

CERTIFICATION TEST REPORT

Report Number.: 16U23813-E3V3 DTS

- Applicant : APPLE, INC. 1 INFINITE LOOP CUPERTINO, CA 95014, U.S.A
 - **Model :** A1822
 - FCC ID : BCGA1822
 - **IC** : 579C-A1822
- EUT Description : TABLET DEVICE
- Test Standard(s) : FCC 47 CFR PART 15 SUBPART C INDUSTRY CANADA RSS - 247 ISSUE 1

Date Of Issue: February 10, 2017

Prepared by: UL Verification Services Inc. 47173 Benicia Street Fremont, CA 94538, U.S.A. TEL: (510) 771-1000 FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	lssue Date	Revisions	Revised By
V1	01/24/2017	Initial Issue	Mengistu Mekuria
V2	02/08/2017	Address TCB's Question	Chin Pang
V3	02/10/2017	Address TCB's Question	Chin Pang

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	APPLE, INC. 1 INFINITE LOOP CUPERTINO, CA 95014, U.S./	Α.			
EUT DESCRIPTION:	TABLET DEVICE				
MODEL: A1822					
SERIAL NUMBER: CONDUCTED (F9FSQ02CHQNX), RADIATED (F9FSJ00HHN					
DATE TESTED: NOVEMBER 15, 2016 – FEBRUARY 08, 2017					
	APPLICABLE STANDARDS	6			
S	TANDARD	TEST RESULTS			
CFR 47	Part 15 Subpart C	Pass			
INDUSTRY CA	NADA RSS-247 Issue 1	Pass			
INDUSTRY CA	NADA RSS-GEN Issue 4	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.

Approved & Released For UL Verification Services Inc. By:

Prepared By:

MENGISTU MEKURIA SENIOR ENGINEER UL VERIFICATION SERVICES INC.

TONY LI LAB ENGINEER UL VERIFICATION SERVICES INC.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, KDB 558074 D01 v03r05, ANSI C63.10-2013, RSS-GEN Issue 4, and RSS-247 Issue 1.

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:2324B-4)
Chamber B (IC:2324B-2)	Chamber E (IC:2324B-5)
Chamber C (IC:2324B-3)	Chamber F (IC:2324B-6)
	Chamber G (IC:2324B-7)
	Chamber H (IC:2324B-8)

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>.

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:

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%.

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a tablet with multimedia functions (music, application support, and video), IEEE 802.11a/b/g/n/ac radio, and Bluetooth radio. The rechargeable battery is not user accessible.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted peak output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
	802.11b 1TX	19.17	82.60
	802.11g 1TX	Covered by HT20 1TX	
2412 - 2472	802.11g 2TX	Covered by H	IT20 2TX CDD
	802.11n HT20 1TX	22.70	186.21
	802.11n HT20 2TX CDD	25.73	374.11

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band	Antenna Gain (dBi)			
(GHz)	Antenna A	Antenna B		
2.4	1.91	0.56		

5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 14E232.

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5.5. WORST-CASE CONFIGURATION AND MODE

For below 1G, 18-26GHz radiated emission, and power line conducted emissions were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

For g and HT20 modes, radiated harmonics spurious and power line conducted emissions were performed with the EUT set at the CDD mode at highest power setting among the CDD/STBC/SDM modes as worst-case scenario.

The fundamental of the EUT was investigated in three orthogonal orientations X/Y/Z, it was determined that Y-Landscape orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in Y-Landscape orientation.

Worst-case data rates as provided by the client were:

802.11b mode: 1 Mbps 802.11g mode: 6 Mbps 802.11n HT20mode: MCS0

The following modes have the same target power and use the same modulation (OFDM). Therefore, 802.11g 1TX and 802.11g 2TX are covered by 802.11n HT20 1TX and 802.11n HT20 2TX CDD respectively.

- 802.11g and 802.11n HT20 1TX
- 802.11g 2TX and 802.11n HT20 2TX CDD

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List							
Description Manufacturer Model Serial Number FCC ID							
Laptop	Apple	A1286	7313700NAGW	N/A			
Laptop AC/DC adapter	Apple	A1343	C062172045DDJ94A6	N/A			
Earphone	Apple	NA	NA	N/A			
EUT AC/DC adapter	Apple	A1357	W010A051	N/A			

I/O CABLES (CONDUCTED TEST)

	I/O Cable List								
Cable Port # of identical Connector Cable Type Cable Remarks									
No		ports	Туре		Length (m)				
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer			
2	USB	1	USB	Shielded	1	N/A			
3	AC	1	AC	Un-shielded	3	N/A			

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List							
Cable No							
None Used							

I/O CABLES (RADIATED BELOW 1 GHZ AND AC LINE CONDUCTED: AC/DC ADAPTER CONFIGURATION)

	I/O Cable List							
Cable	able Port # of Connector Cable Type Cable Remarks							
No		identical	Туре		Length (m)			
1	Earphone Jack	1	3.5mm Audio	Shielded	0.9	N/A		
2	USB	1	USB	shielded	1	N/A		

I/O CABLES (AC LINE CONDUCTED: LAPTOP CONFIGUARTION)

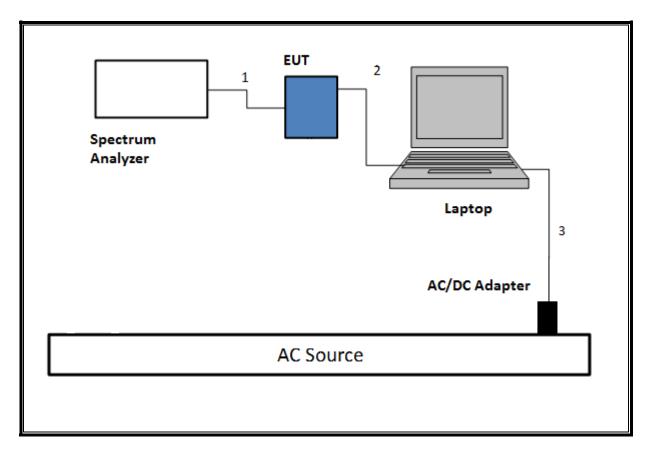
	I/O Cable List								
Cable	ble Port # of Connector Cable Type Cable Remarks								
No		identical	Туре		Length (m)				
1	Earphone Jack	1	3.5mm Audio	Shielded	0.9	N/A			
2	USB	1	USB	Shielded	1	N/A			
3	AC	1	AC	Un-shielded	1.2	N/A			

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TEST SETUP - CONDUCTED TESTS

The EUT was connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

SETUP DIAGRAM

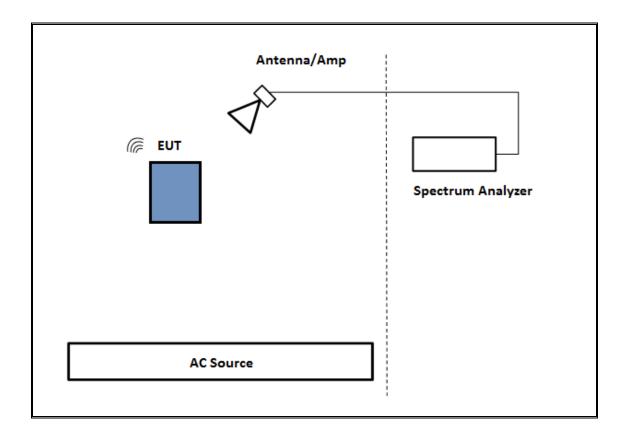


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TEST SETUP- RADIATED-ABOVE 1 GHZ

The EUT was powered by battery. Test software exercised the EUT.

SETUP DIAGRAM

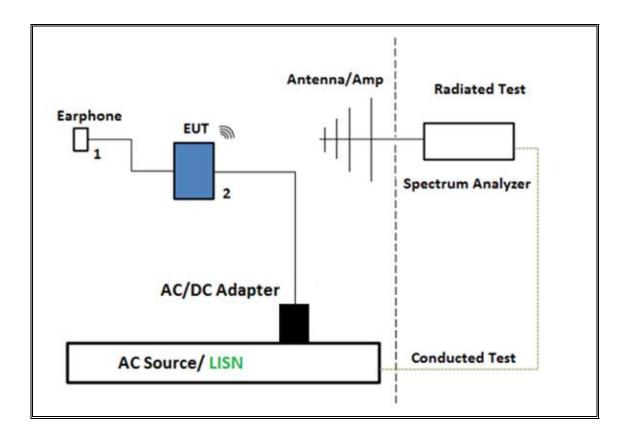


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TEST SETUP- BELOW 1GHz

The EUT was powered by AC/DC adapter and connected with earphone. Test software exercised the EUT.

SETUP DIAGRAM

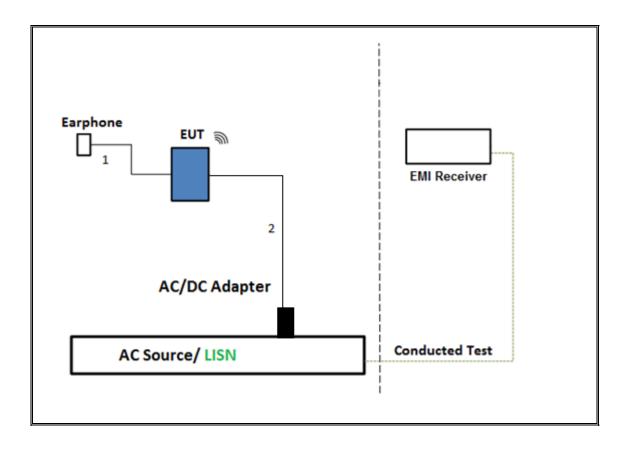


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TEST SETUP- AC LINE CONDUCTED: AC/DC ADAPTER CONFIGURATION

The EUT was tested with earphone connected and powered by AC/DC adapter via USB cable. Test software exercised the EUT.

SETUP DIAGRAM

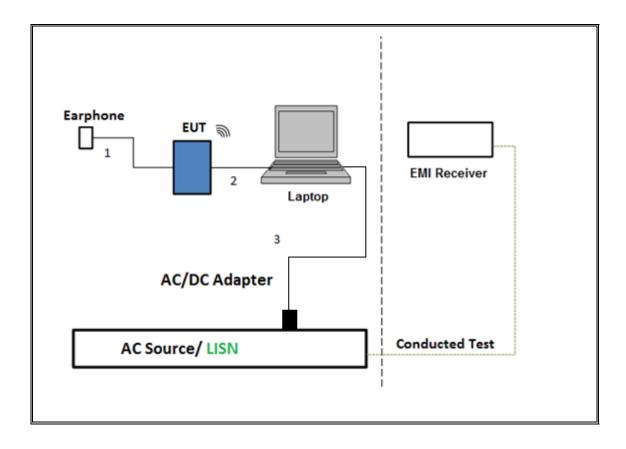


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TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION

The EUT was tested with earphone connected and powered by host PC via USB cable. Test software exercised the EUT.

SETUP DIAGRAM



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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	Asset	Cal Due				
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T344	02/22/2017				
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T407	04/04/2017				
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T286	05/04/2017				
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T740	11/29/2017				
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T340	12/14/2017				
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T899	05/26/2017				
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T834	06/17/2017				
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A-544	T1210	06/30/2017				
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Agilent	N1921A	T1228	06/20/2017				
Power Meter, P-series single channel	Keysight	N1912A	T1273	07/08/2017				
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	T905	06/21/2017				
Spectrum Analyzer, PSA, 3Hz to 44GHz	Keysight	E4446A	T123	10/20/2017				
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	T339	09/22/2017				
Spectrum Analyzer	Keysight	8564E	T106	09/07/2017				
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T447	06/16/2017				
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Keysight	8449B	T402	07/05/2017				
		e Conducted						
*EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	12/19/2016				
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/08/2017				
	UL AUTOM	ATION SOFTWARE						
Radiated Software	UL	UL EMC	Ver 9.5,	April 26, 2016				
Conducted Software	UL	UL EMC	Ver 5.4, C	ctober 13, 2016				
AC Line Conducted Software	UL	UL EMC	Ver 9.5,	May 26, 2015				

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

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7. MEASUREMENT METHODS

<u>6 dB BW</u>: KDB 558074 D01 v03r05, Section 8.1.

Output Power: KDB 558074 D01 v03r05, Section 9.1.2.

Power Spectral Density: KDB 558074 D01 v03r05, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v03r05, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v03r05, Section 12.1.

Band-edge: KDB 558074 D01 v03r05, Section 12.1.

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8. ANTENNA PORT TEST RESULTS

ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

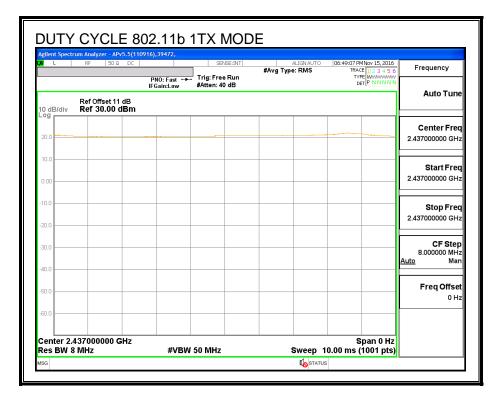
KDB 558074 Zero-Span Spectrum Analyzer Method.

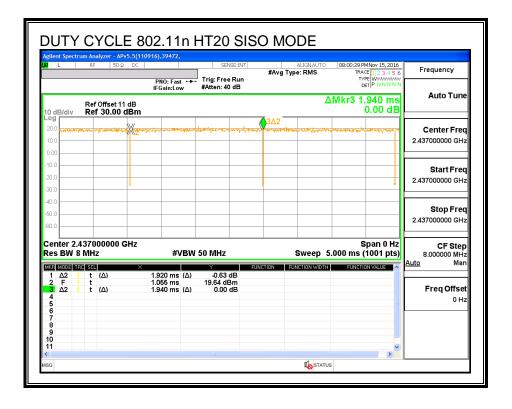
ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (khz)
11b 2.4GHz 1TX	1	1	1	100%	0	0.01
11n HT20 2.4GHz 1TX	1.920	1.940	0.990	98.97%	0	0.01
11n HT20 2.4GHz CDD	1.920	1.945	0.987	98.71%	0	0.01

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DUTY CYCLE PLOTS





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L RF	50 Ω DC PNO: Fas	sense:	#Avg Type: un		8:35 PMNov 15, 2016 TRACE 1 2 3 4 5 6 TYPE WWWWWW DET P N N N N N	Frequency
Ref Offs		w #Atten: 40 dl	3	ΔMkr	3 1.945 ms 0.47 dB	Auto Tune
og	.00 dBm		and and a standard and the	3∆2	www.www.www.www.	Center Fred
10.0						2.437000000 GHz
0.0					——— F	Start Fred
0.0						2.437000000 GH
0.0					F	
0.0						Stop Free 2.437000000 GH:
enter 2.4370000 es BW 8 MHz		VBW 50 MHz	S	weep 5.000	Span 0 Hz ms (1001 pts)	CF Step 8.000000 MHz uto Mar
KR MODE TRC SOL 1 Δ2 1 t (Δ) 2 F 1 t	× 1.920 ms 1.950 ms	19.03 dBm		TION WIDTH F		
3 Δ2 1 t (Δ) 4 5	1.945 ms	s(∆) 0.47 dB			=	Freq Offse 0 Ha
6 7 8						
9 0 1						

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8.1. 11b ANTENNA A SISO MODE IN THE 2.4GHz BAND

8.1.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (1)

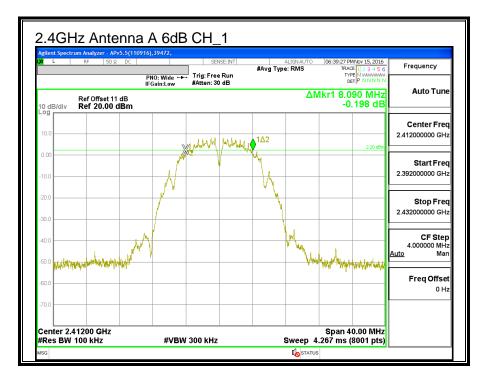
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

Channel	Frequency (MHz)	6 dB BW Antenna A(MHz)	Minimum Limit (MHz)
Low_1	2412	8.090	0.5
Middle_6	2437	8.030	0.5
High_11	2462	7.645	0.5
High_12	2467	8.575	0.5
High_13	2472	8.105	0.5

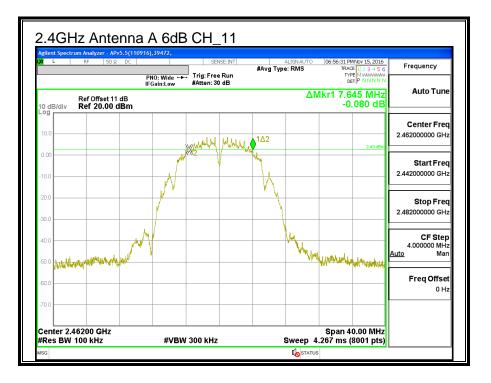
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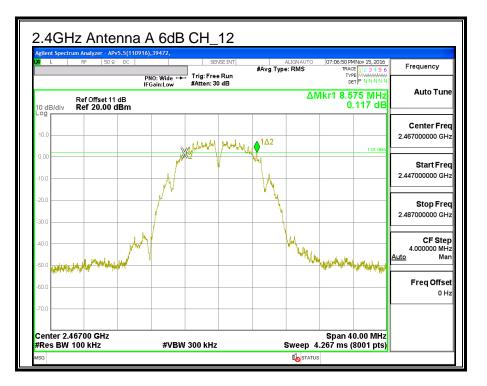
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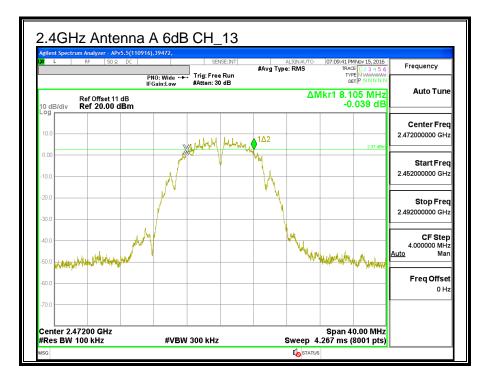
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8.1.2. 99% BANDWIDTH

LIMITS

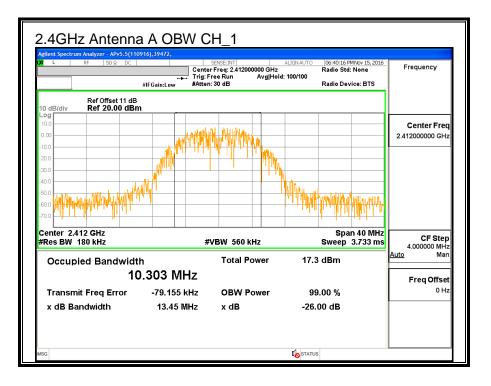
None; for reporting purposes only.

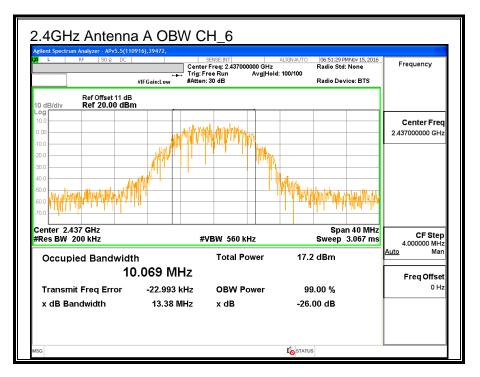
RESULTS

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)
Low_1	2412	10.303
Middle_6	2437	10.069
High_11	2462	10.396
High_12	2467	10.314
High_13	2472	10.291

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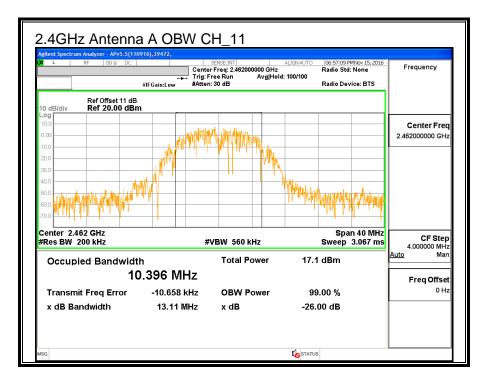
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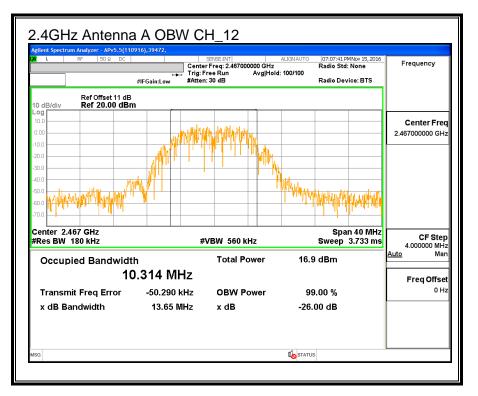




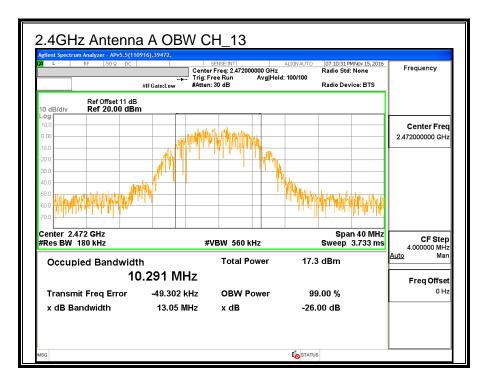
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8.1.3. AVERAGE POWER

ID: 29439 Date: 12/15/2016

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	Power Antenna A (MHz)	
Low_1	2412	15.72	
Middle_6	2437	15.85	
High_11	2462	15.96	
High_12	2467	15.95	
High_13	2472	14.48	

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8.1.4. OUTPUT POWER

ID: 29439 Date: 12/15/2016

LIMITS

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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<u>RESULTS</u>

Limits								
Channel	Frequency	Directional	FCC	IC	IC	Max		
		Gain	Power	Power	EIRP	Power		
			Limit	Limit	Limit			
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)		
Low	2412	1.91	30.00	30	36	30.00		
Mid	2437	1.91	30.00	30	36	30.00		
High_11	2462	1.91	30.00	30	36	30.00		
High_12	2467	1.91	30.00	30	36	30.00		
High_13	2472	1.91	30.00	30	36	30.00		

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
--------------------	------	--

Channel	Frequency	Meas	Total	Power	Margin
		Power	Corr'd	Limit	
			Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	19.01	19.01	30.00	-10.99
Mid	2437	19.15	19.15	30.00	-10.85
High_11	2462	19.17	19.17	30.00	-10.83
High_12	2467	19.15	19.15	30.00	-10.85
High_13	2472	17.92	17.92	30.00	-12.08

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8.1.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

IC RSS-247 (5.2) (2)

For digitally modulated systems, the power spectral density conducted form the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

RESULTS

High_12

High_13

2467

2472

Duty C	Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSE				
PSD Results							
Channel	Frequency	Meas	Total	Limit	Margin		
			Corr'd				
	(MHz)	(dBm)	PSD				
			(dBm)	(dBm)	(dB)		
Low	2412	-6.742	-6.742	8.0	-14.7		
Mid	2437	-7.033	-7.033	8.0	-15.0		
High_11	2462	-7.290	-7.290	8.0	-15.3		

-7.518

-8.941

8.0

8.0

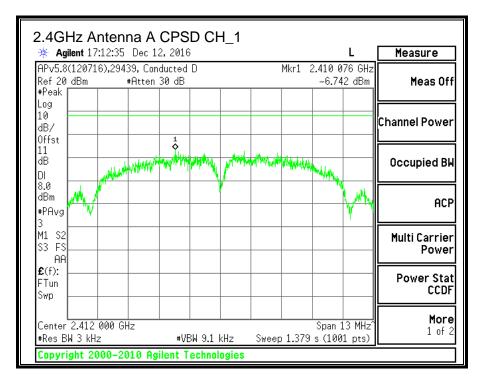
-15.5

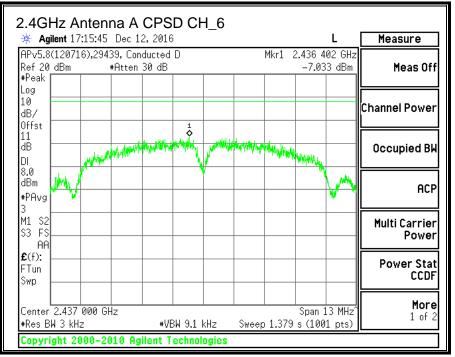
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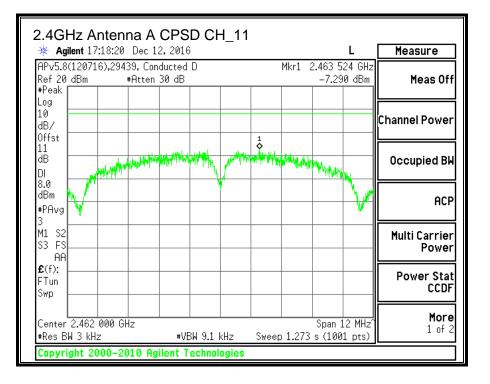
-7.518

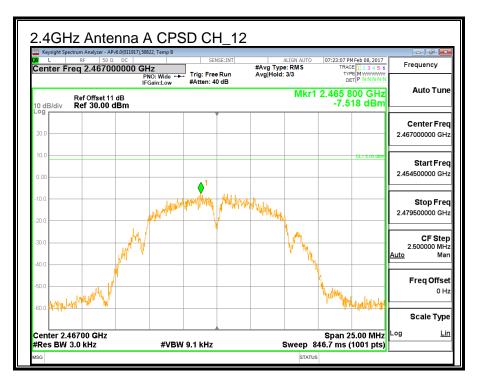
-8.941

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4GHz Antenna A CPSD CH_13	
Pv5.8(120716),29439, Conducted D Mkr1 2.472 793 GHz of 20 dBm #Atten 30 dB -8.941 dBm Meas Peak	Off
199 199 199 199 199 199 199 199	ver
	BW
Žen Ludu 🚺 🔤 🔄 🔤 👘 👘 👘	ICP
1 S2 3 FS AA	
(f): Tun mp Mp Mp Mp Mp Mp Mp Mp Mp Mp M	tat DF
	ore of 2
opyright 2000–2010 Agilent Technologies	

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8.1.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

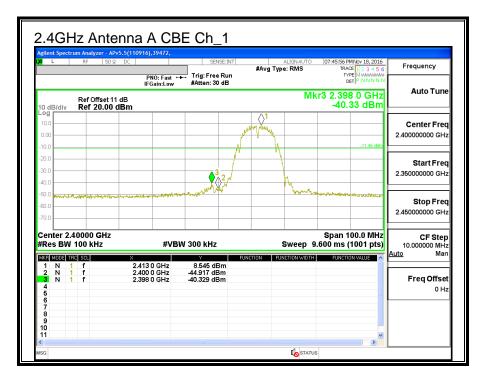
LIMITS

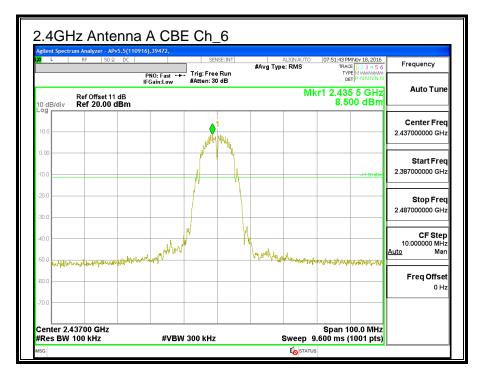
FCC §15.247 (d)

IC RSS-247 (5.5)

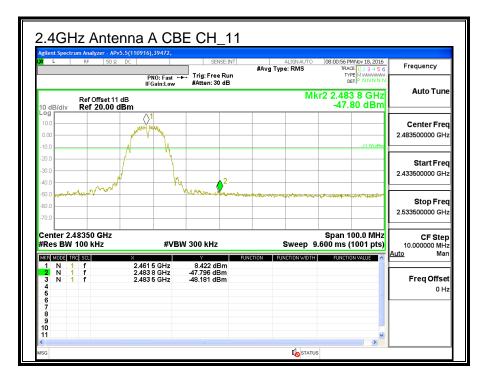
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

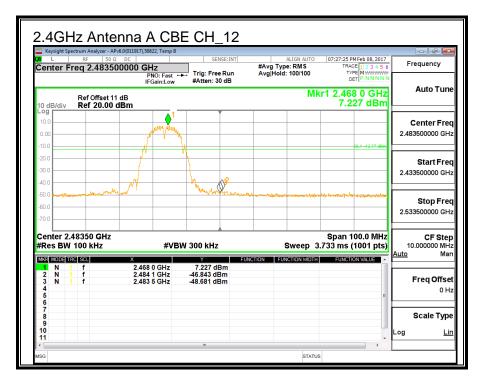
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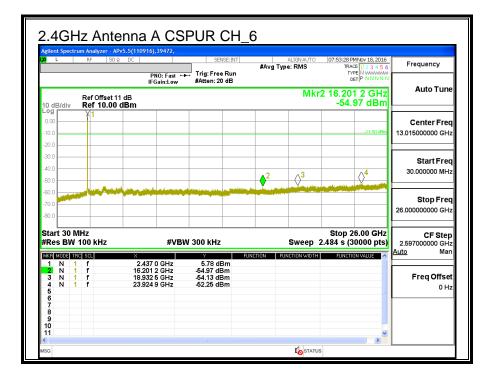


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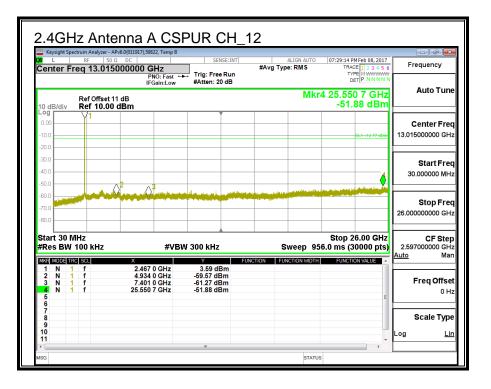
2.4GHz Antenna A CBE			
🔆 Agilent 18:16:33 Dec 12, 2016		L L	Measure
APv5.8(120716),29439, Conducted Ref 20 dBm #Atten 30 dB Peak1		Mkr1 2.473 0 GHz 5.67 dBm	Meas Off
Log 10 dB/ 0ffst			Channel Power
11 dB DI -14.3			Occupied BW
dBm #PAvg			ACP
Center 2.483 5 GHz #Res BW 100 kHz #VB Marker Trace Type	W 300 kHz Sweep S X Axis	Span 100 MHz 3.6 ms (1001 pts) Amplitude	Multi Carrier Power
1 (1) Freq 2 (1) Freq 3 (1) Freq	2.473 0 GHz 2.486 0 GHz 2.483 5 GHz	5.67 dBm -44.68 dBm -46.22 dBm	Power Stat CCDF
			More 1 of 2
Copyright 2000-2010 Agilent Te	echnologies		

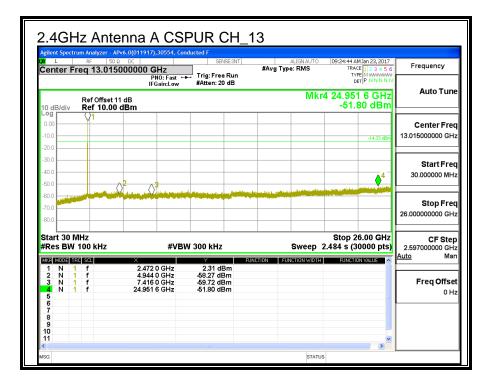
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Agilent Spectrum Analyzer - Af C L RF 50 G	PNO: Fast ←	SENSE:INT	ALIGNAUTO #Avg Type: RMS	07:49:55 PMNov 18, 2016 TRACE 1 2 3 4 5 6 TYPE MWWWWWW DET P N N N N N	Frequency
Ref Offset 1 0 dB/div Ref 10.00		#Atten: 20 dB	Mkr	4 25.576 7 GHz -51.40 dBm	Auto Tune
0.00 X1 0.00 20.0				-11.46.dEm	Center Freq 13.015000000 GHz
40.0 50.0			3		Start Freq 30.000000 MHz
60.0 70.0 80.0					Stop Freq 26.000000000 GHz
Start 30 MHz Res BW 100 kHz	*		Sweep 2	Stop 26.00 GHz 2.484 s (30000 pts) FUNCTION VALUE	CF Step 2.597000000 GHz <u>Auto</u> Man
1 N 1 f 2 N 1 f 3 N 1 f 4 N 1 f 5 6 7	2.412 0 GHz 3.784 5 GHz 15.416 9 GHz 25.576 7 GHz	5.80 dBm -55.31 dBm -55.62 dBm -51.40 dBm			Freq Offset 0 Hz
8 9 10 11				×	



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8.2. 11b ANTENNA B SISO MODE IN THE 2.4GHz BAND

8.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (1)

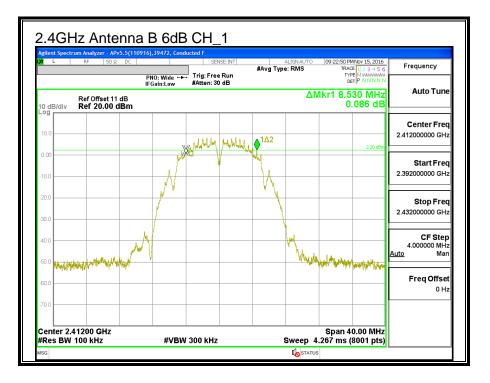
The minimum 6 dB bandwidth shall be at least 500 kHz.

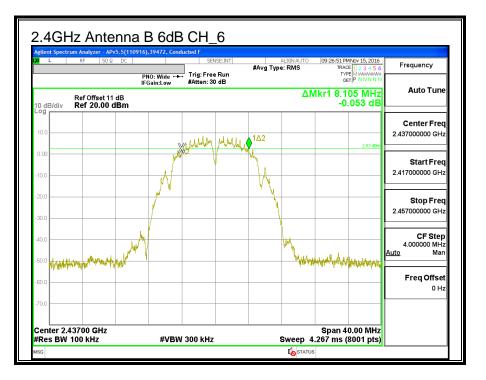
RESULTS

Channel	Frequency (MHz)	6 dB BW Antenna B(MHz)	Minimum Limit (MHz)
Low_1	2412	8.530	0.5
Middle_6	2437	8.105	0.5
High_11	2462	7.985	0.5
High_11	2467	8.055	0.5
High_13	2472	8.085	0.5

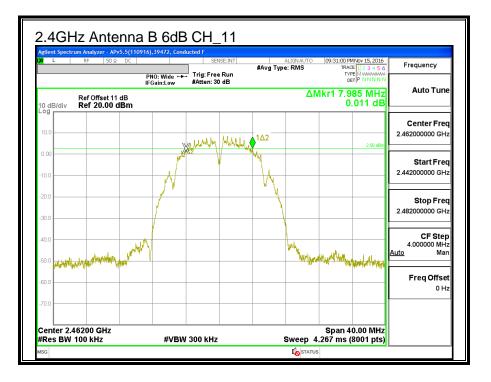
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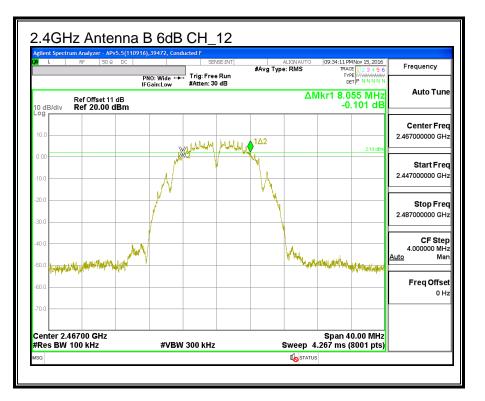
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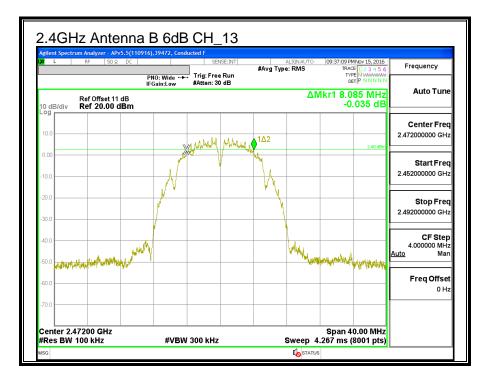


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8.2.2. 99% BANDWIDTH

LIMITS

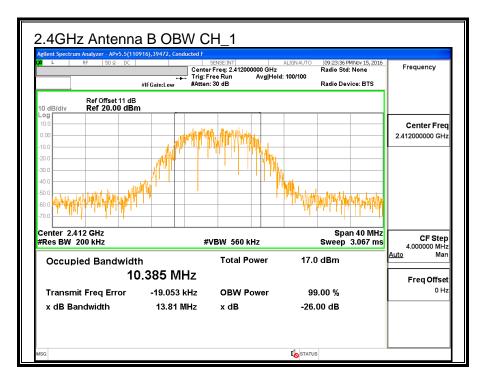
None; for reporting purposes only.

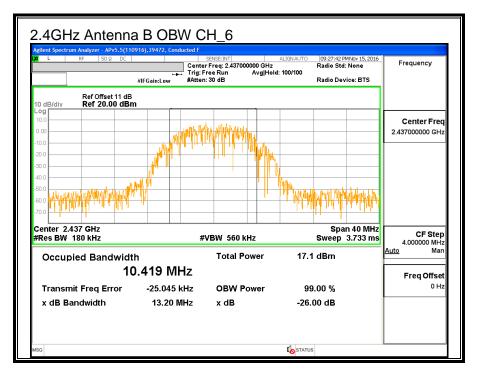
RESULTS

Channel	Frequency (MHz)	99% Bandwidth Antenna B(MHz)
Low_1	2412	10.385
Middle_6	2437	10.419
High_11	2462	10.233
High_12	2467	10.373
High_13	2472	10.350

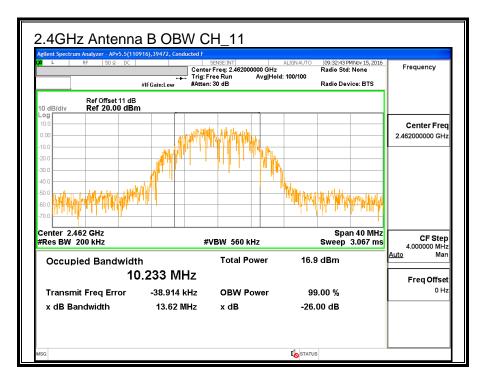
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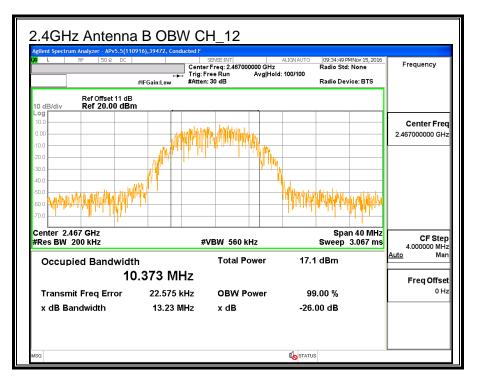
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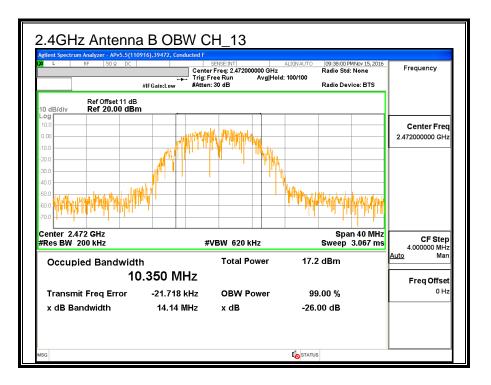


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8.2.3. AVERAGE POWER

ID: 29439	Date:	12/15/2016
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<u>LIMITS</u>

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	Power Antenna B (MHz)
Low_1	2412	15.28
Middle_6	2437	15.31
High_11	2462	15.40
High_12	2467	15.40
High_13	2472	14.48

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8.2.4. OUTPUT POWER

ID: 29439 Date: 12/15/2016

<u>LIMITS</u>

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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<u>RESULTS</u>

Limits						
Channel	Frequency	Directional	FCC	IC	IC	Max
		Gain	Power	Power	EIRP	Power
			Limit	Limit	Limit	
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2412	0.56	30.00	30	36	30.00
Mid	2437	0.56	30.00	30	36	30.00
High_11	2462	0.56	30.00	30	36	30.00
High_12	2467	0.56	30.00	30	36	30.00
High_13	2472	0.56	30.00	30	36	30.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
--------------------	------	--

Channel	Frequency	Meas	Total	Power	Margin
		Power	Corr'd	Limit	
			Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	18.67	18.67	30.00	-11.33
Mid	2437	18.61	18.61	30.00	-11.39
High_11	2462	18.67	18.67	30.00	-11.33
High_12	2467	18.65	18.65	30.00	-11.35
High_13	2472	18.02	18.02	30.00	-11.98

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8.2.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

IC RSS-247 (5.2) (2)

For digitally modulated systems, the power spectral density conducted form the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

RESULTS

High_12

High_13

2467

2472

Duty C	Cycle CF (dB)	0.00	Included	in Calc	ulations	of Corr'o
PSD Resul	ts					
Channel	Frequency	Meas	Total	Limit	Margin	
			Corr'd			
	(MHz)	(dBm)	PSD			
			(dBm)	(dBm)	(dB)	
Low	2412	-7.237	-7.237	8.0	-15.2	
Mid	2437	-7.189	-7.189	8.0	-15.2	
High 11	2462	-7.393	-7.393	8.0	-15.4	

-8.004

-9.088

-8.004

-9.088

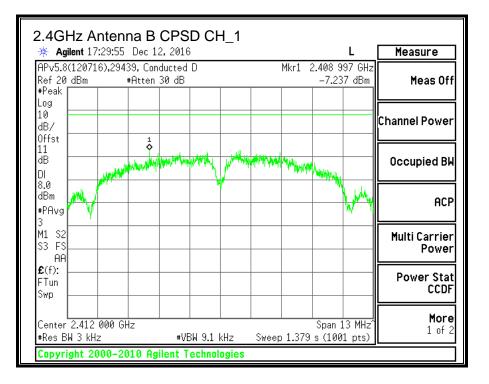
-16.0

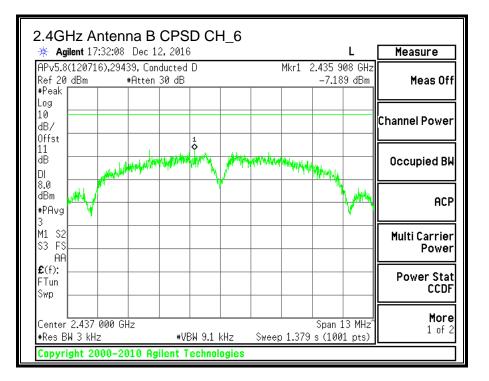
-17.1

8.0

8.0

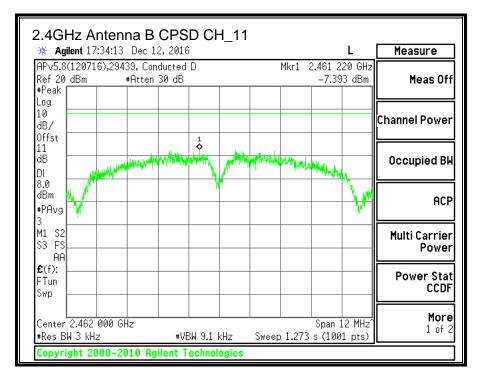
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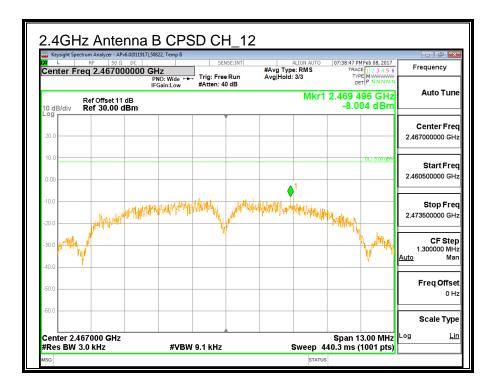




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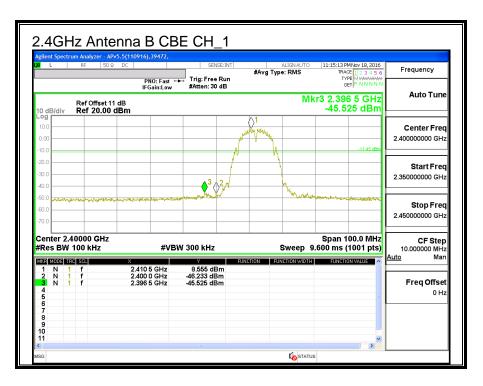




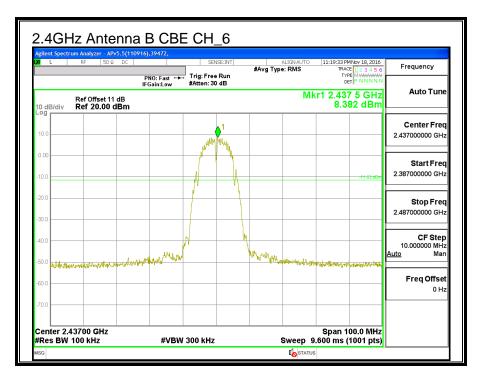
Page 55 of 237

Measure	L				H_13						2.4GI 💥 Ag
Meas Off	092 GHz 88 dBm		Mkr1 á			D		39, Con #Atten			APv5.8 Ref 20 #Peak
Channel Power											Log 10 dB/ Offst
Occupied BW		MARNIN	n where	nadit yilayi		WWW N	eliyhant meliyhan	alaqadana	Wanth		11 dB DI
ACP	1 and the second					,			<i>•</i>	***	8.0 dBm #PAvg 3
Multi Carrier Power											M1 S2 S3 FS AA
Power Stat CCDF											£ (f): FTun Swp
More 1 of 2	13 MHz^ 01 pts)) 1.379	Swee	kHz	 3W 9.1	+VE	l Iz			Center #Res B
					ogies	echnol	ilent T	010 Ag	00-20	ght 20	Copyri

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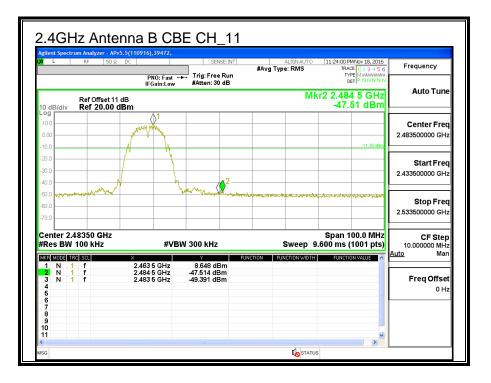


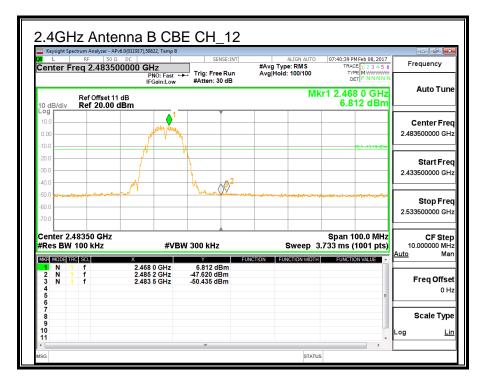
8.2.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS



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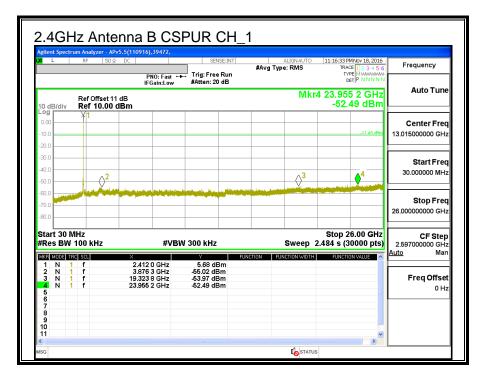


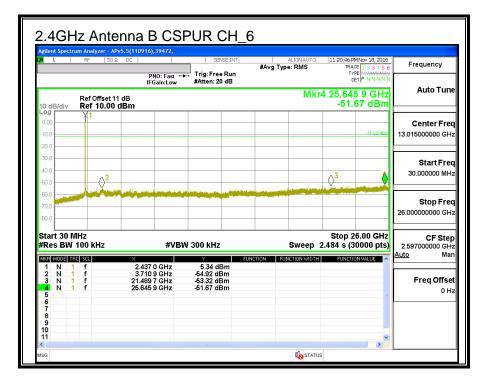


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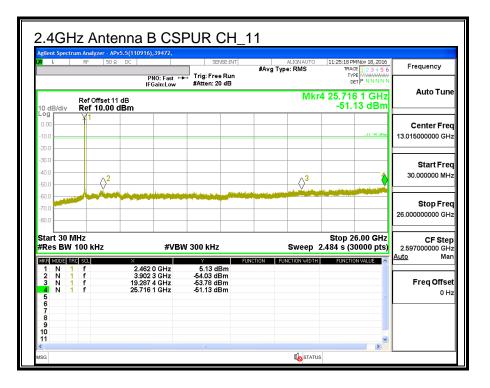
2.4GHz Anten	na B CBE	CH_13			
🛛 🔆 Agilent 17:44:17	Dec 12, 201	6		L	Measure
APv5.8(120716),294 Ref 20 dBm Peak	39, Conducted #Atten 30 dB		Mkr1	. 2.470 5 GH 6.32 dBr	
Log 10 dB/ Offst	, Â				Channel Power
11 dB DI -13.7		32			Occupied BW
4Bm #PAvg					ACP
Center 2.483 5 GHz #Res BW 100 kHz Marker Trace	Type	BW 300 kHz X Axis		Špan 100 MH ns (1001 pts Amplitude	I PUULLATTIET
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Freq Freq Freq	2.470 5 GHz 2.485 3 GHz 2.483 5 GHz		6.32 dBm -47.12 dBm -49.08 dBm CCD	
					More 1 of 2
Copyright 2000-20	Copyright 2000–2010 Agilent Technologies				

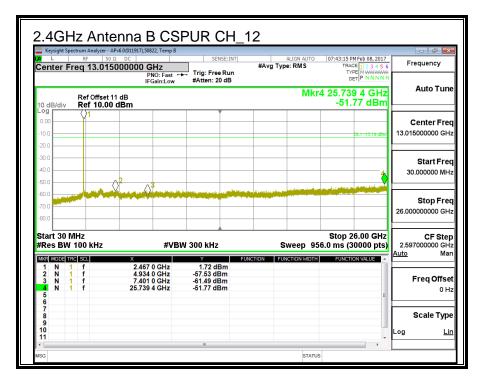
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gilent Spectrum Analyzer - <i>I</i>					
enter Freq 13.01	Ω DC 5000000 GHz PN0: Fast ↔ IFGain:Low	SENSE:INT Trig: Free Run #Atten: 20 dB	ALIGNAUTO #Avg Type: RMS	09:29:15 AM Jan 23, 2017 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N N	Frequency
Ref Offset 0 dB/div Ref 10.00			Mkr	4 24.024 5 GHz -51.77 dBm	Auto Tun
0.00 10.0 20.0					Center Fre 13.015000000 G⊦
40.0				27.25 dBm	Start Fre 30.000000 M⊦
50.0 70.0 30.0					Stop Fre 26.000000000 G⊦
tart 30 MHz Stop 26.00 GHz Res BW 100 kHz #VBW 300 kHz Sweep 2.484 s (30000 pts)				CF Ste 2.597000000 GH	
AKE MODE TEC SCL 1 N 1 f 2 N 1 f 3 N 1 f 4 N 1 f 5 - - - 6 - - -	X 2.472 0 GHz 4.944 0 GHz 7.416 0 GHz 24.024 5 GHz	Y 50 -11.07 dBm -59.65 dBm -60.29 dBm -51.77 dBm	NCTION FUNCTION WIDTH	FUNCTION VALUE	Auto Ma FreqOffso 0 H
7 8 9 10 11				×	

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8.3. 11n HT20 ANTENNA A SISO MODE IN THE 2.4GHz BAND

8.3.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (1)

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

Channel	Frequency (MHz)	6 dB BW Antenna A (MHz)	Minimum Limit (MHz)
Low_1	2412	17.020	0.5
Middle_6	2437	17.540	0.5
High_10	2457	17.130	0.5
High_11	2462	15.910	0.5
High_12	2467	17.250	0.5
High_13	2472	17.545	0.5

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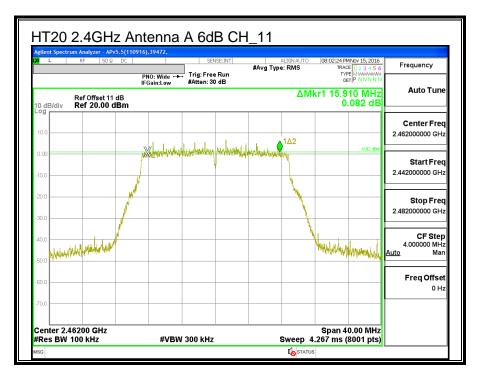
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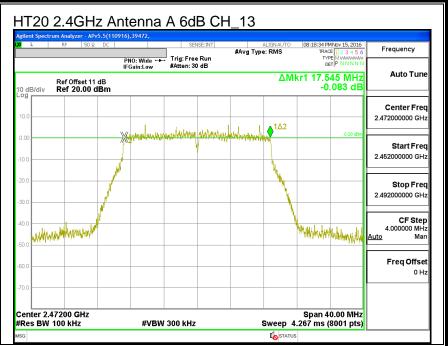
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8.3.2. 99% BANDWIDTH

LIMITS

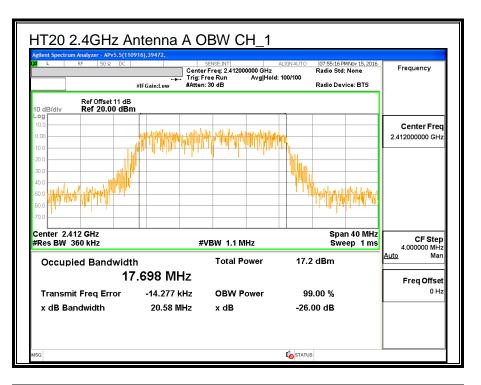
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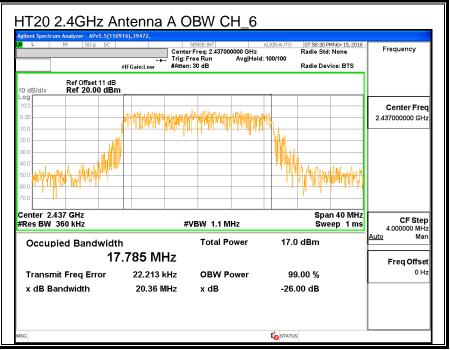
RESULTS

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)
Low_1	2412	17.698
Middle_6	2437	17.785
High_10	2457	17.785
High_11	2462	17.828
High_12	2467	17.705
High_13	2472	17.763

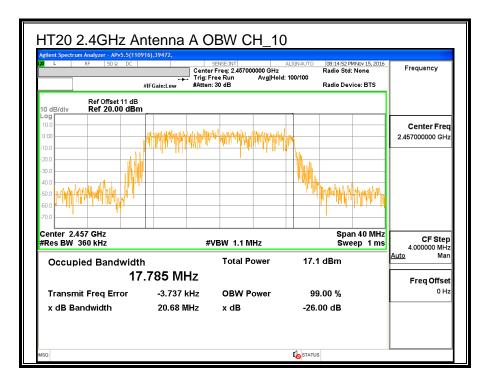
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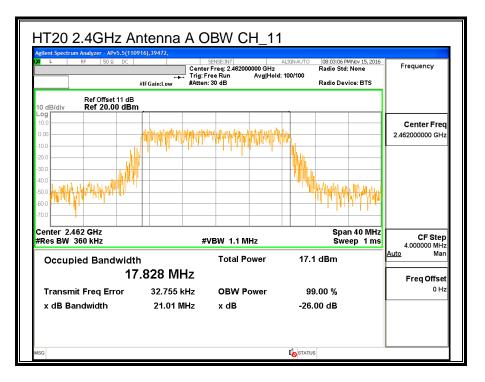
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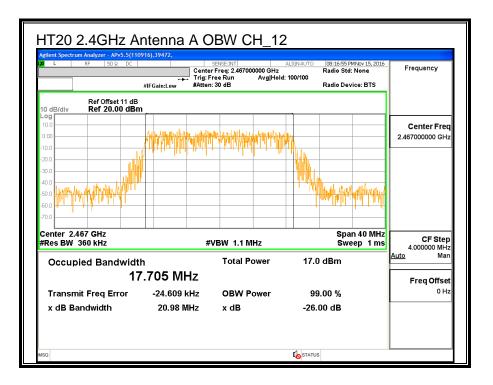
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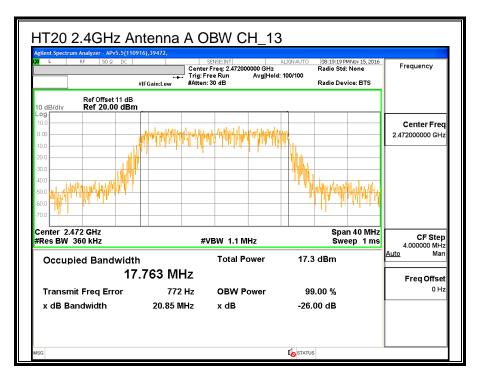




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8.3.3. AVERAGE POWER



LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	Power Antenna A(MHz)
Low_1	2412	14.89
Middle_6	2437	16.00
High_10	2457	15.85
High_11	2462	13.32
High_12	2467	11.74
High_13	2472	3.82

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8.3.4. OUTPUT POWER

ID: 39472 **Date:** 12/19/16

<u>LIMITS</u>

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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RESULTS

Frequency	Directional	FCC	IC	IC	Max
	Gain	Power	Power	EIRP	Power
		Limit	Limit	Limit	
(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
2412	1.91	30.00	30	36	30.00
2437	1.91	30.00	30	36	30.00
2457	1.91	30.00	30	36	30.00
2462	1.91	30.00	30	36	30.00
2467	1.91	30.00	30	36	30.00
2472	1.91	30.00	30	36	30.00
	(MHz) 2412 2437 2457 2462 2467	(MHz) (dBi) 2412 1.91 2437 1.91 2457 1.91 2462 1.91 2467 1.91	Gain Power (MHz) (dBi) (dBm) 2412 1.91 30.00 2437 1.91 30.00 2457 1.91 30.00 2462 1.91 30.00	Gain Power Power (MHz) (dBi) (dBm) (dBm) 2412 1.91 30.00 30 2437 1.91 30.00 30 2457 1.91 30.00 30 2462 1.91 30.00 30 2467 1.91 30.00 30	Gain Power Power EIRP Limit Limit Limit Limit Itimit (MHz) (dBi) (dBm) (dBm) (dBm) (dBm) 2412 1.91 30.00 30 36 2437 1.91 30.00 30 36 2457 1.91 30.00 30 36 2462 1.91 30.00 30 36 2467 1.91 30.00 30 36

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd Power
--------------------	------	--

Results

Channel	Frequency	Meas	Total	Power	Margin
		Power	Corr'd	Limit	
			Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low_1	2412	21.52	21.52	30.00	-8.48
Mid_6	2437	22.70	22.70	30.00	-7.30
High_10	2457	22.64	22.64	30.00	-7.36
High_11	2462	20.61	20.61	30.00	-9.39
High_12	2467	19.47	19.47	30.00	-10.53
High_13	2472	10.59	10.59	30.00	-19.41

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8.3.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

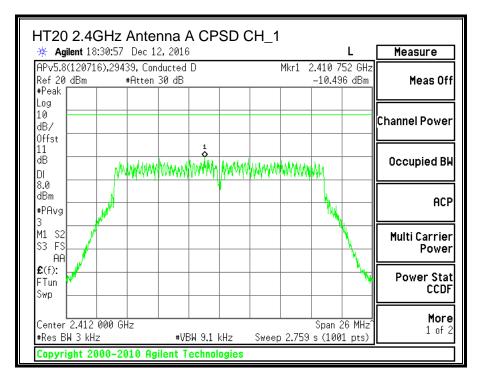
IC RSS-247 (5.2) (2)

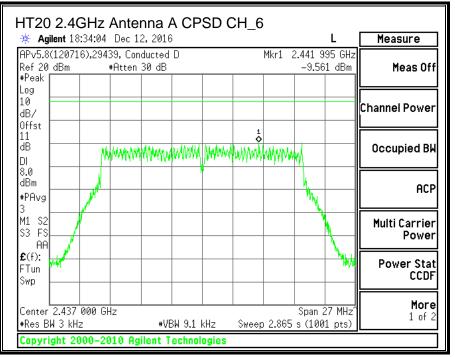
For digitally modulated systems, the power spectral density conducted form the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

RESULTS

Duty C	ycle CF (dB)	0.00	Included	in Calcul	ations of (Corr'd PSD
PSD Resu	ults					
Channel	Frequency	Antenna A	Total	Limit	Margin	
		Meas	Corr'd			
	(MHz)	(dBm)	PSD			
			(dBm)	(dBm)	(dB)	
Low_1	2412	-10.50	-10.50	8.0	-18.5	
Mid_6	2437	-9.56	-9.56	8.0	-17.6	
High_10	2457	-10.29	-10.29	8.0	-18.3	
High_11	2462	-11.76	-11.76	8.0	-19.8	
High_12	2467	-14.15	-14.15	8.0	-22.1	
High_13	2472	-20.94	-20.94	8.0	-28.9	

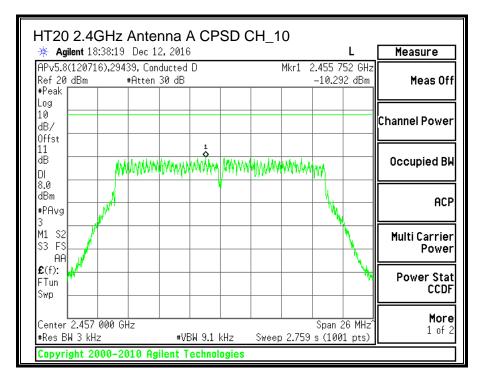
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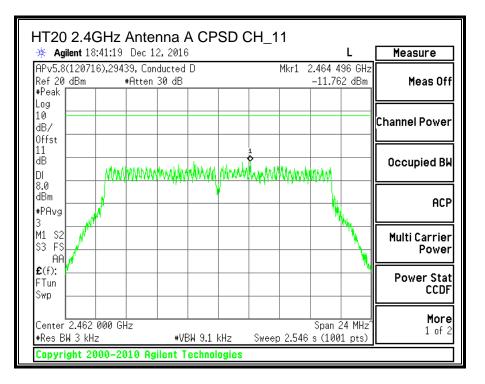




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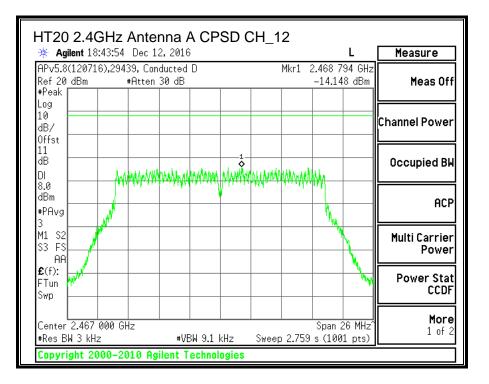
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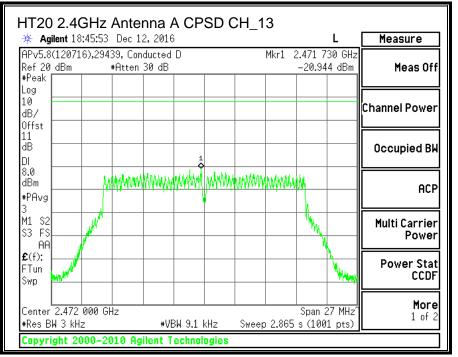




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8.3.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

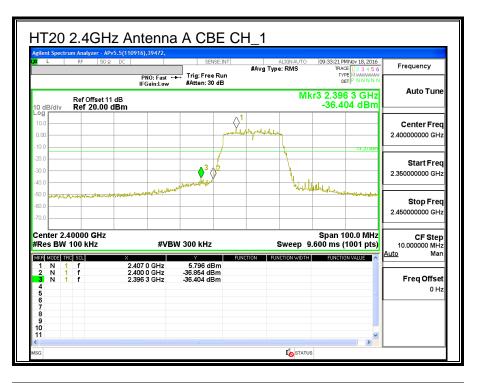
LIMITS

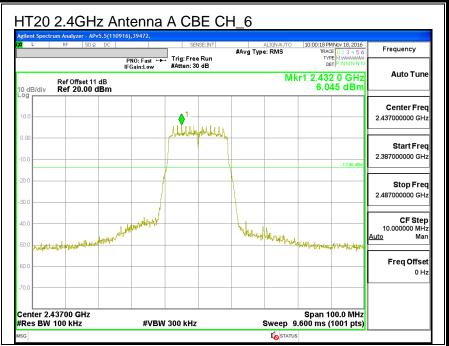
FCC §15.247 (d)

IC RSS-247 (5.5)

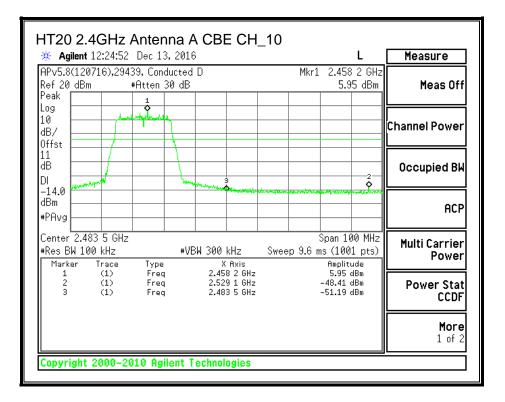
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

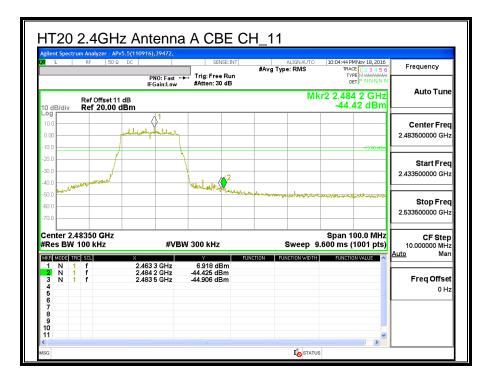
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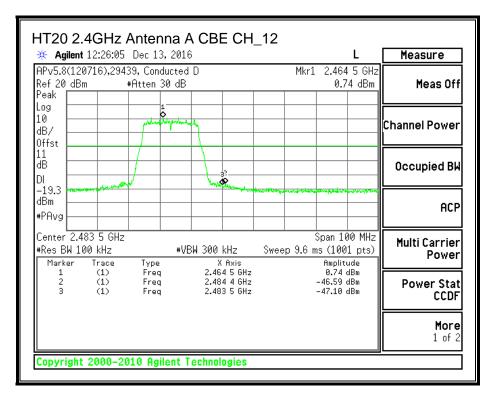


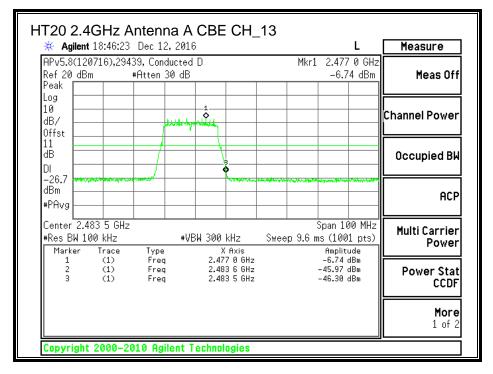
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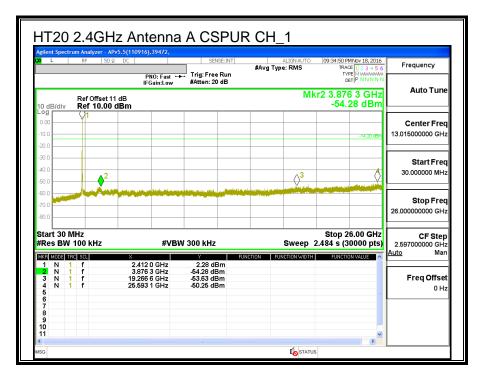


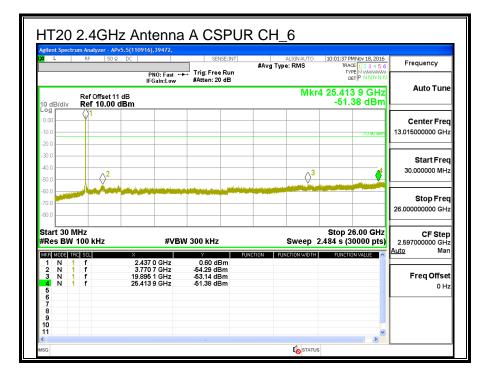
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Frequency	09:28:16 AM Jan 23, 2017 TRACE 1 2 3 4 5 6 TYPE MWWWWW	ALIGNAUTO #Avg Type: RMS	SENSE:INT	Ω DC 0000000 GHz PN0: Fast ←		er Fre	nt
Auto Tu	DET P NNNNN 4 25.832 9 GHz -51.18 dBm	Mkr	#Atten: 20 dB	IFGain:Low	Ref Offset		
	-51.18 GBM			dBm	Ref 10.0	div	g
Center Fr 13.015000000 G							.00).0).0
Start Fr 30.000000 M	-26.74 dBm			A2 03).0).0).0
Stop Fr 26.000000000 G).0).0).0
CF St 2.597000000 G	Stop 26.00 GHz .484 s (30000 pts)	Sweep 3	V 300 kHz	#VBI	iz 00 kHz	30 M BW 1	
Auto M	FUNCTION VALUE	ON FUNCTION WIDTH	-12.41 dBm -60.09 dBm	× 2.472 0 GHz 4.944 0 GHz	f f	IDE TRO N 1 N 1	1
Freq Offs 0			-61.23 dBm -51.18 dBm	7.416 0 GHz 25.832 9 GHz	f f	V 1 V 1	3 4 5 5
							7 3

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8.4. 11n HT20 Antenna B SISO MODE IN THE 2.4GHz BAND

8.4.1. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

IC RSS-247 (5.2) (1)

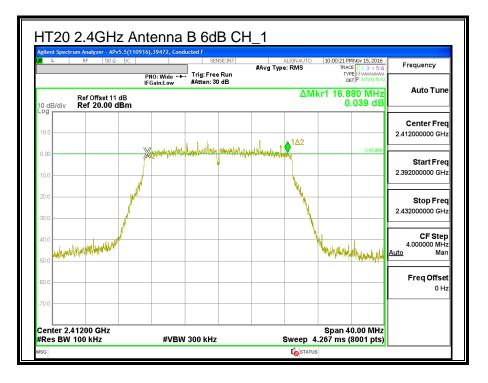
The minimum 6 dB bandwidth shall be at least 500 kHz.

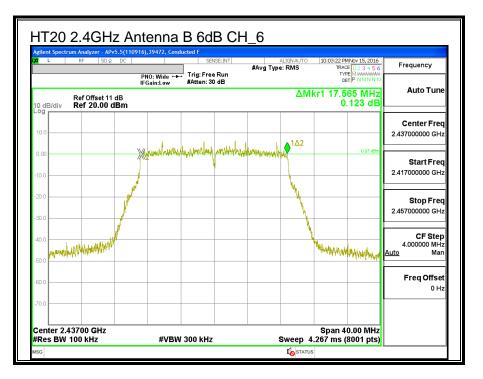
RESULTS

Channel	Frequency (MHz)	6 dB BW Antenna B (MHz)	Minimum Limit (MHz)
Low_1	2412	16.880	0.5
Middle_6	2437	17.565	0.5
High_10	2457	17.565	0.5
High_11	2462	17.010	0.5
High_12	2467	17.540	0.5
High_13	2472	17.545	0.5

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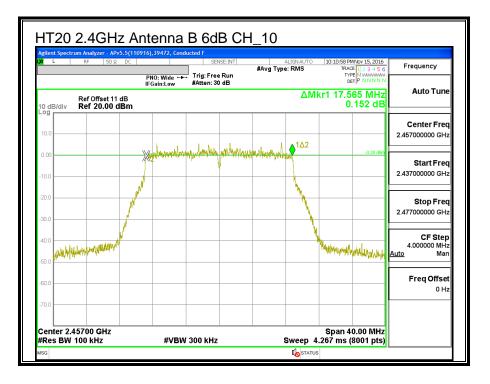
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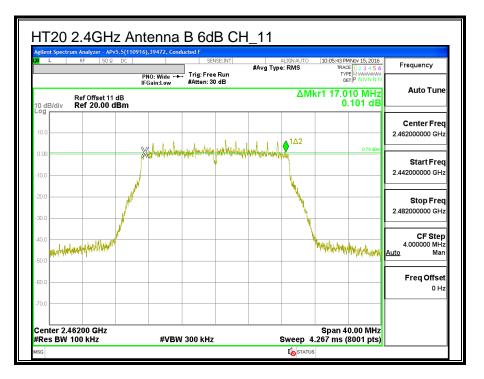




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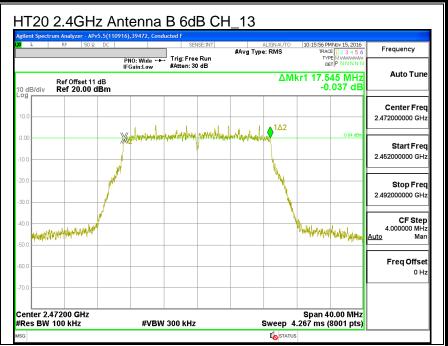




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8.4.2. 99% BANDWIDTH

LIMITS

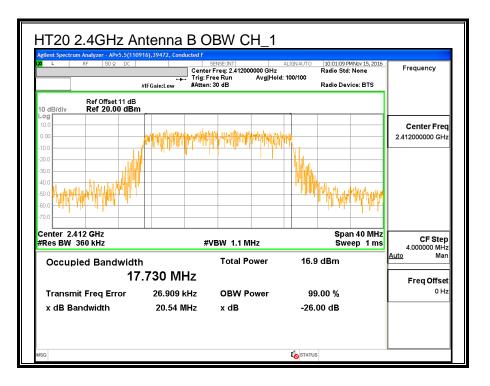
None; for reporting purposes only.

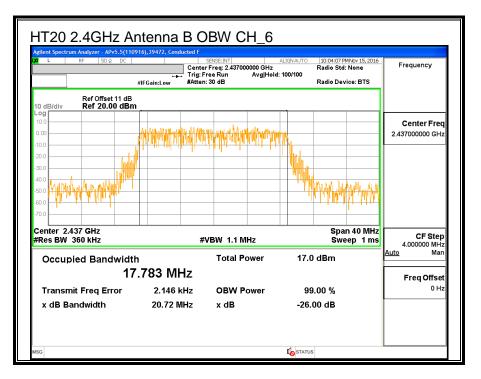
RESULTS

Channel	Frequency (MHz)	99% Bandwidth Antenna B (MHz)
Low_1	2412	17.730
Middle_6	2437	17.783
High_10	2457	17.974
High_11	2462	17.765
High_12	2467	17.707
High_13	2472	17.713

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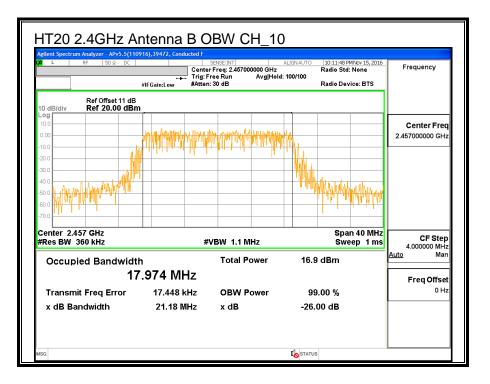
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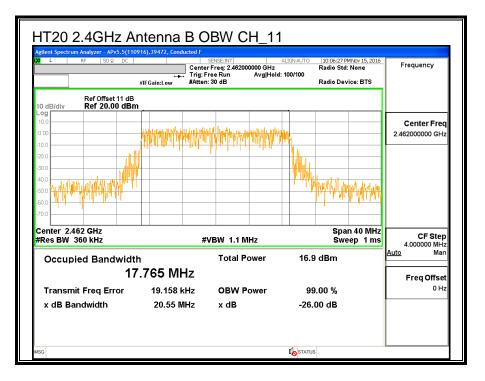




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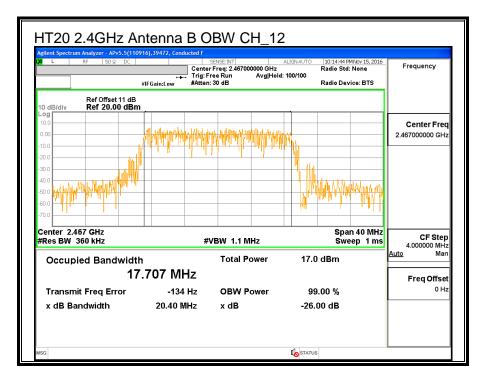
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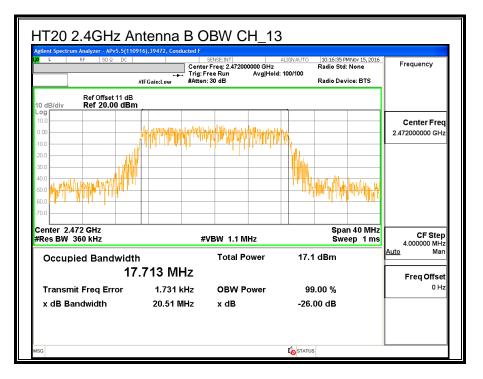




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8.4.3. AVERAGE POWER

ID: 39472 Date: 12/19/2016

<u>LIMITS</u>

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	Power Antenna B (MHz)
Low_1	2412	14.89
Middle_6	2437	15.23
High_10	2457	15.27
High_11	2462	13.41
High_12	2467	11.82
High_13	2472	3.86

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8.4.4. OUTPUT POWER

ID: 39472 **Date:** 12/19/16

LIMITS

FCC §15.247

IC RSS-247 (5.4) (4)

For systems using digital modulation in the 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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RESULTS

Limits						
Channel	Frequency	Directional	FCC	IC	IC	Max
		Gain	Power	Power	EIRP	Power
			Limit	Limit	Limit	
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
Low_1	2412	0.56	30.00	30	36	30.00
Mid_6	2437	0.56	30.00	30	36	30.00
High_10	2457	0.56	30.00	30	36	30.00
High_11	2462	0.56	30.00	30	36	30.00
High_12	2467	0.56	30.00	30	36	30.00
High_13	2472	0.56	30.00	30	36	30.00

Duty Cycle CF (dB) 0.00 In	ncluded in Calculations of Corr'd Power
----------------------------	---

Results

Channel	Frequency	Meas	Total	Power	Margin
		Power	Corr'd	Limit	
			Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low_1	2412	21.23	21.23	30.00	-8.77
Mid_6	2437	21.93	21.93	30.00	-8.07
High_10	2457	22.03	22.03	30.00	-7.97
High_11	2462	20.21	20.21	30.00	-9.79
High_12	2467	19.88	19.88	30.00	-10.12
High_13	2472	9.92	9.92	30.00	-20.08

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8.4.5. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247

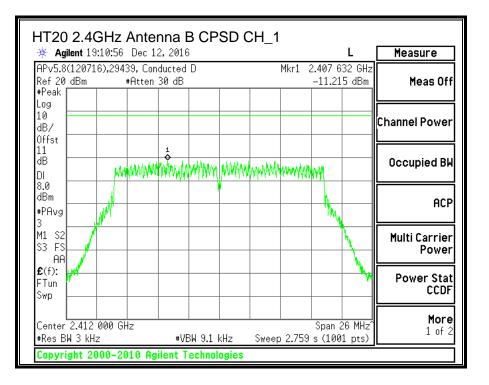
IC RSS-247 (5.2) (2)

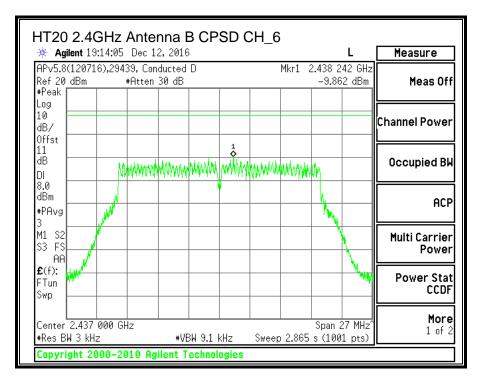
For digitally modulated systems, the power spectral density conducted form the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 KHz band during any time interval of continuous transmissions.

RESULTS

Duty C	ycle CF (dB)	0.00	Included in C	Calculation	ns of Corr'd P	SD
PSD Resu	ults					
Channel	Frequency	Antenna B	Total	Limit	Margin	
		Meas	Corr'd			
	(MHz)	(dBm)	PSD			
			(dBm)	(dBm)	(dB)	
Low_1	2412	-11.22	-11.22	8.0	-19.2	
Mid_6	2437	-9.86	-9.86	8.0	-17.9	
High_10	2457	-10.44	-10.44	8.0	-18.4	
High_11	2462	-12.66	-12.66	8.0	-20.7	
High_12	2467	-13.92	-13.92	8.0	-21.9	
High_13	2472	-20.79	-20.79	8.0	-28.8	

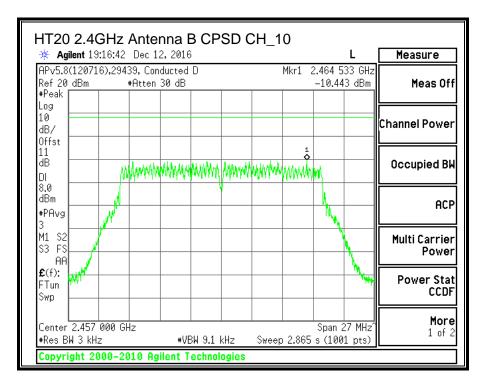
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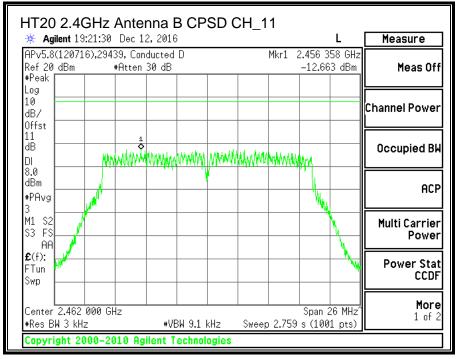




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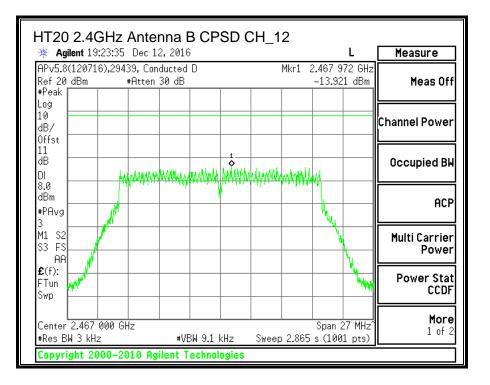
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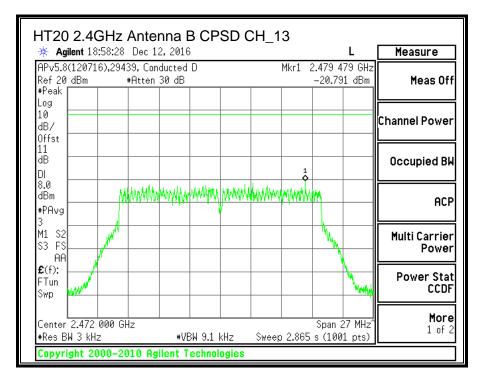




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8.4.6. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

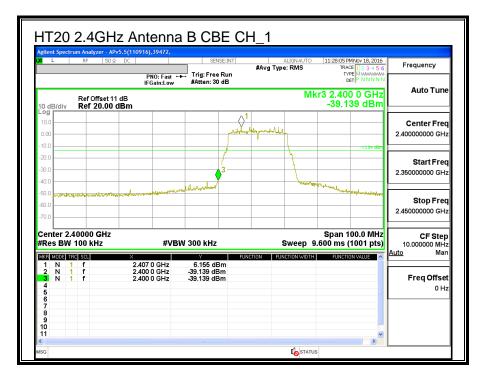
LIMITS

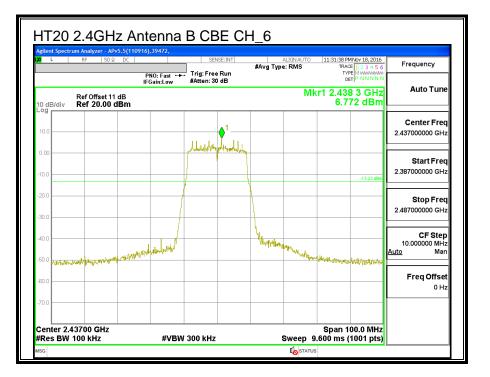
FCC §15.247 (d)

IC RSS-247 (5.5)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

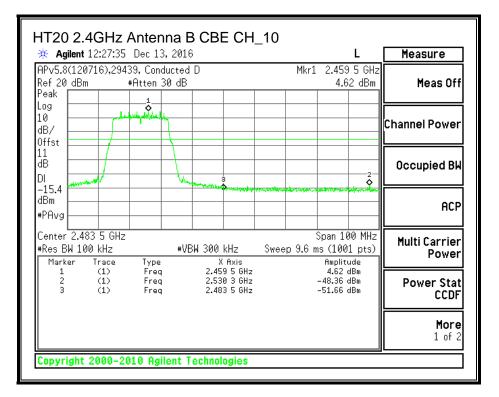
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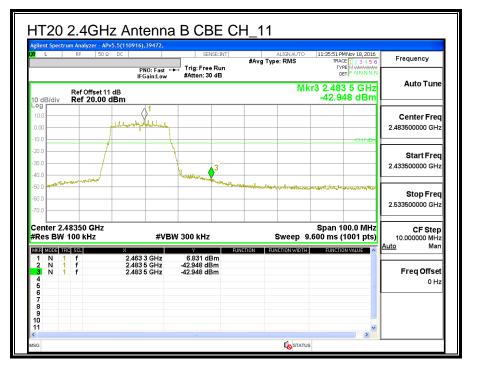




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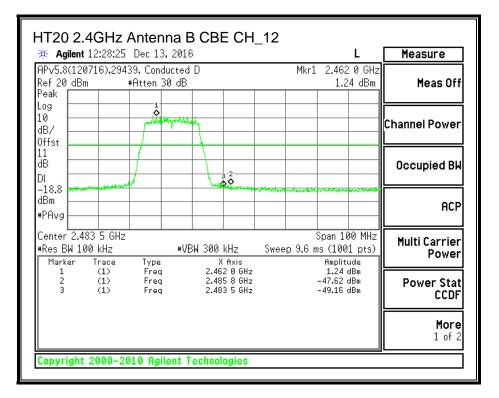
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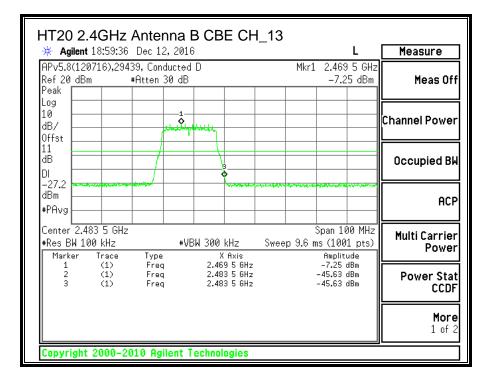




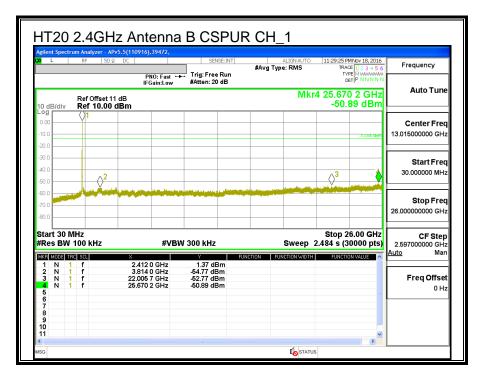
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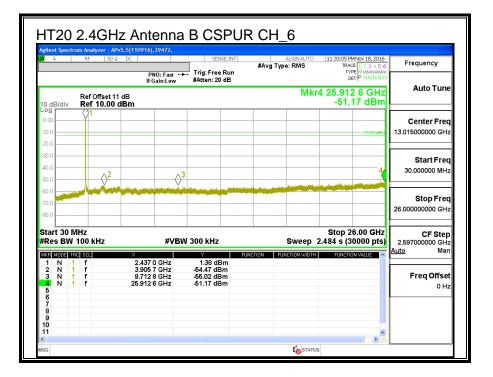
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L RF	r - <mark>ΑΡν6.0(011917),30554, Co</mark> 50 Ω DC	SENSE:INT	ALIGNAUTO	09:29:15 AM Jan 23, 2017	Frequency
enter Freq 13.0	D15000000 GHz PNO: Fast +	Trig: Free Run	#Avg Type: RMS	TRACE 1 2 3 4 5 6 TYPE M MMMMMM DET P N N N N N	Frequency
	IFGain:Low	#Atten: 20 dB	Mkr	4 24.024 5 GHz	Auto Tui
0 dB/div Ref 10	set 11 dB . 00 dBm			-51.77 dBm	
og 0.00					Center Fre
0.0					13.015000000 G
0.0				-27.25 dBm	
0.0					Start Fr
10.0				4	30.000000 MI
60.0 60.0					
0.0					Stop Fre
80.0					26.00000000 G
tart 30 MHz				Stop 26.00 GHz	CF Ste
Res BW 100 kHz	: #VB	W 300 kHz	Sweep 2	2.484 s (30000 pts)	2.597000000 G
KR MODE TRC SCL 1 N 1 f	× 2.472 0 GHz	Y FL -11.07 dBm	JNCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Ma
2 N 1 f 3 N 1 f	4.944 0 GHz 7.416 0 GHz	-59.65 dBm -60.29 dBm			Freq Offs
4 N 1 f 5	24.024 5 GHz	-51.77 dBm			
6					
9					
ō					

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