



7.3. 6dB BANDWIDTH MEASUREMENT

7.3.1. LIMITS

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz. The minimum 6 dB bandwidth shall be at least 500 kHz.

7.3.2. TEST INSTRUMENTS

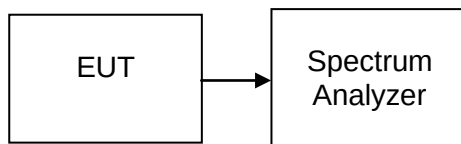
Name of Equipment	Manufacturer	Model	Serial Number	Last Calibration	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US44300399	02/28/2015	02/27/2016

7.3.3. TEST PROCEDURES (please refer to measurement standard)

8.1 Option 1:

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

7.3.4. TEST SETUP



**7.3.5. TEST RESULTS***No non-compliance noted***Test Data****Test mode: IEEE 802.11b (Antenna 0)**

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	8126	>500	PASS
Mid	2437	8127		PASS
High	2462	8131		PASS

Test mode: IEEE 802.11b (Antenna 1)

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	8144	>500	PASS
Mid	2437	8087		PASS
High	2462	8120		PASS

Test mode: IEEE 802.11g (Antenna 0)

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	15157	>500	PASS
Mid	2437	14844		PASS
High	2462	15103		PASS

Test mode: IEEE 802.11g (Antenna 1)

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	15105	>500	PASS
Mid	2437	15069		PASS
High	2462	15177		PASS

**Test mode: IEEE 802.11n HT20 MHz (Antenna 0)**

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	15113	>500	PASS
Mid	2437	15070		PASS
High	2462	15041		PASS

Test mode: IEEE 802.11n HT20 MHz (Antenna 1)

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2412	15706	>500	PASS
Mid	2437	16077		PASS
High	2462	15137		PASS

Test mode: IEEE 802.11n HT40 MHz (Antenna 0)

Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2422	35164	>500	PASS
Mid	2437	35145		PASS
High	2452	35183		PASS

Test mode: IEEE 802.11n HT40 MHz (Antenna 1)

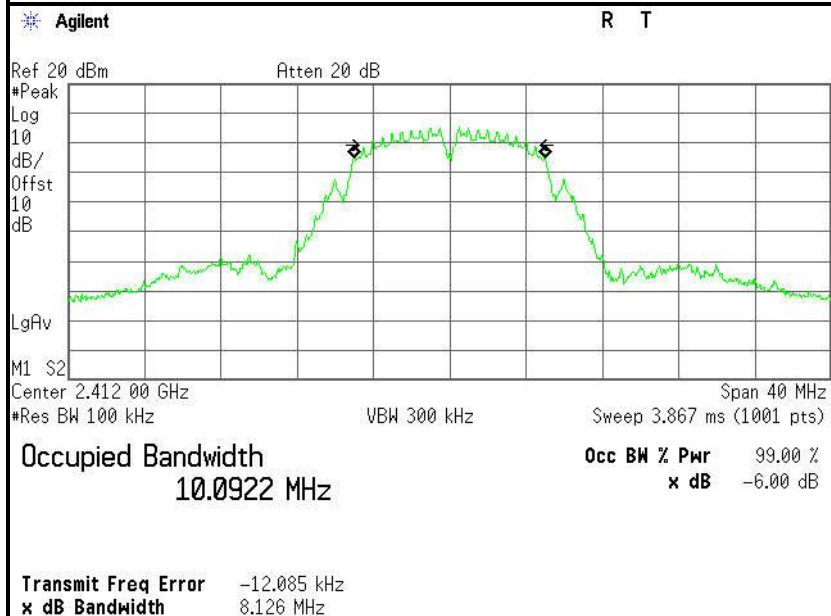
Channel	Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Test Result
Low	2422	35705	>500	PASS
Mid	2437	35706		PASS
High	2452	35190		PASS



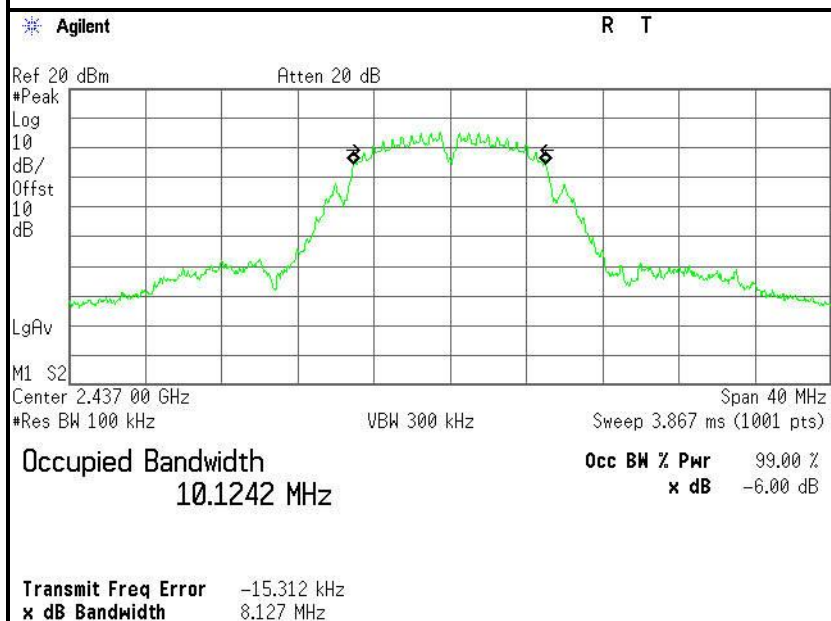
Test Plot

IEEE 802.11b mode (Antenna 0)

6dB Bandwidth (CH Low)

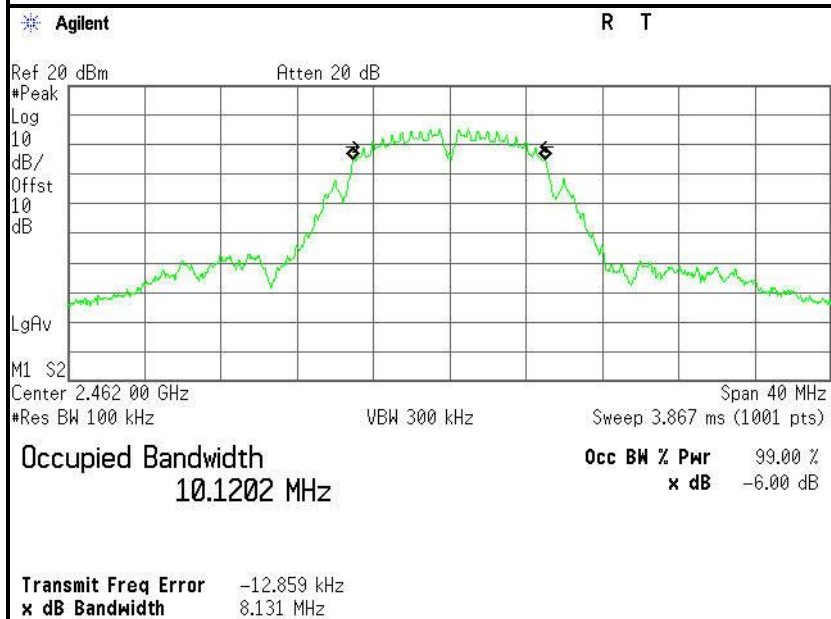


6dB Bandwidth (CH Mid)



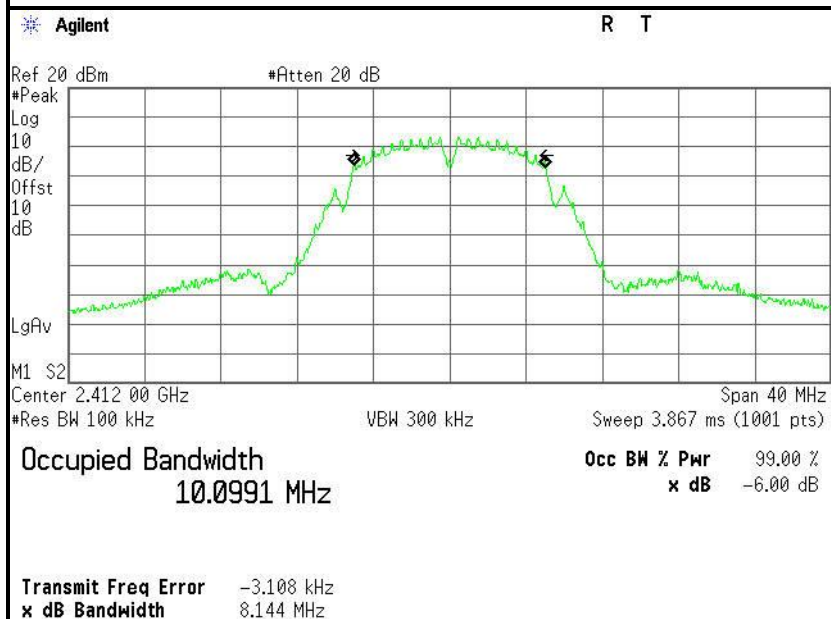


6dB Bandwidth (CH High)



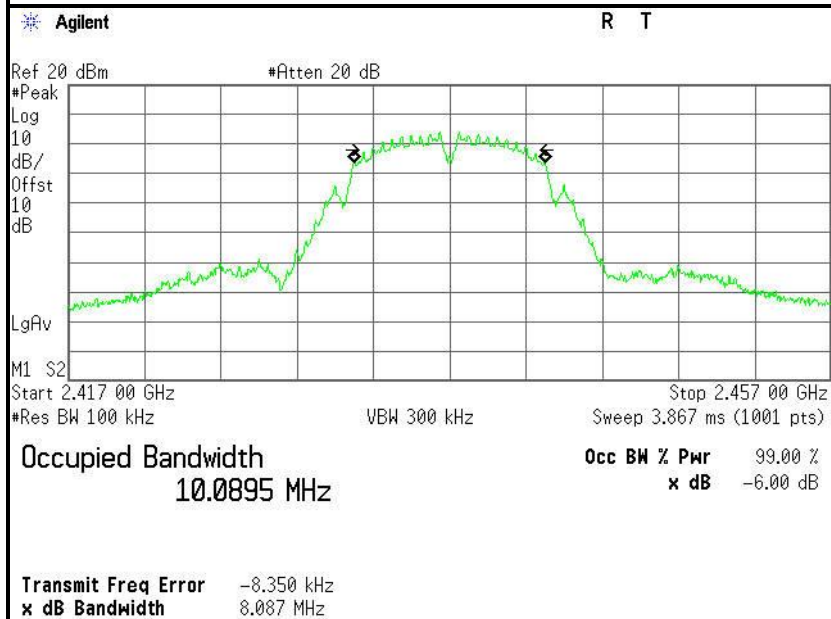
IEEE 802.11b mode (Antenna 1)

6dB Bandwidth (CH Low)

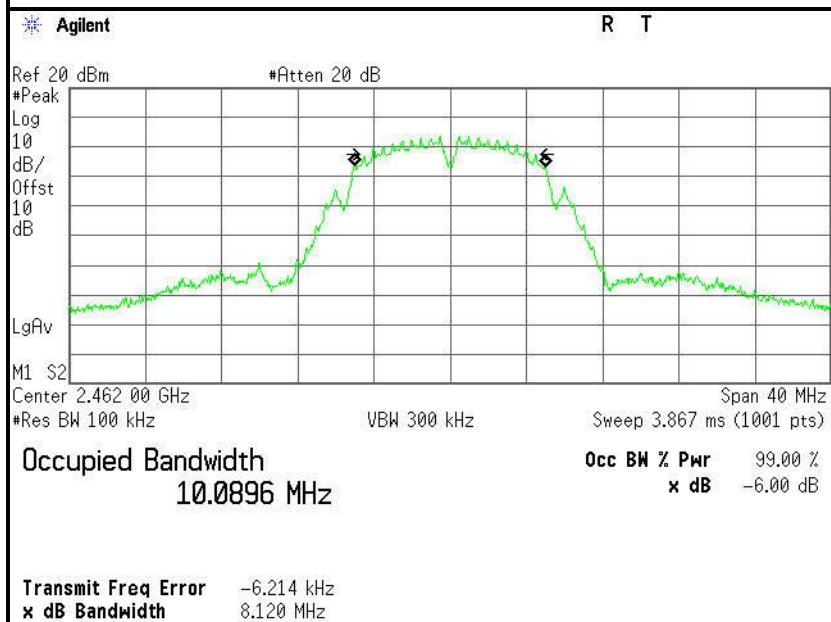




6dB Bandwidth (CH Mid)



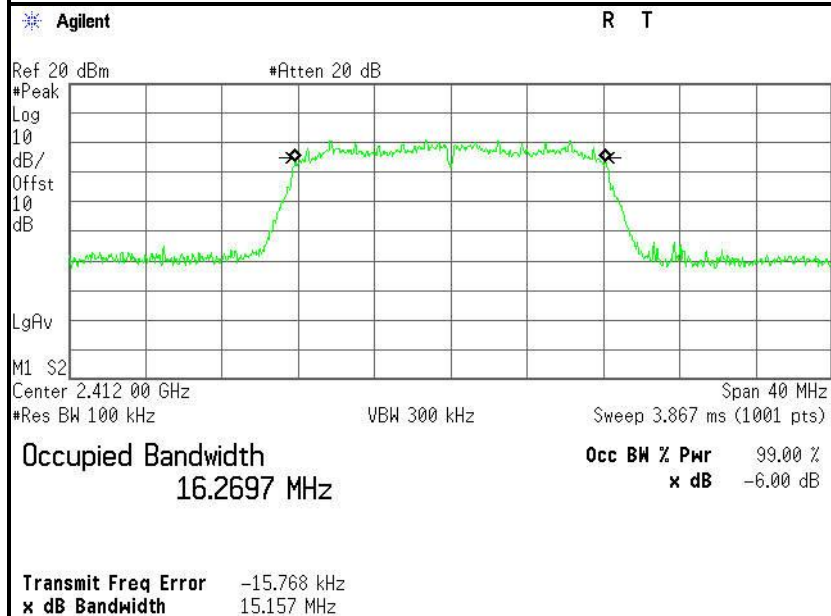
6dB Bandwidth (CH High)



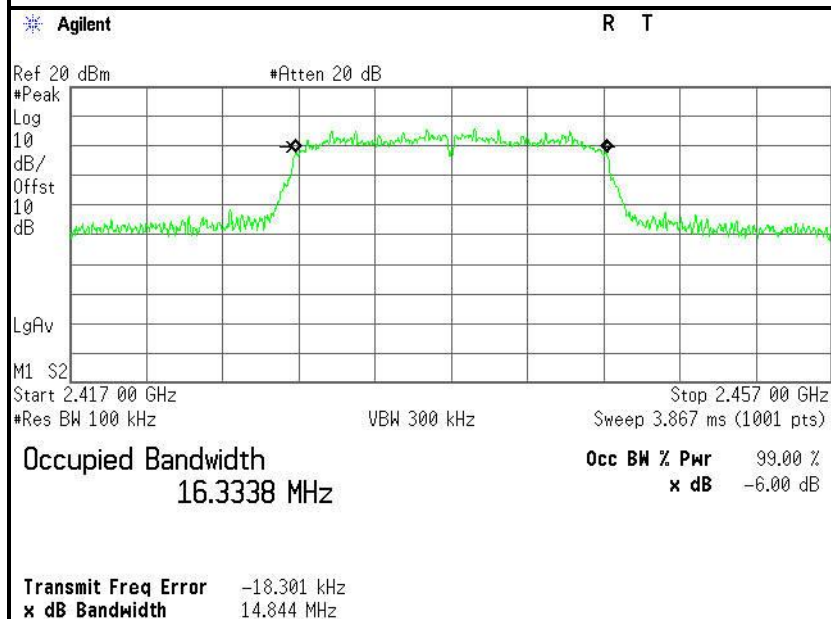


IEEE 802.11g mode (Antenna 0)

6dB Bandwidth (CH Low)

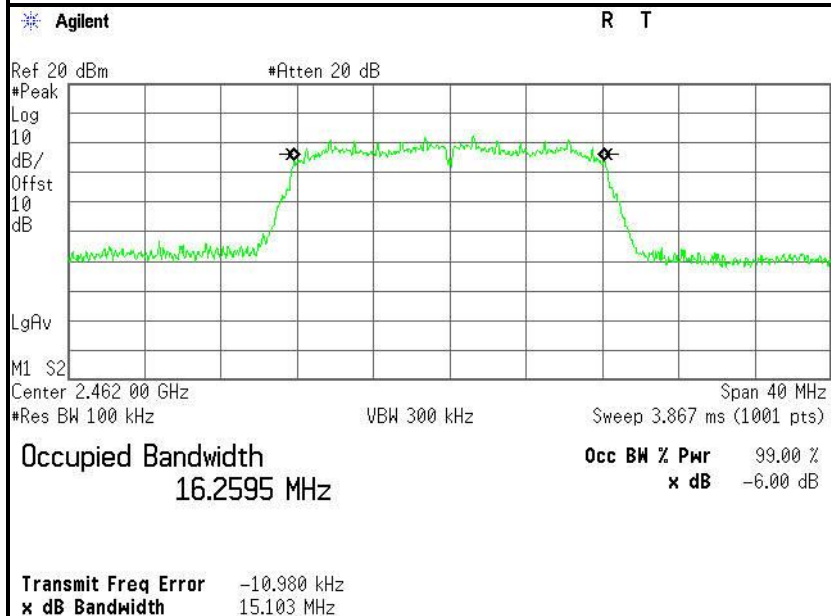


6dB Bandwidth (CH Mid)



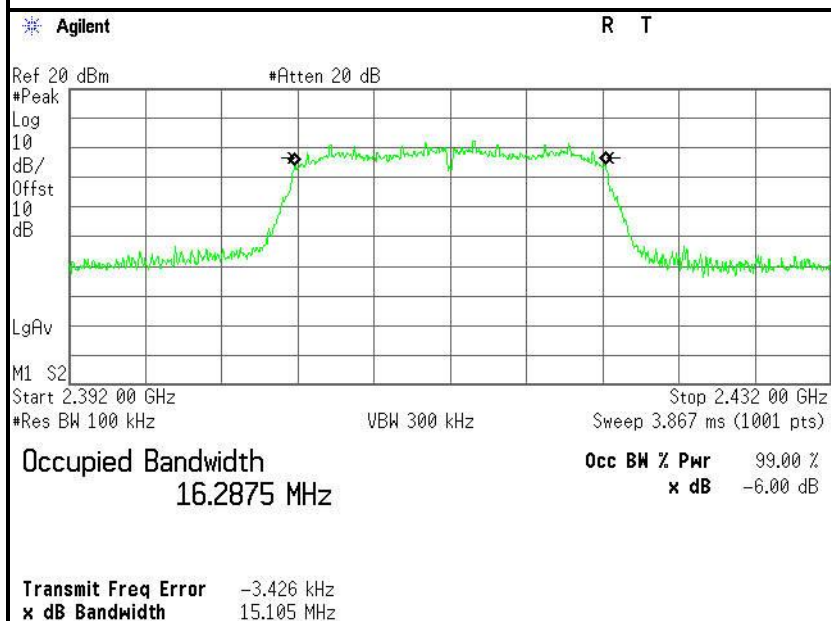


6dB Bandwidth (CH High)



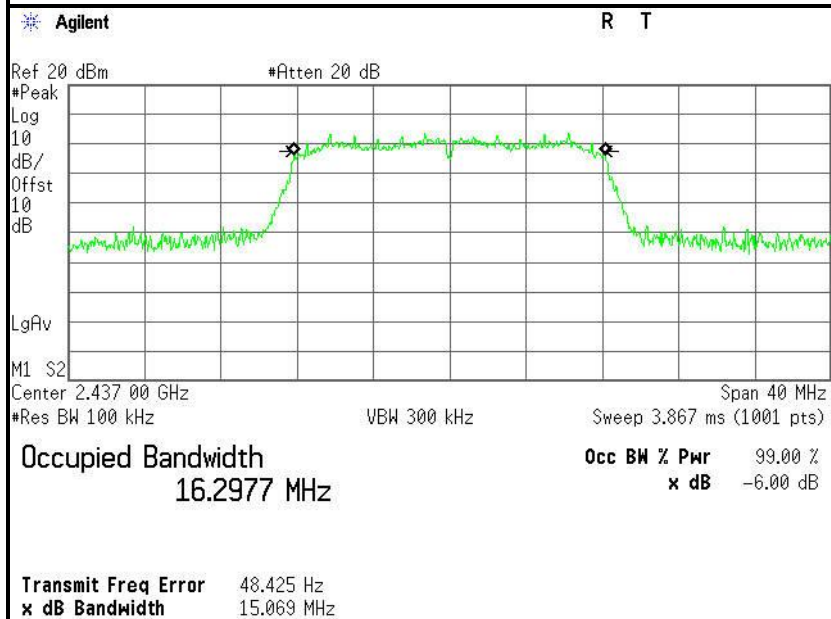
IEEE 802.11g mode (Antenna 1)

6dB Bandwidth (CH Low)

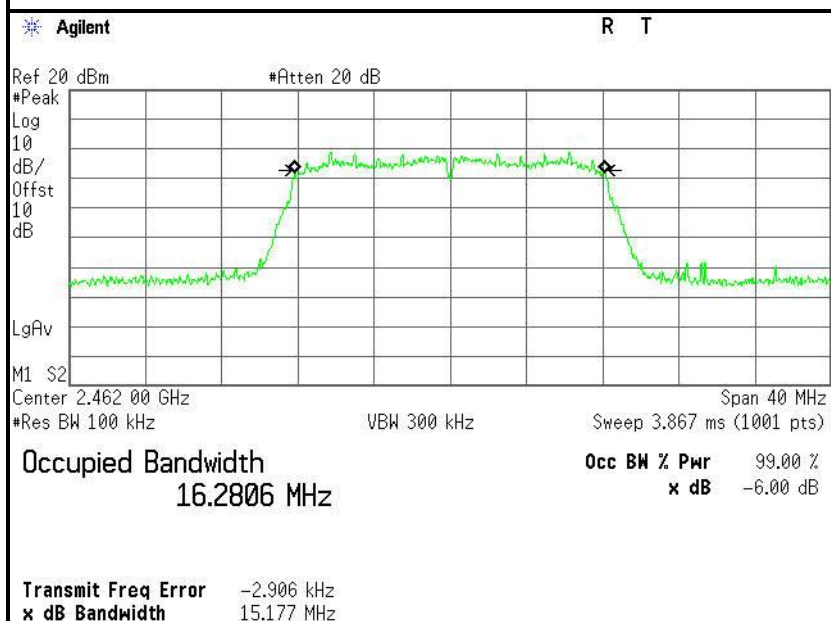




6dB Bandwidth (CH Mid)



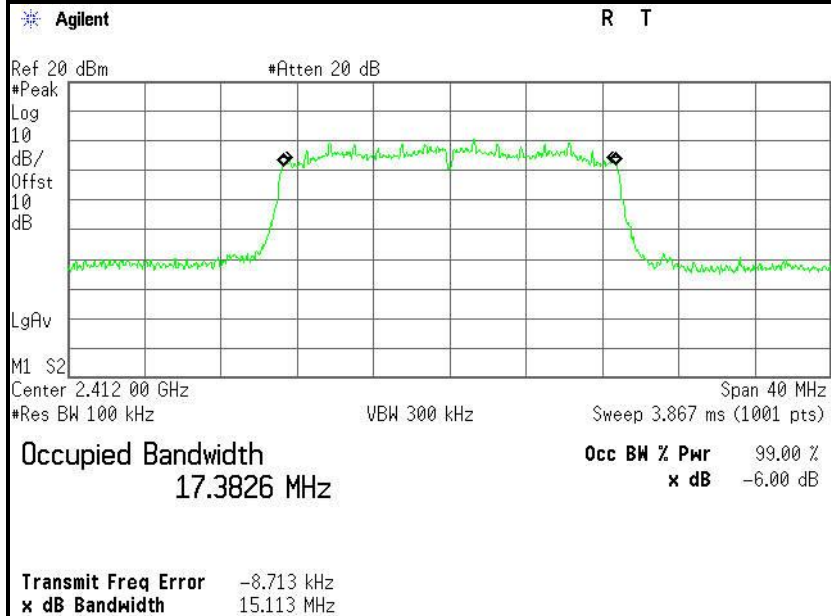
6dB Bandwidth (CH High)



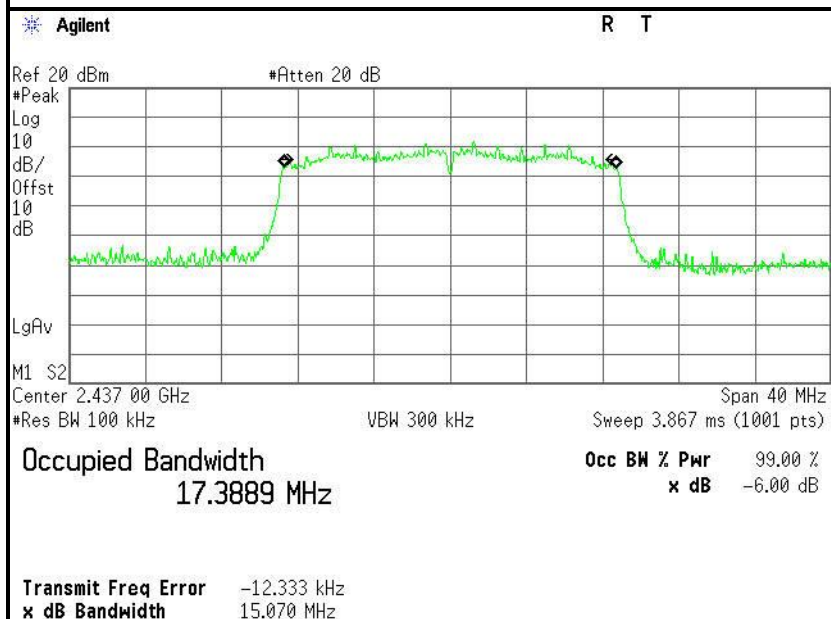


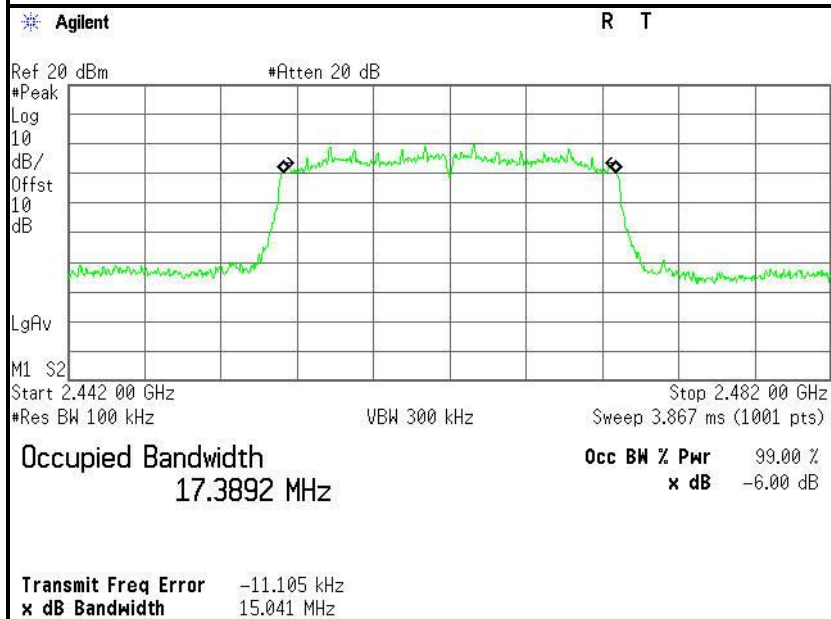
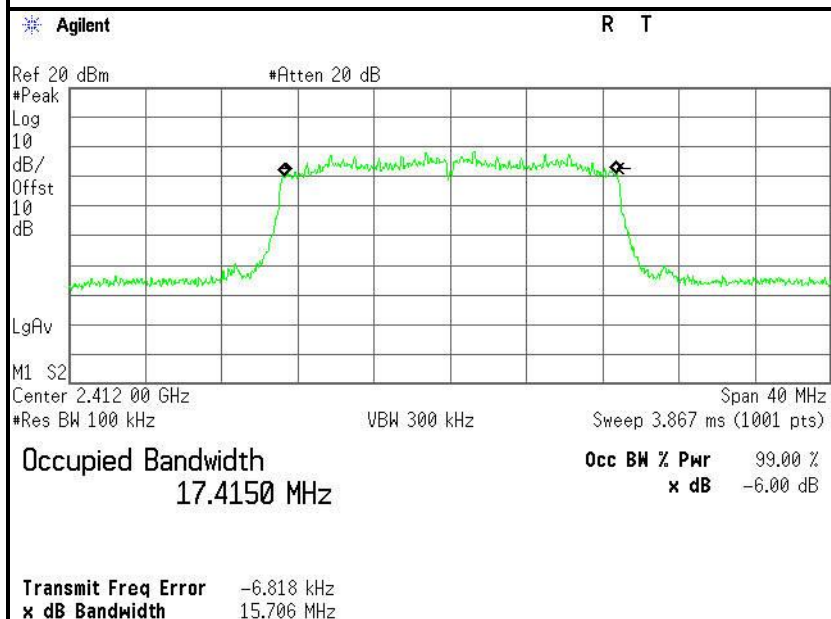
IEEE 802.11n HT20 MHz mode (Antenna 0)

6dB Bandwidth (CH Low)



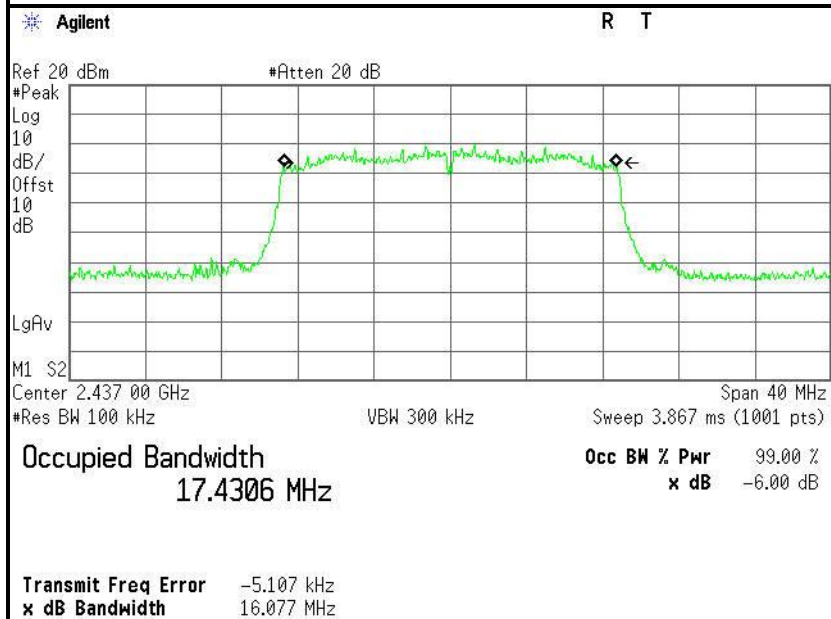
6dB Bandwidth (CH Mid)



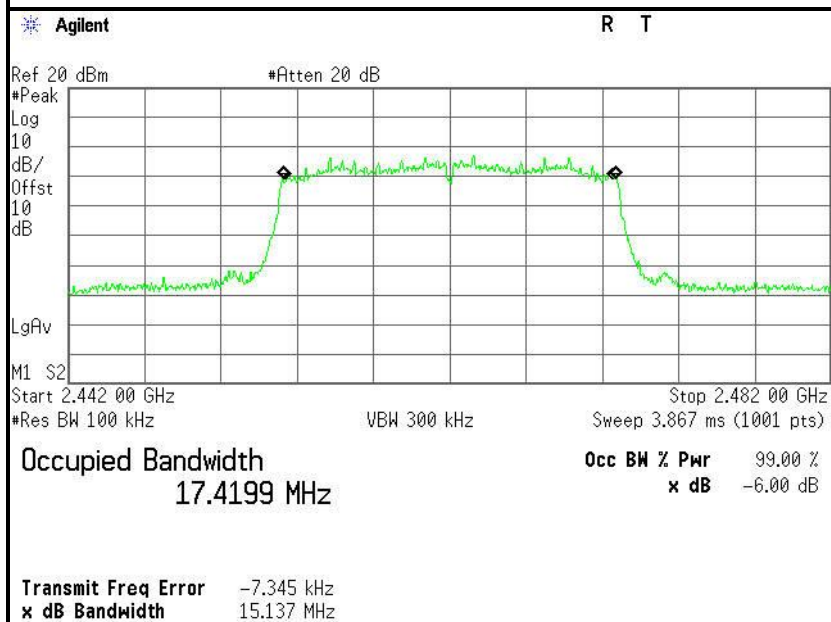
**6dB Bandwidth (CH High)****IEEE 802.11n HT20 MHz mode (Antenna 1)****6dB Bandwidth (CH Low)**



6dB Bandwidth (CH Mid)



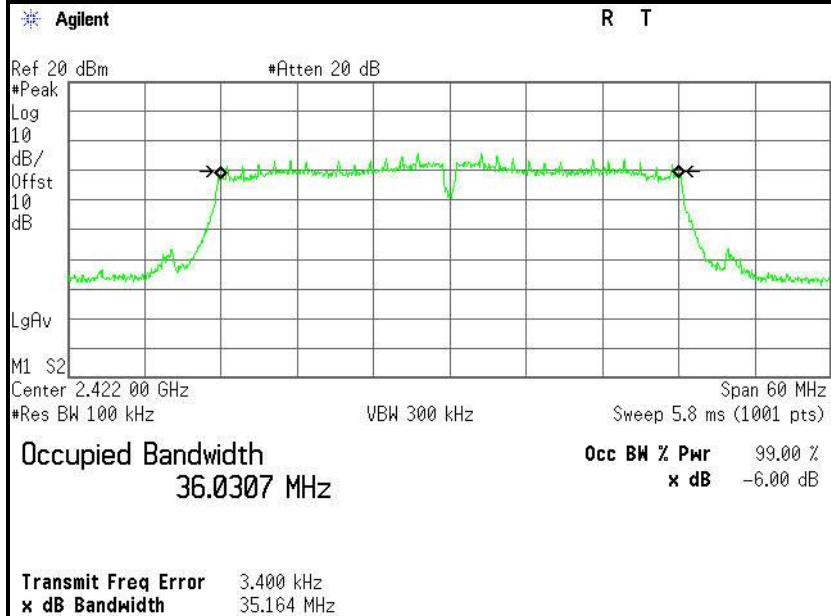
6dB Bandwidth (CH High)



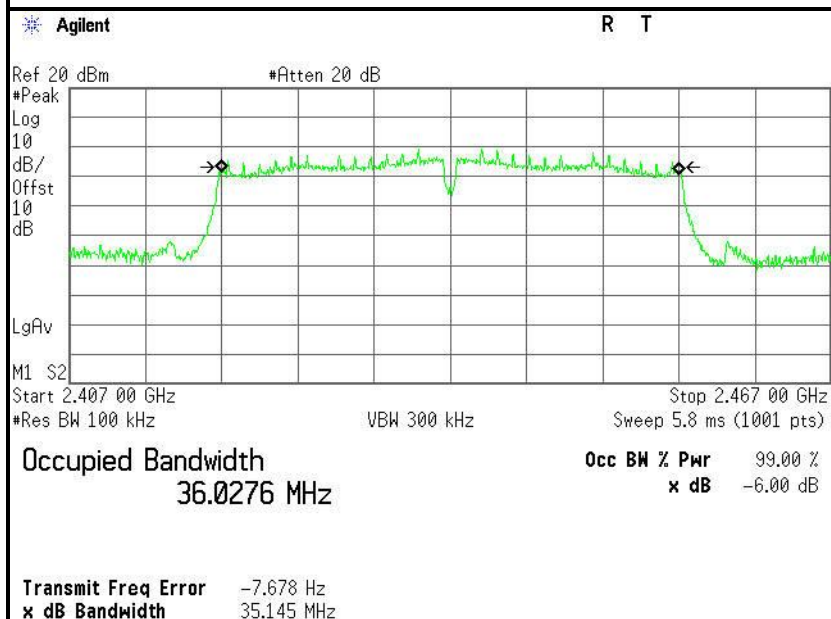


IEEE 802.11n HT40 MHz mode (Antenna 0)

6dB Bandwidth (CH Low)

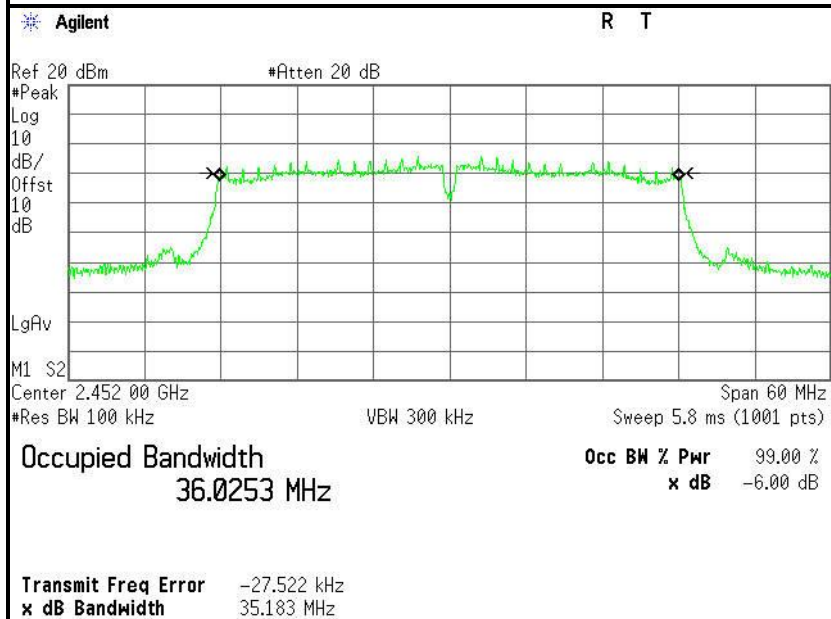


6dB Bandwidth (CH Mid)



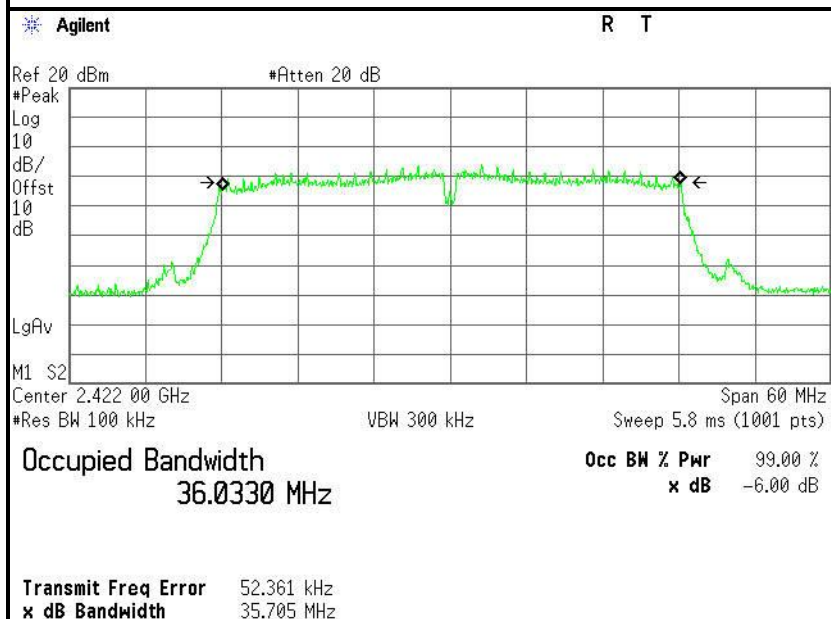


6dB Bandwidth (CH High)



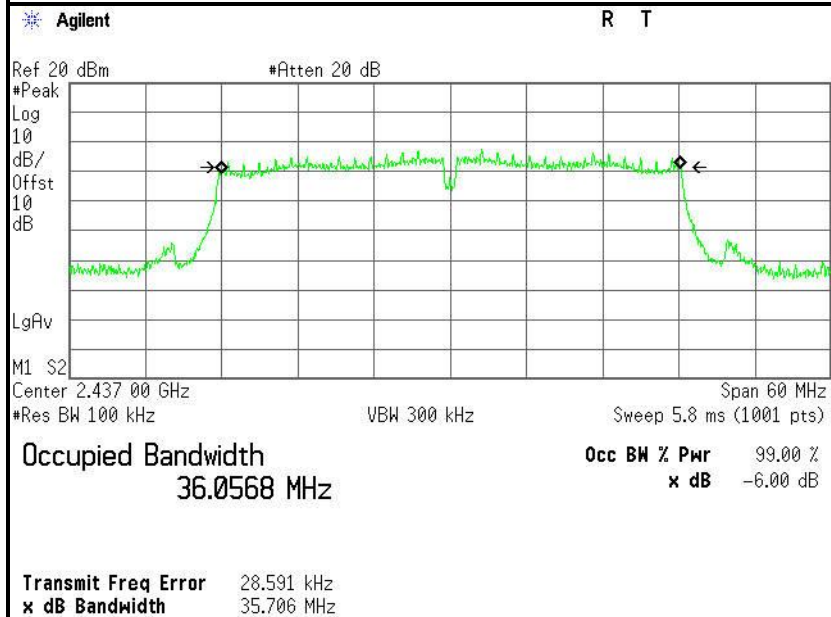
IEEE 802.11n HT40 MHz mode (Antenna 1)

6dB Bandwidth (CH Low)

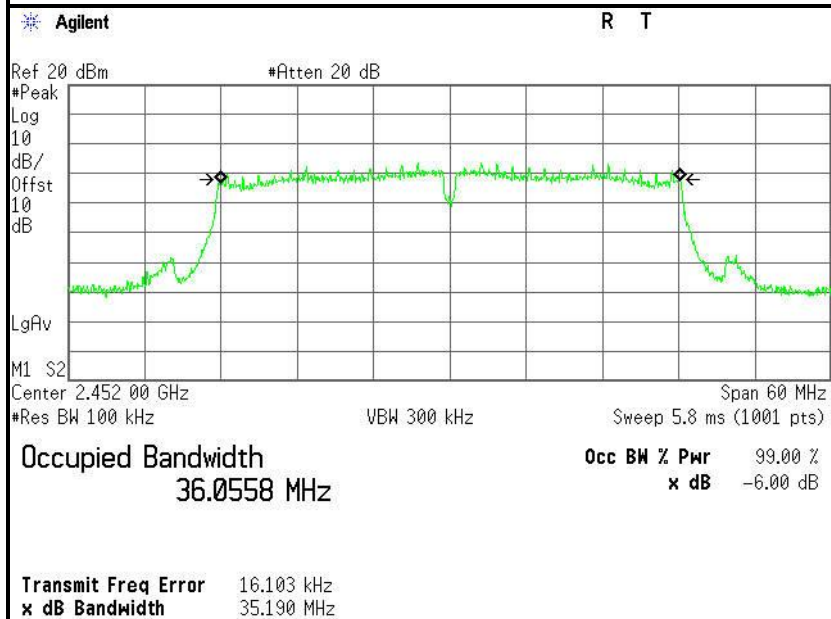




6dB Bandwidth (CH Mid)



6dB Bandwidth (CH High)





7.4. ANTENNA GAIN

MEASUREMENT

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For normal WLAN devices, the DSSS mode is used.

MEASUREMENT PARAMETERS

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz
Trace-Mode	Max hold

LIMITS

FCC	IC
Antenna Gain	
6 dBi	



TEST RESULTS

IEEE 802.11b mode (Antenna 0)

T_{nom}	V_{nom}	Lowest channel 2412MHz	Middle channel 2437MHz	Highest channel 2462MHz
Conducted power [dBm/MHz] Measured with DSSS modulation		7.67	8.18	8.66
Radiated power [dBm/MHz] Measured with DSSS modulation		9.75	10.08	10.36
Gain [dBi] Calculated		2.08	1.90	1.70
Measurement uncertainty		± 1.5 dB (cond.) / ± 3 dB (rad.)		

IEEE 802.11b mode (Antenna 1)

T_{nom}	V_{nom}	Lowest channel 2412MHz	Middle channel 2437MHz	Highest channel 2462MHz
Conducted power [dBm/MHz] Measured with DSSS modulation		7.17	7.42	7.20
Radiated power [dBm/MHz] Measured with DSSS modulation		9.95	10.12	9.39
Gain [dBi] Calculated		2.78	2.70	2.19
Measurement uncertainty		± 1.5 dB (cond.) / ± 3 dB (rad.)		



7.5. PEAK OUTPUT POWER

7.5.1. LIMITS

The maximum peak output power of the intentional radiator shall not exceed the following:

1. According to §15.247(b)(3), for systems using digital modulation in the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz: 1 Watt.
2. According to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.5.2. TEST INSTRUMENTS

Name of Equipment	Manufacturer	Model	Serial Number	Last Calibration	Calibration Due
Power Meter	Anritsu	ML2495A	1204003	02/28/2015	02/27/2016
Power Sensor	Anritsu	MA2411B	1126150	02/28/2015	02/27/2016

7.5.3. TEST PROCEDURES (please refer to measurement standard)

9.1.1 $RBW \geq DTS \text{ bandwidth}$

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the *DTS bandwidth*.

- a) Set the $RBW \geq DTS \text{ bandwidth}$.
- b) Set $VBW \geq 3 \text{ RBW}$.
- c) Set span $\geq 3 \times RBW$
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.



9.1.2 Integrated band power method

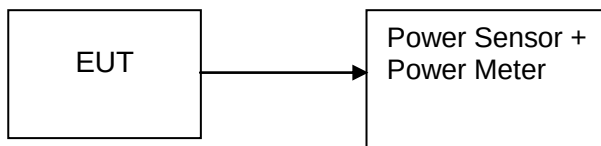
This procedure may be used when the maximum available RBW of the measurement instrument is less than the *DTS bandwidth*.

- a) Set the RBW = 1 MHz.
- b) Set the VBW ≥ 3 RBW
- c) Set the span $\geq 1.5 \times$ DTS bandwidth.
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select peak detector). If the instrument does not have a band power function, sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS bandwidth.

9.1.3 PKPM1 Peak power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

7.5.4. TEST SETUP





7.5.5. TEST RESULTS

No non-compliance noted

Test Data

Test mode: IEEE 802.11b (Antenna 0)

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)	Peak / AVG	Result
Low	2412	17.71	0.05902	1	Peak	PASS
Mid	2437	18.23	0.06653			PASS
High	2462	18.71	0.07430			PASS
Low	2412	13.95	0.02483	1	AVG	PASS
Mid	2437	14.41	0.02761			PASS
High	2462	14.64	0.02911			PASS

Test mode: IEEE 802.11b (Antenna 1)

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)	Peak / AVG	Result
Low	2412	17.21	0.05260	1	Peak	PASS
Mid	2437	17.46	0.05572			PASS
High	2462	17.24	0.05297			PASS
Low	2412	13.43	0.02203	1	AVG	PASS
Mid	2437	13.52	0.02249			PASS
High	2462	13.75	0.02371			PASS

Test mode: IEEE 802.11g (Antenna 0)

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)	Peak / AVG	Result
Low	2412	23.97	0.24946	1	Peak	PASS
Mid	2437	25.85	0.38459			PASS
High	2462	24.20	0.26303			PASS
Low	2412	12.62	0.01828	1	AVG	PASS
Mid	2437	16.78	0.04764			PASS
High	2462	12.75	0.01884			PASS

Test mode: IEEE 802.11g (Antenna 1)

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)	Peak / AVG	Result
Low	2412	24.80	0.30200	1	Peak	PASS
Mid	2437	25.22	0.33266			PASS
High	2462	23.37	0.21727			PASS
Low	2412	14.23	0.02649	1	AVG	PASS
Mid	2437	16.16	0.04130			PASS
High	2462	11.74	0.01493			PASS

**Test mode: IEEE 802.11n HT20 MHz (Combine with Antenna 0 and Antenna 1)**

Channel	Frequency (MHz)	Output Power (dBm)			Output Power (W)	Limit (W)	Peak / AVG	Result
		Antenna 1	Antenna 2	Total				
Low	2412	22.54	22.08	25.33	0.34091	1	Peak	PASS
Mid	2437	23.87	24.05	26.97	0.49788			PASS
High	2462	24.86	19.65	26.00	0.39845			PASS
Low	2412	11.45	10.35	13.95	0.02480	1	AVG	PASS
Mid	2437	12.78	12.74	15.77	0.03776			PASS
High	2462	10.48	8.75	12.71	0.01867			PASS

Test mode: IEEE 802.11n HT40 MHz (Combine with Antenna 0 and Antenna 1)

Channel	Frequency (MHz)	Output Power (dBm)			Output Power (W)	Limit (W)	Peak / AVG	Result
		Antenna 1	Antenna 2	Total				
Low	2422	19.43	18.95	22.21	0.16622	1	Peak	PASS
Mid	2437	23.01	22.40	25.73	0.37377			PASS
High	2452	19.54	20.33	22.96	0.19784			PASS
Low	2422	9.16	8.56	11.88	0.01542	1	AVG	PASS
Mid	2437	12.46	11.80	15.15	0.03276			PASS
High	2452	9.54	9.02	12.30	0.01697			PASS



7.6. BAND EDGES MEASUREMENT

7.6.1. LIMITS

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

7.6.2. TEST INSTRUMENTS

Radiated Emission Test Site 966(2)					
Name of Equipment	Manufacturer	Model Number	Serial Number	Last Calibration	Due Calibration
EMI TEST RECEIVER	Agilent	N9038A	US44300399	02/28/2015	02/27/2016
EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100783	02/28/2015	02/27/2016
Amplifier	MITEQ	AM-1604-3000	1123808	03/18/2015	03/18/2016
High Noise Amplifier	Agilent	8449B	3008A01838	02/28/2015	02/27/2016
Board-Band Horn Antenna	Schwarzbeck	BBHA 9170	9170-497	02/28/2015	02/27/2016
Bilog Antenna	SCHAFFNER	CBL6143	5082	02/28/2015	02/27/2016
Horn Antenna	SCHWARZBECK	BBHA9120	D286	02/28/2015	02/27/2016
Loop Antenna	COM-POWER	AL-130	121044	09/25/2015	09/24/2016
Turn Table	N/A	N/A	N/A	N.C.R	N.C.R
Controller	Sunol Sciences	SC104V	022310-1	N.C.R	N.C.R
Controller	CT	N/A	N/A	N.C.R	N.C.R
Temp. / Humidity Meter	Anymetre	JR913	N/A	02/28/2015	02/27/2016
Antenna Tower	SUNOL	TLT2	N/A	N.C.R	N.C.R
Test S/W	FARAD	LZ-RF / CCS-SZ-3A2			

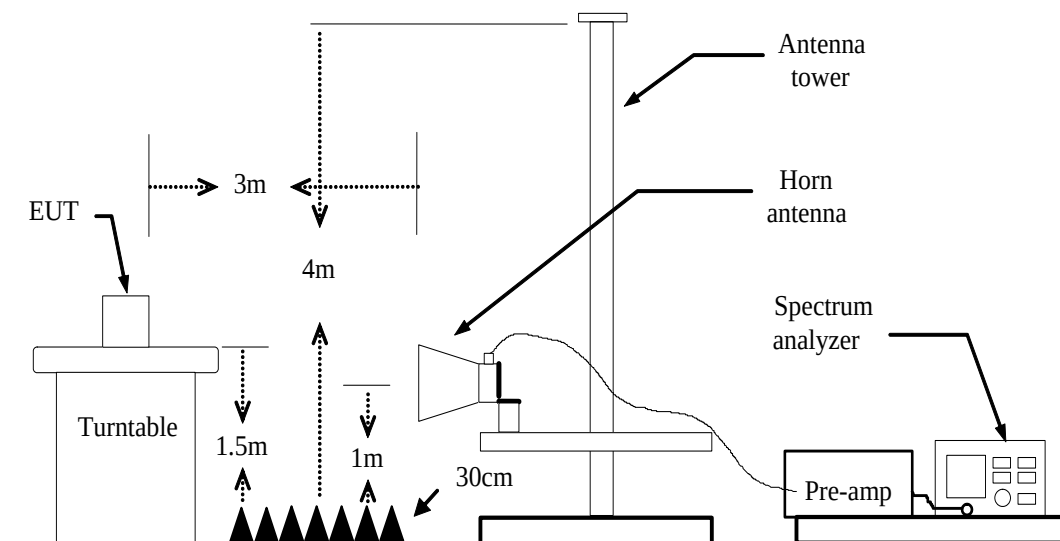
- NOTE:** 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The FCC Site Registration number is 101879.
3. N.C.R = No Calibration Required.



7.6.3. SSTEEST PROCEDURES (please refer to measurement standard)

1. The EUT is placed on a turntable, which is 1.5m above the ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.
4. Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:
 - (a) PEAK: RBW=1MHz / VBW=3MHz / Sweep=AUTO
 - (b) AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO / Detector=Peak
5. Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

7.6.4. TEST SETUP



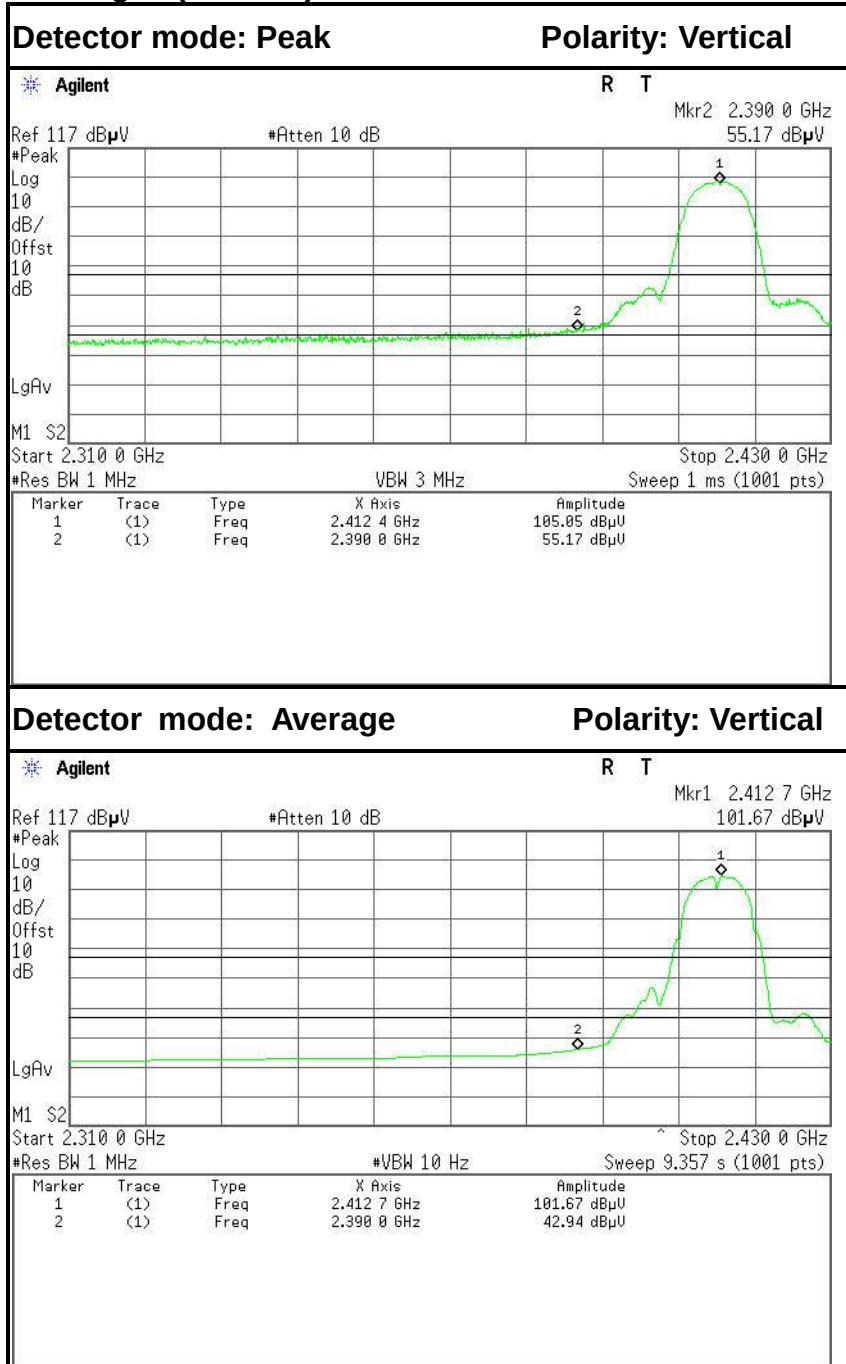


7.6.5. TEST RESULTS

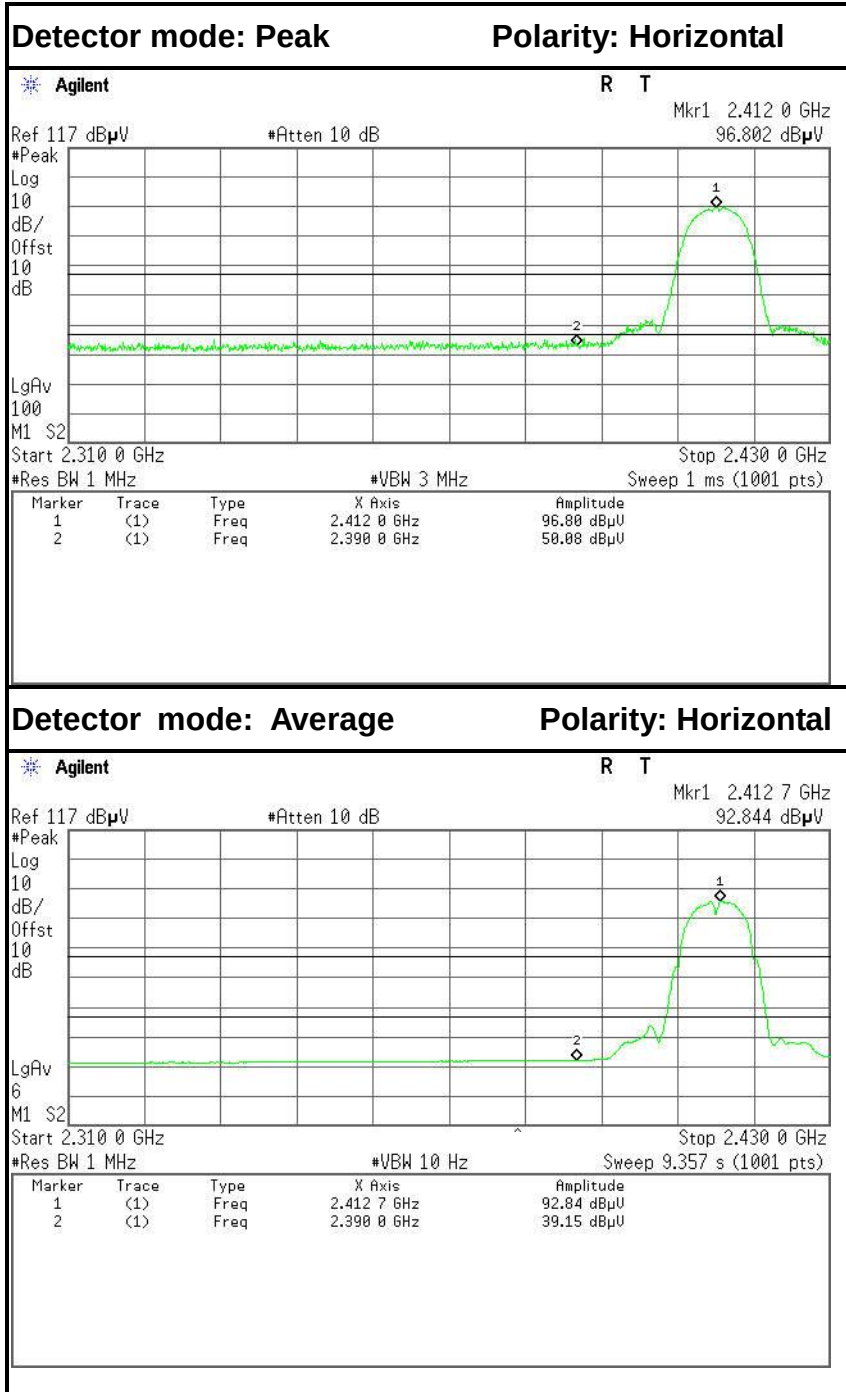
Test Plot

IEEE 802.11b mode (Antenna 0)

Band Edges (CH Low)



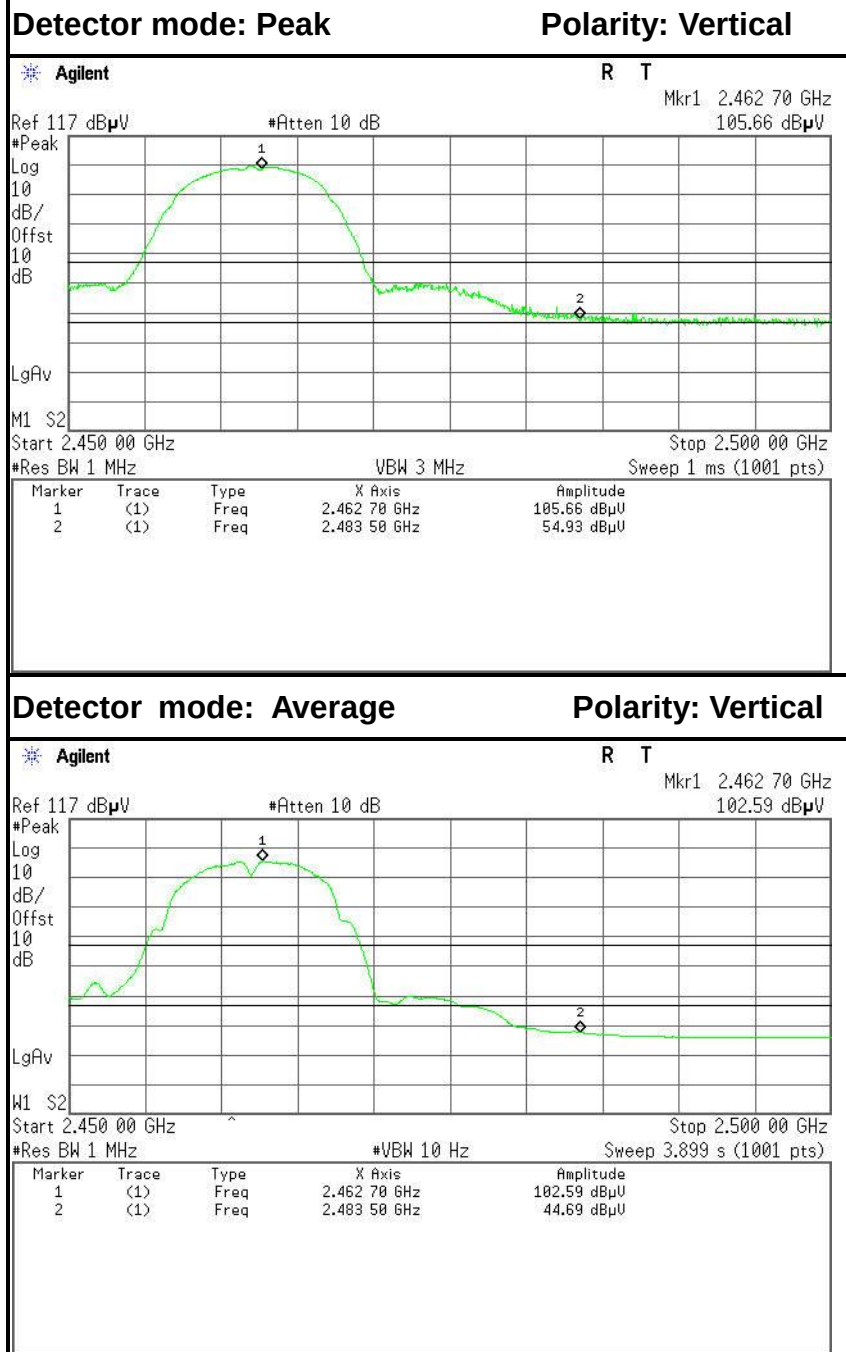
No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2390.0000	48.57	-6.60	55.17	74.00	-18.83	Peak	Vertical
2	2390.0000	36.34	-6.60	42.94	54.00	-11.06	Average	Vertical



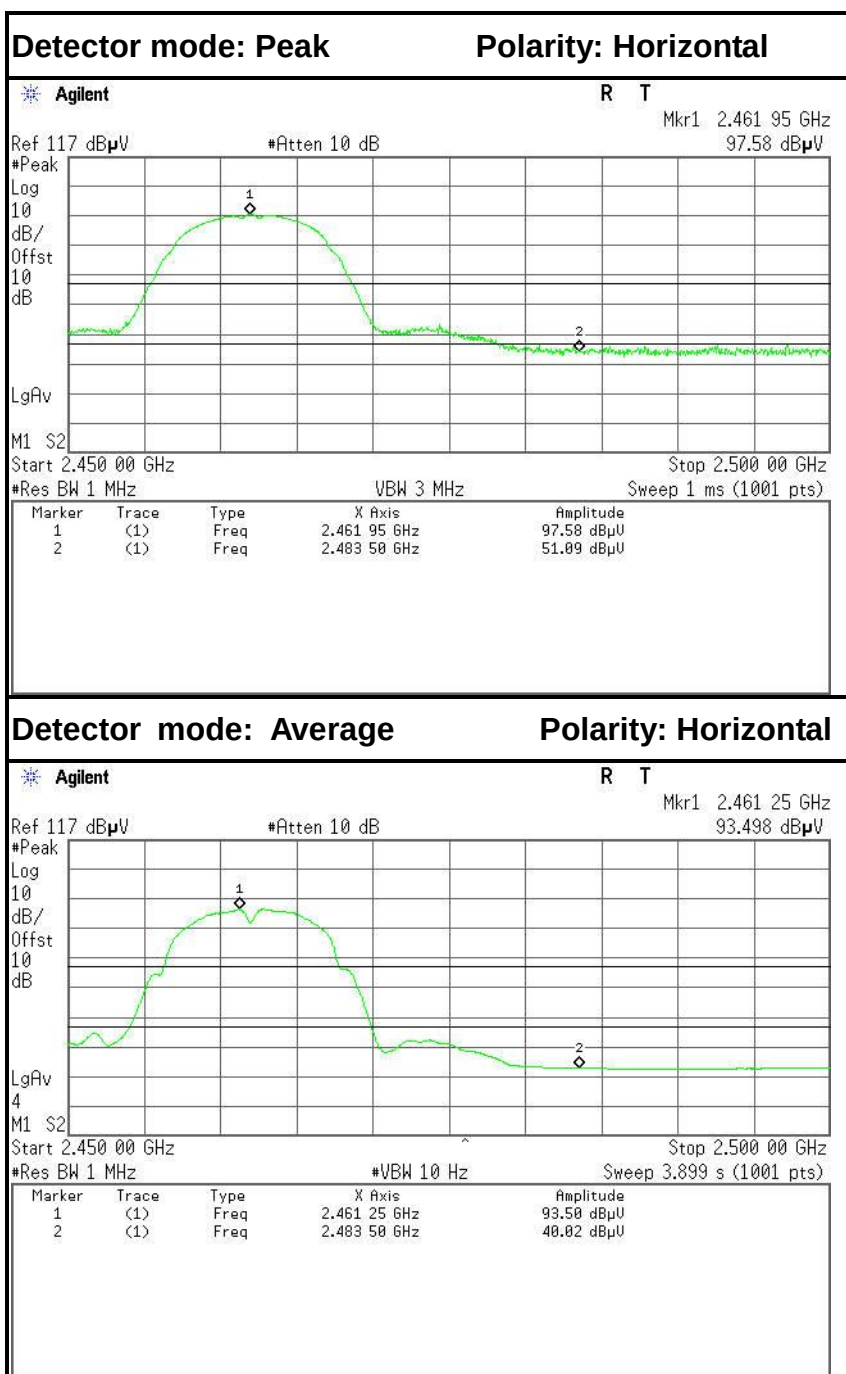
No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2390.0000	43.48	-6.60	50.08	74.00	-23.92	Peak	Horizontal
2	2390.0000	32.55	-6.60	39.15	54.00	-14.85	Average	Horizontal



Band Edges (CH High)



No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2483.5000	48.69	-6.24	54.93	74.00	-19.07	Peak	Vertical
2	2483.5000	38.45	-6.24	44.69	54.00	-9.31	Average	Vertical

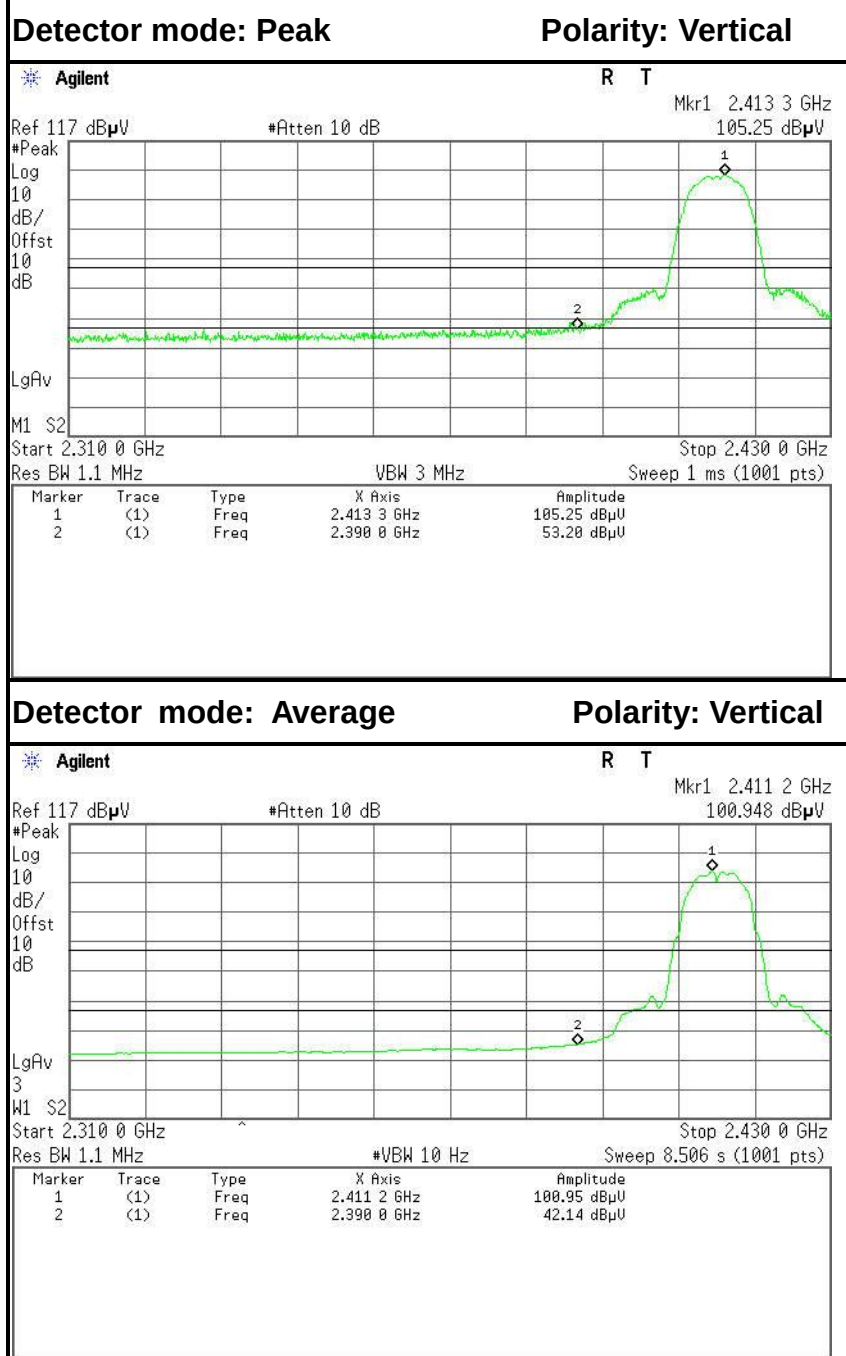


No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2483.5000	44.85	-6.24	51.09	74.00	-22.91	Peak	Horizontal
2	2483.5000	33.78	-6.24	40.02	54.00	-13.98	Average	Horizontal

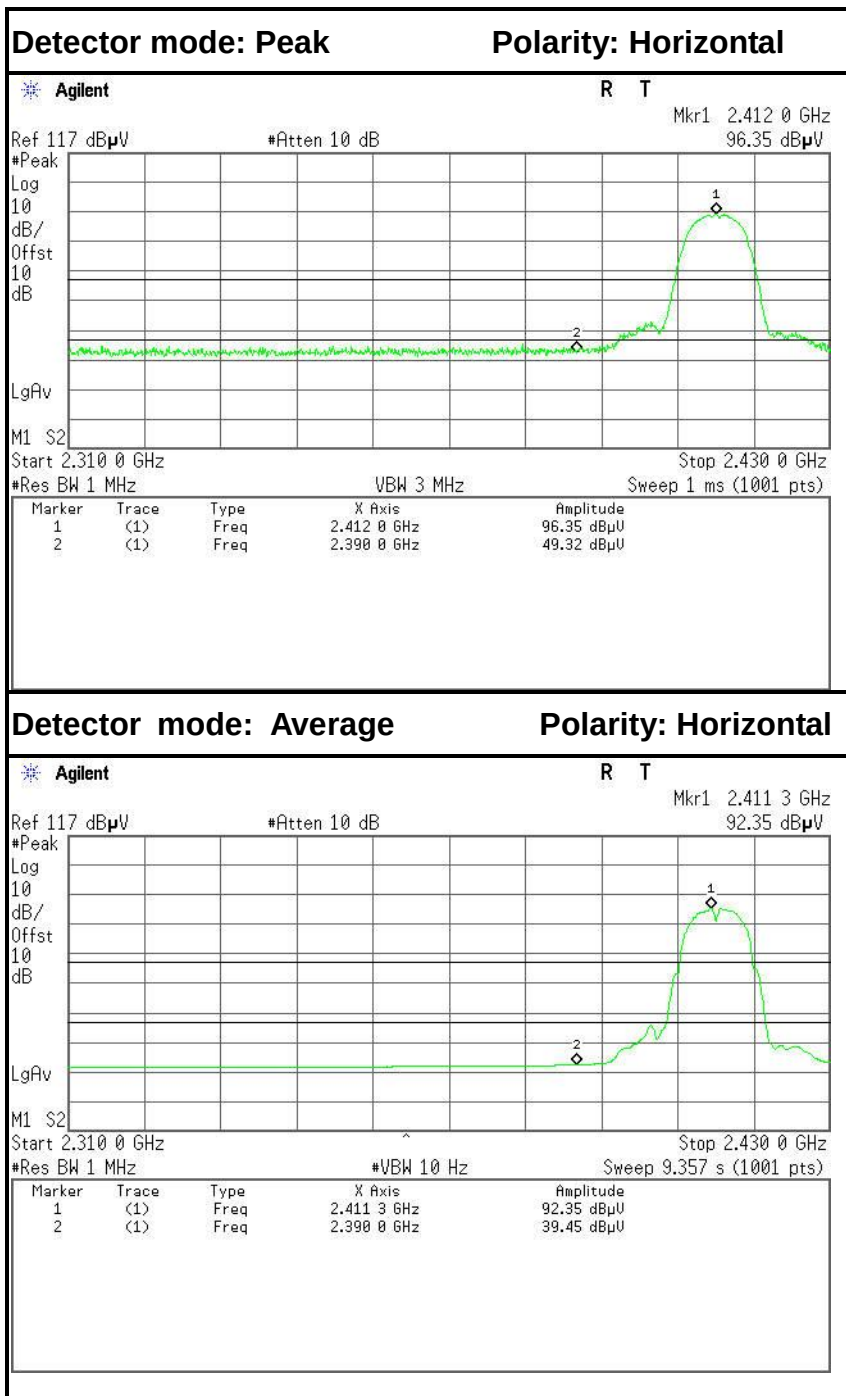


IEEE 802.11b mode (Antenna 1)

Band Edges (CH Low)



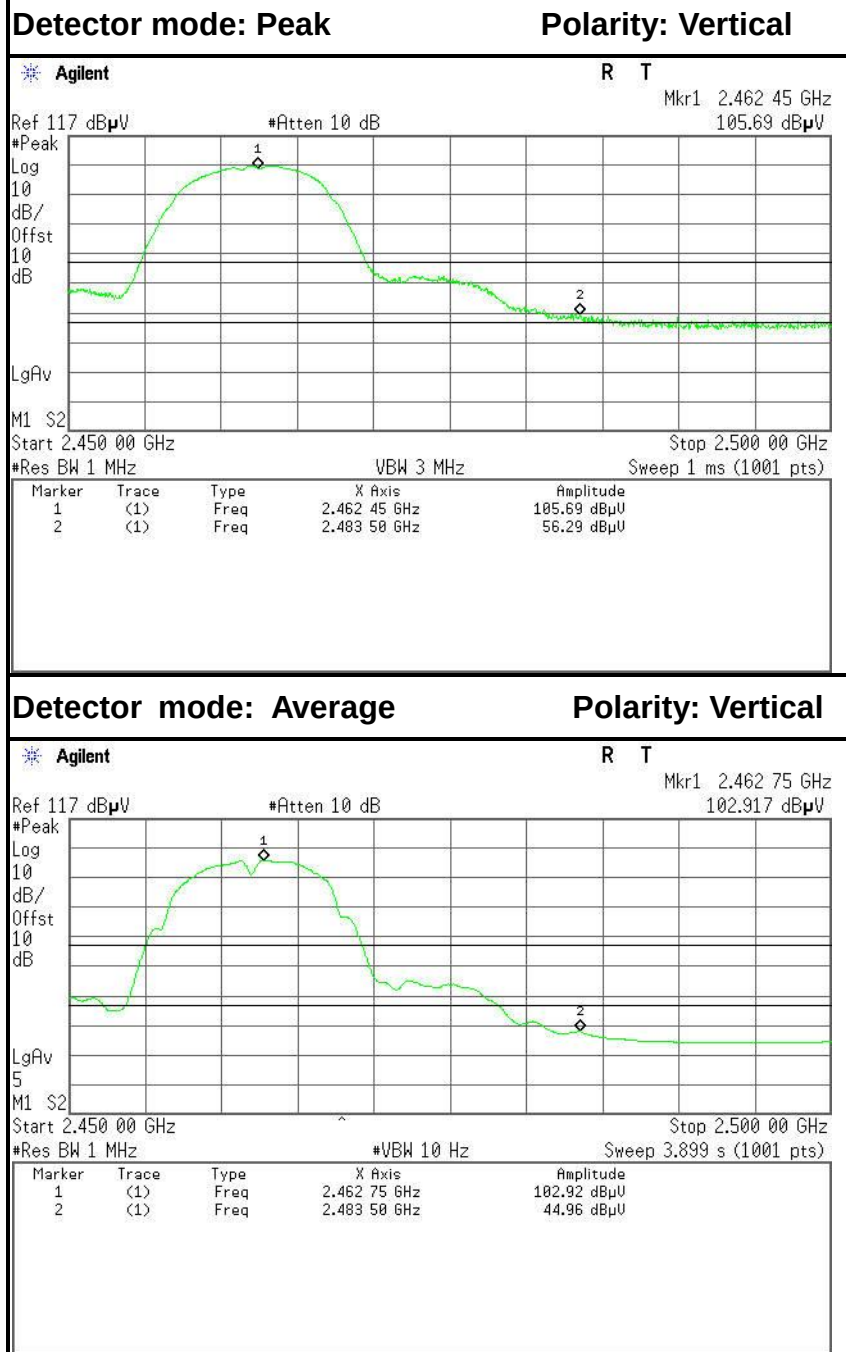
No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2390.0000	46.60	-6.60	53.20	74.00	-20.80	Peak	Vertical
2	2390.0000	35.54	-6.60	42.14	54.00	-11.86	Average	Vertical



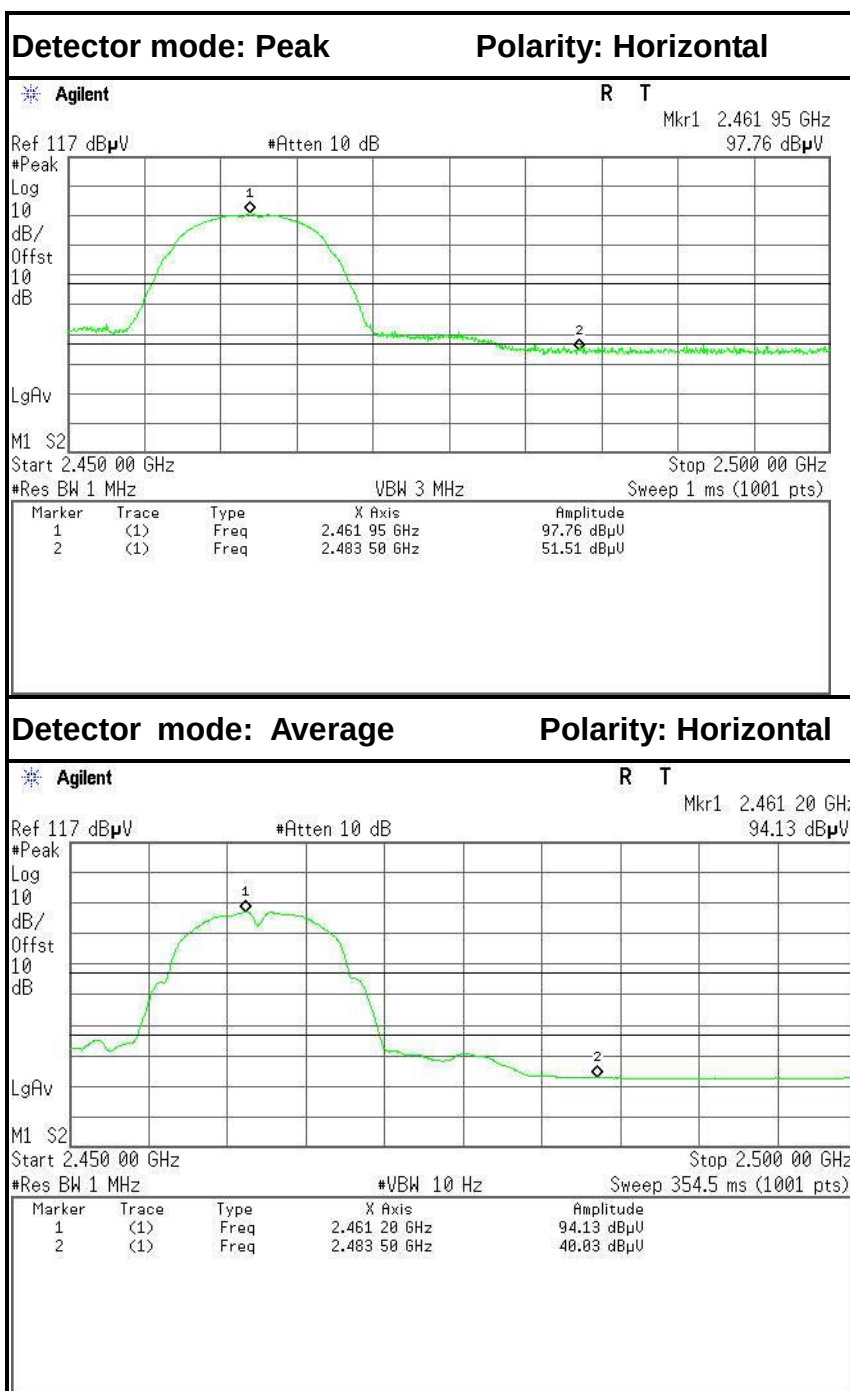
No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2390.0000	42.72	-6.60	49.32	74.00	-24.68	Peak	Horizontal
2	2390.0000	32.85	-6.60	39.45	54.00	-14.55	Average	Horizontal



Band Edges (CH High)



No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2483.5000	50.05	-6.24	56.29	74.00	-17.71	Peak	Vertical
2	2483.5000	38.72	-6.24	44.96	54.00	-9.04	Average	Vertical



No.	Frequency (MHz)	Reading (dBuV)	Corrected (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector	Antenna Pole
1	2483.5000	45.27	-6.24	51.51	74.00	-22.49	Peak	Horizontal
2	2483.5000	33.79	-6.24	40.03	54.00	-13.97	Average	Horizontal