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FCC RADIO TEST REPORT

Applicant's company	**Roku, Inc.**
Applicant Address	12980 Saratoga Avenue Suite #D Saratoga California United States 95070
FCC ID	**TC2-R1009**
Manufacturer's company	**Lite-On Network Communication (Dongguan) Limited**
Manufacturer Address	30#Keji Rd., Yin Hu Industrial Area, Qingxi Town, DongGuan City, Guangdong, China

Product Name	Media Player Device
Brand Name	Roku
Model No.	4210X2, 4230X2
Test Rule	47 CFR FCC Part 15 Subpart C § 15.247
Test Freq. Range	2400 ~ 2483.5MHz
Received Date	Apr. 30, 2015
Final Test Date	Nov. 09, 2015
Submission Type	Original Equipment

Statement

Test result included in this report is for the IEEE 802.11n and IEEE 802.11b/g of the product.

The test result in this report refers exclusively to the presented test model / sample.

Without written approval of SPORTON International Inc., the test report shall not be reproduced except in full.

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in **ANSI C63.10-2013**, **47 CFR FCC Part 15 Subpart C**, **KDB558074 D01 v03r03** and **KDB 662911 D01 v02r01**.

The test equipment used to perform the test is calibrated and traceable to NML/ROC.

Testing Laboratory
1190

Table of Contents

History of This Test Report

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR561812AA	Rev. 01	Initial issue of report	Nov. 16, 2015

1. VERIFICATION OF COMPLIANCE

Product Name	:	Media Player Device
Brand Name	:	Roku
Model No.	:	4210X2, 4230X2
Applicant	:	Roku, Inc.
Test Rule Part(s)	:	47 CFR FCC Part 15 Subpart C § 15.247

Sporton International as requested by the applicant to evaluate the EMC performance of the product sample received on Apr. 30, 2015 would like to declare that the tested sample has been evaluated and found to be in compliance with the tested rule parts. The data recorded as well as the test configuration specified is true and accurate for showing the sample's EMC nature.

Sam Chen

SPORTON INTERNATIONAL INC.

2. SUMMARY OF THE TEST RESULT

Applied Standard: 47 CFR FCC Part 15 Subpart C				
Part	**Rule Section**	**Description of Test**	**Result**	**Under Limit**
4.1	15.207	AC Power Line Conducted Emissions	Complies	6.98 dB
4.2	15.247(b)(3)	Maximum Conducted Output Power	Complies	9.70 dB
4.3	15.247(e)	Power Spectral Density	Complies	12.07 dB
4.4	15.247(a)(2)	6dB Spectrum Bandwidth	Complies	-
4.5	15.247(d)	Radiated Emissions	Complies	0.05 dB
4.6	15.247(d)	Band Edge Emissions	Complies	0.03 dB
4.7	15.203	Antenna Requirements	Complies	-

3. GENERAL INFORMATION

3.1. Product Details

Items	Description
Product Type	IEEE 802.11b/g: WLAN (1TX, 1RX) IEEE 802.11n: WLAN (2TX, 2RX)
Radio Type	Intentional Transceiver
Power Type	From power adapter
Modulation	IEEE 802.11b: DSSS IEEE 802.11g: OFDM IEEE 802.11n: see the below table
Data Modulation	IEEE 802.11b: DSSS (BPSK / QPSK / CCK) IEEE 802.11g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM)
Data Rate (Mbps)	IEEE 802.11b: DSSS (1/ 2/ 5.5/11) IEEE 802.11g: OFDM (6/9/12/18/24/36/48/54) IEEE 802.11n: see the below table
Frequency Range	2400 ~ 2483.5MHz
Channel Number	11 for 20MHz bandwidth
Channel Band Width (99%)	IEEE 802.11b: 10.44 MHz IEEE 802.11g: 16.68 MHz IEEE 802.11n MCS0 (HT20): 17.64 MHz
Maximum Conducted Output Power	IEEE 802.11b: 18.11 dBm IEEE 802.11g: 17.16 dBm IEEE 802.11n MCS0 (HT20): 20.30 dBm
Carrier Frequencies	Please refer to section 3.4
Antenna	Please refer to section 3.3

Items	Description	
Beamforming Function	☐ With beamforming	☒ Without beamforming

Antenna and Band width

Antenna	Single (TX)	Two (TX)
Band width Mode	20 MHz	20 MHz
IEEE 802.11b	V	X
IEEE 802.11g	V	X
IEEE 802.11n	X	V

IEEE 11n Spec.

Protocol	Number of Transmit Chains (NTX)	Data Rate / MCS
802.11n (HT20)	2	MCS 0-15
Note 1: IEEE Std. 802.11n modulation consists of HT20 and HT40 (HT: High Throughput). Then EUT supports HT20. Note 2: Modulation modes consist of below configuration: HT20: IEEE 802.11n		

3.2. Accessories

Power	Brand	Model	Rating
Adapter 1	Roku	FA-1201000SUD	Input: 120V~60Hz, 0.5A Output: 12.0V, 1.0A
Adapter 2	Roku	MU12AH120100-A1	Input: 100-240V~50/60Hz, 0.5A Output: 12V, 1.0A
Adapter 3	Roku	PA-1120-42RU	Input: 100-240V~50/60Hz, 0.5A Output: 12V, 1.0A
Remote controller	**Brand Holder**	**Model**	**Remark**
Remote controller 1	SMK Electronics Coperation	RXT9000-5502EC	RF remote
Remote controller 2	ShenZhen C&D Electronics CO.Ltd.	RC16D-1, RC16D-2, RC16D-RC52	IR remote

3.3. Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)		
					2.4GHz	5GHz	
						Band 1	Band 4
1	LiteON	SWD219B	Note 1	N/A	2.1	1.5	2.0
2	LiteON	SWD219B	Note 1	N/A	-2.0	3.6	2.5

Note1: The 4-layer board uses a combination of the TDK Chip antennas and a printed antenna.

Note2: The EUT has two antennas.

For 2.4GHz

For IEEE 802.11b/g mode (1TX, 1RX):

The EUT supports the antenna with TX and RX diversity functions.

Both Ant. 1 and Ant. 2 support transmit and receive functions, but only one of them will be used at one time.

The Ant. 2 generated the worst case, so it was selected to test and record in the report.

For IEEE 802.11n mode (2TX, 2RX):

Ant. 1 and Ant. 2 will transmit/receive the same signal simultaneously.

Ant. 1 and Ant. 2 can be used as transmitting/receiving antennas.

For 5GHz

For IEEE 802.11a mode (1TX, 1RX):

The EUT supports the antenna with TX and RX diversity functions.

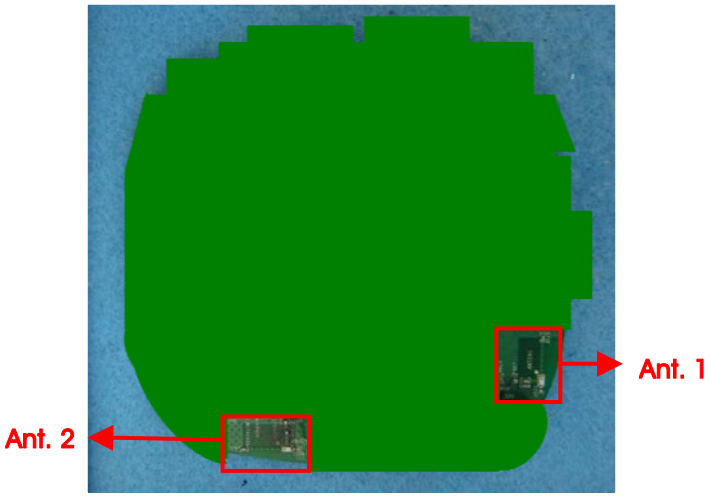
Both Ant. 1 and Ant. 2 support transmit and receive functions, but only one of them will be used at one time.

The Ant. 2 generated the worst case, so it was selected to test and record in the report.

For IEEE 802.11n mode (2TX, 2RX):

Ant. 1 and Ant. 2 will transmit/receive the same signal simultaneously.

Ant. 1 and Ant. 2 can be used as transmitting/receiving antennas.



3.4. Table for Carrier Frequencies

There is a bandwidth system.

For 20MHz bandwidth systems, use Channel 1~Channel 11.

Frequency Band	Channel No.	Frequency	Channel No.	Frequency
2400~2483.5MHz	1	2412 MHz	7	2442 MHz
	2	2417 MHz	8	2447 MHz
	3	2422 MHz	9	2452 MHz
	4	2427 MHz	10	2457 MHz
	5	2432 MHz	11	2462 MHz
	6	2437 MHz	-	-

3.5. Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate	Channel	Ant.
AC Power Line Conducted Emissions	Normal Link	-	-	-
Maximum Conducted Output Power	11b/CCK	1 Mbps	1/6/11	2
	11g/BPSK	6 Mbps	1/6/11	2
	11n HT20	MCS0	1/6/11	1+2
Power Spectral Density	11b/CCK	1 Mbps	1/6/11	2
	11g/BPSK	6 Mbps	1/6/11	2
	11n HT20	MCS0	1/6/11	1+2
6dB Spectrum Bandwidth	11b/CCK	1 Mbps	1/6/11	2
	11g/BPSK	6 Mbps	1/6/11	2
	11n HT20	MCS0	1/6/11	1+2
Radiated Emissions 9kHz~1GHz	Normal Link	-	-	-
Radiated Emissions 1GHz~10th Harmonic	11b/CCK	1 Mbps	1/6/11	2
	11g/BPSK	6 Mbps	1/6/11	2
	11n HT20	MCS0	1/6/11	1+2
Band Edge Emissions	11b/CCK	1 Mbps	1/6/11	2
	11g/BPSK	6 Mbps	1/6/11	2
	11n HT20	MCS0	1/6/11	1+2

The following test modes were performed for all tests:

For Conducted Emission test:

Mode 1. LAN mode with Adapter 1

Mode 2. LAN mode with Adapter 2

Mode 3. LAN mode with Adapter 3

Mode 4. WiFi mode in 2.4GHz with Adapter 1

Mode 5. WiFi mode in 2.4GHz with Adapter 2

Mode 6. WiFi mode in 2.4GHz with Adapter 3

Mode 7. WiFi mode in 5GHz with Adapter 1

Mode 8. WiFi mode in 5GHz with Adapter 2

Mode 9. WiFi mode in 5GHz with Adapter 3

Mode 5 is the worst case, so it was selected to record in this test report.

For Radiated Emission test (Below 1GHz):

Mode 1. LAN mode with Adapter 1

Mode 2. LAN mode with Adapter 2

Mode 3. LAN mode with Adapter 3

Mode 4. WiFi mode in 2.4GHz with Adapter 1

Mode 5. WiFi mode in 2.4GHz with Adapter 2

Mode 6. WiFi mode in 2.4GHz with Adapter 3

Mode 7. WiFi mode in 5GHz with Adapter 1

Mode 8. WiFi mode in 5GHz with Adapter 2

Mode 9. WiFi mode in 5GHz with Adapter 3

Mode 9 is the worst case, so it was selected to record in this test report.

For Radiated Emission test (Above 1GHz):

The EUT could be performed at Z axis only, so the measurement will follow this same test configuration.

Mode 1. CTX-EUT in Z axis

3.6. Table for Testing Locations

Test Site Location				
Address:	No.8, Lane 724, Bo-ai St., Jhubei City, Hsinchu County 302, Taiwan, R.O.C.			
TEL:	886-3-656-9065			
FAX:	886-3-656-9085			
Test Site No.	**Site Category**	**Location**	**FCC Reg. No.**	**IC File No.**
03CH01-CB	SAC	Hsin Chu	262045	IC 4086D
CO02-CB	Conduction	Hsin Chu	262045	IC 4086D
TH01-CB	OVEN Room	Hsin Chu	-	-

Open Area Test Site (OATS); Semi Anechoic Chamber (SAC).

3.7. Table for Multiple Listing

The EUT has two model names which are identical to each other in all aspects except for the following table:

Model Name	Remote controller 1	Remote controller 2	Description
4210X2	X	V	These two models are identical except for the different remote controllers.
4230X2	V	X	

From the above models, model: 4210X2 was selected as representative model for the test and its data was recorded in this report.

3.8. Table for Supporting Units

For Test Site No: CO02-CB

Support Unit	Brand	Model	FCC ID
Notebook	DELL	E6430	DoC
AP	TAMIO	N500RDG	N/A
Flash disk	LightForce	LF-MKU002	N/A
SD care	Kingston	SDC 10	N/A
LCD TV	SONY	KLV-32U300A	DoC

For Test Site No: 03CH01-CB (Below 1GHz)

Support Unit	Brand	Model	FCC ID
Notebook	DELL	E4300	DoC
AP	TAMIO	N500RDG	N/A
Flash disk	LightForce	LF-MKU002	N/A
SD care	Kingston	SDC 10	N/A
LCD TV	SONY	KLV-32U300A	DoC

For Test Site No: 03CH01-CB (Above 1GHz)

Support Unit	Brand	Model	FCC ID
Notebook	DELL	E4300	DoC

For Test Site No: TH01-CB

Support Unit	Brand	Model	FCC ID
Notebook	DELL	E4300	DoC

3.9. Table for Parameters of Test Software Setting

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Test Software Version	Mtool 2.0.0.3		
Mode	Test Frequency (MHz)		
	NCB: 20MHz		
	2412 MHz	2437 MHz	2462 MHz
802.11b	60	64	58
802.11g	62	62	62
802.11n MCS0 HT20	47	63	51

3.10. EUT Operation during Test

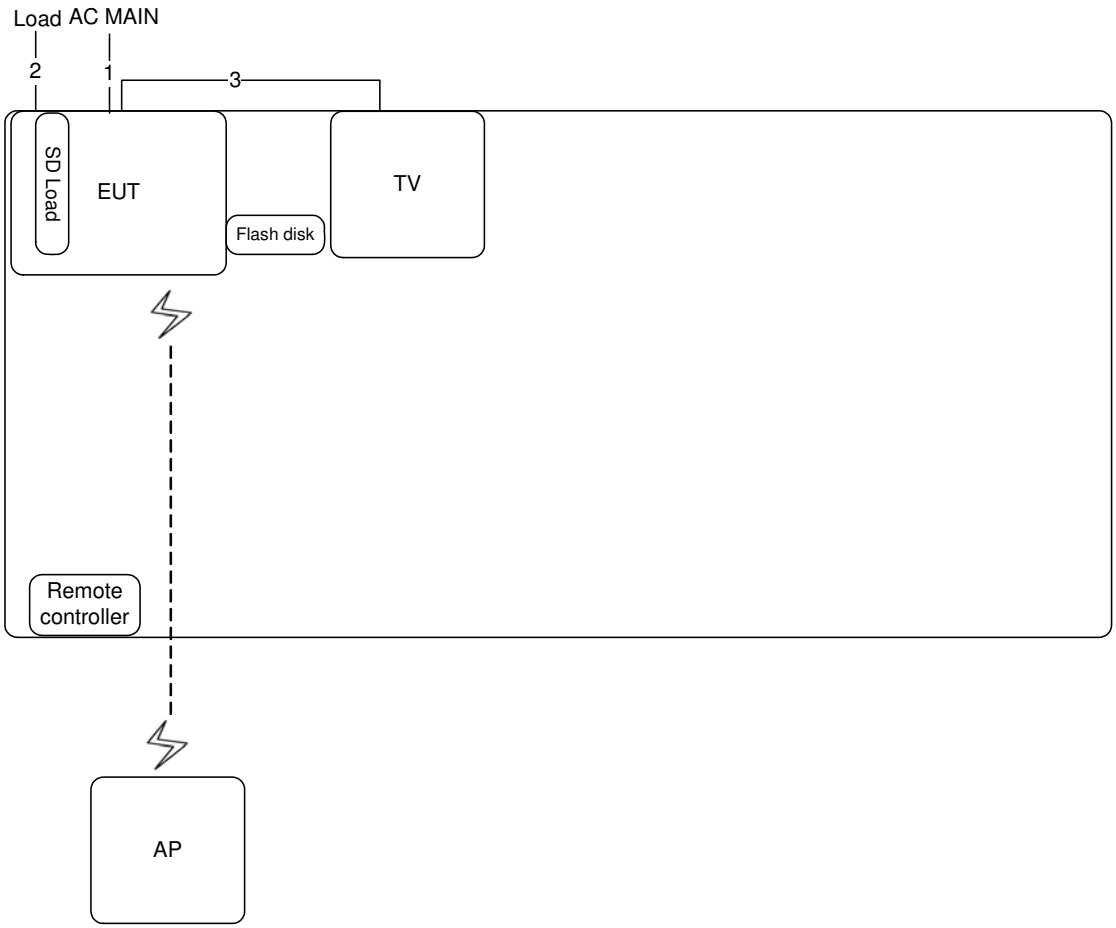
The EUT was programmed to be in continuously transmitting mode.

3.11. Duty Cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle (%)	Duty Factor (dB)	1/T Minimum VBW (kHz)
802.11b	1.000	1.000	100.00	0.00	0.01
802.11g	2.060	2.092	98.47	0.07	0.01
802.11n MCS0 HT20	1.900	1.936	98.14	1.02	0.01

3.12. Test Configurations

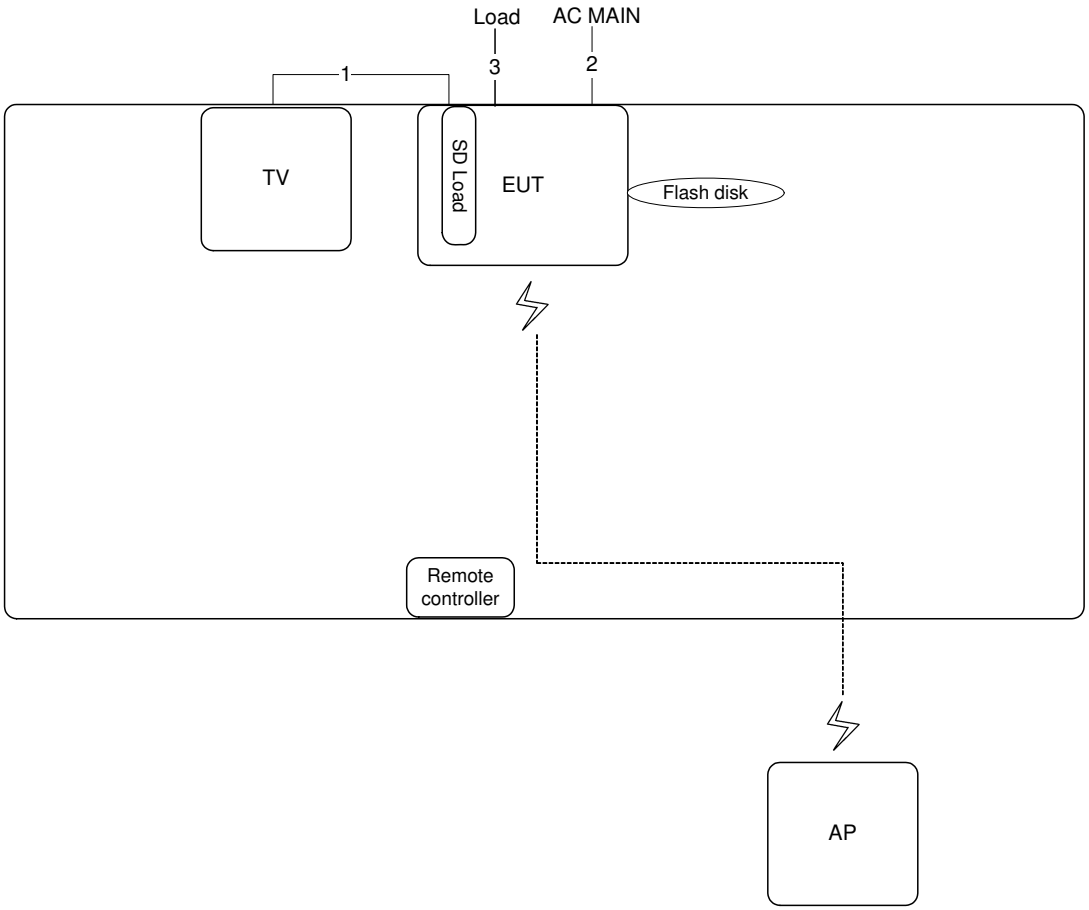
3.12.1. AC Power Line Conduction Emissions Test Configuration



Item	Connection	Shielded	Length
1	Power cable	No	1.5m
2	RJ-45 cable	No	1.5m
3	HDMI cable	Yes	1.5m

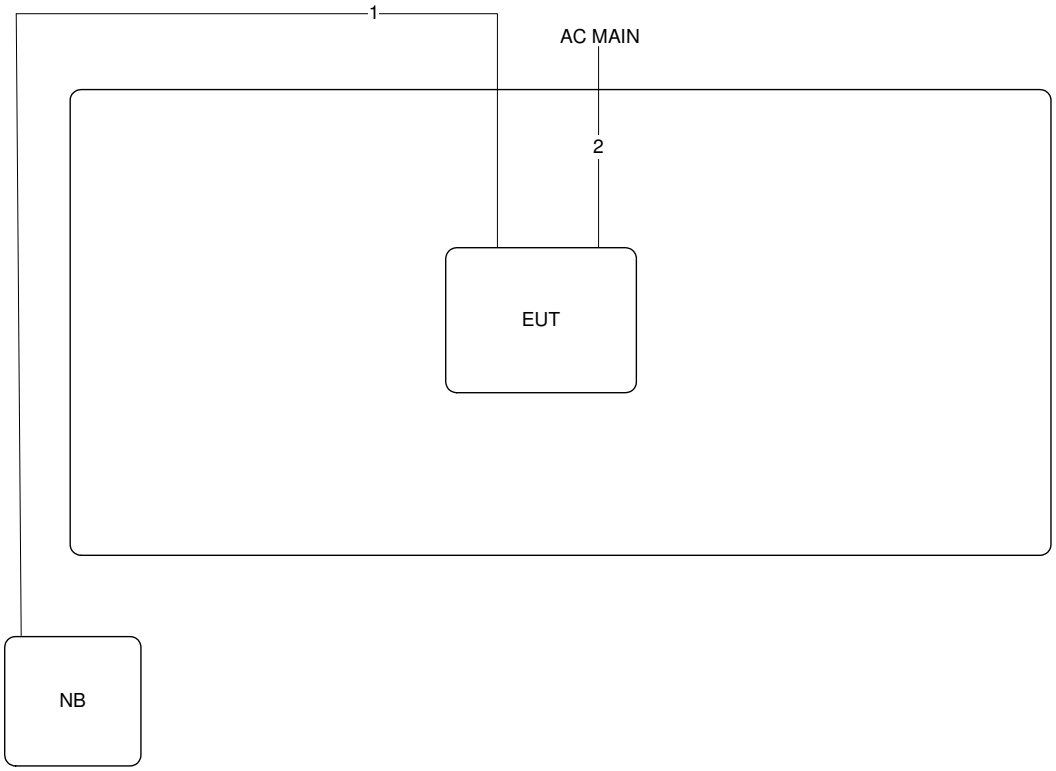
3.12.2. Radiation Emissions Test Configuration

Test Configuration: 30MHz~1GHz



Item	Connection	Shielded	Length
1	HDMI cable	Yes	1.5m
2	Power cable	No	1.5m
3	RJ-45 cable	No	1.5m

Test Configuration: above 1GHz



Item	Connection	Shielded	Length
1	RJ-45 cable	No	10m
2	Power cable	No	1.5m

4. TEST RESULT

4.1. AC Power Line Conducted Emissions Measurement

4.1.1. Limit

For this product which is designed to be connected to the 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 below limits table.

Frequency (MHz)	QP Limit (dBuV)	AV Limit (dBuV)
0.15~0.5	66~56	56~46
0.5~5	56	46
5~30	60	50

4.1.2. Measuring Instruments and Setting

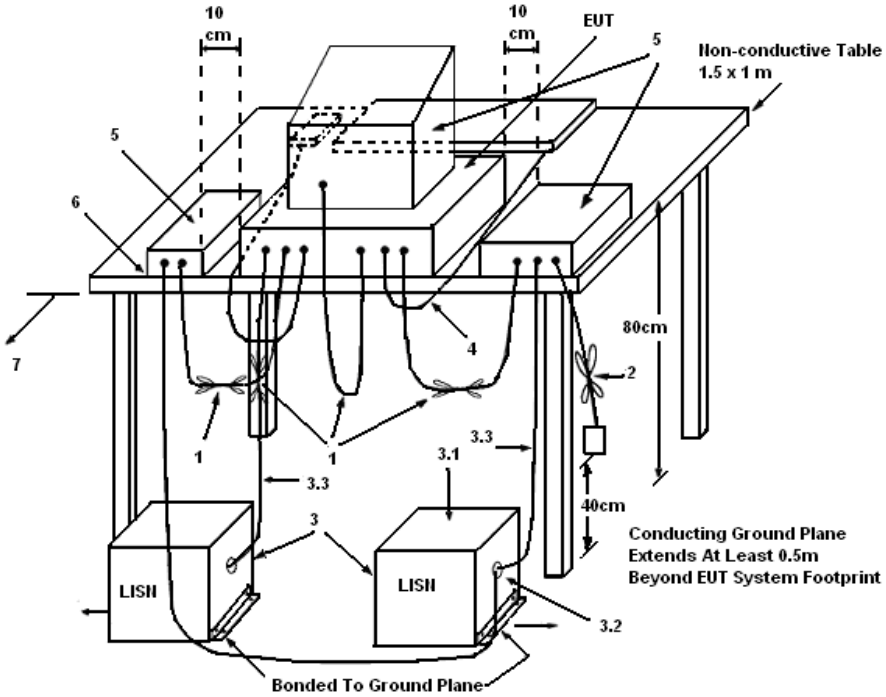
Please refer to section 5 of equipments list in this report. The following table is the setting of the receiver.

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

4.1.3. Test Procedures

1. Configure the EUT according to ANSI C63.10. The EUT or host of EUT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT or host of EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connected to the other LISNs. The LISN should provide 50uH/50ohms coupling impedance.
4. The frequency range from 150 kHz to 30 MHz was searched.
5. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. The measurement has to be done between each power line and ground at the power terminal.

4.1.4. Test Setup Layout



LEGEND:

(1) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

(2) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

(3) EUT connected to one LISN. Unused LISN measuring port connectors shall be terminated in 50 Ω. LISN can be placed on top of, or immediately beneath, reference ground plane.

(3.1) All other equipment powered from additional LISN(s).

(3.2) Multiple outlet strip can be used for multiple power cords of non-EUT equipment.

(3.3) LISN at least 80 cm from nearest part of EUT chassis.

(4) Cables of hand-operated devices, such as keyboards, mice, etc., shall be placed as for normal use.

(5) Non-EUT components of EUT system being tested.

(6) Rear of EUT, including peripherals, shall all be aligned and flush with rear of tabletop.

(7) Rear of tabletop shall be 40 cm removed from a vertical conducting plane that is bonded to the ground plane.

4.1.5. Test Deviation

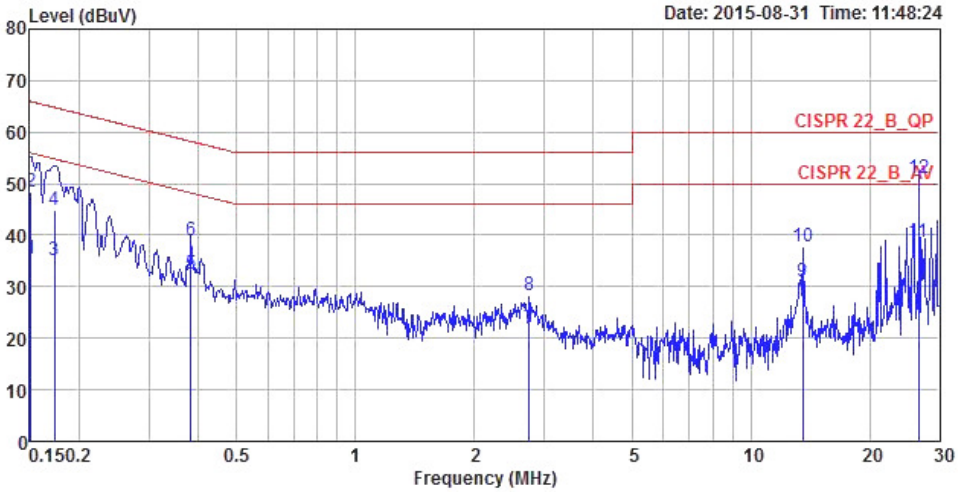
There is no deviation with the original standard.

4.1.6. EUT Operation during Test

The EUT was placed on the test table and programmed in normal function.

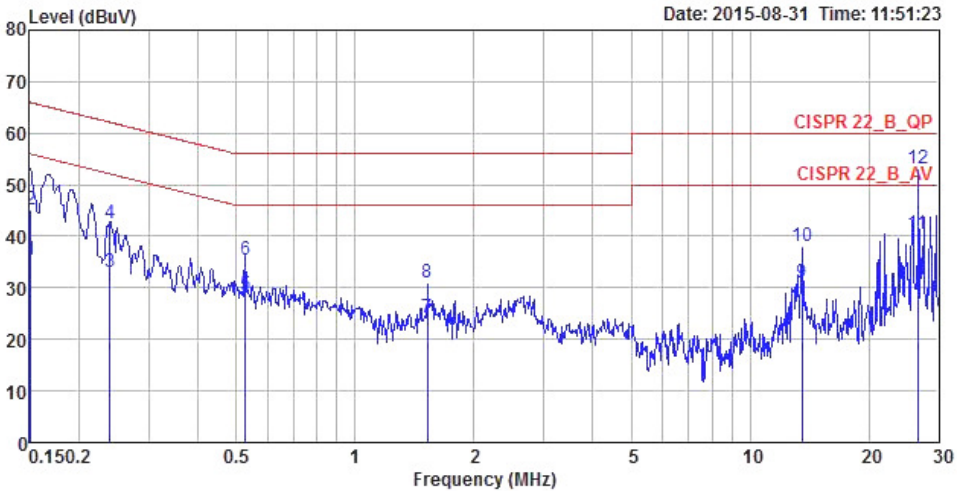
4.1.7. Results of AC Power Line Conducted Emissions Measurement

Temperature	22°C	Humidity	54%
Test Engineer	Da Deng	Phase	Line
Configuration	Normal Link		



	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Pol/Phase	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB		
1	0.1508	35.49	-20.47	55.96	25.32	10.00	0.17	LINE	Average
2	0.1508	48.36	-17.60	65.96	38.19	10.00	0.17	LINE	QP
3	0.1731	34.98	-19.83	54.81	24.81	10.00	0.17	LINE	Average
4	0.1731	44.74	-20.07	64.81	34.57	10.00	0.17	LINE	QP
5	0.3832	32.56	-15.65	48.21	22.35	10.01	0.20	LINE	Average
6	0.3832	38.92	-19.29	58.21	28.71	10.01	0.20	LINE	QP
7	2.7502	21.78	-24.22	46.00	11.44	10.06	0.28	LINE	Average
8	2.7502	28.27	-27.73	56.00	17.93	10.06	0.28	LINE	QP
9	13.5609	30.85	-19.15	50.00	20.14	10.29	0.42	LINE	Average
10	13.5609	37.66	-22.34	60.00	26.95	10.29	0.42	LINE	QP
11	26.5937	38.60	-11.40	50.00	27.58	10.48	0.54	LINE	Average
12	26.5937	51.13	-8.87	60.00	40.11	10.48	0.54	LINE	QP

Temperature	22°C	Humidity	54%
Test Engineer	Da Deng	Phase	Neutral
Configuration	Normal Link		



	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Pol/Phase	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB		
1	0.1508	35.32	-20.64	55.96	25.15	10.00	0.17	NEUTRAL	Average
2	0.1508	45.08	-20.88	65.96	34.91	10.00	0.17	NEUTRAL	QP
3	0.2391	33.13	-19.00	52.13	22.93	10.01	0.19	NEUTRAL	Average
4	0.2391	42.40	-19.73	62.13	32.20	10.01	0.19	NEUTRAL	QP
5	0.5265	28.61	-17.39	46.00	18.39	10.02	0.20	NEUTRAL	Average
6	0.5265	35.43	-20.57	56.00	25.21	10.02	0.20	NEUTRAL	QP
7	1.5274	24.17	-21.83	46.00	13.90	10.04	0.23	NEUTRAL	Average
8	1.5274	30.89	-25.11	56.00	20.62	10.04	0.23	NEUTRAL	QP
9	13.5599	30.92	-19.08	50.00	20.21	10.29	0.42	NEUTRAL	Average
10	13.5599	37.95	-22.05	60.00	27.24	10.29	0.42	NEUTRAL	QP
11	26.5987	40.47	-9.53	50.00	29.45	10.48	0.54	NEUTRAL	Average
12	26.5987	53.02	-6.98	60.00	42.00	10.48	0.54	NEUTRAL	QP

Note:

Level = Read Level + LISN Factor + Cable Loss.

4.2. Maximum Conducted Output Power Measurement

4.2.1. Limit

The limit for output power is 30dBm.

4.2.2. Measuring Instruments and Setting

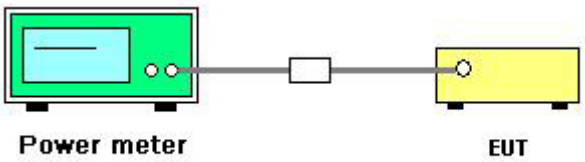
Please refer to section 5 of equipments list in this report. The following table is the setting of the power meter.

Power Meter Parameter	Setting
Bandwidth	50MHz bandwidth is greater than the EUT emission bandwidth
Detector	Average

4.2.3. Test Procedures

1. Test procedures refer KDB558074 D01 v03r03 section 9.2.3.2 Measurement using a power meter (PM).
2. Multiple antenna systems was performed in accordance with KDB 662911 D01 v02r01 Emissions Testing of Transmitters with Multiple Outputs in the Same Band.
3. This procedure provides an alternative for determining the RMS output power using a broadband RF average power meter with a thermocouple detector.

4.2.4. Test Setup Layout



4.2.5. Test Deviation

There is no deviation with the original standard.

4.2.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.2.7. Test Result of Maximum Conducted Output Power

Temperature	25°C	Humidity	45%
Test Engineer	Eddie Weng	Test Date	Aug. 27, 2015

Mode	Frequency	Conducted Power (dBm)	Max. Limit (dBm)	Result
		Ant. 2		
802.11b	2412 MHz	17.01	30.00	Complies
	2437 MHz	18.11	30.00	Complies
	2462 MHz	16.52	30.00	Complies
802.11g	2412 MHz	17.12	30.00	Complies
	2437 MHz	17.09	30.00	Complies
	2462 MHz	17.16	30.00	Complies

Mode	Frequency	Conducted Power (dBm)			Max. Limit (dBm)	Result
		Ant. 1	Ant. 2	Total		
802.11n MCS0 HT20	2412 MHz	13.92	13.71	16.83	30.00	Complies
	2437 MHz	17.44	17.14	20.30	30.00	Complies
	2462 MHz	14.66	14.51	17.60	30.00	Complies

4.3. Power Spectral Density Measurement

4.3.1. Limit

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.

4.3.2. Measuring Instruments and Setting

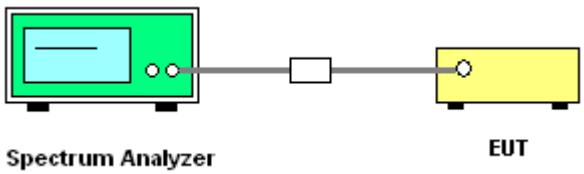
Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	Set the span to 1.5 times the DTS channel bandwidth.
RBW	3 kHz ≤ RBW ≤ 100kHz
VBW	≥ 3 x RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto couple

4.3.3. Test Procedures

1. Test was performed in accordance with KDB558074 D01 v03r03 for Performing Compliance Measurements on Digital Transmission Systems (DTS) - section 10.2 Method PKPSD (peak PSD) and KDB 662911 D01 v02r01 section In-Band Power Spectral Density (PSD) Measurements option (b) Measure and sum spectral maximal across the outputs.
2. Use this procedure when the maximum conducted output power in the fundamental emission is used to demonstrate compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
3. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW (use of a greater number of measurement points than this minimum requirement is recommended).
4. Use the peak marker function to determine the maximum level in any 3 kHz band segment within the fundamental EBW.
5. The resulting PSD level must be ≤ 8 dBm.

4.3.4. Test Setup Layout



4.3.5. Test Deviation

There is no deviation with the original standard.

4.3.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.3.7. Test Result of Power Spectral Density

Temperature	25°C	Humidity	45%
Test Engineer	Eddie Weng		

Mode	Frequency	Power Density (dBm/3kHz)	Power Density Limit (dBm/3kHz)	Result
		Ant. 2		
802.11b	2412 MHz	-4.75	8.00	Complies
	2437 MHz	-5.78	8.00	Complies
	2462 MHz	-7.58	8.00	Complies
802.11g	2412 MHz	-7.15	8.00	Complies
	2437 MHz	-8.60	8.00	Complies
	2462 MHz	-7.42	8.00	Complies

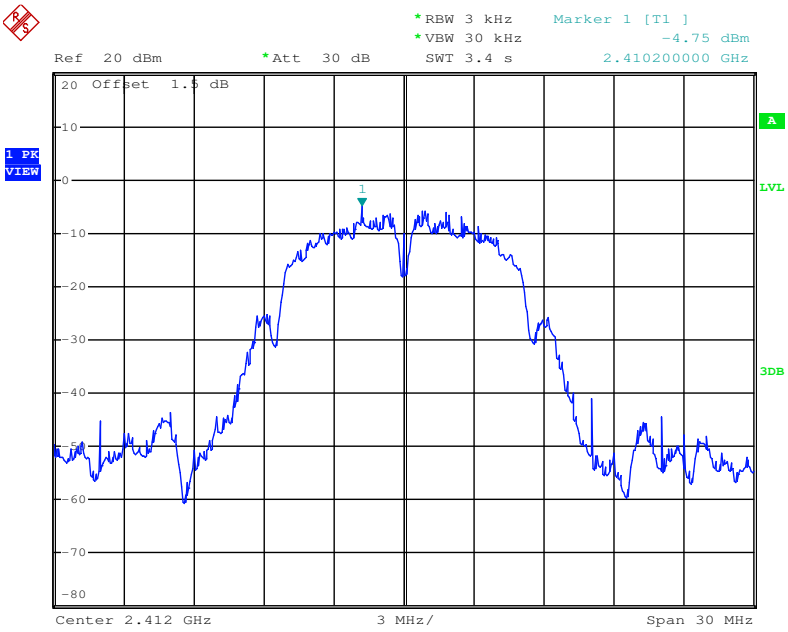
Mode	Frequency	Power Density (dBm/3kHz)			Power Density Limit (dBm/3kHz)	Result
		Ant. 1	Ant. 2	Total		
802.11n MCS0 HT20	2412 MHz	-10.63	-11.54	-8.05	8.00	Complies
	2437 MHz	-6.47	-7.80	-4.07	8.00	Complies
	2462 MHz	-9.44	-9.97	-6.69	8.00	Complies

Note: $DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$ =3.3dBi <6dBi, so the limit doesn't reduce.

Note: All the test values were listed in the report.

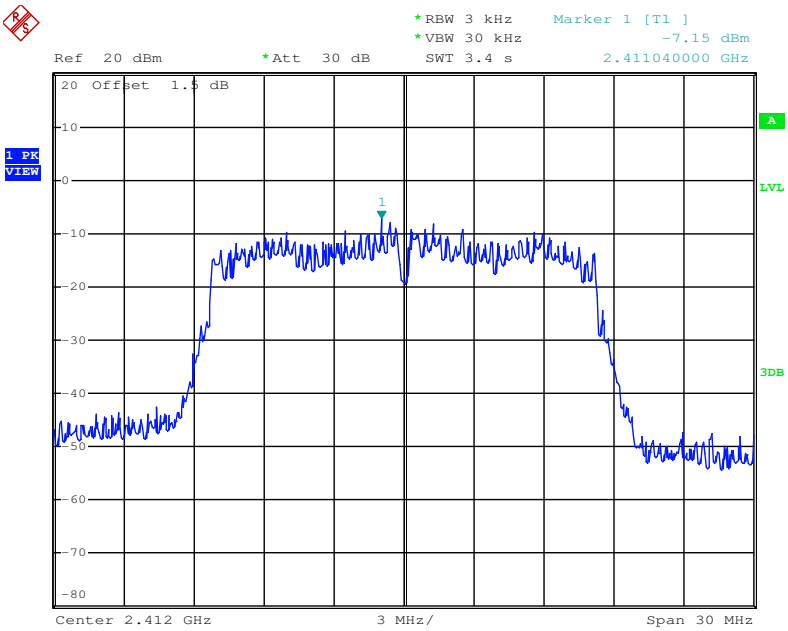
For plots, only the channel with worse result was shown.

Power Density Plot on Configuration IEEE 802.11b / 2412 MHz / Ant. 2



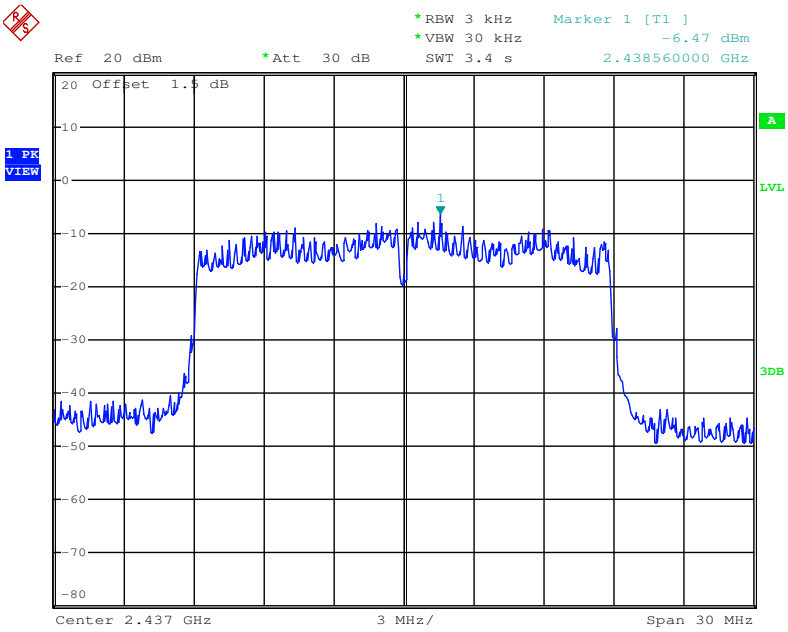
Date: 27.AUG.2015 16:13:17

Power Density Plot on Configuration IEEE 802.11g / 2412 MHz / Ant. 2



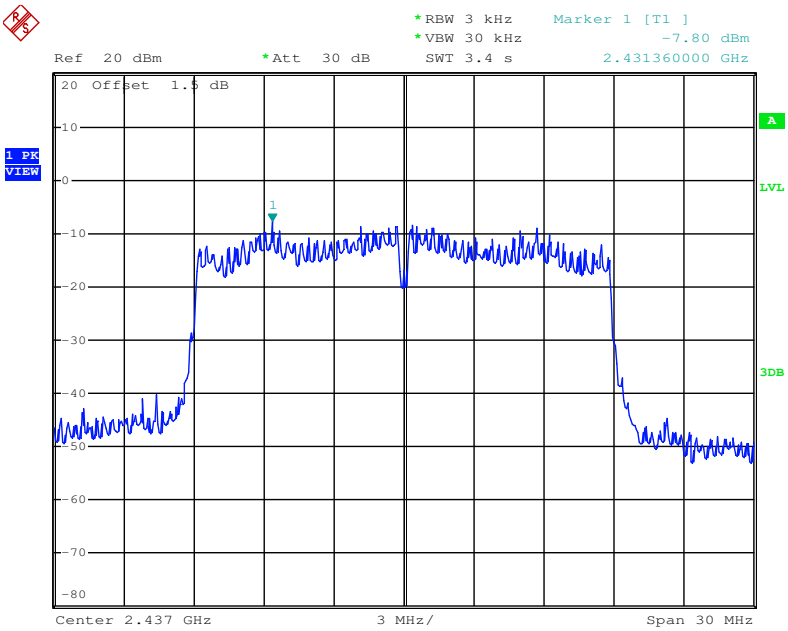
Date: 27.AUG.2015 16:15:37

Power Density Plot on Configuration IEEE 802.11n MCS0 HT20 / 2437 MHz / Ant. 1



Date: 27.AUG.2015 16:17:44

Power Density Plot on Configuration IEEE 802.11n MCS0 HT20 / 2437 MHz / Ant. 2



Date: 27.AUG.2015 16:18:26

4.4. 6dB Spectrum Bandwidth Measurement

4.4.1. Limit

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

4.4.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the Spectrum Analyzer.

6dB Spectrum Bandwidth	
Spectrum Parameters	**Setting**
Attenuation	Auto
Span Frequency	> 6dB Bandwidth
RBW	100kHz
VBW	≥ 3 x RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto
99% Occupied Bandwidth	
Spectrum Parameters	**Setting**
Span	1.5 times to 5.0 times the OBW
RBW	1 % to 5 % of the OBW
VBW	≥ 3 x RBW
Detector	Peak
Trace	Max Hold

4.4.3. Test Procedures

For Radiated 6dB Bandwidth Measurement:

1. The transmitter was radiated to the spectrum analyzer in peak hold mode.
2. Test was performed in accordance with KDB558074 D01 v03r03 for Performing Compliance Measurements on Digital Transmission Systems (DTS) - section 8.0 DTS bandwidth=> 8.1 Option 1.
3. Multiple antenna system was performed in accordance with KDB 662911 D01 v02r01 Emissions Testing of Transmitters with Multiple Outputs in the Same Band.
4. Measured the spectrum width with power higher than 6dB below carrier.

4.4.4. Test Setup Layout

For Radiated 6dB Bandwidth Measurement:

This test setup layout is the same as that shown in section 4.5.4.

4.4.5. Test Deviation

There is no deviation with the original standard.

4.4.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.4.7. Test Result of 6dB Spectrum Bandwidth

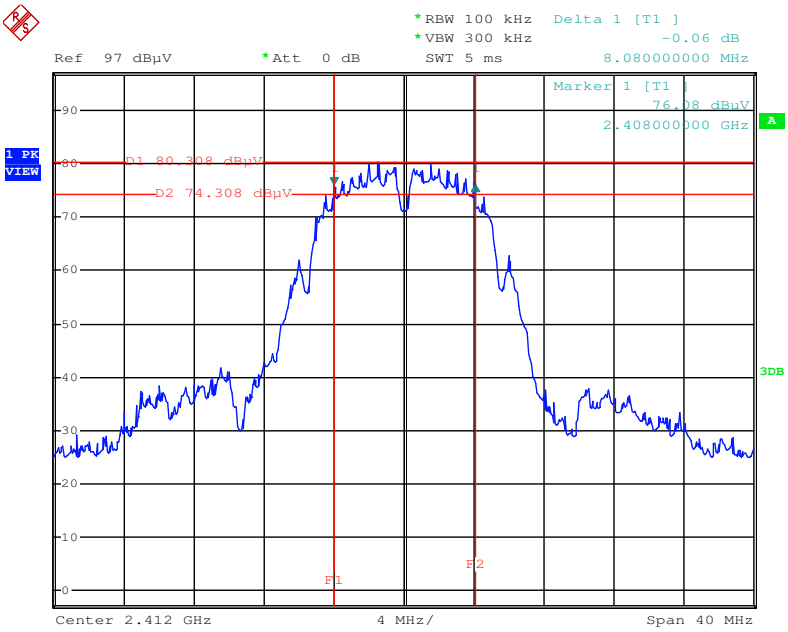
Temperature	25°C	Humidity	45%
Test Engineer	Eddie Weng		

Mode	Frequency	6dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Min. Limit (kHz)	Test Result
802.11b	2412 MHz	8.08	10.32	500	Complies
	2437 MHz	8.16	10.44	500	Complies
	2462 MHz	8.00	10.32	500	Complies
802.11g	2412 MHz	14.88	16.68	500	Complies
	2437 MHz	15.04	16.56	500	Complies
	2462 MHz	14.96	16.56	500	Complies
802.11n MCS0 HT20	2412 MHz	13.20	16.92	500	Complies
	2437 MHz	15.68	17.64	500	Complies
	2462 MHz	13.20	17.04	500	Complies

Note: All the test values were listed in the report.

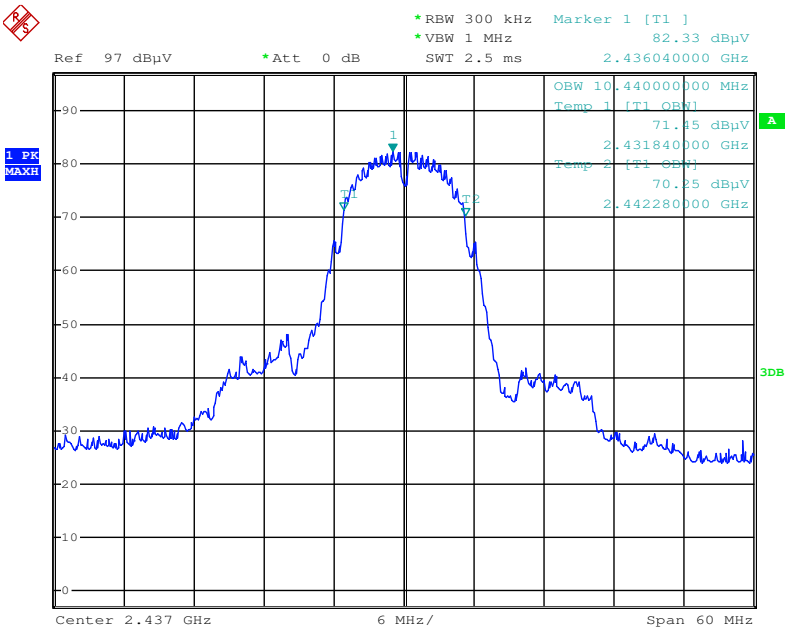
For plots, only the channel with worse result was shown.

6 dB Bandwidth Plot on Configuration IEEE 802.11b / 2412 MHz / Ant. 2



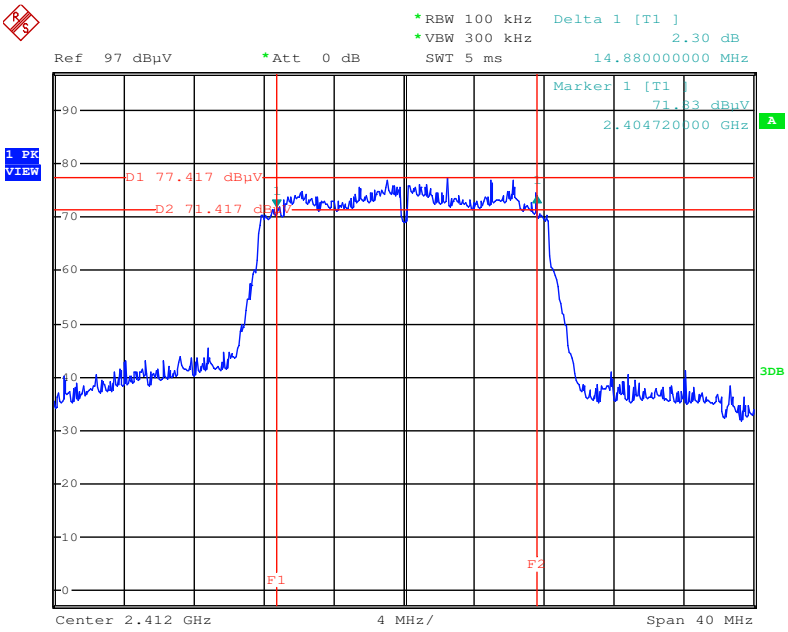
Date: 27.AUG.2015 16:22:15

99% Occupied Bandwidth Plot on Configuration IEEE 802.11b / 2437 MHz / Ant. 2



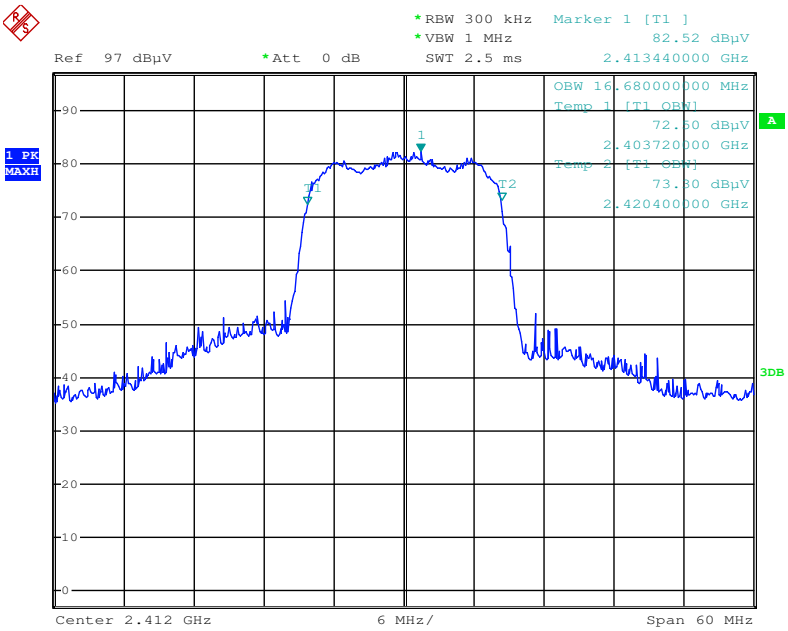
Date: 27.AUG.2015 16:30:56

6 dB Bandwidth Plot on Configuration IEEE 802.11g / 2412 MHz / Ant. 2



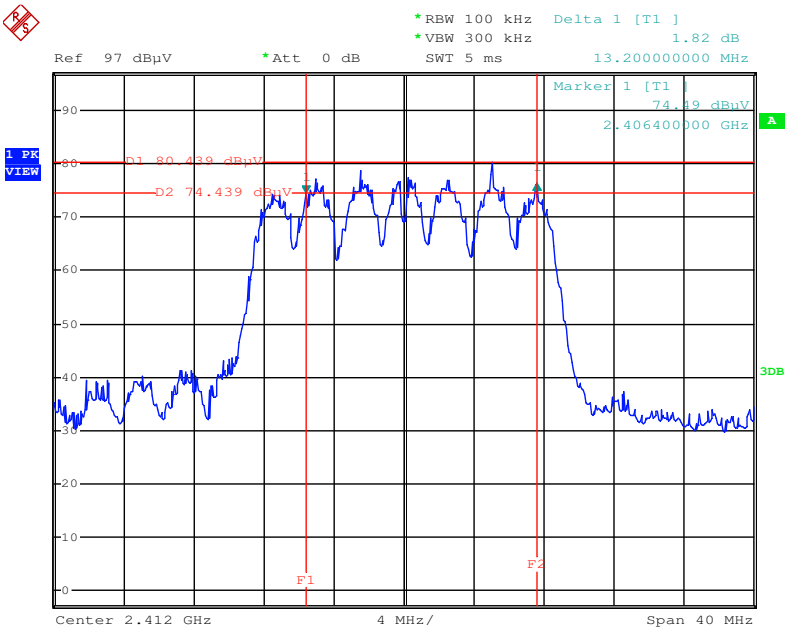
Date: 27.AUG.2015 16:24:39

99% Occupied Bandwidth Plot on Configuration IEEE 802.11g / 2412 MHz / Ant. 2



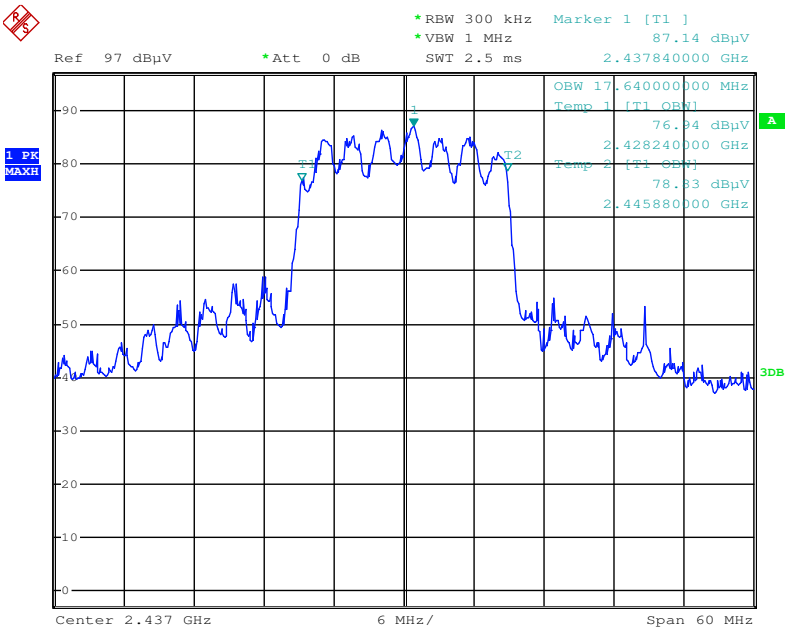
Date: 27.AUG.2015 16:32:18

6 dB Bandwidth Plot on Configuration IEEE 802.11n MCS0 HT20 / 2412 MHz / Ant. 1 + Ant. 2



Date: 27.AUG.2015 16:26:36

99% Occupied Bandwidth Plot on Configuration IEEE 802.11n MCS0 HT20 / 2437 MHz / Ant. 1 + Ant. 2



Date: 27.AUG.2015 16:33:10

4.5. Radiated Emissions Measurement

4.5.1. Limit

30dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/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

4.5.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average
RBW / VBW (Emission in non-restricted band)	100kHz / 300kHz for peak

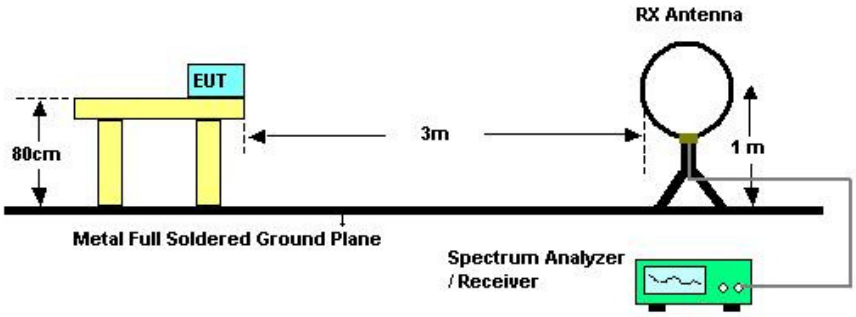
Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RBW 200Hz for QP
Start ~ Stop Frequency	150kHz~30MHz / RBW 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RBW 120kHz for QP

4.5.3. Test Procedures

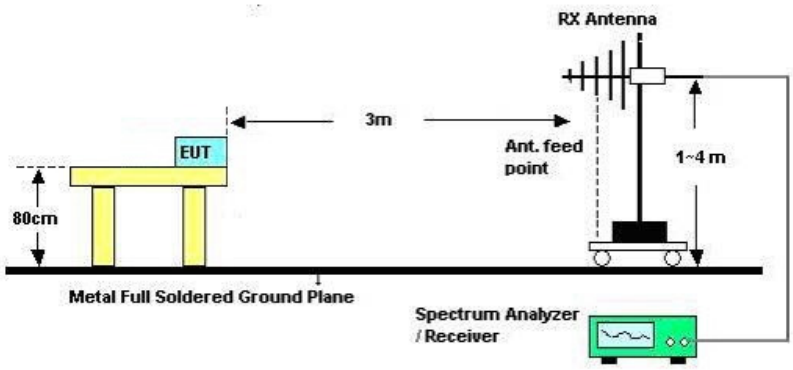
1. Configure the EUT according to ANSI C63.10. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1m & 3m far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 m to 4 m) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Set the test-receiver system to Peak or CISPR quasi-peak Detect Function with specified bandwidth under Maximum Hold Mode.
6. For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for peak reading. Then 1MHz RBW and 1/T VBW for average reading in spectrum analyzer.
7. If the emissions level of the EUT in peak mode was 3 dB lower than the average limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
8. For testing above 1GHz, the emissions level of the EUT in peak mode was lower than average limit (that means the emissions level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
9. In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be QP measured by receiver. High – Low scan is not required in this case.

4.5.4. Test Setup Layout

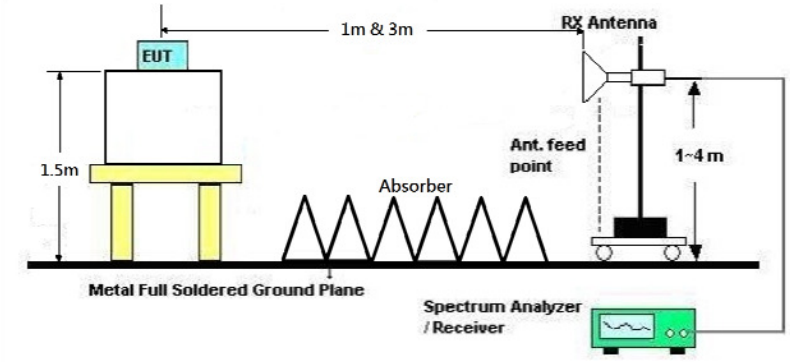
For Radiated Emissions: 9kHz ~30MHz



For Radiated Emissions: 30MHz~1GHz



For Radiated Emissions: Above 1GHz



4.5.5. Test Deviation

There is no deviation with the original standard.

4.5.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.5.7. Results of Radiated Emissions (9kHz~30MHz)

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	Normal Link
Test Date	Nov. 03, 2015	Test Mode	Mode 9

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Limit Line (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

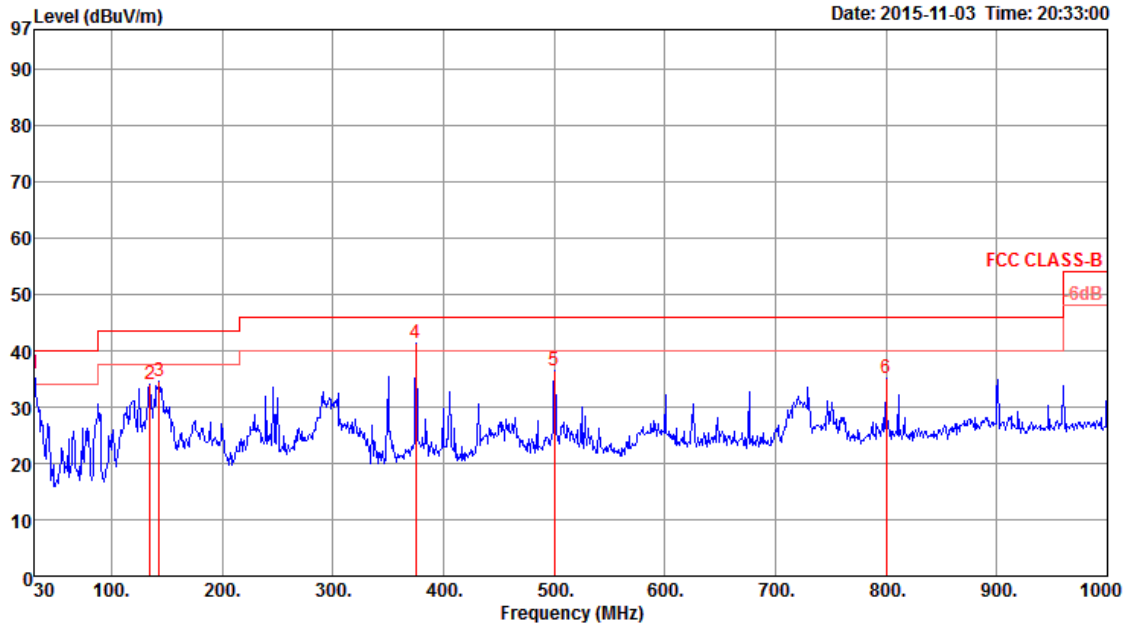
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

4.5.8. Results of Radiated Emissions (30MHz~1GHz)

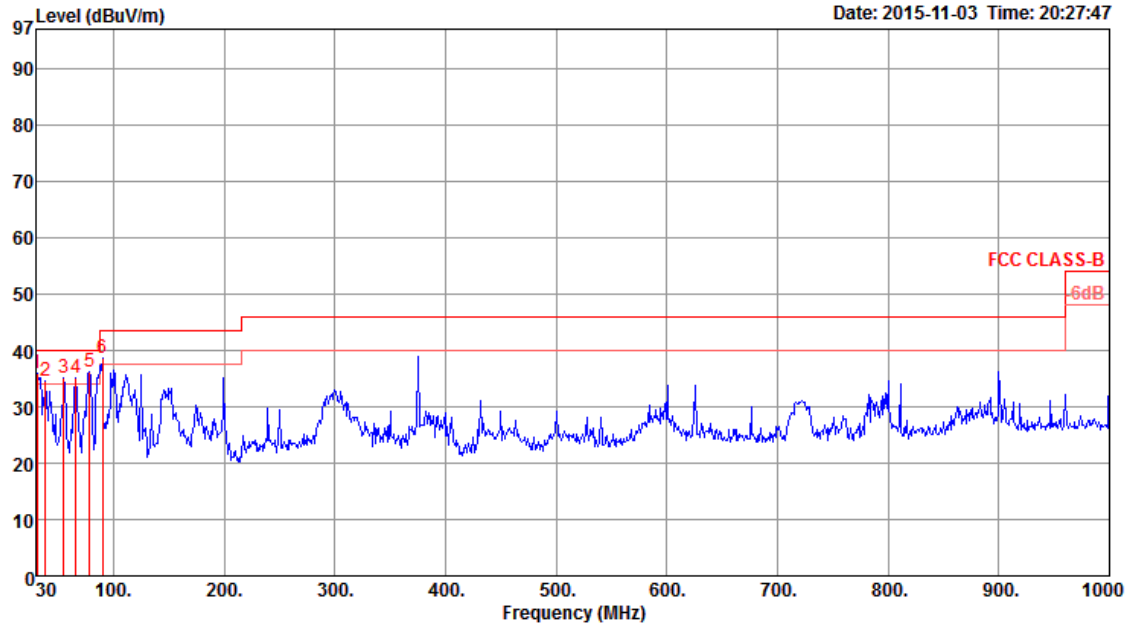
Temperature	26℃	Humidity	68%
Test Engineer	Alvin Li	Configurations	Normal Link
Test Mode	Mode 9		

Horizontal



	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	30.00	35.88	40.00	-4.12	42.22	0.61	20.10	27.05	Peak	400	0	HORIZONTAL
2	134.76	34.00	43.50	-9.50	48.44	1.40	12.25	28.09	Peak	400	0	HORIZONTAL
3	143.49	34.57	43.50	-8.93	49.49	1.42	11.71	28.05	Peak	400	0	HORIZONTAL
4	375.32	41.27	46.00	-4.73	51.25	2.20	15.86	28.04	Peak	400	0	HORIZONTAL
5	500.45	36.35	46.00	-9.65	44.56	2.67	17.80	28.68	Peak	400	0	HORIZONTAL
6	800.18	35.23	46.00	-10.77	39.54	3.22	20.80	28.33	Peak	400	0	HORIZONTAL

Vertical



	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	Remark	A/Pos	T/Pos	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB		cm	deg	
1	30.97	36.01	40.00	-3.99	42.91	0.63	19.52	27.05	Peak	400	0	VERTICAL
2	38.73	34.52	40.00	-5.48	46.59	0.67	14.88	27.62	Peak	400	0	VERTICAL
3	55.22	35.14	40.00	-4.86	54.70	0.84	8.05	28.45	Peak	400	0	VERTICAL
4	65.89	35.02	40.00	-4.98	55.64	0.95	6.84	28.41	Peak	400	0	VERTICAL
5	78.50	36.20	40.00	-3.80	56.16	0.96	7.45	28.37	Peak	400	0	VERTICAL
6	90.14	38.68	43.50	-4.82	56.67	1.04	9.30	28.33	Peak	400	0	VERTICAL

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

4.5.9. Results for Radiated Emissions (1GHz~10th Harmonic)

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11b CH 1 / Ant. 2
Test Date	Aug. 17, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4824.04	53.58	74.00	-20.42	51.31	4.10	32.69	34.52	243	152	Peak	HORIZONTAL
2	4824.04	50.59	54.00	-3.41	48.32	4.10	32.69	34.52	243	152	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4824.00	56.25	74.00	-17.75	53.98	4.10	32.69	34.52	9	147	Peak	VERTICAL
2	4824.04	53.95	54.00	-0.05	51.68	4.10	32.69	34.52	9	147	Average	VERTICAL

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11b CH 6 / Ant. 2
Test Date	Aug. 17, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4874.04	54.18	74.00	-19.82	51.78	4.13	32.78	34.51	186	149	Peak	HORIZONTAL
2	4874.04	51.53	54.00	-2.47	49.13	4.13	32.78	34.51	186	149	Average	HORIZONTAL
3	7310.12	57.99	74.00	-16.01	50.43	5.09	37.23	34.76	212	248	Peak	HORIZONTAL
4	7310.24	52.52	54.00	-1.48	44.96	5.09	37.23	34.76	212	248	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4873.96	55.82	74.00	-18.18	53.42	4.13	32.78	34.51	14	164	Peak	VERTICAL
2	4874.00	53.19	54.00	-0.81	50.79	4.13	32.78	34.51	14	164	Average	VERTICAL
3	7310.36	51.44	54.00	-2.56	43.88	5.09	37.23	34.76	84	152	Average	VERTICAL
4	7312.00	58.16	74.00	-15.84	50.60	5.09	37.23	34.76	84	152	Peak	VERTICAL

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11b CH 11 / Ant. 2
Test Date	Aug. 17, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4924.04	53.56	74.00	-20.44	51.02	4.15	32.88	34.49	191	108	Peak	HORIZONTAL
2	4924.04	50.76	54.00	-3.24	48.22	4.15	32.88	34.49	191	108	Average	HORIZONTAL
3	7385.28	53.52	54.00	-0.48	45.81	5.12	37.36	34.77	213	102	Average	HORIZONTAL
4	7387.04	59.36	74.00	-14.64	51.65	5.12	37.36	34.77	213	102	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4924.00	55.52	74.00	-18.48	52.98	4.15	32.88	34.49	355	164	Peak	VERTICAL
2	4924.04	52.47	54.00	-1.53	49.93	4.15	32.88	34.49	355	164	Average	VERTICAL
3	7384.96	59.40	74.00	-14.60	51.69	5.12	37.36	34.77	87	104	Peak	VERTICAL
4	7385.32	52.93	54.00	-1.07	45.22	5.12	37.36	34.77	87	104	Average	VERTICAL

Temperature	26℃	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11g CH 1 / Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4823.50	38.21	54.00	-15.79	35.94	4.10	32.69	34.52	66	161	Average	HORIZONTAL
2	4825.70	48.96	74.00	-25.04	46.69	4.10	32.69	34.52	66	161	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4823.80	40.48	54.00	-13.52	38.21	4.10	32.69	34.52	360	165	Average	VERTICAL
2	4826.00	52.83	74.00	-21.17	50.56	4.10	32.69	34.52	360	165	Peak	VERTICAL

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11g CH 6 / Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	4874.30	38.97	54.00	-15.03	36.57	4.13	32.78	34.51	331	190	Average	HORIZONTAL
2	4884.60	49.09	74.00	-24.91	46.66	4.13	32.81	34.51	331	190	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	4869.40	52.16	74.00	-21.84	49.76	4.13	32.78	34.51	357	173	Peak	VERTICAL
2	4874.50	39.53	54.00	-14.47	37.13	4.13	32.78	34.51	357	173	Average	VERTICAL

Temperature	26℃	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11g CH 11 / Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	4921.80	48.30	74.00	-25.70	45.76	4.15	32.88	34.49	62	180	Peak	HORIZONTAL
2	4922.80	35.07	54.00	-18.93	32.53	4.15	32.88	34.49	62	180	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	4918.10	51.41	74.00	-22.59	48.92	4.14	32.84	34.49	5	150	Peak	VERTICAL
2	4923.80	39.19	54.00	-14.81	36.65	4.15	32.88	34.49	5	150	Average	VERTICAL

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11n MCS0 HT20 CH 1 / Ant. 1 + Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4824.10	46.76	74.00	-27.24	44.49	4.10	32.69	34.52	155	155	Peak	HORIZONTAL
2	4824.20	36.45	54.00	-17.55	34.18	4.10	32.69	34.52	155	155	Average	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4826.60	36.50	54.00	-17.50	34.23	4.10	32.69	34.52	181	153	Average	VERTICAL
2	4828.90	48.70	74.00	-25.30	46.43	4.10	32.69	34.52	181	153	Peak	VERTICAL

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11n MCS0 HT20 CH 6 / Ant. 1 + Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4867.70	36.65	54.00	-17.35	34.25	4.13	32.78	34.51	157	176	Average	HORIZONTAL
2	4891.80	50.86	74.00	-23.14	48.42	4.13	32.81	34.50	157	176	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4856.90	48.81	74.00	-25.19	46.45	4.12	32.75	34.51	140	189	Peak	VERTICAL
2	4892.10	36.94	54.00	-17.06	34.50	4.13	32.81	34.50	140	189	Average	VERTICAL

Temperature	26℃	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11n MCS0 HT20 CH 11 / Ant. 1 + Ant. 2
Test Date	Aug. 18, 2015		

Horizontal

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4919.20	36.06	54.00	-17.94	33.52	4.15	32.88	34.49	142	187	Average	HORIZONTAL
2	4926.30	48.44	74.00	-25.56	45.90	4.15	32.88	34.49	142	187	Peak	HORIZONTAL

Vertical

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	cm		
1	4908.60	37.01	54.00	-16.99	34.53	4.14	32.84	34.50	114	165	Average	VERTICAL
2	4930.60	49.62	74.00	-24.38	47.08	4.15	32.88	34.49	114	165	Peak	VERTICAL

Note:

The amplitude of spurious emissions that are attenuated by more than 20dB below the permissible value has no need to be reported.

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

4.6. Emissions Measurement

4.6.1. Limit

30dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (micorvolts/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

4.6.2. Measuring Instruments and Setting

Please refer to section 5 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	100 MHz
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average
RBW / VBW (30dBc in any 100 kHz bandwidth emission)	100 kHz / 300 kHz for Peak

4.6.3. Test Procedures

For Radiated band edges Measurement:

1. The test procedure is the same as section 4.5.3.

For Radiated Out of Band Emission Measurement:

1. Test was performed in accordance with KDB558074 D01 v03r03 for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 10.1 Unwanted Emissions into Non-Restricted Frequency Bands Measurement Procedure.

4.6.4. Test Setup Layout

For Radiated band edges Measurement:

This test setup layout is the same as that shown in section 4.5.4.

For Radiated Out of Band Emission Measurement:

This test setup layout is the same as that shown in section 4.5.4.

4.6.5. Test Deviation

There is no deviation with the original standard.

4.6.6. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

4.6.7. Test Result of Band Edge and Fundamental Emissions

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11b CH 1, 6, 11 / Ant. 2
Test Date	Aug. 17, 2015		

Channel 1

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2388.40	55.59	74.00	-18.41	24.59	2.86	28.14	0.00	345	100	Peak	HORIZONTAL
2	2390.00	46.23	54.00	-7.77	15.23	2.86	28.14	0.00	345	100	Average	HORIZONTAL
3	2412.80	93.49			62.50	2.87	28.12	0.00	345	100	Average	HORIZONTAL
4	2413.00	97.36			66.37	2.87	28.12	0.00	345	100	Peak	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2412 MHz.

Channel 6

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2379.00	55.10	74.00	-18.90	24.08	2.85	28.17	0.00	333	142	Peak	HORIZONTAL
2	2382.60	43.90	54.00	-10.10	12.88	2.85	28.17	0.00	333	142	Average	HORIZONTAL
3	2436.20	93.62			62.64	2.88	28.10	0.00	333	142	Average	HORIZONTAL
4	2438.20	97.20			66.24	2.89	28.07	0.00	333	142	Peak	HORIZONTAL
5	2483.50	44.08	54.00	-9.92	13.15	2.91	28.02	0.00	333	142	Average	HORIZONTAL
6	2483.90	55.03	74.00	-18.97	24.10	2.91	28.02	0.00	333	142	Peak	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2437 MHz.

Channel 11

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2461.40	94.10			63.15	2.90	28.05	0.00	330	119	Average	HORIZONTAL
2	2463.00	97.75			66.80	2.90	28.05	0.00	330	119	Peak	HORIZONTAL
3	2483.50	45.16	54.00	-8.84	14.23	2.91	28.02	0.00	330	119	Average	HORIZONTAL
4	2484.10	54.85	74.00	-19.15	23.92	2.91	28.02	0.00	330	119	Peak	HORIZONTAL

Item 1, 2 are the fundamental frequency at 2462 MHz.

Temperature	26℃	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11g CH 1, 6, 11 / Ant. 2
Test Date	Aug. 17, 2015		

Channel 1

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2389.80	64.73	74.00	-9.27	33.73	2.86	28.14	0.00	355	147	Peak	HORIZONTAL
2	2390.00	50.25	54.00	-3.75	19.25	2.86	28.14	0.00	355	147	Average	HORIZONTAL
3	2410.80	99.29			68.30	2.87	28.12	0.00	355	147	Peak	HORIZONTAL
4	2413.00	90.00			59.01	2.87	28.12	0.00	355	147	Average	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2412 MHz.

Channel 6

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2380.20	55.35	74.00	-18.65	24.33	2.85	28.17	0.00	354	140	Peak	HORIZONTAL
2	2387.40	44.00	54.00	-10.00	13.00	2.86	28.14	0.00	354	140	Average	HORIZONTAL
3	2436.20	89.30			58.32	2.88	28.10	0.00	354	140	Average	HORIZONTAL
4	2437.00	100.37			69.41	2.89	28.07	0.00	354	140	Peak	HORIZONTAL
5	2483.50	53.98	74.00	-20.02	23.05	2.91	28.02	0.00	354	140	Peak	HORIZONTAL
6	2487.80	44.26	54.00	-9.74	13.34	2.92	28.00	0.00	354	140	Average	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2437 MHz.

Channel 11

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2462.00	101.21			70.26	2.90	28.05	0.00	329	119	Peak	HORIZONTAL
2	2463.00	89.86			58.91	2.90	28.05	0.00	329	119	Average	HORIZONTAL
3	2483.50	46.63	54.00	-7.37	15.70	2.91	28.02	0.00	329	119	Average	HORIZONTAL
4	2485.40	58.87	74.00	-15.13	27.94	2.91	28.02	0.00	329	119	Peak	HORIZONTAL

Item 1, 2 are the fundamental frequency at 2462 MHz.

Temperature	26°C	Humidity	68%
Test Engineer	Alvin Li	Configurations	IEEE 802.11n MCS0 HT20 CH 1, 6, 11 / Ant. 1 + Ant. 2
Test Date	Aug. 18, 2015		

Channel 1

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2389.40	67.53	74.00	-6.47	36.53	2.86	28.14	0.00	311	121	Peak	HORIZONTAL
2	2390.00	53.78	54.00	-0.22	22.78	2.86	28.14	0.00	311	121	Average	HORIZONTAL
3	2413.00	110.01			79.02	2.87	28.12	0.00	311	121	Peak	HORIZONTAL
4	2413.00	99.64			68.65	2.87	28.12	0.00	311	121	Average	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2412 MHz.

Channel 6

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2388.60	67.79	74.00	-6.21	36.79	2.86	28.14	0.00	189	125	Peak	HORIZONTAL
2	2390.00	48.70	54.00	-5.30	17.70	2.86	28.14	0.00	189	125	Average	HORIZONTAL
3	2436.20	112.26			81.28	2.88	28.10	0.00	189	125	Peak	HORIZONTAL
4	2436.20	103.24			72.26	2.88	28.10	0.00	189	125	Average	HORIZONTAL
5	2483.50	62.17	74.00	-11.83	31.24	2.91	28.02	0.00	189	125	Peak	HORIZONTAL
6	2483.50	48.16	54.00	-5.84	17.23	2.91	28.02	0.00	189	125	Average	HORIZONTAL

Item 3, 4 are the fundamental frequency at 2437 MHz.

Channel 11

	Freq	Level	Limit Line	Over Limit	Read Level	Cable Loss	Antenna Factor	Preamp Factor	T/Pos	A/Pos	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB/m	dB	deg	Cm		
1	2460.80	99.70			68.75	2.90	28.05	0.00	301	120	Average	HORIZONTAL
2	2463.20	109.99			79.04	2.90	28.05	0.00	301	120	Peak	HORIZONTAL
3	2483.50	70.02	74.00	-3.98	39.09	2.91	28.02	0.00	301	120	Peak	HORIZONTAL
4	2483.50	53.97	54.00	-0.03	23.04	2.91	28.02	0.00	301	120	Average	HORIZONTAL

Item 1, 2 are the fundamental frequency at 2462 MHz.

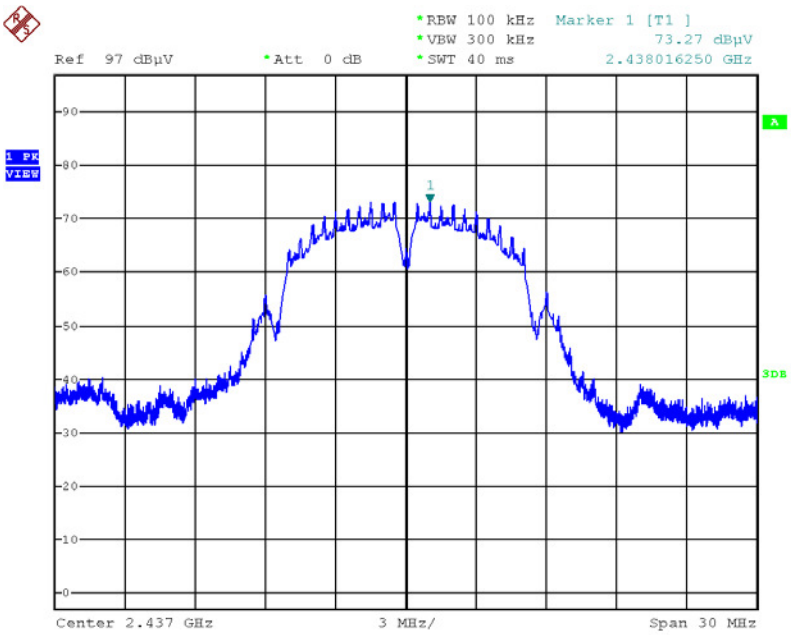
Note:

Emission level (dBuV/m) = 20 log Emission level (uV/m).

Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

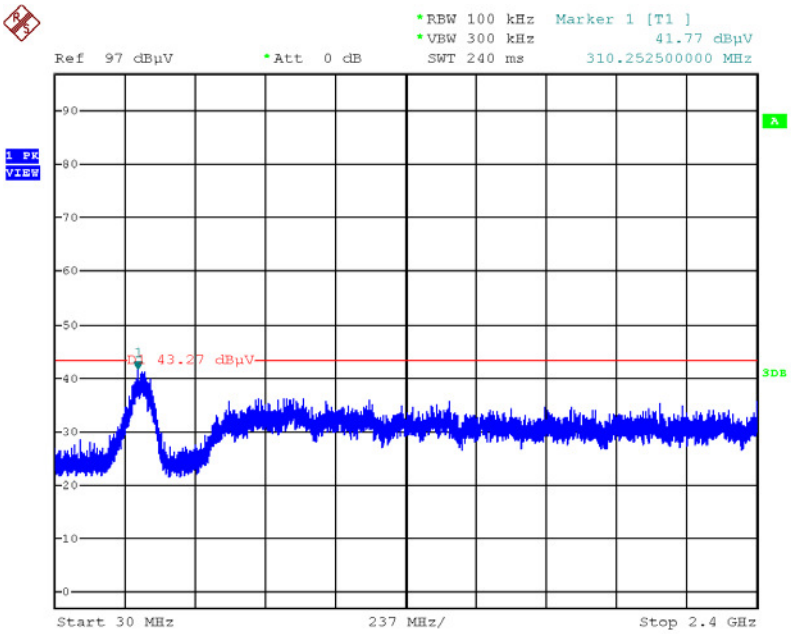
For Emission not in Restricted Band

Plot on Configuration IEEE 802.11b / Reference Level



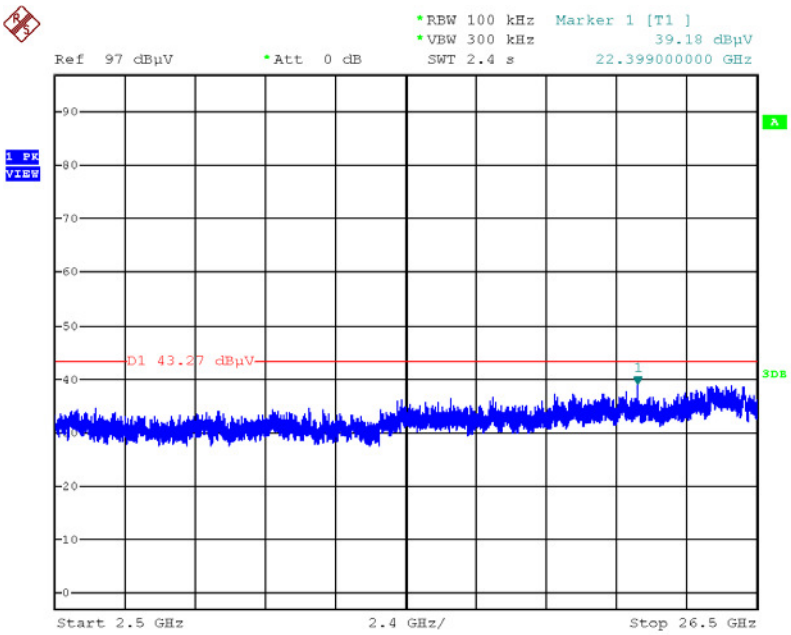
Date: 18.AUG.2015 02:16:16

Plot on Configuration IEEE 802.11b / CH 1 / 30MHz~2400MHz (down 30dBc)



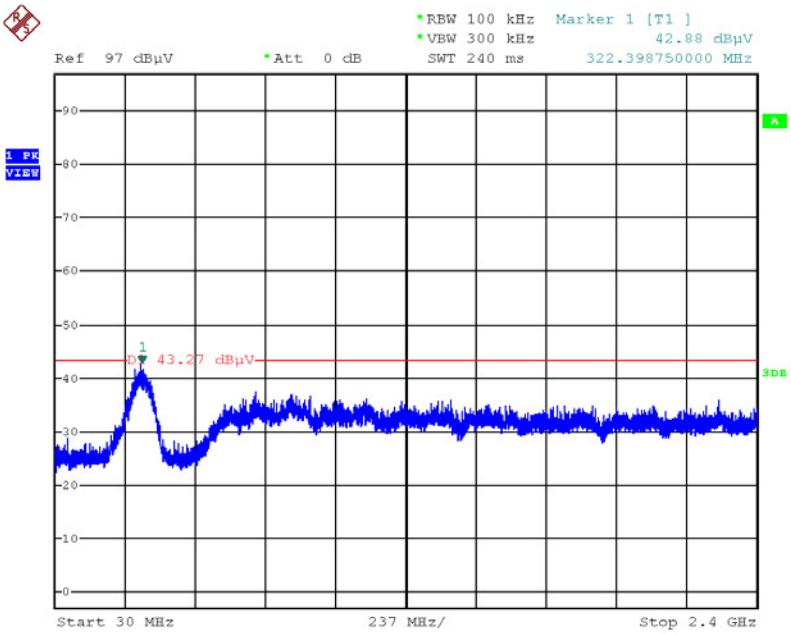
Date: 18.AUG.2015 02:28:20

Plot on Configuration IEEE 802.11b / CH 1 / 2500MHz~26500MHz (down 30dBc)



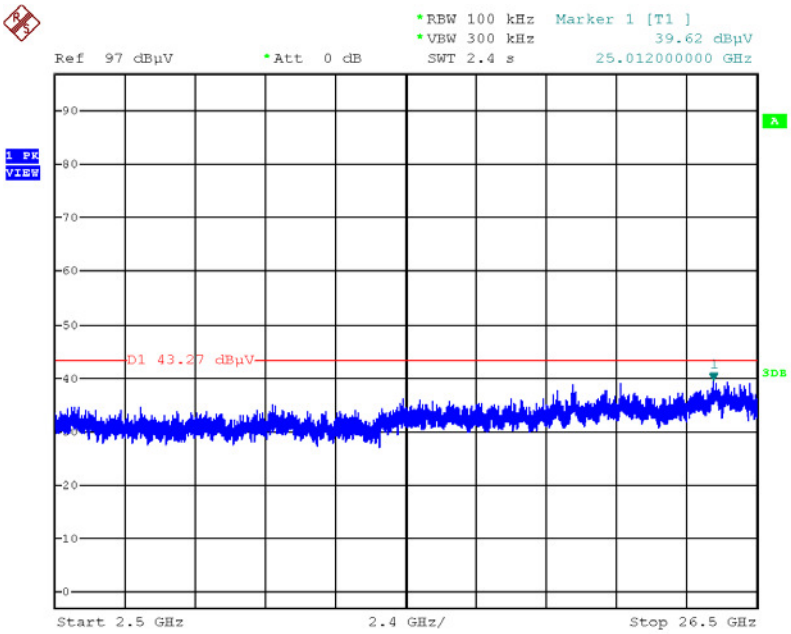
Date: 18.AUG.2015 02:18:40

Plot on Configuration IEEE 802.11b / CH 11 / 30MHz~2400MHz (down 30dBc)



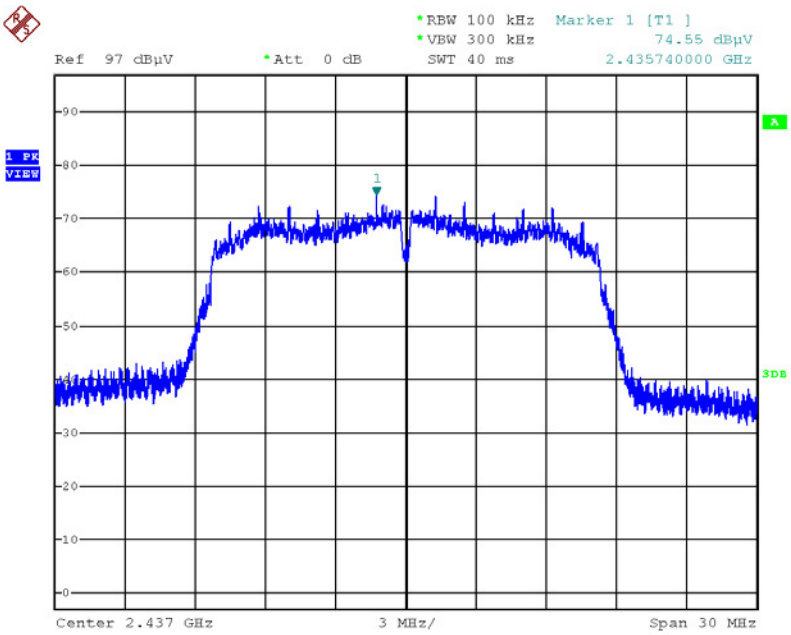
Date: 18.AUG.2015 02:19:35

Plot on Configuration IEEE 802.11b / CH 11 / 2500MHz~26500MHz (down 30dBc)



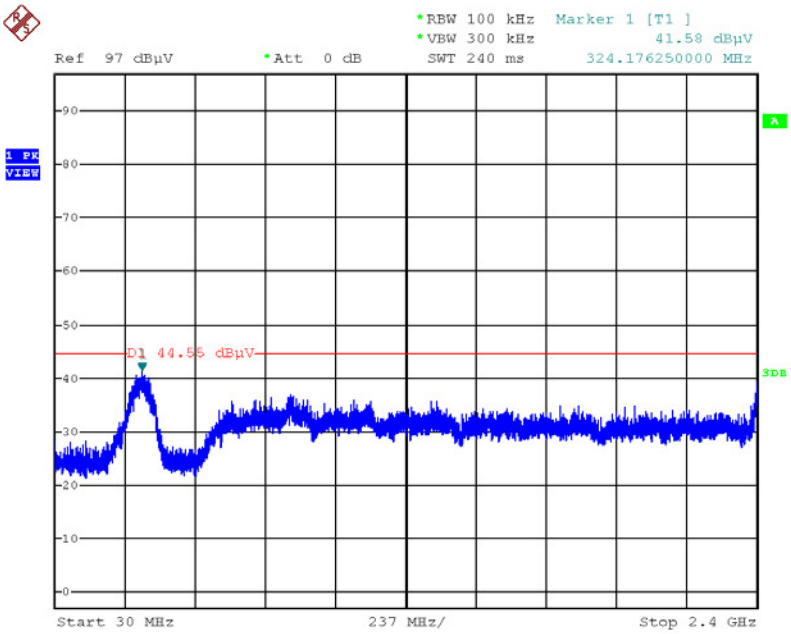
Date: 18.AUG.2015 02:20:02

Plot on Configuration IEEE 802.11g / Reference Level



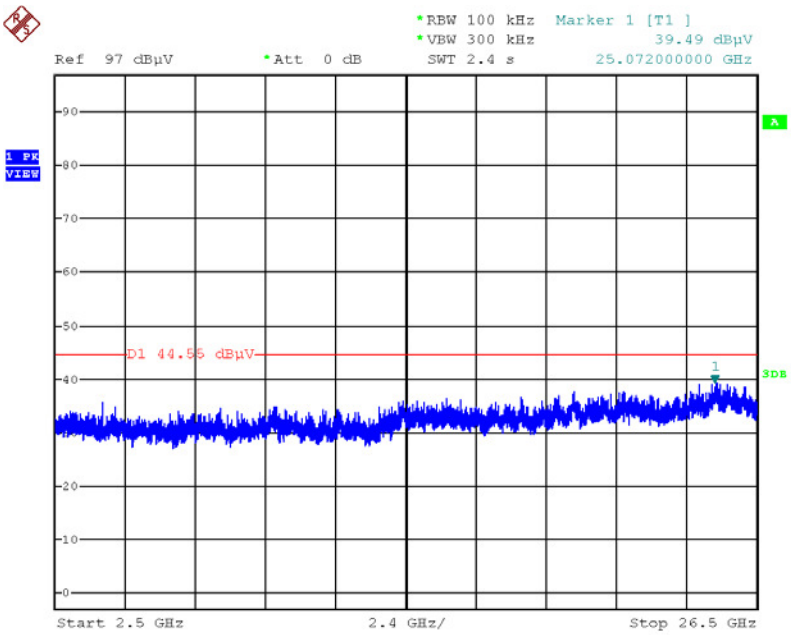
Date: 18.AUG.2015 02:21:33

Plot on Configuration IEEE 802.11g / CH 1 / 30MHz~2400MHz (down 30dBc)



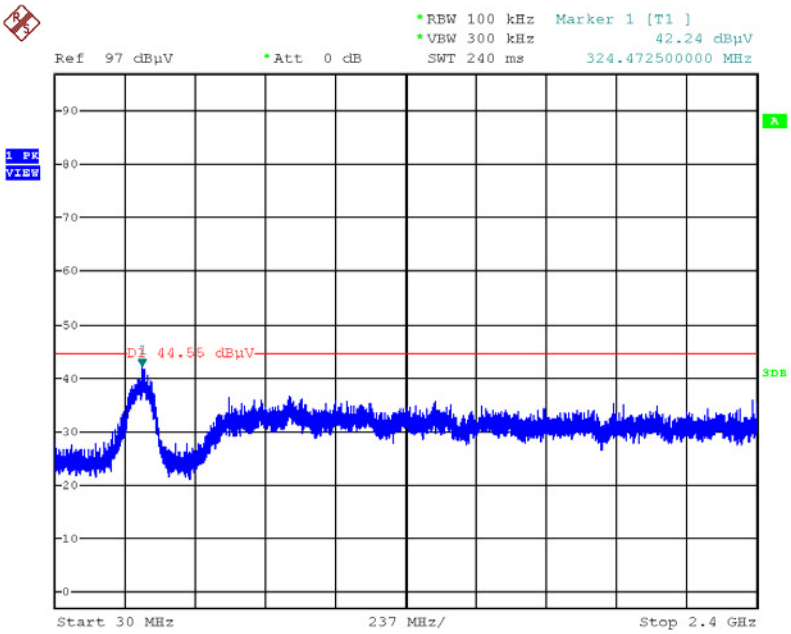
Date: 18.AUG.2015 02:22:02

Plot on Configuration IEEE 802.11g / CH 1 / 2500MHz~26500MHz (down 30dBc)



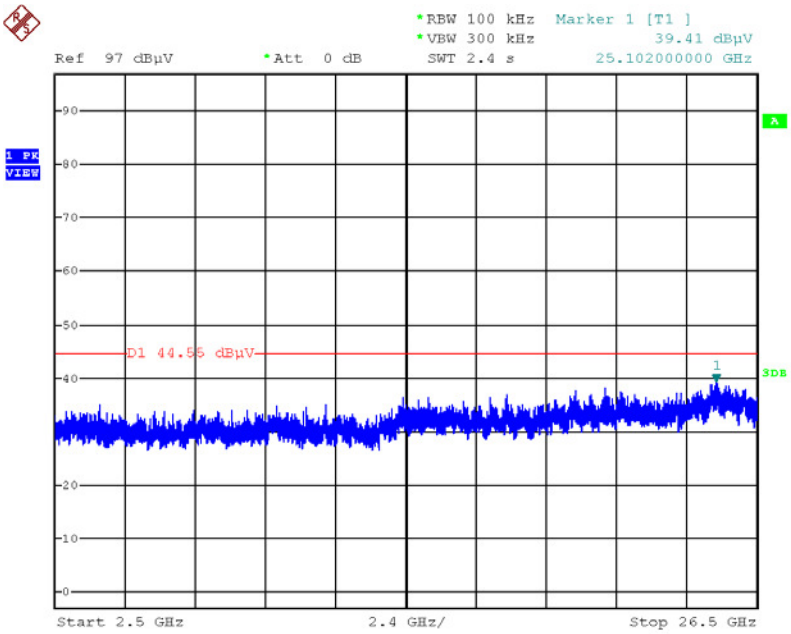
Date: 18.AUG.2015 02:22:27

Plot on Configuration IEEE 802.11g / CH 11 / 30MHz~2400MHz (down 30dBc)



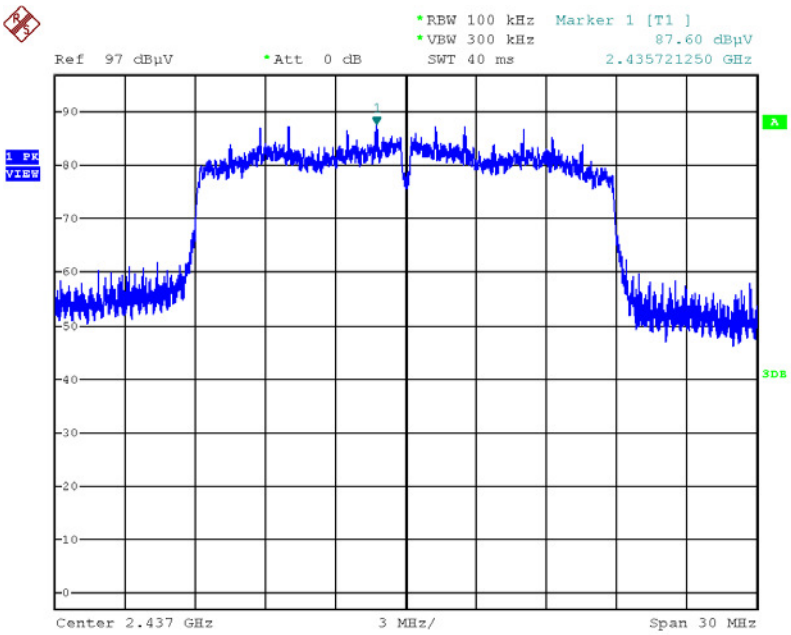
Date: 18.AUG.2015 02:23:00

Plot on Configuration IEEE 802.11g / CH 11 / 2500MHz~26500MHz (down 30dBc)



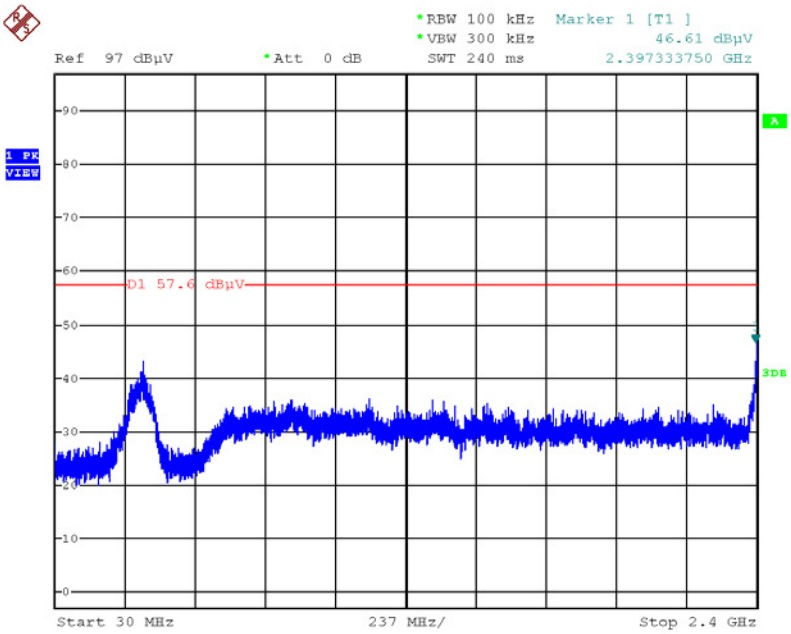
Date: 18.AUG.2015 02:23:27

Plot on Configuration IEEE 802.11n MCS0 HT20 / Reference Level



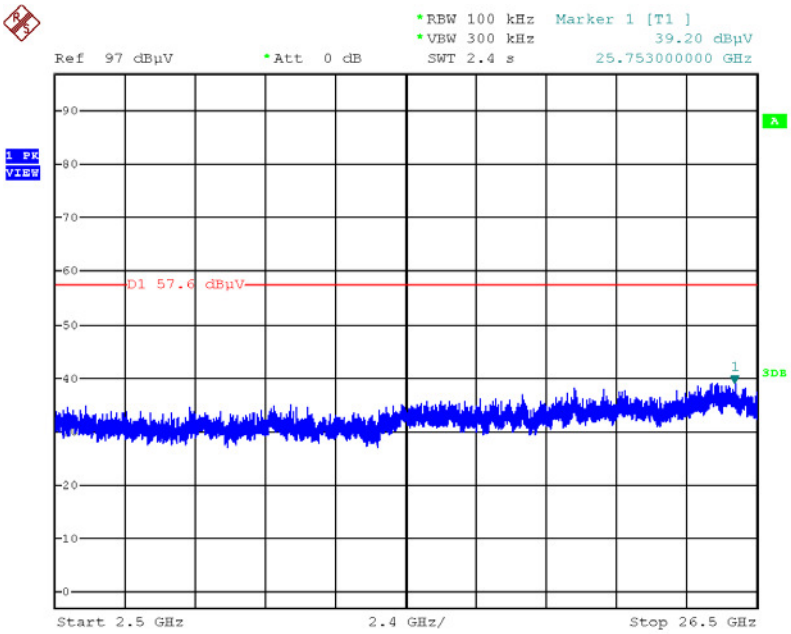
Date: 18.AUG.2015 02:24:20

Plot on Configuration IEEE 802.11n MCS0 HT20 / CH 1 / 30MHz~2400MHz (down 30dBc)



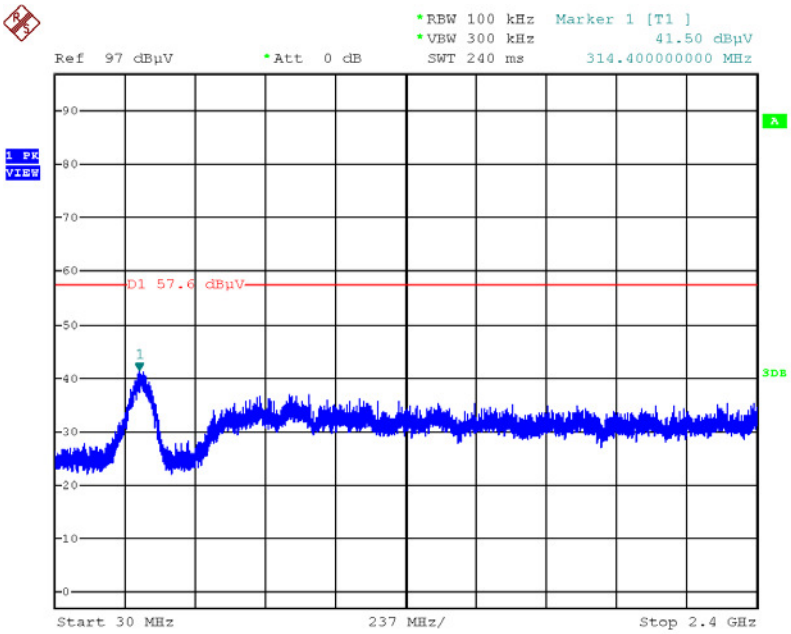
Date: 18.AUG.2015 02:24:56

Plot on Configuration IEEE 802.11n MCS0 HT20 / CH 1 / 2500MHz~26500MHz (down 30dBc)



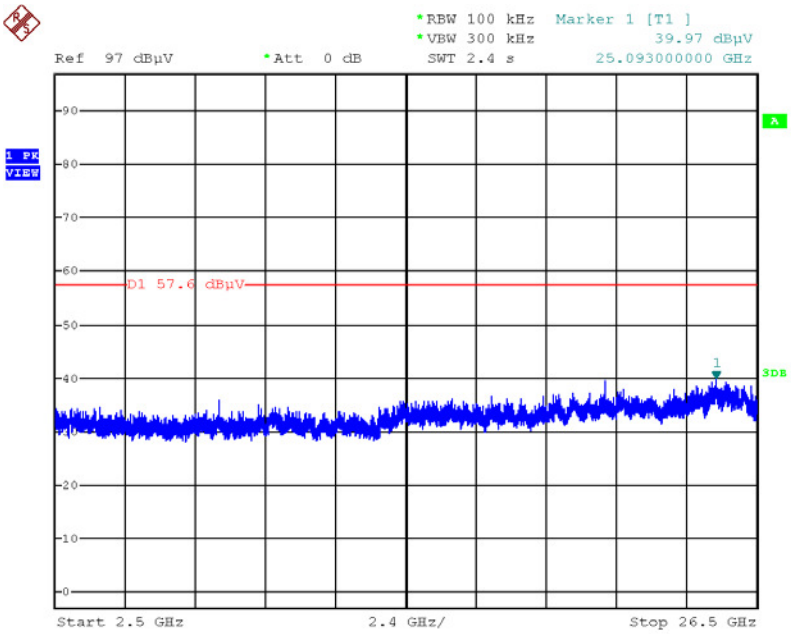
Date: 18.AUG.2015 02:25:20

Plot on Configuration IEEE 802.11n MCS0 HT20 / CH 11 / 30MHz~2400MHz (down 30dBc)



Date: 18.AUG.2015 02:25:54

Plot on Configuration IEEE 802.11n MCS0 HT20 / CH 11 / 2500MHz~26500MHz (down 30dBc)



Date: 18.AUG.2015 02:26:31

4.7. Antenna Requirements

4.7.1. Limit

Except for special regulations, the Low-power Radio-frequency Devices must not be equipped with any jacket for installing an antenna with extension cable. 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 the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed.

4.7.2. Antenna Connector Construction

Please refer to section 3.3 in this test report; antenna connector complied with the requirements.

5. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Remark
LISN	Schwarzbeck	NSLK 8127	8127650	9kHz ~ 30MHz	Nov. 17, 2014	Conduction (CO02-CB)
LISN	Schwarzbeck	NSLK 8127	8127478	9kHz ~ 30MHz	Nov. 17, 2014	Conduction (CO02-CB)
EMI Receiver	Agilent	N9038A	MY52260140	9kHz ~ 8.4GHz	Jan. 13, 2015	Conduction (CO02-CB)
COND Cable	Woken	Cable	01	0.15MHz ~ 30MHz	Dec. 01, 2014	Conduction (CO02-CB)
Software	Audix	E3	5.410e	-	N.C.R.	Conduction (CO02-CB)
Pulse Limiter	Schwarzbeck	VTSD 9561F	9561-F073	9kHz ~ 30MHz	Sep. 26, 2014	Conduction (CO02-CB)
Pulse Limiter	Schwarzbeck	VTSD 9561F	9561-F073	9kHz ~ 30MHz	Sep. 30, 2015	Conduction (CO02-CB)
BILOG ANTENNA	Schaffner	CBL6112D	22021	20MHz ~ 2GHz	May 06, 2015	Radiation (03CH01-CB)
Loop Antenna	Teseq	HLA 6120	24155	9kHz - 30 MHz	Mar. 12, 2015*	Radiation (03CH01-CB)
Horn Antenna	EMCO	3115	00075790	750MHz ~ 18GHz	Oct. 28, 2014	Radiation (03CH01-CB)
Horn Antenna	EMCO	3115	00075790	750MHz ~ 18GHz	Oct. 22, 2015	Radiation (03CH01-CB)
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170252	15GHz ~ 40GHz	Jul. 21, 2015	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8447D	2944A10991	0.1MHz ~ 1.3GHz	Feb. 24, 2015	Radiation (03CH01-CB)
Pre-Amplifier	Agilent	8449B	3008A02310	1GHz ~ 26.5GHz	Jan. 12, 2015	Radiation (03CH01-CB)
Pre-Amplifier	WM	TF-130N-R1	923365	26GHz ~ 40GHz	Nov. 25, 2014	Radiation (03CH01-CB)
Spectrum Analyzer	R&S	FSP40	100056	9kHz ~ 40GHz	Nov. 06, 2014	Radiation (03CH01-CB)
EMI Receiver	Agilent	N9038A	MY52260123	9kHz ~ 8.4GHz	Jan. 21, 2015	Radiation (03CH01-CB)
RF Cable-low	Woken	Low Cable-1	N/A	30 MHz ~ 1 GHz	Nov. 15, 2014	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-1	N/A	1 GHz ~ 40 GHz	Nov. 15, 2014	Radiation (03CH01-CB)
RF Cable-high	Woken	High Cable-40G-2	N/A	1 GHz ~ 40 GHz	Nov. 15, 2014	Radiation (03CH01-CB)
Spectrum analyzer	R&S	FSP40	100979	9kHz~40GHz	Dec. 12, 2014	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-7	1 GHz – 26.5 GHz	Nov. 15, 2014	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-8	1 GHz – 26.5 GHz	Nov. 15, 2014	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-9	1 GHz – 26.5 GHz	Nov. 15, 2014	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-10	1 GHz – 26.5 GHz	Nov. 15, 2014	Conducted (TH01-CB)
RF Cable-high	Woken	RG402	High Cable-6	1 GHz – 26.5 GHz	Nov. 15, 2014	Conducted (TH01-CB)
Power Sensor	Agilent	U2021XA	MY53410001	50MHz~18GHz	Nov. 03, 2014	Conducted (TH01-CB)

Note: Calibration Interval of instruments listed above is one year.
"*" Calibration Interval of instruments listed above is two years.
N.C.R means Non-Calibration required.

6. MEASUREMENT UNCERTAINTY

Test Items	Uncertainty	Remark
Conducted Emission (150kHz ~ 30MHz)	3.2 dB	Confidence levels of 95%
Radiated Emission (30MHz ~ 1,000MHz)	3.6 dB	Confidence levels of 95%
Radiated Emission (1GHz ~ 18GHz)	3.7 dB	Confidence levels of 95%
Radiated Emission (18GHz ~ 40GHz)	3.5 dB	Confidence levels of 95%
Conducted Emission	1.7 dB	Confidence levels of 95%