



FCC RF Test Report

APPLICANT : Lenovo(Shanghai) Electronics
Technology Co., Ltd.
EQUIPMENT : Standalone VR Headset
BRAND NAME : Lenovo
MODEL NAME : Lenovo VR-1541F
MARKETING NAME : Mirage Solo with Daydream
FCC ID : O57VR1541F
STANDARD : FCC Part 15 Subpart C §15.247
CLASSIFICATION : (DTS) Digital Transmission System

The product was received on Sep. 01, 2017 and testing was completed on Dec. 13, 2017. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Approved by: James Huang / Manager



Sporton International (Kunshan) Inc.

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SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Pass	-
3.2	15.247(b)	Power Output Measurement	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
		Conducted Spurious Emission		Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.24 dB at 2483.56 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 12.82 dB at 0.524 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-



1 General Description

1.1 Applicant

Lenovo(Shanghai) Electronics Technology Co., Ltd.
NO.68 BUILDING, 199 FENJU RD, Pilot Free Trade Zone, 200131, China

1.2 Manufacturer

Lenovo PC HK Limited
23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Standalone VR Headset
Brand Name	Lenovo
Model Name	Lenovo VR-1541F
Marketing Name	Mirage Solo with Daydream
FCC ID	O57VR1541F
EUT supports Radios application	WLAN 2.4GHz 802.11b/g/n HT20/ WLAN 5GHz 802.11a/n HT20/ HT40 WLAN 5GHz 802.11ac VHT20/VHT40/VHT80/ Bluetooth v2.0 + EDR/ Bluetooth v 4.0 LE/ Bluetooth v4.2 LE/ Bluetooth v5.0 LE
HW Version	R5
SW Version	OVR2.170822.001
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.



1.4 Product Specification of Equipment Under Test

Standards-related Product Specification										
Tx/Rx Channel Frequency Range	2412 MHz ~ 2462 MHz									
Maximum (Peak) Output Power to antenna	<p><SISO Ant. 1> 802.11b : 21.49 dBm (0.1409 W) 802.11g : 24.09 dBm (0.2564 W) 802.11n HT20 : 23.47 dBm (0.2223 W)</p> <p><SISO Ant. 2> 802.11b : 21.69 dBm (0.1476 W) 802.11g : 24.15 dBm (0.2600 W) 802.11n HT20 : 23.85 dBm (0.2427 W)</p> <p>MIMO <Ant. 1 + 2> 802.11n HT20 : 26.82 dBm (0.4808 W)</p>									
99% Occupied Bandwidth	802.11b : 13.54MHz 802.11g : 18.68MHz 802.11n HT20 : 20.03MHz									
Antenna Type / Gain	Ant. 1: Dipole Antenna with gain 1.5 dBi Ant. 2: Dipole Antenna with gain 1.5 dBi									
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)									
Antenna Function for Transmitter	<table border="1"> <thead> <tr> <th></th> <th>Ant. 1</th> <th>Ant. 2</th> </tr> </thead> <tbody> <tr> <td>802.11 b/g/n SISO</td> <td>V</td> <td>V</td> </tr> <tr> <td>802.11 n MIMO</td> <td>V</td> <td>V</td> </tr> </tbody> </table>		Ant. 1	Ant. 2	802.11 b/g/n SISO	V	V	802.11 n MIMO	V	V
		Ant. 1	Ant. 2							
	802.11 b/g/n SISO	V	V							
802.11 n MIMO	V	V								

Note:

1. MIMO Ant. 1+2 is a calculated result from sum of the power MIMO Ant. 1 and MIMO Ant. 2.
2. For 802.11b/g, we only test one Antenna port with higher conducted power.
3. For 802.11n HT20, we only test MIMO mode due to the MIMO power are higher than SISO mode.

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Specification of Accessory

Specification of Accessory			
AC Adapter 1 (US)	Brand Name	Lenovo (Huntkey)	Model Name C-P35
	Power Rating	I/P: 100-240Vac, 500mA, O/P: 5.2V/ 2000 mA	
AC Adapter 1 (EU)	Brand Name	Lenovo (Huntkey)	Model Name C-P36
	Power Rating	I/P: 100-240Vac, 500mA, O/P: 5.2V/ 2000 mA	
AC Adapter 1 (UK)	Brand Name	Lenovo (Huntkey)	Model Name C-P37
	Power Rating	I/P: 100-240Vac, 500mA, O/P: 5.2V/ 2000 mA	
AC Adapter 1 (Korea)	Brand Name	Lenovo (Huntkey)	Model Name C-P46
	Power Rating	I/P: 100-240Vac, 500mA, O/P: 5.2V/ 2000 mA	
AC Adapter 1 (AU)	Brand Name	Lenovo (Huntkey)	Model Name C-P48
	Power Rating	I/P: 100-240Vac, 500mA, O/P: 5.2V/ 2000 mA	
AC Adapter 2 (US)	Brand Name	Lenovo (Acbel)	Model Name C-P35
	Power Rating	I/P: 100-240Vac, 300mA, O/P: 5.2V/ 2000 mA	
AC Adapter 2 (EU)	Brand Name	Lenovo (Acbel)	Model Name C-P36
	Power Rating	I/P: 100-240Vac, 300mA, O/P: 5.2V/ 2000 mA	
AC Adapter 2 (UK)	Brand Name	Lenovo (Acbel)	Model Name C-P37
	Power Rating	I/P: 100-240Vac, 300mA, O/P: 5.2V/ 2000 mA	
Battery	Brand Name	Lenovo (SCUD)	Model Name L17D1P33
	Power Rating	3.85Vdc, 4000mAh	Type Li-ion
USB cable	Brand Name	Lenovo (Saibao)	Model Name SGA-A016A
	Signal Line	1.0 meter, shielded cable, without ferrite core	
Controller	Brand Name	Lenovo (Daydream)	Model Name DG1CA
Earphone	Brand Name	Lenovo	Model Name CE-1601T
	Signal Line	0.5 meter, Unshielded cable, without ferrite core	

1.7 Component List

Note: There are two types of EUT, the details refer the following table. According to the difference, we choose the sample 1 to full test.

Component	Sample 1		Sample 2	
UFS(64G)	THGAF4G9N4LBAIR	Toshiba	KLUCG4J1ED-B0C1	Samsung



1.8 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO 17025 by National Voluntary Laboratory Accreditation Program (NVLAP code: 600155-0) and the FCC designation No is CN5013.

Test Site	Sporton International (Kunshan) Inc.		
Test Site Location	No.3-2 Ping-Xiang Rd, Kunshan Development Zone Kunshan City Jiangsu Province 215335 China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.		FCC Test Firm Registration No.
	TH01-KS	CO01-KS	630927

Sporton International (Shenzhen) Inc. is accredited to ISO 17025 by National Voluntary Laboratory Accreditation Program (NVLAP code: 600156-0) and the FCC designation No is CN5019.

Test Site	Sporton International (Shenzhen) Inc.		
Test Site Location	No. 3 Bldg the third floor of south, Shahe River west, Fengzeyuan Warehouse, Nanshan District Shenzhen City Guangdong Province 518055 China TEL: +86-755-3320-2398		
Test Site No.	Sporton Site No.		FCC Test Firm Registration No.
	03CH04-SZ		577730

Note: The test site complies with ANSI C63.4 2014 requirement.



1.9 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conducted emission (150 kHz to 30 MHz) and radiated emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Y plane) were recorded in this report.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		



2.2 Test Mode

Final test mode of conducted test items and radiated spurious emissions are considering the modulation and worse data rates as below table.

Single Antenna

Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps

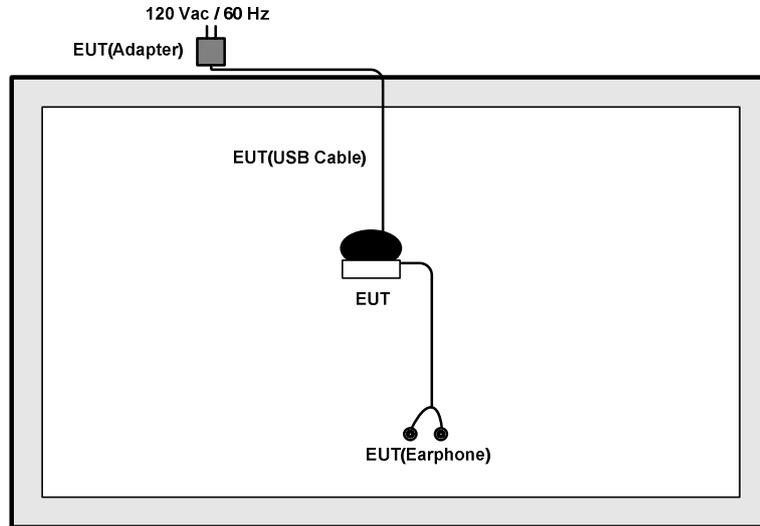
MIMO Antenna

Modulation	Data Rate
802.11n HT20	MCS0

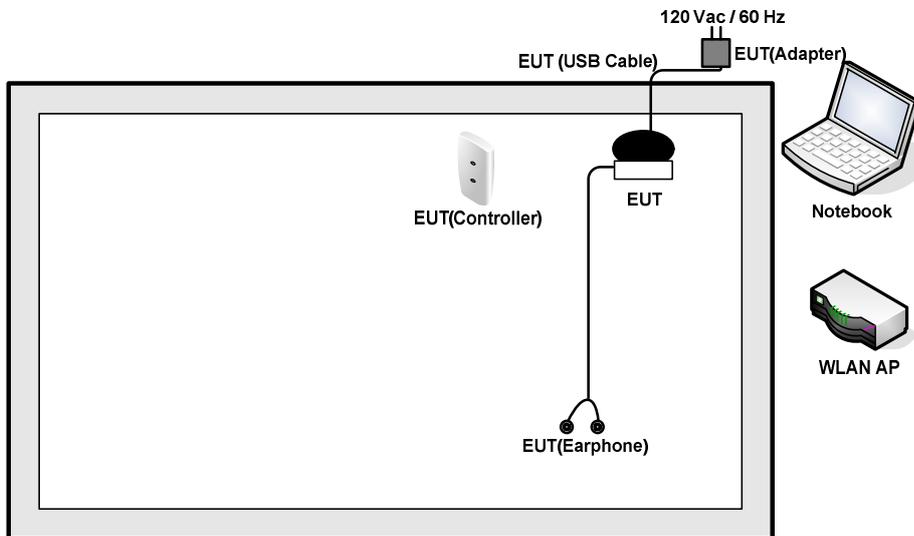
Test Cases	
AC Conducted Emission	Mode 1 : Bluetooth Link with Controller + WLAN Link(2.4G) + Earphone + USB Cable (Charging from Adapter 1) Mode 2 : Bluetooth Link with Controller + WLAN Link(2.4G) + Earphone + USB Cable (Charging from Adapter 2)
Remark:	
1. For Radiated TCs, The tests were performance with Adapter 1, Controller, Earphone and USB Cable. 2. The worst case of conducted emission is mode 2; only the test data of it was reported.	

2.3 Connection Diagram of Test System

<WLAN Tx Mode>



<AC Conducted Emission Mode>



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	D-Link	DIR-855	KA2DIR855A2	N/A	Unshielded, 1.8 m
2.	Notebook	Lenovo	G480	N/A	N/A	AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m

2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuous transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the notebook under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss.

Offset = RF cable loss.

Following shows an offset computation example with cable loss 5.8 dB.

Offset(dB) = RF cable loss(dB).
= 5.8 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

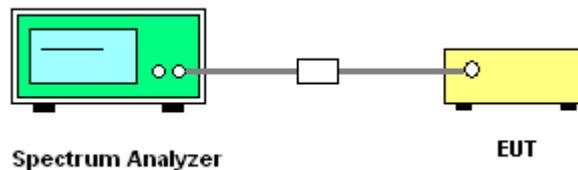
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 DTS D01 Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) = 1MHz and set the Video bandwidth (VBW) = 3MHz.
6. Measure and record the results in the test report.

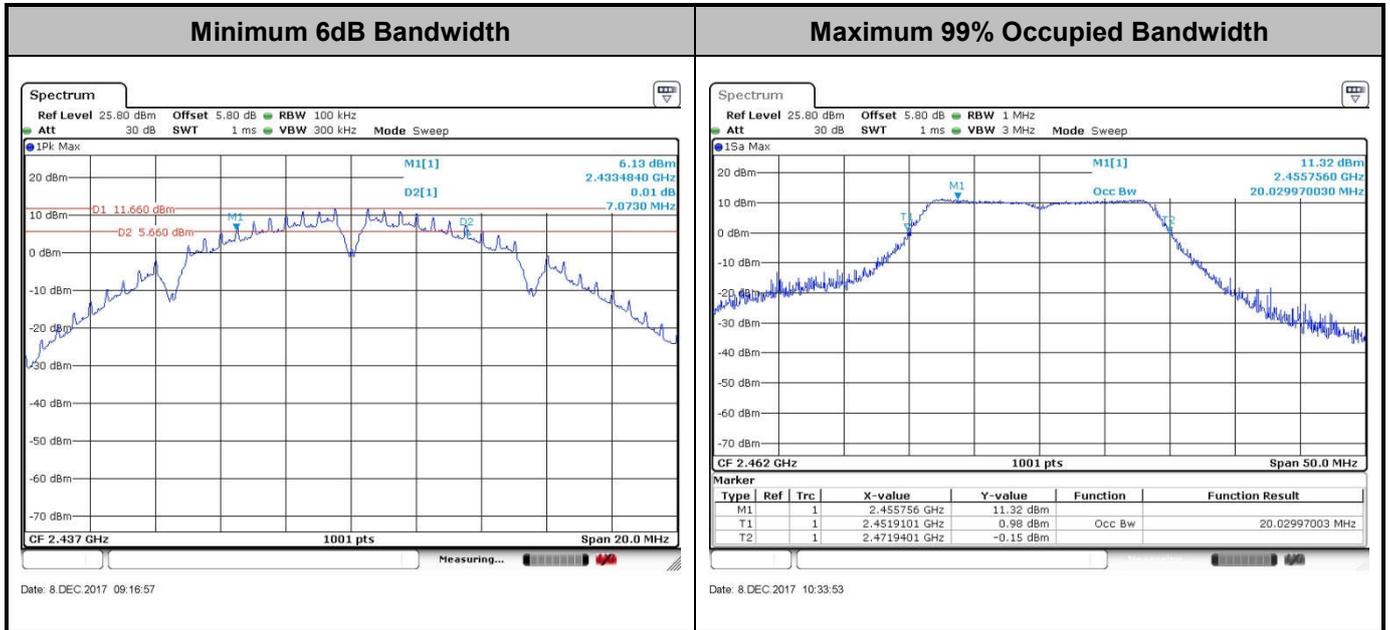
3.1.4 Test Setup





3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

Please refer to Appendix A.



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Peak Output Power Measurement

3.2.1 Limit of Peak Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

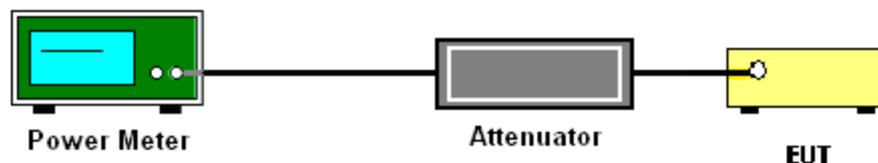
3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04 section 9.1.2 PKPM1 Peak power meter method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.
5. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average output Power (Reporting Only)

Please refer to Appendix A



3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure 10.2 Method PKPSD of FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

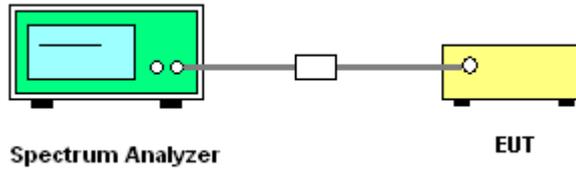
If measurements performed using method (2) plus $10 \log(N)$ exceeds the emission limit, the test should choose method (1) before declaring that the device fails the emission limit.

Method (1): Measure and sum the spectra across the outputs.

The total final Power Spectral Density is from a device with 2 transmitter outputs. The spectrum measurements of the individual outputs are all performed with the same span and number of points, the spectrum value in the first spectral bin of output 1 is summed with that in the first spectral bin of output 2 to obtain the value for the first frequency bin of the summed spectrum.

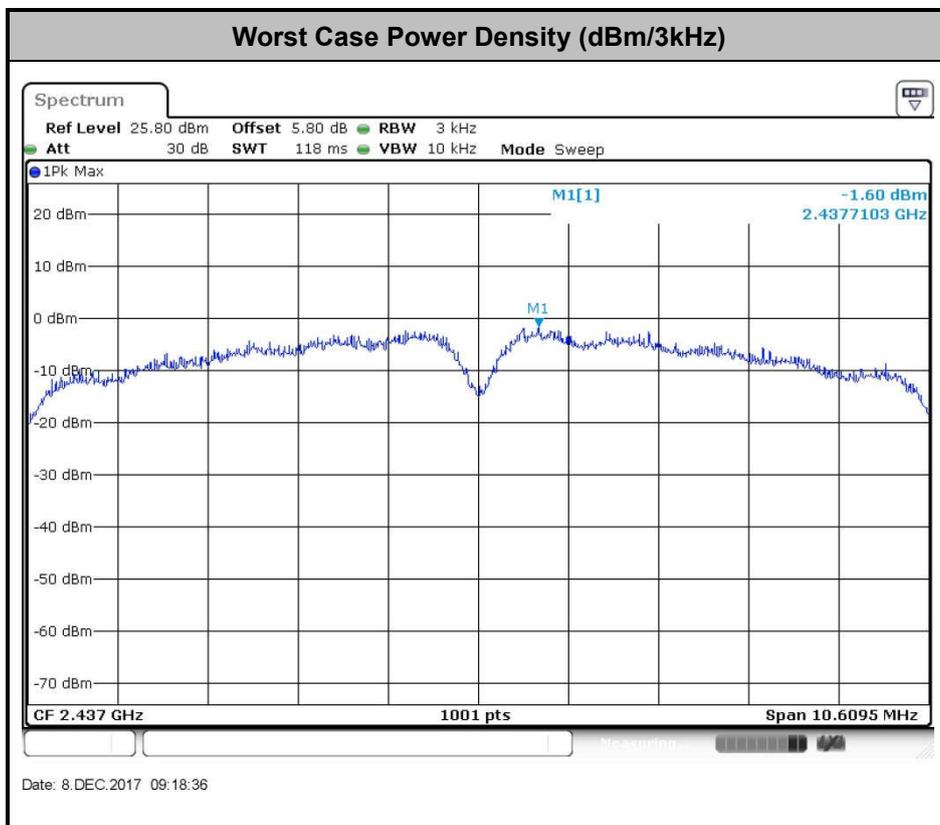
Method (2): Measure and add $10 \log(N)$ dB, where N is the number of outputs. (N=2)

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

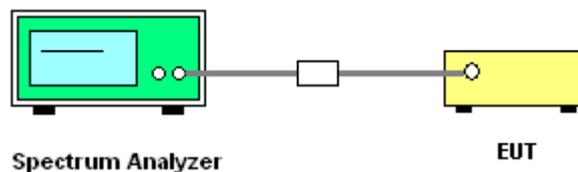
3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup

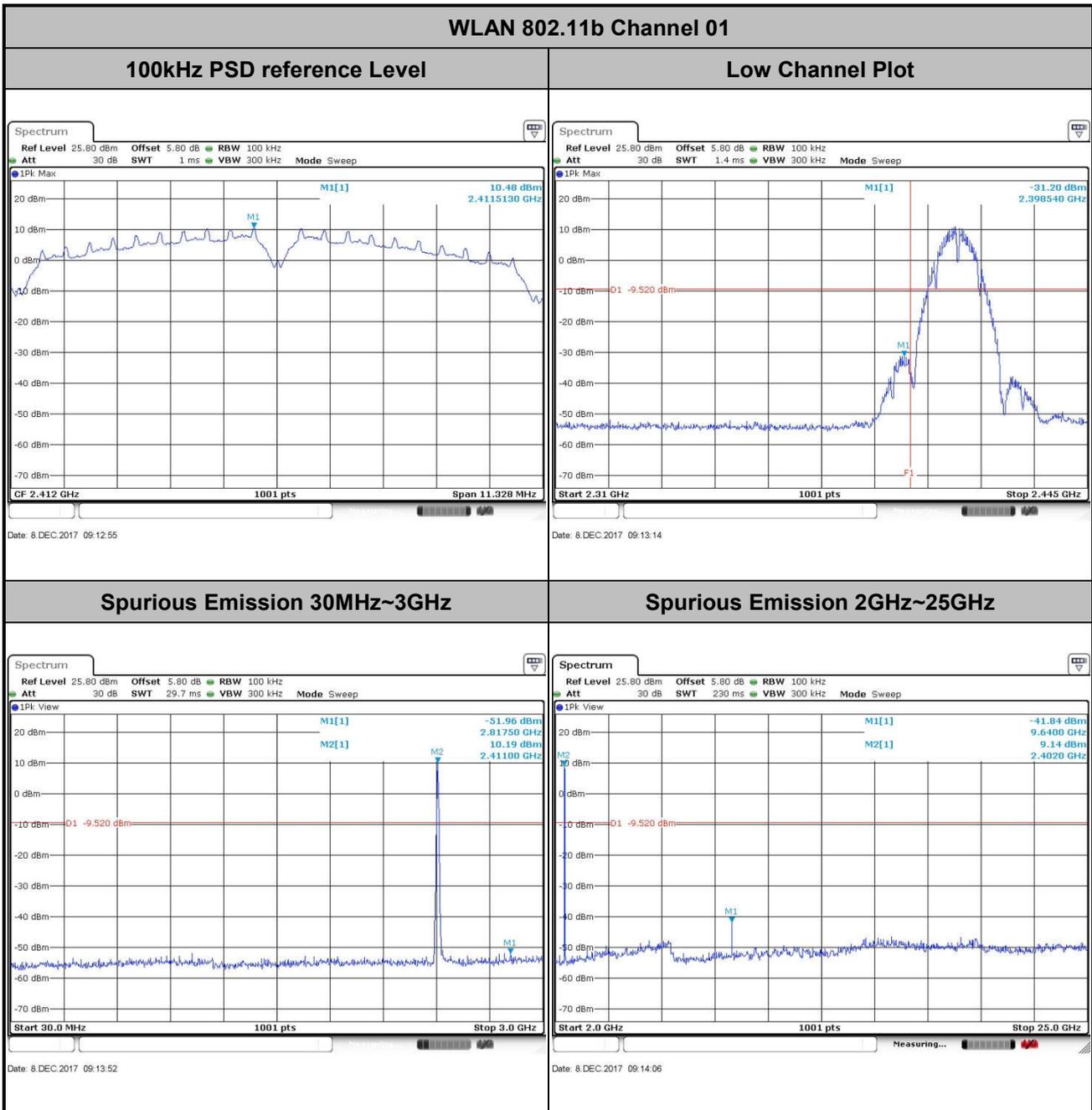




3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Number of TX = 1, Ant. 1 (Measured)

Number of TX	1	Ant. :	1
Test Mode :	802.11b	Temperature :	21~25°C
Test Band :	2.4GHz Low	Relative Humidity :	51~55%
Test Channel :	01	Test Engineer :	Silent Hai

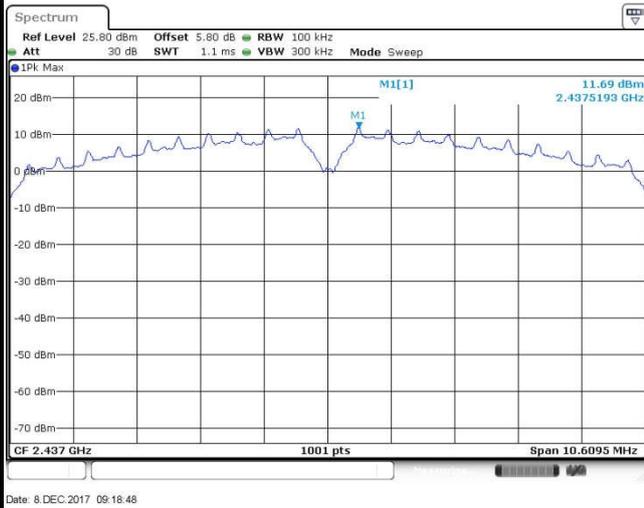




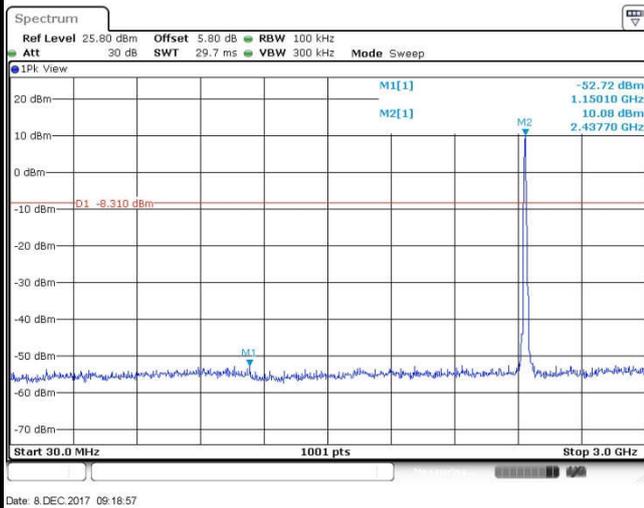
Number of TX :	1	Ant. :	1
Test Mode :	802.11b	Temperature :	21~25°C
Test Band :	2.4GHz Mid	Relative Humidity :	51~55%
Test Channel :	06	Test Engineer :	Silent Hai

WLAN 802.11b Channel 06

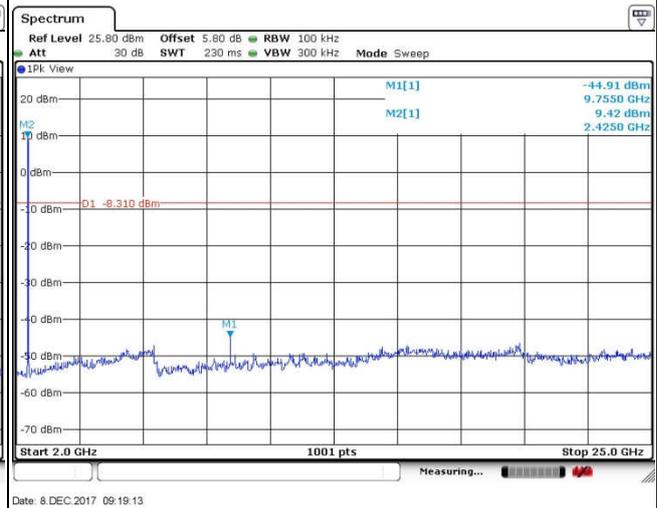
100kHz PSD reference Level



Spurious Emission 30MHz~3GHz



Spurious Emission 2GHz~25GHz

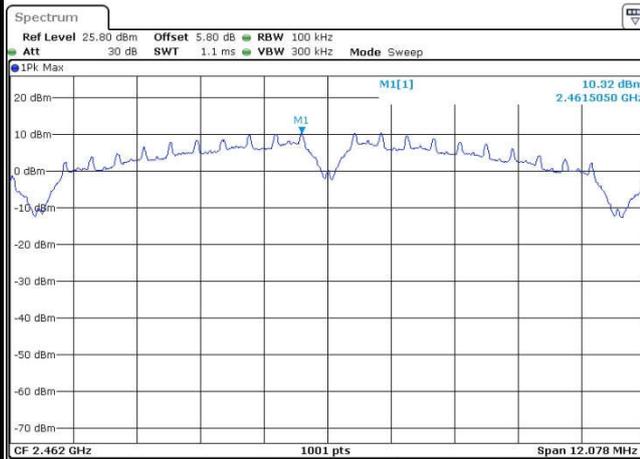




Number of TX :	1	Ant. :	1
Test Mode :	802.11b	Temperature :	21~25°C
Test Band :	2.4GHz High	Relative Humidity :	51~55%
Test Channel :	11	Test Engineer :	Silent Hai

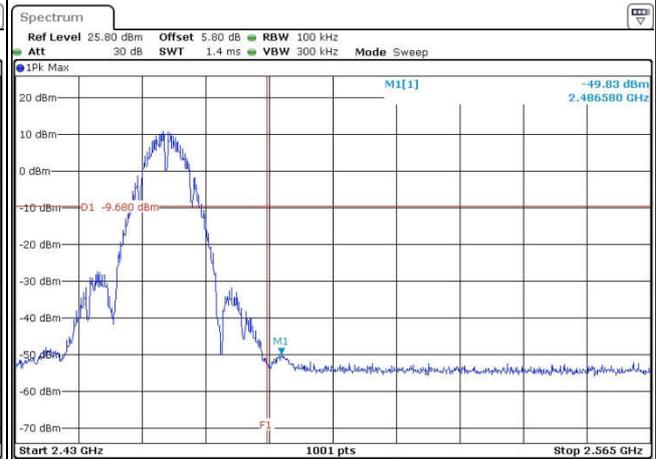
WLAN 802.11b Channel 11

100kHz PSD reference Level



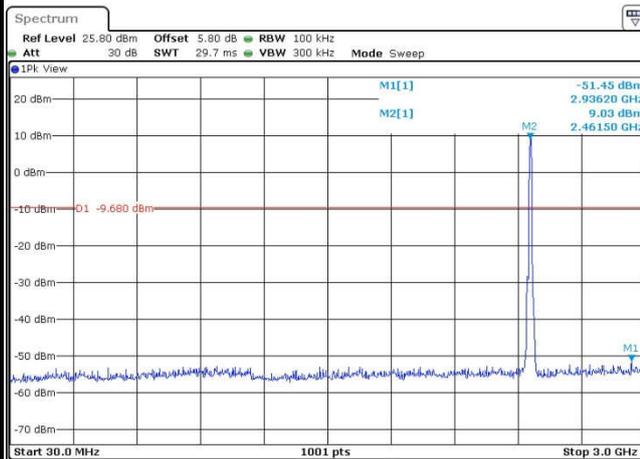
Date: 8 DEC 2017 09:21:47

High Channel Plot



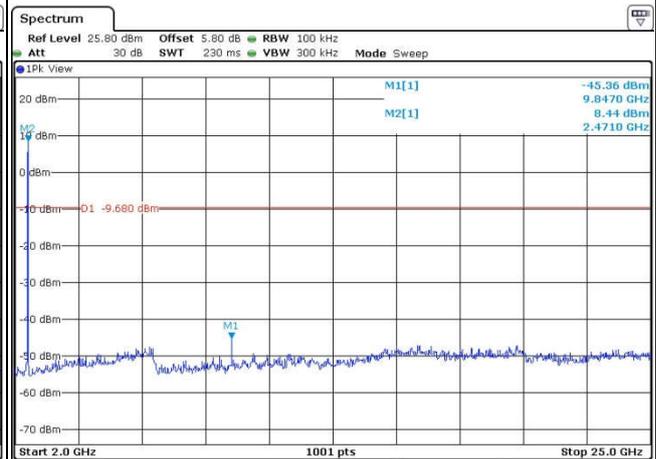
Date: 8 DEC 2017 09:22:25

Spurious Emission 30MHz~3GHz



Date: 8 DEC 2017 09:23:21

Spurious Emission 2GHz~25GHz



Date: 8 DEC 2017 09:23:37

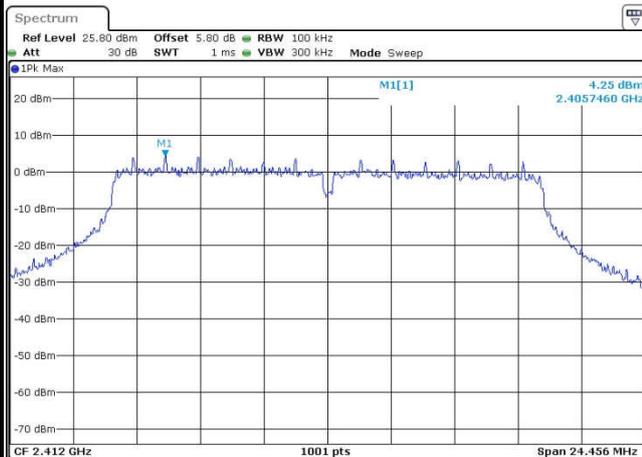


Number of TX = 1, Ant. 2 (Measured)

Number of TX :	1	Ant. :	2
Test Mode :	802.11g	Temperature :	21~25°C
Test Band :	2.4GHz Low	Relative Humidity :	51~55%
Test Channel :	01	Test Engineer :	Silent Hai

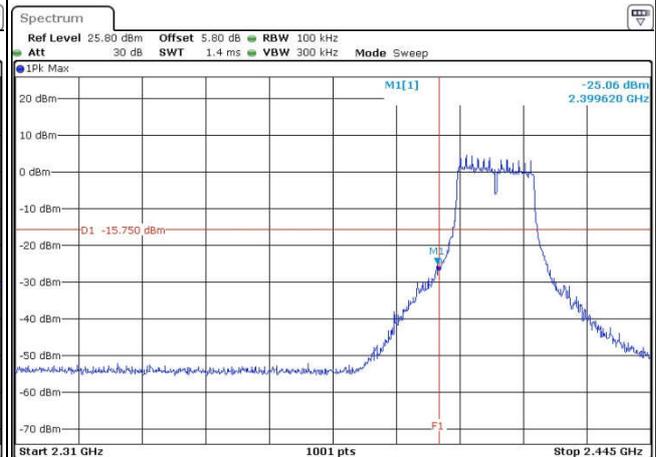
WLAN 802.11g Channel 01

100kHz PSD reference Level



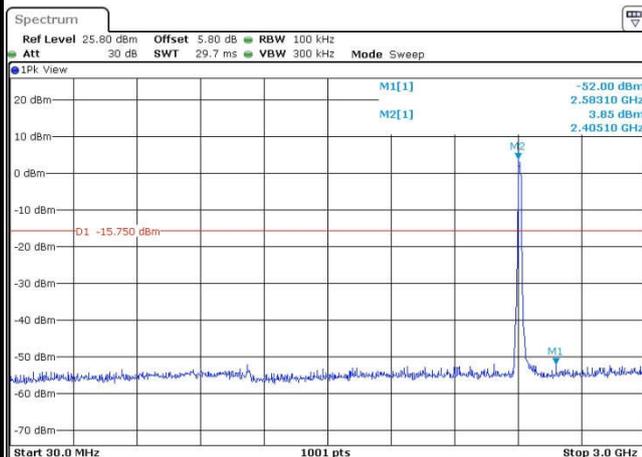
Date: 8 DEC 2017 09:29:47

Low Channel Plot



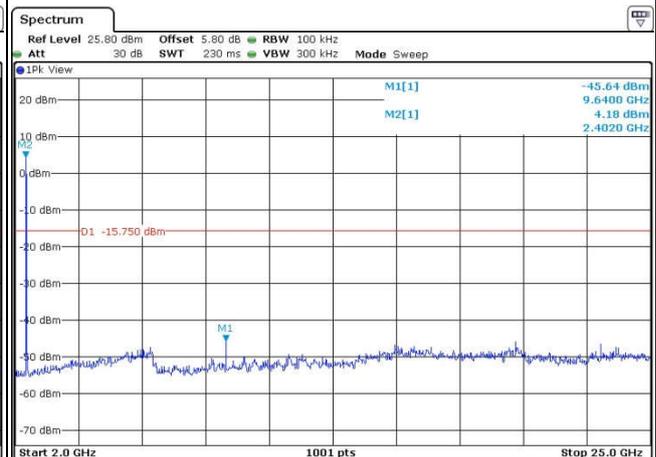
Date: 8 DEC 2017 09:30:07

Spurious Emission 30MHz~3GHz



Date: 8 DEC 2017 09:30:42

Spurious Emission 2GHz~25GHz



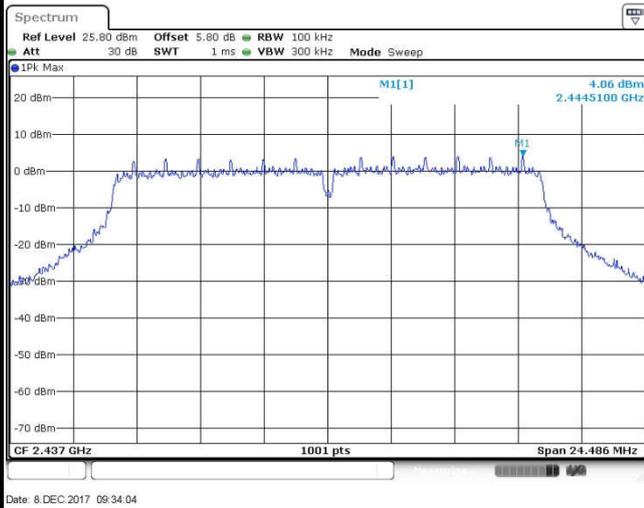
Date: 8 DEC 2017 09:30:59



Number of TX :	1	Ant. :	2
Test Mode :	802.11g	Temperature :	21~25°C
Test Band :	2.4GHz Mid	Relative Humidity :	51~55%
Test Channel :	06	Test Engineer :	Silent Hai

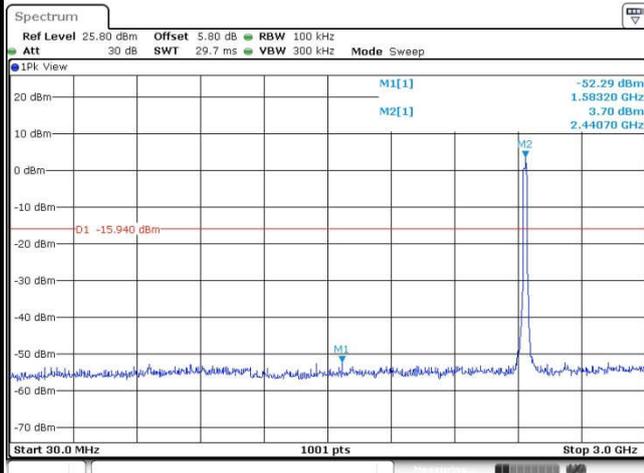
WLAN 802.11g Channel 06

100kHz PSD reference Level



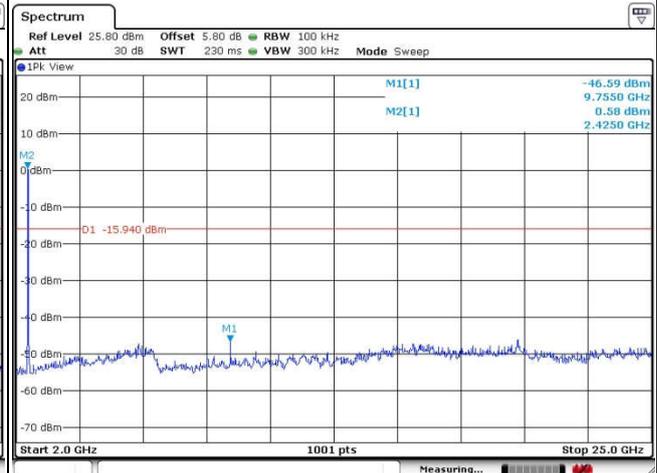
Date: 8 DEC 2017 09:34:04

Spurious Emission 30MHz~3GHz



Date: 8 DEC 2017 09:34:20

Spurious Emission 2GHz~25GHz



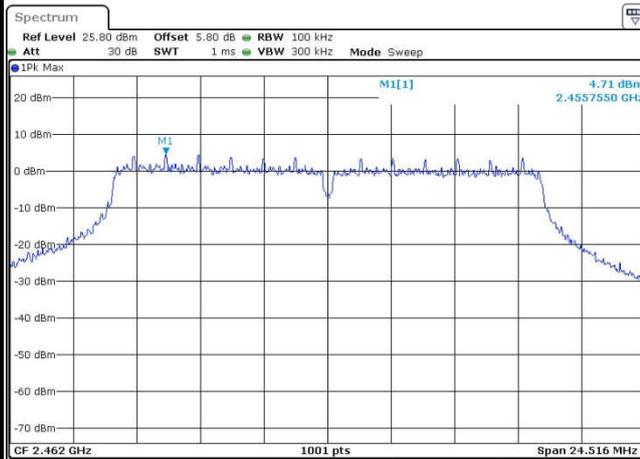
Date: 8 DEC 2017 09:34:40



Number of TX :	1	Ant. :	2
Test Mode :	802.11g	Temperature :	21~25°C
Test Band :	2.4GHz High	Relative Humidity :	51~55%
Test Channel :	11	Test Engineer :	Silent Hai

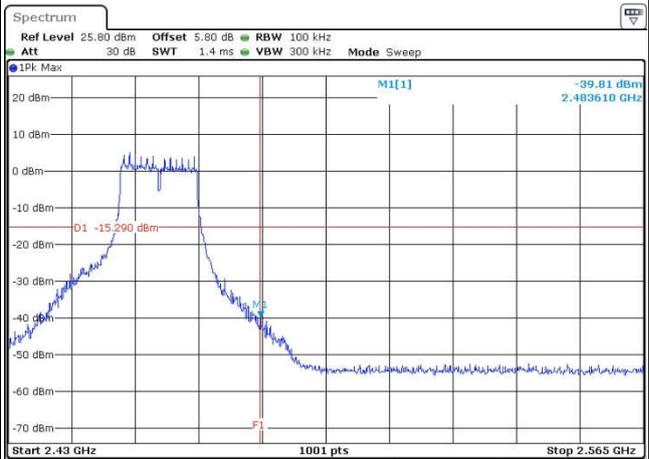
WLAN 802.11g Channel 11

100kHz PSD reference Level



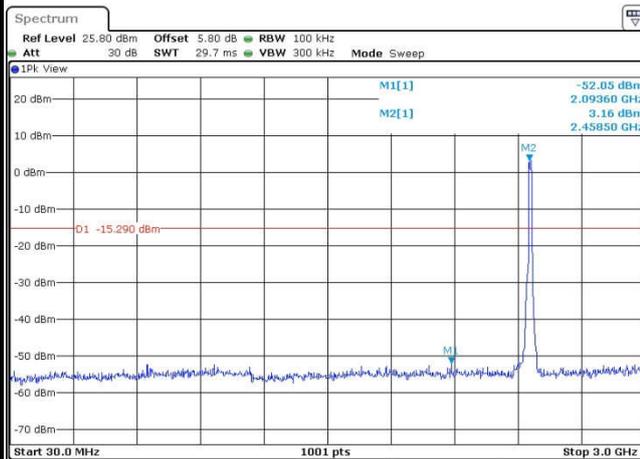
Date: 8 DEC 2017 09:43:12

High Channel Plot



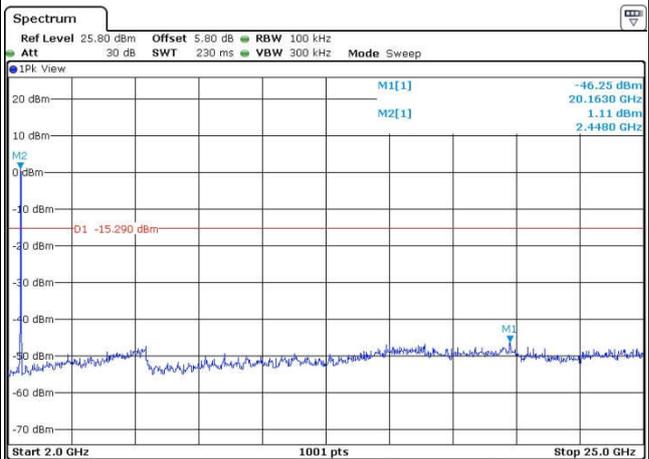
Date: 8 DEC 2017 09:43:32

Spurious Emission 30MHz~3GHz



Date: 8 DEC 2017 09:43:42

Spurious Emission 2GHz~25GHz



Date: 8 DEC 2017 09:44:34

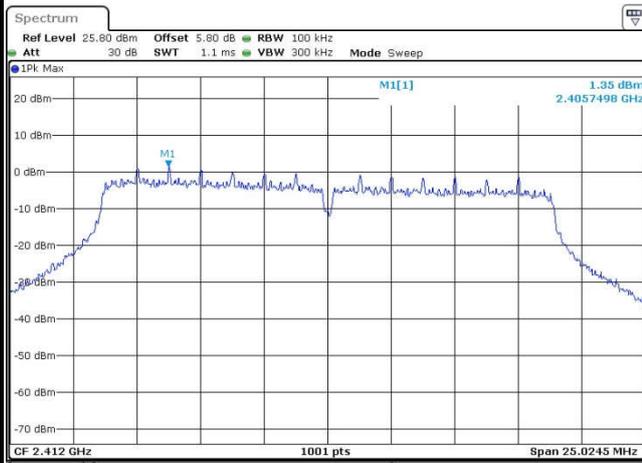


Number of TX = 2, Ant. 1 (Measured)

Number of TX :	2	Ant. :	1
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz Low	Relative Humidity :	51~55%
Test Channel :	01	Test Engineer :	Silent Hai

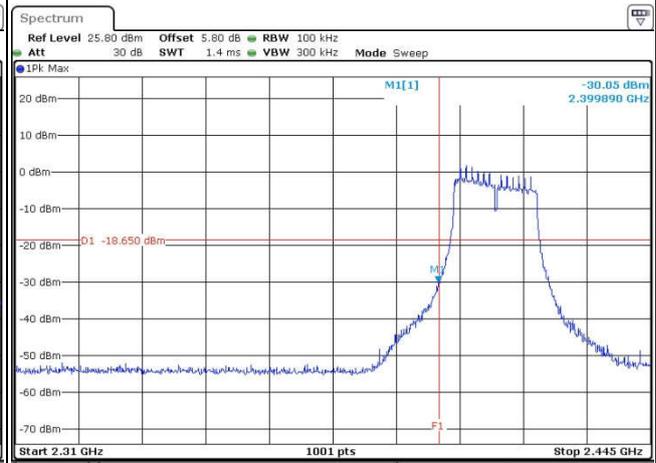
WLAN 802.11n HT20 Channel 01

100kHz PSD reference Level



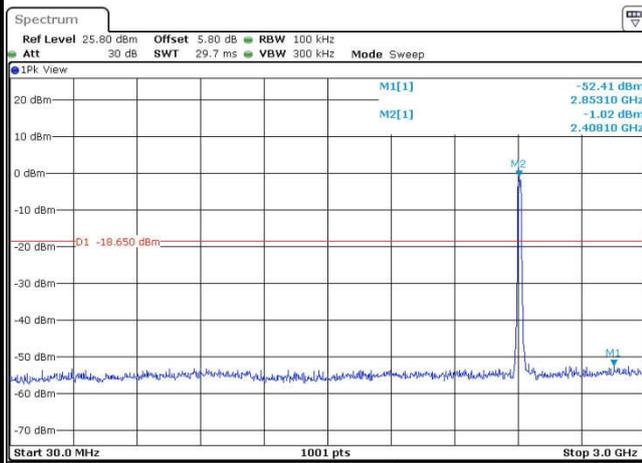
Date: 8 DEC 2017 10:23:16

Low Channel Plot



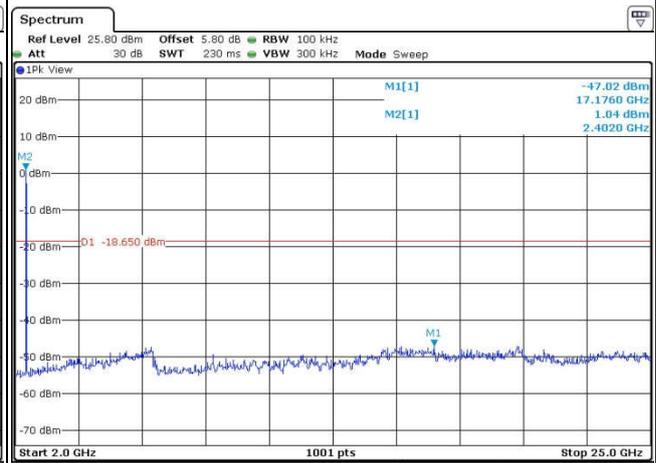
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Spurious Emission 30MHz~3GHz

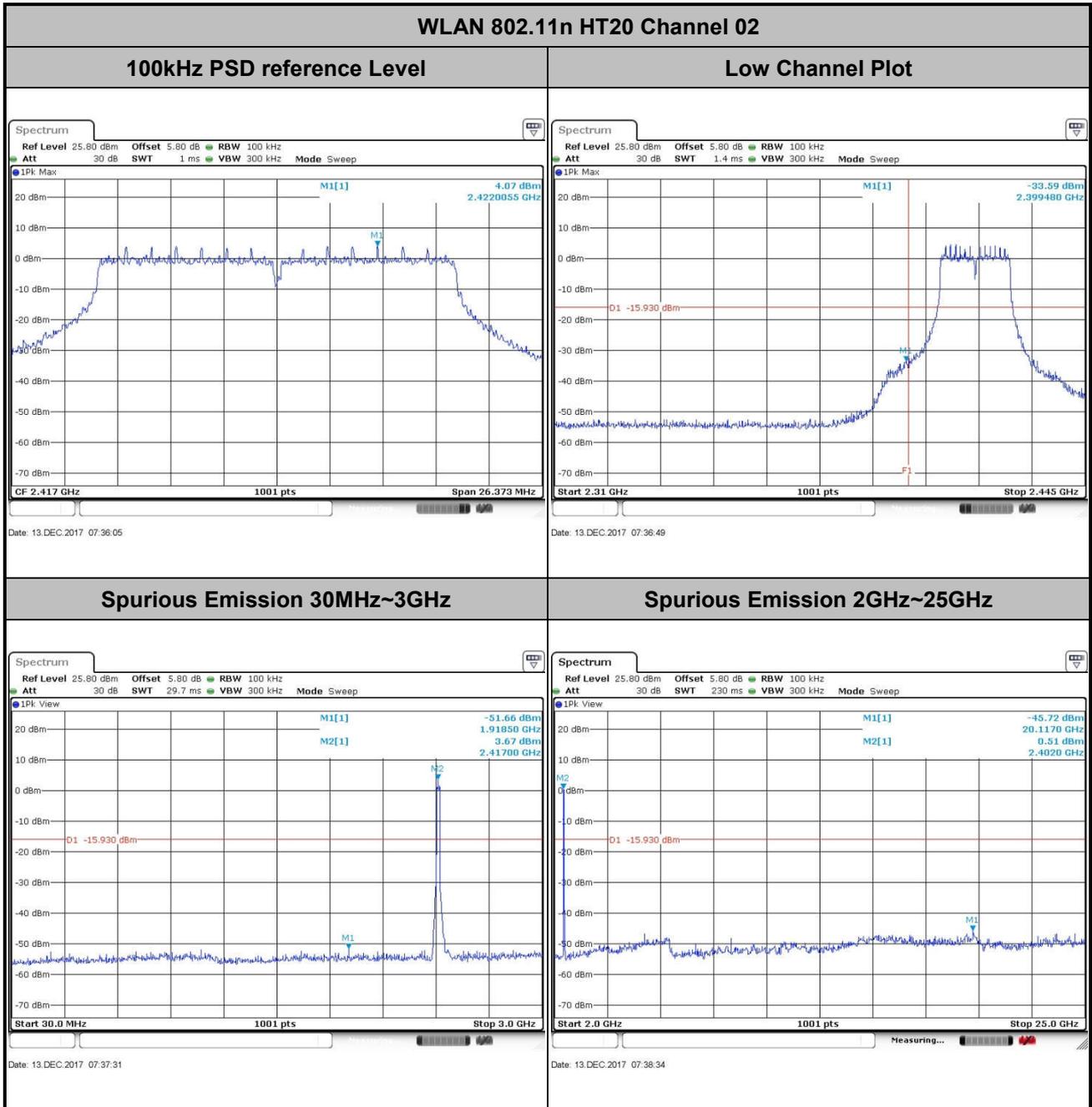


Date: 8 DEC 2017 10:25:24

Spurious Emission 2GHz~25GHz



Date: 8 DEC 2017 10:25:39

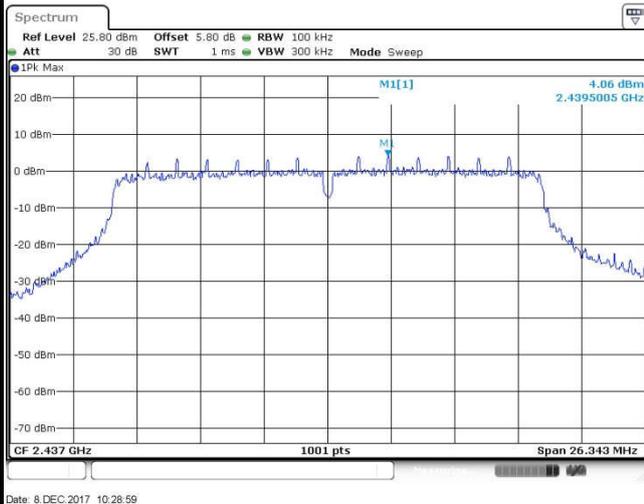




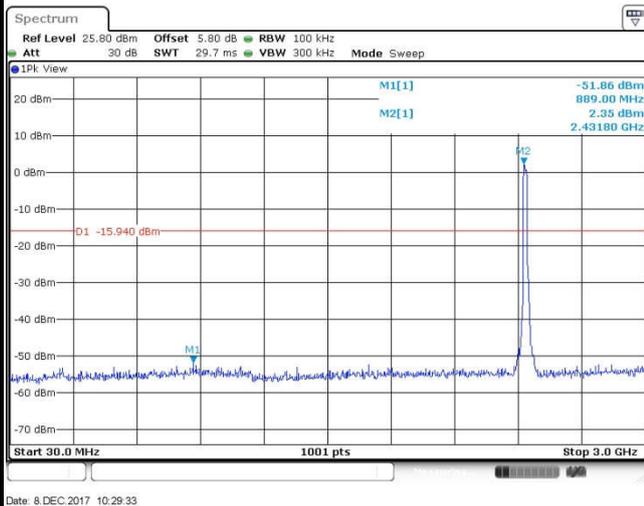
Number of TX :	2	Ant. :	1
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz Mid	Relative Humidity :	51~55%
Test Channel :	06	Test Engineer :	Silent Hai

WLAN 802.11n HT20 Channel 06

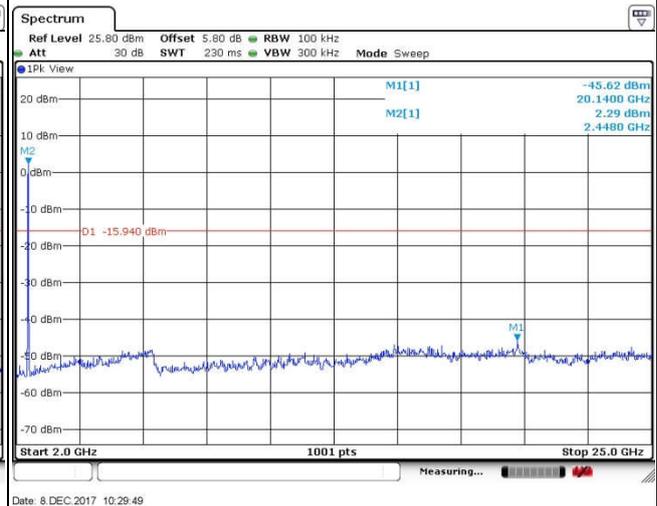
100kHz PSD reference Level



Spurious Emission 30MHz~3GHz

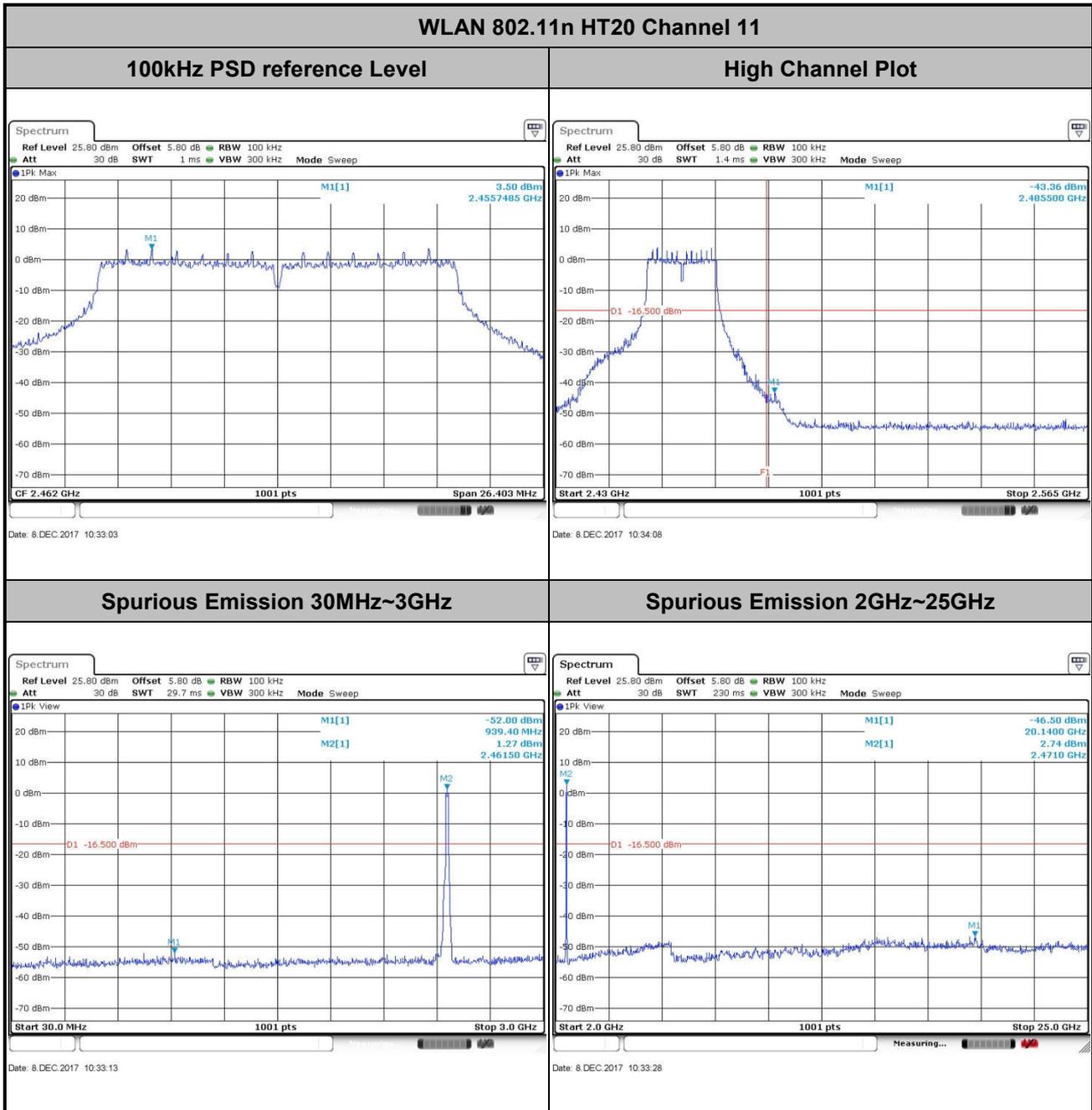


Spurious Emission 2GHz~25GHz





Number of TX :	2	Ant. :	1
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz High	Relative Humidity :	51~55%
Test Channel :	11	Test Engineer :	Silent Hai



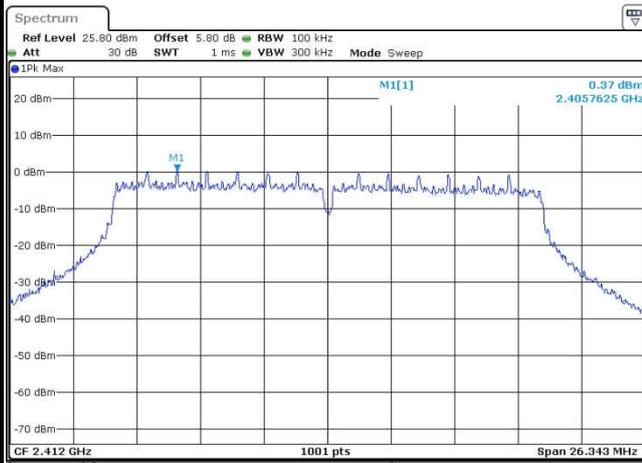


Number of TX = 2, Ant. 2 (Measured)

Number of TX :	2	Ant. :	2
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz Low	Relative Humidity :	51~55%
Test Channel :	01	Test Engineer :	Silent Hai

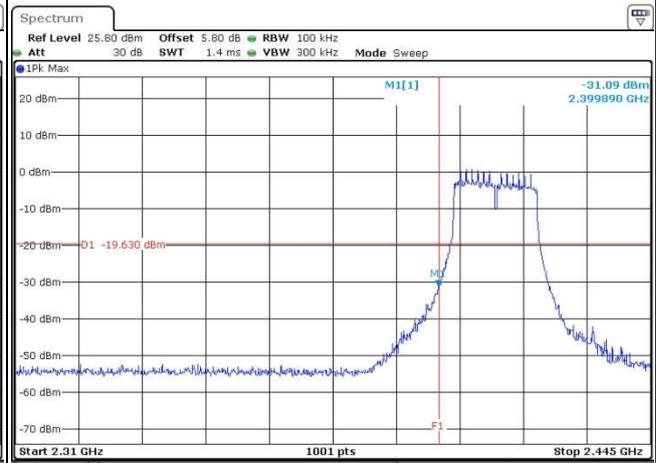
WLAN 802.11n HT20 Channel 01

100kHz PSD reference Level



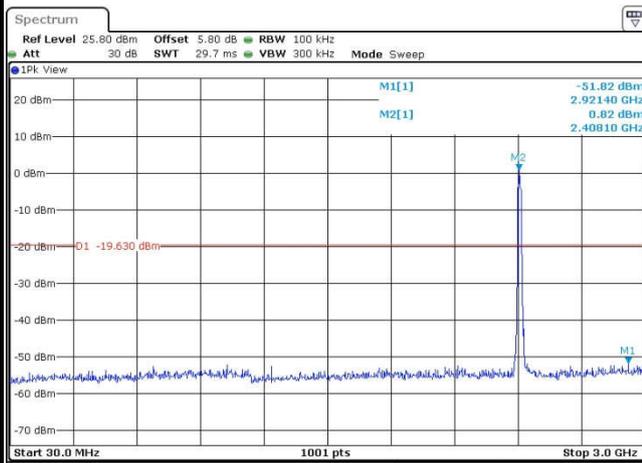
Date: 8 DEC 2017 10:14:34

Low Channel Plot



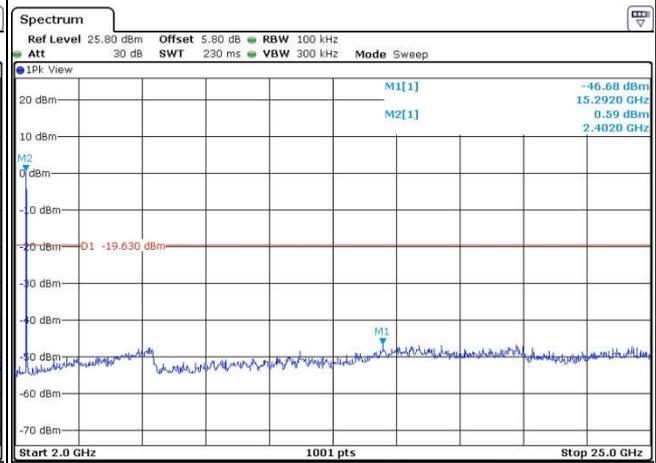
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Spurious Emission 30MHz~3GHz

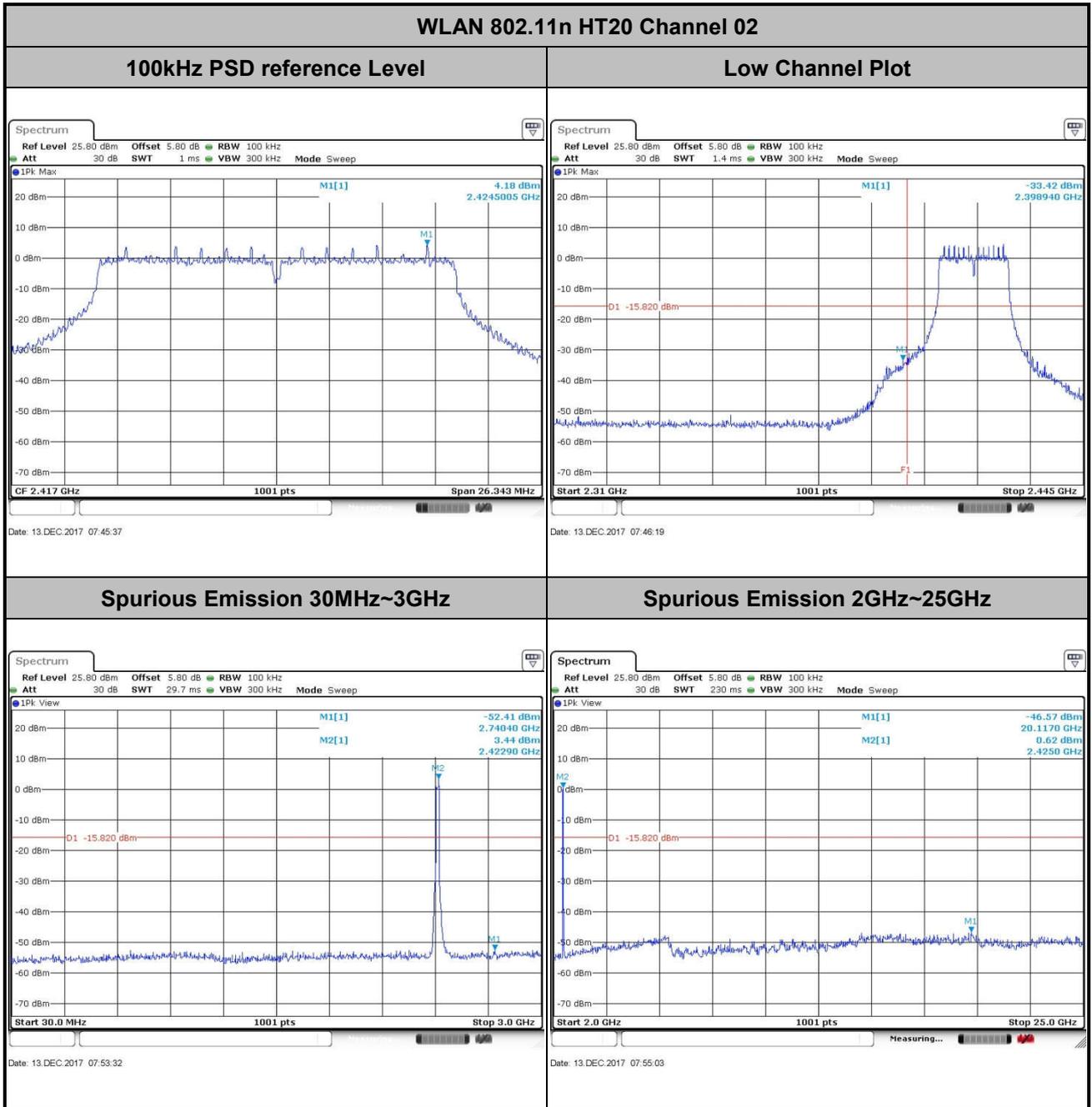


Date: 8 DEC 2017 10:16:39

Spurious Emission 2GHz~25GHz



Date: 8 DEC 2017 10:17:22

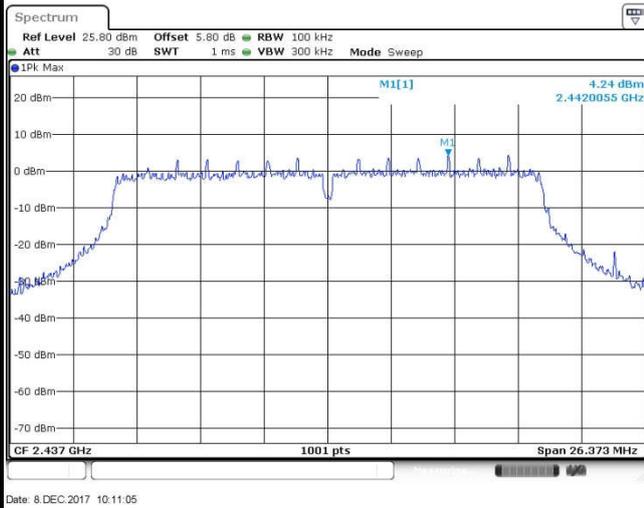




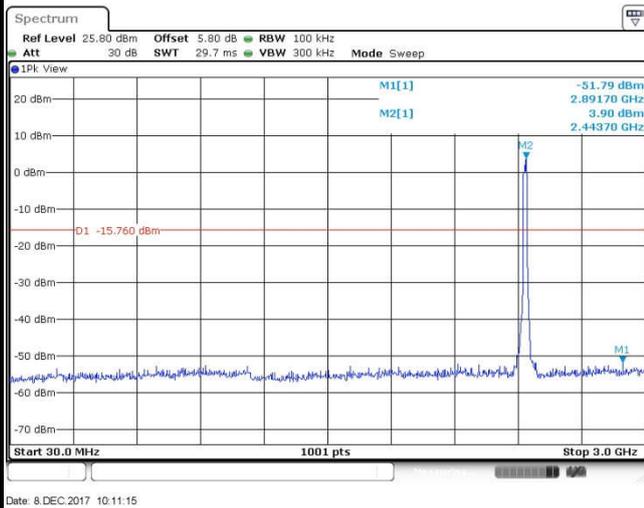
Number of TX :	2	Ant. :	2
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz Mid	Relative Humidity :	51~55%
Test Channel :	06	Test Engineer :	Silent Hai

WLAN 802.11n HT20 Channel 06

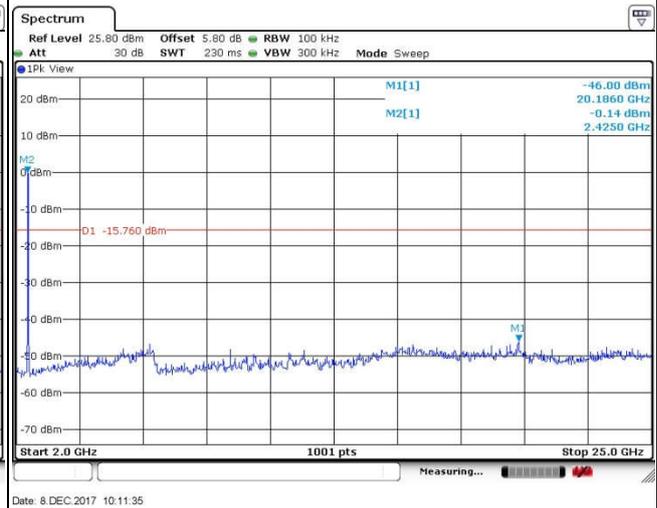
100kHz PSD reference Level



Spurious Emission 30MHz~3GHz

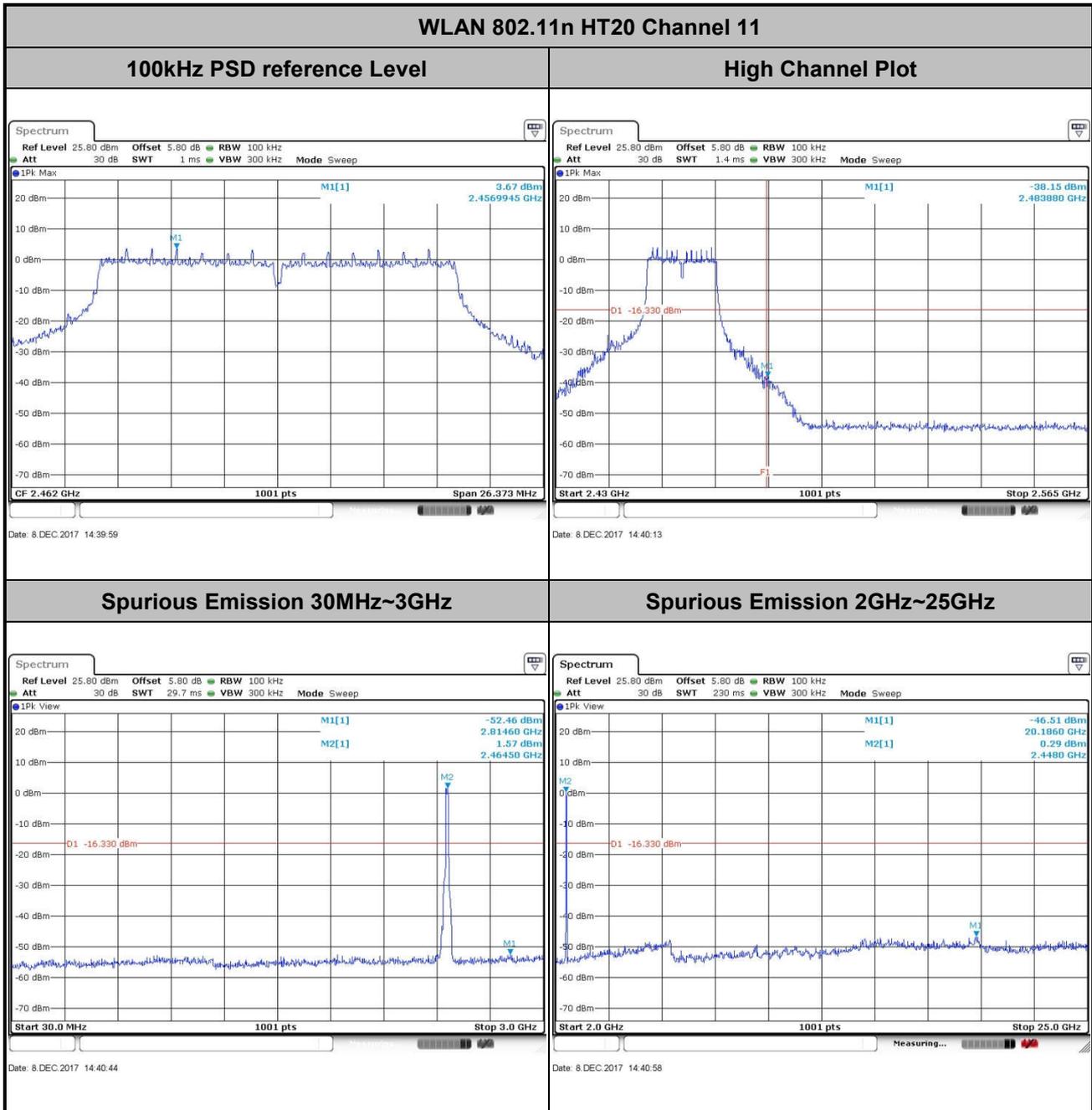


Spurious Emission 2GHz~25GHz





Number of TX :	2	Ant. :	2
Test Mode :	802.11n HT20	Temperature :	21~25°C
Test Band :	2.4GHz High	Relative Humidity :	51~55%
Test Channel :	11	Test Engineer :	Silent Hai





3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated band edge and Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/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

3.5.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

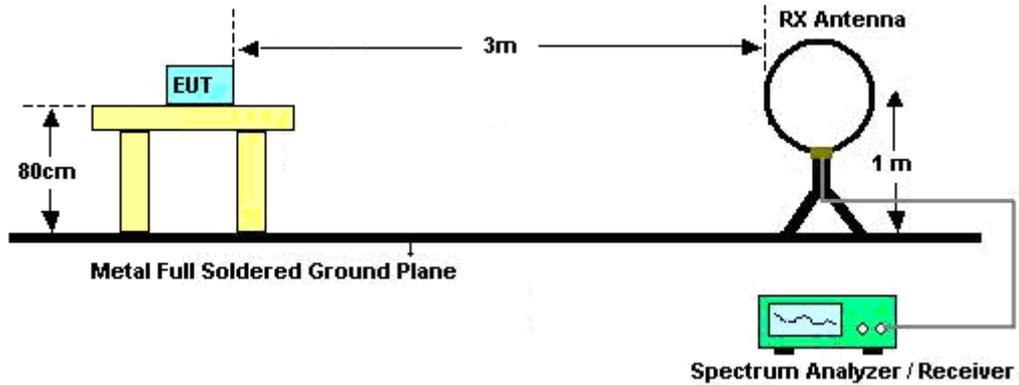


3.5.3 Test Procedures

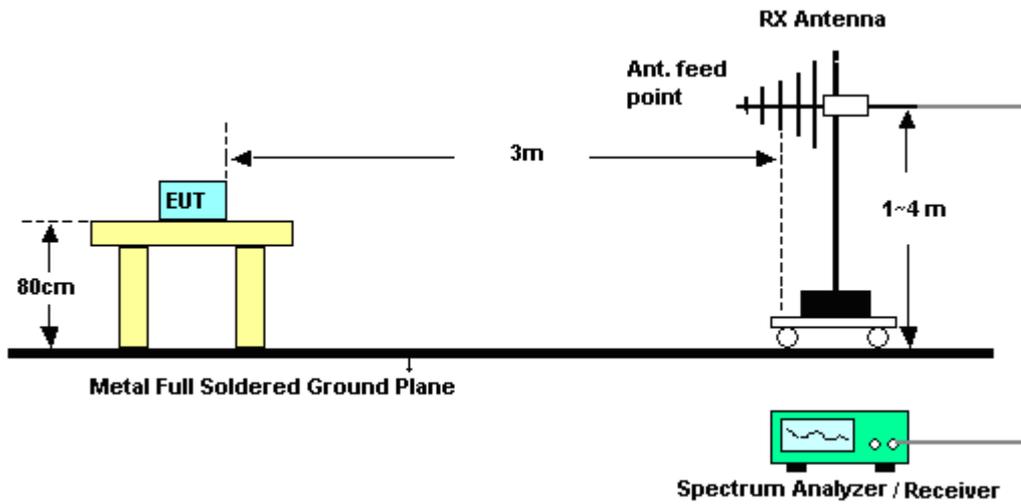
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v04.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
For average measurement:
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW $\geq 1/T$, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

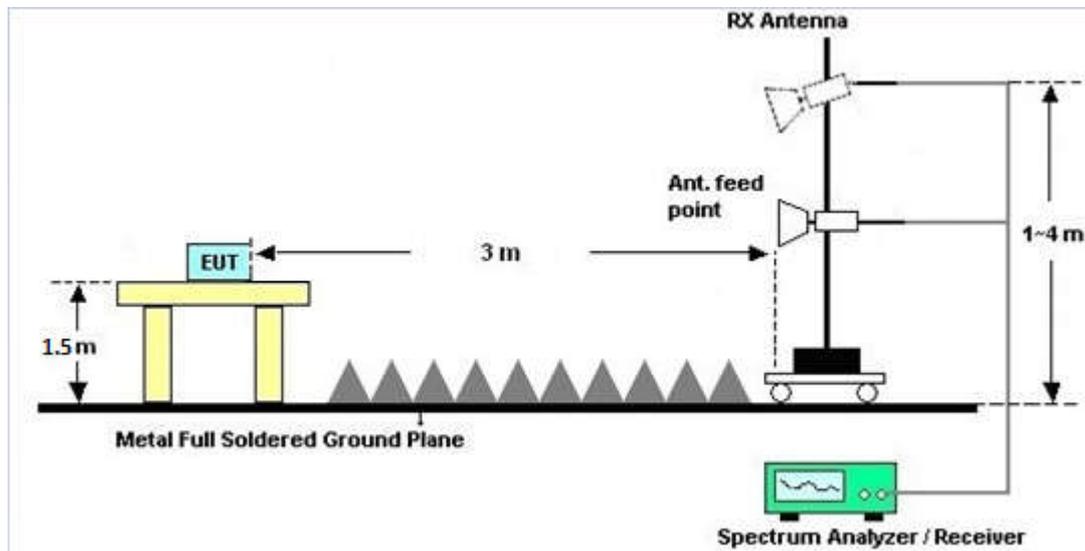
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9kHz ~ 30MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B.

3.5.7 Duty Cycle

Please refer to Appendix C.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix B.



3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

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 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-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.

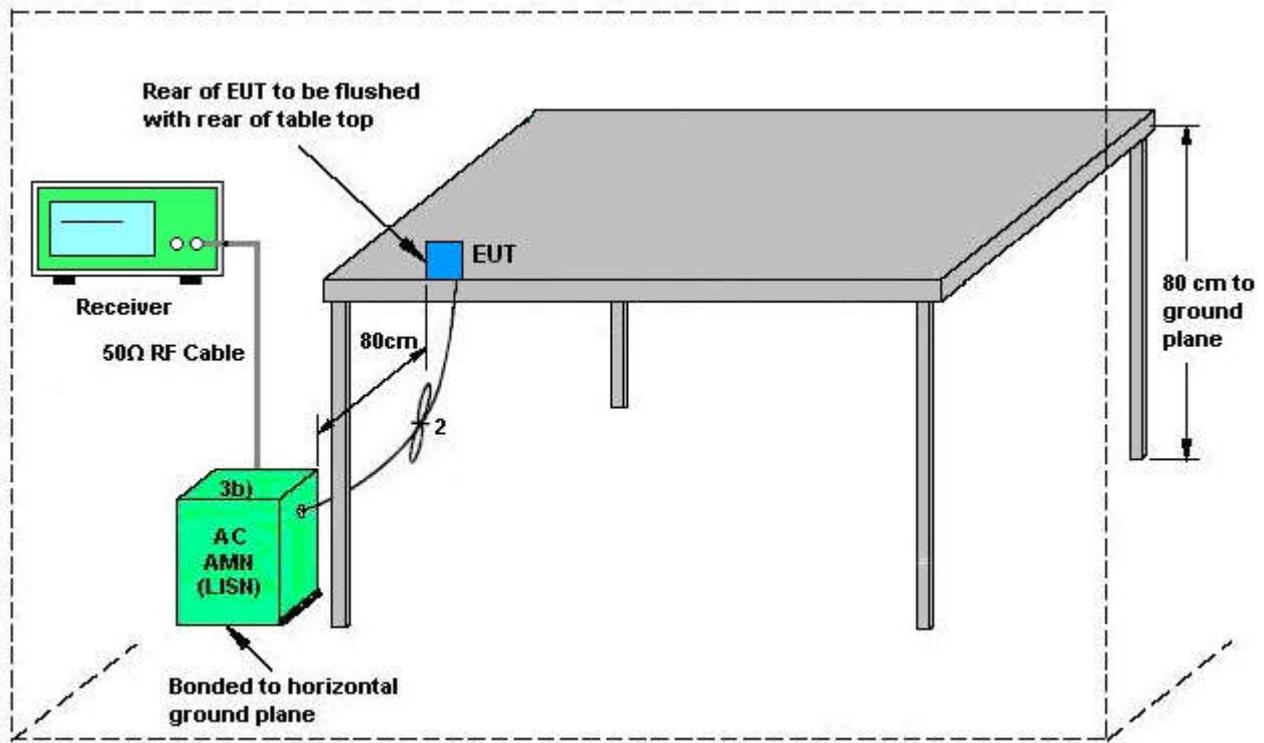
3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room, and it was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF bandwidth = 9kHz) with Maximum Hold Mode.

3.6.4 Test Setup

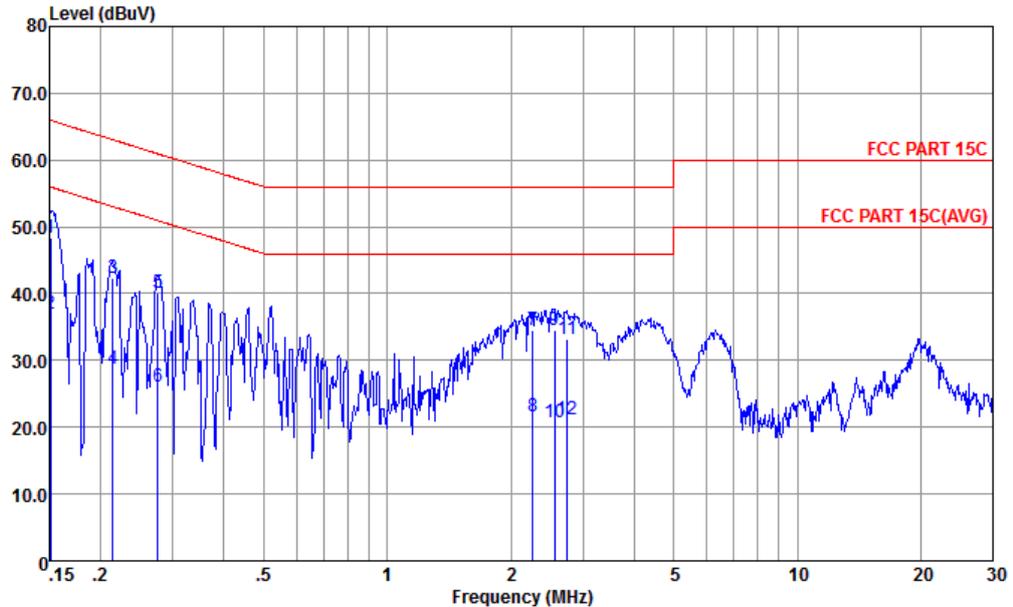


AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network



3.6.5 Test Result of AC Conducted Emission

Test Mode :	Mode 2	Temperature :	22~24°C
Test Engineer :	Amos Zhang	Relative Humidity :	42~46%
Test Voltage :	120Vac / 60Hz	Phase :	Line
Function Type :	Bluetooth Link with Controller + WLAN Link(2.4G) + Earphone + USB Cable (Charging from Adapter 2)		

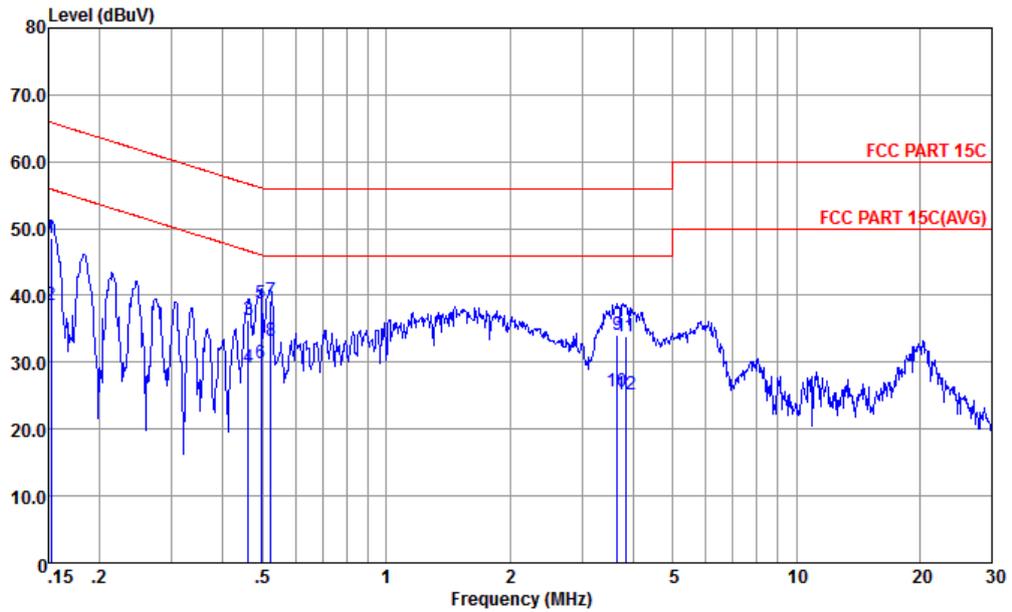


Site : CO01-KS
 Condition : FCC PART 15C LISN-L-171013-060103 LINE
 mode : Mode 2

	Freq	Level	Over	Limit	Read	LISN	Cable	Remark
	MHz	dBuV	Limit	Line	Level	Factor	Loss	
			dB	dBuV	dBuV	dB	dB	
1 *	0.151	48.38	-17.58	65.96	37.60	0.16	10.62	QP
2	0.151	36.98	-18.98	55.96	26.20	0.16	10.62	Average
3	0.214	42.26	-20.79	63.05	31.61	0.20	10.45	QP
4	0.214	28.76	-24.29	53.05	18.11	0.20	10.45	Average
5	0.276	40.15	-20.79	60.94	29.50	0.22	10.43	QP
6	0.276	26.15	-24.79	50.94	15.50	0.22	10.43	Average
7	2.261	34.60	-21.40	56.00	24.10	0.29	10.21	QP
8	2.261	21.70	-24.30	46.00	11.20	0.29	10.21	Average
9	2.554	34.60	-21.40	56.00	24.10	0.30	10.20	QP
10	2.554	20.80	-25.20	46.00	10.30	0.30	10.20	Average
11	2.750	33.10	-22.90	56.00	22.60	0.31	10.19	QP
12	2.750	21.10	-24.90	46.00	10.60	0.31	10.19	Average



Test Mode :	Mode 2	Temperature :	22~24°C
Test Engineer :	Amos Zhang	Relative Humidity :	42~46%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Function Type :	Bluetooth Link with Controller + WLAN Link(2.4G) + Earphone + USB Cable (Charging from Adapter 2)		



Site : CO01-KS
 Condition : FCC PART 15C LISN-N-171013-060103 NEUTRAL
 mode : Mode 2

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.152	48.49	-17.38	65.87	37.60	0.28	10.61	QP
2	0.152	38.49	-17.38	55.87	27.60	0.28	10.61	Average
3	0.461	36.43	-20.24	56.67	25.80	0.29	10.34	QP
4	0.461	29.23	-17.44	46.67	18.60	0.29	10.34	Average
5	0.494	38.80	-17.30	56.10	28.20	0.29	10.31	QP
6	0.494	29.90	-16.20	46.10	19.30	0.29	10.31	Average
7	0.524	39.18	-16.82	56.00	28.60	0.29	10.29	QP
8 *	0.524	33.18	-12.82	46.00	22.60	0.29	10.29	Average
9	3.661	34.10	-21.90	56.00	23.60	0.33	10.17	QP
10	3.661	25.70	-20.30	46.00	15.20	0.33	10.17	Average
11	3.840	33.80	-22.20	56.00	23.30	0.33	10.17	QP
12	3.840	25.10	-20.90	46.00	14.60	0.33	10.17	Average



3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting Antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the Antenna exceeds 6 dBi. 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 rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = $G_{ANT} + \text{Array Gain}$, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = $10 \log(N_{ANT}/N_{SS}=1)$ dB.

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$.

Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain G_{ANT} is set equal to the antenna having the highest gain, i.e., F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain "DG" is calculated as following table.

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
2.4 GHz	1.50	1.50	4.51	4.51	0.00	0.00

$Power\ Limit\ Reduction = DG(Power) - 6dBi, (min = 0)$

$PSD\ Limit\ Reduction = DG(PSD) - 6dBi, (min = 0)$



4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Aug. 08, 2017	Dec. 08, 2017~ Dec. 13, 2017	Aug. 07, 2018	Conducted (TH01-KS)
Pulse Power Sensor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 19, 2017	Dec. 08, 2017~ Dec. 13, 2017	Jan. 18, 2018	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 19, 2017	Dec. 08, 2017~ Dec. 13, 2017	Jan. 18, 2018	Conducted (TH01-KS)
EMI Test Receiver	R&S	ESR7	101404	9kHz~7GHz	Apr. 20, 2017	Dec. 07, 2017~ Dec. 08, 2017	Apr. 19, 2018	Radiation (03CH04-SZ)
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY551502 13	10Hz~44GHz	Apr. 20, 2017	Dec. 07, 2017~ Dec. 08, 2017	Apr. 19, 2018	Radiation (03CH04-SZ)
Loop Antenna	R&S	HFH2-Z2	100354	9kHz~30MHz	May 14, 2017	Dec. 07, 2017~ Dec. 08, 2017	May 13, 2018	Radiation (03CH04-SZ)
Bilog Antenna	TeseQ	CBL6111D	41909	30MHz~1GHz	May 16, 2017	Dec. 07, 2017~ Dec. 08, 2017	May 15, 2018	Radiation (03CH04-SZ)
Double Ridge Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-147 4	1GHz~18GHz	Jan. 12, 2017	Dec. 07, 2017~ Dec. 08, 2017	Jan. 11, 2018	Radiation (03CH04-SZ)
Horn Antenna	SCHWARZBECK	BBHA9170	9170#679	15GHz~40GHz	May 17, 2017	Dec. 07, 2017~ Dec. 08, 2017	May 16, 2018	Radiation (03CH04-SZ)
Amplifier	Burgeon	BPA-530	102211	0.01Hz~3000MHz	Oct. 19, 2017	Dec. 07, 2017~ Dec. 08, 2017	Oct. 18, 2018	Radiation (03CH04-SZ)
HF Amplifier	MITEQ	AMF-7D-0010 1800-30-10P-R	1989346	1GHz~18GHz	Jul. 27, 2017	Dec. 07, 2017~ Dec. 08, 2017	Jul. 26, 2018	Radiation (03CH04-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1988315	18GHz~40GHz	Jul. 27, 2017	Dec. 07, 2017~ Dec. 08, 2017	Jul. 26, 2018	Radiation (03CH04-SZ)
AC Power Source	Chroma	61601	N/A	N/A	NCR	Dec. 07, 2017~ Dec. 08, 2017	NCR	Radiation (03CH04-SZ)
Turn Table	EM	EM1000	N/A	0~360 degree	NCR	Dec. 07, 2017~ Dec. 08, 2017	NCR	Radiation (03CH04-SZ)
Antenna Mast	EM	EM1000	N/A	1 m~4 m	NCR	Dec. 07, 2017~ Dec. 08, 2017	NCR	Radiation (03CH04-SZ)
EMI Receiver	R&S	ESC17	100768	9kHz~7GHz;	Apr. 20, 2017	Dec. 07, 2017	Apr. 19, 2018	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060103	9kHz~30MHz	Oct. 13, 2017	Dec. 07, 2017	Oct. 12, 2018	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060105	9kHz~30MHz	Oct. 13, 2017	Dec. 07, 2017	Oct. 12, 2018	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP00000 0811	AC 0V~300V, 45Hz~1000Hz	Oct. 12, 2017	Dec. 07, 2017	Oct. 11, 2018	Conduction (CO01-KS)

NCR: No Calibration Required



5 Uncertainty of Evaluation

Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	2.3dB
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.1dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.0dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.1dB
---	-------



Appendix A. Conducted Test Results

Report Number : FR790102C

Test Engineer:	Silent Hai	Temperature:	21~25	°C
Test Date:	2017/12/8~2017/12/13	Relative Humidity:	51~55	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

2.4GHz Band										
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	99% Occupied BW (MHz)		6dB BW (MHz)		6dB BW Limit (MHz)	Pass/Fail
					Ant 1	Ant 2	Ant 1	Ant 2		
11b	1Mbps	1	1	2412	13.19		7.55		0.50	Pass
11b	1Mbps	1	6	2437	12.84		7.07		0.50	Pass
11b	1Mbps	1	11	2462	13.54		8.05		0.50	Pass
11g	6Mbps	1	1	2412		18.28		16.30	0.50	Pass
11g	6Mbps	1	6	2437		18.23		16.32	0.50	Pass
11g	6Mbps	1	11	2462		18.68		16.34	0.50	Pass
HT20	MCS0	1	1	2412		19.23		17.54	0.50	Pass
HT20	MCS0	1	6	2437		19.18		17.56	0.50	Pass
HT20	MCS0	1	11	2462		19.78		17.58	0.50	Pass
HT20	MCS0	2	1	2412	19.43	19.23	16.68	17.56	0.50	Pass
HT20	MCS0	2	2	2417	19.43	19.18	17.58	17.56	0.50	Pass
HT20	MCS0	2	6	2437	19.23	19.18	17.56	17.58	0.50	Pass
HT20	MCS0	2	11	2462	20.03	19.78	17.60	17.58	0.50	Pass

TEST RESULTS DATA
Peak Output Power

2.4GHz Band																
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	Peak Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
					Ant 1	Ant 2	SUM	Ant 1	Ant 2	Ant 1	Ant 2	Ant 1	Ant 2	Ant 1	Ant 2	
11b	1Mbps	1	1	2412	21.21	21.02		30.00	30.00	1.50	1.50	22.71	22.52	36.00	36.00	Pass
11b	1Mbps	1	6	2437	21.49	20.88		30.00	30.00	1.50	1.50	22.99	22.38	36.00	36.00	Pass
11b	1Mbps	1	11	2462	20.79	21.69		30.00	30.00	1.50	1.50	22.29	23.19	36.00	36.00	Pass
11g	6Mbps	1	1	2412	23.86	24.13		30.00	30.00	1.50	1.50	25.36	25.63	36.00	36.00	Pass
11g	6Mbps	1	6	2437	24.09	24.15		30.00	30.00	1.50	1.50	25.59	25.65	36.00	36.00	Pass
11g	6Mbps	1	11	2462	21.34	23.83		30.00	30.00	1.50	1.50	22.84	25.33	36.00	36.00	Pass
HT20	MCS0	1	1	2412	23.12	23.35		30.00	30.00	1.50	1.50	24.62	24.85	36.00	36.00	Pass
HT20	MCS0	1	6	2437	23.47	23.19		30.00	30.00	1.50	1.50	24.97	24.69	36.00	36.00	Pass
HT20	MCS0	1	11	2462	22.36	23.85		30.00	30.00	1.50	1.50	23.86	25.35	36.00	36.00	Pass
HT20	MCS0	2	1	2412	20.54	21.07	23.82	30.00		1.50		25.32		36.00		Pass
HT20	MCS0	2	2	2417	23.35	23.95	26.67	30.00		1.50		28.17		36.00		Pass
HT20	MCS0	2	6	2437	23.63	23.98	26.82	30.00		1.50		28.32		36.00		Pass
HT20	MCS0	2	11	2462	23.13	22.59	25.88	30.00		1.50		27.38		36.00		Pass

Note: Measured power (dBm) has offset with cable loss.

TEST RESULTS DATA
Average Output Power

2.4GHz Band									
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	Duty Factor (dB)		Average Conducted Power (dBm)		
					Ant 1	Ant 2	Ant 1	Ant 2	SUM
11b	1Mbps	1	1	2412	0.00	0.00	18.52	18.29	
11b	1Mbps	1	6	2437	0.00	0.00	18.67	18.21	
11b	1Mbps	1	11	2462	0.00	0.00	18.25	18.91	
11g	6Mbps	1	1	2412	0.22	0.22	14.33	15.17	
11g	6Mbps	1	6	2437	0.22	0.22	15.51	15.14	
11g	6Mbps	1	11	2462	0.22	0.22	13.67	15.49	
HT20	MCS0	1	1	2412	0.00	0.00	13.92	14.20	
HT20	MCS0	1	6	2437	0.00	0.00	14.59	14.15	
HT20	MCS0	1	11	2462	0.00	0.00	13.78	15.10	
HT20	MCS0	2	1	2412	0.25	0.24	11.57	11.60	14.60
HT20	MCS0	2	2	2417	0.25	0.24	14.79	15.05	17.93
HT20	MCS0	2	6	2437	0.25	0.24	14.94	15.12	18.04
HT20	MCS0	2	11	2462	0.25	0.24	14.57	14.93	17.77

Note: Measured power (dBm) has offset with cable loss.

TEST RESULTS DATA
Peak Power Spectral Density

2.4GHz Band												
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	Peak PSD (dBm/3kHz)			DG (dBi)		Peak PSD Limit (dBm/3kHz)		Pass/Fail
					Ant 1	Ant 2	Ant 1+2	Ant 1	Ant 2	Ant 1	Ant 2	
11b	1Mbps	1	1	2412	-3.50			1.50	1.50	8.00	8.00	Pass
11b	1Mbps	1	6	2437	-1.60			1.50	1.50	8.00	8.00	Pass
11b	1Mbps	1	11	2462	-3.16			1.50	1.50	8.00	8.00	Pass
11g	6Mbps	1	1	2412		-8.91		1.50	1.50	8.00	8.00	Pass
11g	6Mbps	1	6	2437		-9.10		1.50	1.50	8.00	8.00	Pass
11g	6Mbps	1	11	2462		-7.44		1.50	1.50	8.00	8.00	Pass
HT20	MCS0	1	1	2412		-10.03		1.50	1.50	8.00	8.00	Pass
HT20	MCS0	1	6	2437		-10.14		1.50	1.50	8.00	8.00	Pass
HT20	MCS0	1	11	2462		-10.16		1.50	1.50	8.00	8.00	Pass
HT20	MCS0	2	1	2412	-12.13	-13.31	-9.12	4.51		8.00		Pass
HT20	MCS0	2	2	2417	-12.30	-12.26	-9.25	4.51		8.00		Pass
HT20	MCS0	2	6	2437	-9.61	-9.36	-6.35	4.51		8.00		Pass
HT20	MCS0	2	11	2462	-9.59	-10.20	-6.58	4.51		8.00		Pass

Measured power density (dBm) has offset with cable loss.



Appendix B. Radiated Spurious Emission

2.4GHz 2400~2483.5MHz

WIFI 802.11b (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 01 2412MHz		2389.485	45.94	-28.06	74	42.67	27.43	4.78	28.94	100	271	P	H
		2389.59	35.44	-18.56	54	32.17	27.43	4.78	28.94	100	271	A	H
	*	2412	99.7	-	-	96.37	27.49	4.78	28.94	100	271	P	H
	*	2412	96.48	-	-	93.15	27.49	4.78	28.94	100	271	A	H
		2388.015	49.47	-24.53	74	46.2	27.43	4.78	28.94	121	221	P	V
		2390	39.44	-14.56	54	36.17	27.43	4.78	28.94	121	221	A	V
	*	2412	111.21	-	-	107.88	27.49	4.78	28.94	121	221	P	V
	*	2412	107.89	-	-	104.56	27.49	4.78	28.94	121	221	A	V
802.11b CH 06 2437MHz		2377.9	46.07	-27.93	74	42.92	27.37	4.72	28.94	157	273	P	H
		2389.38	35.07	-18.93	54	31.8	27.43	4.78	28.94	157	273	A	H
	*	2437	101.26	-	-	97.77	27.61	4.82	28.94	157	273	P	H
	*	2437	98.09	-	-	94.6	27.61	4.82	28.94	157	273	A	H
		2488.45	46.47	-27.53	74	42.77	27.8	4.85	28.95	157	273	P	H
		2485.86	35.56	-18.44	54	31.92	27.74	4.85	28.95	157	273	A	H
		2389.8	47.52	-26.48	74	44.25	27.43	4.78	28.94	119	225	P	V
		2389.94	37.41	-16.59	54	34.14	27.43	4.78	28.94	119	225	A	V
	*	2437	112.58	-	-	109.09	27.61	4.82	28.94	119	225	P	V
	*	2437	108.87	-	-	105.38	27.61	4.82	28.94	119	225	A	V
		2486.77	48.43	-25.57	74	44.79	27.74	4.85	28.95	119	225	P	V
	2485.79	38.11	-15.89	54	34.47	27.74	4.85	28.95	119	225	A	V	



802.11b CH 11 2462MHz	*	2462	102.88	-	-	99.33	27.68	4.82	28.95	149	273	P	H
	*	2462	99.54	-	-	95.99	27.68	4.82	28.95	149	273	A	H
		2485.84	47.11	-26.89	74	43.47	27.74	4.85	28.95	149	273	P	H
		2483.52	36.94	-17.06	54	33.3	27.74	4.85	28.95	149	273	A	H
	*	2462	112.64	-	-	109.09	27.68	4.82	28.95	140	224	P	V
	*	2462	109	-	-	105.45	27.68	4.82	28.95	140	224	A	V
		2484.56	53.1	-20.9	74	49.46	27.74	4.85	28.95	140	224	P	V
		2488.24	43.83	-10.17	54	40.13	27.8	4.85	28.95	140	224	A	V
Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against Peak and Average limit line. 												



**2.4GHz 2400~2483.5MHz
WIFI 802.11b (Harmonic @ 3m)**

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11b CH 01 2412MHz		4824	41.43	-32.57	74	62.58	31.49	5.55	58.19	152	260	P	H
		4824	41.85	-32.15	74	63	31.49	5.55	58.19	152	260	P	V
802.11b CH 06 2437MHz		4874	40.47	-33.53	74	61.31	31.61	5.65	58.1	251	0	P	H
		7311	44.91	-29.09	74	59.4	36.17	7.26	57.92	251	0	P	H
		4874	40.37	-33.63	74	61.21	31.61	5.65	58.1	251	0	P	V
		7311	45.32	-28.68	74	59.81	36.17	7.26	57.92	251	0	P	V
802.11b CH 11 2462MHz		4924	39.18	-34.82	74	59.61	31.73	5.86	58.02	152	260	P	H
		7386	44.44	-29.56	74	58.61	36.28	7.2	57.65	189	238	P	H
		4924	40.21	-33.79	74	60.64	31.73	5.86	58.02	152	260	P	V
		7386	44.52	-29.48	74	58.69	36.28	7.2	57.65	189	238	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz
WIFI 802.11g (Band Edge @ 3m)

WIFI Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11g CH 01 2412MHz		2389.695	53.08	-20.92	74	49.81	27.43	4.78	28.94	160	271	P	H
		2389.8	41.23	-12.77	54	37.96	27.43	4.78	28.94	160	271	A	H
	*	2412	99.01	-	-	95.68	27.49	4.78	28.94	160	271	P	H
	*	2412	91.41	-	-	88.08	27.49	4.78	28.94	160	271	A	H
		2389.59	62.17	-11.83	74	58.9	27.43	4.78	28.94	122	224	P	V
		2389.8	49.59	-4.41	54	46.32	27.43	4.78	28.94	122	224	A	V
	*	2412	109.11	-	-	105.78	27.49	4.78	28.94	122	224	P	V
	*	2412	101.36	-	-	98.03	27.49	4.78	28.94	122	224	A	V
802.11g CH 06 2437MHz		2388.54	45.8	-28.2	74	42.53	27.43	4.78	28.94	157	273	P	H
		2389.66	35.95	-18.05	54	32.68	27.43	4.78	28.94	157	273	A	H
	*	2437	99.89	-	-	96.4	27.61	4.82	28.94	157	273	P	H
	*	2437	92.15	-	-	88.66	27.61	4.82	28.94	157	273	A	H
		2488.17	46.23	-27.77	74	42.53	27.8	4.85	28.95	157	273	P	H
		2486.84	36.74	-17.26	54	33.1	27.74	4.85	28.95	157	273	A	H
		2389.94	49.85	-24.15	74	46.58	27.43	4.78	28.94	118	225	P	V
		2389.8	40.53	-13.47	54	37.26	27.43	4.78	28.94	118	225	A	V
	*	2437	110.71	-	-	107.22	27.61	4.82	28.94	118	225	P	V
	*	2437	102.94	-	-	99.45	27.61	4.82	28.94	118	225	A	V
		2485.58	53.38	-20.62	74	49.74	27.74	4.85	28.95	118	225	P	V
		2485.09	42.32	-11.68	54	38.68	27.74	4.85	28.95	118	225	A	V



802.11g CH 11 2462MHz	*	2462	97.57	-	-	94.02	27.68	4.82	28.95	146	273	P	H
	*	2462	89.89	-	-	86.34	27.68	4.82	28.95	146	273	A	H
		2485.28	56.27	-17.73	74	52.63	27.74	4.85	28.95	146	273	P	H
		2483.6	40.22	-13.78	54	36.58	27.74	4.85	28.95	146	273	A	H
	*	2462	107.15	-	-	103.6	27.68	4.82	28.95	131	222	P	V
	*	2462	99.69	-	-	96.14	27.68	4.82	28.95	131	222	A	V
		2484.96	66.93	-7.07	74	63.29	27.74	4.85	28.95	131	222	P	V
		2483.72	49.61	-4.39	54	45.97	27.74	4.85	28.95	131	222	A	V
Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against Peak and Average limit line. 												



2.4GHz 2400~2483.5MHz
WIFI 802.11g (Harmonic @ 3m)

Table with 14 columns: WIFI Ant. 1, Note, Frequency (MHz), Level (dBµV/m), Over Limit (dB), Limit Line (dBµV/m), Read Level (dBµV), Antenna Factor (dB/m), Cable Loss (dB), Preamp Factor (dB), Ant Pos (cm), Table Pos (deg), Peak Avg. (P/A), Pol. (H/V). Rows include data for 802.11g CH 01 (2412MHz), CH 06 (2437MHz), and CH 11 (2462MHz).



2.4GHz 2400~2483.5MHz
WIFI 802.11n HT20 (Band Edge @ 3m)

Table with 14 columns: WIFI Ant. 1+2, Note, Frequency (MHz), Level (dBµV/m), Over Limit (dB), Limit Line (dBµV/m), Read Level (dBµV), Antenna Factor (dB/m), Cable Loss (dB), Preamp Factor (dB), Ant Pos (cm), Table Pos (deg), Peak Avg. (P/A), Pol. (H/V). Rows include data for 802.11n HT20 CH 01 (2412MHz) and 802.11n HT20 CH 06 (2437MHz).



802.11n HT20 CH 11 2462MHz	*	2462	100.41	-	-	96.86	27.68	4.82	28.95	138	264	P	H
	*	2462	92.65	-	-	89.1	27.68	4.82	28.95	138	264	A	H
		2484.44	58.34	-15.66	74	54.7	27.74	4.85	28.95	138	264	P	H
		2483.52	43.53	-10.47	54	39.89	27.74	4.85	28.95	138	264	A	H
	*	2462	110.91	-	-	107.36	27.68	4.82	28.95	142	163	P	V
	*	2462	103.22	-	-	99.67	27.68	4.82	28.95	142	163	A	V
		2484.8	68.63	-5.37	74	64.99	27.74	4.85	28.95	142	163	P	V
802.11n HT20 CH 02 2417MHz		2389.38	56.8	-17.2	74	53.53	27.43	4.78	28.94	116	171	P	H
		2389.8	43.09	-10.91	54	39.82	27.43	4.78	28.94	116	171	A	H
	*	2417	106.03	-	-	102.7	27.49	4.78	28.94	116	171	P	H
	*	2417	97.17	-	-	93.84	27.49	4.78	28.94	116	171	A	H
		2389.8	62.52	-11.48	74	59.25	27.43	4.78	28.94	100	150	P	V
		2389.8	47.86	-6.14	54	44.59	27.43	4.78	28.94	100	150	A	V
	*	2417	111.41	-	-	108.08	27.49	4.78	28.94	100	150	P	V
*	2417	103.92	-	-	100.59	27.49	4.78	28.94	100	150	A	V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz
WIFI 802.11n HT20 (Harmonic @ 3m)

WIFI Ant. 1+2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11n HT20 CH 01 2412MHz		4824	42.64	-31.36	74	63.79	31.49	5.55	58.19	152	360	P	H
		4824	40.36	-33.64	74	61.51	31.49	5.55	58.19	152	360	P	V
802.11n HT20 CH 06 2437MHz		4874	40.45	-33.55	74	61.29	31.61	5.65	58.1	152	260	P	H
		7311	44.55	-29.45	74	59.04	36.17	7.26	57.92	189	238	P	H
		4874	40.28	-33.72	74	61.12	31.61	5.65	58.1	152	260	P	V
		7311	45.34	-28.66	74	59.83	36.17	7.26	57.92	189	238	P	V
802.11n HT20 CH 11 2462MHz		4924	39.54	-34.46	74	59.97	31.73	5.86	58.02	152	260	P	H
		7386	44.62	-29.38	74	58.79	36.28	7.2	57.65	189	238	P	H
		4924	41.51	-32.49	74	61.94	31.73	5.86	58.02	152	260	P	V
		7386	45.05	-28.95	74	59.22	36.28	7.2	57.65	189	238	P	V
802.11n HT20 CH 02 2417MHz		4834	39.47	-34.53	74	60.45	31.53	5.65	58.16	152	360	P	H
		7251	44.33	-29.67	74	58.99	36.11	7.32	58.09	152	360	P	H
		4834	39.58	-34.42	74	60.56	31.53	5.65	58.16	152	360	P	V
		7251	44.32	-29.68	74	58.98	36.11	7.32	58.09	152	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Antenna 2 verify the worst mode of Antenna 1

WIFI 802.11b (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 11 2462MHz	*	2462	106.76	-	-	103.21	27.68	4.82	28.95	118	164	P	H
	*	2462	103.82	-	-	100.27	27.68	4.82	28.95	118	164	A	H
		2488.28	46.92	-27.08	74	43.22	27.8	4.85	28.95	118	164	P	H
		2484.4	36.7	-17.3	54	33.06	27.74	4.85	28.95	118	164	A	H
	*	2462	113.23	-	-	109.68	27.68	4.82	28.95	129	173	P	V
	*	2462	109.87	-	-	106.32	27.68	4.82	28.95	129	173	A	V
		2485.28	51.83	-22.17	74	48.19	27.74	4.85	28.95	129	173	P	V
		2484.96	40.11	-13.89	54	36.47	27.74	4.85	28.95	129	173	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz

WIFI 802.11b (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 11 2462MHz		4924	38.32	-35.68	74	58.75	31.73	5.86	58.02	151	360	P	H
		7386	44.03	-29.97	74	58.2	36.28	7.2	57.65	151	360	P	H
		4924	40.21	-33.79	74	60.64	31.73	5.86	58.02	151	360	P	V
		7386	43.9	-30.1	74	58.07	36.28	7.2	57.65	151	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz
WIFI 802.11g (Band Edge @ 3m)

WIFI Ant. 2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11g CH 11 2462MHz	*	2462	103.88	-	-	100.33	27.68	4.82	28.95	100	164	P	H
	*	2462	96.61	-	-	93.06	27.68	4.82	28.95	100	164	A	H
		2485.16	60	-14	74	56.36	27.74	4.85	28.95	100	164	P	H
		2483.56	45.38	-8.62	54	41.74	27.74	4.85	28.95	100	164	A	H
	*	2462	109.91	-	-	106.36	27.68	4.82	28.95	136	151	P	V
	*	2462	102.3	-	-	98.75	27.68	4.82	28.95	136	151	A	V
		2483.6	65.86	-8.14	74	62.22	27.74	4.85	28.95	136	151	P	V
		2483.56	50.76	-3.24	54	47.12	27.74	4.85	28.95	136	151	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2400~2483.5MHz
WIFI 802.11g (Harmonic @ 3m)

WIFI Ant. 2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11g CH 11 2462MHz		4924	38.08	-35.92	74	58.51	31.73	5.86	58.02	210	253	P	H
		7386	44.3	-29.7	74	58.47	36.28	7.2	57.65	210	253	P	H
		4924	39.06	-34.94	74	59.49	31.73	5.86	58.02	252	0	P	V
		7386	44.78	-29.22	74	58.95	36.28	7.2	57.65	252	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Emission below 1GHz
2.4GHz WIFI 802.11g (LF)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz 802.11g LF		30.97	24.98	-15.02	40	31.97	24.52	0.27	31.78	100	210	P	H
		107.6	22.03	-21.47	43.5	35.76	16.73	1.09	31.55	-	-	P	H
		232.73	22.3	-23.7	46	35.03	16.87	1.68	31.28	-	-	P	H
		303.54	22.44	-23.56	46	32.35	19.55	1.87	31.33	-	-	P	H
		556.71	27.01	-18.99	46	31.24	24.39	2.58	31.2	-	-	P	H
		750.71	29.18	-16.82	46	31.36	26.02	3.03	31.23	-	-	P	H
		30	23.77	-16.23	40	30.2	25.1	0.25	31.78	-	-	P	V
		121.18	22.1	-21.4	43.5	35.34	17.13	1.14	31.51	-	-	P	V
		172.59	22.8	-20.7	43.5	36.08	16.69	1.37	31.34	-	-	P	V
		465.53	25.21	-20.79	46	32.06	21.99	2.34	31.18	-	-	P	V
		591.63	27.45	-18.55	46	31.12	24.88	2.68	31.23	-	-	P	V
	881.66	32.31	-13.69	46	32.06	28.18	3.34	31.27	100	235	P	V	
Remark	1. No other spurious found. 2. All results are PASS against limit line.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	Peak or Average
H/V	Horizontal or Vertical



A calculation example for radiated spurious emission is shown as below:

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

- Level(dBμV/m) =
Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
- Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

- Level(dBμV/m)
= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)
= 55.45 (dBμV/m)
- Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

- Level(dBμV/m)
= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)
= 43.54 (dBμV/m)
- Over Limit(dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 43.54(dBμV/m) – 54(dBμV/m)
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.

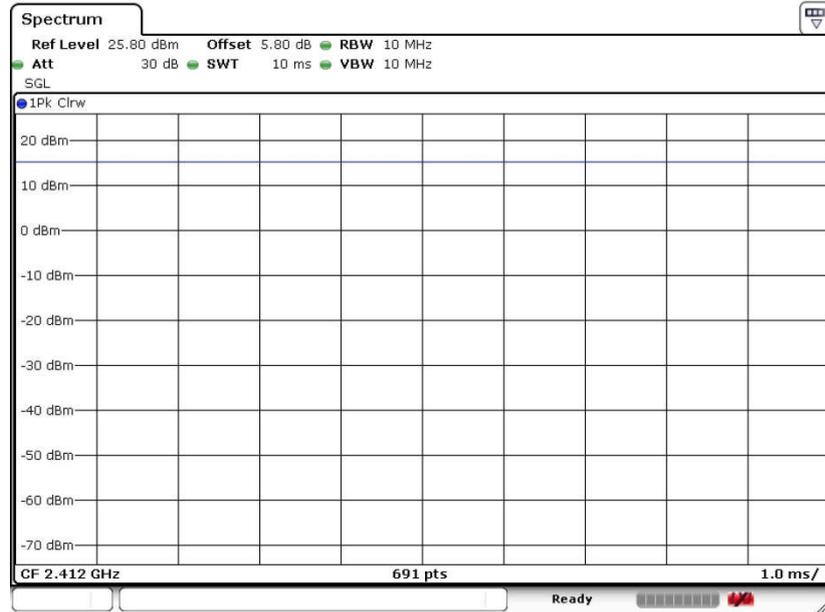


Appendix C. Duty Cycle Plots

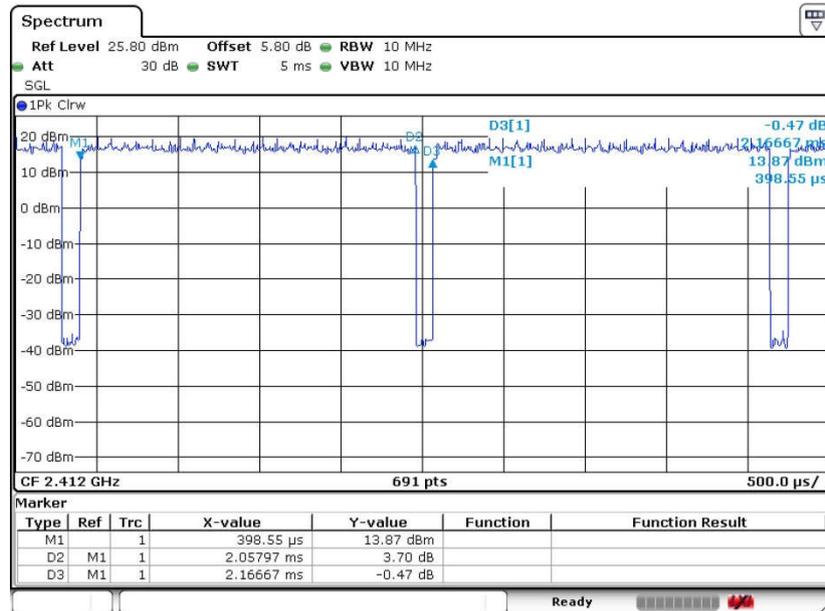
Antenna	Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
1	802.11b	100	-	-	10Hz
1	802.11g	94.98	2.058	0.486	1kHz
2	802.11b	100	-	-	10Hz
2	802.11g	95.00	2.065	0.484	1kHz
1+2(1)	802.11n HT20	94.31	1.920	0.521	1kHz
1+2(2)	802.11n HT20	94.64	1.920	0.521	1kHz



802.11b Ant.1

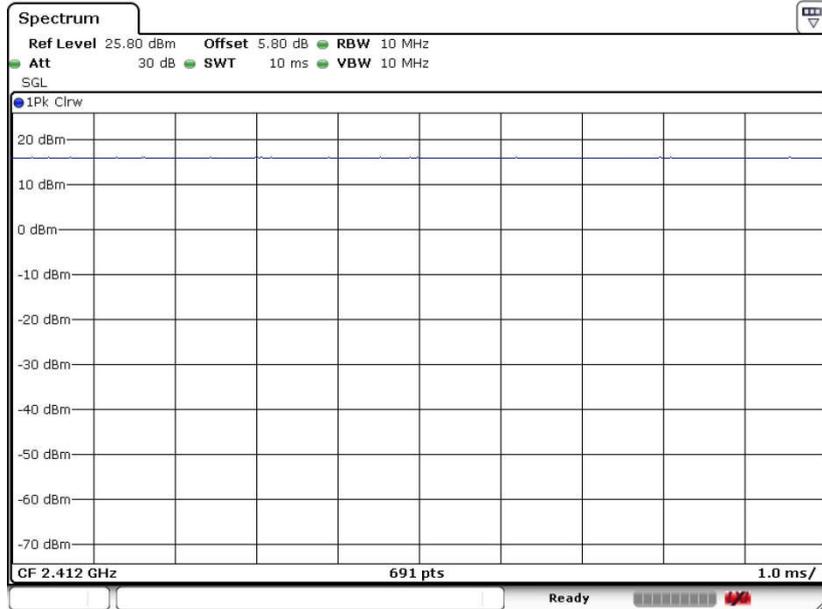


802.11g Ant.1

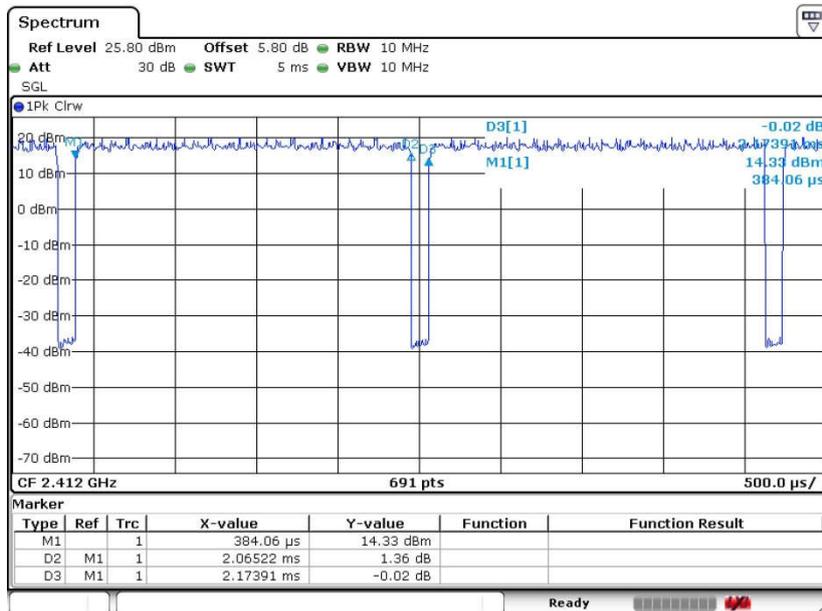




802.11b Ant.2

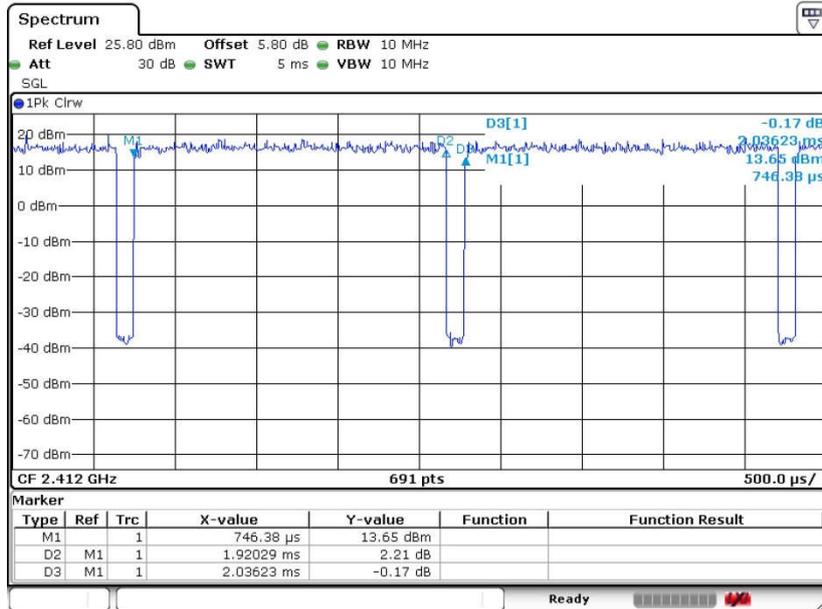


802.11g Ant.2





802.11n20 Ant.1+2(1)



802.11n20 Ant.1+2(2)

