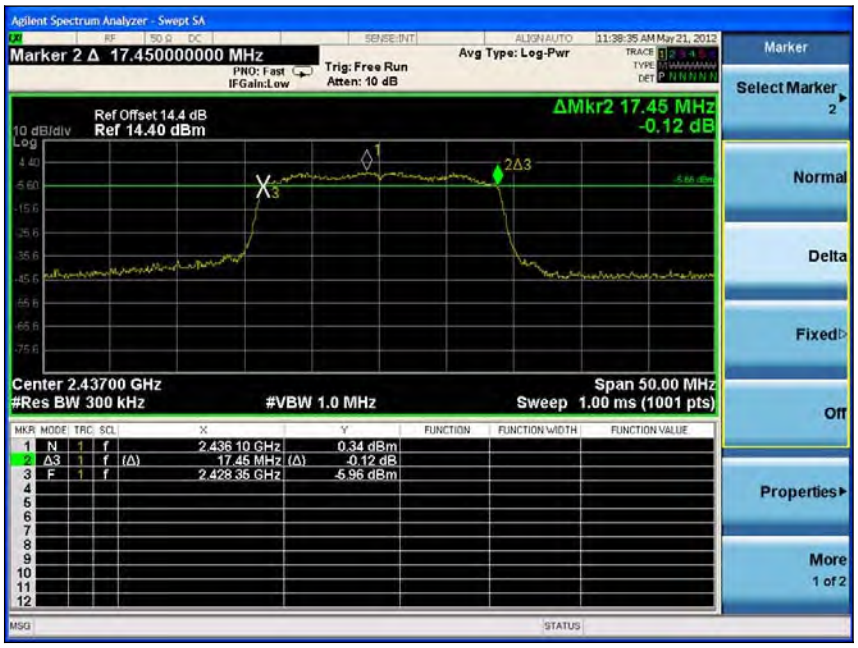
802.11n_HT20

Low channel

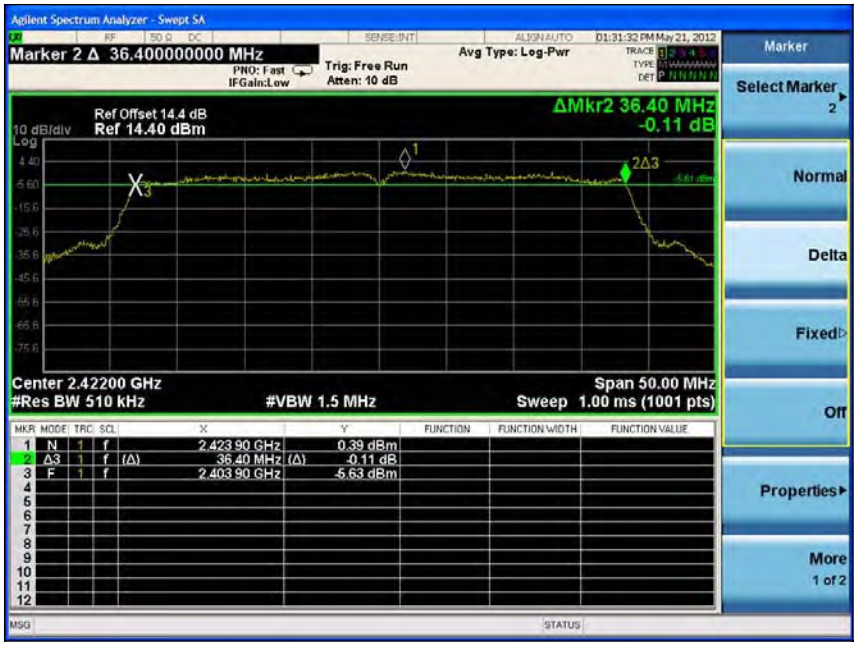
Middle channel



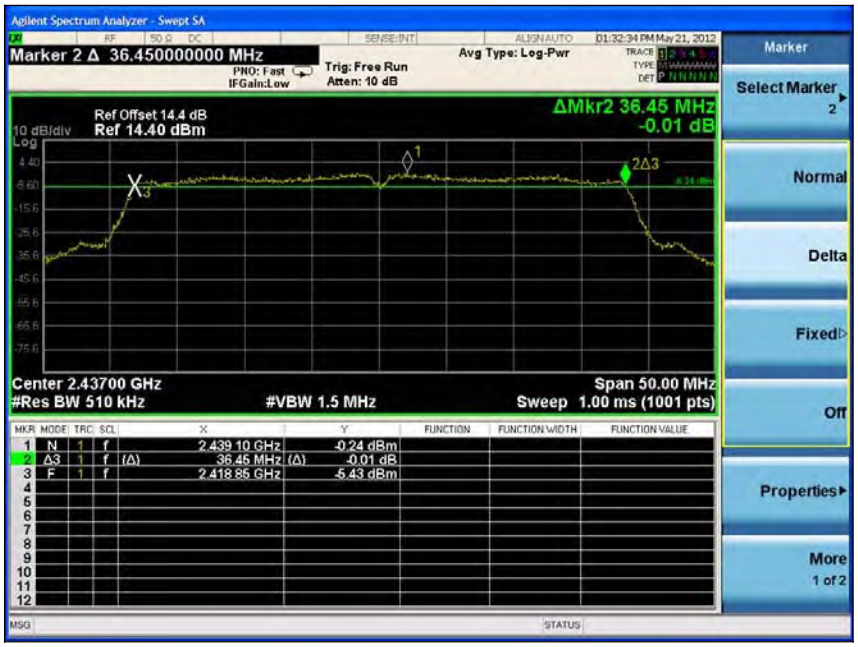
High channel

802.11n_HT40

Low channel



Middle channel



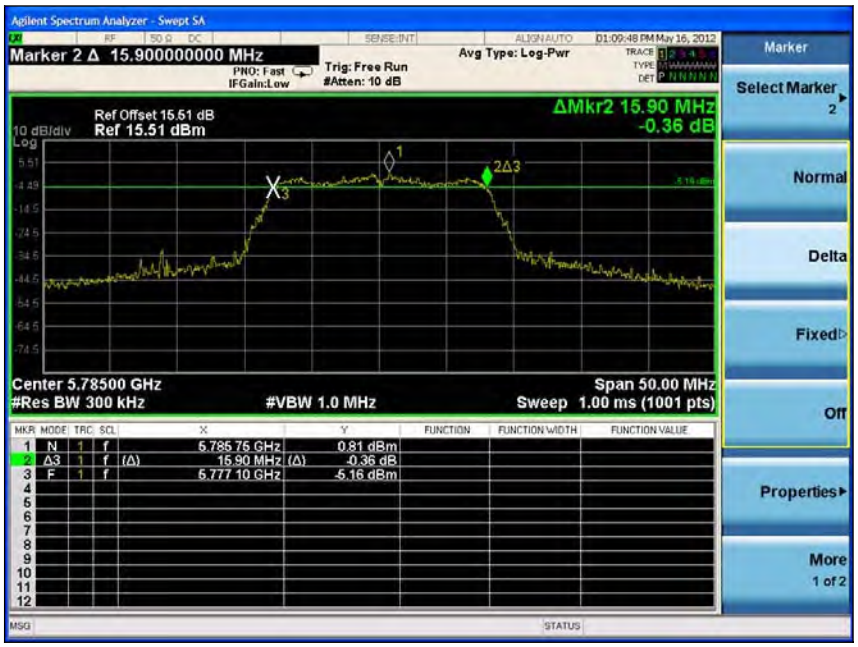
High channel

5.8GHz

802.11a

Low channel

Middle channel

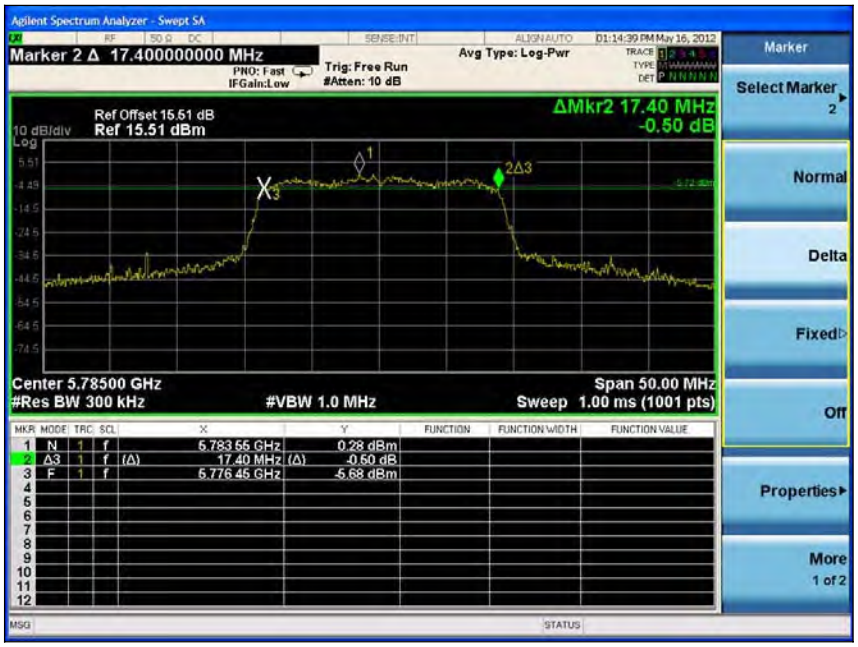


High channel

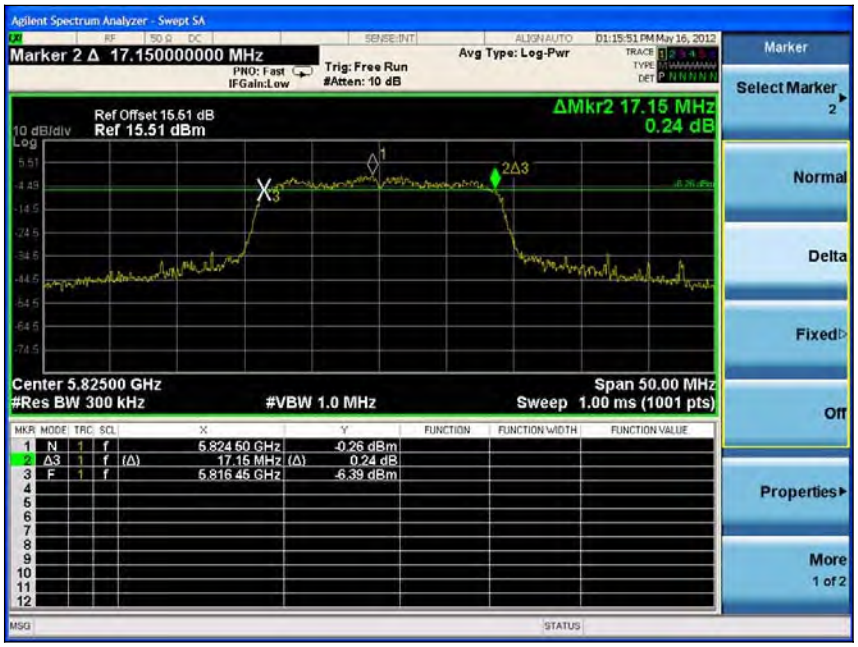
802.11n_HT20

Low channel

Middle channel



High channel



802.11n_HT40

Low channel

High channel

ANT1

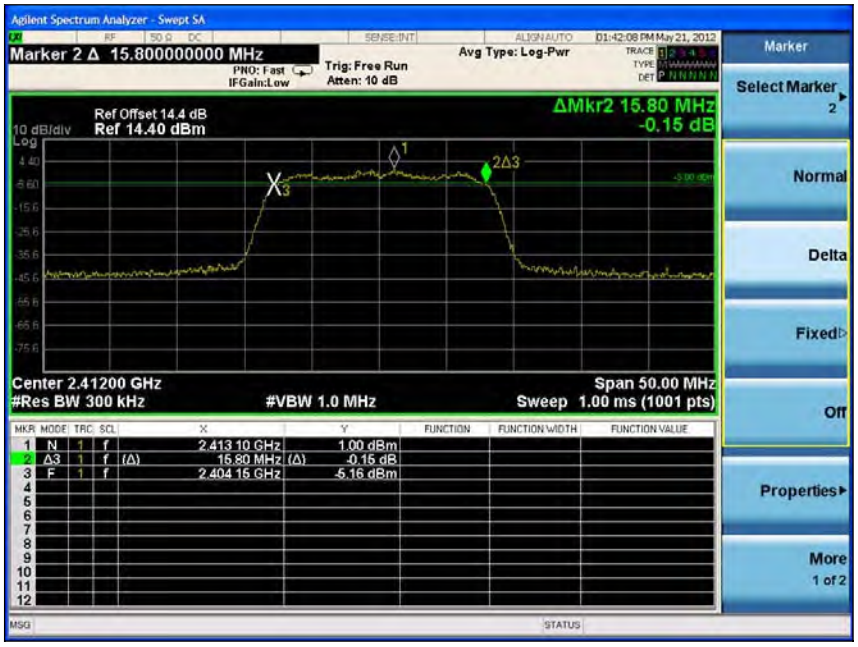
2.4 GHz

DSSS : 802.11b

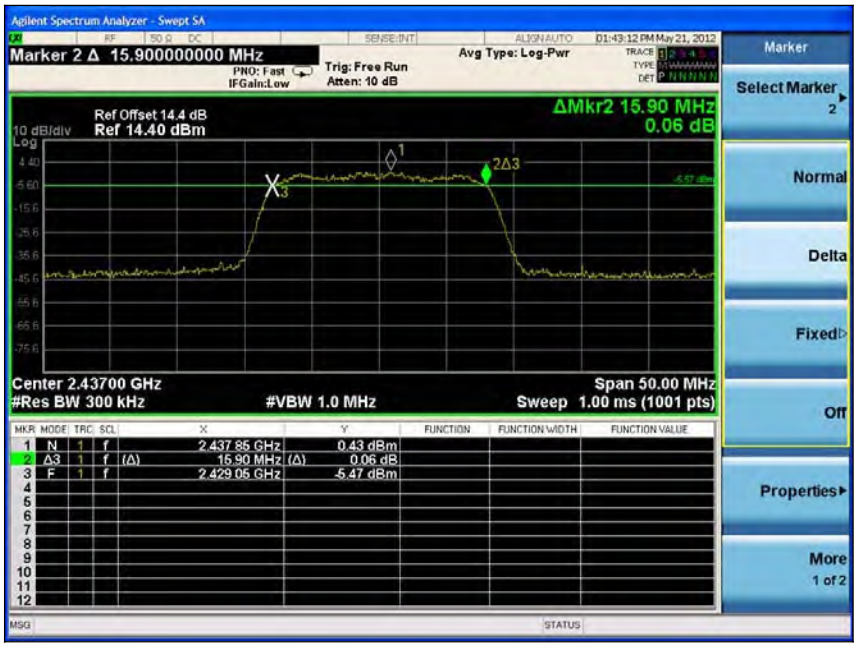
- The EUT does not use 11b of ANT1 port.

802.11g

Low channel



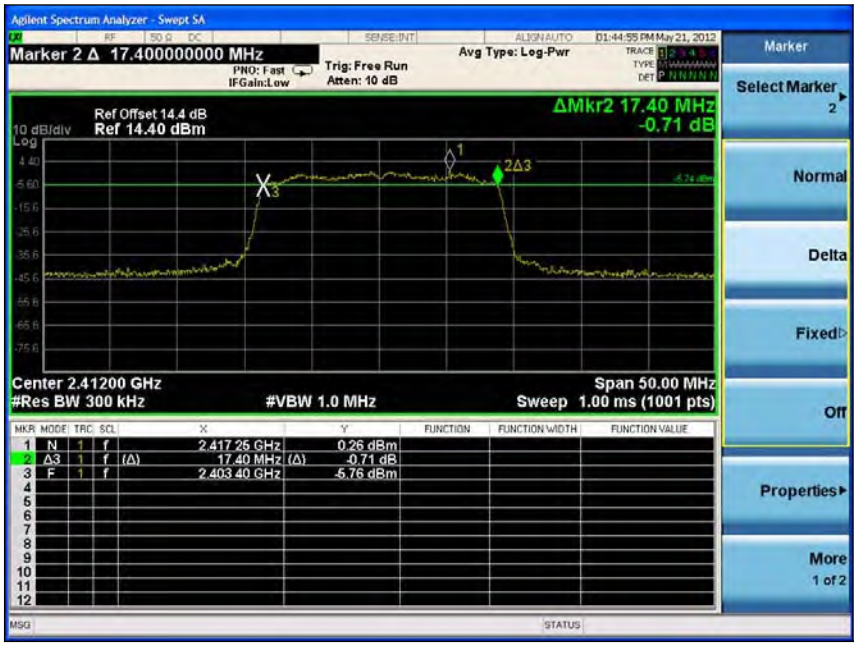
Middle channel



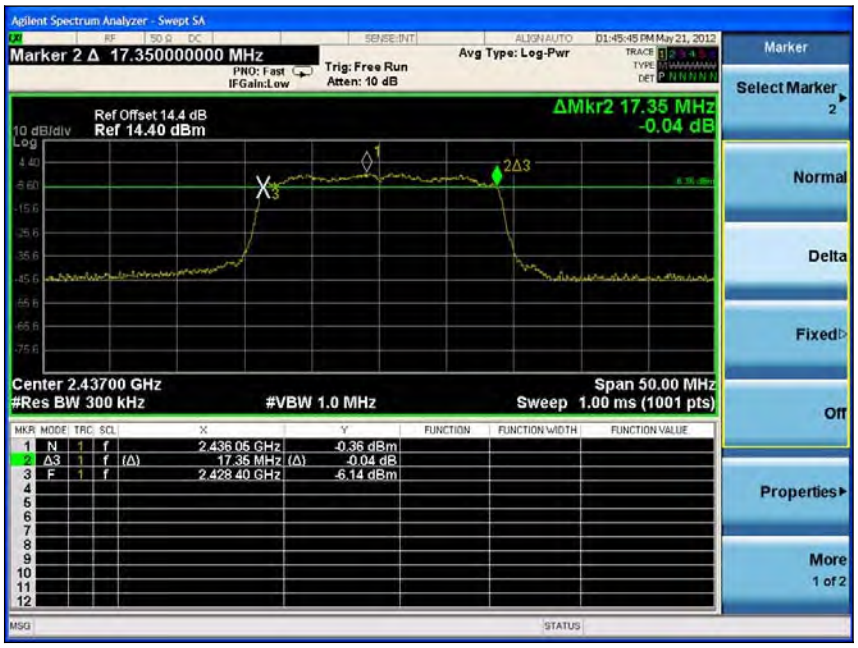
High channel

802.11n_HT20

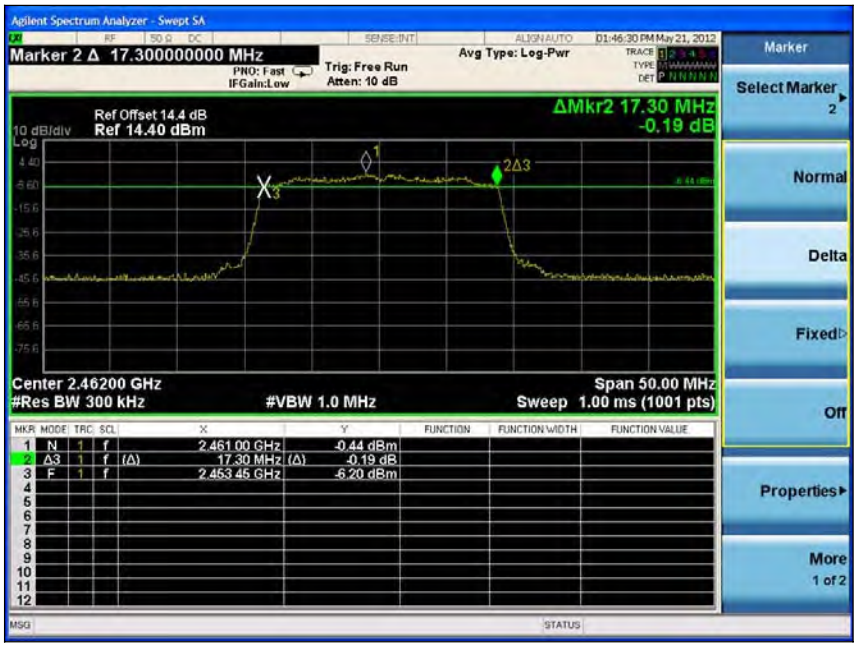
Low channel



Middle channel



High channel



802.11n_HT40

Low channel

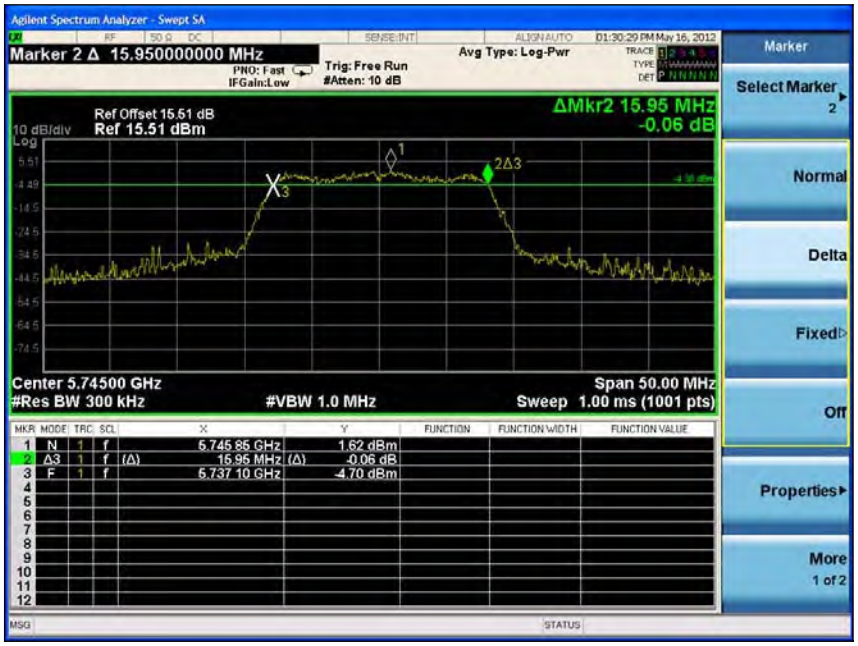
Middle channel

High channel

5.8GHz

802.11a

Low channel



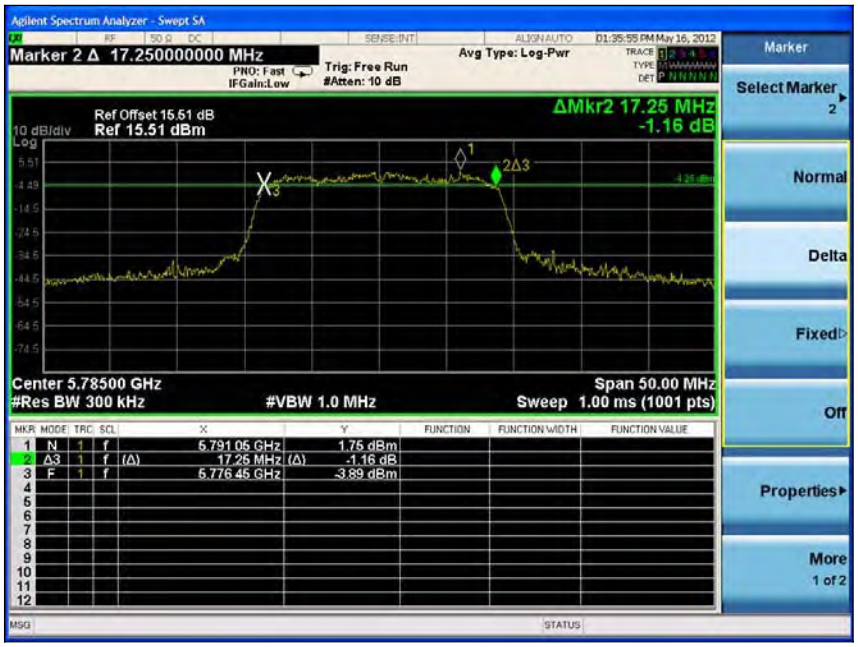
Middle channel

High channel

802.11n_HT20

Low channel

Middle channel

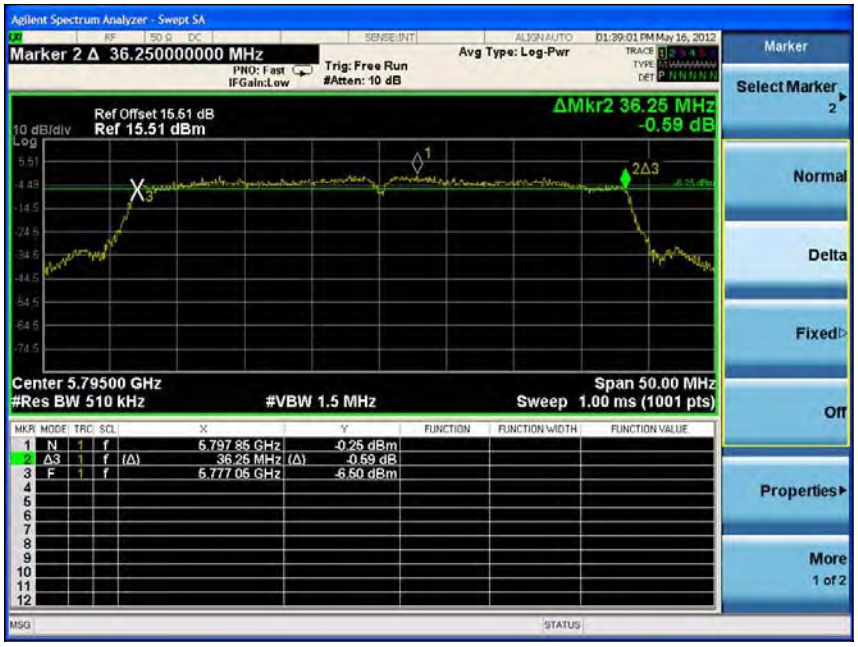


High channel

802.11n_HT40

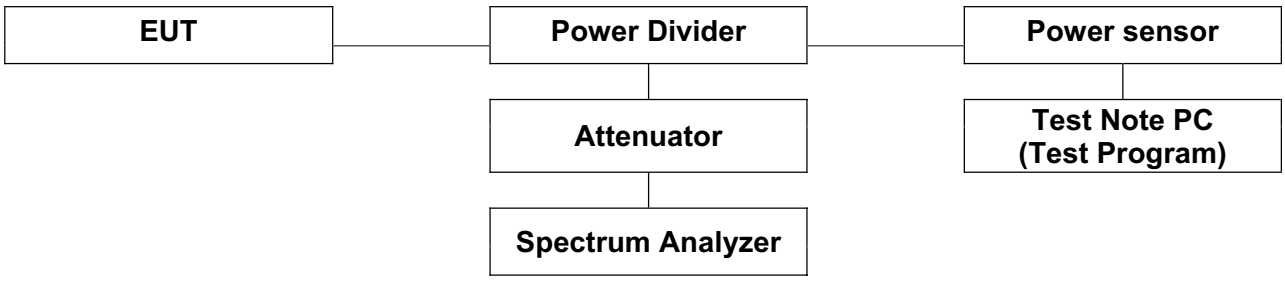
Low channel

High channel



4. Maximum peak output power measurement

4.1. Test setup



4.2. Limit

According to §15.247(b)(3), for systems using digital modulation in the 902 ~ 928 ㎒, 2 400 ~2 483.5 ㎒, and 5 725 ~ 5 850 ㎒ band: 1 Watt. As an alternative to a peak power measurement, compliance with the one watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antenna elements. The average must not include any intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4), the conducted output power limit specified in paragraph(b) of this section is based on the use of antenna with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph(c) of this section, if transmitting antenna of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section , as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6㏈i.

4.3. Test procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

4.3.1. 11b, g, n_HT20

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.
3. Test program : (S/W name : R&S Power Viewer, Version : 3.2.0)
4. Measure peak & average power each channel.

4.3.2. 11n_HT40

Peak measurements are recorded using the PK2 measurement procedure in section 5.2 of KDB 558074.
1. This procedure provides an integrated measurement alternative when the maximum available RBW < EBW.
2. Set the RBW = 1 ㎒
3. Set the VBW = 3 ㎒
4. Set the span to a value that is 5 – 30 % greater than the EBW.
5. Detector = Peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the spectrum analyzer's integrated band power measurement function with band limits set equal to the EBW band edges (for some analyzers, this may require a manual override to ensure use of peak detector). If the spectrum analyzer does not have a band power function, sum the spectrum levels (in linear power units) at 1 ㎒ intervals extending across the EBW of the spectrum.

Average measurements are recorded using the AVG1 measurement procedure in section 5.2 of KDB 558074.
1. Set the analyzer span to 5 - 30 % greater than the EBW.
2. Set the RBW = 1 ㎒.
3. Set the VBW ≥ 3 ㎒.
4. Detector = power average (RMS).
5. Ensure that the number of measurement points in the sweep ≥ 2 × (span/RBW).
6. Manually set the sweep time to : ≥ 10 × (number of measurement points in sweep) × (transmission symbol period).
7. Perform the measurement over a single sweep.
8. Use the spectrum analyzer's integrated band power measurement function with band limits set equal to the EBW band edges to determine the maximum conducted output power of the EUT over the EBW.

4.4. Test result

Ambient temperature : (24 ± 2) ℃
Relative humidity : 49 % R.H.

4.4.1. 11a/b/g/n-HT20

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Data Rate (Mbps)	Attenuator + Cable offset (㏈)	Peak Power Result (㏈m)	Average power Result (㏈m)	Peak Power Limit (㏈m)
DSSS 802.11b	ANT0	Low	2 412	1	8.85	12.63	8.49	30
		Middle	2 437	1	8.88	12.29	8.18	
		High	2 462	1	8.93	12.19	8.10	
	ANT1	Low	2 412	1	Not Support			
		Middle	2 437	1				
		High	2 462	1				
OFDM 802.11g	ANT0	Low	2 412	6	8.85	22.38	9.01	
		Middle	2 437	6	8.88	21.62	8.71	
		High	2 462	6	8.93	21.74	8.69	
	ANT1	Low	2 412	6	8.85	21.88	8.65	
		Middle	2 437	6	8.88	21.36	8.42	
		High	2 462	6	8.93	21.08	8.06	
OFDM 802.11n_ HT20	ANT0	Low	2 412	MCS0	8.85	21.27	9.05	
		Middle	2 437	MCS0	8.88	20.87	8.75	
		High	2 462	MCS0	8.93	21.03	8.88	
	ANT1	Low	2 412	MCS0	8.85	20.67	8.75	
		Middle	2 437	MCS0	8.88	20.40	8.23	
		High	2 462	MCS0	8.93	20.29	8.21	
	ANT0+ANT1 (Calculated)	Low	2 412	MCS0	-	23.99	11.91	28.60
		Middle	2 437	MCS0	-	23.65	11.51	
		High	2 462	MCS0	-	23.69	11.57	

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Data Rate (Mbps)	Attenuator + Cable offset (㏈)	Peak Power Result (㏈m)	Average power Result (㏈m)	Peak Power Limit (㏈m)
OFDM 802.11a	ANT0	Low	5 745	6	9.32	19.53	9.18	30
		Middle	5 785	6	9.36	18.80	8.65	
		High	5 825	6	9.42	19.14	8.73	
	ANT1	Low	5 745	6	9.32	21.42	10.33	
		Middle	5 785	6	9.36	21.72	10.05	
		High	5 825	6	9.42	21.70	9.82	
OFDM 802.11n_ HT20	ANT0	Low	5 745	MCS0	9.32	19.50	9.06	
		Middle	5 785	MCS0	9.36	18.80	8.54	
		High	5 825	MCS0	9.42	19.14	8.82	
	ANT1	Low	5 745	MCS0	9.32	21.16	9.71	
		Middle	5 785	MCS0	9.36	20.83	10.00	
		High	5 825	MCS0	9.42	21.47	10.22	
	ANT0+ANT1 (Calculated)	Low	5 745	MCS0	-	23.42	12.41	27.80
		Middle	5 785	MCS0	-	22.94	12.34	
		High	5 825	MCS0	-	23.47	12.59	

4.4.2. 11n-HT40

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Data Rate (Mbps)	6dB Bandwidth (㎒)	Peak Power Result (dB m)	Average power Result (dB m)	Peak Power Limit (dB m)
OFDM 802.11n_ HT40	ANT0	Low	2 422	MCS0	36.40	16.47	8.23	30
		Middle	2 437	MCS0	36.45	16.27	8.14	
		High	2 452	MCS0	36.65	15.51	8.09	
	ANT1	Low	2 422	MCS0	36.55	16.15	7.72	
		Middle	2 437	MCS0	36.45	16.22	7.68	
		High	2 452	MCS0	36.75	16.03	7.57	
	ANT0+ANT1 (Calculated)	Low	2 422	MCS0	-	19.32	10.99	28.60
		Middle	2 437	MCS0	-	19.26	10.93	
		High	2 452	MCS0	-	18.79	10.85	
OFDM 802.11n_ HT40	ANT0	Low	5 755	MCS0	36.05	15.71	8.40	30
		High	5 795	MCS0	36.35	15.86	8.18	
	ANT1	Low	5 755	MCS0	35.60	16.56	9.72	
		High	5 795	MCS0	36.25	16.40	9.36	
	ANT0+ANT1 (Calculated)	Low	5 755	MCS0	-	19.17	12.12	27.80
		High	5 795	MCS0	-	19.15	11.82	

Remark

According to KDB662911, peak power of each port (ANT0 and ANT1) was combined by using below calculation.

ANT0+ANT1 (Calculated)
Power: 10log{10^(ANT0_Average Power/10)+10^(ANT1_Average Power/10)}

In case of 2 ㎓ 11n_HT20 and HT40, worst antenna gain: 4.40 ㏈i.
4.40 – 3 = 1.40 ㏈.
Peak power limit = 30 – 1.40 = 28.60 ㏈m

In case of 5 ㎓ 11n_HT20 and HT40, worst antenna gain: 5.20 ㏈i.
5.20 – 3 = 2.20 ㏈.
Peak power limit = 30 – 2.20 = 27.80 ㏈m

ANT0

Average Power

2 422 MHz

2 437 MHz

2 452 MHz

5 755 MHz

5 795 MHz

Peak Power

2 422 MHz

2 437 MHz

2 452 MHz

5 755 MHz

5 795 MHz

ANT1

Average Power

2 422 MHz

2 437 MHz

2 452 MHz

5 755 MHz

5 795 MHz

Peak Power

2 422 MHz

2 437 MHz

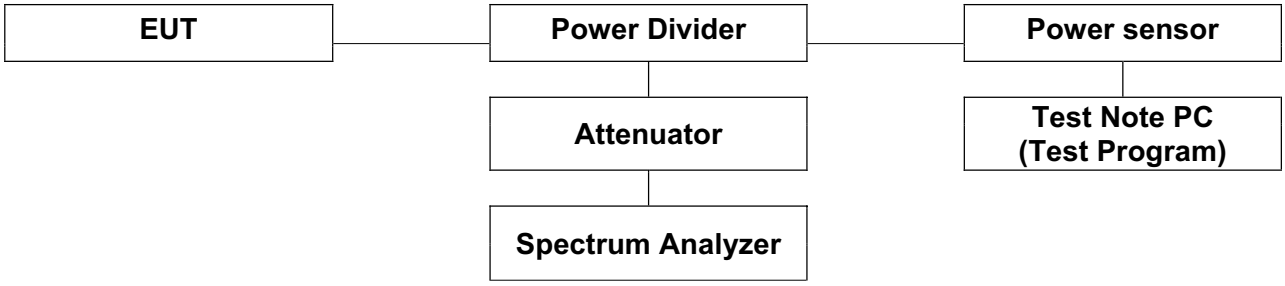
2 452 MHz

5 755 MHz

5 795 MHz

5. Power spectral density measurement

5.1. Test setup



5.2. Limit

§15.247(e) For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈ m in any 3 ㎑ band any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

The measurements are recorded using the PKPSD measurement procedure in section 5.3 of KDB 558074.
1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW = 100 ㎑
3. Set the VBW ≥ 300 ㎑
4. Set the span to 5 – 30 % greater than the EBW.
5. Detector = Peak
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum level in any 100 ㎑ band segment within the fundamental EBW.
10. Scale the observed power level to an equivalent level in 3 ㎑ by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where : BWCF =10log(3 ㎑/100 ㎑ = -15.2 ㏈).
11. The resulting PSD level must be ≤ 8 ㏈ m.

5.4. Test result

Ambient temperature : (24 ± 2) ℃
Relative humidity : 49 % R.H.

ANT0

-11b/g/a

Operation Mode	Data Rate (Mbps)	Channel	Frequency	Measured PSD (dB m)	Bandwidth Correction Factor (dB)	Corrected PSD (dB m)	Maximum Limit (dB m)
DSSS (802.11b)	1	Low	2 412 ㎒	-0.29	-15.20	-15.49	8
		Middle	2 437 ㎒	-0.62	-15.20	-15.82	8
		High	2 462 ㎒	-0.62	-15.20	-15.82	8
OFDM (802.11g)	6	Low	2 412 ㎒	-1.66	-15.20	-16.86	8
		Middle	2 437 ㎒	-1.36	-15.20	-16.56	8
		High	2 462 ㎒	-1.64	-15.20	-16.84	8
OFDM (802.11a)	6	Low	5 745 ㎒	-3.30	-15.20	-18.50	8
		Middle	5 785 ㎒	-4.61	-15.20	-19.81	8
		High	5 805 ㎒	-4.91	-15.20	-20.11	8

-11n_HT20, HT40

Operation Mode	Data Rate (Mbps)	Channel	Frequency	Measured PSD (dB m)	Add 10log(2) (dB m)	Bandwidth Correction Factor (dB)	Corrected PSD (dB m)	Maximum Limit (dB m)
OFDM (802.11n_ HT20)	MCS0	Low	2 412 ㎒	-2.18	0.83	-15.20	-14.37	8
		Middle	2 437 ㎒	-1.30	1.71	-15.20	-13.49	8
		High	2 462 ㎒	-1.57	1.44	-15.20	-13.76	8
OFDM (802.11n_ HT40)	MCS0	Low	2 422 ㎒	-4.53	-1.52	-15.20	-16.72	8
		Middle	2 437 ㎒	-4.78	-1.77	-15.20	-16.97	8
		High	2 452 ㎒	-5.26	-2.25	-15.20	-17.45	8
OFDM (802.11n_ HT20)	MCS0	Low	5 745 ㎒	-1.85	1.16	-15.20	-14.04	8
		Middle	5 785 ㎒	-3.90	-0.89	-15.20	-16.09	8
		High	5 805 ㎒	-3.56	-0.55	-15.20	-15.75	8
OFDM (802.11n_ HT40)	MCS0	Low	5 755 ㎒	-4.97	-1.96	-15.20	-17.16	8
		High	5 795 ㎒	-5.80	-2.79	-15.20	-17.99	8

ANT1

-11b/g/a

Operation Mode	Data Rate (Mbps)	Channel	Frequency	Measured PSD (dB m)	Bandwidth Correction Factor (dB)	Corrected PSD (dB m)	Maximum Limit (dB m)
DSSS (802.11b)	1	Low	2 412 ㎒	Not Support			8
		Middle	2 437 ㎒				8
		High	2 462 ㎒				8
OFDM (802.11g)	6	Low	2 412 ㎒	-1.91	-15.20	-17.11	8
		Middle	2 437 ㎒	-2.19	-15.20	-17.39	8
		High	2 462 ㎒	-2.10	-15.20	-17.30	8
OFDM (802.11a)	6	Low	5 745 ㎒	-3.18	-15.20	-18.38	8
		Middle	5 785 ㎒	-0.63	-15.20	-15.83	8
		High	5 805 ㎒	-3.68	-15.20	-18.88	8

-11n_HT20, HT40

Operation Mode	Data Rate (Mbps)	Channel	Frequency	Measured PSD (dB m)	Add 10log(2) (dB m)	Bandwidth Correction Factor (dB)	Corrected PSD (dB m)	Maximum Limit (dB m)
OFDM (802.11n_ HT20)	MCS0	Low	2 412 ㎒	-2.88	0.13	-15.20	-15.07	8
		Middle	2 437 ㎒	-2.68	0.33	-15.20	-14.87	8
		High	2 462 ㎒	-2.53	0.48	-15.20	-14.72	8
OFDM (802.11n_ HT40)	MCS0	Low	2 422 ㎒	-5.23	-2.22	-15.20	-17.42	8
		Middle	2 437 ㎒	-4.92	-1.91	-15.20	-17.11	8
		High	2 452 ㎒	-5.23	-2.22	-15.20	-17.42	8
OFDM (802.11n_ HT20)	MCS0	Low	5 745 ㎒	-0.64	2.37	-15.20	-12.83	8
		Middle	5 785 ㎒	-2.36	0.65	-15.20	-14.55	8
		High	5 805 ㎒	-3.53	-0.52	-15.20	-15.72	8
OFDM (802.11n_ HT40)	MCS0	Low	5 755 ㎒	-4.69	-1.68	-15.20	-16.88	8
		High	5 795 ㎒	-5.24	-2.23	-15.20	-17.43	8

Note;

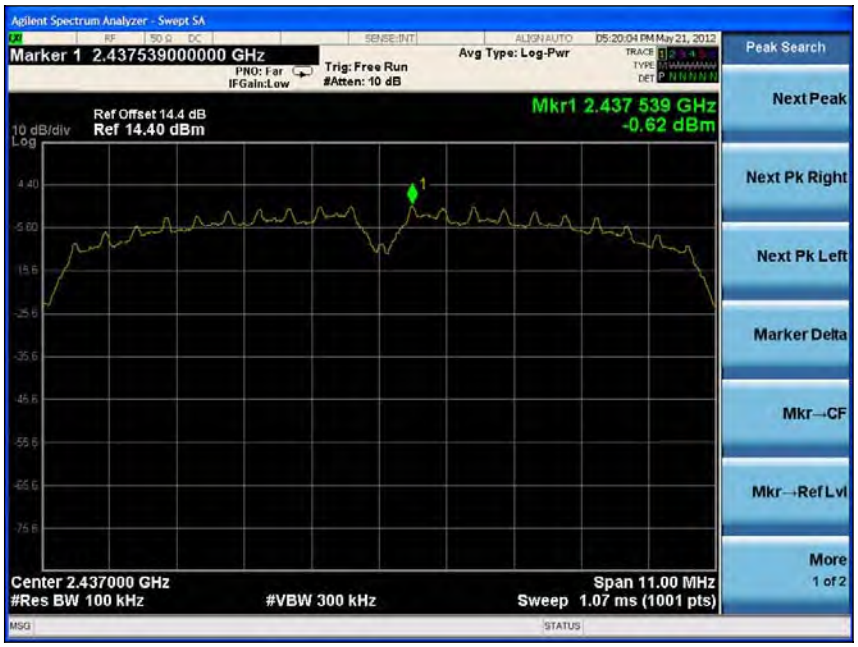
- Corrected Power Spectral Density (dB m) = Measured Power Spectral Density (dB m) + Bandwidth Correction Factor (dB) + 10log(2)
- In case of 11n, It has 2 outputs and 10log (2) is **10log(2) = 3.01 dB**

ANT0

2.4 GHz

802.11b
Low channel

Middle channel

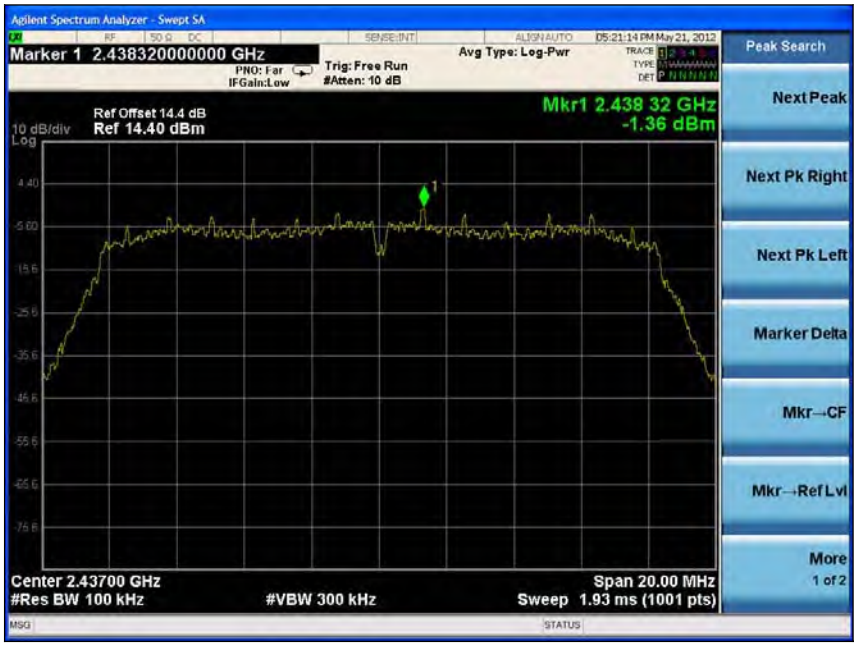


High channel

802.11g

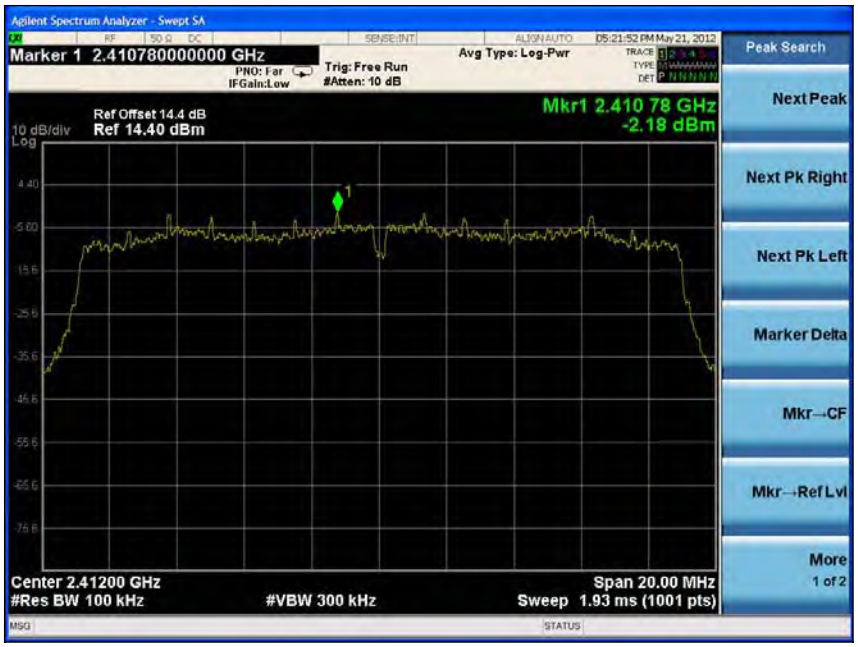
Low channel

Middle channel

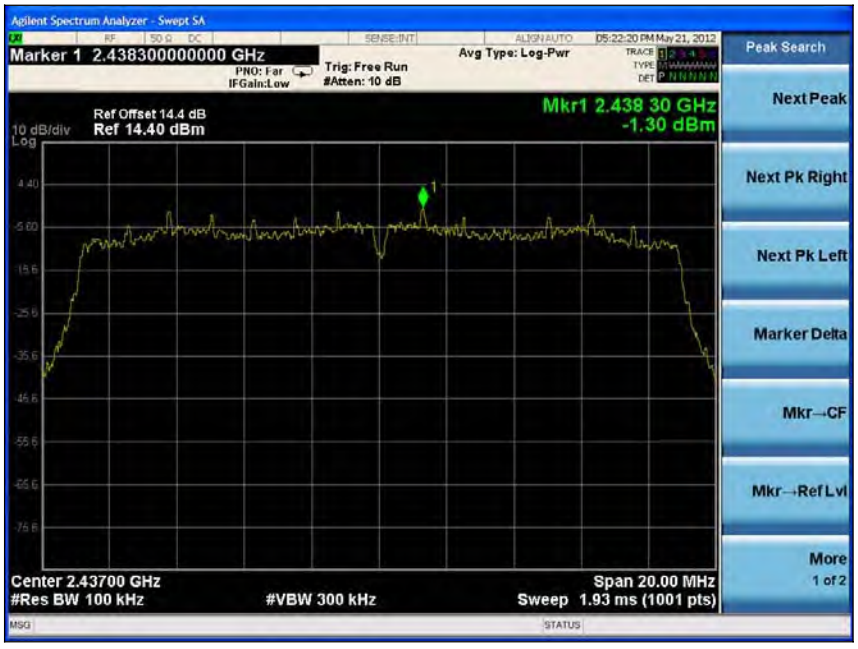


High channel

802.11n_HT20
Low channel



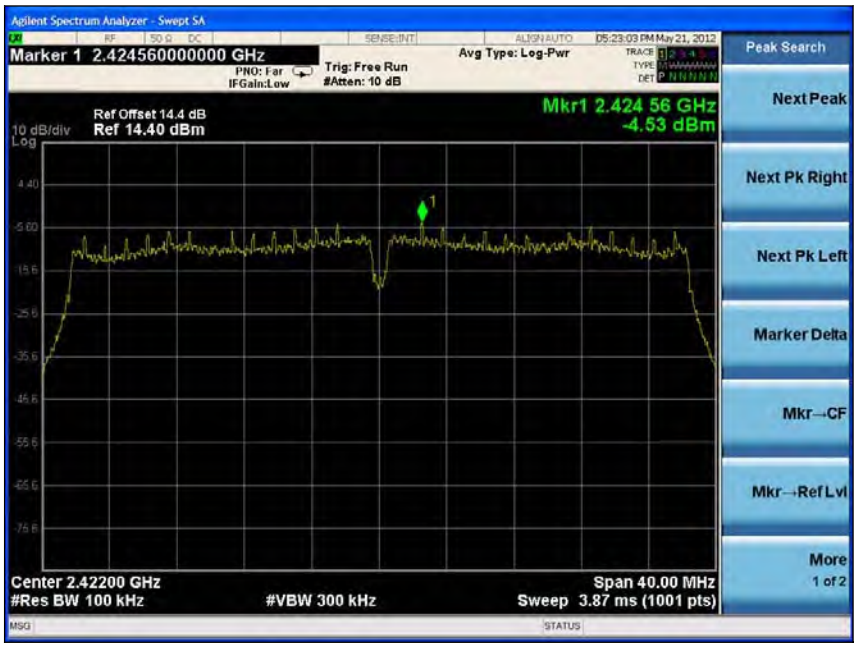
Middle channel



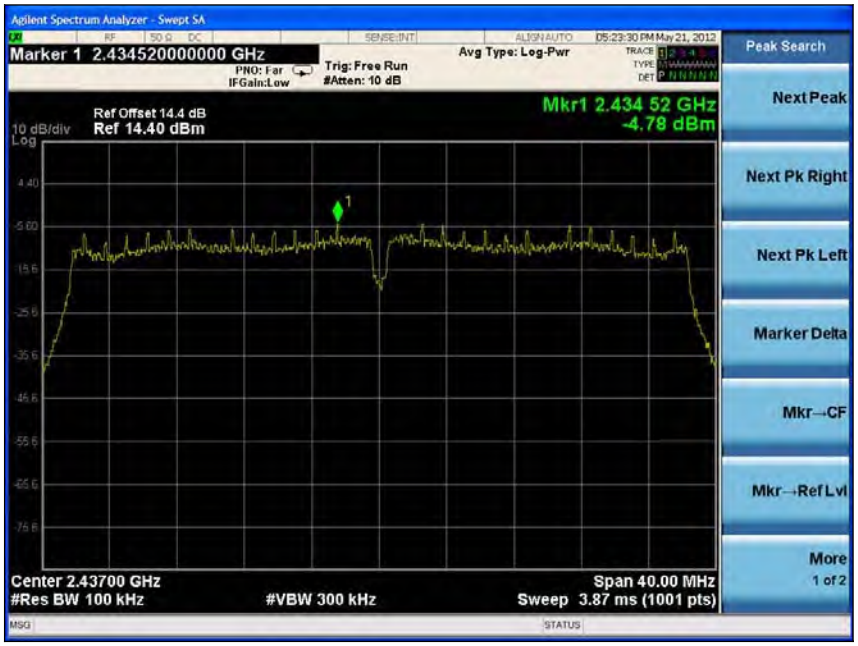
High channel

802.11n_HT40

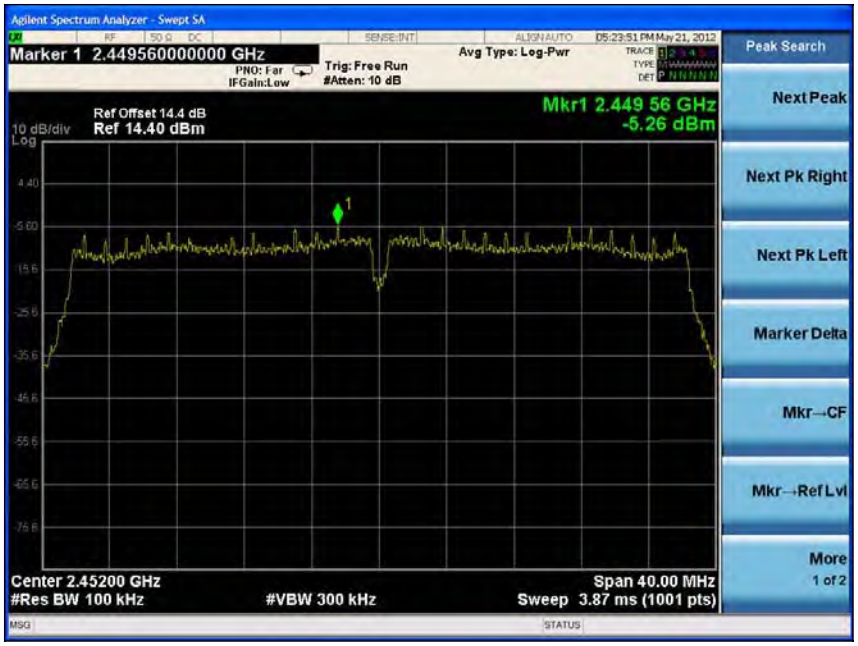
Low channel



Middle channel



High channel



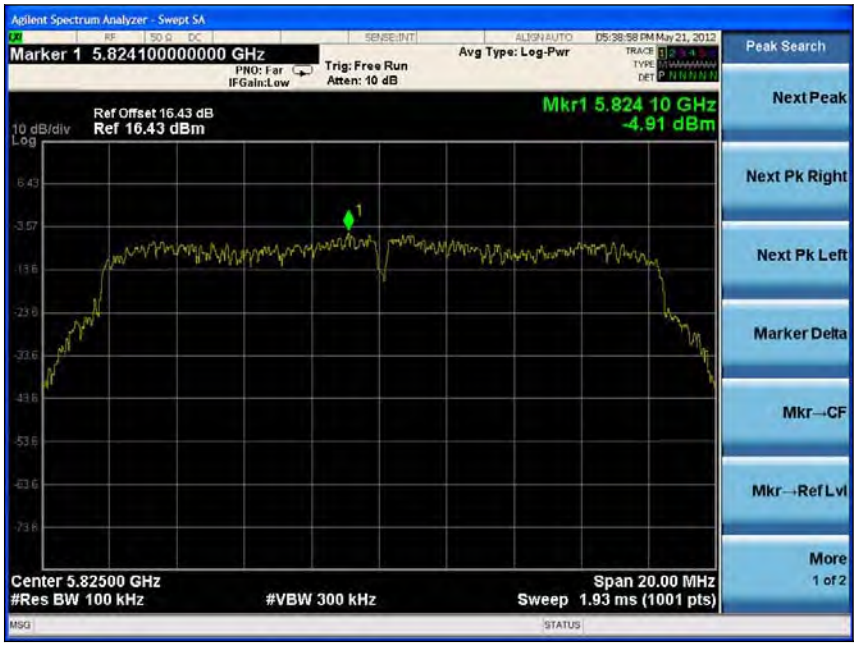
5.8GHz

802.11a

Low channel

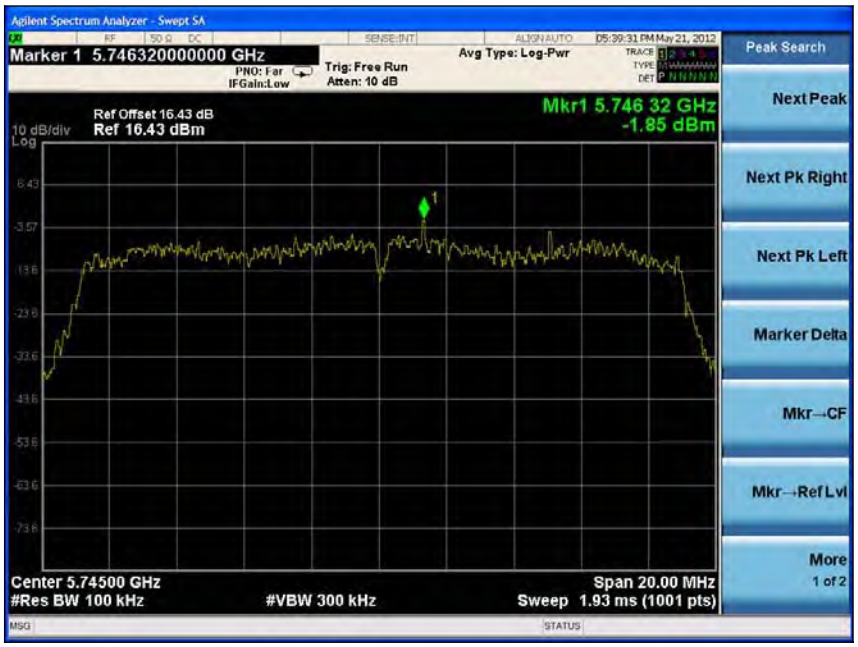
Middle channel

High channel



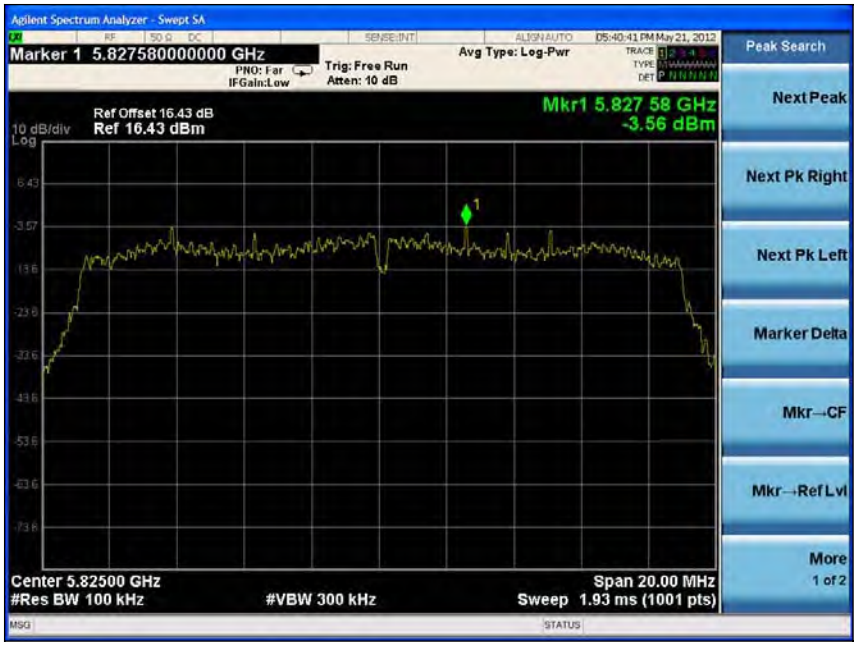
802.11n_HT20

Low channel



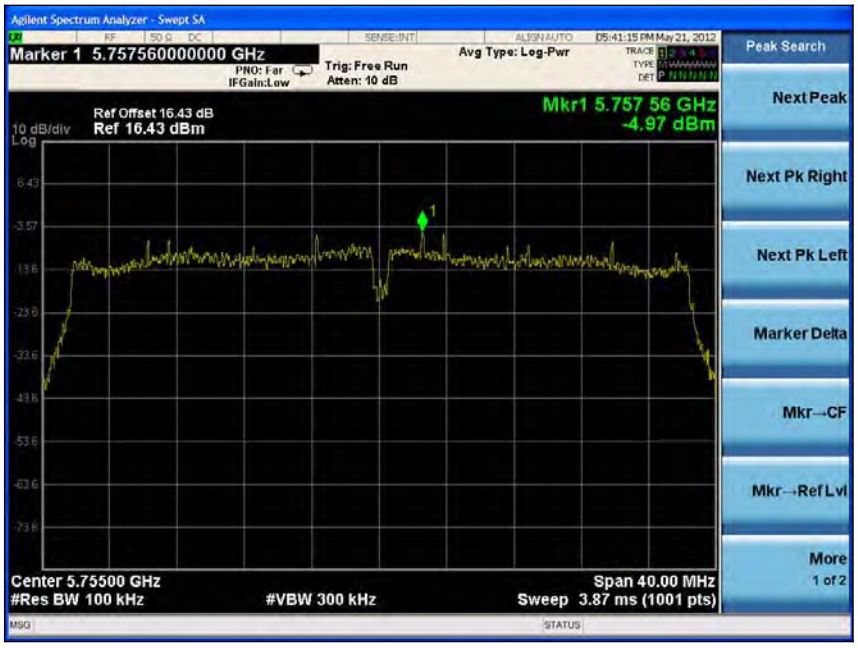
Middle channel

High channel

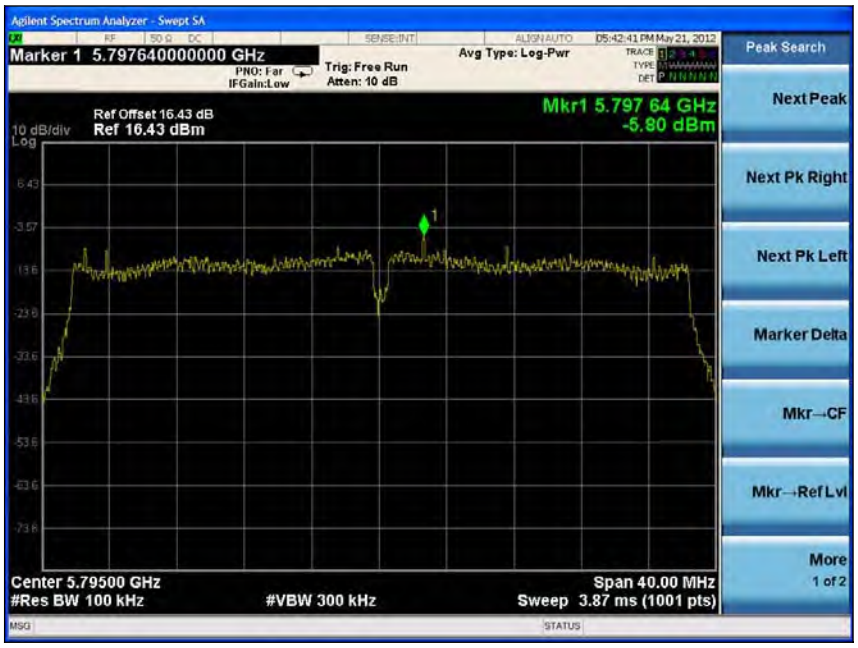


802.11n_HT40

Low channel



High channel



ANT1

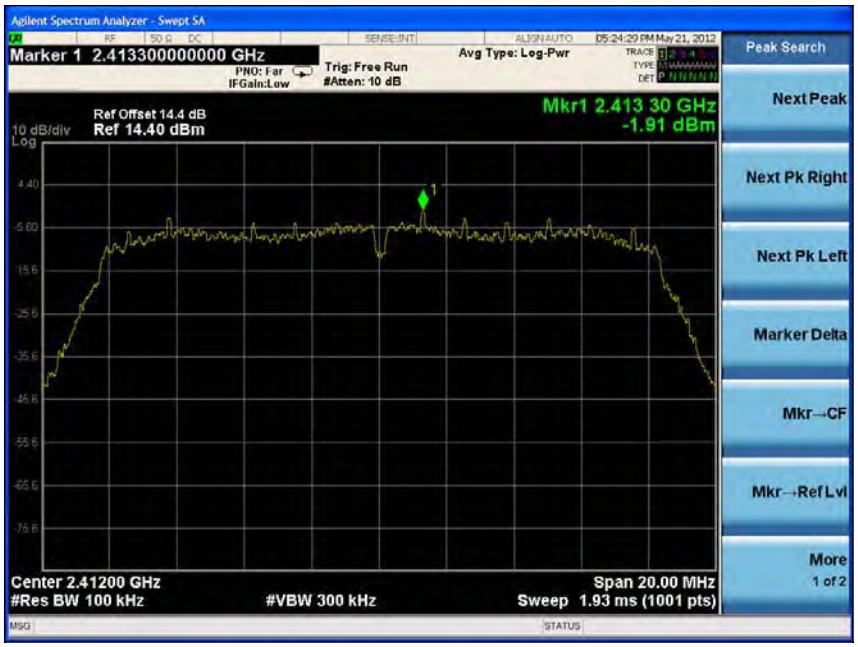
2.4 GHz

DSSS : 802.11b

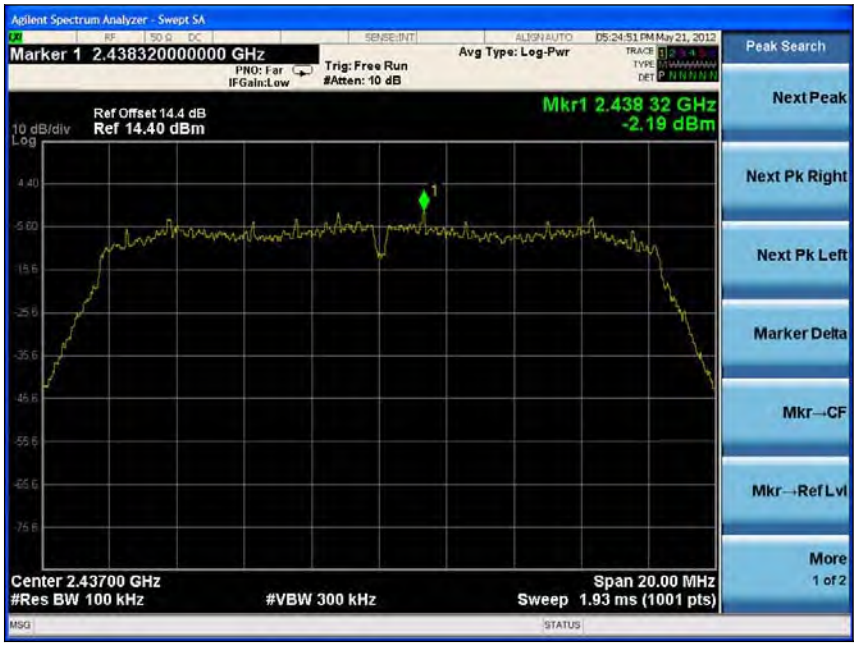
- The EUT does not use 11b of ANT1 port.

802.11g

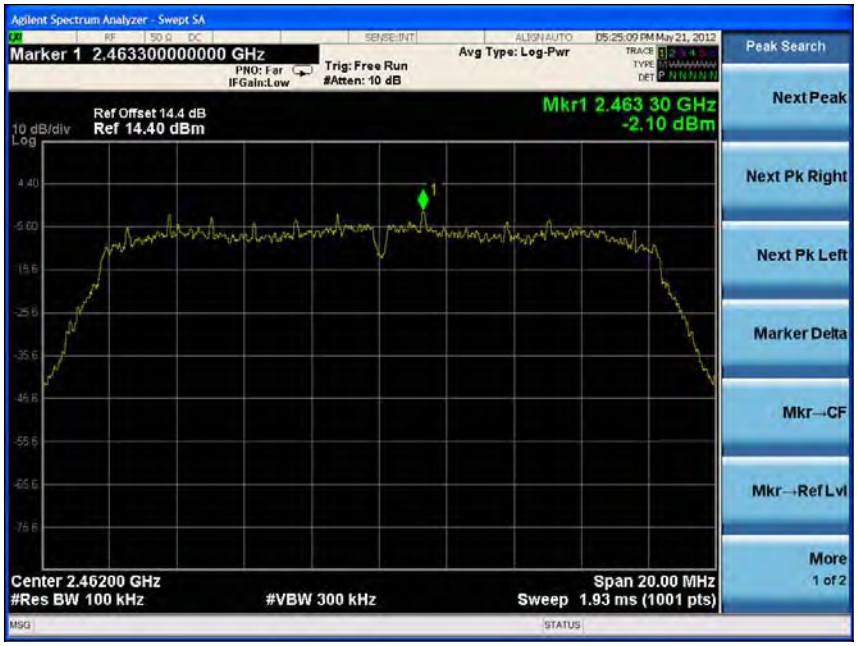
Low channel



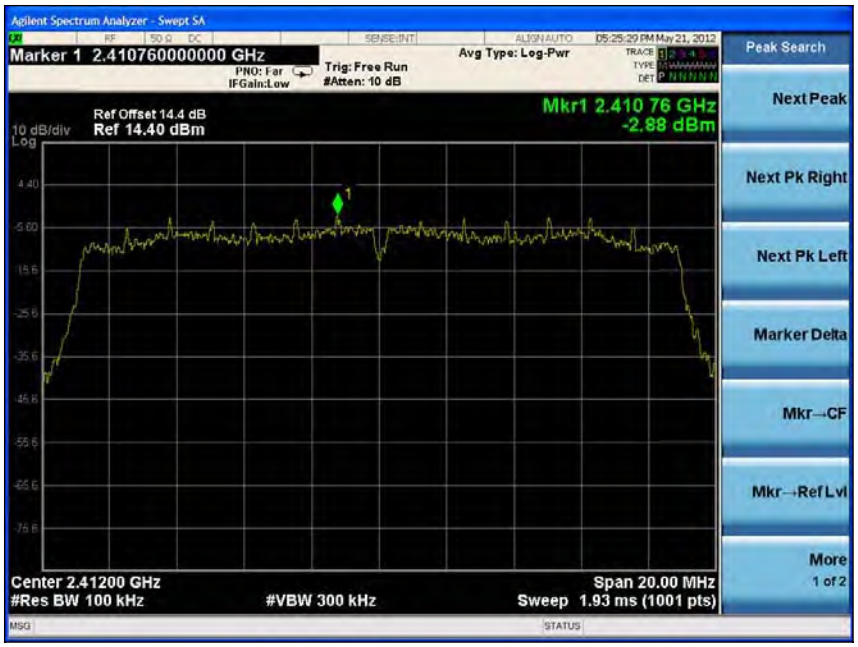
Middle channel



High channel

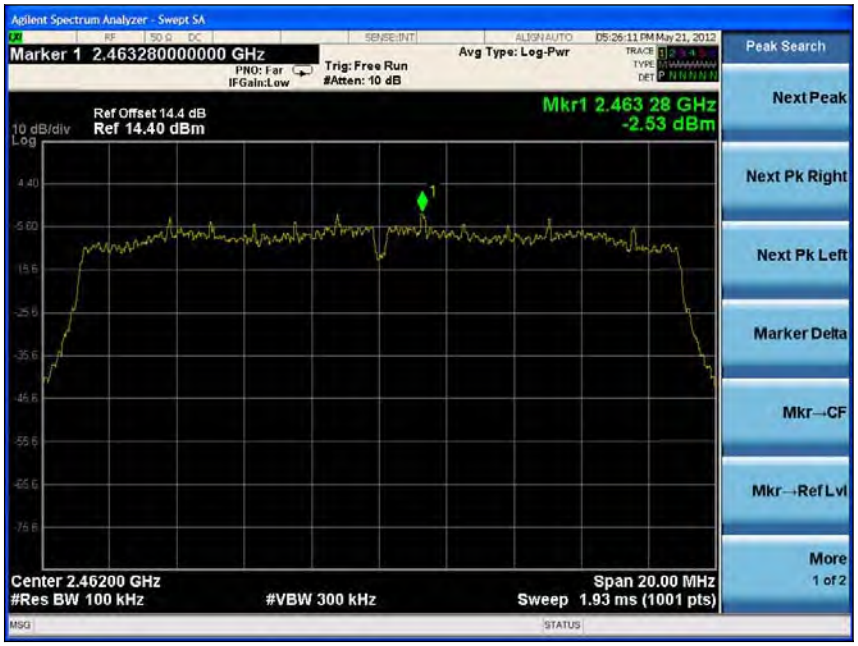


802.11n_HT20
Low channel



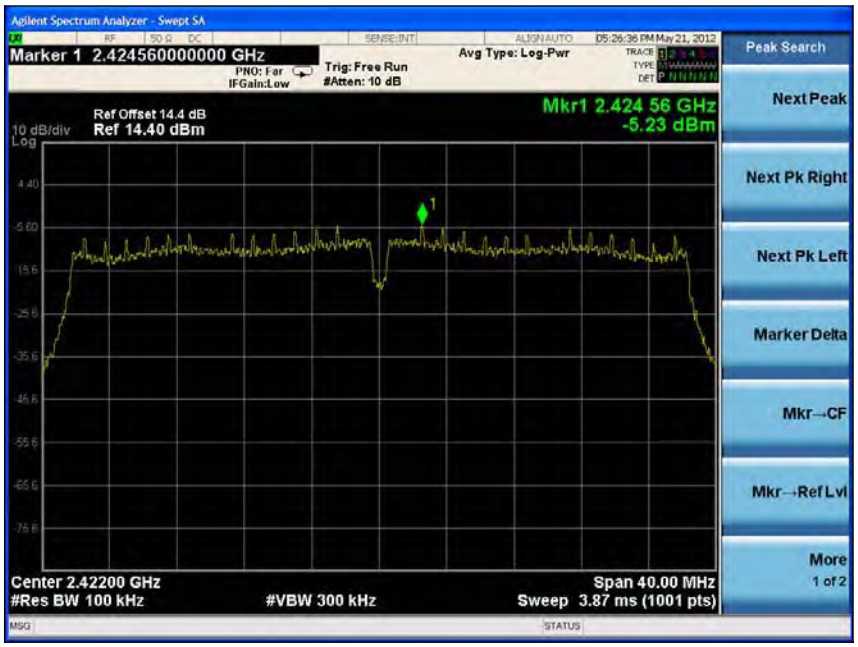
Middle channel

High channel



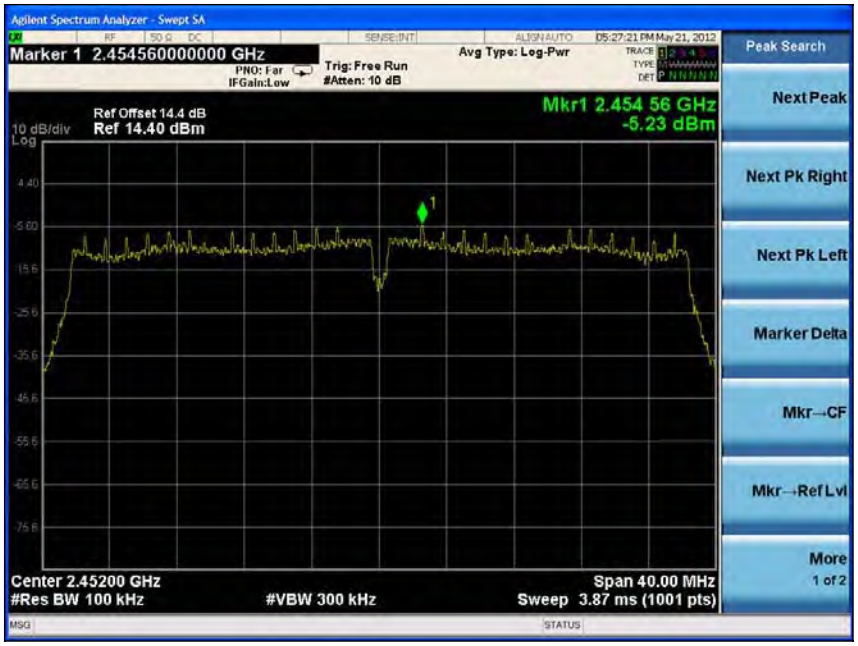
802.11n_HT40

Low channel



Middle channel

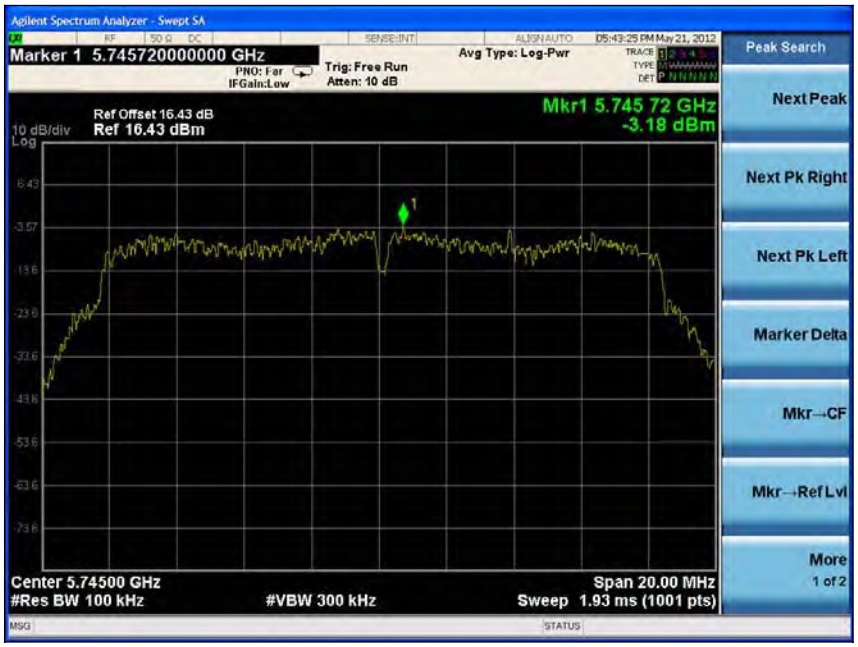
High channel



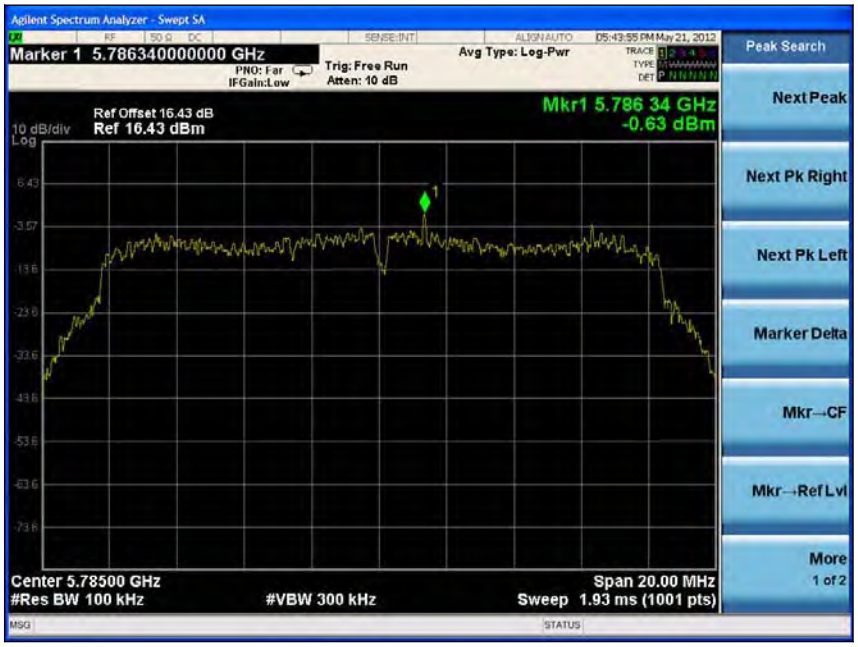
5.8GHz

802.11a

Low channel



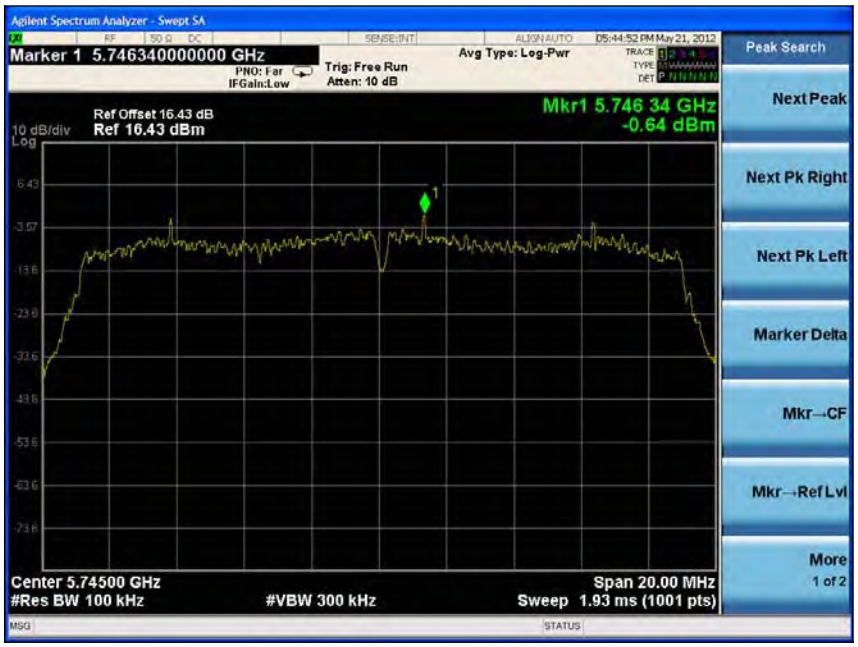
Middle channel



High channel

802.11n_HT20

Low channel

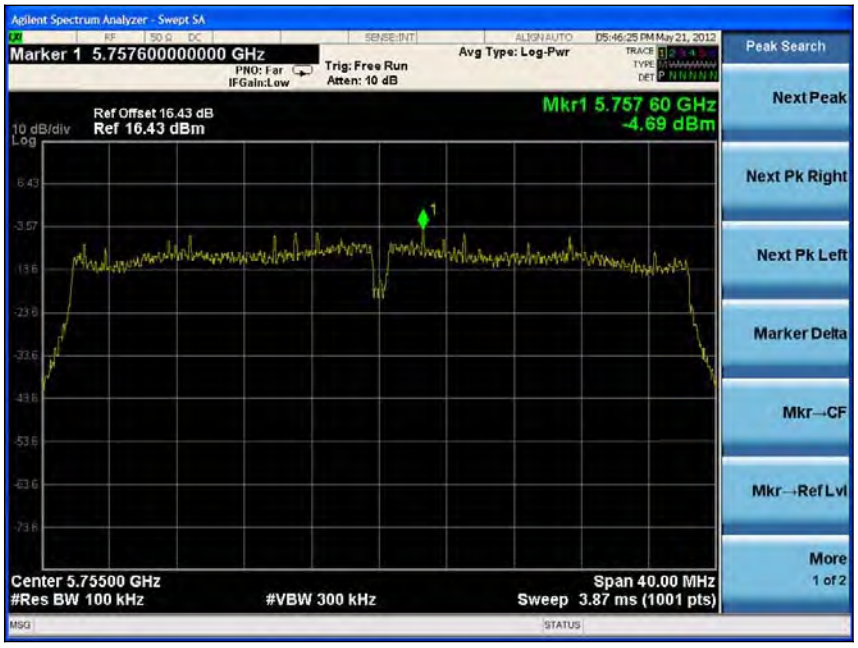


Middle channel

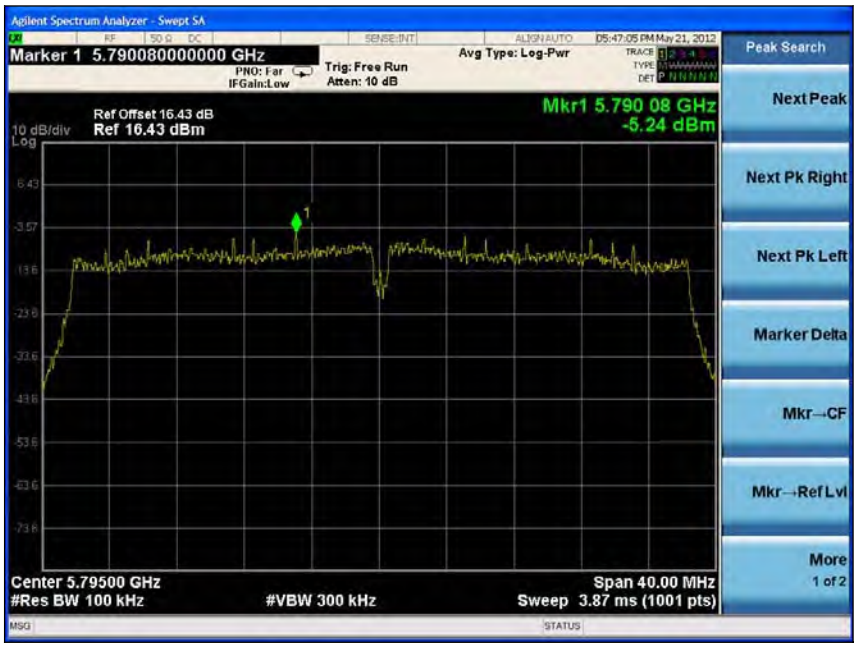
High channel

802.11n_HT40

Low channel

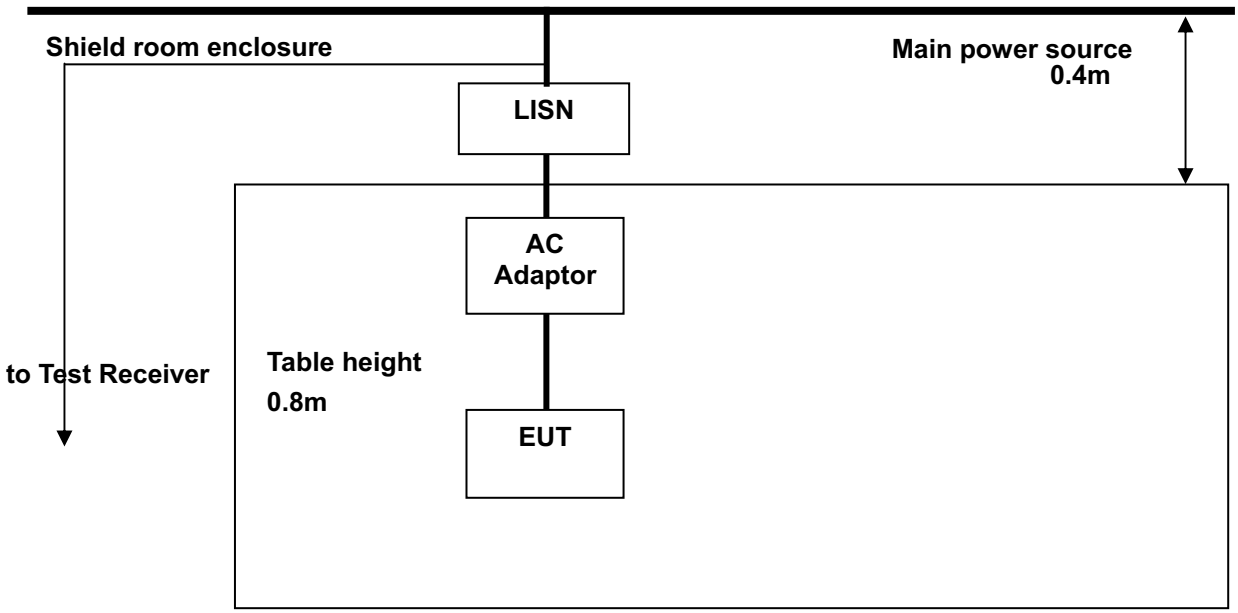


High channel



6. Transmitter AC Power Line Conducted Emission

6.1. Test Setup



6.2. Limit

According to §15.207(a) for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network(LISN).
Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

* Decreases with the logarithm of the frequency.

6.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

1. The test procedure is performed in a 6.5m × 3.6m× 3.6m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m(W)× 1.5 m(L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. The excess power cable between the EUT and the LISN was bundled. All connecting cables of EUT were moved to find the maximum emission.

6.4. Test Results (Worst case configuration_11n_HT20 mode – MCS0)

The following table shows the highest levels of conducted emissions on both phase of Hot and Neutral line.

Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

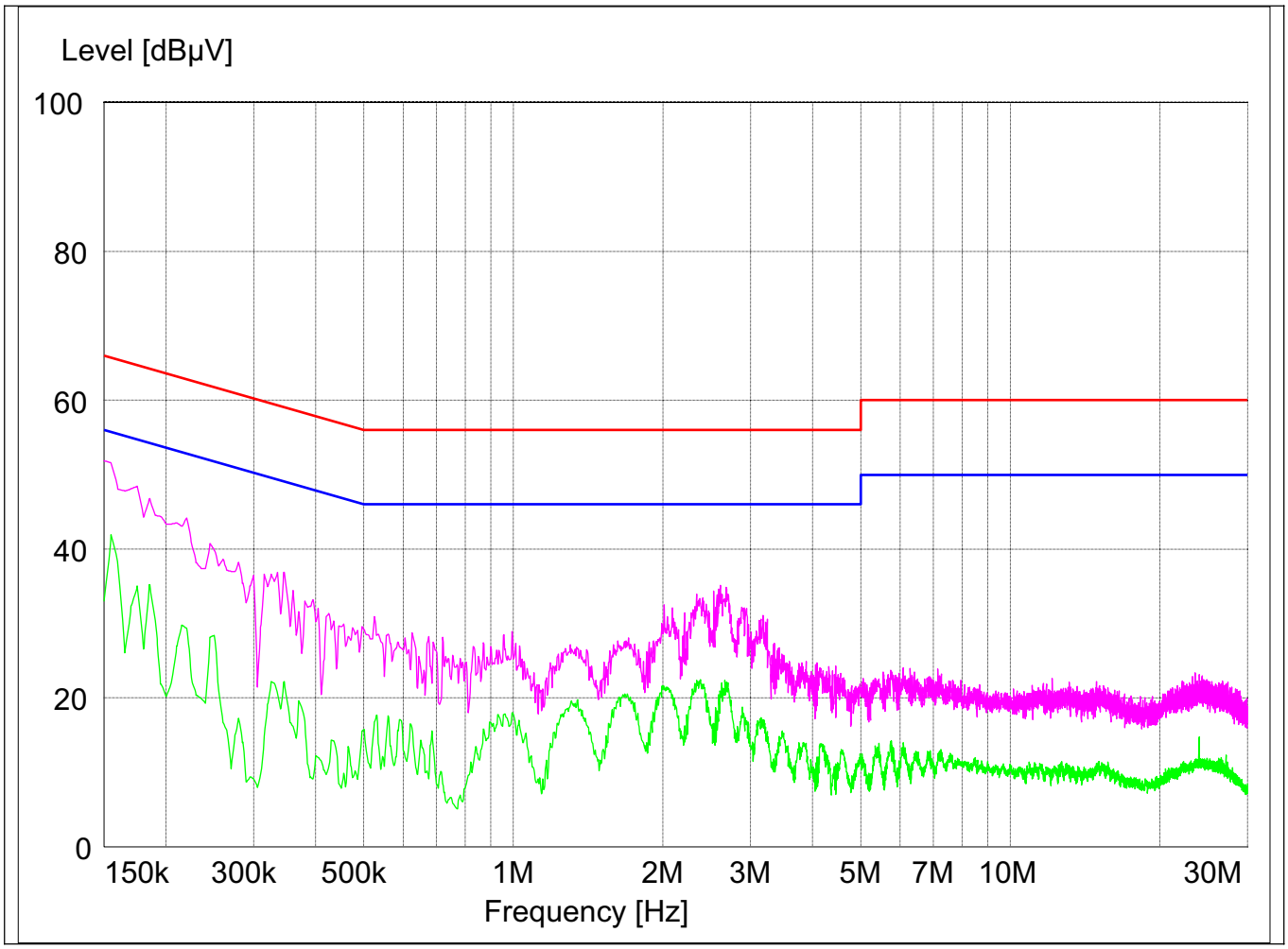
Frequency range : 0.15 ㎒ – 30 ㎒
Measured Bandwidth : 9 ㎑

FREQ.	LEVEL(dB㎶)		LINE	LIMIT(dB㎶)		MARGIN(dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.16	38.20	33.70	H	65.73	55.73	17.65	12.15
0.34	19.30	10.70	H	59.33	49.33	29.89	28.49
2.01	14.70	10.40	H	56.00	46.00	31.62	25.92
2.37	18.80	12.60	H	56.00	46.00	27.52	23.72
2.61	21.20	12.90	H	56.00	46.00	25.12	23.42
24.00	11.30	6.60	H	60.00	50.00	38.56	33.26
0.16	35.70	30.40	N	65.73	55.73	20.06	15.36
0.17	31.30	26.40	N	64.96	54.96	23.67	18.57
2.36	21.00	11.60	N	56.00	46.00	25.24	24.64
2.67	25.20	12.50	N	56.00	46.00	21.04	23.74
15.30	7.90	3.70	N	60.00	50.00	42.11	36.31
24.00	9.90	5.50	N	60.00	50.00	39.78	34.18

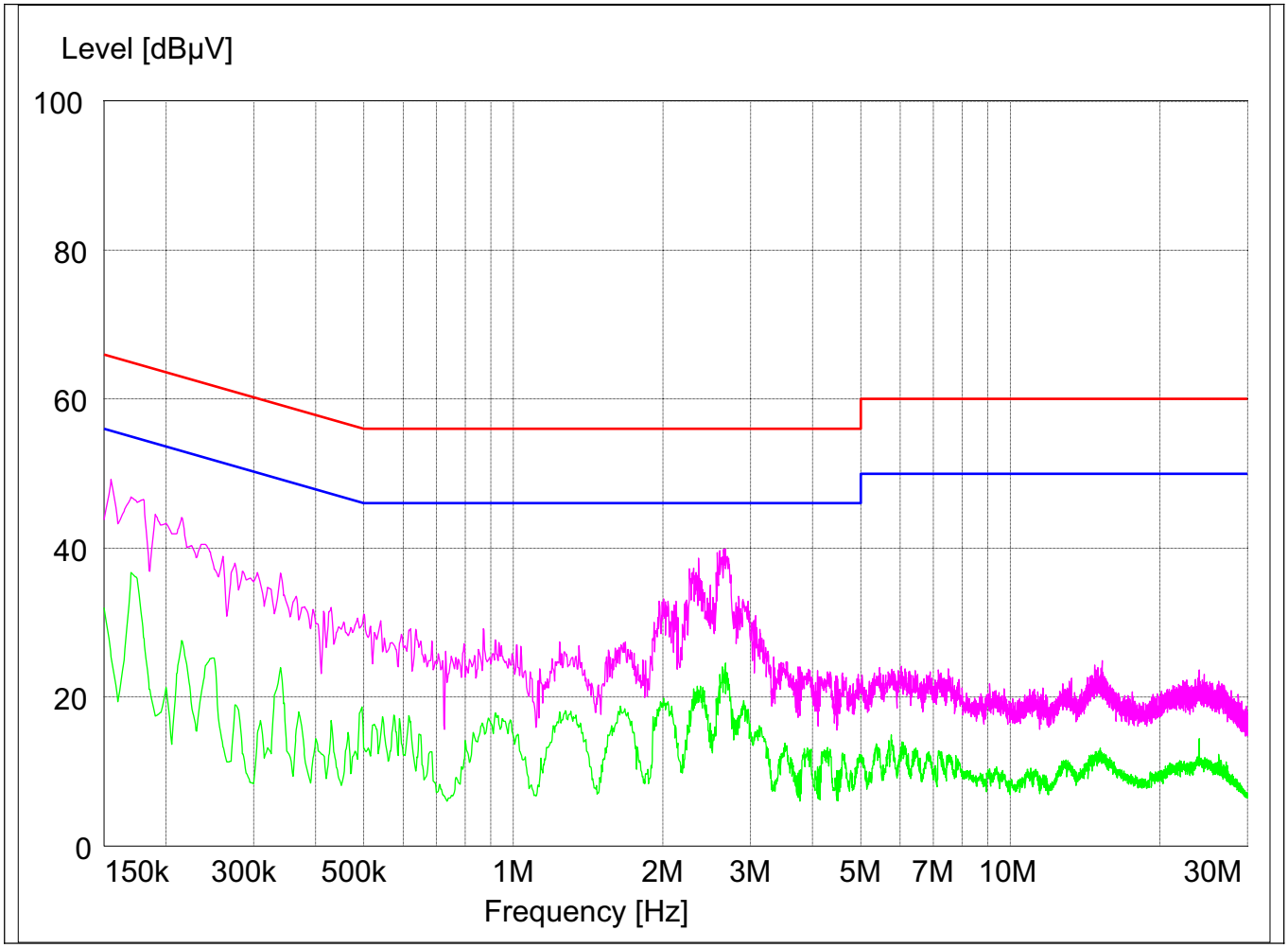
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)



7. Antenna Requirement

7.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section § 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

7.2. Antenna Connected Construction

The antenna used of this product is Internal antenna.

The peak max gain of each antennas ANT0 & ANT1 and calculated antenna gain of ANT0+ANT1 are as below :

Antenna	11b/g/n	11a/n	11a/n – Non DFS
ANT0	3.42	4.94	4.71
ANT1	4.40	5.20	4.13
ANT0+ANT1 (Calculated)	6.93	8.08	7.44

Formula

- ANT0+ANT1 (Calculated) = 10log [{10^(ANTB/20)+10^(ANTC/20)}^{2}/2]