TEST REPORT

of

FCC Part 15 Subpart B&C §15.247/ RSS-210 Issue 8, RSS-Gen Issue 3

FCC ID/IC Certification: RWA-SE208BW / 10000A-SE208BW

Equipment Under Test	:	Optical Smart Hub
Model Name	:	SE-208BW
Serial No.	:	N/A
Applicant	:	Toshiba Samsung Storage Technology Korea Corporation
Manufacturer	:	Toshiba Samsung Storage Technology Korea Corporation
Date of Test(s)	:	2011.11.12 ~ 2011.11.29
Date of Issue	:	2011.11.29

In the configuration tested, the EUT complied with the standards specified above.

Tested By: **Date** **2011.11.29**

Logan Lee

Approved By: **Date** **2011.11.29**

Feel Jeong

INDEX

Table of contents

1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd.
- 413-15, Gomae-Dong Giheung-Gu, Yongin-Si, Gyeonggi-Do, South Korea.
- Wireless Div. 2FL, 18-34, Sanbon-dong, Gunpo-si, Gyeonggi-do, Korea 435-040

www.kr.sgs.com/ee
Telephone : +82 +31 428 5700
FAX : +82 +31 427 2371

1.2. Details of Applicant

Applicant	:	Toshiba Samsung Storage Technology Korea Corpration
Address	:	14th Floor, Bldg. No. 102, Digital Empire2, 486, Sin-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea 443-734
Contact Person	:	Moon, Young-Min
Phone No.	:	+82 31 8006 6333

1.3. Description of EUT

Kind of Product	Optical Smart Hub
Model Name	SE-208BW
Serial Number	N / A
Power Supply	AC 110 V
Frequency Range	2 412 ~ 2 462 ㎒ (802.11b/g/n-HT20_SISO) 2 422 ~ 2 452 ㎒ (802.11n-HT40_SISO)
Modulation Technique	DSSS, OFDM
Number of Channels	11 channel (11b/g/n_HT20), 7 channel (11n_HT40)
Antenna Type	Integral Type
Antenna Gain	3.10 ㏈i

1.4. Declaration by the manufacturer

- N/A

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal Due.
Signal Generator	R & S	SMR40	100272	Jul. 15, 2012
Signal Generator	Agilent	8648D	3847M00534	Apr. 01, 2012
Spectrum Analyzer	R & S	FSV30	100955	Apr. 01, 2012
Low Pass Filter	Minicircuits	NLP-1200+	V9500401023-3	Aug. 22, 2012
High Pass Filter	Wainwright	WHKX3.0/18G-6SS	4	Sep. 14, 2012
High Pass Filter	Wainwright	WHNX7.5/26.5G-6SS	11	Sep. 15, 2012
DC power Supply	Agilent	U8002A	MY48490027	Jan. 05, 2012
Preamplifier	H.P.	8447D	1726A01265	Sep. 27, 2012
Preamplifier	R & S	SCU-18	10070	Aug. 09, 2012
Preamplifier	SCHWARZBECK MESSELEKTRONIK	JS44-18004000-35-8P	1546891	Jul. 04, 2012
Test Receiver	R & S	ESU40	100075	Feb. 13, 2012
Bilog Antenna	SCHWARZBECK MESSELEKTRONIK	VULB9163	9163-437	Aug. 02, 2012
Horn Antenna	R & S	HF907	100208	Jun. 08, 2012
Horn Antenna	SCHWARZBECK MESSELEKTRONIK	BBHA9170	BBHA9170431	Mar. 17, 2012
EMI Test Receiver	R & S	ESCI7	100778	Jul. 25, 2012
2-Line V-Network	R & S	ENV216	101180	May. 25, 2012
Antenna Master	INNCO	MA4000-EP	N/A	N.C.R.
Turn Table	INNCO	DT-3000S	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (21.5 m × 13.0 m × 9.0 m)	N/A	N.C.R.

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD:FCC Part15 subpart B&C, RSS-210, RSS-Gen			
Standard section		**Test Item**	**Result**
15.205(a) 15.209 15.247(d)	A8.5	Transmitter Radiated Spurious Emissions Conducted Spurious Emission	Complied
15.109(a)	RSS-Gen 6	Receiver Radiated Spurious Emission	Complied
15.247(a)(2)	A8.2(a)	6 dB Bandwidth and 99% BW	Complied
15.247(b)(3)	A8.4(4)	Maximum Peak Output Power	Complied
15.247(e)	A8.3(2)	Power Spectral Density	Complied
15.207	RSS-Gen 7.2.4	Transmitter AC Power Line Conducted Emission	Complied
15.107	RSS-Gen 7.2.4	Receiver AC Power Line Conducted Emission	Complied
15.247(i) 1.1307(b)(1)	RSS-Gen 5.5/ RSS-102	Maximum Permissible Exposure (Exposure of Humans to RF Fields)	Complied

1.7. Conclusion of worst-case

The field strength of spurious emission was measured in three orthogonal EUT positions(X-axis, Y-axis and Z-axis). Worst case is Y-axis. 1 Mbps is the highest output power in the 11b. 6 Mbps is the highest output power in the 11g. In case of 11n, we chose MCS0 mode.

1.8. Test report revision

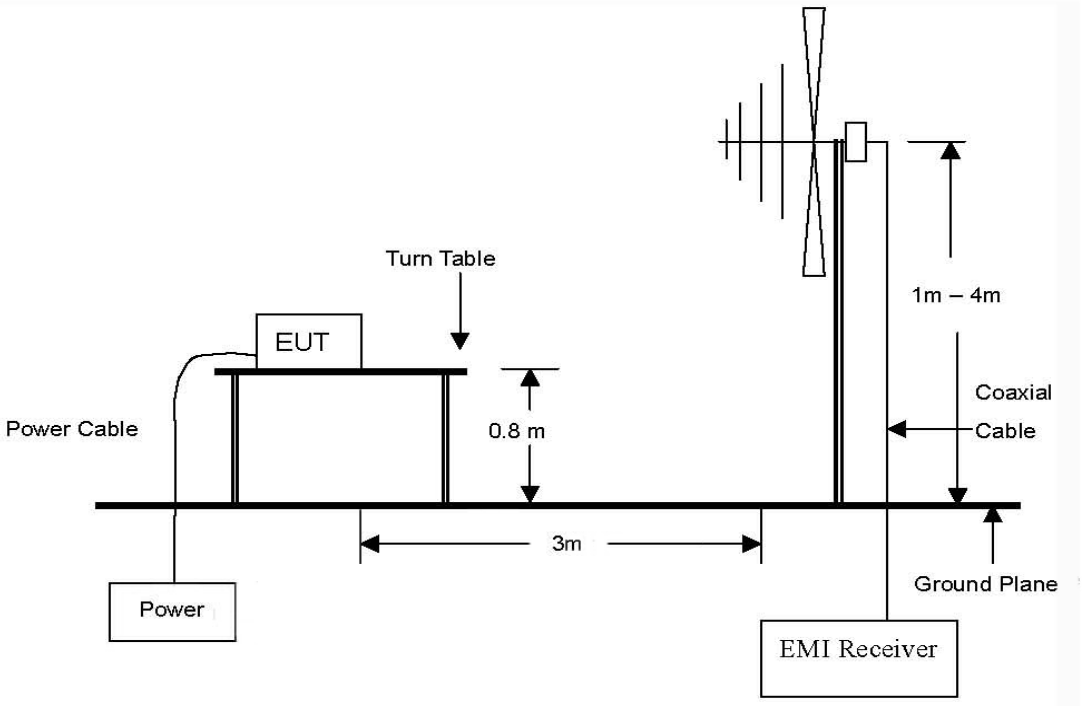
Revision	Report number	Description
0	F690501/RF-RTL005124	Initial
1	F690501/RF-RTL005124-1	Add test equipments ESC17 & ENV216 Change the name of EUT
2	F690501/RF-RTL005124-2	99% bandwidth data has been revised
3	F690501/RF-RTL005124-3	Apply average limit for just peak reading. All peak & average power test using spectrum analyzer 99% bandwidth data has been revised

2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

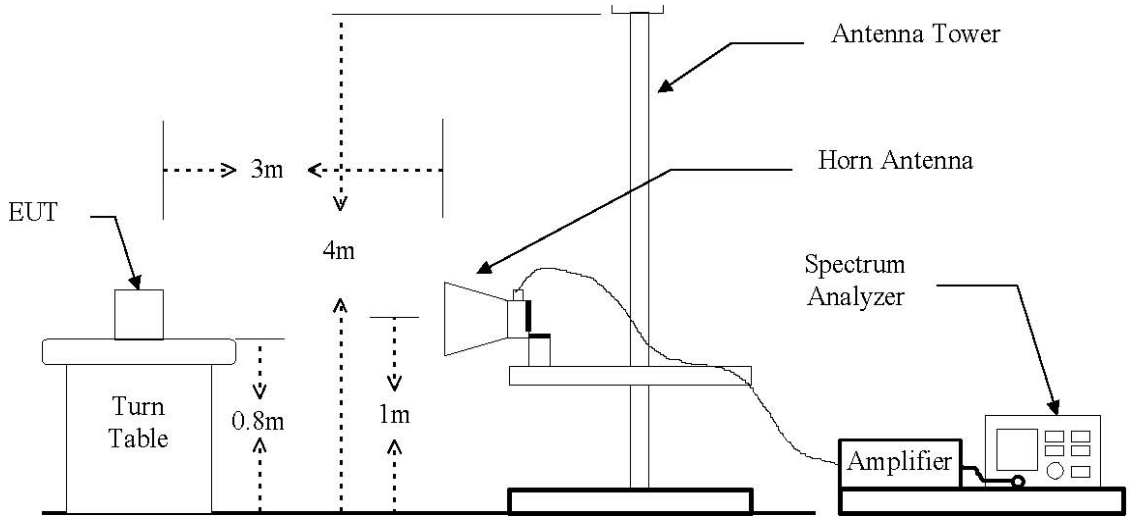
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 24 ㎓ Emissions.



2.1.2. Conducted Spurious Emission

2.2. Limit

According to §15.247(d), in any 100 ㎑ 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 ㏈ below that in the 100 ㎑ 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

According to § 15.209(a), Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table：

Frequency (㎒)	Distance (Meters)	Field Strength (㏈㎶/m)	Field Strength (㎶/m)
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

2.3. Test Procedures

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

2.3.1. Test Procedures for Radiated Spurious Emissions

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE ;

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 10 ㎐ for Average detection (AV) at frequency above 1 ㎓.

2.3.2. Test Procedures for Conducted Spurious Emissions

1. The transmitter output was connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 100 ㎑.

2.4. Test Results

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

2.4.1. Spurious Radiated Emission (Worst case configuration_11g mode)

The frequency spectrum from 30 ㎒ to 1 000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈. All reading values are Quasi-peak values.

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
33.88	40.98	Q.P	V	12.31	-24.52	28.77	40.00	11.23
80.84	42.23	Q.P	V	8.82	-23.99	27.06	40.00	12.94
82.00	46.06	Q.P	V	9.21	-23.94	31.33	40.00	8.67
86.64	41.33	Q.P	V	10.77	-23.93	28.17	40.00	11.83
92.48	45.39	Q.P	V	12.21	-23.89	33.71	43.50	9.79
128.56	44.00	Q.P	V	9.50	-23.51	29.99	43.50	13.51
475.04	35.76	Q.P	V	16.20	-22.63	29.33	46.00	16.67
Above 500.00	Not Detected	-	-	-	-	-	-	-

Remark:

1. All spurious emission at channels are almost the same below 1 ㎓, so that the middle channel was chosen at representative in final test.

2. Actual = Reading + AF + AMP + CL

2.4.2. Spurious Radiated Emission

The frequency spectrum above 1000 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈.

DSSS : 802.11b
Low Channel (2 412 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (㏈ uV)	Detect Mode	Pol.	AF (㏈/m)	CL (㏈)	Actual (㏈ uV/m)	Limit (㏈ uV/m)	Margin (㏈)
2 390.00*	24.04	Peak	V	29.34	5.93	59.31	74.00	14.69
2 390.00*	11.47	Average	V	29.34	5.93	46.74	54.00	7.26

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP+CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
4 827.69	39.74	Peak	V	34.08	-34.37	39.45	54.00	14.55
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

Middle Channel (2 437 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP+CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
4 879.16	39.67	Peak	V	34.14	-34.51	39.30	54.00	14.70
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

High Channel (2 462 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 483.50*	23.67	Peak	V	29.56	5.56	58.79	74.00	15.21
2 483.50*	11.50	Average	V	29.56	5.56	46.62	54.00	7.38

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 932.59	39.84	Peak	V	34.21	-34.65	39.40	54.00	14.60
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

OFDM : 802.11g
Low Channel (2 412 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 390.00*	24.49	Peak	V	29.34	5.93	59.76	74.00	14.24
2 390.00*	11.61	Average	V	29.34	5.93	46.88	54.00	7.12

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 822.96	38.44	Peak	V	34.07	-34.36	38.15	54.00	15.85
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

Middle Channel (2 437 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 885.86	39.31	Peak	V	34.15	-34.52	38.94	54.00	15.06
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

High Channel (2 462 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 483.50*	25.50	Peak	V	29.56	5.56	60.62	74.00	13.38
2 483.50*	11.84	Average	V	29.56	5.56	46.96	54.00	7.04

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 923.68	39.10	Peak	V	34.20	-34.62	38.68	54.00	15.32
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

OFDM : 802.11n(HT20)
Low Channel (2 412 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 390.00*	23.71	Peak	V	29.34	5.93	58.98	74.00	15.02
2 390.00*	11.66	Average	V	29.34	5.93	46.93	54.00	7.07

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 819.03	39.12	Peak	V	34.06	-34.34	38.84	54.00	15.16
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

Middle Channel (2 437 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 874.00	39.40	Peak	V	34.14	-34.49	39.05	54.00	14.95
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

High Channel (2 462 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 483.50*	25.94	Peak	V	29.56	5.56	61.06	74.00	12.94
2 483.50*	11.90	Average	V	29.56	5.56	47.02	54.00	6.98

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 930.73	38.35	Peak	V	34.21	-34.65	37.91	54.00	16.09
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

OFDM : 802.11n(HT40)
Low Channel (2 422 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 390.00*	23.97	Peak	V	29.34	5.93	59.24	74.00	14.76
2 390.00*	12.17	Average	V	29.34	5.93	47.44	54.00	6.56

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 852.57	38.97	Peak	V	34.11	-34.43	38.65	54.00	15.35
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

Middle Channel (2 442 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
4 891.47	40.44	Peak	V	34.16	-34.54	40.06	54.00	13.94
Above 4 900.00	Not Detected	-	-	-	-	-	-	-

High Channel (2 452 ㎒)

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB uV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Actual (dB uV/m)	Limit (dB uV/m)	Margin (dB)
2 483.50*	26.70	Peak	V	29.56	5.56	61.82	74.00	12.18
2 483.50*	12.91	Average	V	29.56	5.56	48.03	54.00	5.97

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 924.43	39.04	Peak	V	34.20	-34.63	38.61	54.00	15.39
Above 5 000.00	Not Detected	-	-	-	-	-	-	-

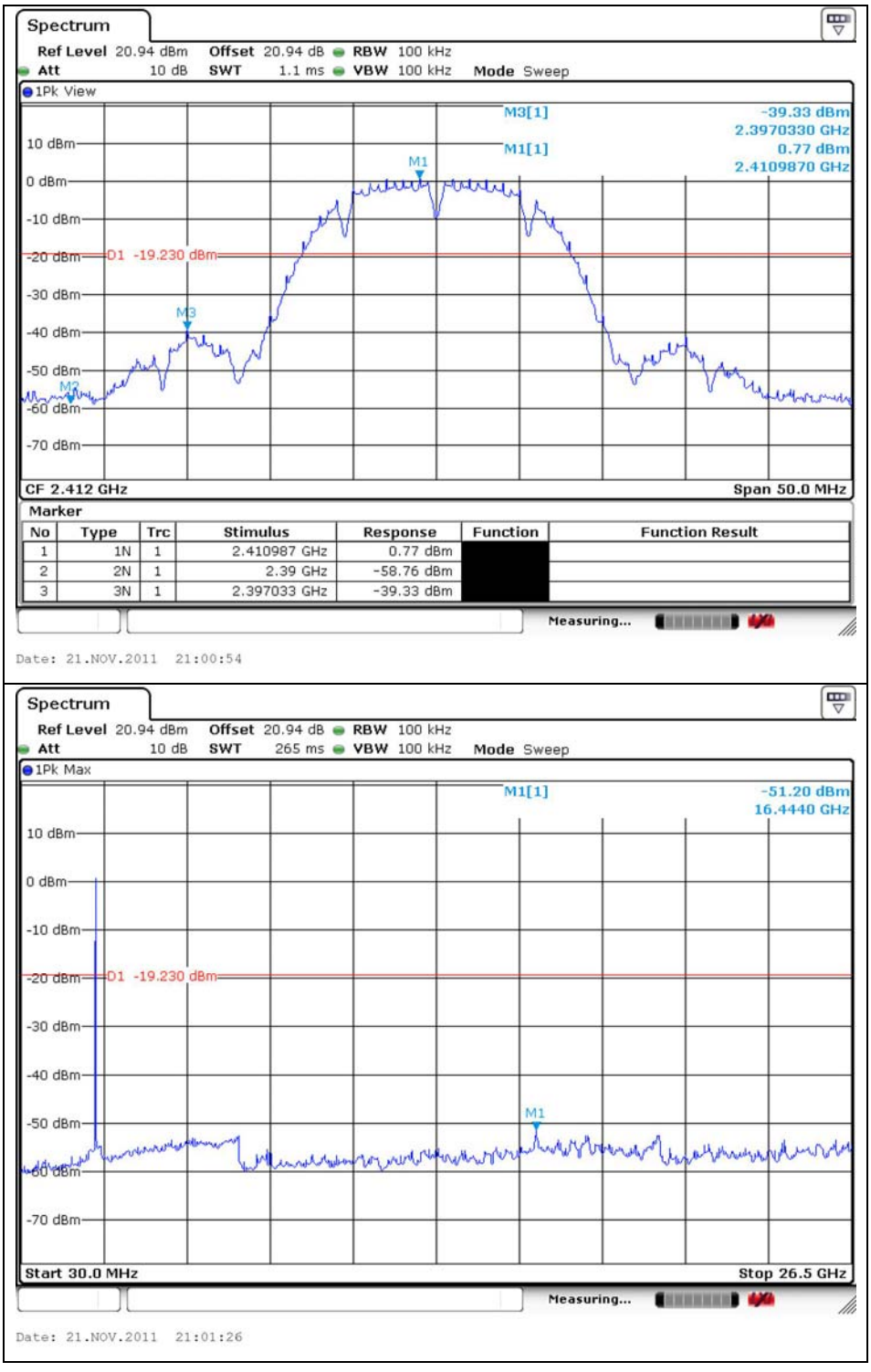
Remarks ;

1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental Frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Average test would be performed if the peak result were greater than the average limit.
5. Actual = Reading + AF + AMP + CL

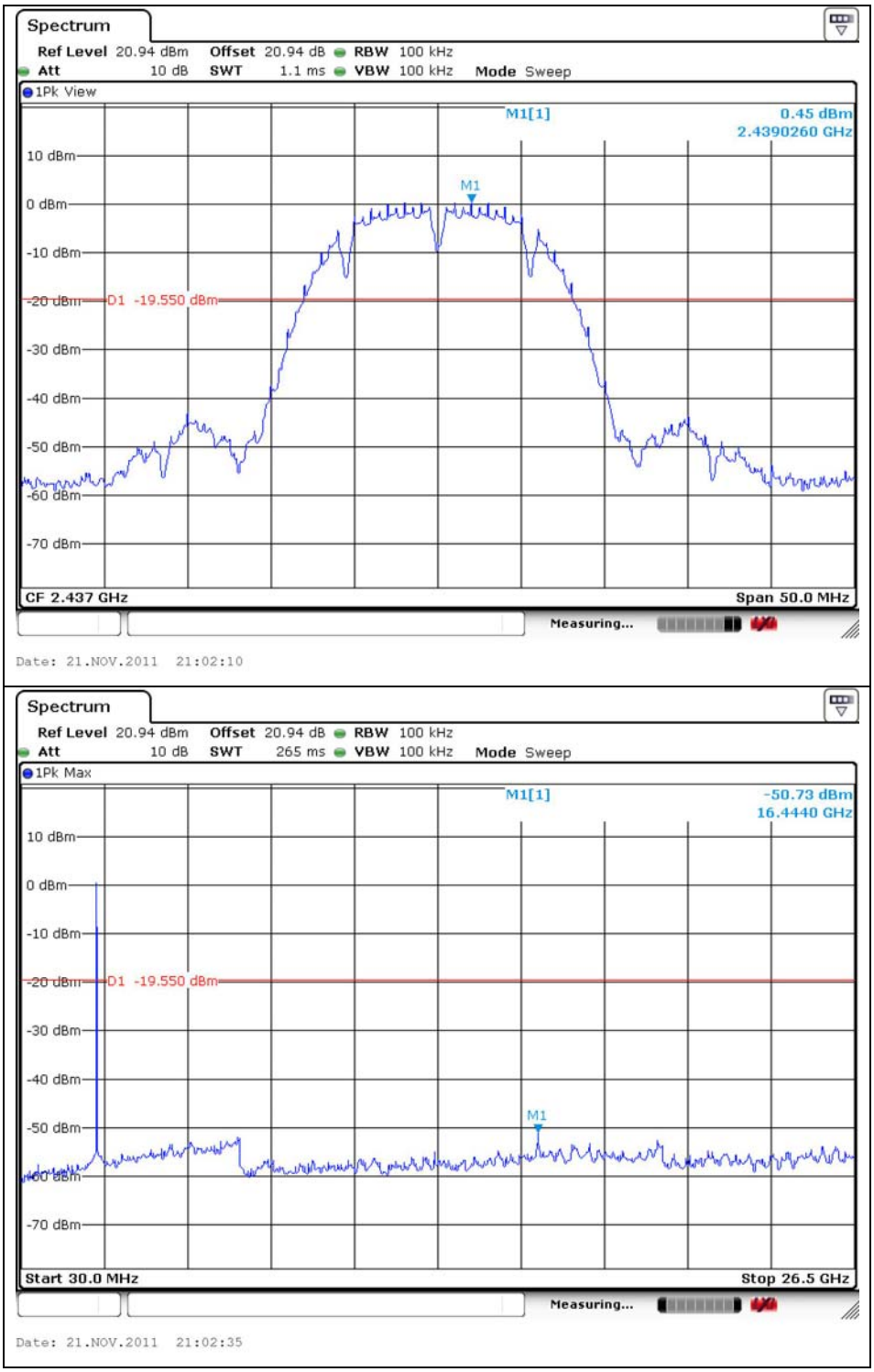
2.4.3. Spurious RF Conducted Emissions: Plot of Spurious RF Conducted Emission

DSSS : 802.11b

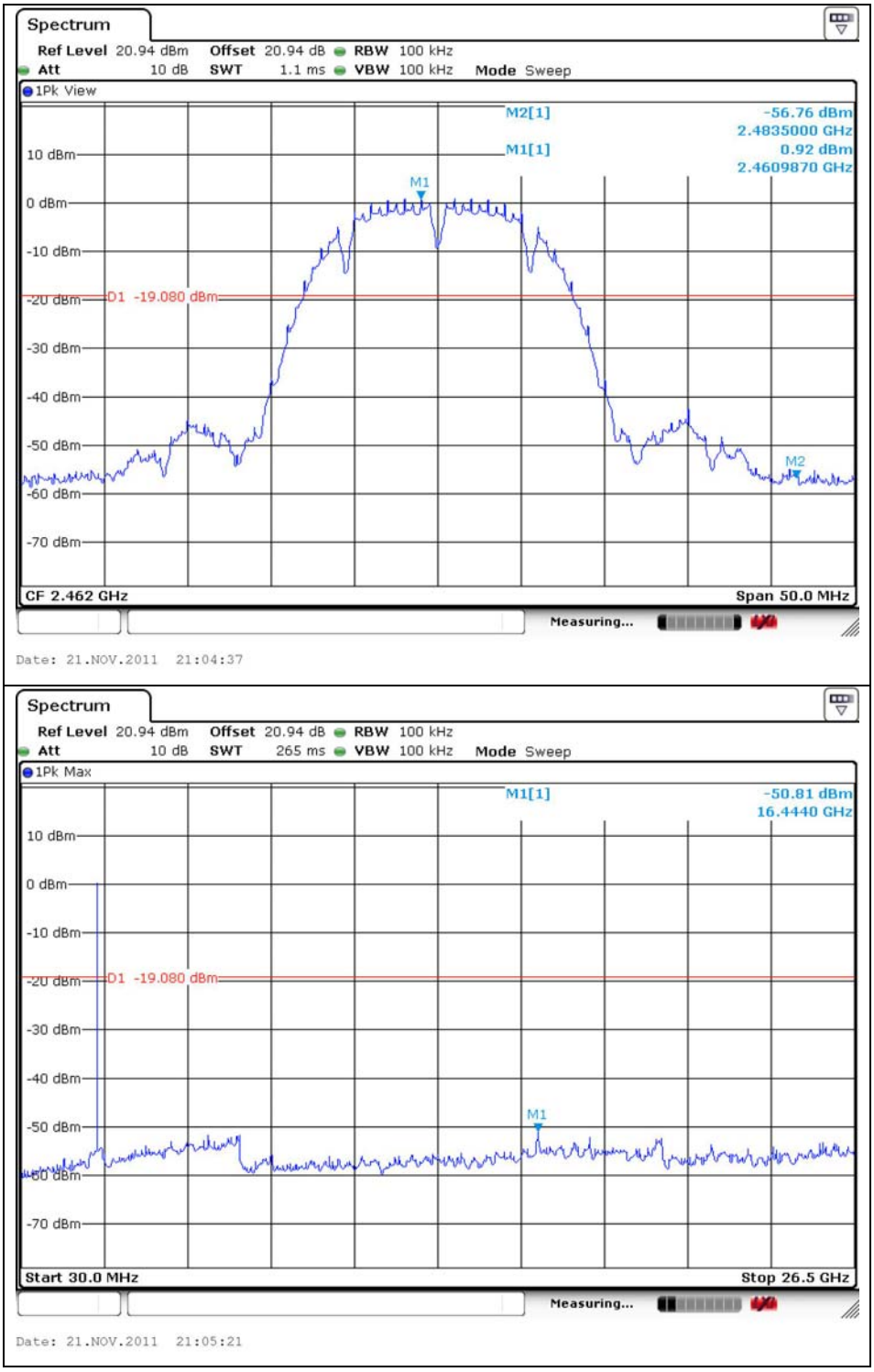
Low Channel



Middle Channel

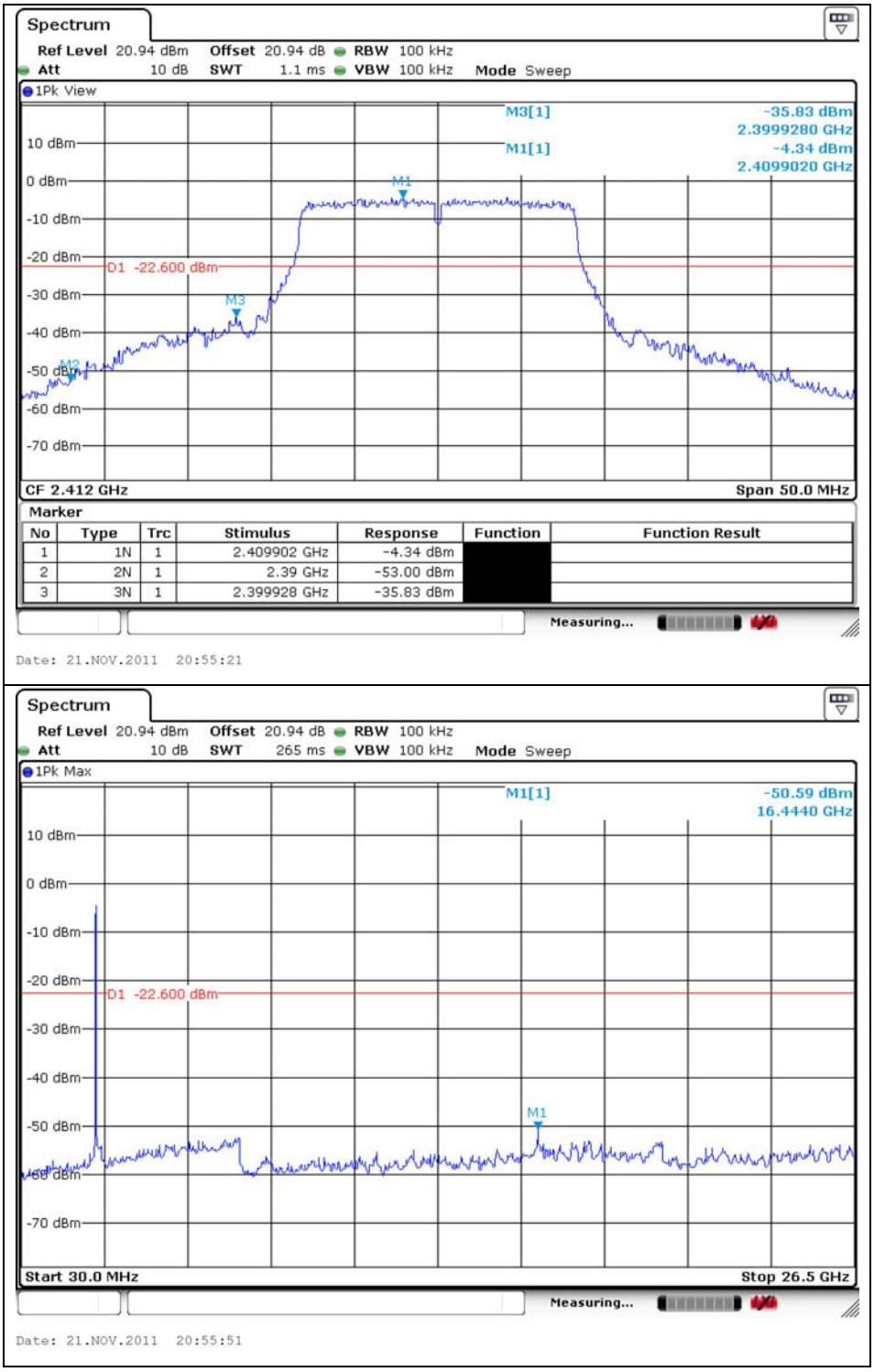


High Channel

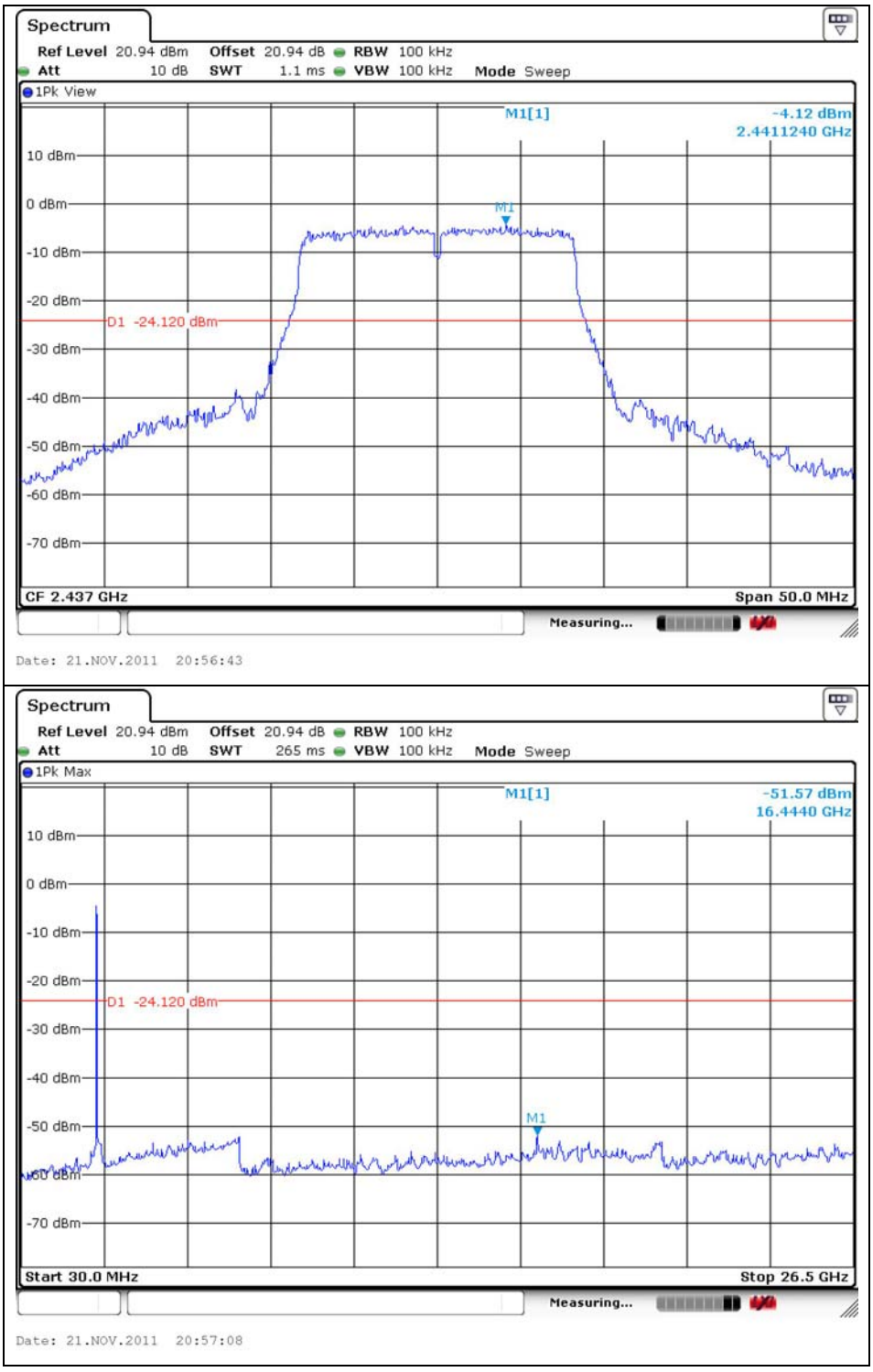


OFDM : 802.11g

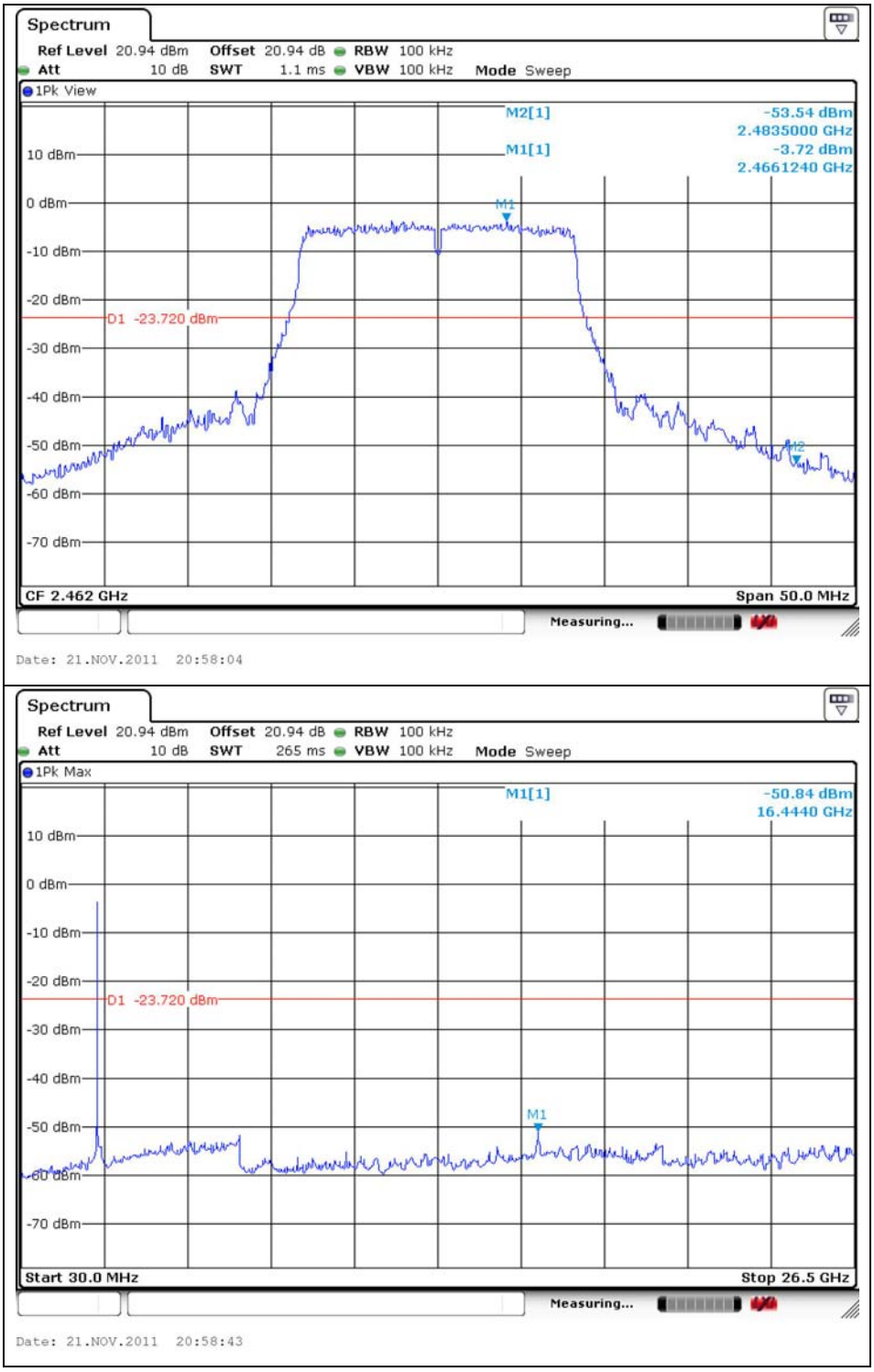
Low Channel



Middle Channel

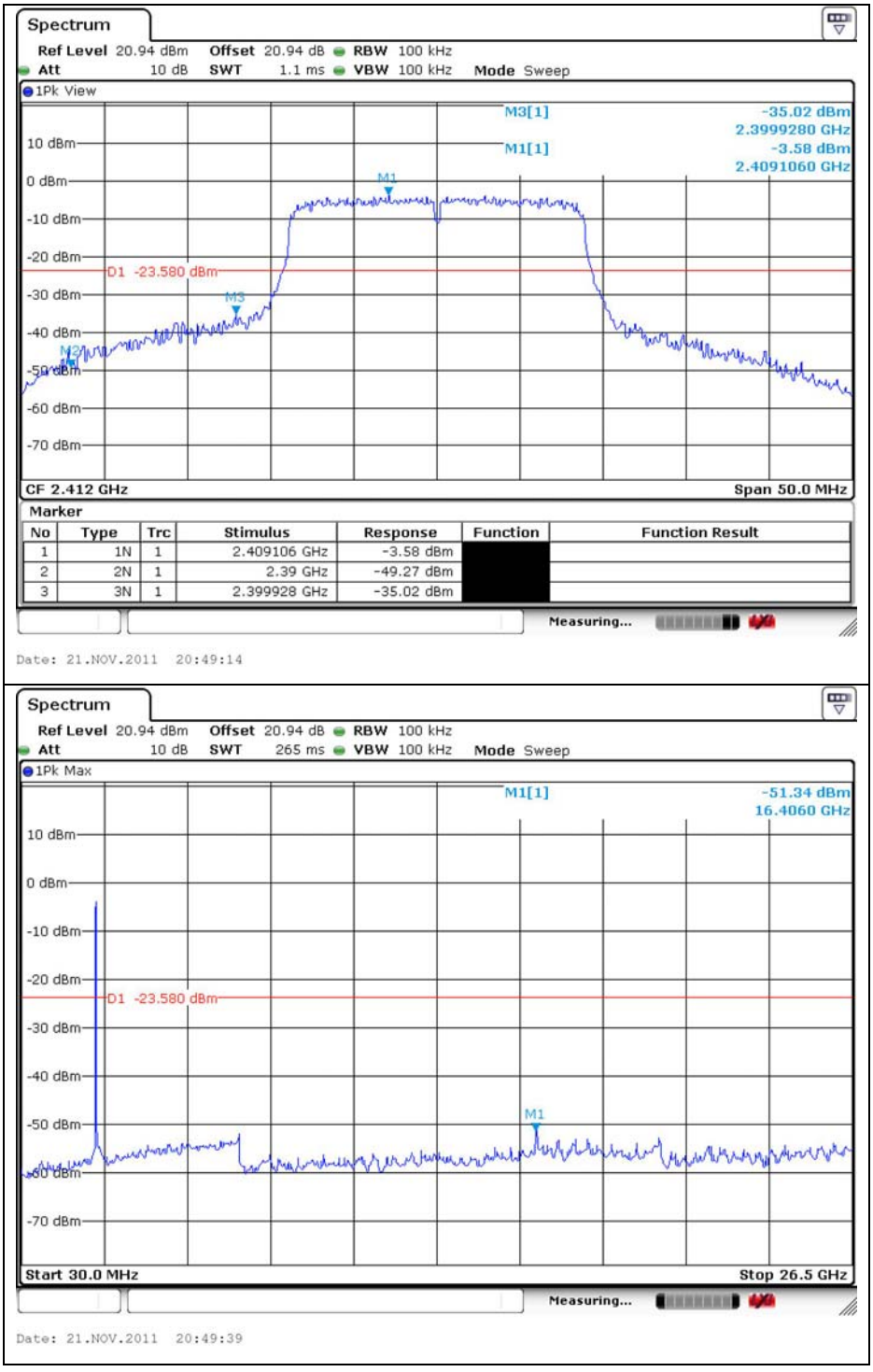


High Channel

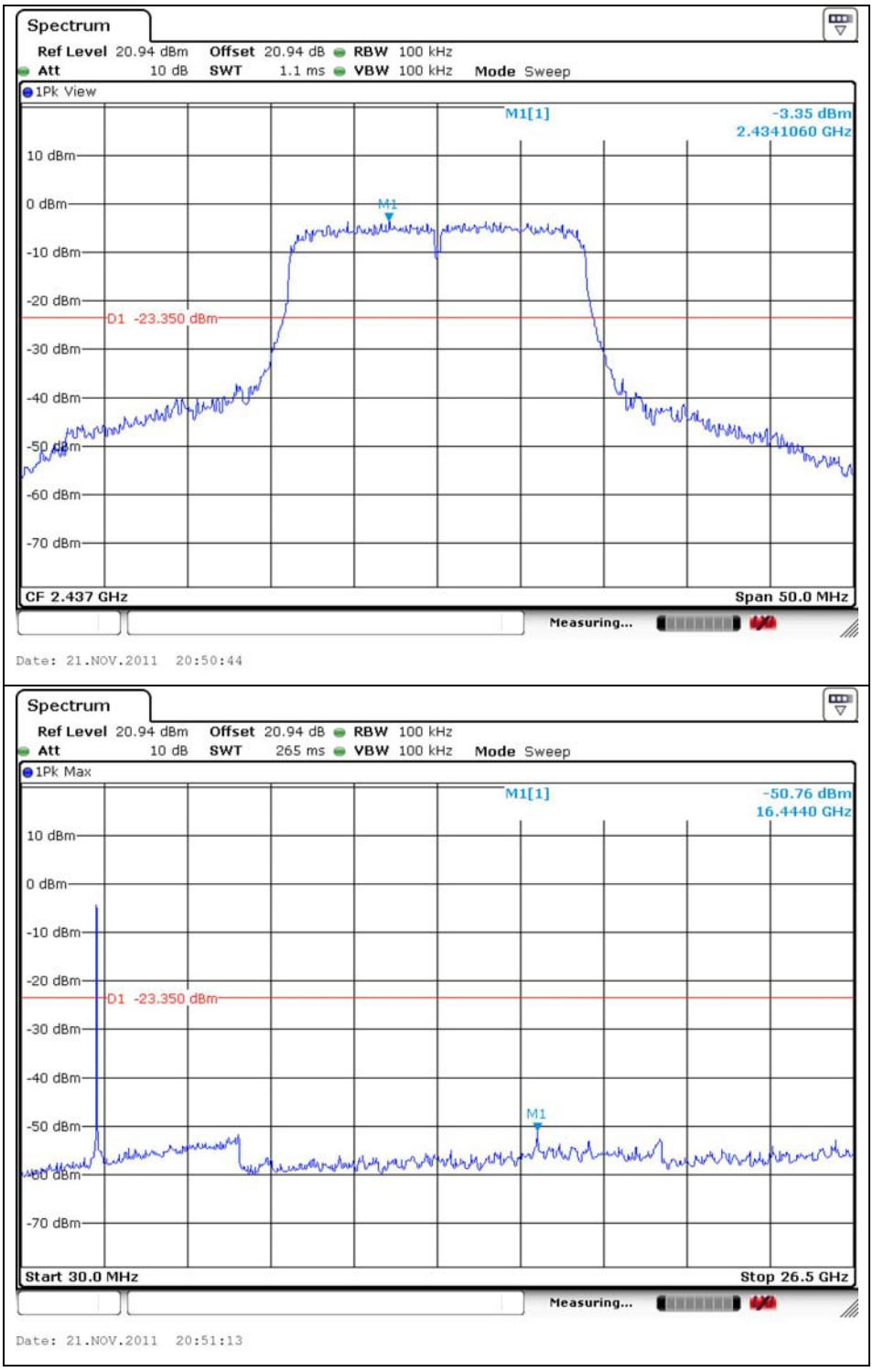


OFDM : 802.11n(HT20)

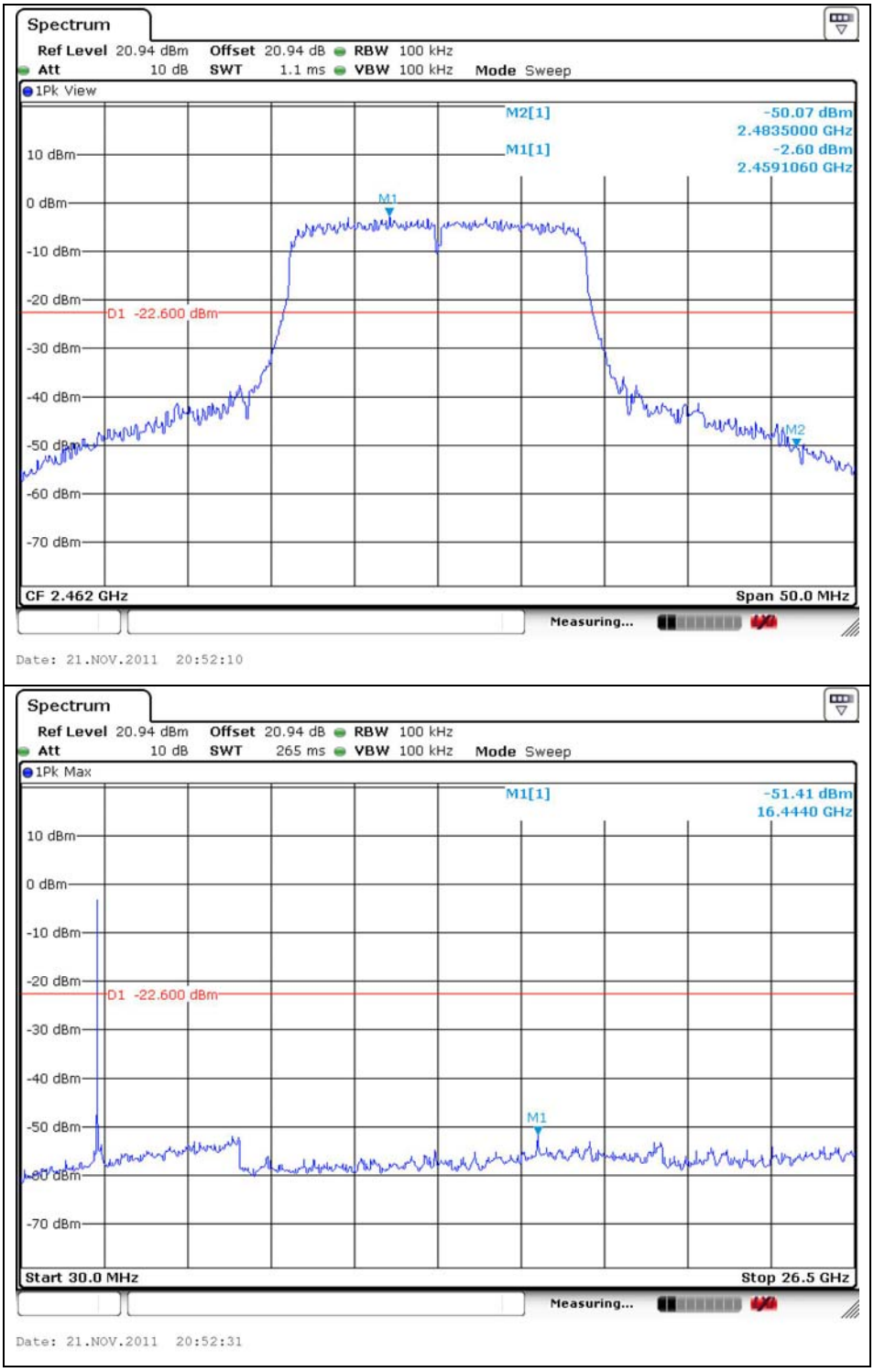
Low Channel



Middle Channel

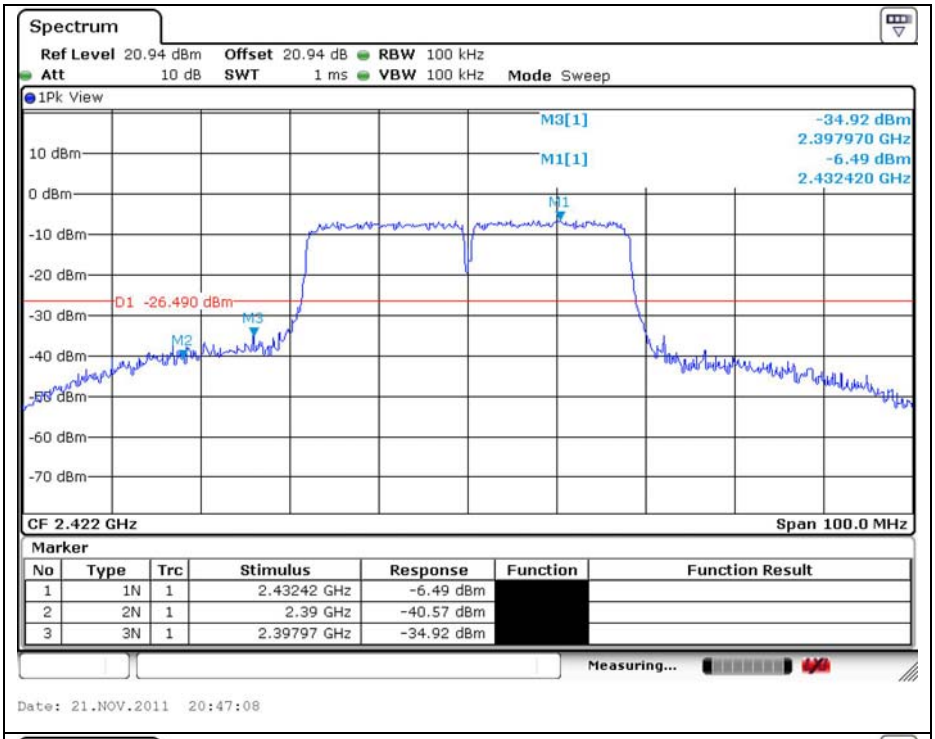


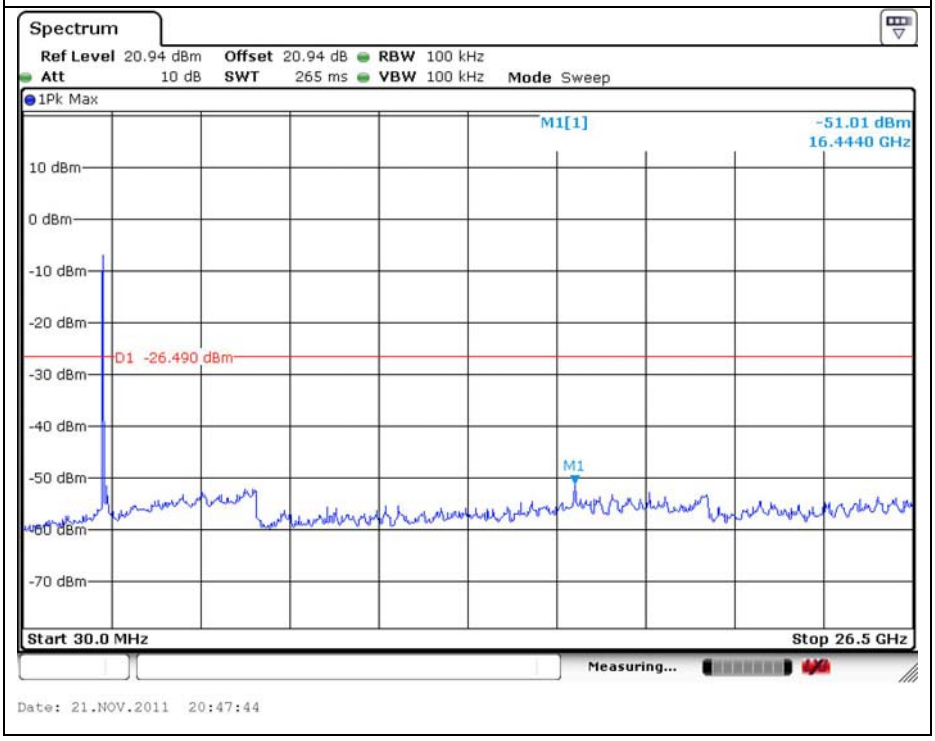
High Channel



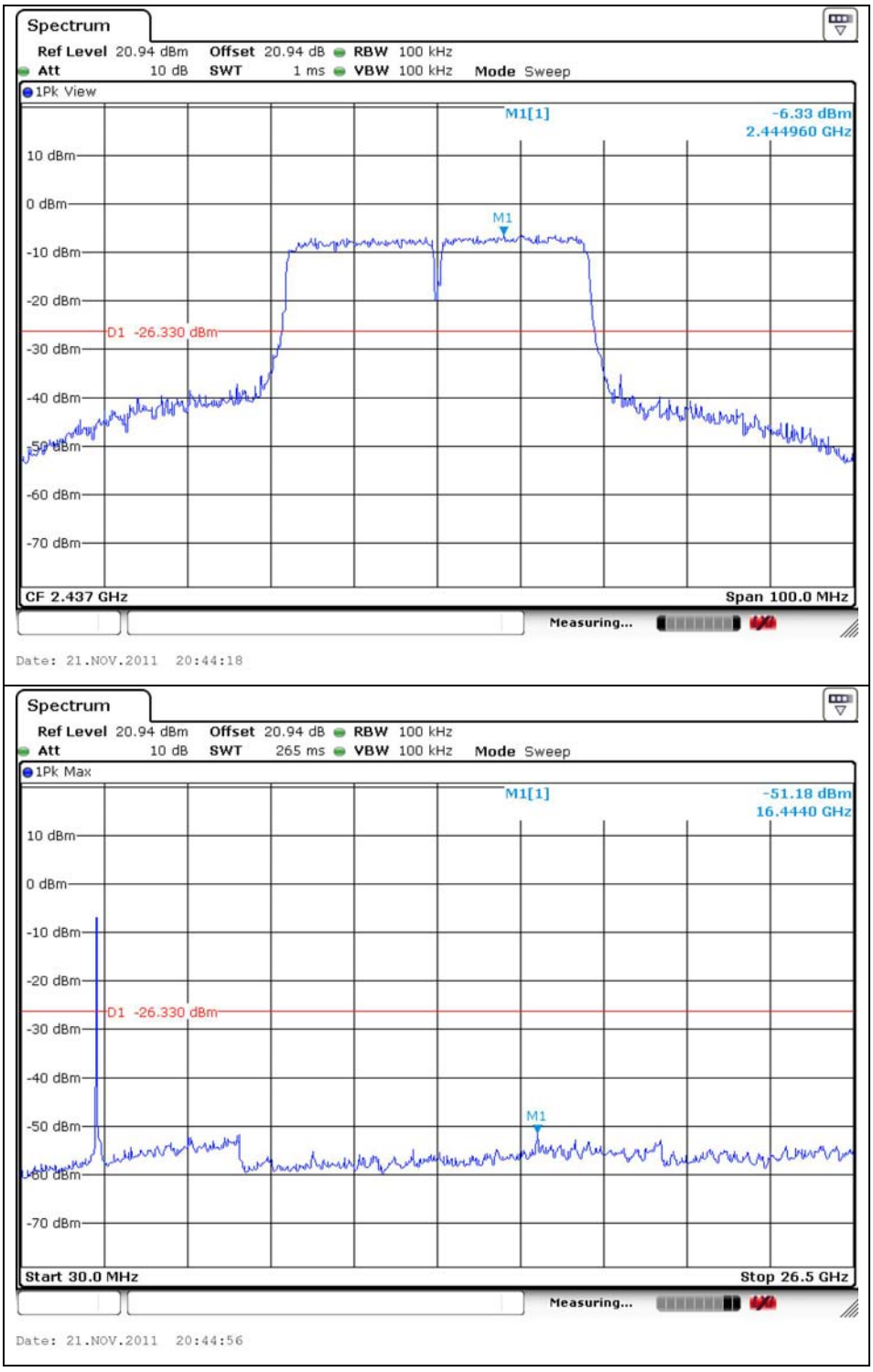
OFDM : 802.11n(HT40)

Low Channel

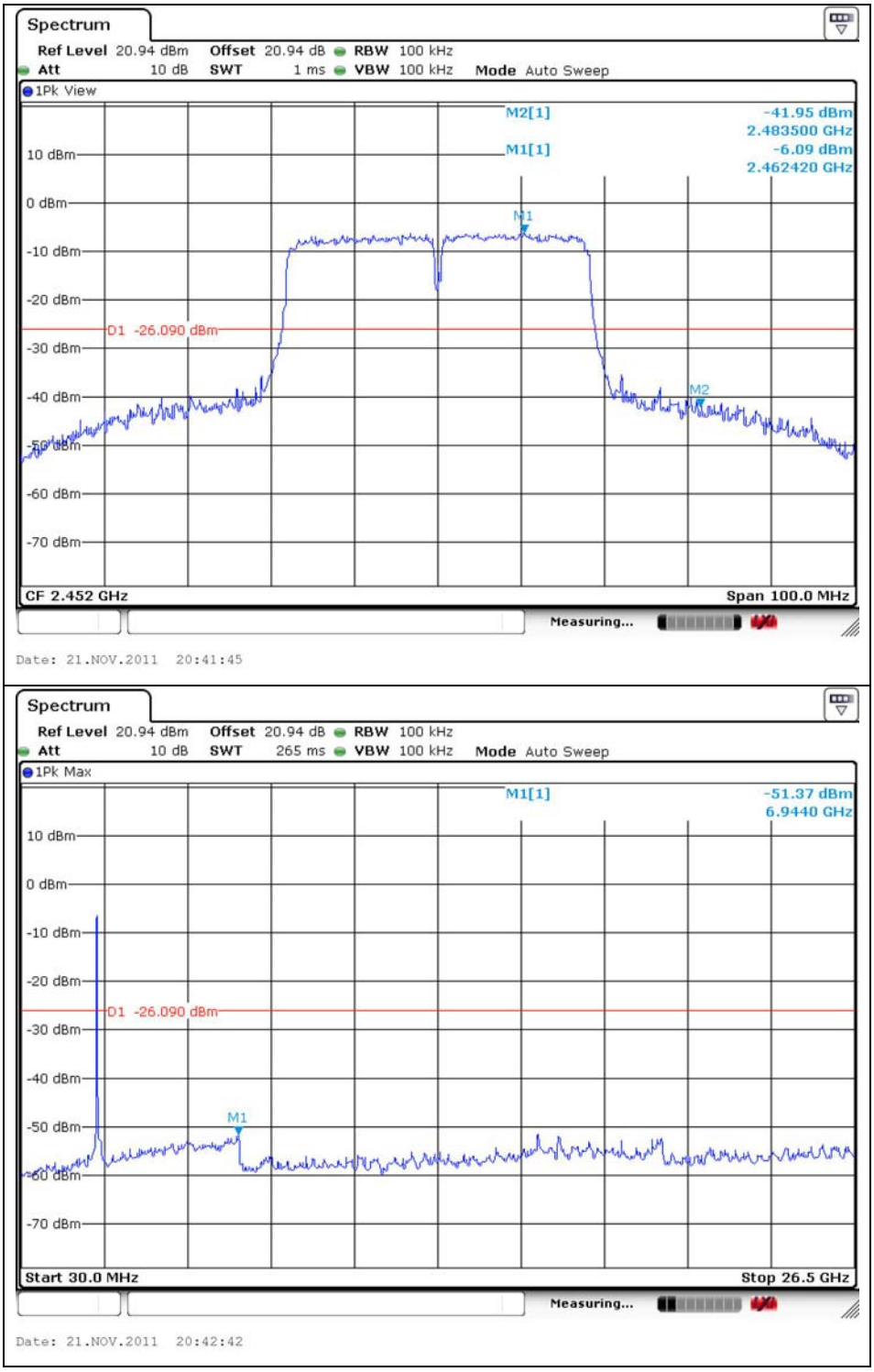




Middle Channel



High Channel



3. Receiver Radiated spurious emissions

3.1. Test setup - Same as clause 2.1.

3.1.1. Receiver Radiated Spurious Emissions - Same as clause 2.1.1.

3.2. Limit

According to §15.109(a), Except for Class A digital devices, the field strength of radiated emission from unintentional radiator at a distance of 3 m shall not exceed the following values:

Frequency (㎒)	Distance (Meters)	Radiated (㏈ μV/m)	Radiated (μV/m)
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

3.3. Test Procedures - Same as clause 2.3.

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

3.3.1. Test Procedures for Radiated Spurious Emissions- Same as clause 2.3.1.

3.4. Test Results

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

3.4.1. Spurious Radiated Emission (Worst case configuration_11g mode)

The frequency spectrum from 30 ㎒ to 26.5 ㎓ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈. The reading values are Quasi-peak values below 1 ㎓ and using peak & average method above 1 ㎓.

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (㎒)	Reading (㏈㎶)	Detect Mode	Pol.	AF (㏈/m)	AMP + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
33.88	40.45	Q.P	V	12.31	-24.52	28.24	40.00	11.76
82.00	45.70	Q.P	V	9.21	-23.94	30.97	40.00	9.03
87.44	42.08	Q.P	V	11.04	-23.93	29.19	40.00	10.81
92.47	45.10	Q.P	V	12.21	-23.89	33.42	43.50	10.08
128.94	42.64	Q.P	V	9.46	-23.50	28.60	43.50	14.90
300.05	36.77	Q.P	V	13.06	-22.00	27.83	46.00	18.17
490.94	33.66	Q.P	V	16.44	-22.74	27.36	46.00	18.64
Above 500.00	Not Detected	-	-	-	-	-	-	-

Remark:

1. All spurious emission at channels are almost the same from 30 ㎒ to 26.5 ㎓, so that the middle channel was chosen at representative in final test.
2. Actual = Reading + AF + AMP + CL

4. 6 dB Bandwidth Measurement and 99% BW

4.1. Test Setup

4.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 ~928 ㎒, 2 400 ~ 2 483.5 ㎒, and 5 725 ~ 5 825 ㎒ bands. The minimum of 6 dB Bandwidth shall be at least 500 ㎑

4.3. Test Procedure

1. The 6 dB bandwidth was measured with a spectrum analyzer connected to RF antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 6 dB band width of the emission was determined.

2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 100 ㎑, Span = 50 ㎒, Detect mode = Peak detector.

3. The 99% bandwidth of fundamental frequency was measured with the spectrum analyzer using RBW ≥ 1% of the selected span, VBW = 3 times the RBW, Detect mode = Sampling detector.

4.4. Test Results

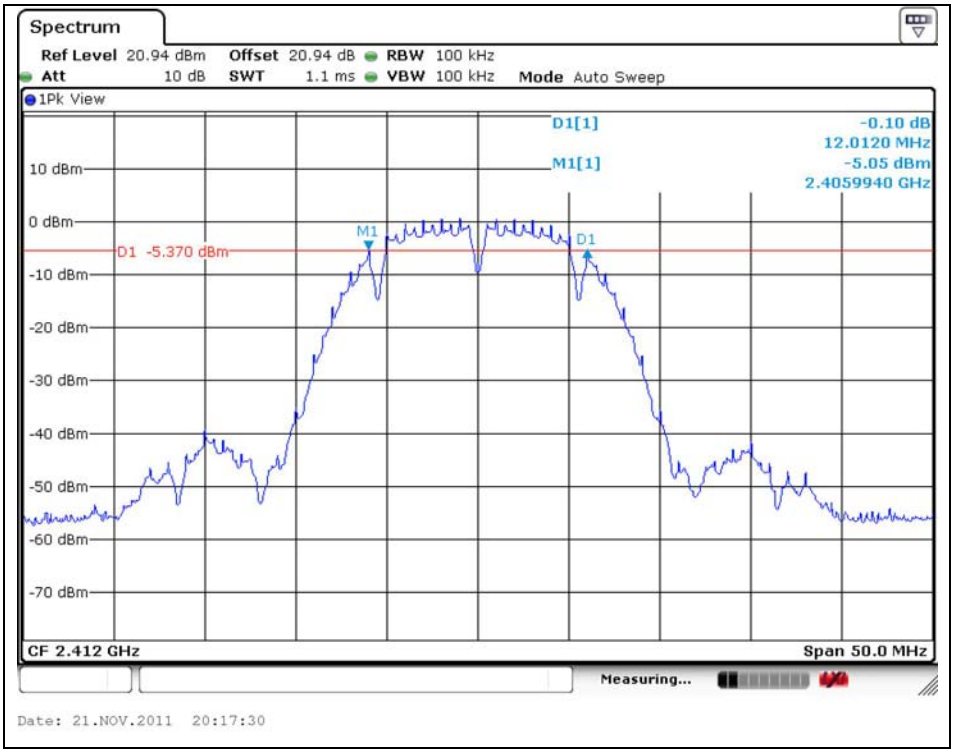
Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Channel Frequency (㎒)	6 ㏈ Bandwidth (㎒)	99 % Bandwidth (㎒)
DSSS (802.11b)	Low	2 412	12.01	14.40
	Middle	2 437	12.01	14.33
	High	2 462	12.01	14.33
OFDM (802.11g)	Low	2 412	16.50	17.08
	Middle	2 437	16.50	17.00
	High	2 462	16.50	17.00
OFDM (802.11n_HT20)	Low	2 412	17.51	17.66
	Middle	2 437	17.51	17.66
	High	2 462	17.37	17.66
OFDM (802.11n_HT40)	Low	2 422	36.47	35.96
	Middle	2 437	36.38	35.89
	High	2 452	36.37	35.89

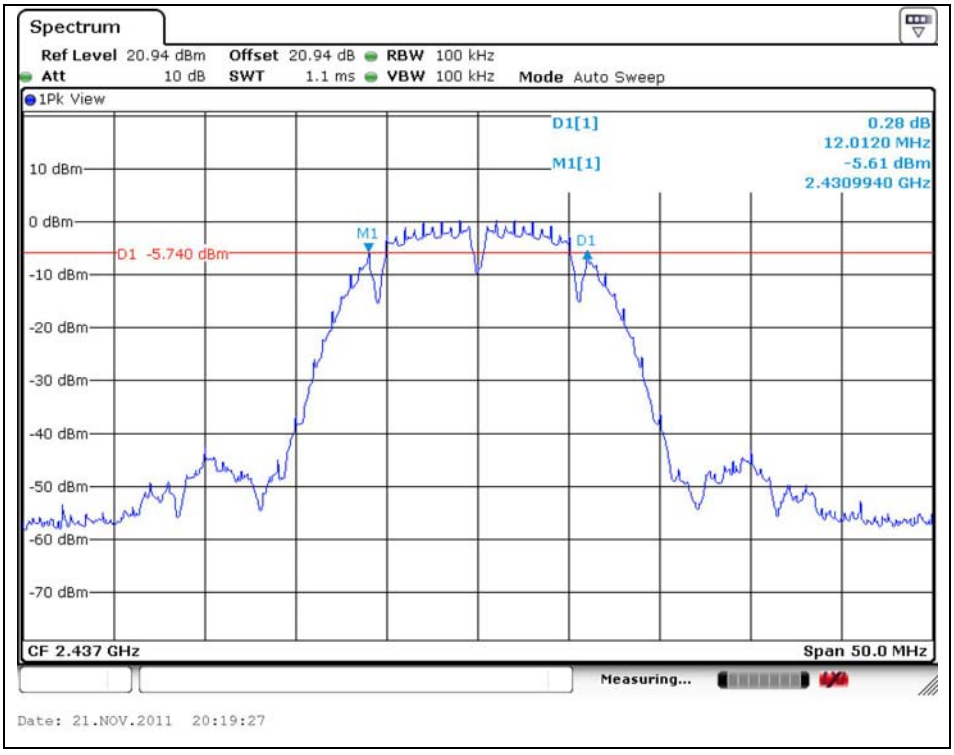
6 dB Bandwidth

DSSS : 802.11b

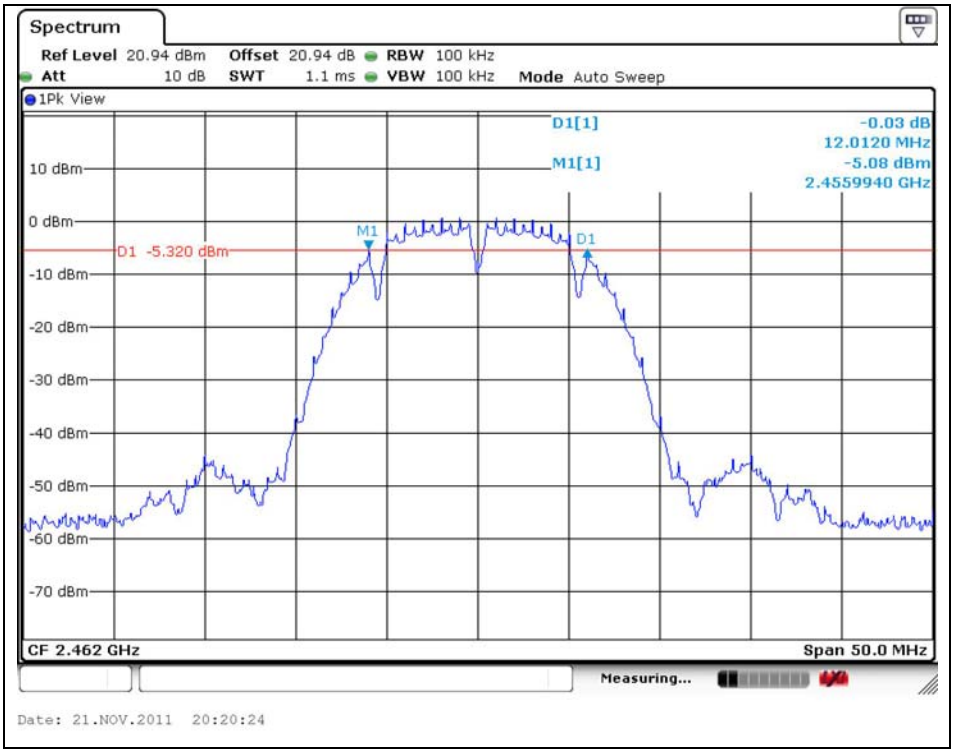
Low Channel



Middle Channel

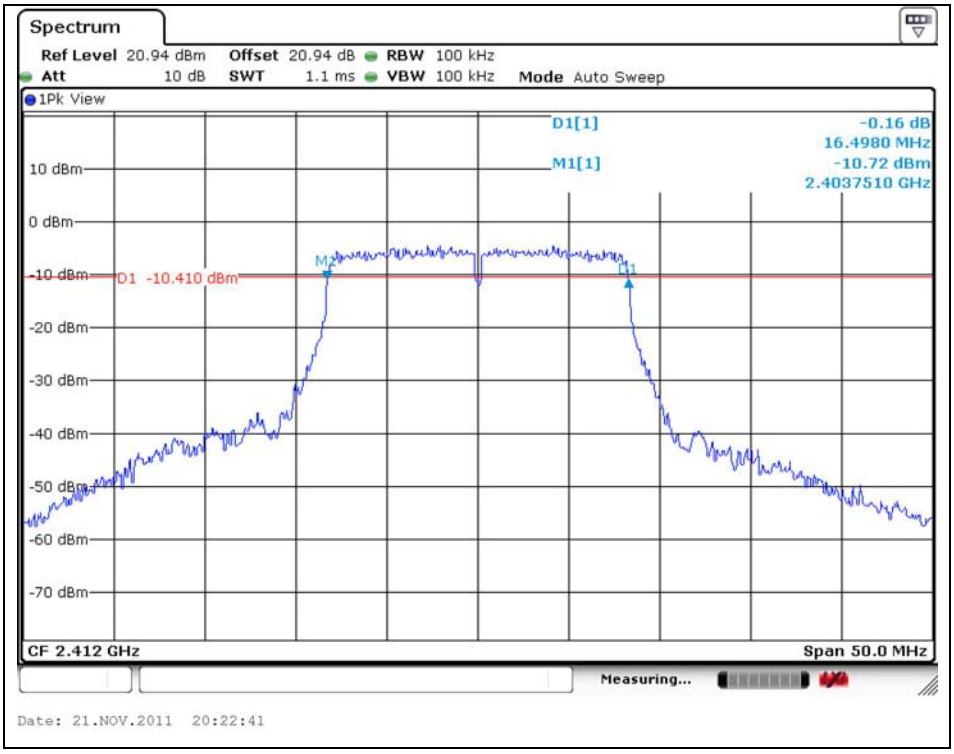


High Channel

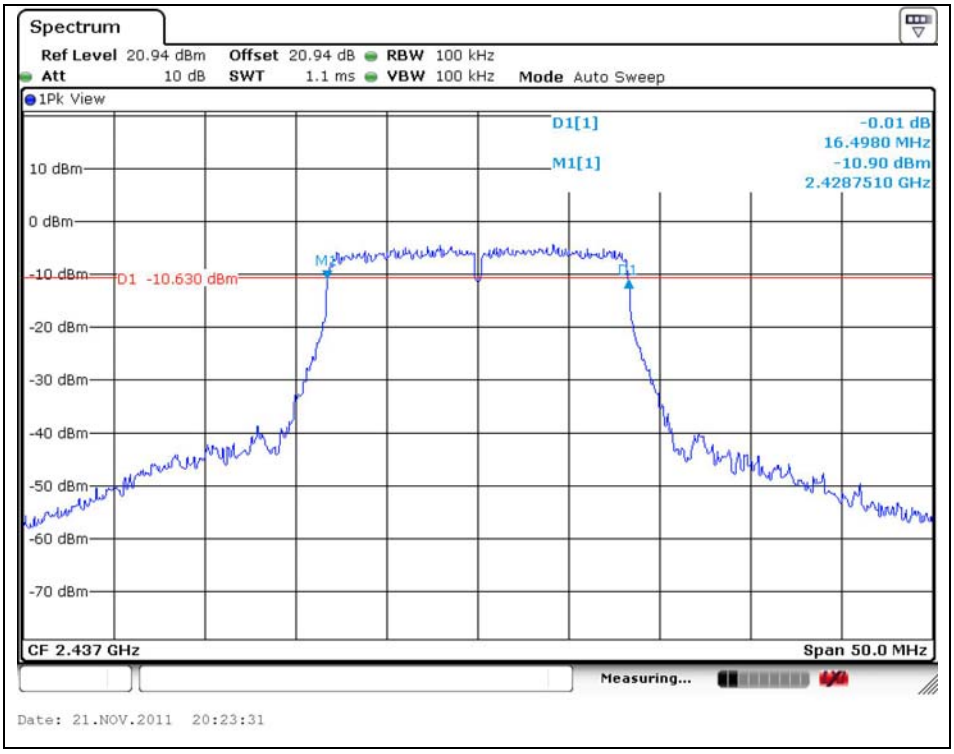


OFDM : 802.11g

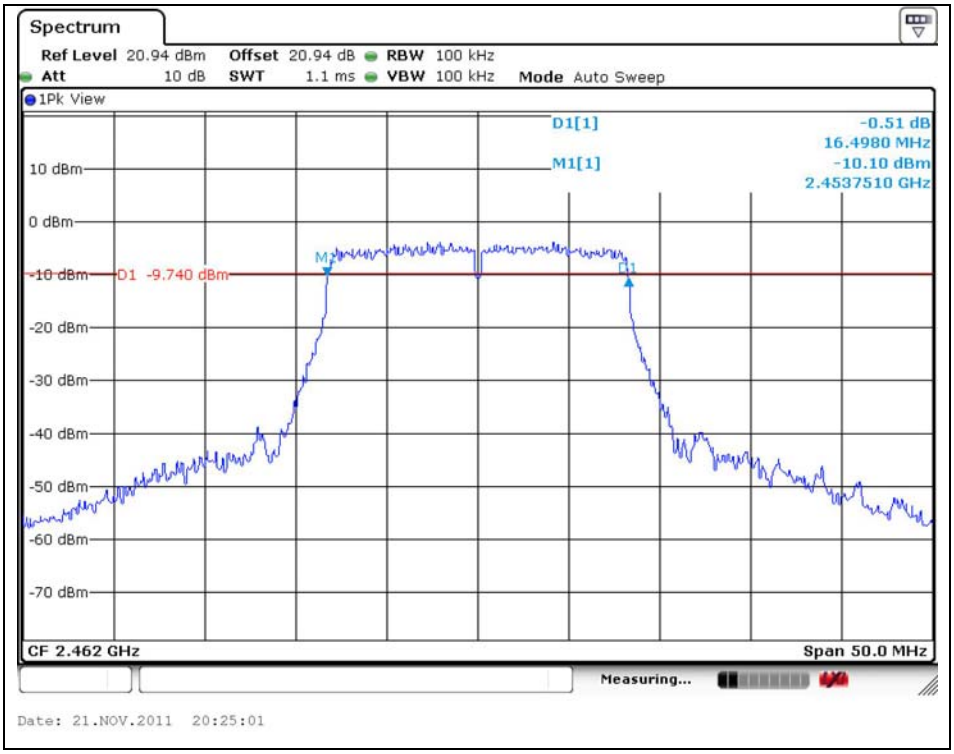
Low Channel



Middle Channel

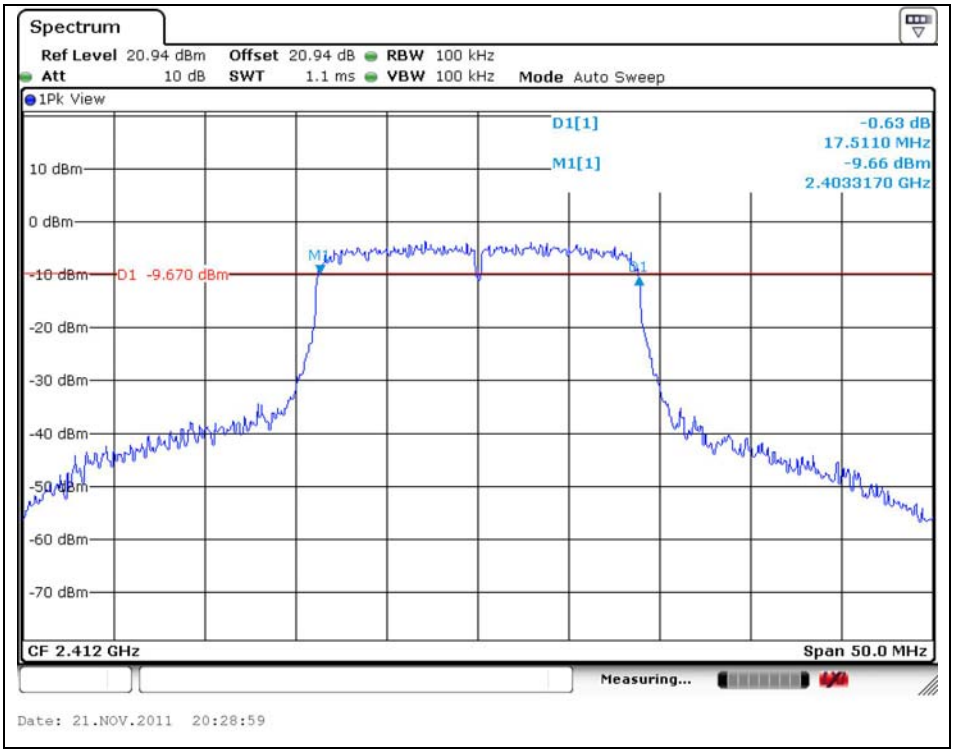


High Channel

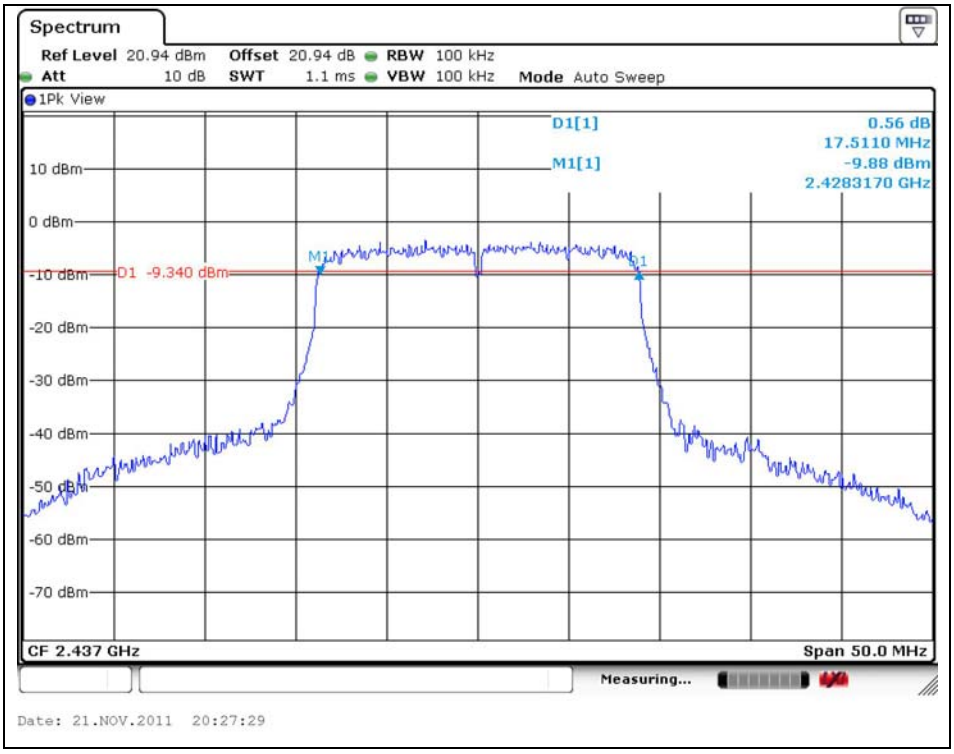


OFDM : 802.11n_HT20

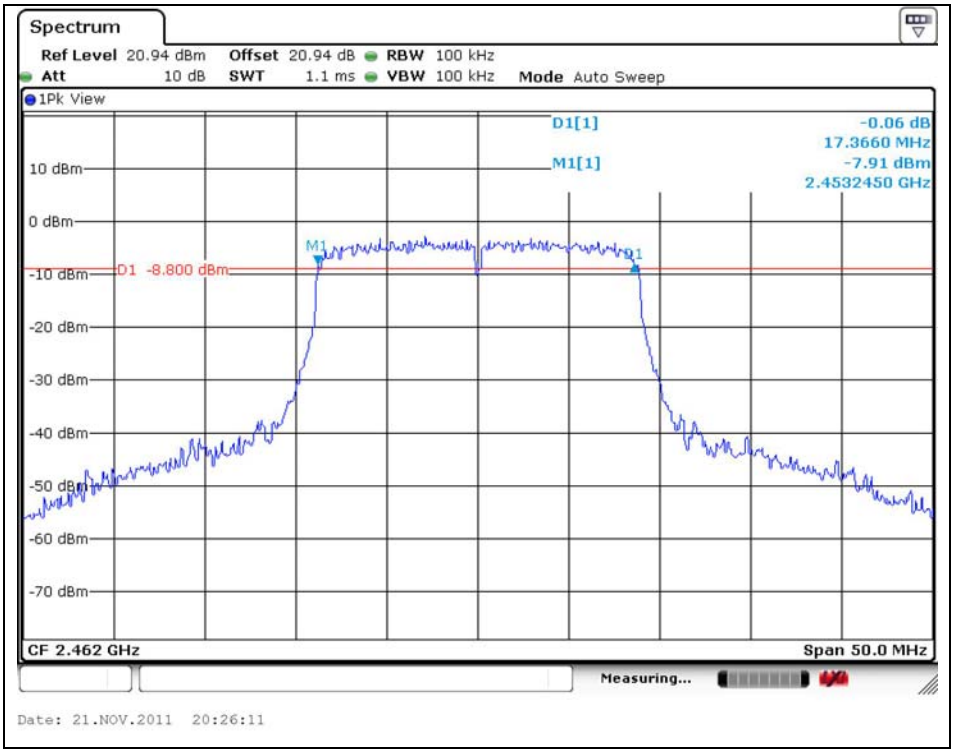
Low Channel



Middle Channel

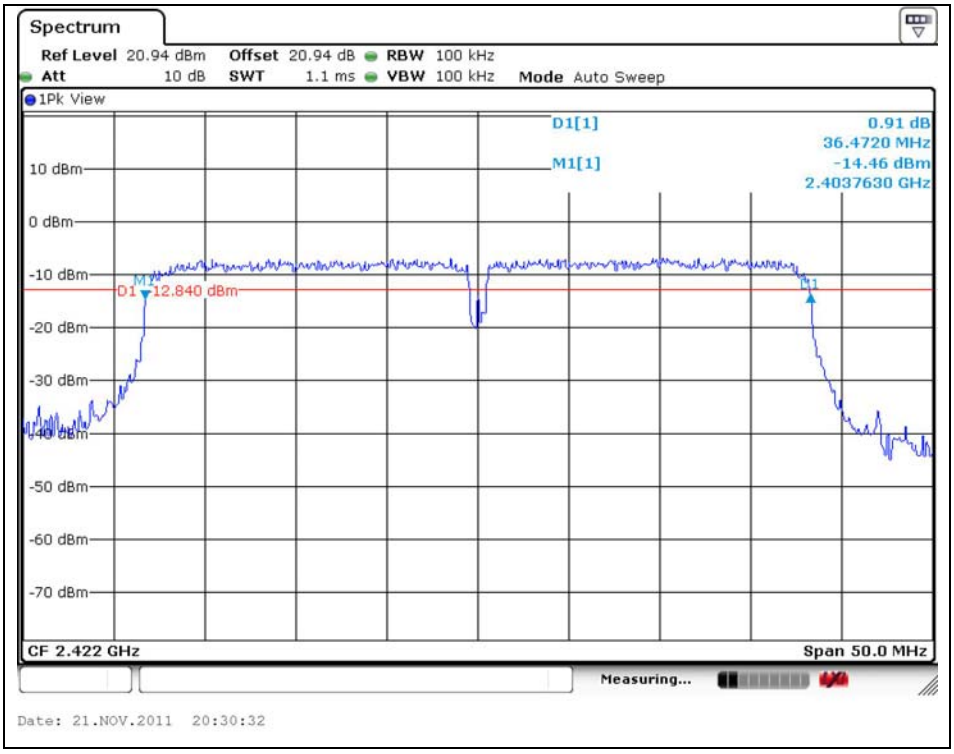


High Channel

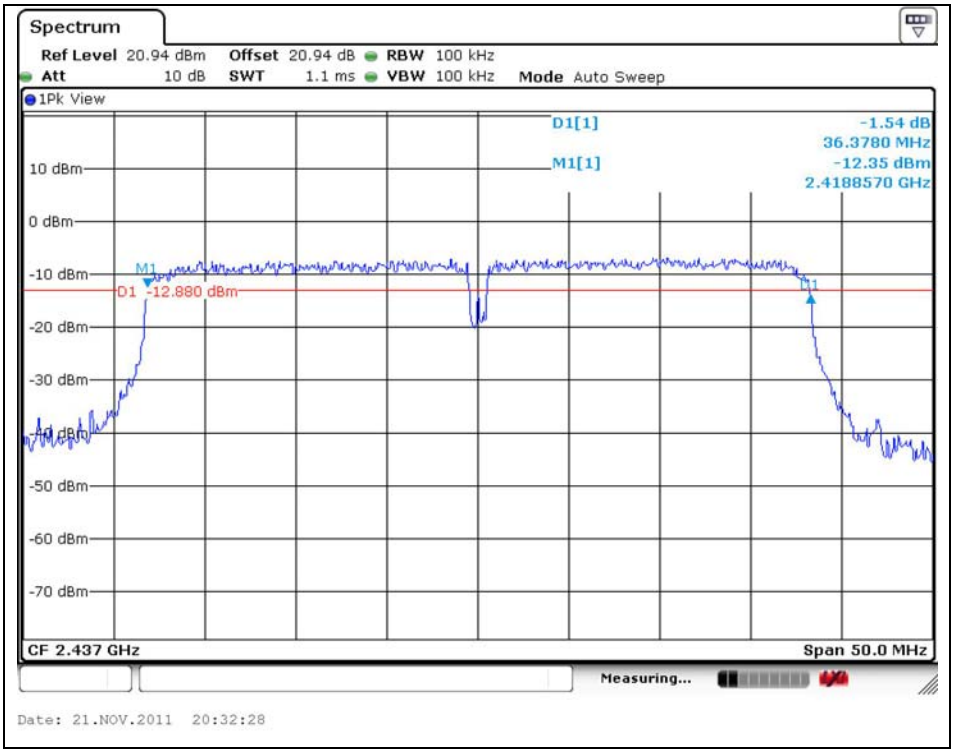


OFDM : 802.11n_HT40

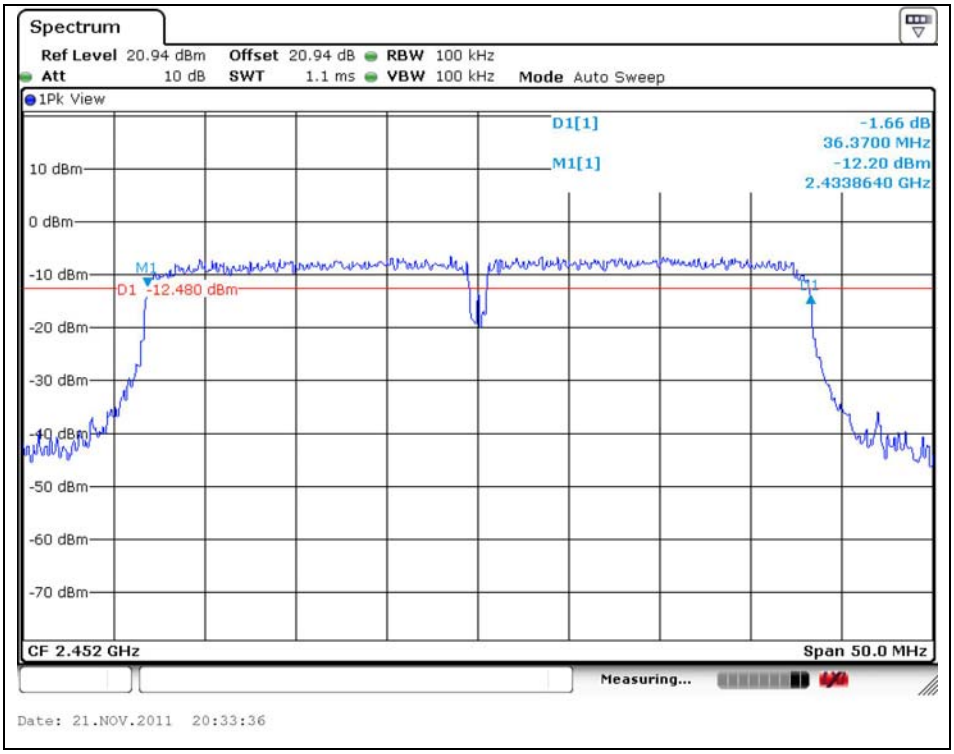
Low Channel



Middle Channel



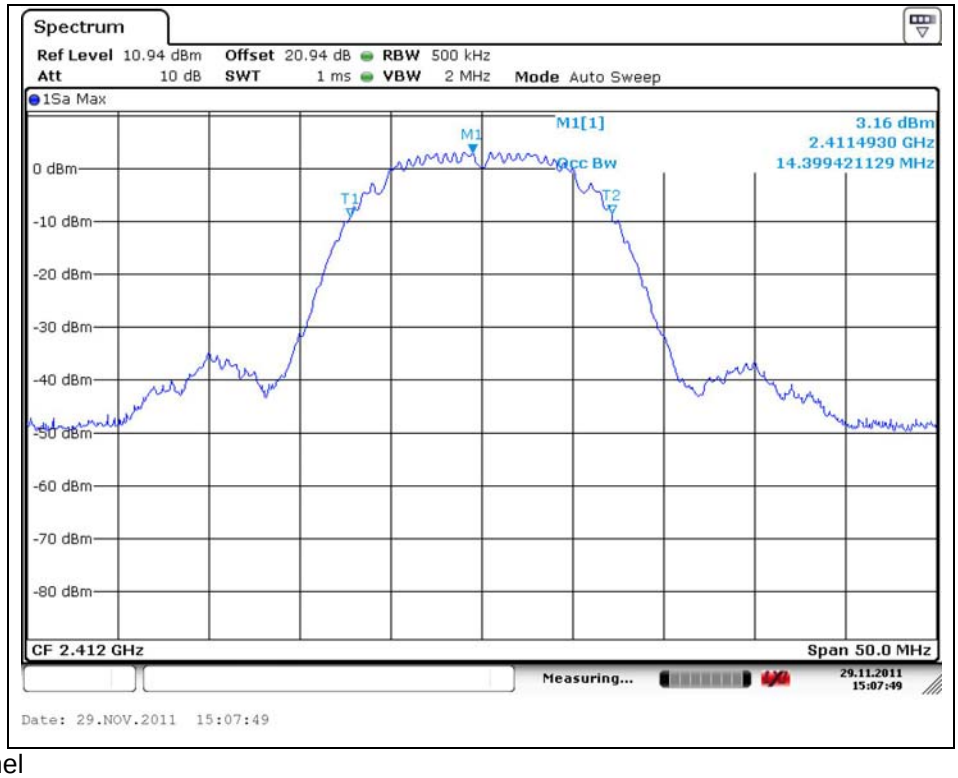
High Channel



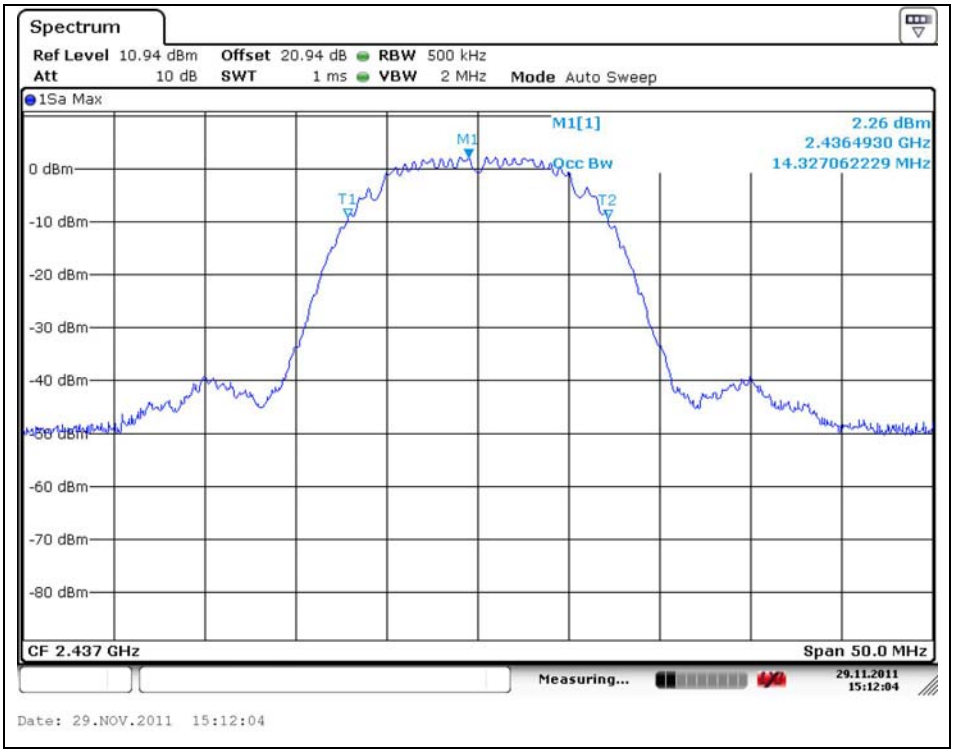
99% Bandwidth

DSSS : 802.11b

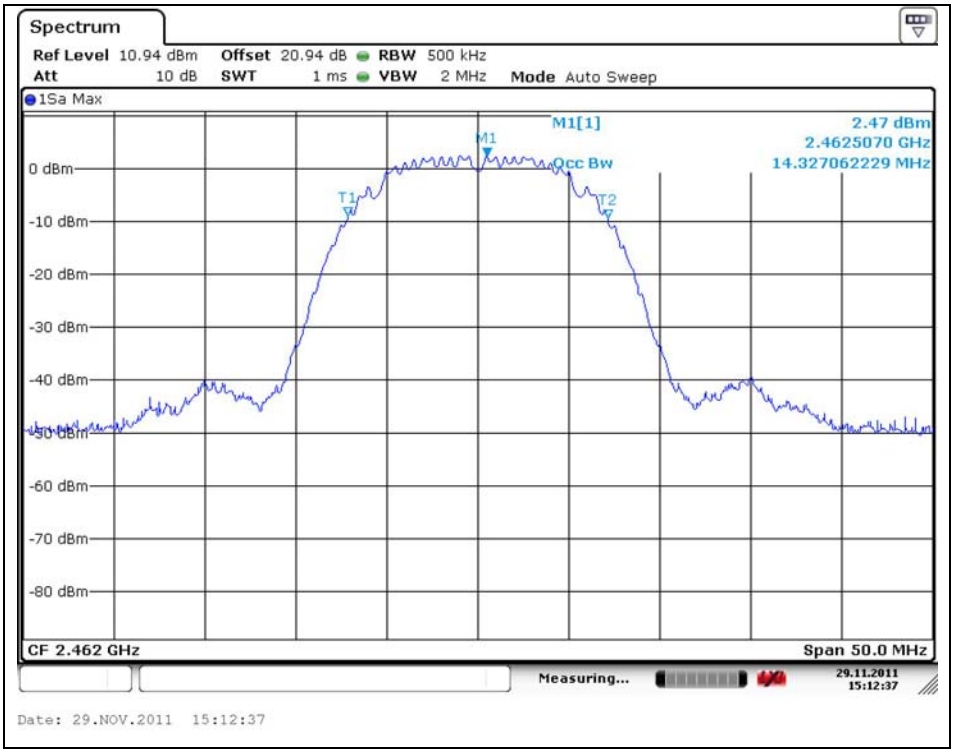
Low Channel



Middle Channel

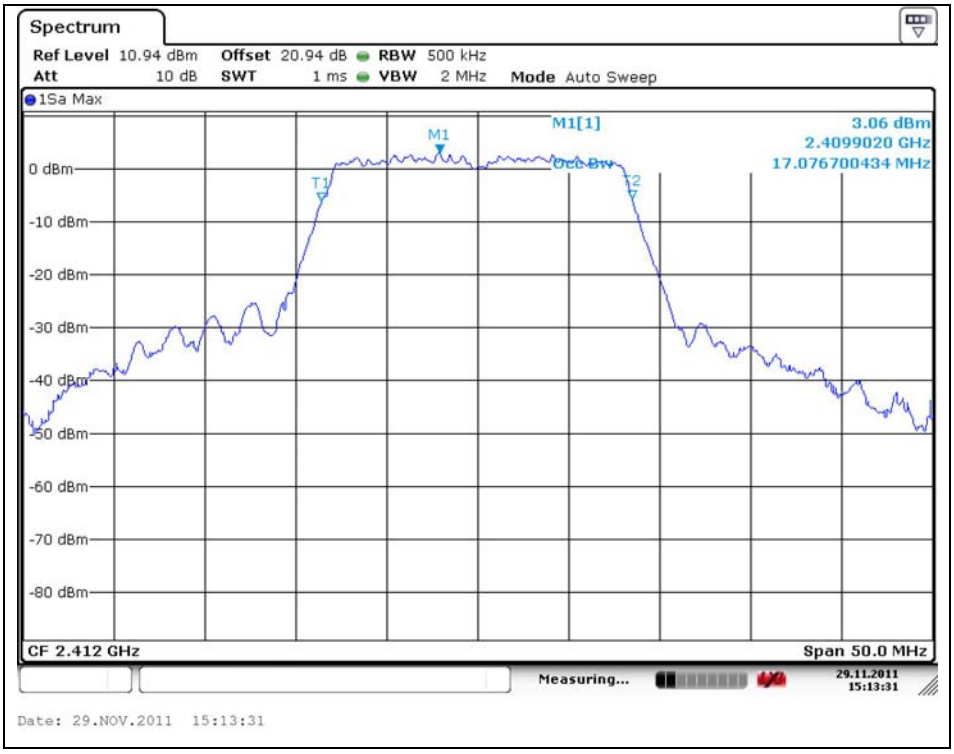


High Channel

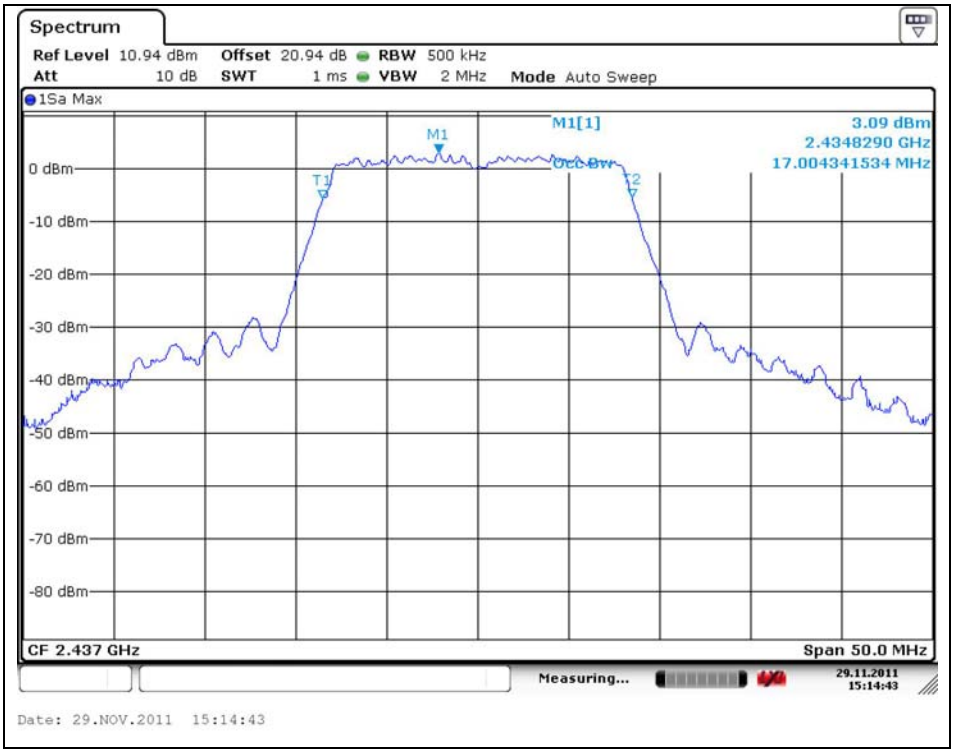


OFDM : 802.11g

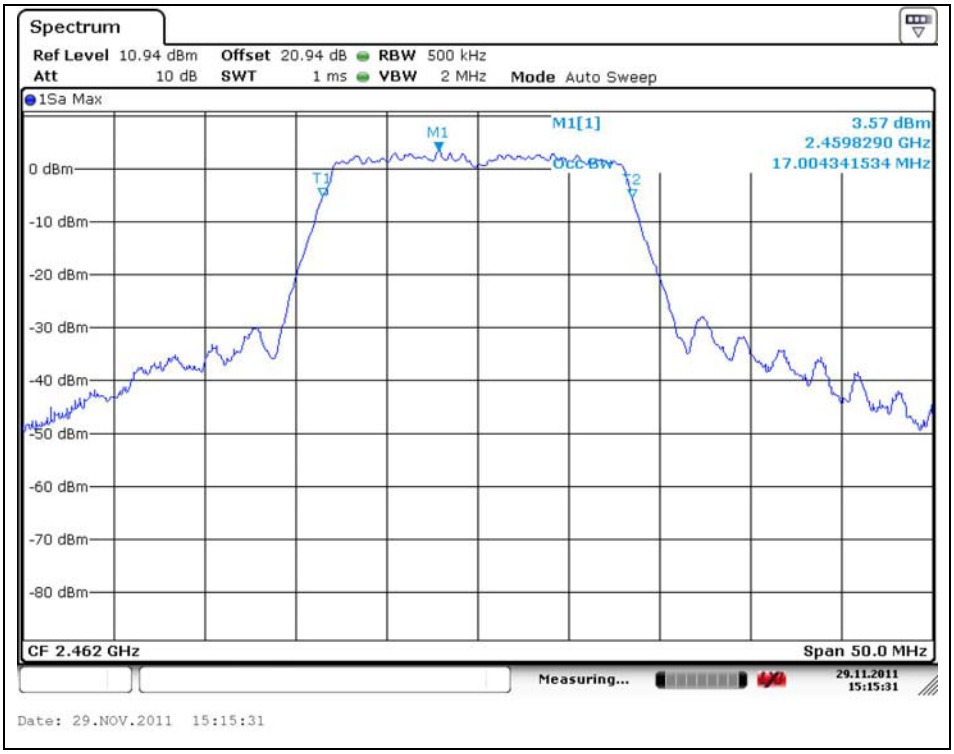
Low Channel



Middle Channel

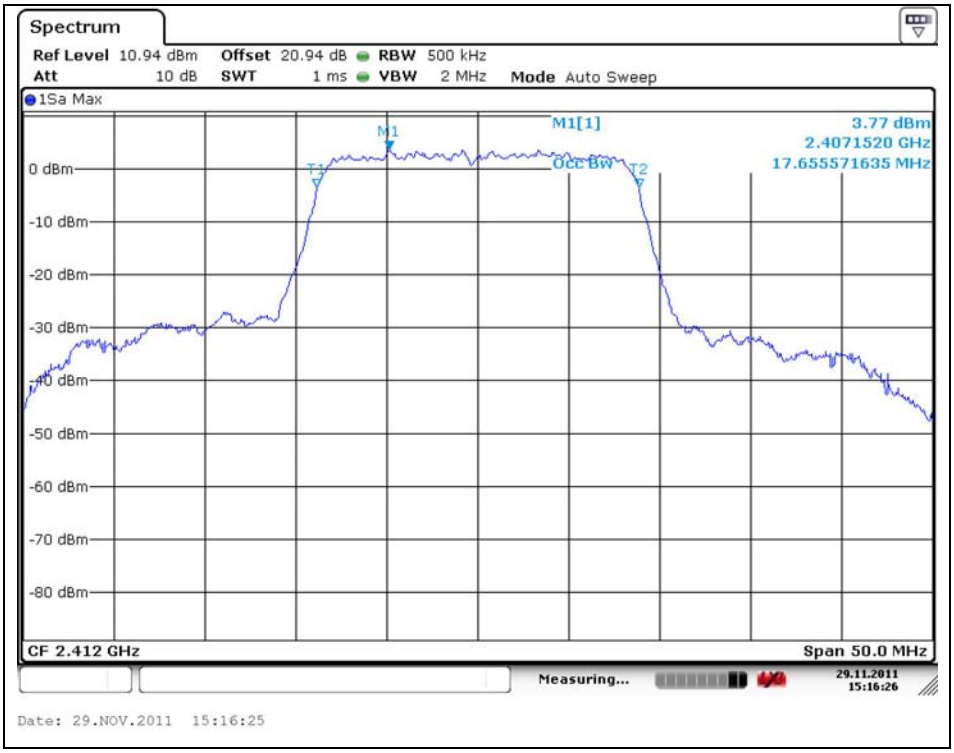


High Channel

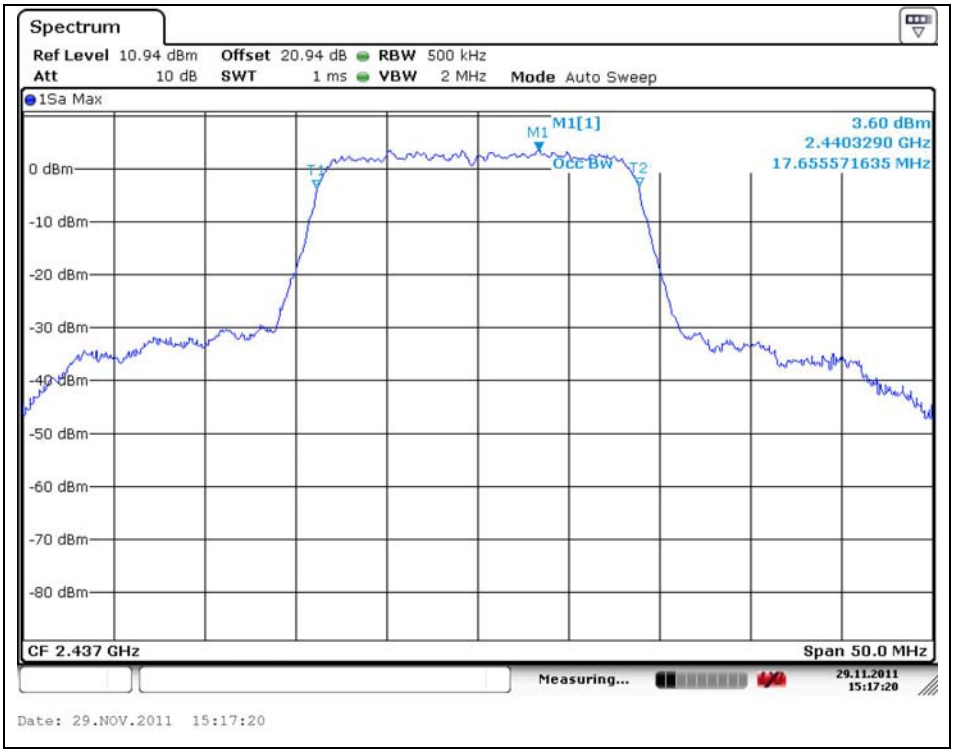


OFDM : 802.11n_HT20

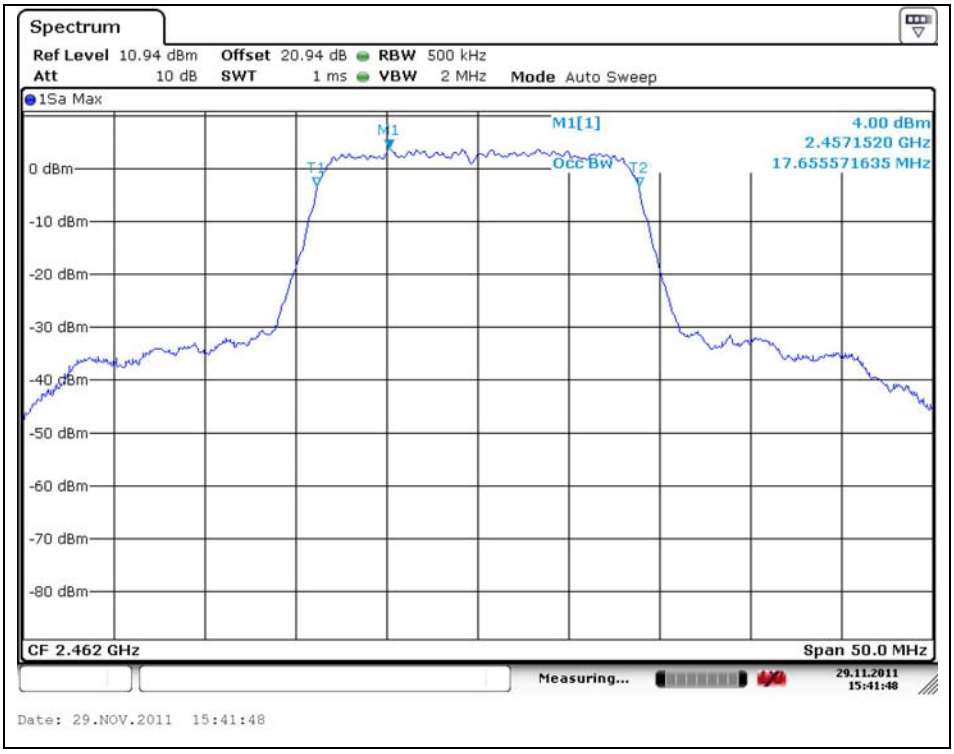
Low Channel



Middle Channel

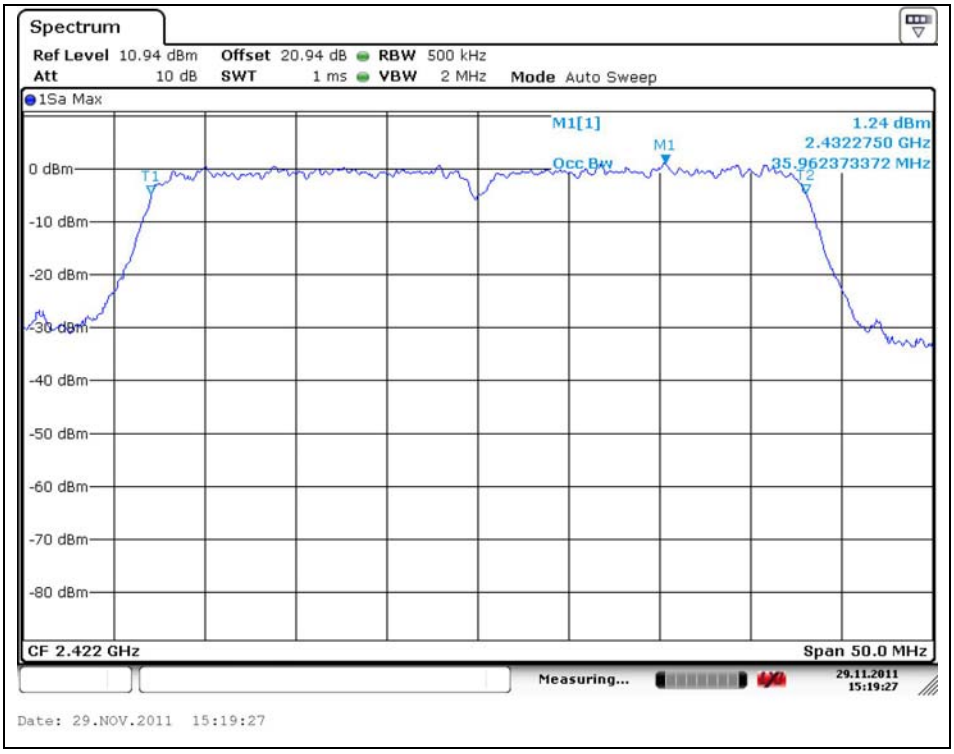


High Channel

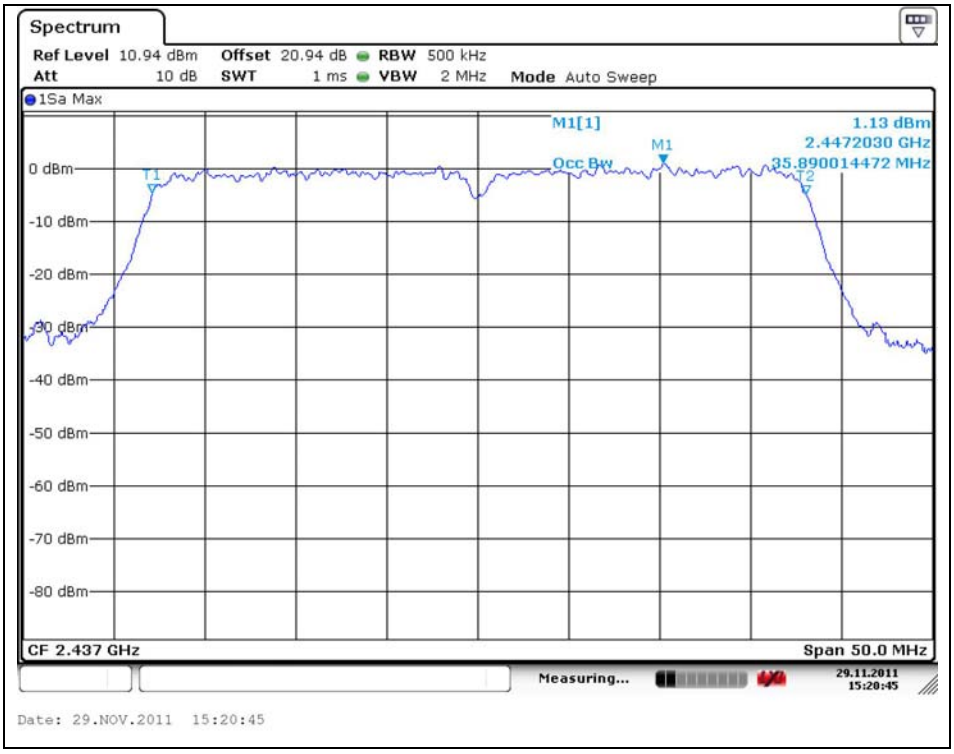


OFDM : 802.11n_HT40

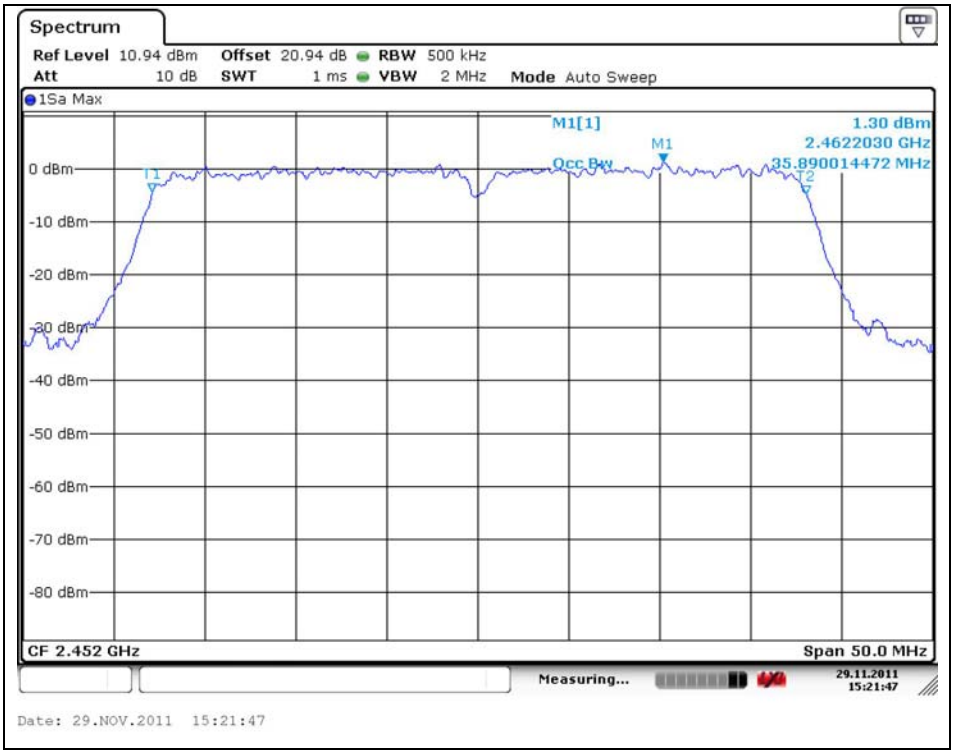
Low Channel



Middle Channel



High Channel



5. Maximum Peak Output Power Measurement

5.1. Test Setup

5.2. 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.

5.3. Test Procedure

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 spectrum analyzer.
3. The spectrum analyzer is set to the peak power detection.

5.4. Test Results

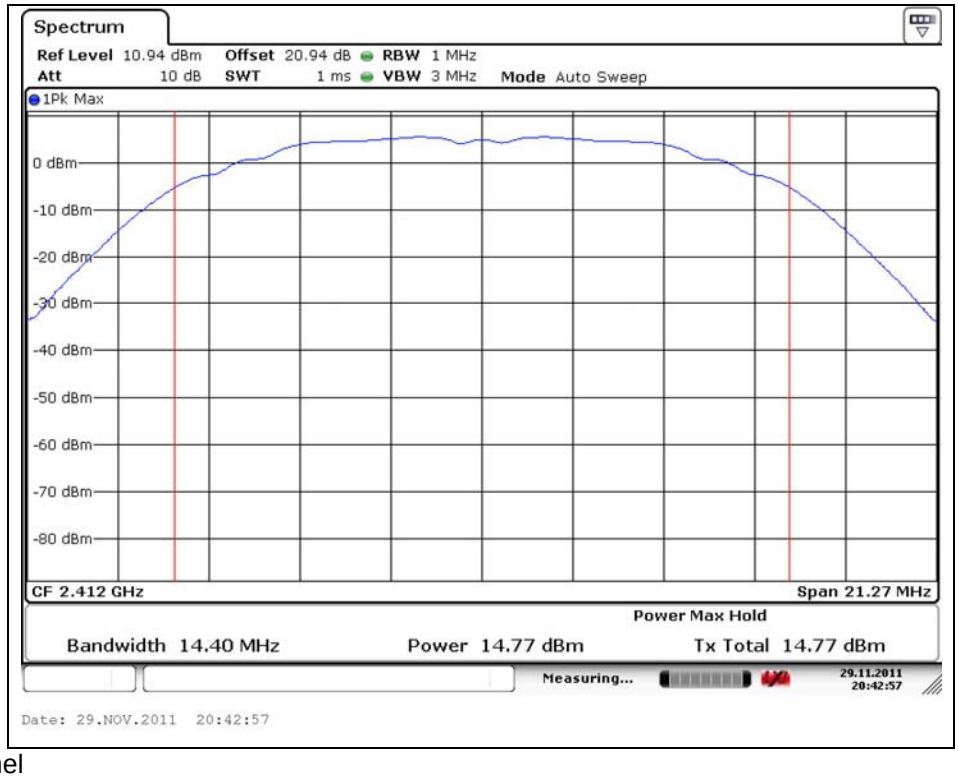
Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Channel Frequency (㎒)	Peak Power Output (㏈m)	Peak Power Limit (㏈m)
DSSS (802.11b)	Low	2 412	14.77	30
	Middle	2 437	14.52	30
	High	2 462	14.61	30
OFDM (802.11g)	Low	2 412	17.20	30
	Middle	2 437	17.12	30
	High	2 462	17.63	30
OFDM (802.11n_HT20)	Low	2 412	18.34	30
	Middle	2 437	18.33	30
	High	2 462	18.84	30
OFDM (802.11n_HT40)	Low	2 422	18.58	30
	Middle	2 437	18.28	30
	High	2 452	18.57	30

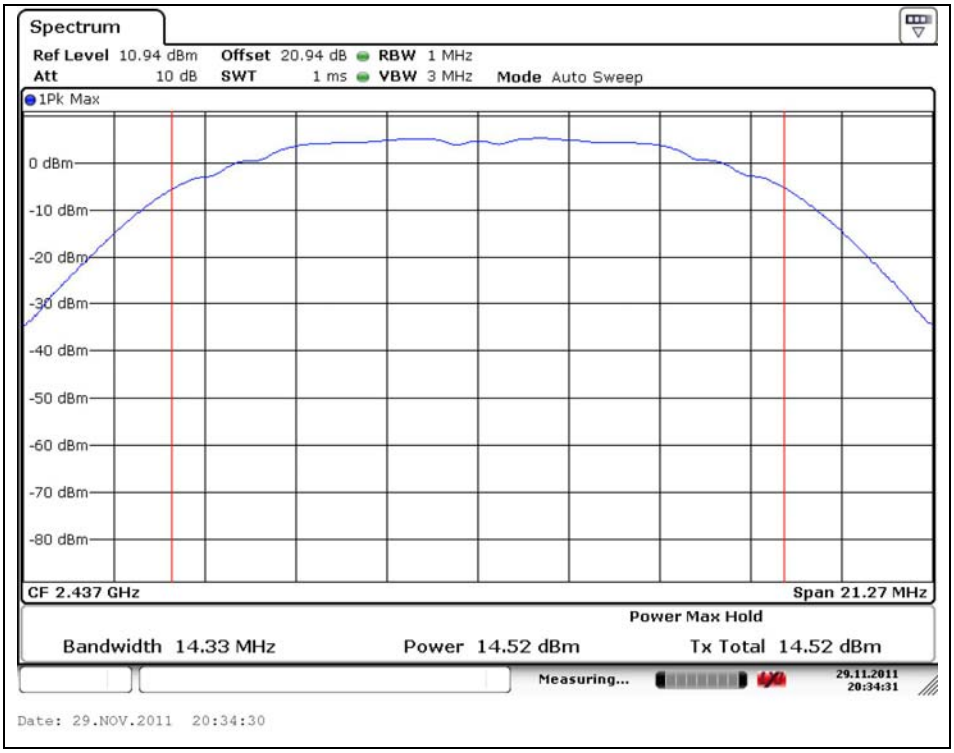
Peak Output Power

DSSS : 802.11b

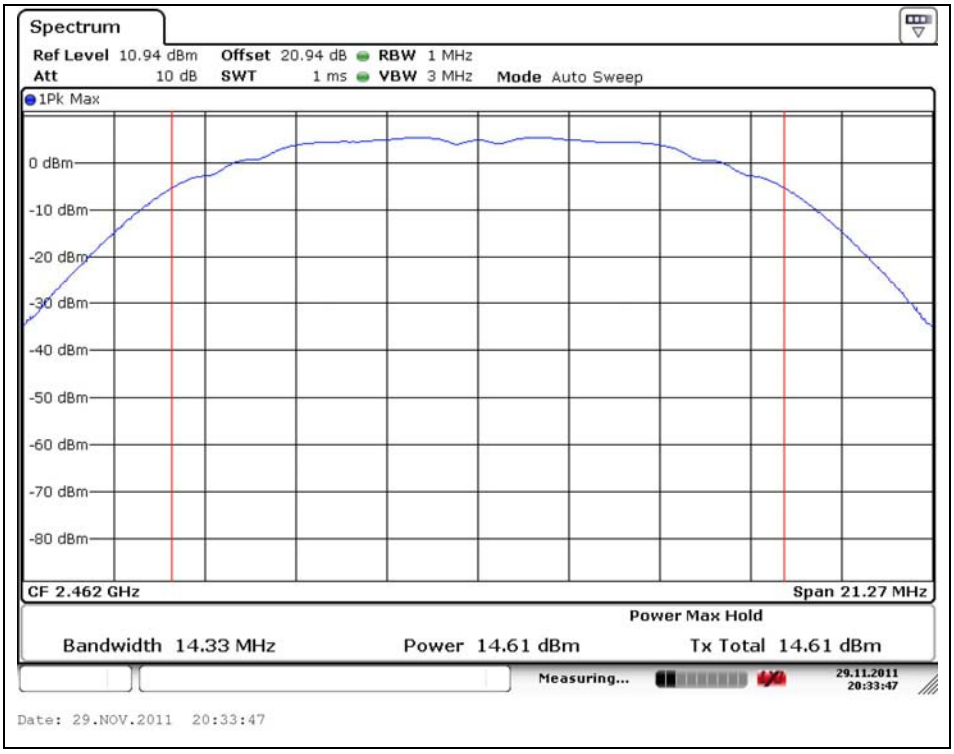
Low Channel



Middle Channel

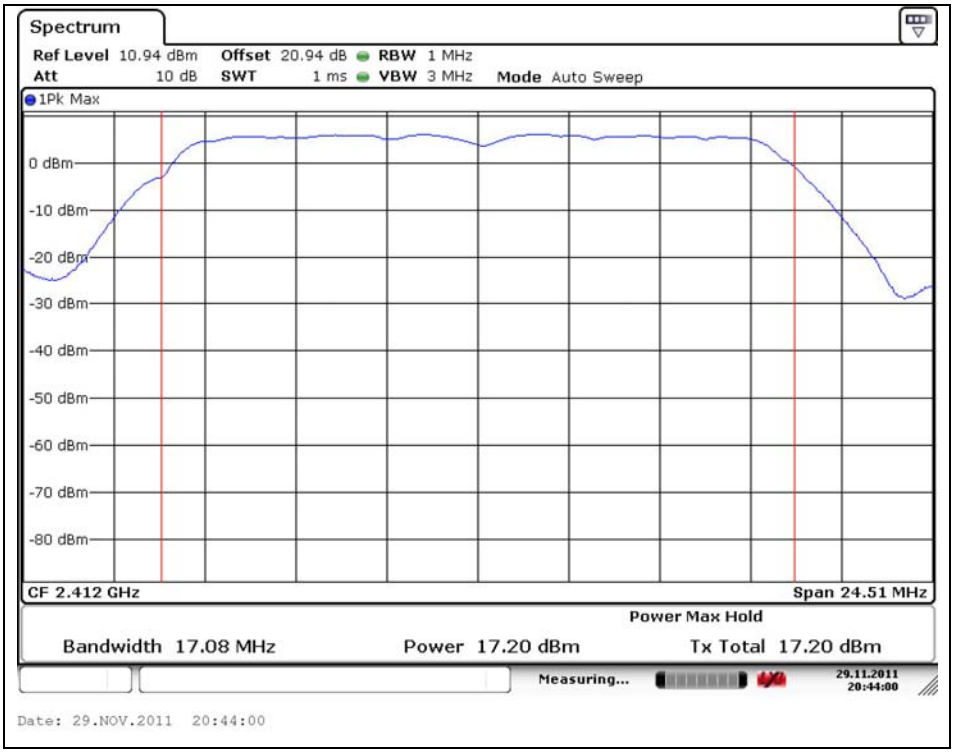


High Channel

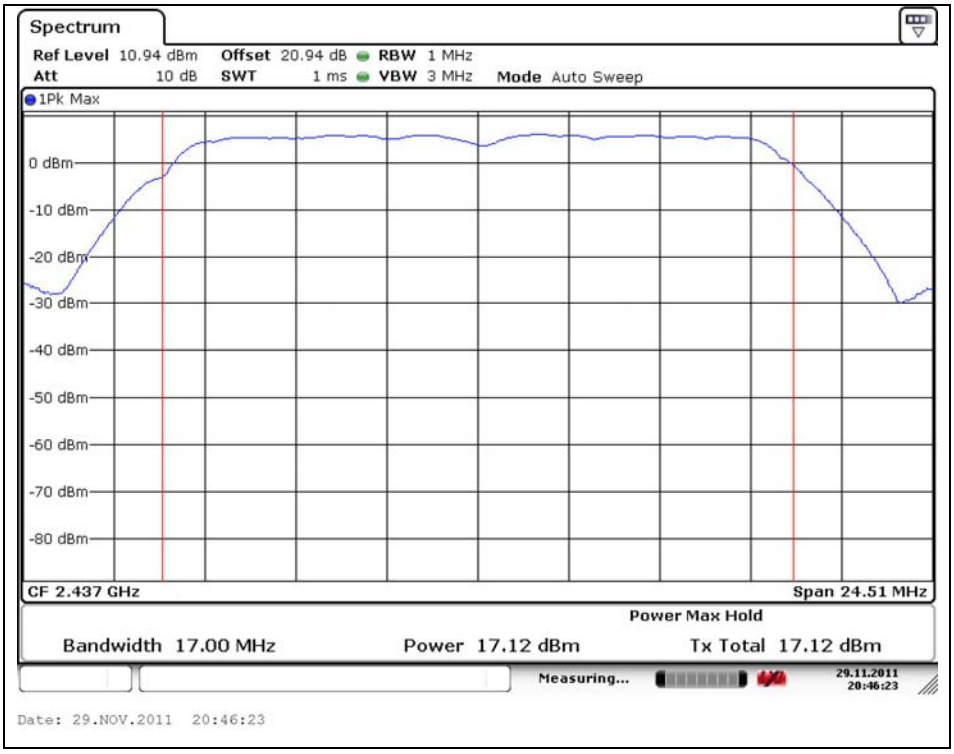


OFDM : 802.11g

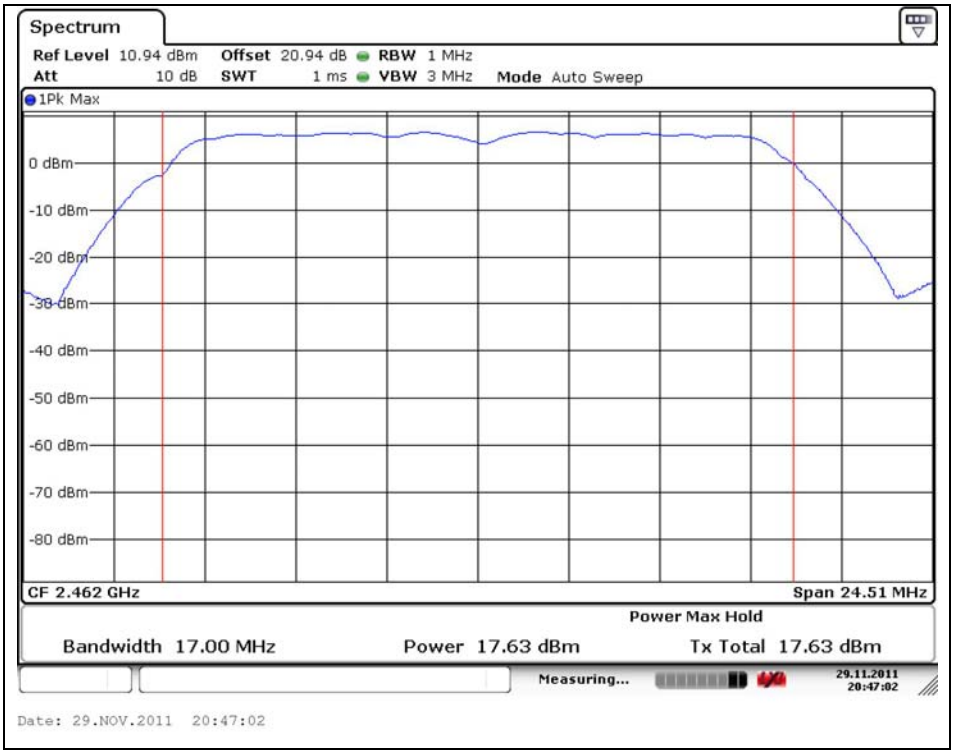
Low Channel



Middle Channel

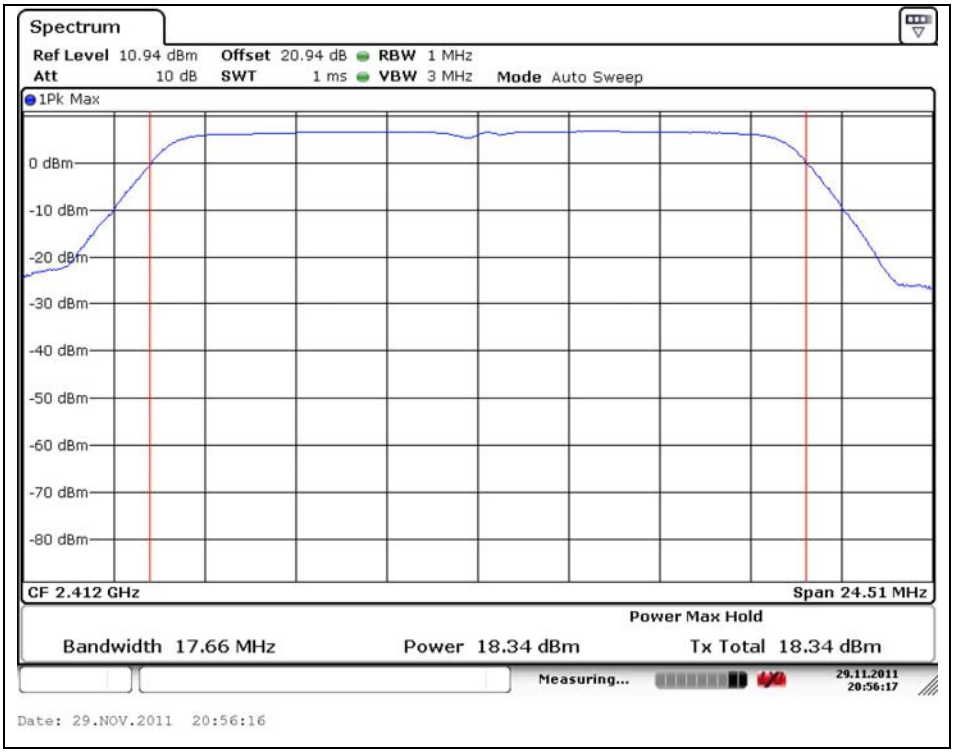


High Channel

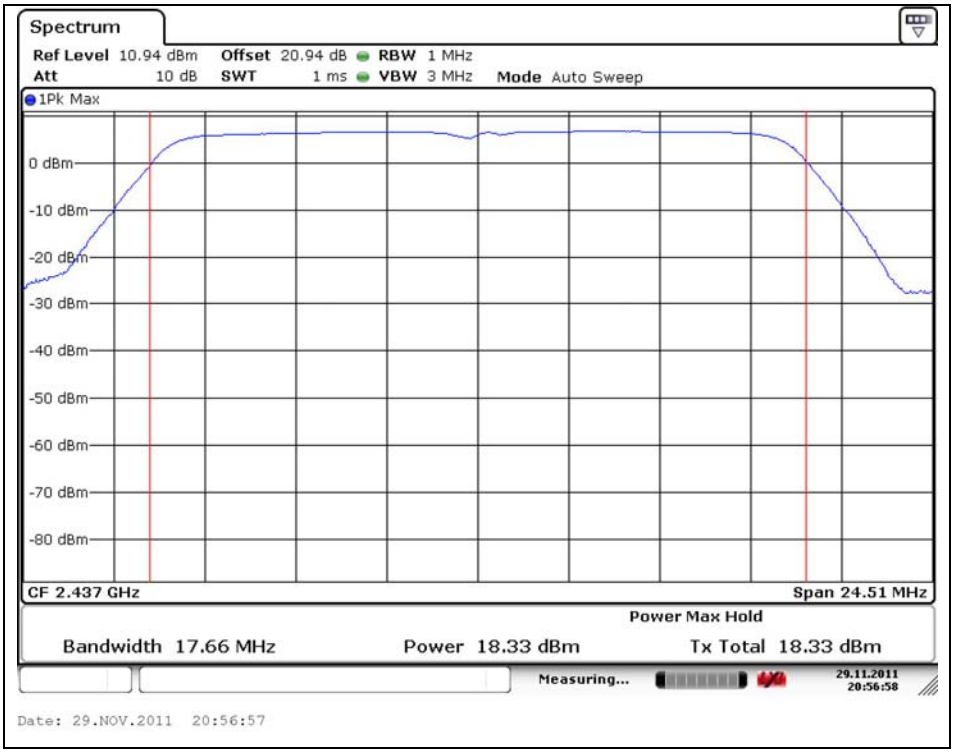


OFDM : 802.11n_HT20

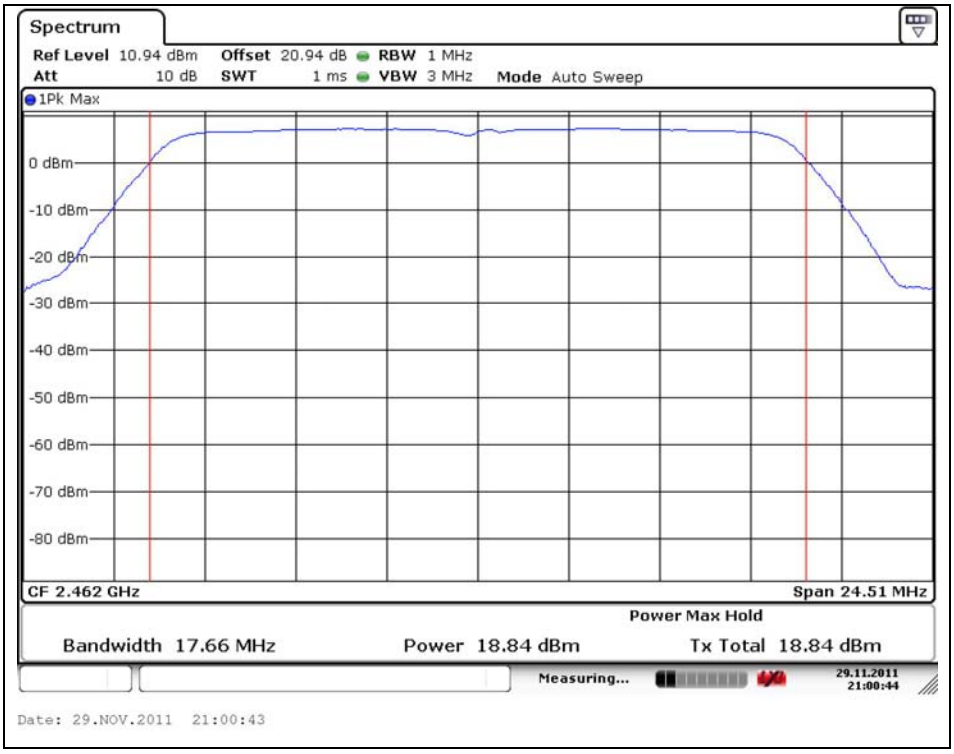
Low Channel



Middle Channel

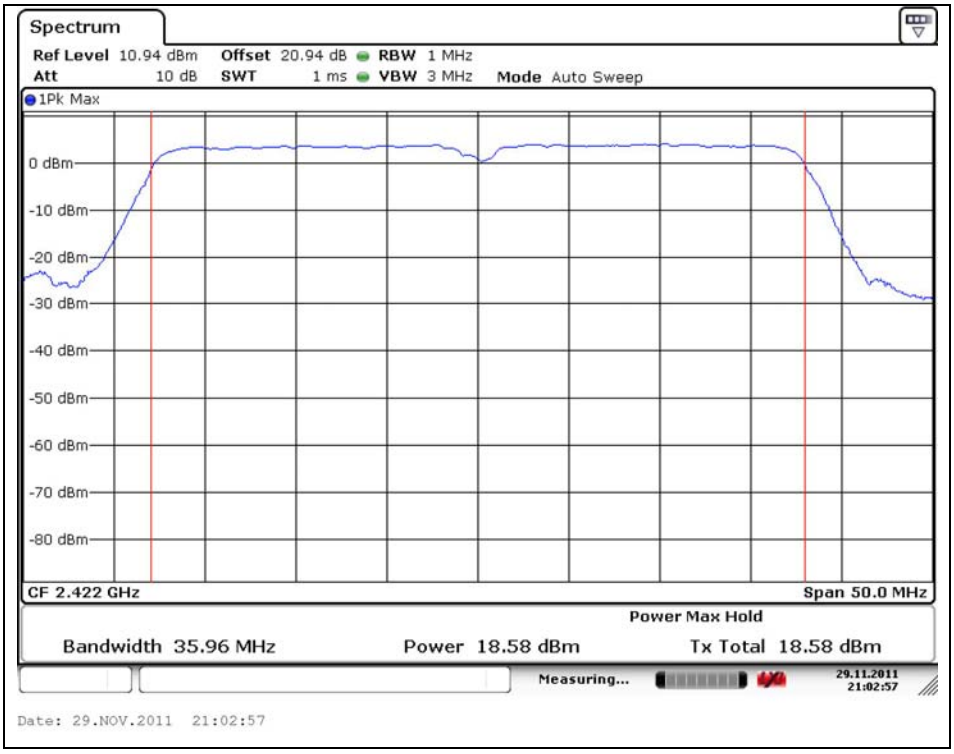


High Channel

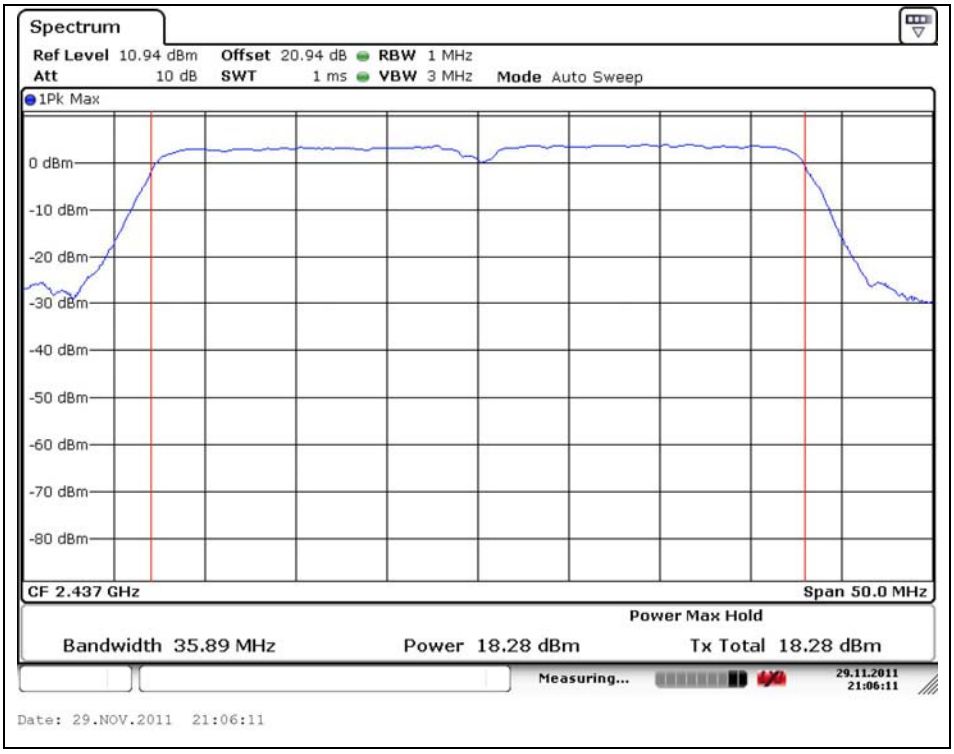


OFDM : 802.11n_HT40

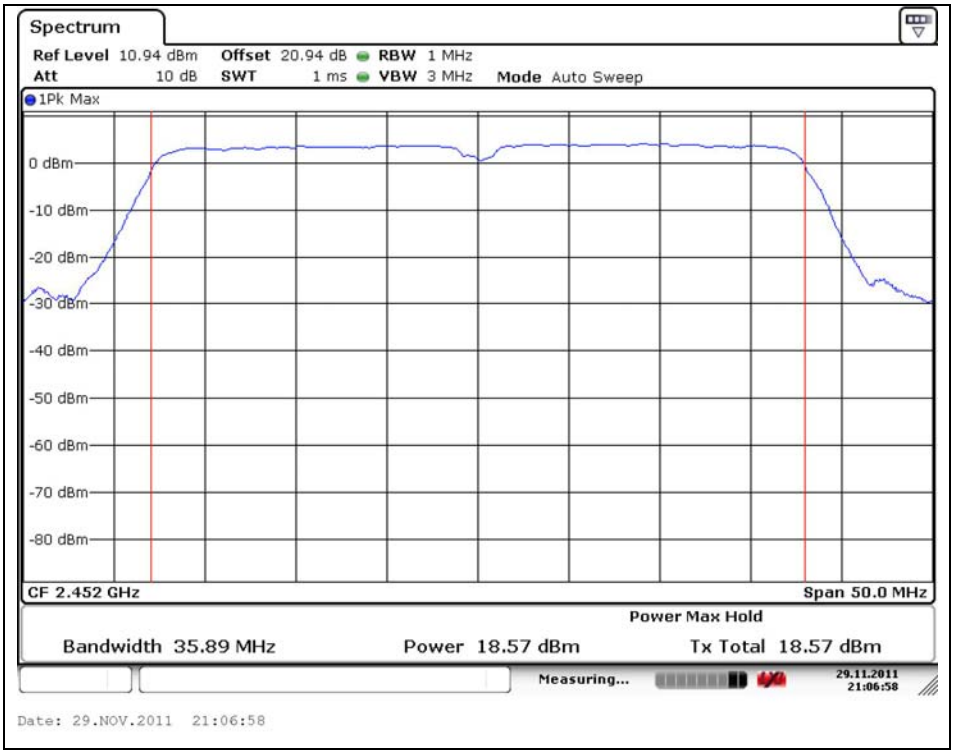
Low Channel



Middle Channel



High Channel



6. POWER SPECTRAL DENSITY MEASUREMENT

6.1. Test Setup

6.2. 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.

6.3. Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the Max Hold function record the separation of adjacent channels.
4. Repeat above procedures until all frequencies measured were complete.
5. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using ; RBW = 3 ㎑, VBW = 10 ㎑, Span = 150 ㎑ and Sweep = 100 s.

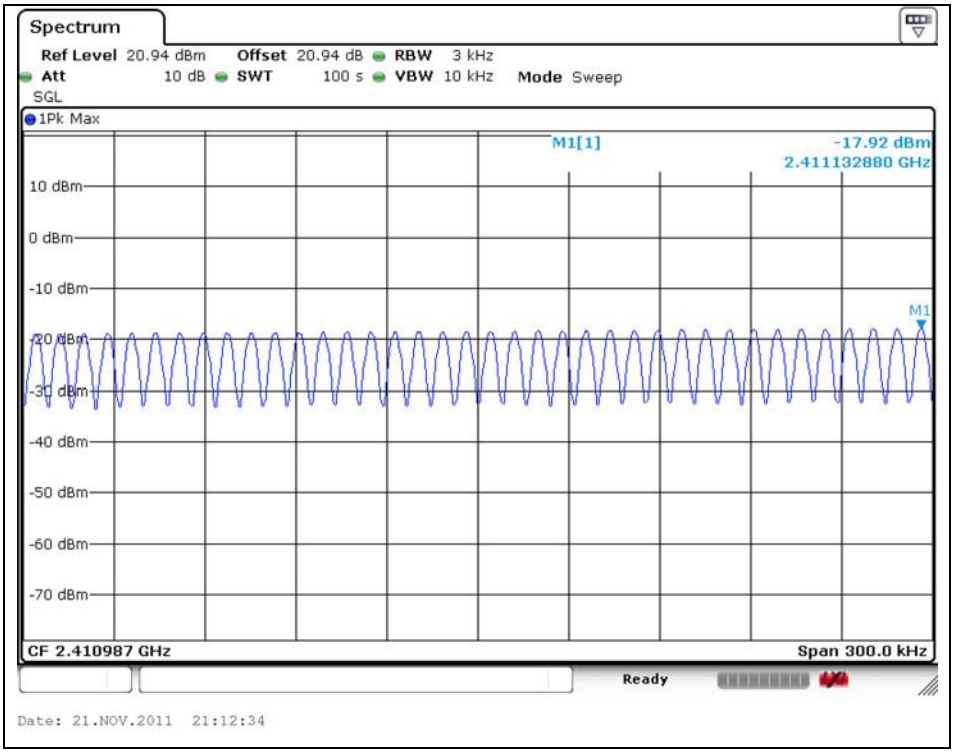
6.4. Test Results

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

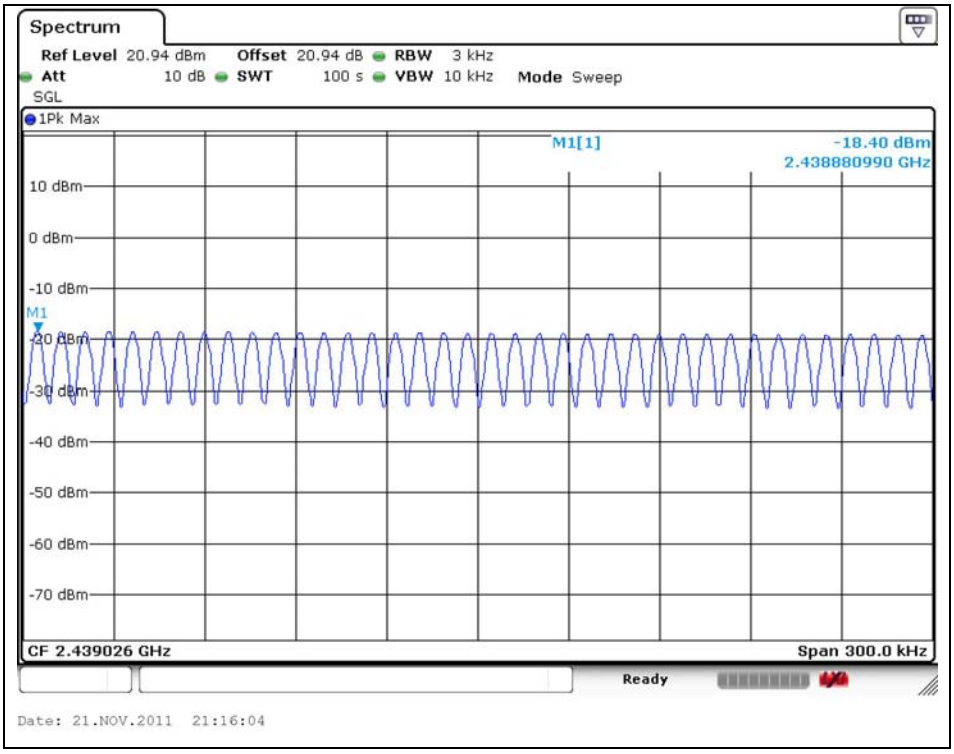
Operation Mode	Frequency	Final RF Power Level in 3 ㎑ BW (㏈m)	Maximum Limit (㏈m)
DSSS (802.11b)	2 412 ㎒	-17.92	8
	2 437 ㎒	-18.40	8
	2 462 ㎒	-18.01	8
OFDM (802.11g)	2 412 ㎒	-20.15	8
	2 437 ㎒	-19.17	8
	2 462 ㎒	-18.61	8
OFDM (802.11n_HT20)	2 412 ㎒	-18.82	8
	2 437 ㎒	-18.94	8
	2 462 ㎒	-18.17	8
OFDM (802.11n_HT40)	2 422 ㎒	-18.28	8
	2 437 ㎒	-19.76	8
	2 452 ㎒	-21.50	8

DSSS : 802.11b

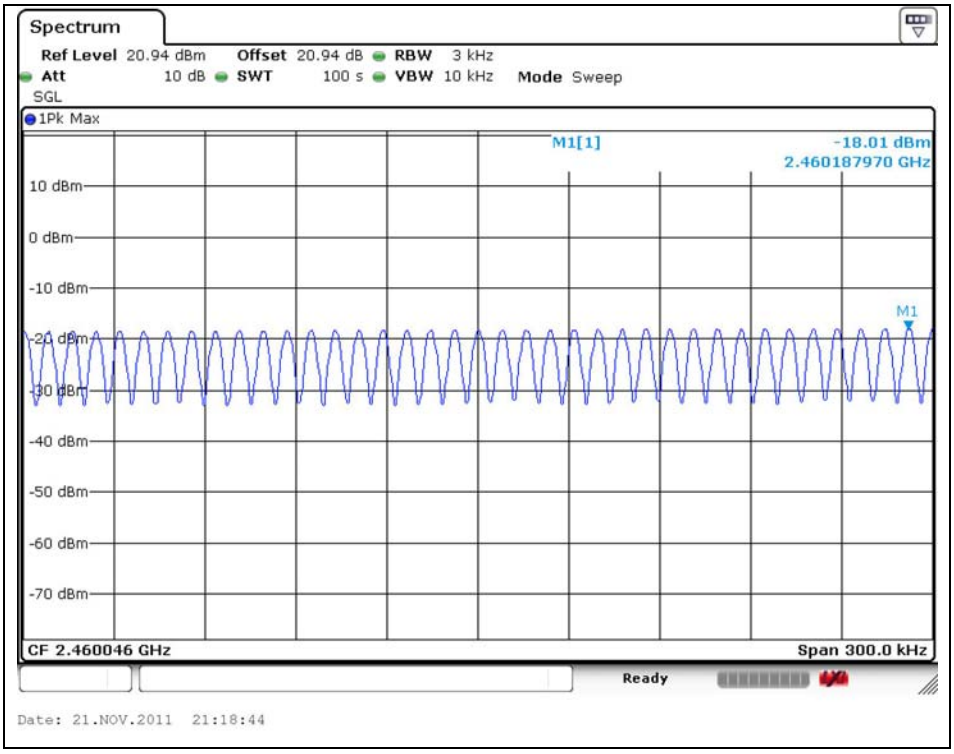
Low Channel



Middle Channel

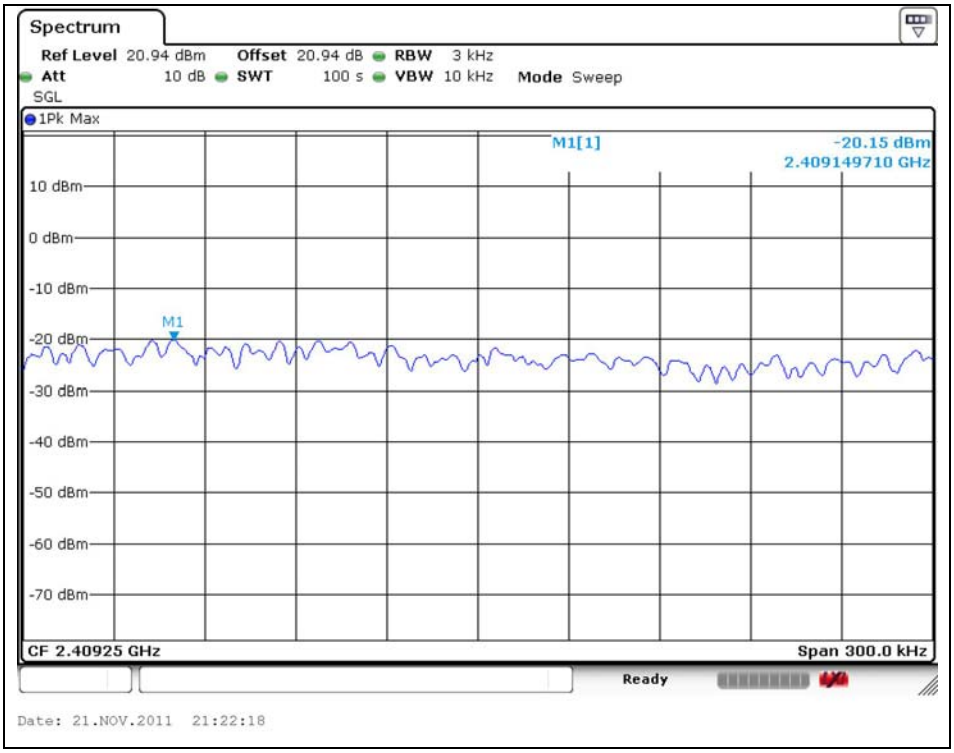


High Channel

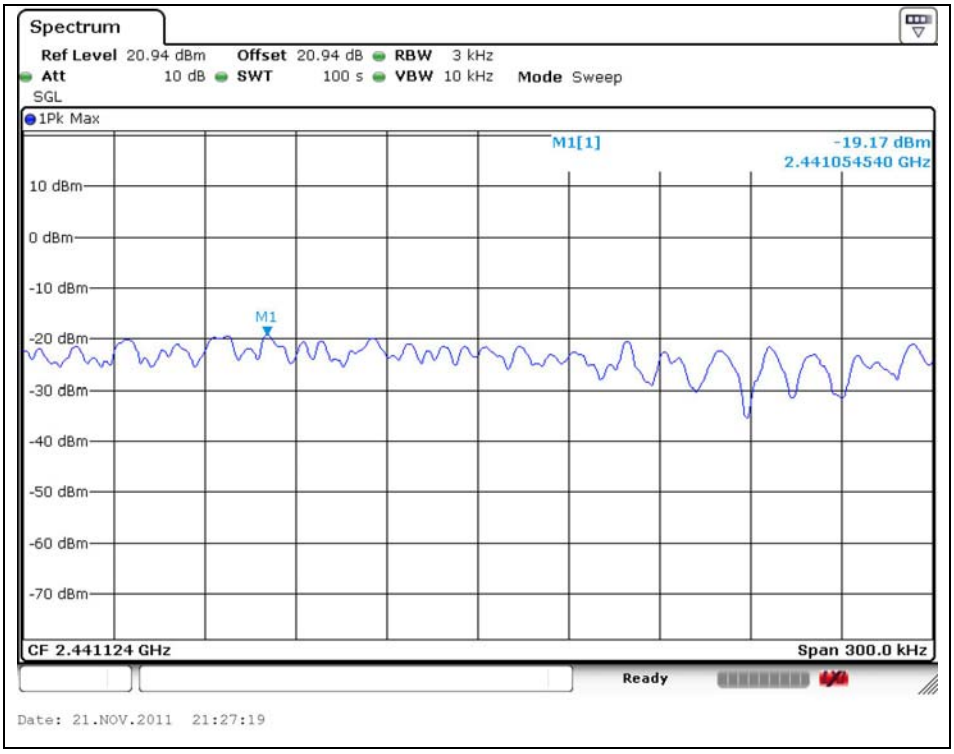


OFDM : 802.11g

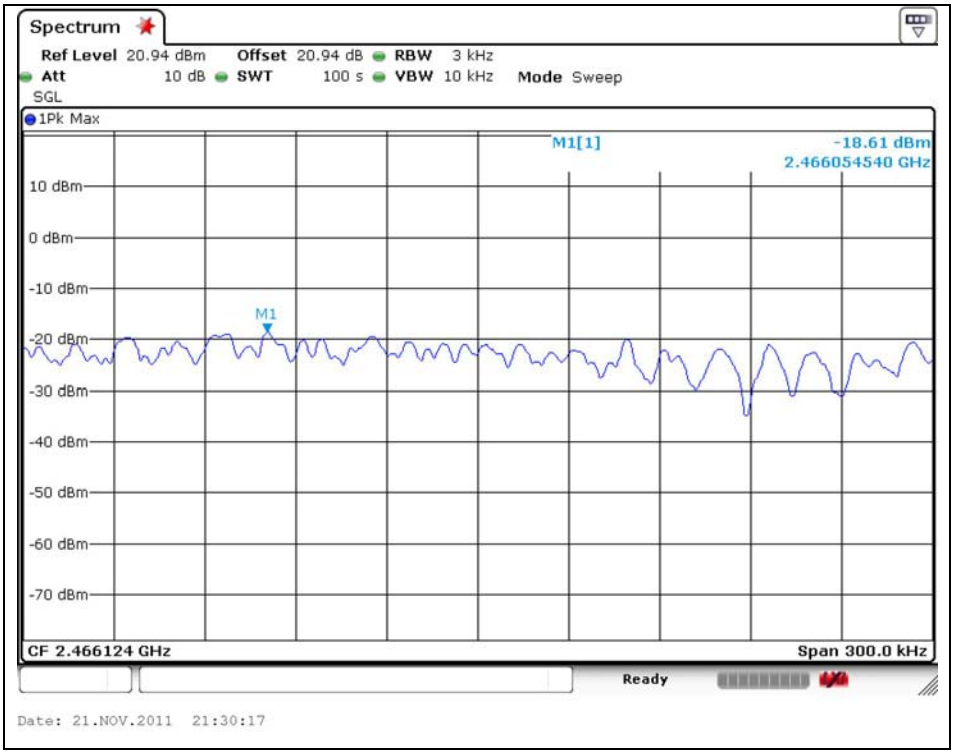
Low Channel



Middle Channel

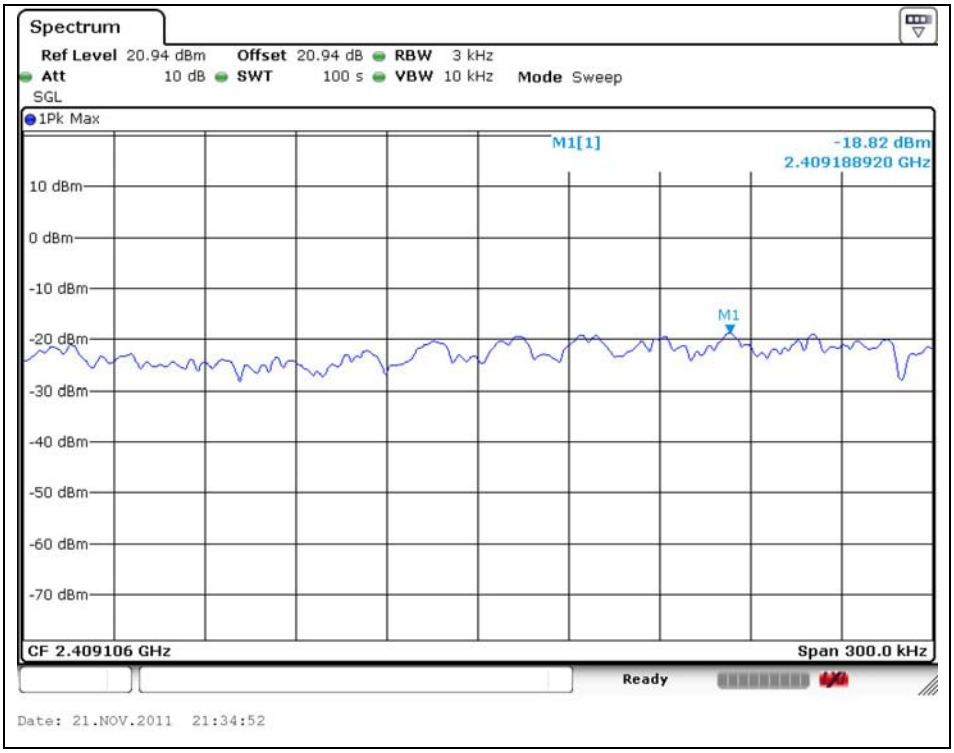


High Channel

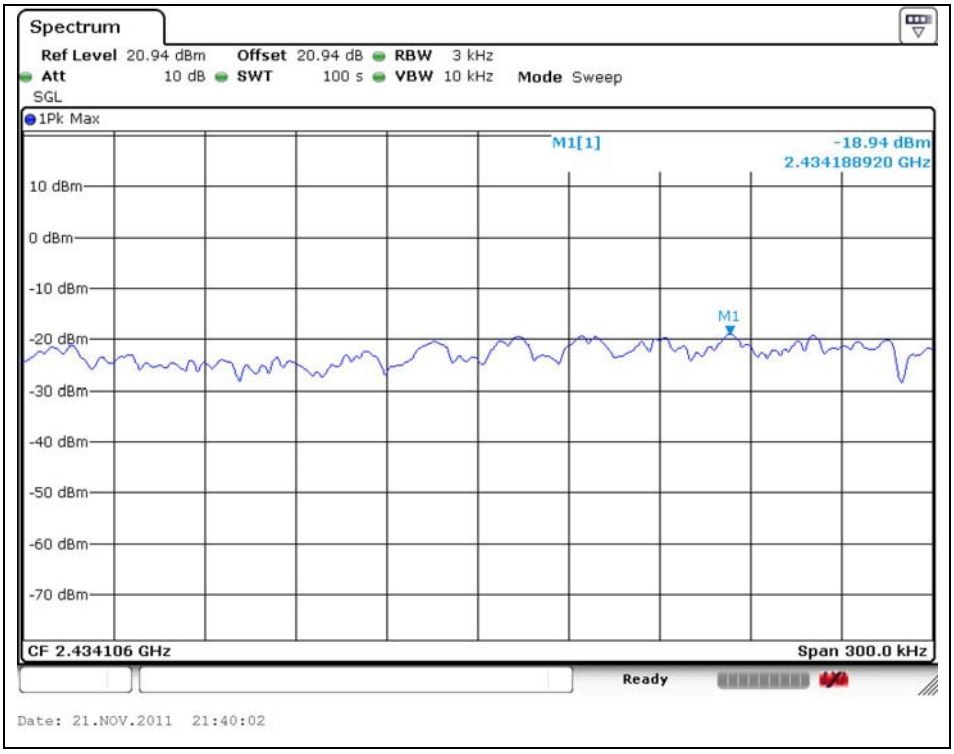


OFDM : 802.11n_HT20

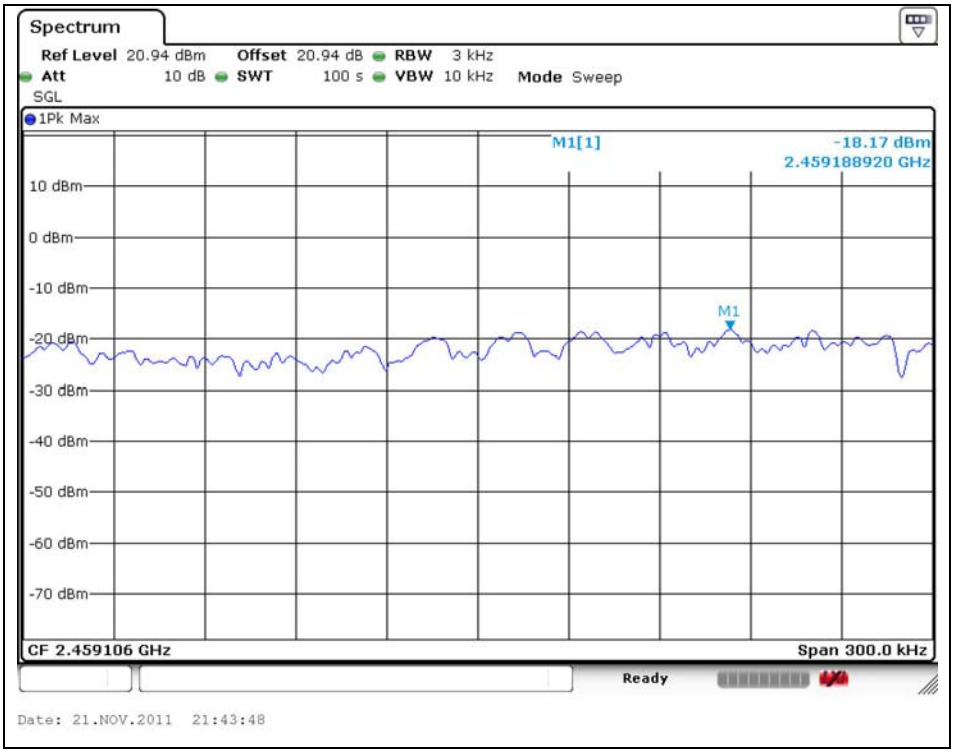
Low Channel



Middle Channel

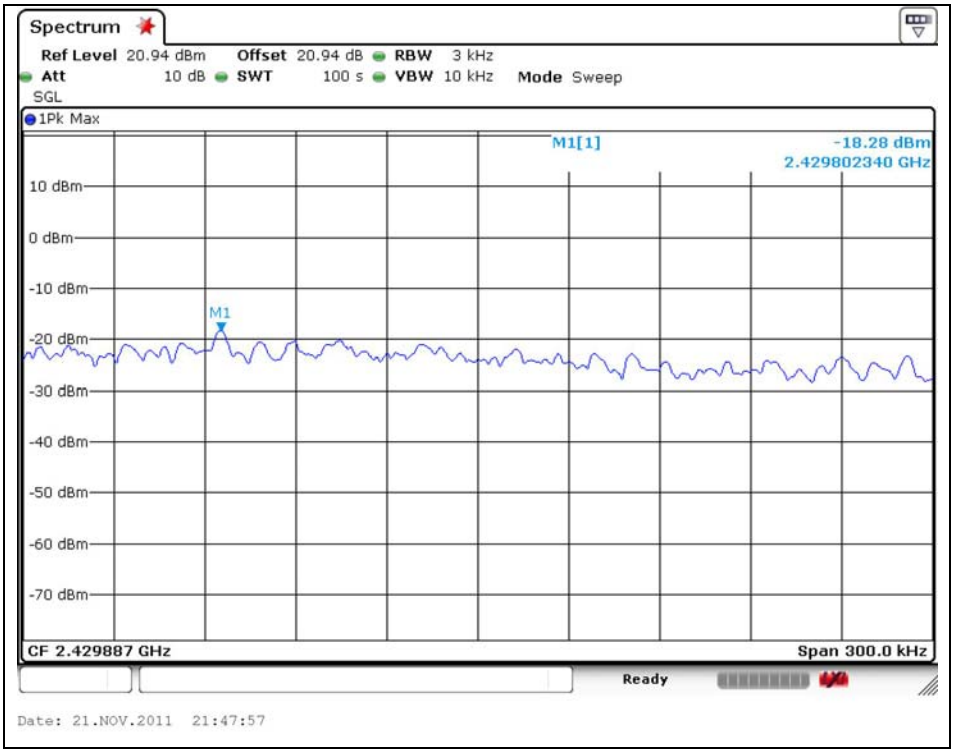


High Channel

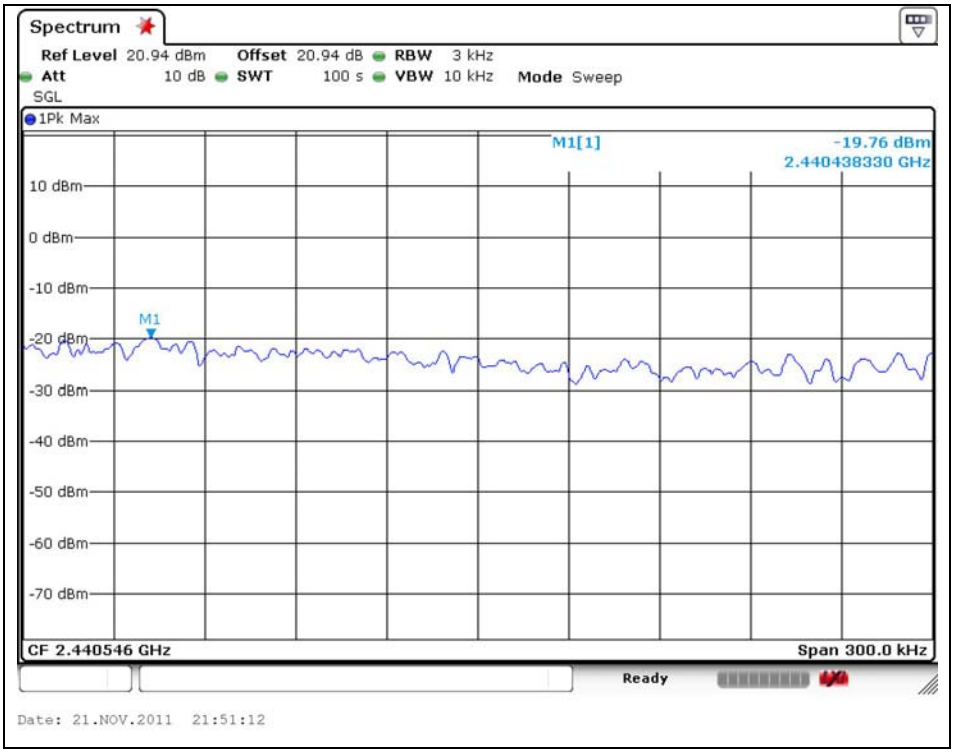


OFDM : 802.11n_HT40

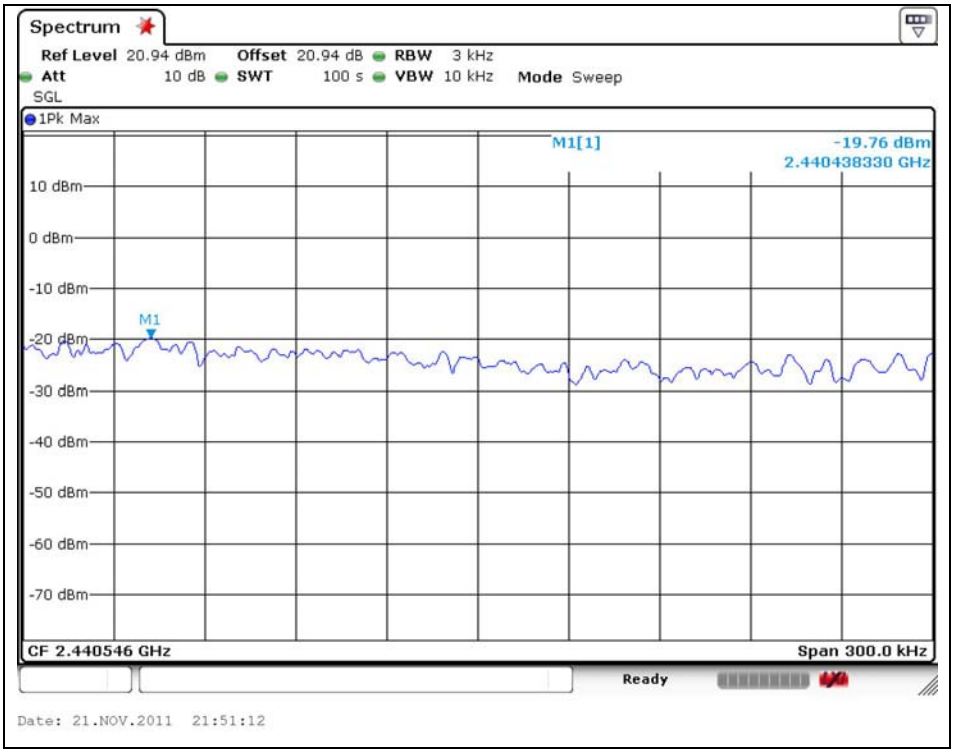
Low Channel



Middle Channel

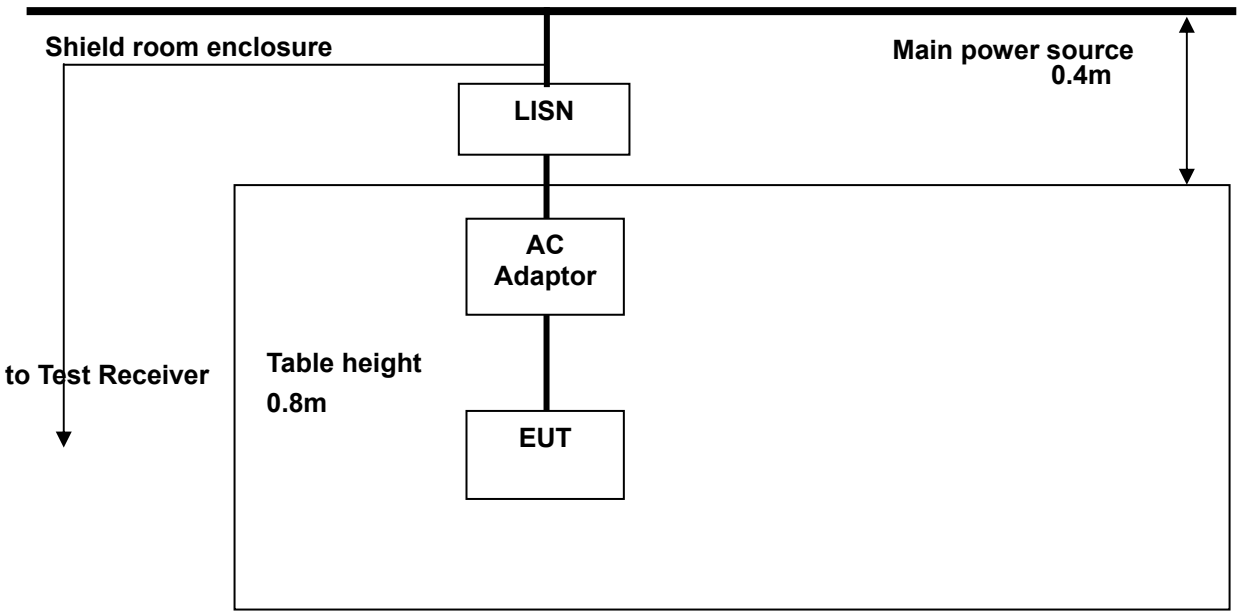


High Channel



7. Transmitter AC Power Line Conducted Emission

7.1. Test Setup



7.2. 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 (㏈㎶)	
	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.

7.3. Test Procedures

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

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. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

7.4. Test Results (Worst case configuration_11g mode)

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.

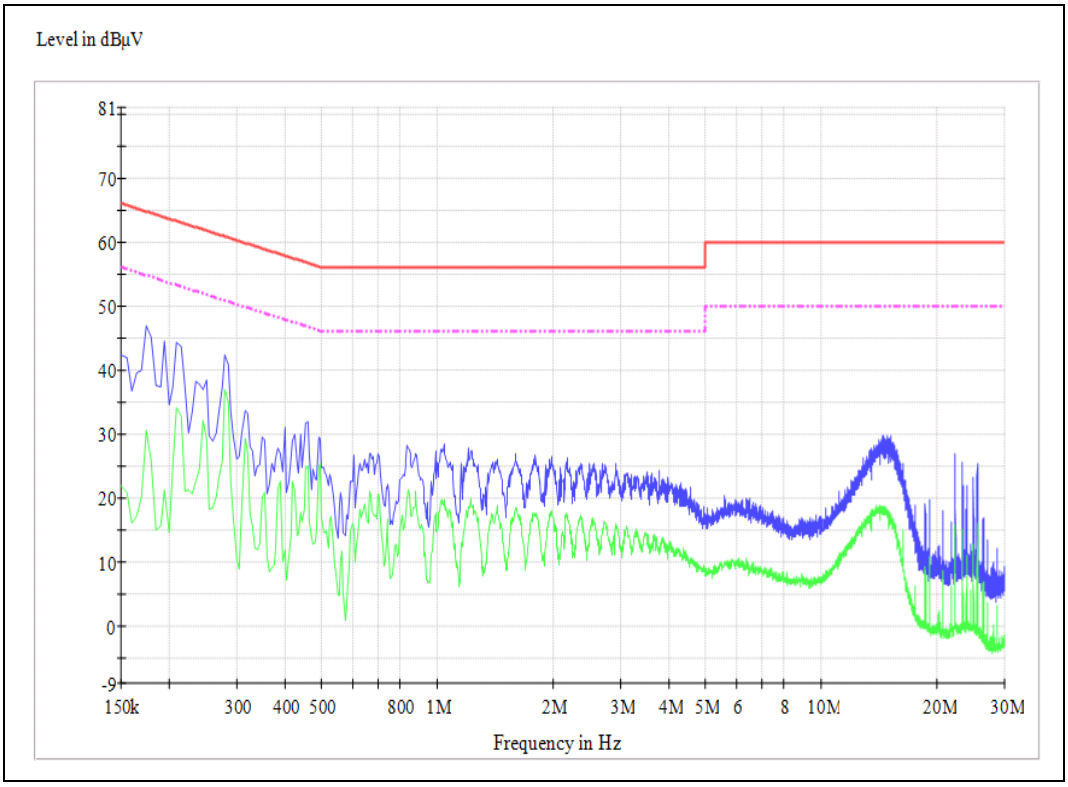
Frequency range : 0.15 ㎒ – 30 ㎒
Measured Bandwidth : 9 ㎑

FREQ.	LEVEL(dB㎶)		LINE	LIMIT(dB㎶)		MARGIN(dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.18	45.71	30.95	H	64.72	54.72	19.01	23.77
0.21	42.43	35.19	H	63.21	53.21	20.78	18.02
0.28	40.31	37.89	H	60.82	50.82	20.51	12.93
0.46	27.87	25.07	H	56.69	46.69	28.82	21.63
14.48	24.21	18.61	H	60.00	50.00	35.80	31.39
0.16	41.93	28.93	N	65.73	55.73	23.80	26.80
0.28	44.56	43.18	N	60.82	50.82	16.25	7.63
0.45	32.73	25.44	N	56.97	46.97	24.23	21.52
0.65	29.21	23.56	N	56.00	46.00	26.79	22.44
15.07	28.81	23.54	N	60.00	50.00	31.19	26.46

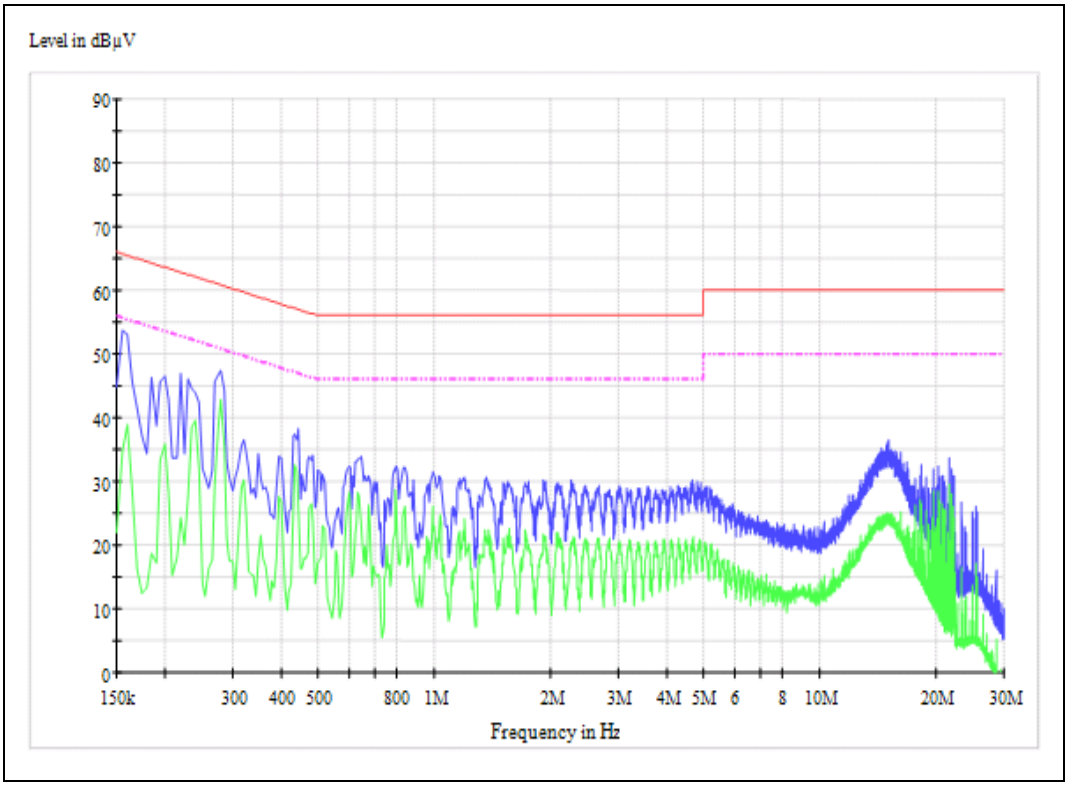
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)



8. Receiver AC Power Line Conducted Emission

8.1. Test Setup- Same as clause 7.1.

8.2. Limit

According to §15.107(a) Except for Class A digital devices, for equipment 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 μH/50 oh ㎳ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency of Emission (㎒)	Conducted limit (㏈μV)	
	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.

8.3. Test Procedures- Same as clause 7.3.

8.4. Test Results

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

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

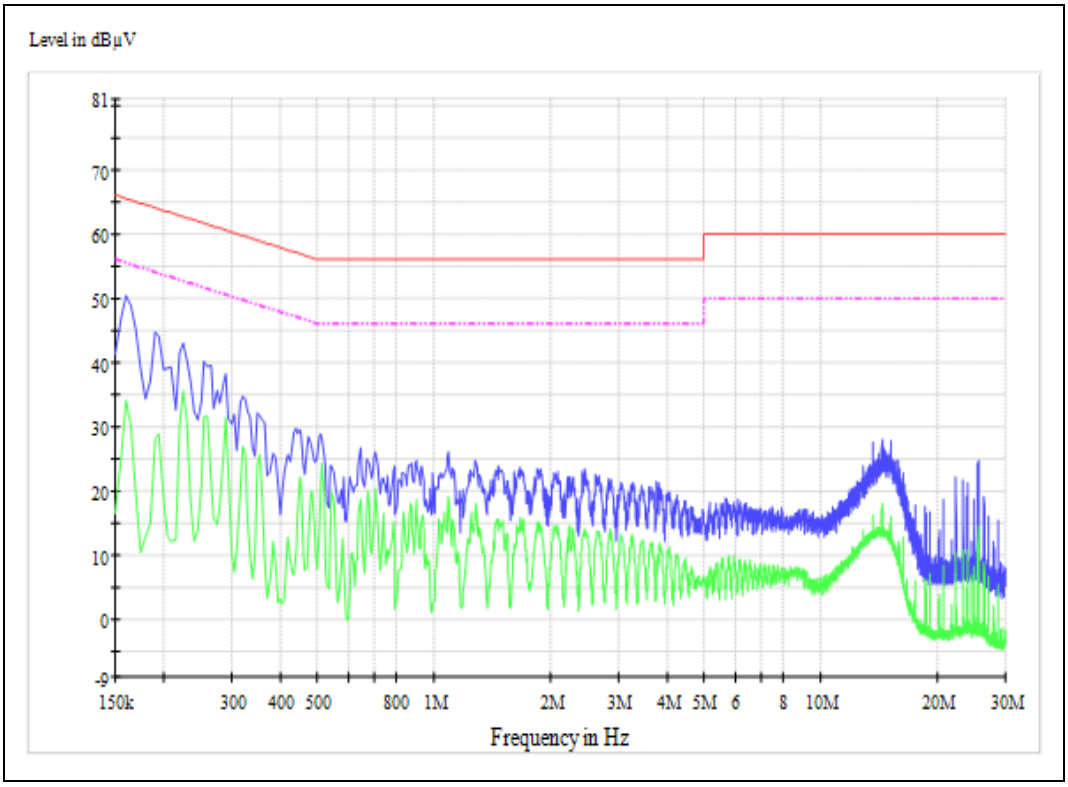
Frequency range : 0.15 ㎒ – 30 ㎒
Measured Bandwidth : 9 ㎑

FREQ.	LEVEL(dB㎶)		LINE	LIMIT(dB㎶)		MARGIN(dB)	
(㎒)	Q-Peak	Average		Q-Peak	Average	Q-Peak	Average
0.16	48.82	34.15	H	65.46	55.46	16.65	21.31
0.19	42.45	30.02	H	64.04	54.04	21.58	24.01
0.23	40.64	35.47	H	62.63	52.63	21.99	17.16
0.26	37.82	32.24	H	61.59	51.59	23.75	19.35
14.39	20.75	14.84	H	60.00	50.00	39.25	35.16
0.15	49.31	35.50	N	66.00	56.00	16.69	20.50
0.18	47.03	33.34	N	64.49	54.49	17.45	21.14
0.22	41.57	34.80	N	62.82	52.82	21.25	18.02
0.29	39.88	38.33	N	60.52	50.52	20.65	12.20
15.50	25.01	18.57	N	60.00	50.00	34.99	31.43

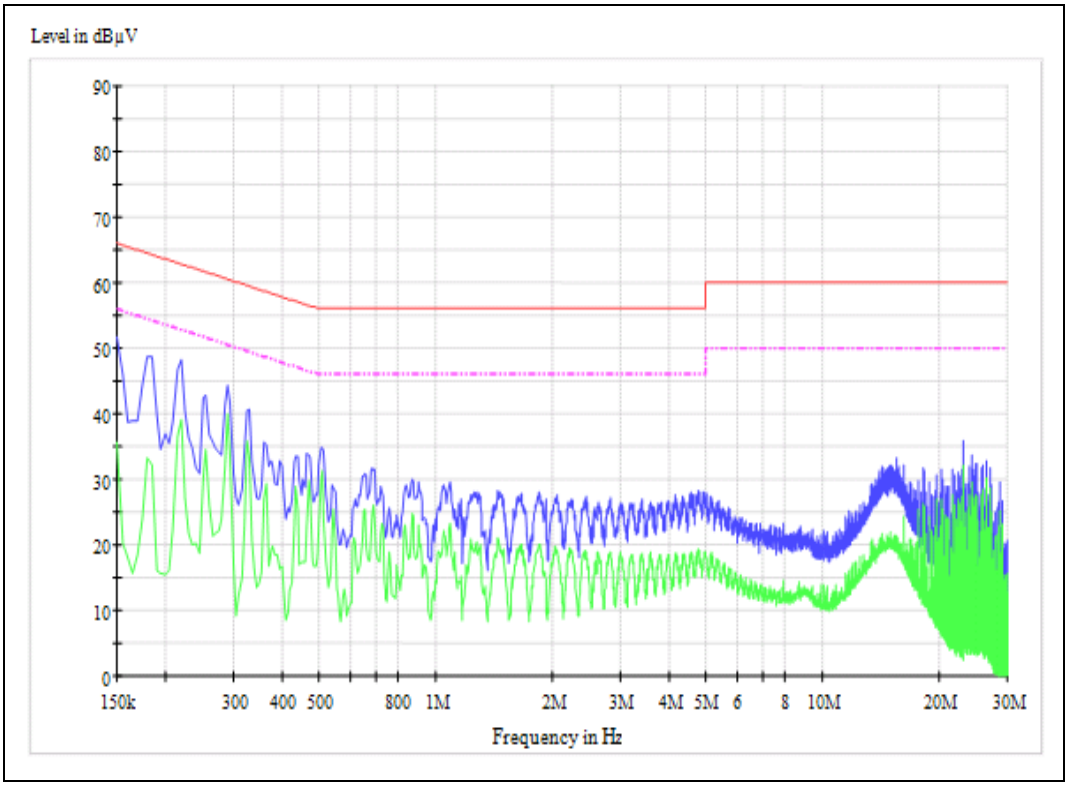
Note ;
Line (H) : Hot
Line (N) : Neutral

Plot of Conducted Power line

Test mode : (Hot)



Test mode : (Neutral)



9. Antenna Requirement

9.1. 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.

9.2. Antenna Connected Construction

Antenna used in this product is Integral type (FPCB Antenna) gain of 3.10 dBi.

10. RF Exposure Evaluation

10.1. Output Average Power to Antenna

10.2. Test Setup

10.3. Limit

None; for reporting purposes only.

10.4. Test Procedure

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 spectrum analyzer.
3. The spectrum analyzer is set to the average power detection.

10.5. Test Results

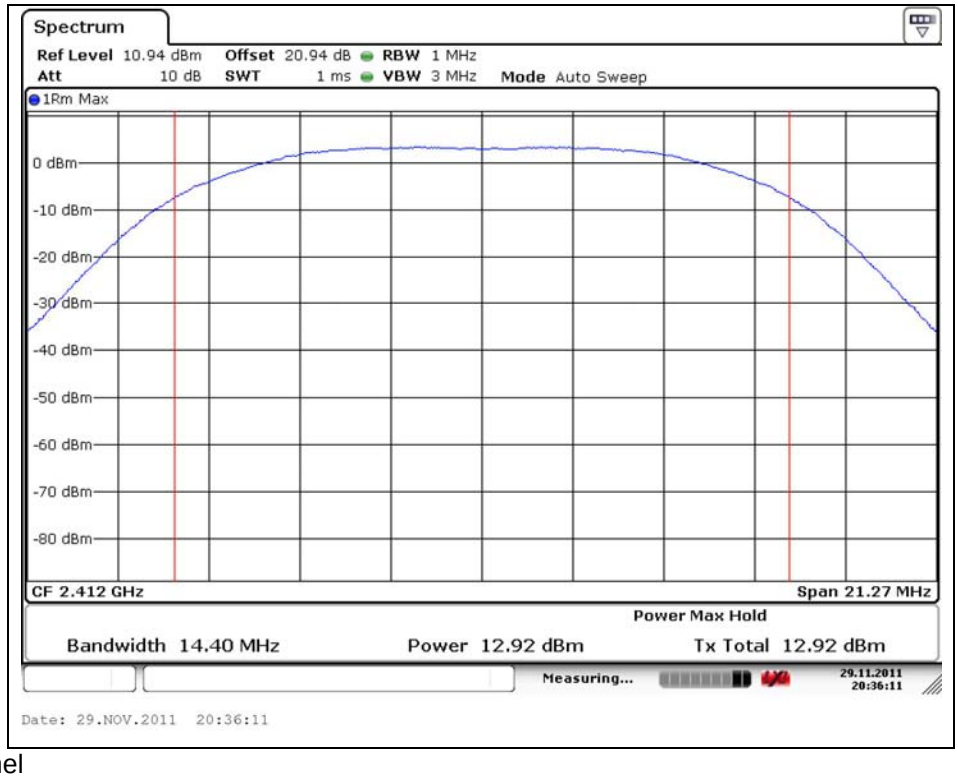
Ambient temperature : (24 ± 2) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Channel Frequency (㎒)	Output Average Power (㏈m)
DSSS (802.11b)	Low	2 412	12.92
	Middle	2 437	12.60
	High	2 462	12.82
OFDM (802.11g)	Low	2 412	13.79
	Middle	2 437	13.75
	High	2 462	14.29
OFDM (802.11n_HT20)	Low	2 412	15.01
	Middle	2 437	14.93
	High	2 462	15.46
OFDM (802.11n_HT40)	Low	2 422	15.24
	Middle	2 437	15.02
	High	2 452	15.26

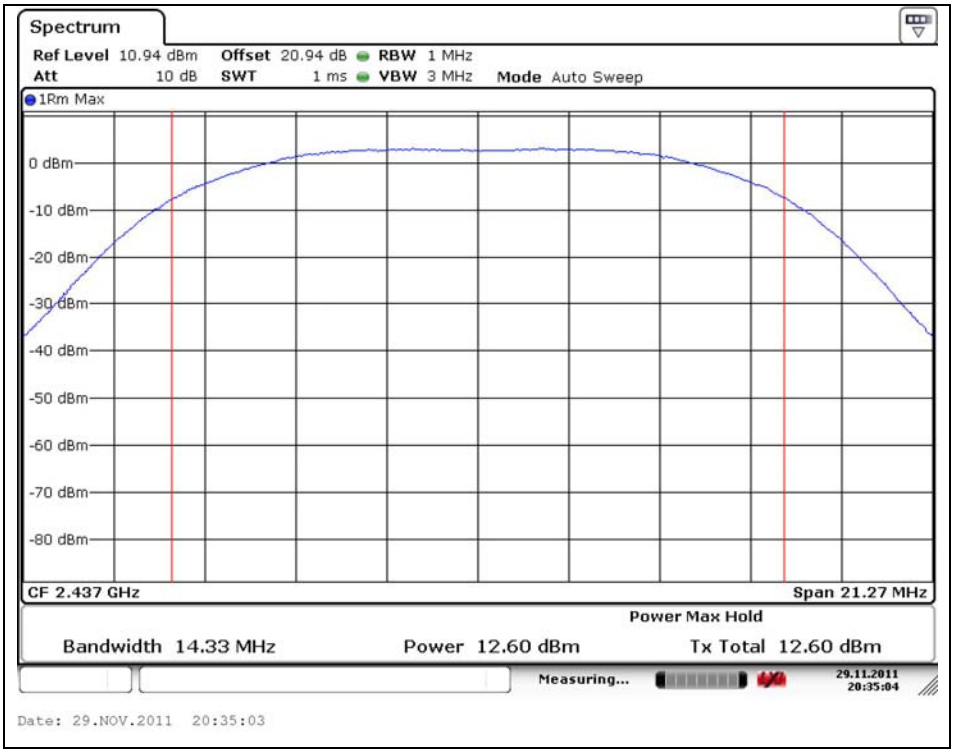
Average Output Power

DSSS : 802.11b

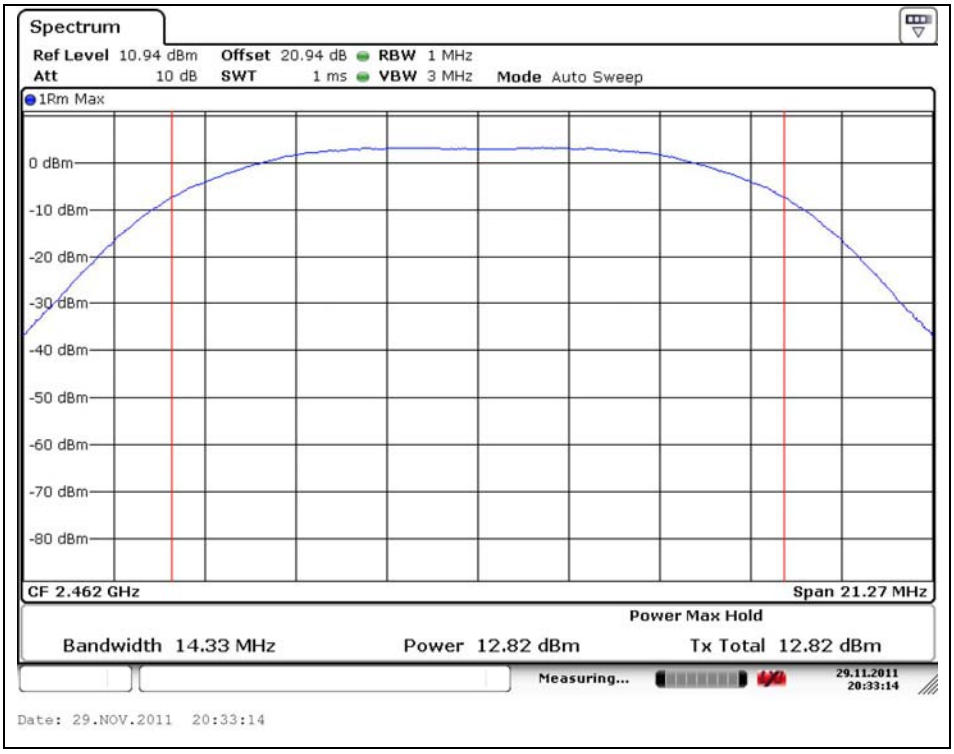
Low Channel



Middle Channel

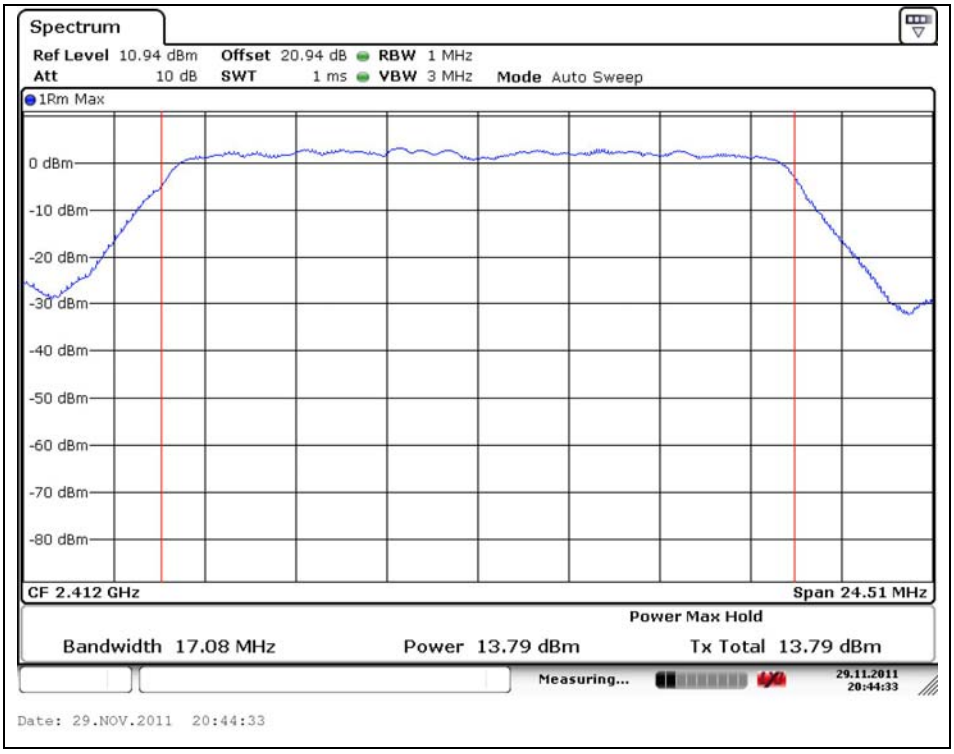


High Channel

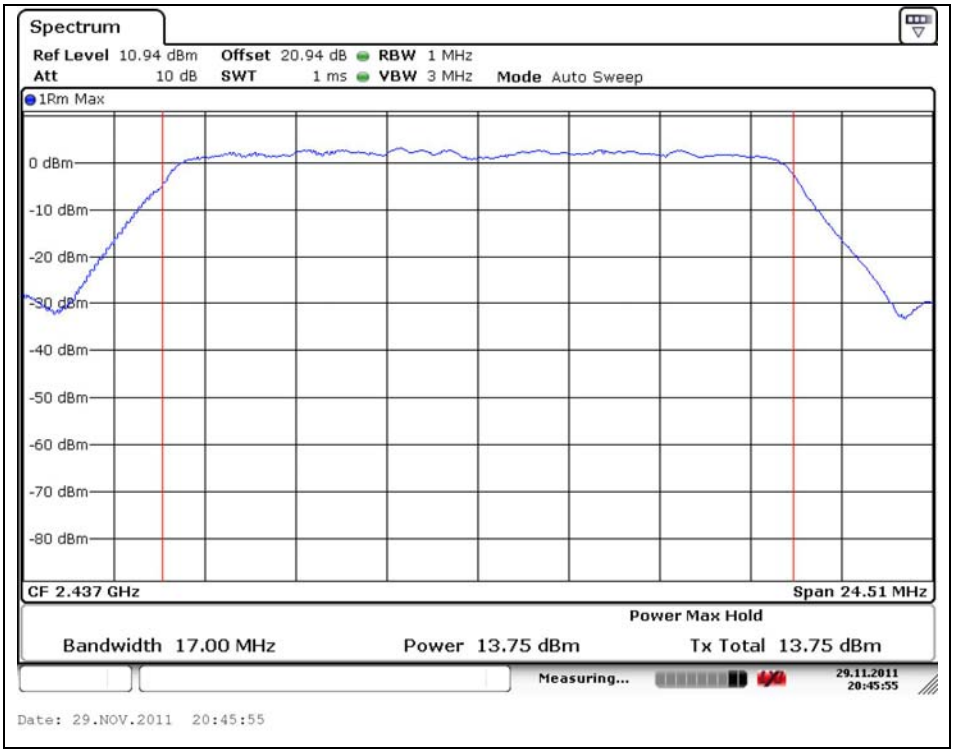


OFDM : 802.11g

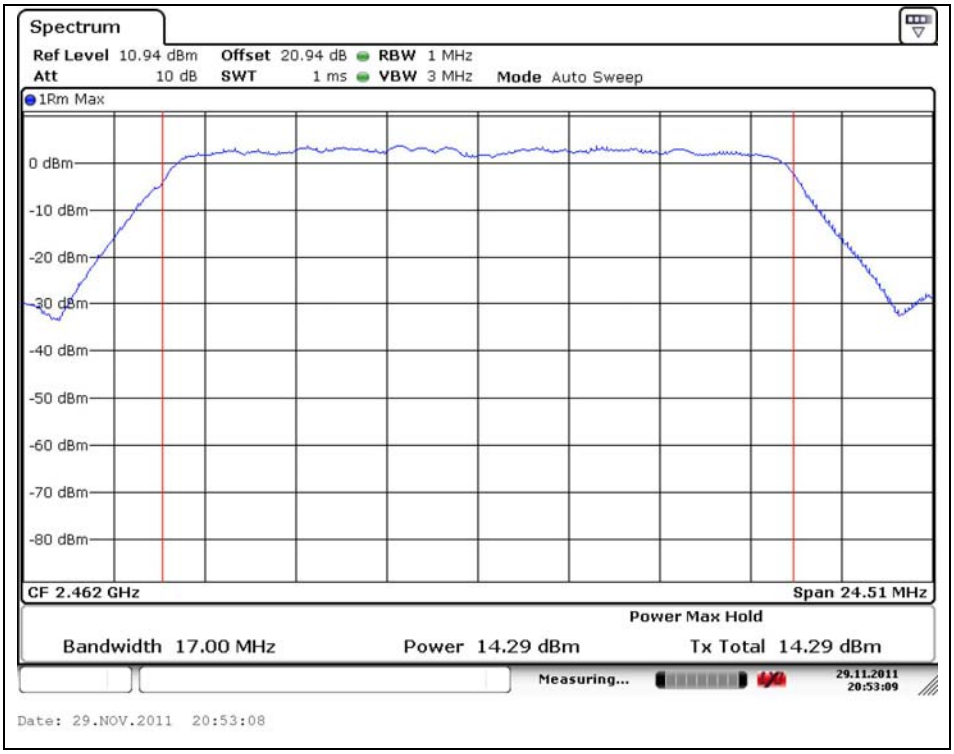
Low Channel



Middle Channel

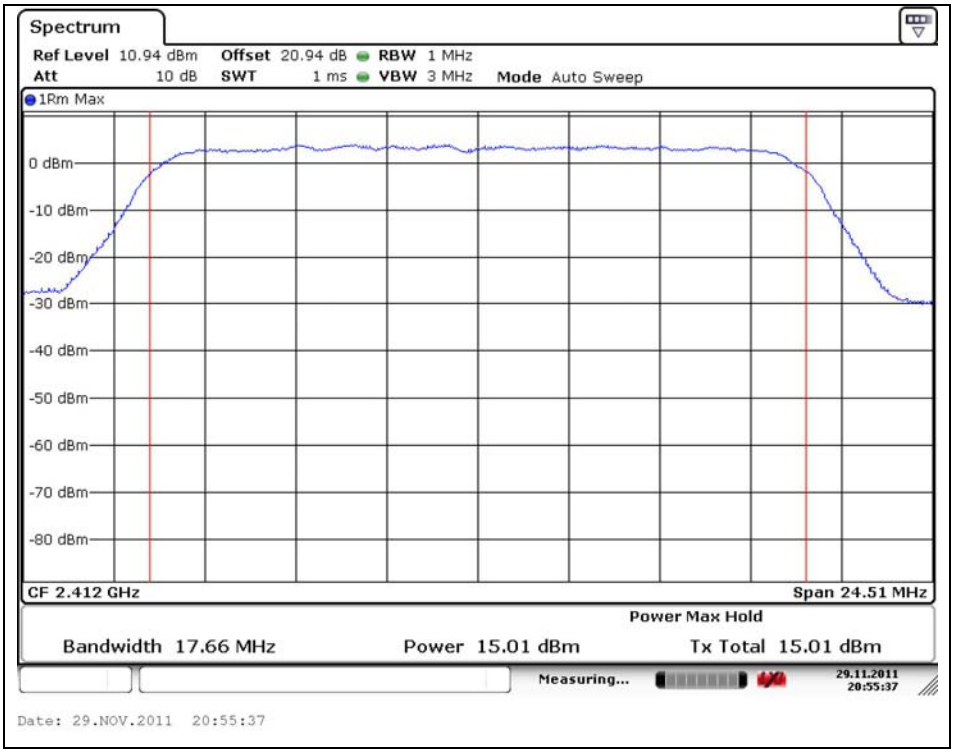


High Channel

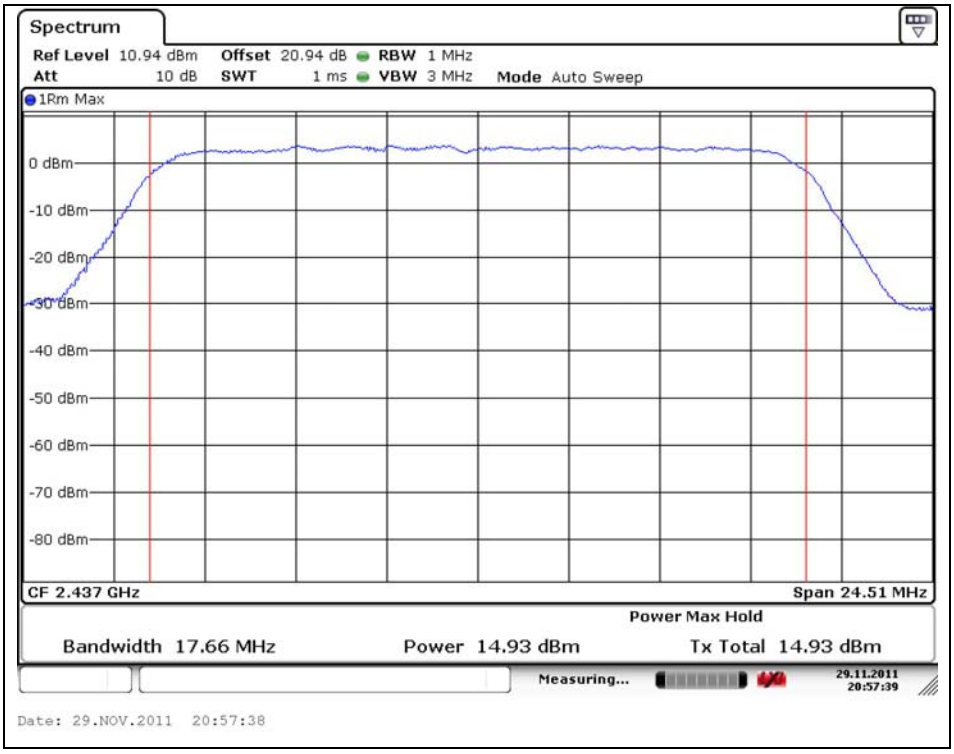


OFDM : 802.11n_HT20

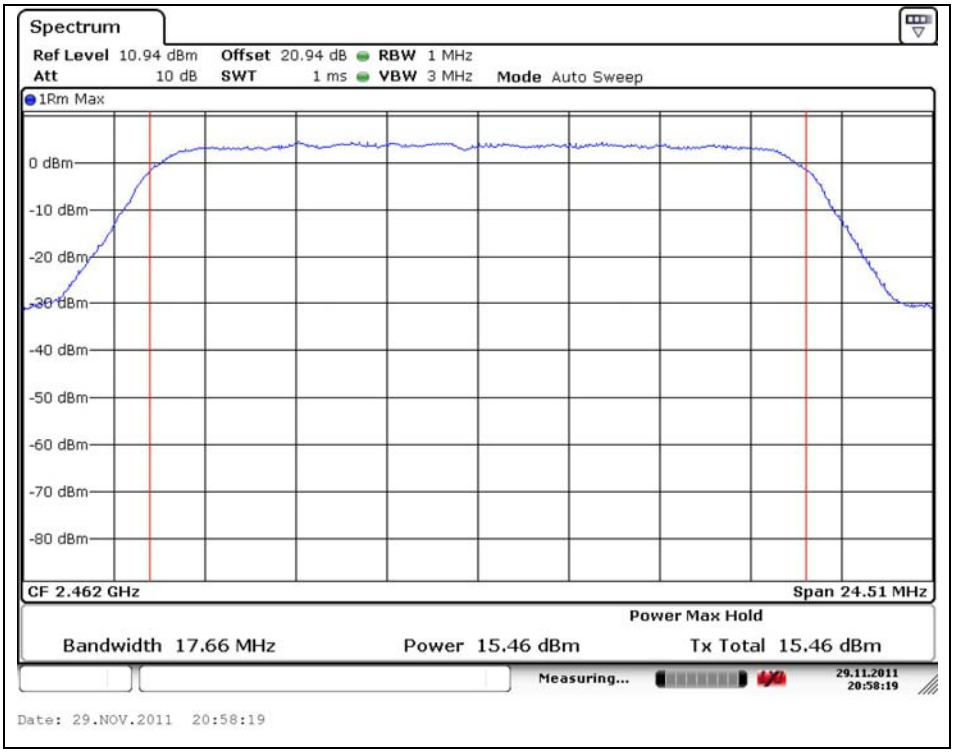
Low Channel



Middle Channel

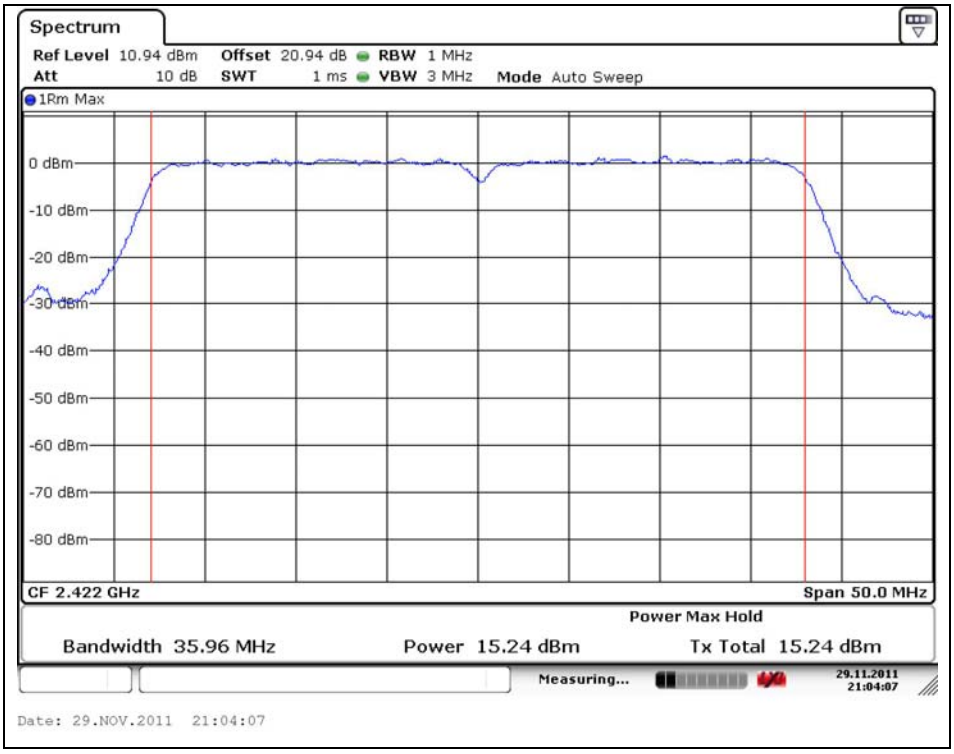


High Channel

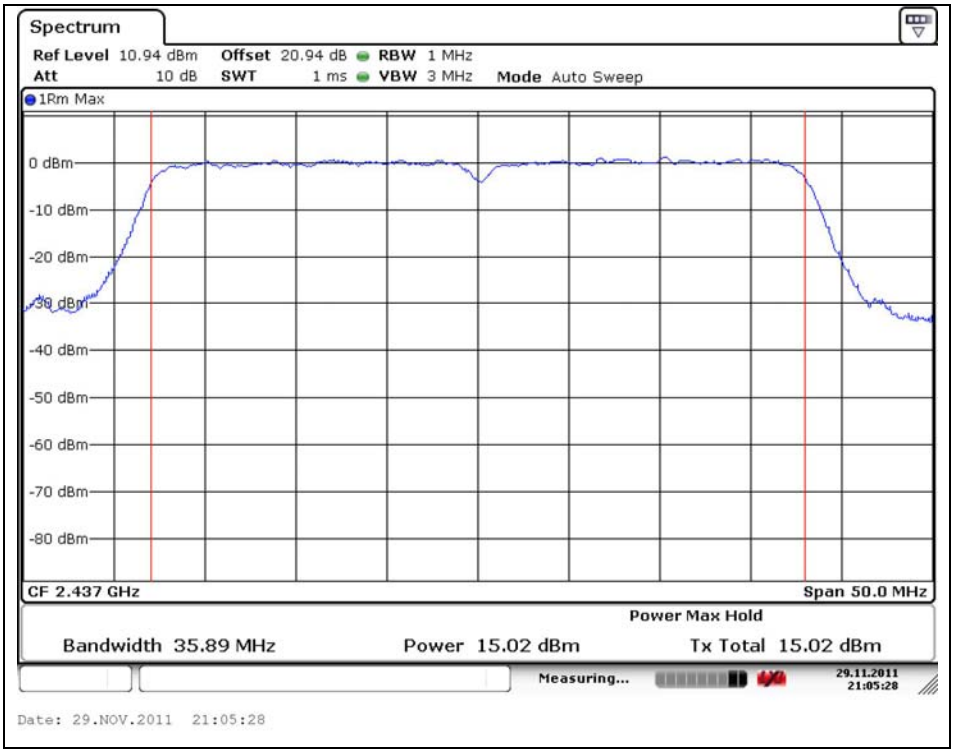


OFDM : 802.11n_HT40

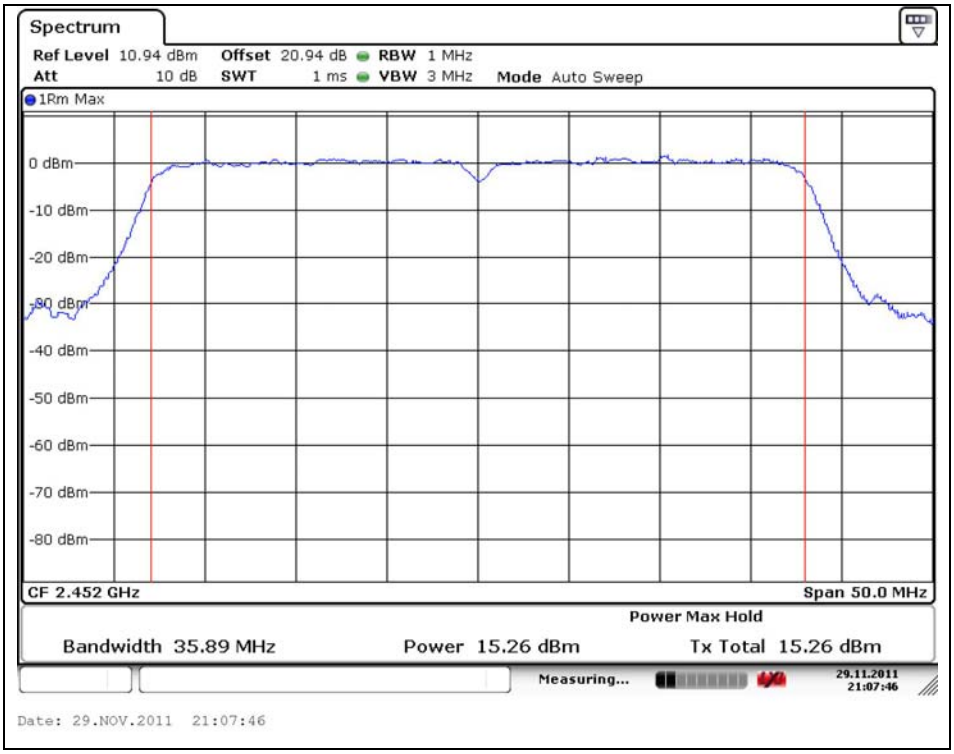
Low Channel



Middle Channel



High Channel



10.6. Environmental evaluation and exposure limit according to FCC CFR 47 part 1, 1.1307(b), 1.1310

According to FCC 1.1310 : The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in §1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (㎒)	Electric Field Strength(V/m)	Magnetic Field Strength (A/m)	Power Density (㎽/㎠)	Average Time
(A) Limits for Occupational /Control Exposures				
300 – 1 500	--	--	F/300	6
1 500 – 100 000	--	--	5	6
(B) Limits for General Population/Uncontrol Exposures				
300 – 1 500	--	--	F/1500	6
1 500 – 100 000	**--**	**--**	**1**	**30**

10.6.1. Friis transmission formula: Pd = (Pout*G)/(4*pi*R^2)

Where Pd = power density in ㎽/㎠

Pout = output power to antenna in ㎽

G = gain of antenna in linear scale

Pi = 3.1416

R = distance between observation point and center of the radiator in ㎝

Pd the limit of MPE, 1 ㎽/㎠. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

10.6.2. Test Result of RF Exposure Evaluation

Test Item : RF Exposure Evaluation Data
Test Mode : Normal Operation

10.6.3. Output Power into Antenna & RF Exposure Evaluation Distance

DSSS : 802.11b

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 412	12.92	3.10	0.007 96	1
Middle	2 437	12.60	3.10	0.007 39	1
High	2 462	12.82	3.10	0.007 78	1

OFDM : 802.11g

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 412	13.79	3.10	0.009 72	1
Middle	2 437	13.75	3.10	0.009 63	1
High	2 462	14.29	3.10	0.010 91	1

OFDM : 802.11n_HT20

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 412	15.01	3.10	0.012 87	1
Middle	2 437	14.93	3.10	0.012 64	1
High	2 462	15.46	3.10	0.014 28	1

OFDM : 802.11n_HT40

Channel	Channel Frequency (㎒)	Output Average Power to Antenna (dB m)	Antenna Gain (dB i)	Power Density at 20 ㎝ (㎽/㎠)	LIMITS (㎽/㎠)
Low	2 422	15.24	3.10	0.013 57	1
Middle	2 437	15.02	3.10	0.012 90	1
High	2 452	15.26	3.10	0.013 64	1

Note :
1. The power density Pd (5th column) at a distance of 20 ㎝ calculated from the friis transmission formula is far below the limit of 1 ㎽/㎠ .