RF TEST REPORT

Test Equipment	:	AUDI Head-Up Display
Model Name	:	AUDI HUD
FCC ID	:	WHBAUDIHUD
Date of receipt	:	2017.09.18
Test duration	:	2017.10.16 ~ 2017.10.20
Date of issue	:	2017.11.09

Applicant : Mobile Appliance, Inc.

Gwanyang-dong-1701~1706, Daerung Techno #15, 401, Simin-daero, Dongan-gu, Anyang-si, Gyeonggi-do, Korea.

Test Laboratory : Lab-T, Inc.

2182-42 Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si Gyeonggi-do 17036, Korea

Test specification	:	FCC Part 15 Subpart C 15.247
Test mode	:	802.11 b/g/n_HT20
RF Output Power	:	15.02 dBm
Test result	:	Pass

The above equipment was tested by Lab-T Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.
The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose.
This test report shall not be reproduced except in full, without the written approval of Lab-T, Inc

Tested by:

Engineer
SungSin Kim

Reviewed by:

Technical Manager
SangHoon Yu

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APPENDIX I 56

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1. Client Information

Applicant	:	Mobile Appliance, Inc.
Address	:	Gwanyang-dong-1701~1706, Daerung Techno #15, 401, Simin-daero, Dongan-gu, Anyang-si, Gyeonggi-do, Korea.
Telephone No.	:	+82 31-330-9185
Person in charge	:	Jin Oh Choi / jjinoh79@mobileappliance.co.kr

Manufacturer	:	Mobile Appliance, Inc
Address	:	Gwanyang-dong-1701~1706, Daerung Techno #15, 401, Simin-daero, Dongan-gu, Anyang-si, Gyeonggi-do, Korea.

2. Laboratory Information

Test Laboratory	:	Lab-T, Inc.
Address	:	2182-42 Baegok-daero, Mohyeon-myeon, Cheoin-gu, Yongin-si Gyeonggi-do 17036, Korea
Telephone No.	:	+82 31-322-6767
Facsimile No.	:	+82 31-322-6768

Certificate

FCC Designation No.	:	KR0159
FCC Registration No.	:	133186

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3. Information About Test Equipment

3.1 Equipment Information

Equipment type	AUDI Head-Up Display
Equipment model name	AUDI HUD
Equipment add model name	-
Frequency range	802.11 b/g/n_HT20 : 2 412 MHz ~ 2 462 MHz
Modulation type	CCK, OFDM
Modulation technology	DSSS(802.11b), OFDM(802.11g/n_HT20)
Power supply	DC 12 V
H/W version	AUDI_HUD_C1
S/W version	V1.0.0

Note1: The above EUT information was declared by the manufacturer.

3.2 Antenna Information

Antenna 1	Type	Chip Antenna
	Gain	1.99 dBi
Antenna 2	Type	N/A
	Gain	N/A

3.3 Test Frequency

Test mode	Test frequency (MHz)		
	Lowest frequency	Middle frequency	Highest frequency
802.11b	2 412	2 437	2 462
802.11g	2 412	2 437	2 462
802.11n_HT20	2 412	2 437	2 462

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3.4 Worst-Case

802.11b	802.11g	802.11n_HT20	-
11 Mbps	54 Mbps	MCS7	-

Note:The power measurement has been conducted to determine the worst-case mode from all possible combi nations between available modulations, data rates.

3.5 Tested Companion Device Information

Type	Manufacturer	Model	Note
-	-	-	-
-	-	-	-

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4. Test Report

4.1 Summary

FCC Part 15			
Reference	Parameter	Clause	Status
Transmitter Requirements			
15.203 15.247(b)(4)	Antenna Requirement	5.3.2	C
15.247(b)(3)	Maximum Peak Output Power	5.3.3	C
15.247(e)	Peak Power Spectral Density	5.3.2	C
15.247(a)(2)	6 dB Channel Bandwidth	5.3.2	C
-	Occupied Bandwidth	5.3.7	C
15.247(d) 15.205(a) 15.209(a)	Spurious Emission, Band Edge and Restricted bands	5.3.8	C
15.207(a)	Conducted Emissions	5.3.9	N/A
NOTE 1 : C = Comply N/C = Not Comply N/T = Not Tested N/A = Not Applicable NOTE 2 : Not Applicable (This device is used battery for power supplying. (DC 12 V) Therefore this test item was not performed)			

* The general test methods used to test this device is ANSI C63.10:2013

4.2 Measurement Uncertainty

Mesurement items	Expanded Uncertainty	
RF Output Power	±0.748 dB	(The confidence level is about 95 %, *k*=2)
Power Spectral Density	±0.938 dB	(The confidence level is about 95 %, *k*=2)
Occupied Channel Bandwidth	±10 221 Hz	(The confidence level is about 95 %, *k*=2)
Conducted Spurious Emissions	±0.436 dB	(The confidence level is about 95 %, *k*=2)
Radiated Spurious Emissions (1 GHz under)	±4.560 dB	(The confidence level is about 95 %, *k*=2)
Radiated Spurious Emissions (Above 1 GHz)	±4.460 dB	(The confidence level is about 95 %, *k*=2)
Conducted emission	±4.080 dB	(The confidence level is about 95 %, *k*=2)

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4.3 Test Report Version

Test Report No.	Date	Description
TRRFCC17-0011	17.11.09	Initial issue

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4.4 Transmitter Requirements

4.4.1 Antenna Requirement

4.4.1.1 Regulation

Accoding to §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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Accoding to §15.247(b)(4) e 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.

4.4.1.2 Result

Comply
(The transmitter has a Internal Chip Antenna. The directional peak gain of the antenna is 1.99 dBi.)

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4.4.2 Maximum Peak Output Power

4.4.2.1 Regulation

According to §15.247(b)(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 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 antennas and antenna elements. The average must not include any time 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 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.

4.4.2.2 Measurement Procedure

These test measurement settings are specified in section 9.0 of 558074 D01 DTS Meas Guidance.

4.4.2.2.1 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

4.4.2.3 Result

Comply (measurement data : refer to the next page)

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4.4.2.4 Measurement data

Test mode : 802.11b

Maximum Peak Output Power				Average Power
Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)	Result (dBm)
2 412	7.96	30.00	22.04	4.86
2 437	7.54	30.00	22.46	4.40
2 462	6.99	30.00	23.01	3.85

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

Test mode : 802.11g

Maximum Peak Output Power				Average Power
Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)	Result (dBm)
2 412	14.76	30.00	15.24	5.97
2 437	14.40	30.00	15.60	5.63
2 462	14.41	30.00	15.59	5.21

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

Test mode : 802.11n_HT20

Maximum Peak Output Power				Average Power
Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)	Result (dBm)
2 412	15.02	30.00	14.98	6.00
2 437	14.98	30.00	15.02	5.64
2 462	14.78	30.00	15.22	5.22

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

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4.4.3 Peak Power Spectral Density

4.4.3.1 Regulation

According to §15.247(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during 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.

4.4.3.2 Measurement Procedure

These test measurement settings are specified in section 10.0 of 558074 D01 DTS Meas Guidance.

4.4.3.2.1 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.4.3.3 Result

Comply (measurement data : refer to the next page)

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4.4.3.4 Measurement data

Test mode : 802.11b

Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
2 412	-16.71	8.00	24.71
2 437	-17.28	8.00	25.28
2 462	-16.92	8.00	24.92

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

Test mode : 802.11g

Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
2 412	-18.88	8.00	26.88
2 437	-19.12	8.00	27.12
2 462	-19.53	8.00	27.53

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

Test mode : 802.11n_HT20

Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
2 412	-19.08	8.00	27.08
2 437	-19.49	8.00	27.49
2 462	-19.70	8.00	27.70

Note1 : Since the directional gain of the Chip Antenna declared by the manufacturer (GANT = 1.99 dBi), does not exceed 6.0 dBi ,there was no need to reduce the output power.
Note2 : We took the insertion loss of the cable loss into consideration within the measuring instrument.

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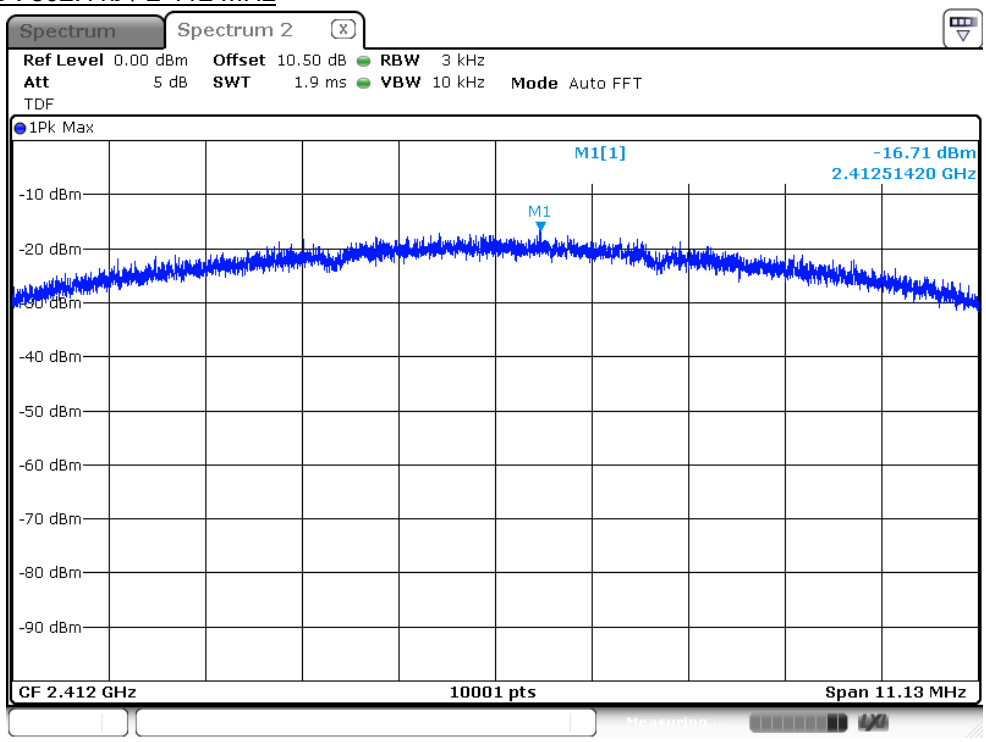
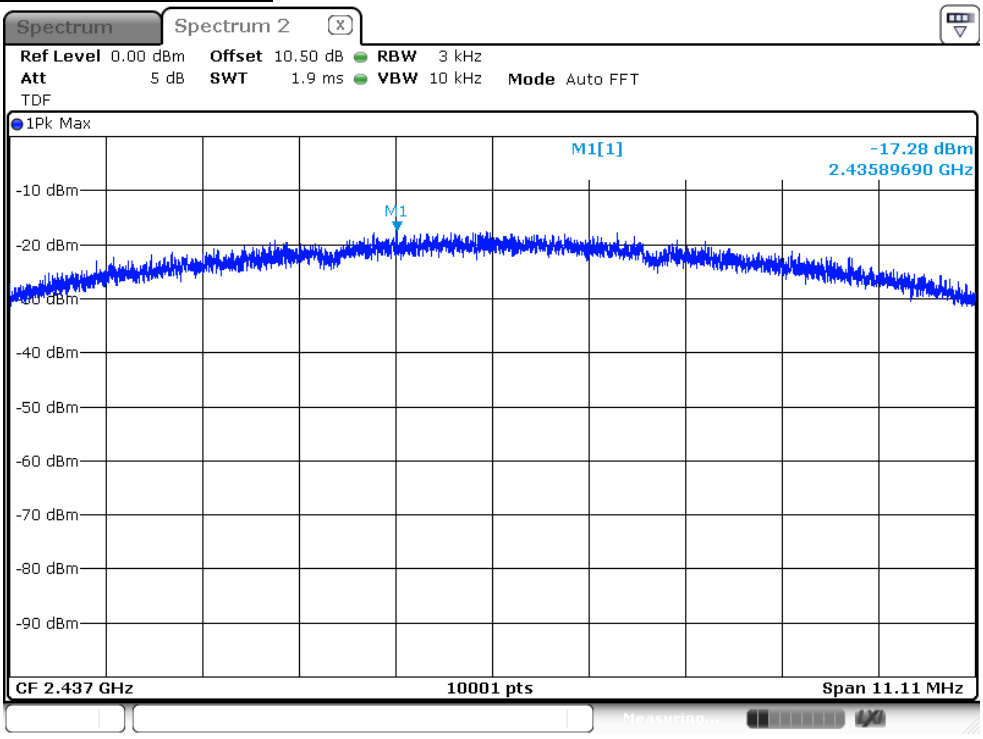
4.4.3.5 Test Plot

Test mode : 802.11b / 2 412 MHz



Test mode : 802.11b / 2 437 MHz



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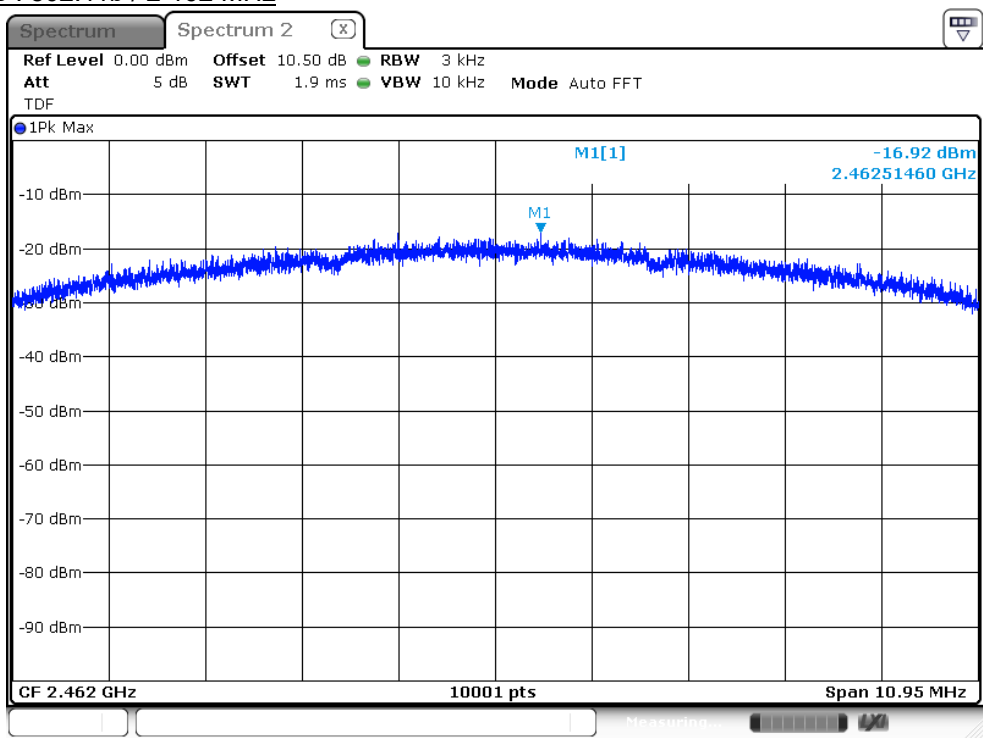
Test mode : 802.11b / 2 462 MHz



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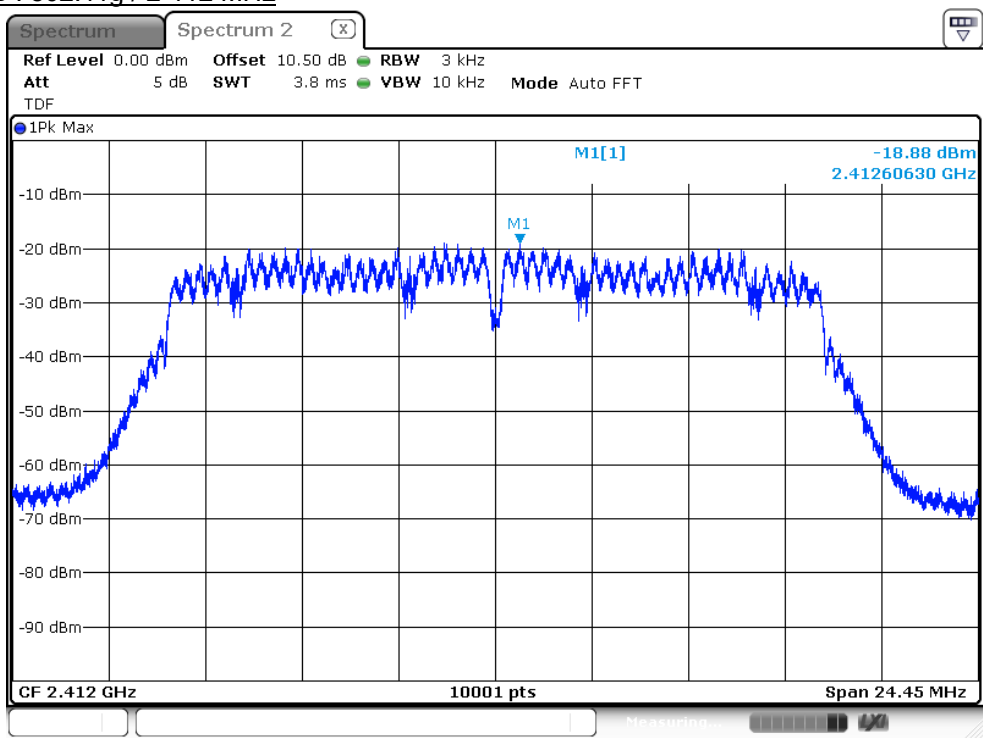
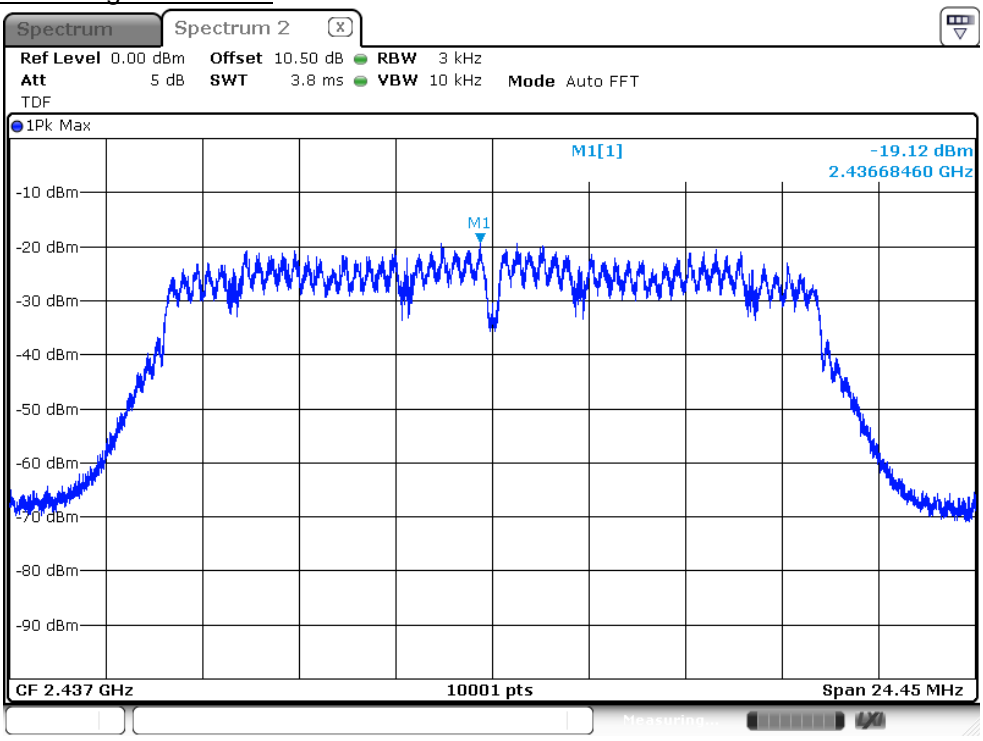
Test mode : 802.11g / 2 412 MHz



Test mode : 802.11g / 2 437 MHz



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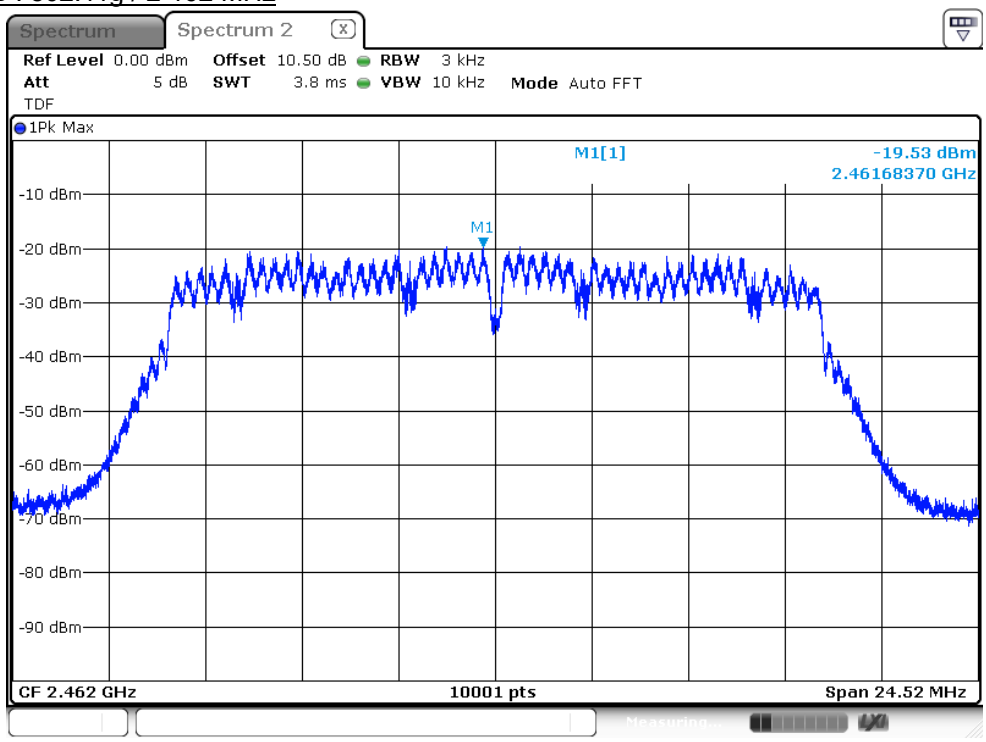
Test mode : 802.11g / 2 462 MHz



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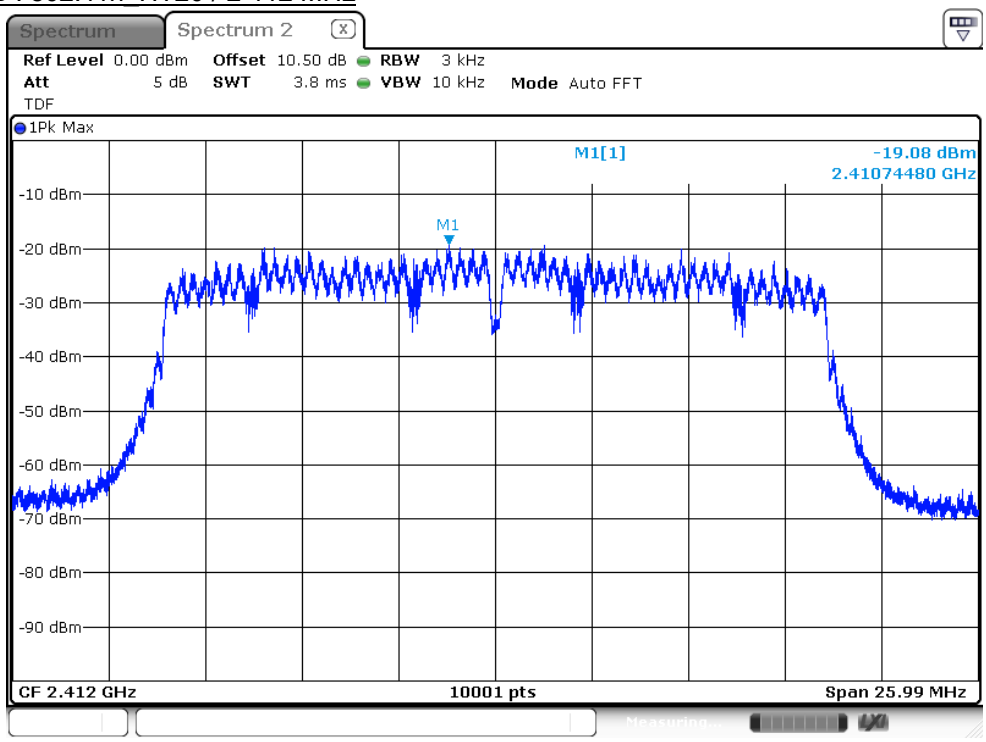
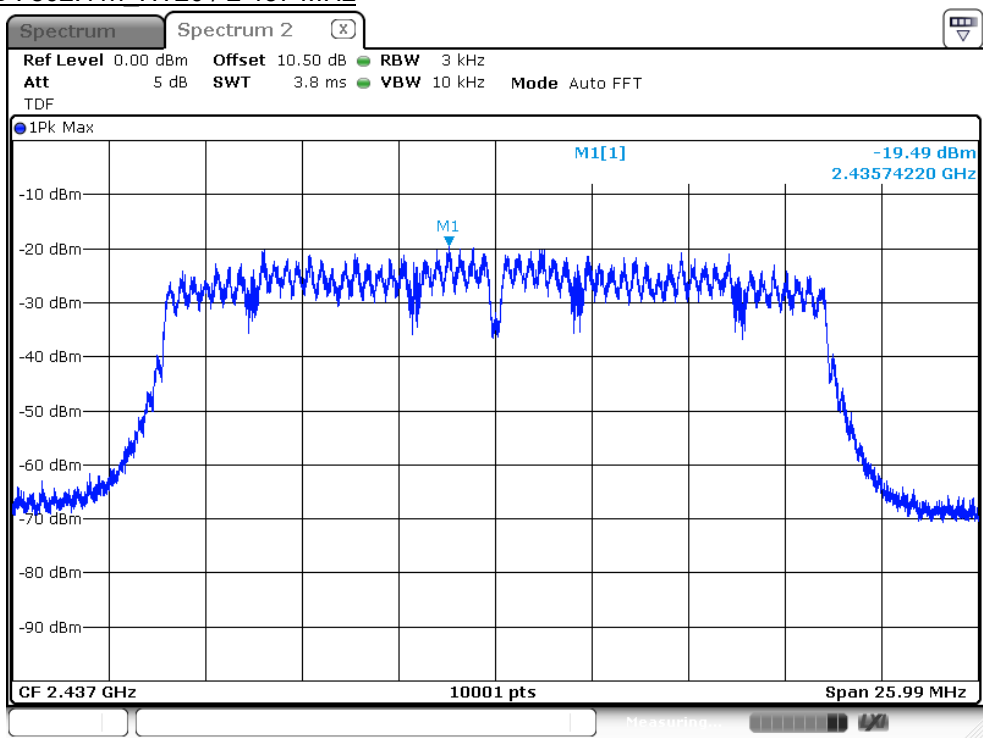
Test mode : 802.11n_HT20 / 2 412 MHz



Test mode : 802.11n_HT20 / 2 437 MHz



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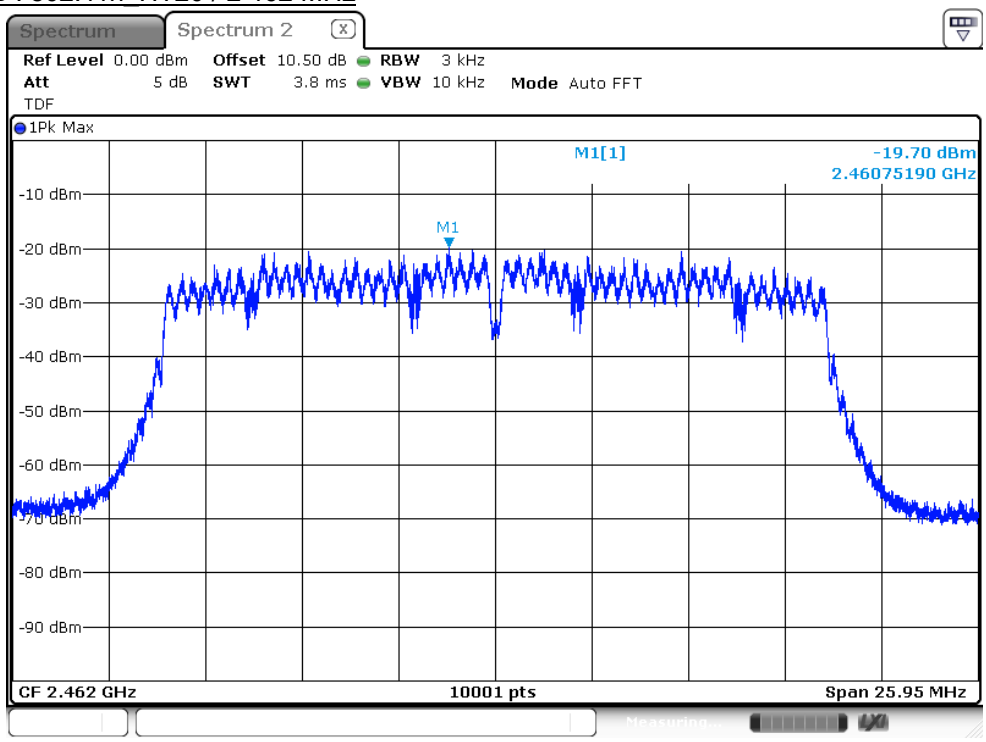
Test mode : 802.11n_HT20 / 2 462 MHz



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4.4.4 6 dB Bandwidth(DTS Bandwidth)

4.4.4.1 Regulation

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

4.4.4.2 Measurement Procedure

These test measurement settings are specified in section 8.0 of 558074 D01 DTS Meas Guidance.

4.4.4.2.1 DTS Channel Bandwidth-Option 1

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) 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.

4.4.4.2.2 DTS Channel Bandwidth Measurement Procedure-Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥3 RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

4.4.4.3 Result

Comply (measurement data : refer to the next page)

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4.4.4.4 Measurement data

Test mode : 802.11b

Frequency (MHz)	6 dB Bandwidth (MHz)	Min. Limit (MHz)	Occupied Bandwidth (99 % Bandwith)(MHz)
2 412	7.42	0.50	12.25
2 437	7.41	0.50	12.30
2 462	7.30	0.50	12.25

Test mode : 802.11g

Frequency (MHz)	6 dB Bandwidth (MHz)	Min. Limit (MHz)	Occupied Bandwidth (99 % Bandwith)(MHz)
2 412	16.30	0.50	16.32
2 437	16.38	0.50	16.33
2 462	16.35	0.50	16.32

Test mode : 802.11n_HT20

Frequency (MHz)	6 dB Bandwidth (MHz)	Min. Limit (MHz)	Occupied Bandwidth (99 % Bandwith)(MHz)
2 412	17.33	0.50	17.51
2 437	17.31	0.50	17.51
2 462	17.30	0.50	17.51

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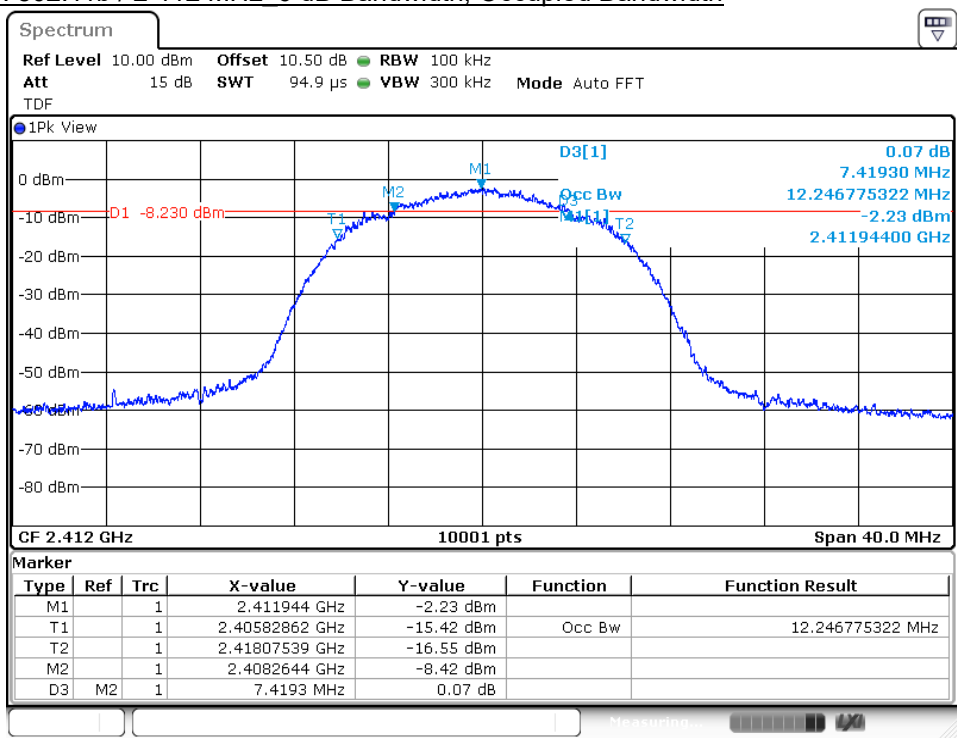
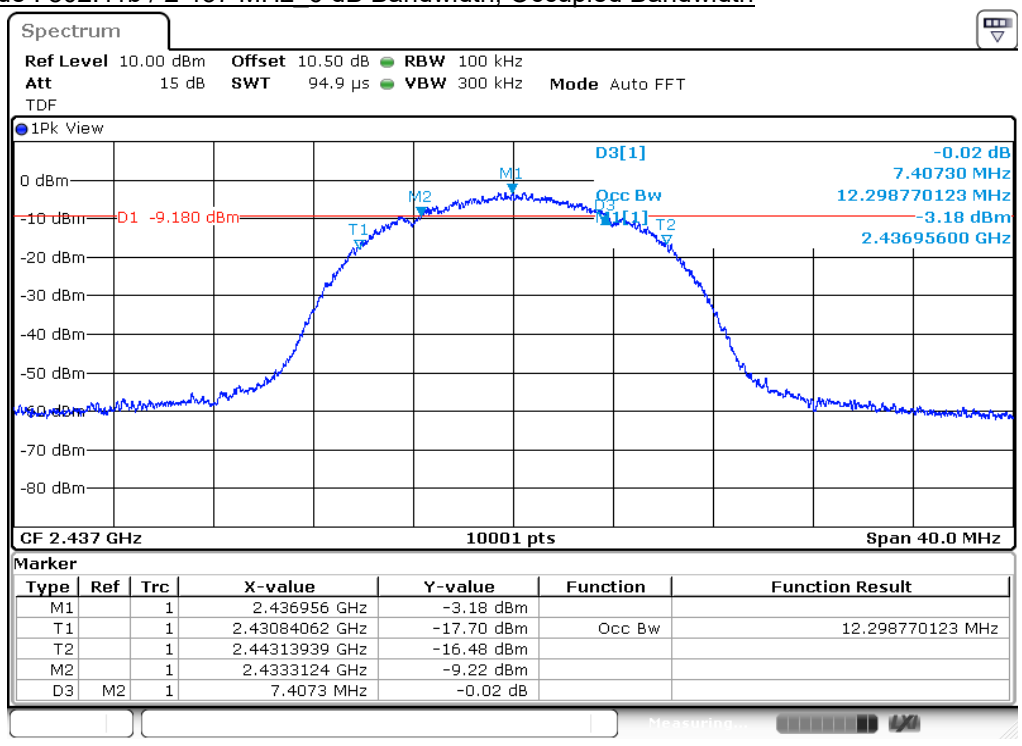
4.4.4.5 Test Plot

Test mode : 802.11b / 2 412 MHz_6 dB Bandwidth, Occupied Bandwidth



Test mode : 802.11b / 2 437 MHz_6 dB Bandwidth, Occupied Bandwidth



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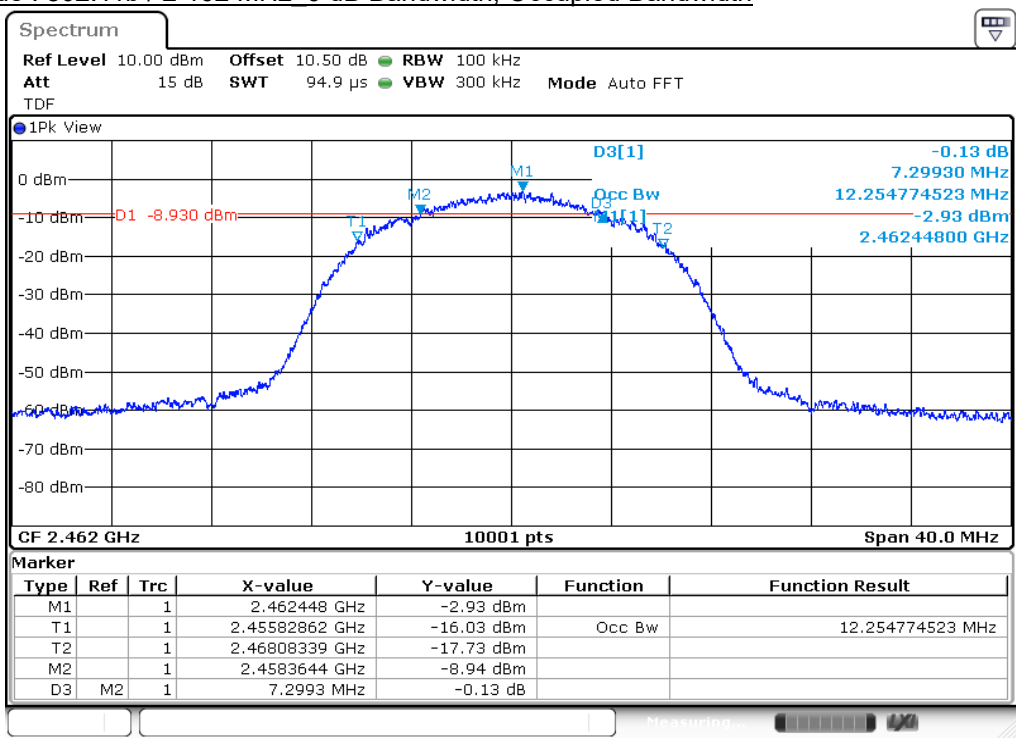
Test mode : 802.11b / 2 462 MHz_6 dB Bandwidth, Occupied Bandwidth



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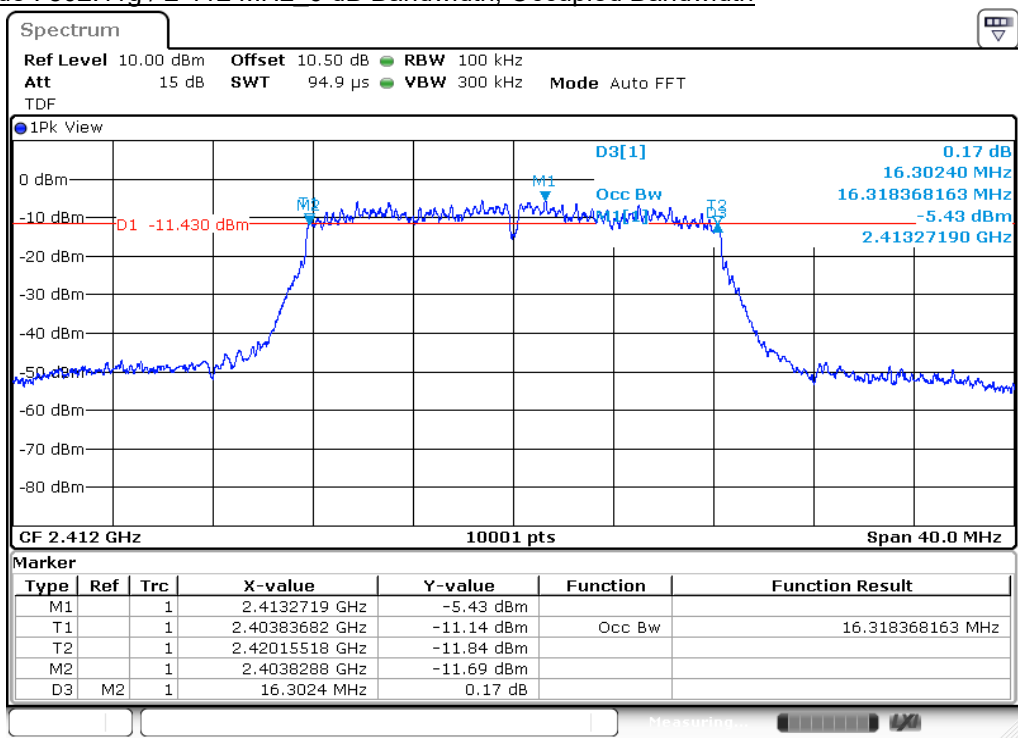
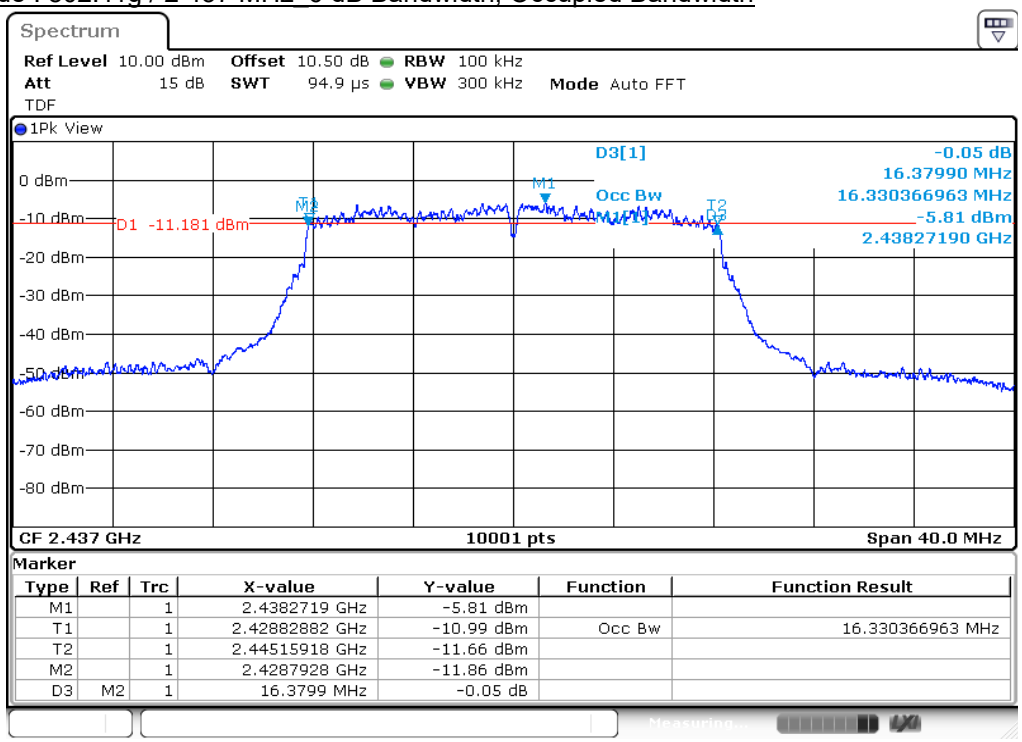
Test mode : 802.11g / 2 412 MHz_6 dB Bandwidth, Occupied Bandwidth



Test mode : 802.11g / 2 437 MHz_6 dB Bandwidth, Occupied Bandwidth



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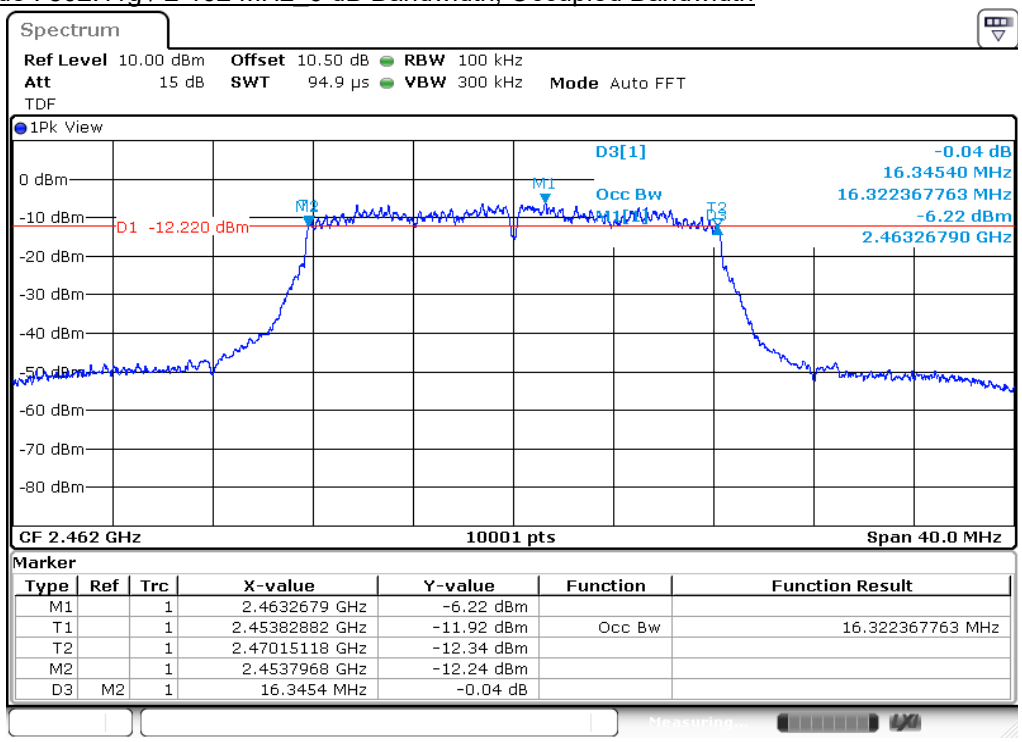
Test mode : 802.11g / 2 462 MHz_6 dB Bandwidth, Occupied Bandwidth



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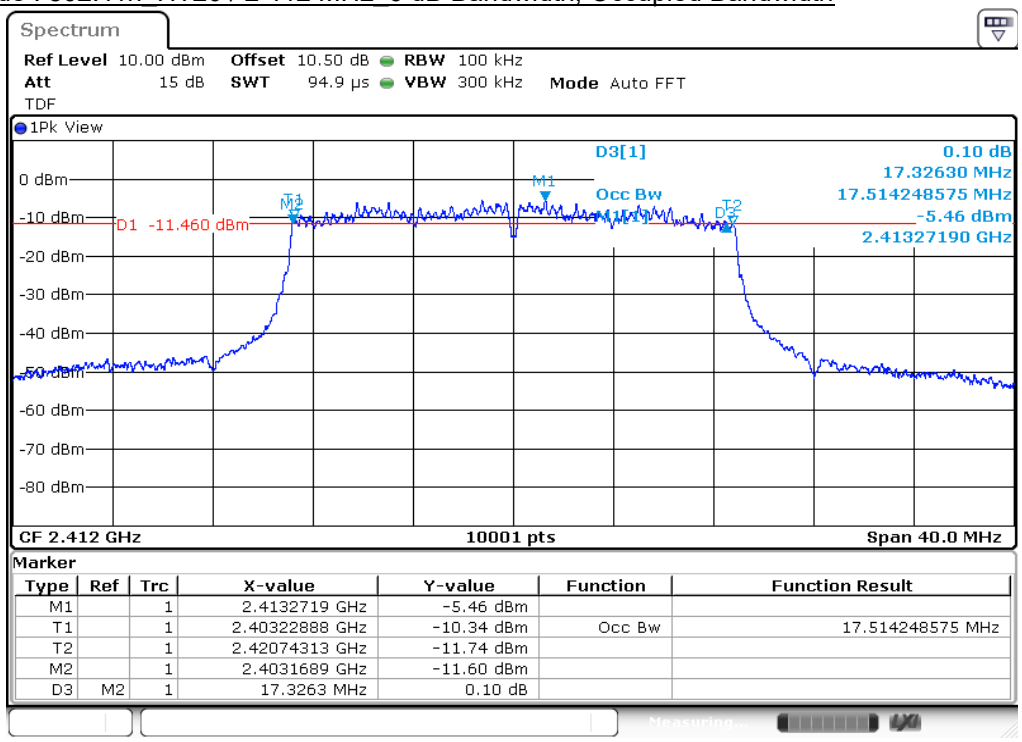
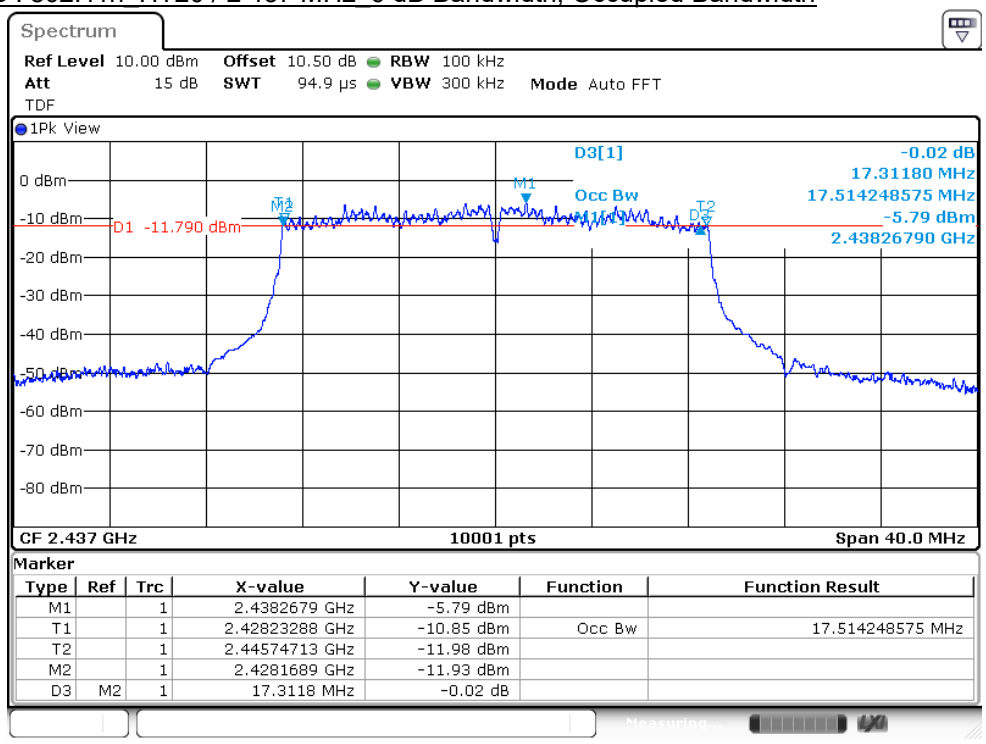
Test mode : 802.11n_HT20 / 2 412 MHz_6 dB Bandwidth, Occupied Bandwidth



Test mode : 802.11n_HT20 / 2 437 MHz_6 dB Bandwidth, Occupied Bandwidth



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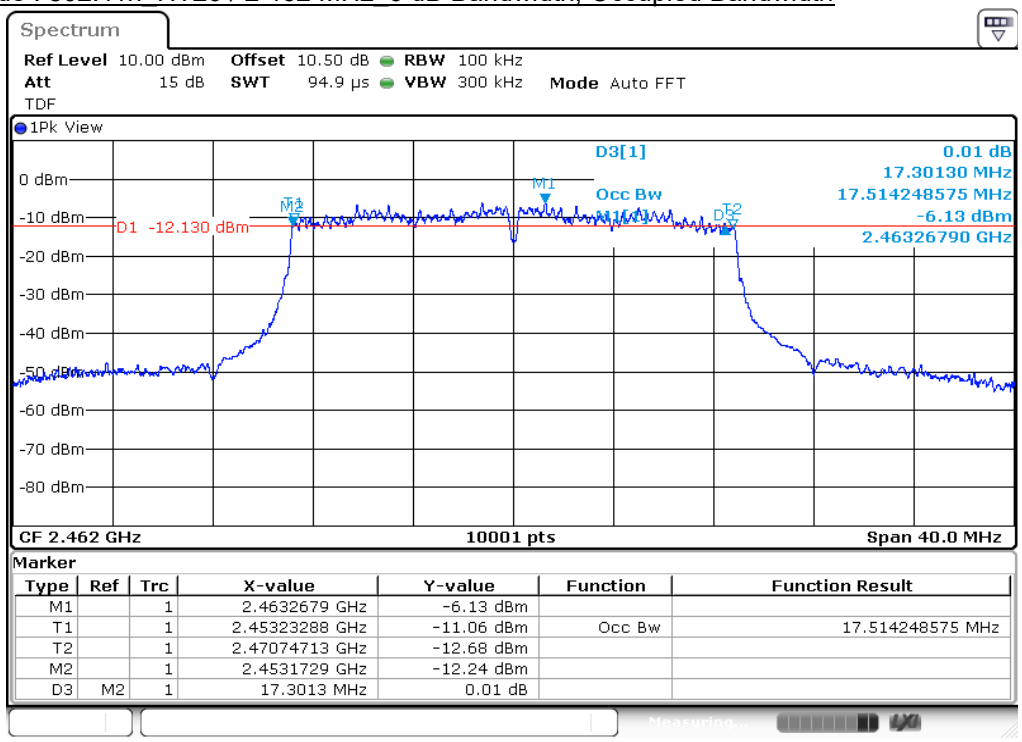
Test mode : 802.11n_HT20 / 2 462 MHz_6 dB Bandwidth, Occupied Bandwidth



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4.4.5 Spurious Emission, Band Edge, and Restricted bands

4.4.5.1 Regulation

According to §15.247(d) in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with 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 notexceed the field strength levels specified in the following table:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shallnot be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permItted under other sections of this part, e.g., §§15.231 and 15.241.

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According to §15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 – 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 – 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 – 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 – 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 – 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 – 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 – 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 – 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurement

4.4.5.2 Measurement Procedure

4.4.5.2.1 Band-edge Compliance of RF Conducted Emissions

4.4.5.2.1.1 Reference Level Measurement

Establish a reference level by using the following procedure:

1) Set instrument center frequency to DTS channel center frequency.
2) Set the span to ≥ 1.5 times the DTS bandwidth.
3) Set the RBW = 100 kHz.
4) Set the VBW ≥ 3 x RBW.
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 PSD level.

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4.4.5.2.1.2 Emissions Level Measurement

1) Set the center frequency and span to encompass frequency range to be measured.
2) Set the RBW = 100 kHz.
3) Set the VBW ≥ 3 x RBW.
4) Detector = peak.
5) Ensure that the number of measurement points ≥ span/RBW
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 amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b).
Report the three highest emissions relative to the limit.

4.4.5.2.2 Conducted Spurious Emissions

Set the spectrum analyzer as follows:

1) Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
Typically, several plots are required to cover this entire span.
2) RBW = 100 kHz
3) VBW ≥ 3 x RBW
4) Sweep = auto
5) Detector function = peak
6) Trace = max hold
7) Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
8) Each frequency found during preliminary measurements was re-examined and investigated.
The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

4.4.5.2.3 Radiated Spurious Emissions

1) The preliminary and final rdiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m anechoic chamber. The EUT was tested at a distance 3 meters.
2) The EUT was placed on the top of the 0.8 m height or 1.5 m height non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1 000 MHz using the TRILOG broadband antenna, and from 1 000 MHz to 26 500 MHz using the horn antenna.
4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

NOTE1 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
NOTE2 : The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the vide bandwidth is 1 kHz(1/T) for Average detection (AV) at frequency above 1 GHz. (where T= pulse width)
NOTE3 : The 0.8 m height is for below 1 GHz testing, and 1.5 m is for above 1 GHz testing

4.4.5.3 Result

Comply (measurement data : refer to the next page)

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4.4.5.4 Measurement data_Radiated Spurious Emissions

Test mode : Below 1 GHz (Worst case : 802.11n_HT20 / Lowest Frequency)

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBμV)	Ant Factor (dB)	Loss (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Below 30 MHz	Not Detected	-	-	-	-	-	-	-
40.866	QP	V	30.20	18.40	-29.50	19.10	40.00	20.90
42.987	QP	V	41.20	17.40	-29.10	29.50	40.00	10.50
75.405	QP	V	38.60	15.30	-28.90	25.00	40.00	15.00
125.855	QP	V	34.80	18.20	-28.20	24.80	43.50	18.70
138.468	QP	V	39.00	18.90	-28.10	29.80	43.50	13.70
163.694	QP	V	38.20	18.80	-27.80	29.20	43.50	14.30
202.115	QP	V	44.70	15.80	-27.60	32.90	43.50	10.60
302.045	QP	V	37.80	19.50	-27.10	30.20	46.00	15.80

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Result : Reading + Ant Factor + Loss

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Test mode : 802.11b_ Above 1 GHz / Lowest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBμV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 353.81	PK	H	40.30	31.50	7.00	34.50	44.30	83.50	39.20
4 822.85	PK	H	45.30	34.00	10.00	34.50	54.80	83.50	28.70
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11b_ Above 1 GHz / Middle Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBμV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4 874.04	PK	H	42.90	34.00	10.10	34.50	52.50	83.50	31.00
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11b_ Above 1 GHz / Highest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBμV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2 487.84	PK	H	40.20	32.20	7.20	34.50	45.10	83.50	38.40
4 922.66	PK	H	41.00	34.10	10.10	34.50	50.70	83.50	32.80
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

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Test mode : 802.11g_ Above 1 GHz / Lowest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 389.95	PK	H	48.20	31.70	7.00	34.50	52.40	83.50	31.10
4 822.85	PK	H	44.00	34.00	10.00	34.50	53.50	83.50	30.00
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11g_ Above 1 GHz / Middle Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 880.15	PK	H	41.30	34.10	10.10	34.50	51.00	83.50	32.50
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11g_ Above 1 GHz / Highest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 491.86	PK	H	40.00	32.20	7.20	34.50	44.90	83.50	38.60
4 918.70	PK	H	41.10	34.10	10.10	34.50	50.80	83.50	32.70
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

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Test mode : 802.11n_HT20_ Above 1 GHz / Lowest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 389.83	PK	H	46.90	31.70	7.00	34.50	51.10	83.50	32.40
4 818.56	PK	H	43.10	34.00	10.00	34.50	52.60	83.50	30.90
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11n_HT20_ Above 1 GHz / Middle Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4 871.72	PK	H	42.20	34.00	10.10	34.50	51.80	83.50	31.70
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

Test mode : 802.11n_HT20_ Above 1 GHz / Highest Frequency

Frequency (MHz)	Detector	Pol. (V/H)	Reading (dBµV)	Ant Factor (dB)	Loss	Dutycycle Factor (dB)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2 487.67	PK	H	40.70	32.20	7.20	34.50	45.60	83.50	37.90
4 918.44	PK	H	39.80	34.10	10.10	34.50	49.50	83.50	34.00
Above 5 GHz	Not Detected	-	-	-	-	-	-	-	

Note 1 : Loss : Cable loss - Amp gain
Note 2 : Peak Result : Reading + Ant Factor + Loss
Note 3 : Average Reasult : Reading + Ant Factor + Loss + Dutycycle Factor
Dutycycle Factor : 20log(Dutycycle) * Refer to 4.4.5.7
Note 4 : Below 1 GHz Measured distance : 3 m, Above 1 GHz Measured distance : 1 m
Above 1 GHz Distance Factor = 20log(1 / 3) = -9.54
Above 1 GHz Limit Peak = 74 - (-9.54) = 83.54
Above 1 GHz Limit Average = 54 - (-9.54) = 63.54
Note 5 : Average measurement did not take place because the peak data did not exceed Average Limit.

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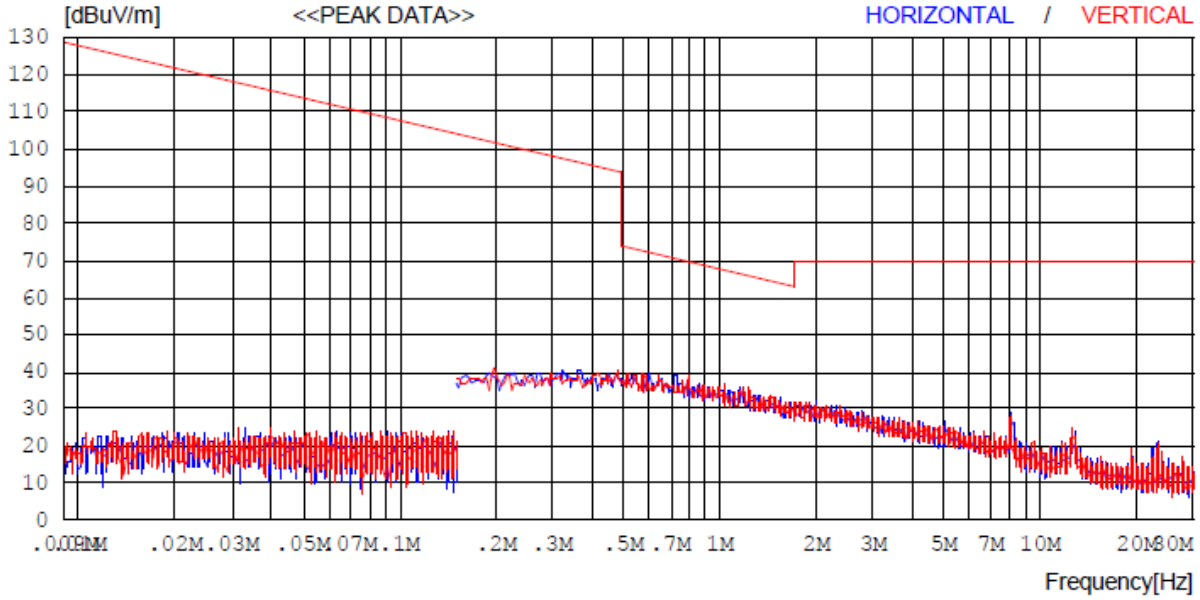
4.4.5.5 Measurement Plot_Radiated Spurious Emissions

Test mode : 9 kHz ~ 30 MHz (Worst case : 802.11n_HT20 / Lowest Frequency)



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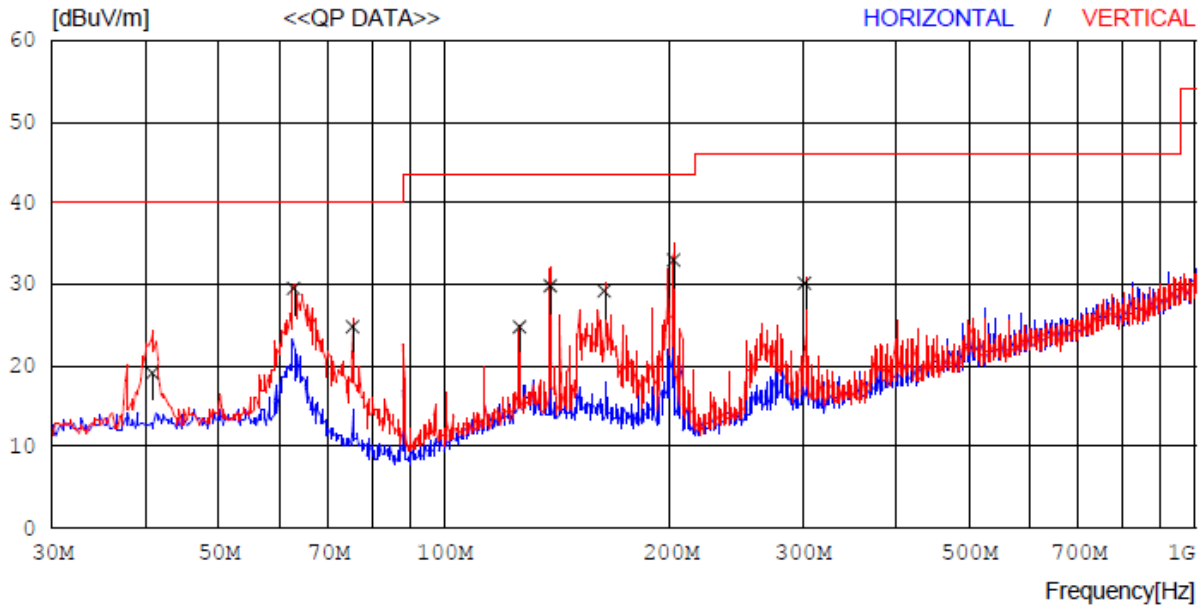
Test mode : 30 MHz ~ 1 GHz (Worst case : 802.11n_HT20 / Lowest Frequency)



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Vertical ------										
1	40.866	30.2	18.4	-29.5	0.0	19.1	40.0	20.9	100	1
2	62.987	41.2	17.4	-29.1	0.0	29.5	40.0	10.5	200	358
3	75.405	38.6	15.3	-28.9	0.0	25.0	40.0	15.0	200	74
4	125.855	34.8	18.2	-28.2	0.0	24.8	43.5	18.7	100	1
5	138.468	39.0	18.9	-28.1	0.0	29.8	43.5	13.7	100	1
6	163.694	38.2	18.8	-27.8	0.0	29.2	43.5	14.3	100	1
7	202.115	44.7	15.8	-27.6	0.0	32.9	43.5	10.6	100	1
8	302.045	37.8	19.5	-27.1	0.0	30.2	46.0	15.8	200	358

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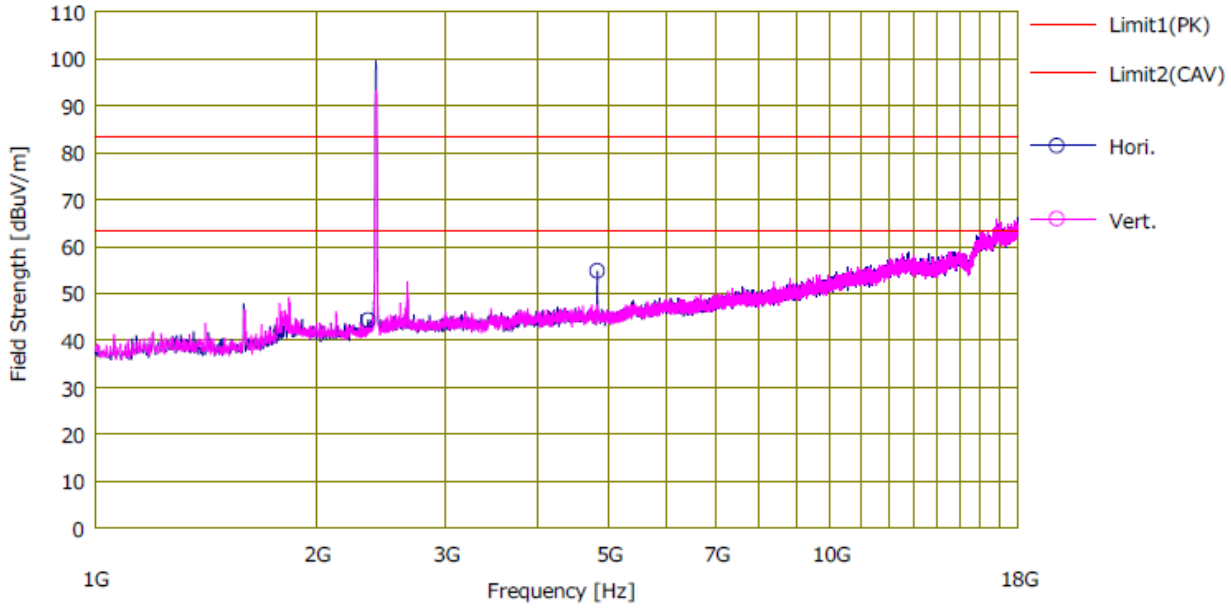
Test mode : 1 GHz ~ 18 GHz_(Worst case : 802.11n_HT20 / Lowest Frequency)



No.	Freq.	Reading	Ant.Fa	Loss	Gain	Result	Limit		Margin		Pola.	Height	Angle	Ant. Type	Comment
							<PK>	<CAV>	<PK>	<CAV>					
	[MHz]	[dBuV]	[dB/m]	[dB]	[dB]	dBuV/m]	dBuV/m]	dBuV/m]	[dB]	[dB]	[H/V]	[cm]	[deg]		
1	2353.806	40.3	31.5	7.0	34.5	44.3	83.5	63.5	39.2	19.2	Hori.	150	208	8719K	
2	4822.848	45.3	34.0	10.0	34.5	54.8	83.5	63.5	28.7	8.7	Hori.	150	138	8719K	

Note 1 : Measured distance : 1 m
Note 2 : Limit : Peak : 83.5 dBμV/m
Average : 63.5 dBμV/m

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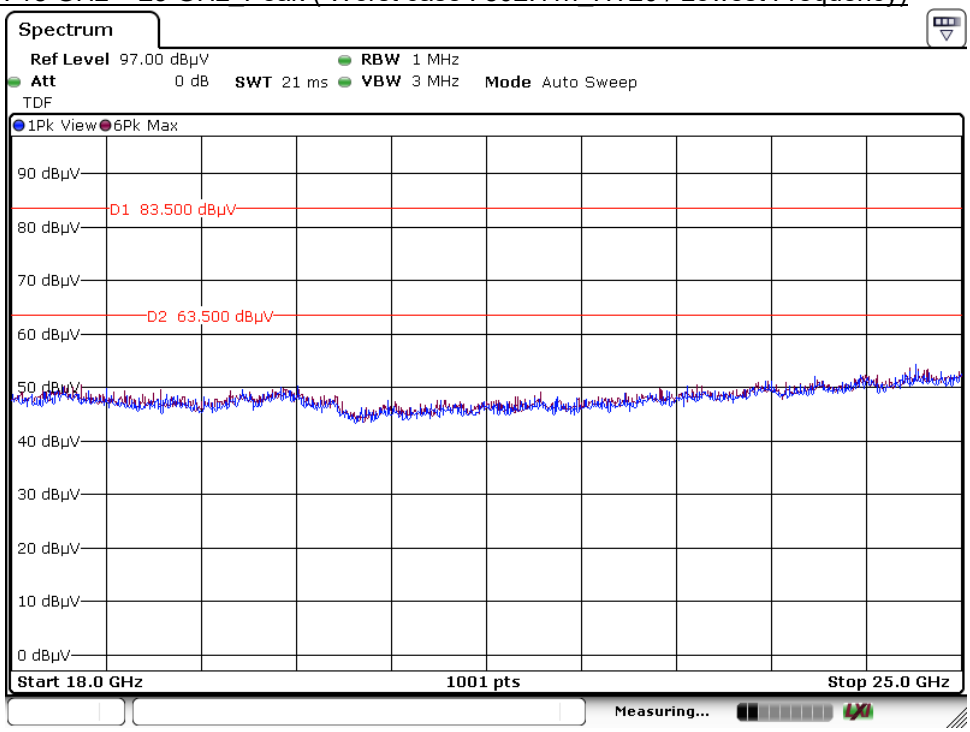
Test mode : 18 GHz ~ 25 GHz_Peak (Worst case : 802.11n_HT20 / Lowest Frequency)



Note 1 : Measured distance : 1 m
Note 2 : Limit : Peak : 83.5 dBµV/m
Average : 63.5 dBµV/m

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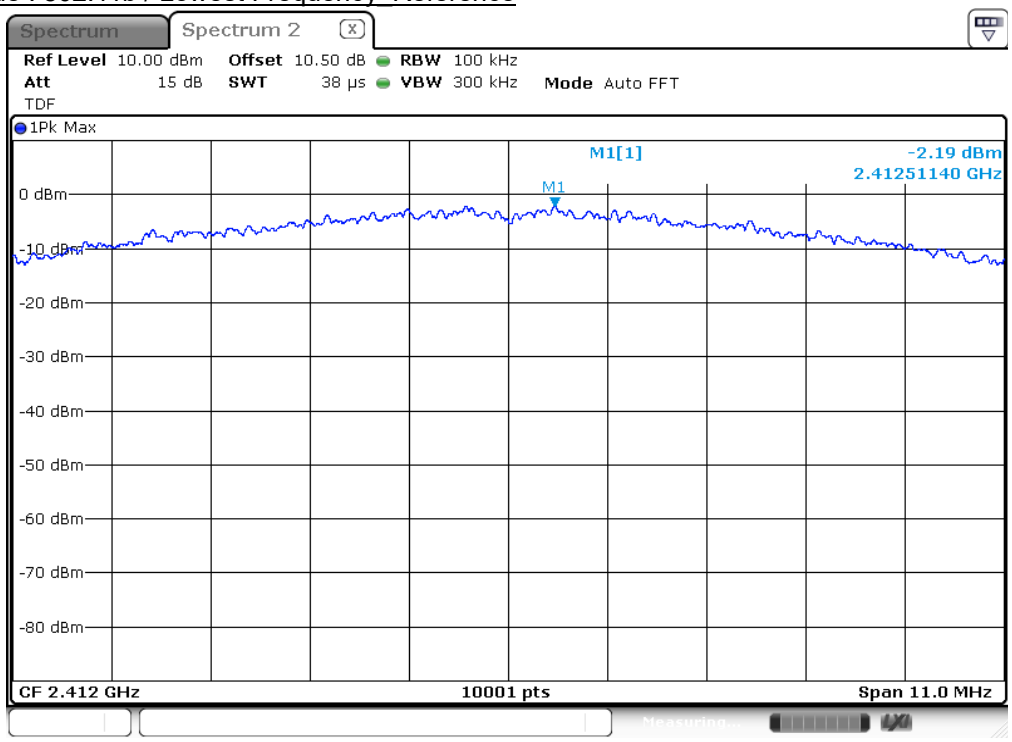
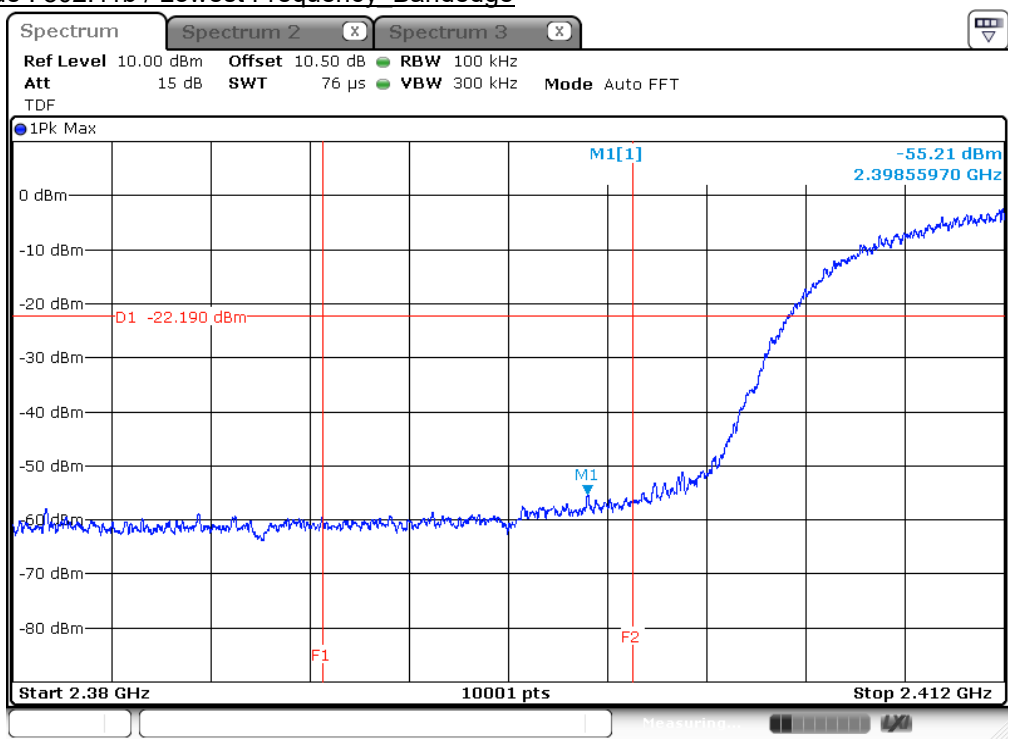
4.4.5.6 Measurement data_Conducted Spurious Emissions

Test mode : 802.11b / Lowest Frequency_Reference



Test mode : 802.11b / Lowest Frequency_Bandedge



Note: Limit : -2.19 dBm - 20 dB = -22.19 dBm

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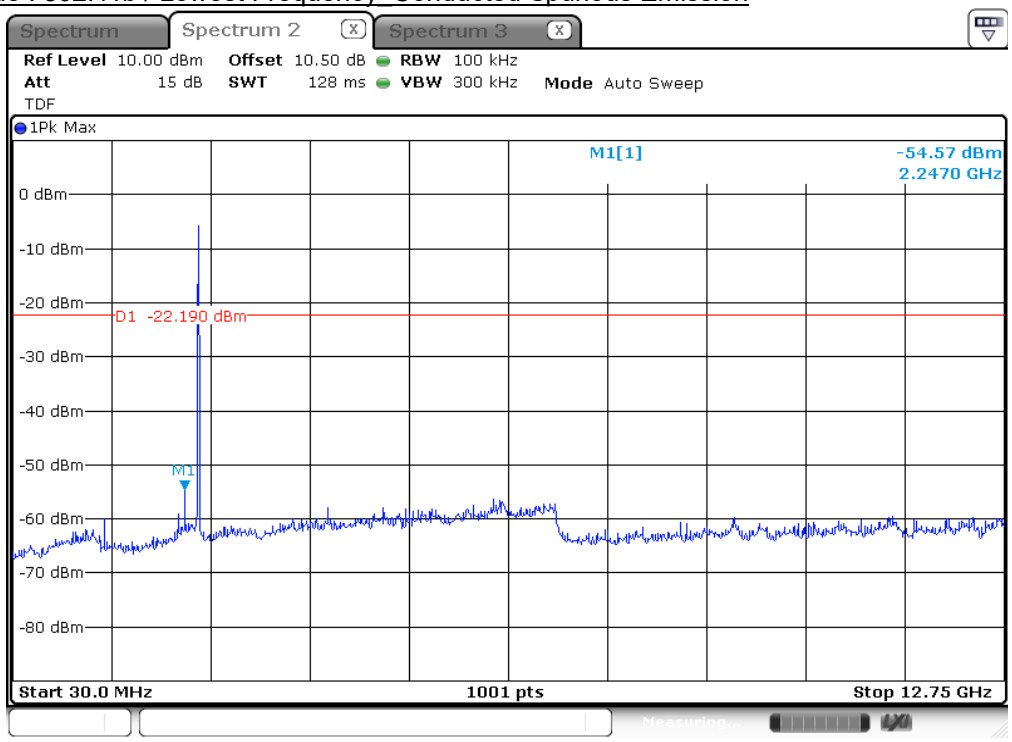
Test mode : 802.11b / Lowest Frequency_Conducted Spurious Emission



Note: Limit : -2.19 dBm - 20 dB = -22.19 dBm

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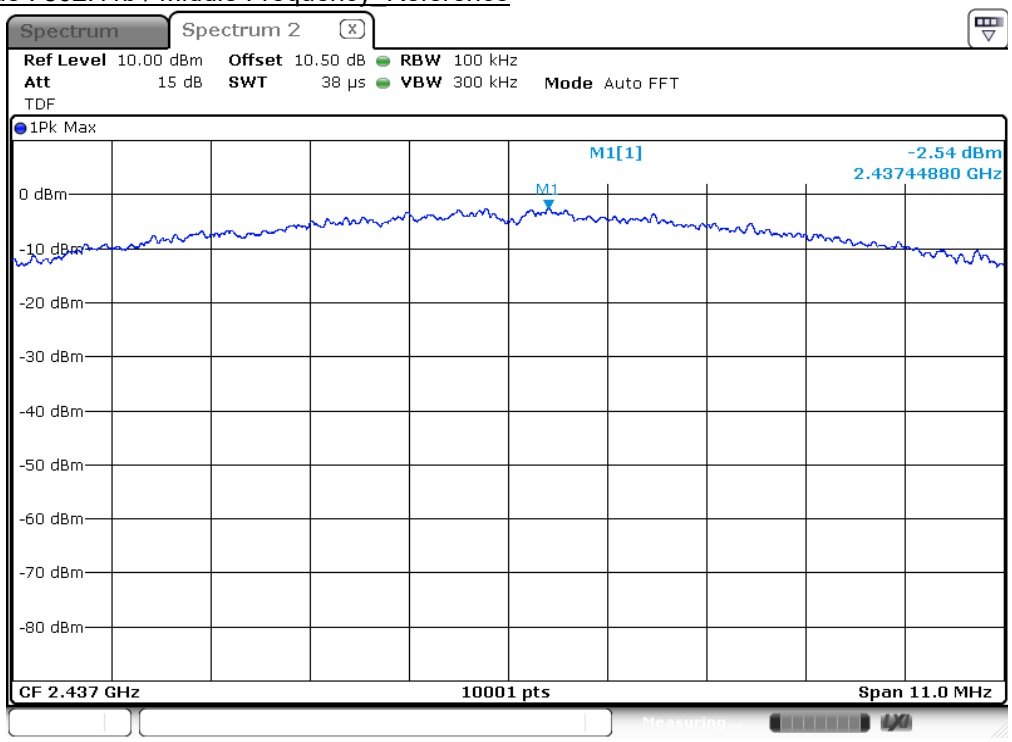
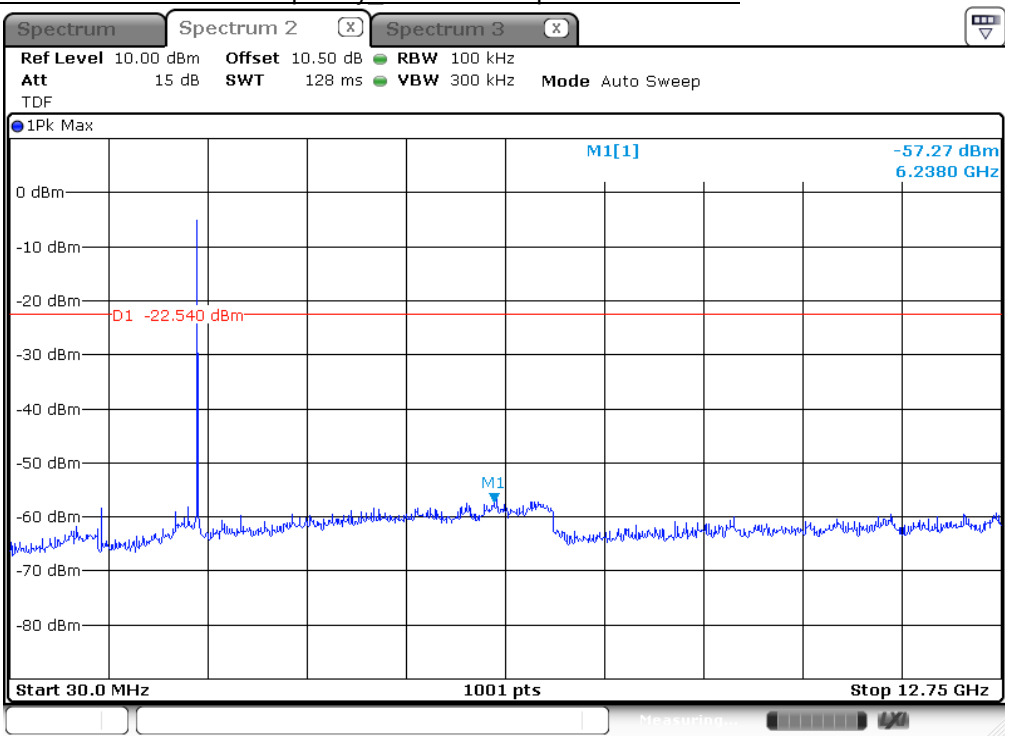
Test mode : 802.11b / Middle Frequency_Reference



Test mode : 802.11b / Middle Frequency_Conducted Spurious Emission



Note: Limit : -2.54 dBm - 20 dB = -22.54 dBm

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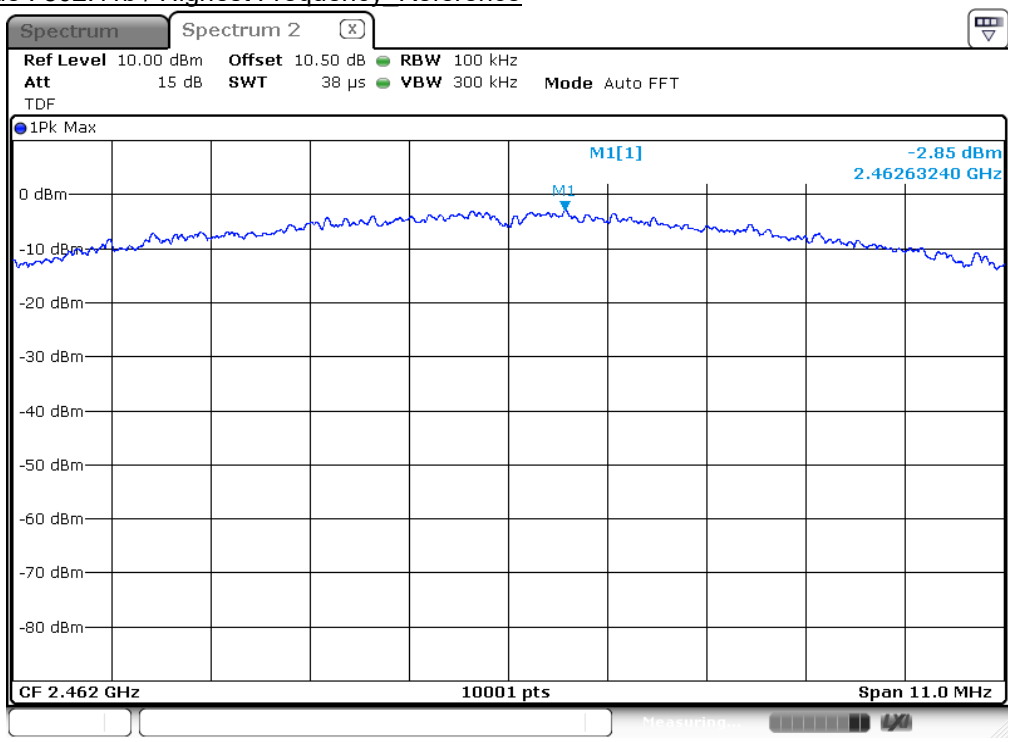
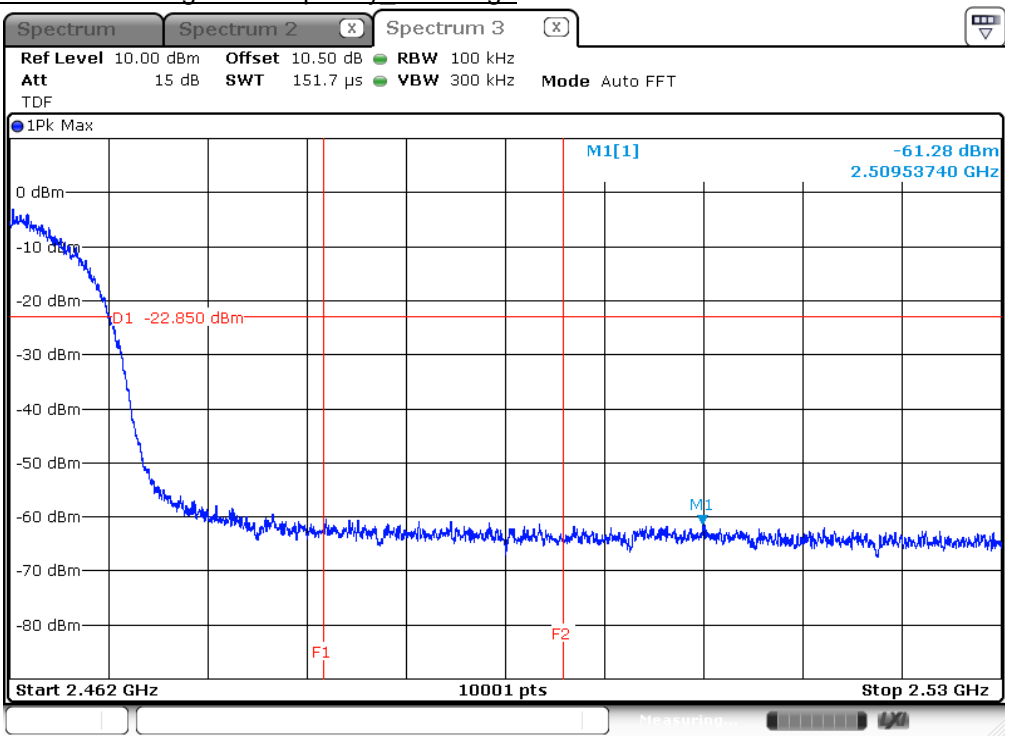
Test mode : 802.11b / Highest Frequency_Reference



Test mode : 802.11b / Highest Frequency_Bandedge



Note: Limit : -2.85 dBm - 20 dB = -22.85 dBm

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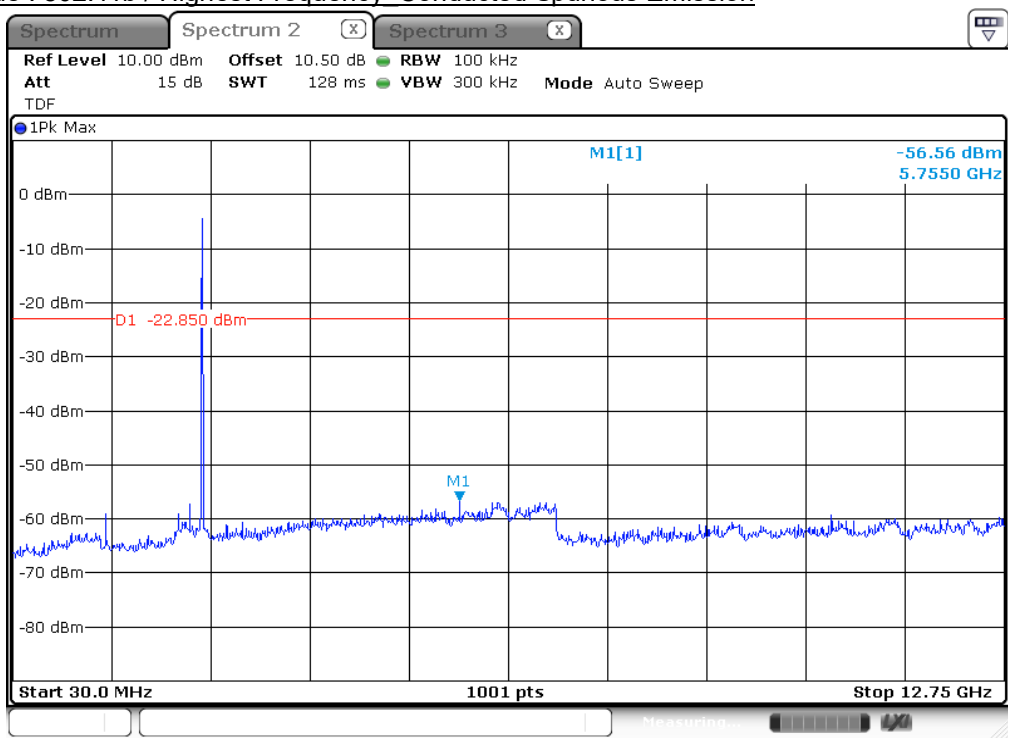
Test mode : 802.11b / Highest Frequency Conducted Spurious Emission



Note: Limit : -2.85 dBm - 20 dB = -22.85 dBm

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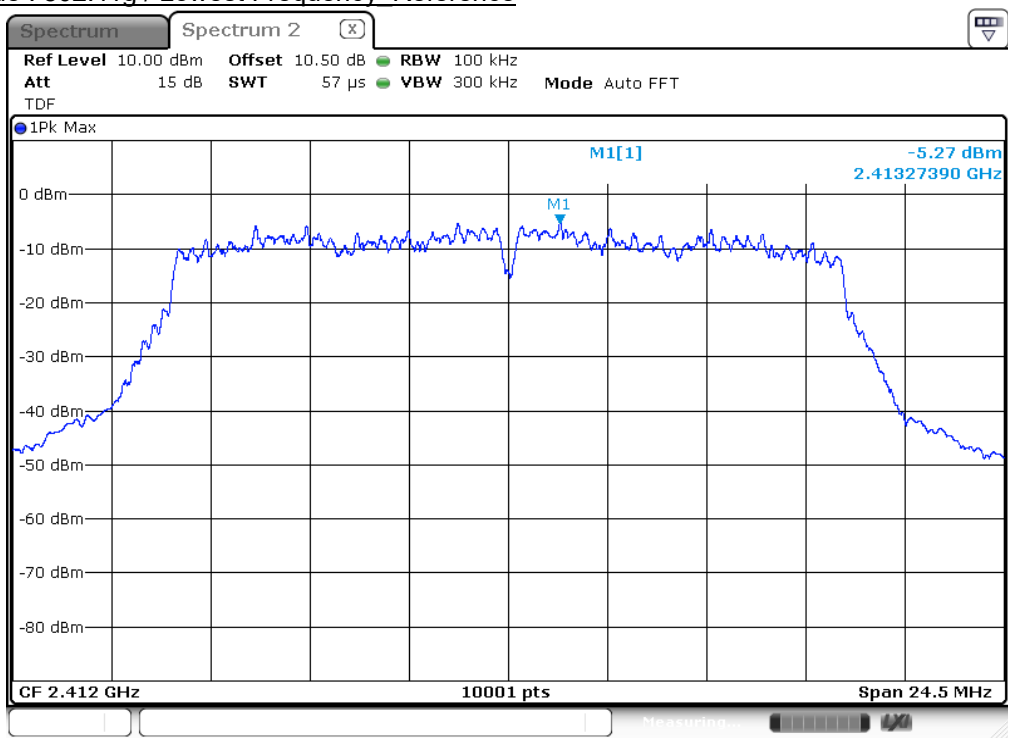
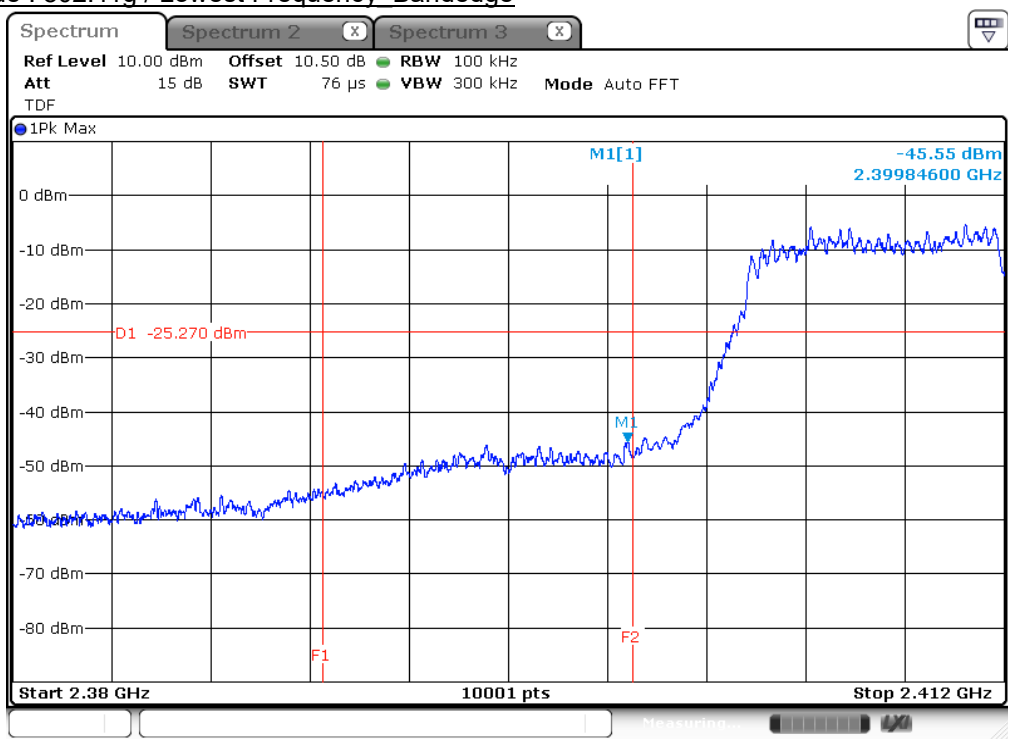
Test mode : 802.11g / Lowest Frequency_Reference



Test mode : 802.11g / Lowest Frequency_Bandedge



Note: Limit : -5.27 dBm - 20 dB = -25.27 dBm

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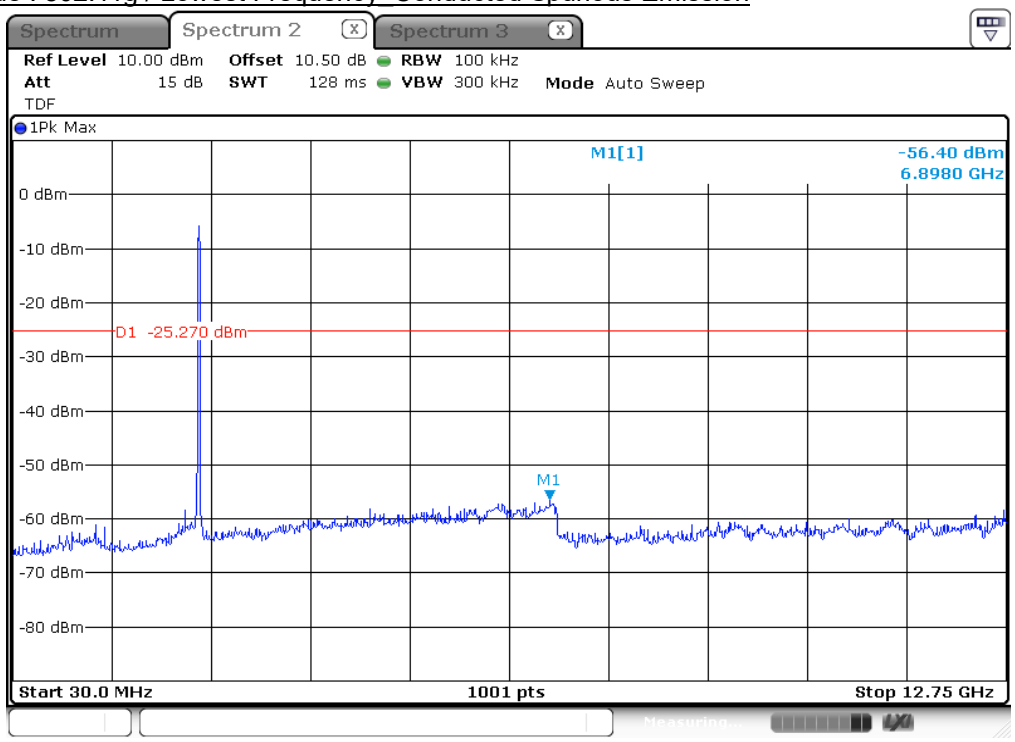
Test mode : 802.11g / Lowest Frequency_Conducted Spurious Emission



Note: Limit : -5.27 dBm - 20 dB = -25.27 dBm

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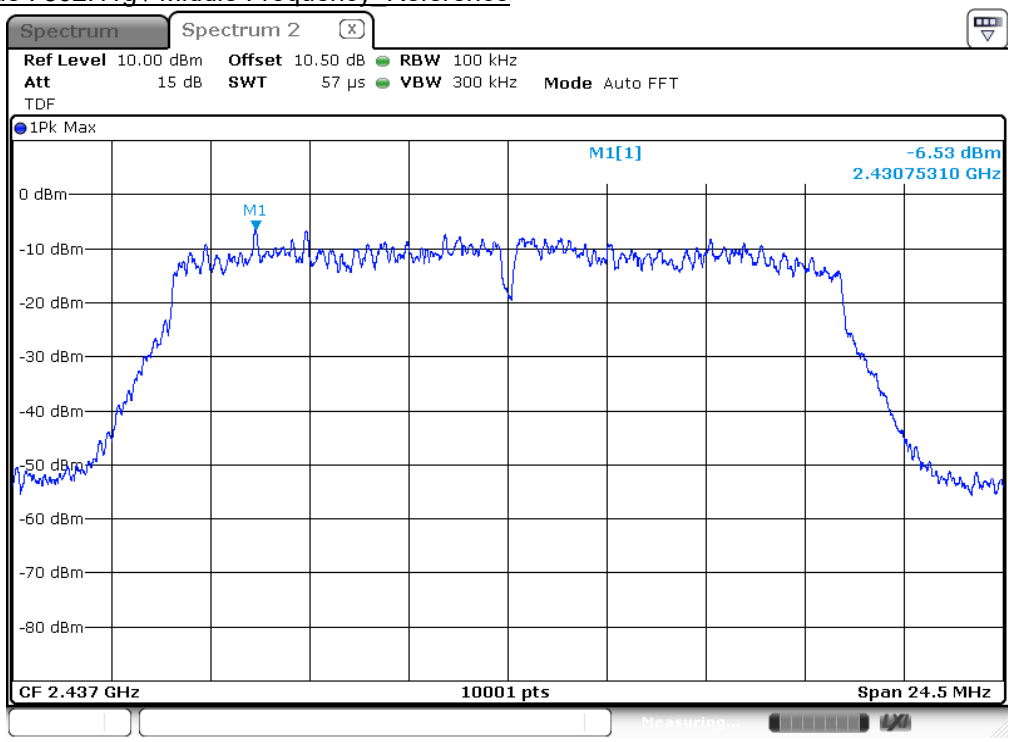
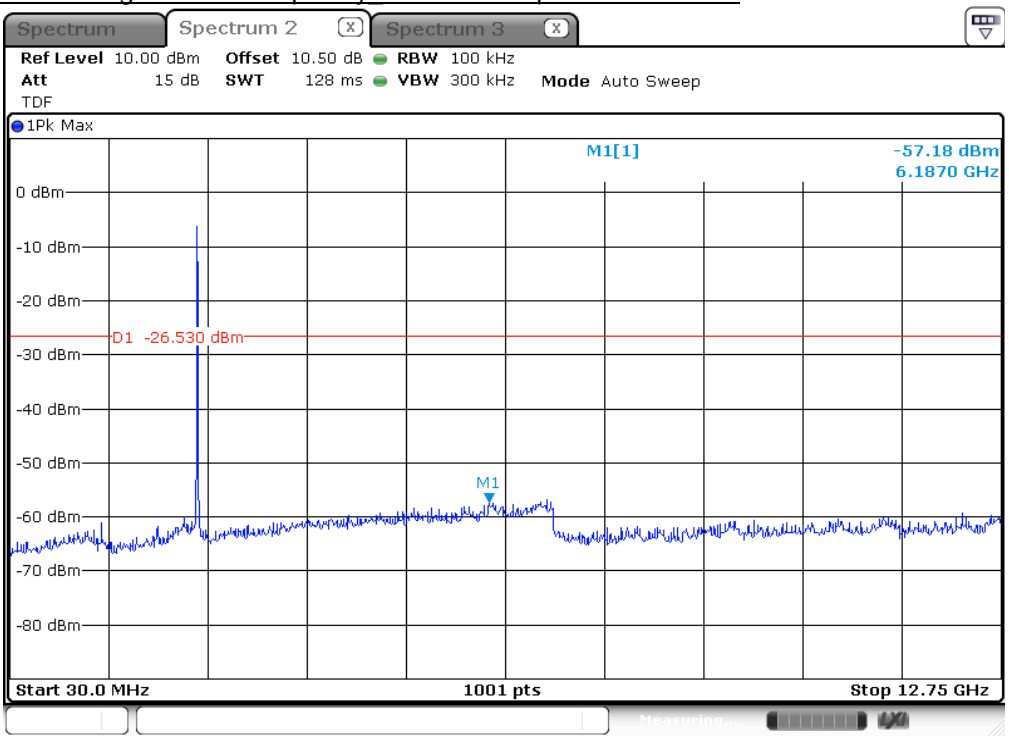
Test mode : 802.11g / Middle Frequency_Reference



Test mode : 802.11g / Middle Frequency_Conducted Spurious Emission



Note: Limit : -6.53 dBm - 20 dB = -26.53 dBm

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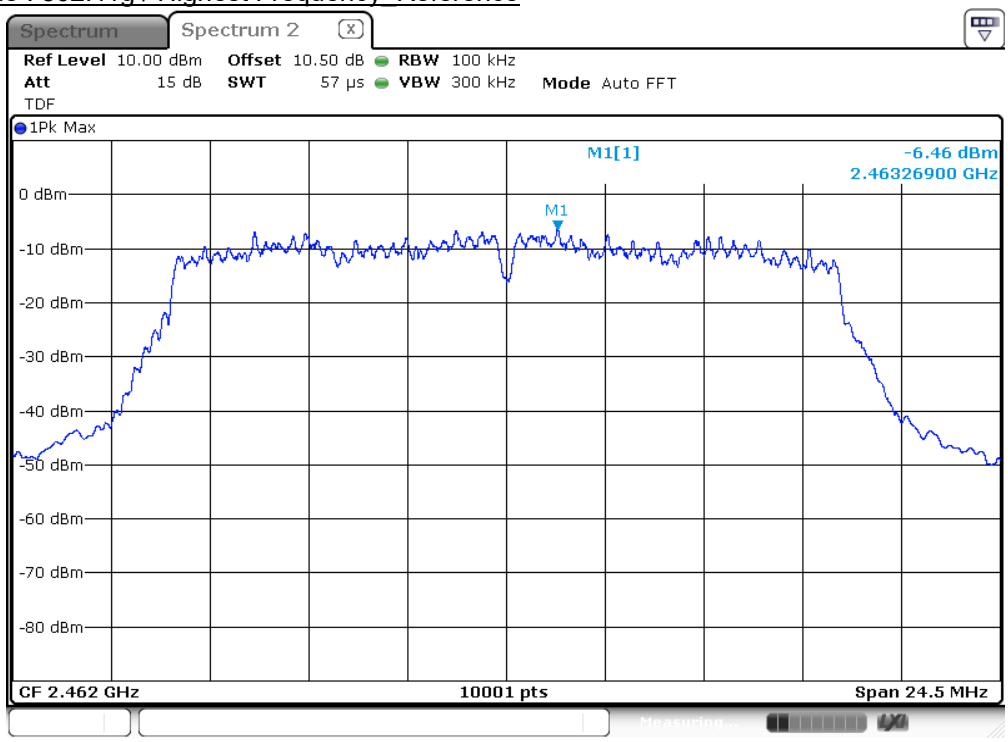
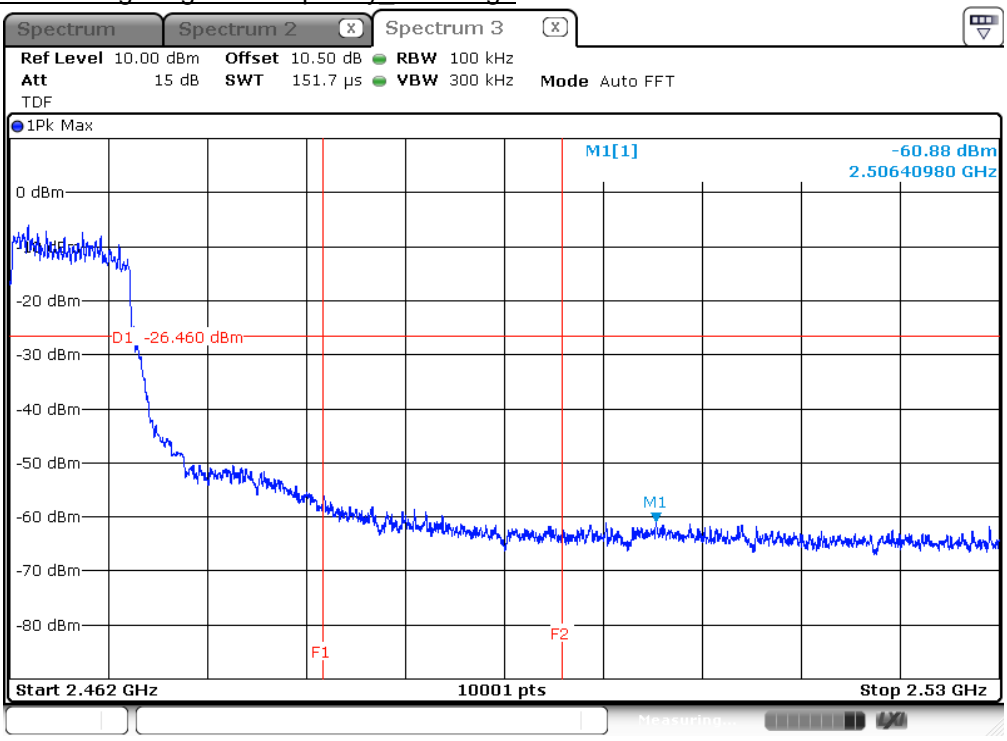
Test mode : 802.11g / Highest Frequency_Reference



Test mode : 802.11g / Highest Frequency_Bandedge



Note: Limit : -6.46 dBm - 20 dB = -26.46 dBm

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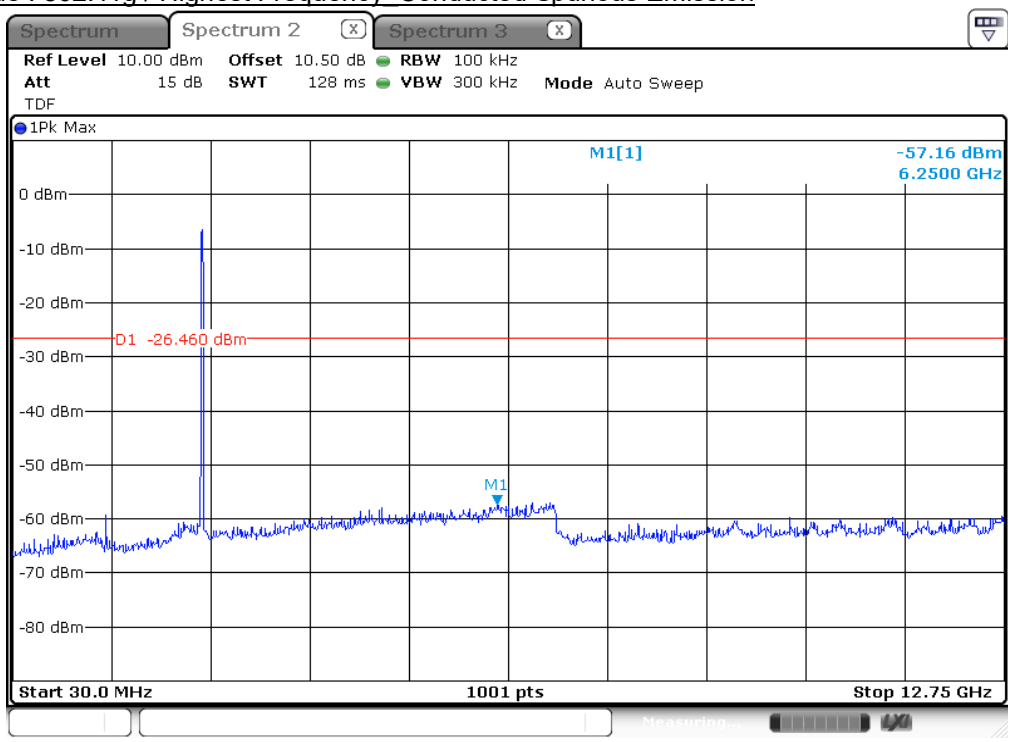
Test mode : 802.11g / Highest Frequency Conducted Spurious Emission



Note: Limit : -6.46 dBm - 20 dB = -26.46 dBm

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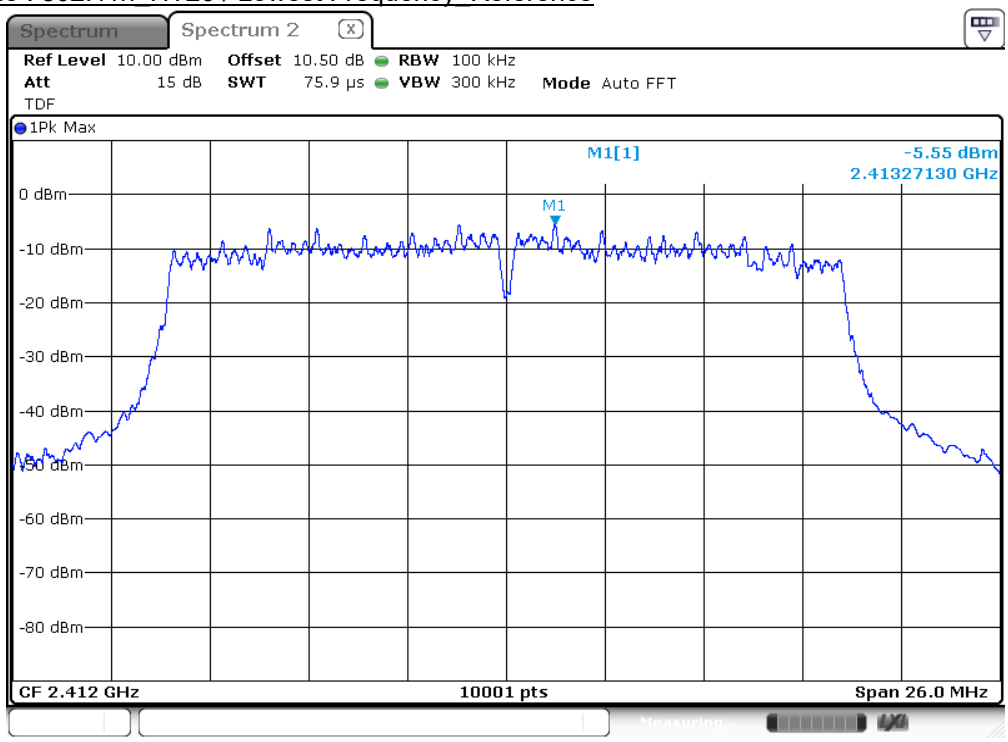
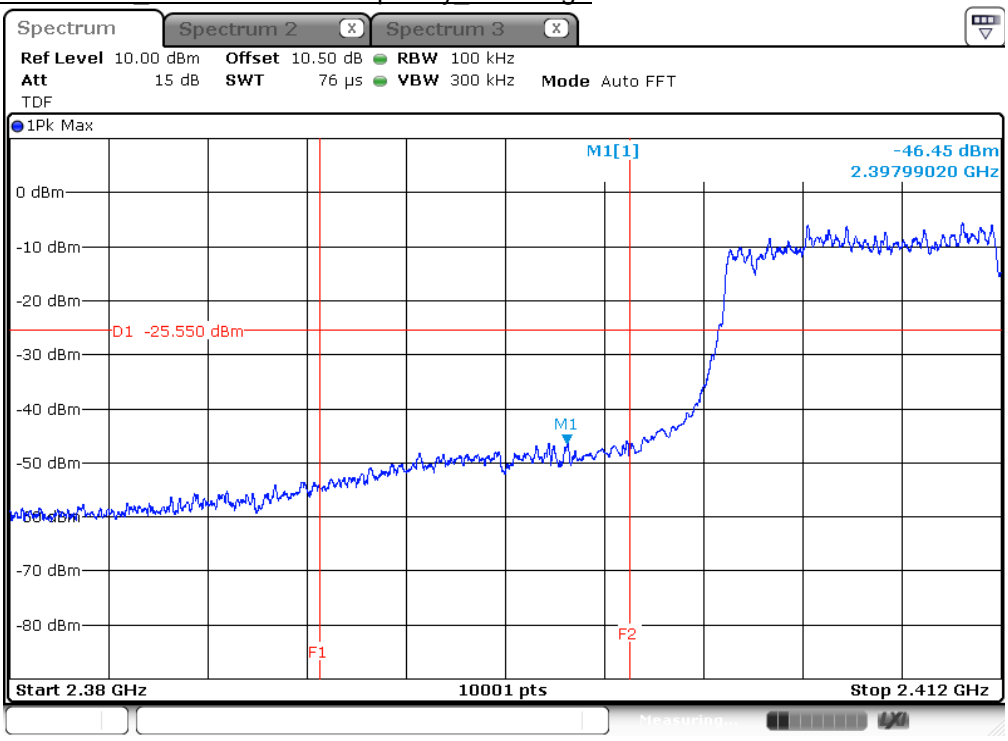
Test mode : 802.11n_HT20 / Lowest Frequency_Reference



Test mode : 802.11n_HT20 / Lowest Frequency_Bandedge



Note: Limit : -5.55 dBm - 20 dB = -25.55 dBm

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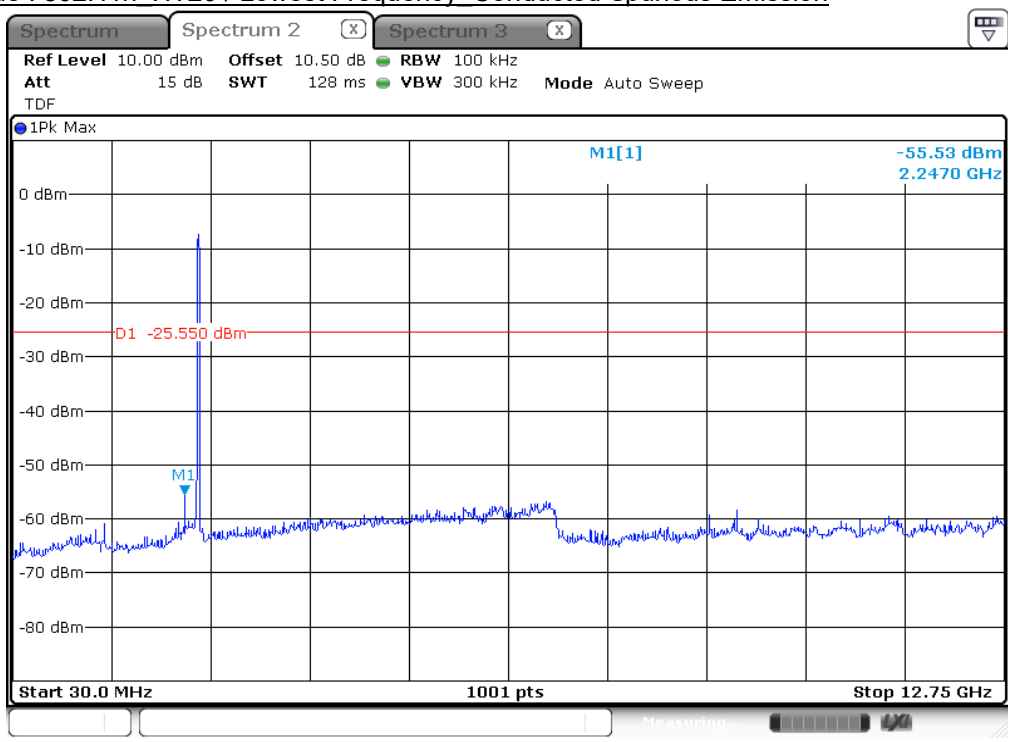
Test mode : 802.11n_HT20 / Lowest Frequency_Conducted Spurious Emission



Note: Limit : -5.55 dBm - 20 dB = -25.55 dBm

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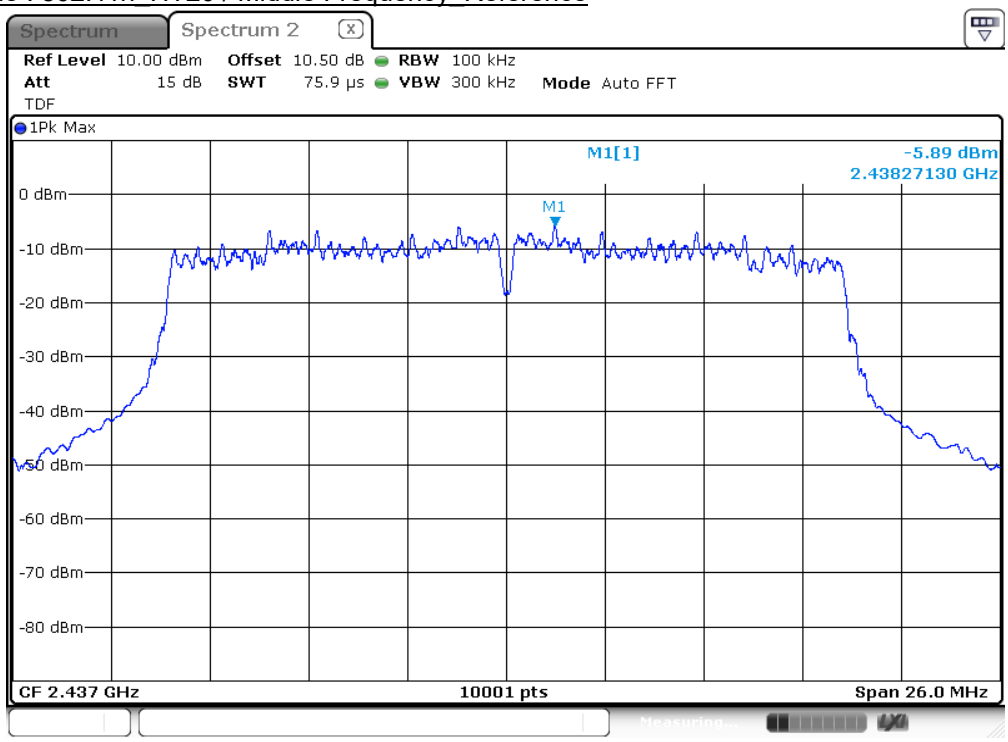
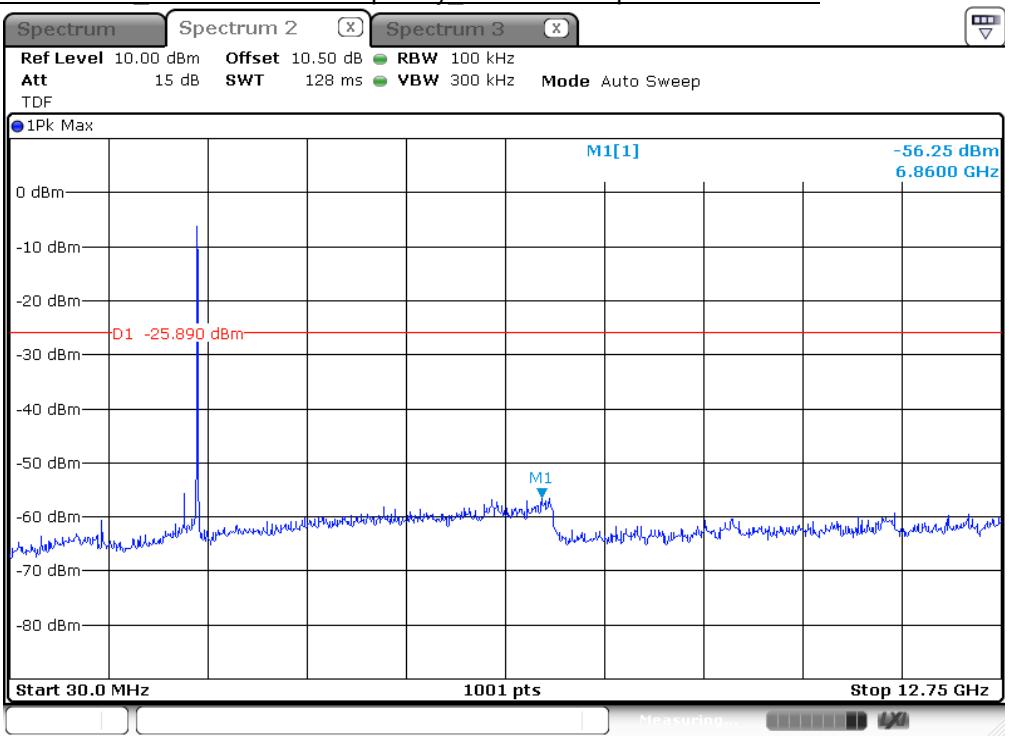
Test mode : 802.11n_HT20 / Middle Frequency_Reference



Test mode : 802.11n_HT20 / Middle Frequency_Conducted Spurious Emission



Note: Limit : -5.89 dBm - 20 dB = -25.89 dBm

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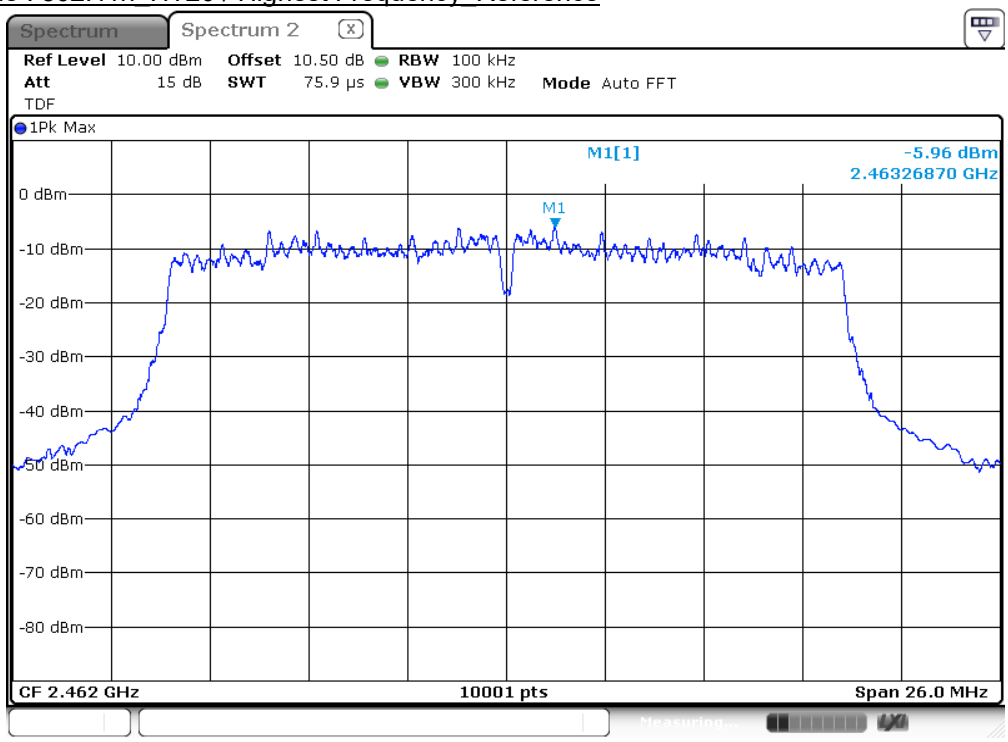
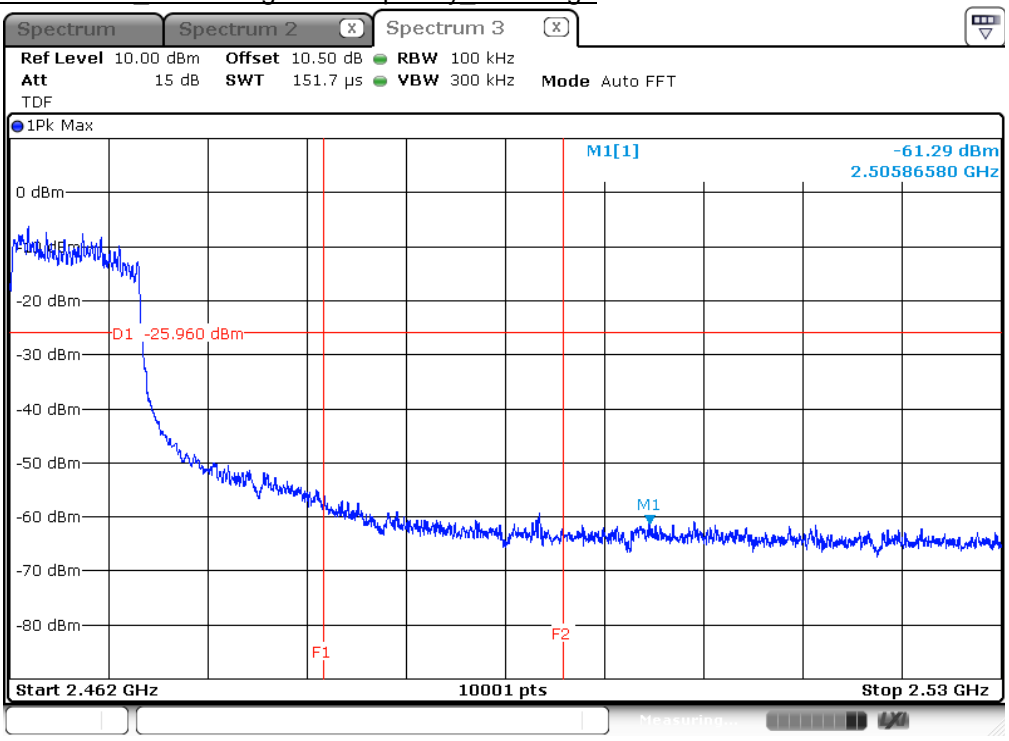
Test mode : 802.11n_HT20 / Highest Frequency_Reference



Test mode : 802.11n_HT20 / Highest Frequency_Bandedge



Note: Limit : -5.96 dBm - 20 dB = -25.96 dBm

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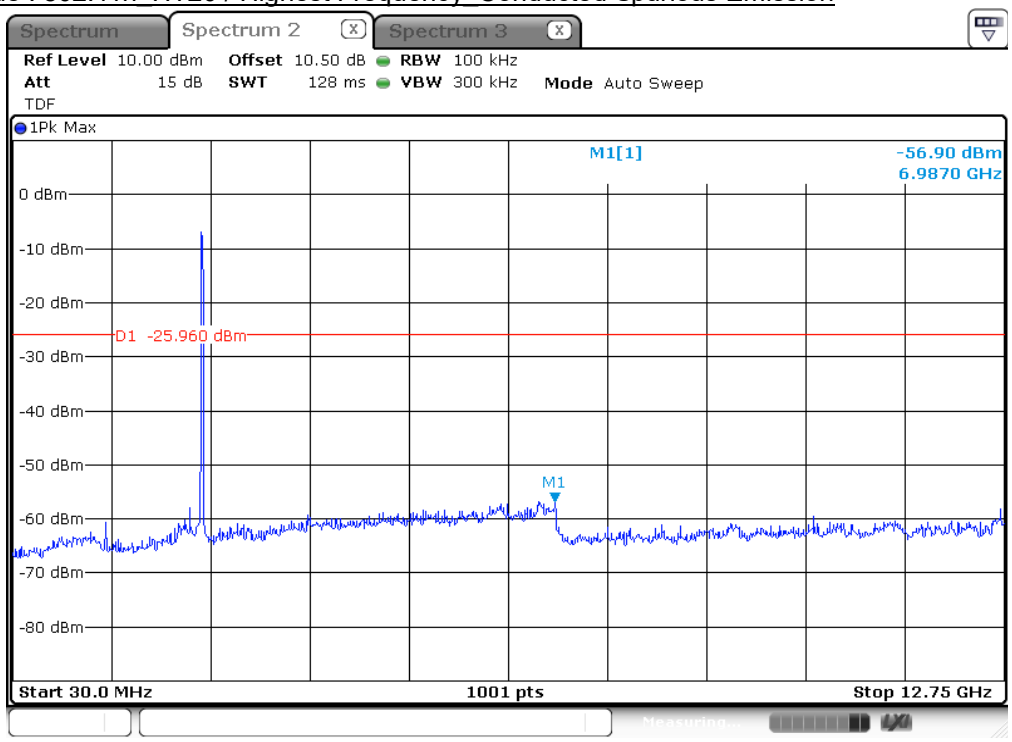
Test mode : 802.11n_HT20 / Highest Frequency_Conducted Spurious Emission



Note: Limit : -5.96 dBm - 20 dB = -25.96 dBm

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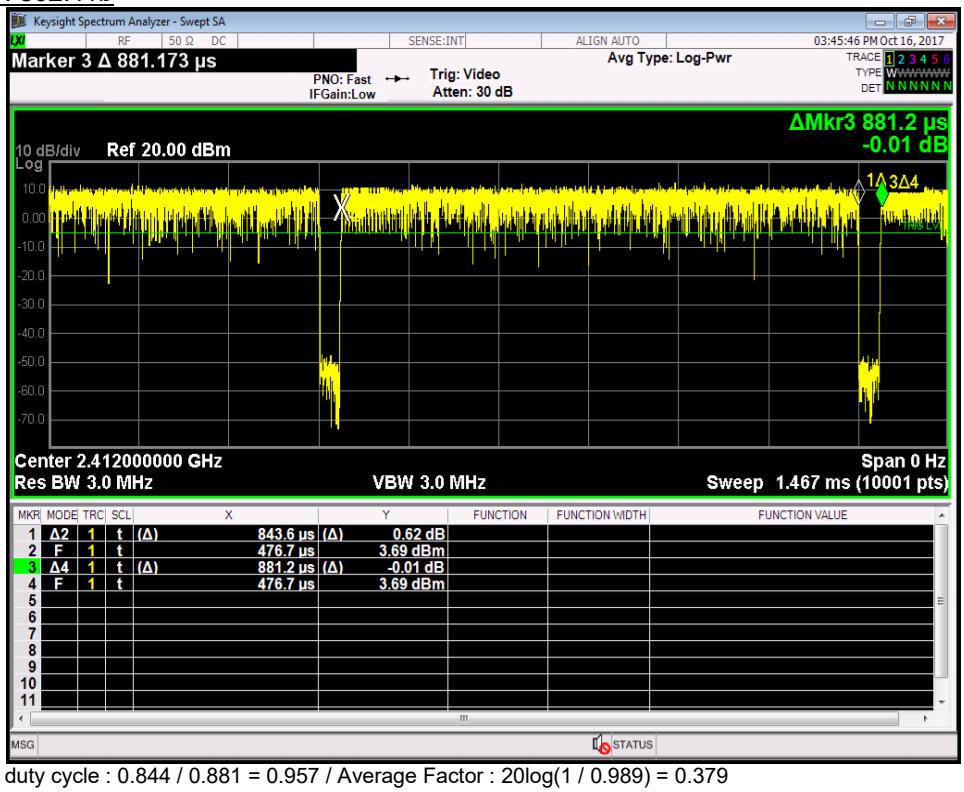
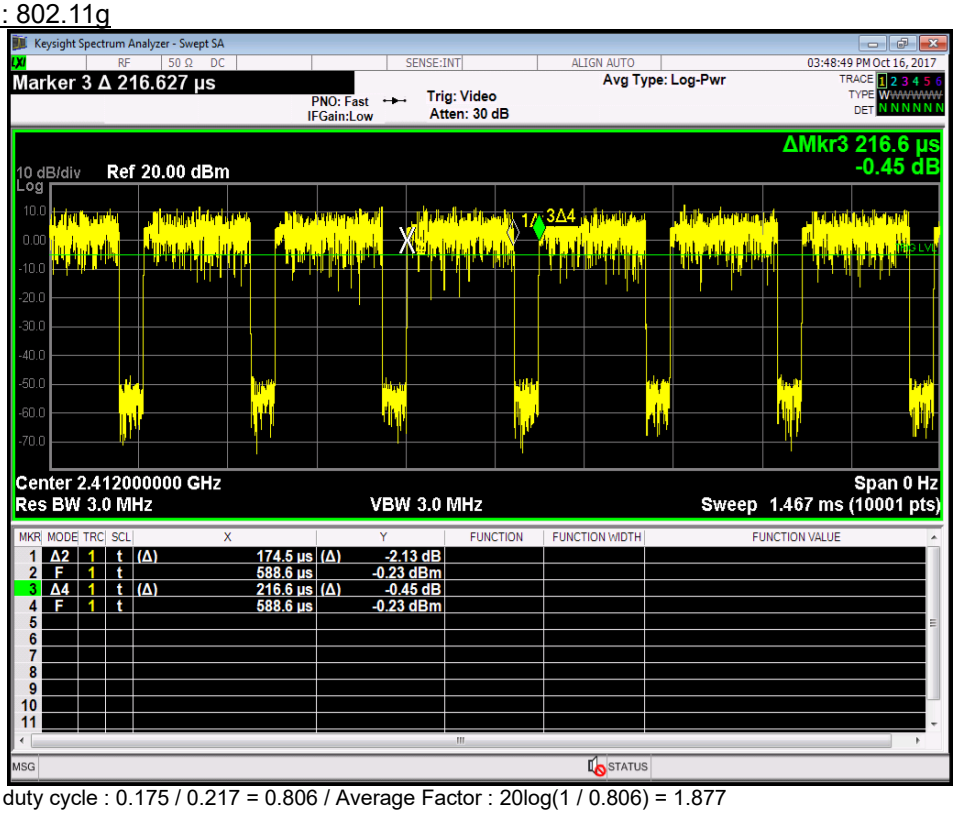
4.4.5.7 Measurement Plot_Dutycycle

Test mode : 802.11b



duty cycle : 0.844 / 0.881 = 0.957 / Average Factor : 20log(1 / 0.989) = 0.379

Test mode : 802.11g



Note: duty cycle : 0.175 / 0.217 = 0.806 / Average Factor : 20log(1 / 0.806) = 1.877

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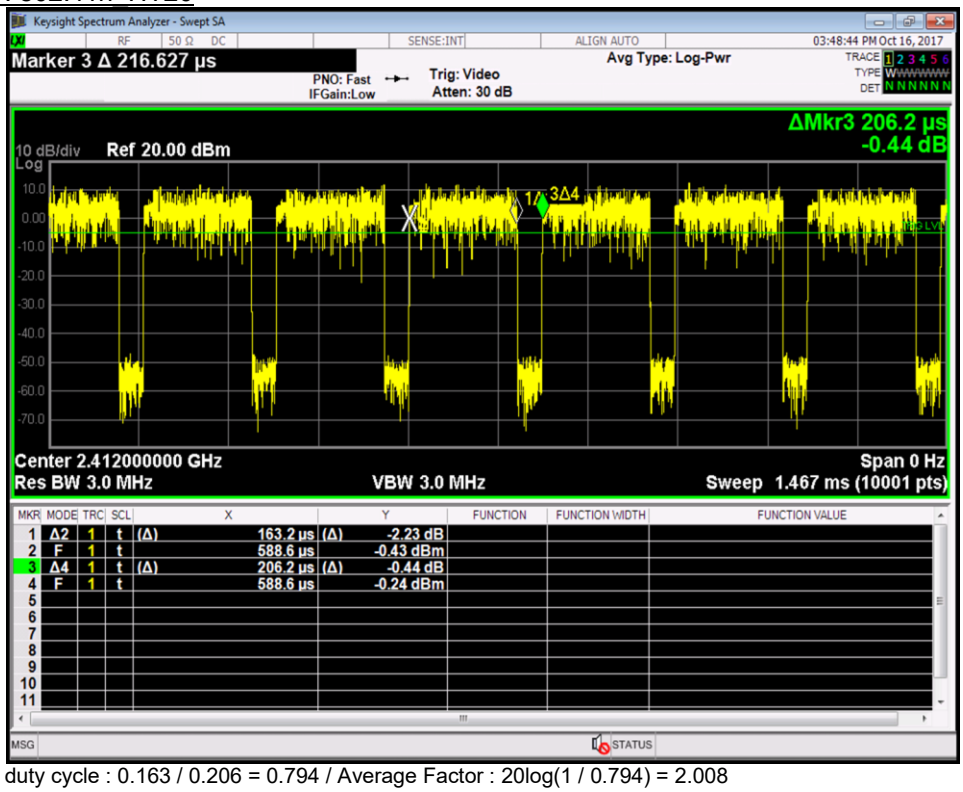
Test mode : 802.11n_HT20



Note: duty cycle : 0.163 / 0.206 = 0.794 / Average Factor : 20log(1 / 0.794) = 2.008

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4.4.6 Conducted Emission

4.4.6.1 Regulation

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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Ω 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 boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

4.4.6.2 Measurement Procedure

1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5 m away from the side wall of the shielded room.

2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω/50 μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.

3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.

4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.

5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASIPEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

4.4.6.3 Result

Not Applicable (This device is used battery for power supplying. (DC 12 V)
Therefore this test item was not performed)

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APPENDIX I

TEST EQUIPMENT USED FOR TESTS

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To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment.

Equipment	Manufacturer	Model	Serial No.	Cal. Date (yy.mm.dd)	Next Cal.Date (yy.mm.dd)
PXA Signal Analyzer	KEYSIGHT	N9030A	MY54410264	2017.01.12	2018.01.12
FSV Signal Analyzer	ROHDE&SCHWARZ	FSV40	101010	2017.05.02	2018.05.02
Power Sensor	KEYSIGHT	U2022XA	MY55320008	2017.08.16	2018.08.16
Dynamic Mesurement DC Source	HP	66332A	US37471465	2017.01.12	2018.01.12
Digital MultiMeter	HP	34401A	US36025428	2017.01.12	2018.01.12
Signal Generator	ROHDE&SCHWARZ	SMB100A	178384	2017.10.16	2018.10.16
ATTENUATOR	INMET	26A-3	TR006	2017.10.13	2018.10.13
EMI Test Receiver	ROHDE&SCHWARZ	ESU40	100445	2016.12.16	2017.12.16
BiLog Antenna	Schwarzbeck	VULB9160	9160-3381	2017.06.15	2019.06.15
Preamplifier	TSJ	MLA-10k01-b01-27	1870369	2017.04.24	2018.04.24
Antenna Mast(10 m)	TOKIN	5977	-	-	-
Antenna Mast(10 m)	Innco	MA4640-XPET-0800	578	-	-
Controller(10 m)	TOKIN	5909L	141909L-1	-	-
Controller(10 m)	Innco	CO3000	40040217	-	-
Turn Table(10 m)	TOKIN	5983-1.5	-	-	-
10 m Semi-Anechoic Chamber	SY CORPORATION	-	-	-	-
Active Loop H-Field	ETS	6502	00150598	2017.06.01	2019.06.01
Double Ridege Horn Antenna	ETS	3117	00168719	2017.09.01	2019.09.01
Double Ridege Horn Antenna	A.H Systems, Inc	SAS-574	2581	2017.04.25	2019.04.25
PREAMPLIFIER	Agilent	8449B	3008A02110	2017.01.13	2018.01.13
PREAMPLIFIER	A.H Systems, Inc	PAM-1840VH	166	2017.01.13	2018.01.13

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