FCC 47 CFR § 2.1093
IEC TR 63170-2018

POWER DENSITY EVALUATION REPORT
(Part 1 : Test in Static Transmission Condition)

FOR

GSM/WCDMA/LTE 5G NR Phone + BT/BLE, DTS/UNII a/b/g/n/ac and NFC

MODEL NUMBER: SM-A236V

FCC ID: A3LSMA236V

REPORT NUMBER: 4790558569-S2V2

ISSUE DATE: 11/22/2022

Prepared for
SAMSUNG ELECTRONICS CO., LTD.
129 SAMSUNG-RO, YEONGTONG-GU, SUWON-SI,
GYEONGGI-DO, 16677, KOREA

Prepared by
UL KOREA, LTD.
26TH FLOOR, 152, TEHERAN-RO, GANGNAM-GU SEOUL, 06236, KOREA

SUWON TEST SITE: UL KOREA, LTD. SUWON LABORATORY
218 MAEYEONG-RO, YEONGTONG-GU,
SUWON-SI, GYEONGGI-DO, 16675, KOREA
TEL: (031) 337-9902
FAX: (031) 213-5433

ACCREDITED
Testing Laboratory
TL-637

Revision History

Rev.	Date	Revisions	Revised By
V1	11/14/2022	Initial Issue	--
V2	11/22/2022	Revised in Sec.1, Sec.6.4, Sec.10, Sec.11, Sec.12.1 Revised in appendix B & C	Jeongyeon Won

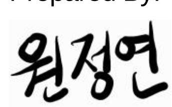
Table of Contents

1. Attestation of Test Results

Applicant Name	SAMSUNG ELECTRONICS CO.,LTD.	
FCC ID	A3LSMA236V	
Model Name	SM-A236V	
Applicable Standards	FCC 47 CFR § 2.1093 IEC TR 63170-2018	
Exposure Category	RADIOFREQUENCY RADIATION EXPOSURE (above 6GHz)	
	Power density Uncontrol (mW/cm² over 4cm²) for 30min average	
fGeneral population / Uncontrolled exposure	1.0	
Applicable limit	☒ Uncontrol	
	Measured psPD	Reported psPD
n261 Result (mW/cm^2 over 4cm^2)	*0.63*	*0.79*
n260 Result (mW/cm^2 over 4cm^2)	*0.58*	*0.79*
Simultaneous TX	*1.00*	
Date Tested	10/14/2022 to 11/21/2022	
Test Results	Pass	

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government. This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released By:	Prepared By:
	
Justin Park Operations Leader UL Korea, Ltd. Suwon Laboratory	Jeongyeon Won Laboratory Engineer UL Korea, Ltd. Suwon Laboratory

2. Introduction

The equipment under test (EUT) is a Phone, model SM-A236V (FCC ID: A3LSMA236V), it contains Qualcomm modems supporting 2G/3G/4G technologies and 5G NR bands. These WWAN modems enable Qualcomm Smart Transmit features with algorithms to control and manage transmitting power in real time and to ensure at all times the time-averaged RF exposure from WWAN is in compliance with FCC requirements.

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.

- Power density (PD) compliance for all WWAN radios (4G + 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 Part 0 report. The validation of the Qualcomm Smart Transmit time-averaging algorithm and compliance under the Tx varying transmission scenario for WWAN technologies are reported in Part 2 report.
- PD compliance for WLAN radios is assessed based on maximum transmit power as per relevant FCC KDBs.
- Demonstrate 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 separately.

By following the above steps, this report demonstrates that this EUT complies with FCC RF exposure limits for FCC equipment authorization of FCC ID: A3LSMA236V.

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

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

3. Measurement setup and General Information

The SAR measurement are recorded in UL FCC Report_SAR_Part.1 (Report No. 4790558569-S1). This section provides the detail of the test setup used for PD measurement.

3.1. 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 RF exposure (power density) up to 110GHz as close as 2mm from any transmitter.

3.1.1. Power density probe

The EummWV2 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)
- ISO 17025 accredited calibration

3.1.2. 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: 30GHz at 10 mm from the case surface
- Frequency accuracy: ± 100MHz
- 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 x 100 x 100 mm
- Weight: 1kg

Table 2-1 shows the verification test results. The measured power density (PD) value is within 10% of target level. Note that the uncertainty of 5G verification source is 1.4dB (k=2).

3.2. Test Specification, Methods and Procedures

Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- SPEAG, 5G Module V1.2 Application Note: 5G Compliance Testing, August 2018
- IEC TR 63170 Edition 1.0 2018-08

In addition to the above, TCB workshop information was used.

- TCB workshop November, 2017; Page 19 - 25, RF Exposure Procedures (Power Density Evaluation)
- TCB workshop October, 2018; Page 3, RF Exposure Procedures (Millimeter Wave Assessment)
- TCB workshop October, 2018; Page 5, RF Exposure Procedures (Millimeter Wave Measurement)
- TCB workshop April, 2019; Page 3, RF Exposure Procedures (Millimeter Wave RF Exposure Evaluation)
- TCB workshop November, 2019; Page 14, RF Exposure Procedures (Millimeter Wave Scan Requirements)

3.3. Test Specification, Methods and Procedures

The test sites and measurement facilities used to collect data are located at

Suwon
SAR 1
SAR 8
SAR 9

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637.
The full scope of accreditation can be viewed at :
https://www.iasonline.org/wp-content/uploads/2017/05/TL-637 -cert-New.pdf.

4. Test Condition, Configuration, and Assessment

4.1. Qualcomm Smart Transmit parameters

The input parameters described are required for functionality of Qualcomm Smart Transmit algorithm.

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

Part 0 report documents determination of P_{limit} for sub-6 WWAN bands, and *input.power.limit* for 5G mmW NR bands using the below design targets and device related uncertainty:

- *SAR_design_target* of 1.0 W/kg for 1g SAR and sub-6 WWAN device design related uncertainty of 1.0 dB.
- *PD_design_target* of 0.617 mW/cm^2 4cm^{2}PD and mmW device design related uncertainty of 2.1 dB.

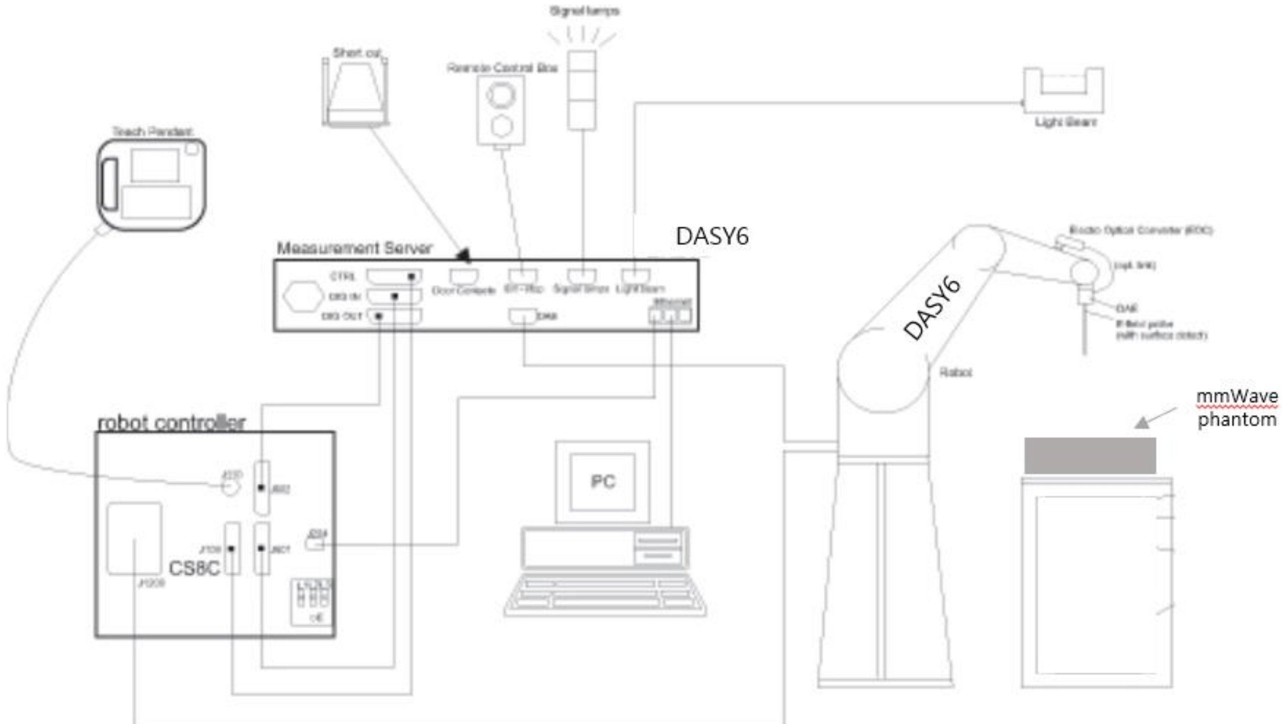
4.2. Qualcomm Smart Transmit parameters for the 5G mmW NR

The input.power.limit parameter for 5G mmW NR radio determined in Section 8.5 of this report are populated via EFS entry into the EUT.

5. Measurement System & Test Equipment

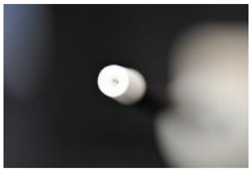
5.1. Measurement System

The DASY6 & 8 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- The EUmmWVx probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win10 and the DASY6 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom which is specialized for 5G other accessories according to the targeted measurement.

5.2. EUmmWVx / 5G Probe
E-Field mm-Wave Probe for General Near-Field Measurements



Two dipoles optimally arranged to obtain pseudo-vector information
Minimum 3 measurements/point, 120º rotated around probe axis
Sensors (0.8mm length) printed on glass substrate protected by high density foam
Low perturbation of the measured field
Requires positioner which can do accurate probe rotation

Frequency Range	750 MHz – 110 GHz
Dynamic Range	< 20 V/m - 10'000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm (DASY6)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm Sensor displacement to probe's calibration point: < 0.3 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 (cDASY6 5G or ICEy-mmW module required)
Compatibility	cDASY6 + 5G-Module SW1.0 and higher

5.3. Data Acquisition Electronics(DAE)

Serial optical link for communication with DASY4/5 embedded system (fully remote controlled) Two-step probe touch detector for mechanical surface detection and emergency robsot stop

Measurement Range	−100 – +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)
Input Offset Voltage	<5 µV (with auto zero)
Input Resistance	200 Mohm
Input Bias Current	<50 fA
Battery Power	>10 hours of operation (with two 9.6 V NiMH batteries)
Dimensions (L × W × H)	60 × 60 × 68 mm

6. Measurement Procedures

6.1. System Verification Scan Procedures

cDASY6 5G Module V1.2 supports “5G Scan”, a fine resolution scan performed on two different planes which is used to reconstruct the E- and H-fields as well as the power density; the average power density is derived from this measurement.

Step 1: Power Reference Measurement
The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to devise under test.

Step 2: 5G Scan
The steps in the X, Y, and Z directions are specified in terms of fractions of the signal wavelength ,lambda.
Area Scan Parameters extracted from SPEAG, 5G Module V1.2 Application Note.

Recommended settings for measurement of verification sources

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 ($\frac{\lambda}{4}$)	31/31	26 × 26
90	0.25 ($\frac{\lambda}{4}$)	29/29	35 × 35

The minimum distance of probe sensors to verification source surface, horn antenna, is 10 mm.
In other case, distance is determined as λ / 5, details are shown in section 6.3.

Step 3: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.
When the drift is larger than ± 5 %, test is repeated from step1.

6.2. Scan Procedures

Step 1: Power Reference Measurement
Same as System Verification Scan Procedures step 1.

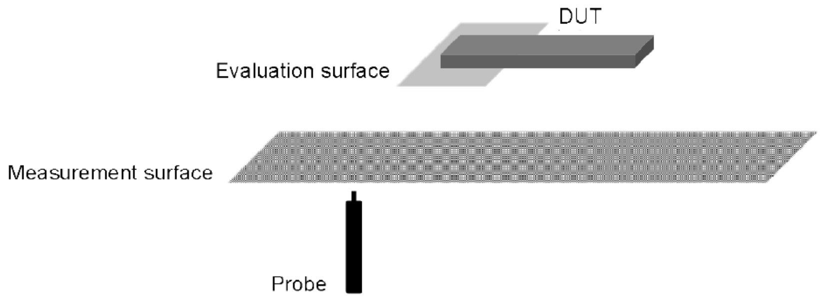
Step 2: 5G Scan
Same as System Verification Scan Procedures step 2. But measurement area is defined based on TCB workshop “A sufficiently large measurement region and proper measurement spatial resolution are required to maintain field reconstruction accuracy”.

Step 3: Power drift measurement
Same as System Verification Scan Procedures step 3.
When the drift is smaller than ± 5 %, it is considered in the uncertainty budget if drifts larger than 5%, uncertainty is re-calculate.

6.3. Total Field and Power Flux Density Reconstruction(measurement distance)

Reconstruction algorithms are used to project or transform the measured fields from the measurement surface to the evaluation surface (below fig) in order to determine power density or to compute spatial-average and/or local power density with known uncertainty.

Manufacture has developed a reconstruction approach based on the Gerchberg-Saxton algorithm, which benefits from the availability of the E-field polarization ellipse information obtained with the EUmmWVx probe. This reconstruction algorithm, together with the ability of the probe to measure extremely close to the source without perturbing the field, permits reconstruction of the E- and H-fields, as well as of the power density, on measurement planes located as near as λ / 5 away.



6.4. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
5G probe	SPEAG	EummWV4	9559	2-28-2023
5G probe	SPEAG	EummWV4	9536	2-28-2023
Data Acquisition Electronics	SPEAG	DAE4	1670	6-7-2023
Data Acquisition Electronics	SPEAG	DAE4	1667	4-27-2023
5G Verification Source (30GHz)	SPEAG	5G verification source_30GHz	1047	1-28-2023
5G Verification Source (30GHz)	SPEAG	5G verification source_30GHz	1082	3-1-2023
Thermometer	Lutron	MHB-382SD	AH.91463	8-4-2023
Thermometer	Lutron	MHB-382SD	AK.12102	8-9-2023

7. Measurement Uncertainty

Measurement Uncertainty for cDASY6 Module mmWave						
Error Description	Uncertainty value (±dB)	Probe Dist.	Divisor	(Ci)	Std. Unc. (±dB)	(Vi)
Uncertainty terms dependent on the measurement system						
1.Probe Calibration	**0.49**	Normal	1	1	0.49	Infinity
2.Probe correction	**0.00**	Rectangular	1.73	1	0.00	Infinity
3.Frequency response (BW =< 1 GHz)	**0.20**	Rectangular	1.73	1	0.12	Infinity
4.Sensor cross coupling	**0.00**	Rectangular	1.73	1	0.00	Infinity
5.Isotropy	**0.50**	Rectangular	1.73	1	0.29	Infinity
6.Linearity	**0.20**	Rectangular	1.73	1	0.12	Infinity
7.Probe scattering	**0.00**	Rectangular	1.73	1	0.00	Infinity
8.Probe positioning offset	**0.30**	Rectangular	1.73	1	0.17	Infinity
9.Probe positioning repeatability	**0.04**	Rectangular	1.73	1	0.02	Infinity
10.Sensor mechanical offset	**0.00**	Rectangular	1.73	1	0.00	Infinity
11.Probe spatial resolution	**0.00**	Rectangular	1.73	1	0.00	Infinity
12.Field impedance dependance	**0.00**	Rectangular	1.73	1	0.00	Infinity
13.Amplitude and phase drift	**0.00**	Rectangular	1.73	1	0.00	Infinity
14.Amplitude and phase noise	**0.04**	Rectangular	1.73	1	0.02	Infinity
15.Measurement area truncation	**0.10**	Rectangular	1.73	1	0.06	Infinity
16.Data acquisition	**0.03**	Normal	1.00	1	0.03	Infinity
17.Sampling	**0.00**	Rectangular	1.73	1	0.00	Infinity
18.Field reconstruction	**0.60**	Rectangular	1.73	1	0.35	Infinity
19.Forward transformation	**0.00**	Rectangular	1.73	1	0.00	Infinity
20.Power density scaling	**-**	Rectangular	1.73	1	-	Infinity
21.Spatial averaging	**0.10**	Rectangular	1.73	1	0.06	Infinity
22.System detection limit	**0.04**	Rectangular	1.73	1	0.02	Infinity
Uncertainty terms dependent on the DUT and environmental factors						
23.Probe coupling with DUT	**0.00**	Rectangular	1.73	1	0.00	Infinity
24.Modulation response	**0.40**	Rectangular	1.73	1	0.23	Infinity
25.Integration time	**0.00**	Rectangular	1.73	1	0.00	Infinity
26.Response time	**0.00**	Rectangular	1.73	1	0.00	Infinity
27.Device holder influence	**0.10**	Rectangular	1.73	1	0.06	Infinity
28.DUT alignment	**0.00**	Rectangular	1.73	1	0.00	Infinity
29.RF ambient conditions	**0.04**	Rectangular	1.73	1	0.02	Infinity
30.Ambient reflections	**0.04**	Rectangular	1.73	1	0.02	Infinity
31.Immunity / secondary reception	**0.00**	Rectangular	1.73	1	0.00	Infinity
32.Drift of the DUT	**0.22**	Rectangular	1.73	1	0.13	Infinity
Combined Std. Uncertainty					0.76	Infinity
Expanded Standard Uncertainty (95%)					**1.53**	

7.1. DECISION RULE

Decision rule for statement(s) of conformity is based on Procedure 1, Clause 4.4.2 in IEC Guide 115:2007.

8. DUT Information

8.1. DUT Description

Device Dimension	Refer to Appendix A.
Back Cover	The Back Cover is not removable
Battery Options	The rechargeable battery is not user accessible.
Test sample information	**No.** / **S/N** / **Notes** 1 / 664a0eddb8347ece / mmWave Radiated

8.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
5G NR mmW	NR Band 261 (50MHz & 100MHz) NR Band 260 (50MHz & 100MHz)	DFT-s-ODFM : QPSK, 16QAM, 64QAM CP-ODFM : QPSK, 16QAM, 64QAM	100%

8.3. 5G NR mmWave Test and Reporting Considerations

Item	Description		
Frequency range, Channel Bandwidth, Numbers and Frequencies	Band 261	Frequency range: 27500 – 28350 MHz	
		Channel Bandwidth	
		100MHz	50MHz
		MHz / Channel	MHz / Channel
	Low	27559.32 / 2071821	27559.32 / 2071821
	Mid	27923.52 / 2077891	27923.52 / 2077891
	High	28292.16 / 2084035	28292.16 / 2084035
	Band 260	Frequency range: 37000 – 40000 MHz	
		Channel Bandwidth	
		100MHz	50MHz
		MHz / Channel	MHz / Channel
	Low	37051.80 / 2230029	37051.80 / 2230029
	Mid	38498.88 / 2254147	38498.88 / 2254147
	High	39949.92 / 2278331	39949.92 / 2278331
Sub carrier Spacing	120 kHz		
Total Number of Supported Uplink CCs (SISO)	2		
Total Number of Supported Uplink CCs (MIMO)	2 (CP-OFDM Only)		
Total Number of Supported DL CCs	4		
LTE Anchor Bands (n261)	LTE B2 / 5 / 13 / 48 / 66		
LTE Anchor Bands (n260)	LTE B2 / 5 / 13 / 48 / 66		
Duplex Type (mmWave)	TDD		

8.4. Time-Averaging Algorithm for RF Exposure Compliance

The equipment under test(EUT) are supporting 3G/4G/5G NR technologies through Qualcomm@ modem. Qualcomm@ modem is enabled with Qualcomm@ Smart Transmit feature. This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure is in compliance with FCC requirements all the time. Refer to Compliance Summary document for detailed description of Qualcomm@ Smart Transmit feature.

The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of *SAR_design_target* or *PD_design_target*, below the predefined time-averaged power limit (i.e., P_{limit} for sub-6 radio, and *input.power.limit* for 5G mmW NR), for each characterized technology and band. Smart Transmit allows the device to transmit at higher power instantaneously when needed. but manages power limiting to maintain time-averaged transmit power to *input.power.limit* listed in Section 8.5.

The purpose of this report (Part 1 test) is to demonstrate that the EUT meets FCC PD limits when transmitting in static transmission scenario at maximum allowable time-averaged power level given by *input.power.limit.*

8.5. Input Power Limit

All power density measurements for this device were performed at the *input.power.limit* given in below tables. Input power is per antenna element and polarization for each antenna module. When input power limit is calculated to be above the maximum input power, the device is limited to the maximum input power.

5G NR n261 K Patch Input Power Limit

Antenna	Beam ID_1	Beam ID_2	input.power.limit (dBm)
K patch	0		**9.5**
	1		**10.3**
	2		**7.5**
	3		**6.0**
	4		**6.5**
	5		**6.9**
	6		**6.8**
	7		**5.9**
	8		**6.1**
	9		**3.3**
	10		**2.9**
	11		**3.0**
	12		**2.9**
	13		**4.0**
	14		**3.0**
	15		**3.1**
	16		**2.7**
	17		**3.5**
	128		**8.5**
	129		**8.7**
	130		**7.0**
	131		**5.3**
	132		**7.8**
	133		**5.7**
	134		**8.7**
	135		**4.9**
	136		**8.6**
	137		**2.9**
	138		**2.6**
	139		**2.9**
	140		**2.6**
	141		**3.2**
	142		**2.6**
	143		**3.1**
	144		**3.1**
	145		**2.5**
	0	128	**5.6**
	1	129	**6.1**
	2	130	**4.4**
	3	131	**3.5**
	4	132	**4.2**
	5	133	**3.7**
	6	134	**4.1**
	7	135	**2.9**
	8	136	**4.2**
	9	137	**-0.8**
	10	138	**-0.5**
	11	139	**-0.3**
	12	140	**-0.3**
	13	141	**0.5**
	14	142	**-0.9**
	15	143	**-0.1**
	16	144	**-0.1**
	17	145	**0.0**

5G NR n260 K Patch Input Power Limit

Antenna	Beam ID_1	Beam ID_2	input.power.limit (dBm)
K patch	0		7.9
	1		6.3
	2		6.9
	3		5.9
	4		7.9
	5		6.0
	6		6.1
	7		5.8
	8		3.8
	9		3.5
	10		3.3
	11		2.6
	12		3.2
	13		3.3
	14		3.5
	15		3.5
	16		3.2
	128		8.7
	129		8.3
	130		8.4
	131		6.0
	132		6.7
	133		5.7
	134		5.8
	135		9.5
	136		3.4
	137		3.6
	138		3.4
	139		3.7
	140		4.5
	141		3.8
	142		3.5
	143		3.8
	144		4.0
	0	128	4.6
	1	129	3.9
	2	130	4.3
	3	131	2.4
	4	132	4.3
	5	133	2.5
	6	134	2.7
	7	135	4.0
	8	136	0.2
	9	137	-0.1
	10	138	0.0
	11	139	-0.4
	12	140	0.0
	13	141	-0.1
	14	142	0.4
	15	143	0.0
	16	144	-0.2

9. RF Exposure Conditions (Test Configurations)

9.1. Operating mode(s)

DUTs can transmit in operating modes and frequency bands using different signal characteristics (e.g. modulation, source coding, channel bandwidth, etc.) that require power density tests. The appropriate operating modes should be selected for testing taking into consideration differences in maximum output power and production variations, to ensure maximum power density is assessed.

Supported mode:

☒ CW
☐ AM
☐ FMCW
☐ FM
☐ pi/2-BPSK
☐ pi/2-QPSK
☐ D-QPSK
☐ QPSK
☐ Up to 16QAM
☐ Up to 64QAM
☐ Up to 256QAM
☐ pi/2-16QAM

9.2. Measurement position(s)

Power density evaluated at worst-surfaces according to test results of Power density Part.0 report.

Band	Antenna	Back Rear	Front	Top Edge 1	Bottom Edge 3	Left Edge 4	Right Edge 2
5G NR Band n260	K Patch	Yes	Yes	Yes	No	No	Yes
5G NR Band n261	K Patch	Yes	Yes	Yes	No	No	Yes

Please refer to Appendix A for Antenna’s location.

10. Dielectric Property & System Check

10.1. Dielectric Property

Media is air so Relative Permittivity (ϵr) and Conductivity (σ) is 1.

10.2. System Check

Per Nov 2017,TCB Workshop

System validation is required before a system is deployed for measurement
System check is also required before each series of continuous measurement and, as applicable, repeated at least weekly
Peak and spatially averaged power density at the peak location(s) must be compared to calibrated results according to the defined test conditions

– the same spatial resolution and measurement region used in the waveguide calibration should be applied to system validation and system check
– 4 cm^2 spatial averaging have been used according to FCC requirement.
– power density distribution should also be verified, both spatially (shape) and numerically (level) through visual inspection for noticeable differences
– the measured results should be within 10% of the calibrated targets

SAR 1 Room

SAR Lab	Date	Sorce SN	Sorce Cal. Due Data	Measured Total psPD for 4cm^2 (W/m2)	**Target (Ref. Value)** (W/m2)	**Delta ±10 %**	visual inspection	Plot No.
SAR 1	10-14-2022	1047	1-28-2023	63.0	68.7	-8.30	confirmed	
SAR 1	10-16-2022	1047	1-28-2023	63.6	68.7	-7.42	confirmed	
SAR 1	10-17-2022	1047	1-28-2023	64.1	68.7	-6.70	confirmed	
SAR 1	10-25-2022	1047	1-28-2023	63.1	68.7	-8.15	confirmed	
SAR 1	10-26-2022	1047	1-28-2023	62.9	68.7	-8.44	confirmed	1

SAR 8 Room

SAR Lab	Date	Sorce SN	Sorce Cal. Due Data	Measured Total psPD for 4cm^2 (W/m2)	**Target (Ref. Value)** (W/m2)	**Delta ±10 %**	visual inspection	Plot No.
SAR 8	11-10-2022	1082	3-1-2023	43.3	44.4	-2.48	confirmed	2
SAR 8	11-14-2022	1082	3-1-2023	43.9	44.4	-1.13	confirmed	
SAR 8	11-21-2022	1082	3-1-2023	44.3	44.4	-0.23	confirmed	

Note(s):
psPD value used the pS_{tot} avg value of test result plot.

11. Measured and Reported (Scaled) Results

Both Normal psPD and Total psPD are record in test results according to TCB workshop October 2018 note . But Only Total psPD level are considered according to FCC requirement.

11.1. NR Band n261 Test Results

Antenna	Dist. (mm)	Test Position	Freq. (MHz)	Ch.	Beam ID1	Beam ID2	input.power. limit (dBm)	Tested Power (dBm)	Tested Signal	Duty Cycle	Power Drift	Normal psPD (mW/cm^2)	Total psPD (mW/cm^2)	Plot No.
					V	H						Meas.	Meas.	
k patch	2 mm	Rear	27559.32	Low	16		2.7	3.7	CW	100.0%	-0.06	0.459	0.540	
	2 mm	Rear	27923.52	mid		143	3.1	4.1	CW	100.0%	0.06	0.216	0.285	
	2 mm	Front	27559.32	Low	10		2.9	3.9	CW	100.0%	-0.06	0.116	0.120	
	2 mm	Front	27559.32	Low		140	2.6	3.6	CW	100.0%	0.00	0.170	0.286	
	2 mm	Edge 2	27559.32	Low	16		2.7	3.7	CW	100.0%	-0.08	0.553	0.592	
	2 mm	Edge 2	27559.32	Low		145	2.5	3.6	CW	100.0%	-0.14	0.495	**0.636**	1
	2 mm	Rear	27923.52	mid	14	142	-0.9	0.1	CW	100.0%	-0.14	0.077	0.098	
	2 mm	Front	27559.32	Low	12	140	-0.3	0.8	CW	100.0%	-0.13	0.163	0.210	
	2 mm	Edge 2	27923.52	mid	14	142	-0.9	0.1	CW	100.0%	-0.15	0.217	0.287	

NR Band n261 Additional Surfaces

Antenna	Dist. (mm)	Test Position	Freq. (MHz)	Ch.	Beam ID1	Beam ID2	input.power. limit (dBm)	Tested Power (dBm)	Tested Signal	Duty Cycle	Power Drift	Normal psPD (mW/cm^2)	Total psPD (mW/cm^2)	Plot No.
					V	H						Meas.	Meas.	
k patch	10 mm	Rear	27559.32	Low	11		3.0	4.1	CW	100.0%	0.07	0.318	0.327	
	10 mm	Edge 1	27923.52	Mid	13		4.0	5.0	CW	100.0%	0.11	0.091	0.113	

(10 W/m^2 = 1.0 mW/cm^2)

Note(s):

1. This device utilizes power reduction for some WLAN wireless modes and technologies for simultaneous transmission compliance. These mechanisms are assessed In the SAR Test Report.
2. *PD_design_target* of 0.617 mW/cm^2 was used with mmW device design related uncertainty of 2.1 dB.
3. *Input.power.limit* parameter for 5G mmW NR radio was calculated in RF Exposure Part 0 test report.
4. The measurement was tested by setting it to a higher Tested Power than *Input.power.limit*.
5. Devices enabled with Qualcomm Smart Transmit feature, simultaneous transmission analysis is evaluated by combining the exposure from each WWAN and WLAN antenna. 5G mmW NR and WLAN simultaneous transmission scenario is evaluated under the Total Exposure Ratio.
6. The device was configured to transmit CW wave signal for testing. Additional testing was not evaluated for different modulations, RB configurations, component carriers, channel configurations since the smart transmit algorithm monitors powers on a per symbol basis, which is independent of these signal characteristics.

11.2. NR Band n260 Test Results

Antenna	Dist. (mm)	Test Position	Freq. (MHz)	Ch.	Beam ID1	Beam ID2	input.power.limit (dBm)	Power (dBm) Signal	Tested Signal	Duty Cycle	Power Drift	Normal psPD (mW/cm^2)	Total psPD (mW/cm^2)	Plot No.
					V	H						Meas.	Meas.	
k patch	2 mm	Rear	38498.88	mid	12		3.2	4.2	CW	100.0%	-0.02	0.259	0.334	
	2 mm	Rear	38498.88	mid		137	3.6	4.6	CW	100.0%	-0.04	0.410	0.441	
	2 mm	Front	39949.92	High	16		3.2	4.2	CW	100.0%	0.01	0.059	0.078	
	2 mm	Front	39949.92	High		138	3.4	4.4	CW	100.0%	-0.09	0.072	0.080	
	2 mm	Edge 2	39949.92	High	11		2.6	3.6	CW	100.0%	-0.14	0.292	0.347	
	2 mm	Edge 2	39949.92	High		138	3.4	4.4	CW	100.0%	-0.02	0.512	**0.578**	2
	2 mm	Rear	38498.88	mid	12	140	0.0	1.0	CW	100.0%	0.04	0.182	0.238	
	2 mm	Front	38498.88	mid	8	136	0.2	1.2	CW	100.0%	-0.05	0.082	0.126	
	2 mm	Edge 2	39949.92	High	11	139	-0.4	0.6	CW	100.0%	-0.09	0.191	0.218	

NR Band n260 Additional Surfaces

Antenna	Dist. (mm)	Test Position	Freq. (MHz)	Ch.	Beam ID1	Beam ID2	input.power.limit (dBm)	Tested Power (dBm)	Tested Signal	Duty Cycle	Power Drift	Normal psPD (mW/cm^2)	Total psPD (mW/cm^2)	Plot No.
					V	H						Meas.	Meas.	
k patch	10 mm	Rear	37051.80	low	12		3.2	4.2	CW	100.0%	-0.09	0.141	0.154	
	10 mm	Edge 1	37051.80	low		140	4.5	5.4	CW	100.0%	0.07	0.140	0.155	

(10 W/m^2 = 1.0 mW/cm^2)

Note(s):

1. This device utilizes power reduction for some WLAN wireless modes and technologies for simultaneous transmission compliance. These mechanisms are assessed In the SAR Test Report.
2. *PD_design_target* of 0.617 mW/cm^2 was used with mmW device design related uncertainty of 2.1 dB.
3. *Input.power.limit* parameter for 5G mmW NR radio was calculated in RF Exposure Part 0 test report.
4. The measurement was tested by setting it to a higher Tested Power than *Input.power.limit*.
5. Devices enabled with Qualcomm Smart Transmit feature, simultaneous transmission analysis is evaluated by combining the exposure from each WWAN and WLAN antenna. 5G mmW NR and WLAN simultaneous transmission scenario is evaluated under the Total Exposure Ratio.
6. The device was configured to transmit CW wave signal for testing. Additional testing was not evaluated for different modulations, RB configurations, component carriers, channel configurations since the smart transmit algorithm monitors powers on a per symbol basis, which is independent of these signal characteristics.

12. Simultaneous Transmission Conditions

Total exposure ratio calculated by taking ratio of reported SAR divided by SAR limit and adding it to measured power density divided by power density limit. Numerical sum of the two ratios should be less than 1

$$TER = \sum_{a=1}^{A} \frac{SAR_a}{SAR_a, limit} + \sum_{b=1}^{B} \frac{psPD_b}{psPD_b, limit} < 1$$

The Total exposure ratio shall be less than unity to ensure compliance with the limits.

$$\sum_{n=1}^{N} \frac{4G\ SAR_n}{4G\ SAR_n, limit} + \sum_{m=1}^{M} \frac{5G\ mmW\ NR\ psPD_m}{5G\ mmW\ NR\ psPD_m, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

Qualcomm Smart Transmit algorithm for WWAN adds directly the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G mmW NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G mmW NR to not exceed FCC limit. Therefore, per FCC guidance, Total Exposure Ratio does not need to be evaluated directly for the 4G and 5G simultaneous compliance via summation. The validation of the time-averaging algorithm and compliance under the Tx varying transmission scenario for WWAN technologies are reported in Part 2 report.

$$\sum_{n=1}^{N} \frac{4G\ SAR_n}{4G\ SAR_n, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

$$\sum_{m=1}^{M} \frac{5G\ mmW\ NR\ psPD_m}{5G\ mmW\ NR\ psPD_m, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

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 device uncertainty of 2.1 dB. For this device, the manufacturer has added an additional permanent back-off for every beam in the calculations for input.power.limits used in the EFS files. The back-off levels can be found in the Part 0 Test report. Therefore, 5G mmW NR RF exposure for this DUT is evaluated by reported psPD calculated as;

Reported_psPD = (*PD_design_target* + 2.1 dB) X $10^{(\text{-WWAN back-off in dB/10})}$ = 0. 794mW / cm^2

Note that since not all the beams supported by this EUT are measured, reported_psPD cannot be computed based on limited measured_psPD data. Alternatively, since measured psPD for all the beams will be PD_design_target + 2.1 dB, reported_psPD is computed based on this worst-case psPD as shown above.

The compliance analysis for simultaneous transmission scenarios of WWAN with Smart Transmit and 4G & WLAN can be found in two reports indicated in the table below.

	Simultaneous Scenario	Evaluation Report
1.	4G LTE WWAN + WLAN	FCC SAR Evaluation Report (Part 1)
2.	4G LTE WWAN + 5G mmW NR WWAN	RF Exposure Part 2 Test Report

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations				
Standalone	1	EN-DC (LTE + 5G mmW NR)	+	DTS_Ant.		
	2	EN-DC (LTE + 5G mmW NR)	+	U-NII_Ant.		
	3	EN-DC (LTE + 5G mmW NR)	+	BT		
	4	EN-DC (LTE + 5G mmW NR)	+	BT	+	U-NII_Ant.

Note(s):

1. 5G mmW NR Operations are limited to Non-Standalone (EN-DC) operations only.
2. 5G NR antenna arrays cannot transmit at the same time.
3. 5G NR bands cannot transmit at the same time.
4. For EN-DC mode, Qualcomm Smart Transmit algorithm in WWAN adds directly the time-averaged RF exposure from 4G(LTE) and time-averaged RF exposure from 5G NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G NR to not exceed FCC limit. Therefore, simultaneous transmission compliance between 4G+5G NR operation is demonstrated in the Part 2 Report during algorithm validation. In Part 1 Report, simultaneous transmission compliance was evaluated individually with other Radios (WLAN and (or) BT) using 5G mmW NR.

12.1. 5G mmW NR psPD for TER Ratio analysis

Antenna	NR Band	Surface	Evaluation Distance (mm)	Adjustment Factor due to Simulation	Adjusted Reported psPD (mW/cm2)	Measured psPD (mW/cm2)	Final Reported psPD (mW/cm2)
K-patch	n261	Back	2	**1.000**	**0.794**	0.540	0.794
	n261	Front	2	0.601	0.477	0.286	0.477
	n261	Edge 1	2	0.293	0.233	0.165	0.233
	n261	Edge 2	2	**1.000**	**0.794**	0.636	0.794
	n261	Edge 3	2	0.075	0.060	-	0.060
	n261	Edge 4	2	0.052	0.041	-	0.041
	n260	Back	2	**1.000**	**0.794**	0.441	0.794
	n260	Front	2	0.682	0.542	0.126	0.542
	n260	Edge 1	2	0.461	0.366	0.140	0.366
	n260	Edge 2	2	**1.000**	**0.794**	0.578	0.794
	n260	Edge 3	2	0.078	0.062	-	0.062
	n260	Edge 4	2	0.074	0.059	-	0.059
	n261	Rear	10	0.471	0.374	0.327	0.374
	n260	Rear	10	0.535	0.425	0.154	0.425
	n261	Edge 1	10	0.164	0.130	0.113	0.130
	n260	Edge 1	10	0.320	0.254	0.155	0.254

12.2. 5G mmW NR Head Total Exposure Ratio

		psPD	2.4GHz Ant Reported SAR	5GHz Ant Reported SAR	Bluetooth Reported SAR	psPD+2.4GHz Ant Reported SAR	psPD+5GHz Ant Reported SAR	psPD+Bluetooth Reported SAR	psPD+5GHz Ant +Bluetooh Reported SAR
		mW/cm^2	W/kg	W/kg	W/kg				
		1	2	3	4	1+2	1+3	1+4	1+3+4
Applicable Limit		1.0	1.6	1.6	1.6	1.0	1.0	1.0	1.0
Front (Head)	Reproted Value	0.542	0.038	0.564	0.166				
	Ratio to Limit	0.542	0.024	0.353	0.104	0.566	0.895	0.646	0.998

Note(s):

1. Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.
2. Worst-case power density results for each test configuration among all antenna arrays and among all supported bands were considered for Total Exposure Ratio analysis.
3. For power density measurements, a test separation distance of 2 mm was used for phablet configuration due to probe restraints.
4. Total Exposure Ratio (TER) is less than 1 in RF exposure conditions.

12.3. 5G mmW NR Body-worn Total Exposure Ratio

		psPD	2.4GHz Ant Reported SAR	5GHz Ant Reported SAR	Bluetooth Reported SAR	psPD+2.4GHz Ant Reported SAR	psPD+5GHz Ant Reported SAR	psPD+Bluetooth Reported SAR	psPD+5GHz Ant +Bluetooh Reported SAR
		mW/cm^2	W/kg	W/kg	W/kg				
		1	2	3	4	1+2	1+3	1+4	1+3+4
Applicable Limit		1.0	1.6	1.6	1.6	1.0	1.0	1.0	1.0
Rear	Reproted Value	0.425	0.206	0.503	0.054				
	Ratio to Limit	0.425	0.129	0.314	0.034	0.554	0.739	0.459	0.773
Front	Reproted Value	0.542	0.206	0.118	0.022				
	Ratio to Limit	0.542	0.129	0.074	0.014	0.671	0.616	0.556	0.630

Note(s):

1. Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.
2. Worst-case power density results for each test configuration among all antenna arrays and among all supported bands were considered for Total Exposure Ratio analysis.
3. For power density measurements, a test separation distance of 2/10 mm was used for phablet configuration due to probe restraints.
4. Total Exposure Ratio (TER) is less than 1 in RF exposure conditions.
5. Green value is estimated SAR value.

12.4. 5G mmW NR Hotspot Total Exposure Ratio

		psPD	2.4GHz Ant Reported SAR	5GHz Ant Reported SAR	Bluetooth Reported SAR	psPD+2.4GHz Ant Reported SAR	psPD+5GHz Ant Reported SAR	psPD+Bluetooth Reported SAR	psPD+5GHz Ant +Bluetooh Reported SAR
		mW/cm^2	W/kg	W/kg	W/kg				
		1	2	3	4	1+2	1+3	1+4	1+3+4
Applicable Limit		1.0	1.6	1.6	1.6	1.0	1.0	1.0	1.0
Rear	Reproted Value	0.425	0.468	0.605	0.134				
	Ratio to Limit	0.425	0.293	0.378	0.084	0.718	0.803	0.509	0.887
Front	Reproted Value	0.542	0.468	0.368	0.044				
	Ratio to Limit	0.542	0.293	0.230	0.028	0.835	0.772	0.570	0.800
Edge 1	Reproted Value	0.254	0.211	0.972	0.071				
	Ratio to Limit	0.254	0.132	0.608	0.044	0.386	0.862	0.298	0.906
Edge 2	Reproted Value	0.794	0.000	0.000	0.000				
	Ratio to Limit	0.794	0.000	0.000	0.000	0.794	0.794	0.794	0.794
Edge 3	Reproted Value	0.062	0.000	0.000	0.000				
	Ratio to Limit	0.062	0.000	0.000	0.000	0.062	0.062	0.062	0.062
Edge 4	Reproted Value	0.059	0.468	0.231	0.027				
	Ratio to Limit	0.059	0.293	0.144	0.017	0.352	0.203	0.076	0.220

Note(s):

1. Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.
2. Worst-case power density results for each test configuration among all antenna arrays and among all supported bands were considered for Total Exposure Ratio analysis.
3. For power density measurements, a test separation distance of 2/10 mm was used for phablet configuration due to probe restraints.
4. Total Exposure Ratio (TER) is less than 1 in RF exposure conditions.
5. Green value is estimated SAR value.

12.5. 5G mmW NR Phablet Total Exposure Ratio

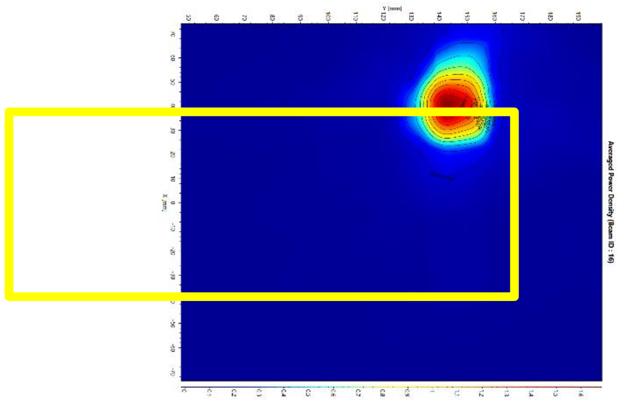
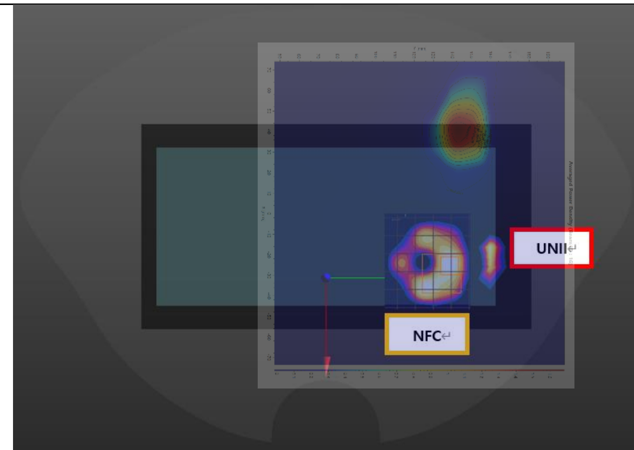
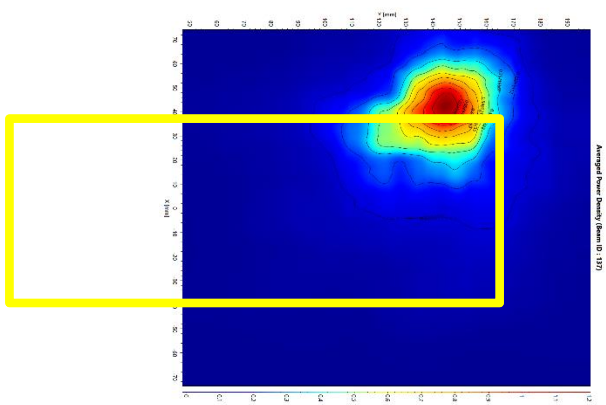
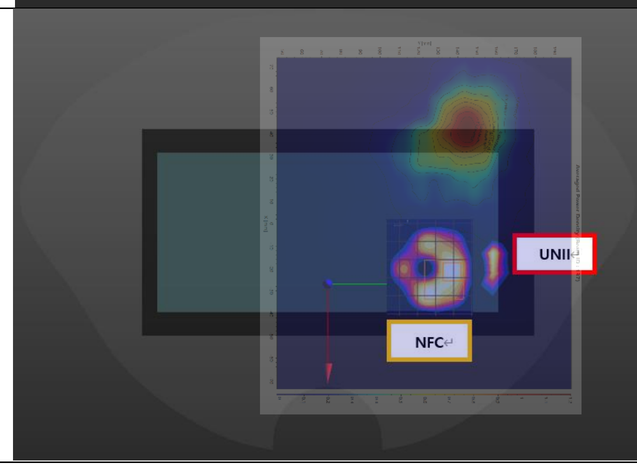
		psPD	5Hz Ant Reported SAR	NFC Ant Reported SAR	psPD+5GHz Ant Reported SAR	psPD+NFC Ant Reported SAR	psPD+5GHz Ant +NFC Reported SAR
		mW/cm^2	W/kg	W/kg			
		1	2	3	1+2	1+3	1+2+3
Applicable Limit		1.0	4.0	4.0	1.0	1.0	1.0
Rear *Note.4* (at 4cm^2 PD hotspot)	Reproted Value	0.794	0.148	0.002			
	Ratio to Limit	0.794	0.037	0.000	0.831	0.794	0.832
Rear *Note.4* (at SAR hotspot)	Reproted Value	0.079	1.482	0.018			
	Ratio to Limit	0.079	0.371	0.005	0.450	0.084	0.454
Front	Reproted Value	0.542	1.482	0.000			
	Ratio to Limit	0.542	0.371	0.000	0.913	0.542	0.913
Edge 1	Reproted Value	0.366	1.399	0.000			
	Ratio to Limit	0.366	0.350	0.000	0.716	0.366	0.716
Edge 2	Reproted Value	0.794	0.000	0.000			
	Ratio to Limit	0.794	0.000	0.000	0.794	0.794	0.794
Edge 3	Reproted Value	0.062	0.000	0.000			
	Ratio to Limit	0.062	0.000	0.000	0.062	0.062	0.062
Edge 4	Reproted Value	0.059	1.482	0.000			
	Ratio to Limit	0.059	0.371	0.000	0.430	0.059	0.430

Note(s):

1. Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.
2. Worst-case power density results for each test configuration among all antenna arrays and among all supported bands were considered for Total Exposure Ratio analysis.
3. For power density measurements, a test separation distance of 2/10 mm was used for phablet configuration due to probe restraints.
4. For Rear side, TER is over 1.0. So Additional test procedures are applied according to Sec.G.1.3 in Qualcomm document (80-W2112-4).

   Please refer to next page in report.
5. Green value is estimated SAR value.

TER for Rear side was evaluated use to the spatial separation of the antennas per described in 80-w2112-4 section G.1.3. In the below plots, it is demonstrated that the -10 dB contours of the SAR distributions have no overlap with the simulated area for power density. It was confirmed that all beams for both n260 and n261 operations are fully contained within the simulated area.

	mmWave K patch	mmWave + NFC + 5GHz WLAN Antenna
mmWave n261 K patch + WLAN + NFC		
mmWave n260 K patch + WLAN + NFC		

So according to the above plot, PD and SAR are spatially separated. Therefore, the TER is calculated by conservatively applying the following equation according to the guide in G.1.3. Refer to Section 12.5 in this report for the calculated results.

Calculation formula:

a. TER at 4cm^2 PD hotspot = *reported* normalized 4cm2 PD + $10^{(-10dB/10)}$ **reported* normalized WiFi/BT SAR

b. TER at WiFi/BT SAR hotspot = *reported* normalized WiFi/BT SAR + $10^{(-10dB/10)}$ * *reported* normalized 4cm2 PD

Mathematical Derivation of TER Compliance

$$Total\ Normalized\ RFx\ =\ Normalized\ RFx\ _{Time\ Averaged\ WWAN} + Normalized\ RFx\ _{WLAN}\ \leq\ 1.0 \quad (1)$$

Since WWAN Smart Transmit algorithm adds directly the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G mmW NR, per chipset manufacturer's guidance, Normalized RF exposure from 4G and from 5G mmW NR could be assumed as

$$Normalized\ RFx\ _{Time\ Averaged\ WWAN} = \frac{4G\ SAR}{4G\ SAR\ Limit} + \frac{5G\ mmW\ NR\ psPD}{5G\ mmW\ NR\ psPD\ Limit} \leq\ 1.0 \quad (2)$$

Smart Transmit algorithm assumes that 4G and 5G mmW NR hotspots are co-located and therefore:

$$Time\ Averaged\ WWAN = [\ x(t) \times A] + [(1\text{-}x(t)) \times B] \leq 1.0\ Normalized\ Limit \quad (3)$$

A = Max normalized time-averaged SAR exposure from 4G
B = Max normalized time-averaged PD exposure from 5G mmW NR

x(t) = Ranges between [0,1]
x(t) × A = Percentage of normalized time-averaged RF exposure from 4G
(1-x(t)) × B = 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 1.0 Normalized Limit. If the equations below (4a, 4b) are proven, then, mathematically equation (5) would be proven.

$$A\ +\ norm.\ SAR\ from\ WLAN \leq 1.0\ normalized\ limit \quad (4a)$$

$$B\ +\ norm.\ SAR\ from\ WLAN \leq 1.0\ normalized\ limit \quad (4b)$$

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

Without 5G mmW NR, Smart Transmit limits the maximum RF exposure contributed from 4G to 100% normalized exposure. For this device, the manufacturer has added an additional permanent back-off for every beam in the calculations for input.power.limits used in the EFS files. therefore:

$$Smart\ Tx\ WWAN\text{: } A = max\ (normalized\ SAR\ exposure\ from\ 4G) \leq 1.0\ normalized\ limit \quad (6a)$$

$$Smart\ Tx\ WWAN\text{: } B = max\ (normalized\ PD\ exposure\ from\ 5G\ mmW\ NR) x 10^{(\text{-}WWAN\ backoff\ in\ dB)/10} \leq 1.0\ normalized\ limit \quad (6b)$$

To demonstrate simultaneous transmission compliance in equation (1), below equations (7a & 7b) obtained by combining equations (4a & 4b) and (6a & 6b), should be proven for simultaneous transmission compliance:

$$Total\ Normalized\ RFx\ =\ Normalized\ SAR\ _{4G\ WWAN} + Normalized\ SAR\ _{WLAN} < 1.0 \quad (7a)$$

$$Total\ Normalized\ RFx\ =\ 10^{(-WWAN\ backoff\ in\ dB)/10} x\ Normalized\ psPD\ _{5G\ mmW\ NR\ WWAN} + Normalized\ SAR\ _{WLAN} < 1.0 \quad (7b)$$

Which are re-written as:

$$Total\ Normalized\ RFx\ =\ \frac{4G\ SAR}{4G\ SAR\ Limit} + \frac{WLAN\ SAR}{WLAN\ SAR\ Limit} < 1 \quad (8a)$$

$$Total\ Normalized\ RFx\ =\ 10^{(-WWAN\ backoff\ in\ dB)/10} * \frac{5G\ mmW\ NR\ psPD}{5G\ mmW\ NR\ psPD\ Limit} + \frac{WLAN\ SAR}{WLAN\ SAR\ Limit} < 1 \quad (8b)$$

Analysis for equation (8a) is performed in Section 12 of FCC SAR Evaluation Report (Part 1). Analysis for equation (8b) is performed in this Sec 12.

Appendixes

<u>Refer to separated files for the following appendixes.</u>

4790558569-S2 FCC Report PD_App A_Setup Photos

4790558569-S2 FCC Report PD_App B_System Check Plots

4790558569-S2 FCC Report PD_App C_Highest Test Plots

4790558569-S2 FCC Report PD_App D_Probe Calibration Certificates

4790558569-S2 FCC Report PD_App E_Verification source Calibration Certificates

END OF REPORT