SONOS

Antenna Test Report

Aug 1, 2024

FCC ID:	SBVRM019
IC:	5373A-RM019
Model:	S19
Product Description:	802.11 a/b/g/n(HT20) Master Device with BLE and NFC
Test Engineer:	Gregory Best

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1. Measurement Method

Antenna Measurements in Anechoic Chambers The influence of atmospheric conditions and surrounding objects are non-ideal for accurate antenna measurements. An anechoic chamber offers a non-reflective, no-echo room for performing the antenna measurements. The anechoic chamber can simulate outer space, which is the most ideal location for antenna measurements. All gain measurements were performed in accordance with IEEE Std. 149 (IEEE Standard Procedures for Antenna Measurements). Losses of any test test cables were calibrated out post-measurement. Please refer to Figure 1 as the measurement chamber diagram.

1. Perform chamber calibration using reference antennas

2. Center the EUT in the chamber using the laser alignment system.

3. Connect the antenna micro-coax cable to the mast cable.

4. Capture antenna gain pattern using the automated measurement software.

5. Export the measurement data.

6. De-embed any additional cable losses in the setup (i.e., losses of any test cables that are not present in the actual product assembly).

7. Post-process measured data to extract the peak gain per antenna (take the maximum of the measured individual antenna pattern).

8. Combine antenna patterns per spatial point using the equations below (provided in KDB 662911, details outline in approved PAG submission) for correlated and uncorrelated gains, respectively

$$\text{Directional gain} = 10\log[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 / N_{ANT}]\ \text{dBi}$$

Eq 1. Correlated Directional Gain Calculation

$$\text{Directional gain} = 10\log[(10^{G1/10} + 10^{G2/10} + \ldots + 10^{GN/10}) / N_{ANT}]\ \text{dBi}$$

Eq 2. Uncorrelated Directional Gain Calculation

9. Take the maximum of the combined directional gain pattern.

Example Math for ANT0 + ANT1 (at the spatial location where the highest combined gain occurs):

Directional Gain = 10*log((10^(%%%/20) + 10^(%%%/20))^2 / 2) dBi = 5.3 dBi

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2. Antenna Information

Antenna Designation	Sonos P/N	Band of Operation	Description
ANT0	105-00139	2.4 & 5 GHz	Dual-band Dipole with Coaxial Cable, WLAN
ANT1	105-00140	2.4 & 5 GHz	Dual-band Dipole with Coaxial Cable, WLAN
ANT2	105-00141	2.4 & 5 GHz	Dual-band Dipole with Coaxial Cable, WLAN
ANT3	105-00142	2.4 & 5 GHz	Dual-band Dipole with Coaxial Cable, WLAN

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3. Antenna Gain

Antenna Gains: Radio 0

Backhaul Radio					
	SISO Gain		MIMO Correlated Gain		Mimo Un-Correlated Gain
	Chain	Highest Peak (dBi)	Ant Combo	Highest Peak (dBi)	Highest Peak (dBi)
U-NII 1 5150 - 5250 MHz	139	3.8	139+140+141+142	5.0	1.6
	140	1.6			
	141	5.1			
	142	7.4			
U-NII 2A 5250 - 5350 MHz	139	3.5	139+140+141+142	4.9	1.2
	140	1.9			
	141	6.2			
	142	7.1			
U-NII 2C	139	3.4	139+140+141+142	5.6	1.1
	140	1.9			
	141	5.3			
	142	6.6			
U-NII 3	139	2.5	139+140+141+142	4.8	-0.1
	140	1.0			
	141	4.7			
	142	5.4			

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4. Antenna Test Chamber Details

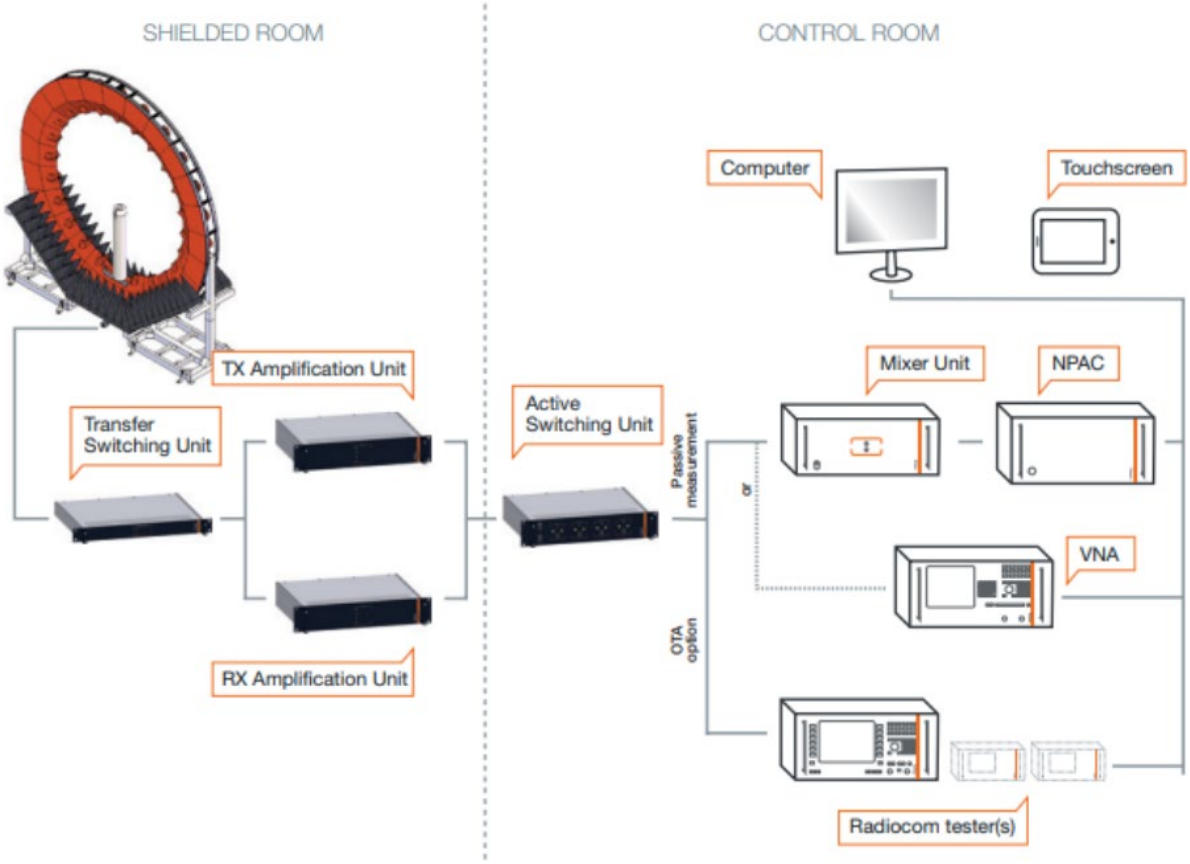

Figure 1. Measurement Chamber Diagram

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Test dates	Jan 22 – Feb 9, 2024
Engineers	Michael Strack Yuchan Lu Greg Best
Calibrated test equipment used	MVG SG24S E5071C ENA MVG Standard Reference Dipoles 1. SD2450 2. SD5150 3. SD5650 4. WD6000
Commercial test software used	SatEnv (MVG) WaveStudio (MVG) MATLAB R2022b (Mathworks)

Table 1. Calibrated Test Equipment

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Test Location

Sonos Antenna Chamber, 2 Avenue de Lafayette, Boston, MA 02111 USA.

Peak Gain was measured using the antenna test chamber. The antennas for S19 were measured in the full product assembly.

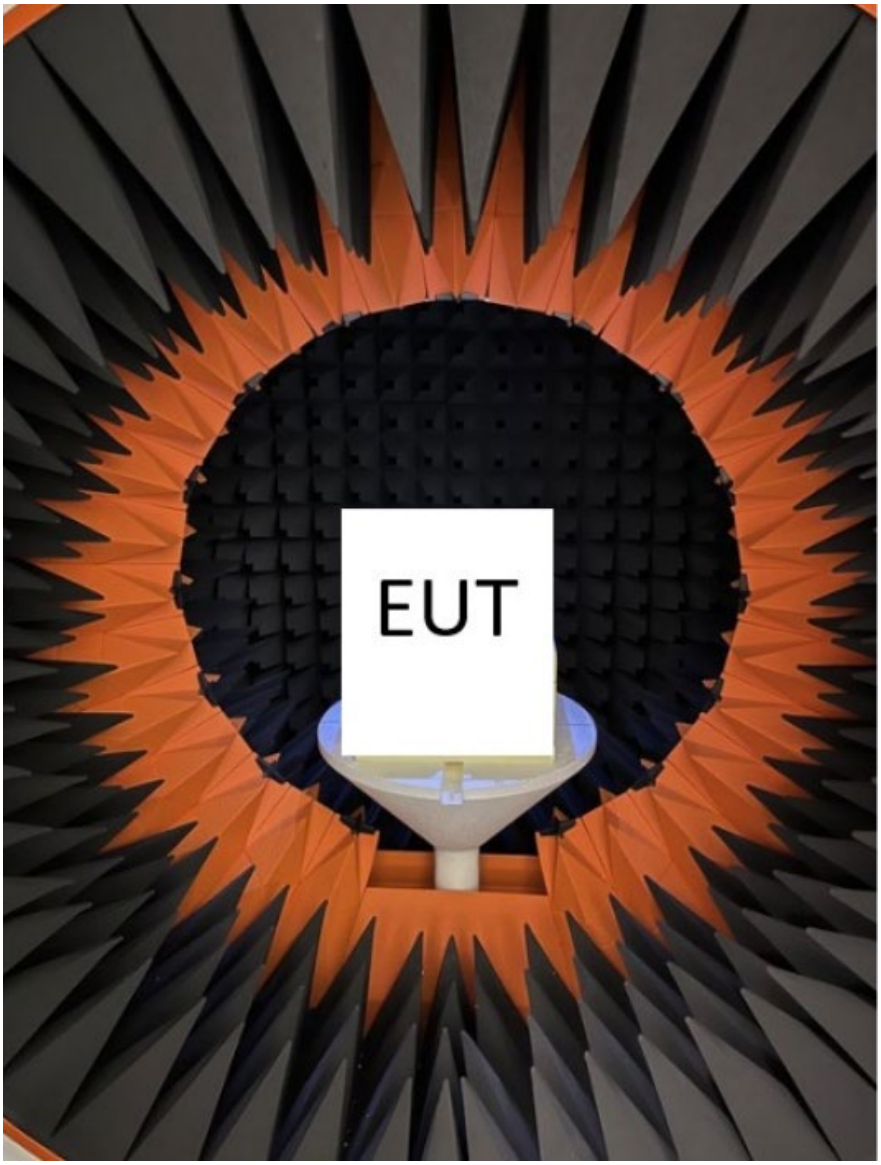

Figure 2.EUT placed inside the test chamber

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5. Test Equipment List

Description	Manufacturer	ID Number
Antenna Measurement System	MVG	Sonos 02

-END-

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