050	2229167	12		5.8	2	100	66	Top	0.165	0.168
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M2	39.950	2277500	42		1.7	1	100	1	Right	2.960	3.670
	39.950	2277500	42	170	-2.1	1	100	1	Right	3.180	3.820
	39.950	2277500		162	1.7	1	50	33	Right	**5.480**	**6.660**
	39.950	2277500		162	1.7	1	50	33	Back	1.790	2.160
	39.950	2277500		162	1.7	1	50	33	Front	1.560	1.880

n260	PD_Design_Target (W/m^2):		6				
	Total Uncertainty (dB):		2.2				
	Worst-case location (x,y,z) (m):		S4 (Edge Right) (0.03411, -0.01000, -0.00100)				
Module	Printed backoff Value bj (linear)	FCC PD Limit (W/m^2)	bj*PD_design_target + total uncertainty (W/m^2)	Beam/Beam-pair ID	Measured PD (W/m^2)	Surface	Contribution Factor c(i,j)
0	0.9772	10	9.730	12	5.040	S2	0.0154
1	0.955	10	9.509	162	6.660	S4	1
Verfication:	(0.0154 x 5.04) + (1 x 6.66) = 6.737616 < 9.509						

Note: Module 0 contains antennas M0 and M1, module 1 contains antenna M2

Table 4-5: PD Measurement results for 261

Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M1	27.550	2070833	27		-0.7	1	100	1	Back	1.540	1.690
	27.550	2070833	40	168	-2.9	1	100	1	Back	3.660	4.280
	27.550	2070833		157	3.0	1	100	66	Back	**5.500**	**6.470**
	27.550	2070833		157	3.0	1	100	66	Left	0.180	0.189
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M0	28.300	2083330	23		5.6	1	100	1	Back	3.330	3.860
	27.550	2070833	10	138	2.3	1	100	1	Back	2.000	2.540
	28.300	2083330		150	6.8	1	100	1	Back	**4.820**	**5.660**
	28.300	2083330		150	6.8	1	100	1	Left	0.087	0.093
	28.300	2083330		150	6.8	1	100	1	Top	1.120	1.170
Module/Antenna	Frequency		Beam ID1	Beam ID2	input.power.limit	CC	BW	RB	DUT Surface	Normal psPD	Total psPD
	GHz	Ch.	V	H	dBm	#	MHz	#		W/m^2	W/m^2
M2	27.925	2077084	44		-0.1	1	100	1	Right	2.160	3.160
	27.925	2077084		164	-0.1	1	100	1	Right	2.650	3.990
	27.925	2077084	36	164	-3.5	1	50	1	Right	**4.450**	**6.380**
	27.925	2077084	36	164	-3.5	1	50	1	Back	1.140	1.600
	27.925	2077084	36	164	-3.5	1	50	1	Front	1.290	1.960

n261	PD_Design_Target (W/m^2):		6				
	Total Uncertainty (dB):		2.2				
	Worst-case location (x,y,z) (m):		S4 (Edge Right) (0.03411, -0.00700, 0.00000)				
Module	Printed backoff Value bj (linear)	FCC PD Limit (W/m^2)	bj*PD_design_target + total uncertainty (W/m^2)	Beam/Beam-pair ID	Measured PD (W/m^2)	Surface	Contribution Factor c(i,j)
0	0.9772	10	9.730	157	6.470	S2	0.0092
1	0.9772	10	9.730	36/164	6.380	S4	0.9998
Verfication:	(0.0092 x 6.47) + (0.9998 x 6.38) = 6.438248 < 9.73						

Note: Module 0 contains antennas M0 and M1, module 1 contains antenna M2

The PD distribution plots for both point PD and 4cm^2 avg PD for the highest PD configuration in Tables 4-1, 4-2 & 4-3 is given below.

Note: Dasy mmWave module automatically computes grid extents from anchor scan

n258:

Model, Manufacturer	Dimensions [mm]	DUT Type
A2481	132.0 x 65.0 x 7.0	Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G -	EDGE RIGHT, 2.00	Custom Band	CW, 0--	27450.0, 27450000	1.0

Hardware Setup

Medium	Probe, Calibration Date	DAE, Calibration Date
Air---	EUmmWV4 - SN9496_F1-78GHz, 2021-02-26	DAE4 Sn1548, 2021-02-22

Scan Setup

	5G Scan
Grid Extents [mm]	25.0 x 25.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	2.0
MAIA	N/A

Measurement Results

	5G Scan
Date	2021-06-29, 23:07
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	4.92
psPDtot+ [W/m^2]	7.09
psPDmod+ [W/m^2]	7.85
E_{max} [V/m]	113
Power Drift [dB]	-0.02

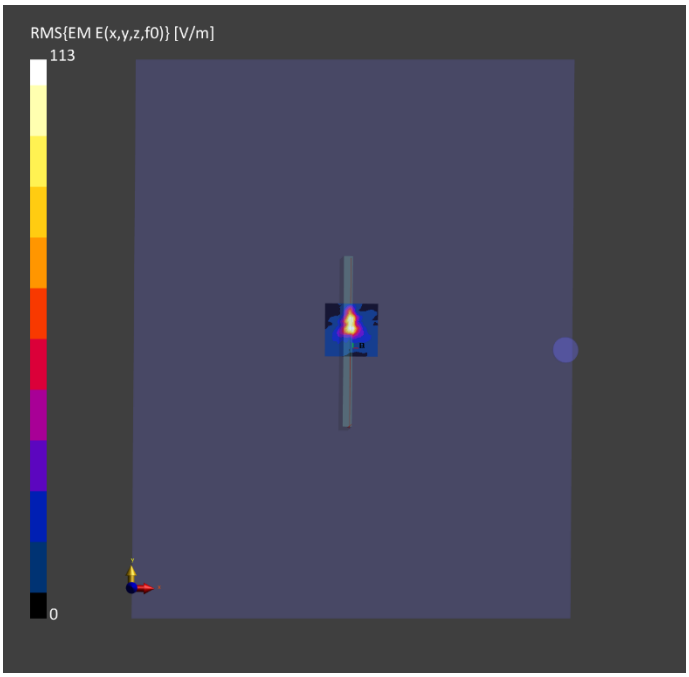

Figure 4-1: Band n258, beam ID 32, 4 cm^2 PD, Edge Right

n260:

Model, Manufacturer	Dimensions [mm]	DUT Type
A2481	132.0 x 65.0 x 7.0	Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G -	EDGE RIGHT, 2.00	Custom Band	CW, 0--	39950.0, 39950000	1.0

Hardware Setup

Medium	Probe, Calibration Date	DAE, Calibration Date
--Air-	EUmmWV4 - SN9496_F1-78GHz, 2021-02-26	DAE4 Sn1548, 2021-02-22

Scan Setup

	5G Scan
Grid Extents [mm]	25.0 x 25.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	2.0
MAIA	N/A

Measurement Results

	5G Scan
Date	2021-06-25, 22:09
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	5.48
psPDtot+ [W/m^2]	6.66
psPDmod+ [W/m^2]	7.44
E_{max} [V/m]	137
Power Drift [dB]	0.04

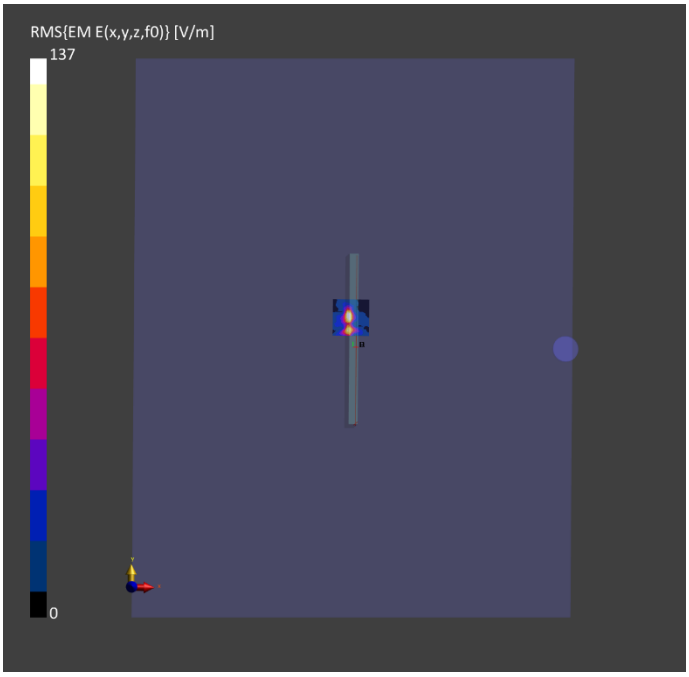

Figure 4-2: Band n260, beam ID 162, 4 cm^2 PD, Edge Right

n261:

Model, Manufacturer	Dimensions [mm]	DUT Type
A2481	132.0 x 65.0 x 7.0	Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G -	BACK, 2.00	Custom Band	CW, 0--	27550.0, 27550000	1.0

Hardware Setup

Medium	Probe, Calibration Date	DAE, Calibration Date
Air---	EUmmWV4 - SN9496_F1-78GHz, 2021-02-26	DAE4 Sn1548, 2021-02-22

Scan Setup

	5G Scan
Grid Extents [mm]	25.0 x 25.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	2.0
MAIA	N/A

Measurement Results

	5G Scan
Date	2021-06-26, 07:24
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	5.50
psPDtot+ [W/m^2]	6.47
psPDmod+ [W/m^2]	6.77
E_{max} [V/m]	90.3
Power Drift [dB]	-0.02

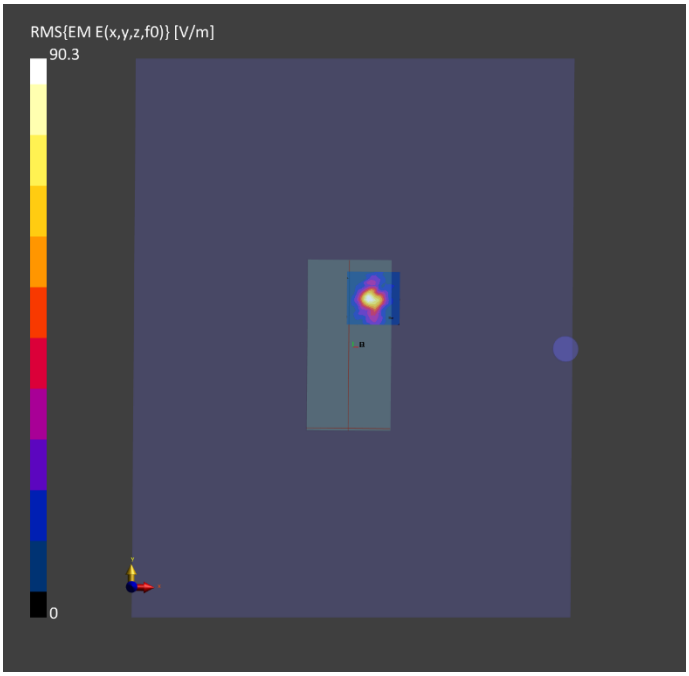

Figure 4-3: Band n261, beam ID 157, 4 cm^2 PD, Back

4.3. Simultaneous Transmission Analysis

The EUT supports simultaneous transmission of multiple radios. RF exposure compliance in simultaneous transmission scenarios is evaluated in this section.

It must be noted here that Qualcomm's Smart Transmit time-averaging algorithm was applied to only WWAN (Sub-6GHz/5G mmW NR) on this device, where the time-averaged power level is controlled so that the RF exposure is ≤ $SAR_{Design\ Target}$ (corresponding to P_{limit}) for Sub-6 GHz WWAN and ≤ $PD_{Design\ Target}$ (corresponding to input.power.limit) for 5G mmW NR. Since there is total design related uncertainty arising from TxAGC and device-to-device variation, the worst-case RF exposure should be determined by accounting for this uncertainty in the corresponding design target, thus, with 1dB of device uncertainty for sub-6 WWAN and 2.2dB of device uncertainty for 5G mmW NR. Therefore, the worst-case RF exposure for this EUT is:

Table 4-6: Worst-case time-averaged RF exposure for WWAN

Scenario	WWAN	
	Sub-6 GHz WWAN	5G mmW NR
Maximum time-averaged power level	P_{limit}	input.power.limit
Maximum time-averaged exposure (Design Targets)	0.8 W/kg (1-g SAR)	6 W/m²
Design-related uncertainty (dB)	1.00	2.20
Worst-case time-averaged RF exposure	Reported SAR† = 1 W/kg (1-g SAR)	Reported PD* = 10 W/m²

†: For this EUT, (P_{limit} + 1.0dB uncertainty) ≥ P_{max} (maximum RF tune-up output power). Therefore, time-averaged SAR exposure from Smart Transmit enabled EUT (at P_{limit}) cannot exceed the reported SAR corresponding to P_{max} listed in Table 4-1.

WLAN reported 1g SAR at the maximum RF tune-up output power is listed in Table 4-2.

4.3.1. Analysis

RF exposure compliance with WWAN+WLAN simultaneous transmission scenarios is demonstrated for various radio configurations using the equation below:

> Total norm. RF exposure = norm. RF exposure from Smart Transmit enabled WWAN (norm. SAR from Sub-6 GHz + norm. PD from 5G mmW NR) + norm. SAR from WLAN ≤ 1.0 normalized limit (1)

Smart Transmit algorithm in WWAN adds directly the time-averaged RF exposure from Sub-6 GHz WWAN and time-averaged RF exposure from 5G mmW NR, i.e.,

> norm. RF exposure from Smart Transmit enabled WWAN: (normalized SAR exposure from Sub-6 GHz) + (normalized PD exposure from 5G mmW NR) ≤ 1.0 normalized limit (2)

In other words, Smart Transmit algorithm controls the total RF exposure from both Sub-6 GHz radio and 5G mmW NR to not exceed the FCC limit. All WWAN sub6 antennas are assumed to collocate with each mmW module (i.e., ignoring spatial distribution of WWAN Sub-6 hotspots) and directly adds normalized RF exposures from Sub-6 GHz WWAN and from each 5G mmW NR module, i.e.,

> If A = max normalized time-averaged SAR exposure from Sub-6 GHz,
> B = max normalized time-averaged PD exposure from 5G mmW NR,

Then, equation (2) can be re-written as below because All WWAN sub6 antennas are assumed to collocate with each mmW module and 5G mmW NR hotspot:

> Smart Transmit enabled WWAN: x(t) * A + (1-x(t)) * B ≤ 1.0 normalized limit (3)

Here, "*x(t)*A*" represents percentage of normalized time-averaged RF exposure from Sub-6 GHz WWAN, and x(t) ranges between [0,1]; "*(1-x(t))*B*" is remaining percentage of RF exposure contribution from 5G mmW NR. Smart Transmit controls '*x*' in real time such that the sum of these exposures never exceeds the 1.0 normalized limit.

Note that mathematically:

$$x(t) * A + (1 - x(t)) * B \leq max(A, B) \leq 1.0\ normalized\ limit \text{ for x(t) } \in [0,1] \quad (4)$$

Therefore, if equations (5a) and (5b) are proven:

$$A + norm.SAR\ from\ WLAN \leq 1.0\ norm.limit \quad (5a),$$

$$B + norm.SAR\ from\ WLAN \leq 1.0\ norm.limit \quad (5b),$$

Then, based on equation (4), the condition below is also proved:

$$[x(t) * A + (1 - x(t)) * B\ ] + norm.SAR\ from\ WLAN \leq 1.0\ norm.limit \quad (5c)$$

which is the same as equation (1), as a means to demonstrate compliance for simultaneous transmission.

Additionally, it should be noted that in the absence of 5G mmW NR, Smart Transmit limits the maximum RF exposure contributed from Sub-6 GHz WWAN to 100% normalized exposure (i.e., *x*=1.0 in equation 3). Therefore:

Smart Transmit enabled WWAN: A=max (normalized SAR exposure from Sub-6 GHz) ≤ 1.0 normalized limit (6a)

Smart Transmit enabled WWAN: B=max (normalized PD exposure from 5G mmW NR) ≤ 1.0 normalized limit (6b)

Thus, for compliance demonstration given by equation (1), equation (7) is obtained by combining equations (5a & 5b) and (6a & 6b) and should be proven to guarantee simultaneous transmission compliance:

Total normalized RF exposure = norm. SAR from Sub-6 GHz WWAN + norm. SAR from WLAN < 1.0 normalized FCC limit (7a)

Total normalized RF exposure = norm. PD from 5G mmW NR WWAN + norm. SAR from WLAN < 1.0 normalized FCC limit (7b)

The compliance for simultaneous transmission scenarios of WWAN (Sub-6 GHz/5G mmW NR) radio enabled with Smart Transmit and WLAN without Smart Transmit is re-evaluated for all transmission scenarios supported by this EUT.

As described in equation (7), simultaneous transmission analysis for WWAN + WLAN is performed in two parts:

1. Sub-6 GHz WWAN + WLAN (i.e., Eq. (7a) with compliance demonstration in §4.3.2)
2. 5G mmW NR WWAN + WLAN (i.e., Eq. (7b) with compliance demonstration in §4.3.3)

By combining equations *a* and *b* variants, the FCC requirement expressed in Eq. (1) is re-written below:

Total norm. RF exposure = norm. RF exposure from Smart Transmit enabled WWAN (norm. SAR from Sub-6 GHz WWAN + norm. PD from 5G mmW NR) + norm. SAR from WLAN ≤ 1.0 normalized limit (1)

4.3.2. Simultaneous Transmission Compliance Demonstration for Sub-6 GHz WWAN + WLAN

Simultaneous transmission analysis for Sub-6 WWAN + WLAN is shown in the UL *FCC SAR Test Report* 13573771-S1.

4.3.3. Simultaneous Transmission Compliance Demonstration for 5G mmW NR WWAN + WLAN

Simultaneous transmission analysis is performed in this section using worst-case PD values listed in Tables 4-3 to 4-5 for compliance demonstration of 5G mmW NR WWAN + WLAN, along with all worst-case reported SAR, extracted from UL *FCC SAR Test Report* 13573771-S1, values for WLAN listed in Table 4-2.

Simultaneous transmission analysis on all 5G mmW NR WWAN + WLAN scenarios are listed below:

Table 4-7: Simultaneous transmission analysis scenarios for 5G mmW NR WWAN + WLAN

1	2.4GHz WLAN* + 5G mmW NR
2	5GHz WLAN* + 5G mmW NR
3	5GHz WLAN* + BT + 5G mmW NR

*: For each of the WLAN bands, worst-case SAR out of both WLAN antennas and WLAN MIMO scenarios is used during simultaneous transmission analysis. Additionally, note that WLAN 2.4GHz and WLAN 5GHz cannot transmit simultaneously.

The total exposure ratio (TER) is calculated using the equation below, followed by the calculated TER for this EUT:

$$TER = \sum_{n=1}^{N} \frac{\mathrm{SAR}_n}{\mathrm{SAR}_{n,limit}} + \sum_{n=1}^{N} \frac{\mathrm{S}_{m,avg}}{\mathrm{S}_{m,limit}} < 1$$

Table 4-8: 5G mmW NR Simulation PD Surface Ratio n258

n258						
Surface	PD Magnitude Ratio		Head	Body[1]	Meas. Total PD	Measured Total PD x Magnitude Ratio (W/m^2)
	2mm	5mm	PD @ 2mm (W/m^2)	PD @ 5mm (W/m^2)	(W/m^2)	
S1	0.555	-	**5.500**	**3.161**	2.190	2.190
S2	1.000	0.500	-	**5.700**	-	-
S3	0.259	-	-	**1.474**	0.134	0.134
S4	1.000	0.570	-	**5.700**	-	-
S5	0.173	-	-	**0.985**	0.272	0.272
S6	0.028	-	-	**0.157**	-	-

[1] Results for Body were calculated using the most conservative ratio between the PD Magnitudes for 2mm and 5mm.

Table 4-9: 5G mmW NR Simulation PD Surface Ratio n260

n260						
Surface	PD Magnitude Ratio		Head	Body[1]	Meas. Total PD	Measured Total PD x Magnitude Ratio (W/m^2)
	2mm	5mm	PD @ 2mm (W/m^2)	PD @ 5mm (W/m^2)	(W/m^2)	
S1	0.504	-	**5.000**	**2.925**	1.880	1.880
S2	1.000	0.330	-	**5.800**	-	-
S3	0.127	-	-	**0.737**	0.075	0.075
S4	1.000	0.580	-	**5.800**	-	-
S5	0.172	-	-	**1.000**	0.168	0.168
S6	0.032	-	-	**0.184**	-	-

[1] Results for Body were calculated using the most conservative ratio between the PD Magnitudes for 2mm and 5mm.

Table 4-10: 5G mmW NR Simulation PD Surface Ratio n261

n261						
Surface	PD Magnitude Ratio		Head	Body[1]	Meas. Total PD	Measured Total PD x Magnitude Ratio (W/m^2)
	2mm	5mm	PD @ 2mm (W/m^2)	PD @ 5mm (W/m^2)	(W/m^2)	
S1	0.593	-	**5.900**	**3.322**	1.960	1.960
S2	1.000	0.560	-	**5.600**	-	-
S3	0.227	-	-	**1.270**	0.189	0.189
S4	1.000	0.540	-	**5.600**	-	-
S5	0.168	-	-	**0.938**	1.170	1.170
S6	0.031	-	-	**0.172**	-	-

[1] Results for Body were calculated using the most conservative ratio between the PD Magnitudes for 2mm and 5mm.

Table 4-11: Head TER for Worst-Case WLAN + 5G mmW NR n258

Head TER	psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
	W/m^2	W/kg	W/kg	W/kg			
TER Combinations	1	2	3	4	1+2	1+3	1+3+4
Applicable limit	10	1.6	1.6	1.6	1	1	1
Reported Exposure	5.500	0.371	0.296	0.067	-	-	-
Ratio to Limit	0.550	0.232	0.185	0.042	0.782	0.735	0.777

Table 4-12: Head TER for Worst-Case WLAN + 5G mmW NR n260

Head TER	psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
	W/m^2	W/kg	W/kg	W/kg			
TER Combinations	1	2	3	4	1+2	1+3	1+3+4
Applicable limit	10	1.6	1.6	1.6	1	1	1
Reported Exposure	5.000	0.371	0.296	0.067	-	-	-
Ratio to Limit	0.500	0.232	0.185	0.042	0.732	0.685	0.727

Table 4-13: Head TER for Worst-Case WLAN + 5G mmW NR n261

Head TER	psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
	W/m^2	W/kg	W/kg	W/kg			
TER Combinations	1	2	3	4	1+2	1+3	1+3+4
Applicable limit	10	1.6	1.6	1.6	1	1	1
Reported Exposure	5.900	0.371	0.296	0.067	-	-	-
Ratio to Limit	0.590	0.232	0.185	0.042	0.822	0.775	0.817

Table 4-14: Body/Hotspot TER for Worst-Case WLAN + 5G mmW NR n258

n258								
Body/Hotspot TER		psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
		W/m^2	W/kg	W/kg	W/kg			
Scenario		1	2	3	4	1+2	1+3	1+3+4
Applicable limit		10	1.6	1.6	1.6	1	1	1
S1 @ 5 mm	Reported Exposure	3.161	0.000	0.362	0.047	-	-	-
	Ratio to Limit	0.316	0.000	0.226	0.029	0.316	0.542	0.572
S2 @ 5mm	Reported Exposure	5.700	0.470	0.392	0.078	-	-	-
	Ratio to Limit	0.570	0.294	0.245	0.048	0.864	0.815	0.863
S3 @ 5mm	Reported Exposure	1.474	0.497	0.362	0.078	-	-	-
	Ratio to Limit	0.147	0.311	0.226	0.049	0.458	0.374	0.422
S4 @ 5mm	Reported Exposure	5.700	0.425	0.000	0.077	-	-	-
	Ratio to Limit	0.570	0.266	0.000	0.048	0.836	0.570	0.618
S5 @ 5mm	Reported Exposure	0.985	0.000	0.315	0.010	-	-	-
	Ratio to Limit	0.099	0.000	0.197	0.006	0.099	0.295	0.301
S6 @ 5mm	Reported Exposure	0.157	0.000	0.362	0.018	-	-	-
	Ratio to Limit	0.016	0.000	0.226	0.011	0.016	0.242	0.253

Table 4-15: Body/Hotspot TER for Worst-Case WLAN + 5G mmW NR n260

n260								
Body/Hotspot TER		psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
		W/m^2	W/kg	W/kg	W/kg			
Scenario		1	2	3	4	1+2	1+3	1+3+4
Applicable limit		10	1.6	1.6	1.6	1	1	1
S1 @ 5 mm	Reported Exposure	2.925	0.000	0.362	0.047	-	-	-
	Ratio to Limit	0.292	0.000	0.226	0.029	0.292	0.519	0.548
S2 @ 5mm	Reported Exposure	5.800	0.470	0.392	0.078	-	-	-
	Ratio to Limit	0.580	0.294	0.245	0.048	0.874	0.825	0.873
S3 @ 5mm	Reported Exposure	0.737	0.497	0.362	0.078	-	-	-
	Ratio to Limit	0.074	0.311	0.226	0.049	0.385	0.300	0.349
S4 @ 5mm	Reported Exposure	5.800	0.425	0.000	0.077	-	-	-
	Ratio to Limit	0.580	0.266	0.000	0.048	0.846	0.580	0.628
S5 @ 5mm	Reported Exposure	1.000	0.000	0.315	0.010	-	-	-
	Ratio to Limit	0.100	0.000	0.197	0.006	0.100	0.297	0.303
S6 @ 5mm	Reported Exposure	0.184	0.000	0.362	0.018	-	-	-
	Ratio to Limit	0.018	0.000	0.226	0.011	0.018	0.245	0.256

Table 4-16: Body/Hotspot TER for Worst-Case WLAN + 5G mmW NR n261

n261								
Body/Hotspot TER		psPD	2.4 GHz WiFi	5 GHz WiFi	BT P_{low}	psPD + 2.4 GHz WLAN	psPD + 5 GHz WLAN	psPD + 5 GHz WLAN + BT
		W/m^2	W/kg	W/kg	W/kg			
Scenario		1	2	3	4	1+2	1+3	1+3+4
Applicable limit		10	1.6	1.6	1.6	1	1	1
S1 @ 5 mm	Reported Exposure	3.322	0.000	0.362	0.047	-	-	-
	Ratio to Limit	0.332	0.000	0.226	0.029	0.332	0.558	0.588
S2 @ 5mm	Reported Exposure	5.600	0.470	0.392	0.078	-	-	-
	Ratio to Limit	0.560	0.294	0.245	0.048	0.854	0.805	0.853
S3 @ 5mm	Reported Exposure	1.270	0.497	0.362	0.078	-	-	-
	Ratio to Limit	0.127	0.311	0.226	0.049	0.438	0.353	0.402
S4 @ 5mm	Reported Exposure	5.600	0.425	0.000	0.077	-	-	-
	Ratio to Limit	0.560	0.266	0.000	0.048	0.826	0.560	0.608
S5 @ 5mm	Reported Exposure	0.938	0.000	0.315	0.010	-	-	-
	Ratio to Limit	0.094	0.000	0.197	0.006	0.094	0.290	0.297
S6 @ 5mm	Reported Exposure	0.172	0.000	0.362	0.018	-	-	-
	Ratio to Limit	0.017	0.000	0.226	0.011	0.017	0.243	0.255

5. Conclusions

Table 5-1 shows the worst-case 1-g SAR at P_{limit} and worst-case 4cm^2-avg PD at *input.power.limit.*

Table 5-1: Reported RF exposure level

Reported RF Exposure Level		Notes
Highest 1-g SAR at P_{limit} + *Tolerance* (W/kg)	0.959	Refer to §1 for the reference SAR Report
Highest 4cm^2-avg PD at *input.power.limit* (W/m^2)	7.090	§4.2
Highest 1-g SAR (W/kg) for simultaneous Tx (Sub-6 WWAN + WLAN)	1.456	Refer to §1 for the reference SAR Report
Highest Total Exposure Ratio for simultaneous Tx (5G mmW NR + WLAN)	0.874	§4.3

Qualcomm's Smart Transmit feature employed in the EUT meets the $SAR_{Design\ Target}$ and $PD_{Design\ Target}$ (within the design uncertainties) when operating in the static transmission condition at P_{limit} and *input.power.limit*, respectively, and is compliant with the FCC RF exposure limits.

Appendices

Refer to separated files for the following appendixes.

A. mmW Probe Certificate

B. Verification Source Certificate