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SAR EVALUATION REPORT

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

Date of Testing:
06/17/2022 – 07/31/2022
Test Site/Location:
Element Washington DC LLC,
Morgan Hill, CA, USA
Document Serial No.:
1C2205090024-15.BCG (Rev 1)

FCC ID: **BCGA2759**

APPLICANT: **APPLE, INC.**

DUT Type: Tablet Device
Application Type: Certification
FCC Rule Part(s): CFR §2.1093
Models: A2759

Equipment Class	Band & Mode	Tx Frequency	SAR 1g Body (W/kg)
DTS	2.4 GHz WLAN	2412 - 2472 MHz	1.17
NII	U-NII-1	5180 - 5240 MHz	1.18
NII	U-NII-2A	5260 - 5320 MHz	N/A
NII	U-NII-2C	5500 - 5720 MHz	1.18
NII	U-NII-3	5745 - 5825 MHz	1.18
DSS/DTS	Bluetooth	2402 - 2480 MHz	1.18
NII	NB UNII-3	5733 - 5844	1.00
Simultaneous SAR per KDB 690783 D01v01r03:			1.56

Note: This revised Test Report supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

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 1.6 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

The SAR Tick is an initiative of the Mobile & Wireless Forum (MWF). While a product may be considered eligible, use of the SAR Tick logo requires an agreement with the MWF. Further details can be obtained by emailing: sartick@mwfai.info.

TABLE OF CONTENTS

1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
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
U-NII-5	Voice/Data	5955 - 6415 MHz
U-NII-6	Voice/Data	6435 - 6515 MHz
U-NII-7	Voice/Data	6535 - 6875 MHz
U-NII-8	Voice/Data	6895 - 7115 MHz
Bluetooth	Data	2402 - 2480 MHz
NB UNII-1	Data	5162 - 5245 MHz
NB UNII-3	Data	5733 - 5844 MHz

1.2 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.

1.2.1 Maximum WLAN Time-Averaged Output Power

Note: Targets for 802.11ax RU operations can be found in Appendix F.

Mode	IEEE 802.11 (Maximum in dBm) - Antenna WF8 Tolerance (+0/-3.00 dB)						
	Channel	SISO				MIMO	
		b	g	n	ax SU	g/n	ax SU
2.4 GHz WIFI 20 MHz Bandwidth	1	16.50	15.50	15.50	14.50	14.50	13.50
	2	16.50	16.50	16.50	16.50	16.50	16.50
	3	16.50	16.50	16.50	16.50	16.50	16.50
	4	16.50	16.50	16.50	16.50	16.50	16.50
	5	16.50	16.50	16.50	16.50	16.50	16.50
	6	16.50	16.50	16.50	16.50	16.50	16.50
	7	16.50	16.50	16.50	16.50	16.50	16.50
	8	16.50	16.50	16.50	16.50	16.50	16.50
	9	16.50	16.50	16.50	16.50	16.50	16.50
	10	16.50	16.50	16.50	16.50	16.50	16.50
	11	16.50	15.50	15.50	15.00	14.50	13.50
	12	16.50	14.50	14.50	13.00	12.00	11.00
	13	16.50	10.50	10.50	N/A	8.00	N/A

Note: In MIMO operations, each antenna transmits at maximum allowed powers as indicated above.

Mode	IEEE 802.11 (Maximum in dBm) - Antenna WF7 Tolerance (+0/-3.00 dB)						
	Channel	SISO				MIMO	
		b	g	n	ax SU	g/n	ax SU
2.4 GHz WIFI 20 MHz Bandwidth	1	15.00	15.00	15.00	14.50	14.50	13.50
	2	15.00	15.00	15.00	15.00	15.00	15.00
	3	15.00	15.00	15.00	15.00	15.00	15.00
	4	15.00	15.00	15.00	15.00	15.00	15.00
	5	15.00	15.00	15.00	15.00	15.00	15.00
	6	15.00	15.00	15.00	15.00	15.00	15.00
	7	15.00	15.00	15.00	15.00	15.00	15.00
	8	15.00	15.00	15.00	15.00	15.00	15.00
	9	15.00	15.00	15.00	15.00	15.00	15.00
	10	15.00	15.00	15.00	15.00	15.00	15.00
	11	15.00	15.00	15.50	15.00	14.50	13.50
	12	15.00	14.50	14.50	13.00	12.00	11.00
	13	15.00	10.50	10.50	N/A	8.00	N/A

Note: In MIMO operations, each antenna transmits at maximum allowed powers as indicated above.

Mode	Channel	IEEE 802.11 (Maximum in dBm) - Antenna WF5T Tolerance (+0/-3.00 dB)						
		SISO			MIMO CDD		MIMO SDM	
		a	n/ac	ax SU	a/n/ac	ax SU	n/ac	ax SU
5 GHz WIFI 20 MHz Bandwidth	36	17.50	17.50	17.50	17.00	16.50	17.00	16.50
	40	17.50	17.50	17.50	17.00	17.00	17.00	17.00
	44	17.50	17.50	17.50	17.00	17.00	17.00	17.00
	48	17.50	17.50	17.50	17.00	17.00	17.00	17.00
	52	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	56	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	60	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	64	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	100	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	104	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	108	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	112	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	116	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	120	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	124	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	128	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	132	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	136	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	140	15.50	15.50	14.00	14.00	13.00	14.00	13.00
	144	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	149	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	153	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	157	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	161	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	165	15.00	15.00	15.00	15.00	15.00	15.00	15.00
5 GHz WIFI 40 MHz Bandwidth	38	[redacted]	15.00	14.50	13.00	12.50	13.00	12.50
	46		17.50	17.50	17.50	17.50	17.50	17.50
	54		16.00	16.00	16.00	16.00	16.00	16.00
	62		15.00	15.00	14.00	12.50	14.00	12.50
	102		14.75	13.50	14.25	12.50	14.25	12.50
	110		15.50	15.50	15.50	15.50	15.50	15.50
	118		15.50	15.50	15.50	15.50	15.50	15.50
	126		15.50	15.50	15.50	15.50	15.50	15.50
	134		15.50	15.50	15.50	15.50	15.50	15.50
	142		15.50	15.50	15.50	15.50	15.50	15.50
	151		15.00	15.00	15.00	15.00	15.00	15.00
	159		15.00	15.00	15.00	15.00	15.00	15.00
5 GHz WIFI 80 MHz Bandwidth	42		14.00	13.00	12.00	11.00	12.00	11.00
	58		15.00	13.00	13.50	12.00	13.50	12.00
	106		13.00	12.25	12.00	11.00	12.00	11.00
	122		15.50	15.50	15.50	15.25	15.50	15.25
	138		15.50	15.50	15.50	15.50	15.50	15.50
	155		15.00	15.00	15.00	15.00	15.00	15.00
5GHz WIFI 160 Mhz Bandwidth	50		9.50	9.00	8.50	8.50	8.50	8.50
	114		8.00	8.00	7.50	7.00	7.50	7.00

Note: In MIMO operations, each antenna transmits at maximum allowed powers as indicated above. 802.11a supports up to 20MHz, 802.11n supports up to 40MHz, 802.11ac/ax support up to 160MHz

Mode	Channel	IEEE 802.11 (Maximum in dBm) - Antenna WF5B Tolerance (+0/-3.00 dB)						
		SISO			MIMO CDD		MIMO SDM	
		a	n/ac	ax SU	a/n/ac	ax SU	n/ac	ax SU
5 GHz WIFI 20 MHz Bandwidth	36	16.00	16.00	16.00	16.00	16.50	16.00	16.50
	40	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	44	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	48	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	52	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	56	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	60	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	64	15.50	15.50	15.50	15.50	15.50	15.50	15.50
	100	16.00	16.00	16.00	16.00	16.00	16.00	16.50
	104	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	108	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	112	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	116	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	120	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	124	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	128	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	132	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	136	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	140	16.00	16.00	14.00	14.00	13.00	14.00	13.00
	144	16.00	16.00	16.00	16.00	16.00	16.00	16.00
	149	16.50	16.50	16.50	16.50	16.50	16.50	16.50
	153	16.50	16.50	16.50	16.50	16.50	16.50	16.50
	157	16.50	16.50	16.50	16.50	16.50	16.50	16.50
	161	16.50	16.50	16.50	16.50	16.50	16.50	16.50
	165	16.50	16.50	16.50	16.50	16.50	16.50	16.50
5 GHz WIFI 40 MHz Bandwidth	38	[redacted]	15.00	14.50	13.00	12.50	13.00	12.50
	46		16.00	16.00	16.00	16.00	16.00	16.00
	54		15.50	15.50	15.50	15.50	15.50	15.50
	62		15.00	15.00	14.00	12.50	14.00	12.50
	102		14.75	13.50	14.25	12.50	14.25	12.50
	110		16.00	16.00	16.00	16.00	16.00	16.00
	118		16.00	16.00	16.00	16.00	16.00	16.00
	126		16.00	16.00	16.00	16.00	16.00	16.00
	134		16.00	16.00	16.00	16.00	16.00	16.00
	142		16.00	16.00	16.00	16.00	16.00	16.00
	151		16.50	16.50	16.50	16.50	16.50	16.50
	159		16.50	16.50	16.50	16.50	16.50	16.50
5 GHz WIFI 80 MHz Bandwidth	42		14.00	13.00	12.00	11.00	12.00	11.00
	58		15.00	13.00	13.50	12.00	13.50	12.00
	106		13.00	11.50	12.00	11.00	12.00	11.00
	122		16.00	16.00	16.00	15.25	16.00	15.25
	138		16.00	16.00	16.00	16.00	16.00	16.00
	155		16.50	16.50	16.50	16.00	16.50	16.00
5GHz WIFI 160 Mhz Bandwidth	50		9.50	9.00	8.50	8.50	8.50	8.50
	114		8.00	8.00	7.50	7.00	7.50	7.00

Note: In MIMO operations, each antenna transmits at maximum allowed powers as indicated above. 802.11a supports up to 20MHz, 802.11n supports up to 40MHz, 802.11ac/ax support up to 160MHz

1.2.2 Bluetooth Maximum Output Power

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF8	Modulated Average (iPA) - Single Tx Chain (dBm) - Antenna WF8
Bluetooth BDR/LE	Maximum	**17.50**	**12.00**
	Nominal	**16.00**	**10.50**
Bluetooth EDR	Maximum	**15.00**	**8.00**
	Nominal	**13.50**	**6.50**
Bluetooth HDR	Maximum	**12.00**	**5.50**
	Nominal	**10.50**	**4.00**

Mode / Band		Modulated Average (ePA) - TxBF (dBm) - Antenna WF8	Modulated Average (iPA) - TxBF (dBm) - Antenna WF8
Bluetooth BDR/LE	Maximum	**17.00**	**12.00**
	Nominal	**15.50**	**10.50**
Bluetooth EDR	Maximum	**13.50**	**8.00**
	Nominal	**12.00**	**6.50**
Bluetooth HDR	Maximum	**12.00**	**5.50**
	Nominal	**10.50**	**4.00**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF7	Modulated Average (iPA) - Single Tx Chain (dBm) - Antenna WF7
Bluetooth BDR/LE	Maximum	**16.00**	**12.50**
	Nominal	**14.50**	**11.00**
Bluetooth EDR	Maximum	**15.00**	**8.50**
	Nominal	**13.50**	**7.00**
Bluetooth HDR	Maximum	**12.00**	**6.00**
	Nominal	**10.50**	**4.50**

Mode / Band		Modulated Average - (ePA) TxBF (dBm) - Antenna WF7	Modulated Average (iPA) - TxBF (dBm) - Antenna WF7
Bluetooth BDR/LE	Maximum	**16.00**	**12.50**
	Nominal	**14.50**	**11.00**
Bluetooth EDR	Maximum	**13.50**	**8.50**
	Nominal	**12.00**	**7.00**
Bluetooth HDR	Maximum	**12.00**	**6.00**
	Nominal	**10.50**	**4.50**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

1.2.3 NB UNII Maximum Output Power

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF5T
NB UNII-1 BDR	Maximum	**10.00**
	Nominal	**8.50**
NB UNII-1 HDR	Maximum	**12.00**
	Nominal	**10.50**

Mode / Band		Modulated Average (ePA) - TxBF (dBm) - Antenna WF5T
NB UNII-1 BDR	Maximum	**7.00**
	Nominal	**5.50**
NB UNII-1 HDR	Maximum	**9.00**
	Nominal	**7.50**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF5B
NB UNII-1 BDR	Maximum	**10.00**
	Nominal	**8.50**
NB UNII-1 HDR	Maximum	**12.00**
	Nominal	**10.50**

Mode / Band		Modulated Average (ePA) - TxBF (dBm) - Antenna WF5B
NB UNII-1 BDR	Maximum	**7.00**
	Nominal	**5.50**
NB UNII-1 HDR	Maximum	**9.00**
	Nominal	**7.50**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF5T
NB UNII-3 BDR	Maximum	**16.00**
	Nominal	**14.50**
NB UNII-3 HDR	Maximum	**13.50**
	Nominal	**12.00**

Mode / Band		Modulated Average (ePA) - TxBF (dBm) - Antenna WF5T
NB UNII-3 BDR	Maximum	**16.00**
	Nominal	**14.50**
NB UNII-3 HDR	Maximum	**13.50**
	Nominal	**12.00**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

Mode / Band		Modulated Average (ePA) - Single Tx Chain (dBm) - Antenna WF5B
NB UNII-3 BDR	Maximum	**17.50**
	Nominal	**16.00**
NB UNII-3 HDR	Maximum	**14.50**
	Nominal	**13.00**

Mode / Band		Modulated Average (ePA) - TxBF (dBm) - Antenna WF5B
NB UNII-3 BDR	Maximum	**17.50**
	Nominal	**16.00**
NB UNII-3 HDR	Maximum	**14.50**
	Nominal	**13.00**

Note: In TxBF operations, each antenna transmits at maximum allowed powers as indicated above.

1.3 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.

Table 1-1
Device Edges/Sides for SAR Testing

Device Sides/Edges for SAR Testing						
Mode	Back	Front	Top	Bottom	Right	Left
2.4 GHz WLAN Ant WF8	Yes	No	Yes	No	Yes	No
2.4 GHz WLAN Ant WF7	Yes	No	Yes	No	No	Yes
5 GHz WLAN Ant WF5T	Yes	No	No	No	Yes	No
5 GHz WLAN Ant WF5B	Yes	No	No	No	Yes	No
Bluetooth Ant WF8	Yes	No	Yes	No	Yes	No
Bluetooth Ant WF7	Yes	No	Yes	No	No	Yes
NB UNII Ant WF5T	Yes	No	No	No	Yes	No
NB UNII Ant WF5B	Yes	No	No	No	Yes	No

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.

1.4 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 1-2
Simultaneous Transmission Scenarios

No.	Capable Transmit Configuration
1	2.4 GHz WiFi MIMO
2	2.4 GHz Bluetooth TxBF
3	5GHz WiFi MIMO
4	5GHz NB UNII TxBF
5	6 GHz WiFi MIMO
6	2.4 GHz Bluetooth Antenna WF7 + 2.4 GHz WiFi Antenna WF8
7	2.4 GHz Bluetooth + 5 GHz WIFI
8	2.4 GHz Bluetooth + 5 GHz WIFI MIMO
9	2.4 GHz Bluetooth TxBF + 5 GHz WiFi
10	2.4 GHz Bluetooth TxBF + 5 GHz WiFi MIMO
11	2.4 GHz Bluetooth + 6 GHz WiFi
12	2.4 GHz Bluetooth + 6 GHz WiFi MIMO
13	2.4 GHz Bluetooth TxBF + 6 GHz WiFi
14	2.4 GHz Bluetooth TxBF + 6 GHz WiFi MIMO
15	5 GHz NB UNII + 2.4 GHz WiFi
16	5 GHz NB UNII + 2.4 GHz WiFi MIMO
17	5 GHz NB UNII TxBF + 2.4 GHz WiFi
18	5 GHz NB UNII TxBF + 2.4 GHz WiFi MIMO

1. 2.4GHz WIFI and 2.4 GHz Bluetooth can transmit simultaneously on separate antennas, Specific 2.4 GHz WIFI Antenna that can only transmit simultaneously with 2.4 GHz Bluetooth is listed in the above table. In this scenario, Wi-Fi max power will not exceed minimum of (13.5dBm, SAR max cap, Reg max cap) power. Additionally, in disconnected mode, BT will be using iPA only.
2. 5 GHz WLAN, 5 GHz NB UNII share the same antenna path and cannot transmit simultaneously on any antenna (Antenna WF5T, Antenna WF5B).
3. 2.4 GHz WLAN and 5 GHz WLAN cannot transmit simultaneously.
4. This device supports 2x2 MIMO Tx for WLAN 802.11a/g/n/ac/ax. 802.11a/g/n/ac/ax supports CDD and 802.11n/ac/ax additionally supports SDM. Each WLAN antenna can transmit independently or together when operating with MIMO.
5. This device supports VOWIFI.
6. No other combinations of antennas and modes are supported.

1.5 Miscellaneous SAR Test Considerations

(A) WIFI/BT

Based on the maximum allowed power for the respective antennas, 5GHz WLAN U-NII-1 was evaluated for Antenna WF5T and 5GHz WLAN U-NII-2A was evaluated for Antenna WF5B. Additional testing for 5GHz WLAN U-NII-2A Antenna WF5T and for 5GHz WLAN U-NII-1 Antenna WF5B SAR was not required since all reported SAR was less than 1.2 W/kg per FCC KDB Publication 248227 D01v02r02.

The WLAN/Bluetooth chipset in this device is produced by two different suppliers. The electrically identical modules are manufactured with the identical mechanical structure to meet the same specifications and functions. Two device variants are referenced as Variant 1 and Variant 2 in this report. The worst case configurations were evaluated for both Variant 1 and Variant 2.

This device supports channel 1-13 for 2.4 GHz WLAN. However, because channel 12/13 targets are not higher than that of channels 1-11, channels 1, 6, and 11 were considered for SAR testing per FCC KDB 248227 D01V02r02.

This device supports IEEE 802.11ac with the following features:

a) Up to 160 MHz Bandwidth only for 5/6 GHz
b) 2 Tx antenna output
c) 256 QAM is supported
d) TDWR and Band gap channels are supported

This device supports IEEE 802.11ax with the following features:

a) Up to 160 MHz Bandwidth only for 5/6 GHz
b) Up to 20 MHz Bandwidth only for 2.4 GHz
c) 2Tx antenna output
d) Up to 1024 QAM is supported
e) TDWR and Band gap channels are supported for 5/6 GHz
f) MU-MIMO UL Operations are not supported

1.6 Guidance Applied

Per April 2019 TCB Workshop Notes, SAR testing was not required for 802.11ax when applying the initial test configuration procedures of KDB 248227, with 802.11ax considered a higher order 802.11 mode.

- IEEE 1528-2013
- FCC KDB Publication 248227 D01v02r02 (SAR Considerations for 802.11 Devices)
- 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)
- April 2019 TCB Workshop Notes (IEEE 802.11ax)

1.7 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 9.

2 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.

2.1 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 2-1).

Equation 2-1
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]

3 DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

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

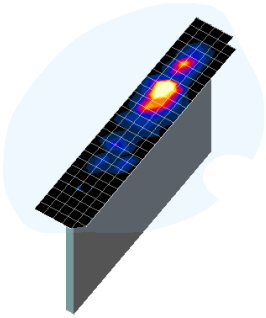


Figure 3-1
Sample SAR Area Scan

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 3-1) 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 3-1) 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 3-1. 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 3-1
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*Δz_{zoom}(n-1)	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	≤ 1.5*Δz_{zoom}(n-1)	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	≤ 1.5*Δz_{zoom}(n-1)	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	≤ 1.5*Δz_{zoom}(n-1)	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	≤ 1.5*Δz_{zoom}(n-1)	≥ 22

*Also compliant to IEEE 1528-2013 Table 6

4 TEST CONFIGURATION POSITIONS

4.1 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.

4.2 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.

5 RF EXPOSURE LIMITS

5.1 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.

5.2 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 5-1
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.

6 FCC MEASUREMENT PROCEDURES

6.1 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.

6.2 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v02r02 for more details.

6.2.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

6.2.2 U-NII-1 and U-NII-2A

For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, SAR measurement using OFDM SAR test procedures is not required for U-NII-1 unless the highest reported SAR for U-NII-2A is > 1.2 W/kg. When different maximum output powers are specified for the bands, SAR measurement for the U-NII band with the lower maximum output power is not required unless the highest reported SAR for the U-NII band with the higher maximum output power, adjusted by the ratio of lower to higher specified maximum output power for the two bands, is > 1.2 W/kg. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.2.3 U-NII-2C and U-NII-3

The frequency range covered by U-NII-2C and U-NII-3 is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification. Unless band gap channels are permanently disabled, SAR must be considered for these channels. Each band is tested independently according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

6.2.4 2.4 GHz SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2) When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

2.4 GHz 802.11 g/n/ax OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test Configuration Procedures should be followed. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.2.5 OFDM Transmission Mode and SAR Test Channel Selection

When the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a, 802.11n and 802.11ac or 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. Per April 2019 TCB Workshop guidance, 802.11ax was considered the highest order 802.11 mode. When the maximum output powers are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.2.6 Initial Test Configuration Procedure

For OFDM, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order IEEE 802.11 mode. The channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements (See Section 6.2.5). When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.2.7 Subsequent Test Configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is ≤ 1.2 W/kg, no additional SAR tests for the subsequent test configurations are required. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.2.8 MIMO SAR considerations

Per KDB Publication 248227 D01v02r02, the simultaneous SAR provisions in KDB Publication 447498 D01v06 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1g single transmission chain SAR measurements is <1.6 W/kg, no additional SAR measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

7 RF CONDUCTED POWERS

7.1 WLAN Conducted Powers

Table 7-1
2.4 GHz WLAN Maximum Average RF Power – Ant WF8, Variant 1

2.4GHz Conducted Power [dBm]					
Freq [MHz]	Channel	IEEE Transmission Mode			
		802.11b	802.11g	802.11n	802.11ax SU
		Average	Average	Average	Average
2412	1	15.00	14.61	14.58	13.47
2417	2	N/A	15.43	15.22	15.12
2437	6	15.21	15.21	15.23	15.41
2457	10	N/A	15.30	15.23	15.26
2462	11	15.27	14.93	14.91	14.12

Table 7-2
2.4 GHz WLAN Maximum Average RF Power – Ant WF8, Variant 2

2.4GHz Conducted Power [dBm]					
Freq [MHz]	Channel	IEEE Transmission Mode			
		802.11b	802.11g	802.11n	802.11ax
		Average	Average	Average	Average
2412	1	14.96	14.53	14.45	13.52
2417	2	N/A	15.45	15.43	15.43
2437	6	15.07	15.35	15.40	15.57
2457	10	N/A	15.50	15.47	15.46
2462	11	15.08	14.46	14.53	14.32

Table 7-3
2.4 GHz WLAN Maximum Average RF Power – Ant WF7, Variant 1

2.4GHz Conducted Power [dBm]					
Freq [MHz]	Channel	IEEE Transmission Mode			
		802.11b	802.11g	802.11n	802.11ax SU
		Average	Average	Average	Average
2412	1	14.07	13.82	14.00	N/A
2417	2	N/A	N/A	N/A	14.09
2437	6	14.02	14.01	14.07	13.87
2462	11	13.92	13.90	13.87	13.80

Table 7-4
2.4 GHz WLAN Maximum Average RF Power – Ant WF7, Variant 2

2.4GHz Conducted Power [dBm]					
Freq [MHz]	Channel	IEEE Transmission Mode			
		802.11b	802.11g	802.11n	802.11ax
		Average	Average	Average	Average
2412	1	13.89	13.92	13.94	N/A
2417	2	N/A	N/A	N/A	13.98
2437	6	14.04	14.04	14.01	14.03
2462	11	14.00	14.03	14.04	14.06

Table 7-5
5 GHz WLAN Maximum Average RF Power – Ant WF5T, Variant 1

5GHz (40MHz) Conducted Power [dBm]				
Freq [MHz]	Channel	IEEE Transmission Mode		
		802.11n	802.11ac	802.11ax
		Average	Average	Average
5190	38	13.05	13.77	13.59
5230	46	16.74	16.46	16.52
5270	54	14.99	14.97	15.21
5310	62	14.10	14.43	14.35

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	IEEE Transmission Mode	
		802.11ac	802.11ax
		Average	Average
5530	106	11.66	10.68
5610	122	14.51	14.59
5690	138	14.53	14.56
5775	155	14.02	14.17

Table 7-6
5 GHz WLAN Maximum Average RF Power – Ant WF5T, Variant 2

5GHz (40MHz) Conducted Power [dBm]				
Freq [MHz]	Channel	IEEE Transmission Mode		
		802.11n	802.11ac	802.11ax
		Average	Average	Average
5190	38	13.05	13.47	13.41
5230	46	16.57	16.84	16.55
5270	54	14.96	14.92	15.22
5310	62	14.09	14.47	14.28

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	IEEE Transmission Mode	
		802.11ac	802.11ax
		Average	Average
5530	106	11.54	10.43
5610	122	14.58	14.66
5690	138	14.68	14.61
5775	155	14.05	14.06

Table 7-7
5 GHz WLAN Maximum Average RF Power – Ant WF5B, Variant 1

5GHz (40MHz) Conducted Power [dBm]				
Freq [MHz]	Channel	IEEE Transmission Mode		
		802.11n		802.11ax
		Average	Average	Average
5190	38	13.04	13.45	13.46
5230	46	15.10	15.68	15.14
5270	54	14.60	15.41	14.32
5310	62	14.03	14.75	14.23

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	IEEE Transmission Mode	
		802.11ac	802.11ax
		Average	Average
5530	106	11.56	10.29
5610	122	15.52	15.14
5690	138	15.60	15.17
5775	155	15.90	15.58

Table 7-8
5 GHz WLAN Maximum Average RF Power – Ant WF5B, Variant 2

5GHz (40MHz) Conducted Power [dBm]				
Freq [MHz]	Channel	IEEE Transmission Mode		
		802.11n	802.11ac	802.11ax
		Average	Average	Average
5190	38	13.01	13.42	13.32
5230	46	15.05	15.20	15.23
5270	54	14.64	14.92	14.61
5310	62	13.98	14.43	14.30

5GHz (80MHz) Conducted Power [dBm]			
Freq [MHz]	Channel	IEEE Transmission Mode	
		802.11ac	802.11ax
		Average	Average
5530	106	11.45	10.34
5610	122	15.41	15.07
5690	138	15.59	15.03
5775	155	15.86	15.71

Conducted powers were measured for each Mode/Band and applied condition. All conducted power measurements were verified to be within tolerance.

7.2 Notes for WLAN

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission modes with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.
- The WLAN chipset in this device is produced by two different suppliers. The electrically identical modules are manufactured with the identical mechanical structure to meet the same specifications and functions.
- Two device variants are referenced as Variant 1 and Variant 2 in this report.
- WLAN SAR worst case configuration was spot checked on Variant 1 and Variant 2.

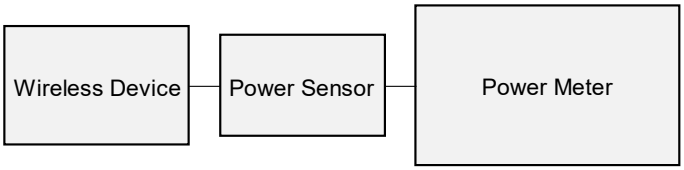


Figure 7-1
Power Measurement Setup

7.3 Bluetooth Maximum Conducted Powers

Table 7-9
Bluetooth Maximum Average RF Power – Ant WF8, Variant 1

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	16.90	48.978
2441	GFSK	1.0	39	16.44	44.055
2480	GFSK	1.0	78	16.57	45.394

Table 7-10
Bluetooth Maximum Average RF Power – Ant WF8, Variant 2

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	16.30	42.658
2441	GFSK	1.0	39	16.28	42.462
2480	GFSK	1.0	78	16.07	40.458

Table 7-11
Bluetooth Maximum Average RF Power – Ant WF7, Variant 1

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	15.28	33.729
2441	GFSK	1.0	39	14.78	30.061
2480	GFSK	1.0	78	14.84	30.479

Table 7-12
Bluetooth Maximum Average RF Power – Ant WF7, Variant 2

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	15.61	36.392
2441	GFSK	1.0	39	15.58	36.141
2480	GFSK	1.0	78	15.42	34.834

Table 7-13
NB UNII Maximum Average RF Power – Ant WF5T, Variant 1

`	Band	Frequency	Channel	Average
HDR	UNII1	5162	Low	11.1
		5204	Middle	11.17
		5245	High	11.2
BDR	UNII3	5733	Low	15.06
		5789	Middle	15.18
		5844	High	15.11

Table 7-14
NB UNII Maximum Average RF Power – Ant WF5T, Variant 2

Type	Band	Frequency	Channel	Average
HDR	UNII1	5162	Low	11.19
		5204	Middle	11.15
		5245	High	11.21
BDR	UNII3	5733	Low	15.07
		5789	Middle	15.21
		5844	High	15.35

Table 7-15
NB UNII Maximum Average RF Power – Ant WF5B, Variant 1

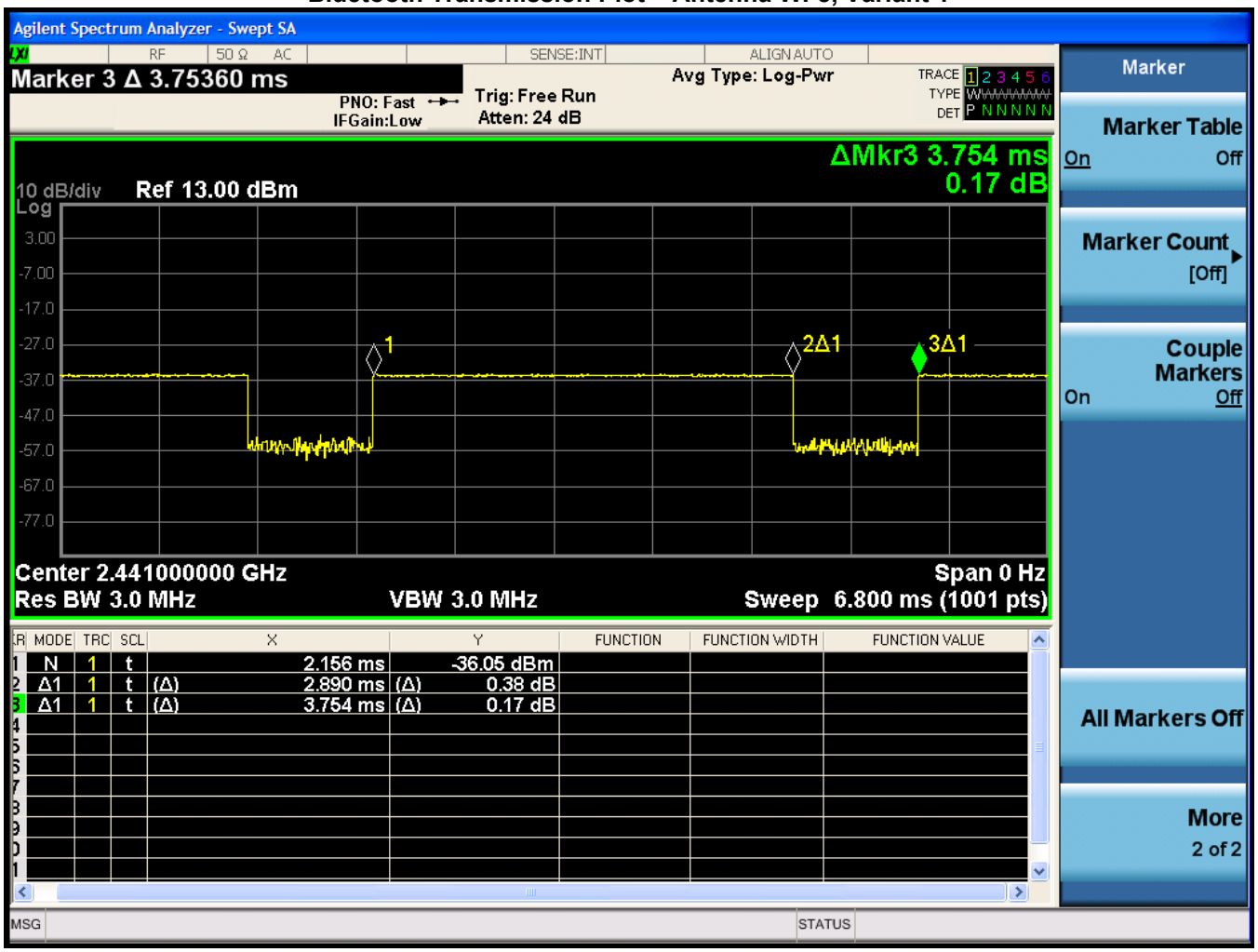
Type	Band	Frequency	Channel	Average
HDR	UNII1	5162	Low	11.1
		5204	Middle	11.29
		5245	High	11.12
BDR	UNII3	5733	Low	15.9
		5789	Middle	16.73
		5844	High	16.66

Table 7-16
NB UNII Maximum Average RF Power – Ant WF5B, Variant 2

Type	Band	Frequency	Channel	Average
HDR	UNII1	5162	Low	10.78
		5204	Middle	11.06
		5245	High	10.81
BDR	UNII3	5733	Low	15.78
		5789	Middle	16.94
		5844	High	16.68

7.4 Bluetooth Duty Cycle Plots

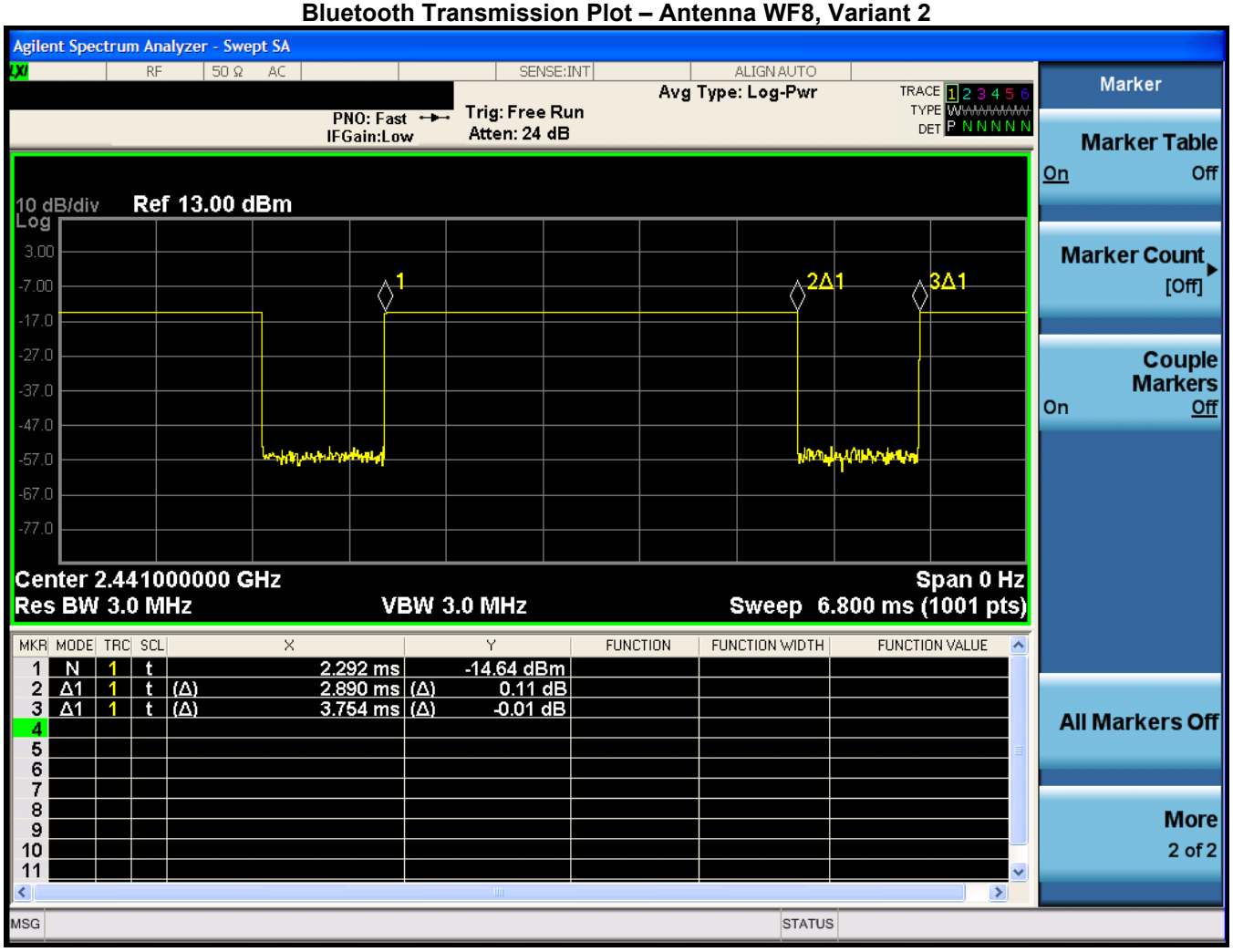
Figure 7-2
Bluetooth Transmission Plot – Antenna WF8, Variant 1



Equation 7-1
Bluetooth Duty Cycle Calculation – Antenna WF8, Variant 1

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.890\ ms}{3.754\ ms} * 100\% = 77\%$$

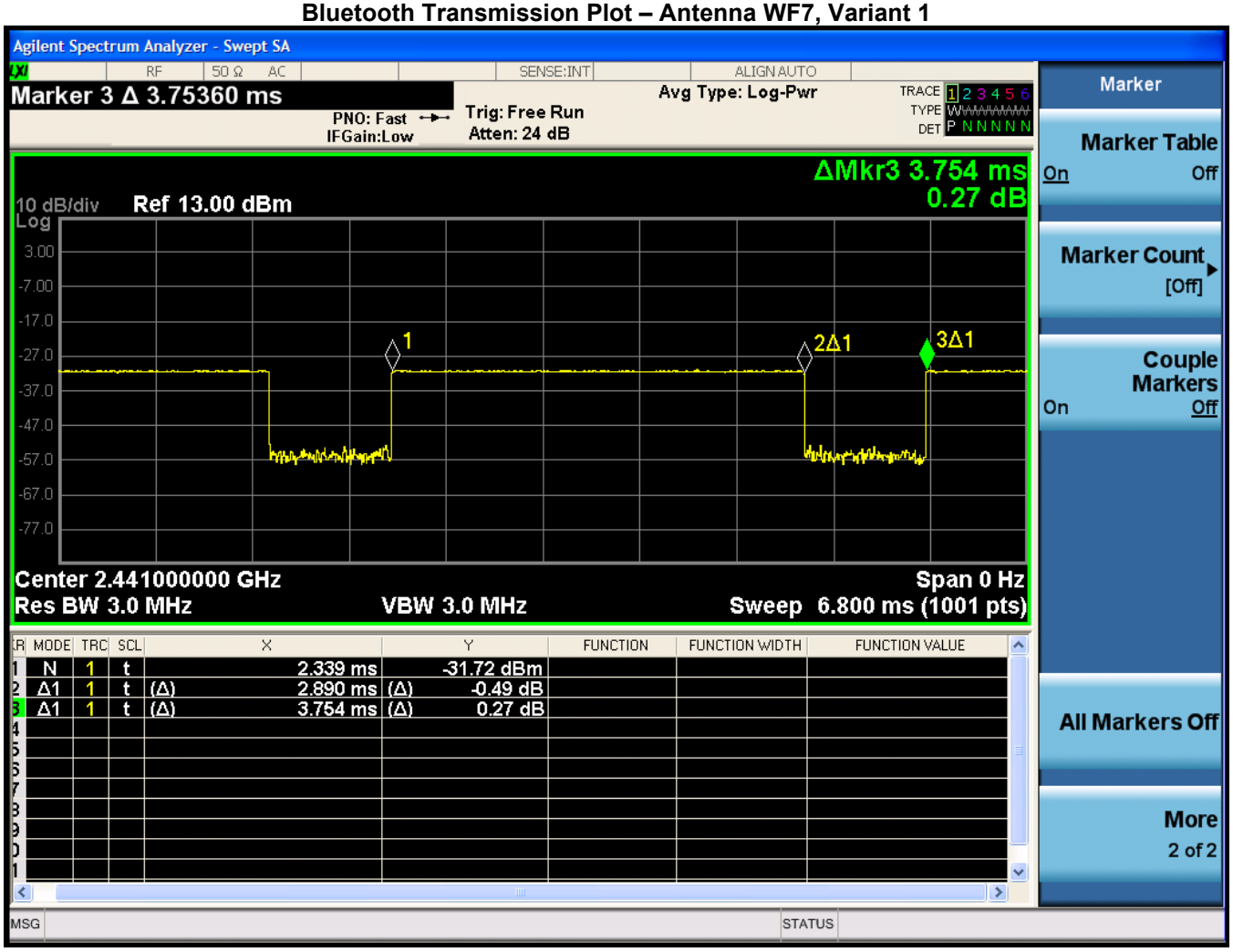
Figure 7-3
Bluetooth Transmission Plot – Antenna WF8, Variant 2



Equation 7-2
Bluetooth Duty Cycle Calculation – Antenna WF8, Variant 2

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.890\ ms}{3.754\ ms} * 100\% = 77\%$$

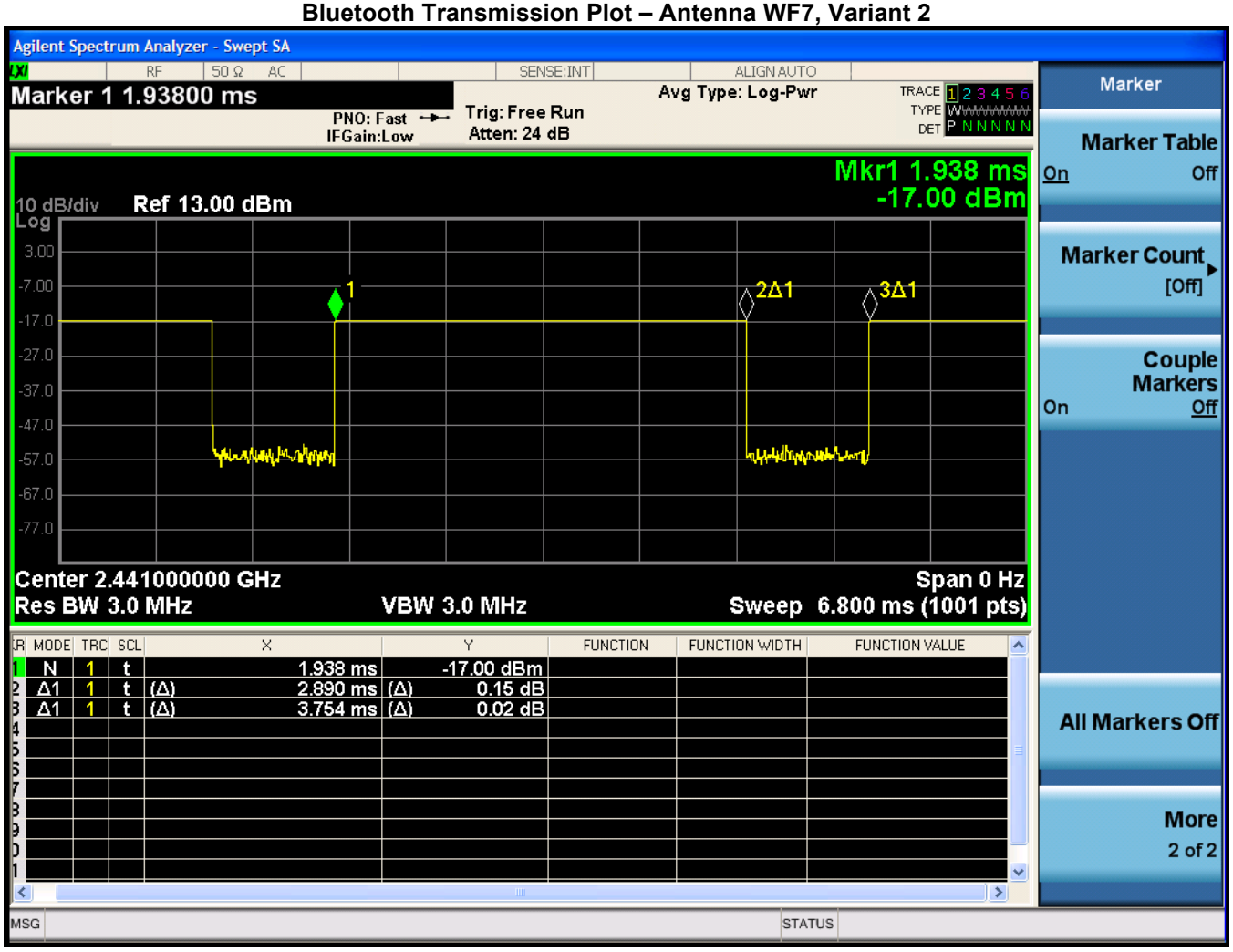
Figure 7-4
Bluetooth Transmission Plot – Antenna WF7, Variant 1



Equation 7-3
Bluetooth Duty Cycle Calculation – Antenna WF7, Variant 1

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.890\ ms}{3.754\ ms} * 100\% = 77\%$$

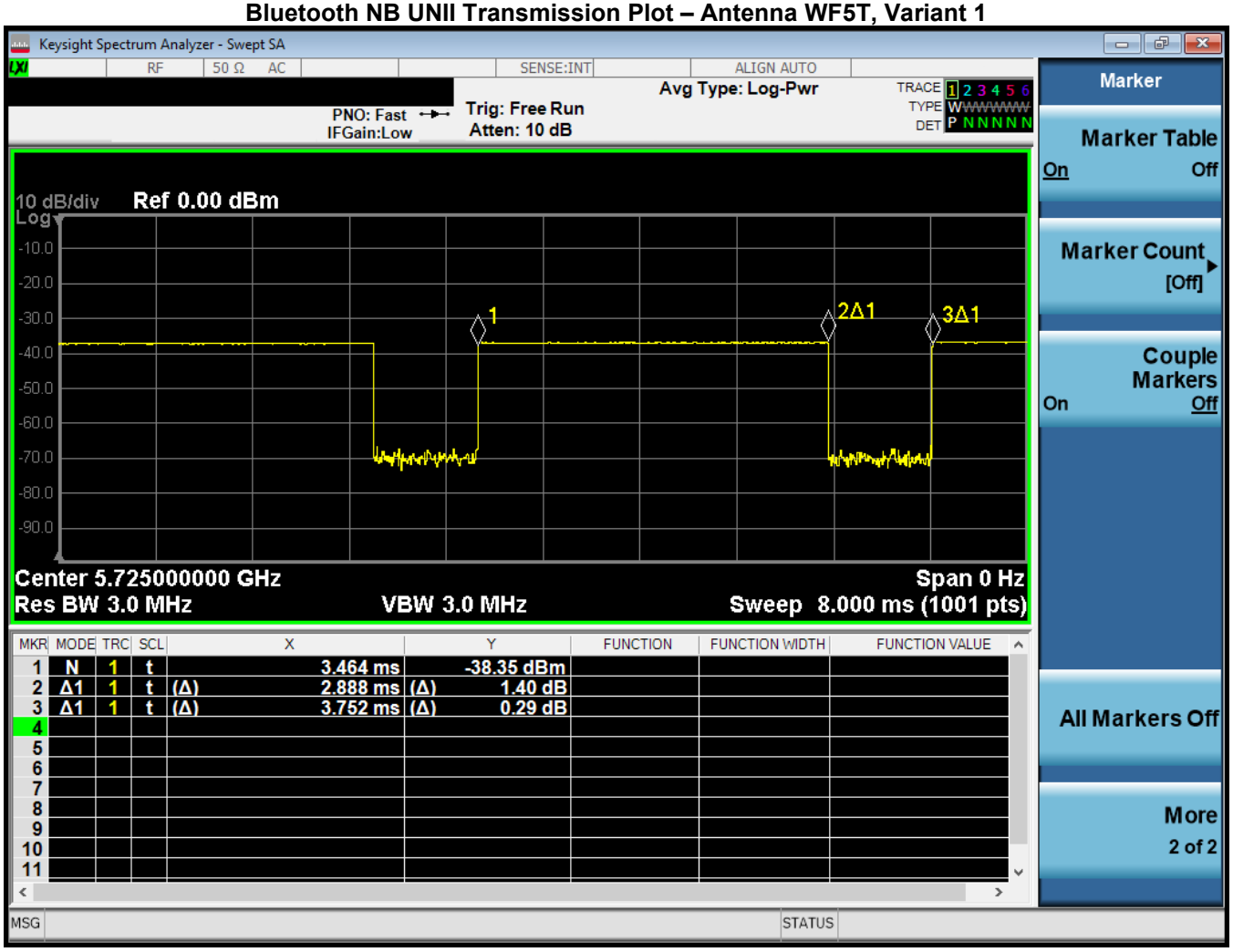
Figure 7-5
Bluetooth Transmission Plot – Antenna WF7, Variant 2



Equation 7-4
Bluetooth Duty Cycle Calculation – Antenna WF7, Variant 2

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.890\ ms}{3.754\ ms} * 100\% = 77\%$$

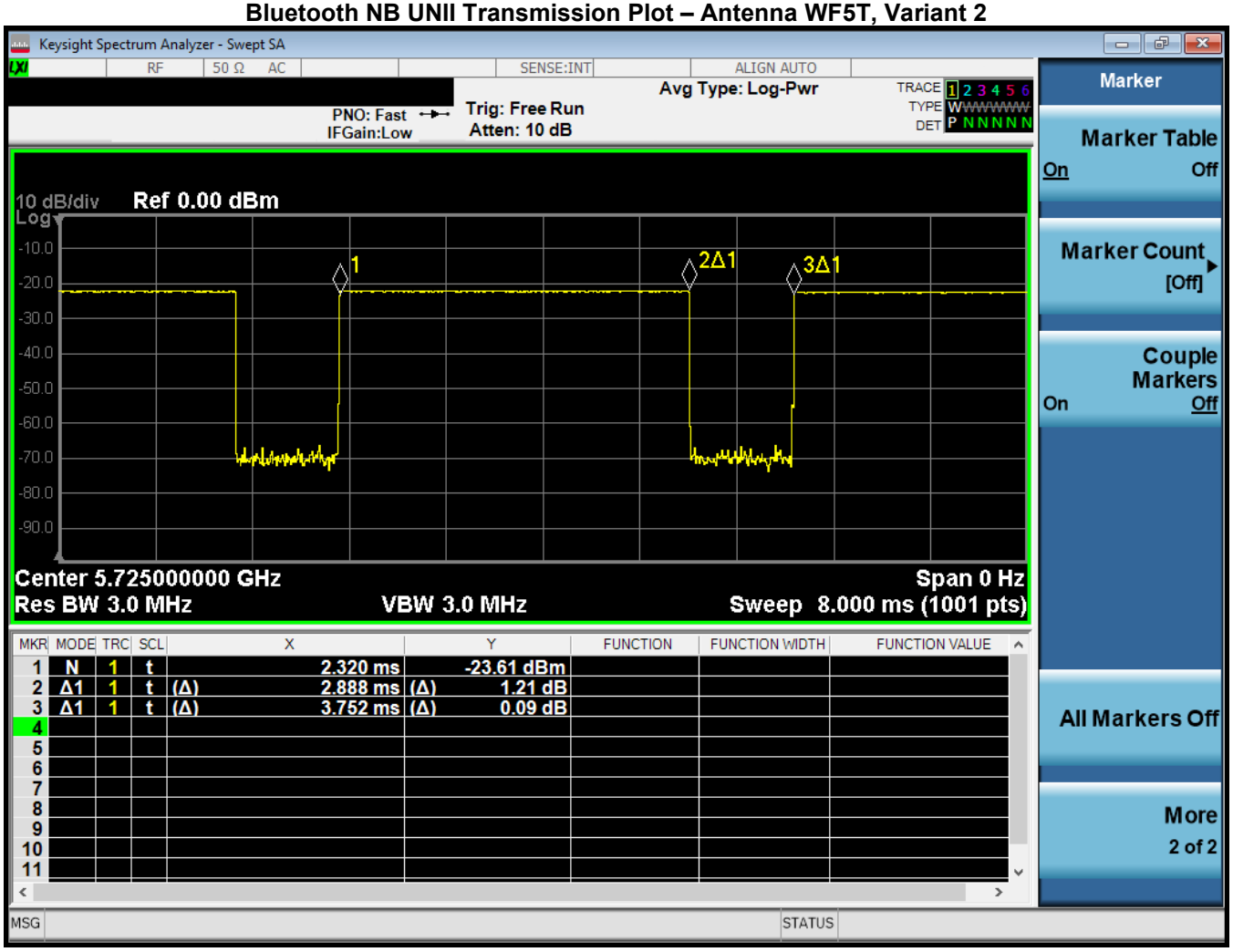
Figure 7-6
Bluetooth NB UNII Transmission Plot – Antenna WF5T, Variant 1



Equation 7-5
Bluetooth NB UNII Duty Cycle Calculation – Antenna WF5T, Variant 1

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.888\ ms}{3.752\ ms} * 100\% = 77\%$$

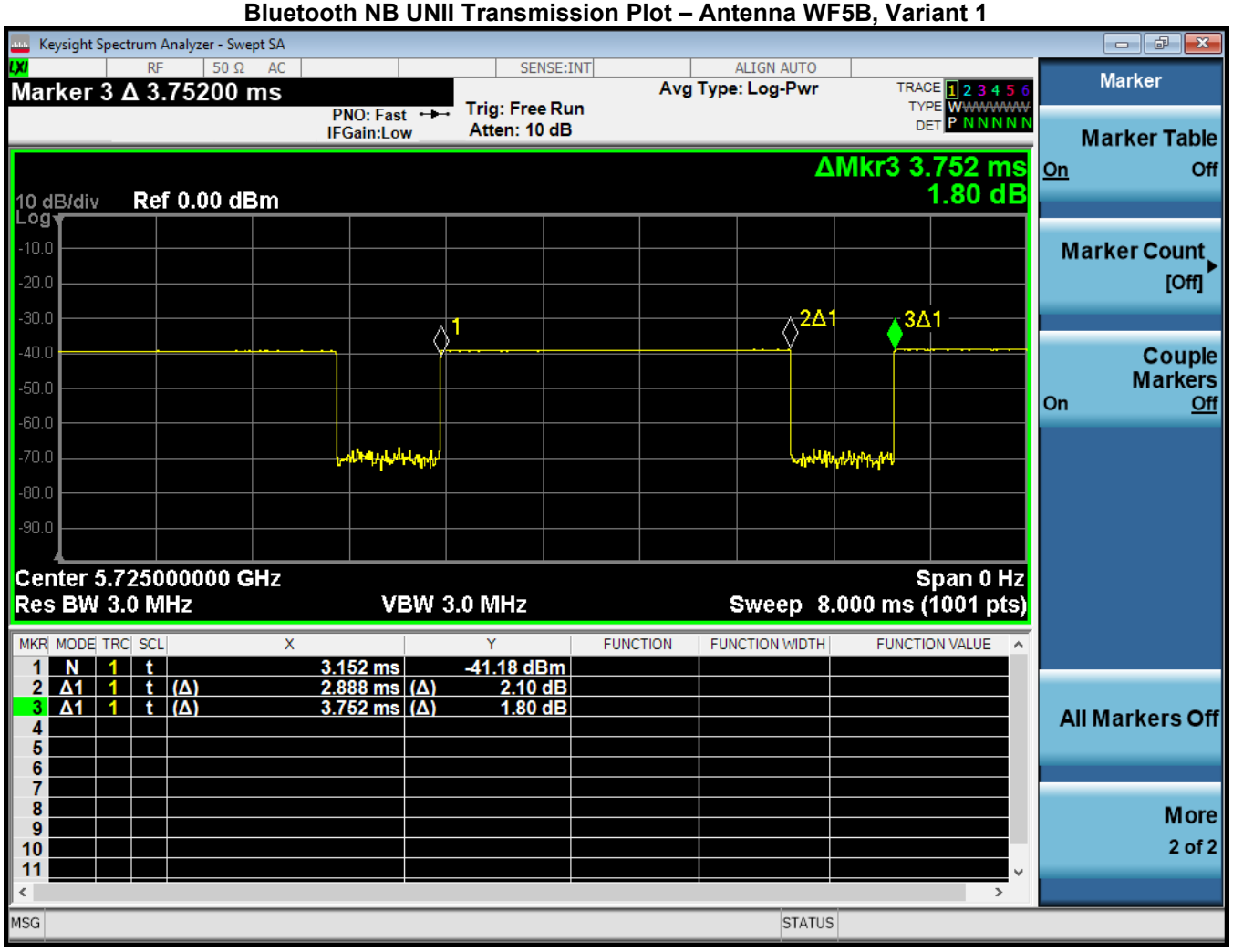
Figure 7-7
Bluetooth NB UNII Transmission Plot – Antenna WF5T, Variant 2



Equation 7-6
Bluetooth NB UNII Duty Cycle Calculation – Antenna WF5T, Variant 2

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.888\ ms}{3.752\ ms} * 100\% = 77\%$$

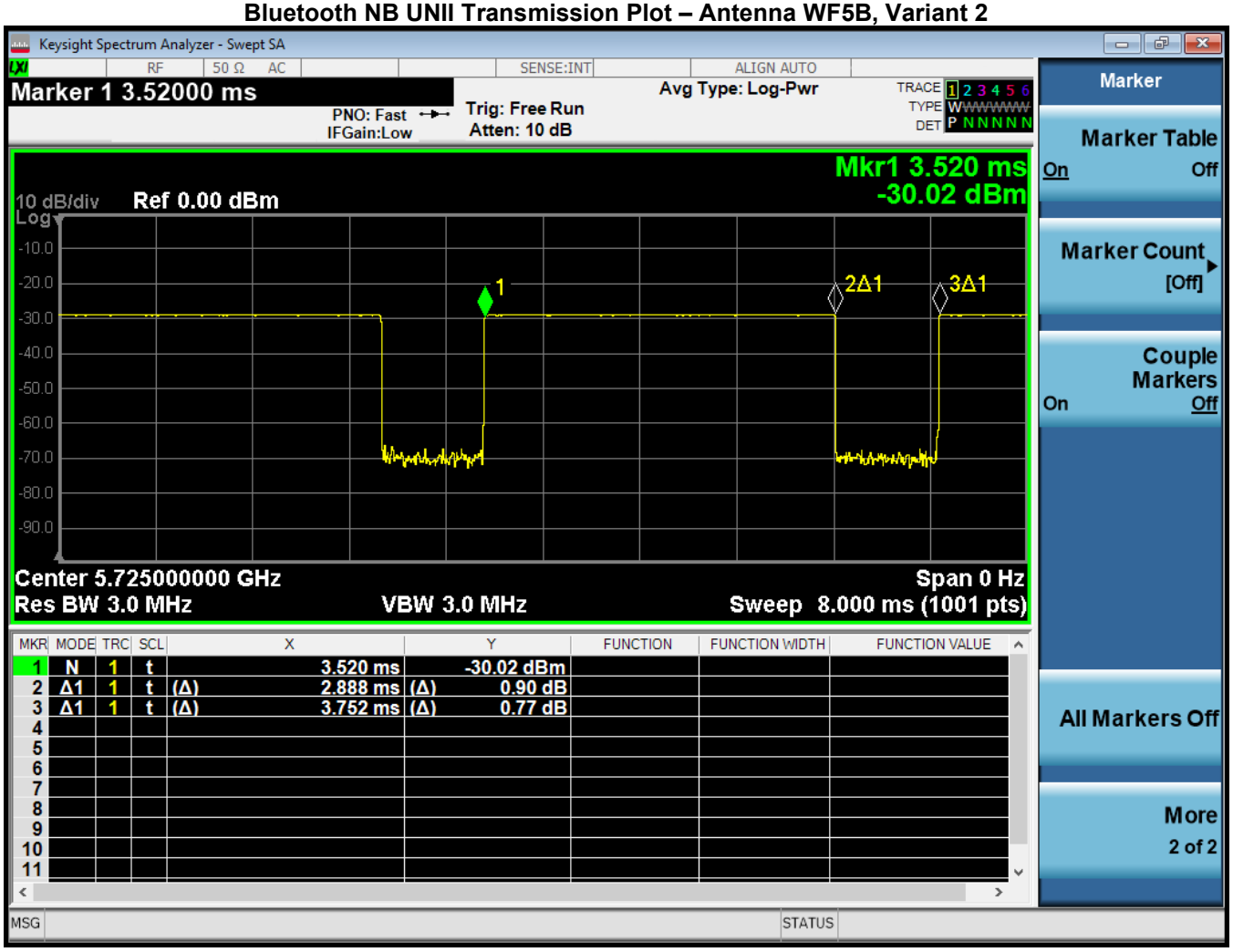
Figure 7-8
Bluetooth NB UNII Transmission Plot – Antenna WF5B, Variant 1



Equation 7-7
Bluetooth NB UNII Duty Cycle Calculation – Antenna WF5B, Variant 1

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.888\ ms}{3.752\ ms} * 100\% = 77\%$$

Figure 7-9
Bluetooth NB UNII Transmission Plot – Antenna WF5B, Variant 2



Equation 7-8
Bluetooth NB UNII Duty Cycle Calculation – Antenna WF5B, Variant 2

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{2.888\ ms}{3.752\ ms} * 100\% = 77\%$$

7.5 Notes for Bluetooth

- The Bluetooth chipset in this device is produced by two different suppliers. The electrically identical modules are manufactured with the identical mechanical structure to meet the same specifications and functions. Two device variants are referenced as Variant 1 and Variant 2 in this report.
- Bluetooth SAR worst case configuration was spot checked on Variant 1 and Variant 2.
- Full power measurements were performed for Variant 1 and Variant 2 per FCC KDB Procedures 248227.

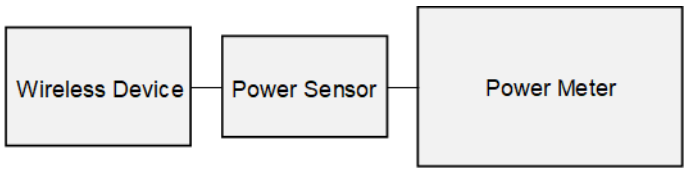


Figure 7-10
Power Measurement Setup

8 SYSTEM VERIFICATION

8.1 Tissue Verification

Table 8-1
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
06/17/2022	2450 Head	20.8	2300	1.652	40.058	1.670	39.500	-1.08%	1.41%
			2310	1.659	40.045	1.679	39.480	-1.19%	1.43%
			2320	1.666	40.030	1.687	39.460	-1.24%	1.44%
			2400	1.728	39.952	1.756	39.289	-1.59%	1.69%
			2450	1.769	39.897	1.800	39.200	-1.72%	1.78%
			2480	1.792	39.861	1.833	39.162	-2.24%	1.78%
			2500	1.808	39.831	1.855	39.136	-2.53%	1.78%
			2510	1.816	39.817	1.866	39.123	-2.68%	1.77%
			2535	1.837	39.787	1.893	39.092	-2.96%	1.78%
			2550	1.850	39.768	1.909	39.073	-3.09%	1.78%
			2560	1.858	39.752	1.920	39.060	-3.23%	1.77%
			2600	1.891	39.692	1.964	39.009	-3.72%	1.75%
			2650	1.932	39.613	2.018	38.945	-4.26%	1.72%
			2680	1.955	39.572	2.051	38.907	-4.68%	1.71%
			2700	1.970	39.533	2.073	38.882	-4.97%	1.67%
06/20/2022	2450 Head	24.8	2300	1.667	40.122	1.670	39.500	-0.18%	1.57%
			2310	1.679	40.086	1.679	39.480	0.00%	1.53%
			2320	1.690	40.046	1.687	39.460	0.18%	1.49%
			2400	1.783	39.718	1.756	39.289	1.54%	1.09%
			2450	1.842	39.530	1.800	39.200	2.33%	0.84%
			2480	1.876	39.393	1.833	39.162	2.35%	0.59%
			2500	1.899	39.317	1.855	39.136	2.37%	0.46%
			2510	1.909	39.279	1.866	39.123	2.30%	0.40%
			2535	1.937	39.197	1.893	39.092	2.32%	0.27%
			2550	1.955	39.142	1.909	39.073	2.41%	0.18%
			2560	1.967	39.099	1.920	39.060	2.45%	0.10%
			2600	2.015	38.920	1.964	39.009	2.60%	-0.23%
			2650	2.075	38.739	2.018	38.945	2.82%	-0.53%
			2680	2.111	38.603	2.051	38.907	2.93%	-0.78%
			2700	2.134	38.524	2.073	38.882	2.94%	-0.92%

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
06/30/2022	5200-5800 Head	20.9	5180	4.472	35.152	4.635	36.009	-3.52%	-2.38%
			5190	4.485	35.130	4.645	35.998	-3.44%	-2.41%
			5200	4.496	35.110	4.655	35.986	-3.42%	-2.43%
			5210	4.508	35.100	4.666	35.975	-3.39%	-2.43%
			5220	4.519	35.091	4.676	35.963	-3.36%	-2.42%
			5240	4.540	35.055	4.696	35.940	-3.32%	-2.46%
			5250	4.550	35.036	4.706	35.929	-3.31%	-2.49%
			5260	4.561	35.018	4.717	35.917	-3.31%	-2.50%
			5270	4.573	35.001	4.727	35.906	-3.26%	-2.52%
			5280	4.588	34.985	4.737	35.894	-3.15%	-2.53%
			5290	4.600	34.971	4.748	35.883	-3.12%	-2.54%
			5300	4.611	34.955	4.758	35.871	-3.09%	-2.55%
			5310	4.619	34.942	4.768	35.860	-3.13%	-2.56%
			5320	4.628	34.925	4.778	35.849	-3.14%	-2.58%
			5500	4.820	34.610	4.963	35.643	-2.88%	-2.90%
			5510	4.831	34.585	4.973	35.632	-2.86%	-2.94%
			5520	4.843	34.565	4.983	35.620	-2.81%	-2.96%
			5530	4.856	34.550	4.994	35.609	-2.76%	-2.97%
			5540	4.869	34.531	5.004	35.597	-2.70%	-2.99%
			5550	4.880	34.511	5.014	35.586	-2.67%	-3.02%
			5560	4.890	34.489	5.024	35.574	-2.67%	-3.05%
			5580	4.913	34.447	5.045	35.551	-2.62%	-3.11%
			5600	4.938	34.413	5.065	35.529	-2.51%	-3.14%
			5610	4.949	34.405	5.076	35.518	-2.50%	-3.13%
			5620	4.960	34.394	5.086	35.506	-2.48%	-3.13%
			5640	4.981	34.344	5.106	35.483	-2.45%	-3.21%
			5660	5.006	34.310	5.127	35.460	-2.36%	-3.24%
			5670	5.018	34.293	5.137	35.449	-2.32%	-3.26%
			5680	5.027	34.277	5.147	35.437	-2.33%	-3.27%
			5690	5.037	34.258	5.158	35.426	-2.35%	-3.30%
			5700	5.048	34.237	5.168	35.414	-2.32%	-3.32%
			5710	5.062	34.217	5.178	35.403	-2.24%	-3.35%
			5720	5.076	34.203	5.188	35.391	-2.16%	-3.36%
			5745	5.105	34.181	5.214	35.363	-2.09%	-3.34%
			5750	5.110	34.176	5.219	35.357	-2.09%	-3.34%
			5755	5.116	34.171	5.224	35.351	-2.07%	-3.34%
			5765	5.128	34.151	5.234	35.340	-2.03%	-3.36%
			5775	5.137	34.130	5.245	35.329	-2.06%	-3.39%
			5785	5.149	34.118	5.255	35.317	-2.02%	-3.39%
			5795	5.159	34.104	5.265	35.305	-2.01%	-3.40%
			5800	5.165	34.096	5.270	35.300	-1.99%	-3.41%
			5800	5.165	34.096	5.270	35.300	-1.99%	-3.41%
			5805	5.172	34.091	5.275	35.294	-1.95%	-3.41%
			5825	5.196	34.049	5.296	35.271	-1.89%	-3.46%
			5835	5.208	34.041	5.305	35.230	-1.83%	-3.37%
			5845	5.219	34.027	5.315	35.210	-1.81%	-3.36%
			5855	5.231	34.011	5.325	35.197	-1.77%	-3.37%
			5865	5.240	33.996	5.336	35.190	-1.80%	-3.39%
			5865	5.240	33.996	5.336	35.190	-1.80%	-3.39%
			5865	5.240	33.996	5.336	35.190	-1.80%	-3.39%
			5865	5.240	33.996	5.336	35.190	-1.80%	-3.39%
			5875	5.249	33.980	5.347	35.183	-1.83%	-3.42%
			5885	5.261	33.967	5.357	35.177	-1.79%	-3.44%
			5905	5.282	33.920	5.379	35.163	-1.80%	-3.53%

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
07/31/2022	5200-5800 Head	21.7	5180	4.502	36.028	4.635	36.009	-2.87%	0.05%
			5190	4.512	36.016	4.645	35.998	-2.86%	0.05%
			5200	4.523	35.993	4.655	35.986	-2.84%	0.02%
			5210	4.534	35.968	4.666	35.975	-2.83%	-0.02%
			5220	4.546	35.945	4.676	35.963	-2.78%	-0.05%
			5240	4.575	35.909	4.696	35.940	-2.58%	-0.09%
			5250	4.587	35.893	4.706	35.929	-2.53%	-0.10%
			5260	4.598	35.876	4.717	35.917	-2.52%	-0.11%
			5270	4.605	35.864	4.727	35.906	-2.58%	-0.12%
			5280	4.610	35.841	4.737	35.894	-2.68%	-0.15%
			5290	4.619	35.816	4.748	35.883	-2.72%	-0.19%
			5300	4.632	35.797	4.758	35.871	-2.65%	-0.21%
			5310	4.647	35.787	4.768	35.860	-2.54%	-0.20%
			5320	4.662	35.767	4.778	35.849	-2.43%	-0.23%
			5500	4.861	35.462	4.963	35.643	-2.06%	-0.51%
			5510	4.872	35.447	4.973	35.632	-2.03%	-0.52%
			5520	4.885	35.439	4.983	35.620	-1.97%	-0.51%
			5530	4.898	35.422	4.994	35.609	-1.92%	-0.53%
			5540	4.913	35.407	5.004	35.597	-1.82%	-0.53%
			5550	4.924	35.387	5.014	35.586	-1.79%	-0.56%
			5560	4.935	35.370	5.024	35.574	-1.77%	-0.57%
			5580	4.957	35.335	5.045	35.551	-1.74%	-0.61%
			5600	4.983	35.297	5.065	35.529	-1.62%	-0.65%
			5610	4.993	35.282	5.076	35.518	-1.64%	-0.66%
			5620	5.003	35.266	5.086	35.506	-1.63%	-0.68%
			5640	5.028	35.227	5.106	35.483	-1.53%	-0.72%
			5660	5.046	35.205	5.127	35.460	-1.58%	-0.72%
			5670	5.058	35.191	5.137	35.449	-1.54%	-0.73%
			5680	5.068	35.174	5.147	35.437	-1.53%	-0.74%
			5690	5.081	35.161	5.158	35.426	-1.49%	-0.75%
			5700	5.092	35.137	5.168	35.414	-1.47%	-0.78%
			5710	5.104	35.112	5.178	35.403	-1.43%	-0.82%
			5720	5.119	35.090	5.188	35.391	-1.33%	-0.85%
			5745	5.143	35.039	5.214	35.363	-1.36%	-0.92%
			5750	5.148	35.033	5.219	35.357	-1.36%	-0.92%
			5755	5.152	35.029	5.224	35.351	-1.38%	-0.91%
			5765	5.165	35.019	5.234	35.340	-1.32%	-0.91%
			5775	5.179	34.994	5.245	35.329	-1.26%	-0.95%
			5785	5.190	34.964	5.255	35.317	-1.24%	-1.00%
			5795	5.199	34.945	5.265	35.305	-1.25%	-1.02%
			5800	5.203	34.940	5.270	35.300	-1.27%	-1.02%
			5800	5.203	34.940	5.270	35.300	-1.27%	-1.02%
			5805	5.209	34.936	5.275	35.294	-1.25%	-1.01%
			5825	5.237	34.913	5.296	35.271	-1.11%	-1.01%
			5835	5.251	34.895	5.305	35.230	-1.02%	-0.95%
			5845	5.262	34.883	5.315	35.210	-1.00%	-0.93%
			5855	5.268	34.867	5.325	35.197	-1.07%	-0.94%
			5865	5.279	34.847	5.336	35.190	-1.07%	-0.97%
			5865	5.279	34.847	5.336	35.190	-1.07%	-0.97%
			5865	5.279	34.847	5.336	35.190	-1.07%	-0.97%
			5865	5.279	34.847	5.336	35.190	-1.07%	-0.97%
			5875	5.291	34.828	5.347	35.183	-1.05%	-1.01%
			5885	5.301	34.801	5.357	35.177	-1.05%	-1.07%
			5905	5.326	34.767	5.379	35.163	-0.99%	-1.13%

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.

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

8.2 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 8-2
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 (%)
AM4	2450	HEAD	06/17/2022	20.8	22.4	0.10	750	3837	5.420	52.60	54.200	3.04%
AM3	2450	HEAD	06/20/2022	23.9	22.9	0.10	750	7427	5.290	52.60	52.900	0.57%
AM9	5250	HEAD	06/30/2022	24.0	21.0	0.05	1123	7638	3.710	80.50	74.200	-7.83%
AM9	5250	HEAD	07/31/2022	21.5	20.5	0.05	1123	7638	3.730	80.50	74.600	-7.33%
AM9	5600	HEAD	06/30/2022	24.0	21.0	0.05	1123	7638	4.160	83.70	83.200	-0.60%
AM9	5600	HEAD	07/31/2022	21.5	20.5	0.05	1123	7638	3.950	83.70	79.000	-5.62%
AM9	5750	HEAD	06/30/2022	24.0	21.0	0.05	1123	7638	3.830	80.50	76.600	-4.84%
AM9	5750	HEAD	07/31/2022	21.5	20.5	0.05	1123	7638	3.780	80.50	75.600	-6.09%

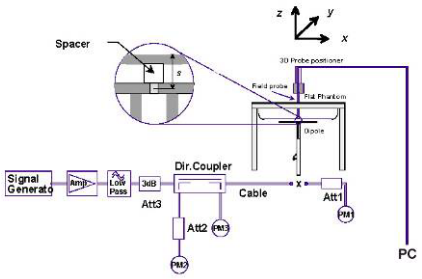


Figure 8-1
System Verification Setup Diagram

Figure 8-2
System Verification Setup Photo

9 SAR DATA SUMMARY

9.1 Standalone SAR Data

Table 9-1
2.4 GHz WLAN Body SAR Data – Antenna WF8

MEASUREMENT RESULTS																					
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g) (W/kg)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g) (W/kg)	SAR (10g) (W/kg)	Reported SAR (10g) (W/kg)	Plot #
MHz	Ch.																				
2412	1	802.11b	DSSS	22	16.50	15.00	0.19	0 mm	Ant WF8	V1	D52G3R42LM	1	back	99.7	0.824	1.413	1.003	1.168	0.371	0.526	
2437	6	802.11b	DSSS	22	16.50	15.21	0.04	0 mm	Ant WF8	V1	D52G3R42LM	1	back	99.7	0.758	1.346	1.003	1.023	0.335	0.452	
2462	11	802.11b	DSSS	22	16.50	15.27	0.02	0 mm	Ant WF8	V1	D52G3R42LM	1	back	99.7	0.848	1.327	1.003	1.129	0.381	0.507	A1
2412	1	802.11b	DSSS	22	16.50	14.96	-0.09	0 mm	Ant WF8	V2	XCYJ26MT23	1	back	99.7	0.750	1.426	1.003	1.073	0.342	0.489	
2462	11	802.11b	DSSS	22	16.50	15.27	0.02	0 mm	Ant WF8	V1	D52G3R42LM	1	top	99.7	0.294	1.327	1.003	0.391	0.124	0.165	
2462	11	802.11b	DSSS	22	16.50	15.27	0.06	0 mm	Ant WF8	V1	D52G3R42LM	1	bottom	99.7	0.018	1.327	1.003	0.024	0.007	0.009	
2462	11	802.11b	DSSS	22	16.50	15.27	0.12	0 mm	Ant WF8	V1	D52G3R42LM	1	right	99.7	0.026	1.327	1.003	0.035	0.011	0.015	
2462	11	802.11b	DSSS	22	16.50	15.27	0.05	0 mm	Ant WF8	V1	D52G3R42LM	1	left	99.7	0.000	1.327	1.003	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 9-2
2.4 GHz WLAN Body SAR Data – Antenna WF7

MEASUREMENT RESULTS																					
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g) (W/kg)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g) (W/kg)	SAR (10g) (W/kg)	Reported SAR (10g) (W/kg)	Plot #
MHz	Ch.																				
2412	1	802.11b	DSSS	22	15.00	14.07	0.02	0 mm	Ant WF7	V1	XW76RD2XXT	1	back	99.7	0.805	1.239	1.003	1.000	0.358	0.445	
2437	6	802.11b	DSSS	22	15.00	14.02	0.01	0 mm	Ant WF7	V1	XW76RD2XXT	1	back	99.7	0.841	1.253	1.003	1.057	0.415	0.522	
2462	11	802.11b	DSSS	22	15.00	13.92	0.09	0 mm	Ant WF7	V1	XW76RD2XXT	1	back	99.7	0.796	1.282	1.003	1.024	0.391	0.503	
2437	6	802.11b	DSSS	22	15.00	14.04	0.03	0 mm	Ant WF7	V2	XYKLWWL2CL	1	back	99.7	0.725	1.247	1.003	0.907	0.322	0.403	
2437	6	802.11b	DSSS	22	15.00	14.04	0.01	0 mm	Ant WF7	V2	XYKLWWL2CL	1	top	99.7	0.139	1.247	1.003	0.174	0.068	0.085	
2437	6	802.11b	DSSS	22	15.00	14.04	0.04	0 mm	Ant WF7	V2	XYKLWWL2CL	1	bottom	99.7	0.021	1.247	1.003	0.026	0.008	0.010	
2437	6	802.11b	DSSS	22	15.00	14.04	0.02	0 mm	Ant WF7	V2	XYKLWWL2CL	1	right	99.7	0.000	1.247	1.003	0.000	0.000	0.000	
2437	6	802.11b	DSSS	22	15.00	14.04	0.06	0 mm	Ant WF7	V2	XYKLWWL2CL	1	left	99.7	0.119	1.247	1.003	0.149	0.042	0.053	
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 9-3
5 GHz WLAN Body SAR Data – Antenna WF5T

MEASUREMENT RESULTS																					
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.														(W/kg)			(W/kg)	(W/kg)	(W/kg)	
5230	46	802.11n	OFDM	40	17.50	16.74	0.06	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	back	97.9	0.154	1.191	1.021	0.187	0.061	0.074	
5230	46	802.11n	OFDM	40	17.50	16.74	0.01	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	top	97.9	0.010	1.191	1.021	0.012	0.002	0.002	
5230	46	802.11n	OFDM	40	17.50	16.74	0.20	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	bottom	97.9	0.000	1.191	1.021	0.000	0.000	0.000	
5190	38	802.11n	OFDM	40	15.00	13.05	-0.08	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	right	97.9	0.375	1.567	1.021	0.600	0.130	0.208	
5230	46	802.11n	OFDM	40	17.50	16.74	-0.02	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	right	97.9	0.972	1.191	1.021	1.182	0.340	0.413	
5230	46	802.11n	OFDM	40	17.50	16.57	0.02	0 mm	Ant WF5T	V2	XCYJ26MT23	13.5	right	97.9	0.843	1.239	1.021	1.066	0.298	0.377	
5230	46	802.11n	OFDM	40	17.50	16.74	0.20	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	left	97.9	0.023	1.191	1.021	0.028	0.007	0.009	
5690	138	802.11ac	OFDM	80	15.50	14.68	0.07	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	back	95.4	0.070	1.208	1.048	0.089	0.024	0.030	
5690	138	802.11ac	OFDM	80	15.50	14.68	-0.18	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	top	95.4	0.023	1.208	1.048	0.029	0.005	0.006	
5690	138	802.11ac	OFDM	80	15.50	14.68	0.04	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	bottom	95.4	0.000	1.208	1.048	0.000	0.000	0.000	
5530	106	802.11ac	OFDM	80	13.00	11.54	-0.12	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	right	95.4	0.374	1.400	1.048	0.549	0.119	0.175	
5610	122	802.11ac	OFDM	80	15.50	14.58	-0.04	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	right	95.4	0.829	1.236	1.048	1.074	0.269	0.348	
5690	138	802.11ac	OFDM	80	15.50	14.68	0.04	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	right	95.4	0.806	1.208	1.048	1.020	0.258	0.327	
5610	122	802.11ac	OFDM	80	15.50	14.51	-0.01	0 mm	Ant WF5T	V1	D52G3R42LM	29.3	right	95.4	0.765	1.256	1.048	1.007	0.270	0.355	
5690	138	802.11ac	OFDM	80	15.50	14.68	0.01	0 mm	Ant WF5T	V2	RHC919JY0Y	29.3	left	95.4	0.014	1.208	1.048	0.018	0.003	0.004	
5775	155	802.11ac	OFDM	80	15.00	14.05	0.07	0 mm	Ant WF5T	V2	XCYJ26MT23	29.3	back	95.4	0.067	1.245	1.048	0.087	0.020	0.026	
5775	155	802.11ac	OFDM	80	15.00	14.05	0.03	0 mm	Ant WF5T	V2	XCYJ26MT23	29.3	top	95.4	0.008	1.245	1.048	0.010	0.000	0.000	
5775	155	802.11ac	OFDM	80	15.00	14.05	0.04	0 mm	Ant WF5T	V2	XCYJ26MT23	29.3	bottom	95.4	0.000	1.245	1.048	0.000	0.000	0.000	
5775	155	802.11ac	OFDM	80	15.00	14.05	-0.03	0 mm	Ant WF5T	V2	XCYJ26MT23	29.3	right	95.4	0.795	1.245	1.048	1.037	0.257	0.335	
5775	155	802.11ac	OFDM	80	15.00	14.02	-0.06	0 mm	Ant WF5T	V1	LP69VHY533	29.3	right	95.4	0.752	1.253	1.048	0.987	0.263	0.345	
5775	155	802.11ac	OFDM	80	15.00	14.05	0.01	0 mm	Ant WF5T	V2	XCYJ26MT23	29.3	left	95.4	0.015	1.245	1.048	0.020	0.002	0.003	
5230	46	802.11ac	OFDM	40	17.50	16.74	0.01	0 mm	Ant WF5T	V1	QML6TVH0Q5	13.5	right	97.9	0.970	1.191	1.021	1.180	0.343	0.417	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population															Body 1.6 W/kg (mW/g) averaged over 1 gram						

Blue entry represents variability measurement.

Table 9-4
5 GHz WLAN Body SAR Data – Antenna WF5B

MEASUREMENT RESULTS																					
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.														(W/kg)			(W/kg)	(W/kg)	(W/kg)	
5230	46	802.11n	OFDM	40	16.00	15.05	-0.09	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	back	97.9	0.109	1.245	1.021	0.139	0.038	0.048	
5230	46	802.11n	OFDM	40	16.00	15.05	0.08	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	top	97.9	0.000	1.245	1.021	0.000	0.000	0.000	
5230	46	802.11n	OFDM	40	16.00	15.05	0.07	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	bottom	97.9	0.042	1.245	1.021	0.053	0.010	0.013	
5190	38	802.11n	OFDM	40	15.00	13.01	0.04	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	right	97.9	0.516	1.581	1.021	0.833	0.146	0.236	
5230	46	802.11n	OFDM	40	16.00	15.05	0.04	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	right	97.9	0.827	1.245	1.021	1.051	0.239	0.304	
5230	46	802.11n	OFDM	40	16.00	15.10	0.01	0 mm	Ant WF5B	V1	XW76RD2XXT	13.5	right	97.9	0.711	1.230	1.021	0.893	0.206	0.259	
5230	46	802.11n	OFDM	40	16.00	15.05	0.07	0 mm	Ant WF5B	V2	XYKLWWL2CL	13.5	left	97.9	0.015	1.245	1.021	0.019	0.005	0.006	
5690	138	802.11ac	OFDM	80	16.00	15.60	-0.08	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	back	95.4	0.131	1.096	1.048	0.150	0.052	0.060	
5690	138	802.11ac	OFDM	80	16.00	15.60	0.02	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	top	95.4	0.001	1.096	1.048	0.001	0.000	0.000	
5690	138	802.11ac	OFDM	80	16.00	15.60	-0.02	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	bottom	95.4	0.025	1.096	1.048	0.029	0.004	0.005	
5530	106	802.11ac	OFDM	80	13.00	11.56	0.04	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	0.375	1.393	1.048	0.547	0.108	0.158	
5610	122	802.11ac	OFDM	80	16.00	15.52	0.00	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	1.010	1.117	1.048	1.182	0.303	0.355	
5690	138	802.11ac	OFDM	80	16.00	15.60	0.02	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	1.030	1.096	1.048	1.183	0.312	0.358	A2
5690	138	802.11ac	OFDM	80	16.00	15.59	-0.19	0 mm	Ant WF5B	V2	RHC919JY0Y	29.3	right	95.4	0.970	1.099	1.048	1.117	0.293	0.337	
5690	138	802.11ac	OFDM	80	16.00	15.60	0.01	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	left	95.4	0.028	1.096	1.048	0.032	0.009	0.010	
5775	155	802.11ac	OFDM	80	16.50	15.90	-0.11	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	back	95.4	0.157	1.148	1.048	0.189	0.061	0.073	
5775	155	802.11ac	OFDM	80	16.50	15.90	-0.12	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	top	95.4	0.000	1.148	1.048	0.000	0.000	0.000	
5775	155	802.11ac	OFDM	80	16.50	15.90	0.08	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	bottom	95.4	0.028	1.148	1.048	0.034	0.007	0.008	
5775	155	802.11ac	OFDM	80	16.50	15.90	0.08	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	0.979	1.148	1.048	1.178	0.302	0.363	
5775	155	802.11ac	OFDM	80	16.50	15.86	0.05	0 mm	Ant WF5B	V2	RHC919JY0Y	29.3	right	95.4	0.964	1.159	1.048	1.171	0.297	0.361	
5775	155	802.11ac	OFDM	80	16.50	15.90	0.06	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	left	95.4	0.013	1.148	1.048	0.016	0.001	0.001	
5610	122	802.11ac	OFDM	80	16.00	15.52	0.01	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	0.944	1.117	1.048	1.105	0.281	0.329	
5690	138	802.11ac	OFDM	80	16.00	15.60	-0.02	0 mm	Ant WF5B	V1	D52G3R42LM	29.3	right	95.4	1.020	1.096	1.048	1.172	0.320	0.368	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population															Body 1.6 W/kg (mW/g) averaged over 1 gram						

Blue entries represent variability measurements.

Table 9-5
Bluetooth Body SAR Data – Antenna WF8

MEASUREMENT RESULTS																				
FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	(W/kg)	(W/kg)	
2402	0	Bluetooth	FHSS	17.50	16.90	0.02	0 mm	Ant WF8	V1	D52G3R42LM	1	back	77.0	0.915	1.148	1.006	1.057	0.429	0.495	
2441	39	Bluetooth	FHSS	17.50	16.44	0.02	0 mm	Ant WF8	V1	D52G3R42LM	1	back	77.0	0.728	1.276	1.006	0.935	0.348	0.447	
2480	78	Bluetooth	FHSS	17.50	16.57	0.01	0 mm	Ant WF8	V1	D52G3R42LM	1	back	77.0	0.727	1.239	1.006	0.906	0.333	0.415	
2402	0	Bluetooth	FHSS	17.50	16.30	-0.01	0 mm	Ant WF8	V2	XCYJ26MT23	1	back	77.0	0.749	1.318	1.006	0.993	0.348	0.461	
2402	0	Bluetooth	FHSS	17.50	16.90	0.01	0 mm	Ant WF8	V1	D52G3R42LM	1	Top	77.0	0.293	1.148	1.006	0.338	0.134	0.155	
2402	0	Bluetooth	FHSS	17.50	16.90	0.02	0 mm	Ant WF8	v1	D52G3R42LM	1	bottom	77.0	0.019	1.148	1.006	0.022	0.007	0.008	
2402	0	Bluetooth	FHSS	17.50	16.90	0.04	0 mm	Ant WF8	V1	D52G3R42LM	1	right	77.0	0.024	1.148	1.006	0.028	0.009	0.010	
2402	0	Bluetooth	FHSS	17.50	16.90	0.06	0 mm	Ant WF8	v1	D52G3R42LM	1	left	77.0	0.001	1.148	1.006	0.001	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													

Note: The reported SAR was scaled to the 77.5% transmission duty factor to determine compliance since the duty factor of the device is permanently limited to 77.5% per the manufacturer.

Table 9-6
Bluetooth Body SAR Data – Antenna WF7

FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	(W/kg)	(W/kg)	
2402	0	Bluetooth	FHSS	16.00	15.28	0.07	0 mm	Ant WF7	V1	QML6TVH0Q5	1	back	77.0	0.996	1.180	1.006	1.182	0.423	0.502	
2441	39	Bluetooth	FHSS	16.00	14.78	0.00	0 mm	Ant WF7	V1	QML6TVH0Q5	1	back	77.0	0.758	1.324	1.006	1.010	0.359	0.478	
2480	78	Bluetooth	FHSS	16.00	14.84	-0.05	0 mm	Ant WF7	V1	QML6TVH0Q5	1	back	77.0	0.583	1.306	1.006	0.766	0.267	0.351	
2402	0	Bluetooth	FHSS	16.00	15.61	-0.05	0 mm	Ant WF7	V2	XCYJ26MT23	1	back	77.0	1.070	1.094	1.006	1.178	0.469	0.516	A3
2402	0	Bluetooth	FHSS	16.00	15.61	0.03	0 mm	Ant WF7	V2	XCYJ26MT23	1	Top	77.0	0.251	1.094	1.006	0.276	0.117	0.129	
2402	0	Bluetooth	FHSS	16.00	15.61	0.06	0 mm	Ant WF7	V2	XCYJ26MT23	1	bottom	77.0	0.012	1.094	1.006	0.013	0.004	0.004	
2402	0	Bluetooth	FHSS	16.00	15.61	0.02	0 mm	Ant WF7	V2	XCYJ26MT23	1	right	77.0	0.000	1.094	1.006	0.000	0.000	0.000	
2402	0	Bluetooth	FHSS	16.00	15.61	-0.18	0 mm	Ant WF7	V2	XCYJ26MT23	1	left	77.0	0.121	1.094	1.006	0.133	0.044	0.048	
2402	0	Bluetooth	FHSS	16.00	15.61	-0.01	0 mm	Ant WF7	V2	XCYJ26MT23	1	back	77.0	0.990	1.094	1.006	1.090	0.437	0.481	
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: The reported SAR was scaled to the 77.5% transmission duty factor to determine compliance since the duty factor of the device is permanently limited to 77.5% per the manufacturer.
Blue entry represents variability measurement.

Table 9-7
NB UNII Body SAR Data – Antenna WF5T

FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	(W/kg)	(W/kg)	
5245	High	NB UNII 1	FHSS	12.00	11.20	-0.04	0 mm	Ant WF5T	V1	QML6TVH0Q5	4	back	77.0	0.030	1.202	1.006	0.036	0.009	0.011	
5245	High	NB UNII 1	FHSS	12.00	11.20	0.06	0 mm	Ant WF5T	V1	QML6TVH0Q5	4	Top	77.0	0.000	1.202	1.006	0.000	0.000	0.000	
5245	High	NB UNII 1	FHSS	12.00	11.20	0.04	0 mm	Ant WF5T	V1	QML6TVH0Q5	4	bottom	77.0	0.000	1.202	1.006	0.000	0.000	0.000	
5162	Low	NB UNII 1	FHSS	12.00	11.19	0.02	0 mm	Ant WF5T	V2	XYKLWWL2CL	4	right	77.0	0.158	1.205	1.006	0.192	0.052	0.063	
5204	Middle	NB UNII 1	FHSS	12.00	11.15	0.08	0 mm	Ant WF5T	V2	XYKLWWL2CL	4	right	77.0	0.180	1.216	1.006	0.220	0.058	0.071	
5245	High	NB UNII 1	FHSS	12.00	11.21	0.01	0 mm	Ant WF5T	V2	XYKLWWL2CL	4	right	77.0	0.186	1.199	1.006	0.224	0.060	0.072	
5245	High	NB UNII 1	FHSS	12.00	11.20	0.06	0 mm	Ant WF5T	V1	QML6TVH0Q5	4	right	77.0	0.217	1.202	1.006	0.262	0.073	0.088	
5245	High	NB UNII 1	FHSS	12.00	11.20	0.06	0 mm	Ant WF5T	V1	QML6TVH0Q5	4	left	77.0	0.000	1.202	1.006	0.000	0.000	0.000	
5844	High	NB UNII 3	FHSS	16.00	15.35	0.02	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	back	77.0	0.071	1.161	1.006	0.083	0.021	0.025	
5844	High	NB UNII 3	FHSS	16.00	15.35	0.08	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	Top	77.0	0.075	1.161	1.006	0.088	0.024	0.028	
5844	High	NB UNII 3	FHSS	16.00	15.35	0.09	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	bottom	77.0	0.000	1.161	1.006	0.000	0.000	0.000	
5733	Low	NB UNII 3	FHSS	16.00	15.07	0.05	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	right	77.0	0.799	1.239	1.006	0.996	0.256	0.319	A4
5789	Middle	NB UNII 3	FHSS	16.00	15.21	0.08	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	right	77.0	0.745	1.199	1.006	0.899	0.243	0.293	
5844	High	NB UNII 3	FHSS	16.00	15.35	-0.01	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	right	77.0	0.698	1.161	1.006	0.815	0.223	0.260	
5733	Low	NB UNII 3	FHSS	16.00	15.06	0.09	0 mm	Ant WF5T	V1	QML6TVH0Q5	1	right	77.0	0.680	1.242	1.006	0.850	0.227	0.284	
5844	High	NB UNII 3	FHSS	16.00	15.35	-0.10	0 mm	Ant WF5T	V2	XYKLWWL2CL	1	left	77.0	0.011	1.161	1.006	0.013	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						

Note: The reported SAR was scaled to the 77.5% transmission duty factor to determine compliance since the duty factor of the device is permanently limited to 77.5% per the manufacturer.

Table 9-8
NB UNII Body SAR Data – Antenna WF5B

FREQUENCY		Mode	Service	Maximum Allowed Power [dBm]	Conducted Power [dBm]	Power Drift [dB]	Spacing	Antenna Config.	Variant	Device Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	SAR (1g)	Scaling Factor (Cond Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	SAR (10g)	Reported SAR (10g)	Plot #
MHz	Ch.													(W/kg)			(W/kg)	(W/kg)	(W/kg)	
5204	Middle	NB UNII 1	FHSS	12.00	11.29	0.04	0 mm	Ant WF5B	V1	QML6TVH0Q5	4	back	77.0	0.026	1.178	1.006	0.031	0.008	0.009	
5204	Middle	NB UNII 1	FHSS	12.00	11.29	0.02	0 mm	Ant WF5B	V1	QML6TVH0Q5	4	Top	77.0	0.000	1.178	1.006	0.000	0.000	0.000	
5204	Middle	NB UNII 1	FHSS	12.00	11.29	0.08	0 mm	Ant WF5B	V1	QML6TVH0Q5	4	bottom	77.0	0.004	1.178	1.006	0.005	0.000	0.000	
5204	Middle	NB UNII 1	FHSS	12.00	11.29	-0.04	0 mm	Ant WF5B	V1	QML6TVH0Q5	4	right	77.0	0.288	1.178	1.006	0.341	0.076	0.090	
5204	Middle	NB UNII 1	FHSS	12.00	11.06	0.04	0 mm	Ant WF5B	V2	XYKLWWL2CL	4	right	77.0	0.242	1.242	1.006	0.302	0.064	0.080	
5204	Middle	NB UNII 1	FHSS	12.00	11.29	0.03	0 mm	Ant WF5B	V1	QML6TVH0Q5	4	left	77.0	0.000	1.178	1.006	0.000	0.000	0.000	
5733	Low	NB UNII 3	FHSS	17.50	15.78	0.04	0 mm	Ant WF5B	V2	XCYJ26MT23	1	back	77.0	0.093	1.486	1.006	0.139	0.036	0.054	
5733	Low	NB UNII 3	FHSS	17.50	15.78	0.03	0 mm	Ant WF5B	V2	XCYJ26MT23	1	Top	77.0	0.000	1.486	1.006	0.000	0.000	0.000	
5733	Low	NB UNII 3	FHSS	17.50	15.78	0.04	0 mm	Ant WF5B	V2	XCYJ26MT23	1	bottom	77.0	0.021	1.486	1.006	0.031	0.003	0.004	
5733	Low	NB UNII 3	FHSS	17.50	15.78	-0.01	0 mm	Ant WF5B	V2	XCYJ26MT23	1	right	77.0	0.646	1.486	1.006	0.966	0.206	0.308	
5789	Middle	NB UNII 3	FHSS	17.50	16.94	-0.12	0 mm	Ant WF5B	V2	XCYJ26MT23	1	right	77.0	0.645	1.138	1.006	0.738	0.204	0.234	
5844	High	NB UNII 3	FHSS	17.50	16.68	-0.19	0 mm	Ant WF5B	V2	XCYJ26MT23	1	right	77.0	0.572	1.208	1.006	0.695	0.187	0.227	
5733	Low	NB UNII 3	FHSS	17.50	15.90	0.01	0 mm	Ant WF5B	V1	LP69VHY533	1	right	77.0	0.645	1.445	1.006	0.938	0.203	0.295	
5733	Low	NB UNII 3	FHSS	17.50	15.78	0.04	0 mm	Ant WF5B	V2	XCYJ26MT23	1	left	77.0	0.013	1.486	1.006	0.019	0.002	0.003	
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: The reported SAR was scaled to the 77.5% transmission duty factor to determine compliance since the duty factor of the device is permanently limited to 77.5% per the manufacturer.

9.2 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 11 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. The orange highlights throughout the report represents the highest scaled SAR per Equipment Class.

WLAN Notes:

1. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 2.4 GHz WIFI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz 802.11g/n/ax) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 6.2.4 for more information.
2. Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02 for 5 GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed powers. Other transmission modes were not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg for 1g evaluations. See Section 6.2.5 for more information.
3. Per KDB Publication 248227 D01v02r02, SAR for MIMO was evaluated by following the simultaneous SAR provisions from KDB Publication 447498 D01v06 by either evaluating the sum of the 1g SAR values of each antenna transmitting independently or making a SAR measurement with both antennas transmitting simultaneously. Please see Section 11 for complete analysis.
4. When the maximum reported 1g averaged SAR is ≤0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg for 1g evaluations or all test channels were measured.
5. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance. Procedures used to measure the duty factor are identical to that in the associated EMC test reports.
6. The time-averaged mechanism for WLAN operations was disabled for the above SAR measurements. The SAR was scaled to the maximum time-averaged output power

Bluetooth Notes

1. Bluetooth SAR was evaluated with a test mode with hopping disabled with DH5 operation. The reported SAR was scaled to the 77.5% transmission duty factor to determine compliance since the duty factor of the device is limited to 77.5% per the manufacturer. See Section 7.4 for the time domain plot and calculation for the duty factor of the device.

10 FCC MULTI-TX AND ANTENNA SAR CONSIDERATIONS

10.1 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 together.

10.2 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.

*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 10.4 for more information about the Spatial Separation Analysis.

10.3 Body SAR Simultaneous Transmission Analysis

Table 10-1
Simultaneous Transmission Scenario with Bluetooth and 5 GHz WLAN

Simult Tx	Configuration	Bluetooth Ant WF8 SAR (W/kg)	Bluetooth Ant WF7 SAR (W/kg)	5 GHz WLAN Ant WF5T SAR (W/kg)	5 GHz WLAN Ant WF5B SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	4	1+2+3+4
Body SAR	Back	1.057	1.182	0.187	0.189	**1.558***
	Top	0.338	0.276	0.029	0.001	0.644
	Bottom	0.022	0.013	0.000	0.053	0.088
	Right	0.028	0.000	1.182	1.183	1.211*
	Left	0.001	0.133	0.028	0.032	0.194

Table 10-2
Simultaneous Transmission Scenario with NB UNII and 2.4 GHz WLAN

Simult Tx	Configuration	NB UNII Ant WF5T SAR (W/kg)	NB UNII Ant WF5B SAR (W/kg)	2.4 GHz WLAN Ant WF8 SAR (W/kg)	2.4 GHz WLAN Ant WF7 SAR (W/kg)	Σ SAR (W/kg)
		1	2	3	4	1+2+3+4
Body SAR	Back	0.083	0.139	1.168	1.057	**1.390***
	Top	0.088	0.000	0.391	0.174	0.653
	Bottom	0.000	0.031	0.024	0.026	0.081
	Right	0.996	0.966	0.035	0.000	1.031*
	Left	0.013	0.019	0.000	0.149	0.181

Table 10-3
Simultaneous Transmission Scenario with BT Antenna WF7 and 2.4 GHz WLAN WF8

Simult Tx	Configuration	Bluetooth Ant WF7 SAR (W/kg)	2.4 GHz WLAN Ant WF8 SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Body SAR	Back	1.182	1.168	**1.182***
	Top	0.276	0.391	0.667
	Bottom	0.013	0.024	0.037
	Right	0.000	0.035	0.035
	Left	0.133	0.000	0.133

Table 10-4
Simultaneous Transmission Scenario with Bluetooth and 6 GHz WLAN

Simult Tx	Configuration	Bluetooth Ant WF8 SAR (W/kg)	Bluetooth Ant WF7 SAR (W/kg)	WiFi 6 GHz Ant WF5T (W/kg)	WiFi 6 GHz Ant WF5B (W/kg)	Σ SAR (W/kg)
		1	2	3	4	1+2+3+4
Body SAR	Back	1.057	1.182	0.099	0.142	**1.423***
	Top	0.338	0.276	0.018	0.000	0.632
	Bottom	0.022	0.013	0.003	0.157	0.195
	Right	0.028	0.000	1.189	0.960	1.217*
	Left	0.001	0.133	0.039	0.025	0.198

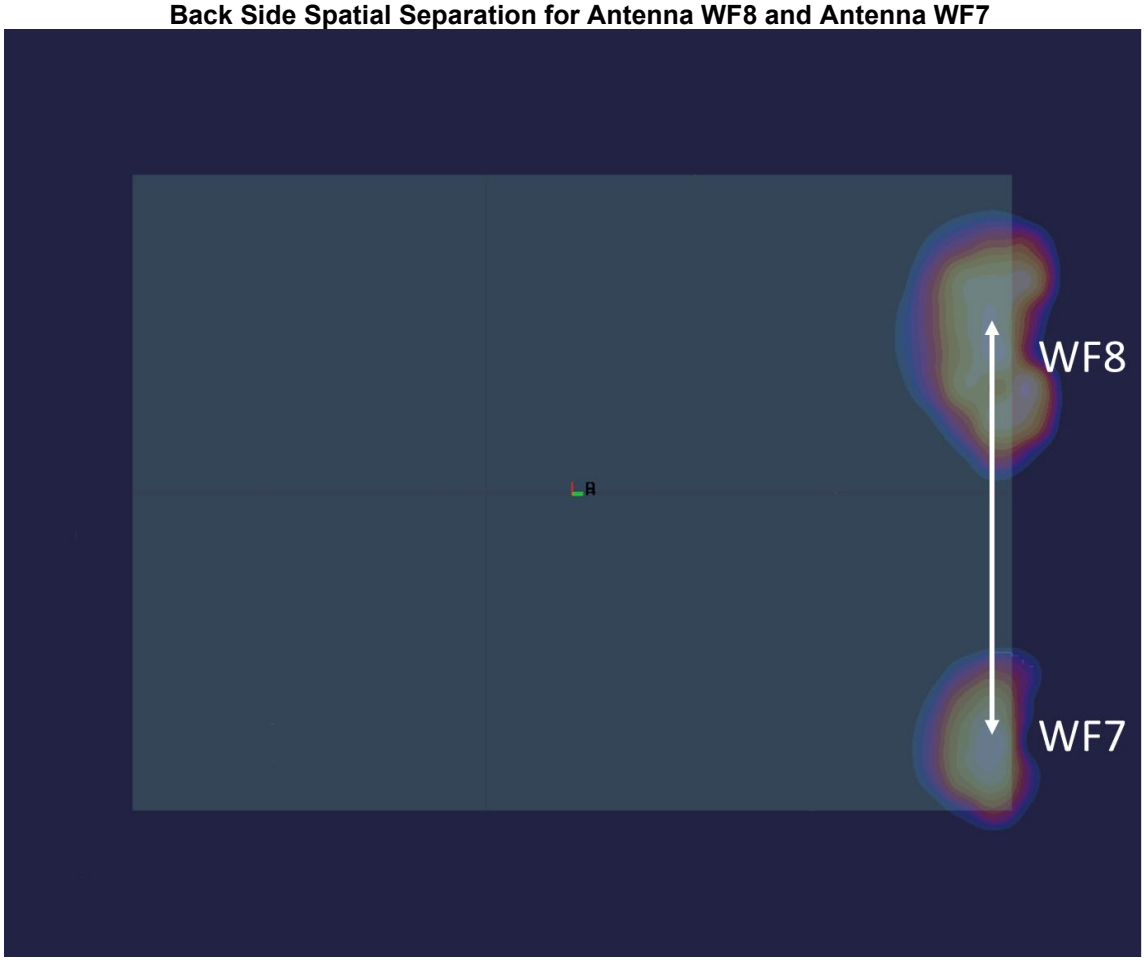
10.4 Spatial Separation Analysis

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.

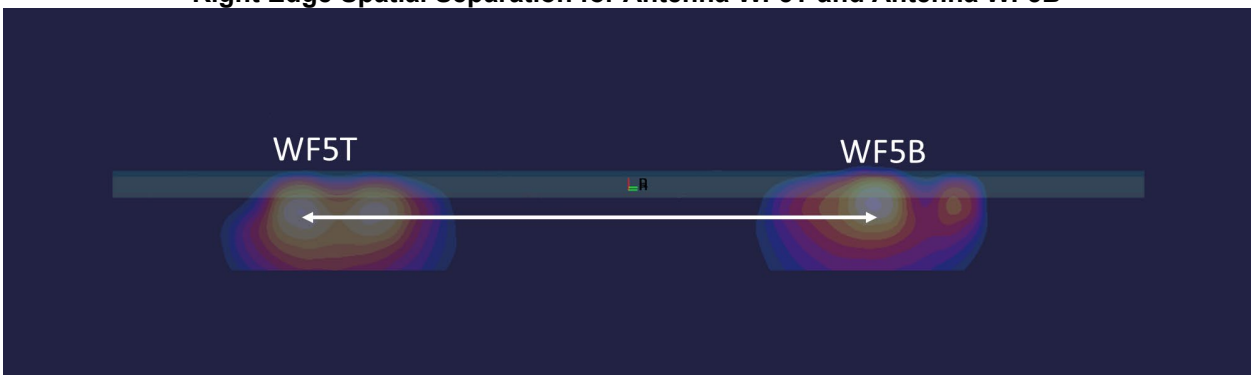
10.4.1 Back Side Spatial Separation Analysis

Figure 10-1
Back Side Spatial Separation for Antenna WF8 and Antenna WF7



10.4.2 Right Edge Spatial Separation Analysis

Figure 10-2
Right Edge Spatial Separation for Antenna WF5T and Antenna WF5B



10.5 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.

11 SAR MEASUREMENT VARIABILITY

11.1 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 11-1
Body SAR Measurement Variability Results

BODY VARIABILITY RESULTS														
Band	FREQUENCY	Mode	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							(W/kg)	(W/kg)		(W/kg)		(W/kg)	
2450	2402.00	Bluetooth	FHSS	WF7	1.00	back	0 mm	1.070	0.990	1.08	N/A	N/A	N/A	N/A
5250	5230.00	802.11n, 40 MHz Bandwidth	OFDM	WF5T	13.50	right	0 mm	0.972	0.970	1.00	N/A	N/A	N/A	N/A
5600	5610.00	802.11ac, 80 MHz Bandwidth	OFDM	WF5B	29.30	right	0 mm	1.010	0.944	1.07	N/A	N/A	N/A	N/A
5750	5690.00	802.11ac, 80 MHz Bandwidth	OFDM	WF5B	29.30	right	0 mm	1.030	1.020	1.00	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						

11.2 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.

12 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	E4438C	ESG Vector Signal Generator	3/24/2022	Annual	3/24/2023	MY45093678
Agilent	E4438C	ESG Vector Signal Generator	3/22/2022	Annual	3/22/2023	US41460739
Agilent	N5182A	MXG Vector Signal Generator	1/12/2022	Annual	1/12/2023	MY47420837
Agilent	N5182A	MXG Vector Signal Generator	11/17/2021	Annual	11/17/2022	US46240505
Agilent	8753ES	S-Parameter Vector Network Analyzer	2/11/2022	Annual	2/11/2023	MY40003841
Agilent	E5515C	Wireless Communications Test Set	5/4/2021	Biennial	5/4/2023	GB41450275
Agilent	E5515C	Wireless Communications Test Set	1/14/2020	Triennial	1/14/2023	GB43304447
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343972
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	343971
Amplifier Research	150A100C	Amplifier	CBT	N/A	CBT	350132
Anritsu	MN8110B	I/O Adaptor	CBT	N/A	CBT	6261747881
Anritsu	ML2496A	Power Meter	3/31/2022	Annual	3/31/2023	1138001
Anritsu	ML2496A	Power Meter	3/29/2022	Annual	3/29/2023	1306009
Anritsu	ML2496A	Power Meter	2/11/2022	Annual	2/11/2023	1405003
Anritsu	MA2411B	Pulse Power Sensor	3/28/2022	Annual	3/28/2023	1339007
Anritsu	MA2411B	Pulse Power Sensor	3/2/2022	Annual	3/2/2023	1126066
Anritsu	MA24106A	USB Power Sensor	3/28/2022	Annual	3/28/2023	1520503
Anritsu	MA24106A	USB Power Sensor	3/28/2022	Annual	3/28/2023	1520501
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	1/21/2022	Annual	1/21/2023	160574418
Mitutoyo	500-196-30	CD-6"ASX 6Inch Digital Caliper	2/16/2022	Triennial	2/16/2025	A20238413
Keysight Technologies	N6705B	DC Power Analyzer	5/5/2021	Triennial	5/5/2024	MY53004059
Keysight Technologies	N9020A	MXA Signal Analyzer	3/4/2022	Annual	3/4/2023	US46470561
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	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-1200+	Low Pass Filter DC to 1000 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	CBT	N/A	CBT	2050
Narda	4772-3	Attenuator (3dB)	CBT	N/A	CBT	9406
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Huber + Suhner	74Z-0-0-21	Torque Wrench	4/6/2022	Biennial	4/6/2024	83881
SPEAG	DAK-3.5	Dielectric Assessment Kit	5/12/2022	Annual	5/12/2023	1070
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	DAK-12	Dielectric Assessment Kit (10MHz - 3GHz)	11/16/2021	Annual	11/16/2022	1121
SPEAG	D2450V2	2450 MHz SAR Dipole	5/11/2022	Annual	5/11/2023	750
SPEAG	D5GHzV2	5 GHz SAR Dipole	3/22/2022	Annual	3/22/2023	1123
SPEAG	DAE4	Dasy Data Acquisition Electronics	1/13/2022	Annual	1/13/2023	793
SPEAG	DAE4	Dasy Data Acquisition Electronics	2/22/2022	Annual	2/22/2023	1403
SPEAG	DAE4	Dasy Data Acquisition Electronics	3/21/2022	Annual	3/21/2023	1408
SPEAG	EX3DV4	SAR Probe	1/19/2022	Annual	1/19/2023	3837
SPEAG	EX3DV4	SAR Probe	2/22/2022	Annual	2/22/2023	7427
SPEAG	EX3DV4	SAR Probe	3/22/2022	Annual	3/22/2023	7638

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.

13 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	1.732	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	1.732	1	1	0.1	0.1	∞
Modulation Response	E.2.5	4.8	R	1.732	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	1.732	1	1	0.5	0.5	∞
Integration Time	E.2.8	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	3	R	1.732	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.8	R	1.732	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E.6.3	6.7	R	1.732	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E.5	4	R	1.732	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	1.732	1	1	2.9	2.9	∞
SAR Scaling	E.6.5	0	R	1.732	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	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Unceritainty	E.3.4	0.6	R	1.732	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

14 CONCLUSION

14.1 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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