



**FCC Part 15.247 Certification Application**

**Industrie Canada RSS210 Certification  
Application**

**EMI Test Report  
on  
SilverSpring Relay Radio  
Model: 210-040101**

**FCC ID: OWS-NIC502**

**IC ID: 5975A-NIC502**

**Prepared by:**  
David Waitt  
21565 Mary Alice Way  
Los Gatos California  
[david@waitt.us](mailto:david@waitt.us)  
(408) 832 7053

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## General Information

**Unit(s) Under Test:** 900MHz Relay Radio  
**Model(s):** 210-040101

**Product Description:** Relay Radio

**FCC ID:** OWS-NIC502  
**IC ID:** 5975A-NIC502

**Tested For:** Silver Spring Networks  
2755 Campus Drive  
Suite 205  
San Mateo, CA 94403

**Tested At:** (Radiated Emissions)  
Elliott Laboratories  
41039 Boyce Road  
Fremont, CA

(RF Conducted tests)  
Elliott Laboratories  
41039 Boyce Road  
Fremont, CA 94538

**Tested By:** Rafael Veralas, Test Engineer, Elliott Labs  
David Waitt, (Independent Consultant)

**Tested To:** FCC CFR 47, Part 15.247, 900MHz FHSS  
IC RSS-210 / Issue 7

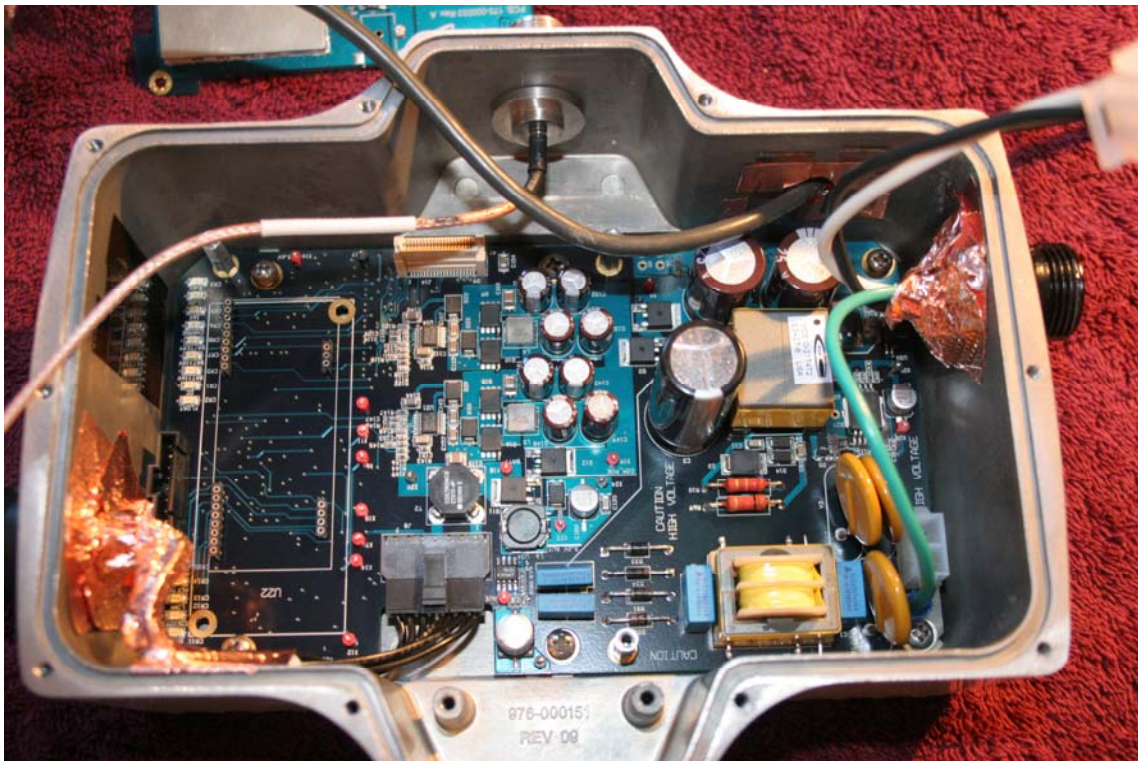
**Tested On:** 2 / 3 July 2007

**Requested  
Certifications:** FCC Part 15 Subpart C certification  
IC RSS-210 / Issue 7 Certification

## Detailed Product Information

The Relay Radio is a 900MHz FHSS radio that is used to relay information from SilverSpring wireless electric meters to the SilverSpring wireless network infrastructure.

Number of hopping channels:	83
Operating Frequency Range:	902.3 MHz to 924.9 MHz
Channel spacing:	300kHz
RF Power Output:	30 dBm Max
Antenna Gain:	Approx 2.5 dBi
Antenna Type:	Single, external, Omni
Operating Voltage:	3.6 VDC @ approx 1.2 A (Max RF Xmit)
DUT:	Engineering prototype, equivalent to mass produced items
Modifications:	Modification made during testing include the addition of copper tape internal to the device to provide shielding to some of the harnesses..



## Test Results Summary

This report presents the results of the tests that verify compliance with FCC Part 15.247 and RSS210

A brief results summary of all the in this report is below.

<b>Part 15 Paragraph</b>	<b>RSS-210, Issue 6 Paragraph</b>	<b>Test</b>	<b>Results</b>
15.247(b)(2)	A8.4(1)	Maximum Power	dBm Max 0.195884 W
15.247(a)(1)(i)	A8.1(c)	20dB Bandwidth	157.5 kHz Max
15.247(d) 15.205	A8.5 2.2	Out of Band Spurious Emissions Radiated Emissions in Restricted bands	1.3dB in spec min @ 7415.16MHz (Restricted Band)
15.247(a)(1)(i)	A8.1(c)	Number of hopping channels	83
15.247(a)(1)(i)	A8.1(b)	Channel Spacing	300kHz

## Test Facilities

All radiated emissions testing for 15.247 (15.205) were performed at:

Elliott Laboratories  
41039 Boyce Road  
Fremont, CA 94538

Testing was conducted in accordance with ANSI C63.4 (2003)

### General:

Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data for chamber 1 has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Within the chamber, ambient levels are well below this requirement. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

### Antenna, Antenna Mast and Turntable

The Horn antennas that are use to measure radiated emissions above 1000MHz are amounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

ANSI C63.4 specifies that the test height above the ground plane shall be 80cm unless the equipment is intended to be floor mounted. During the radiated emissions tests the equipment is positioned on a motorized turntable in conformance with the most recent ANSI requirements.

## Equipment Lists

### Instrument Calibration

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles.

The following test equipment was used to perform the testing

### Elliott Test Equipment

<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
Agilent	Spectrum Analyzer	E4440A	1771	11 Jul 2007
EMCO	Horn Antenna S/N 1366	3115	1366	11 Jul 2007
HP	Pre Amp	8449B	263	16 Mar 2008

## Test Methods

Unless otherwise noted in the specific test procedure, tests are performed at a low, middle and high channel band used by the device. Unless otherwise noted, all testing was performed on these channels / frequencies.

<b>902 - 928 MHz Band</b>	
Channel	Freq( MHz )
Low	902.3
Mid	915.4
High	926.9

The device was running special diagnostic software to allow it to transmit random data on a particular channel indefinitely. This diagnostic software allowed the frequency hopping function to be disabled or enabled as tested required.

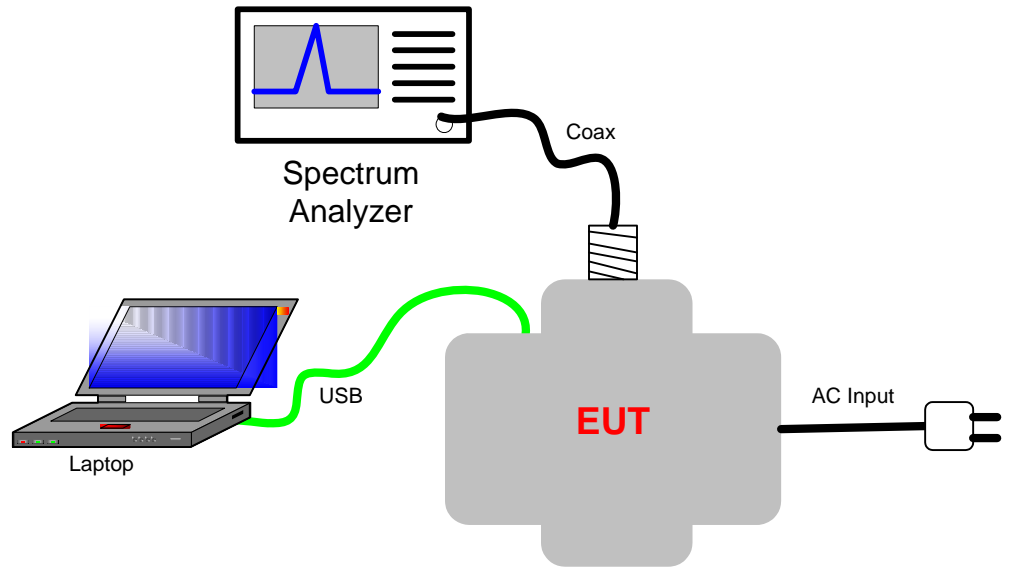
The diagnostic software also allowed variation of the RF transmit power. The maximum power setting that allowed compliance with the radiated emissions requirements (determined during testing) will be programmed into the configuration firmware of the relay radio. This will ensure compliance with the FCC / IC radiated emissions requirements.

The tests listed below are performed using the basic “conducted” test setup shown below unless otherwise noted

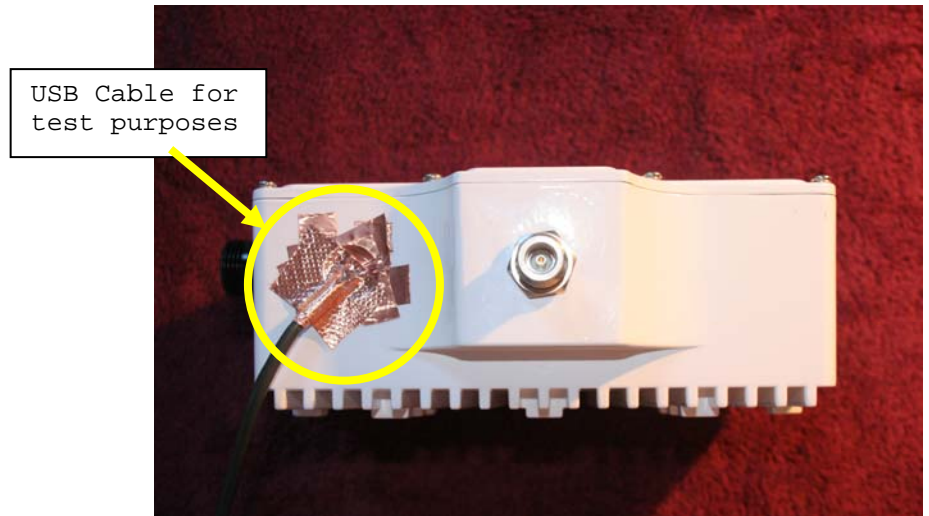
<b>Part 15</b>	<b>Test</b>
15.247(b)(2)	RF Transmit power
15.247(a)(1)(i)	Bandwidth
15.247(a)(1)(i)	Number of hopping channels
15.247(a)(1)	Channel Spacing
15.247(a)(1)(i)	Time on channel

**Basic Conducted RF Bench Test Setup**

The bench top RF test setup is shown to the right. Unless otherwise noted, the support equipment for the bench tests is listed below.



It should be noted that the hole drilled through the housing of the EUT to accommodate the USB cable is for test purposes ONLY and is NOT present in the production units.



<u>Support Equipment</u>				
<u>Description</u>	<u>Model number</u>	<u>FCC ID or SN</u>	<u>Manufacturer</u>	<u>Power Cable</u>
<u>Laptop</u>	<u>Satellite</u>	<u>DOC</u>	<u>Toshiba</u>	<u>Laptop PS, unshielded</u>



## Test Results

Detailed test procedures and test results are contained in the following sections. In cases where the test setup differs from the “Conducted RF Bench Top” test setup shown earlier, the test setup is also presented within that section of the test report.

<b>Test Conditions</b>			
<b>Temperature</b>	23C	<b>Humidity:</b>	Approx 55%
<b>ATM pressure</b>	1020 mBar	<b>Grounding:</b>	None
<b>Tested By</b>	David Waitt	<b>Date of Test:</b>	2 July 2007
<b>Test Reference</b>	Refer to individual test results		
<b>Tested Freq Range</b>	Test dependent		
<b>Test Voltage</b>	120 VAC		
<b>Modifications</b>	No internal modifications were made t the unit during he conducted testing. Some modification were made during the radiated emissions testing.		

## Maximum RF Power Output at Antenna Terminals

### Specifications:

FCC Specification: Paragraph: 15.247(b)(2)

IC Specification: RSS-210/7, A8.4(1)

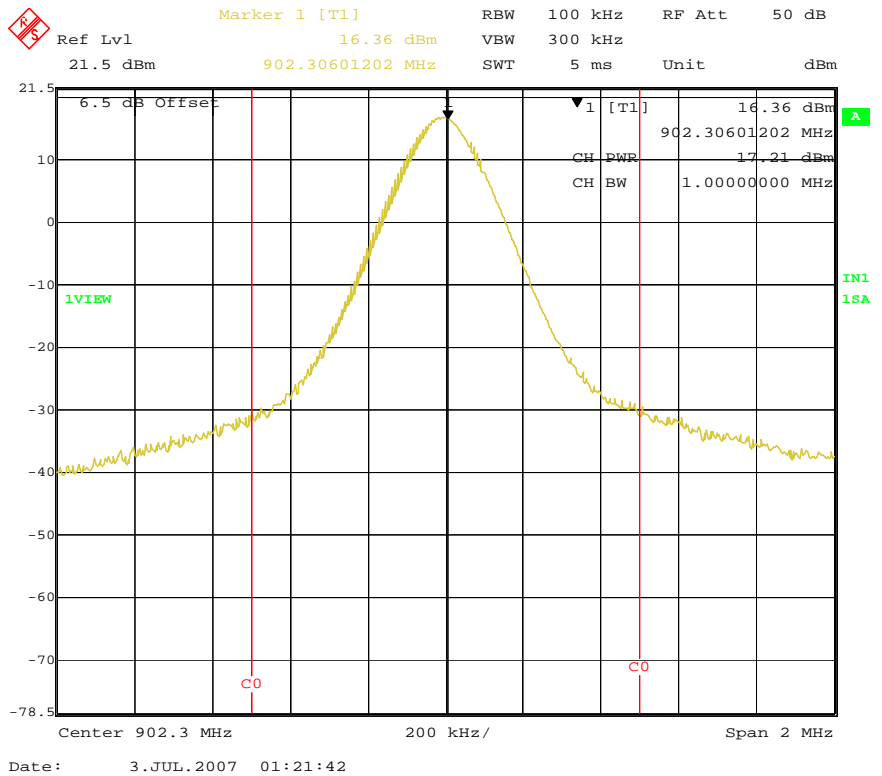
### Procedure:

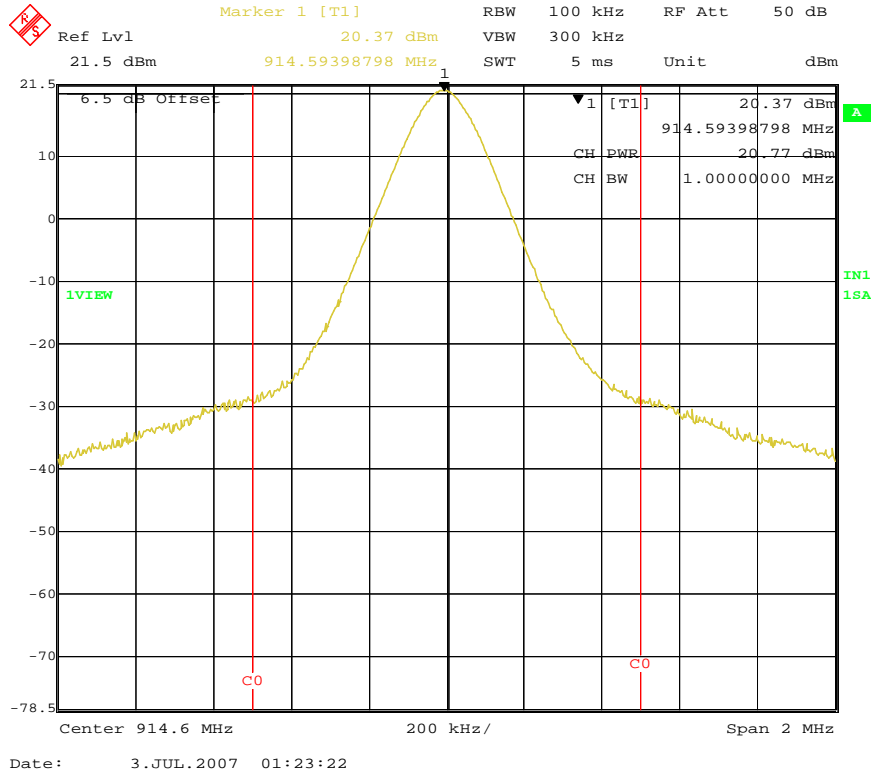
The test was configured as shown in the RF conducted bench top test setup. The unit was sequentially tuned to the test channels (Low, Mid and High) and configured to transmit random data (100% duty cycle). The RF transmit integrated channel power was then measured on the spectrum analyzer. RBW=100kHz, VBW = 300kHz

### Results:

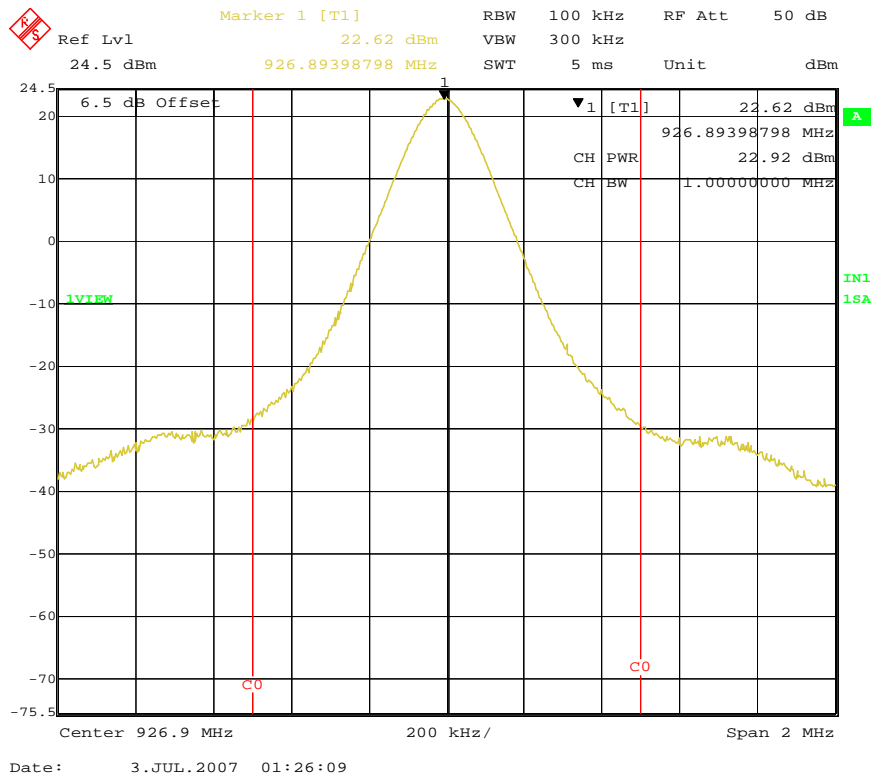
Measured RF power levels are below.

	Power (dBm)	Power (mW)	(Max EIRP) Peak antenna gain (3.08 dBi)
LOW	17.21	52.601	20.29
MID	20.77	119.398	23.85
HIGH	22.92	195.884	26.00





RF Power Out, Middle Channel



RF Power Out, High Channel

## 20 dB Bandwidth

### Specifications

FCC Specification: Paragraph 15.247(a)(1)(i)

IC Specification: RSS-210 / 7 A8.1(c)

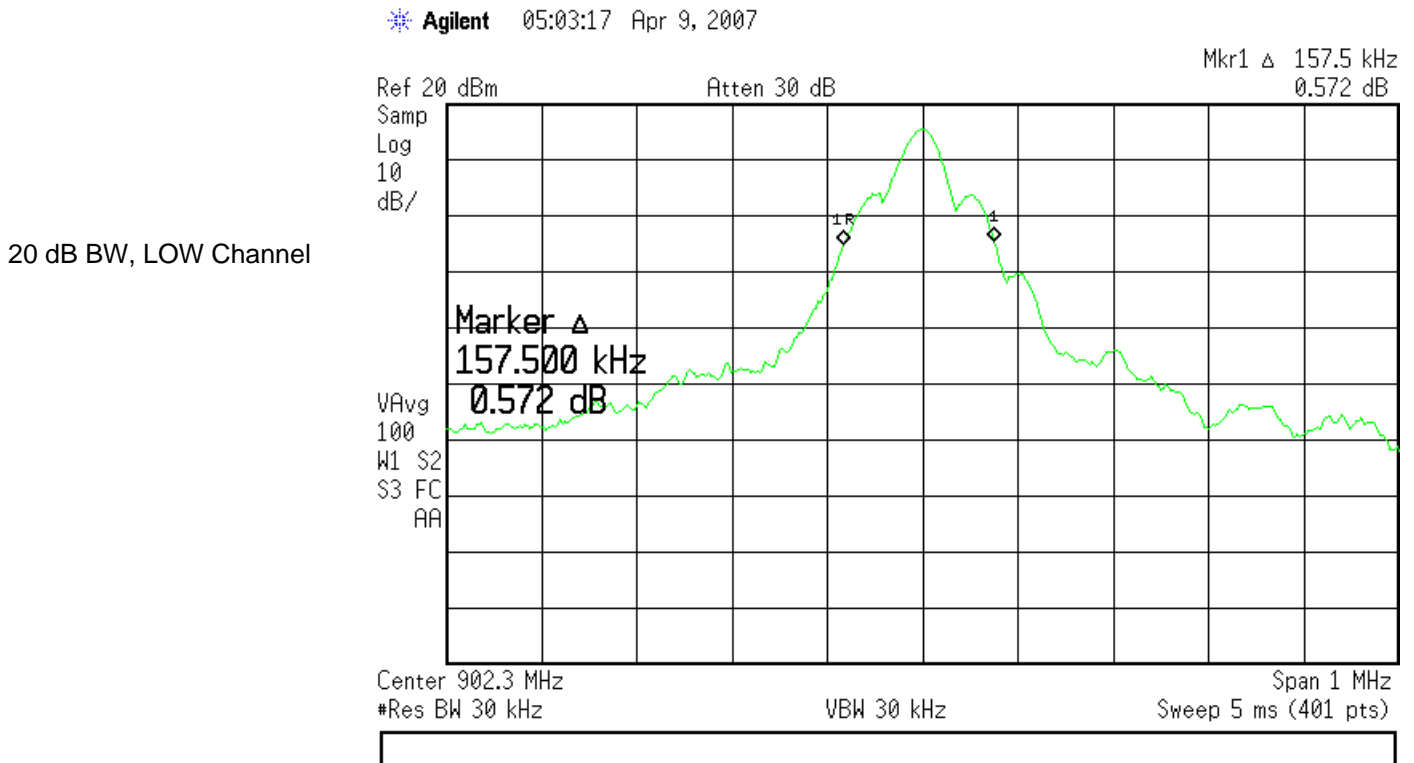
### Procedure:

The 20 dB bandwidth was measured on the low middle and high channels of the 900 MHz band using the conducted RF test setup. The spectrum analyzer was configured for MAX HOLD and the trace allowed to stabilize. A peak search was performed and the then “Delta-Marker” used to locate the points at –20dB below the peak.

The bandwidth test was performed at the power settings that will be used in the final system.

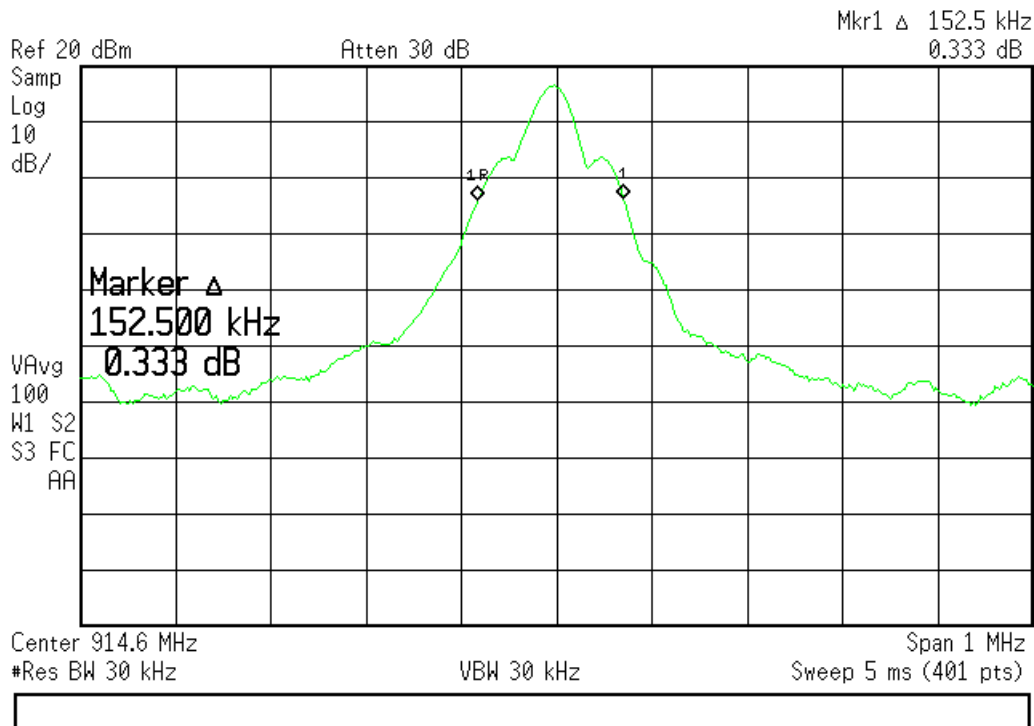
### Results:

	20 dB BW (kHz)	Spec (kHz)	Delta (kHz)
LOW	157.5	500	342.5
MID	152.5	500	347.5
HIGH	147.5	500	352.5



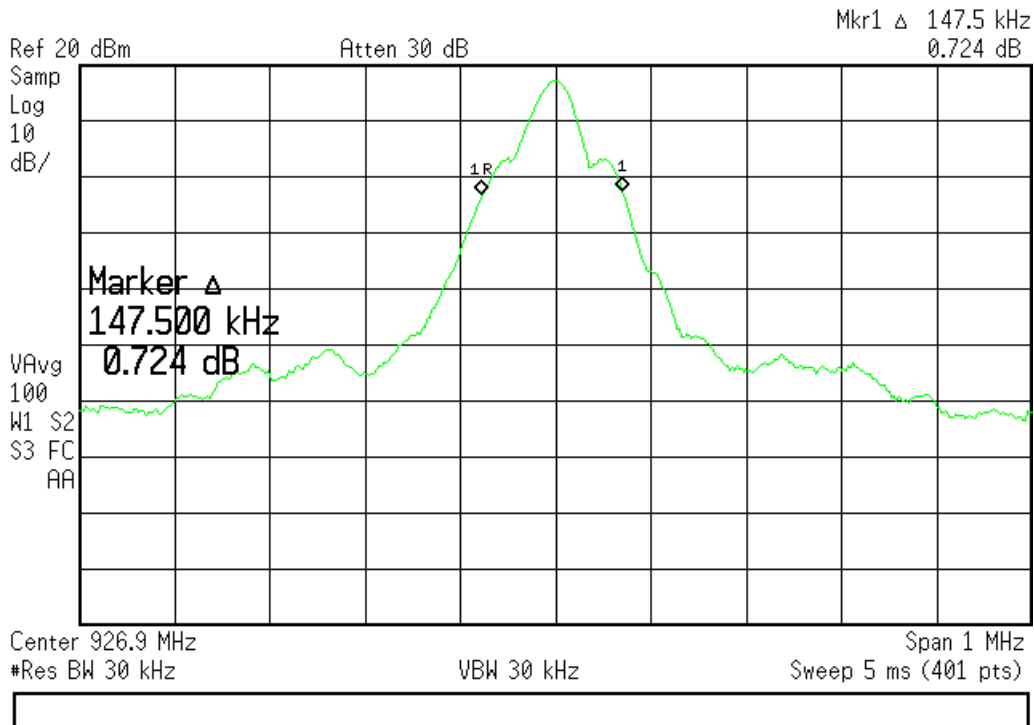
Agilent 05:01:05 Apr 9, 2007

20 dB BW, MID Channel



Agilent 04:58:27 Apr 9, 2007

20 dB BW, HIGH channel\_



## 900MHz Band Edge

### Specifications:

FCC Specification: Paragraph 15.247(d)

IC Specification: RSS-210/7 A8.5

### Procedure:

The test setup was configured as shown in the conducted test setup. The UUT was configured to continuously transmit random data on the low, and then the high test channel. The span of the analyzer was centered on the 902 and 928 MHz band edge respectively.

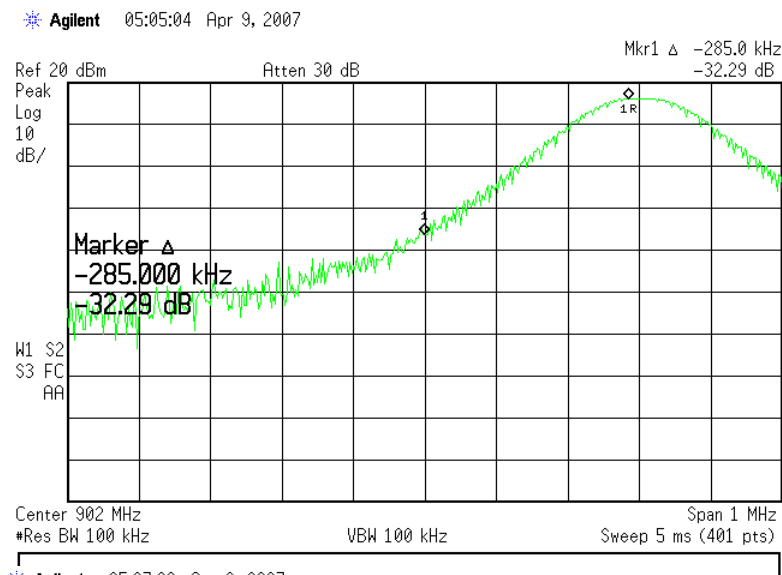
The RBW & VBW were set to 100 kHz. The trace was allowed to stabilize then a Peak-search and a marker delta measurement to the band edge was performed to verify that the RF power at the band edge was at least 20 dB below the peak of the fundamental level.

### Results:

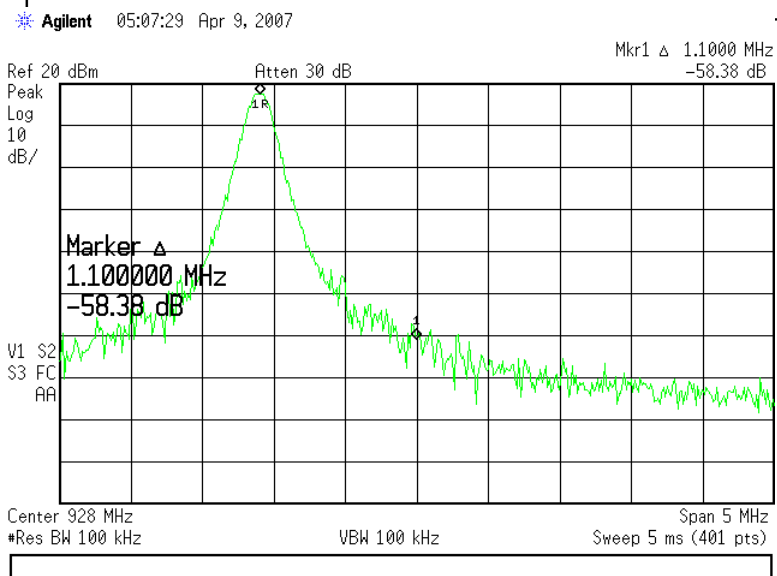
Level at 902 MHz: -32.29dBc Spec -20 dBc Min

Level at 928 MHz: -58.38dBc Spec -20 dBc Min

902 MHz Bandedge



928 MHz Bandedge



## Radiated Emissions in Restricted Bands & Out of Band Radiated Emissions

### Specifications:

FCC Specification: Paragraph 15.247(d)

IC Specification: RSS-210 / 7 Sec 2.2

### Procedure:

This test was conducted inside a semi-anechoic chamber at BACL. The unit was placed on a rotating wooden table 80cm above the ground plane. A Horn antenna was secured to a mast 3 meter away. The unit was tested at each of the Low, Mid and High channels. The UUT was running in the diagnostic mode and set to transmit at maximum on each of the channels in turn. The test equipment was configured as shown below.

The EUT was rotated 360 degrees and the height of the antenna adjusted from 1 to 4 meters above the ground plane to determine the maximum level of the emission. The level of the harmonic emission was measured in two modes, "Peak" and "Average".

The spectrum analyzer reading made by the test software and the appropriate correction factors (antenna factor, cable loss,...) were then applied by the test lab software to obtain a final corrected measurement.

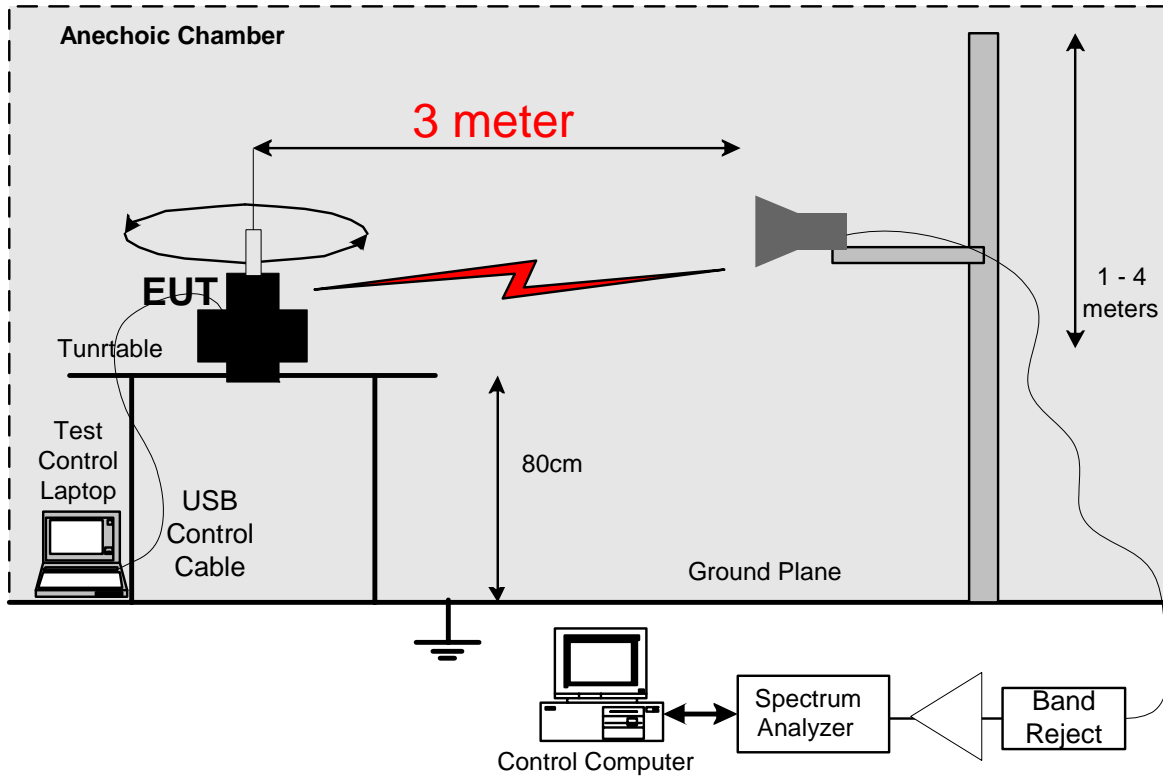
Preliminary emission scans were performed on the EUT in three orthogonal planes. It was determined that the horizontal plane was the worst case. The final radiated emissions data was recorded with the EUT being horizontal. This procedure was performed for all of the channels outlined in the Test Methods section of this report.

The band up to 10 GHz was examined. The table below indicates the harmonics that fall within restricted bands.

CHAN	FUND	2	3	4	5	6	7	8	9	10
LOW	902.3	1804.6	2706.9	3609.2	4511.5	5413.8	6316.1	7218.4	8120.7	9023.0
MID	915.4	1830.8	2746.2	3661.6	4577.0	5492.4	6407.8	7323.2	8238.6	9154.0
HIGH	926.7	1853.4	2780.1	3706.8	4633.5	5560.2	6486.9	7413.6	8340.3	9267.0

### 15.205 Harmonic test tables

*NOTE: RED indicates a harmonic that falls within a restricted band and is subject to 15.205. The harmonics in Green are NOT in restricted bands and are subject to 15.209*



**Radiated Emissions in Restricted Bands Test Setup**

<u>Support Equipment</u>				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	A20	DOC	IBM	Laptop PS, unshielded

<u>Test Conditions</u>			
Temperature	24 C	Humidity:	73%
ATM pressure	29.72 in	Grounding:	None
Tested By	Rafeal Verelas, Elliott	Date of Test:	July 2007
Test Reference	FCC Part 15.205 IC Paragraph RSS210, 6.2.3 ( c )		
Setup Method	ANSI C63.4		
Tested Range	1 GHz to 10GHz		
Test Voltage	3.6 VDC		
Modifications	No modifications were made to the unit		

**NOTES:** For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.

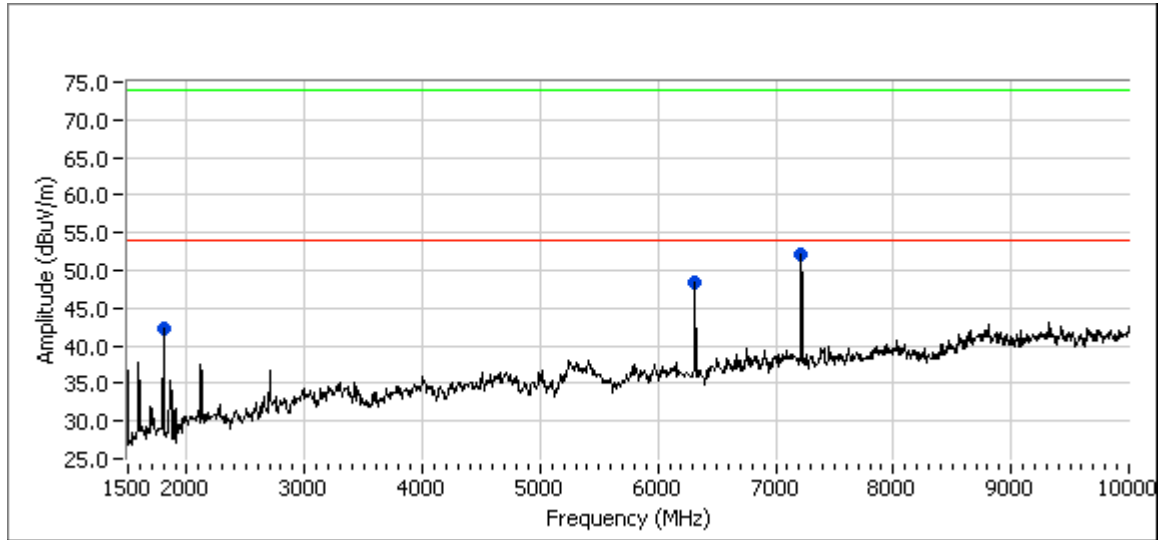
Restricted Band Peak Measurements: RBW = VBW = 1 MHz

Restricted Band Average Measurements: RBW = 1MHz and VBW = 10 Hz.

All other measurements, RBW = 1MHz and VBW = 3MHz, video averaging on (100 samples).

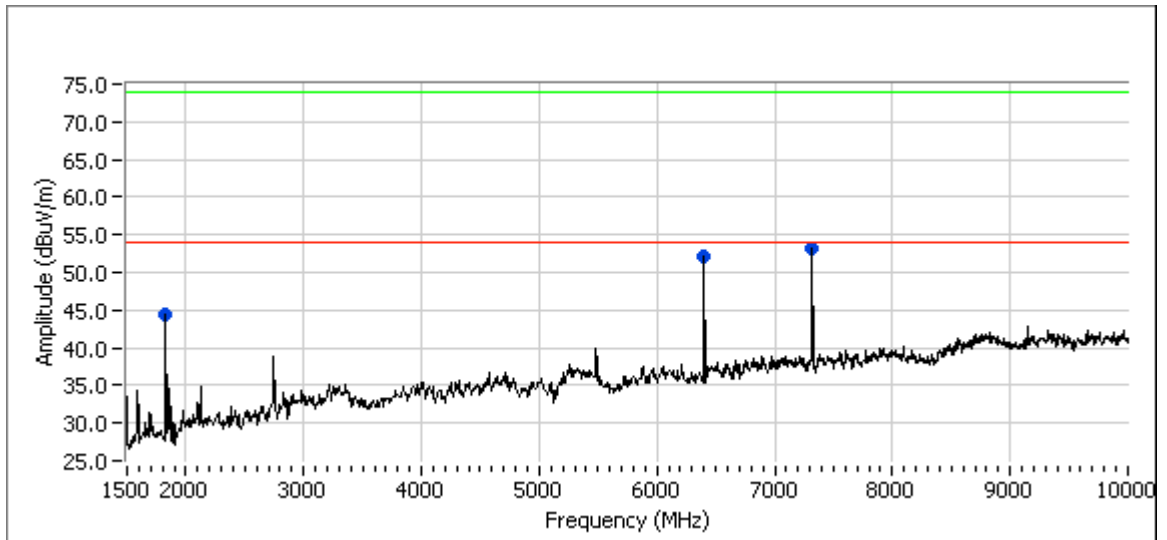


Results:  
EUT Transmitting on LOW channel, 902.3 MHz



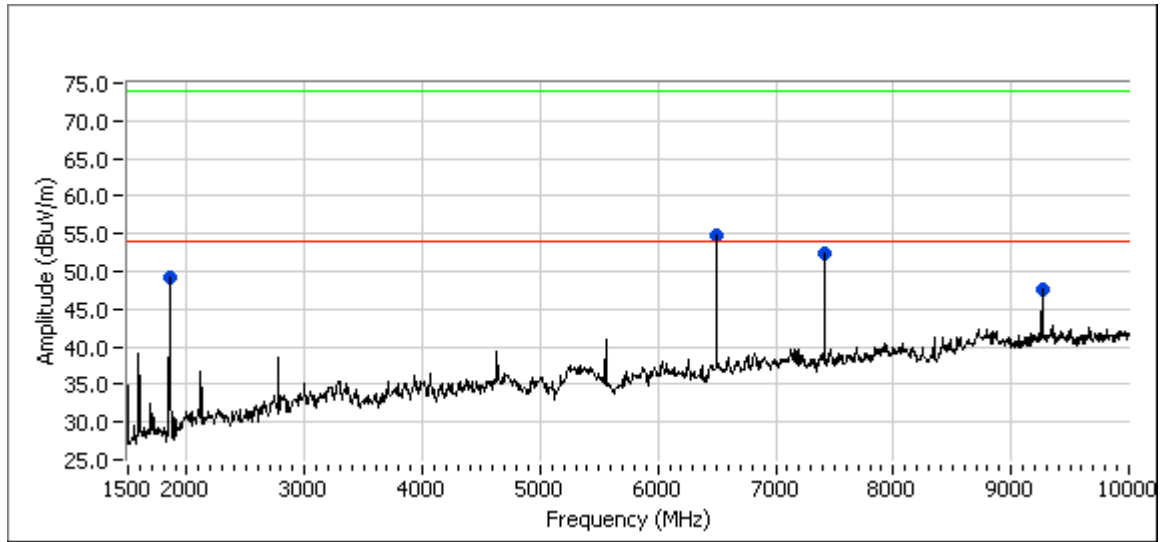
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7218.270	49.4	H	54.0	-4.6	AVG	208	1.4	Note 2
7218.270	53.7	H	74.0	-20.3	PK	208	1.4	Note 2
6316.110	45.9	H	54.0	-8.1	AVG	118	1.0	Note 2
6316.110	50.2	H	74.0	-23.8	PK	118	1.0	Note 2

EUT Transmitting on MID channel, 914.6 MHz



Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7316.770	51.0	H	54.0	-3.0	AVG	308	1.1	
7316.770	54.5	H	74.0	-19.5	PK	308	1.1	
1829.170	44.9	V	54.0	-9.1	AVG	216	1.0	Note 2
1829.170	46.5	V	74.0	-27.5	PK	216	1.0	Note 2
6402.280	53.5	V	54.0	-0.5	AVG	90	1.0	Note 2
6402.280	56.0	V	74.0	-18.0	PK	90	1.0	Note 2

EUT Transmitting on HIGH channel, 926.9 MHz



Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247 Limit	Margin	Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
6488.270	52.2	H	54.0	-1.8	AVG	124	1.0	
6488.270	55.1	H	74.0	-18.9	PK	124	1.0	
1853.810	49.4	V	54.0	-4.6	AVG	210	1.0	
1853.810	50.3	V	74.0	-23.7	PK	210	1.0	
9269.020	45.1	V	54.0	-8.9	AVG	285	1.3	
9269.020	51.8	V	74.0	-22.2	PK	285	1.3	
7415.160	52.7	H	54.0	-1.3	AVG	358	1.4	
7415.160	55.5	H	74.0	-18.5	PK	358	1.4	

## Number of Hopping Channels

### Specifications:

FCC Specification: Paragraph 15.247(a)(1)(i)

IC Specification: RSS-210 / 7 A8.1(c)

### Procedure:

The test setup is as shown in the Conducted RF bench setup. The EUT was configured to hop sequentially through all of its channels. (This is not possible with the normal operating code). The spectrum analyzer was set to MAX HOLD to capture the number of hopping channels. The entire 902 - 928 MHz band was examined in three sub-bands. 902 - 910 MHz, 910 - 920MHz and 920 - 928 MHz. The results are below.

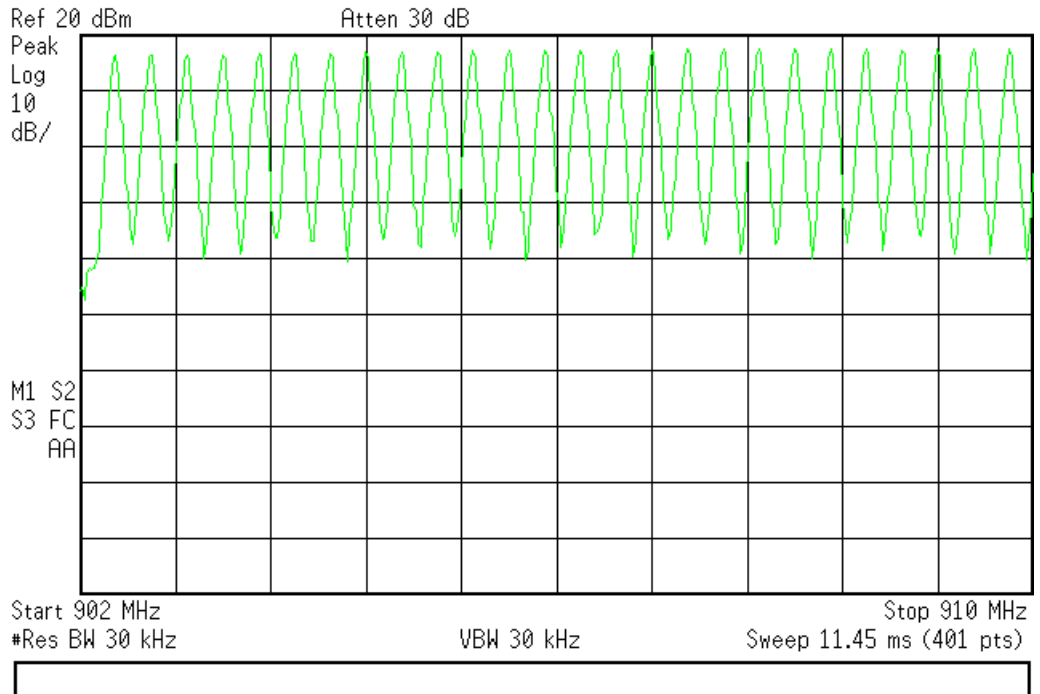
### Results:

All 83 hopping channels were recorded.

From (MHz)	to (MHz)	Num of Channels
902	910	26
910	920	33
920	928	24
<b>TOTAL</b>		<b>83</b>

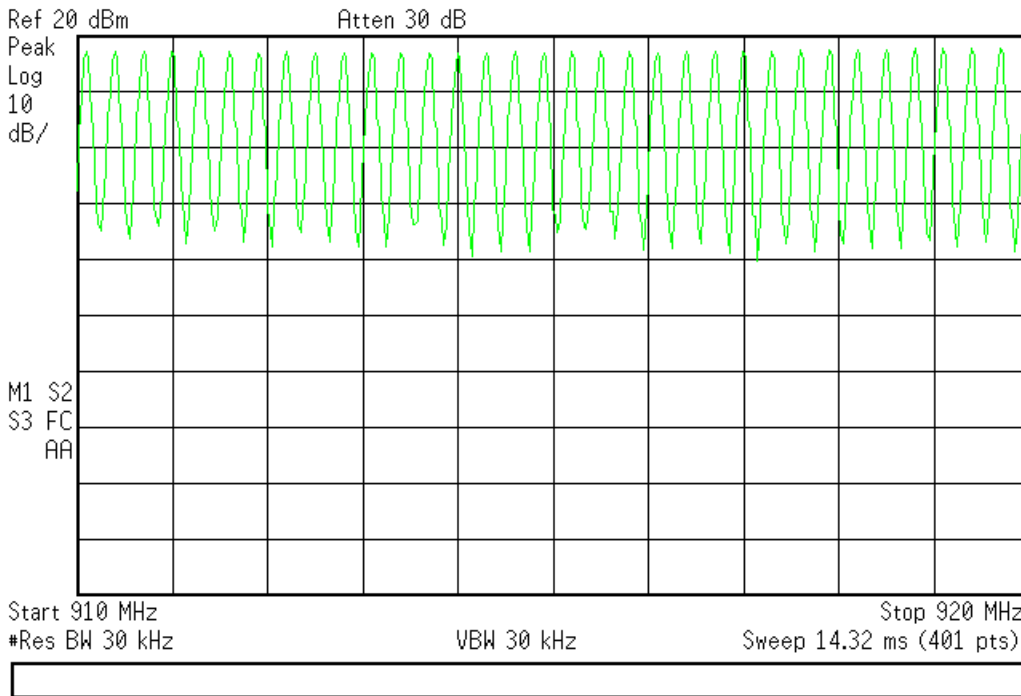
Agilent 05:21:34 Apr 9, 2007

902 - 910 MHz (26 Chan)



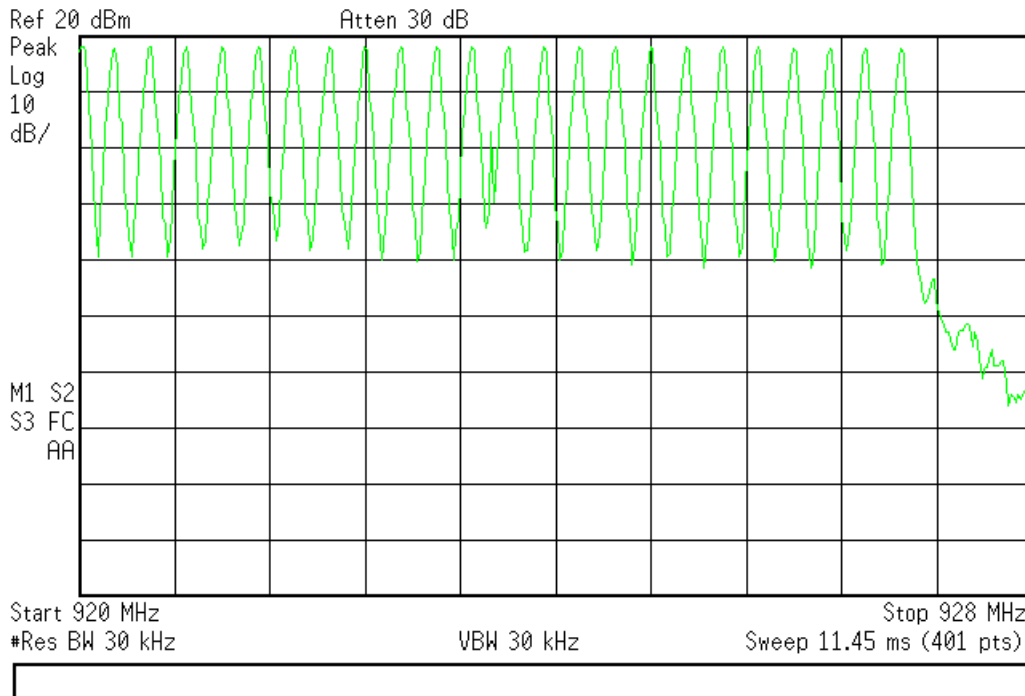
Agilent 05:22:42 Apr 9, 2007

910 - 920 MHz (33Chan)



Agilent 05:24:08 Apr 9, 2007

920 - 928 MHz (24Chan)



## Channel Spacing

### Specifications:

FCC Specification: Paragraph 15.247(a)(1)

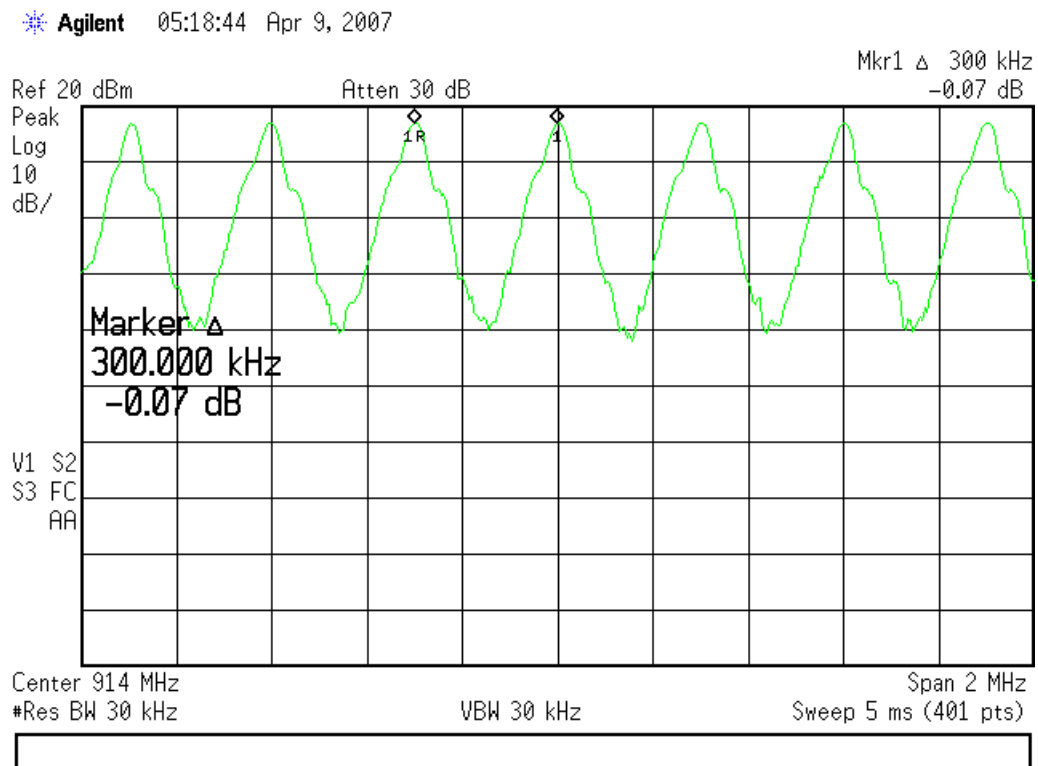
IC Specification: RSS-210 / 7 A8.1(b)

### Procedure:

The test setup is as shown in the Conducted RF bench setup. The EUT was configured to hop sequentially through all of its channels. (This is not possible with the normal operating code). The spectrum analyzer was set to MAX HOLD to capture a few of the sequential channel frequencies. The spectrum analyzer markers were used to determine the channel spacing. The results are below.

### Results:

Channel spacing was measured at **300kHz**. The specification requires that the channel spacing be greater than the measured 20 dB BW. The 20 dB BW was measured at a maximum of 157.5 kHz.



## 30MHz - 1 GHz Spurious Radiated Emissions

### Specification:

FCC Specification: 15.109(f)

IC Specification: RSS210 / 7 A8.5

### Procedure:

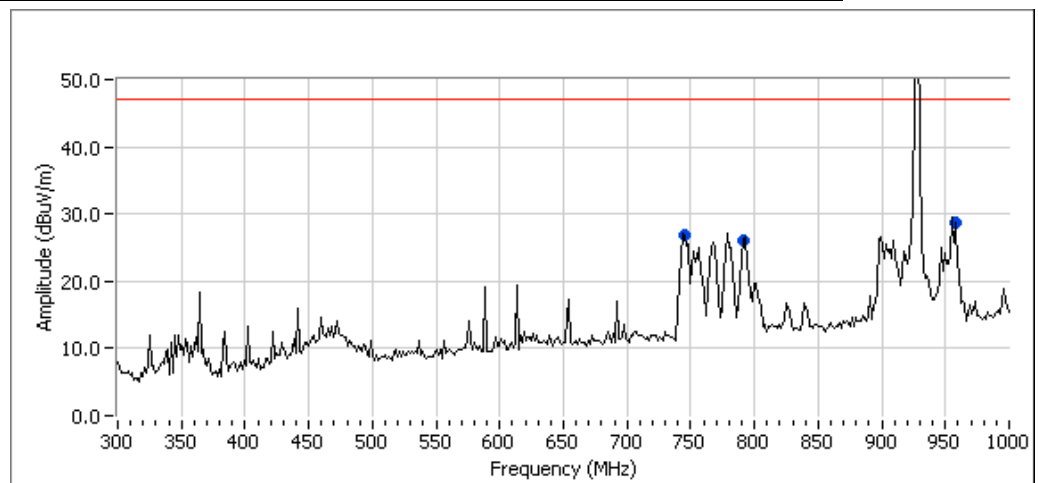
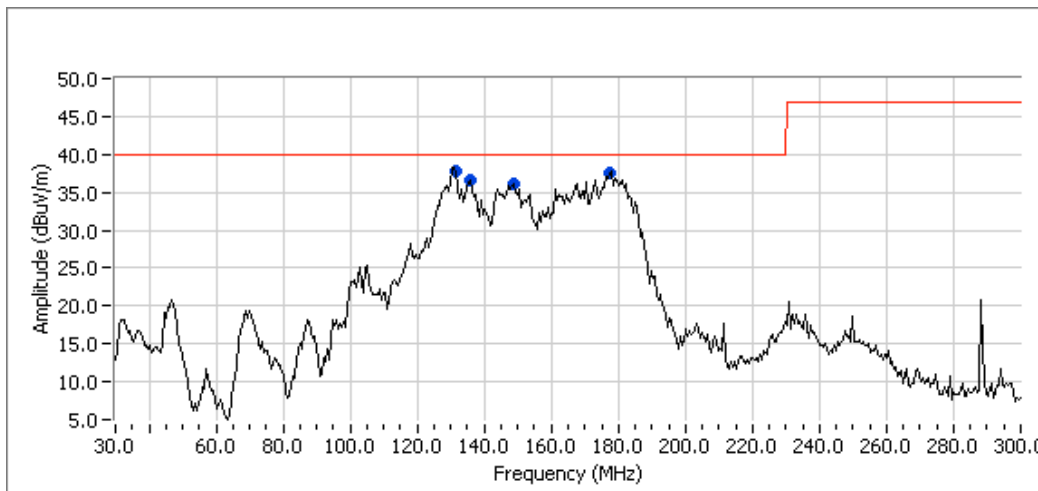
The test was configured as a standard ANSI C63.4 Class B radiated emissions test setup. The EUT was tested in both RCV and XMIT modes. The frequency range of 30 to 1000 MHz was scanned.

### Results: (RCV mode)

The unit was set to receive only mode. Preliminary emissions were checked in all three orthogonal planes, the worst case results are presented. The units was tested in Receive mode and transmit mode.

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	EN55022 Class A		Detector Pk/QP/Avg	Azimuth degrees	Height meters
			Limit	Margin			
131.856	34.9	H	40.0	-5.1	QP	292	3.0
149.236	33.9	H	40.0	-6.1	QP	115	2.0
176.980	33.7	H	40.0	-6.3	QP	15	2.5
135.627	33.6	H	40.0	-6.4	QP	225	2.5
954.692	31.4	V	47.0	-15.6	QP	302	1.0
745.590	13.7	H	47.0	-33.3	QP	241	3.0

### Maximized quasi-peak readings (includes manipulation of EUT interface cables)



## AC Line Conducted Emissions

Specification:

CISPR 22

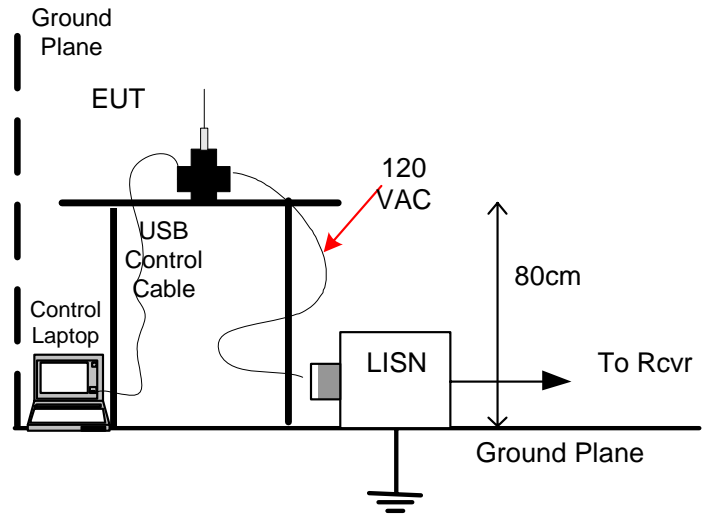
Procedure:

The test was set up according to the guidelines set forth in EN55022:1998 and FCC Part 2 for AC Line Conducted Emissions. The measurement used a LISN line on each AC line and an EMI receiver. A peak scan was made over the measurement frequency range (150 kHz to 30 MHz). The highest peaks were then marked and re-measured and quasi-peaked and averaged.

The test was configured as shown below. The product was tested with a generic power supply running on 120 VAC @ 60 Hz. The power supply provides 3.6 VDC to the EUT. The EUT was configured to transmit in order to draw the maximum current from the power supply. This results in the worst case conducted emissions.

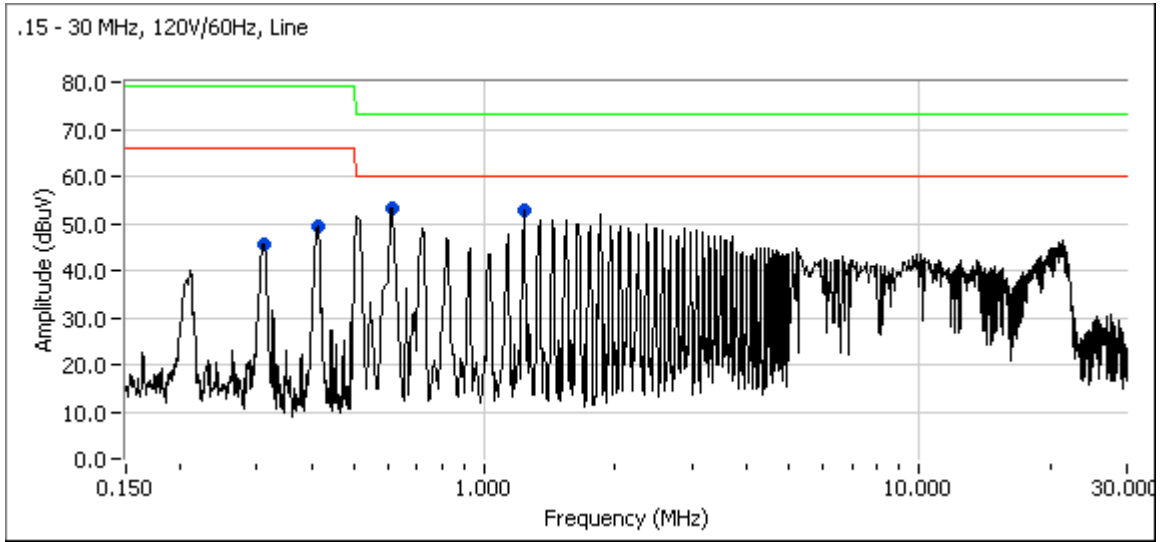
Results:

AC line Conducted Emissions, QP and AVG Results



Frequency MHz	Level dB $\mu$ V	AC Line	EN55022 Class A		Detector QP/Ave
			Limit	Margin	
0.616	47.4	Neutral	60.0	-12.6	AVG
0.615	47.2	Line 1	60.0	-12.8	AVG
1.234	43.4	Line 1	60.0	-16.6	AVG
1.235	43.4	Neutral	60.0	-16.6	AVG
0.616	54.0	Neutral	73.0	-19.0	QP
0.615	53.6	Line 1	73.0	-19.4	QP
1.234	52.5	Line 1	73.0	-20.5	QP
1.235	52.5	Neutral	73.0	-20.5	QP
0.412	43.4	Line 1	66.0	-22.6	AVG
0.412	43.4	Neutral	66.0	-22.6	AVG
0.412	49.0	Neutral	79.0	-30.0	QP
0.412	48.9	Line 1	79.0	-30.1	QP

### AC Line conducted emissions, LINE



### AC Line conducted emissions, NEUTRAL

