

CFR 47 FCC Part 15.247

TEST REPORT

Product : **RISC-based Ready-to-Run Wireless
Embedded Computer**

Trade Name : MOXA

Model Number : W311; W311-LX; W321; W321-LX

FCC ID : SLEW321-W311

Prepared for

MOXA Inc.

Fl.4, No.135, Lane 235, Pao-Chiao Rd., Shing Tien City, Taipei, R.O.C.

TEL. : +886 2 8919 1230

FAX. : +886 2 8919 1231

Prepared by

Interocean EMC Technology Corp.

244 No.5-2, Lin 1, Tin-Fu Tsun, Lin-Kou Hsiang,
Taipei County, Taiwan, R.O.C.

TEL.: +886 2 2600 6861

FAX.: +886 2 2600 6859

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The test results in the report only to the tested sample.

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Statement of Compliance

Applicant: MOXA Inc.
Manufacturer: MOXA Inc.
Product: RISC-based Ready-to-Run Wireless Embedded Computer
Model No.: W311; W311-LX; W321; W321-LX
Tested Power Supply: 120Vac, 60Hz
Date of Final Test: Mar. 11, 2009
Configuration of Measurements and Standards Used :
FCC Rules and Regulations Part 15 Subpart C

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.4, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

- Note:** 1. The result of the testing report relate only to the item tested.
2. The testing report shall not be reproduced expect in full, without the written approval of IETC

Report Issued: 2009/03/19

Project Engineer: *Anya Lee*
Anya Lee

Approved: *Jerry Liu*
Jerry Liu

1 General Information

1.1 Description of Equipment Under Test

- Product** : RISC-based Ready-to-Run Wireless Embedded Computer
- Model Number** : W311; W311-LX; W321; W321-LX
- Applicant** : **MOXA Inc.**
Fl.4, No.135, Lane 235, Pao-Chiao Rd., Shing Tien City, Taipei, R.O.C.
- Manufacturer** : **MOXA Inc.**
Fl.4, No.135, Lane 235, Pao-Chiao Rd., Shing Tien City, Taipei, R.O.C.
- Operating Frequency** : 2412MHz ~ 2462MHz; 5745MHz ~ 5825MHz
- Channel Number** : Refer to section 1.2
- Type of Modulation** : DSSS; OFDM
- Antenna description** : This device uses Dipole antenna.

Antenna Gain	:	2 dBi
Connector type	:	SMA-Male-RP

Sample Receive date : Jan. 19, 2009

Date of Test : Feb. 03 ~ Mar. 11, 2009

- Additional Description** : 1. The EUT is “**RISC-based Ready-to-Run Wireless Embedded Computer**”.
2. All model included in this report, the difference please see detail as follows:

Model Number	W311	W311-LX	W321	W321-LX
Embedded Linux Kernel 2.6		✓		✓
Without OS	✓		✓	
Serial Port	1	1	2	2

3. The model **W311** is representative selected in the test and included in this report.
4. For more detail specification about EUT, please refer to the user's manual.

Product Specifications

Standard Compliance	802.11a/b/g
Radio Frequency Type	DSSS, CCK, OFDM
Media Access Protocol	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)
Modulation	802.11a/g: OFDM (64-QAM, 16-QAM, QPSK, BPSK) 802.11b: DSS (DBPSK, DQPSK, CCK)
Transmission Power (Typical)	5.15 to 5.35 GHz: 15 dBm @6 Mbps; 12 dBm @54 Mbps 5.725 to 5.825 GHz: 15 dBm @6 Mbps; 12 dBm @54 Mbps USA: 2.412 to 2.462 GHz (IEEE802.11g): 17 dBm @6 Mbps; EU: 2.412 to 2.472 GHz 15 dBm @54Mbps 2.412 to 2.462 GHz (IEEE802.11b): 18 dBm@ 1 to 11 Mbps
Receiver Sensitivity (Typical)	5.15 to 5.35 GHz: 6 Mbps @ -90 dBm; 54 Mbps @ -72 dBm 5.47 to 5.725 GHz: 6 Mbps @ -90 dBm; 54 Mbps @ -72 dBm 5.725 to 5.825 GHz: 6 Mbps @ -89 dBm; 54 Mbps @ -72 dBm USA: 2.412 to 2.462 GHz (IEEE802.11g): 6 Mbps @ -90 dBm; EU: 2.412 to 2.472 GHz 54 Mbps @ -73 dBm USA: 2.412 to 2.462 GHz (IEEE802.11b): 11 Mbps @ -87 dBm; EU: 2.412 to 2.472 GHz 1 Mbps @ -94 dBm
Transmission Rate	54 Mbps with auto fallback (54, 48, 36, 24, 18, 12, 11, 9, 6, 5.5, 2, 1 Mbps) 802.11b supported rates: 1, 2, 5.5, 11 Mbps 802.11a/g supported rates: 6, 9, 12, 18, 24, 36, 48, 54 Mbps
Transmission Distance	100 meters at 11 Mbps (with no obstructions)
Security	WEP 64-bit/128-bit, WPA, WPA2 data encryption
Antenna Connector	Reverse SMA
Antenna	External 2 dBi dipole antenna
WLAN Mode	Infrastructure, Ad-Hoc

1.2 Table for Carrier Frequencies

802.11b/ 802.11g

CH No.	1	2	3	4	5	6	7	8	9	10	11
CF (MHz)	2412	2417	2422	2427	2432	2437	2442	2447	2452	2457	2462

802.11a

CH No.	149	153	157	161	165
CF (MHz)	5745	5765	5785	5805	5825

1.3 Test Facility

- Site Description** : ☑RF Test Room ☑OATS 2
- Name of Firm** : Interocean EMC Technology Corp.
- Company web** : <http://www.ietc.com.tw>
- Site 1, 2 Location** : No.5-2, Lin 1, Tin-Fu Tsun, Lin-Kou Hsiang, Taipei County, Taiwan, R.O.C.
- Site 3, 4 Location** : No. 12, Ruei-Shu Valley, Ruei-Ping Tsun, Lin-Kou Hsiang, Taipei County, Taiwan, R.O.C.
- Site Filing** :
- Federal Communication Commissions – USA
Registration No.: 96399 (OATS 1 & 2)
Registration No.: 518958 (OATS 3 & 4)
Designation No.: TW1020
 - Voluntary Control Council for Interference by Information Technology Equipment (VCCI) – Japan
Registration No. (Conducted Room): C-1094
Registration No. (Conducted Room): T-271
Registration No. (OATS 1): R-1040
Registration No. (OATS 2): R-1041
 - Industry Canada (IC)
Submission: 113543
 - Japan Electrical Safety & Environment Technology Laboratories (JET)
Registration No.: 04S03-01
- Site Accreditation** :
- Bureau of Standards and Metrology and Inspection (BSMI) – Taiwan, R.O.C.
Accreditation No.:
SL2-IN-E-0026 for CNS13438 / CISPR22
SL2-R1-E-0026 for CNS13439 / CISPR13
SL2-R2-E-0026 for CNS13439 / CISPR13
SL2-A1-E-0026 for CNS13783-1 / CISPR14-1
 - TÜV NORD
Certificate No: TNTW0801R
 - Taiwan Accreditation Foundation (TAF)
Accreditation No.: 1113



1.4 Test Equipment

Instrument	Manufacturer	Model	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSP30	100002	2009/12/10
Spectrum Analyzer	Agilent	8564EC	4046A00331	2009/04/11
Preamplifier	Agilent	8449B	3008A01434	2009/03/31
Preamplifier	Agilent	83050A	3950A00225	2009/08/10
Preamplifier	SCHAFFNER	CA30100	2	2009/10/20
Horn Antenna	COM-POWER	AH-118	10081	2010/05/12
Horn Antenna	Schwarzbeck	BBHA 9170	213	2010/06/08
Wide Bandwidth Sensor	Anritsu	MA2491A	728133	2009/10/16
Power Meter	Anritsu	ML2495A	736010	2009/10/16
Temp & Humidity chamber	GIAN FORCE	GTH-150-40-2P-U	MAA0305-012	2009/05/14
Signal Generator	Agilent	E8254A	US41140164	2009/05/21
MULTI UE TESTER	JRC	NJZ-2000	ET00184	2009/12/22

Note: The above equipments are within the valid calibration period.

1.5 Summary of Measurement

Report Clause	Test Parameter	Reference Document CFR47 Part15	Results
2	RF Radiated spurious emission test	§15.205, 15.209	Pass
3	RF Conducted spurious emission	§15.247	Pass
4	Maximum Peak output power test	§15.247(b)	Pass
5	Power test of Data Rate	§15.247(b)	Pass
6	6dB Bandwidth	§15.247(a)(2)	Pass
7	Power spectral density	§15.247(e)	Pass
8	Emission on the Band Edge	§15.247(d)	Pass
9	AC Power Line Conducted Emission test	§15.247(b)	Pass

1.6 Justification

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of the frequency band were all arrive limit requirement, thus we evaluate the EUT pass the specified test.

2 RF Radiated spurious emission test

2.1 Limit

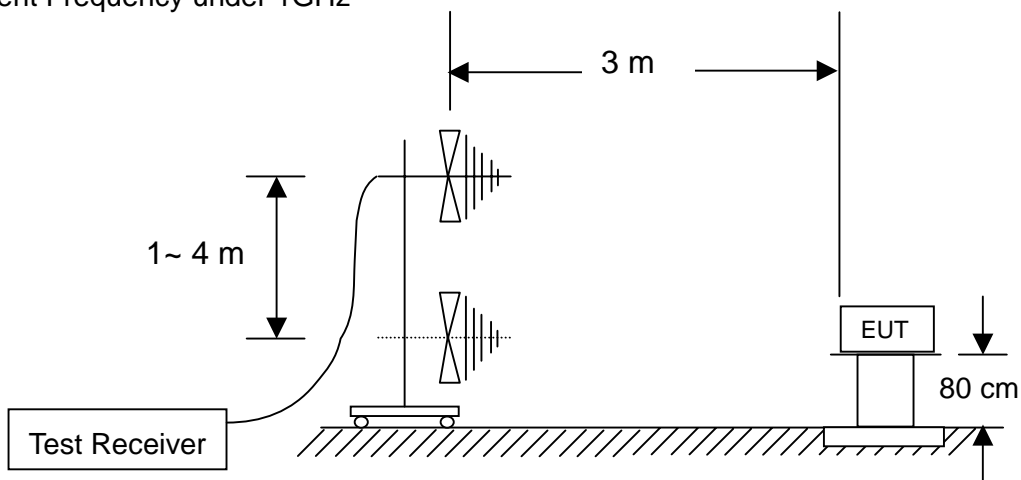
For intentional radiator, the radiated emission shall comply with §15.209(a).

For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (c)

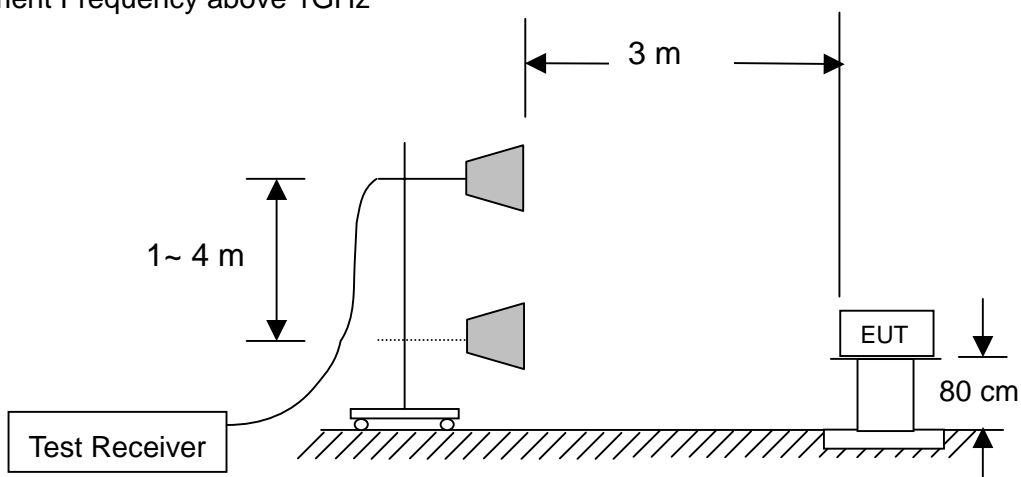
Frequency (MHz)	Field strength dB(μ V/m)	Measurement distance (meters)
1.705~30.0	29.5	30
30 ~ 88	40	3
88~216	43.5	3
216~960	46	3
Above 960	54	3

2.2 Configuration of Measurement

Measurement Frequency under 1GHz



Measurement Frequency above 1GHz



2.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

Radiated emission measurements were performed from 30MHz to 40GHz. Spectrum Analyzer Resolution Bandwidth is 100kHz or greater for frequencies 30MHz to 1GHz, 1MHz for frequencies above 1GHz.

The EUT for testing is arranged on a wooden turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meter and down to 1 meter.

2.4 Test Result

PASS.

The final test data is shown on as following pages.

Radiated spurious emission

Test Environment

Ambient temperature : 26.0°C

Relative humidity : 53%

Radiated Emission below 1GHz

After verifying 802.11b/g (CH1/CH6/CH11) modes, the worse case was found at 802.11b CH1 mode, the data will present on report.

2.4GHz								
Worst case: 802.11b CH1								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
194.300	H	44.90	29.80	10.47	25.57	43.50	-17.93	QP
481.820	H	44.20	29.82	21.63	36.01	46.00	-9.99	QP
862.000	H	29.10	29.07	29.12	29.15	46.00	-16.85	QP
192.443	V	42.63	29.80	10.48	23.31	43.50	-20.19	QP
481.830	V	54.20	33.40	21.63	42.43	46.00	-3.57	QP
862.100	V	28.63	32.39	29.12	25.36	46.00	-20.64	QP

Remark : Corrected Level = Reading + Correction Factor – Preamp

Correction Factor = Antenna Factor + Cable Loss

The present spurious only show those points are above noise level and the frequency range test from 30MHz to 1GHz.

After verifying 802.11a (CH149/CH157/CH165) modes, the worse case was found at 802.11a CH149 mode, the data will present on report.

5GHz								
Worst case: 802.11a CH149								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
193.210	H	44.73	29.80	10.47	25.40	43.50	-18.10	QP
249.021	H	45.02	29.60	15.31	30.73	46.00	-15.27	QP
483.740	H	44.30	29.83	20.73	35.20	46.00	-10.80	QP
192.440	V	32.42	29.80	10.48	13.10	43.50	-30.40	QP
249.036	V	45.29	33.40	15.31	27.20	46.00	-18.80	QP
483.771	V	44.61	33.04	20.73	32.30	46.00	-13.70	QP

Remark : Corrected Level = Reading + Correction Factor – Preamp

Correction Factor = Antenna Factor + Cable Loss

The present spurious only show those points are above noise level and the frequency range test from 30MHz to 1GHz.

Radiated spurious emission

Radiated Emission above 1GHz

2.4GHz

802.11b CH1								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4824	H	45.43	36.50	39.97	48.90	54	-5.10	PK
*7236	H	42.06	36.69	42.82	48.19	54	-5.81	PK
*9648	H	41.68	37.10	43.42	48.00	54	-6.00	PK
*12060	H	42.96	36.54	46.13	52.55	54	-1.45	PK
*14472	H	52.08	61.11	52.04	43.01	54	-10.99	PK
*16884	H	53.69	60.35	49.31	42.65	54	-11.35	PK
*19296	H	54.95	59.61	43.70	39.04	54	-14.96	PK
*21708	H	55.08	57.48	44.57	42.17	54	-11.83	PK
*24120	H	58.31	53.54	45.80	50.57	54	-3.43	PK
4824	V	46.69	36.50	39.97	50.16	74	-23.84	PK
4824	V	35.95	36.50	39.97	39.42	54	-14.58	AV
*7236	V	43.21	36.69	42.82	49.34	54	-4.66	PK
*9648	V	43.62	37.10	43.42	49.94	54	-4.06	PK
*12060	V	42.35	36.54	46.13	51.94	54	-2.06	PK
*14472	V	52.67	61.11	52.04	43.60	54	-10.40	PK
*16884	V	54.61	60.35	49.31	43.57	54	-10.43	PK
*19296	V	55.02	59.61	43.70	39.11	54	-14.89	PK
*21708	V	55.21	57.48	44.57	42.30	54	-11.70	PK
*24120	V	58.61	53.54	45.80	50.87	54	-3.13	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp

Correction Factor = Antenna Factor + Cable Loss

* Mark indicated background noise level.

802.11b CH6								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4874	H	46.74	36.50	40.01	50.25	54	-3.75	PK
*7311	H	42.63	36.72	42.96	48.87	54	-5.13	PK
*9748	H	42.55	37.10	43.70	49.15	54	-4.85	PK
*12185	H	42.78	36.41	46.17	52.54	54	-1.46	PK
*14622	H	53.14	60.81	51.51	43.84	54	-10.16	PK
*17059	H	52.36	59.98	50.37	42.75	54	-11.25	PK
*19496	H	54.28	60.06	43.70	37.92	54	-16.08	PK
*21933	H	53.94	57.73	44.44	40.65	54	-13.35	PK
*24370	H	57.41	54.06	45.80	49.15	54	-4.85	PK
4874	V	50.75	36.50	40.01	54.26	74	-19.74	PK
4874	V	43.04	36.50	40.01	46.55	54	-7.45	AV
*7311	V	43.01	36.72	42.96	49.25	54	-4.75	PK
*9748	V	43.51	37.10	43.70	50.11	54	-3.89	PK
*12185	V	43.36	36.41	46.17	53.12	54	-0.88	PK
*14622	V	54.32	60.81	51.51	45.02	54	-8.98	PK
*17059	V	53.20	59.98	50.37	43.59	54	-10.41	PK
*19496	V	55.64	60.06	43.70	39.28	54	-14.72	PK
*21933	V	54.98	57.73	44.44	41.69	54	-12.31	PK
*24370	V	58.66	54.06	45.80	50.40	54	-3.60	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp

Correction Factor = Antenna Factor + Cable Loss

* Mark indicated background noise level.

802.11b CH11								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4924	H	48.70	36.50	40.04	52.24	54	-1.76	PK
*7386	H	43.10	36.75	43.09	49.44	54	-4.56	PK
*9848	H	43.50	37.10	43.98	50.38	54	-3.62	PK
*12310	H	42.43	36.29	46.23	52.37	54	-1.63	PK
*14772	H	54.65	60.29	50.67	45.03	54	-8.97	PK
*17234	H	53.66	60.13	52.05	45.58	54	-8.42	PK
*19696	H	52.13	59.55	43.54	36.12	54	-17.88	PK
*22158	H	54.19	57.17	44.43	41.45	54	-12.55	PK
*24620	H	56.20	54.15	45.82	47.87	54	-6.13	PK
4924	V	51.02	36.50	40.04	54.56	74	-19.44	PK
4924	V	43.62	36.50	40.04	47.16	54	-6.84	AV
*7386	V	43.61	36.75	43.09	49.95	54	-4.05	PK
*9848	V	44.35	37.10	43.98	51.23	54	-2.77	PK
*12310	V	42.51	36.29	46.23	52.45	54	-1.55	PK
*14772	V	55.32	60.29	50.67	45.70	54	-8.30	PK
*17234	V	54.99	60.13	52.05	46.91	54	-7.09	PK
*19696	V	53.10	59.55	43.54	37.09	54	-16.91	PK
*22158	V	55.36	57.17	44.43	42.62	54	-11.38	PK
*24620	V	56.74	54.15	45.82	48.41	54	-5.59	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp

Correction Factor = Antenna Factor + Cable Loss

* Mark indicated background noise level.

802.11g CH1								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4824	H	44.06	36.50	39.97	47.53	54	-6.47	PK
*7236	H	42.31	36.69	42.82	48.44	54	-5.56	PK
*9648	H	41.62	37.10	43.42	47.94	54	-6.06	PK
*12060	H	42.81	36.54	46.13	52.40	54	-1.60	PK
*14472	H	51.56	61.11	52.04	42.49	54	-11.51	PK
*16884	H	53.69	60.35	49.31	42.65	54	-11.35	PK
*19296	H	54.36	59.61	43.70	38.45	54	-15.55	PK
*21708	H	55.12	57.48	44.57	42.21	54	-11.79	PK
*24120	H	58.01	53.54	45.80	50.27	54	-3.73	PK
4824	V	45.94	36.50	39.97	49.41	54	-4.59	PK
*7236	V	43.24	36.69	42.82	49.37	54	-4.63	PK
*9648	V	43.28	37.10	43.42	49.60	54	-4.40	PK
*12060	V	42.20	36.54	46.13	51.79	54	-2.21	PK
*14472	V	52.19	61.11	52.04	43.12	54	-10.88	PK
*16884	V	54.11	60.35	49.31	43.07	54	-10.93	PK
*19296	V	55.20	59.61	43.70	39.29	54	-14.71	PK
*21708	V	55.31	57.48	44.57	42.40	54	-11.60	PK
*24120	V	58.90	53.54	45.80	51.16	54	-2.84	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp
 Correction Factor = Antenna Factor + Cable Loss
 * Mark indicated background noise level.

802.11g CH6								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4874	H	46.06	36.50	40.01	49.57	54	-4.43	PK
*7311	H	42.60	36.72	42.96	48.84	54	-5.16	PK
*9748	H	42.71	37.10	43.70	49.31	54	-4.69	PK
*12185	H	42.42	36.41	46.17	52.18	54	-1.82	PK
*14622	H	53.00	60.81	51.51	43.70	54	-10.30	PK
*17059	H	52.24	59.98	50.37	42.63	54	-11.37	PK
*19496	H	54.13	60.06	43.70	37.77	54	-16.23	PK
*21933	H	54.29	57.73	44.44	41.00	54	-13.00	PK
*24370	H	57.60	54.06	45.80	49.34	54	-4.66	PK
4874	V	46.56	36.50	40.01	50.07	54	-3.93	PK
*7311	V	42.70	36.72	42.96	48.94	54	-5.06	PK
*9748	V	43.50	37.10	43.70	50.10	54	-3.90	PK
*12185	V	43.21	36.41	46.17	52.97	54	-1.03	PK
*14622	V	54.36	60.81	51.51	45.06	54	-8.94	PK
*17059	V	53.51	59.98	50.37	43.90	54	-10.10	PK
*19496	V	55.62	60.06	43.70	39.26	54	-14.74	PK
*21933	V	55.17	57.73	44.44	41.88	54	-12.12	PK
*24370	V	58.71	54.06	45.80	50.45	54	-3.55	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp
 Correction Factor = Antenna Factor + Cable Loss
 * Mark indicated background noise level.

802.11g CH11								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
4924	H	46.05	36.50	40.04	49.59	54	-4.41	PK
*7386	H	43.11	36.75	43.09	49.45	54	-4.55	PK
*9848	H	43.31	37.10	43.98	50.19	54	-3.81	PK
*12310	H	42.05	36.29	46.23	51.99	54	-2.01	PK
*14772	H	55.31	60.29	50.67	45.69	54	-8.31	PK
*17234	H	53.61	60.13	52.05	45.53	54	-8.47	PK
*19696	H	51.12	59.55	43.54	35.11	54	-18.89	PK
*22158	H	53.10	57.17	44.43	40.36	54	-13.64	PK
*24620	H	56.14	54.15	45.82	47.81	54	-6.19	PK
4924	V	45.33	36.50	40.04	48.87	54	-5.13	PK
*7386	V	43.62	36.75	43.09	49.96	54	-4.04	PK
*9848	V	44.18	37.10	43.98	51.06	54	-2.94	PK
*12310	V	42.36	36.29	46.23	52.30	54	-1.70	PK
*14772	V	55.27	60.29	50.67	45.65	54	-8.35	PK
*17234	V	55.39	60.13	52.05	47.31	54	-6.69	PK
*19696	V	53.20	59.55	43.54	37.19	54	-16.81	PK
*22158	V	45.41	57.17	44.43	32.67	54	-21.33	PK
*24620	V	56.91	54.15	45.82	48.58	54	-5.42	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp
 Correction Factor = Antenna Factor + Cable Loss
 * Mark indicated background noise level.

5GHz

802.11a CH149								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
*11490	H	45.94	36.40	41.80	51.34	54	-2.66	PK
*17235	H	54.13	60.13	46.11	40.11	54	-13.89	PK
*22980	H	56.14	56.26	45.07	44.95	54	-9.05	PK
*28725	H	26.74	25.52	47.07	48.29	54	-5.71	PK
*34470	H	29.96	26.59	48.01	51.38	54	-2.62	PK
*11490	V	46.14	36.40	41.80	51.54	54	-2.46	PK
*17235	V	54.41	60.13	46.11	40.39	54	-13.61	PK
*22980	V	56.01	56.26	45.07	44.82	54	-9.18	PK
*28725	V	27.36	25.52	47.07	48.91	54	-5.09	PK
*34470	V	30.14	26.59	48.01	51.56	54	-2.44	PK

802.11a CH157								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
*11570	H	46.14	36.43	41.84	51.55	54	-2.45	PK
*17355	H	54.97	60.23	47.99	42.73	54	-11.27	PK
*23140	H	55.08	55.29	45.18	44.97	54	-9.03	PK
*28925	H	26.79	25.36	46.94	48.37	54	-5.63	PK
*34710	H	29.63	26.39	48.25	51.49	54	-2.51	PK
*11570	V	46.46	36.43	41.84	51.87	54	-2.13	PK
*17355	V	55.14	60.23	47.99	42.90	54	-11.10	PK
*23140	V	55.39	55.29	45.18	45.28	54	-8.72	PK
*28925	V	28.10	25.36	46.94	49.68	54	-4.32	PK
*34710	V	29.97	26.39	48.25	51.83	54	-2.17	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp
 Correction Factor = Antenna Factor + Cable Loss
 * Mark indicated background noise level.

802.11a CH165								
Frequency (MHz)	Antenna Polarization	Reading (dB μ V)	Preamp (dB)	Correction Factor (dB/m)	Corrected Level (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)	Det. Mode
*11650	H	46.37	36.46	41.89	51.80	54	-2.20	PK
*17475	H	55.04	60.33	48.87	43.58	54	-10.42	PK
*23300	H	54.93	54.16	45.28	46.05	54	-7.95	PK
*29125	H	25.96	25.17	47.00	47.79	54	-6.21	PK
*34950	H	29.63	26.15	48.54	52.02	54	-1.98	PK
*11650	V	46.88	36.46	41.89	52.31	54	-1.69	PK
*17475	V	55.31	60.33	48.87	43.85	54	-10.15	PK
*23300	V	55.36	54.16	45.28	46.48	54	-7.52	PK
*29125	V	26.10	25.17	47.00	47.93	54	-6.07	PK
*34950	V	29.91	26.15	48.54	52.30	54	-1.70	PK

Remark : Corrected Level = Reading + Correction Factor – Preamp
 Correction Factor = Antenna Factor + Cable Loss
 * Mark indicated background noise level.

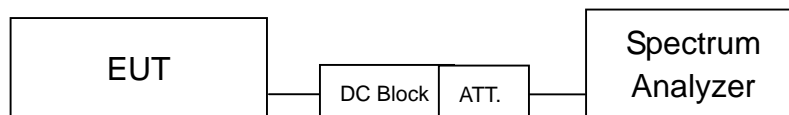
3 RF Conducted spurious emission

3.1 Limit

According to 15.247(d) requirement :

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

3.2 Configuration of Measurement



3.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

The measurements were performed from 30MHz to 40GHz RF antenna conducted per FCC 15.247 (c) was measured from the EUT antenna port using a 50ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 100 kHz.

Harmonics and spurious noise must be at least 20dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. The table below is the results from the highest emission for each channel within the authorized band. This table was used to determine the spurious limit for each channel.

3.4 Test Result

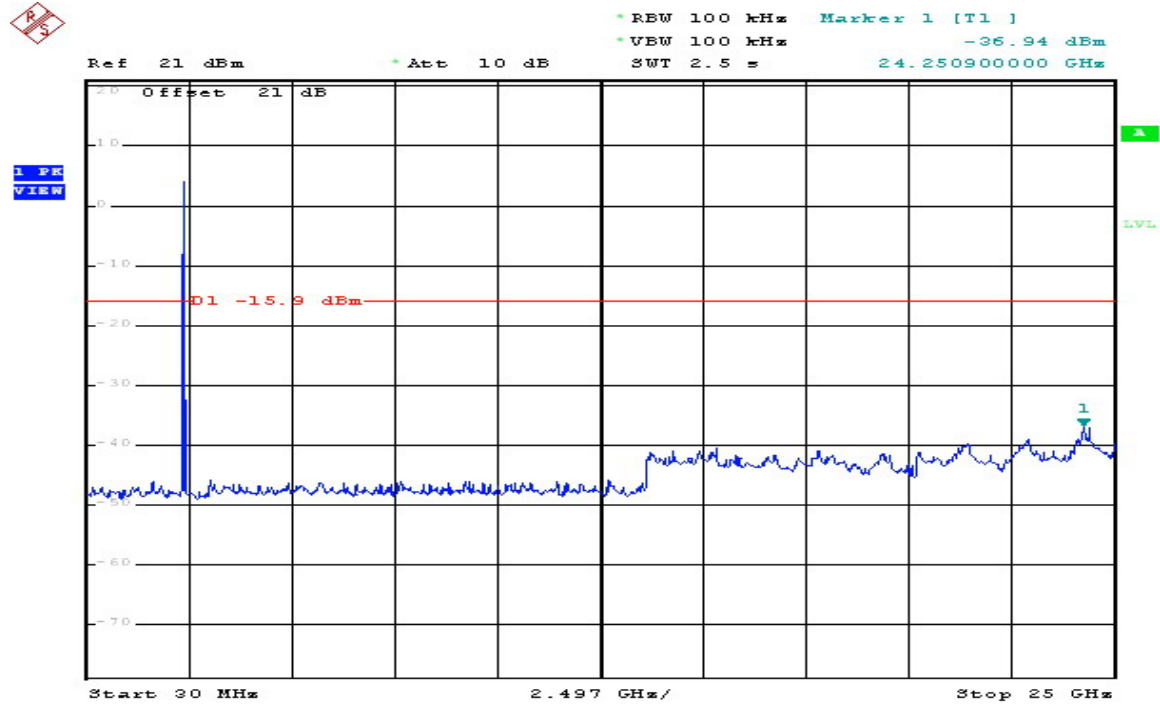
PASS.

The final test data is shown on as following pages.

Conducted spurious emission

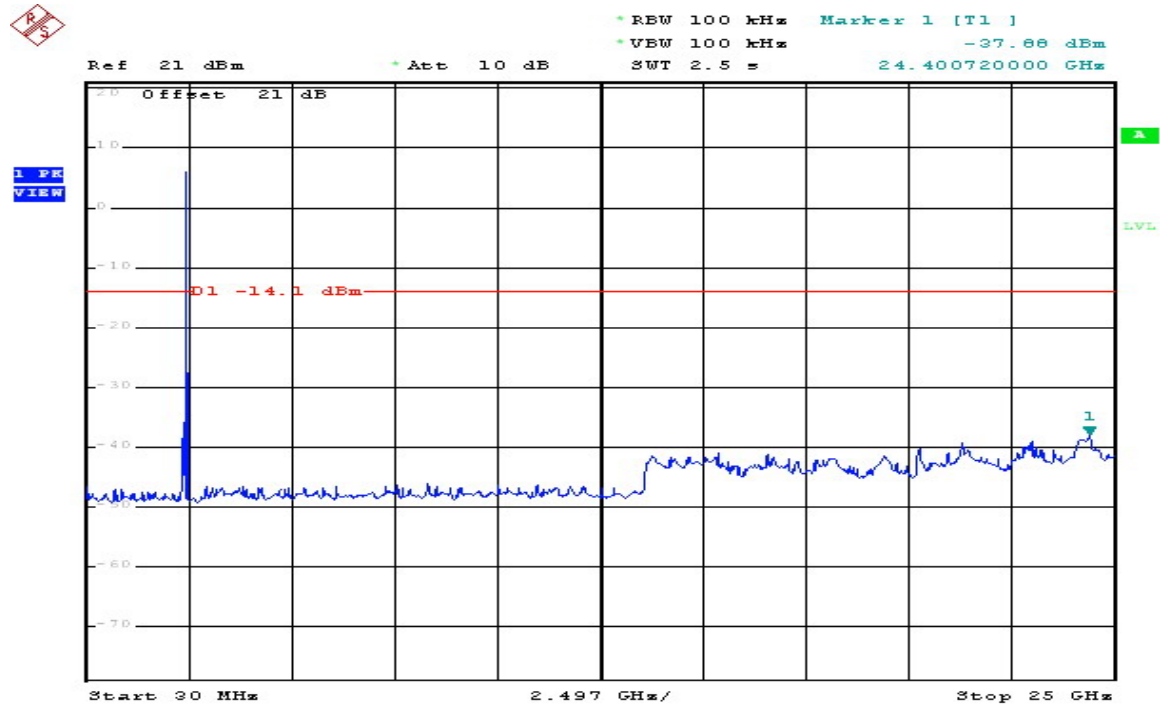
2.4GHz

802.11b CH1 2412MHz



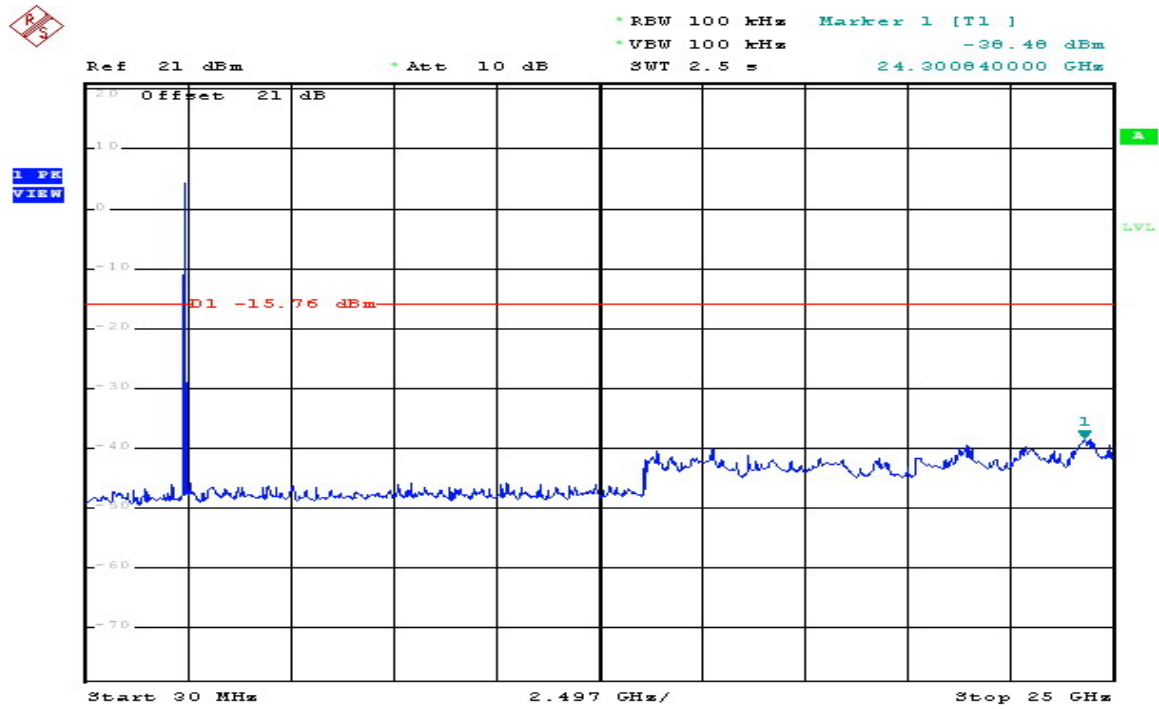
Comment: 802.11b Conducted Spurious 2412MHz
Date: 3.FEB.2009 13:15:55

802.11b CH6 2437MHz



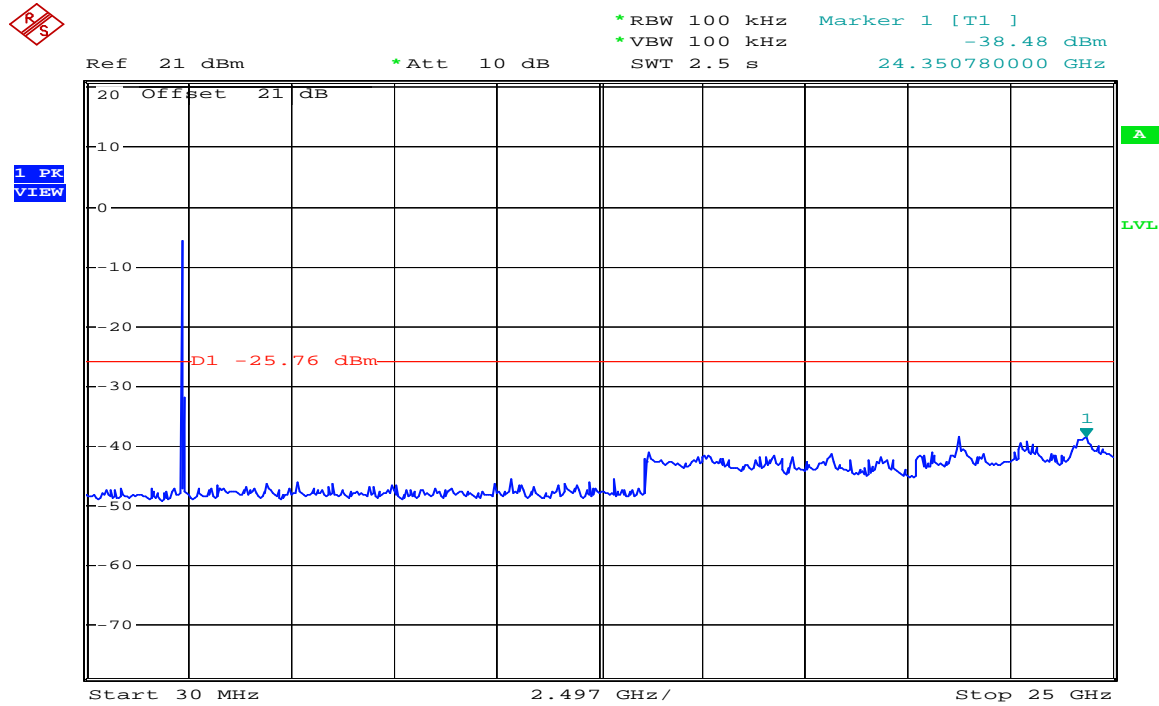
Comment: 802.11b Conducted Spurious 2437MHz
Date: 3.FEB.2009 13:17:04

802.11b CH11 2462MHz



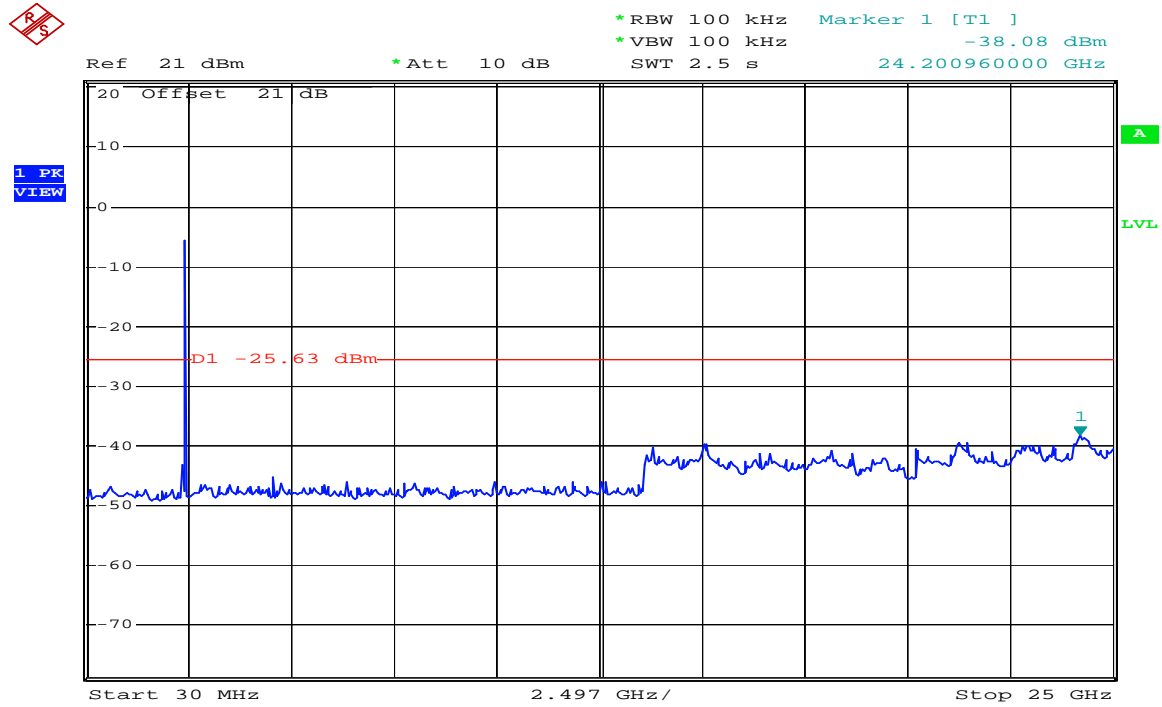
Comment: 802.11b Conducted Spurious 2462MHz
Date: 3.FEB.2009 13:18:46

802.11g CH1 2412MHz



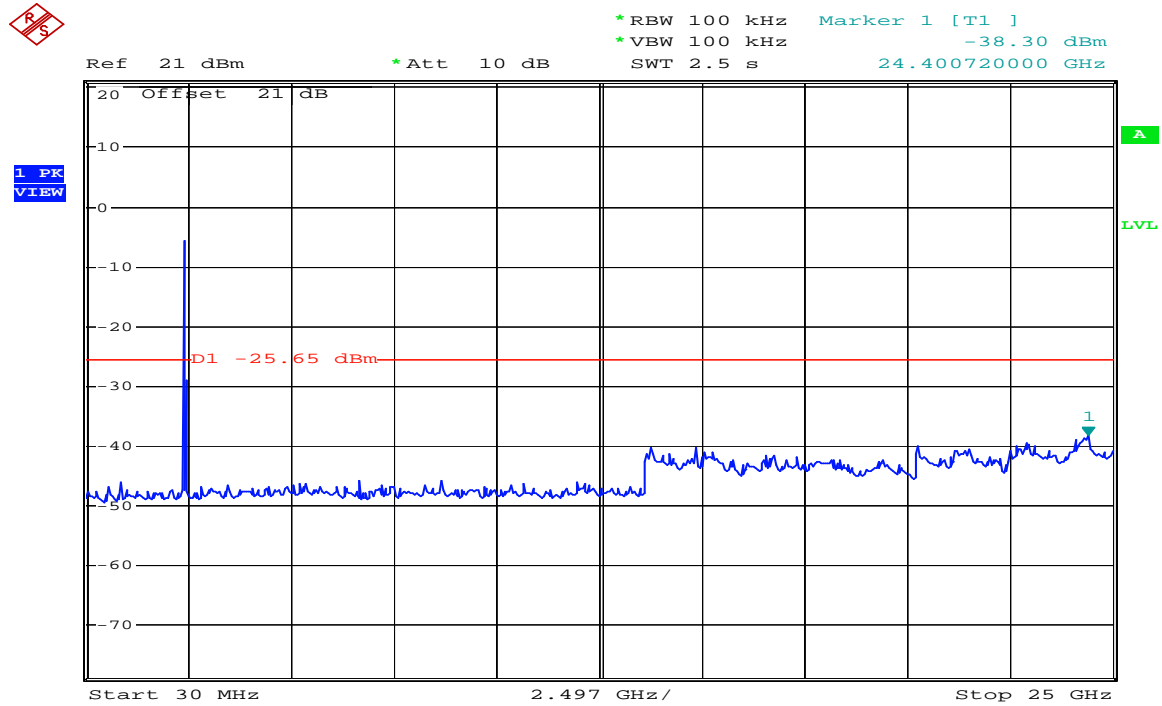
Comment: 802.11g Conducted Spurious 2412MHz
Date: 10.MAR.2009 15:28:47

802.11g CH6 2437MHz



Comment: 802.11g Conducted Spurious 2437MHz
Date: 10.MAR.2009 15:29:46

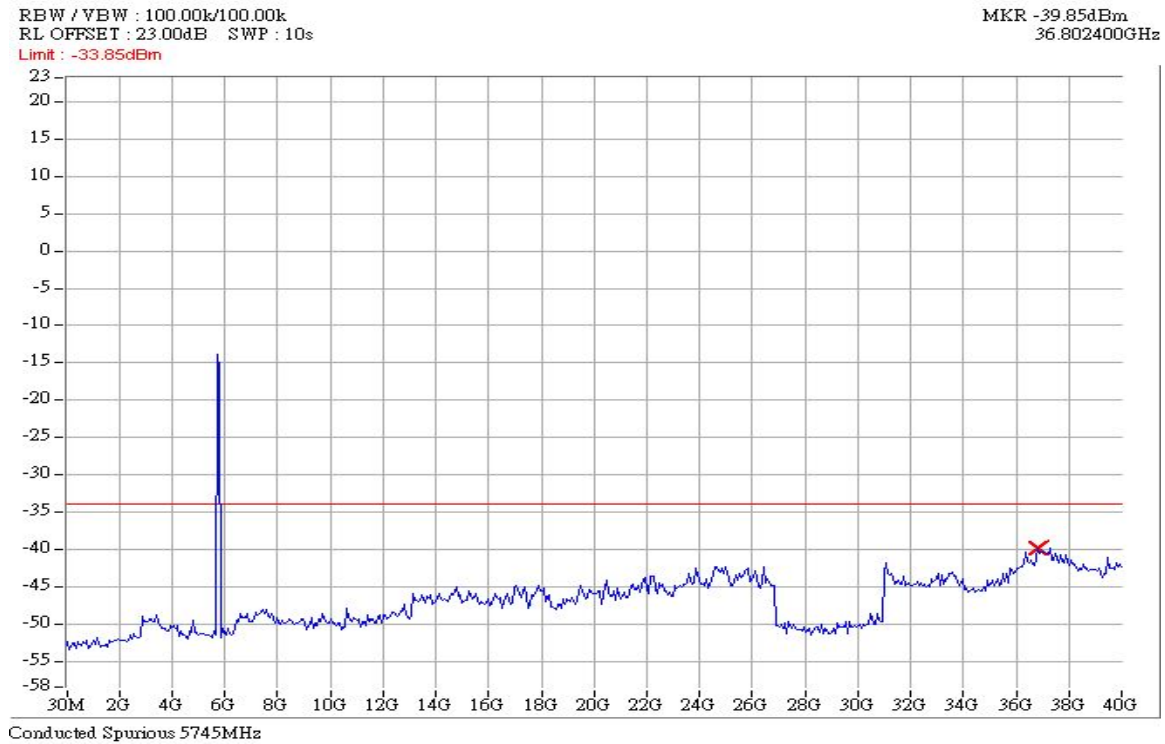
802.11g CH11 2462MHz



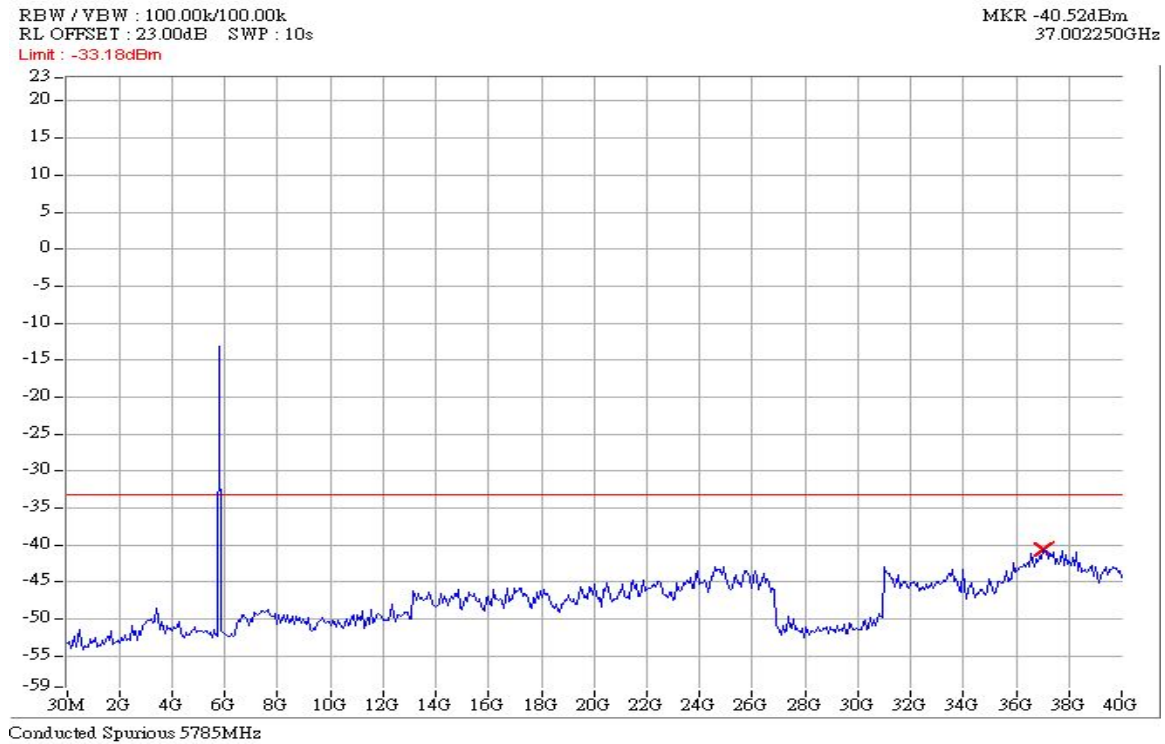
Comment: 802.11g Conducted Spurious 2462MHz
Date: 10.MAR.2009 15:33:50

5GHz

802.11a CH149 5745MHz



802.11a CH157 5785MHz



802.11a CH165 5825MHz

RBW / VBW : 100.00k/100.00k
RL OFFSET : 23.00dB SWP : 10s
Limit : -31.35dBm

MKR -40.52dBm
37.335333GHz



Conducted Spurious 5825MHz

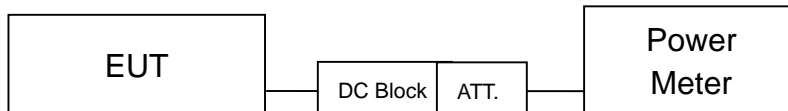
4 Maximum Peak output power test

4.1 Limit

According to FCC Part15.247 (b)(3) requirement :

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: The maximum conducted output power shall be less than 1Watt.

4.2 Configuration of Measurement



4.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

For FCC §15.247(b) the power output was measured on the EUT using a 50 ohm SMA cable connected to peak power meter via power sensor. Peak output power was read directly from power meter. The test was performed at 3 channels (lowest, middle and highest).

4.4 Test Result

PASS.

The final test data is shown on as following pages.

Maximum output power

2.4GHz

Mode : 802.11b					
CH	Freq. (MHz)	Maximum transmit power		Limit (dBm)	Margin (dB)
		(dBm)	(watts)		
1	2412	17.87	0.0612	30	-12.13
6	2437	18.68	0.0738	30	-11.32
11	2462	18.45	0.0700	30	-11.55

Mode : 802.11g					
CH	Freq. (MHz)	Maximum transmit power		Limit (dBm)	Margin (dB)
		(dBm)	(watts)		
1	2412	19.28	0.0847	30	-10.72
6	2437	19.52	0.0895	30	-10.48
11	2462	19.57	0.0906	30	-10.43

5GHz

Mode : 802.11a					
CH	Temp. (°C)	Maximum transmit power		Limit (dBm)	Margin (dB)
		(dBm)	(watts)		
149	5745	13.90	0.0245	30	-16.10
157	5785	13.63	0.0231	30	-16.37
165	5825	13.80	0.0240	30	-16.20

5 Power test of Data Rate

Mode	Bandwidth (MHz)	Channel	Data Rate	Output Power	
				(dBm)	(watts)
802.11b	20	6	1	18.56	0.0718
			5.5	18.64	0.0731
			11	18.68	0.0738
802.11g	20	6	6	19.52	0.0895
			36	19.17	0.0826
			54	18.29	0.0675
802.11a	20	40	6	13.28	0.0213
			36	13.24	0.0211
			54	13.22	0.0210
802.11a	20	157	6	13.63	0.0231
			36	13.36	0.0217
			54	13.24	0.0211

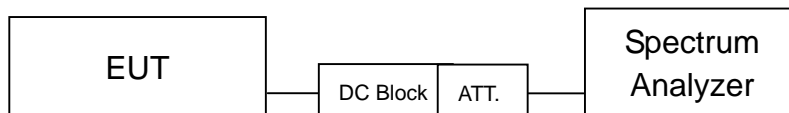
6 6dB Bandwidth

6.1 Limit

According to FCC Part15.247 (a)(2) requirement :

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

6.2 Configuration of Measurement



6.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

The minimum 6dB bandwidth was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 100kHz, the video bandwidth set \geq RBW, and the SPAN>>RBW. The test was performed at 3 channels (lowest, middle and highest).

6.4 Test Result

PASS.

The final test data is shown on as following pages.

6dB bandwidth

2.4GHz

Test Mode : 802.11b			
CH No.	Freq. (MHz)	6dB Bandwidth (MHz)	Limit (kHz)
1	2412	9.92	>500
6	2437	9.92	>500
11	2462	9.96	>500

Test Mode : 802.11g			
CH No.	Freq. (MHz)	6dB Bandwidth (MHz)	Limit (kHz)
1	2412	16.64	>500
6	2437	16.64	>500
11	2462	16.60	>500

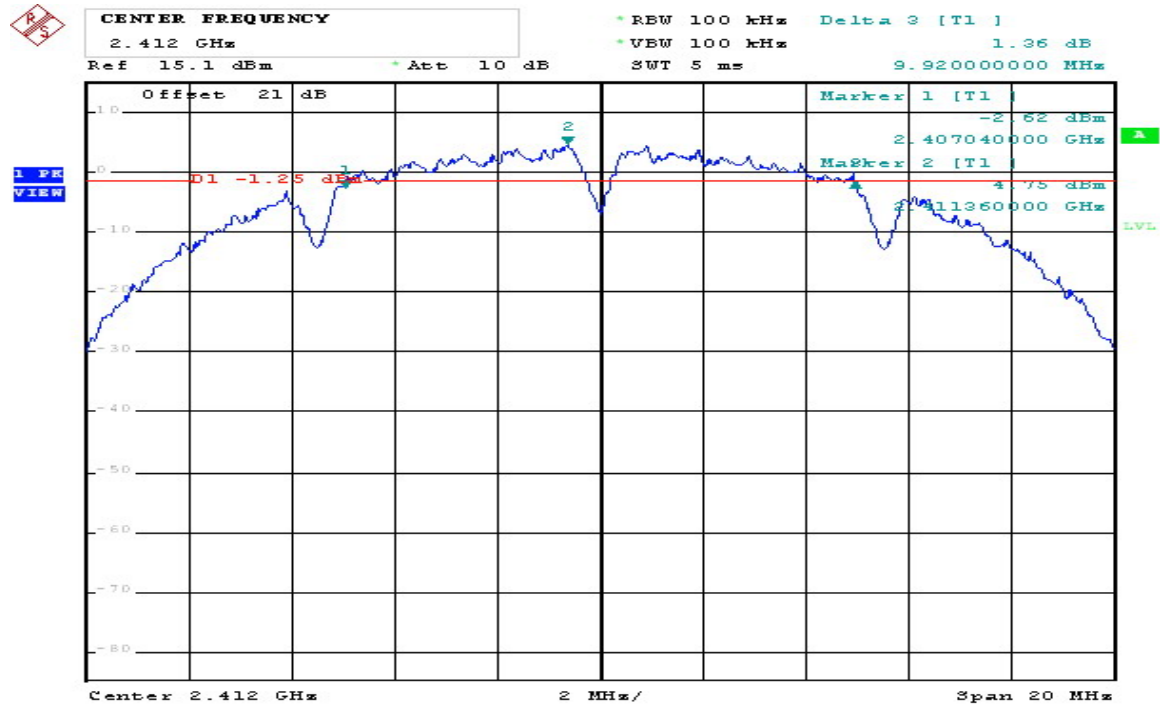
5GHz

Test Mode : 802.11a			
CH No.	Freq. (MHz)	6dB Bandwidth (MHz)	Limit (kHz)
149	5745	16.64	>500
157	5785	16.60	>500
165	5825	16.64	>500

6dB Bandwidth

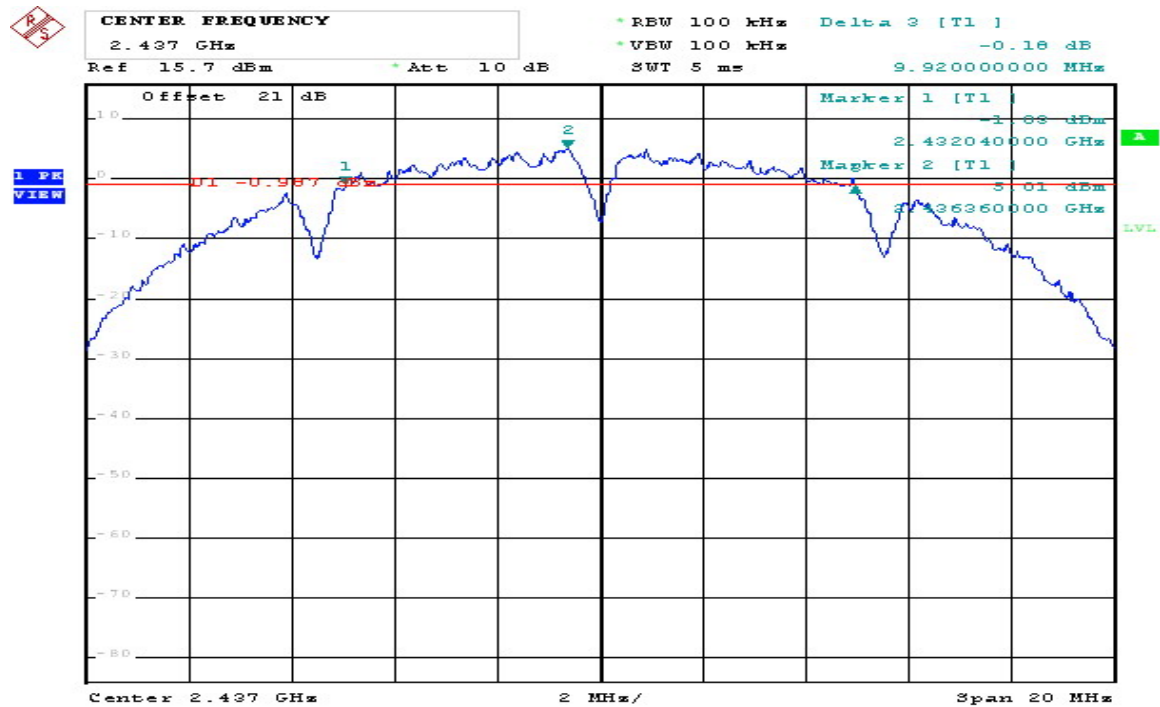
2.4GHz

802.11b CH1 2412MHz



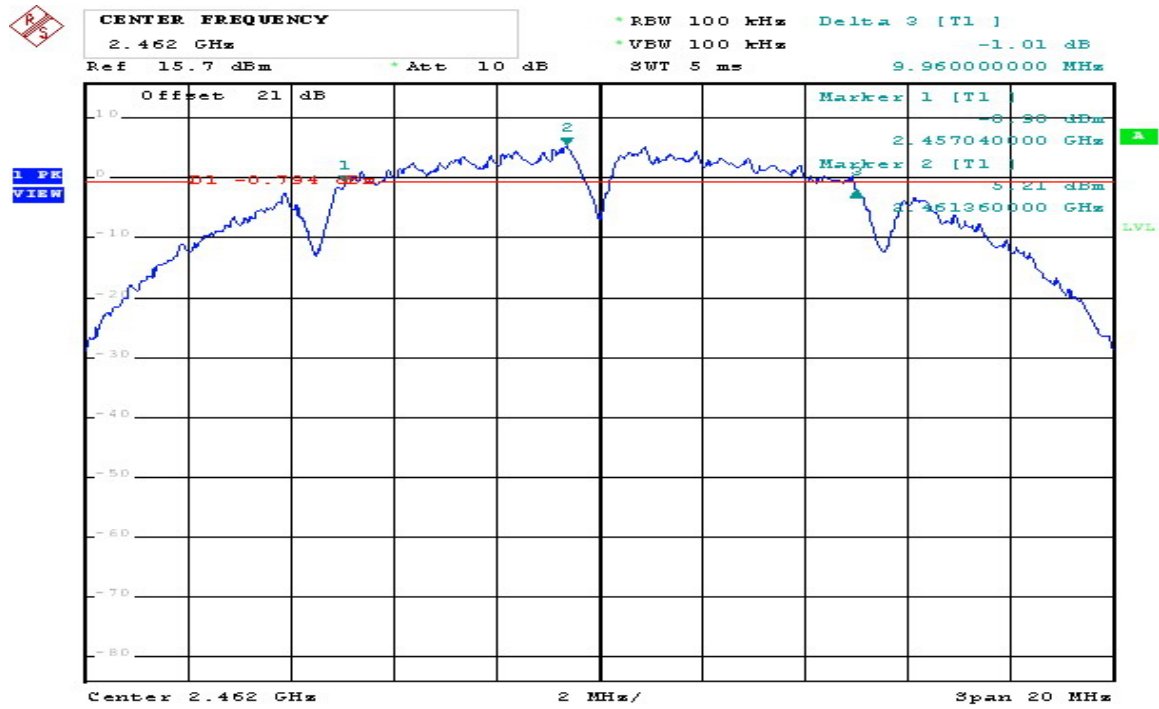
Comment: 802.11b 2412MHz
Date: 3.FEB.2009 12:11:08

802.11b CH6 2437MHz



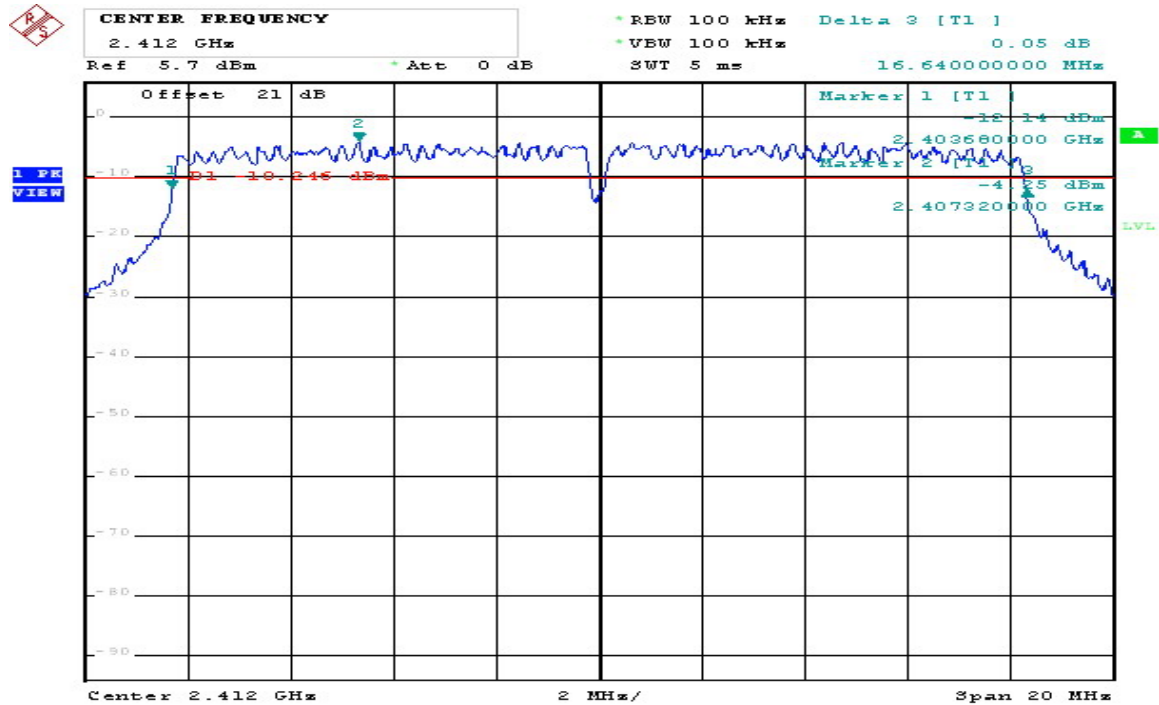
Comment: 802.11b 2437MHz
Date: 3.FEB.2009 12:17:14

802.11b CH11 2462MHz



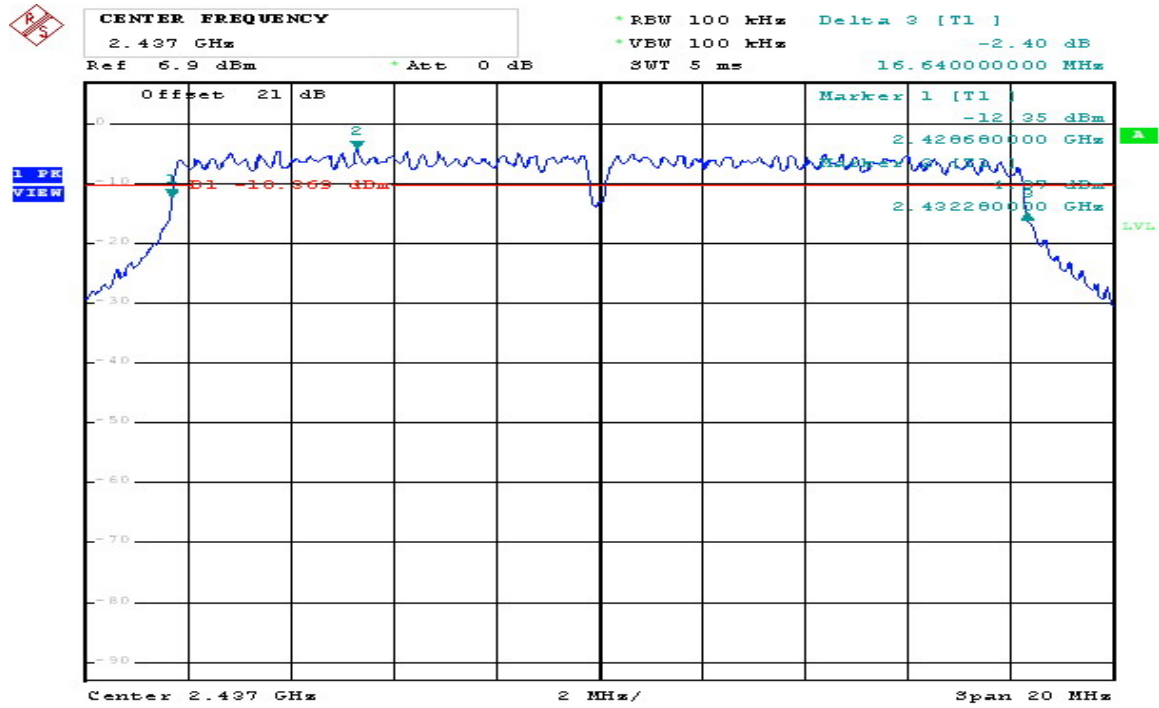
Comment: 802.11b 2462MHz
Date: 3.FEB.2009 12:23:59

802.11g CH1 2412MH



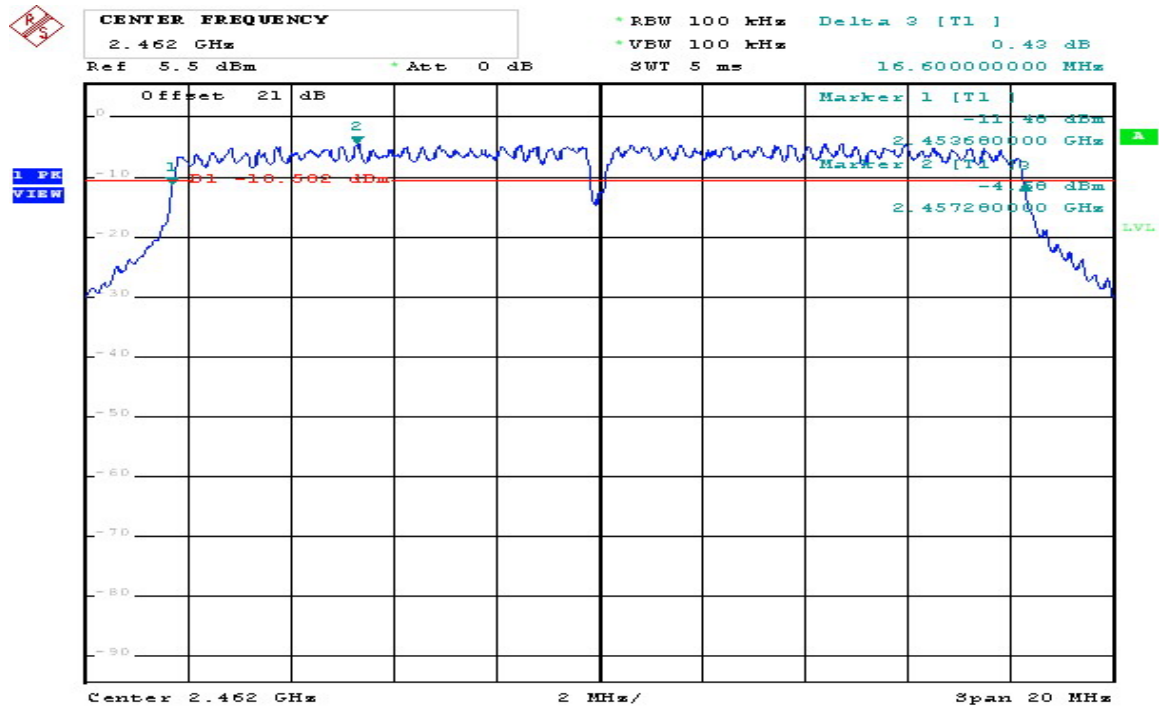
Comment: 802.11g 2412MHz
Date: 3.FEB.2009 12:31:55

802.11g CH6 2437MHz



Comment: 802.11g 2437MHz
Date: 3.FEB.2009 12:38:02

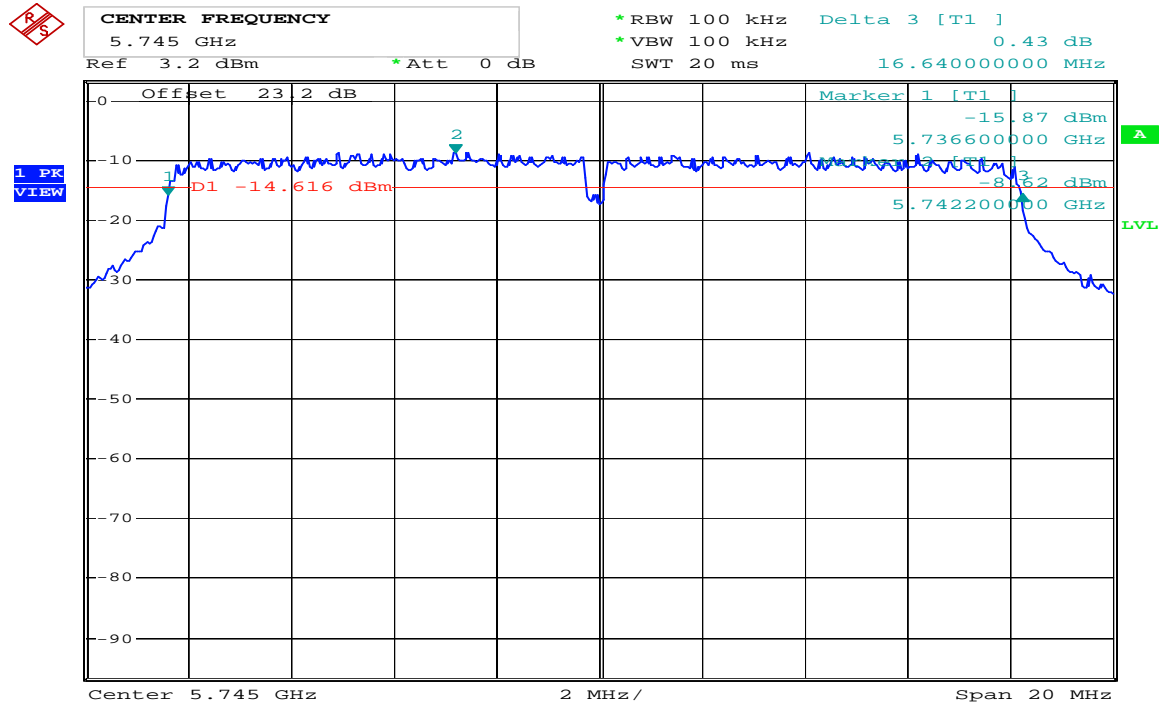
802.11g CH11 2462MHz



Comment: 802.11g 2462MHz
Date: 3.FEB.2009 12:40:54

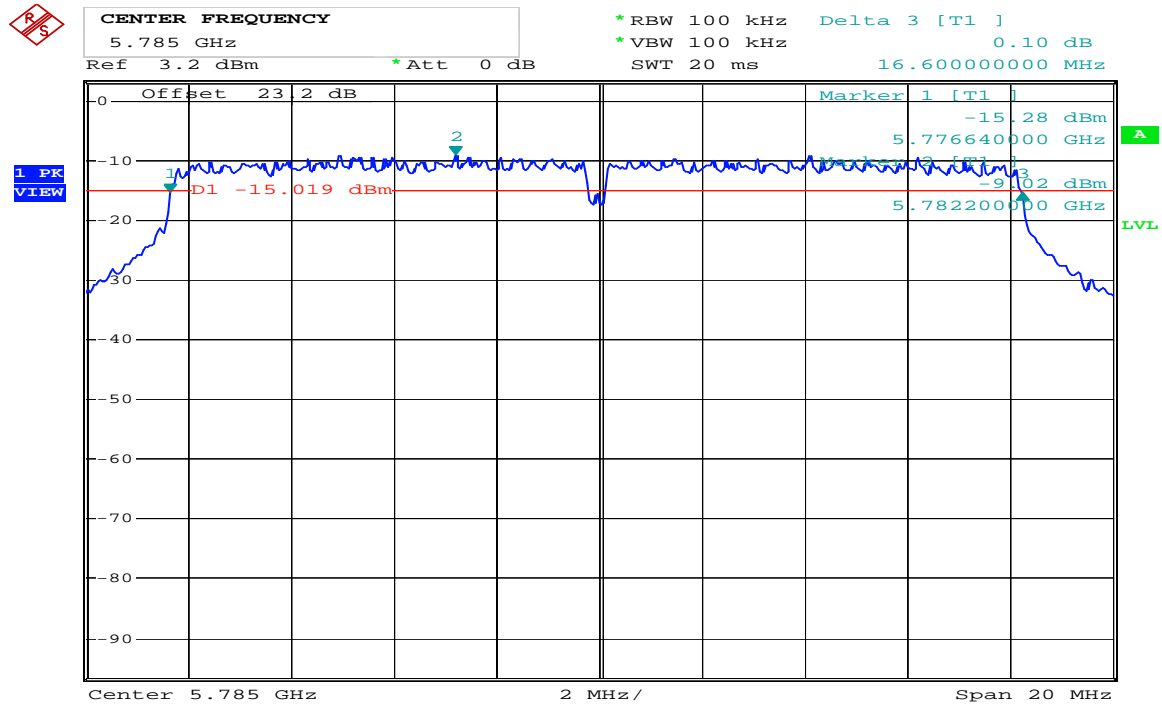
5GHz

802.11a CH149 5745MHz



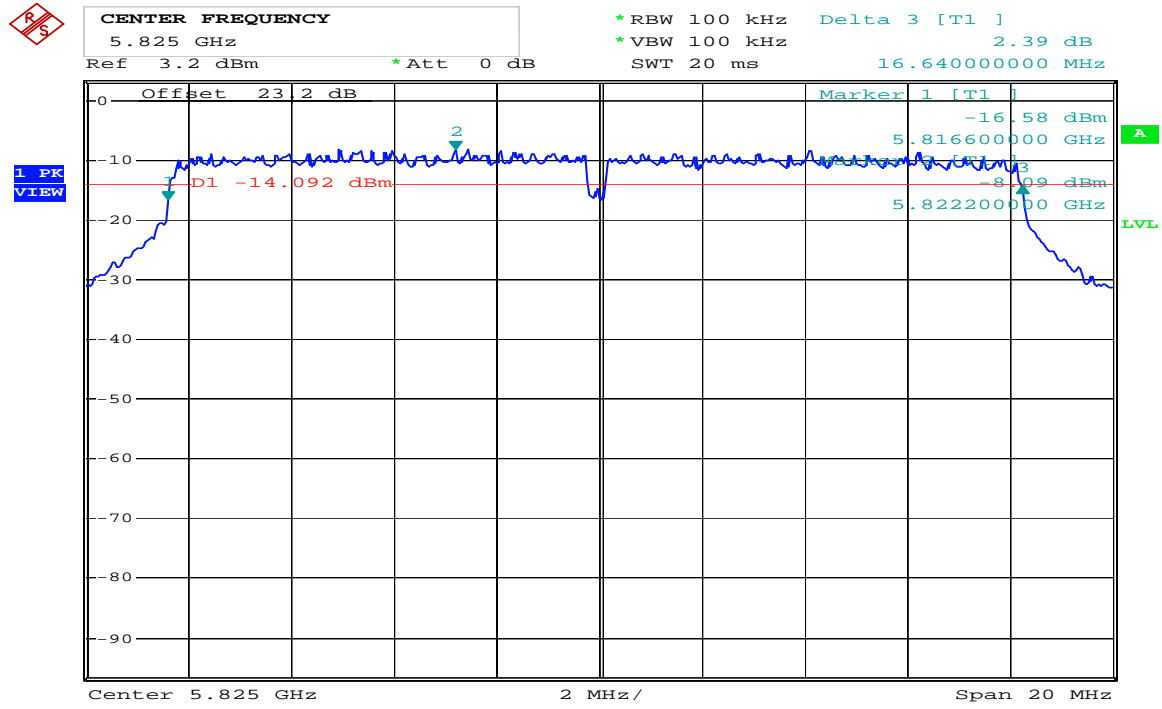
Comment: 802.11a 5745MHz
Date: 10.MAR.2009 09:26:43

802.11a CH157 5785MHz



Comment: 802.11a 5785MHz
Date: 10.MAR.2009 09:39:22

802.11a CH165 5825MHz



Comment: 802.11a 5825MHz
Date: 10.MAR.2009 09:41:46

99%Occupied bandwidth

2.4GHz

Test Mode : 802.11b		
CH No.	Freq. (MHz)	Occupied Bandwidth (MHz)
1	2412	14.96
6	2437	15.00
11	2462	14.96

Test Mode : 802.11g		
CH No.	Freq. (MHz)	Occupied Bandwidth (MHz)
1	2412	16.48
6	2437	16.44
11	2462	16.48

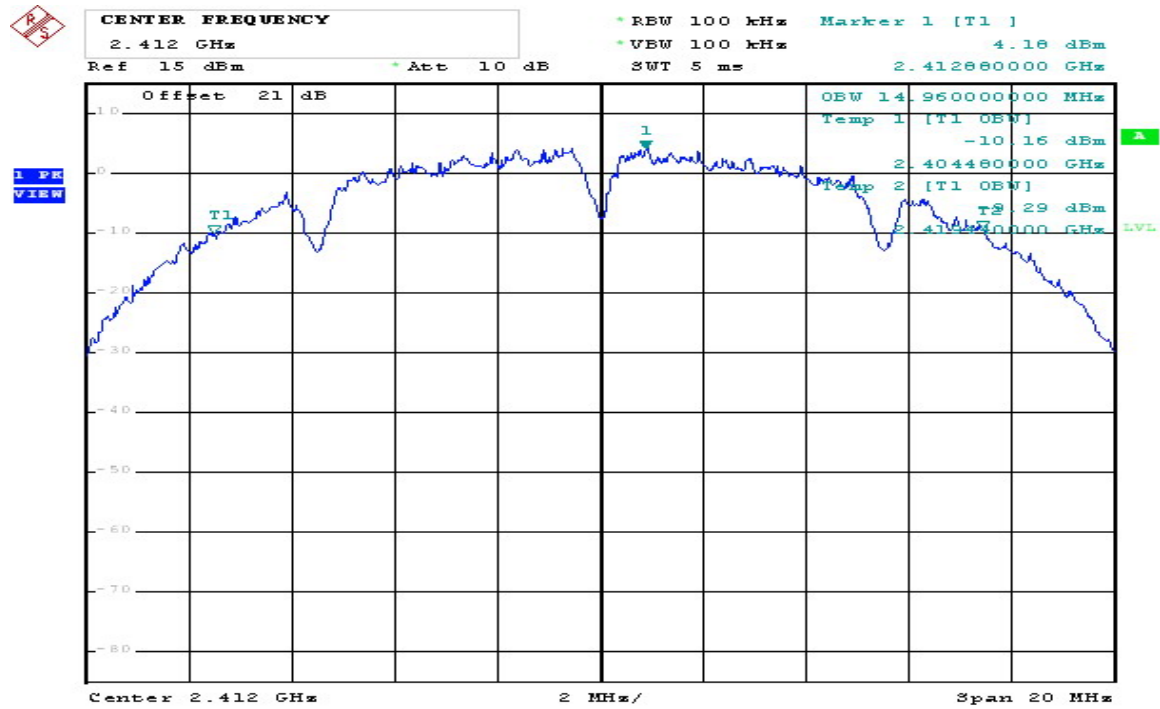
5GHz

Test Mode : 802.11a		
CH No.	Freq. (MHz)	Occupied Bandwidth (MHz)
149	5745	16.52
157	5785	16.52
165	5825	16.52

99%Occupied bandwidth

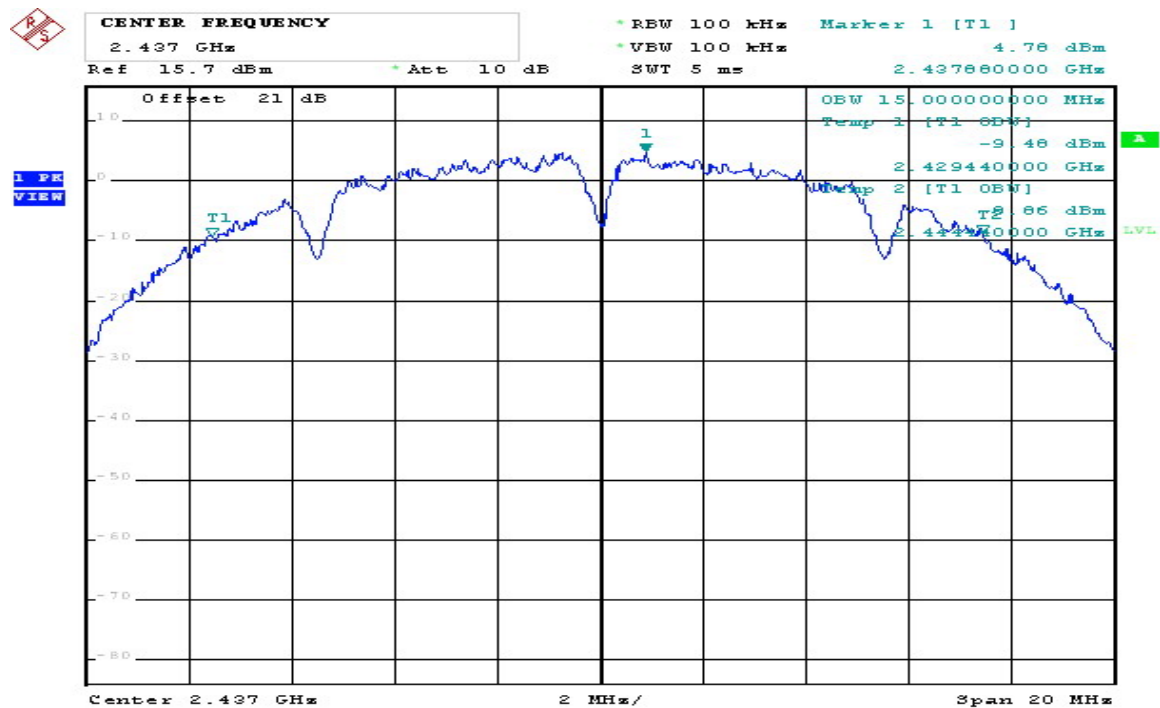
2.4GHz

802.11b CH1 2412MHz



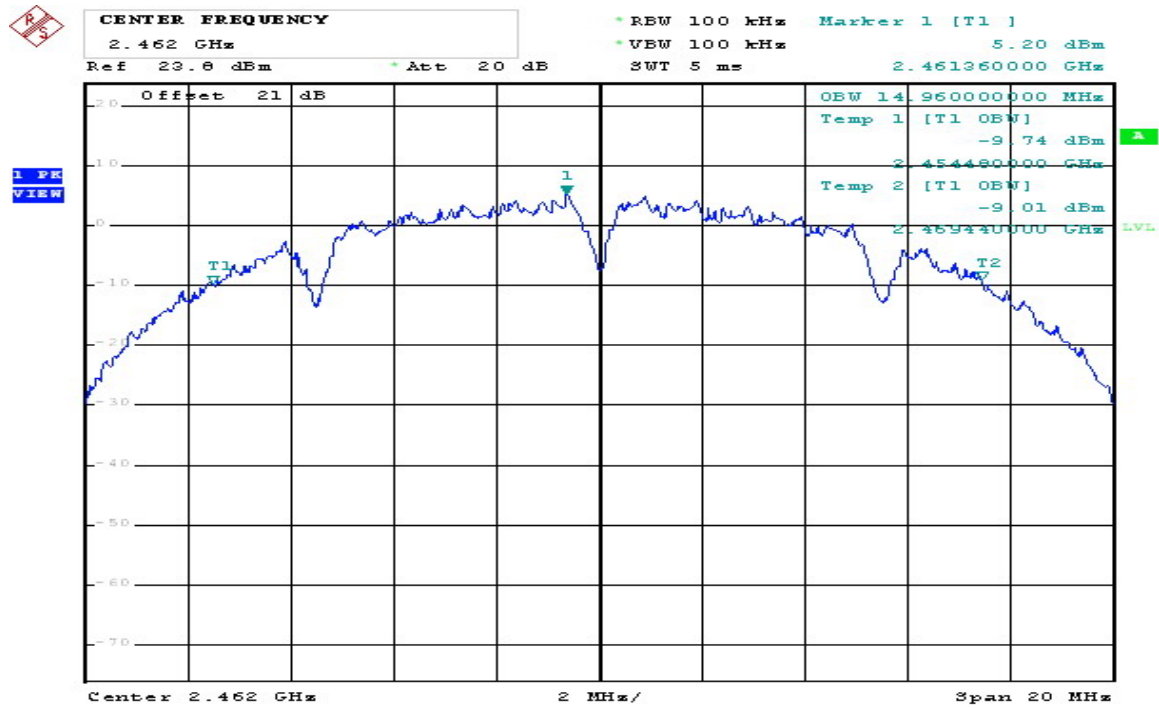
Comment: 802.11b 2412MHz
Date: 3.FEB.2009 12:12:20

802.11b CH6 2437MHz



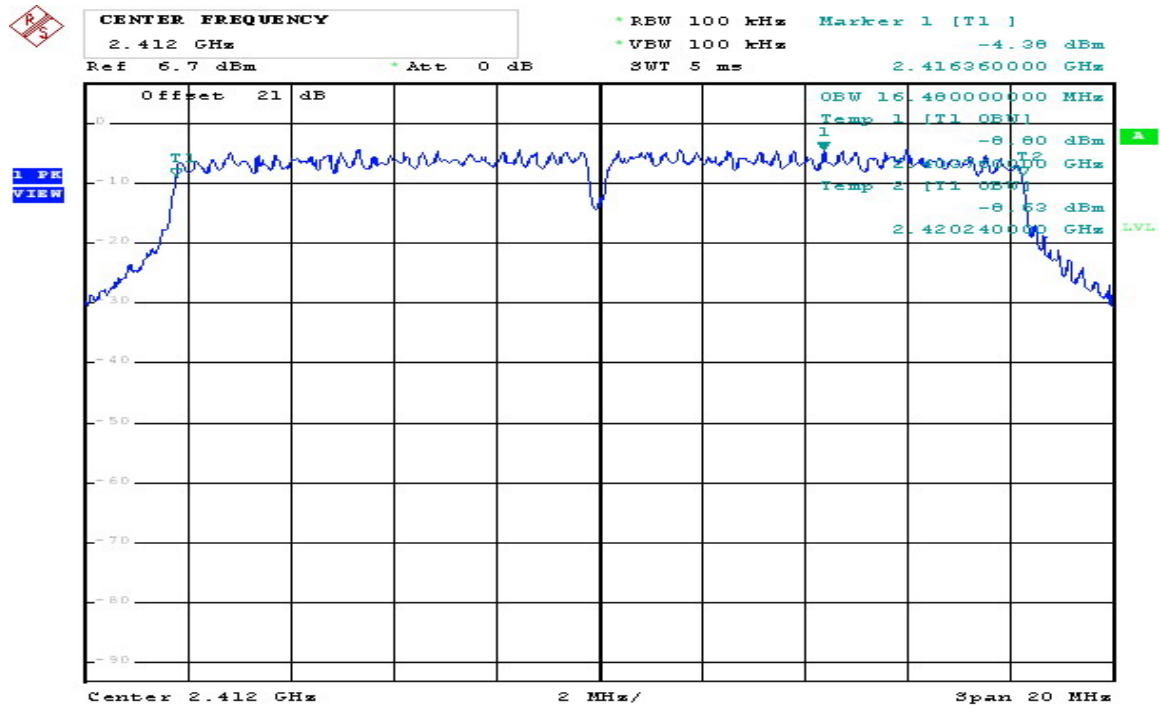
Comment: 802.11b 2437MHz
Date: 3.FEB.2009 12:18:27

802.11b CH11 2462MHz



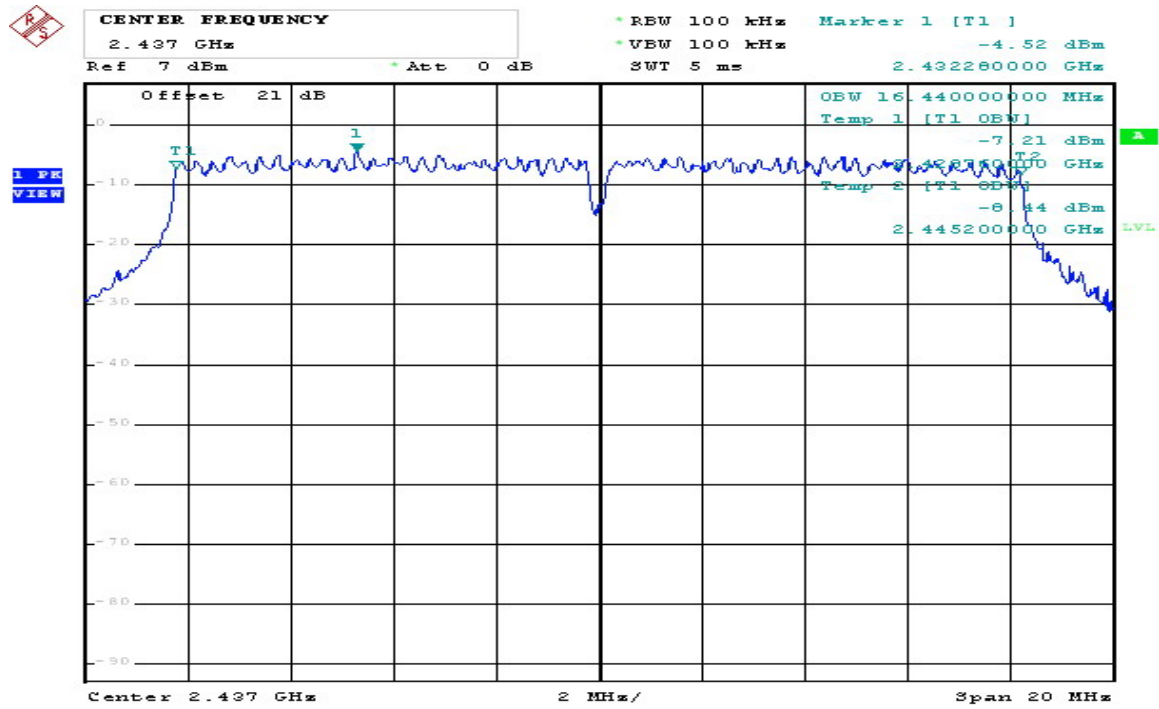
Comment: 802.11b 2462MHz
 Date: 3.FEB.2009 12:25:11

802.11g CH1 2412MHz



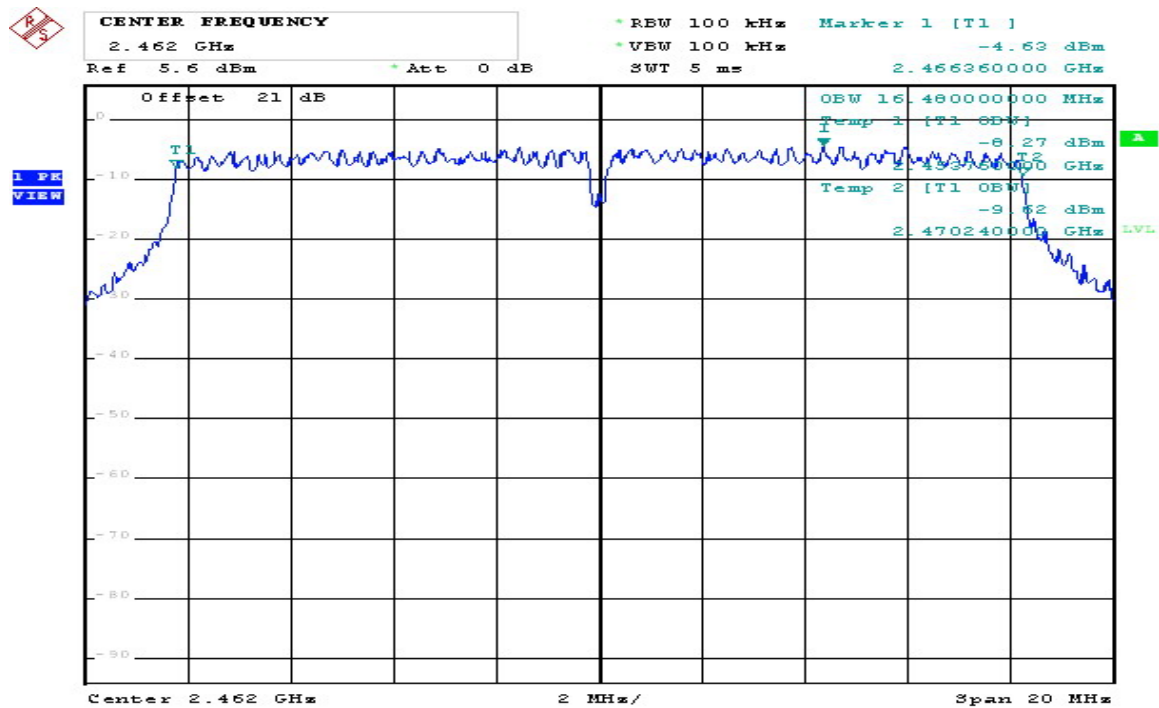
Comment: 802.11g 2412MHz
 Date: 3.FEB.2009 12:33:08

802.11g CH6 2437MHz



Comment: 802.11g 2437MHz
Date: 3.FEB.2009 12:39:15

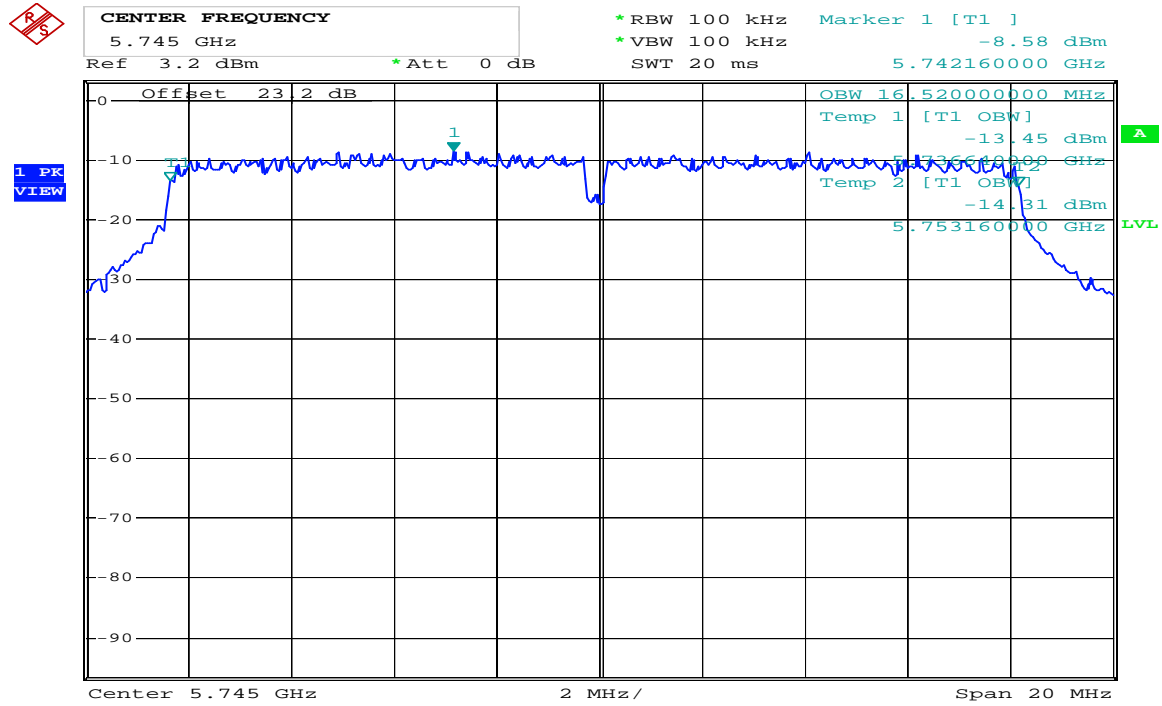
802.11g CH11 2462MHz



Comment: 802.11g 2462MHz
Date: 3.FEB.2009 12:42:05

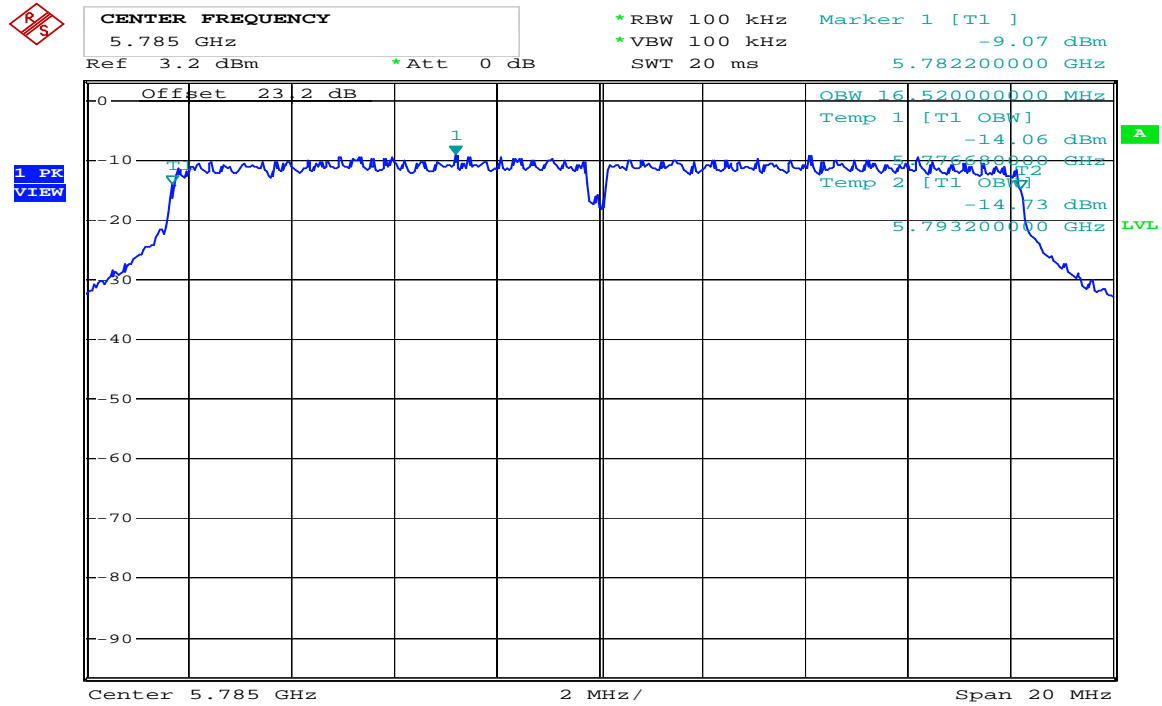
5GHz

802.11a CH149 5745MHz



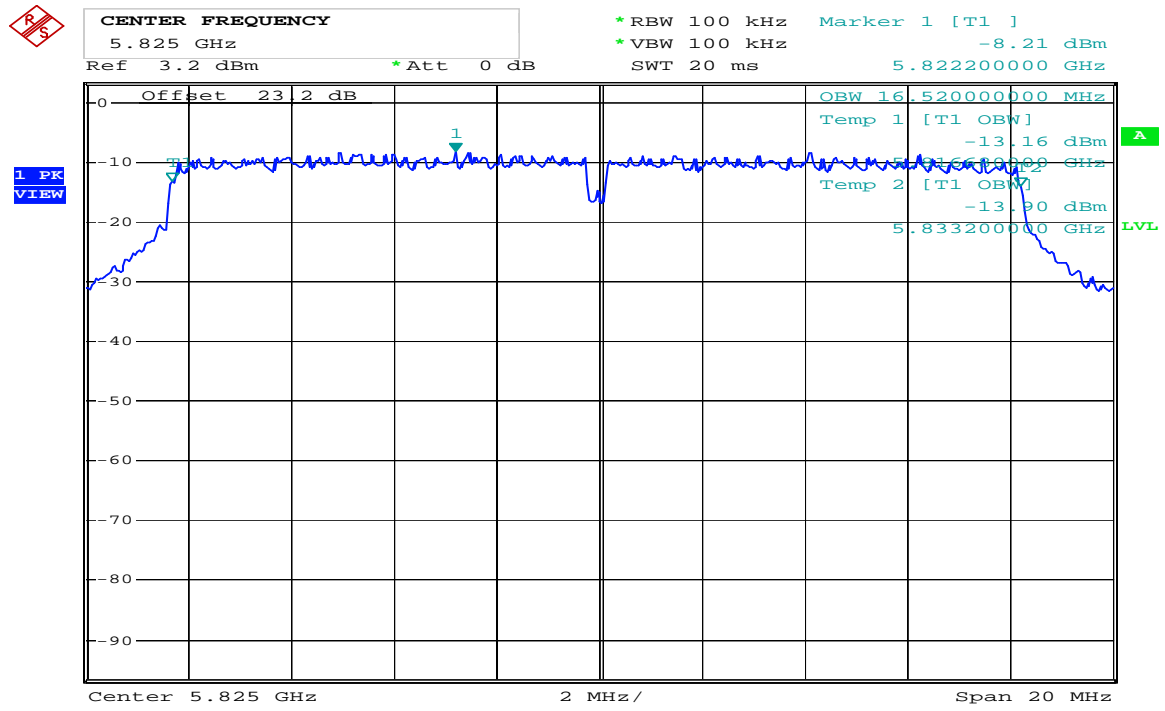
Comment: 802.11a 5745MHz
Date: 10.MAR.2009 09:27:00

802.11a CH157 5785MHz



Comment: 802.11a 5785MHz
Date: 10.MAR.2009 09:39:38

802.11a CH165 5825MHz



Comment: 802.11a 5825MHz
Date: 10.MAR.2009 09:42:03

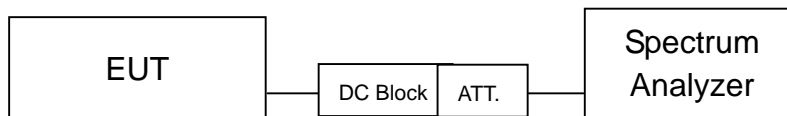
7 Power spectral density

7.1 Limit

According to FCC Part15.247 (e) requirement :

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.

7.2 Configuration of Measurement



7.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

The power spectrum density was measured from the antenna port of the EUT using a 50ohm spectrum analyzer with the resolution bandwidth set at 3kHz, video bandwidth set at 10kHz, span of 1.5MHz, and sweep time set at 500 seconds. Power Density was read directly correction was added to the reading to obtain power at the EUT antenna terminals. The test was performed at 3 channels (lowest, middle and highest).

7.4 Test Result

PASS.

The final test data is shown on as following pages.

Power spectral density

2.4GHz

802.11b				
CH	Freq. (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Margin (dB)
1	2412	-6.72	8	-14.72
6	2437	-8.34	8	-16.34
11	2462	-8.35	8	-16.35

802.11g				
CH	Freq. (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Margin (dB)
1	2412	-19.58	8	-27.58
6	2437	-19.47	8	-27.47
11	2462	-19.35	8	-27.35

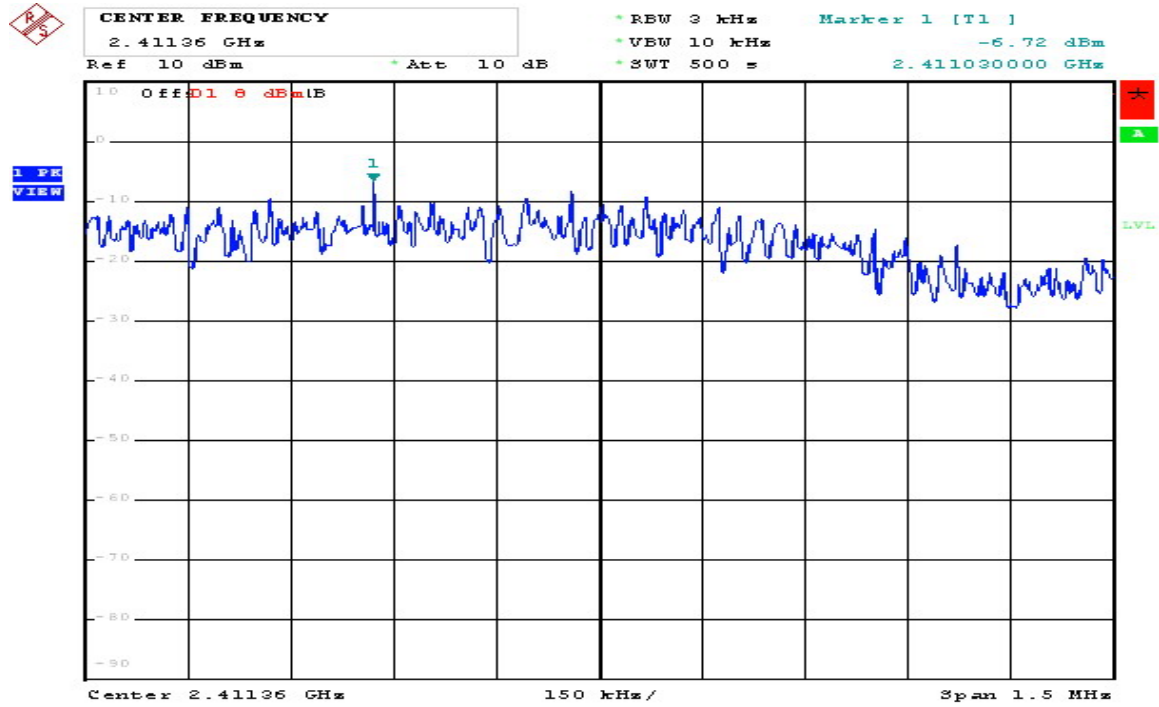
5GHz

802.11a				
CH	Temp. (°C)	Power Spectral Density (dBm)	Limit (dBm)	Margin (dB)
149	5745	-23.34	8	-31.34
157	5785	-23.62	8	-31.62
165	5825	-22.77	8	-30.77

Power spectral density

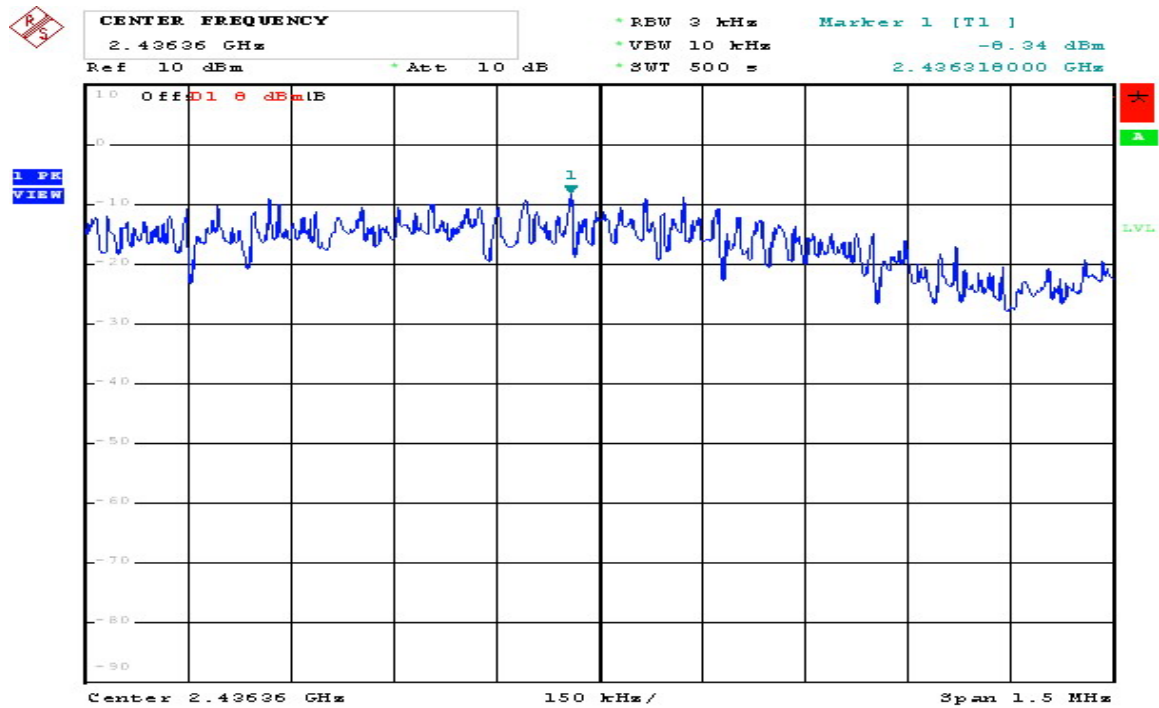
2.4GHz

802.11b CH1 2412MHz



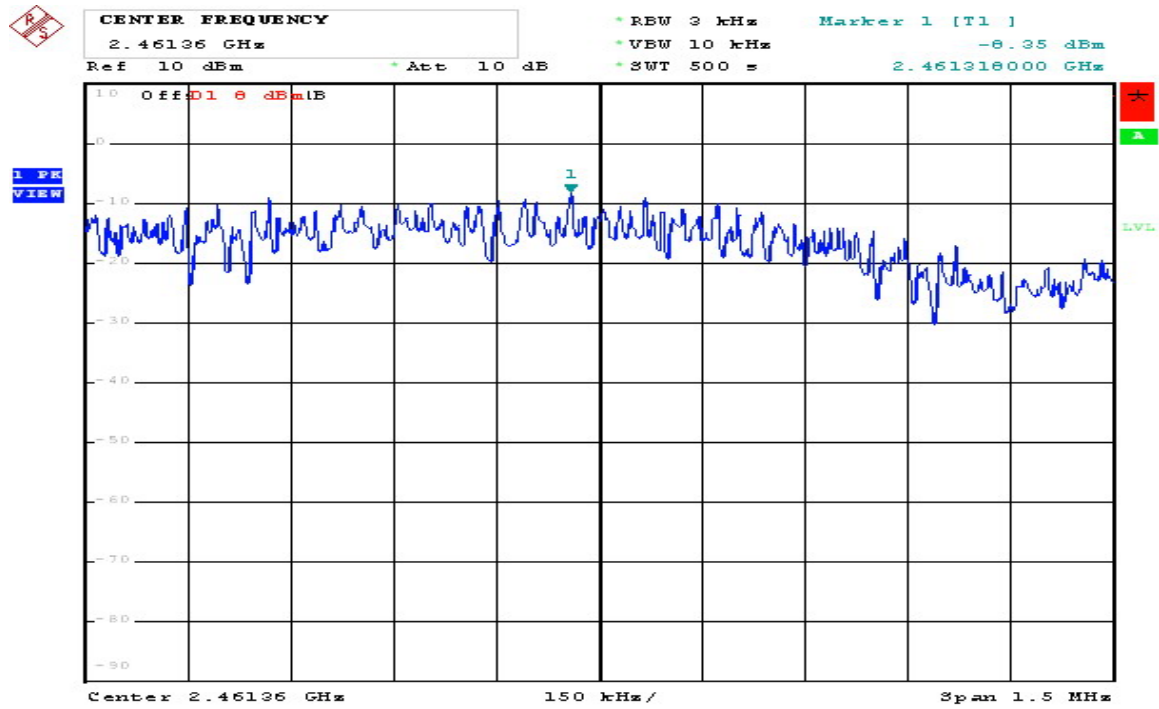
Comment: 802.11b 2412MHz
Date: 3.FEB.2009 12:12:00

802.11b CH6 2437MHz



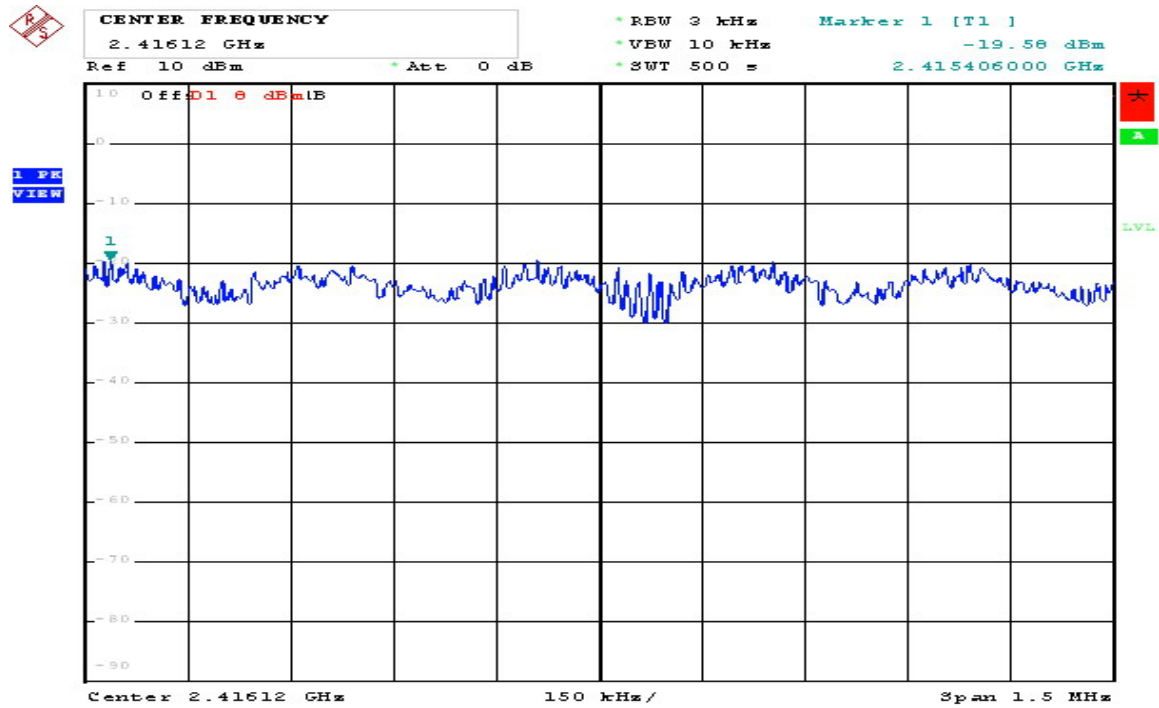
Comment: 802.11b 2437MHz
Date: 3.FEB.2009 12:21:52

802.11b CH11 2462MHz



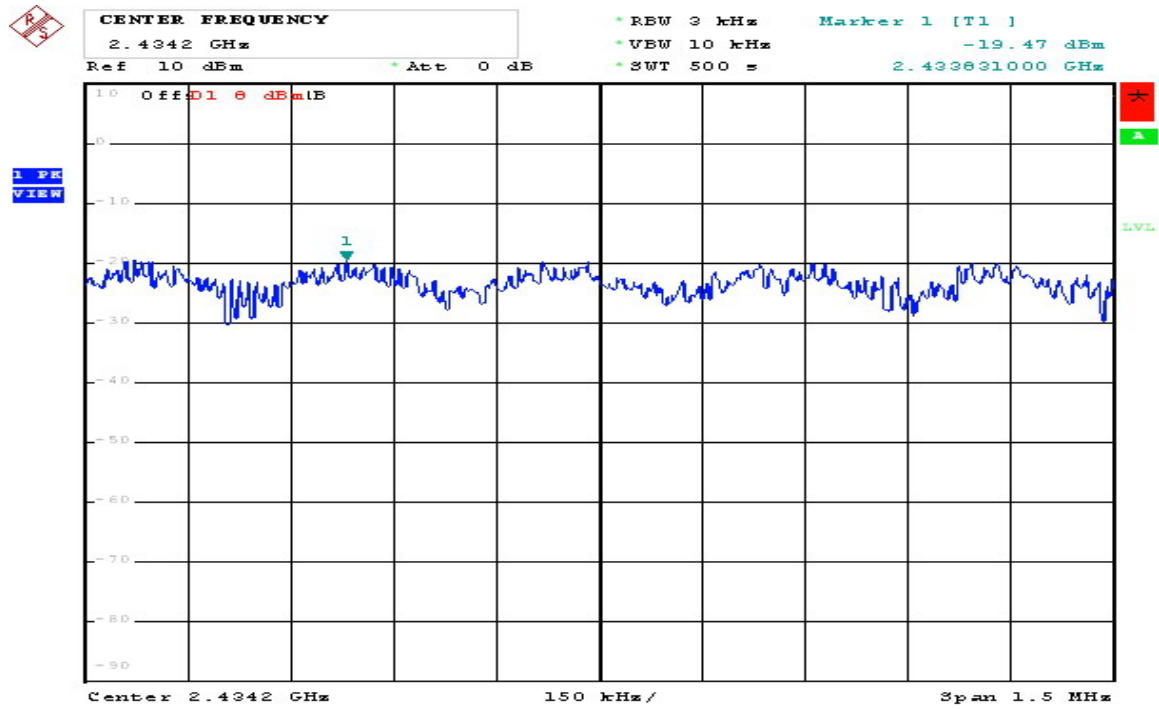
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Date: 3.FEB.2009 12:24:52

802.11g CH1 2412MHz



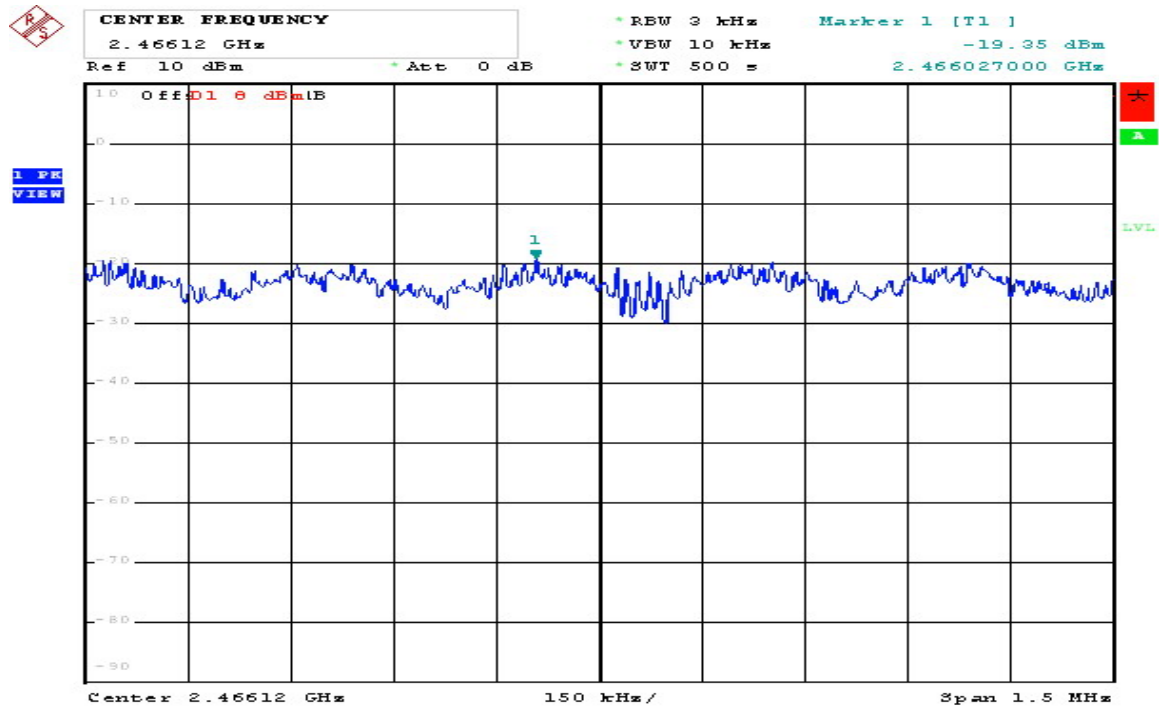
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Date: 3.FEB.2009 15:50:04

802.11g CH6 2437MHz



Comment: 802.11g 2437MHz
Date: 3.FEB.2009 15:47:56

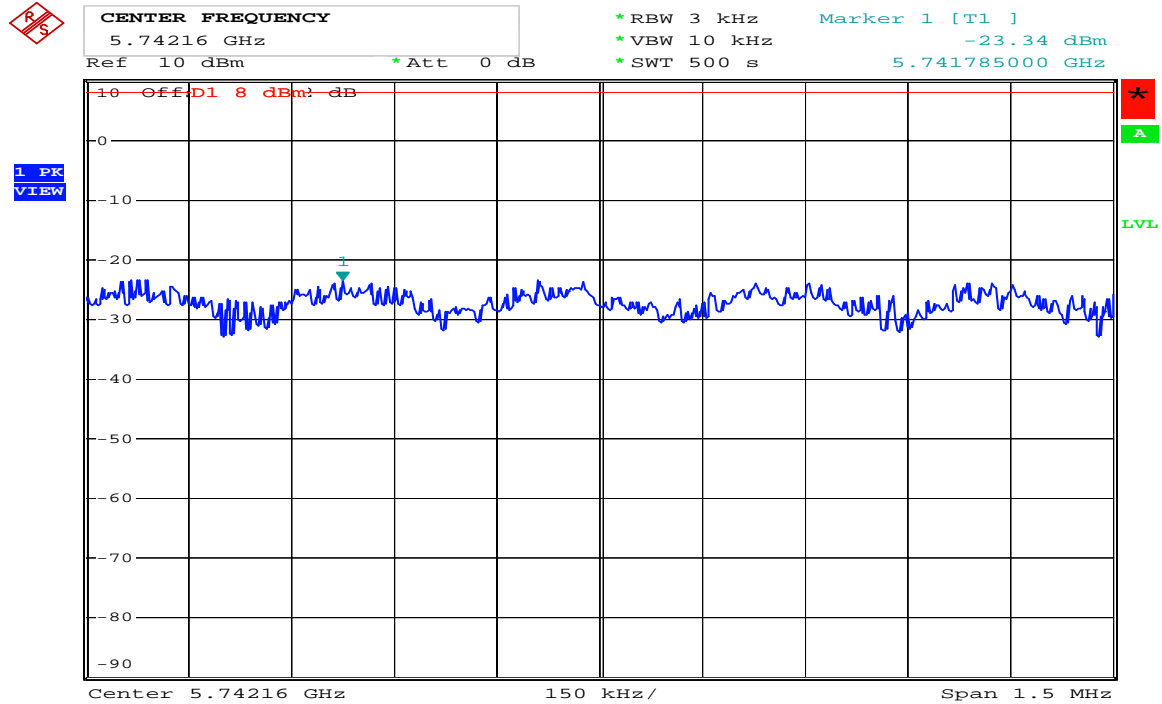
802.11g CH11 2462MHz



Comment: 802.11g 2462MHz
Date: 3.FEB.2009 15:36:49

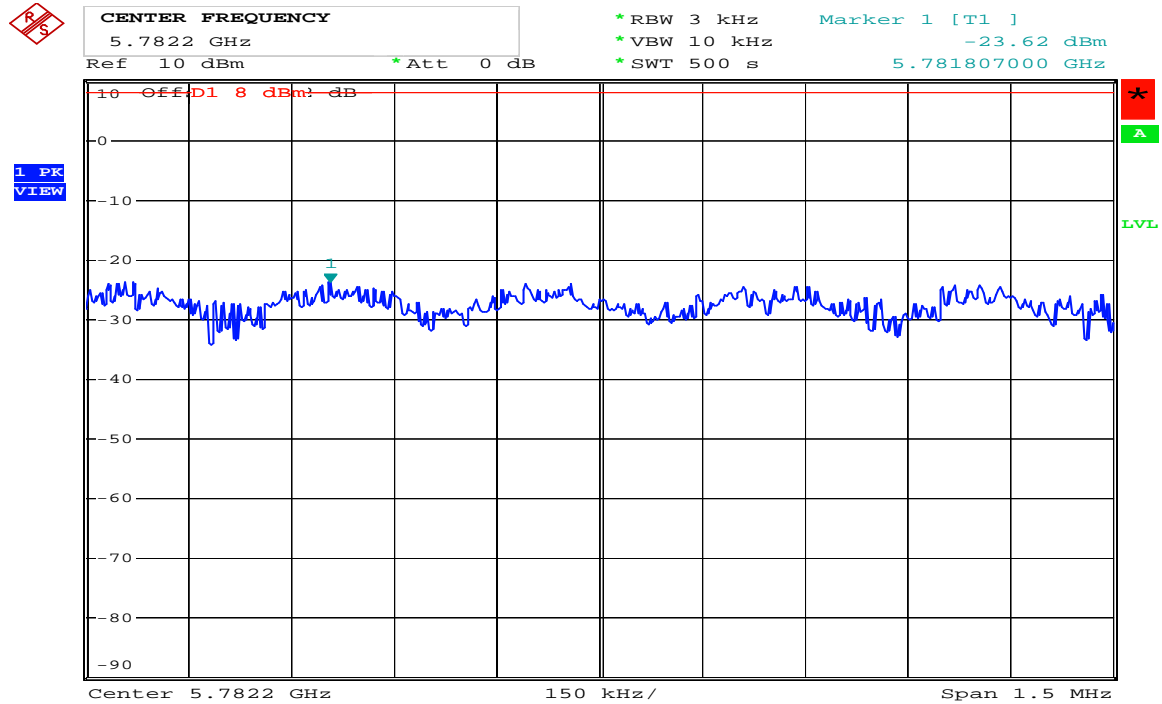
5GHz

802.11a CH149 5745MHz



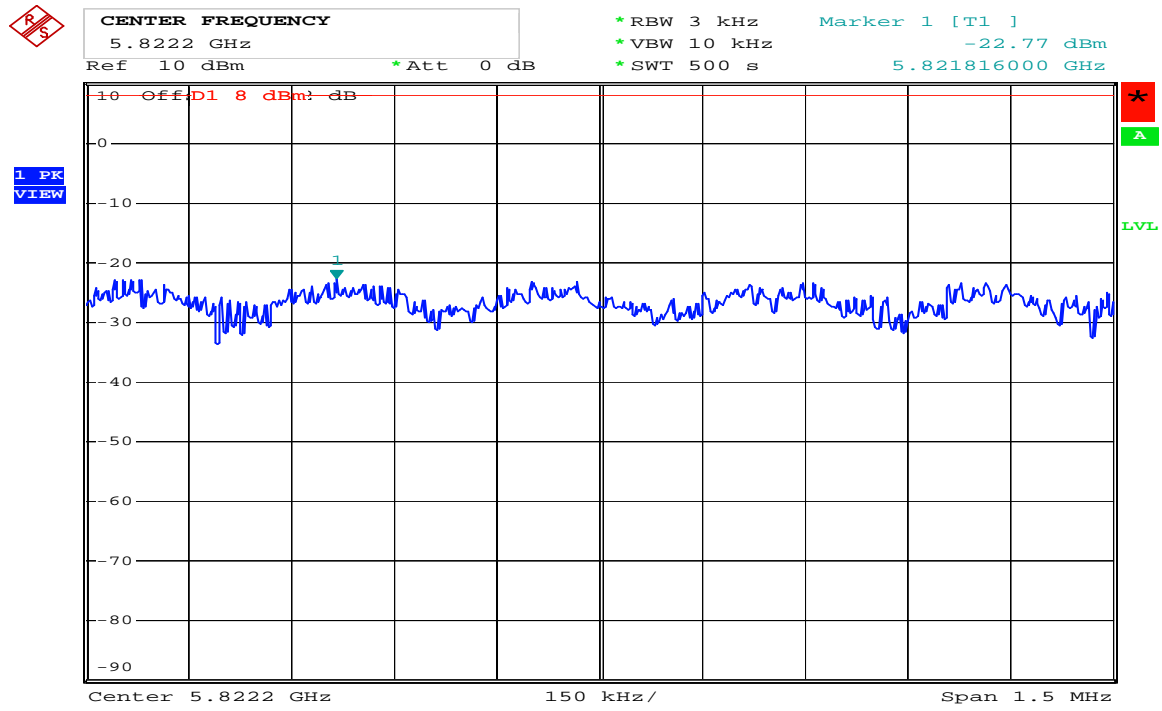
Comment: 802.11a 5745MHz
Date: 10.MAR.2009 09:27:56

802.11a CH157 5785MHz



Comment: 802.11a 5785MHz
Date: 10.MAR.2009 09:38:45

802.11a CH165 5825MHz



Comment: 802.11a 5825MHz
Date: 10.MAR.2009 09:43:04

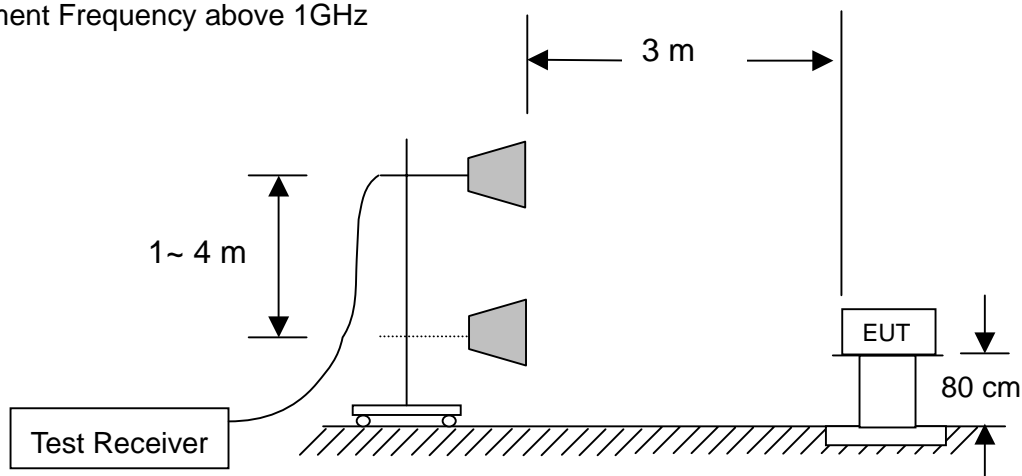
8 Emission on the Band Edge test

8.1 Limit

In any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

8.2 Configuration of Measurement

Measurement Frequency above 1GHz



8.3 Test Procedure

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

Set RBW =1M, VBW= RBW for peak, and VBW=10Hz for average.

The EUT for testing is arranged on a wooden turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meter and down to 1 meter.

8.4 Test Result

PASS.

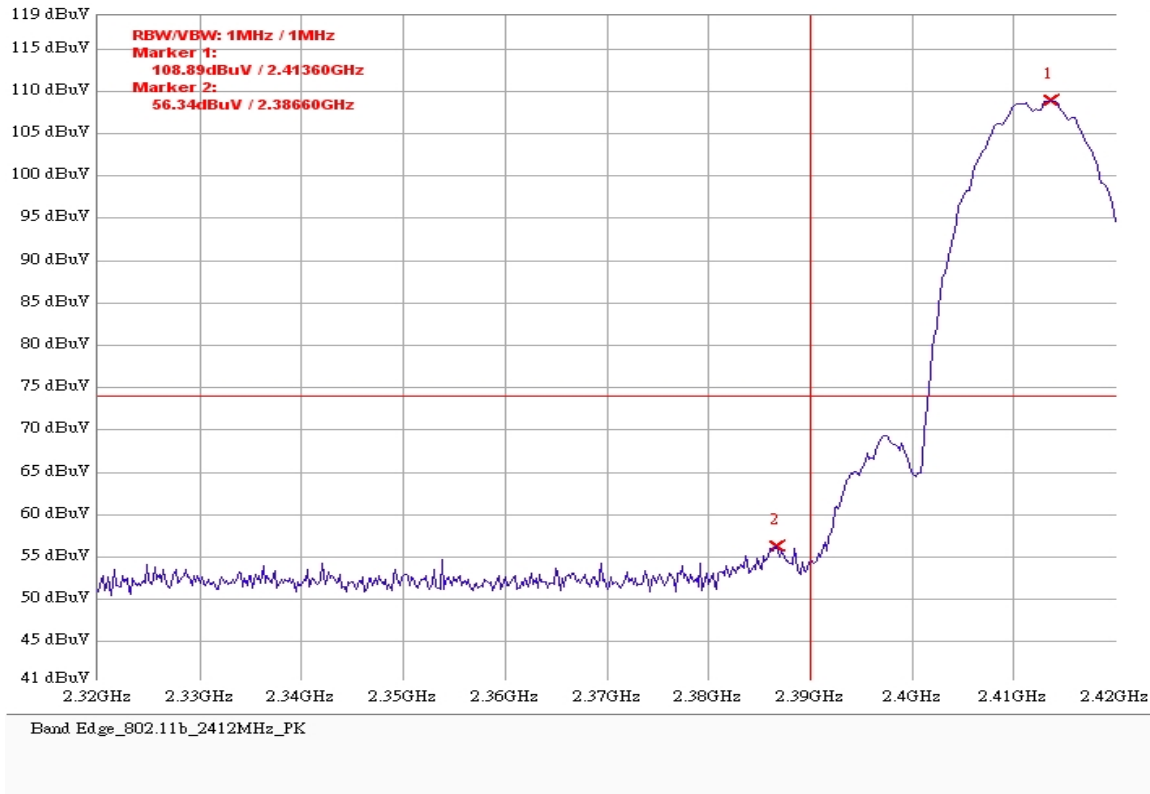
The final test data is shown on as following pages.

Band edge

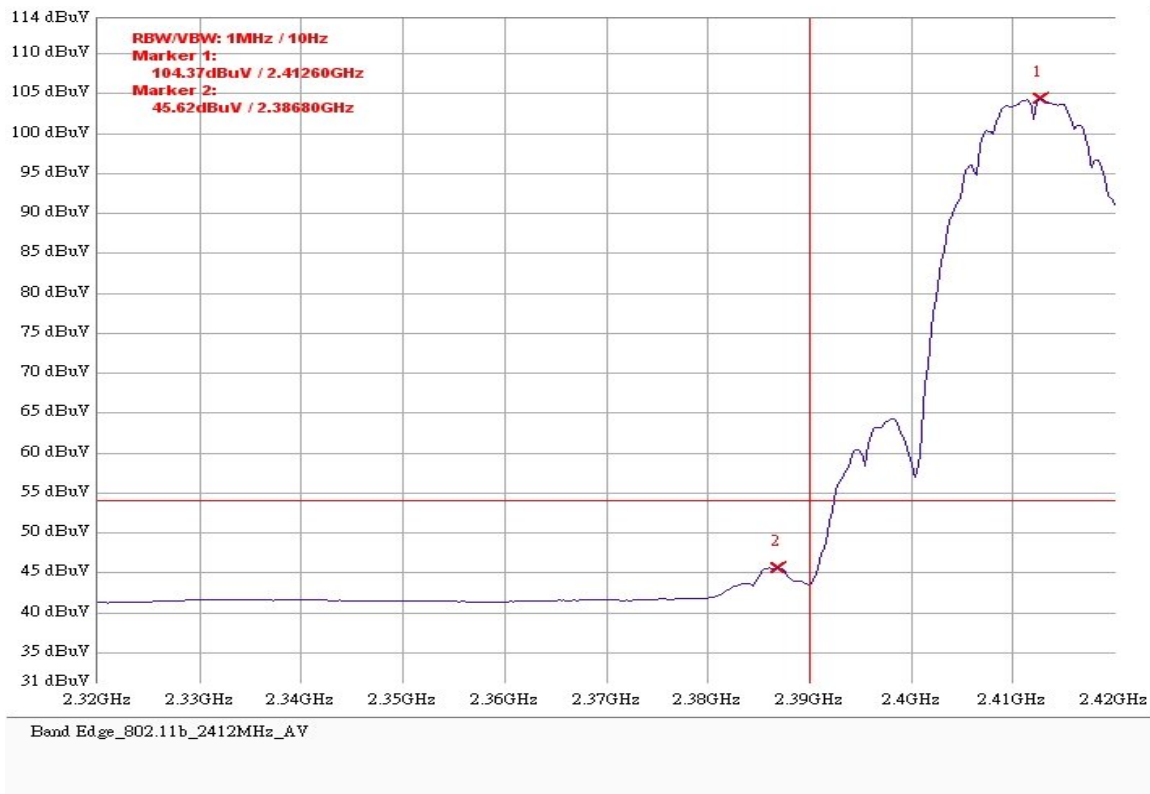
802.11b					
CH	Restrict Freq. Band (MHz)	Detector Mode	Maximum level (dB μ V/m)	Limit (dBm)	Margin (dB)
1	2310~2390	PK	56.34	74	-17.66
		AV	45.62	54	-8.38
11	2483.5~2500	PK	54.79	74	-19.21
		AV	42.78	54	-11.22

802.11g					
CH	Restrict Freq. Band (MHz)	Detector Mode	Maximum level (dB μ V/m)	Limit (dBm)	Margin (dB)
1	2310~2390	PK	63.88	74	-10.12
		AV	47.30	54	-6.70
11	2483.5~2500	PK	62.22	74	-11.78
		AV	45.18	54	-8.82

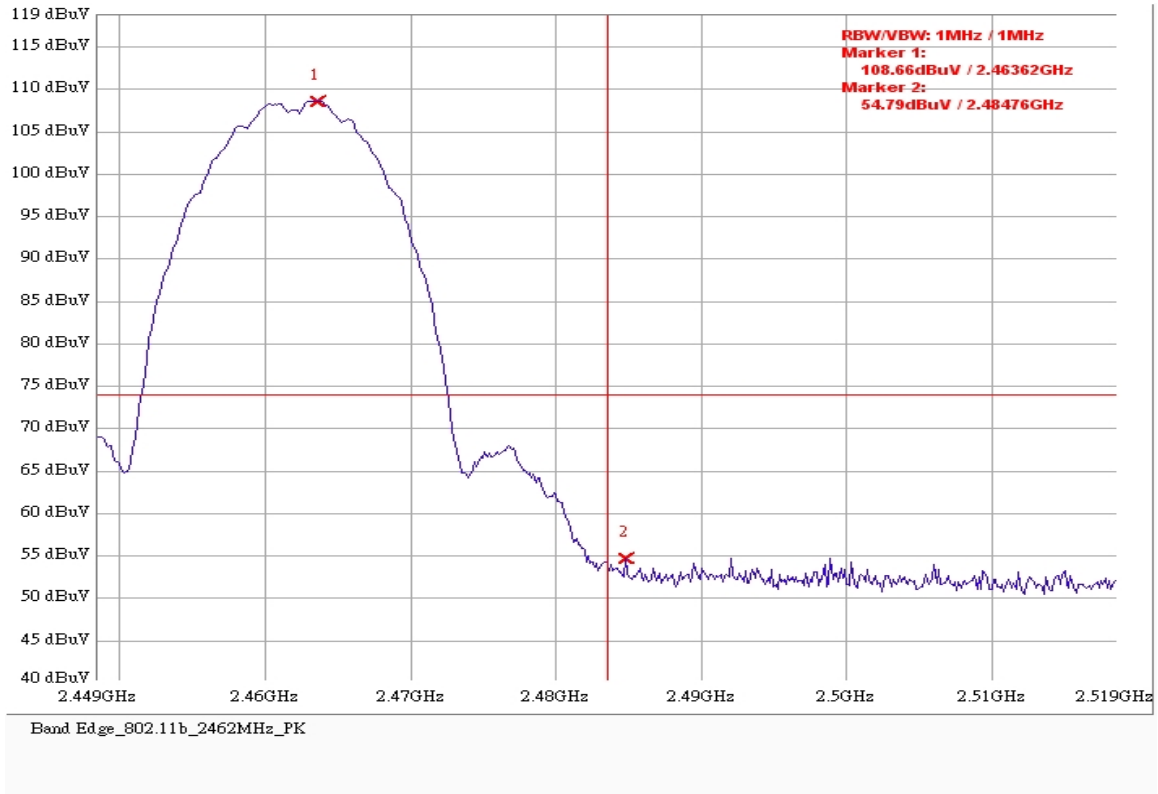
802.11b CH1 2412MHz PK



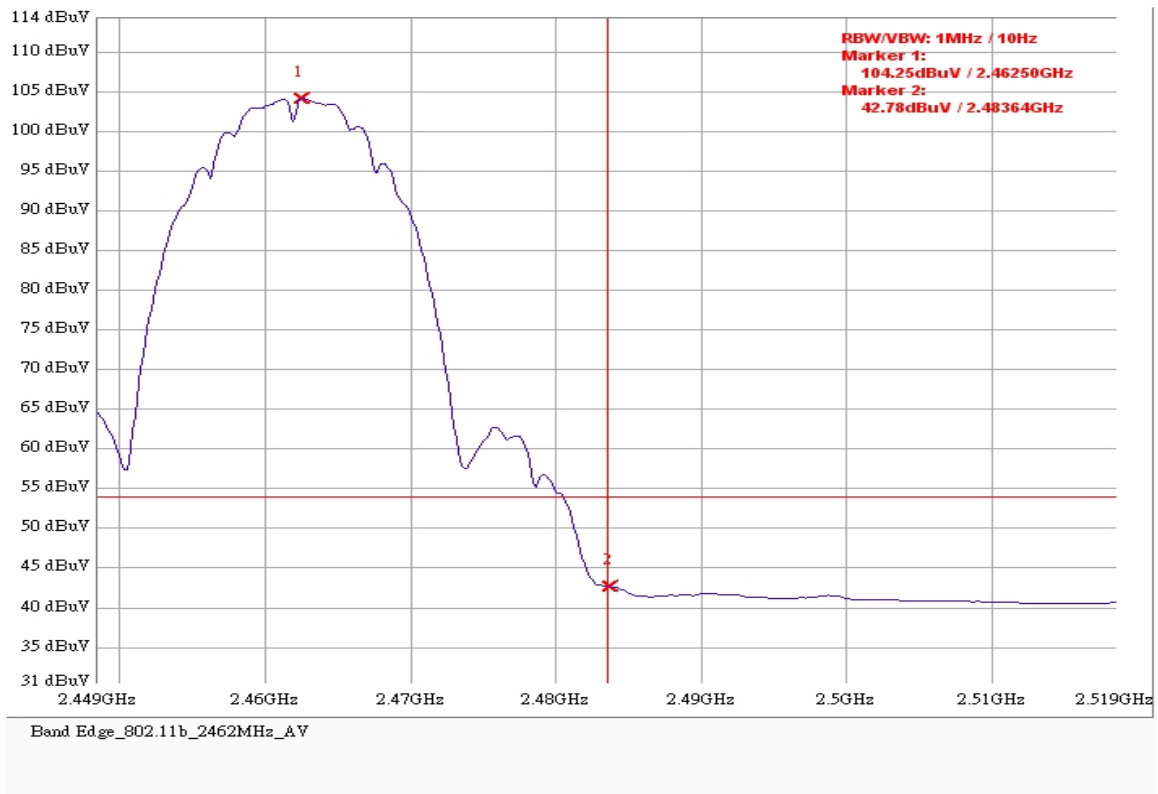
802.11b CH1 2412MHz AV



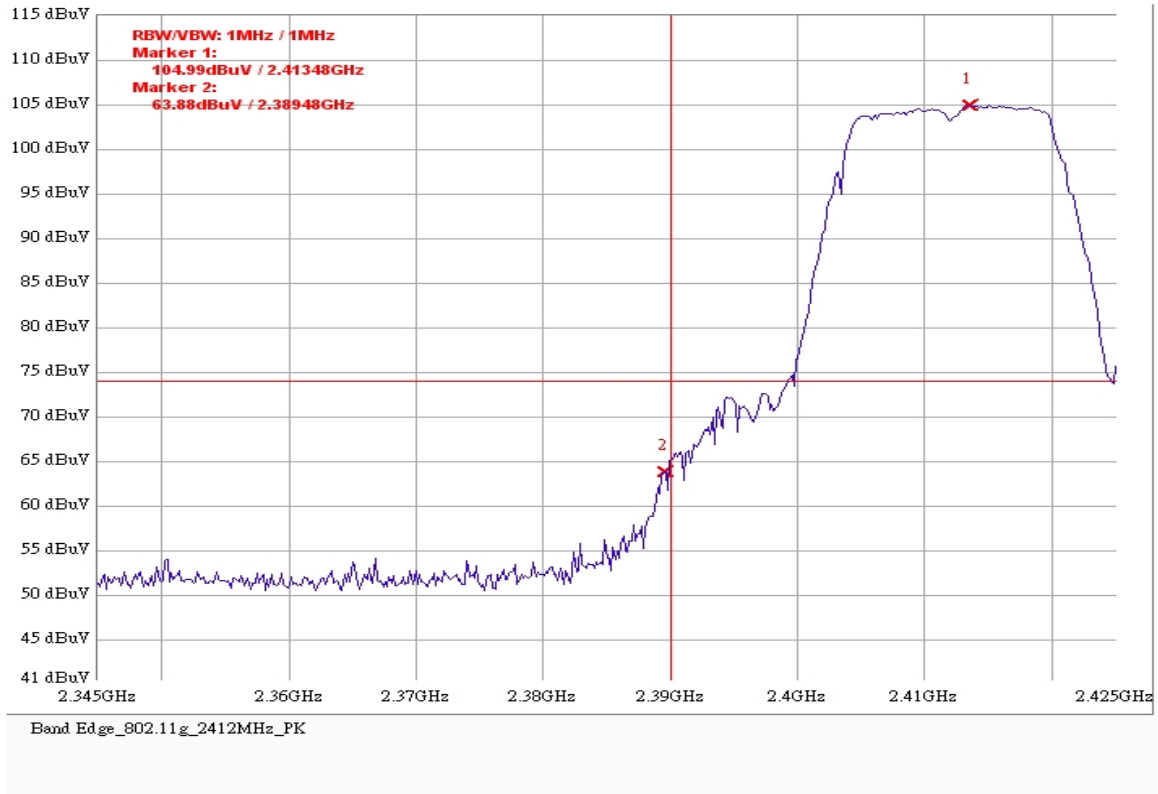
802.11b CH11 2462MHz PK



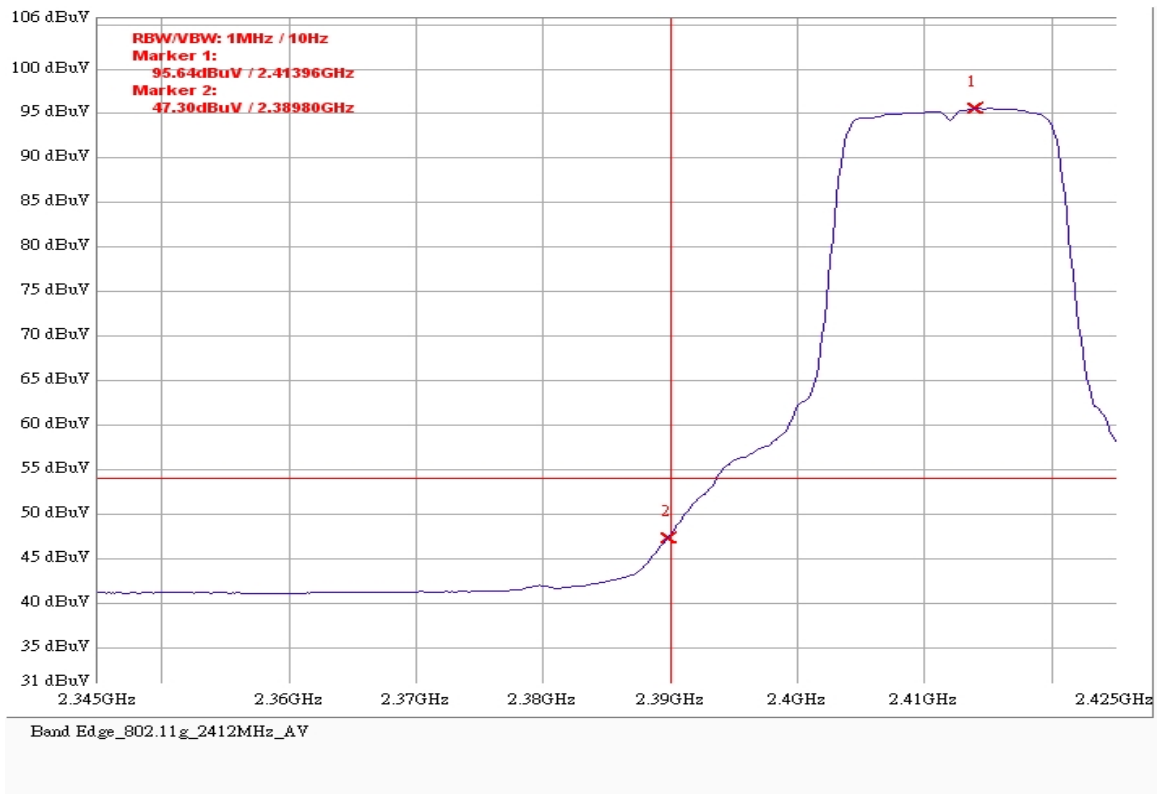
802.11b CH11 2462MHz AV



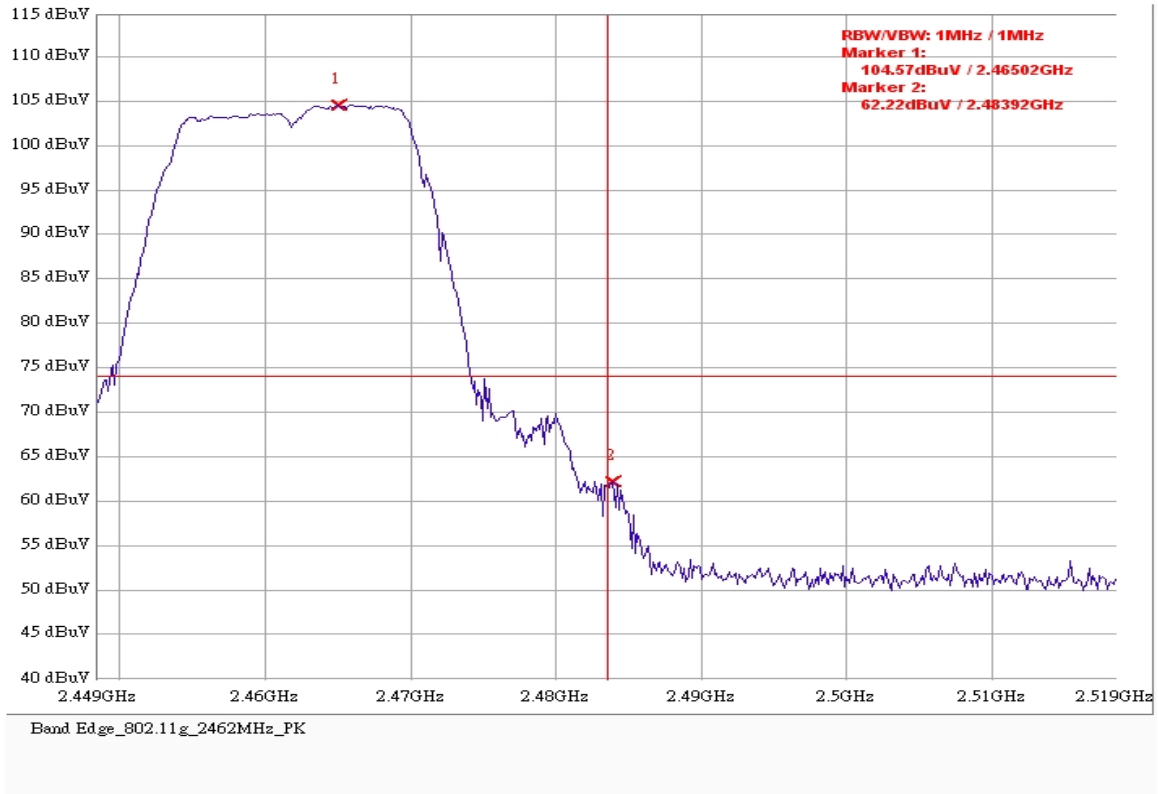
802.11g CH1 2412MHz PK



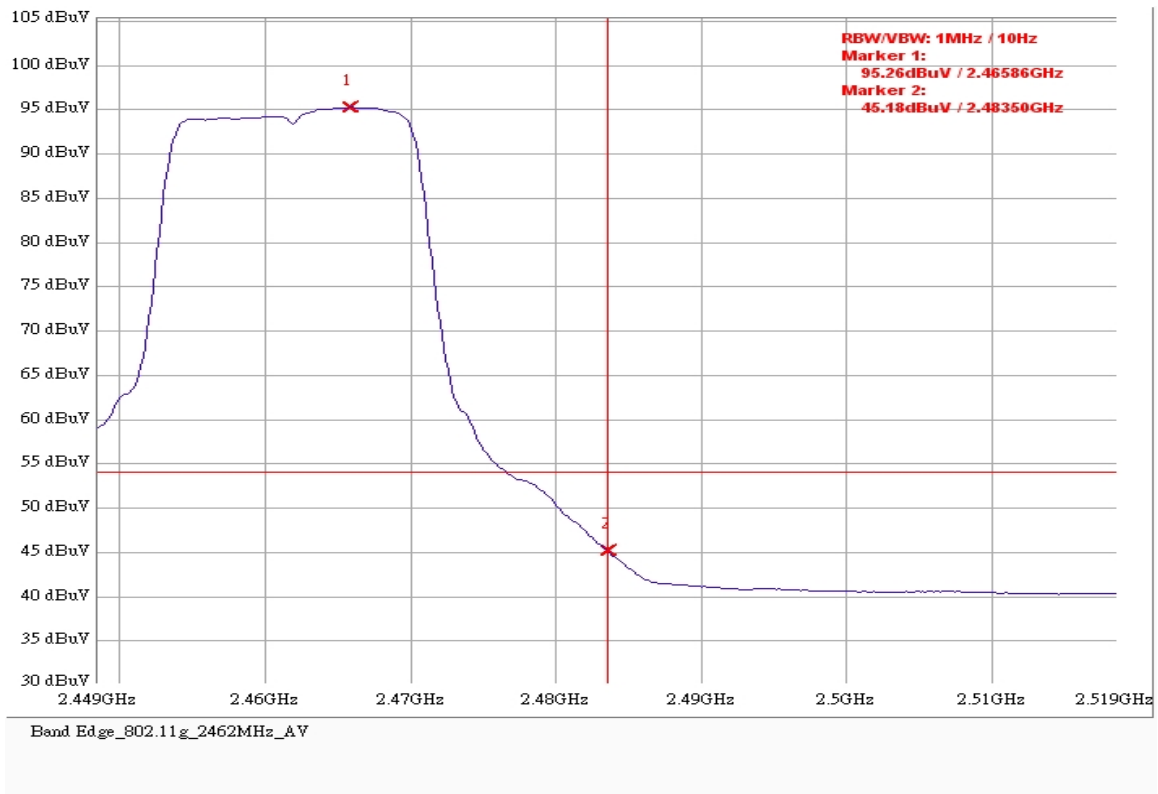
802.11g CH1 2412MHz AV



802.11g CH11 2462MHz PK



802.11g CH11 2462MHz AV



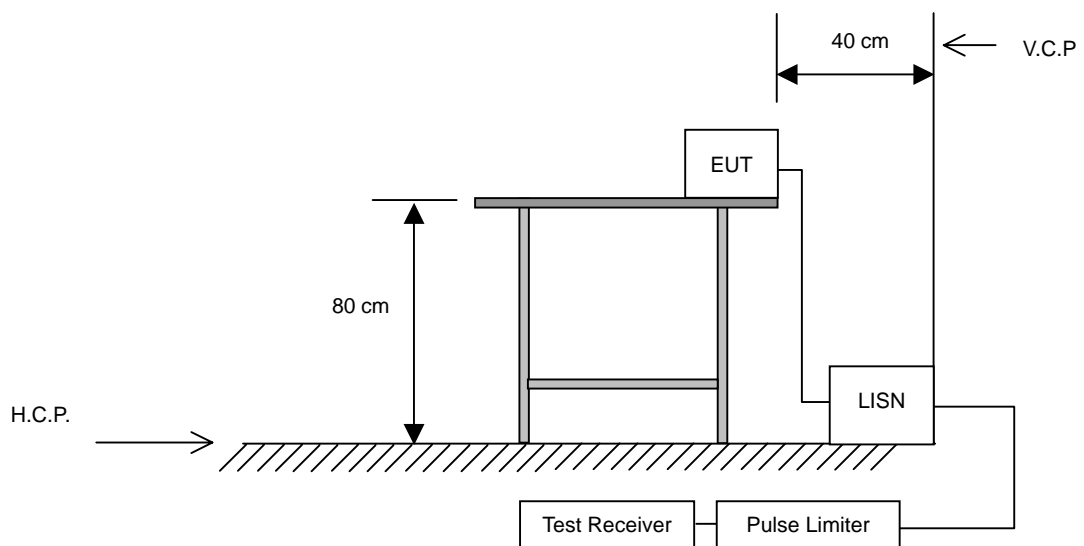
9 AC Power Line Conducted Emission test

9.1 Limit

Frequency (MHz)	Quasi-Peak (dB μ V)	Average (dB μ V)
0.15 to 0.5	66 to 56	56 to 46
> 0.5 to 5	56	46
> 5 to 30	60	50

NOTE: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

9.2 Configuration of Measurement



9.3 Test Procedures

The EUT was setup to ANSI C63.4, 2003; tested to DTS test procedure of Oct 2002 KDB558074 for compliance to FCC 47CFR 15.247 requirements.

- 1) The EUT was placed 80cm height above ground on a non-conductive table and vertical conducting plane located 40cm to the rear of the EUT.
- 2) The EUT was connected to the main power through Line Impedance Stabilization Networks (LISN). This setup provided a 50ohm/50mH coupling impedance for the measuring equipment. The auxiliary equipment will place in secondary LISN.
- 3) Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4/2003 on conducted measurement.

9.4 Test Result

PASS.

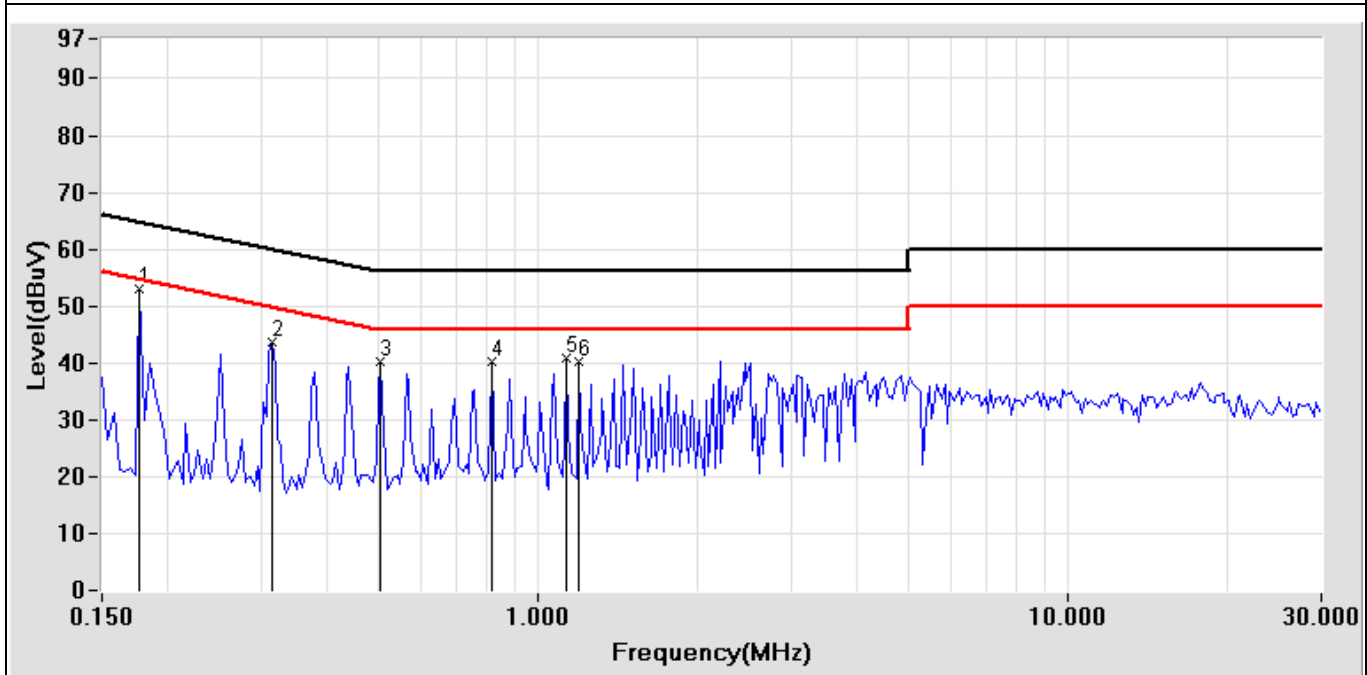
The final test data is shown on as following pages.

Power Line Conducted Test Data

EUT: RISC-based Ready-to-Run Wireless Embedded Computer CLIENT: MOXA MODEL: W311 RATING: 120V/60Hz Temperature: 18.0 °C Humidity: 65 %	POLARITY: Line DISTANCE: Serial No.: FILE/DATA#: MOXA.emi/57 OPERATOR: Terry TEST SITE: Conduction1
---	--

Frequency (MHz)	Factor (dB)	Meter Reading (dBμV)		Emission Level (dBμV)		Limits (dBμV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.177	0.13	46.90	38.90	47.03	39.03	64.63	54.63	-17.60	-15.60
0.314	0.13	43.56	43.50	43.69	43.63	59.86	49.86	-16.17	-6.23
0.502	0.14	40.00	39.60	40.14	39.74	56.00	46.00	-15.86	-6.26
0.818	0.15	39.10	39.00	39.25	39.15	56.00	46.00	-16.75	-6.85
1.130	0.15	39.75	38.93	39.90	39.08	56.00	46.00	-16.10	-6.92
1.193	0.16	39.60	38.20	39.76	38.36	56.00	46.00	-16.24	-7.64

Remark:
 1. All readings are Quasi-Peak and Average values.
 2. Factor = Insertion Loss + Cable Loss.



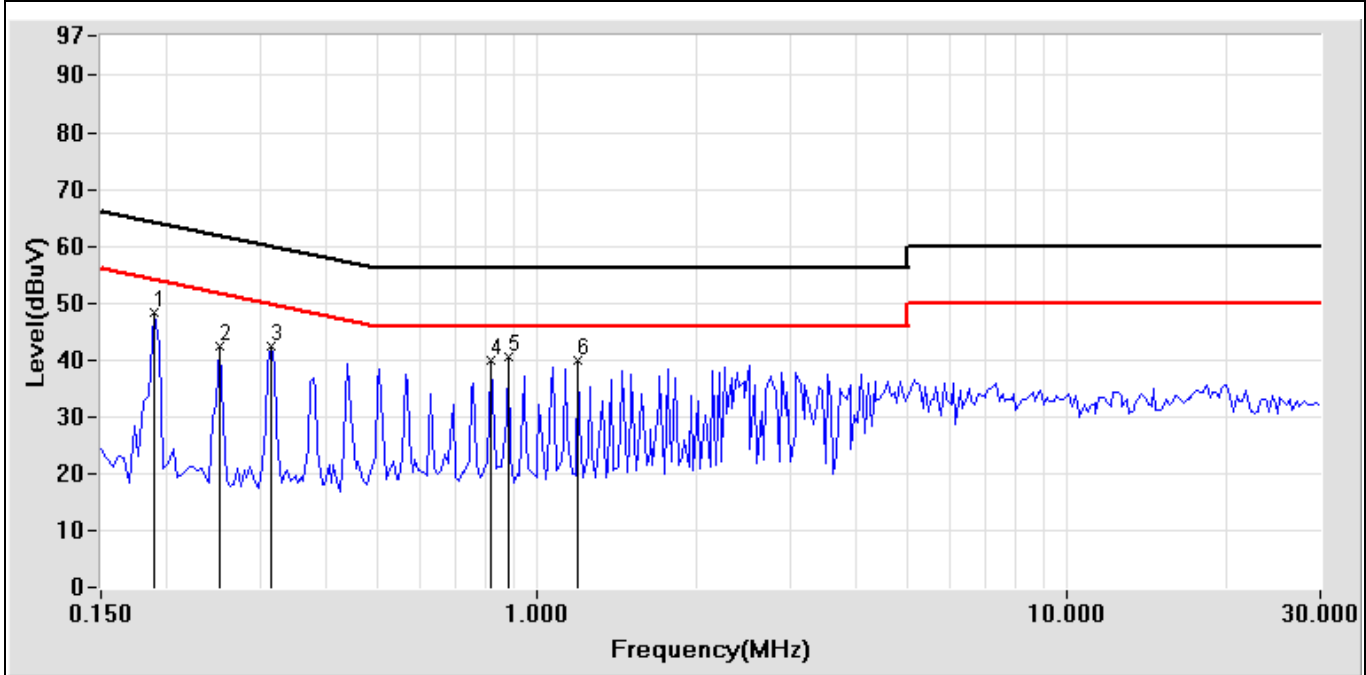
Test Mode: Mode 1: Working Mode

Power Line Conducted Test Data

EUT: RISC-based Ready-to-Run Wireless Embedded Computer CLIENT: MOXA MODEL: W311 RATING: 120V/60Hz Temperature: 18.0 °C Humidity: 65 %	POLARITY: Neutral DISTANCE: Serial No.: FILE/DATA#: MOXA.emi/56 OPERATOR: Terry TEST SITE: Conduction1
---	---

Frequency (MHz)	Factor (dB)	Meter Reading (dBµV)		Emission Level (dBµV)		Limits (dBµV)		Margin (dB)	
		Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average	Quasi-Peak	Average
0.189	0.13	46.78	38.26	46.91	38.39	64.08	54.08	-17.17	-15.69
0.252	0.13	40.95	35.12	41.08	35.25	61.69	51.69	-20.61	-16.44
0.314	0.13	42.18	41.92	42.31	42.05	59.86	49.86	-17.55	-7.81
0.818	0.15	38.90	38.90	39.05	39.05	56.00	46.00	-16.95	-6.95
0.880	0.15	39.46	38.80	39.61	38.95	56.00	46.00	-16.39	-7.05
1.193	0.16	40.04	38.80	40.20	38.96	56.00	46.00	-15.80	-7.04

Remark:
 1. All readings are Quasi-Peak and Average values.
 2. Factor = Insertion Loss + Cable Loss.



Test Mode: Mode 1: Working Mode

10 Photographs of Test

10.1 Power Line Conducted Emission Measurement



Front View

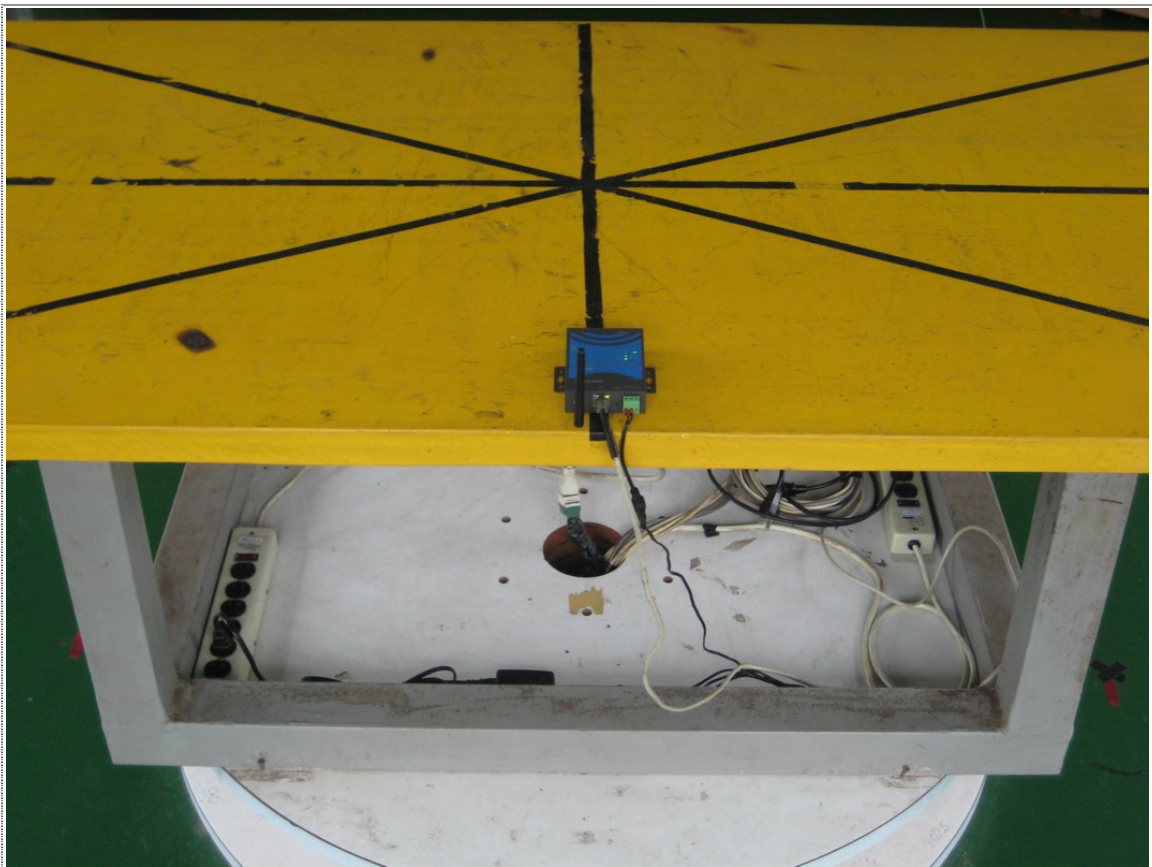


Rear View

10.2 Radiated Emission Measurement

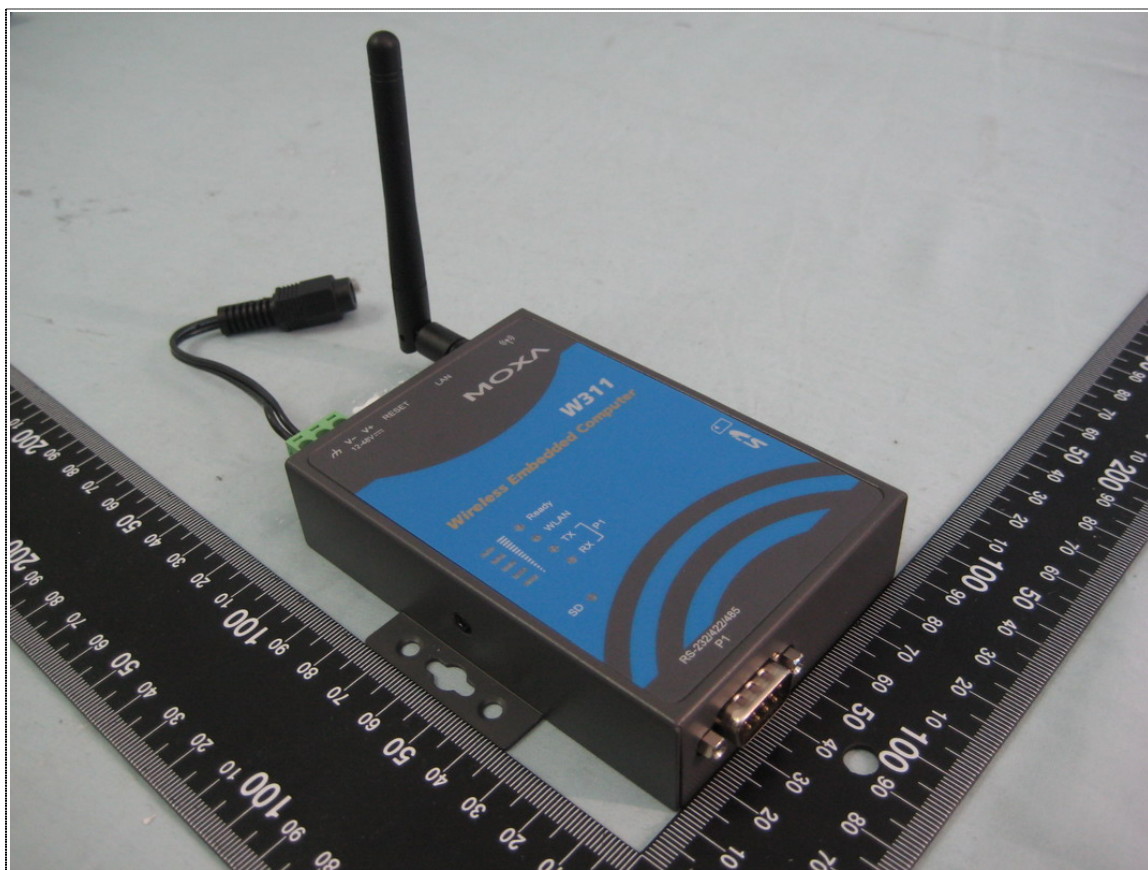


Front View

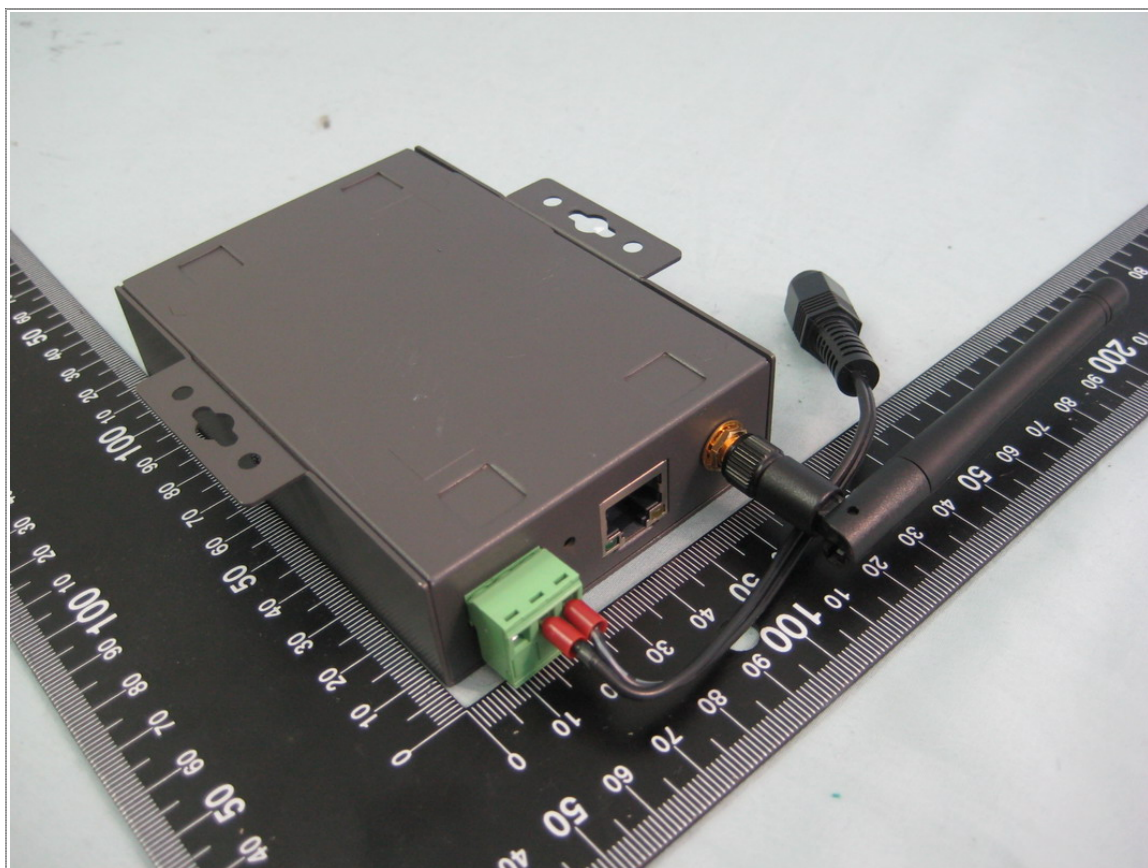


Rear View

11 Photographs of EUT



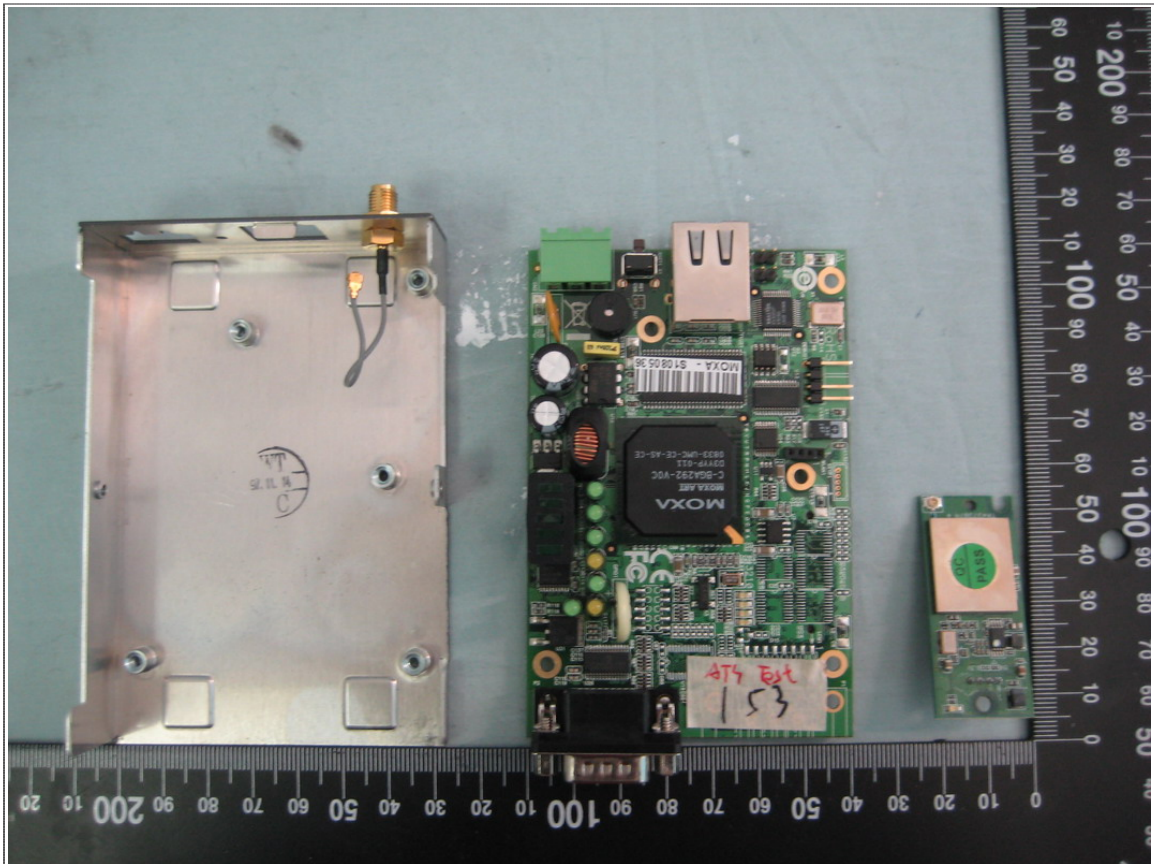
Front View of EUT



Rear View of EUT



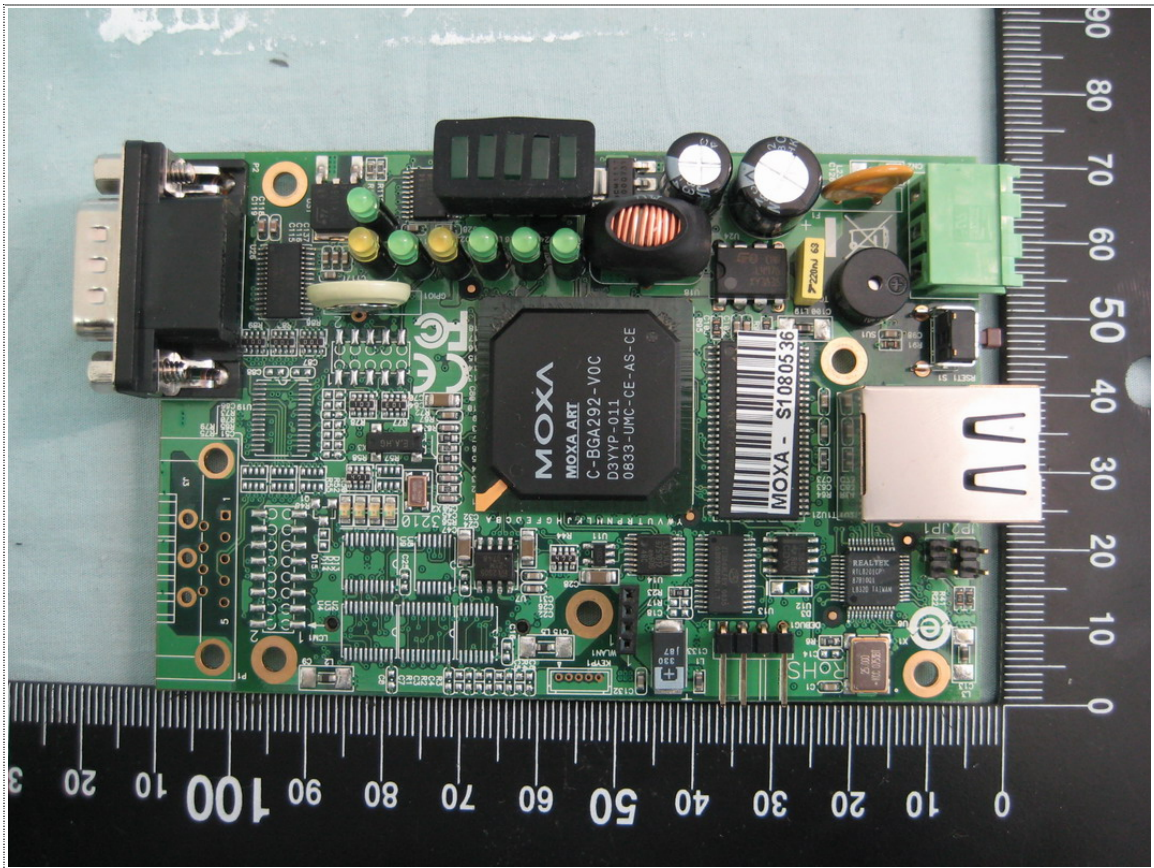
Inner View of EUT-1



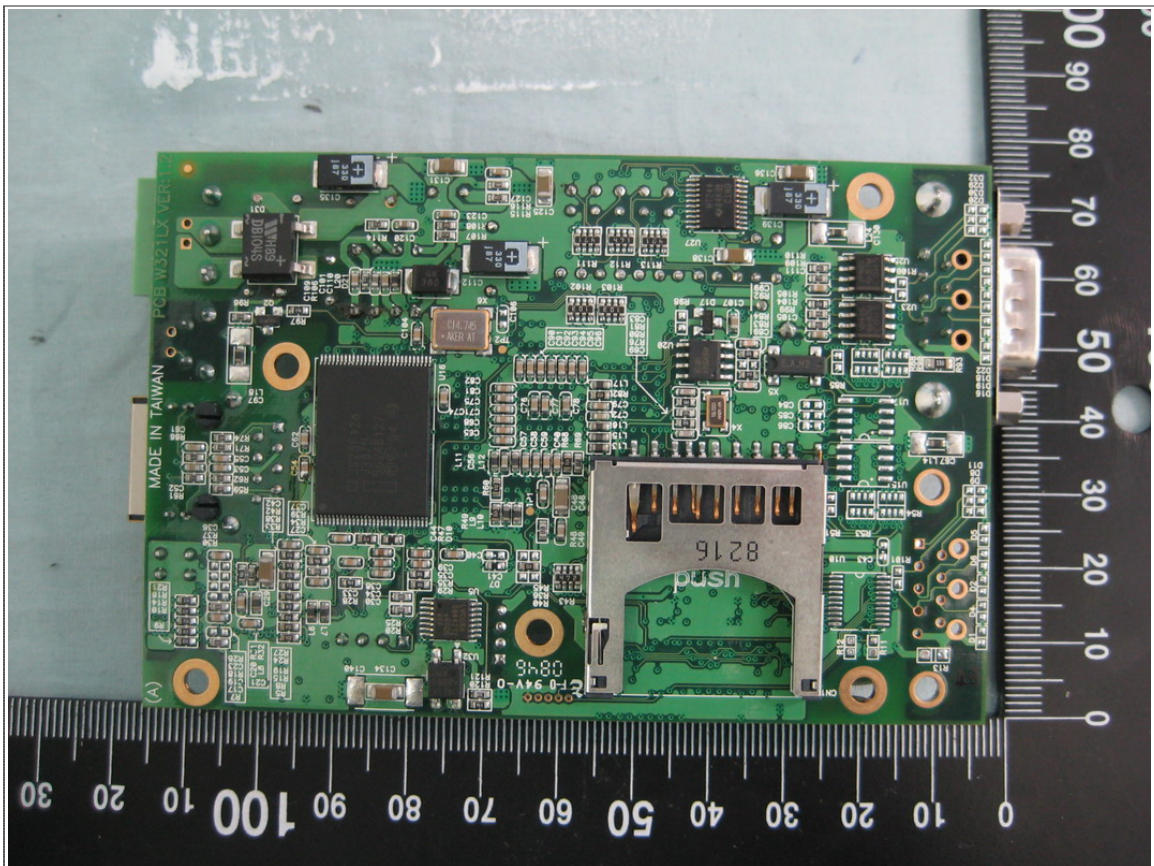
Inner View of EUT-2



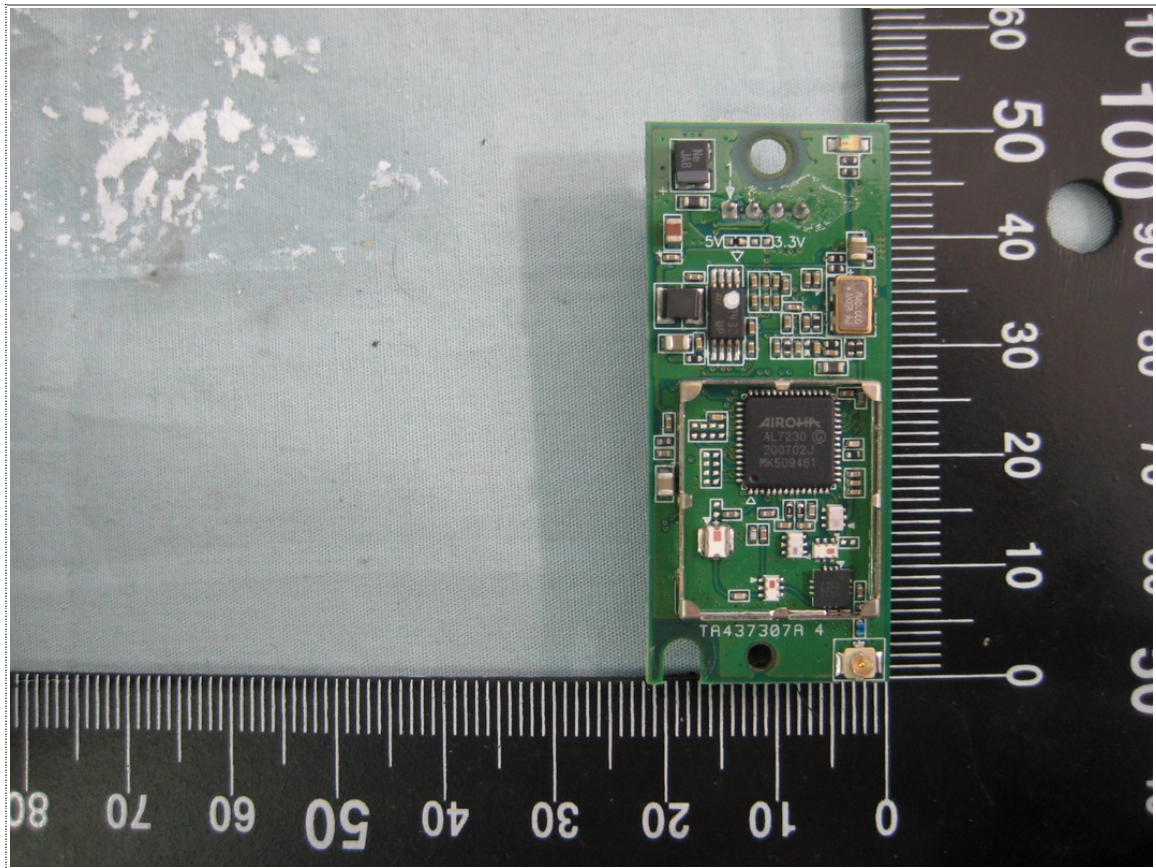
WLAN module Location



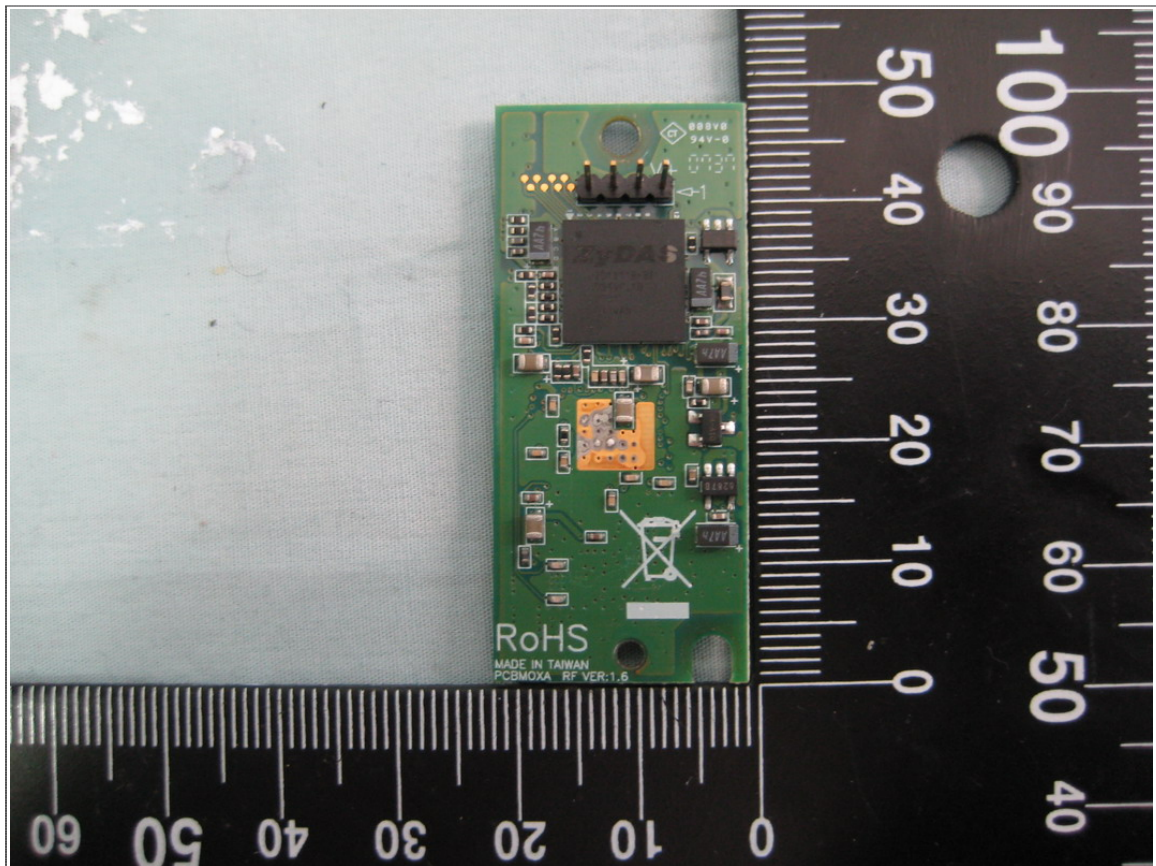
Front View of Main Board-1



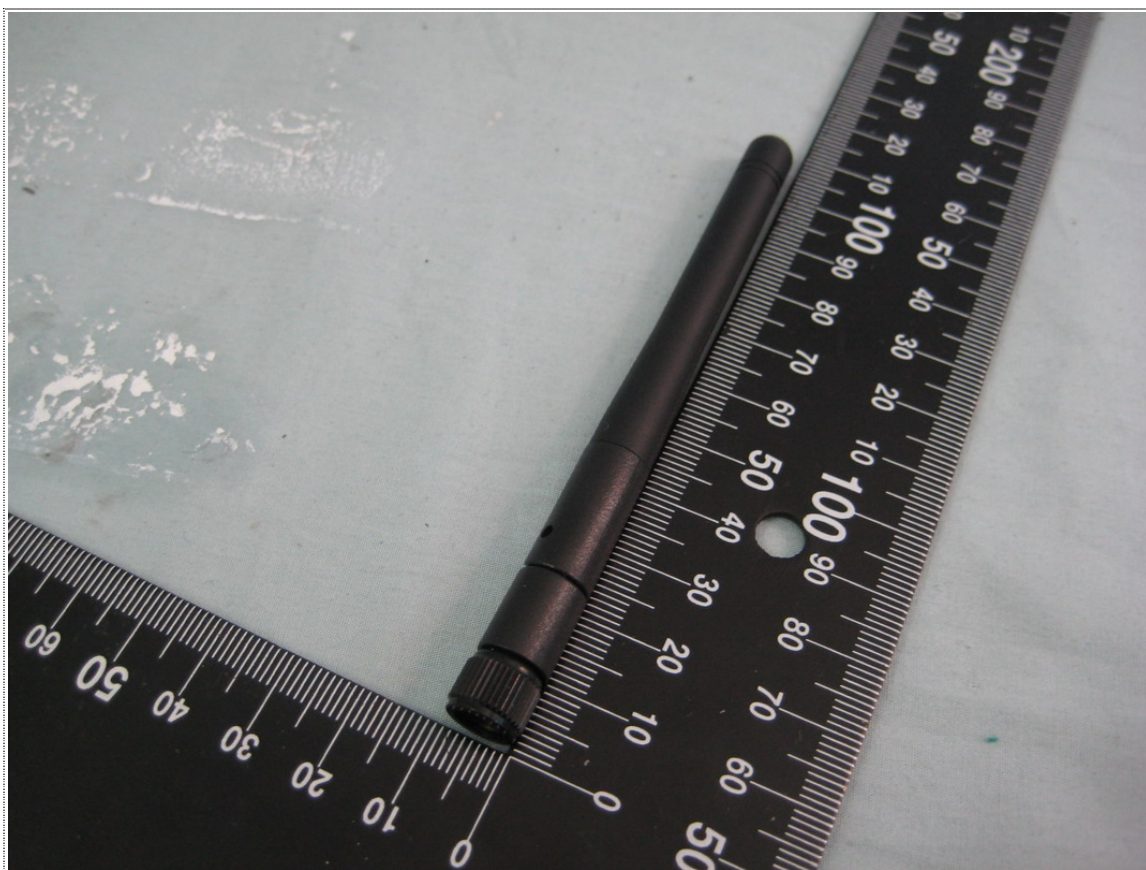
Rear View of Main Board-1



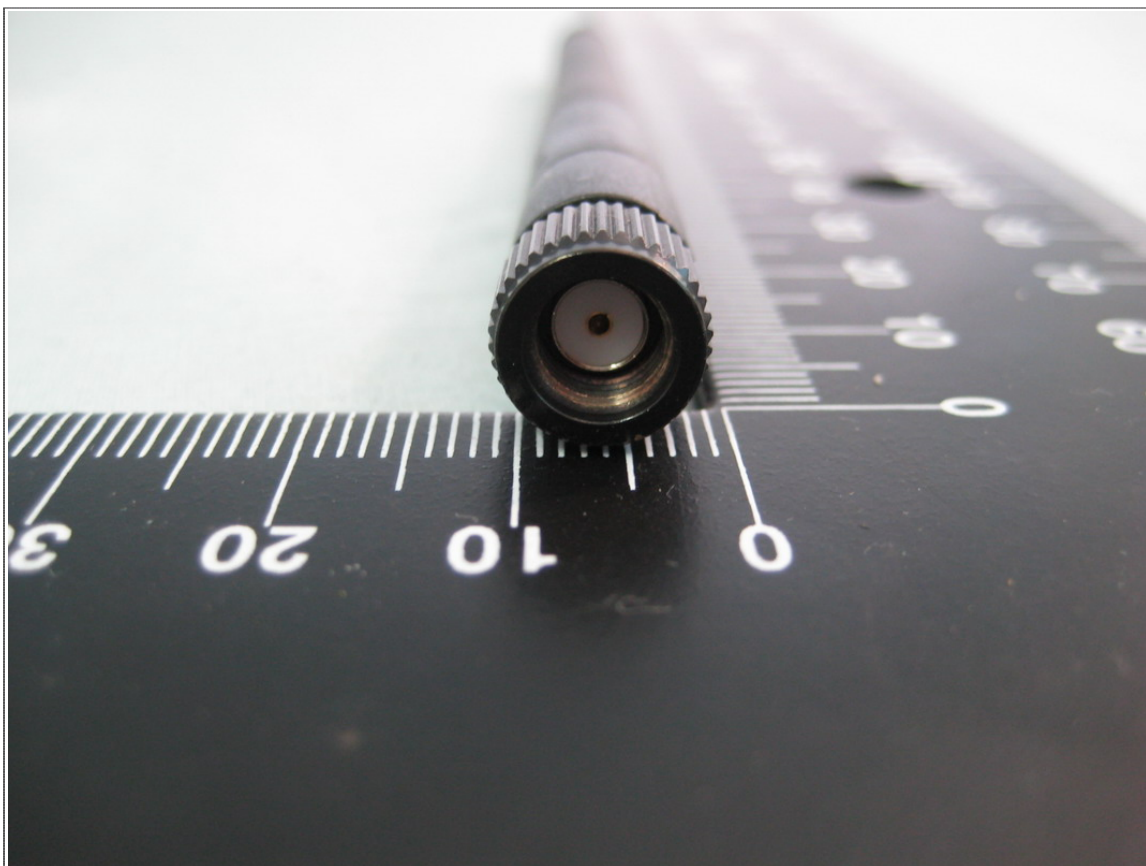
Front View of WLAN Board



Rear View of WLAN Board



View of Antenna



Antenna Connector



Spec. of Adapter

Maximum Permissible Exposure (MPE) Evaluation Report

Product : **RISC-based Ready-to-Run
Wireless Embedded Computer**
Model Number : W311; W311-LX; W321; W321-LX

Accordinging : FCC Guidelines for Human Exposure IEEE C95.1

Applicant : MOXA Inc.

Address : Fl.4, No.135, Lane 235, Pao-Chiao Rd., Shing Tien City,
Taipei, R.O.C.

Issued By : Interocean EMC Technology Corp.

LAB Location : 244 No.5-2, Lin 1, Tin-Fu Tsun, Lin-Kou Hsiang, Taipei
County, Taiwan, R.O.C.

The test report consists of 5 pages in total. It shall not be reproduced except in full, without the written approval of IETC. This document may be altered or revised by IETC only, and shall be noted in the revision section of the document. The test results in the report only to the tested sample.

Report Issued : 2009/03/19

Project Engineer : *Anya Lee*
Anya Lee

Approved : *Jerry Liu*
Jerry Liu

Table of Contents

1	Introduction	4
2	Classification	4
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4	Friis Formula	5
5	EUT Operating condition	5
6	Test Results	5

Summary of Tests

RISC-based Ready-to-Run Wireless Embedded Computer

Model: W311; W311-LX; W321; W321-LX

Test	Reference	Results
MPE Evaluation	FCC Guidelines for Human Exposure IEEE C95.1	Pass

RF Exposure Measurement (Fixed use Device)

1 Introduction

2.4GHz frequency band is regarded specially as a dangerous band for its heating harmfulness to the human body. That's why microwave oven is operating in this frequency band. The manufacturer whose product is working in this frequency band is obligatory to prove the harmfulness of his product.

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Fully Anechoic Chamber (FAC), and the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

2 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. Warning statement for keeping 20cm separation distance and the prohibition of operating next to a person has been printed on the user's manual. So, this product is classified as the Fixed use Device

3 RF Exposure Limit

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

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)
(A) Limits For Occupational / Control Exposures				
30-300	61.4	0.163	1.0	6
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
(B) Limits For General Population / Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1500	...	...	F/500	30
1500-100,000	...	...	1.0	30

F = Frequency in MHz

4 Friis Formula

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

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

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

5 EUT Operating condition

The software provided by Manufacturer enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

6 Test Results

Frequency (MHz)	Maximum Antenna gain (dBi)	Output power To antenna (dBm)	Power density (mW/cm ²)	Limit of Power density (mW/cm ²)
2412 to 2462	2	19.57	0.0286	1.0
5745 to 5825	2	13.90	0.0077	1.0
5150 to 5250	2	13.28	0.0067	1.0

The minimum allowable distance is very close to the enclosure of the antenna. So, the user has no need to worry about the harmfulness of radiation. But it is recommended to always keep, at least, 20cm separation distance with the antenna.