

# **CERTIFICATION TEST REPORT**

**Report Number. :** 11526444-E2V4

- Applicant : SONOS, INC. 614 CHAPALA STREET SANTA BARBARA, CA, 93101, U.S.A.
  - Model : S13
  - FCC ID : SBVRM012
- **EUT Description** : 802.11 a/b/g/n (HT20) Client Device
- **Test Standard(s)** : FCC 47 CFR PART 15 SUBPART E (Except DFS)

Date Of Issue: July 31, 2017

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NVLAP LAB CODE 200065-0

**Revision History** 

Rev.	lssue Date	Revisions	Revised By
V1	06/30/17	Initial Issue	D. Coronia
V2	07/18/17	Updated Section 6 & 9.3.3 (updated PSD limit)	D. Coronia
V3	07/24/17	Updated Section 6 & 10.2	D. Coronia
V4	07/31/17	Updated Section 9.3.3, 9.9.4, 10.1 & remove below 30MHz data	D. Coronia

Page 2 of 241

# TABLE OF CONTENTS

1.		ATTESTATION OF TEST RESULTS	5
2.	-	TEST METHODOLOGY	6
3.		FACILITIES AND ACCREDITATION	6
4.	(	CALIBRATION AND UNCERTAINTY	7
2	4. 1	1. MEASURING INSTRUMENT CALIBRATION	7
2	4.2	2. SAMPLE CALCULATION	7
2	4.3	3. MEASUREMENT UNCERTAINTY	7
5.		EQUIPMENT UNDER TEST	8
ł	5. 1	1. DESCRIPTION OF EUT	8
Ę	5.2	2. MAXIMUM OUTPUT POWER	8
ł	5.3	3. DESCRIPTION OF AVAILABLE ANTENNAS	8
Ę	5.4	4. SOFTWARE AND FIRMWARE	8
Ę	5.5	5. WORST-CASE CONFIGURATION AND MODE	9
ł	5.6	6. DESCRIPTION OF TEST SETUP	10
6.	-	TEST AND MEASUREMENT EQUIPMENT	12
7.	ļ	SUMMARY TABLE	13
7. 8.	ŝ	SUMMARY TABLE	13 14
7. 8. 9.		SUMMARY TABLE MEASUREMENT METHODS ANTENNA PORT TEST RESULTS	13 14 15
7. 8. 9.	9. 1	SUMMARY TABLE	13 14 15 15
7. 8. 9.	;     	SUMMARY TABLE	13 14 15 15 16
7. 8. 9.	9.1 9.2	SUMMARY TABLE	13 14 15 15 16 16
7. 8. 9.	9.2 9.2	SUMMARY TABLE MEASUREMENT METHODS ANTENNA PORT TEST RESULTS 1. ON TIME, DUTY CYCLE 2. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND 9.2.1. 26 dB BANDWIDTH 9.2.2. 99% BANDWIDTH 9.2.3. OUTPUT POWER AND PPSD	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>24</i>
7. 8. 9.	9. 1 9. 2 9. 3	SUMMARY TABLE MEASUREMENT METHODS ANTENNA PORT TEST RESULTS 1. ON TIME, DUTY CYCLE 2. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND 9.2.1. 26 dB BANDWIDTH 9.2.2. 99% BANDWIDTH 9.2.3. OUTPUT POWER AND PPSD 3. 11n HT20 3TX CDD MIMO MODE IN THE 5.2GHz BAND.	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>24</i> <i>30</i>
7. 8. 9.	9.1 9.2 9.3	SUMMARY TABLE	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>24</i> <i>30</i> <i>30</i> <i>30</i> <i>36</i>
7. 8. 9.	9. 1 9. 2 9. 3 9. 3	SUMMARY TABLE       T         MEASUREMENT METHODS       T         ANTENNA PORT TEST RESULTS       T         1. ON TIME, DUTY CYCLE       T         2. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND       T         9.2.1. 26 dB BANDWIDTH       T         9.2.2. 99% BANDWIDTH       T         9.2.3. OUTPUT POWER AND PPSD       T         3. 11n HT20 3TX CDD MIMO MODE IN THE 5.2GHz BAND       T         9.3.1. 26 dB BANDWIDTH       T         9.3.2. 99% BANDWIDTH       T         9.3.3. OUTPUT POWER AND PPSD       T	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>24</i> <i>30</i> <i>36</i> <i>42</i>
7. 8. 9.	9.1 9.2 9.3	SUMMARY TABLE	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>30</i> <i>30</i> <i>36</i> <i>42</i> <i>50</i>
7. 8. 9.	9.1 9.2 9.3 9.4	SUMMARY TABLE	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>24</i> <i>30</i> <i>36</i> <i>42</i> <i>50</i> <i>54</i>
7. 8. 9.	9.1 9.2 9.3 9.4 9.4	SUMMARY TABLE       MEASUREMENT METHODS         ANTENNA PORT TEST RESULTS	<b>13</b> <b>14</b> <b>15</b> <i>16</i> 16 20 24 <i>30</i> 36 42 <i>50</i> 54 55 54 55
7. 8. 9. 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	9.3 9.4 9.2	SUMMARY TABLE       MEASUREMENT METHODS         ANTENNA PORT TEST RESULTS	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>30</i> <i>36</i> <i>42</i> <i>50</i> <i>54</i> <i>56</i> <i>56</i> <i>56</i> <i>56</i> <i>56</i> <i>56</i> <i>56</i> <i>56</i>
7. 8. 9. 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	9. 1 9. 1 9. 2 9. 2 9. 2 9. 2 9. 2 9. 2 9. 2 9. 2	SUMMARY TABLE	<b>13</b> <b>14</b> <b>15</b> <i>16</i> <i>16</i> <i>20</i> <i>30</i> <i>36</i> <i>42</i> <i>50</i> <i>54</i> <i>58</i> <i>63</i> <i>63</i> <i>63</i> <i>63</i>

FCC ID:	SBVRM012	
9.5 9.5	5.2. 99% BANDWIDTH 5.3. OUTPUT POWER AND PPSD	69 75
9.6.	11n HT20 2TX CDD MIMO MODE IN THE 5.6GHz BAND	
9.6		
9.6		86 00
9.0 0 <del>-</del>		
9.7.	11n H120 31X CDD MIMO MODE IN THE 5.6GHZ BAND	
9.7	7.2. 99% BANDWIDTH	
9.7	7.3. OUTPUT POWER AND PPSD	
9.8.	11n HT20 2TX CDD MIMO MODE IN THE 5.8GHz BAND	
9.8	3.1. 6 dB BANDWIDTH	114
9.8	3.2. 26 dB BANDWIDTH	
9.8		
9.0		
9.9.	11n H120 31X CDD MIMO MODE IN THE 5.8GHz BAND	
9.9	0.2. 26 dB BANDWIDTH	
9.9	9.3. 99% BANDWIDTH	143
9.9	9.4. OUTPUT POWER AND PSD	149
10. F	RADIATED TEST RESULTS	156
10.1.	LIMITS AND PROCEDURE	
10.	.1.1. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND	
10.	1.3. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHZ BAND	
10.	.1.4. 11n HT20 3TX CDD MIMO MODE IN THE 5.3GHz BAND	
10.	.1.5. 11n HT20 2TX CDD MIMO MODE IN THE 5.6GHz BAND	
10.	.1.6. 11n HT20 3TX CDD MIMO MODE IN THE 5.6GHz BAND	
10.	1.8 11n HT20 2TX CDD MIMO MODE IN THE 5.8GHZ BAND	209 219
10.2.	WORST-CASE BELOW 1 GHz	
10.3.	WORST-CASE 18 to 26 GHz	
10.4.	WORST-CASE 26 to 40 GHz	233
11. /	ART POWER SETTINGS TABLE FOR CONDUCTED AND RADIATED MEASU	REMENTS235
11.1.	CONDUCTED OUTPUT POWER SETTING FOR 2x2:	235
11.2.	CONDUCTED OUTPUT POWER SETTING FOR 3x3:	235
11.3.	RADIATED BANDEDGE POWER SETTING FOR 2x2:	236
11.4.	RADIATED BANDEDGE POWER SETTING FOR 3x3:	236
12. /	AC POWER LINE CONDUCTED EMISSIONS	237
13. 5	SETUP PHOTOS	240

Page 4 of 241

### **1. ATTESTATION OF TEST RESULTS**

COMPANY NAME: SONOS, INC. 614 CHAPALA STREET SANTA BARBARA, CA 93101, U.S.A.				
EUT DESCRIPTION:	T DESCRIPTION: 802.11 a/b/g/n (HT20) Client Device			
MODEL:	MODEL: S13			
SERIAL NUMBER: 170378-28-CA-10-05-CC-2, 170378-28-CA-10-05-CC-0, 170378- 00-07-80-E			-28-CA-	
DATE TESTED:	MARCH 27 TO MAY 16, 2017			
	APPLICABLE STANDARDS			
STANDARD TEST RESULTS				
CFR 47 Part 15 Subpart E (Except DFS) Pass				

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

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

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Page 5 of 241

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v01r02/D03 v01r01/D06 v01, FCC KDB 789033 D02 v01r01, FCC KDB 644545 D03 v01, ANSI C63.10-2013.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
🛛 Chamber A (IC:2324B-1)	Chamber D (IC:22541-1)
Chamber B (IC:2324B-2)	Chamber E (IC:22541-2)
Chamber C (IC:2324B-3)	Chamber F (IC:22541-3)
	Chamber G (IC:22541-4)
	Chamber H (IC:22541-5)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <u>http://ts.nist.gov/standards/scopes/2000650.htm</u>.

Page 6 of 241

# 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

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

### 4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB - 26.9 dB = 28.9 dBuV/m

### 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

Uncertainty figures are valid to a confidence level of 95%.

Page 7 of 241

# 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

The EUT is 802.11 a/b/g/n (HT20) Client Device. Product model S13 is a high-performance all-in-one wireless smart speaker and part of Sonos' home sound system. S13 adds integrated voice control functionality with far field microphones. Moreover, the device will support multiple voice platforms and music services, allowing customers to effortlessly control their music on Sonos.

### 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

222.	
<u> </u>	

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11n HT20 CDD 2TX	19.38	86.70
5260 - 5320	802.11n HT20 CDD 2TX	20.48	111.69
5500 - 5700	802.11n HT20 CDD 2TX	20.16	103.75
5745 - 5825	802.11n HT20 CDD 2TX	20.90	123.03

<u>3x3:</u>

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11n HT20 CDD 3TX	21.55	142.89
5260 - 5320	802.11n HT20 CDD 3TX	20.14	103.28
5500 - 5700	802.11n HT20 CDD 3TX	19.90	97.72
5745 - 5825	802.11n HT20 CDD 3TX	21.94	156.31

NOTE: Covered modes are test reduction modes. The output powers on the covered modes are equal to or less than the mode referenced and use the same modulation.

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an integrated antenna, with a maximum gain as follows:

	Peak Antenna Gain (dBi)			
Frequency (GHz)	Chain 0	Chain 1	Chain 2	
5180 - 5825	3.41	2.26	4.22	

### 5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Atheros Radio Test 2 (ART2-GUI).

Page 8 of 241

### 5.5. WORST-CASE CONFIGURATION AND MODE

Radiated bandage, harmonics, and spurious emissions from 1 GHz to 18GHz were performed. The EUT was set to transmit at the Low/Middle/High channels with designed (target) output powers.

Radiated emission below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT was set to transmit at the channel with highest output power as worst-case scenario.

The EUT can only be setup in desktop orientation; therefore, all radiated testing was performed with the EUT in desktop orientation.

Worst-case data rates as provided by the client was: 802.11n HT20 mode: 26 Mbps (MCS3)

Page 9 of 241

### 5.6. DESCRIPTION OF TEST SETUP

#### SUPPORT EQUIPMENT

Support Equipment List						
Description	Manufacturer	Model	Serial Number	FCC ID		
Laptop	Lenovo	X230	PK1D7EM			
AC Adapter	Lenovo	42T4418	11S42T4418Z1ZF3B048J2Z			

### I/O CABLES

I/O Cable List							
Cable Port #of identical Connector Cable Type Cable Remarks							
No		ports	Туре		Length (m)		
1	AC Power	1	AC	Unshielded	1	AC Mains to EUT	
2	Ethernet	1	RJ45	Unshielded	10	EUT to Laptop	
3	DC Power	1	DC	Shielded	1.2	AC/DC Adapter to Laptop	
4	AC Power	1	AC	Unshielded	1	AC Mains to AC/DC Adapter	

### TEST SETUP

The EUT is a stand-alone unit and connected to support laptop via Ethernet cable. The Atheros Radio Test 2 (ART2-GUI) test software is exercising the EUT during testing.

Page 10 of 241

### SETUP DIAGRAM



Page 11 of 241

# 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List							
Description	Manufacturer	Model	T No.	Cal Date	Cal Due		
Amplifier, 1 - 18GHz	Miteq	AFS42	1165	08/01/16	08/01/17		
Amplifier, 1-26.5GHz	Agilent	8449B	404	07/05/16	07/05/17		
Amplifier, 26-40GHz	Miteq	NSP 4000 SP2	88	04/29/17	04/29/18		
Amplifier, 10KHz to 1GHz, 32dB	Keysight	8447D	10	02/01/17	02/01/18		
Antenna, Broadband Hybrid 30MHz to 2000MHz	Sunol Science	JB1	130	09/01/16	09/01/17		
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	711	01/30/17	01/30/18		
Antenna, Horn 18-26.5GHz	ARA	MWH-2640/B	449	07/08/16	07/08/17		
Antenna, Horn 26.5-40GHz	ARA	MWH-2640/B	446	06/12/16	06/12/17		
Power Meter	Keysight	N1911A	1269	03/29/17	03/29/18		
Wideband Power Sensor	Keysight	N1921A	1224	03/29/17	03/29/18		
USB RF Power Sensor 10Mhz-6Ghz	ETS-LINDGREN	7002-006	1081	11/18/16	11/18/17		
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	1210	06/30/16	06/30/17		
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	907	01/23/17	01/23/18		
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	146	07/13/16	07/13/17		
LISN	FISCHER	FCC-LISN-50/250-25-2-01	T1310	06/08/16	06/08/17		

Test Software List					
Description	Manufacturer	Model	Version		
Radiated Software	UL	UL EMC	Ver 9.5, Apr 26, 2016		
Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		
Antenna Port Software	UL	UL RF	Ver 6.0, Jan 19, 2017		

The following test and measurement equipment was utilized for the tests documented in this report:

NOTE: \*testing is completed before equipment calibration expiration date.

Page 12 of 241

# 7. SUMMARY TABLE

FCC Part Section	Test Description	Test Limit	Test Condition	Test Result
§15.407 (a)	Occupied Band width (26dB)	N/A		Pass
§15.407	6dB Band width (5.8Ghz)	>500KHz		Pass
§15.407 (a)(1)	TX Cond. Power 5.15-5.25 GHz	<24dBm (FCC) / <23 dBm EIRP or <10+10Log(99% BW) EIRP (IC)		Pass
§15.407 (a)(2)	TX Cond. Power 5.25-5.35 & 5.47- 5.725 GHz	<24dBm or <11+10log (OBW) (FCC) / <24 dBm or <11+10Log(99% BW) (IC)		Pass
§15.407 (a)(3)	TX Cond. Power 5.725-5.850 GHz	<30dBm	Conducted	Pass
§15.407 (a)(1)	PSD (5.15-5.25 GHz)	<11dBm/MHz (FCC) <10 dBm/MHz EIRP (IC)		Pass
§15.407 (a)(2)	PSD (5.3,5.5GHz)	<11dBm/MHz		Pass
§15.407 (a)(3)	PSD (5.8GHz)	<30dBm per 500kHz		Pass
§15.207 (a) §15.407(b) (6)	AC Power Line conducted emissions	Section 10		Pass
§15.407 (b) & 15.209	Radiated Spurious Emission	<54dBuV/m	Radiated	Pass

Page 13 of 241

# 8. MEASUREMENT METHODS

On Time and Duty Cycle: KDB 789033 D02 v01r03, Section B.

6 dB Emission BW: KDB 789033 D02 v01r03, Section C.2.1

26 dB Emission BW: KDB 789033 D02 v01r03, Section C.

<u>99% Occupied BW</u>: KDB 789033 D02 v01r03, Section D.

Conducted Output Power: KDB 789033 D02 v01r03, Section E.3.b (Method PM-G) and KDB 662911 D01 v02r01.

Power Spectral Density: KDB 789033 D02 v01r03, Section F and KDB 662911 D01 v02r01.

Unwanted emissions in restricted bands: KDB 789033 D02 v01r03, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v01r03, Sections G.3, G.4, and G.5.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Page 14 of 241

# 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME, DUTY CYCLE

### LIMITS

None; for reporting purposes only.

### PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

### **RESULTS**

Mode	<b>ON</b> Time	Period	Duty Cycle	Duty	Duty Cycle	1/T
	В		x	Cycle	<b>Correction Factor</b>	Minimum VBW
	(msec)	(msec)	(linear)	(%)	(dB)	(kHz)
802.11n HT20	0.499	0.544	0.917	91.7%	0.37	2.004

### **DUTY CYCLE PLOTS**



Page 15 of 241

### 9.2. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND

### 9.2.1. 26 dB BANDWIDTH

### LIMITS

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)
Low	5180	23.60	38.20
Mid	5200	25.30	40.65
High	5240	25.05	32.45

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Page 16 of 241





Page 17 of 241





Page 18 of 241





Page 19 of 241

### 9.2.2. 99% BANDWIDTH

### **LIMITS**

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)
Low	5180	17.5253	17.6829
Mid	5200	17.3552	17.7205
High	5240	17.4165	17.5243

Page 20 of 241

Chain 0 OBW , CH LOW	L [Freq/Channel]
Ch Freq 5.18 GHz Occupied Bandwidth Averages: 20	Trig Free 5.18000000 GHz
APv6.7(050417),GE43578, Cond B	Start Freq 5.16000000 GHz
Ref 20 dBm #Atten 30 dB *Samp Log 10 dB/	Stop Freq           5.20000000 GHz           CF Step
Offst 11.4 dB	4.00000000 MHz <u>Auto</u> Man <b>Freq Offset</b> 0.00000000 Hz
Lenter 5.180 00 GHZ           *Res BW 360 kHz         #VBW 1.1 MHz         Sweep 1.0	066 ms (1000 pts)
Occupied Bandwidth осс вм % 17.5253 MHz	Рыг 99.00 % On <u>Off</u> х dB -26.00 dB
Transmit Freq Error-45.958 kHzx dB Bandwidth21.573 MHz*	
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Page 21 of 241

Chain 0 OBW , CH MID		
🔆 Agilent 18:15:37 May 16, 2017	L	Freq/Channel
<b>Ch Freq</b> 5.2 GHz Occupied Bandwidth	Trig Free Averages: 20	Center Freq 5.20000000 GHz
APv6.7(050417),GE43578, Cond B		Start Freq 5.18000000 GHz
Ref 20 dBm #Atten 30 dB #Samp Log		<b>Stop Freq</b> 5.22000000 GHz
dB/ Offst		<b>CF Step</b> 4.0000000 MHz <u>Auto</u> Man
dB         VIII         VIIII           Center 5.200 00 GHz         +UPU 1 1 MU           Poo BU 360 kHz         +UPU 1 1 MU	Span 40 MHz	FreqOffset 0.00000000 Hz
Occupied Bandwidth 17.3552 MHz	Occ BW % Pwr 99.00 % × dB -26.00 dB	Signal Track <sup>On <u>Off</u></sup>
Transmit Freq Error 58.958 kHz × dB Bandwidth 21.244 MHz*		
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Page 22 of 241

Chain 0 OBW , CH HIGH ∦ Agilent 18:29:37 May 16, 2017 L	Freq/Channel
Ch Freq 5.24 GHz Trig Free Occupied Bandwidth Averages: 20	Center Freq 5.24000000 GHz
APv6.7(050417),GE43578, Cond B	Start Freq 5.22000000 GHz
Ref 20 dBm #Atten 30 dB #Samp Log ★ Activity Anticipation of Anticipation Activity Anticipation Activity Activ	<b>Stop Freq</b> 5.26000000 GHz
10 dB/ 0ffst 11.4	<b>CF Step</b> 4.00000000 MHz <u>Auto</u> Man
dB         WM         Span 40 MHz           Center 5.240 00 GHz         Span 40 MHz         Span 40 MHz           #Res BU 360 kHz         #VBU 11 MHz         Sween 1.066 ms (1.000 ptc)	FreqOffset 0.00000000 Hz
Occupied Bandwidth         осс вм % Рыг         99.00 %           17.4165 MHz         * dB         -26.00 dB	Signal Track <sup>On <u>Off</u></sup>
Transmit Freq Error -42.763 kHz x dB Bandwidth 21.960 MHz*	
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Page 23 of 241

### 9.2.3. OUTPUT POWER AND PPSD

### LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Page 24 of 241

### TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

#### **DIRECTIONAL ANTENNA GAIN**

For Power, the TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	Uncorrelated Chains
Antenna	Antenna	Directional
Gain	Gain	Gain
(dBi)	(dBi)	(dBi)
3.41	2.26	2.87

For PSD, The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	<b>Correlated Chains</b>
Antenna	Antenna	Directional
Gain	Gain	Gain
(dBi)	(dBi)	(dBi)
3.41	2.26	5.86

Page 25 of 241

### RESULTS

**ID:** GE43578 **Date:** 5/16/17

#### Antenna Gain and Limits

Channel	Frequency	Directional	Directional	Power	PSD
		Gain	Gain	Limit	Limit
		for Power	for PSD		
	(MHz)	(dBi)	(dBi)	(dBm)	(dBm)
Low	5180	2.87	5.86	24.00	11.00
Mid	5200	2.87	5.86	24.00	11.00
High	5240	2.87	5.86	24.00	11.00

Duty Cycle CF (dB)	0.37	Included in Calculations of Corr'd PSD
	0.07	

#### **Output Power Results**

Channel	Frequency	Chain 0	Chain 1	Total	Power	Power
		Meas	Meas	Corr'd	Limit	Margin
		Power	Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5180	15.39	17.04	19.30	24.00	-4.70
Mid	5200	15.46	17.12	19.38	24.00	-4.62
High	5240	15.42	17.08	19.34	24.00	-4.66

#### PSD Results

Channel	Frequency	Chain 0	Chain 1	Total	PSD	PSD
		Meas	Meas	Corr'd	Limit	Margin
		PSD	PSD	PSD		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5180	4.135	5.825	8.44	11.00	-2.56
Mid	5200	4.308	5.990	8.61	11.00	-2.39
High	5240	4.226	5.545	8.32	11.00	-2.68

<u>Note:</u> the power readings above were measured with gated method, and the measurement was taken only during the ON time. No duty cycle correction was necessary.

Page 26 of 241





Page 27 of 241





Page 28 of 241





Page 29 of 241

### 9.3. 11n HT20 3TX CDD MIMO MODE IN THE 5.2GHz BAND

### 9.3.1. 26 dB BANDWIDTH

### <u>LIMITS</u>

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	26 dB BW Chain 0	26 dB BW Chain 1	26 dB BW Chain 2
		(MHZ)	(MHZ)	(MHZ)
Low	5180	26.30	38.55	38.25
Mid	5200	26.85	36.55	35.05
High	5240	26.60	33.30	32.10

Page 30 of 241





Page 31 of 241





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Page 33 of 241





Page 34 of 241



Page 35 of 241

### 9.3.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)
Low	5180	17.775	17.895	17.972
Mid	5200	17.845	17.918	17.950
High	5240	17.770	17.902	17.815

Page 36 of 241

L RF 50 Q DC	),44350, Temp A	SENSE:INT	LIGN AUTO 02:31:15 AM Mar 3	1, 2017
enter Freq 5.18000000	GHz Cente Trig: I	r Freq: 5.180000000 GHz Free Run Avg Hold:	Radio Std: None 20/20	Frequency
	#IFGain:Low #Atter	n: 30 dB	Radio Device: B	TS
Ref Offset 14.4 dE	•			
00	por in many man in marker	ung performance	<b>~</b>	5 18000000 G
1.0	<u>/</u>			
1.0			Mylenaplicand de below	<u> </u>
			- in Arton Individ	CHA4
1.0				— <b> </b>
0.0				
10				
enter 5.18 GHz Res BW 360 kHz	#	VBW 1.1 MHz	Span 40 Sweep	MHZ CF St 1 ms 4 000000 M
Occupied Bandwidt	•	Total Power	21.1 dBm	Auto N
47	' 775 M⊔⇒	rotari onor	2111 4211	
17				FreqOff
Transmit Freq Error	69.617 kHz	% of OBW Powe	r 99.00 %	
x dB Bandwidth	21.45 MHz	x dB	-26.00 dB	



Page 37 of 241

L RF 50 Ω	DC		SEI	NSE:INT	AL	IGN AUTO	02:37:14 A	M Mar 31, 2017	Eregueneu
enter Freq 5.18000	00000 (	€Hz	Center Fr Trig: Free	eq: 5.18000 Run	0000 GHz Avg Hold: 2	:0/20	Radio Std	: None	Frequency
	4	IFGain:Low	#Atten: 3	0 dB			Radio Dev	vice: BTS	
Ref Offset 0 dB/div Ref 20.0	14.6 dB 0 dBm								
<b>bg</b>									Center E
.00		phillipper and program	mannen	mouther	manger	<u>ا</u>			5.180000000 G
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1.0 white have been and the	ALMAN *					- MAN	un warden wa	Millioholas	
.0						-			
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enter 5.18 GHz							Spa	n 40 MHz	CES
Res BW 360 kHz			#VE	SW 1.1 M	IHz		Swe	eep 1 ms	4.000000 N
Occupied Band	width			Total P	ower	21.4	4 dBm		Auto
	17.	972 Mł	Ηz						Freg Off
Transmit Freg Err	or	110.81	Hz	% of O	<b>BW Power</b>	99	9.00 %		
x dB Bandwidth		31.97 N	IHz	x dB		-26.	00 dB		



Page 38 of 241

enter Fre	RF 50 Q DC 29 5.200000000 NFE	GHz #IFGain:Low	Center Fr Trig: Free #Atten: 3	vse:INT req: 5.20000 e Run 0 dB	ALI 00000 GHz Avg Hold: 20	gn auto 0/20	02:47:01 A Radio Std Radio Dev	M Mar 31, 2017 I: None vice: BTS	Frequency
0 dB/div	Ref Offset 14.6 dB Ref 20.00 dBm								
og 0.0 1.00		all the set of a set of the set	ange and a second	ppsharwi	YTAN WARKER				Center Fre 5.200000000 Gł
0.0 0.0	man when the man the man					Hum	Advent	rthur show Will Will	
0.0									
0.0									
enter 5.2 Res BW	GHz 360 kHz		#VE	SW 1.1 M	IHz		Spa Swe	an 40 MHz eep 1 ms	CF Ste
Occup	ied Bandwidth	1		Total P	ower	21.7	7 dBm		<u>Auto</u> Ma
	17	.918 Mł	Ιz						Freq Offs
Transm	it Freq Error	71.653 k	Hz	% of O	BW Power	99	9.00 %		01
x dB Ba	ndwidth	32.85 M	lHz	x dB		-26.	00 dB		



Page 39 of 241

L RF 50 Ω DC L enter Freq 5.240000000	GHz #IFGain:Low	SENSE:INT r Freq: 5.240000000 GHz Free Run Avg Hold: n: 30 dB	ALIGN AUTO 03:14:22 AM M Radio Std: N 20/20 Radio Device	ar31, 2017 one Frequency a: BTS
Ref Offset 14.4 de dB/div Ref 20.00 dBm	\$ 		_	
9g 0.0 .00	meanthanthanthant	of a provide and the second seco	444 N	Center Fr 5.240000000 G
0.0			how have have	INdiana a
				a ainistain
enter 5.24 GHz Res BW 360 kHz	#	VBW 1.1 MHz	Span - Swee	40 MHz CF St p 1 ms 4.00000 M
Occupied Bandwidt	n .770 MHz	Total Power	20.9 dBm	Auto M
Transmit Freq Error	86.291 kHz 23.12 MHz	% of OBW Powe	er 99.00 %	0
	23.12 11112	A db	-20.00 08	



Page 40 of 241

keysight Spectrum Analyzer - APv6.3(03231)           L         RF         50 Ω         DC           Inter Freq 5.240000000         NFE	GHz #IFGain:Low	SENSE:INT r Freq: 5.240000000 GHz Free Run Avg Hold h: 30 dB	ALIGN AUTO 03:20:20 Radio S I: 20/20 Radio D	) AM Mar 31, 2017 td: None evice: BTS	Frequency
Ref Offset 14.6 dE dB/div Ref 20.00 dBm	3				
9	ni leman manungar man	and the construction was preserved	1		Center F 5.240000000
Multure and a second with the	P		New March Street	hala watala hala	
0					
0					
nter 5.24 GHz es BW 360 kHz	#	VBW 1.1 MHz	Sp Sv	an 40 MHz veep 1 ms	CF S 4.000000
Occupied Bandwidt		Total Power	20.9 dBm		Auto
1/	.815 MHZ				Freq Of
Transmit Freq Error x dB Bandwidth	85.531 kHz 23.32 MHz	% of OBW Pow x dB	er 99.00 % -26.00 dB		

Page 41 of 241

### 9.3.3. OUTPUT POWER AND PPSD

### LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Page 42 of 241

### TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

#### **DIRECTIONAL ANTENNA GAIN**

For Power, the TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	Chain 2	<b>Uncorrelated Chains</b>
Antenna	Antenna	Antenna	Directional
Gain	Gain	Gain	Gain
(dBi)	(dBi)	(dBi)	(dBi)
3.41	2.26	4.22	3.37

For PSD, The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	Chain 2	<b>Correlated Chains</b>
Antenna	Antenna	Antenna	Directional
Gain	Gain	Gain	Gain
(dBi)	(dBi)	(dBi)	(dBi)
3.41	2.26	4.22	8.10

Page 43 of 241

### RESULTS

**ID:** GE43578 **Date:** 5/16/17

#### Antenna Gain and Limits

Channel	Frequency	Directional	Directional	Power	PSD
		Gain	Gain	Limit	Limit
		for Power	for PSD		
	(MHz)	(dBi)	(dBi)	(dBm)	(dBm)
Low	5180	3.37	8.10	24.00	8.90
Mid	5200	3.37	8.10	24.00	8.90
High	5240	3.37	8.10	24.00	8.90

Duty Cycle CF (dB)	0.37	Included in Calculations of Corr'd Power & PSD
	0.01	

#### **Output Power Results**

Channel	Frequency	Chain 0	Chain 1	Chain 2	Total	Power	Power
		Meas	Meas	Meas	Corr'd	Limit	Margin
		Power	Power	Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5180	16.41	16.52	16.30	21.55	24.00	-2.45
Mid	5200	16.31	16.49	16.22	21.48	24.00	-2.52
High	5240	15.90	15.96	15.61	20.97	24.00	-3.03

#### **PSD Results**

Channel	Frequency	Chain 0	Chain 1	Chain 2	Total	PSD	PSD
		Meas	Meas	Meas	Corr'd	Limit	Margin
		PSD	PSD	PSD	PSD		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5180	1.392	1.078	0.955	6.29	8.90	-2.61
Mid	5200	0.603	1.277	0.897	6.08	8.90	-2.82
High	5240	1.165	1.168	0.833	6.20	8.90	-2.70

<u>Note:</u> the power readings above were measured with gated method, and the measurement was taken only during the ON time. No duty cycle correction was necessary.





Page 45 of 241













Page 48 of 241

Keysight Sp	ectrum Analyzer -	APv6.3(032317)	45256, Temp A		SHOE HER	_				
Center F	req 5.240	000000 (	GHz		ENSE:INT	#Avg Typ	e: RMS	11:23:33 P	MMar 31, 2017 CE 1 2 3 4 5 6	Frequency
		NFE	PNO: Fast H IFGain:Low	Atten: 2	ee Run 26 dB	Avg Hold	: 100/100	D		
0 dB/div	Ref Offset Ref 30.0	14.6 dB 0 dBm					Mkr	2 5.235 0.8	70 GHz 33 dBm	Auto Tun
.09					Ĭ					Center Fre
20.0			_							5.240000000 GH
10.0			_	<u>2</u>						Start Fre
0.00					¢'	manner				5.215000000 GH
10.0										Stop Fre
20.0										5.265000000 GH
30.0			4				how			CF Ste
40.0		all and the ball					Property Contraction			Auto Ma
-theory and	and allow and							- Contractor	and all makes	Freq Offs
50.0										01
60.0										Scale Typ
Center 5	24000 GH7	,			<u> </u>			Span f	0.00 MHz	Log <u>L</u>

Page 49 of 241

### 9.4. 11n HT20 2TX CDD MIMO MODE IN THE 5.3GHz BAND

### 9.4.1. 26 dB BANDWIDTH

### <u>LIMITS</u>

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)
Low	5260	25.40	32.35
Mid	5300	25.55	35.00
High	5320	25.35	38.35

Page 50 of 241





Page 51 of 241





Page 52 of 241





### 9.4.2. 99% BANDWIDTH

### **LIMITS**

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)
Low	5260	17.4148	17.6130
Mid	5300	17.4903	17.5244
High	5320	17.6056	17.4169

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Page 54 of 241

Chain 0 OBW , CH LOW ∦ Agilent 20:22:59 May 16, 2017 L	Freq/Channel
Ch Freq 5.26 GHz Trig Fre Occupied Bandwidth Averages: 20	Center Freq 5.26000000 GHz
APv6.7(050417),GE43578, Cond B	Start Freq 5.24000000 GHz
Ref 20 dBm #Atten 30 dB #Samp Log 10 AP/	Stop Freq 5.28000000 GHz
db/ Offst 11.4 dB	4.00000000 MHz Auto Man
Center 5.260 00 GHz Span 40 MH #Res BW 360 kHz #VBW 1.1 MHz Sweep 1.066 ms (1000 pts	z 0.00000000 Hz
Occupied Bandwidth         Occ BM % Pwr         99.00 %           17.4148 MHz         × dB         -26.00 dB	( On <u>Off</u>
Transmit Freq Error141.042 kHzx dB Bandwidth21.646 MHz*	
Copyright 2000–2011 Agilent Technologies	



Page 55 of 241

Chain 0 OBW , CH MID	L	Freg/Channel
Ch Freq 5.3 GHz	Trig Free	Center Freq 5.30000000 GHz
Uccupied Bandwidth	Hverages: 20	Start Freq 5.2800000 GHz
HPv6./(05041/),GE435/8, Cond B Ref 20 dBm #Atten 30 dB #Samp		Stop Freq
10 dB/ Offst		CF Step 4.00000000 MHz
11.4 dB Center 5 300 00 GHz	Span 40 MHz	Freq Offset
*Res BW 360 kHz         *VBW 1.1 MHz           Occupied Bandwidth         *///>	Sweep 1.066 ms (1000 pts)	Signal Track
17.4903 MHz Transmit Freg Error 53.519 kHz	<b>× dB</b> –26.00 dB	
x dB Bandwidth 21.217 MHz* Copyright 2000-2011 Agilent Technologi	es	



Page 56 of 241

Chain 0 OBW , CH HIGH	
Agilent 20:36:26 May 16, 2017	Freq/Unannel
Ch Freq 5.32 GHz Trig Free Occupied Bandwidth Averages: 20	Center Freq 5.32000000 GHz
	Start Freq 5.30000000 GHz
Ref 20 dBm #Atten 30 dB #Samp Log 10	<b>Stop Freq</b> 5.34000000 GHz
dB/ offst	<b>CF Step</b> 4.00000000 MHz <u>Auto</u> Man
Center 5.320 00 GHz Span 40 MHz #Res BW 360 kHz #VBW 1.1 MHz Sweep 1.066 ms (1000 pts)	Freq Offset 0.00000000 Hz
Occupied Bandwidth         Occ BW % Pwr         99.00 %           17.6056 MHz         × dB         -26.00 dB	Signal Track <sup>On <u>Off</u></sup>
Transmit Freq Error 27.479 kHz x dB Bandwidth 21.984 MHz*	
Copyright 2000–2011 Agilent Technologies	



Page 57 of 241

### 9.4.3. OUTPUT POWER AND PPSD

### LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1– MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

#### **DIRECTIONAL ANTENNA GAIN**

For Power, the TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	Uncorrelated Chains
Antenna	Antenna	Directional
Gain	Gain	Gain
(dBi)	(dBi)	(dBi)
3.41	2.26	2.87

For PSD, The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0	Chain 1	<b>Correlated Chains</b>
Antenna	Antenna	Directional
Gain	Gain	Gain
(dBi)	(dBi)	(dBi)
3.41	2.26	5.86

Page 58 of 241

### **RESULTS**

#### Bandwidth, Antenna Gain and Limits

Channel	Frequency	Min	Directional	Directional	Power	PSD
		26 dB	Gain	Gain	Limit	Limit
		BW	for Power	for PSD		
	(MHz)	(MHz)	(dBi)	(dBi)	(dBm)	(dBm)
Low	5260	32.35	2.87	5.86	24.00	11.00
Mid	5300	35.00	2.87	5.86	24.00	11.00
High	5320	38.35	2.87	5.86	24.00	11.00

Duty Cycle CF (dB) 0.37 Included in Calculations of Corr'd PSD

#### **Output Power Results**

Channel	Frequency	Chain 0	Chain 1	Total	Power	Power
		Meas	Meas	Corr'd	Limit	Margin
		Power	Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5260	16.45	17.91	20.25	24.00	-3.75
Mid	5300	16.61	18.12	20.44	24.00	-3.56
High	5320	16.74	18.09	20.48	24.00	-3.52

### **PSD Results**

Channel	Frequency	Chain 0	Chain 1	Total	PSD	PSD
		Meas	Meas	Corr'd	Limit	Margin
		PSD	PSD	PSD		
	(MHz)	(dBm)	(dBm)	(dBm)	(dBm)	(dB)
Low	5260	5.311	6.226	9.17	11.00	-1.83
Mid	5300	5.325	6.357	9.25	11.00	-1.75
High	5320	5.384	6.518	9.37	11.00	-1.63

<u>Note:</u> the power readings above were measured with gated method, and the measurement was taken only during the ON time. No duty cycle correction was necessary.





Page 60 of 241





Page 61 of 241





### 9.5. 11n HT20 3TX CDD MIMO MODE IN THE 5.3GHz BAND

### 9.5.1. 26 dB BANDWIDTH

### <u>LIMITS</u>

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)	26 dB BW Chain 2 (MHz)
Low	5260	27.00	33.35	33.05
Mid	5300	38.25	42.75	41.90
High	5320	24.65	33.50	28.85

Page 63 of 241









Page 65 of 241











Page 68 of 241

### 9.5.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)	
Low	5260	17.850	17.900	17.840	
Mid	5300	17.989	18.360	17.990	
High	5320	17.849	17.910	17.839	

Page 69 of 241

L RF 50 Ω DC	7),44350, Temp A	SENSE:INT	ALIGN AUTO	03:29:08 AM Mar 31, 2017	Ere guerou
enter Freq 5.26000000	GHz Cente	r Freq: 5.260000000 GHz Free Run Avg Hol	d: 20/20	Radio Std: None	Frequency
	#IFGain:Low #Atte	n: 30 dB		Radio Device: BTS	
Ref Offset 14.4 dE	3				
g					0
00	wannowand	have been and the second	why he		5.26000000 G
0.0	×		- No		
0.0 Junit 1 Standard Market			"W	WWW. Miles	
				- Manager Al	
1.0					
1.0					
0.0					
				0	
enter 5.26 GHZ Res BW 360 kHz	#	VBW 1.1 MHz		Sweep 1 ms	CF St 4.000000 M
Occupied Bandwidt	n	Total Power	21.0	Auto N	
17	850 MHz				
					Freq Offs
ransmit Freq Error	97.106 KHZ	% of OBW Pow	ver 99.	.00 %	
x dB Bandwidth	22.47 MHz	x dB	-26.0	00 dB	



Page 70 of 241