Nemko Test Report:	140724-3TRFWL
Applicant:	BelAir Networks Inc. 603 March Road, Ottawa, ON K2K 2M5 Canada
Apparatus:	DRU
FCC ID:	RAR30005001
In Accordance With:	FCC Part 15 Subpart C, 15.247 FHSS System and Digitally Modulated Radiators 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
Authorized By:	Andrey Adelberg, Senior Wireless/EMC Specialist
Date:	March 1, 2010
Total Number of Pages:	26

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TABLE OF CONTENTS

Section 1 : Report Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003.

The assessment summary is as follows:

Apparatus Assessed:	DRU
Specification:	FCC Part 15 Subpart C, 15.247
Compliance Status:	Complies
Exclusions:	None
Non-compliances:	None
Report Release History:	Original Release
Test Location:	Nemko Canada Inc. 303 River Road Ottawa, Ontario K1V 1H2
Registration Number:	176392 (3 m Semi-Anechoic Chamber)
Tests Performed By:	Kevin Ma, Wireless/EMC Specialist
Test Dates:	January 2010

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Section 2 : Equipment Under Test

2.1 Identification of Equipment Under Test (EUT)

The following information identifies the EUT under test:

Type of Equipment:	DRU 5 GHz Radio Module
Brand Name:	BelAir
Model Name:	DRU
Model Number:	B2CH113AA-A
Nemko Sample Number:	1
FCC ID:	RAR30005001
Date of Receipt:	January 18, 2010

2.2 Accessories

The following information identifies accessories used to exercise the EUT during testing:

Description:	DC power supply
Brand Name:	BelAir
Model Name or Number:	SDS60US05B-XD0034A
Serial Number:	05455686
Nemko Sample Number:	1
Connection Port:	DC port

Description:	Laptop
Brand Name:	DELL
Model Name or Number:	Latitude D600
Nemko Sample Number:	2
Connection Port:	Ethernet connection

2.3 EUT Description

The EUT is a MIMO WiFi module designed to operate in the 2.4–2.4835 GHz band, and 5.725–5.85 GHz band, 2×3 MIMO for 2.4 GHz, and 2×2 MIMO for 5 GHz.

There are two independent radio units. This report covers the 5 GHz radio, FCC ID: RAR30005001. The 2.4 GHz radio is assessed under FCC ID: RAR30002001.

2.4 Technical Specifications of the EUT

Operating Band: 5725–5850 MHz

Operating Frequency: 5740–5835 MHz

Modulation: 802.11 a & n

Channel Bandwidth: 20 MHz

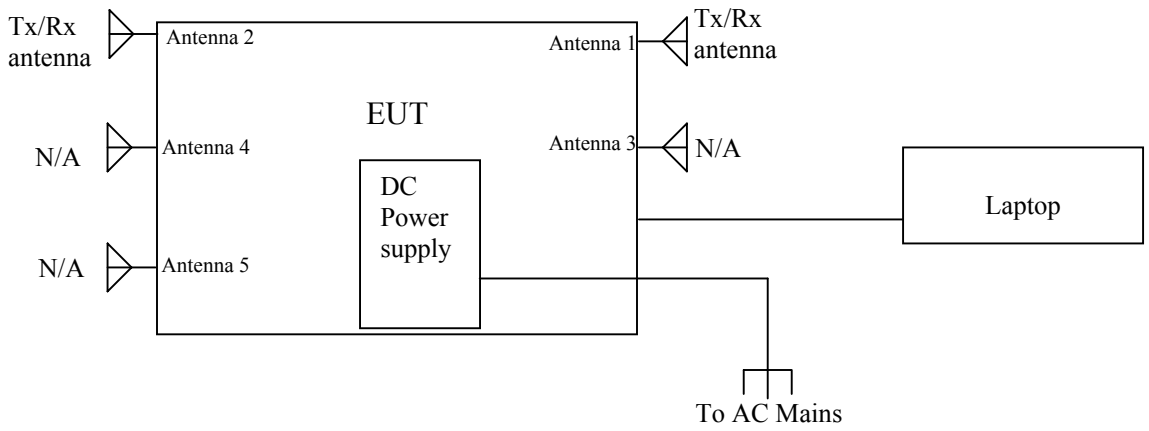
Emission Designator: 20M0W7D

Antenna Data:
1. 7 dBi, BelAir Omni directional antenna, BMAG00287-A
2. 15 dBi, BelAir Directional antenna, BMDG30083-A01

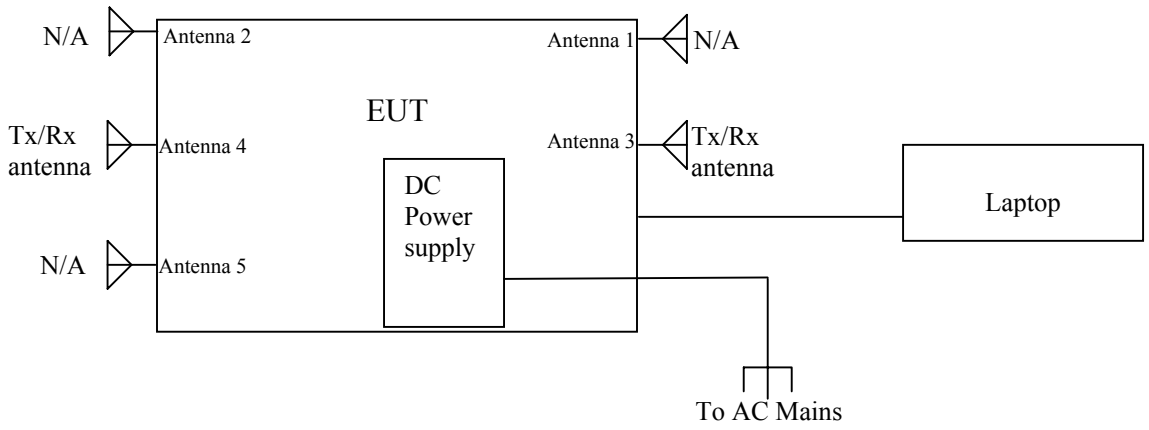
Power Supply Requirements: 120 VAC, 60 Hz

2.5 EUT Setup diagram

Dual-band Omni directional antenna setup:



5 GHz Single band antenna setup:



2.6 Operation of the EUT during testing

The EUT was controlled to transmit at desired frequency from laptop.

2.7 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

Section 3 : Test Conditions

3.1 Specifications

The apparatus was assessed against the following specifications:

FCC Part 15 Subpart C, 15.247
FHSS System and Digitally Modulated Radiators
902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

3.2 Deviations From Laboratory Test Procedures

No deviations were made from laboratory test procedures.

3.3 Test Environment

All tests were performed under the following environmental conditions:

Temperature range	:	15–30 °C
Humidity range	:	20–75 %
Pressure range	:	86–106 kPa
Power supply range	:	±5 % of rated voltages

3.4 Measurement Uncertainty

Nemko Canada measurement uncertainty has been calculated using guidance of UKAS LAB 34:2003 and TIA-603-B Nov 7, 2002. All calculations have been performed to provide a confidence level of 95 % and can be found in Nemko Canada document MU-003.

3.5 Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Cal. Date	Next Cal.
3 m EMI Test Chamber	TDK	SAC-3	FA002047	May 06/09	May 06/10
Biconical	Sunol	BC2	FA002078	Nov. 12/09	Nov. 12/10
Log Periodic Antenna	Sunol	LP5	FA002077	Nov. 18/09	Nov. 18/10
Bilog	Sunol	JB3	FA002108	Jan. 18/10	Jan. 18/11
Flush Mount Turntable	Sunol	FM2022	FA002082	NCR	NCR
Controller	Sunol	SC104V	FA002060	NCR	NCR
Mast	Sunol	TLT2	FA002061	NCR	NCR
International Power Supply	California Inst.	3001i	FA001021	Jan. 13/09	Jan. 13/11
Spectrum Analyzer	Rohde & Schwarz	FSU46	FA001877	Sep. 29/09	Sep. 29/10
Horn Antenna #2	EMCO	3115	FA000825	Jan. 21/09	Jan. 21/11
1 – 18 GHz Amplifier	JCA	JCA118-503	FA002091	Oct 07/09	Oct 07/10
Receiver/Spectrum Analyzer	Rohde & Schwarz	ESU 40	FA002071	Nov. 30/09	Nov. 30/10
Horn 18 – 26.5 GHz	Electro-Metrics	SH-50/60-1	FA000479	COU	COU
Horn 26.5 – 40 GHz	Electro-Metrics	SH-50/60-2	FA000485	COU	COU
18.0 – 26.0 GHz Amplifier	NARDA	BBS-1826N612	FA001550	COU	COU
26 – 40.0 GHz Amplifier	NARDA	DBL-2640N610	FA001556	COU	COU
Multimeter	Fluke	16	FA001831	Jan 13/09	Jan 13/11
Air probe	Fluke	None	FA001248	NCR	NCR
Attenuator	Narda	776B-20	FA001153	COU	COU
Combiner	Mini-circuits	ZA3PD-4	FA001156	COU	COU

COU – Calibrate on Use
NCR – No Calibration Required

Section 4 : Results Summary

This section contains the following:

FCC Part 15 Subpart C : Test Results

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

N No : not applicable / not relevant.

Y Yes : Mandatory i.e. the apparatus shall conform to these tests.

N/T Not Tested, mandatory but not assessed. (See Report Summary)

4.1 FCC Part 15 Subpart C : Test Results

Part 15	Test Description	Required	Result
15.31(e)	Variation of power supply	Y	PASS
15.207(a)	Powerline Conducted Emissions	Y	PASS
15.209(a)	Radiated Emissions within Restricted Bands	Y	PASS
15.247(a)(1)	Frequency hopping systems	N	
15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	N	
15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	N	
15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	N	
15.247(a)(2)	6 dB BW for systems using digital modulation techniques	Y	PASS
15.247(b)(1)	Maximum peak output power of Frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	N	
15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	N	
15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Y	PASS
15.247(b)(4)	Maximum peak output power	Y	PASS
15.247(c)(1)	Fixed point-to-point Operation with directional antenna gains greater than 6 dBi	Y	PASS
15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	N	
15.247(d)	Conducted Spurious Emissions	Y	PASS
15.247(e)	Power Spectral Density for Digitally Modulated Devices	Y	PASS
15.247(f)	Time of Occupancy for Hybrid Systems	N	

Appendix A : Test Results

Clause 15.207(a) Powerline Conducted Emissions

Frequency of Conducted limit (dBµV)

Emission (MHz)	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

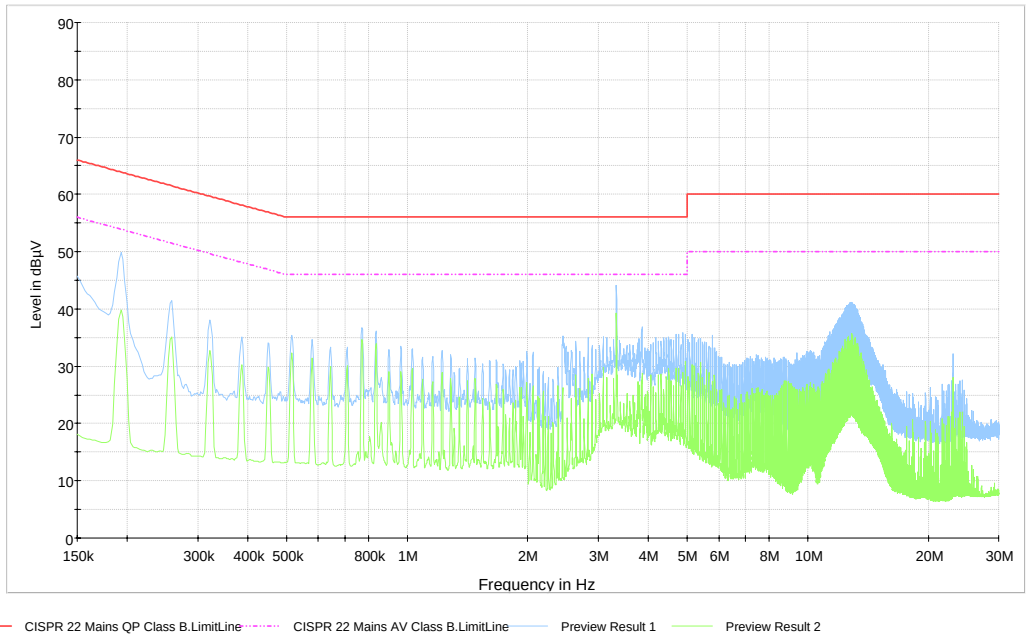
* Decreases with the logarithm of the frequency.

Test Results: Pass

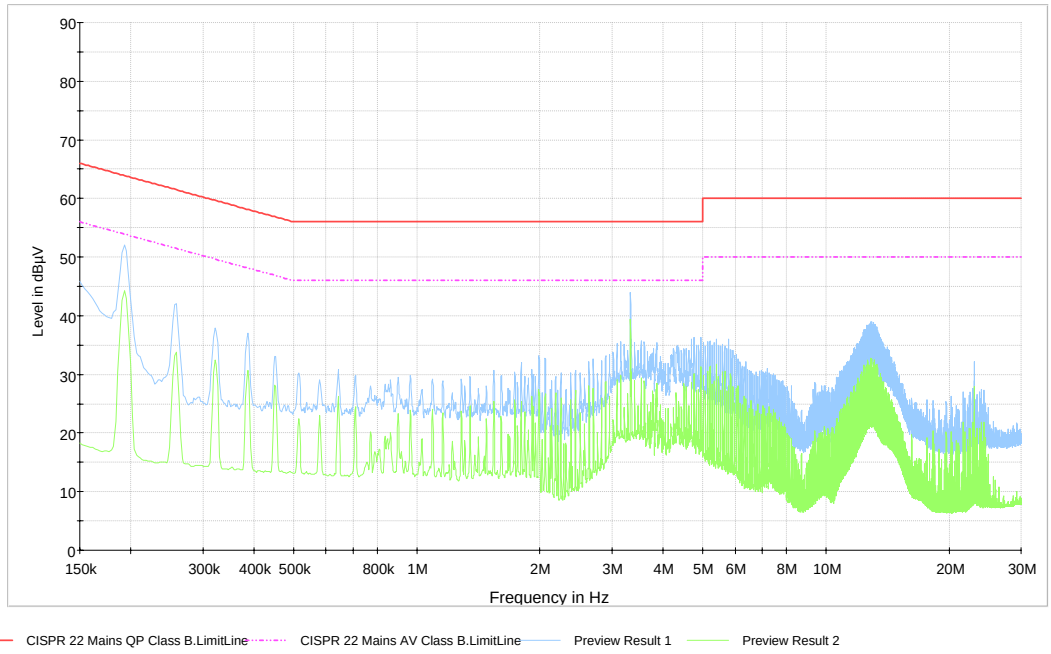
Additional Observations:

All plots were obtained using a receiver with an IF of 9 kHz using a Quasi-Peak and Average detector. The plots have been corrected with the cable loss and LISN loss to show compliance.

Phase:



Neutral:



Clause 15.209(a) Radiated Emissions within Restricted Bands

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength		Measurement Distance (meters)
	(μV/m)	(dBμV/m)	
0.009–0.490	2400/F	67.6−20log(F)	300
0.490–1.705	24000/F	87.6−20log(F)	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
Above 960	500	54.0	3

Note: F = fundamental frequency in kHz

Test Results: Pass

Additional Observations:

The Spectrum was searched from 30 MHz to the 40 GHz.

These results apply to emissions found in the Restricted bands defined in FCC Part 15 Subpart C, 15.205.

Peak Detector with 100 kHz/300 kHz RBW/VBW was used for measurements below 1 GHz and 1 MHz/3 MHz RBW/VBW for frequencies above 1 GHz. Since EUT has 100 % duty cycle average measurements were performed at the frequencies above 1 GHz with 1 MHz/10 Hz RBW/VBW spectrum analyzer settings.

Only the worst-case test results are provided.

802.11a

Antenna	Channel MHz	Frequency, MHz	FS Peak, dBµV/m	FS Peak Limit, dBµV/m	Margin, dB	FS Avg, dBµV/m	FS Avg Limit, dBµV/m	Margin, dB
Omni 7 dBi	5740	5120.8	65.86	74.00	8.14	53.86	54.00	0.14
		5367.6	63.12	74.00	10.88	52.78	54.00	1.22
	5790	5120.8	68.99	74.00	5.01	53.72	54.00	0.28
		5350.5	65.23	74.00	8.77	51.45	54.00	2.55
	5835	5132.3	66.38	74.00	7.62	53.27	54.00	0.73
		5350.5	64.12	74.00	9.88	52.57	54.00	1.43
Directional 15 dBi	5740	5148.9	67.30	74.00	6.70	53.08	54.00	0.92
		5389.4	64.53	74.00	9.47	50.63	54.00	3.37
	5790	5069.8	66.28	74.00	7.72	53.14	54.00	0.86
		5351.2	63.93	74.00	10.07	50.07	54.00	3.93
	5835	5150.0	66.14	74.00	7.86	52.87	54.00	1.13
		5362.3	62.61	74.00	11.39	49.60	54.00	4.40

802.11n

Antenna	Channel MHz	Frequency, MHz	FS Peak, dBµV/m	FS Peak Limit, dBµV/m	Margin, dB	FS Avg, dBµV/m	FS Avg Limit, dBµV/m	Margin, dB
Omni 7 dBi	5740	5131.2	64.44	74.00	9.56	53.10	54.00	0.90
		5357.7	63.21	74.00	10.79	53.01	54.00	0.99
	5790	5131.2	67.56	74.00	6.44	53.38	54.00	0.62
		5369.9	64.12	74.00	9.88	51.23	54.00	2.77
	5835	5120.8	68.46	74.00	5.54	53.81	54.00	0.19
		5358.1	66.56	74.00	7.44	52.24	54.00	1.76
Directional 15 dBi	5740	5068.7	66.40	74.00	7.60	53.22	54.00	0.78
		5376.0	63.60	74.00	10.40	50.59	54.00	3.41
	5790	5150.0	71.99	74.00	2.01	53.21	54.00	0.79
		5350.7	64.46	74.00	9.54	50.09	54.00	3.91
	5835	5150.0	70.86	74.00	3.14	52.83	54.00	1.17
		5364.2	62.76	74.00	11.24	49.73	54.00	4.27

Note: Field Strength (FS) result includes antenna factor, cable losses and amplifier gain where applicable.

There were no additional emissions or change in existing emissions when both the 2.4 GHz radio and 5 GHz radios operated simultaneously.

Clause 15.247(a)(2) 6 dB bandwidth for systems using digital modulation techniques

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

Test Results: Pass

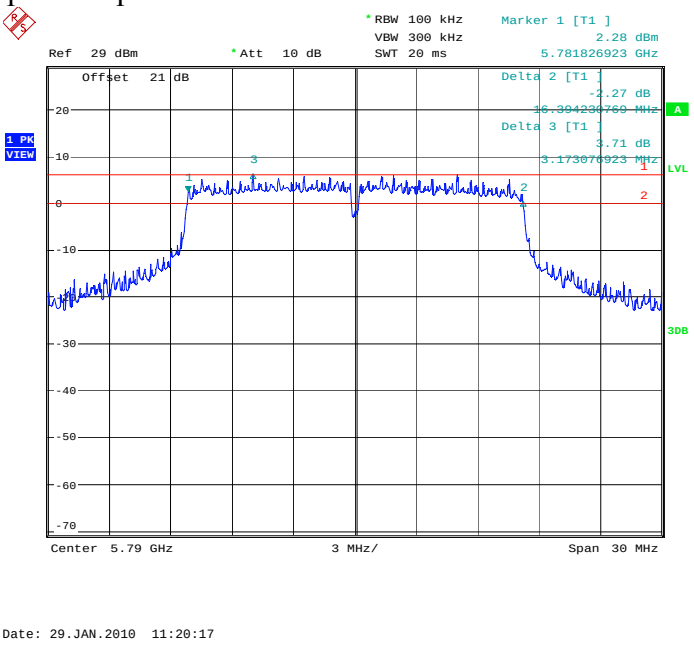
Additional Observations:

The peak detector was used with 100 kHz/300 kHz RBW/VBW.
The span was wider than 6 dB bandwidth.

802.11a

Frequency, MHz	6 dB BW, MHz	Limit, MHz	Margin, MHz
5740	16.346	0.5	15.846
5790	16.394	0.5	15.894
5835	16.346	0.5	15.846

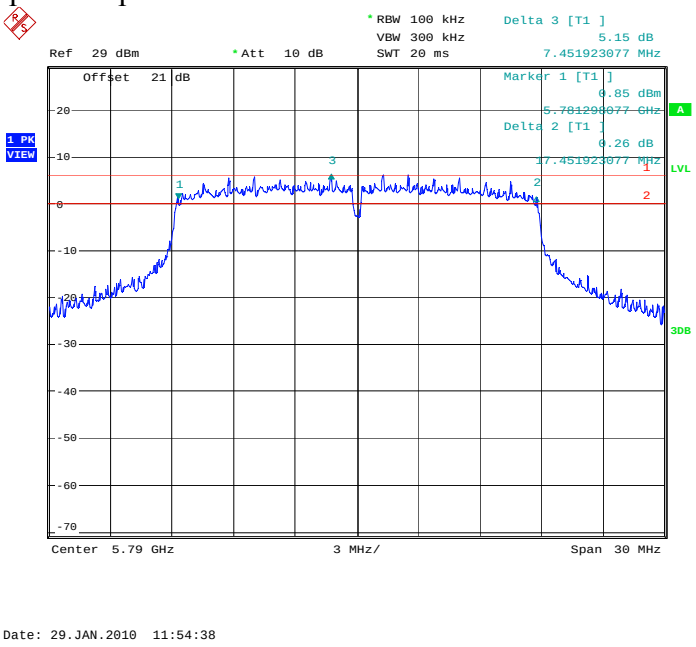
6 dB BW spectral plot sample:



802.11n

Frequency, MHz	6 dB BW, MHz	Limit, MHz	Margin, MHz
5740	17.548	0.5	17.048
5790	17.451	0.5	16.951
5835	17.548	0.5	17.048

6 dB BW spectral plot sample:



Clause 15.247(b)(3) Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W. As an alternative to a peak power measurement, compliance with the 1 W limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Clause 15.247(b)(4) Maximum peak output power

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Clause 15.247(c)(1) Fixed point-to-point Operation with directional antenna gains greater than 6 dBi

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
(ii) Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.
(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

Test Results: Pass

Additional Observations:

Transmit output power was measured while supply voltage was varied from 102 VAC to 138 VAC (85 % to 115 % of the nominal rated supply voltage). No change in transmit output power was observed.
The output RF power was measured on the antenna port 1 and 2 for omni directional antenna, 3 and 4 for directional antenna by means of a spectrum analyzer and following the *'Power Output Option 2, Method 1'* procedure from the FCC guidelines for Measurement of Digital Transmission Systems operating under Section 15.247. The total output power equal to the summary of the output RF power was measured on the antenna port 1 and 2, or antenna port 3 and 4.

802.11a

Omni-directional antennas

Freq. (MHz)	G_{ANT} (dBi)	Cable loss (dB)	$G_{ANT+CABLE}$ (dBi)	Antenna 1 Cond. (mW)	Antenna 2 Cond. (mW)	Total output power (dBm)	Limit (dBm)	Margin (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
5740	7	1	6	136.08	99.73	23.72	30.00	6.28	29.72	36.00	6.28
5790	7	1	6	66.70	59.29	21.00	30.00	9.00	27.00	36.00	9.00
5835	7	1	6	68.95	62.40	21.18	30.00	8.82	27.18	36.00	8.82

Output power limit = 30 dBm – (antenna gain – 6 dBi) [for antennas greater than 6 dBi]

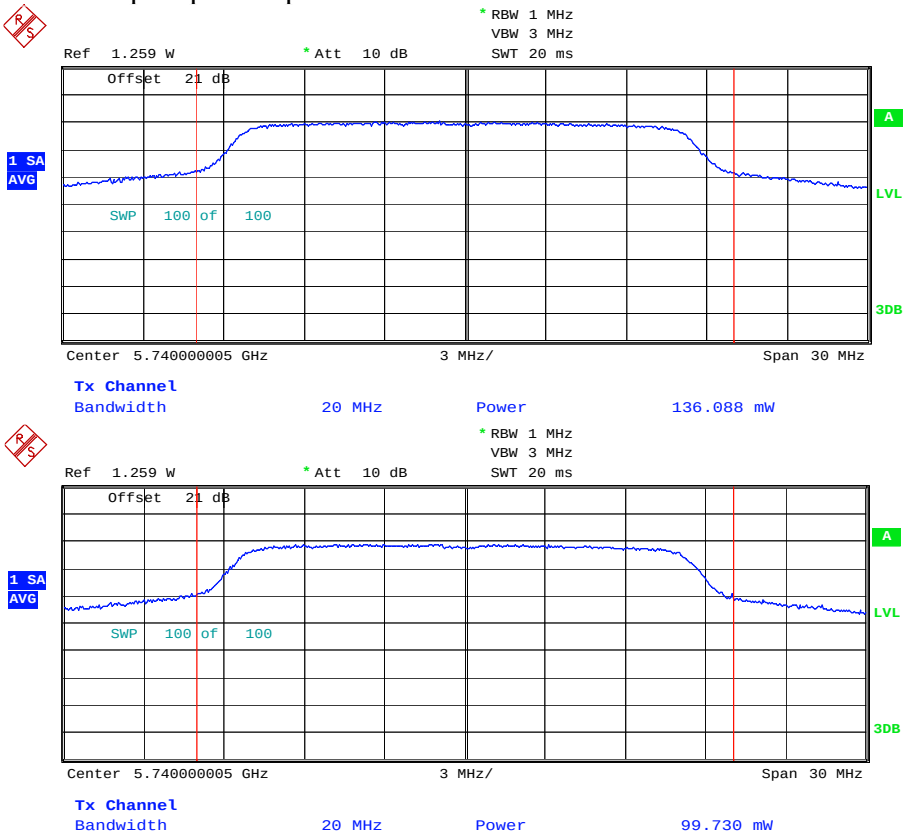
Note: antenna gain considered as a combination of the actual antenna gain with the cable.

Directional antennas.

Freq. (MHz)	G_{ANT} (dBi)	Cable loss (dB)	$G_{ANT+CABLE}$ (dBi)	Antenna 3 Cond. (mW)	Antenna 4 Cond. (mW)	Total output power (dBm)	Limit (dBm)	Margin (dB)	EIRP (dBm)
5740	15	1	14	28.96	28.16	17.56	30.00	12.44	31.56
5790	15	1	14	17.97	16.12	15.32	30.00	14.68	29.32
5835	15	1	14	10.18	9.84	13.01	30.00	16.99	27.01

Note: antenna gain considered as a combination of the actual antenna gain with the cable.

Output power sample spectral plots:



802.11n

Omni-directional antennas

Freq. (MHz)	G_{ANT} (dBi)	Cable loss (dB)	$G_{ANT+CABLE}$ (dBi)	Antenna 1 Cond. (mW)	Antenna 2 Cond. (mW)	Total output power (dBm)	Limit (dBm)	Margin (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)
5740	7	1	6	130.36	99.93	23.62	30.00	6.38	29.62	36.00	6.38
5790	7	1	6	66.89	58.07	20.96	30.00	9.04	26.96	36.00	9.04
5835	7	1	6	66.21	61.05	21.04	30.00	8.96	27.04	36.00	8.96

Output power limit = 30 dBm – (antenna gain – 6 dBi) [for antennas greater than 6 dBi]

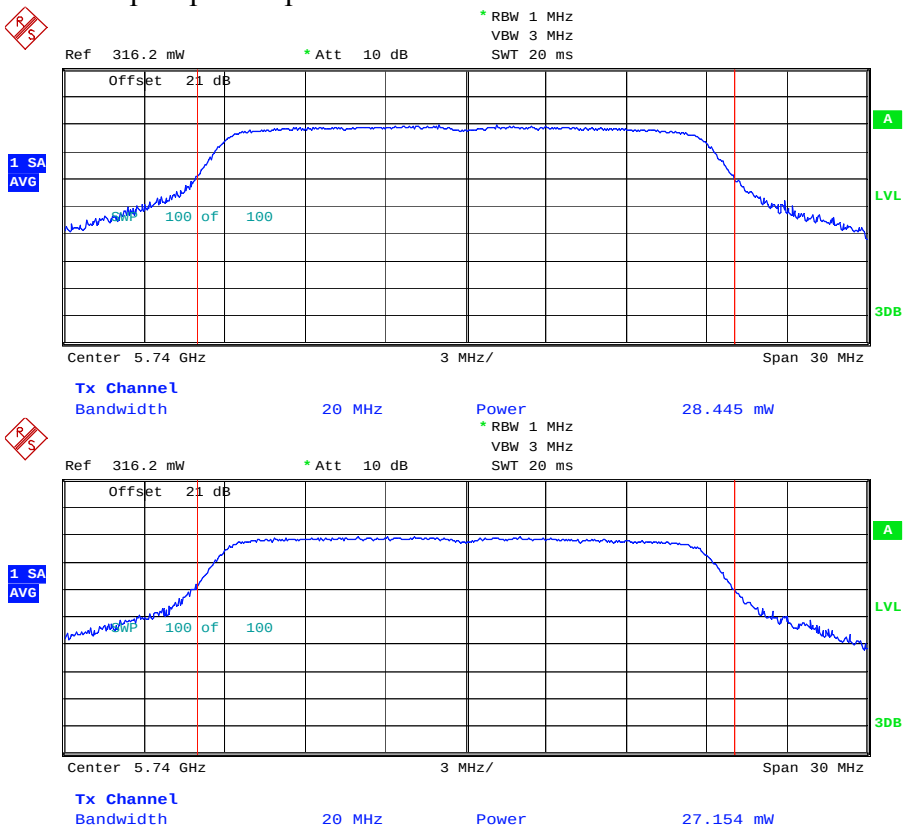
Note: antenna gain considered as a combination of the actual antenna gain with the cable.

Directional antennas.

Freq. (MHz)	G_{ANT} (dBi)	Cable loss (dB)	$G_{ANT+CABLE}$ (dBi)	Antenna 3 Cond. (mW)	Antenna 4 Cond. (mW)	Total output power (dBm)	Limit (dBm)	Margin (dB)	EIRP (dBm)
5740	15	1	14	28.44	27.15	17.45	30.00	12.55	31.45
5790	15	1	14	17.59	15.85	15.24	30.00	14.76	29.24
5835	15	1	14	9.92	9.57	12.89	30.00	17.11	26.89

Note: antenna gain considered as a combination of the actual antenna gain with the cable.

Output power sample spectral plots:



Clause 15.247(d) Conducted Spurious Emissions

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

Test Results: Pass

Additional Observations:

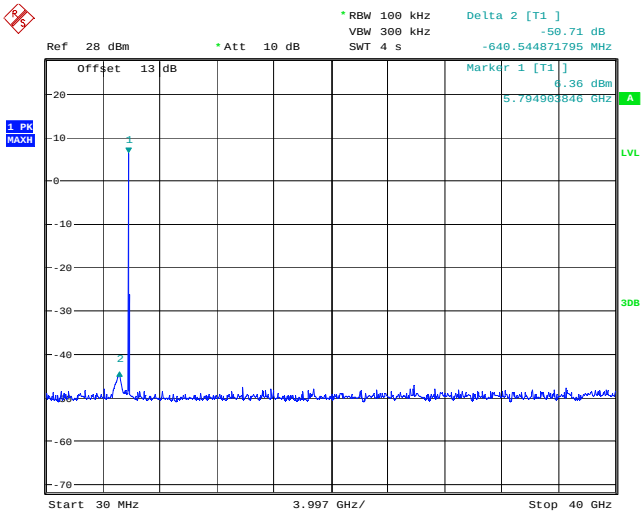
The Spectrum was searched from 30 MHz to 40 GHz for low (5740 MHz), mid (5790 MHz) and high (5835 MHz) carrier frequencies.

All measurements for spurious emissions were performed conducted using a Spectrum analyzer with Peak Detector with 100 kHz/300 kHz RBW/VBW. The spurious emissions were measured individually on antenna port 1 and 2, and combined with antenna port 1 and 2 by using a RF combiner.

Only the worst-case test results are provided.

802.11a

Channel 5790 MHz at antenna port 1



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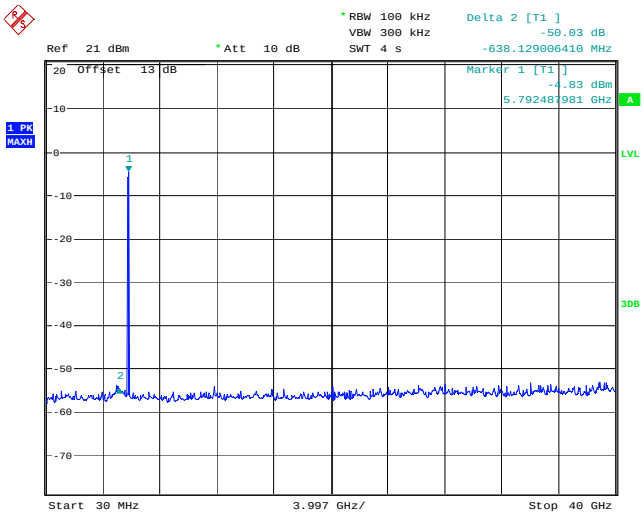
802.11n

Channel 5790 MHz at antenna port 1



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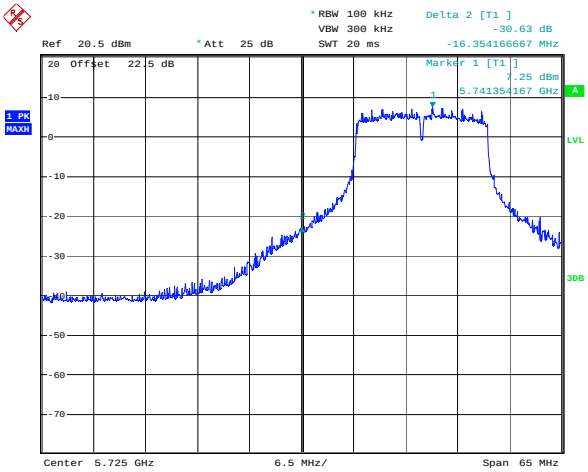
There were no additional emissions or change in existing emissions when both the 2.4 GHz radio and 5 GHz radios operated simultaneously.

Band edges measurements:

Lower band edge (measured on antenna port 1)

802.11a



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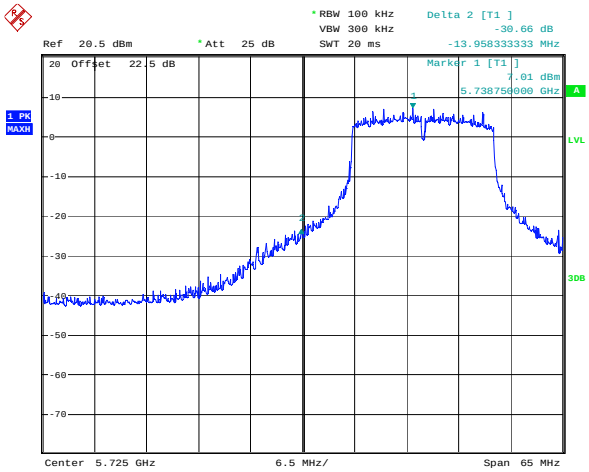
802.11n



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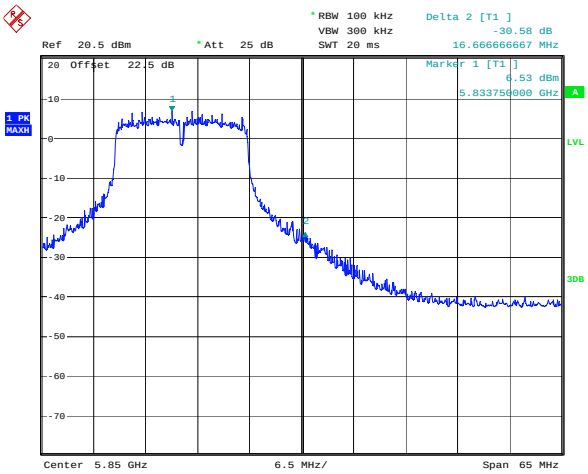
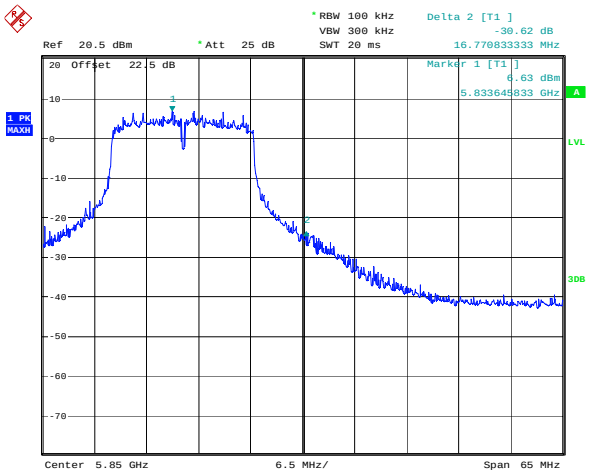
Upper band edge (measured on antenna port 1)

802.11a



Date: 3.FEB.2010 09:06:36

802.11n



Date: 3.FEB.2010 09:05:25

<u>Band edge results:</u>

Lower band edge:

Minimum attenuation below the fundamental is 30.63 dB

Upper band edge:

Minimum attenuation below the fundamental is 30.58 dB

Clause 15.247(e) Power Spectral Density for Digitally Modulated Devices

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Results: Pass

Additional Observations:

The Power Spectral Density was measured on the antenna port 1 and 2 individually by means of a spectrum analyzer and following procedure described in 'PSD Option 1' in FCC guidelines for Measurement of Digital Transmission Systems operating under Section 15.247. The total PSD equal to the summary of the PSD was measured on the antenna port 1 and 2 for omni directional antenna, 3 and 4 for directional antenna**.**

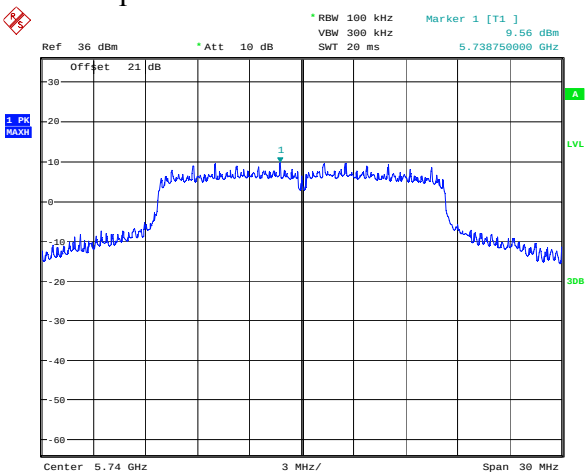
Only the worst case of data is provided.

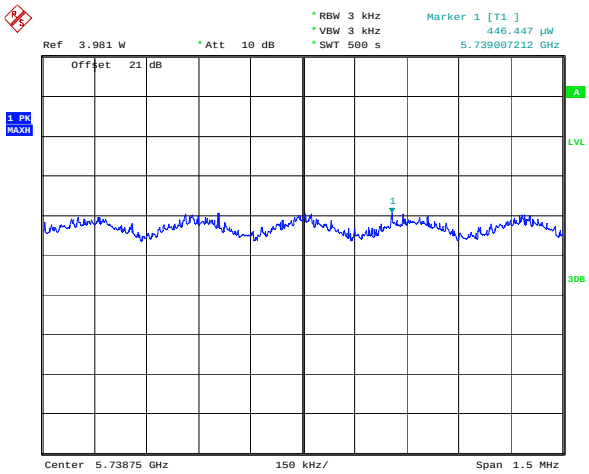
802.11a

Freq. (MHz)	Antenna 1 Cond. (mW/3 kHz)	Antenna 2 Cond. (mW/3 kHz)	Total PSD Cond. (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
5740	0.446	0.376	-0.85	8.00	8.85
5790	0.258	0.166	-3.72	8.00	11.72
5835	0.243	0.238	-3.17	8.00	11.17

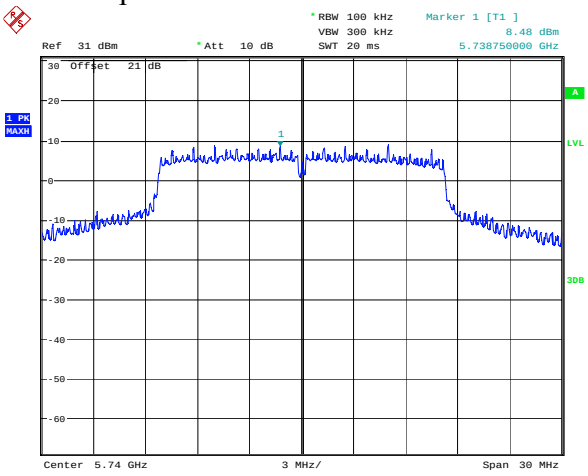
PSD spectral plots samples:

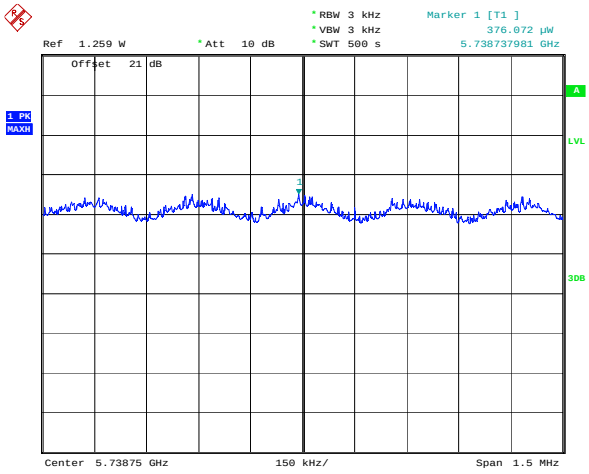
Antenna port 1





Antenna port 2



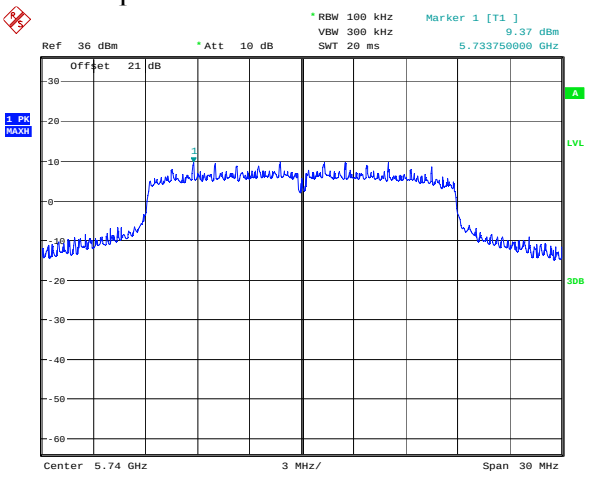


802.11n

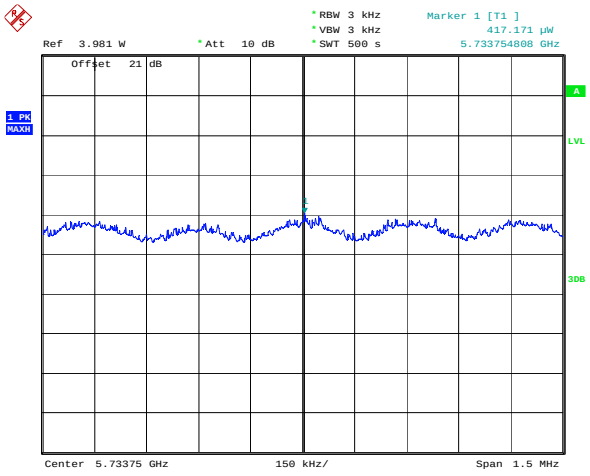
Freq. (MHz)	Antenna 1 Cond. (mW/3 kHz)	Antenna 2 Cond. (mW/3 kHz)	Total PSD Cond. (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
5740	0.417	0.321	-1.31	8.00	9.31
5790	0.226	0.176	-3.95	8.00	11.95
5835	0.276	0.180	-3.41	8.00	11.41

PSD spectral plots samples:

Antenna port 1

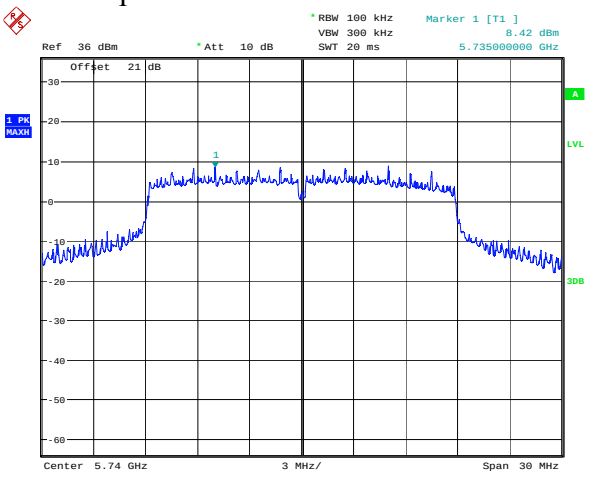


Date: 29.JAN.2010 10:45:58

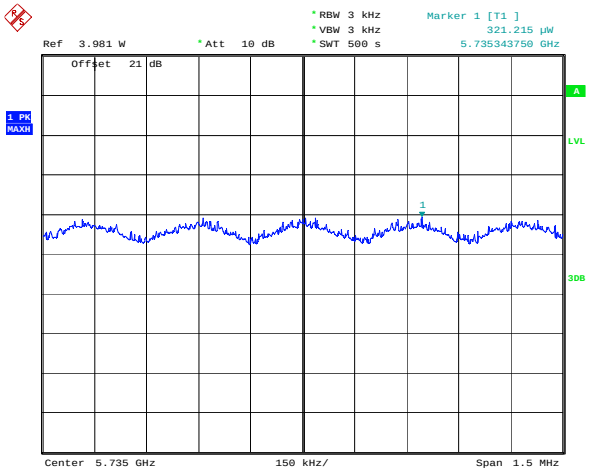


Date: 29.JAN.2010 10:56:11

Antenna port 2



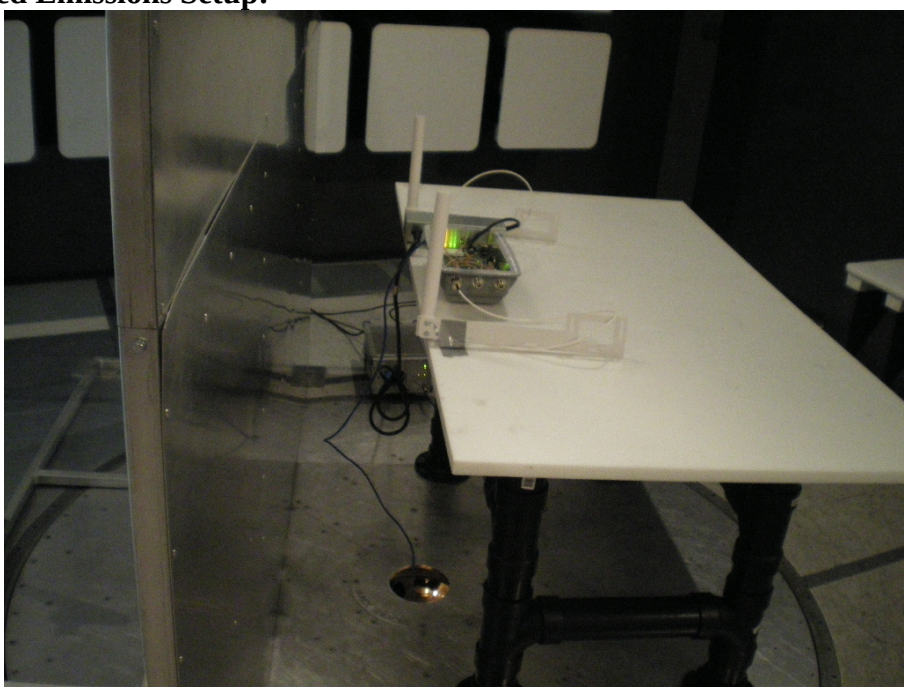
Date: 29.JAN.2010 10:57:28



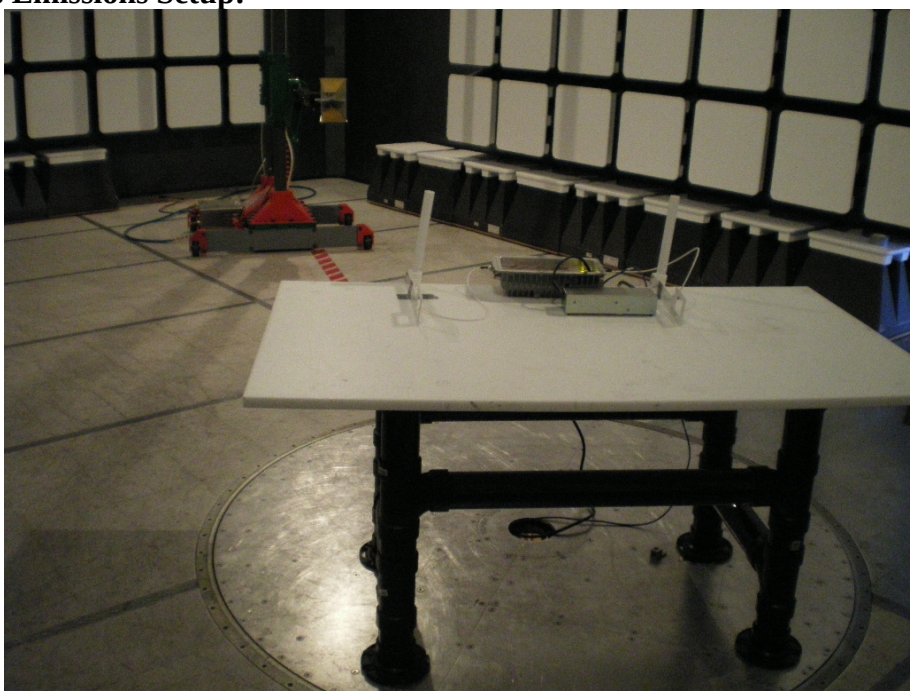
Date: 29.JAN.2010 11:06:42

Appendix B : Setup Photographs

Conducted Emissions Setup:

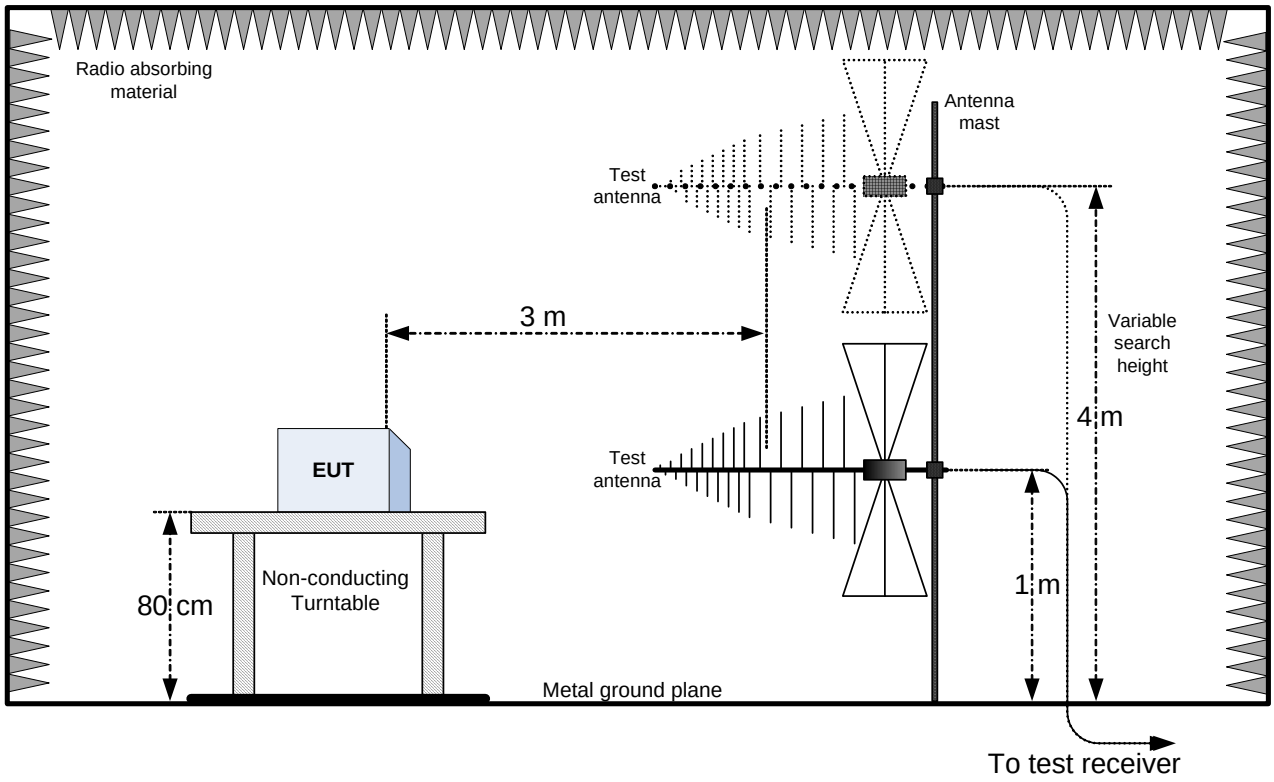


Spurious Emissions Setup:



Appendix C : Block Diagram of Test Setups

Radiated Emissions above 30 MHz Test Site



Conducted Emissions Test Site