

**WIFI MAXIMUM CONDUCTED (AVERAGE) OUTPUT POWER**

<b>FCC Rule Part(s)</b>	<b>Standards Doc(s) for FCC Rule Part(s)</b>	<b>IC Rule Part(s)</b>	<b>Standards Docs for IC Rule Part(s)</b>
CFR47 §15.247 (b)(3)	KDB 558074 §9.2.2.2 KDB 558074 §9.2.2.4	RSS-247 §5.4.4	Cannot find reference.

**WiFi Conducted Output Power Measurements**

Each conducted measurement was taken once with the opposite antenna turned off, and once with the opposite antenna transmitting simultaneously with the measured antenna (i.e. both antennas transmitting). The reported measurements are grouped into one block containing measurements taken with the opposite antenna off, and a second block of all measurements with the opposite antenna transmitting simultaneously with the measured antenna.

The maximum measured WiFi Conducted Average Output Power for both blocks of measurements is **10.86 dBm** which occurs under 802.11g modulation. The maximum measured output power for the three modes of modulation is as follows:

802.11b: 10.50dBm (Ch 6, both antennas on)

802.11g: 10.86dBm (Ch 6, both antennas on)

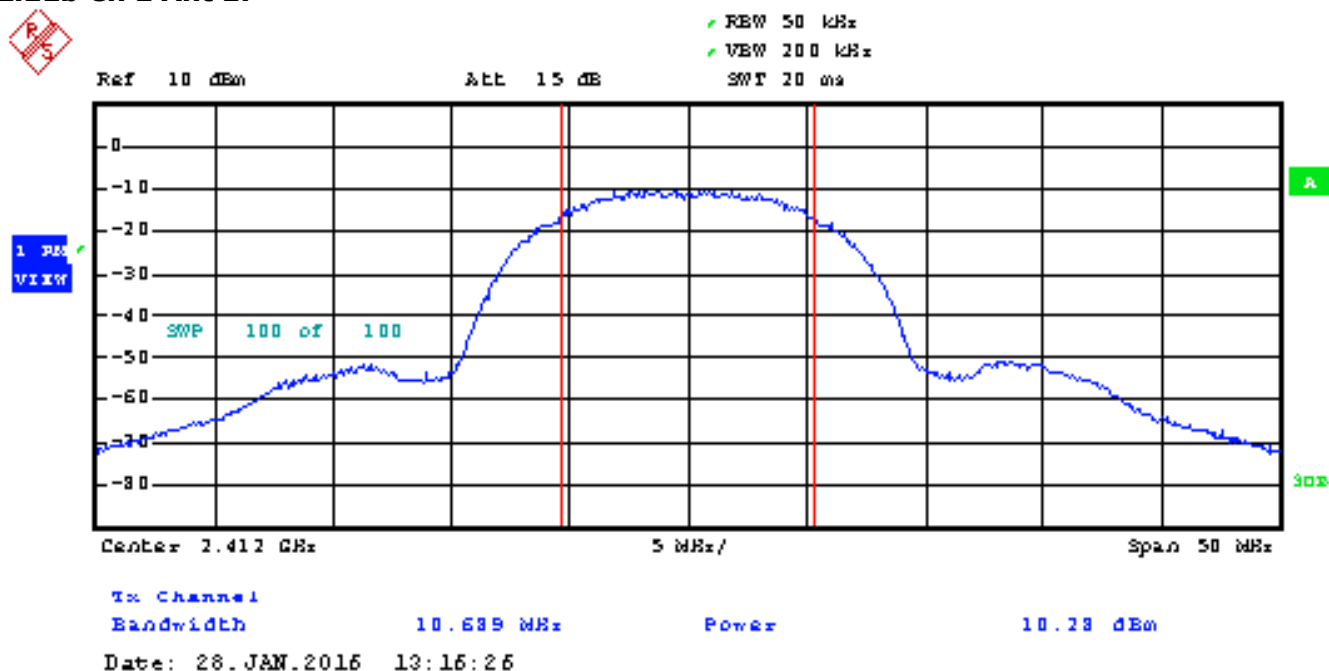
802.11n: 10.74dBm (Ch 6, both antennas on)

Measurements are shown starting on the next page.

## Block 1 – Measurements with Opposite Antenna Off

### 802.11b Operation

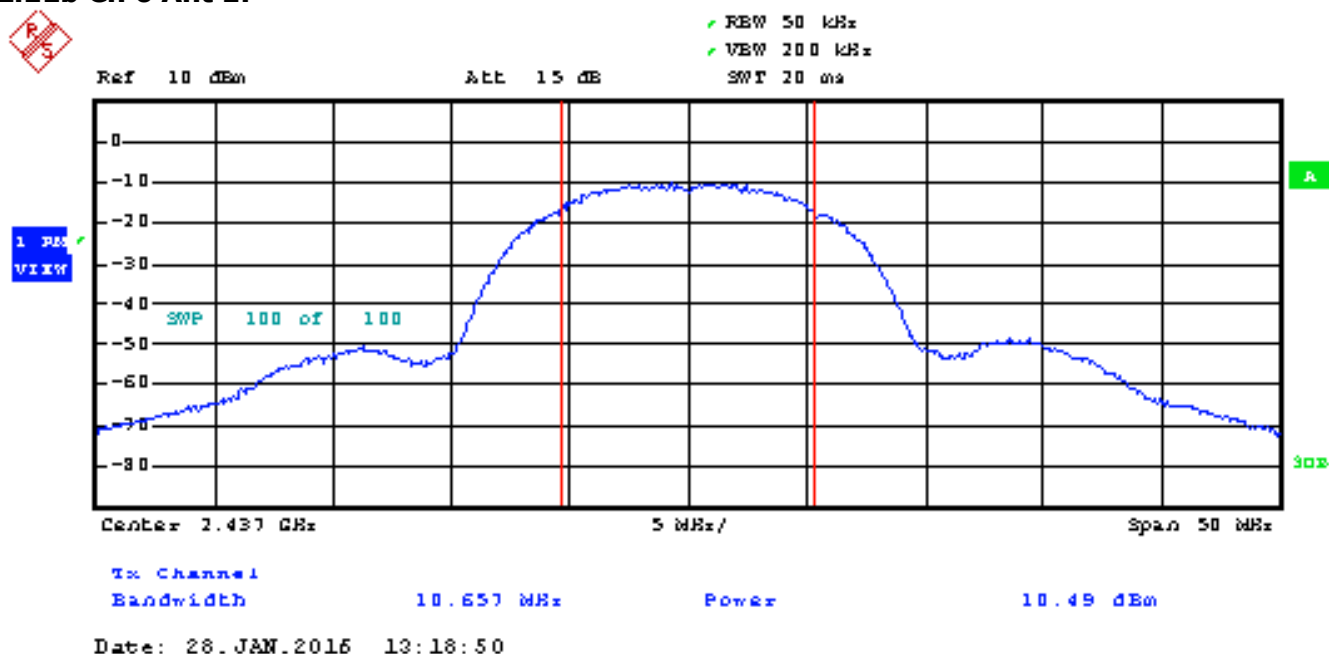
#### 802.11b Ch 1 Ant 1:



Power: **10.23 dBm**

### WiFi Conducted Output Power Measurements Cont.

#### 802.11b Ch 6 Ant 1:



Power: **10.49 dBm**

**802.11b Ch 11 Ant 1:**

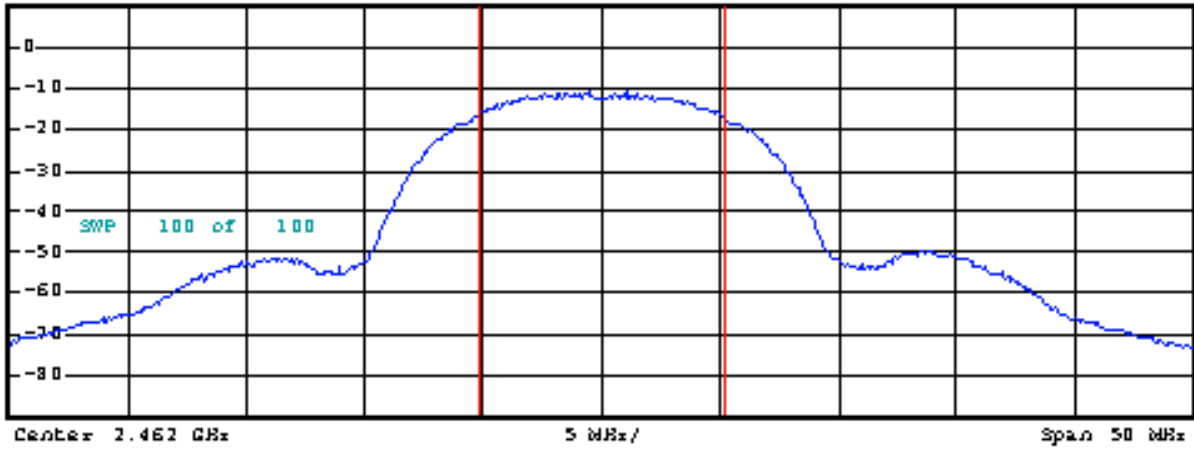
✓ RBW 50 kHz  
✓ VBW 200 kHz  
SWT 20 ms

Ref 10 dBm

Att 15 dB

SWT 20 ms

1 PPK  
VIEW



Tx Channel

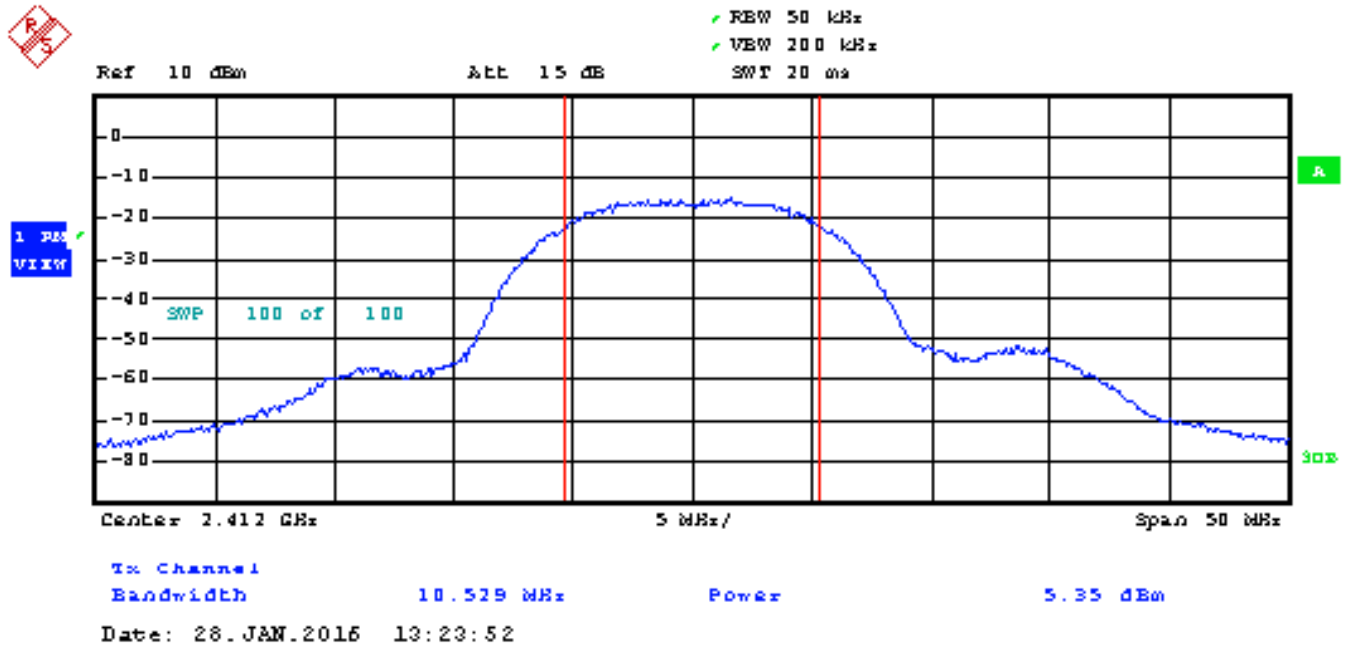
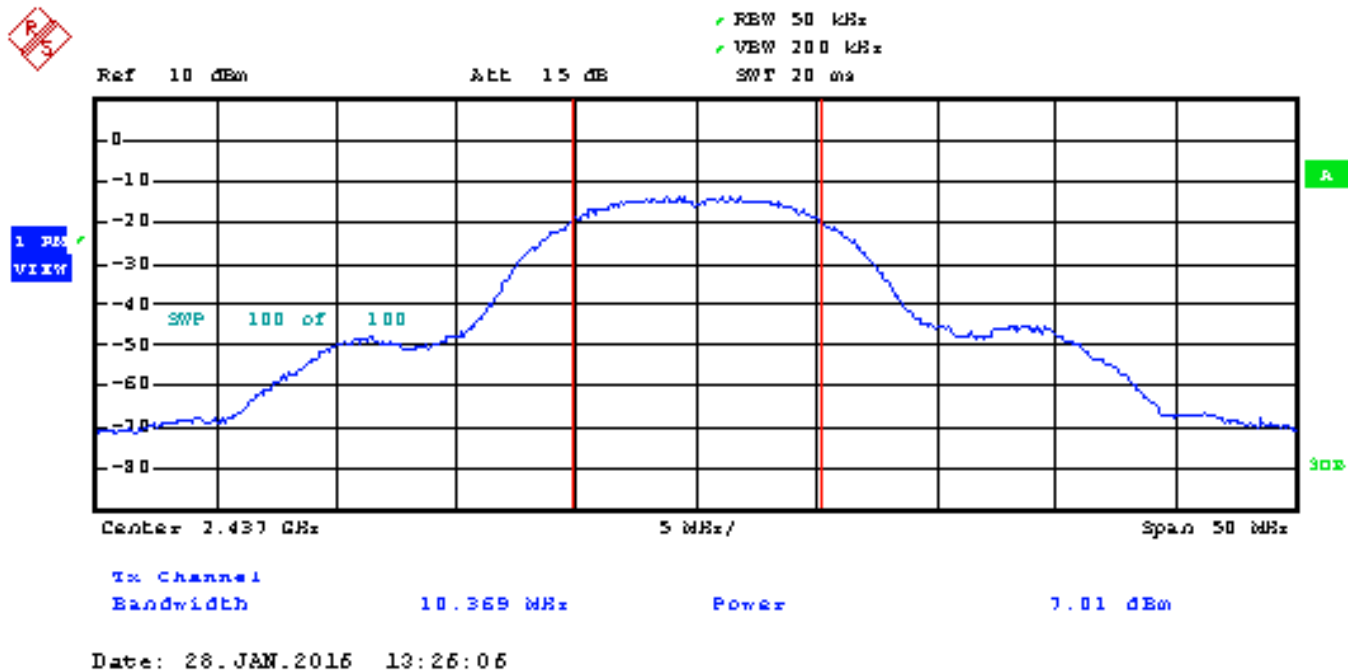
Bandwidth 10.449 MHz

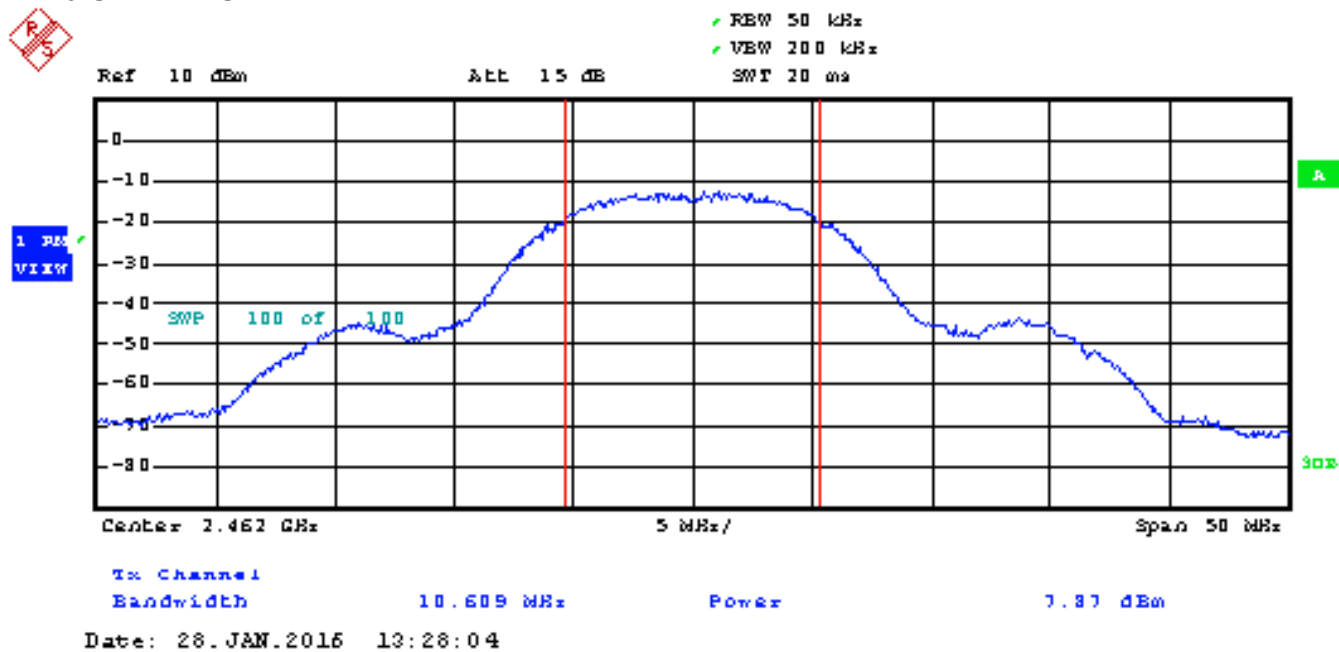
Power

9.74 dBm

Date: 28.JAN.2016 13:20:48

**Power: 9.74 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11b Ch 1 Ant 2:****Power: 5.35 dBm****802.11b Ch 6 Ant 2:****Power: 7.01 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11b Ch 11 Ant 2:****Power: 7.87 dBm**

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Operation

For 802.11g operation, the lab report states on page 14, section 7.1 that the WiFi duty cycle for 802.11g is measured to be less than 98%. For the lab report, refer to lab report file "TSSCBASE1 EXHIBIT 5-3C-A FCC AND IC RADIATED EMISSIONS FOR WIFI Part 1 of 2.pdf" and "TSSCBASE1 EXHIBIT 5-3C-A FCC AND IC RADIATED EMISSIONS FOR WIFI Part 2 of 2.pdf". A copy of the duty cycle from the lab report is pasted below. KDB 558734, section 9.2.2.4 is followed for 802.11g operation. This permits the duty cycle correction factor to be added to the measured average power. The lab report shows the duty cycle correction factor for 802.11g is **0.11 dB**.

## 7.1. ON TIME AND DUTY CYCLE

### LIMITS

None, for reporting purposes only.

### PROCEDURE

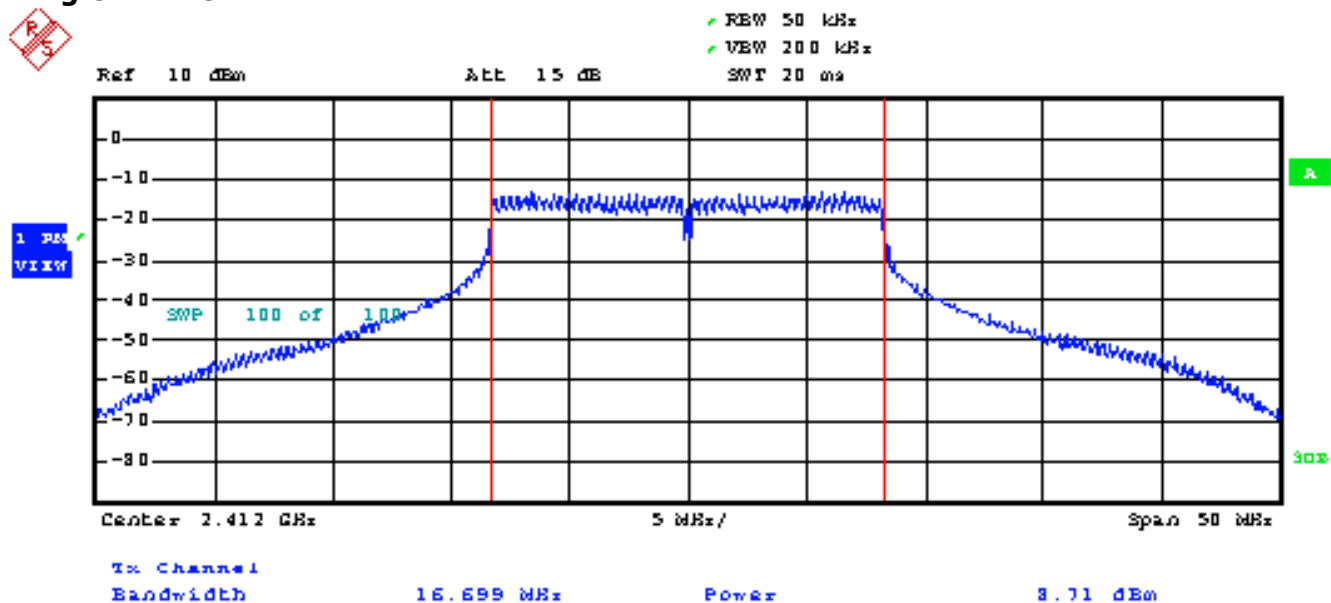
KDB 558074 Zero-Span Spectrum Analyzer Method.

### 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)
<b>2.4GHz Band</b>						
802.11b (ANTENNA 1)	1.889	1.903	0.993	99.26%	0.00	0.010
802.11b (ANTENNA 2)	1.888	1.904	0.992	99.16%	0.00	0.010
802.11g (ANTENNA 1)	0.800	0.821	0.975	97.51%	0.11	1.250
802.11g (ANTENNA 2)	0.800	0.821	0.975	97.54%	0.11	1.249
802.11n HT20 (ANTENNA 1)	2.912	2.933	0.993	99.28%	0.00	0.010
802.11n HT20 (ANTENNA 2)	2.912	2.933	0.993	99.28%	0.00	0.010

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Ch 1 Ant 1:

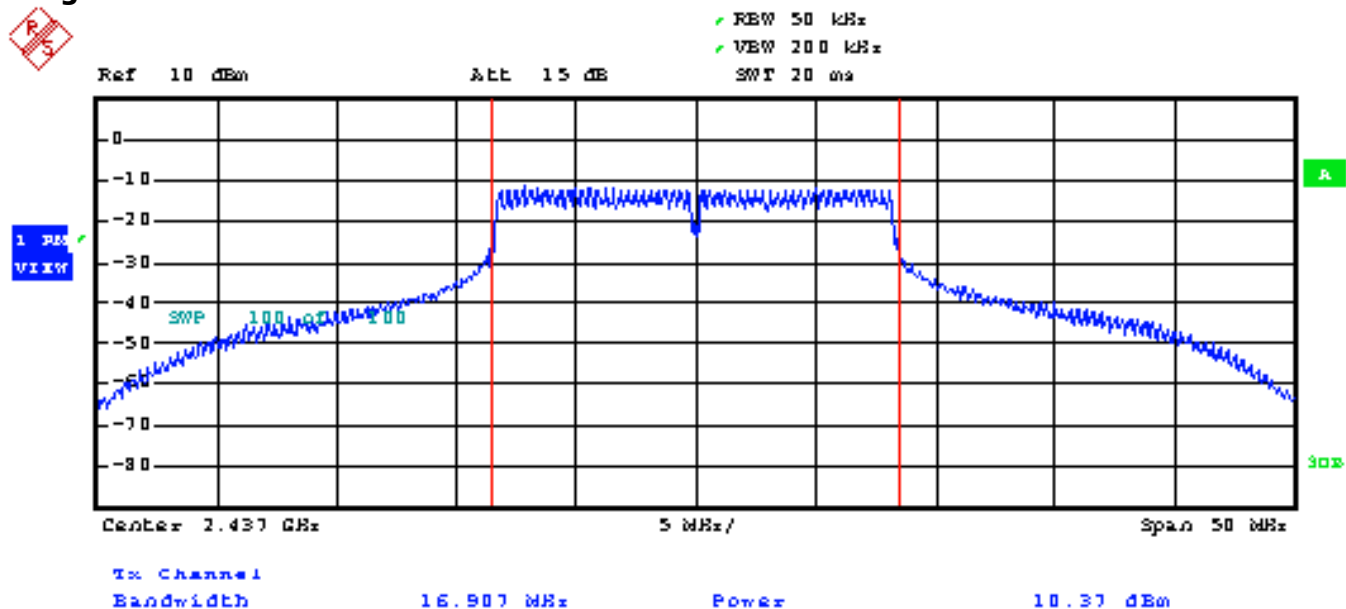


Date: 28.JAN.2016 13:45:22

**Actual Power:** = 8.71 dBm (measured) + 0.11 dBi (duty correction)  
= **8.82 dBm**

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Ch 6 Ant 1:

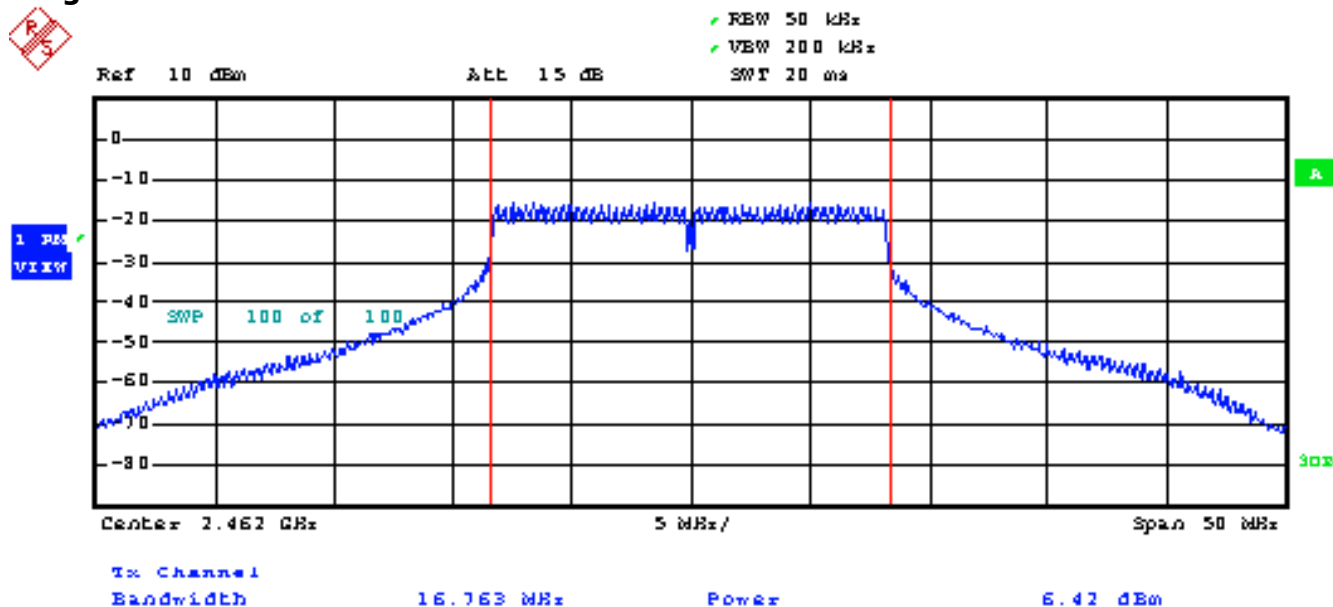


Date: 28.JAN.2016 13:46:57

**Measured Power:** 10.37 dBm  
**Actual Power:** = 10.37 dBm (measured) + 0.11 dBi (duty correction)  
= **10.48 dBm**

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Ch 11 Ant 1:

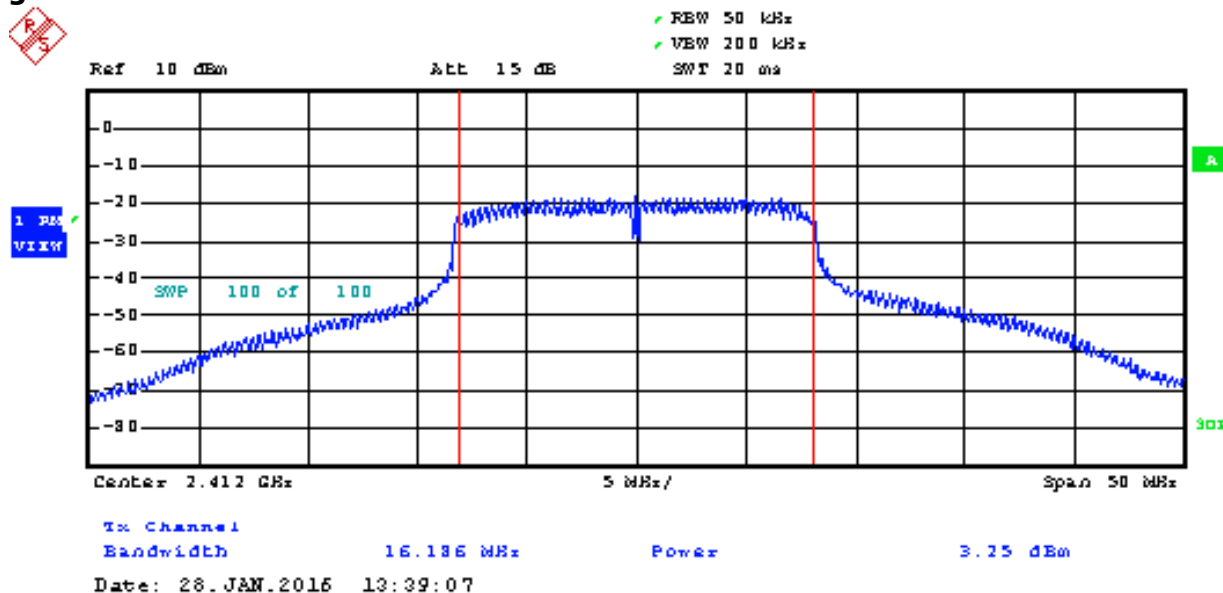


**Measured Power:** 6.42 dBm

**Actual Power:** = 6.42 dBm (measured) + 0.11 dBi (duty correction)  
= **6.53 dBm**

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Ch 1 Ant 2:



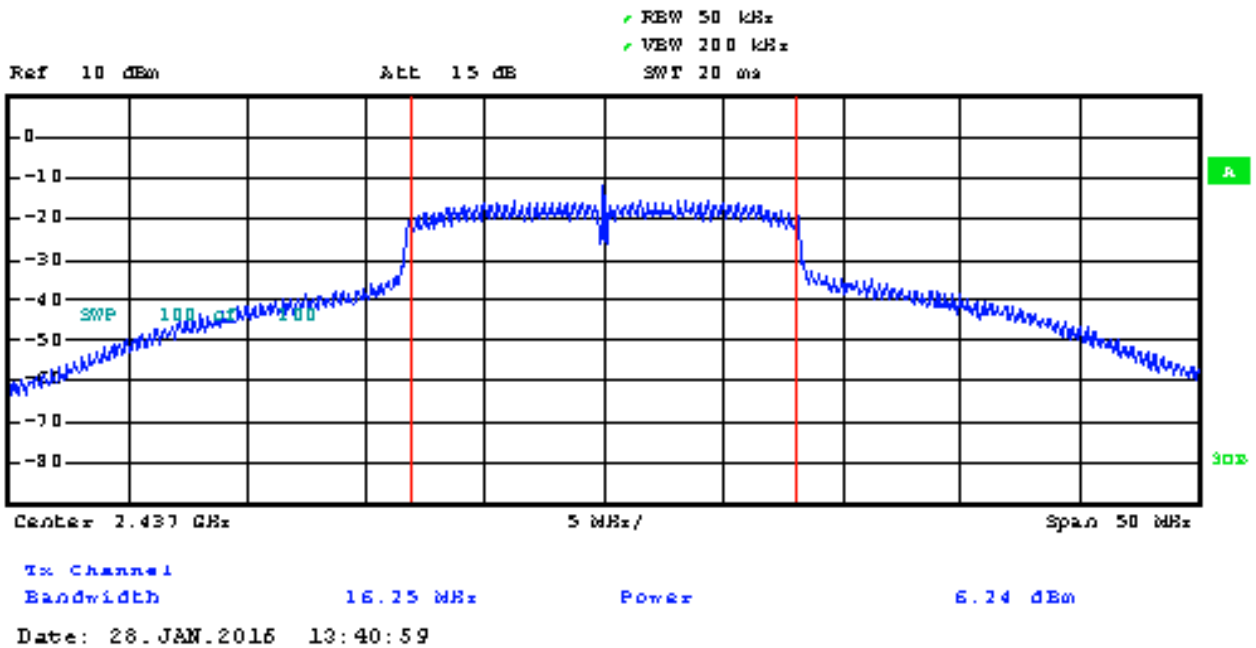
**Measured Power:** 3.25 dBm

**Actual Power:** = 3.25 dBm (measured) + 0.11 dBi (duty correction)  
= **3.36 dBm**



**WiFi Conducted Output Power Measurements Cont.****802.11g Ch 6 Ant 2:**

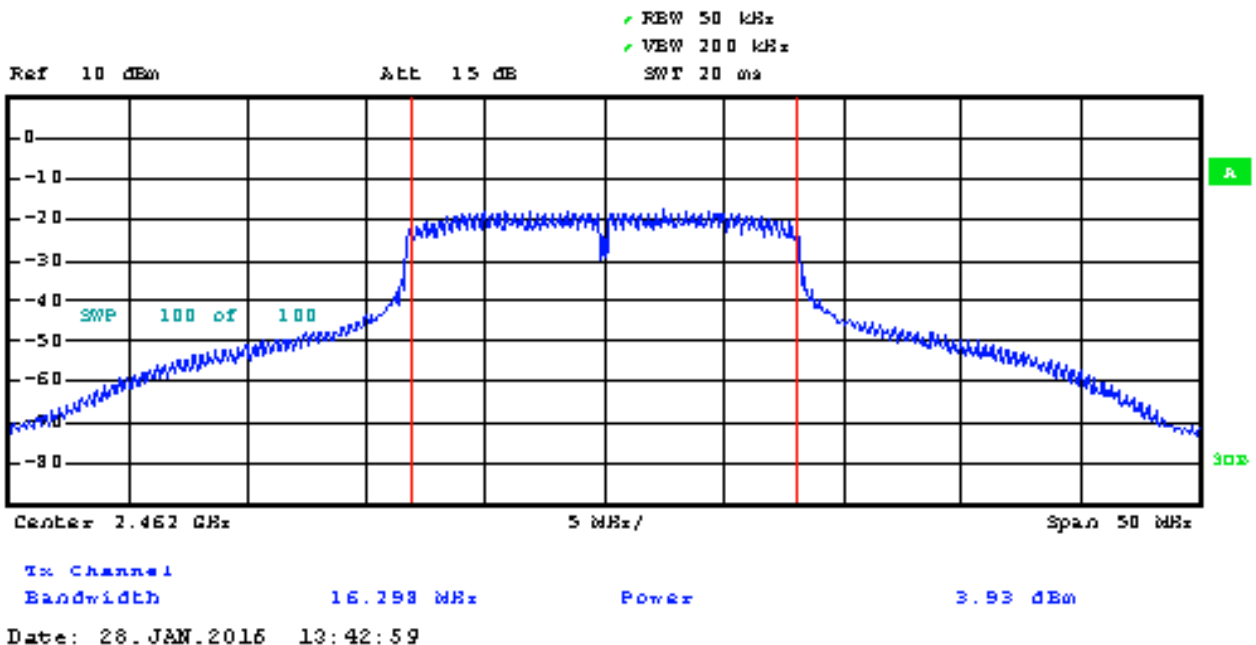
1 PWR  
VIEW

**Measured Power:** 6.24 dBm

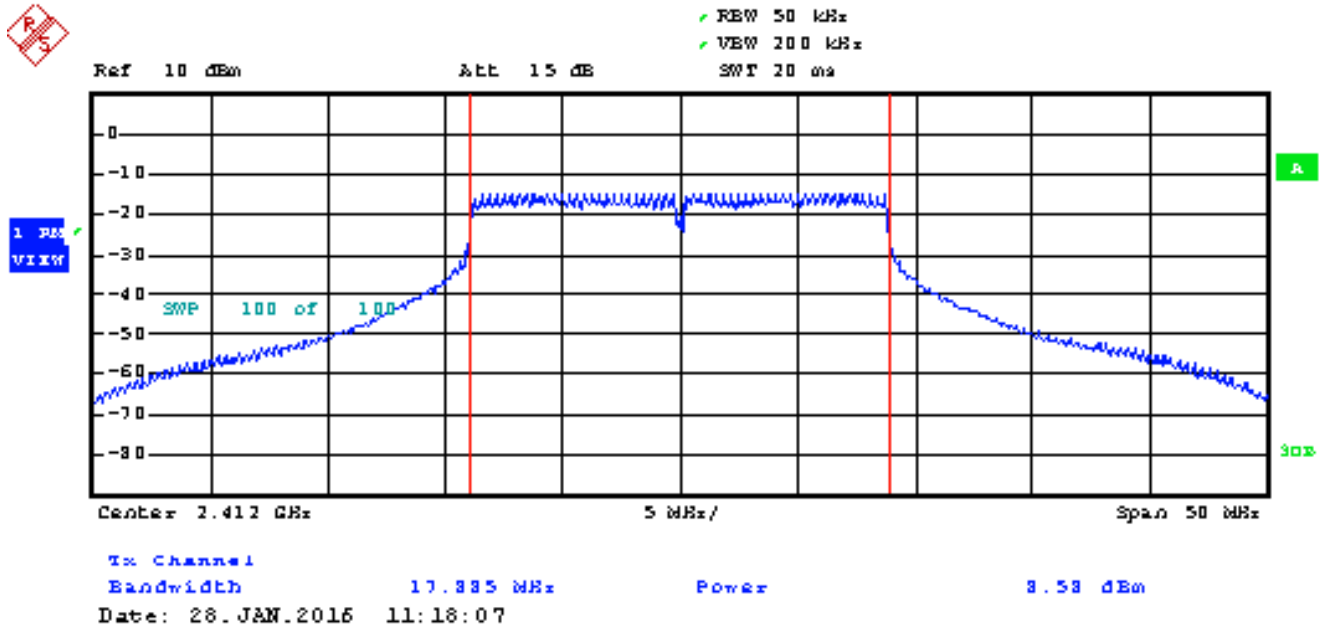
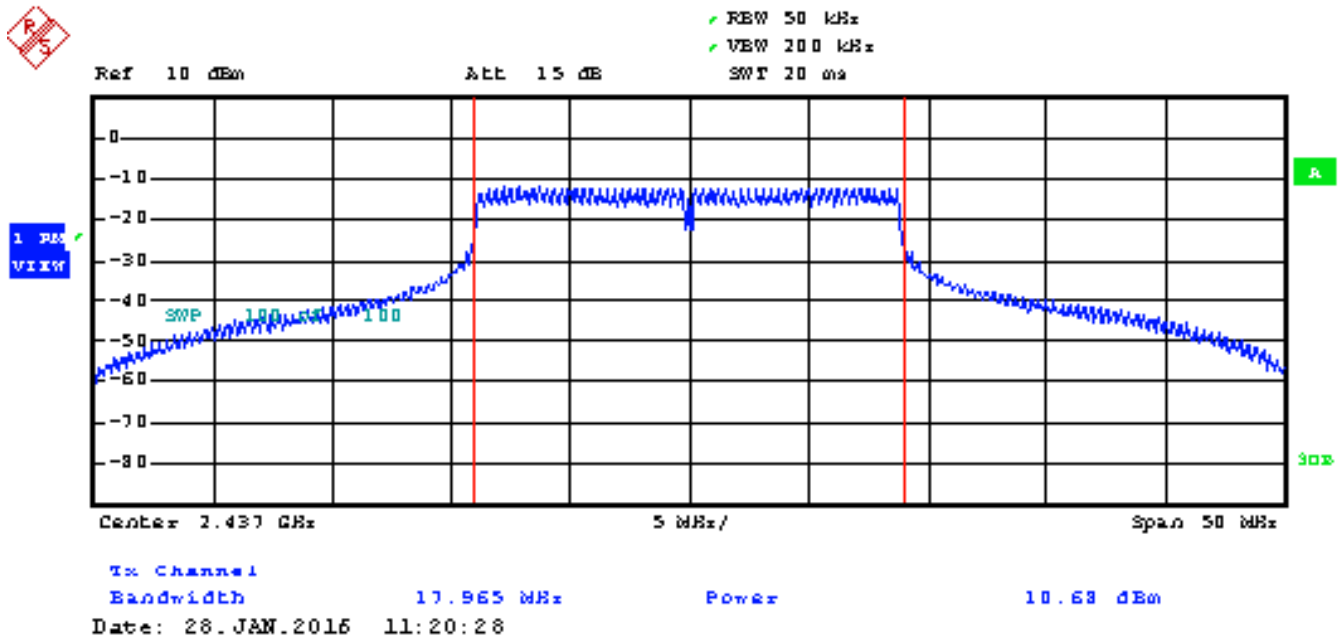
**Actual Power:** = 6.24 dBm (measured) + 0.11 dBi (duty correction)  
= **6.35 dBm**

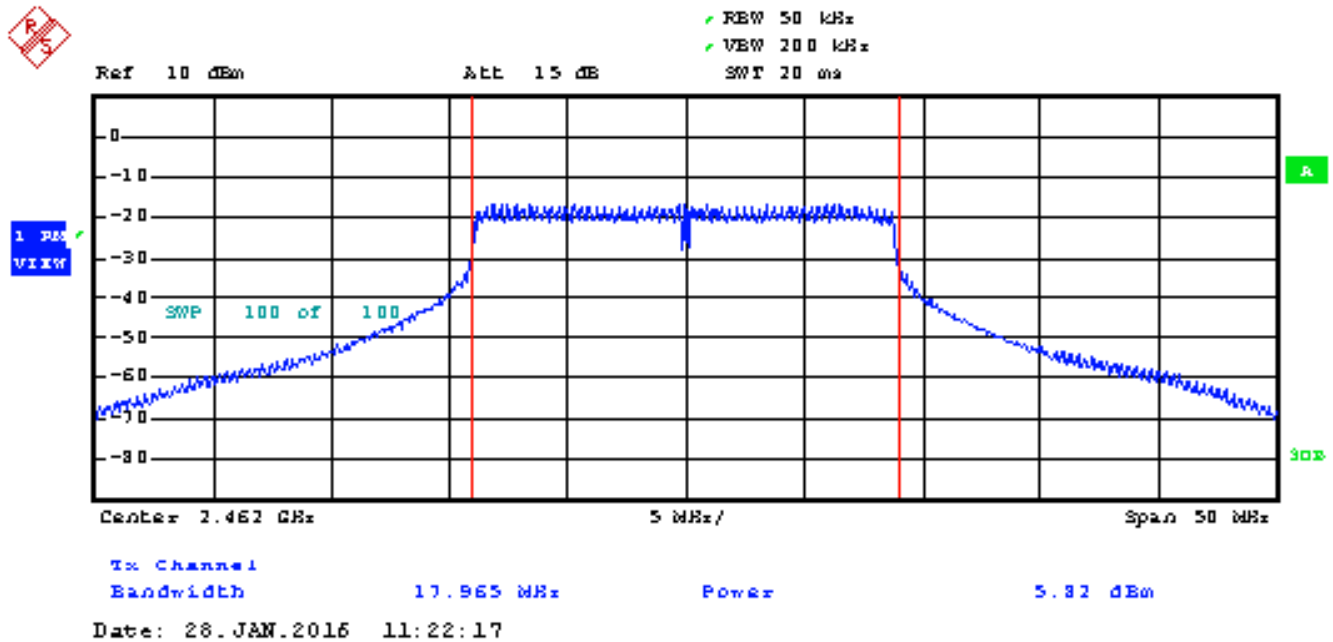
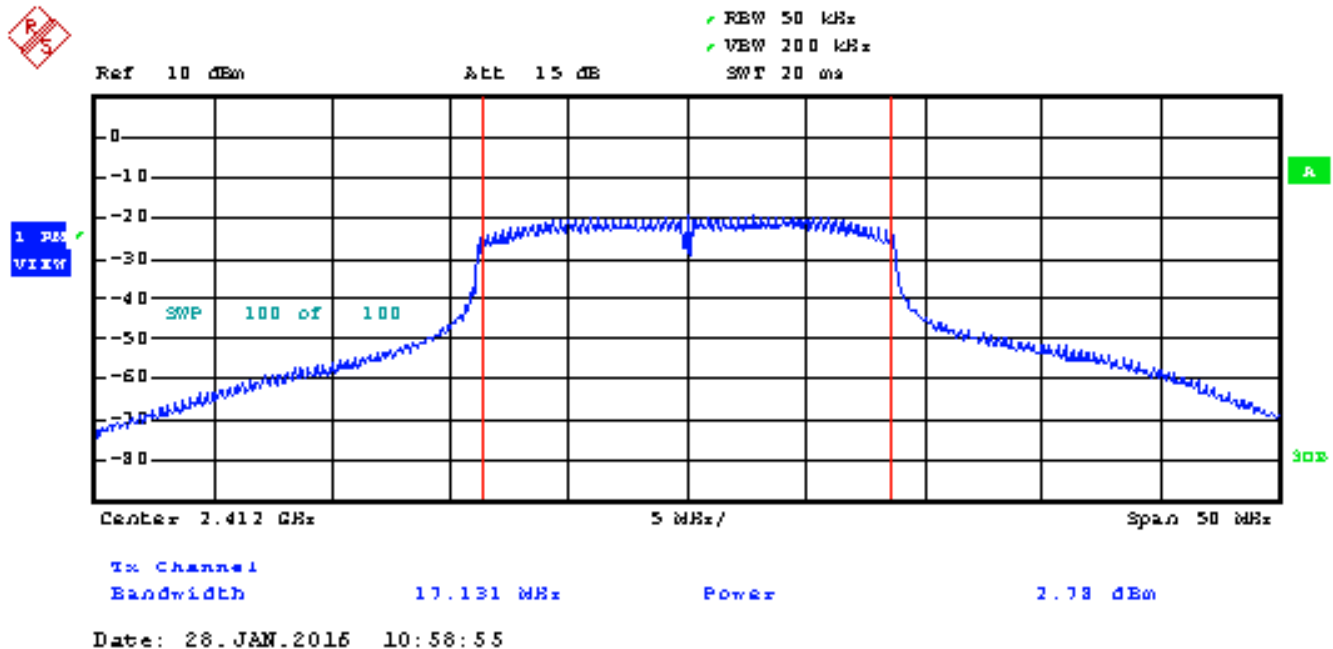
**WiFi Conducted Output Power Measurements Cont.****802.11g Ch 11 Ant 2:**

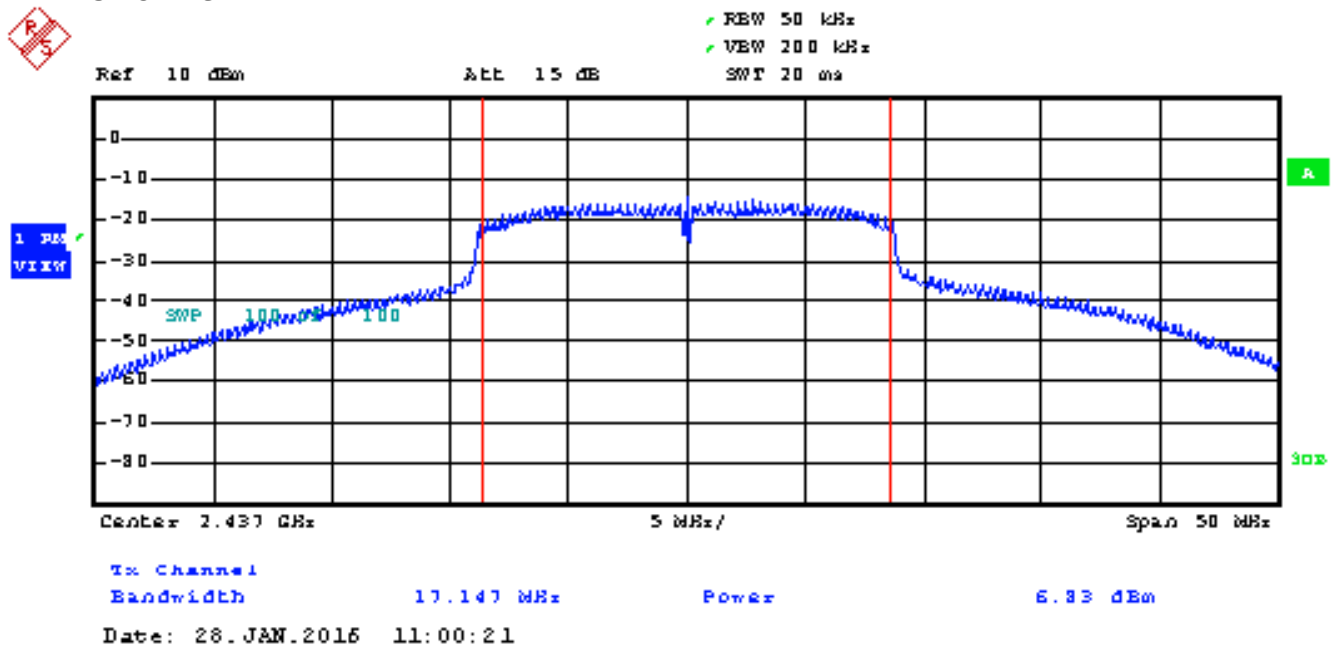
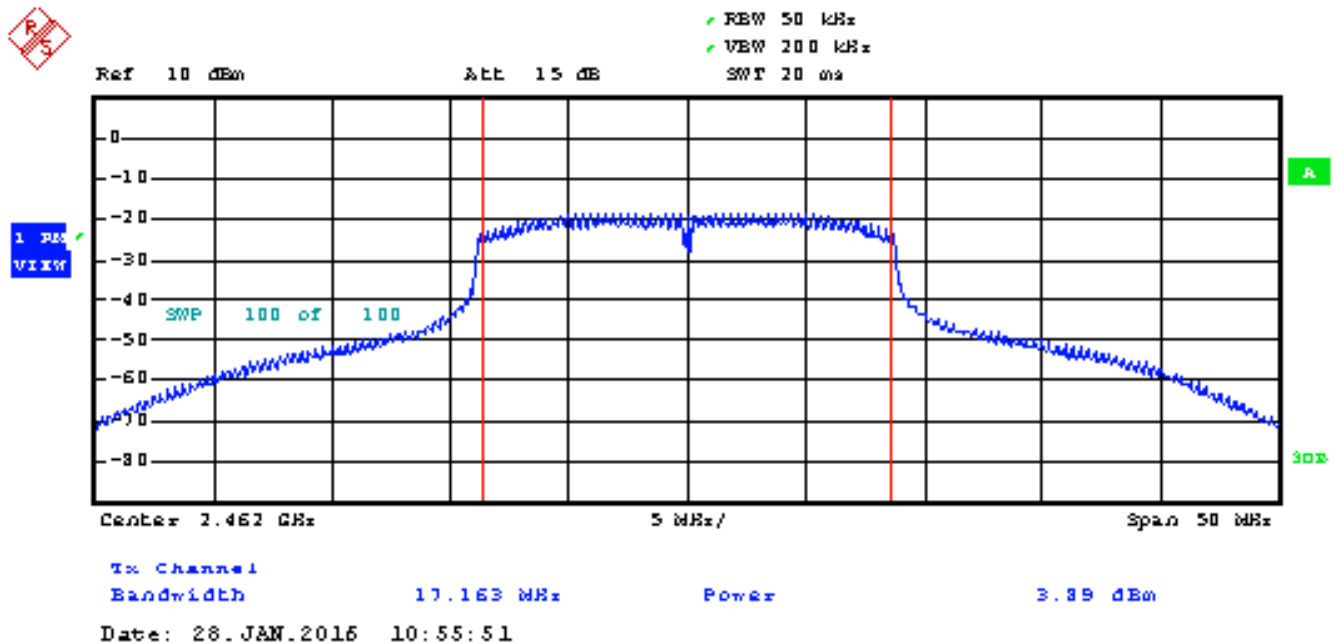
1 PWR  
VIEW

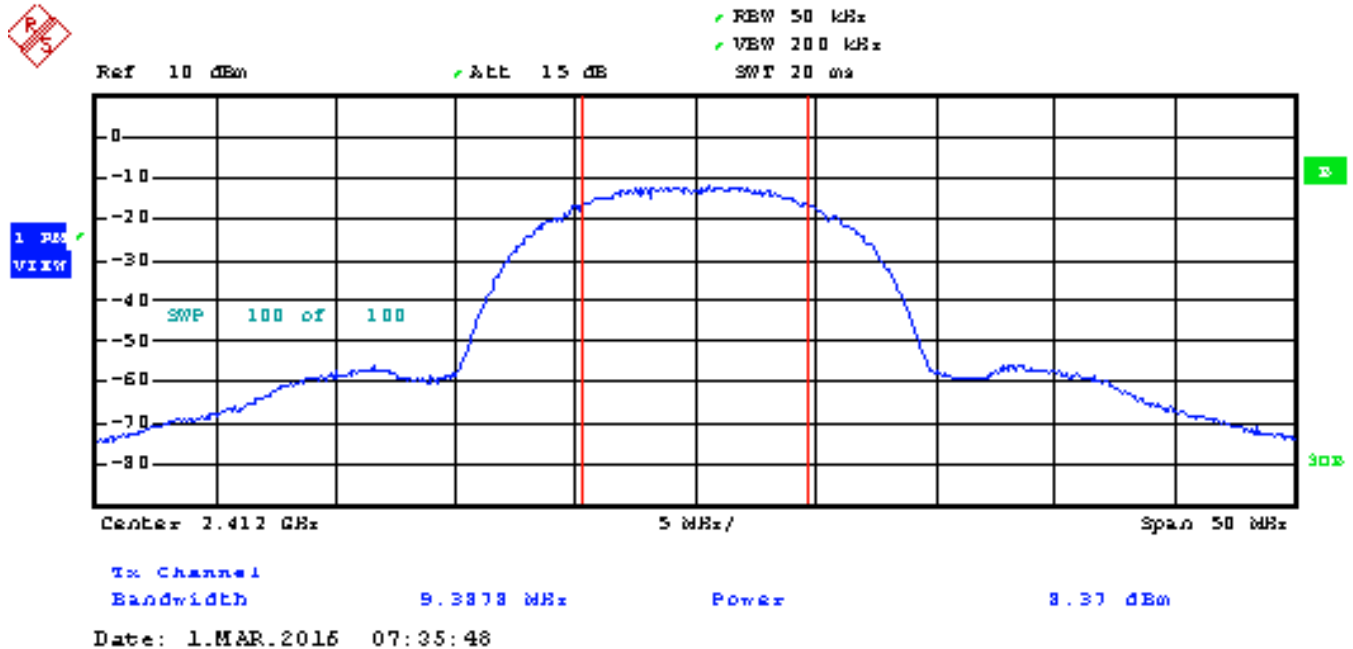
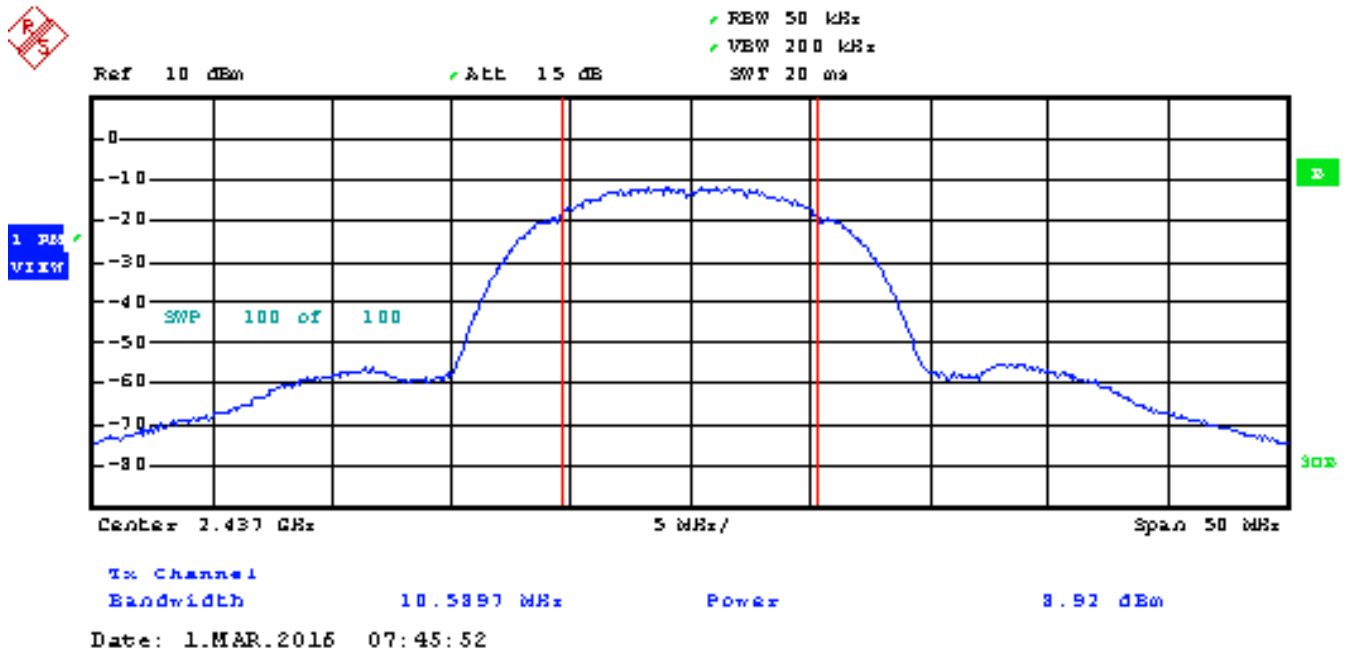
**Measured Power:** 3.93 dBm

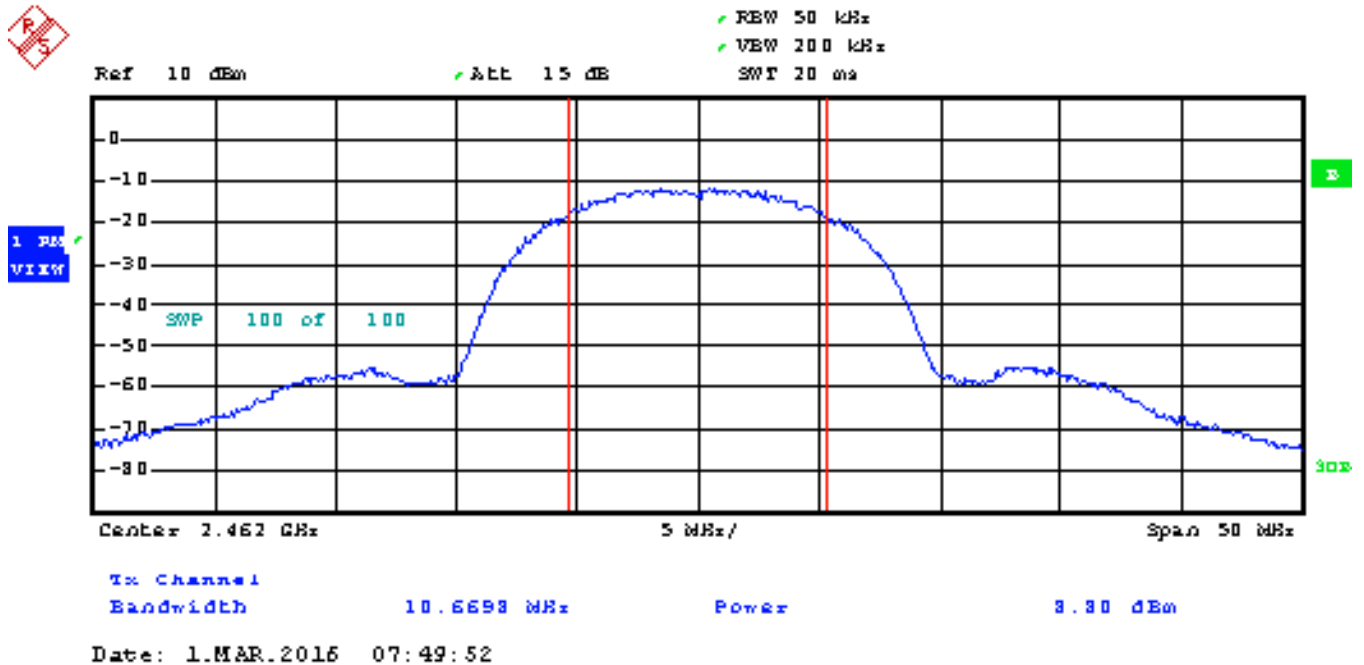
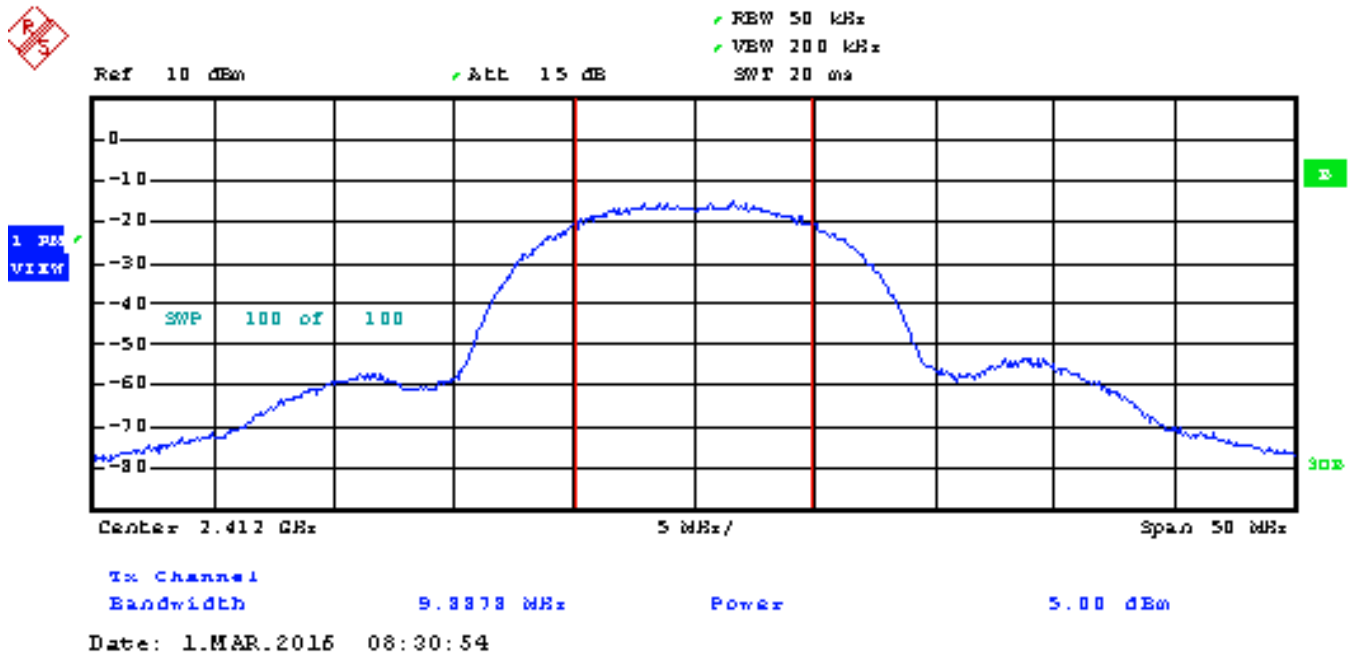
**Actual Power:** = 3.93 dBm (measured) + 0.11 dBi (duty correction)  
= **4.04 dBm**

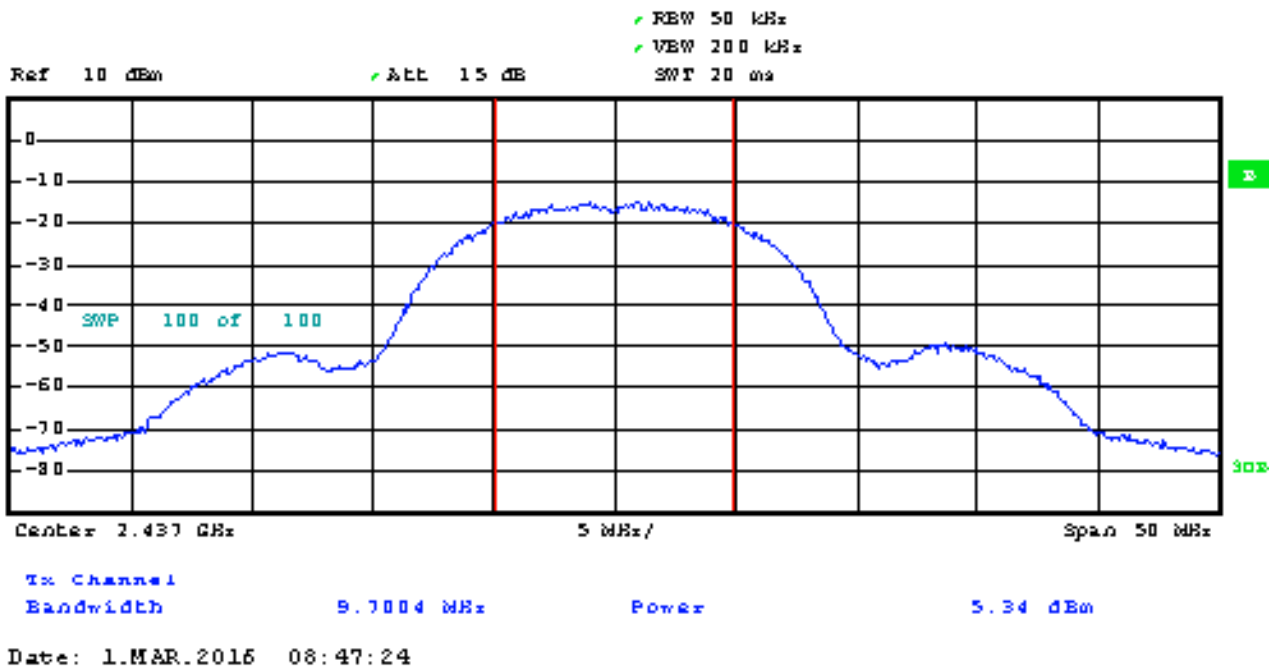
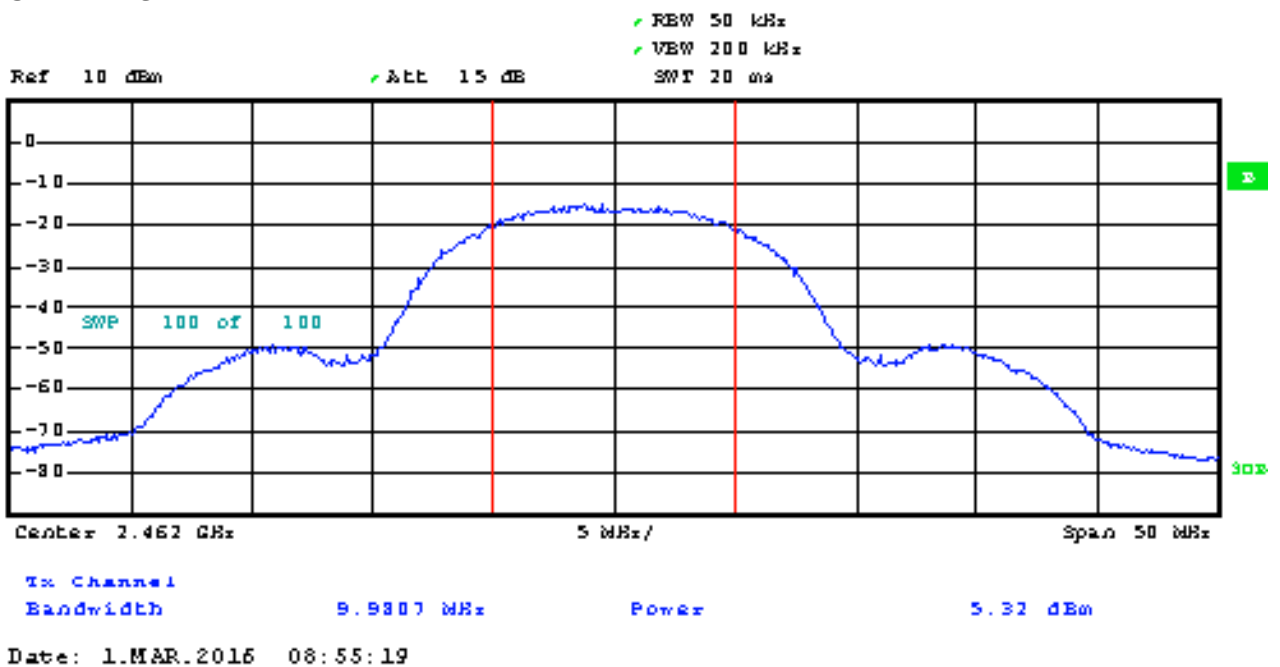
**WiFi Conducted Output Power Measurements Cont.****802.11n Operation****802.11n Ch 1 Ant 1:****Power: 8.58 dBm****WiFi Conducted Output Power Measurements Cont.****802.11n Ch 6 Ant 1:****Power: 10.68 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11n Ch 11 Ant 1:****Power: 5.82 dBm****802.11n Ch 1 Ant 2:****Power: 2.78 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11n Ch 6 Ant 2:****Power: 6.83 dBm****WiFi Conducted Output Power Measurements Cont.****802.11n Ch 11 Ant 2:****Power: 3.89 dBm**

**WiFi Conducted Output Power Measurements Cont.****Block 2 – Measurements with Opposite Antenna On****802.11b Operation****802.11b Ch 1 Ant 1:****Power: 8.37 dBm****802.11b Ch 6 Ant 1:****Power: 8.92 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11b Ch 11 Ant 1:****Power: 8.80 dBm****802.11b Ch 1 Ant 2:****Power: 5.00 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11b Ch 6 Ant 2:****Power: 5.34 dBm****802.11b Ch 11 Ant 2:****Power: 5.32 dBm**

## WiFi Conducted Output Power Measurements Cont.

### 802.11g Operation

For 802.11g operation, the lab report states on page 14, section 7.1 that the WiFi duty cycle for 802.11g is measured to be less than 98%. For the lab report, refer to lab report file "TSSCBASE1 EXHIBIT 5-3C-A FCC AND IC RADIATED EMISSIONS FOR WIFI Part 1 of 2.pdf" and "TSSCBASE1 EXHIBIT 5-3C-A FCC AND IC RADIATED EMISSIONS FOR WIFI Part 2 of 2.pdf". A copy of the duty cycle from this section is pasted below. Therefore KDB 558734, section 9.2.2.4 is followed for 802.11g operation. This permits the duty cycle correction factor to be added to the measured average power. The lab report shows the duty cycle correction factor for 802.11g is **0.11 dB**.

## 7.1. ON TIME AND DUTY CYCLE

### LIMITS

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### PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

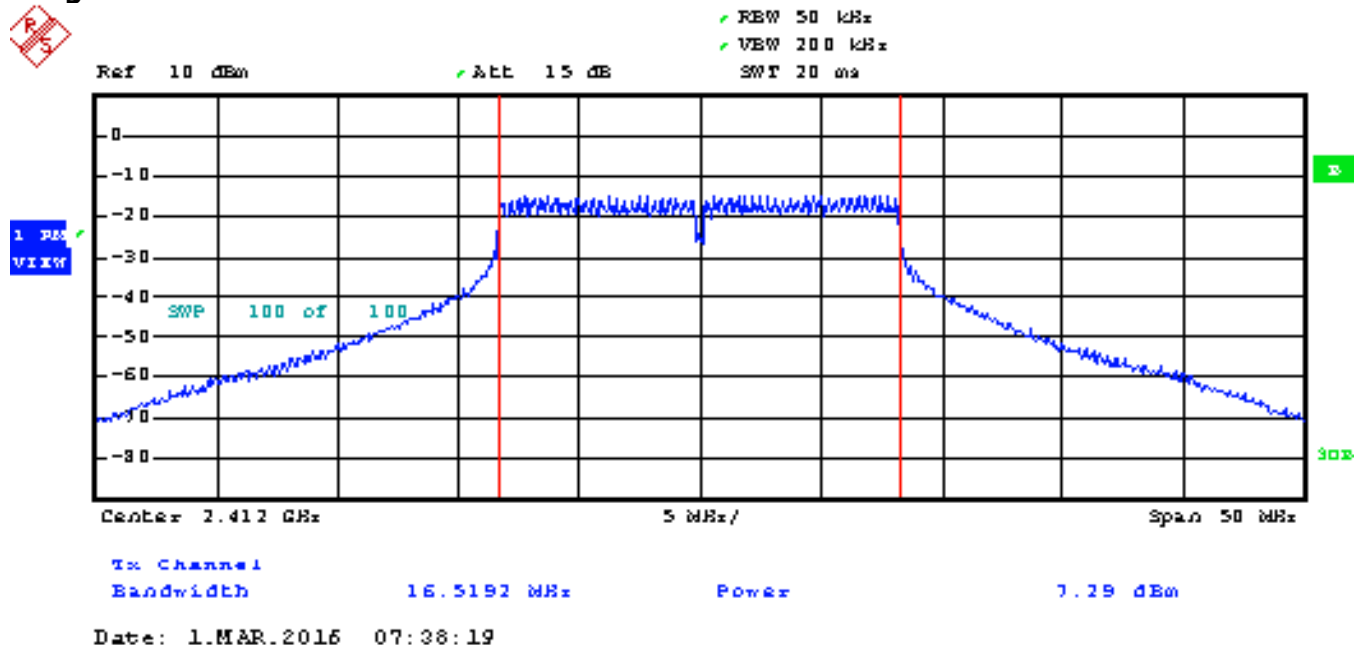
### ON TIME AND DUTY CYCLE RESULTS

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802.11n HT20 (ANTENNA 2)	2.912	2.933	0.993	99.28%	0.00	0.010



## WiFi Conducted Output Power Measurements Cont.

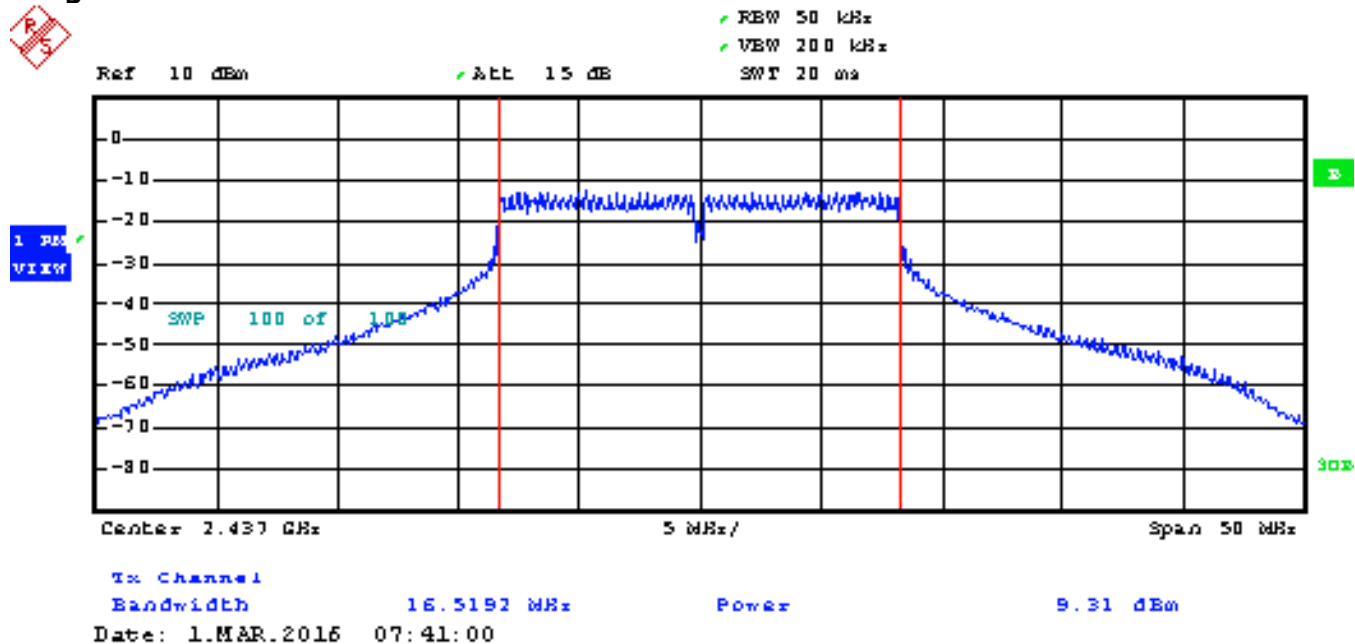
### 802.11g Ch 1 Ant 1:



**Measured Power:** 7.29 dBm

**Actual Power:** = 7.29 dBm (measured) + 0.11 dBi (duty correction)  
= **7.40 dBm**

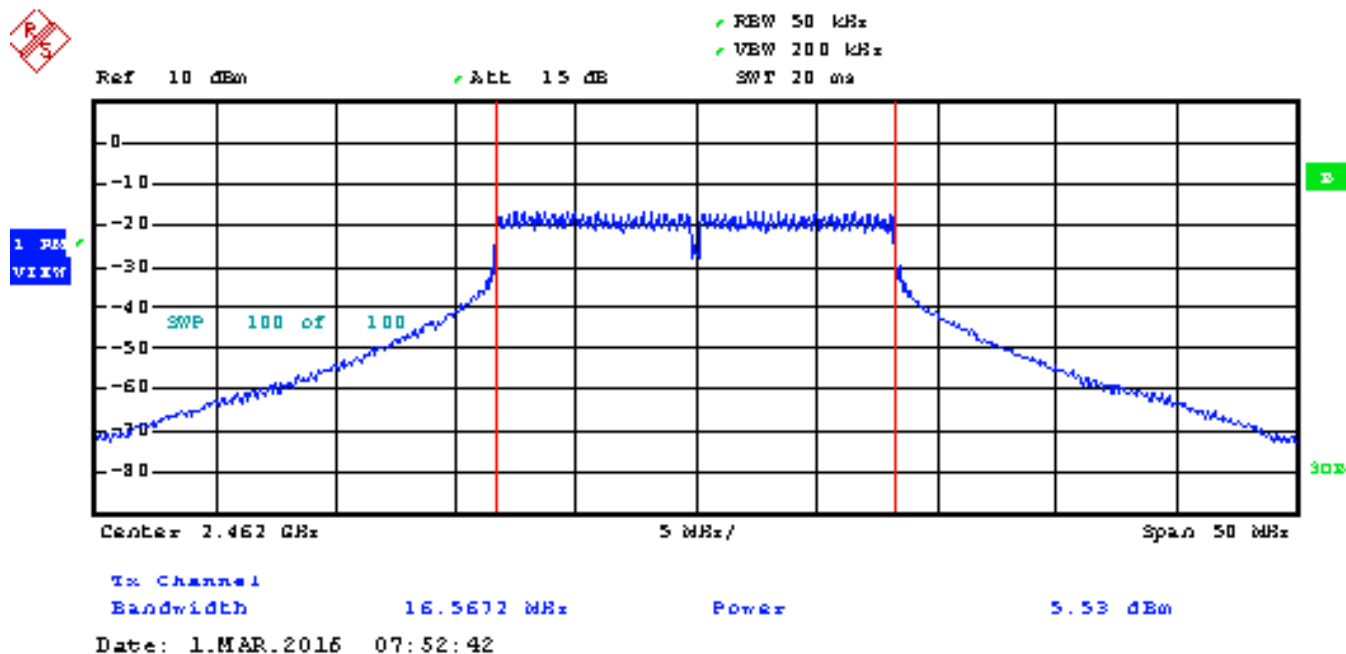
### 802.11g Ch 6 Ant 1:



**Measured Power:** 9.31 dBm

**Actual Power:** = 9.31 dBm (measured) + 0.11 dBi (duty correction)  
= **9.42 dBm**

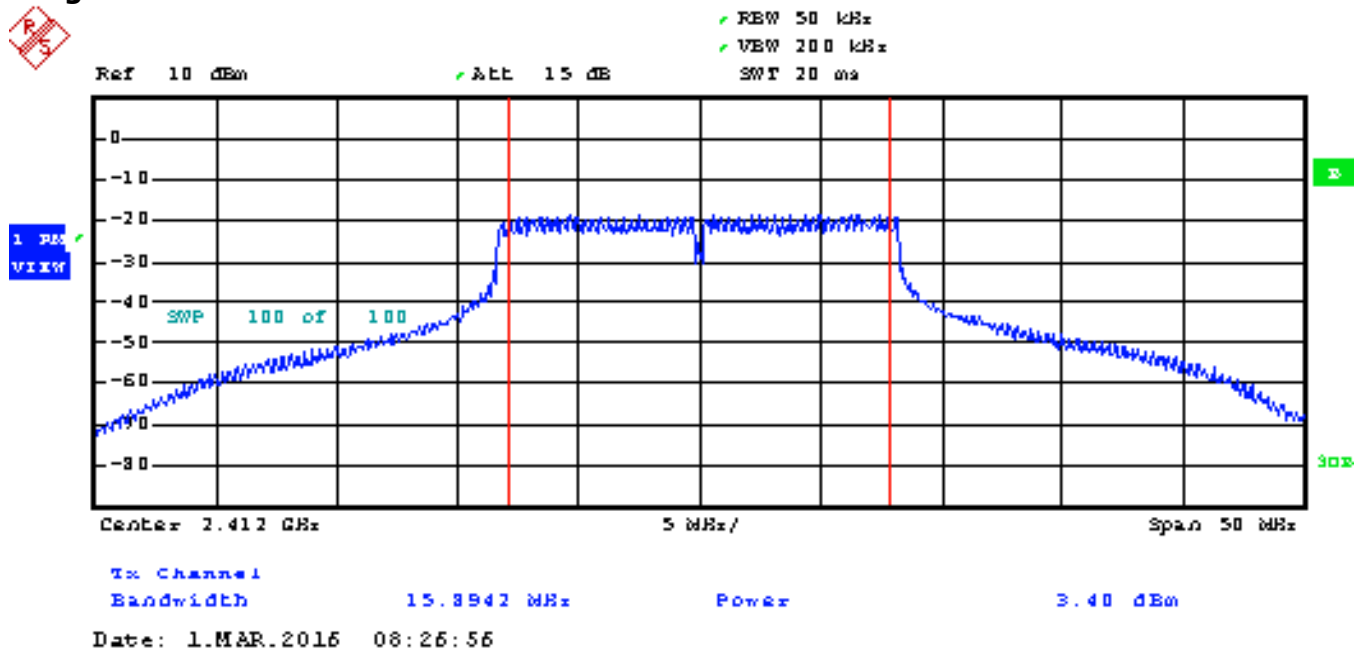
**802.11g Ch 11 Ant 1:**



**Measured Power:** 5.53 dBm

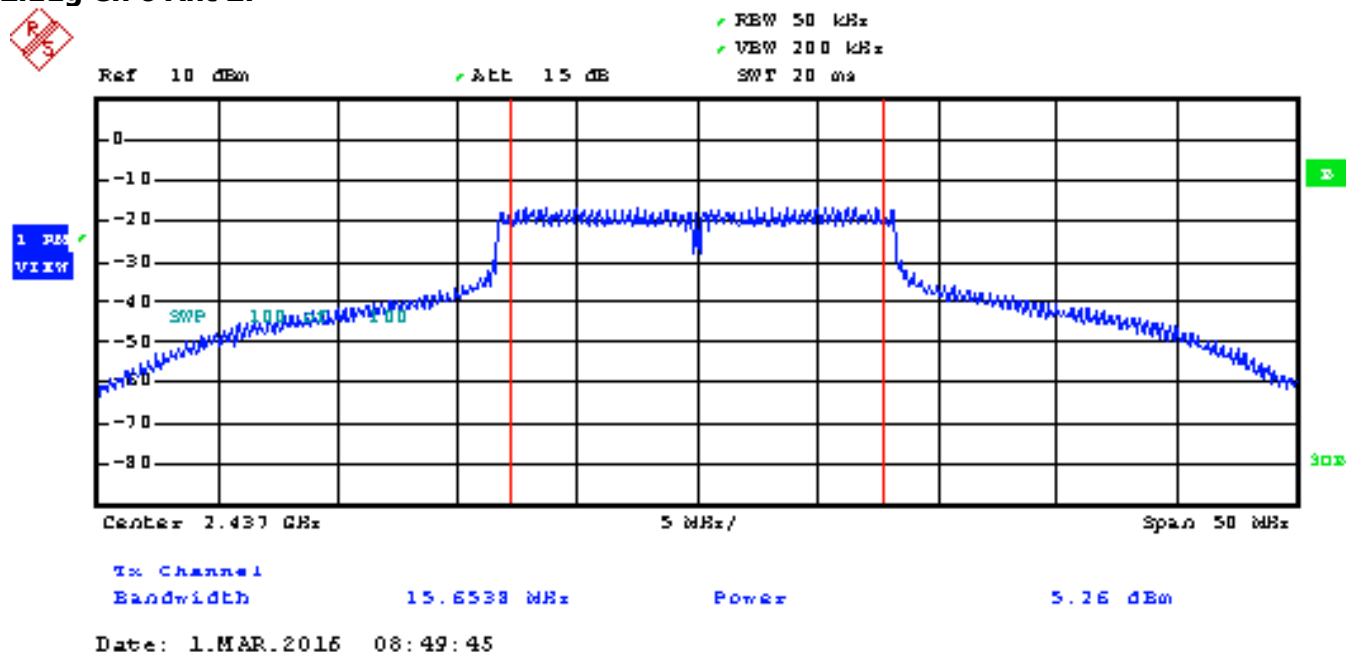
**Actual Power:** = 5.53 dBm (measured) + 0.11 dBi (duty correction)  
 = **5.64 dBm**

**802.11g Ch 1 Ant 2:**

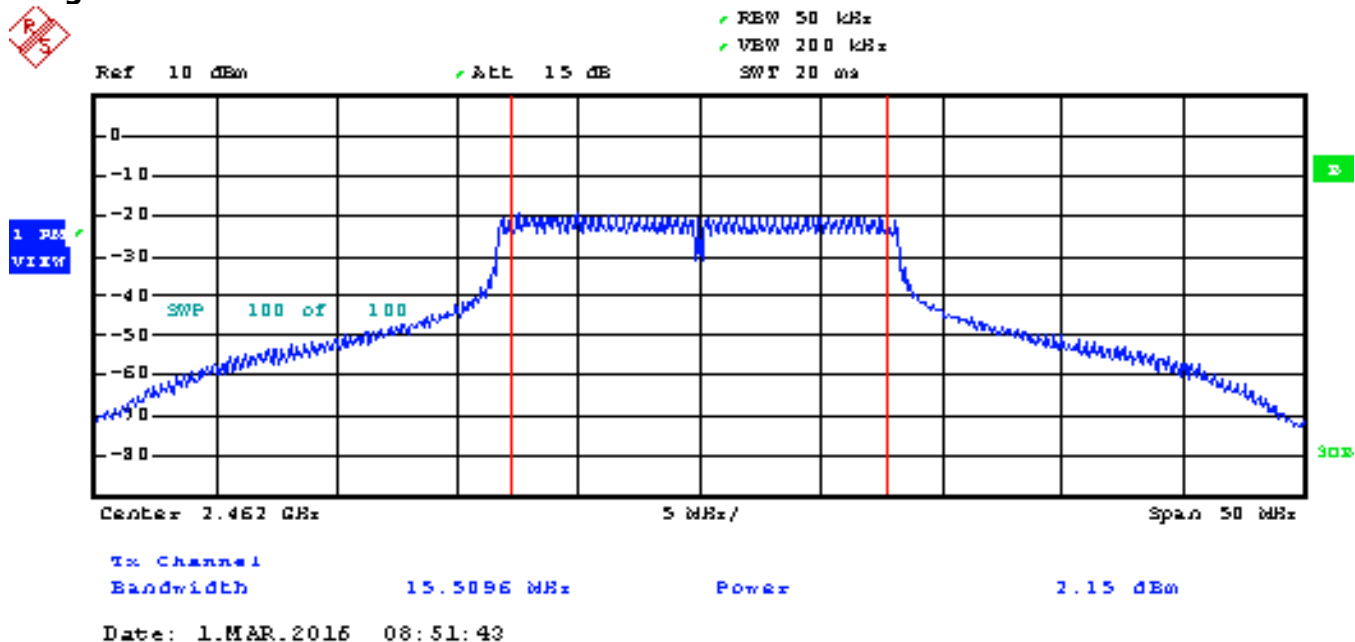


**Measured Power:** 3.40 dBm

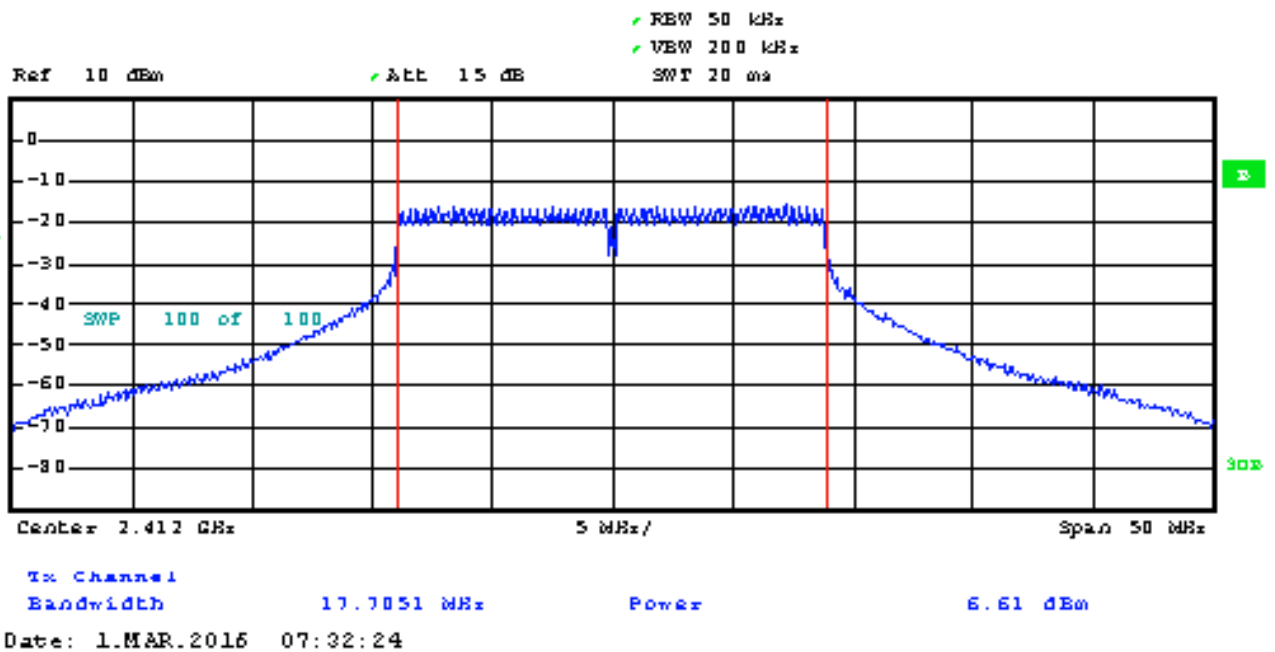
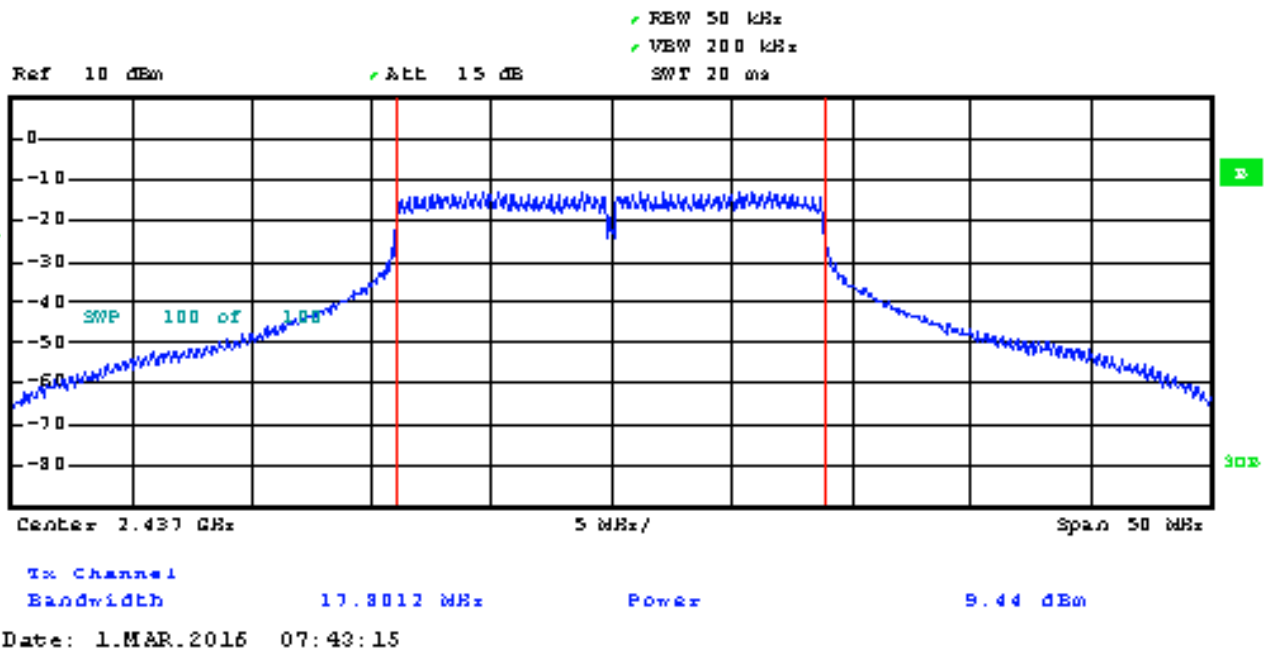
**Actual Power:** = 3.40 dBm (measured) + 0.11 dBi (duty correction)  
 = **3.51 dBm**

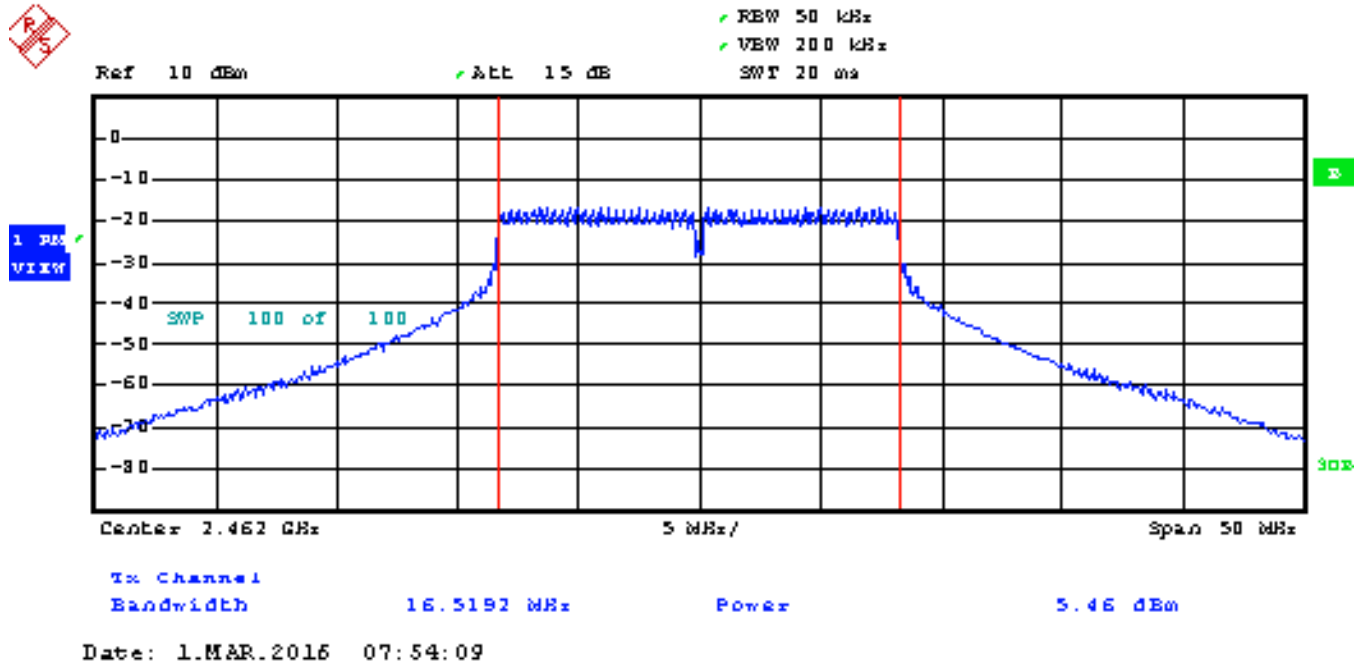
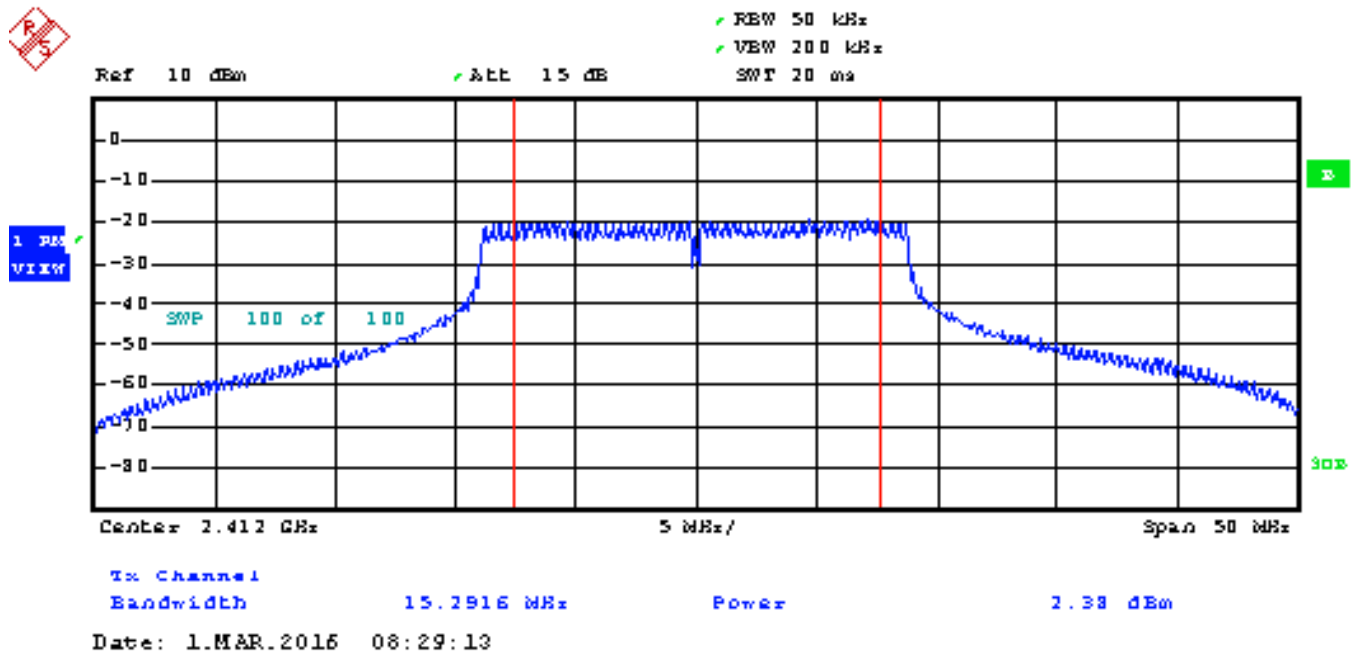
**WiFi Conducted Output Power Measurements Cont.****802.11g Ch 6 Ant 2:****Measured Power:** 5.26dBm

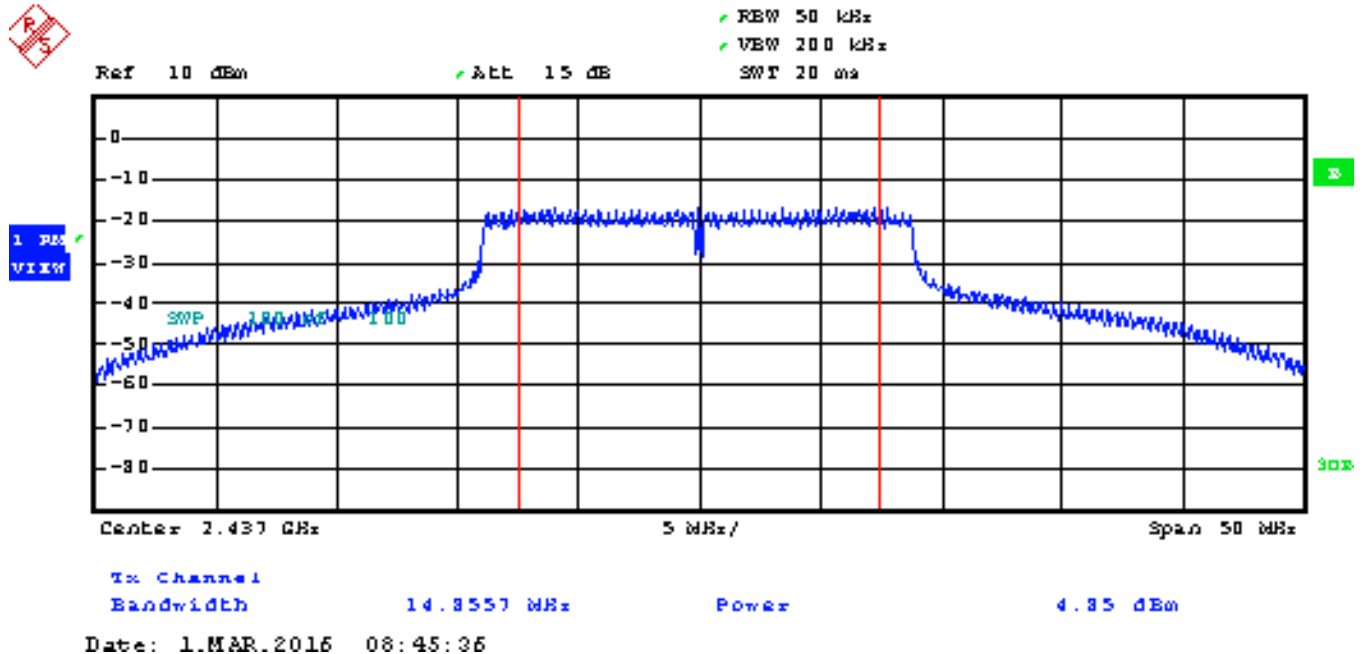
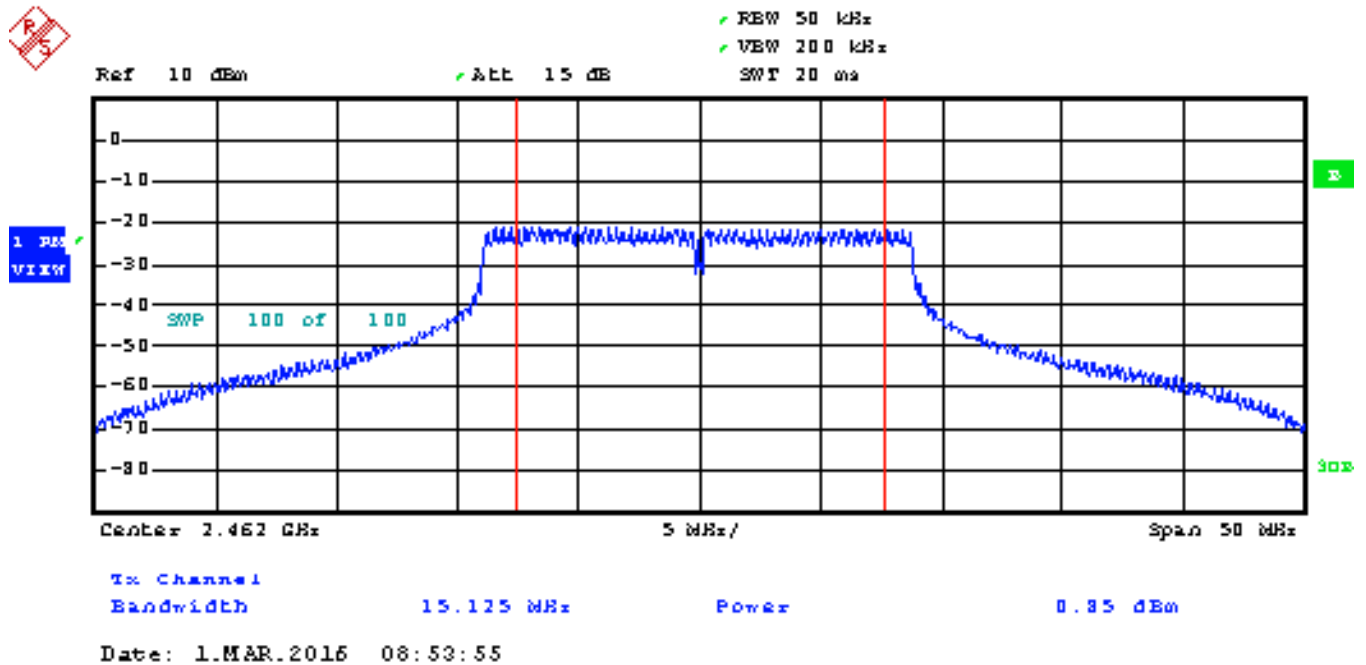
**Actual Power:** = 5.26 dBm (measured) + 0.11 dBi (duty correction)  
 = **5.37 dBm**

**802.11g Ch 11 Ant 2:****Measured Power:** 2.15 dBm

**Actual Power:** = 2.15 dBm (measured) + 0.11 dBi (duty correction)  
 = **2.26 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11n Operation****802.11n Ch 1 Ant 1:****Power: 6.61 dBm****802.11n Ch 6 Ant 1:****Power: 9.44 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11n Ch 11 Ant 1:****Power: 5.46 dBm****WiFi Conducted Output Power Measurements Cont.****802.11n Ch 1 Ant 2:****Power: 2.38 dBm**

**WiFi Conducted Output Power Measurements Cont.****802.11n Ch 6 Ant 2:****Power: 4.85 dBm****WiFi Conducted Output Power Measurements Cont.****802.11n Ch 11 Ant 2:****Power: 0.85 dBm**

## Power and Gain Summary

### Antenna Directional Gain Calculation

The directional gain for multiple antennas is calculated per KDB662911. The directional gain calculated will be used in the MPE report.

Summation is done as per KDB662911. Antenna gains for Antenna 1 & Antenna 2 are the same: they are both 1.0 dB. In our device the 2 antennas are correlated. Therefore KDB662911, section F(2)(i) applies. This states:

KDB662911, §F(2)(i)

(i) If all antennas have the same gain,  $G_{ANT}$ :

*Directional gain* =  $G_{ANT} + 10 \log(N_{ANT}/N_{SS})$  dBi, where  $N_{SS}$  = the number of independent spatial streams of data and  $G_{ANT}$  is the antenna gain in dBi. (This formula can also be applied when antennas have different gains if the highest antenna gain is substituted for  $G_{ANT}$ .)

In our case:  $N_{SS}=1$ ,  $N_{ANT} = 2$ , and  $G_{ANT}=1$ . Then, directional gain =  $1+10 \log(2) = 4.01\text{dB}$ .

**Power and Gain Summary Cont.****Summary of Average Conducted Power Measurements - Block1 and Block2**

- In Block 1, Measured average conducted power is taken individually for each antenna.

- In Block 2, an equivalent average conducted output power for both antennas is calculated by linearly summing their individual outputs, as per KDB662911 §E(1) The results from Block 1 & Block 2 are organized in the table below. The maximum average conducted power value is **10.86 dBm**. In this case it occurs on channel 6 in 802.11g mode, when both antennas are transmitting.

	Frequency (MHz)	Modulation	Ch	Ant	Max Avg Cond Pwr (dBm)	Combined Max Avg Cond Pwr (Block 2 Only) (dBm)
<b>Block 1</b>	2412	802.11b	1	1	10.23	10.23
	2412			2	5.35	5.35
	2437		6	1	10.49	10.49
	2437			2	7.01	7.01
	2467		11	1	9.74	9.74
	2467			2	7.87	7.87
	2412	802.11g	1	1	8.82	8.82
	2412			2	3.36	3.36
	2437		6	1	10.48	10.48
	2437			2	6.35	6.35
	2467		11	1	6.53	6.53
	2467			2	4.04	4.04
	2412	802.11n	1	1	8.58	8.58
	2412			2	2.78	2.78
	2437		6	1	10.68	10.68
	2437			2	6.83	6.83
	2467		11	1	5.82	5.82
	2467			2	3.89	3.89
<b>Block 2</b>	2412	802.11b	1	1	8.37	10.01
	2412			2	5.00	
	2437		6	1	8.92	10.50
	2437			2	5.34	
	2467		11	1	8.80	10.41
	2467			2	5.32	
	2412	802.11g	1	1	7.40	8.89
	2412			2	3.51	
	2437		6	1	9.42	<b>10.86</b>
	2437			2	5.37	
	2467		11	1	5.64	7.28
	2467			2	2.26	
	2412	802.11n	1	1	6.61	8.00
	2412			2	2.38	
	2437		6	1	9.44	10.74
	2437			2	4.85	
	2467		11	1	5.46	6.75
	2467			2	0.85	