

9.3 Bluetooth & Wi-Fi Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. 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 that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a 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. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

10 Conducted Output Power

10.1 Wi-Fi and BT Measurement result

The output power of BT antenna is as following:

Mode	Conducted Power (dBm)		
	Channel 0 (2402MHz)	Channel 39 (2441MHz)	Channel 78(2480MHz)
Bluetooth	7.49	9.27	7.67
Tune up	8	9.5	8

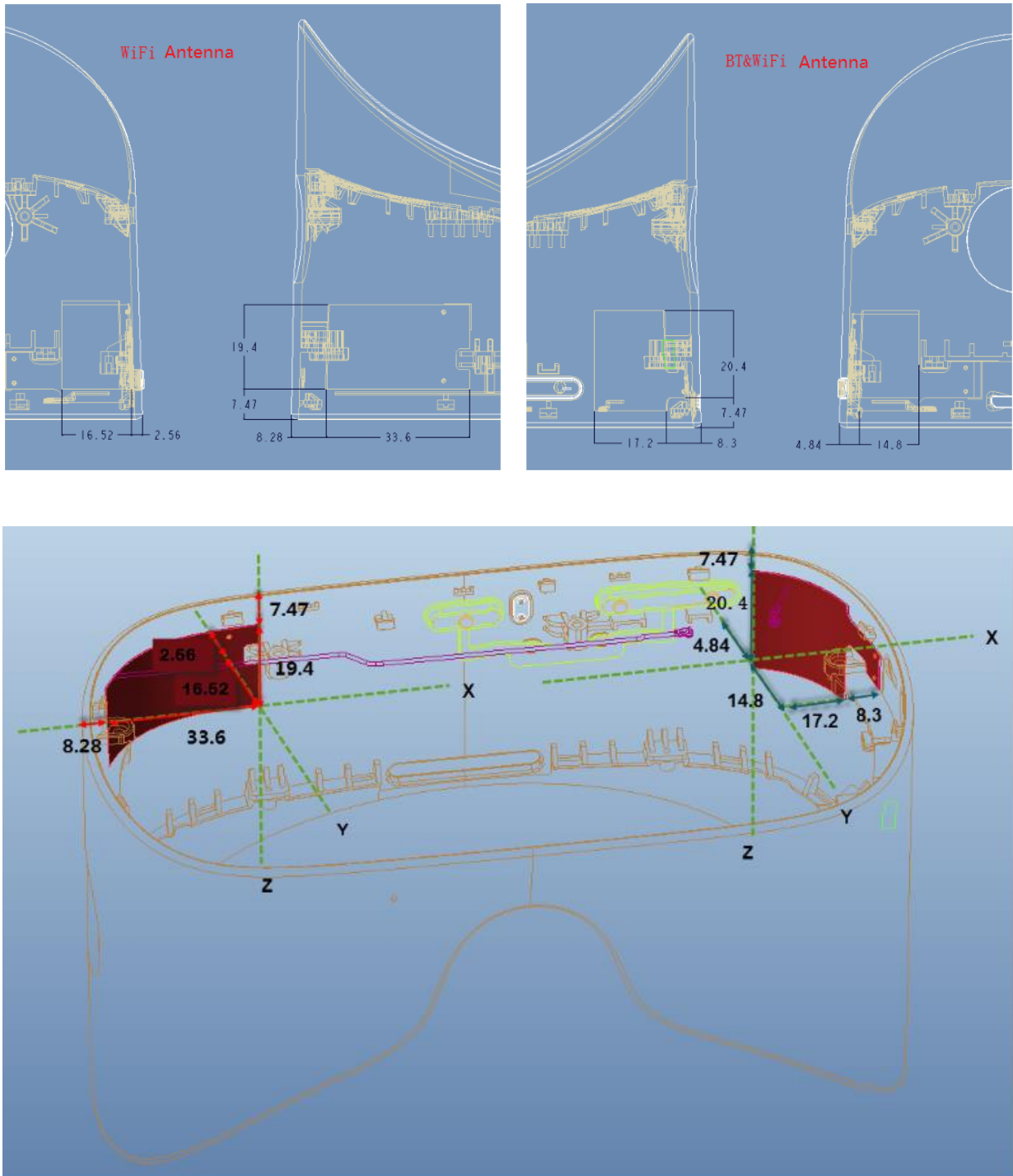
The average conducted power for Wi-Fi is as following:

Model	Channel	Freq. (MHz)	Avg. Power (Chain1) dBm	Avg. Power (Chain2) dBm	Avg. Power (MIMO) dBm	Tune up
11b	CH1	2412	19.32	19.51	22.43	24
	CH6	2437	19.35	19.42	22.40	24
	CH11	2462	19.17	19.36	22.28	24
11g	CH1	2412	17.21	17.43	20.33	22
	CH6	2437	18.32	18.46	21.40	23
	CH11	2462	15.95	16.26	19.12	20.5
11n HT20	CH1	2412	16.78	16.79	19.80	21.5
	CH6	2437	18.27	18.32	21.31	23
	CH11	2462	15.44	15.71	18.59	20
11n HT40	CH3	2422	15.60	15.82	18.72	20
	CH6	2437	17.63	17.84	20.75	22
	CH9	2452	14.92	15.17	18.06	19
11a UNII-1	CH36	5180	16.37	16.33	19.36	21
	CH40	5200	16.17	16.07	19.13	21
	CH44	5220	16.22	16.14	19.19	21
	CH48	5240	16.24	15.92	19.09	21
11a UNII-2A	CH52	5260	16.84	16.79	19.83	21
	CH56	5280	16.51	16.29	19.41	21
	CH60	5300	16.75	16.45	19.61	21
	CH64	5320	16.52	16.34	19.44	21
11a UNII-2C	CH100	5500	18.48	18.04	21.28	23
	CH104	5520	18.35	18.12	21.25	23
	CH108	5540	18.31	18.17	21.25	23
	CH112	5560	18.27	18.02	21.16	23
	CH116	5580	18.81	18.52	21.68	23
	CH120	5600	18.79	18.67	21.74	23
	CH124	5620	18.75	18.52	21.65	23
	CH128	5640	18.63	18.37	21.51	23
	CH132	5660	18.69	18.42	21.57	23
	CH136	5680	18.61	18.46	21.55	23
	CH140	5700	18.82	18.47	21.66	23

11a UNII-3	CH149	5745	18.26	18.23	21.26	23
	CH153	5765	18.13	18.18	21.17	23
	CH157	5785	18.02	18.07	21.06	23
	CH161	5805	18.14	18.21	21.19	23
	CH165	5825	18.64	18.76	21.71	23
11n HT20 UNII-1	CH36	5180	16.57	16.51	19.55	21
	CH40	5200	16.32	16.29	19.32	21
	CH44	5220	16.46	16.42	19.45	21
	CH48	5240	16.28	16.25	19.28	21
11n HT20 UNII-2A	CH52	5260	16.44	16.41	19.44	21
	CH56	5280	16.38	16.02	19.21	21
	CH60	5300	16.42	16.14	19.29	21
	CH64	5320	16.25	16.08	19.18	21
11n HT20 UNII-2C	CH100	5500	16.53	16.23	19.39	21
	CH104	5520	16.47	16.38	19.44	21
	CH108	5540	16.42	16.24	19.34	21
	CH112	5560	16.61	16.28	19.46	21
	CH116	5580	16.29	16.11	19.21	21
	CH120	5600	16.52	16.41	19.48	21
	CH124	5620	16.34	16.12	19.24	21
	CH128	5640	16.44	16.37	19.42	21
	CH132	5660	16.27	16.08	19.19	21
	CH136	5680	16.55	16.24	19.41	21
	CH140	5700	16.10	15.97	19.05	21
11n HT20 UNII-3	CH149	5745	18.15	18.18	21.18	23
	CH153	5765	18.24	18.18	21.22	23
	CH157	5785	18.38	18.34	21.37	23
	CH161	5805	18.17	18.32	21.26	23
	CH165	5825	17.96	18.22	21.10	23
11n HT40 UNII-1	CH38	5190	11.38	11.33	14.37	16
	CH46	5230	11.31	11.15	14.24	16
11n HT40 UNII-2A	CH54	5270	13.11	12.85	15.99	17
	CH62	5310	12.91	12.66	15.80	17
11n HT40 UNII-2C	CH102	5510	13.53	13.20	16.38	18
	CH110	5550	13.53	13.13	16.34	18
	CH118	5590	13.47	13.34	16.42	18
	CH126	5630	13.66	13.49	16.59	18
	CH134	5670	13.87	13.57	16.73	18
11n HT40 UNII-3	CH151	5755	17.99	17.89	20.95	22.5
	CH159	5795	17.81	17.78	20.81	22.5
11ac HT20 UNII-1	CH36	5180	16.02	15.96	19.00	20.5
	CH40	5200	15.95	15.88	18.93	20.5
	CH44	5220	15.93	15.89	18.92	20.5

	CH48	5240	16.05	15.93	19.00	20.5
11ac HT20 UNII-2A	CH52	5260	16.37	16.32	19.36	21
	CH56	5280	16.09	16.12	19.12	21
	CH60	5300	16.26	16.21	19.25	21
	CH64	5320	16.21	16.04	19.14	21
11ac HT20 UNII-2C	CH100	5500	16.35	16.17	19.27	21
	CH104	5520	16.32	16.16	19.25	21
	CH108	5540	16.28	16.14	19.22	21
	CH112	5560	16.37	16.28	19.34	21
	CH116	5580	16.76	16.54	19.66	21
	CH120	5600	16.55	16.22	19.40	21
	CH124	5620	16.33	16.17	19.26	21
	CH128	5640	16.29	16.05	19.18	21
	CH132	5660	16.24	16.21	19.24	21
	CH136	5680	16.37	16.19	19.29	21
11ac HT20 UNII-3	CH140	5700	16.36	16.46	19.42	21
	CH149	5745	18.33	18.29	21.32	23
	CH153	5765	17.98	18.05	21.03	23
	CH157	5785	18.05	18.11	21.09	23
	CH161	5805	18.19	18.24	21.23	23
11ac HT40 UNII-1	CH165	5825	18.01	18.13	21.08	23
	CH38	5190	12.35	12.43	15.40	17
11ac HT40 UNII-2A	CH46	5230	12.33	12.20	15.28	17
	CH54	5270	14.04	13.97	17.02	18
11ac HT40 UNII-2C	CH62	5310	13.85	13.57	16.72	18
	CH102	5510	13.41	13.25	16.34	18
	CH110	5550	13.50	13.06	16.30	18
	CH118	5590	13.38	12.99	16.20	18
	CH126	5630	13.42	12.96	16.21	18
11ac HT40 UNII-3	CH134	5670	13.77	13.53	16.66	18
	CH142	5710	17.81	17.74	20.79	22.5
11ac HT80 UNII-1	CH151	5755	17.53	17.59	20.57	22.5
11ac HT80 UNII-2A	CH42	5210	10.30	10.18	13.25	15
11ac HT80 UNII-2C	CH58	5290	11.29	11.17	14.24	16
11ac HT80 UNII-3	CH106	5530	12.78	12.13	15.48	17
	CH122	5610	12.44	12.56	15.51	17
	CH155	5775	16.24	16.39	19.33	21

11 Antenna Locations



Picture 11.1 Antenna Locations

12 Standalone SAR Test Exclusion Considerations

Standalone 1-g head SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g SAR test exclusion threshold for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$\left[\frac{(\text{max. power of channel, including tune-up tolerance, mW})}{(\text{min. test separation distance, mm})} \right] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$$
 for 1-g SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

Table 12.1: Standalone SAR test exclusion considerations

Band/Mode	F(GHz)	Position	SAR test exclusion threshold(mW)	RF output power		SAR test exclusion
				dBm	mW	
Bluetooth	2.441	Head	9.60	9.5	8.91	Yes
WLAN 2.4GHz	2.45	Head	9.58	24	251.2	No
WLAN 5GHz	5.3	Head	6.52	21	125.9	No
	5.6	Head	6.34	23	199.5	No
	5.8	Head	6.23	23	199.5	No

13 SAR Test Result

The calculated SAR is obtained by the following formula:

$$\text{Reported SAR} = \text{Measured SAR} \times 10^{(P_{\text{Target}} - P_{\text{Measured}})/10}$$

Where P_{Target} is the power of manufacturing upper limit;

P_{Measured} is the measured power in chapter 10.

13.1 WLAN Evaluation for 2.4G

Table 13.1-1: SAR Values – 802.11b

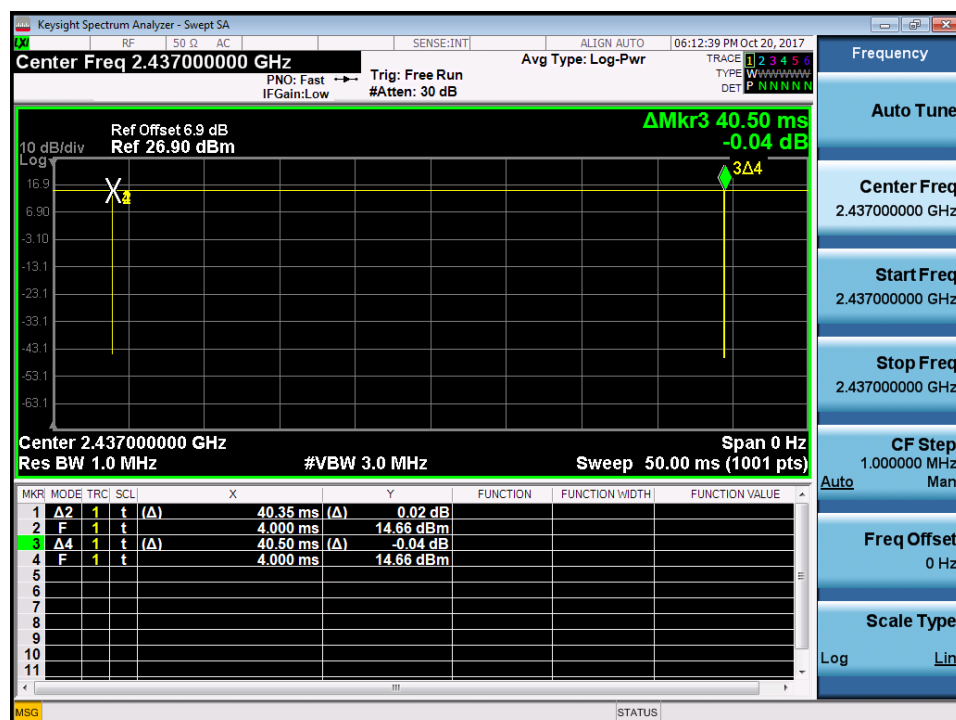
Ambient Temperature: 22.9 °C					Liquid Temperature: 22.5°C				
Frequency		Mode	Figure No.	Conducted Power (dBm)	Max. tune-up Power (dBm)	Measured SAR(10g) (W/kg)	Reported SAR(10g) (W/kg)	Measured SAR(1g) (W/kg)	Reported SAR(1g) (W/kg)
MHz	Ch.								
2412	1	802.11b	Fig.1	22.43	24	0.113	0.16	0.205	0.29

According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. The scaled reported SAR is presented as below.

Table 13.1-2: SAR Values – 802.11b (Scaled Reported SAR)

Frequency			Mode	Actual duty factor	maximum duty factor	Reported SAR (1g)(W/kg)	Scaled reported SAR (1g)(W/kg)
MHz	Ch.						
2412	1		802.11b	99.63%	100%	0.29	0.29

SAR is not required for OFDM because the 802.11b adjusted SAR ≤ 1.2 W/kg.



Picture 13.1 Duty factor plot for 2.4G

13.2 WLAN Evaluation For 5G

Table 13.2-1: OFDM mode specified maximum output power of WLAN antenna

802.11 mode	a	g	n		ac			
Ch. BW(MHz)	20	20	20	40	20	40	80	160
U-NII-1	X		X	X	X	X	X	
U-NII-2A	X		X	X	X	X	X	
U-NII-2C	X		X	X	X	X	X	
U-NII-3	X		X	X	X	X	X	
§ 15.247 (5.8 GHz)								

X: maximum(conducted) output power(mW), including tolerance, specified for production units

Table 13.2-2: Maximum output power specified of WLAN antenna

802.11 mode	a	g	n		ac			
Ch. BW(MHz)	20	20	20	40	20	40	80	160
U-NII-1	126		126	40	112	50	32	
U-NII-2A	126		126	50	126	63	40	
U-NII-2C	200		126	63	126	63	50	
U-NII-3	200		200	178	200	178	126	
§ 15.247 (5.8 GHz)								

- The maximum output power specified for production units is the same for all channels, modulations and data rates in each channel bandwidth configuration of the 802.11a/g/n/ac modes.
- The **blue highlighted** cells represent highest output configurations in each standalone or aggregated frequency band, with tune-up tolerance included.

Table 13.2-3: Maximum output power measured of WLAN antenna, for the applicable OFDM configurations according to the default power measurement procedures for selection initial test configurations

802.11 mode	a	n		ac		
BW(MHz)	20	20	40	20	40	80
U-NII-1	36/40/44/48 86/82/83/81	36/40/44/48 Lower power	38/46 Lower power	36/40/44/48 Lower power	38/46 Lower power	42 Lower power
U-NII-2A	52/56/60/64 96/87/91/88	52/56/60/64 Lower power	54/62 Lower power	52/56/60/64 Lower power	54/62 Lower power	58 Lower power
U-NII-2C	100/104/108/112 134/133/133/131 116/ 120 /124/128 147/149/146/142 132/136/140 143/143/147	100/104/108/112 116/132/136/140 Lower power	102/110/134 Lower power	100/104/108 /112 116/132/136/ 140 Lower power	102/110/134 Lower power	106/122 Lower power
U-NII-3	149/153/157/161/ 165 134/131/128/131/148	149/153/157/16 1/165 Lower power	151/159 Lower power	149/153/157 /161/165 Lower power	151/159 Lower power	155 Lower power

- Channels with measured maximum power within 0.25dB are considered to have the same measured output. Channels selected for initial test configuration are **highlighted in yellow**.