

# FCC 47 CFR PART 15 SUBPART C INDUSTRY CANADA RSS-247 ISSUE 1

**CERTIFICATION TEST REPORT** 

FOR

# TABLET DEVICE

# **MODEL NUMBER: A1673**

FCC ID: BCGA1673 IC: 579C-A1673

# REPORT NUMBER: 15U22427-E3V2

**ISSUE DATE: FEBRUARY 16, 2016** 

Prepared for APPLE, INC. 1 INFINITE LOOP CUPERTINO, CA 95014, U.S.A.

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	02/04/2016	Initial Issue	C. Pang
V2	02/16/2016	Revised report to address TCB's questions	T. Chu

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# **1. ATTESTATION OF TEST RESULTS**

CFR 47 F	Pass							
ST	TEST RESULTS							
	APPLICABLE STANDARDS							
DATE TESTED:	NOVEMBER 17, 2015 – J	ANUARY 21, 2016						
SERIAL NUMBER: RADIATED (DLXQV00RH36D); CONDUCTED (DLXQT001H3								
MODEL:	<b>ODEL:</b> A1673							
EUT DESCRIPTION:	TABLET DEVICE							
COMPANY NAME:	APPLE, INC. 1 INFINITE LOOP CUPERTINO, CA 95014,	U.S.A.						

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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# 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 v03r04, 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	🛛 Chamber D
Chamber B	Chamber E
Chamber C	🛛 Chamber F
	🛛 Chamber G
	Chamber H

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through H are covered under Industry Canada company address code 2324B with site numbers 2324B -1 through 2324B-8, respectively.

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

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# 4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	± 3.52 dB
Radiated Disturbance, 30 to 1000 MHz	± 4.94 dB
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 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 output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2412 - 2472	802.11b 1TX	19.43	87.70
2412 - 2472	802.11g 1Tx	Covered by HT20 1TX	
2412 - 2472	802.11g 2TX	Covered by HT20 2TX	
2412 - 2472	802.11n HT20 1TX	24.16	260.62
2412 - 2472	802.11n HT20 2TX	26.74	472.06

# 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band	Antenna Gain (dBi)			
(GHz)	Antenna A	Antenna B	Antenna C	
2.4	-0.18	-1.75	1.06	

# 5.4. SOFTWARE AND FIRMWARE

The software installed in the EUT during testing was 13E31820K.

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# 5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power 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 respectively.

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

For simultaneous transmission of multiple channels from the same antenna in the 2.4GHz and 5GHz bands, tests were conducted for various configurations having the highest power. No noticeable new emission was found.

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	Dell	Latitude 3540	6LNG802	N/A				
Earphone	Apple	NA	NA	N/A				
Macbook Air	Apple	A1466	C02P41RZG086	N/A				
EUT AC/DC adapter	Apple	A1385	D293062F3WVDHLHCF	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	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks	
None							

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

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

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

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

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### TEST SETUP

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

#### SETUP DIAGRAM



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### TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS

The EUT was tested with earphone connected and powered by AC adapter. 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	00143449	2/10/2016	
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	A022813-2	3/5/2016	
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	1782158	1/26/2016	
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	323562	5/7/2016	
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY53310972	3/31/2016	
Antenna, Horn 1-18GHz	ETS Lindgren	3117	29310	3/26/2016	
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	N/A	1/31/2016	
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY51380911	10/15/2016	
Antenna, Horn 1-18GHz	ETS Lindgren	3117	165318	4/10/2016	
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	1818464	4/25/2016	
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent	N9030A	MY53311010	5/26/2016	
Power Meter, P-series single channel	Agilent	N1911A	MY53060011	4/7/2016	
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Agilent	N1921A	MY53020038	3/5/2016	
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826	1013	1/29/2016	
Spectrum Analyzer, 40 GHz	Agilent	8564E	3943A01643	8/14/2016	
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Agilent	8449B	3008A04710	6/29/2016	
	AC Line	Conducted			
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	100935	9/16/2016	
LISN for Conducted Emissions CISPR-16	FCC	50/250-25-2	114	1/16/2016	
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2	161124	9/16/2016	
Power Cable, Line Conducted Emissions	UL	PG1	7/28/2015	7/28/2016	
	UL SO	FTWARE			
* Radiated Software	UL	UL EMC	Ver 9.5, July	/ 22, 2014	
* Conducted Software	UL	UL EMC	Ver 2.2, Marc	h 31, 2015	
* AC Line Conducted Software	UL	UL EMC	Ver 9.5, April 3, 2015		

Note: \* indicates automation software version used in the compliance certification testing

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# 7. MEASUREMENT METHODS

<u>6 dB BW</u>: KDB 558074 D01 v03r04, Section 8.1.

Output Power: KDB 558074 D01 v03r04, Section 9.1.2.

Power Spectral Density: KDB 558074 D01 v03r04, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v03r04, Section 11.0.

Out-of-band emissions in restricted bands: KDB 558074 D01 v03r04, Section 12.1.

Band-edge: KDB 558074 D01 v03r04, Section 12.1.

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# 8. ANTENNA PORT TEST RESULTS

# 8.1. ON TIME AND DUTY CYCLE

## <u>LIMITS</u>

None; for reporting purposes only.

## PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

## ON TIME AND DUTY CYCLE RESULTS

Mode	<b>ON Time</b>	Period	<b>Duty Cycle</b>	Duty	Duty Cycle	1/B
	В		х	Cycle	<b>Correction Factor</b>	Minimum VBW
	(msec)	(msec)	(linear)	(%)	(dB)	(kHz)
2.4GHz Band						
802.11b 1TX	5.000	5.000	1.000	100.00%	0.00	0.010
802.11n HT20 1TX	1.920	1.940	0.990	98.97%	0.00	0.010
802.11n HT20 CDD	1.917	1.941	0.988	98.76%	0.00	0.010

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## **DUTY CYCLE PLOTS**

#### 2.4 GHz BAND

KL.	RF 50 Ω DC	PNO: Fast ↔ IFGain:Low	SENSE:INT Trig: Free Run #Atten: 30 dB	ALIGNAUTO #Avg Type: RMS	01:58:06 PM Jan 21, 2016 TRACE 1 2 3 4 5 6 TYPE WWWWW DET P N N N N N	Frequency
) dB/div	Ref Offset 11 dB Ref 30.00 dBm					Auto Tune
						Cepter Fred
0.0						2.437000000 GHz
.00						
0.0						Start Free
0.0						2.437000000 GH
0.0						
0.0						Stop Fred
0.0						2.437000000 GH
0.0						
enter 2 es BW	.437000000 GHz 8 MHz	#VBW	50 MHz	Sweep 5	Span 0 Hz .000 ms (1001 pts)	CF Step 8.000000 MHz <u>Auto</u> Mar
1						
3 4 5					=	Freq Offsel 0 Hz
6 7 8						
9						



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RL	RF 50 Ω DC	PNO: Fast	SE	e Run	#Avg Type	ALIGN AUTO E: RMS	01:56:57 PM Jan 2 TRACE 1 2 TYPE WM	1,2016 3 4 5 6 Frequency
R d Bidiy	tef Offset 11 dB	IFGain:Low	#Atten: 3			Δ	Mkr3 1.941 -0.55	Auto Tune
0.0	Hummer Marked Se	phinnertopuntur	un laun da mi	www.www.	yogen of the state	Warnert, Milae	3∆4 «(~)4/4/4	<b>Center Free</b> 2.437000000 GHz
0.0 0.0 0.0								Start Fred 2.437000000 GH;
0.0	1 							Stop Free 2.437000000 GHz
enter 2.437 es BW 8 M	7000000 GHz Hz	#V	BW 50 MHz	FUN	S Ction Fun	Sweep 3.	Span 000 ms (1007 FUNCTION VAL	1 pts) Auto
1 Δ2 1 2 F 1 3 Δ4 1 4 F 1 5 6	t (Δ) t t (Δ) t	1.917 ms 696.0 μs 1.941 ms 696.0 μs	Δ) 1.17 15.85 d Δ) -0.55 15.85 d	dB Bm dB Bm				Freq Offset 0 Hz
7 8 9 0								

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# 8.2. 802.11b SISO MODE IN THE 2.4 GHz BAND (ANTENNA B)

# 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	6 dB Bandwidth	Minimum Limit
	(MHz)	(MHz)	(MHz)
Low	2412	8.060	0.5
Mid	2437	8.125	0.5
High_11	2462	8.073	0.5
High_12	2467	8.099	0.5
High_13	2472	8.554	0.5

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### 6 dB BANDWIDTH





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# 8.2.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Low	2412	10.268
Mid	2437	10.303
High_11	2462	10.515
High_12	2467	10.445
High_13	2472	10.415

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### 99% BANDWIDTH





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# 8.2.3. AVERAGE POWER

### LIMITS

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	Power
	(MHz)	(dBm)
Low	2412	15.86
Mid	2437	15.92
High_11	2462	15.98
High_12	2467	15.83
High_13	2472	13.91

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# 8.2.4. OUTPUT POWER

### 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>

L	i	n	ni	it	s
				I L	9

Channel	Frequency	Directional	FCC	IC	IC	Max
		Gain	Power	Power	EIRP	Power
			Limit	Limit	Limit	
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2412	-1.75	30.00	30	36	30.00
Mid	2437	-1.75	30.00	30	36	30.00
High_11	2462	-1.75	30.00	30	36	30.00
High_12	2467	-1.75	30.00	30	36	30.00
High_13	2472	-1.75	30.00	30	36	30.00

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

Resu	lts

Channel	Frequency	Chain 0	Total	Power	Margin
		Meas	Corr'd	Limit	
		Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	18.73	18.73	30.00	-11.27
Mid	2437	18.95	18.95	30.00	-11.05
High_11	2462	18.97	18.97	30.00	-11.03
High_12	2467	18.71	18.71	30.00	-11.29
High_13	2472	16.75	16.75	30.00	-13.25

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PSD

# 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**

Duty Cycle CF (dB)		0.00	Included in Calculations of Corro						
PSD Results									
Channel	Frequency	Antenna B	Total	Limit	Margin				
		Meas	Corr'd						
	(MHz)	(dBm)	PSD						
			(dBm)	(dBm)	(dB)				
Low	2412	-6.88	-6.88	8.0	-14.9				
Mid	2437	-6.54	-6.54	8.0	-14.5				
High_11	2462	-5.92	-5.92	8.0	-13.9				
High_12	2467	-6.76	-6.76	8.0	-14.8				
High_13	2472	-8.22	-8.22	8.0	-16.2				

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<u>PSD</u>





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# 8.2.6. OUT-OF-BAND 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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### **RESULTS**

#### **IN-BAND REFERENCE LEVEL**



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### LOW CHANNEL BANDEDGE



### HIGH CHANNEL BANDEDGE



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### **OUT-OF-BAND EMISSIONS**

RL	RF 50 ជ	PNO: Fast	SENSE:INT	ALIGNAUTO #Avg Type: RMS	11:33:36 AM Jan 19, 2016 TRACE 1 2 3 4 5 6 TYPE M WWWWWWW DET P N N N N	Frequency
0 dB/div	Ref Offset 1 Ref 20.00	1 dB dBm	Atten: 20 db	Mk	r2 3.820 0 GHz -54.41 dBm	Auto Tune
10.0 0.00 10.0	1					Center Fred 13.015000000 GH;
20.0						Start Free 30.000000 MH:
50.0 50.0 70.0						Stop Free 26.000000000 GH:
tart 30 Res BW	MHz / 100 kHz	#VE	3W 300 kHz	Sweep	Stop 26.00 GHz 2.48 s (30000 pts)	CF Step 2.597000000 GH
KE XODE 1 N 2 N 3 4 5 6 7 8 9 9 10 11 12	irc scl	x 2.412 4 GHz 3.820 0 GHz	¥ 4.643 dBm -54.41 dBm	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	Freq Offse 0 H:



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RL	RF S	50 Ω DC		SENS	E:INT	#Ava Typ		05:52:18	PM Jan 19, 2016	Frequency
			PNO: Fast C Gain:Low	Trig: Free F Atten: 20 d	Run B	#A18 19P	. KW5	T) E	PE M WAANAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	
0 dB/div	Ref Offset Ref 20.0	t 11 dB 00 dBm					Mk	r2 5.01 -54.	3 4 GHz 86 dBm	Auto Tune
og	01									0 E
3.00	ĭ									13.015000000 GH
10.0									-12.32 dBm	
0.0										Start Eree
30.0										30.000000 MH
0.0		• 2								
0.0			يوليو بور رويس ال	-	and drawn out	Lange and the		معاقبهما العبرية		Stop Free
50.0										26.00000000 GH
0.0										
tart 30 l Rec BM	MHz 100 kHz		#\/B	W 300 kHz			Sween	Stop 2	26.00 GHz	CF Step
			#40	W JOO KIIZ	FINE		oweep	2.40 3 (		2.597000000 GH Auto Mar
1 N	1 f	2.463	5 GHz	7.42 dBr	n		CHONWIDTH	HONGT	JN VALUE	
2 N 3	1 T	5.013	4 GHZ	-54.86 dBr	n					Freq Offse
4 5										он
6 7										
8 9										



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RL	RF 50	Ω DC	SENSE:IN	r⊓ #Avg	ALIGNAUTO Type: RMS	06:54:32 PM Jan 19, 2016 TRACE 1 2 3 4 5 6	Frequency
		PNO: Fast IFGain:Low	Atten: 20 dB	1		DET P N N N N	v .
0 dB/div	Ref Offset 1 Ref 20.00	1 dB dBm			Mk	r2 3.766 8 GHz -56.28 dBm	Auto Tune
og	1						Contor Fro
a.oo							13.015000000 GH
10.0						-14.48 dBm	
20.0							Start Free
i0.0							30.000000 MH
10.0							
30.0		ومواليه أورو ومرجع والمرجع والم			and a solution of a start		Stop Free
70.0							26.000000000 GH
tart 30 l Res BW	VIHZ 100 kHz	#V	3W 300 kHz		Sweep	2.48 s (30000 pts)	CF Step
KR MODE T	RC SCL	×	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Mar
1 N <sup>2</sup>	f f	2.470 4 GHz 3.766 8 GHz	4.76 dBm -56.28 dBm				
3							Freq Offse
5							0 H
7							
9							
1							

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# 8.3. 802.11b SISO MODE IN THE 2.4 GHz BAND (ANTENNA A)

# 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	6 dB Bandwidth	Minimum Limit
	(MHz)	(MHz)	(MHz)
Low	2412	8.099	0.5
Mid	2437	8.034	0.5
High_11	2462	8.086	0.5
High_12	2467	8.528	0.5
High_13	2472	8.086	0.5

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### 6 dB BANDWIDTH





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# 8.3.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Low	2412	10.245
Mid	2437	10.244
High_11	2462	10.234
High_12	2467	10.301
High_13	2472	10.231

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#### 99% BANDWIDTH





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# 8.3.3. AVERAGE POWER

### LIMITS

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	Power	
	(MHz)	(dBm)	
Low	2412	16.31	
Mid	2437	16.47	
High_11	2462	16.49	
High_12	2467	16.50	
High_13	2472	13.90	

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# 8.3.4. OUTPUT POWER

### 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>

L	i	n	n	i	ts
	-	-	_	-	

Channel	Frequency	Directional	FCC	IC	IC	Max
		Gain	Power	Power	EIRP	Power
			Limit	Limit	Limit	
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2412	-0.18	30.00	30	36	30.00
Mid	2437	-0.18	30.00	30	36	30.00
High_11	2462	-0.18	30.00	30	36	30.00
High_12	2467	-0.18	30.00	30	36	30.00
High_13	2472	-0.18	30.00	30	36	30.00

Duty Cycle CF (dB) 0.	.00	Included in Calculations of Corr'd Power
-----------------------	-----	--

Resu	lts

Channel	Frequency	Chain 0	Total	Power	Margin
		Meas	Corr'd	Limit	
		Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	19.33	19.33	30.00	-10.67
Mid	2437	19.36	19.36	30.00	-10.64
High_11	2462	19.43	19.43	30.00	-10.57
High_12	2467	19.40	19.40	30.00	-10.60
High_13	2472	16.79	16.79	30.00	-13.21

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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 Cycle CF (dB)		0.00	Included in Calculations of Corr'd PSE					
PSD Results								
Channel	Frequency	Antenna A	Total	Limit	Margin			
		Meas	Corr'd					
	(MHz)	(dBm)	PSD					
			(dBm)	(dBm)	(dB)			
Low	2412	-6.246	-6.25	8.0	-14.2			
Mid	2437	-5.423	-5.42	8.0	-13.4			
High_11	2462	-5.558	-5.56	8.0	-13.6			
High_12	2467	-5.463	-5.46	8.0	-13.5			
High_13	2472	-9.181	-9.18	8.0	-17.2			

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<u>PSD</u>





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# 8.3.6. OUT-OF-BAND 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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#### **RESULTS**

#### **IN-BAND REFERENCE LEVEL**



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### LOW CHANNEL BANDEDGE



### HIGH CHANNEL BANDEDGE



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## **OUT-OF-BAND EMISSIONS**

RL	RF SC	PNO: East	SENSE:IN	T #Avg	ALIGN AUTO Type: RMS	11:41:54 PM Jan 19, TRACE 1 2 3 4 TYPE MWWW	Frequency
	Ref Offset	IFGain:Low	Atten: 20 dB		Mkr	3 11.449 8 G	Hz Auto Tune
0 dB/div	Ref 20.00	0 dBm				-55.44 dE	sm
10.0	- <u>q</u>						Center Free
0.00							13.015000000 GH:
0.0						12.07	
0.0							Start Free
0.0							30.000000 MH
0.0			3				
0.0							Stop Free
0.0							26.00000000 GHz
tart 30	MU7					Stop 26.00 G	
Res BV	/ 100 kHz	#VE	W 300 kHz		Sweep	2.48 s (30000 p	ots) 2 597000000 GH
KR MODE	TRC SCL	х	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Mar
1 N 2 N	1 f 1 f	2.413 3 GHz 3.811 8 GHz	6.322 dBm -54 51 dBm				
3 N	1 f	11.449 8 GHz	-55.44 dBm				Freq Offse
5							0 H:
7							
8 9							
0							



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ilent Spect R L	<mark>rum Analyze</mark> RF	r - Swept SA 50 Ω DC			ENSE:INT	#Avg T	ALIGN AUTO	10:53:57 TRA	AM Jan 20, 2016 CE 1 2 3 4 5 6	Frequency
			PNO: Fast IFGain:Lov	Trig: Fre Atten: 2	e Run 0 dB	_		TY D	ET P N N N N N	
) dB/div	Ref Offs Ref 20	et 11 dB . <b>00 dBm</b>					Mk	r2 3.80 -54.	4 4 GHz 65 dBm	Auto Tun
										Center Fre
.00										13.015000000 GH
0.0									11.97 dBm	
0.0										Start Free
0.0										30.000000 MH
1.0		2								
0.0	فيعيان			and other or at	a substan			and the second second		Stop Free
0.0			-							26.00000000 GH
art 30 I	MHz 100 kHz				_		<b>0</b>	Stop 2	26.00 GHz	CF Ste
Kes BW	100 KHZ		#\	BW 300 KH	2		sweep	2.48 S (3	iuuuu pts)	2.597000000 GH
I N	nd sul 1 f	2	.462 6 GHz	6.348 c	IBm	NCTION	FUNCTION WIDTH	FUNCTI	JN VALUE	<u>Auto</u> ma
2 N <sup>·</sup> 3	1 f	3	8.804 4 GHz	-54.65 d	Bm					Freg Offse
5										он
5 7										
3										
D 1										
2										



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K RL	RF 50 Ω	PNO: Fast C	SENSE:INT	ALIGNAUTO #Avg Type: RMS	11:09:46 AM Jan 20, 2016 TRACE 1 2 3 4 5 6 TYPE M WANNAW DET P N N N N	Frequency
0 dB/div	Ref Offset 11 d Ref 20.00 dB	B 3m	Atten. 20 db	Mk	(r2 3.762 0 GHz -54.24 dBm	Auto Tune
10.0						Center Free
10.00					14.45	13.015000000 GH
20.0					-14.45 (358)	Start Free
40.0						30.000000 MH
50.0	<sup>2</sup>				and the state of t	04 E
70.0						26.000000000 GH
tart 30 l Res BW	MHz 100 kHz	#VB	W 300 kHz	Sweep	Stop 26.00 GHz 2.48 s (30000 pts)	CF Ster 2.597000000 GH
ikr mode t 1 n	RC SCL 1 f	× 2.471 3 GHz	4.00 dBm	UNCTION FUNCTION WIDTH	FUNCTION VALUE	<u>Auto</u> Mar
2 N 3 4 5	1 f	3.762 0 GHz	-54.24 dBm			<b>Freq Offse</b> 0 H
6 7 8						
9						

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# 8.4. 802.11b SISO MODE IN THE 2.4 GHz BAND (ANTENNA C)

# 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	6 dB Bandwidth	Minimum Limit
	(MHz)	(MHz)	(MHz)
Low	2412	8.554	0.5
Mid	2437	8.099	0.5
High_11	2462	8.099	0.5
High_12	2467	8.099	0.5
High_13	2472	8.047	0.5

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### 6 dB BANDWIDTH





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# 8.4.2. 99% BANDWIDTH

### LIMITS

None; for reporting purposes only.

#### **RESULTS**

Channel	Frequency	99% Bandwidth
	(MHz)	(MHz)
Low	2412	10.365
Mid	2437	10.430
High_11	2462	10.373
High_12	2467	10.512
High_13	2472	10.263

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#### 99% BANDWIDTH





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# 8.4.3. AVERAGE POWER

### LIMITS

None; for reporting purposes only.

### **RESULTS**

Channel	Frequency	Power	
	(MHz)	(dBm)	
Low	2412	14.98	
Mid	2437	14.96	
High_11	2462	14.86	
High_12	2467	14.94	
High_13	2472	13.98	

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# 8.4.4. OUTPUT POWER

# 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>

L	i	m	its
_			

Channel	Frequency	Directional	FCC	IC	IC	Max
		Gain	Power	Power	EIRP	Power
			Limit	Limit	Limit	
	(MHz)	(dBi)	(dBm)	(dBm)	(dBm)	(dBm)
Low	2412	1.06	30.00	30	36	30.00
Mid	2437	1.06	30.00	30	36	30.00
High_11	2462	1.06	30.00	30	36	30.00
High_12	2467	1.06	30.00	30	36	30.00
High_13	2472	1.06	30.00	30	36	30.00

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

Results
---------

Channel	Frequency	Chain 0	Total	Power	Margin
		Meas	Corr'd	Limit	
		Power	Power		
	(MHz)	(dBm)	(dBm)	(dBm)	(dB)
Low	2412	17.86	17.86	30.00	-12.14
Mid	2437	18.02	18.02	30.00	-11.98
High_11	2462	17.85	17.85	30.00	-12.15
High_12	2467	17.83	17.83	30.00	-12.17
High_13	2472	16.93	16.93	30.00	-13.07

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PSD

# 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	Cycle CF (dB)	0.00	Included	in Calc	ulations	of Corr'd			
PSD Results									
Channel	Frequency	Antenna C	Total	Limit	Margin				
		Meas	Corr'd						
	(MHz)	(dBm)	PSD						
			(dBm)	(dBm)	(dB)				
Low	2412	-7.75	-7.75	8.0	-15.8				
Mid	2437	-7.93	-7.93	8.0	-15.9				
High_11	2462	-8.17	-8.17	8.0	-16.2				
High_12	2467	-8.16	-8.16	8.0	-16.2				
High_13	2472	-9.77	-9.77	8.0	-17.8				

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<u>PSD</u>





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# 8.4.6. OUT-OF-BAND 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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## **RESULTS**

#### **IN-BAND REFERENCE LEVEL**



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# LOW CHANNEL BANDEDGE



# HIGH CHANNEL BANDEDGE



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# **OUT-OF-BAND EMISSIONS**

RL	RF 50 Q DC P	10: Fast Trig: Fre	#Avg #Avg e Run 0 dB	ALIGN AUTO J Type: RMS	05:11:44 PM Jan 20 TRACE 1 2 3 TYPE M WAW DET P N N	, 2016 4 5 6 NNN
R/ 0 dB/div R	ef Offset 11 dB ef 20.00 dBm			Mkr	3 11.542 0 G -55.61 dl	Hz Auto Tune Bm
.og 10.0	1					Center Fred
0.00						13.015000000 GHz
20.0						Start Fred
30.0						30.000000 MH
50.0	<mark>2</mark>	3				
60.0 70.0						26.00000000 GH
start 30 MHz Res BW 10	z 0 kHz	#VBW 300 kHz	2	Sweep	Stop 26.00 ( 2.48 s (30000	GHz CF Step pts) 2.597000000 GH;
1 N 1 1	CL X 7 2.411 :	5 GHz 4,668 d	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto Mar
2 N 1 1 3 N 1 1 4 5 6	F 5.816 F 11.542	3 GHz -55.63 d 0 GHz -55.61 d	Bm Bm			Freq Offse 0 H:
7 8 9 10						



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ilent Spect	rum Analyzer - RF S	- Swept SA 50 Ω DC	NO: Fast	SENSE	EINT	#Avg Type	ALIGN AUTO :: RMS	05:51:23 TRA TY	PM Jan 20, 2016 CE 1 2 3 4 5 6 PE M MANANA ET P N N N N N	Frequency
) dB/div	Ref Offse Ref 20.0	t 11 dB 00 dBm	Gain:Low	Auen. 20 u	5		Mk	r2 5.08 -53.	0 5 GHz 61 dBm	Auto Tune
og 10.0	1									Center Free
).00										13.015000000 GH
0.0									-14.33 dBm	
0.0										Start Free
0.0										30.000000 MH
0.0		<sup>2</sup>								
0.0	ما المحيدة المحيد	and second	(magnetic state		<b>Augusta</b>	uni su nideri				Stop Free
0.0										26.00000000 GH
tart 30 I Res BW	MHz 100 kHz		#VB	W 300 kHz			Sweep	Stop 2 2.48 s (3	26.00 GHz 30000 pts)	CF Ste 2.597000000 GH
KR MODE T	RC SCL	× 2 462	6 GHz	Y 4 73 dBr	FUNC	TION FUN	CTION WIDTH	FUNCTI	DN VALUE	<u>Auto</u> Mar
2 N 3 4 5	i f	5.080	5 GHz	-53.61 dBn	i					Freq Offse 0 H
6 7 8										
9 0										
1										



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gilent Spectr	rum Analyzer - S RF 50	wept SA Ω DC		SENS	E:INT	#Ava Tvp	ALIGNAUTO e: RMS	06:07:58 TRA	PM Jan 20, 2016	Frequency
		PN	D: Fast ⊂ nin:Low	Trig: Free I Atten: 20 c	Run 18	0 //		TY	PE MWAAAAAA ET P N N N N N	
0 dB/div	Ref Offset 1 Ref 20.00	1 dB dBm					Mk	r2 3.87 -54.	5 4 GHz 45 dBm	Auto Tune
og 10.0	1									Center Free
0.00	¥									13.015000000 GH
10.0									-15.30 dBm	
20.0										Start Free
10.0 10.0										30.000000 MH
50.0	<b>0</b> 2								and the second second	
50.0	and and a second	a subsection				a, disella and an				Stop Free
70.0										26.00000000 GH
tart 30 M	/Hz						•	Stop 2	26.00 GHz	CF Step
Res BW	100 KHZ		#VB1	W 300 KHZ			Sweep	2.48 s (3	10000 pts)	2.597000000 GH
1 N 1	f	2.470 4	GHz	2.88 dBr	m	TIUN FUN	ICTION WIDTH	FUNCTI	JN VALUE	
2 N 1 3	f	3.875 4	GHz	-54.45 dBr	n					Freq Offse
4 5										он
6 7										
9										
1										

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# 8.5. 802.11g SISO MODE IN THE 2.4 GHz BAND (ANTENNA B)

Noted: Covered by 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND (ANTENNA B)

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# 8.6. 802.11n HT20 SISO MODE IN THE 2.4 GHz BAND (ANTENNA B)

# 8.6.1. 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	6 dB Bandwidth	Minimum Limit
	(MHz)	(MHz)	(MHz)
Low	2412	17.58	0.5
Mid	2437	17.63	0.5
High_10	2457	17.58	0.5
High_11	2462	17.42	0.5
High_12	2467	17.63	0.5
High_13	2472	17.55	0.5

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# 6 dB BANDWIDTH





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