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SAR EVALUATION REPORT

Applicant Name:
Apple Inc.
One Apple Park Way
Cupertino, CA 95014 USA

Date of Testing:
12/27/2021
Test Report Issue Date:
06/08/2023
Test Site/Location:
Element Morgan Hill, CA, USA
Document Serial No.:
1C2305300033-02.BCG

FCC ID: **BCGA2589**

APPLICANT: **APPLE, INC.**

DUT Type:	Tablet Device
Application Type:	Class II Permissive Change
FCC Rule Part(s):	CFR §2.1093
Models:	A2589, A2591
Permissive Change(s):	See FCC Change Document
Date of Original Certification:	03/10/2022

Equipment Class	Band & Mode	Tx Frequency	SAR 1g Body (W/kg)
CBE	NR Band n48	3555.0 - 3694.98 MHz	1.00
Simultaneous SAR per KDB 690783 D01v01r03:			1.57

Note: This table above includes test data from RF exposure technical report S/N: 1C2111150079-26.BCG (Rev 3) per FCC TCB workshop for data referencing of closely related product FCC ID BCGA2589

Only operations relevant to this permissive change were evaluated for compliance. Please see the original compliance evaluation in RF Exposure Technical Report S/N 1C2111150079-26.BCG (Rev3) for complete evaluation of all other operating modes. The operational description includes a description of all changed items.

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.8 of this report; for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

RJ Ortanez
Executive Vice President

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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
UMTS 850	Data	826.40 - 846.60 MHz
UMTS 1750	Data	1712.4 - 1752.6 MHz
UMTS 1900	Data	1852.4 - 1907.6 MHz
LTE Band 71	Data	665.5 - 695.5 MHz
LTE Band 12	Data	699.7 - 715.3 MHz
LTE Band 17	Data	706.5 - 713.5 MHz
LTE Band 13	Data	779.5 - 784.5 MHz
LTE Band 14	Data	790.5 - 795.5 MHz
LTE Band 26 (Cell)	Data	814.7 - 848.3 MHz
LTE Band 5 (Cell)	Data	824.7 - 848.3 MHz
LTE Band 66 (AWS)	Data	1710.7 - 1779.3 MHz
LTE Band 4 (AWS)	Data	1710.7 - 1754.3 MHz
LTE Band 25 (PCS)	Data	1850.7 - 1914.3 MHz
LTE Band 2 (PCS)	Data	1850.7 - 1909.3 MHz
LTE Band 30	Data	2307.5 - 2312.5 MHz
LTE Band 7	Data	2502.5 - 2567.5 MHz
LTE Band 41	Data	2498.5 - 2687.5 MHz
LTE Band 48	Data	3552.5 - 3697.5 MHz
NR Band n71	Data	665.5 - 695.5 MHz
NR Band n12	Data	701.5 - 713.5 MHz
NR Band n5 (Cell)	Data	826.5 - 846.5 MHz
NR Band n66 (AWS)	Data	1712.5 - 1777.5 MHz
NR Band n25 (PCS)	Data	1852.5 - 1912.5 MHz
NR Band n2 (PCS)	Data	1852.5 - 1907.5 MHz
NR Band n30	Data	2307.5 - 2312.5 MHz
NR Band n7	Data	2502.5 - 2567.5 MHz
NR Band n41	Data	2506.02 - 2679.99 MHz
NR Band n48	Data	3555.0 - 3694.98 MHz
NR Band n77 DoD	Data	3460.02 - 3540 MHz
NR Band n77 C	Data	3710.01 - 3969.99 MHz
2.4 GHz WLAN	Voice/Data	2412 - 2472 MHz
U-NII-1	Voice/Data	5180 - 5240 MHz
U-NII-2A	Voice/Data	5260 - 5320 MHz
U-NII-2C	Voice/Data	5500 - 5720 MHz
U-NII-3	Voice/Data	5745 - 5825 MHz
Bluetooth	Data	2402 - 2480 MHz

1.2 Time-Averaging Algorithm for RF Exposure Compliance

This device is enabled with the 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 (report SN could be found in Section 1.10 – Bibliography).

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

Note that WLAN operations are not enabled with Smart Transmit.

The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of SAR design target, below the predefined time-averaged power limit (i.e., Plimit for sub-6 radio), for each characterized technology and band (see RF Exposure Part 0 Test Report, report SN could be found in Section 1.10 - Bibliography).

Exposure Scenario:	Ant 1b Body	Ant 1b Maximum Tune-up Output Power*	Ant 2b Body	Ant 2b Maximum Tune-up Output Power*	Ant 3b Body	Ant 3b Maximum Tune-up Output Power*	Ant 4 Body	Ant 4 Maximum Tune-up Output Power*	Manufacturer's Smart Transmit Uncertainty (dB)	Pmax target Tolerance (dB)	Plimit target Tolerance (dB)
Averaging Volume:	1g		1g		1g		1g				
Spacing:	0 mm		0 mm		0 mm		0 mm				
DSI:	1		1		1		1				
Technology/Band	**Plimit corresponding to 0.8 W/kg**	Pmax	**Plimit corresponding to 0.8 W/kg**	Pmax	**Plimit corresponding to 0.8 W/kg**	Pmax	**Plimit corresponding to 0.8 W/kg**	Pmax			
NR Band n48 (< 40MHz BW)	12.80	22.00	13.30	20.50	14.50	19.10	11.80	17.70	+/- 1.0	+0.7 /- 1.0	+/- 1.0
NR Band n48 (= 40MHz BW)	12.80	15.00	13.30	13.50	14.50	18.00	11.80	17.00			

Smart Transmit allows the device to transmit at higher power instantaneously, as high as P_{max}, when needed, but enforces power limiting to maintain time-averaged transmit power to P_{limit}. Below table shows P_{limit} EFS settings and maximum tune up output power P_{max} configured for this EUT for various transmit conditions (Device State Index DSI). Note that the device uncertainty for sub-6GHz WWAN is +1.0/-1.0 dB for this EUT.

*Maximum tune up output power Pmax is used to configure EUT during RF tune up procedure. The maximum allowed output power is equal to maximum Tune up output power +0.7/-1.0 dB tolerance and for UHB +/-1.0 dB tolerance

*Note all P_{limit} EFS and maximum tune up output power P_{max} levels entered in above Table correspond to average power levels after accounting for duty cycle in the case of TDD modulation schemes (for e.g., LTE TDD).

The maximum time-averaged output power (dBm) for any 5G WWAN technology, band, and DSI = minimum of "Plimit EFS" and "Maximum tune up output power Pmax" +1.0/-1.0 dB device uncertainty. SAR values in this report were scaled to this maximum time-averaged output power to determine compliance per KDB Publication 447498 D01v06.

The purpose of this report (Part 1 test) is to demonstrate that the EUT meets FCC SAR limits when transmitting in static transmission scenario at maximum allowable time-averaged power levels.

Measurement Condition: All conducted power and SAR measurements in this report (Part 1 test) were performed by setting Reserve power margin (Smart Transmit EFS entry) to 0 dB.

1.3 Power Reduction for SAR

This device additionally utilizes a power reduction mechanism for Bluetooth and WLAN operations. When WLAN/Bluetooth is operating simultaneously with certain combinations of 3G/4G/5G and 5 GHz WLAN antennas, the output power of is permanently reduced.. SAR evaluations were additionally performed at the maximum allowed output power for these scenarios to evaluate simultaneous transmission compliance.

Additionally, this device uses an independent mechanism that limits WIFI powers to a time-averaged output power. For the purposes of this test report, all SAR measurements were performed with the algorithm disabled at the maximum time-averaged output power level. See the original filing for all other operations that were not evaluated in this permissive change.

1.4 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

1.4.1 5G Output Power for Portable Use Conditions

Table 1-1
NR Bands

Mode / Band		Modulated Average Output Power (in dBm)			
		Ant 4	Ant 3B	Ant 2b	Ant 1b
NR TDD Band n48	Max allowed power	**12.80**	**15.50**	**14.30**	**13.80**
[Burst Averaged]	Nominal	**11.80**	**14.50**	**13.30**	**12.80**

Note: For NR TDD, the above powers listed are TDD burst average and framed average values.

1.4.2 Maximum WLAN Time-Averaged Output Power

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

1.4.3 Reduced WLAN Time-Averaged Output Power

Only operations relevant to this permissive change were evaluated for compliance. No other target changes have been made. Targets for all other bands/exposure conditions can be found in the original filing.

1.5 DUT Antenna Locations

The overall diagonal dimension of the device is > 200 mm. A diagram showing the location of the device antennas can be found in Appendix E. Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC filings.

Note: See the original filing for all other operations that were not evaluated in this permissive change.

Table 1-2
Device Edges/Sides for SAR Testing

Mode	Back	Top	Bottom	Right	Left
NR Band n48 Antenna 1b	Yes	No	Yes	No	No
NR Band n48 Antenna 2b	Yes	No	Yes	No	No
NR Band n48 Antenna 3b	Yes	Yes	No	No	No
NR Band n48 Antenna 4	Yes	Yes	No	No	Yes

Note: Per FCC KDB Publication 616217 D04v01r01, particular edges were not required to be evaluated for SAR based on the SAR exclusion threshold in KDB 447498 D01V06. Additional edges may have been evaluated for simultaneous transmission analysis.

1.6 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D01v06, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D01v06 4.3.2 procedures.

Table 1-3
Simultaneous Transmission Scenarios

No.	Capable Transmit Configuration	Body
1	Cellular Band + 2.4 GHz WI-FI	Yes
2	Cellular Band + 5 GHz WI-FI	Yes
3	Cellular Band + 2.4 GHz Bluetooth	Yes
4	Cellular Band + 2.4 GHz Bluetooth Antenna 1a + 2.4 GHz WLAN Antenna 3a	Yes
5	Cellular Band + 2.4 GHz WI-FI MIMO	Yes
6	Cellular Band + 5 GHz WI-FI MIMO	Yes
7	Cellular Band + 2.4 GHz Bluetooth (TxBF)	Yes
8	Cellular Band + 2.4 GHz Bluetooth + 5 GHz WI-FI	Yes
9	Cellular Band + 2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI	Yes
10	Cellular Band + 2.4 GHz Bluetooth + 5 GHz WI-FI MIMO	Yes
11	Cellular Band + 2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI MIMO	Yes
12	2.4 GHz Bluetooth Antenna 1a + 2.4 GHz WLAN Antenna 3a	Yes
13	2.4 GHz Bluetooth + 5 GHz WI-FI	Yes
14	2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI	Yes
15	2.4 GHz Bluetooth + 5 GHz WI-FI MIMO	Yes
16	2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI MIMO	Yes

Table 1-4
Simultaneous Transmission Scenarios of Inter-Band ULCA

No.	Capable Transmit Configuration	Body	Notes
1	Cellular Ant 4 LB + Cellular Ant 1a MB/HB	Yes	LTE Bands transmitting from Ant 4 LB: LTE B12/13/5 LTE Bands transmitting from Ant 1a MB/HB: LTE B4/66/2/7
2	Cellular Ant 4 LB + Cellular Ant 2a MB/HB	Yes	LTE Bands transmitting from Ant 4 LB: LTE B12/13/5 LTE Bands transmitting from Ant 2a MB/HB: LTE B4/66/2/7
3	Cellular Ant 4 LB + Cellular Ant 3a MB/HB	Yes	LTE Bands transmitting from Ant 4 LB: LTE B12/13/5 LTE Bands transmitting from Ant 3a MB/HB: LTE B4/66/2/7
4	Cellular Ant 3b LB + Cellular Ant 1a MB/HB	Yes	LTE Bands transmitting from Ant 3b LB: LTE B12/13/5 LTE Bands transmitting from Ant 1a MB/HB: LTE B4/66/2/7
5	Cellular Ant 3b LB + Cellular Ant 2a MB/HB	Yes	LTE Bands transmitting from Ant 3b LB: LTE B12/13/5 LTE Bands transmitting from Ant 2a MB/HB: LTE B4/66/2/7
6	Cellular Ant 3b LB + Cellular Ant 3a MB/HB	Yes	LTE Bands transmitting from Ant 3b LB: LTE B12/13/5 LTE Bands transmitting from Ant 3a MB/HB: LTE B4/66/2/7
7	Cellular Ant 3b LB + Cellular Ant 4 MB/HB	Yes	LTE Bands transmitting from Ant 3b LB: LTE B12/13/5 LTE Bands transmitting from Ant 4 MB/HB: LTE B4/66/2/7

Note: The technical description includes all the possible Inter-band ULCA combinations.

Table 1-5
Simultaneous Transmission Scenarios with Inter-Band ULCA Active

No.	Capable Transmit Configuration	Body
1	LTE Inter-Band ULCA + 2.4 GHz WI-FI	Yes
2	LTE Inter-Band ULCA + 5 GHz WI-FI	Yes
3	LTE Inter-Band ULCA + 2.4 GHz Bluetooth	Yes
4	LTE Inter-Band ULCA + 2.4 GHz WI-FI + 2.4 GHz Bluetooth	Yes
5	LTE Inter-Band ULCA + 2.4 GHz WI-FI MIMO	Yes
6	LTE Inter-Band ULCA + 5 GHz WI-FI MIMO	Yes
7	LTE Inter-Band ULCA + 2.4 GHz Bluetooth (TxBF)	Yes
8	LTE Inter-Band ULCA + 2.4 GHz Bluetooth + 5 GHz WI-FI	Yes
9	LTE Inter-Band ULCA + 2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI	Yes
10	LTE Inter-Band ULCA + 2.4 GHz Bluetooth + 5 GHz WI-FI MIMO	Yes
11	LTE Inter-Band ULCA + 2.4 GHz Bluetooth (TxBF) + 5 GHz WI-FI MIMO	Yes

Note: LTE inter-band ULCA can operate in any of the combinations in Table 1-9

1. There are no limitations in the above listed simultaneous transmission scenarios between cellular antennas and BT/WI-FI antennas.
2. Wi-Fi 2.4GHz and Bluetooth 2.4 GHz can transmit simultaneously on separate antennas. 2.4 GHz WLAN Antenna 3a can only transmit simultaneously with 2.4GHz Bluetooth Antenna 1a. In this scenario Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power.
3. This device supports 2x2 MIMO Tx for WLAN 802.11a/g/n/ac/ax. 802.11a/g/n/ac/ax supports CDD and STBC and 802.11n/ac/ax additionally supports SDM. Each WLAN antenna can transmit independently or together when operating with MIMO.
4. EN-DC operation is supported with LTE + 5G NR FR1 scenarios. The LTE anchor bands are shown in the NR FR1 checklist.
5. This device supports VoWIFI.

1.7 Miscellaneous SAR Test Considerations

(A) WIFI/BT

There were no changes made to the WIFI and BT operations within this device. Please see original filing for complete evaluation of these operating modes.

(B) Licensed Transmitter(s)

NR implementation supports SA and NSA mode. In EN-DC mode, NR operates with the LTE Bands shown in the NR FR1 checklist acting as anchor bands. Per FCC guidance, SAR tests for NR Bands and LTE Anchors Bands were performed separately due to limitations in SAR probe calibration factors.

This device supports LTE/NR capabilities with overlapping transmission frequency ranges. When the supported frequency range of an LTE/NR Band falls completely within an LTE/NR band with a larger transmission frequency range, both LTE/NR bands have the same target power (or the band with the larger transmission frequency range has a higher target power), and both LTE/NR bands share the same transmission path and signal characteristics, SAR was only assessed for the band with the larger transmission frequency range.

Only operations relevant to this permissive change were evaluated for compliance. Please see original filing for complete evaluation for all other operating modes. The operational description includes a description of all changed items.

1.8 Guidance Applied

- FCC KDB Publication 447498 D01v06 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r04, D02v01r02 (SAR Measurements up to 6 GHz)
- FCC KDB Publication 616217 D04v01r02 (Tablet)

1.9 Device Serial Numbers

Several samples with identical hardware were used to support SAR testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units. The serial numbers used for each test are indicated alongside the results in Section 10.

1.10 Bibliography

Report Type	Report Serial Number
RF Exposure Part 0 Test Report	1C2111150079-28.BCG
Original RF Exposure Part 1 Test Report	Original Filing

2 LTE INFORMATION

LTE Information					
Form Factor	Tablet Device				
Frequency Range of each LTE transmission band	LTE Band 71 (665.5 - 695.5 MHz)				
	LTE Band 12 (699.7 - 715.3 MHz)				
	LTE Band 17 (706.5 - 713.5 MHz)				
	LTE Band 13 (779.5 - 784.5 MHz)				
	LTE Band 14 (790.5 - 795.5 MHz)				
	LTE Band 26 (Cell) (814.7 - 848.3 MHz)				
	LTE Band 5 (Cell) (824.7 - 848.3 MHz)				
	LTE Band 4 (AWS) (1710.7 - 1754.3 MHz)				
	LTE Band 66 (AWS) (1710.7 - 1779.3 MHz)				
	LTE Band 2 (PCS) (1850.7 - 1909.3 MHz)				
	LTE Band 25 (PCS) (1850.7 - 1914.3 MHz)				
	LTE Band 30 (2307.5 - 2312.5 MHz)				
	LTE Band 7 (2502.5 - 2567.5 MHz)				
	LTE Band 41 (2498.5 - 2687.5 MHz)				
	LTE Band 48 (3552.5 - 3697.5 MHz)				
Channel Bandwidths	LTE Band 71: 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 12: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz				
	LTE Band 17: 5 MHz, 10 MHz				
	LTE Band 13: 5 MHz, 10 MHz				
	LTE Band 14: 5 MHz, 10 MHz				
	LTE Band 26 (Cell): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz				
	LTE Band 5 (Cell): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz				
	LTE Band 4 (AWS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 66 (AWS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 2 (PCS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 25 (PCS): 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 30: 5 MHz, 10 MHz				
	LTE Band 7: 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 41: 5 MHz, 10 MHz, 15 MHz, 20 MHz				
	LTE Band 48: 5 MHz, 10 MHz, 15 MHz, 20 MHz				
Channel Numbers and Frequencies (MHz)	Low	Low-Mid	Mid	Mid-High	High
LTE Band 71: 5 MHz	665.5 (133147)		680.5 (133297)	695.5 (133447)	
LTE Band 71: 10 MHz	668 (133172)		680.5 (133297)	693 (133422)	
LTE Band 71: 15 MHz	670.5 (133197)		680.5 (133297)	690.5 (133397)	
LTE Band 71: 20 MHz	673 (133222)		680.5 (133297)	688 (133372)	
LTE Band 12: 1.4 MHz	699.7 (23017)		707.5 (23095)	715.3 (23173)	
LTE Band 12: 3 MHz	700.5 (23025)		707.5 (23095)	714.5 (23165)	
LTE Band 12: 5 MHz	701.5 (23035)		707.5 (23095)	713.5 (23155)	
LTE Band 12: 10 MHz	704 (23060)		707.5 (23095)	711 (23130)	
LTE Band 17: 5 MHz	706.5 (23755)		710 (23790)	713.5 (23825)	
LTE Band 17: 10 MHz	709 (23780)		710 (23790)	711 (23800)	
LTE Band 13: 5 MHz	779.5 (23205)		782 (23230)	784.5 (23255)	
LTE Band 13: 10 MHz	N/A		782 (23230)	N/A	
LTE Band 14: 5 MHz	790.5 (23305)		793 (23330)	795.5 (23355)	
LTE Band 14: 10 MHz	N/A		793 (23330)	N/A	
LTE Band 26 (Cell): 1.4 MHz	814.7 (26697)		831.5 (26865)	848.3 (27033)	
LTE Band 26 (Cell): 3 MHz	815.5 (26705)		831.5 (26865)	847.5 (27025)	
LTE Band 26 (Cell): 5 MHz	816.5 (26715)		831.5 (26865)	846.5 (27015)	
LTE Band 26 (Cell): 10 MHz	819 (26740)		831.5 (26865)	844 (26990)	
LTE Band 5 (Cell): 1.4 MHz	824.7 (20407)		836.5 (20525)	848.3 (20643)	
LTE Band 5 (Cell): 3 MHz	825.5 (20415)		836.5 (20525)	847.5 (20635)	
LTE Band 5 (Cell): 5 MHz	826.5 (20425)		836.5 (20525)	846.5 (20625)	
LTE Band 5 (Cell): 10 MHz	829 (20450)		836.5 (20525)	844 (20600)	
LTE Band 4 (AWS): 1.4 MHz	1710.7 (19957)		1732.5 (20175)	1754.3 (20393)	
LTE Band 4 (AWS): 3 MHz	1711.5 (19965)		1732.5 (20175)	1753.5 (20385)	
LTE Band 4 (AWS): 5 MHz	1712.5 (19975)		1732.5 (20175)	1752.5 (20375)	
LTE Band 4 (AWS): 10 MHz	1715 (20000)		1732.5 (20175)	1750 (20350)	
LTE Band 4 (AWS): 15 MHz	1717.5 (20025)		1732.5 (20175)	1747.5 (20325)	
LTE Band 4 (AWS): 20 MHz	1720 (20050)		1732.5 (20175)	1745 (20300)	
LTE Band 66 (AWS): 1.4 MHz	1710.7 (131979)		1745 (132322)	1779.3 (132665)	
LTE Band 66 (AWS): 3 MHz	1711.5 (131987)		1745 (132322)	1778.5 (132657)	
LTE Band 66 (AWS): 5 MHz	1712.5 (131997)		1745 (132322)	1777.5 (132647)	
LTE Band 66 (AWS): 10 MHz	1715 (132022)		1745 (132322)	1775 (132622)	
LTE Band 66 (AWS): 15 MHz	1717.5 (132047)		1745 (132322)	1772.5 (132597)	
LTE Band 66 (AWS): 20 MHz	1720 (132072)		1745 (132322)	1770 (132572)	
LTE Band 2 (PCS): 1.4 MHz	1850.7 (18607)		1880 (18900)	1909.3 (19193)	
LTE Band 2 (PCS): 3 MHz	1851.5 (18615)		1880 (18900)	1908.5 (19185)	
LTE Band 2 (PCS): 5 MHz	1852.5 (18625)		1880 (18900)	1907.5 (19175)	
LTE Band 2 (PCS): 10 MHz	1855 (18650)		1880 (18900)	1905 (19150)	
LTE Band 2 (PCS): 15 MHz	1857.5 (18675)		1880 (18900)	1902.5 (19125)	
LTE Band 2 (PCS): 20 MHz	1860 (18700)		1880 (18900)	1900 (19100)	
LTE Band 25 (PCS): 1.4 MHz	1850.7 (26047)		1882.5 (26365)	1914.3 (26683)	
LTE Band 25 (PCS): 3 MHz	1851.5 (26055)		1882.5 (26365)	1913.5 (26675)	
LTE Band 25 (PCS): 5 MHz	1852.5 (26065)		1882.5 (26365)	1912.5 (26665)	
LTE Band 25 (PCS): 10 MHz	1855 (26090)		1882.5 (26365)	1910 (26640)	
LTE Band 25 (PCS): 15 MHz	1857.5 (26115)		1882.5 (26365)	1907.5 (26615)	
LTE Band 25 (PCS): 20 MHz	1860 (26140)		1882.5 (26365)	1905 (26590)	
LTE Band 30: 5 MHz	2307.5 (27685)		2310 (27710)	2312.5 (27735)	
LTE Band 30: 10 MHz	N/A		2310 (27710)	N/A	
LTE Band 7: 5 MHz	2502.5 (20775)		2535 (21100)	2567.5 (21425)	
LTE Band 7: 10 MHz	2505 (20800)		2535 (21100)	2565 (21400)	
LTE Band 7: 15 MHz	2507.5 (20825)		2535 (21100)	2562.5 (21375)	
LTE Band 7: 20 MHz	2510 (20850)		2535 (21100)	2560 (21350)	
LTE Band 41: 5 MHz	2506 (39750)	2549.5 (40185)	2593 (40620)	2636.5 (41055)	2680 (41490)
LTE Band 41: 10 MHz	2506 (39750)	2549.5 (40185)	2593 (40620)	2636.5 (41055)	2680 (41490)
LTE Band 41: 15 MHz	2506 (39750)	2549.5 (40185)	2593 (40620)	2636.5 (41055)	2680 (41490)
LTE Band 41: 20 MHz	2510 (39790)	2549.5 (40185)	2593 (40620)	2636.5 (41055)	2680 (41490)
LTE Band 48: 5 MHz	3552.5 (55265)	3600.8 (55748)	N/A	3649.2 (56232)	3697.5 (56715)
LTE Band 48: 10 MHz	3555 (55290)	3601.7 (55757)	N/A	3648.3 (56223)	3695 (56690)
LTE Band 48: 15 MHz	3557.5 (55315)	3602.5 (55765)	N/A	3647.5 (56215)	3692.5 (56665)
LTE Band 48: 20 MHz	3560 (55340)	3603.3 (55773)	N/A	3646.7 (56207)	3690 (56640)
UE Category	DL UE Cat 20 (QPSK, 16QAM, 64QAM, 256QAM) UL UE Cat 18 (QPSK, 16QAM, 64QAM, 256QAM)				
Modulations Supported in UL	QPSK, 16QAM, 64QAM, 256QAM				
LTE MPR Permanently implemented per 3GPP TS 36.101 section 6.2.3~6.2.5? (manufacturer attestation to be provided)	YES				
A-MPR (Additional MPR) disabled for SAR Testing?	YES				
LTE Carrier Aggregation Possible Combinations	The technical description includes all the possible carrier aggregation combinations				
LTE Additional Information	This device does not support full CA features on 3GPP Release 15. All uplink communications are identical to the Release 8 Specifications. Uplink communications are done on the PCC. The following LTE Release 15 Features are not supported: Relay, HetNet, Enhanced MIMO, eICIC, WIFI Offloading, eMBMS, Cross-Carrier Scheduling, Enhanced SC-FDMA.				

NR Information						
Form Factor	Tablet					
Frequency Range of each NR transmission band	NR Band n71 (665.5 - 695.5 MHz)					
	NR Band n12 (701.5 - 713.5 MHz)					
	NR Band n5 (Cell) (826.5 - 846.5 MHz)					
	NR Band n66 (AWS) (1712.5 - 1777.5 MHz)					
	NR Band n25 (PCS) (1852.5 - 1912.5 MHz)					
	NR Band n2 (PCS) (1852.5 - 1907.5 MHz)					
	NR Band n30 (2307.5 - 2312.5 MHz)					
	NR Band n7 (2502.5 - 2567.5 MHz)					
	NR Band n41 (2506.02 - 2679.99 MHz)					
	NR Band n48 (3555.00 - 3694.98 MHz)					
	NR Band n77 DoD (3640.02 - 3540 MHz)					
	NR Band n77 C (3710.01 - 3969.99 MHz)					
Channel Bandwidths	NR Band n71: 5 MHz, 10 MHz, 15 MHz, 20 MHz					
	NR Band n12: 5 MHz, 10 MHz, 15 MHz					
	NR Band n5 (Cell): 5 MHz, 10 MHz, 15 MHz, 20 MHz					
	NR Band n66 (AWS): 5 MHz, 10 MHz, 15 MHz, 20 MHz, 30 MHz, 40 MHz					
	NR Band n25 (PCS): 5 MHz, 10 MHz, 15 MHz, 20 MHz, 25 MHz, 30 MHz, 40 MHz					
	NR Band n2 (PCS): 5 MHz, 10 MHz, 15 MHz, 20 MHz					
	NR Band n30: 5 MHz, 10 MHz					
	NR Band n7: 5 MHz, 10 MHz, 15 MHz, 20 MHz, 25 MHz, 30 MHz, 40 MHz					
	NR Band n41: 20 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 80 MHz, 90 MHz, 100 MHz					
	NR Band n48: 10 MHz, 20 MHz, 40 MHz					
	NR Band n77 DoD: 20 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 70 MHz, 80 MHz, 90 MHz, 100 MHz					
	NR Band n77 C: 20 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 70 MHz, 80 MHz, 90 MHz, 100 MHz					
Channel Numbers and Frequencies (MHz)	Low	Low-Mid	Mid		Mid-High	High
NR Band n71: 5 MHz	665.5 (133100)		680.5 (136100)		695.5 (139100)	
NR Band n71: 10 MHz	668 (133600)		680.5 (136100)		693 (138600)	
NR Band n71: 15 MHz	670.5 (134100)		680.5 (136100)		690.5 (138100)	
NR Band n71: 20 MHz	673 (134600)		680.5 (136100)		688 (137600)	
NR Band n12: 5 MHz	701.5 (140300)		707.5 (141500)		713.5 (142700)	
NR Band n12: 10 MHz	704 (140800)		707.5 (141500)		711 (142200)	
NR Band n12: 15 MHz	706.5 (141300)		707.5 (141500)		708.5 (141700)	
NR Band n5 (Cell): 5 MHz	826.5 (165300)		836.5 (167300)		846.5 (169300)	
NR Band n5 (Cell): 10 MHz	829 (165800)		836.5 (167300)		844 (168800)	
NR Band n5 (Cell): 15 MHz	831.5 (166300)		836.5 (167300)		841.5 (168300)	
NR Band n5 (Cell): 20 MHz	834 (166800)		836.5 (167300)		839 (167800)	
NR Band n66 (AWS): 5 MHz	1712.5 (342500)		1745 (349000)		1777.5 (355500)	
NR Band n66 (AWS): 10 MHz	1715 (343000)		1745 (349000)		1775 (355000)	
NR Band n66 (AWS): 15 MHz	1717.5 (343500)		1745 (349000)		1772.5 (354500)	
NR Band n66 (AWS): 20 MHz	1720 (344000)		1745 (349000)		1770 (354000)	
NR Band n66 (AWS): 30 MHz	1725 (345000)		1745 (349000)		1765 (353000)	
NR Band n66 (AWS): 40 MHz	1730 (346000)		1745 (349000)		1760 (352000)	
NR Band n25 (PCS): 5 MHz	1852.5 (370500)		1882.5 (376500)		1912.5 (382500)	
NR Band n25 (PCS): 10 MHz	1855 (371000)		1882.5 (376500)		1910 (382000)	
NR Band n25 (PCS): 15 MHz	1857.5 (371500)		1882.5 (376500)		1907.5 (381500)	
NR Band n25 (PCS): 20 MHz	1860 (372000)		1882.5 (376500)		1905 (381000)	
NR Band n25 (PCS): 25 MHz	1862.5 (372500)		1882.5 (376500)		1902.5 (380500)	
NR Band n25 (PCS): 30 MHz	1865 (373000)		1882.5 (376500)		1900 (380000)	
NR Band n25 (PCS): 40 MHz	1870 (374000)		1882.5 (376500)		1895 (379000)	
NR Band n2 (PCS): 5 MHz	1852.5 (370500)		1880 (376000)		1907.5 (381500)	
NR Band n2 (PCS): 10 MHz	1855 (371000)		1880 (376000)		1905 (381000)	
NR Band n2 (PCS): 15 MHz	1857.5 (371500)		1880 (376000)		1902.5 (380500)	
NR Band n2 (PCS): 20 MHz	1860 (372000)		1880 (376000)		1900 (380000)	
NR Band n30: 5 MHz	2307.5 (461500)		2310 (462000)		2312.5 (462500)	
NR Band n30: 10 MHz	N/A		2310 (462000)		N/A	
NR Band n7: 5 MHz	2502.5 (500500)		2535 (507000)		2567.5 (513500)	
NR Band n7: 10 MHz	2505 (501000)		2535 (507000)		2565 (513000)	
NR Band n7: 15 MHz	2507.5 (501500)		2535 (507000)		2562.5 (512500)	
NR Band n7: 20 MHz	2510 (502000)		2535 (507000)		2560 (512000)	
NR Band n7: 25 MHz	2512.5 (502500)		2535 (507000)		2557.5 (511500)	
NR Band n7: 30 MHz	2515 (503000)		2535 (507000)		2555 (511000)	
NR Band n7: 40 MHz	2520 (504000)		2535 (507000)		2550 (510000)	
NR Band n41: 20 MHz	2506.02 (501204)	2549.49 (509898)	2592.99 (518598)		2636.49 (527298)	2679.99 (535998)
NR Band n41: 30 MHz	2511 (502200)	2552.01 (510402)	2592.99 (518598)		2634 (526800)	2674.98 (534996)
NR Band n41: 40 MHz	2516.01 (503202)	2567.34 (513468)	N/A		2618.67 (523734)	2670 (534000)
NR Band n41: 50 MHz	2521.02 (504204)		2592.99 (518598)		2664.99 (532998)	
NR Band n41: 60 MHz	2526 (505200)		2592.99 (518598)		2659.98 (531996)	
NR Band n41: 80 MHz	2536.02 (507204)		N/A		2649.99 (529998)	
NR Band n41: 90 MHz	2541 (508200)		N/A		2644.98 (528996)	
NR Band n41: 100 MHz	2546.01 (509202)		2592.99 (518598)		2640 (528000)	
NR Band n48: 10 MHz	3555 (637000)	3601.68 (640112)	N/A		3648.33 (643222)	3694.98 (646332)
NR Band n48: 20 MHz	3560.01 (637334)	3603.33 (640222)	N/A		3646.68 (643112)	3690 (646000)
NR Band n48: 40 MHz	3570 (638000)	N/A	3624.99 (641666)		N/A	3679.98 (645332)
NR Band n77 DoD: 20 MHz	3460.02 (630668)		3500.01 (633334)		3540 (636000)	
NR Band n77 DoD: 30 MHz	3465 (631000)		3500.01 (633334)		3534.99 (635666)	
NR Band n77 DoD: 40 MHz	3470.01 (631334)		N/A		3529.98 (635332)	
NR Band n77 DoD: 50 MHz	3475.02 (631668)		N/A		3525 (635000)	
NR Band n77 DoD: 60 MHz	N/A		3500.01(633334)		N/A	
NR Band n77 DoD: 70 MHz	N/A		3500.01(633334)		N/A	
NR Band n77 DoD: 80 MHz	N/A		3500.01(633334)		N/A	
NR Band n77 DoD: 90 MHz	N/A		3500.01(633334)		N/A	
NR Band n77 DoD: 100 MHz	N/A		3500.01(633334)		N/A	
NR Band n77 C: 20 MHz	3710.01 (647334)	3762 (650800)	3813.99 (654266)	3866.01 (657734)	3918 (661200)	3969.99 (664666)
NR Band n77 C: 30 MHz	3715.02 (647668)	3765 (651000)	3815.01 (654334)	3864.99 (657666)	3915 (661000)	3964.98 (664332)
NR Band n77 C: 40 MHz	3720 (648000)	3768 (651200)	3816 (654400)	3864 (657600)	3912 (660800)	3960 (664000)
NR Band n77 C: 50 MHz	3725.01 (648334)	3782.49 (652166)	3840 (656000)		3897.51 (659834)	3954.99 (663666)
NR Band n77 C: 60 MHz	3730.02 (648668)	3803.34 (653556)	N/A	N/A	3876.66 (658444)	3949.98 (663332)
NR Band n77 C: 70 MHz	3735 (649000)	3804.99 (653666)	N/A		3875.01 (658334)	3945 (663000)
NR Band n77 C: 80 MHz	3740.01 (649334)	N/A	3840 (656000)		N/A	3939.99 (662666)
NR Band n77 C: 90 MHz	3745.02 (649668)	N/A	3840 (656000)		N/A	3934.98 (662332)
NR Band n77 C: 100 MHz	3750 (650000)	N/A	N/A	N/A	N/A	3930 (662000)
SCS for NR Band n71/n12/n5/n66/n25/n2/n30/n7	15 kHz					
SCS for NR Band n41/n48/n77 DoD/n77 C	30 kHz					
Modulations Supported in UL	DFT-s-OFDM: π/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM CP-OFDM: QPSK, 16QAM, 64QAM, 256QAM					
A-MPR (Additional MPR) disabled for SAR Testing?	YES					
EN-DC Carrier Aggregation Possible Combinations	The technical description includes all the possible carrier aggregation combinations					
LTE Anchor Bands for NR Band n71	LTE Band 66/2/7					
LTE Anchor Bands for NR Band n12	LTE Band 66/2					
LTE Anchor Bands for NR Band n5 (Cell)	LTE Band 66/2/30/7/48					
LTE Anchor Bands for NR Band n66 (AWS)	LTE Band 71/12/13/14/5/2/30/7/48					
LTE Anchor Bands for NR Band n25 (PCS)	LTE Band 12/66/48					
LTE Anchor Bands for NR Band n2 (PCS)	LTE Band 12/13/14/5/66/48					
LTE Anchor Bands for NR Band n30	LTE Band 12/14/5/66					
LTE Anchor Bands for NR Band n7	LTE Band 12/5/66					
LTE Anchor Bands for NR Band n41	LTE Band 4/66/2/25					
LTE Anchor Bands for NR Band n48	LTE Band 2/13/5/66					
LTE Anchor Bands for NR Band n77 DoD	LTE Band 7/41					
LTE Anchor Bands for NR Band n77 C	LTE Band 7/41					

3 INTRODUCTION

The FCC and Innovation, Science, and Economic Development Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [22]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

3.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 3-1).

Equation 3-1
SAR Mathematical Equation

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

SAR is expressed in units of Watts per Kilogram (W/kg).

$$SAR = \frac{\sigma \cdot E^2}{\rho}$$

where:

σ = conductivity of the tissue-simulating material (S/m)
ρ = mass density of the tissue-simulating material (kg/m^3)
E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

4 DOSIMETRIC ASSESSMENT

4.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

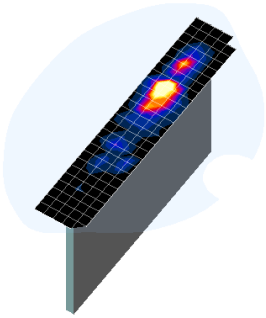


Figure 4-1
Sample SAR Area Scan

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 4-1) and IEEE 1528-2013.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 4-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

   a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 4-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).

   b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.

   c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

Table 4-1
Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

Frequency	Maximum Area Scan Resolution (mm) (Δx_{area}, Δy_{area})	Maximum Zoom Scan Resolution (mm) (Δx_{zoom}, Δy_{zoom})	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
			$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)$*	$\Delta z_{zoom}(n>1)$*	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	≤ 1.5*$\Delta z_{zoom}(n-1)$	≥ 22

*Also compliant to IEEE 1528-2013 Table 6

5 TEST CONFIGURATION POSITIONS

5.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02.

5.2 SAR Testing for Tablet per KDB Publication 616217 D04v01r02

Per FCC KDB Publication 616217 D04v01r02, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR Exclusion Threshold in KDB 447498 D01v06 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

6 RF EXPOSURE LIMITS

6.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

6.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 6-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT *General Population* (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT *Occupational* (W/kg) or (mW/g)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR Hands, Feet, Ankle, Wrists, etc.	4.0	20

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

7 FCC MEASUREMENT PROCEDURES

7.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

8 RF CONDUCTED POWERS

All conducted power measurements for 5G Sub6 WWAN technologies and bands in this section were performed by setting Reserve power margin (Qualcomm® Smart Transmit EFS entry) to 0dB, so that the EUT transmits continuously at minimum (Plimit, maximum tune up output power Pmax).

Note: Lower bandwidth conducted powers for all NR bands can be found in NR Lower Bandwidth RF Conducted Powers Appendix.

Notes: Per October 2020 TCB Workshop Guidance, NR FR1 SAR evaluations are being generally based on adapting the existing LTE SAR procedures (FCC KDB Publication 941225 D05v02r05). Therefore, NR SAR for the lower bandwidths was not required for testing based on the measured output power and the reported NR SAR for the highest bandwidth. Lower bandwidth conducted powers for all NR bands can be found in NR Lower Bandwidths RF Conducted Powers Appendix. Some bands do not support non-overlapping channels. Per FCC Guidance, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.

8.1 NR Band n48

Table 8-1
NR Band n48 Measured P_{Limit} Antenna 1b - 40 MHz Bandwidth

NR Band n48 40 MHz Bandwidth							
			Channel			MPR Allowed per 3GPP [dB]	MPR [dB]
Modulation	RB Size	RB Offset	638000 (3570 MHz)	641666 (3624.99 MHz)	645332 (3679.98 MHz)		
			Conducted Power [dBm]				
DFT-s-OFDM π/2 BPSK	1	1	12.81	12.79	12.68	0	0.0
	1	53	12.87	12.75	12.45		0.0
	1	104	13.00	12.81	12.50		0.0
	50	0	12.82	12.70	12.50	0-0.5	0.0
	50	28	12.78	12.72	12.44	0	0.0
	50	56	12.89	12.80	12.40	0-0.5	0.0
	100	0	12.83	12.75	12.48		0.0
DFT-s-OFDM QPSK	1	1	12.76	12.75	12.70	0	0.0
	1	53	12.80	12.74	12.68		0.0
	1	104	12.92	12.73	12.50		0.0
	50	0	12.77	12.63	12.43	0-1	0.0
	50	28	12.79	12.68	12.40	0	0.0
	50	56	12.85	12.61	12.45	0-1	0.0
	100	0	12.75	12.70	12.40		0.0
DFT-s-OFDM 16QAM	1	1	12.71	12.65	12.51	0-1	0.0
CP-OFDM QPSK	1	1	12.90	12.67	12.60	0-1.5	0.0

8.1.1 NR Band n48

Table 8-2
NR Band n48 Measured P_{Limit} Antenna 2b - 40 MHz Bandwidth

NR Band n48 40 MHz Bandwidth							
			Channel			MPR Allowed per 3GPP [dB]	MPR [dB]
Modulation	RB Size	RB Offset	638000 (3570 MHz)	641666 (3624.99 MHz)	645332 (3679.98 MHz)		
			Conducted Power [dBm]				
DFT-s-OFDM π/2 BPSK	1	1	12.65	12.90	12.90	0	0.0
	1	53	12.61	12.72	12.71		0.0
	1	104	12.77	12.79	12.79		0.0
	50	0	12.67	12.54	12.72	0-0.5	0.0
	50	28	12.73	12.56	12.66	0	0.0
	50	56	12.85	12.70	12.74	0-0.5	0.0
	100	0	12.80	12.58	12.77		0.0
DFT-s-OFDM QPSK	1	1	12.80	12.71	12.92	0	0.0
	1	53	12.89	12.70	12.77		0.0
	1	104	13.00	12.72	12.82		0.0
	50	0	12.82	12.60	12.73	0-1	0.0
	50	28	12.87	12.58	12.77	0	0.0
	50	56	12.94	12.70	12.83	0-1	0.0
	100	0	12.90	12.54	12.74		0.0
DFT-s-OFDM 16QAM	1	1	12.72	12.51	12.82	0-1	0.0
CP-OFDM QPSK	1	1	12.80	12.61	12.78	0-1.5	0.0

8.1.2 NR Band n48

Table 8-3
NR Band n48 Measured P_{Limit} Antenna 3b - 40 MHz Bandwidth

NR Band n48 40 MHz Bandwidth							
			Channel			MPR Allowed per 3GPP [dB]	MPR [dB]
Modulation	RB Size	RB Offset	638000 (3570 MHz)	641666 (3624.99 MHz)	645332 (3679.98 MHz)		
			Conducted Power [dBm]				
DFT-s-OFDM π/2 BPSK	1	1	14.51	14.40	14.58	0	0.0
	1	53	14.56	14.45	14.46		0.0
	1	104	14.68	14.50	14.50		0.0
	50	0	14.48	14.45	14.49	0-0.5	0.0
	50	28	14.56	14.42	14.42	0	0.0
	50	56	14.55	14.47	14.44	0-0.5	0.0
	100	0	14.51	14.40	14.43		0.0
DFT-s-OFDM QPSK	1	1	14.50	14.48	14.50	0	0.0
	1	53	14.67	14.25	14.44		0.0
	1	104	14.72	14.52	14.57		0.0
	50	0	14.61	14.43	14.51	0-1	0.0
	50	28	14.63	14.33	14.44	0	0.0
	50	56	14.77	14.44	14.58	0-1	0.0
	100	0	14.67	14.42	14.50		0.0
DFT-s-OFDM 16QAM	1	1	14.60	14.71	14.70	0-1	0.0
CP-OFDM QPSK	1	1	14.70	14.71	14.52	0-1.5	0.0

8.1.3 NR Band n48

Table 8-4
NR Band n48 Measured P_{Limit} Antenna 4 - 40 MHz Bandwidth

NR Band n48 40 MHz Bandwidth							
			Channel			MPR Allowed per 3GPP [dB]	MPR [dB]
Modulation	RB Size	RB Offset	638000 (3570 MHz)	641666 (3624.99 MHz)	645332 (3679.98 MHz)		
			Conducted Power [dBm]				
DFT-s-OFDM π/2 BPSK	1	1	12.25	12.13	12.03	0	0.0
	1	53	12.17	12.05	12.01		0.0
	1	104	12.34	12.28	12.29		0.0
	50	0	12.12	12.05	11.98	0-0.5	0.0
	50	28	12.16	12.02	12.02	0	0.0
	50	56	12.21	12.14	12.10	0-0.5	0.0
	100	0	12.17	12.03	12.03		0.0
DFT-s-OFDM QPSK	1	1	12.25	12.30	12.12	0	0.0
	1	53	12.28	12.14	12.08		0.0
	1	104	12.32	12.28	12.33		0.0
	50	0	12.16	12.12	12.05	0-1	0.0
	50	28	12.16	12.05	12.09	0	0.0
	50	56	12.17	12.17	12.18	0-1	0.0
	100	0	12.15	12.03	12.07		0.0
DFT-s-OFDM 16QAM	1	1	12.17	12.05	11.97	0-1	0.0
CP-OFDM QPSK	1	1	12.15	12.09	12.09	0-1.5	0.0

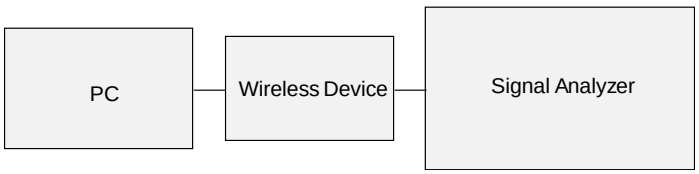


Figure 8-1
Power Measurement Setup

9 SYSTEM VERIFICATION

9.1 Tissue Verification

Table 9-1
Measured Tissue Properties

Calibrated for Tests Performed on	Tissue Type	Tissue Temp During Calibration ('C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ε	Target Conductivity, σ (s/M)	Target Dielectric Constant, ε	%dev σ	%dev ε
12/27/2021	3600 Body	22.9	3300	3.180	51.162	3.080	51.593	*3.25%*	*-0.84%*
			3350	3.236	51.112	3.139	51.525	*3.09%*	*-0.80%*
			3450	3.335	50.976	3.256	51.389	*2.43%*	*-0.80%*
			3500	3.389	50.865	3.314	51.321	*2.26%*	*-0.89%*
			3550	3.436	50.833	3.372	51.254	*1.90%*	*-0.82%*
			3560	3.447	50.816	3.384	51.240	*1.86%*	*-0.83%*
			3600	3.489	50.717	3.431	51.186	*1.69%*	*-0.92%*
			3650	3.542	50.666	3.489	51.118	*1.52%*	*-0.88%*
			3690	3.581	50.579	3.536	51.063	*1.27%*	*-0.95%*
			3700	3.595	50.564	3.548	51.050	*1.32%*	*-0.95%*
			3750	3.658	50.530	3.606	50.982	*1.44%*	*-0.89%*

The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 D01v01r04 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

Note: Per April 2019 TCB Workshop Notes, single head-tissue simulating liquid specified in IEC 62209-1 is permitted to use for all SAR tests.

9.2 Test System Verification

Prior to SAR assessment, the system is verified to ±10% of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in Appendix D.

Table 9-2
System Verification Results – 1g

SAR System	Tissue Frequency (MHz)	Tissue Type	Date	Amb. Temp. (C)	Liquid Temp. (C)	Input Power (W)	Source SN	Probe SN	Measured SAR1g (W/kg)	1W Target SAR1g (W/kg)	1W Normalized SAR 1g (W/kg)	Deviation1g (%)
AM7	3500	Body	12/27/2021	22.0	21.5	0.10	1126	7674	6.580	63.60	65.800	3.46%
AM7	3700	Body	12/27/2021	22.0	21.5	0.10	1097	7674	6.230	62.30	62.300	0.00%

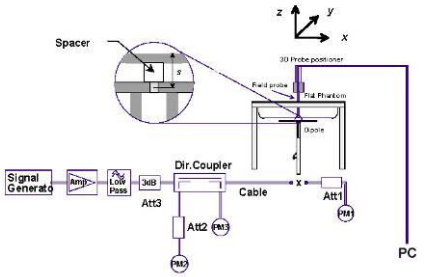


Figure 9-1
System Verification Setup Diagram

Figure 9-2
System Verification Setup Photo

10 SAR DATA SUMMARY

10.1 Standalone SAR Data

Table 10-1
NR Band n48 Ant 1b Body SAR

MEASUREMENT RESULTS																										
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Antenna State	Serial Number	Waveform	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.																(W/kg)		(W/kg)	(W/kg)	(W/kg)	
3570.00	638000	Low	NR Band n48	40	13.8	12.92	0.00	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.674	1.225	0.826	0.174	0.213	
3624.99	641666	Mid	NR Band n48	40	13.8	12.75	-0.01	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	1	0 mm	back	1:1	0.665	1.274	0.847	0.176	0.224	
3679.98	645332	High	NR Band n48	40	13.8	12.70	-0.04	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	1	0 mm	back	1:1	0.612	1.288	0.788	0.161	0.207	
3570.00	638000	Low	NR Band n48	40	13.8	12.85	0.09	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.684	1.245	0.852	0.177	0.220	
3624.99	641666	Mid	NR Band n48	40	13.8	12.68	0.03	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	28	0 mm	back	1:1	0.641	1.294	0.829	0.171	0.221	
3679.98	645332	High	NR Band n48	40	13.8	12.45	0.14	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.602	1.365	0.822	0.158	0.216	
3570.00	638000	Low	NR Band n48	40	13.8	12.75	0.04	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	100	0	0 mm	back	1:1	0.728	1.274	0.927	0.196	0.250	
3570.00	638000	Low	NR Band n48	40	13.8	12.92	0.05	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.000	1.225	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	13.8	12.85	0.03	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.000	1.245	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	13.8	12.92	-0.04	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	104	0 mm	bottom	1:1	0.743	1.225	0.910	0.201	0.246	
3624.99	641666	Mid	NR Band n48	40	13.8	12.75	0.00	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	1	0 mm	bottom	1:1	0.686	1.274	0.874	0.190	0.242	
3679.98	645332	High	NR Band n48	40	13.8	12.70	-0.01	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	1	0 mm	bottom	1:1	0.687	1.288	0.885	0.189	0.243	
3570.00	638000	Low	NR Band n48	40	13.8	12.85	-0.06	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.714	1.245	0.889	0.196	0.244	
3624.99	641666	Mid	NR Band n48	40	13.8	12.68	0.02	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	28	0 mm	bottom	1:1	0.601	1.294	0.778	0.165	0.214	
3679.98	645332	High	NR Band n48	40	13.8	12.45	-0.02	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.637	1.365	0.870	0.176	0.240	
3570.00	638000	Low	NR Band n48	40	13.8	12.75	0.03	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	100	0	0 mm	bottom	1:1	0.742	1.274	0.945	0.208	0.265	
3570.00	638000	Low	NR Band n48	40	13.8	12.90	-0.05	0	Ant 1b	H9TXRFVC3X	CP-OFDM	QPSK	1	1	0 mm	bottom	1:1	0.791	1.230	0.973	0.223	0.274	
3570.00	638000	Low	NR Band n48	40	13.8	12.92	0.07	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	104	0 mm	right	1:1	0.004	1.225	0.005	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	13.8	12.85	0.03	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	right	1:1	0.006	1.245	0.007	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	13.8	12.92	-0.08	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	1	104	0 mm	left	1:1	0.015	1.225	0.018	0.005	0.006	
3570.00	638000	Low	NR Band n48	40	13.8	12.85	0.01	0	Ant 1b	H9TXRFVC3X	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.012	1.245	0.015	0.003	0.004	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population												Body 1.6 W/kg (mW/g) averaged over 1 gram											

Table 10-2
NR Band n48 Ant 2b Body SAR

MEASUREMENT RESULTS																										
FREQUENCY		Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Antenna State	Serial Number	Waveform	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.																(W/kg)		(W/kg)	(W/kg)	(W/kg)	
3570.00	638000	Low	NR Band n48	40	14.3	13.00	-0.02	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.558	1.349	0.753	0.149	0.201	
3624.99	641666	Mid	NR Band n48	40	14.3	12.72	0.05	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.503	1.439	0.724	0.136	0.196	
3679.98	645332	High	NR Band n48	40	14.3	12.92	-0.01	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	1	0 mm	back	1:1	0.553	1.374	0.760	0.147	0.202	
3570.00	638000	Low	NR Band n48	40	14.3	12.94	0.08	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.541	1.368	0.740	0.146	0.200	
3624.99	641666	Mid	NR Band n48	40	14.3	12.70	0.04	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.490	1.445	0.708	0.132	0.191	
3679.98	645332	High	NR Band n48	40	14.3	12.83	0.02	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.594	1.403	0.833	0.160	0.224	
3570.00	638000	Low	NR Band n48	40	14.3	12.90	0.03	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	100	0	0 mm	back	1:1	0.575	1.380	0.794	0.155	0.214	
3570.00	638000	Low	NR Band n48	40	14.3	13.00	0.03	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.001	1.349	0.001	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	14.3	12.94	-0.05	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.000	1.368	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	14.3	13.00	0.02	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	bottom	1:1	0.604	1.349	0.815	0.169	0.228	
3624.99	641666	Mid	NR Band n48	40	14.3	12.72	-0.04	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	bottom	1:1	0.593	1.439	0.853	0.166	0.239	
3679.98	645332	High	NR Band n48	40	14.3	12.92	0.07	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	1	0 mm	bottom	1:1	0.632	1.374	0.868	0.173	0.238	
3570.00	638000	Low	NR Band n48	40	14.3	12.94	-0.01	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.609	1.368	0.833	0.168	0.230	
3624.99	641666	Mid	NR Band n48	40	14.3	12.70	-0.06	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.578	1.445	0.835	0.160	0.231	
3679.98	645332	High	NR Band n48	40	14.3	12.83	-0.04	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.662	1.403	0.929	0.180	0.253	
3570.00	638000	Low	NR Band n48	40	14.3	12.90	0.05	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	100	0	0 mm	bottom	1:1	0.629	1.380	0.868	0.176	0.243	
3570.00	638000	Low	NR Band n48	40	14.3	12.80	-0.15	0	Ant 2b	JFPF0XQ24V	CP-OFDM	QPSK	1	1	0 mm	bottom	1:1	0.669	1.413	0.945	0.186	0.263	
3570.00	638000	Low	NR Band n48	40	14.3	13.00	0.02	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	right	1:1	0.004	1.349	0.005	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	14.3	12.94	-0.05	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	right	1:1	0.003	1.368	0.004	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	14.3	13.00	0.09	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	left	1:1	0.000	1.349	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	14.3	12.94	0.08	0	Ant 2b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.000	1.368	0.000	0.000	0.000	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population												Body 1.6 W/kg (mW/g) averaged over 1 gram											

Table 10-3
NR Band n48 Ant 3b Body SAR

MEASUREMENT RESULTS																										
FREQUENCY			Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Antenna Config	Serial Number	Waveform	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.																	(W/kg)		(W/kg)	(W/kg)	(W/kg)	
3570.00	638000	Low	NR Band n48	40	15.5	14.72	0.07	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.738	1.197	0.883	0.214	0.256	
3624.99	641666	Mid	NR Band n48	40	15.5	14.52	-0.08	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.709	1.253	0.888	0.208	0.261	
3679.98	645332	High	NR Band n48	40	15.5	14.57	-0.01	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.675	1.239	0.836	0.197	0.244	
3570.00	638000	Low	NR Band n48	40	15.5	14.77	0.01	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.761	1.183	0.900	0.220	0.260	
3624.99	641666	Mid	NR Band n48	40	15.5	14.44	-0.03	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.670	1.276	0.855	0.198	0.250	
3679.98	645332	High	NR Band n48	40	15.5	14.58	0.00	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.667	1.236	0.824	0.197	0.243	
3570.00	638000	Low	NR Band n48	40	15.5	14.67	0.05	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	100	0	0 mm	back	1:1	0.774	1.211	0.937	0.223	0.270	
3570.00	638000	Low	NR Band n48	40	15.5	14.72	0.03	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.777	1.197	0.930	0.231	0.277	
3624.99	641666	Mid	NR Band n48	40	15.5	14.52	0.00	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.755	1.253	0.946	0.227	0.284	
3679.98	645332	High	NR Band n48	40	15.5	14.57	0.07	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.795	1.239	0.985	0.236	0.292	
3570.00	638000	Low	NR Band n48	40	15.5	14.77	0.01	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.743	1.183	0.879	0.220	0.260	
3624.99	641666	Mid	NR Band n48	40	15.5	14.44	-0.01	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.708	1.276	0.903	0.212	0.271	
3679.98	645332	High	NR Band n48	40	15.5	14.58	-0.03	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.778	1.236	0.962	0.230	0.284	
3570.00	638000	Low	NR Band n48	40	15.5	14.67	0.04	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	100	0	0 mm	top	1:1	0.770	1.211	0.932	0.231	0.280	
3624.99	641666	Mid	NR Band n48	40	15.5	14.71	-0.01	0	Ant 3b	JFPF0XQ24V	CP-OFDM	QPSK	1	1	0 mm	top	1:1	0.749	1.199	0.898	0.225	0.270	
3570.00	638000	Low	NR Band n48	40	15.5	14.72	-0.09	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	bottom	1:1	0.000	1.197	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	15.5	14.77	0.00	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.000	1.183	0.000	0.000	0.000	
3570.00	638000	Low	NR Band n48	40	15.5	14.72	0.10	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	right	1:1	0.098	1.197	0.117	0.025	0.030	
3570.00	638000	Low	NR Band n48	40	15.5	14.77	0.02	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	right	1:1	0.097	1.183	0.115	0.025	0.030	
3570.00	638000	Low	NR Band n48	40	15.5	14.72	-0.08	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	1	104	0 mm	left	1:1	0.018	1.197	0.022	0.004	0.005	
3570.00	638000	Low	NR Band n48	40	15.5	14.77	-0.03	0	Ant 3b	JFPF0XQ24V	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.018	1.183	0.021	0.004	0.005	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population													Body 1.6 W/kg (mW/g) averaged over 1 gram										

Table 10-4
NR Band n48 Ant 4 Body SAR

MEASUREMENT RESULTS																										
FREQUENCY			Mode	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	MPR [dB]	Antenna Config	Serial Number	Waveform	Modulation	RB Size	RB Offset	Spacing	Side	Duty Cycle	SAR (1g)	Scaling Factor	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.																	(W/kg)		(W/kg)	(W/kg)	(W/kg)	
3570.00	638000	Low	NR Band n48	40	12.8	12.32	0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.730	1.117	0.815	0.218	0.241	
3624.99	641666	Mid	NR Band n48	40	12.8	12.30	-0.07	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	1	0 mm	back	1:1	0.794	1.122	0.891	0.228	0.256	
3679.98	645332	High	NR Band n48	40	12.8	12.33	0.00	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	back	1:1	0.807	1.114	0.899	0.235	0.262	
3570.00	638000	Low	NR Band n48	40	12.8	12.17	0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.704	1.156	0.814	0.207	0.239	
3624.99	641666	Mid	NR Band n48	40	12.8	12.17	-0.02	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.862	1.156	0.996	0.244	0.282	A1
3679.98	645332	High	NR Band n48	40	12.8	12.18	0.02	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.814	1.153	0.939	0.235	0.271	
3570.00	638000	Low	NR Band n48	40	12.8	12.15	0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	100	0	0 mm	back	1:1	0.761	1.161	0.884	0.223	0.259	
3570.00	638000	Low	NR Band n48	40	12.8	12.15	-0.08	0	Ant 4	RRFNYFJ9CV	CP-OFDM	QPSK	1	1	0 mm	back	1:1	0.719	1.161	0.835	0.212	0.246	
3679.98	645332	High	NR Band n48	40	12.8	12.33	-0.10	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	top	1:1	0.238	1.114	0.265	0.078	0.087	
3679.98	645332	High	NR Band n48	40	12.8	12.18	0.04	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	top	1:1	0.240	1.153	0.277	0.079	0.091	
3679.98	645332	High	NR Band n48	40	12.8	12.33	-0.02	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	bottom	1:1	0.004	1.114	0.004	0.000	0.000	
3679.98	645332	High	NR Band n48	40	12.8	12.18	-0.07	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	bottom	1:1	0.006	1.153	0.007	0.000	0.000	
3679.98	645332	High	NR Band n48	40	12.8	12.33	0.00	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	right	1:1	0.000	1.114	0.000	0.000	0.000	
3679.98	645332	High	NR Band n48	40	12.8	12.18	0.00	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	right	1:1	0.000	1.153	0.000	0.000	0.000	
3679.98	645332	High	NR Band n48	40	12.8	12.33	0.05	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	1	104	0 mm	left	1:1	0.512	1.114	0.570	0.137	0.153	
3570.00	638000	Low	NR Band n48	40	12.8	12.17	-0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.469	1.156	0.542	0.129	0.149	
3624.99	641666	Mid	NR Band n48	40	12.8	12.17	-0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.475	1.156	0.549	0.129	0.149	
3679.98	645332	High	NR Band n48	40	12.8	12.18	0.01	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	left	1:1	0.524	1.153	0.604	0.141	0.163	
3570.00	638000	Low	NR Band n48	40	12.8	12.15	-0.07	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	100	0	0 mm	left	1:1	0.449	1.161	0.521	0.124	0.144	
3624.99	641666	Mid	NR Band n48	40	12.8	12.17	0.04	0	Ant 4	RRFNYFJ9CV	DFT-S-OFDM	QPSK	50	56	0 mm	back	1:1	0.785	1.156	0.907	0.232	0.268	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population													Body 1.6 W/kg (mW/g) averaged over 1 gram										

Note: Blue entry represents variability measurement.

10.2 SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 616217 D04v01r02, and FCC KDB Publication 447498 D01v06.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
6. Per FCC KDB 865664 D01v01r04, variability SAR tests were performed when the measured SAR results for a frequency band were greater than or equal to 0.8 W/kg. Repeated SAR measurements are highlighted in the tables above for clarity. Please see Section 12 for variability analysis
7. FCC KDB Publication 616217 D04v01r02 Section 4.3, SAR tests are required for the back surface and edges of the tablet with the tablet touching the phantom. The SAR Exclusion Threshold in FCC KDB 447498 D01v06 was applied to determine SAR test exclusion for adjacent edge configurations.
8. This device uses Smart Transmit for 5G operations to control and manage transmitting power in real time to ensure RF Exposure compliance. Per FCC Guidance, compliance for was assessed at the minimum of the time averaged power and the maximum output power for each band/mode/exposure condition (DSI).
9. The orange highlights throughout the report represents the highest scaled SAR per Equipment Class.
10. See the original filing for all other operations that were not evaluated in this permissive change.

NR Notes:

1. NR implementation supports SA and NSA modes. NR implementation in EN-DC mode operates with the LTE Bands shown in the NR FR1 checklist acting as anchor bands. Per FCC guidance, SAR tests for NR Bands and LTE Anchors Bands were performed separately due to limitations in SAR probe calibration factors.
2. Due to test setup limitations, SAR testing for NR was performed using test mode software to establish the connection.
3. This device additionally supports some EN-DC conditions where additional LTE carriers are added on the downlink only.
4. Per FCC Guidance, NR modulations and RB Sizes/Offsets were selected for testing such that configurations with the highest output power were evaluated for SAR tests.

11 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

11.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to devices with built-in unlicensed transmitters such as 802.11 and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

11.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore, simultaneous transmission analysis is required. Per FCC KDB Publication 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤1.6 W/kg. The different test positions in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1g or 10g SAR.

Note:
Please see the original filing for the standalone reported SAR for modes and bands that were not evaluated for this permissive change.

Only operations relevant to this permissive change were evaluated for compliance. No other simultaneous scenario transmission changes have been made. Please see the original filing for complete evaluation of simultaneous transmission analysis.

SAR Summations for some scenarios when the output power levels are reduced, SAR values at the maximum output power level were used as the most conservative evaluation for simultaneous transmission analysis.

For each position, the highest SAR value across all modes for the applicable cellular band antenna was considered for summation to determine simultaneous SAR test exclusion.

*The SAR distributions for at least one of the antennas are spatially separated from the other antennas per FCC KDB Publication 248227 Section 6.1 procedures. Therefore, the simultaneous transmission were treated independently for this configuration. See section 11.4 for more information about the Spatial Separation Analysis.

Qualcomm Smart Transmit algorithm in WWAN adds directly the time-averaged RF exposure from 4G (including scenarios with inter-band ULCA active) and time-averaged RF exposure from 5G NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G NR and during inter-band ULCA active conditions to not exceed FCC limit. Therefore, simultaneous transmission compliance between 4G+5G operations (including scenarios with inter-band ULCA active) is demonstrated in the Part 2 Report during algorithm validation. See the original filing for all other operations that were not evaluated in this permissive change.

In some cases where simultaneous transmission scenarios overlap with the same power level (for example, cellular band + 2.4 GHz WIFI SISO and cellular band + 2.4 GHz WIFI MIMO), the most conservative SAR summation scenario was evaluated.

11.3 Body SAR Simultaneous Transmission Analysis

Table 11-1
Cellular Band Ant 1b Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 1b SAR (W/kg)	2.4 GHz WLAN Ant 1a Reduced at 10.5dBm SAR (W/kg)	2.4 GHz WLAN Ant 3a SAR (W/kg)
		1	2	3
Body SAR	Back	0.990	0.507	0.466
	Top	0.000	0.024	0.336
	Bottom	0.994	0.180	0.004
	Right	0.010	0.000	1.062
	Left	0.018	0.574	0.000

Table 11-2
Cellular Band Ant 2b Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 2b SAR (W/kg)	2.4 GHz WLAN Ant 1a SAR (W/kg)	2.4 GHz WLAN Ant 3a SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.962	0.955	0.466	0.962*
	Top	0.001	0.024	0.336	0.361
	Bottom	0.994	0.426	0.004	**1.424**
	Right	0.022	0.000	1.062	1.084
	Left	0.008	1.087	0.000	1.095

Table 11-3
Cellular Band Ant 3b Simultaneous Transmission Scenario with 2.4 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 3b SAR (W/kg)	2.4 GHz WLAN Ant 1a SAR (W/kg)	2.4 GHz WLAN Ant 3a Reduced at 9.25dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.995	0.955	0.265	**1.260***
	Top	0.992	0.024	0.214	1.230
	Bottom	0.010	0.426	0.004	0.440
	Right	0.117	0.000	0.559	0.676
	Left	0.023	1.087	0.000	1.110

Table 11-4
Cellular Band Ant 1b Simultaneous Transmission Scenario with 5 GHz WI-FI MIMO

Simult Tx	Configuration	Cellular Band Ant 1b SAR (W/kg)	5 GHz WLAN Ant 1b Reduced SAR (W/kg)	5 GHz WLAN Ant 2b SAR (W/kg)	5 GHz WLAN Ant 3a SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	1+2+3	1+2+4	1+3+4
Body SAR	Back	0.990	0.252	1.062	1.090	**1.242***	**1.242***	1.090*
	Top	0.000	0.000	0.000	0.181	0.000	0.181	0.181
	Bottom	0.994	0.184	0.825	0.011	1.178*	1.189	1.005*
	Right	0.010	0.010	0.060	0.653	0.080	0.673	0.723
	Left	0.018	0.065	0.018	0.000	0.101	0.083	0.036

Table 11-5
Cellular Band Ant 2b Simultaneous Transmission Scenario with 5 GHz WI-FI MIMO

Simult Tx	Configuration	Cellular Band Ant 2b SAR (W/kg)	5 GHz WLAN Ant 1b SAR (W/kg)	5 GHz WLAN Ant 2b Reduced SAR (W/kg)	5 GHz WLAN Ant 3a SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	1+2+3	1+2+4	1+3+4
Body SAR	Back	0.962	1.089	0.511	1.090	**1.473***	1.090*	**1.473***
	Top	0.001	0.000	0.000	0.181	0.001	0.182	0.182
	Bottom	0.994	0.847	0.351	0.011	1.345*	1.005*	1.356
	Right	0.022	0.010	0.060	0.653	0.092	0.685	0.735
	Left	0.008	0.065	0.018	0.000	0.091	0.073	0.026

Table 11-6
Cellular Band Ant 3b Simultaneous Transmission Scenario with 5 GHz WI-FI MIMO

Simult Tx	Configuration	Cellular Band Ant 3b SAR (W/kg)	5 GHz WLAN Ant 1b SAR (W/kg)	5 GHz WLAN Ant 2b SAR (W/kg)	5 GHz WLAN Ant 3a Reduced SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	1+2+3	1+2+4	1+3+4
Body SAR	Back	0.995	1.089	1.062	0.270	1.089*	**1.265***	**1.265***
	Top	0.992	0.000	0.000	0.030	0.992	1.022	1.022
	Bottom	0.010	0.847	0.825	0.011	0.857*	0.868	0.846
	Right	0.117	0.010	0.060	0.136	0.187	0.263	0.313
	Left	0.023	0.065	0.018	0.000	0.106	0.088	0.041

Table 11-3
Cellular Band Ant 1b Simultaneous Transmission Scenario with Bluetooth TxBF

Simult Tx	Configuration	Cellular Band Ant 1b SAR (W/kg)	Bluetooth Ant 1a at 10.5 dBm SAR (W/kg)	Bluetooth Ant 3a SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.990	0.334	0.532	**1.324***
	Top	0.000	0.015	0.435	0.450
	Bottom	0.994	0.123	0.007	1.124
	Right	0.010	0.000	0.988	0.998
	Left	0.018	0.328	0.000	0.346

Table 11-8
Cellular Band Ant 2b Simultaneous Transmission Scenario with Bluetooth TxBF

Simult Tx	Configuration	Cellular Band Ant 2b SAR (W/kg)	Bluetooth Ant 1a SAR (W/kg)	Bluetooth Ant 3a SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.962	1.084	0.532	1.084*
	Top	0.001	0.015	0.435	0.451
	Bottom	0.994	0.320	0.007	**1.321**
	Right	0.022	0.000	0.988	1.010
	Left	0.008	0.687	0.000	0.695

Table 11-9
Cellular Band Ant 3b Simultaneous Transmission Scenario with Bluetooth TxBF

Simult Tx	Configuration	Cellular Band Ant 3b SAR (W/kg)	Bluetooth Ant 1a SAR (W/kg)	Bluetooth Ant 3a at 9 dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.995	1.084	0.163	**1.158***
	Top	0.992	0.015	0.126	1.133
	Bottom	0.010	0.320	0.007	0.337
	Right	0.117	0.000	0.285	0.402
	Left	0.023	0.687	0.000	0.710

Table 11-10
Cellular Band Ant 1b Simultaneous Transmission Scenario with Bluetooth and 2.4 GHz WLAN

Simult Tx	Configuration	Cellular Band Ant 1b SAR (W/kg)	2.4 GHz WLAN Ant 3a SAR (W/kg)	Bluetooth Ant 1a at 10.5 dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.990	0.466	0.334	**1.324***
	Top	0.000	0.336	0.015	0.351
	Bottom	0.994	0.004	0.123	1.121
	Right	0.010	1.062	0.000	1.072
	Left	0.018	0.000	0.328	0.346

Table 11-11
Cellular Band Ant 2b Simultaneous Transmission Scenario with Bluetooth and 2.4 GHz WLAN

Simult Tx	Configuration	Cellular Band Ant 2b SAR (W/kg)	2.4 GHz WLAN Ant 3a SAR (W/kg)	Bluetooth Ant 1a SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.962	0.466	1.084	1.084*
	Top	0.001	0.336	0.015	0.352
	Bottom	0.994	0.004	0.320	**1.318**
	Right	0.022	1.062	0.000	1.084
	Left	0.008	0.000	0.687	0.695

Table 11-12
Cellular Band Ant 3b Simultaneous Transmission Scenario with Bluetooth and 2.4 GHz WLAN

Simult Tx	Configuration	Cellular Band Ant 3b SAR (W/kg)	2.4 GHz WLAN Ant 3a Reduced at 9.25dBm SAR (W/kg)	Bluetooth Ant 1a SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	1+2+3
Body SAR	Back	0.995	0.265	1.084	**1.260***
	Top	0.992	0.214	0.015	1.221
	Bottom	0.010	0.004	0.320	0.334
	Right	0.117	0.559	0.000	0.676
	Left	0.023	0.000	0.687	0.710

Table 11-13
Cellular Band Ant 1b Simultaneous Transmission Scenario with Bluetooth TxBF and 5 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 1b SAR (W/kg)	Bluetooth Ant 1a at 7 dBm SAR (W/kg)	Bluetooth Ant 3a at 8 dBm SAR (W/kg)	5 GHz WLAN Ant 1b Reduced SAR (W/kg)	5 GHz WLAN Ant 2b SAR (W/kg)	5 GHz WLAN Ant 3a SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	5	6	1+2+3+4+5	1+2+3+4+6	1+2+3+5+6
Body SAR	Back	0.990	0.232	0.138	0.252	1.062	1.090	**1.474***	**1.474***	1.228*
	Top	0.000	0.015	0.111	0.000	0.000	0.181	0.126	0.307	0.307
	Bottom	0.994	0.058	0.007	0.184	0.825	0.011	1.243*	1.254	1.070*
	Right	0.010	0.000	0.239	0.010	0.060	0.653	0.319	0.912	0.962
	Left	0.018	0.167	0.000	0.065	0.018	0.000	0.268	0.250	0.203

Table 11-14
Cellular Band Ant 2b Simultaneous Transmission Scenario with Bluetooth TxBF and 5 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 2b SAR (W/kg)	Bluetooth Ant 1a at 9.5 dBm SAR (W/kg)	Bluetooth Ant 3a at 8 dBm SAR (W/kg)	5 GHz WLAN Ant 1b SAR (W/kg)	5 GHz WLAN Ant 2b Reduced SAR (W/kg)	5 GHz WLAN Ant 3a SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	5	6	1+2+3+4+5	1+2+3+4+6	1+2+3+5+6
Body SAR	Back	0.962	0.277	0.138	1.089	0.511	1.090	**1.473***	1.112*	**1.473***
	Top	0.001	0.015	0.111	0.000	0.000	0.181	0.127	0.308	0.308
	Bottom	0.994	0.100	0.007	0.847	0.351	0.011	**1.452***	**1.012***	1.463
	Right	0.022	0.000	0.239	0.010	0.060	0.653	0.331	0.924	0.974
	Left	0.008	0.225	0.000	0.065	0.018	0.000	0.316	0.298	0.251

Table 11-15
Cellular Band Ant 3b Simultaneous Transmission Scenario with Bluetooth TxBF and 5 GHz WLAN MIMO

Simult Tx	Configuration	Cellular Band Ant 3b SAR (W/kg)	Bluetooth Ant 1a at 9.5 dBm SAR (W/kg)	Bluetooth Ant 3a at 5.5 dBm SAR (W/kg)	5 GHz WLAN Ant 1b SAR (W/kg)	5 GHz WLAN Ant 2b SAR (W/kg)	5 GHz WLAN Ant 3a Reduced SAR (W/kg)	Σ SAR (W/kg)		
		1	2	3	4	5	6	1+2+3+4+5	1+2+3+4+6	1+2+3+5+6
Body SAR	Back	0.995	0.277	0.088	1.089	1.062	0.270	**1.366***	**1.366***	1.353*
	Top	0.992	0.015	0.069	0.000	0.000	0.030	1.076	1.106	1.106
	Bottom	0.010	0.100	0.007	0.847	0.825	0.011	0.964*	0.975	0.953
	Right	0.117	0.000	0.136	0.010	0.060	0.136	0.323	0.399	0.449
	Left	0.023	0.225	0.000	0.065	0.018	0.000	0.331	0.313	0.266

11.4 Spatial Separation Analysis

Per FCC KDB Publication 248227, antennas may be considered spatially separated when the aggregate SAR from multiple antennas at any location in the combined SAR distribution is either ≤ 1.2 W/kg where at least 90% of the SAR is attributed to a single SAR distribution or ≤ 0.4 W/kg where no more than one SAR distribution is contributing > 0.1 W/kg.

Spatial separation was determined by inspection of the area scan SAR distributions to confirm that at all locations, SAR was < 1.2 W/kg, where at least 90% of the SAR is attributed to a single SAR distribution. See below for illustrations of the spatial separated antennas considered.

11.4.1 Back Side Spatial Separation Analysis

Figure 11-1
Back Side Spatial Separation for Antenna 1a and Antenna 3a

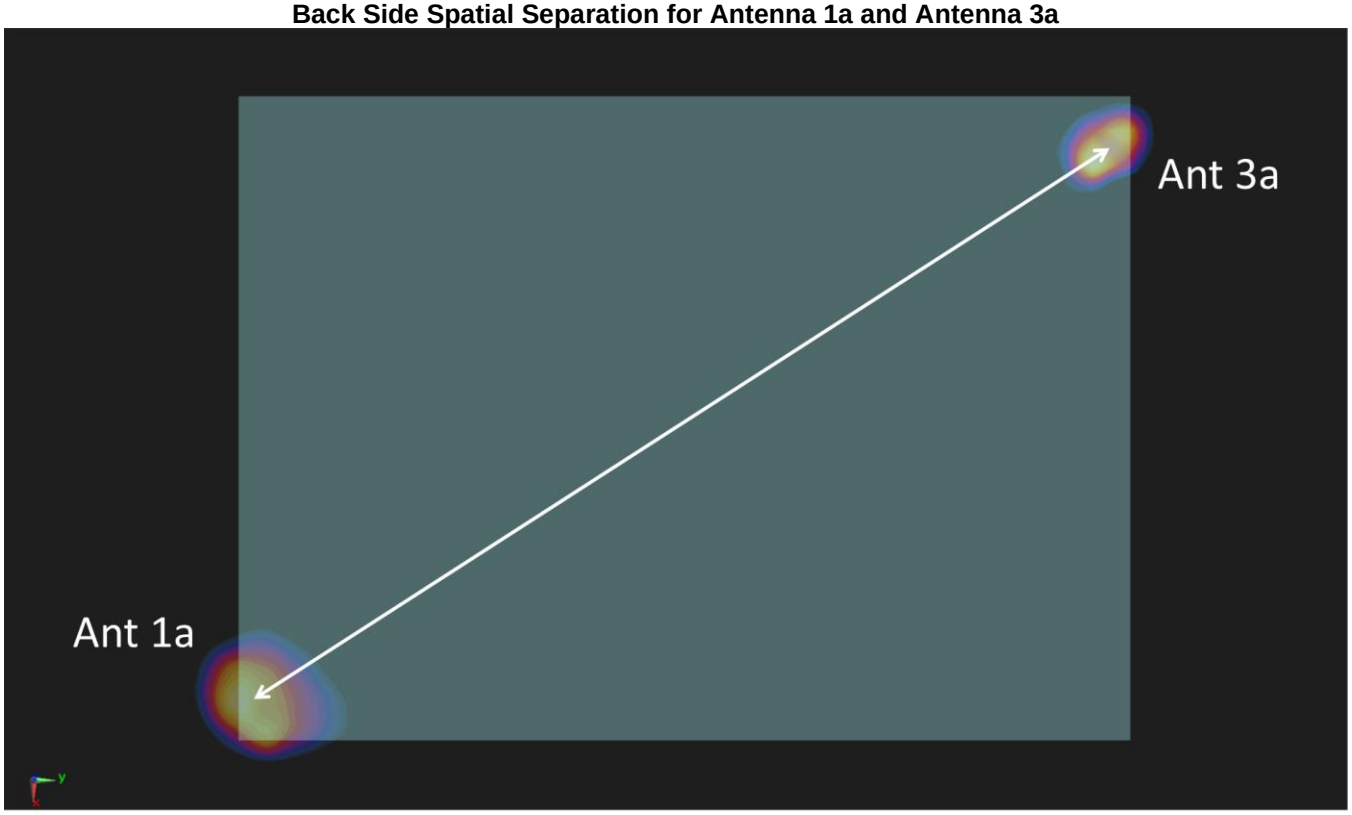


Figure 11-2
Back Side Spatial Separation for Antenna 1a and Antenna 2b

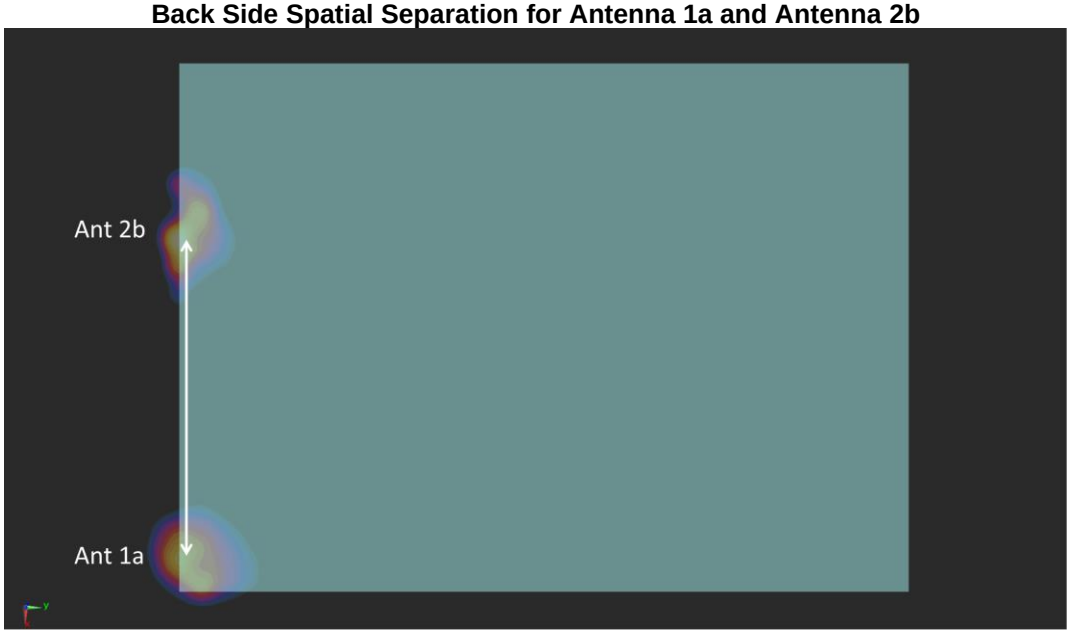


Figure 11-3
Back Side Spatial Separation for Antenna 1b and Antenna 2b

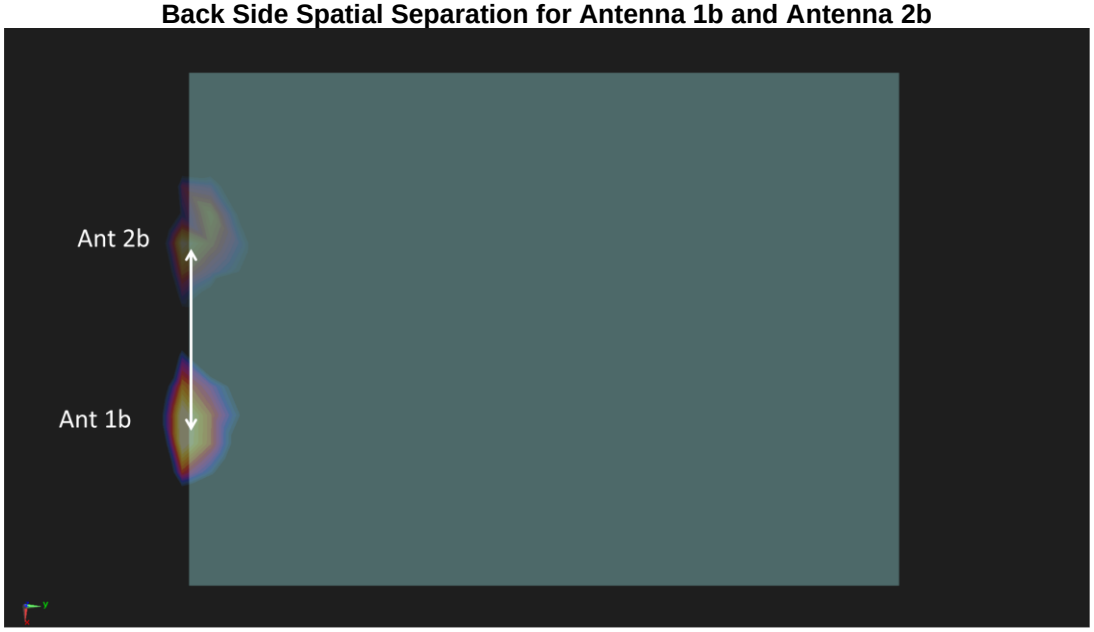


Figure 11-4
Back Side Spatial Separation for Antenna 1b and Antenna 3a

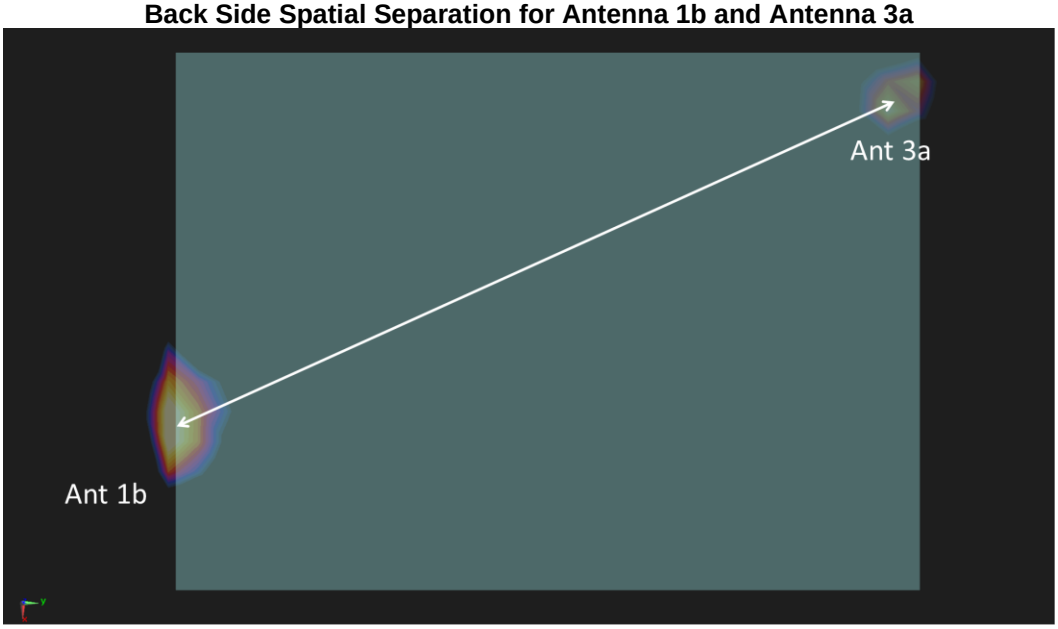


Figure 11-5
Back Side Spatial Separation for Antenna 2b and Antenna 3a

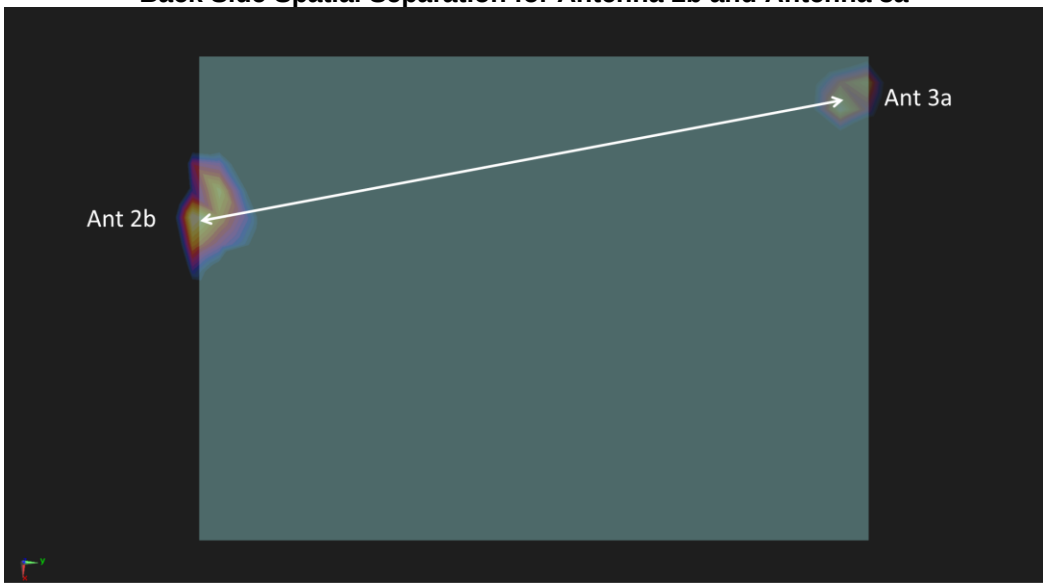


Figure 11-6
Back Side Spatial Separation for Antenna 1a and Antenna 3b

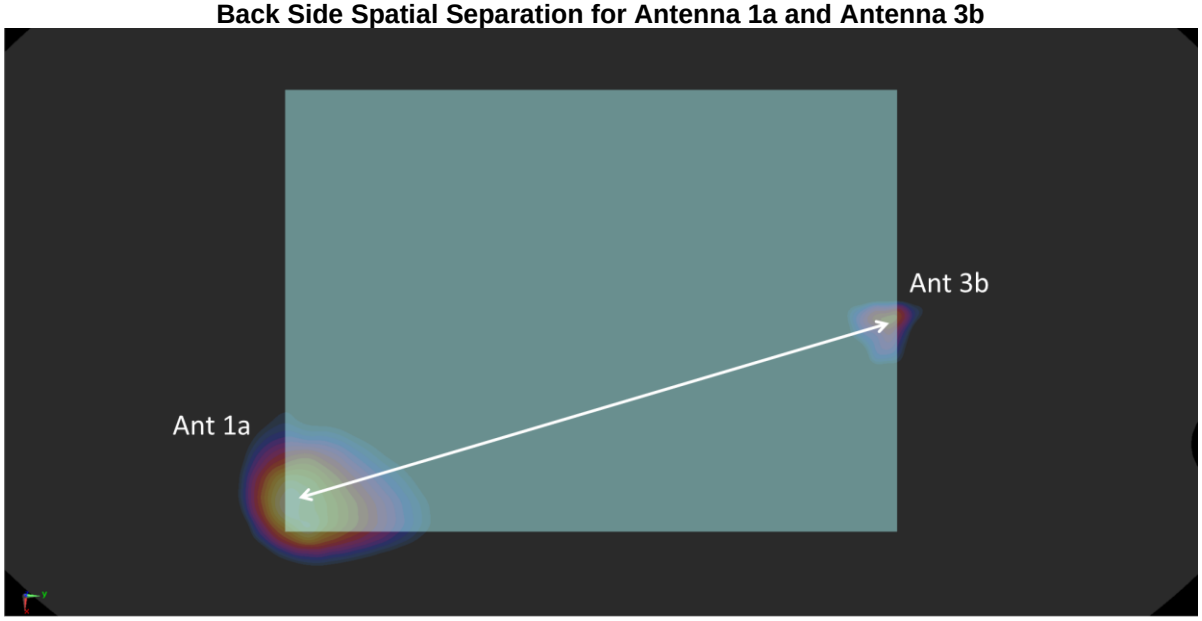


Figure 11-7
Back Side Spatial Separation for Antenna 2b and Antenna 3b

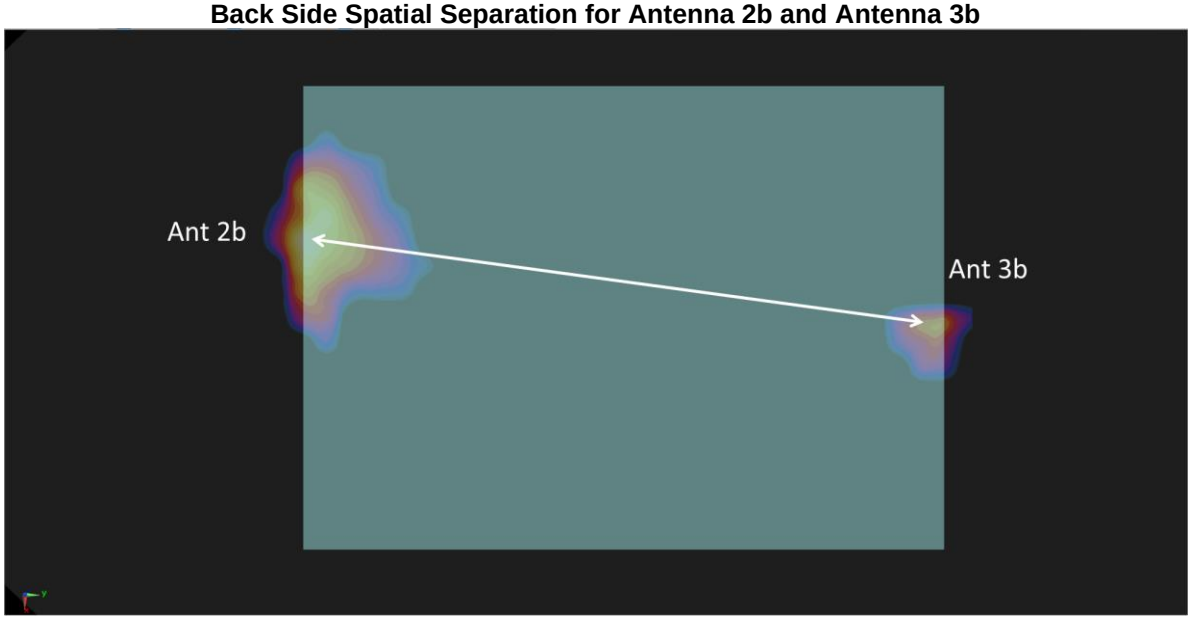
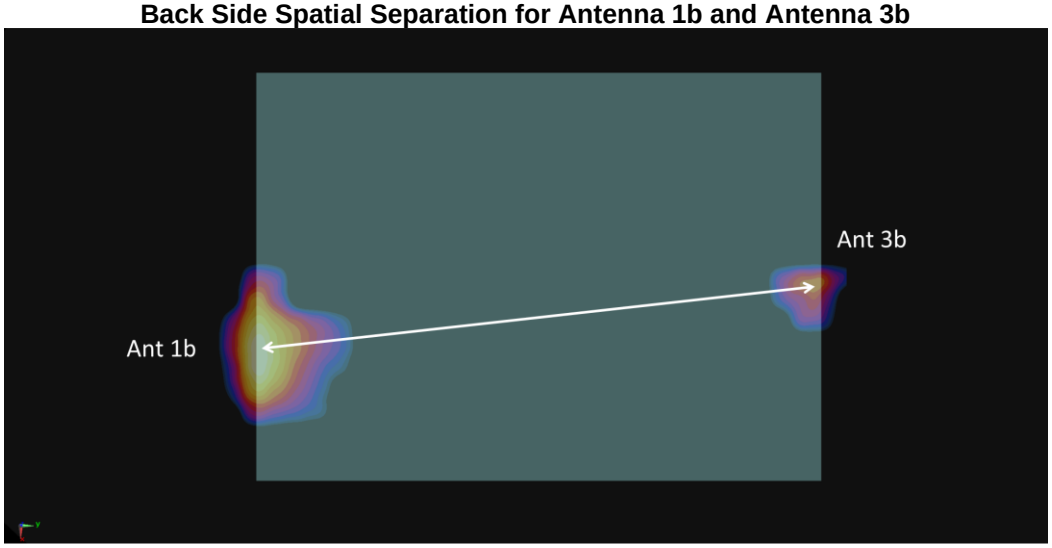
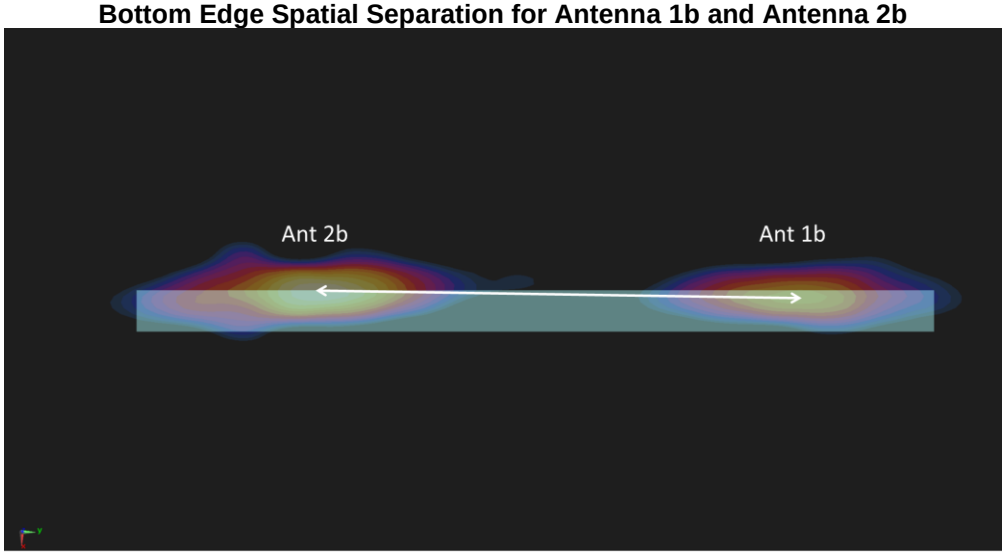


Figure 11-8
Back Side Spatial Separation for Antenna 1b and Antenna 3b



11.4.2 Bottom Edge Spatial Separation Analysis

Figure 11-9
Bottom Edge Spatial Separation for Antenna 1b and Antenna 2b



11.5 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528-2013 Section 6.3.4.1.2.

12 SAR MEASUREMENT VARIABILITY

12.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

1) When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2) A second repeated measurement was performed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1g SAR limit).
3) A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4) Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg
5) When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

Table 12-1
Body SAR Measurement Variability Results

BODY VARIABILITY RESULTS																
Band	FREQUENCY		Mode	Waveform	Service	Ant	Data Rate (Mbps)	Side	Spacing	Measured SAR (1g)	1st Repeated SAR (1g)	Ratio	2nd Repeated SAR (1g)	Ratio	3rd Repeated SAR (1g)	Ratio
	MHz	Ch.								(W/kg)	(W/kg)		(W/kg)		(W/kg)	
3700	3624.99	641666	NR Band n48, 40 MHz Bandwidth	DFT-S-OFDM	DFT-S-OFDM, QPSK, 50 RB, 56 RB Offset	Ant 4	N/A	back	0 mm	0.862	0.785	1.10	N/A	N/A	N/A	N/A
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Body 1.6 W/kg (mW/g) averaged over 1 gram						

12.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for 1g and <3.75 W/kg for 10g for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

13 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E4404B	Spectrum Analyzer	N/A	N/A	N/A	MY45113242
Agilent	N5182A	MXG Vector Signal Generator	11/17/2021	Annual	11/17/2022	US46240505
Agilent	8753ES	S-Parameter Vector Network Analyzer	4/14/2021	Annual	4/14/2022	US39170118
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343971
Anritsu	MA24106A	USB Power Sensor	2/25/2021	Annual	2/25/2022	1520503
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670623
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670633
Control Company	4353	Long Stem Thermometer	10/28/2020	Biennial	10/28/2022	200670635
Control Company	4040	Therm./ Clock/ Humidity Monitor	2/23/2021	Annual	2/23/2022	160574418
Insize	1108-150	Digital Caliper	1/17/2020	Biennial	1/17/2022	409193536
Keysight Technologies	N6705B	DC Power Analyzer	5/5/2021	Triennial	5/5/2024	MY53004059
Keysight Technologies	N9020A	MXA Signal Analyzer	3/26/2020	Biennial	3/26/2022	MY56470202
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	7/6/2021	Annual	7/6/2022	31634
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	9/15/2021	Annual	9/15/2022	2111
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Seekonk	TSF-100	Torque Wrench	7/8/2021	Annual	7/8/2022	47639-29
SPEAG	DAK-3.5	Dielectric Assessment Kit	7/15/2021	Annual	7/15/2022	1039
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	10/7/2021	Annual	10/7/2022	1045
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1237
SPEAG	D3500V2	3500 MHz SAR Dipole	6/9/2021	Triennial	6/9/2023	1126
SPEAG	D3700V2	3700 MHz SAR Dipole	6/9/2021	Triennial	6/9/2023	1097
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/11/2021	Annual	11/11/2022	1646
SPEAG	EX3DV4	SAR Probe	9/6/2021	Annual	9/6/2022	7674

*All equipment was used solely within its respective calibration period

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

14 MEASUREMENT UNCERTAINTIES

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c_i 1gm	c_i 10 gms	1gm u_i (± %)	10gms u_i (± %)	v_i
Measurement System									
Probe Calibration	E.2.1	7	N	1	1	1	7.0	7.0	∞
Axial Isotropy	E.2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E.2.2	1.3	N	1	0.7	0.7	0.9	0.9	∞
Boundary Effect	E.2.3	2	R	1.73	1	1	1.2	1.2	∞
Linearity	E.2.4	0.3	N	1	1	1	0.3	0.3	∞
System Detection Limits	E.2.4	0.25	R	1.73	1	1	0.1	0.1	∞
Modulation Response	E.2.5	4.8	R	1.73	1	1	2.8	2.8	∞
Readout Electronics	E.2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E.2.7	0.8	R	1.73	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.73	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E.6.1	3	R	1.73	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	3	R	1.73	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.73	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E.6.3	6.7	R	1.73	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	4	R	1.73	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E.4.2	3.12	N	1	1	1	3.1	3.1	35
Device Holder Uncertainty	E.4.1	1.67	N	1	1	1	1.7	1.7	5
Output Power Variation - SAR drift measurement	E.2.9	5	R	1.73	1	1	2.9	2.9	∞
SAR Scaling	E.6.5	0	R	1.73	1	1	0.0	0.0	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E.3.1	7.6	R	1.73	1.0	1.0	4.4	4.4	∞
Liquid Conductivity - measurement uncertainty	E.3.3	4.3	N	1	0.78	0.71	3.3	3.0	76
Liquid Permittivity - measurement uncertainty	E.3.3	4.2	N	1	0.23	0.26	1.0	1.1	75
Liquid Conductivity - Temperature Uncertainty	E.3.4	3.4	R	1.73	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Unceritainty	E.3.4	0.6	R	1.73	0.23	0.26	0.1	0.1	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Permittivity - deviation from target values	E.3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Combined Standard Uncertainty (k=1)			RSS				12.2	12.0	191
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				24.4	24.0	

The above measurement uncertainties are according to IEEE Std. 1528-2013

15 CONCLUSION

15.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Innovation, Science, and Economic Development Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

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