



**Nemko Test Report:** 10219671RUS1


**Applicant:** Banner Engineering Corp.  
15755 32<sup>nd</sup> Avenue N.  
Plymouth, MN 55447  
U.S.A.

**Equipment Under Test:  
(E.U.T.)** DX80


FCC ID.: UE3RM7023  
IC: 7044A-RM7023

**In Accordance With:** **FCC Part 15, Subpart C, 15.247 and  
Industry Canada RSS-210, Issue 8**  
Frequency Hopping Transmitters

**Tested By:** Nemko USA Inc.  
802 N. Kealy  
Lewisville, Texas 75057-3136

**TESTED BY:**   
\_\_\_\_\_  
David Light, Senior Wireless Engineer

**DATE:** 24 January 2012

**APPROVED BY:**   
\_\_\_\_\_  
Michael Cantwell, GM

**DATE:** 25 January, 2012

**Total Number of Pages: 55**

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**Section 1. Summary of Test Results**

Manufacturer: Banner Engineering Corp.

Model No.: DX80

Serial No.: None

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 and Industry Canada RSS-210, Issue 8 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted in accordance with ANSI C63.4-2003. Radiated emissions are made on an open area test site.

A description of the test facility is on file with the FCC and Industry Canada.

- |                                     |                            |                                     |                     |
|-------------------------------------|----------------------------|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | New Submission             | <input checked="" type="checkbox"/> | Production Unit     |
| <input type="checkbox"/>            | Class II Permissive Change | <input type="checkbox"/>            | Pre-Production Unit |

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See " Summary of Test Data".



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**Summary Of Test Data**

<b>NAME OF TEST</b>	<b>PARA. NO.</b>	<b>RESULT</b>
Powerline Conducted Emissions	FCC 15.207(a) / RSS-Gen 7.2.4	Complies
Channel Separation	FCC 15.247(a)(1) / RSS-210 A8.1(b)	Complies
Time of Occupancy	FCC 15.247(a)(1) / RSS-210 A8.1(c)	Complies
20 dB Occupied Bandwidth	FCC 15.247(a)(1) / RSS-210 A8.1(b)	Complies
Peak Power Output	FCC 15.247(b) / RSS-210 A8.4(1)	Complies
Spurious Emissions (Antenna Conducted)	FCC 15.247(d) / RSS-210 A8.5	Complies
Spurious Emissions (Radiated)	FCC 15.247(d) / RSS-Gen 7.2.2	Complies
Receiver Spurious Emissions	RSS GEN	Complies

**Footnotes:**

## **Section 2. Equipment Under Test (E.U.T.)**

### **General Equipment Information**

**Frequency Band:**  902 – 928 MHz  
 2400 – 2483.5 MHz  
 5725 – 5850 MHz

**Operating Frequency Range:** 902.48 to 927.68 MHz

**Number of Channels:** 25 or 51

**Channel Spacing:** 400 kHz

**Rated Power:** 1 watt (51 hopping channels)  
250 mW (25 hopping channels)

**User Frequency Adjustment:** None

### **Description of EUT**

EUT is a drop-in replacement for a module on Banner Engineering Corp's DX80 family of industrial sensor monitor and control modules.

**Section 3. Channel Separation**

NAME OF TEST: Channel Separation	PARA. NO.: FCC 15.247(a)(1) RSS-210 A8.1(b)
TESTED BY: David Light	DATE: 23 January 2012

**Test Results:** Complies.

**Measurement Data:** See 20 dB BW plot  
Measured 20 dB bandwidth: 383 kHz Max  
Channel Separation: 400 kHz

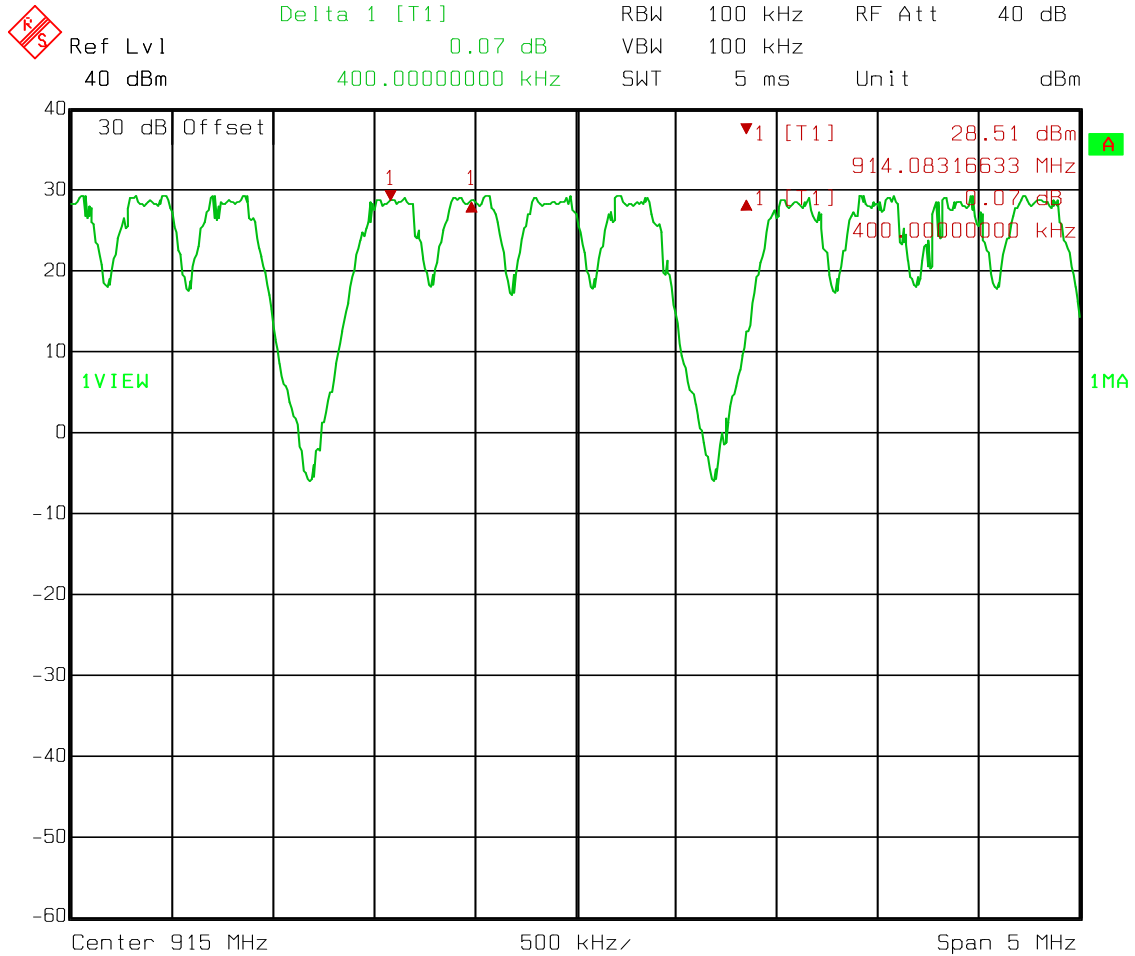
**Equipment Used:** 1036-1472-1469-1082

**Measurement Uncertainty:**  $1 \times 10^{-7}$  ppm

**Temperature:** 23 °C

**Relative Humidity:** 49 %

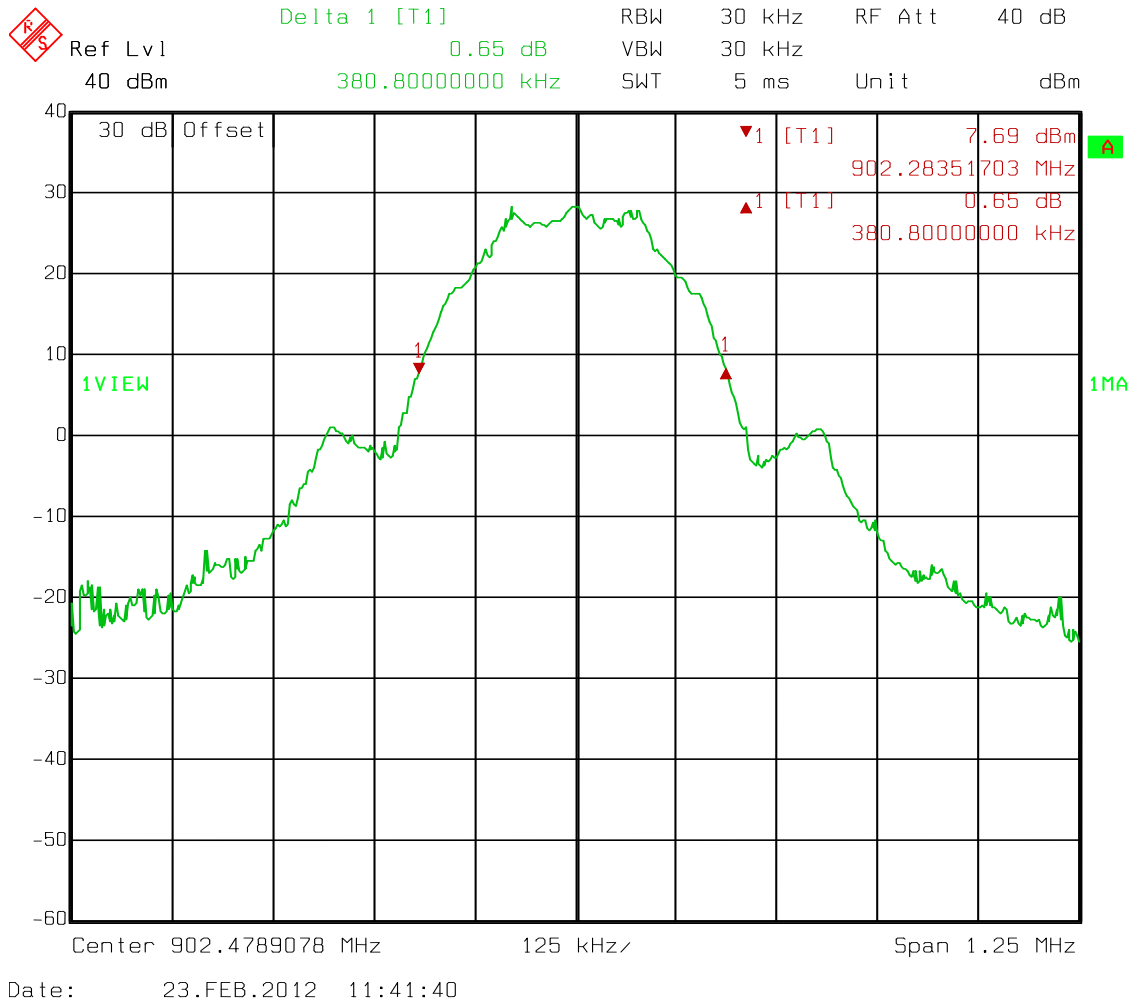
Test Data – Channel Separation



Date: 23.JAN.2012 08:09:11

Test Data – 20 dB Bandwidth

Low Channel

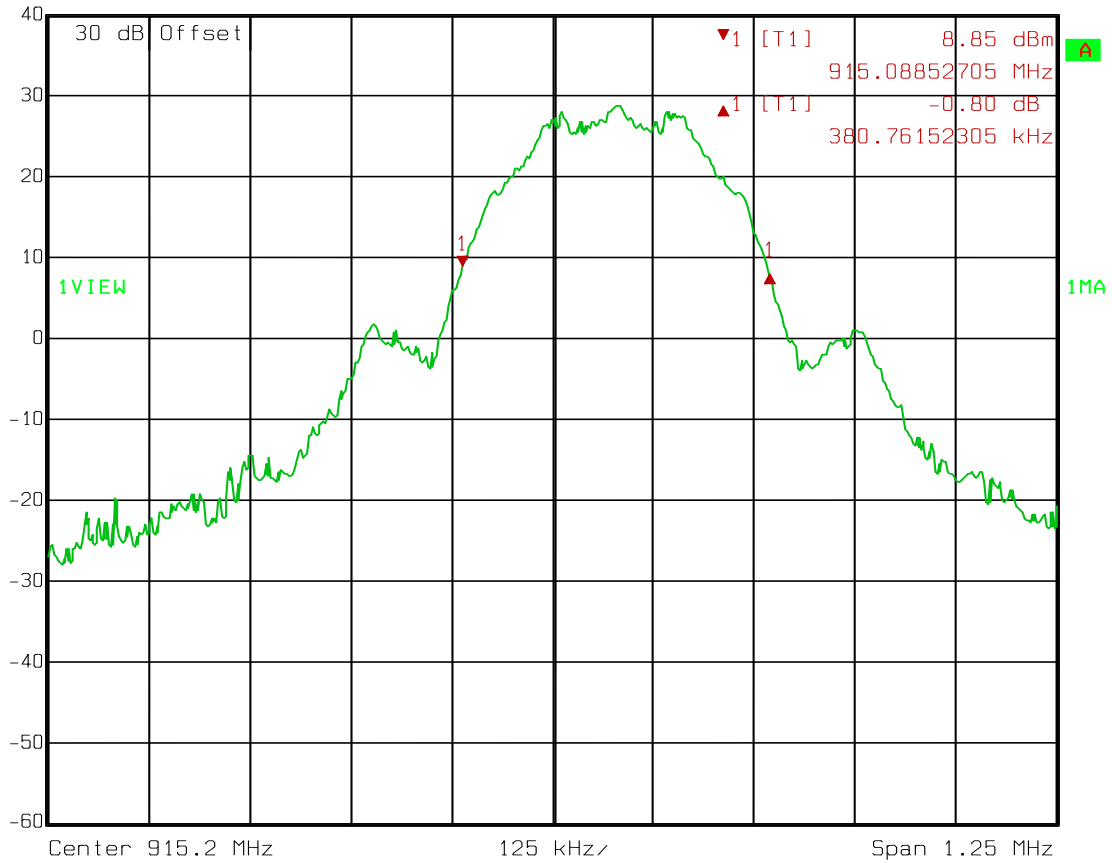




**Test Data – 20 dB Bandwidth**

**Mid Channel**

	Delta 1 [T1]	RBW	30 kHz	RF Att	40 dB
	Ref Lvl	-0.80 dB	VBW	30 kHz	
	40 dBm	380.76152305 kHz	SWT	5 ms	Unit

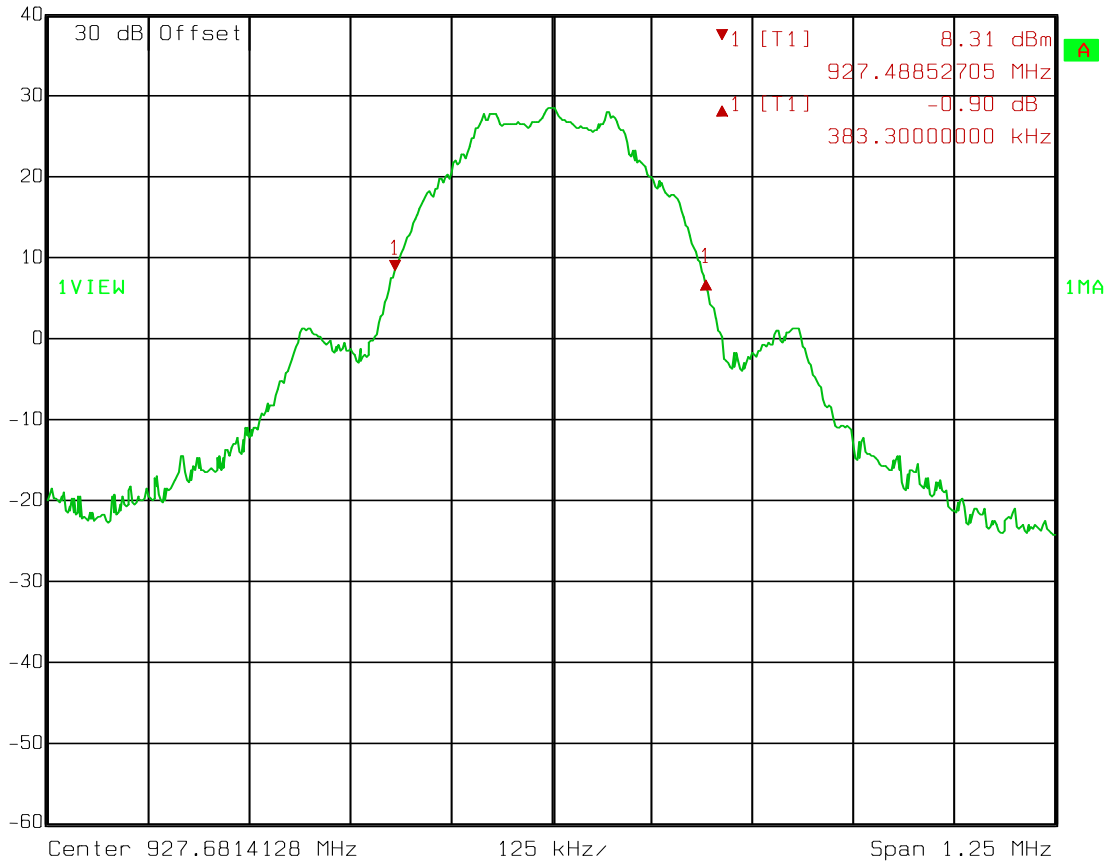


Date: 23.JAN.2012 08:10:43

**Test Data – 20 dB Bandwidth**

**High Channel**

RS	Delta 1 [T1]	RBW	30 kHz	RF Att	40 dB
	Ref Lvl	-0.90 dB	VBW	30 kHz	
	40 dBm	383.3000000 kHz	SWT	5 ms	Unit dBm



Date: 23.FEB.2012 11:44:51

**Section 4. Time of Occupancy**

NAME OF TEST: Time of Occupancy	PARA. NO.: FCC 15.247(a)(1) RSS-210 A8.1(c)
TESTED BY: David Light	DATE: 23 January 2012

**Test Results:** Complies.

**Measurement Data:** Maximum Dwell Time On Any Channel: 174 ms/10 seconds

**Equipment Used:** 1036-1472-1469-1082

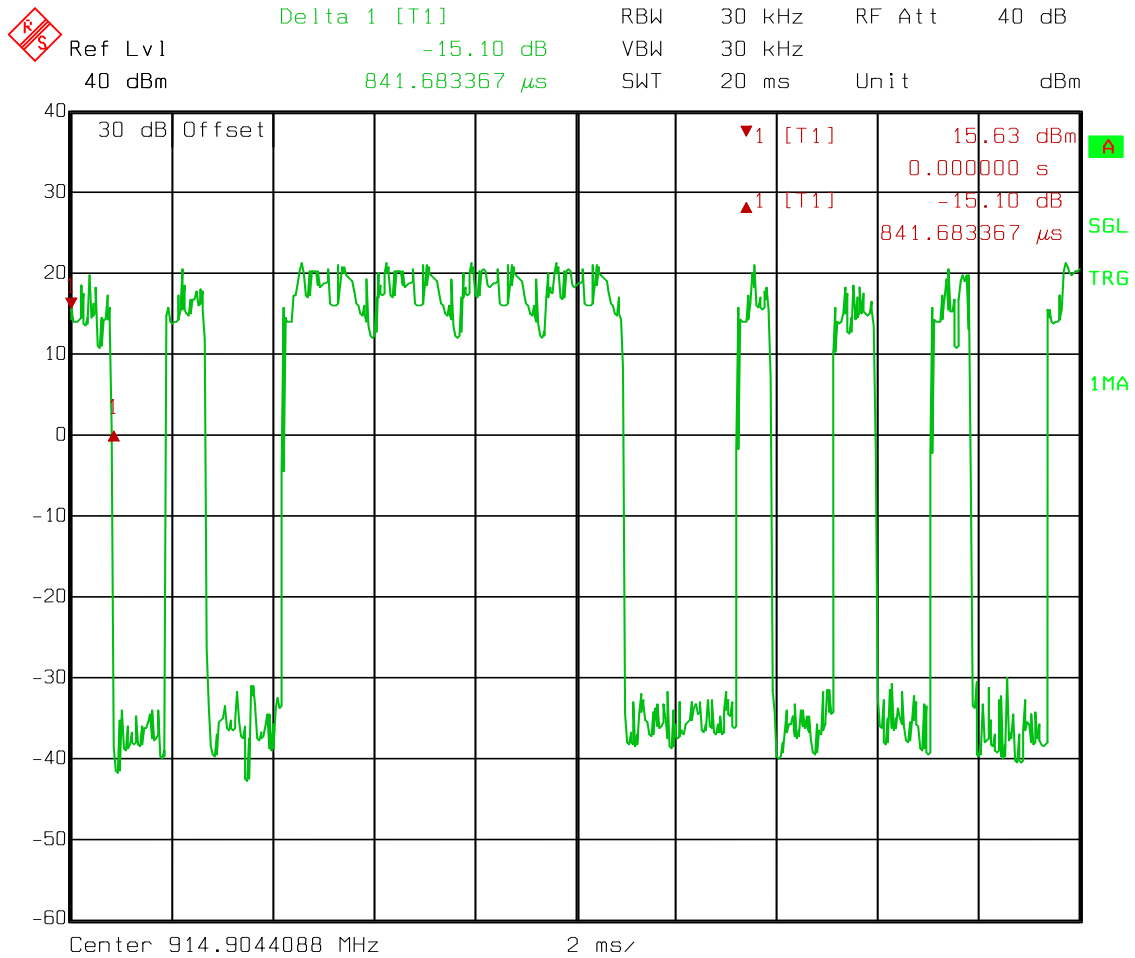
**Measurement Uncertainty:**  $1 \times 10^{-7}$  ppm

**Temperature:** 23 °C

**Relative Humidity:** 48 %

**Test Data – Time of Occupancy**

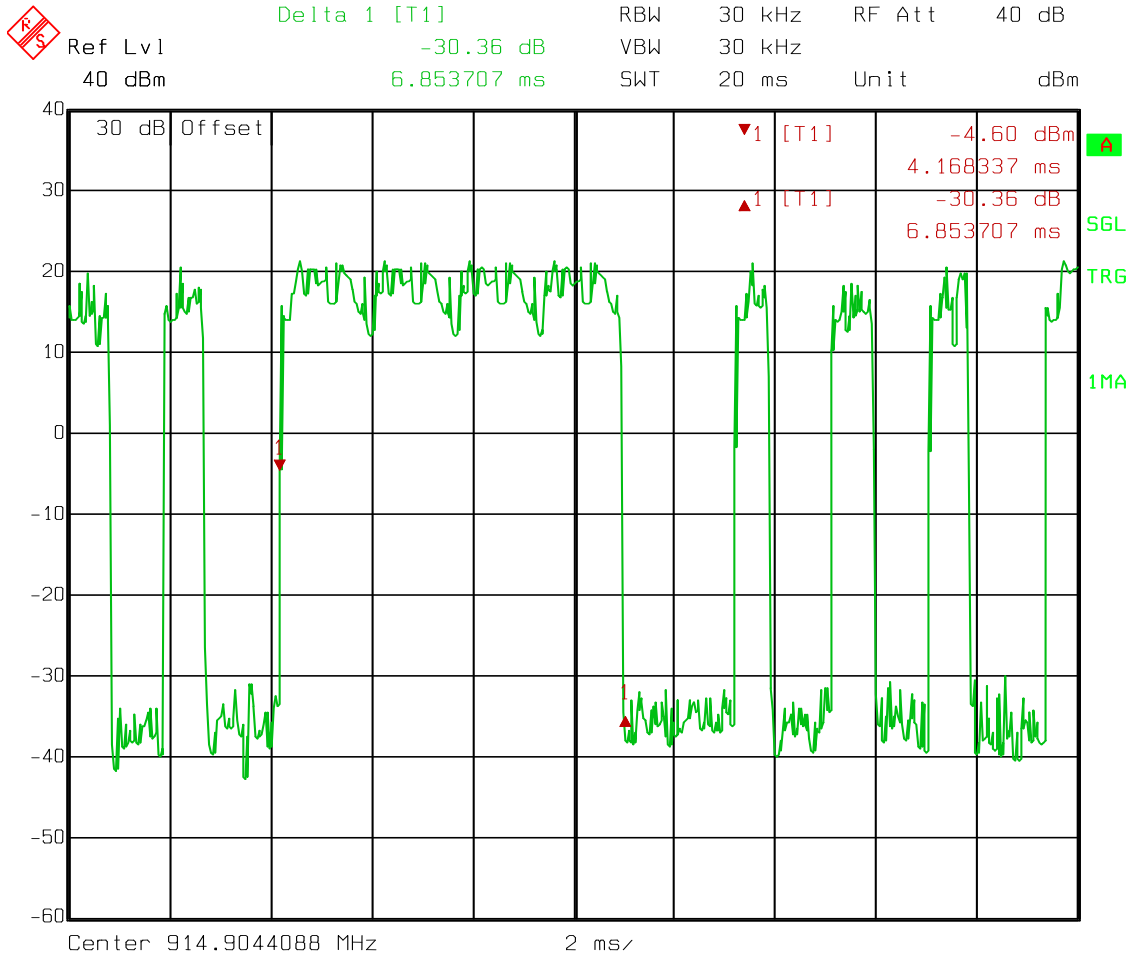
Narrow Pulse Width = 841  $\mu$ s



Date: 23.JAN.2012 11:44:05

Test Data – Time of Occupancy

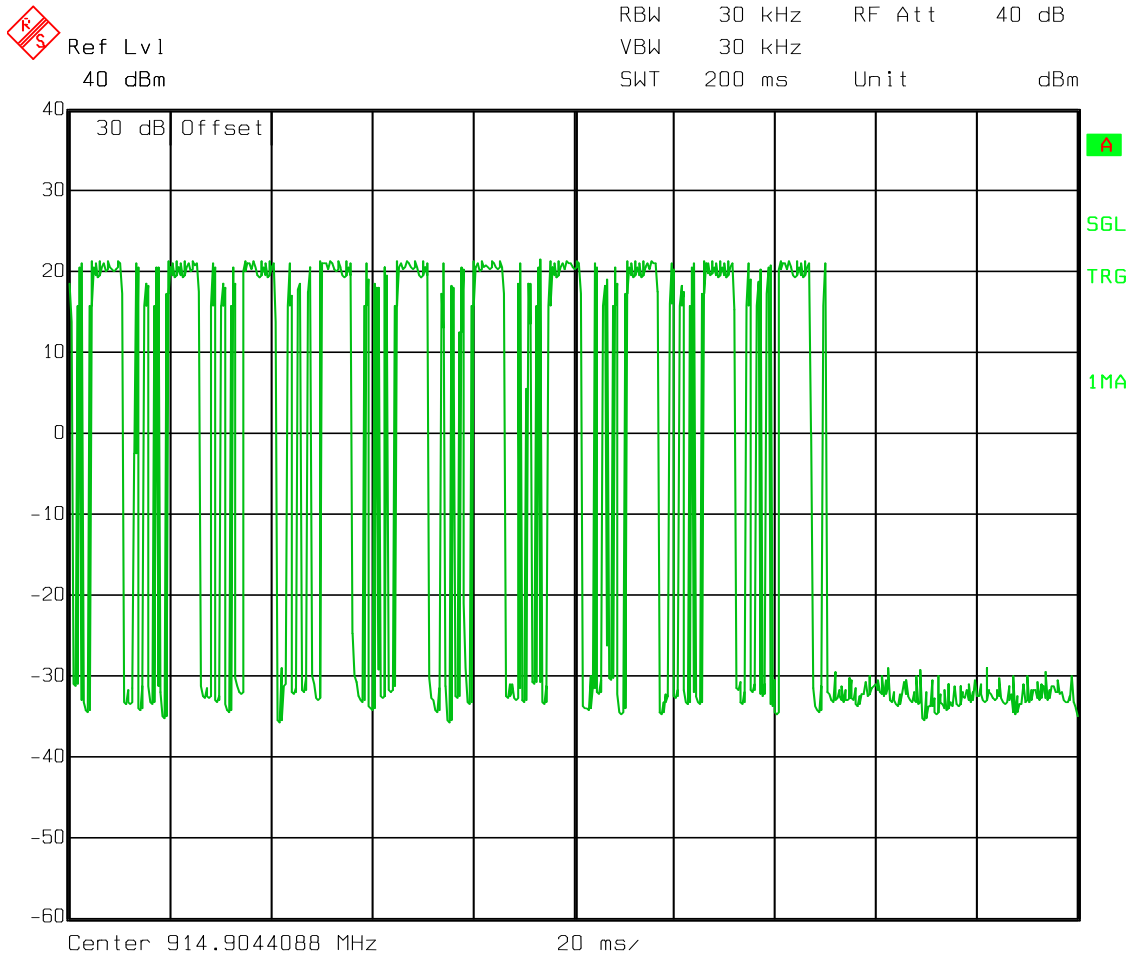
Wide Pulse Width = 6.9 ms



Date: 23.JAN.2012 11:45:01

Test Data – Time of Occupancy

Total Time per Hop



30 Short pulses @ 0.841 ms  
10 Long pulses @ 6.9 ms  
Time per hop = 0.58 seconds

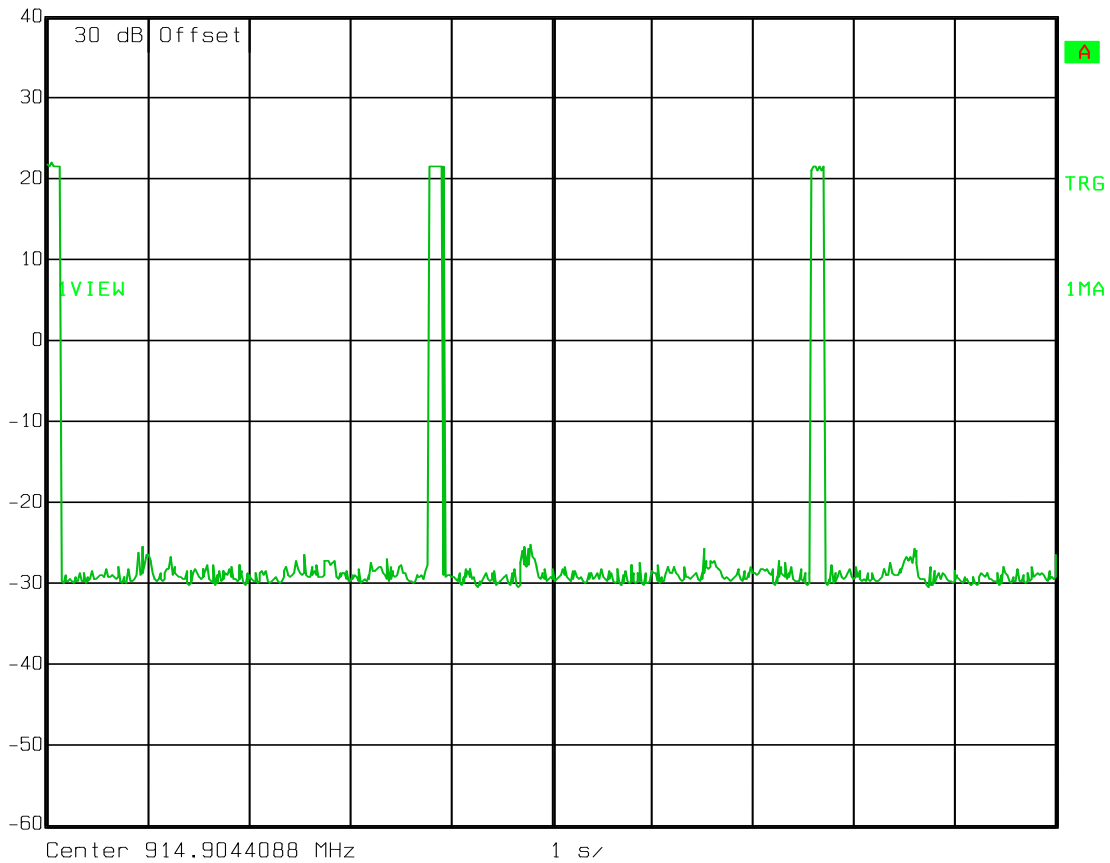
**Test Data – Time of Occupancy**

ON Time in 25 Channel Mode



Ref Lvl  
40 dBm

RBW 30 kHz RF Att 40 dB  
VBW 30 kHz  
SWT 10 s Unit dBm

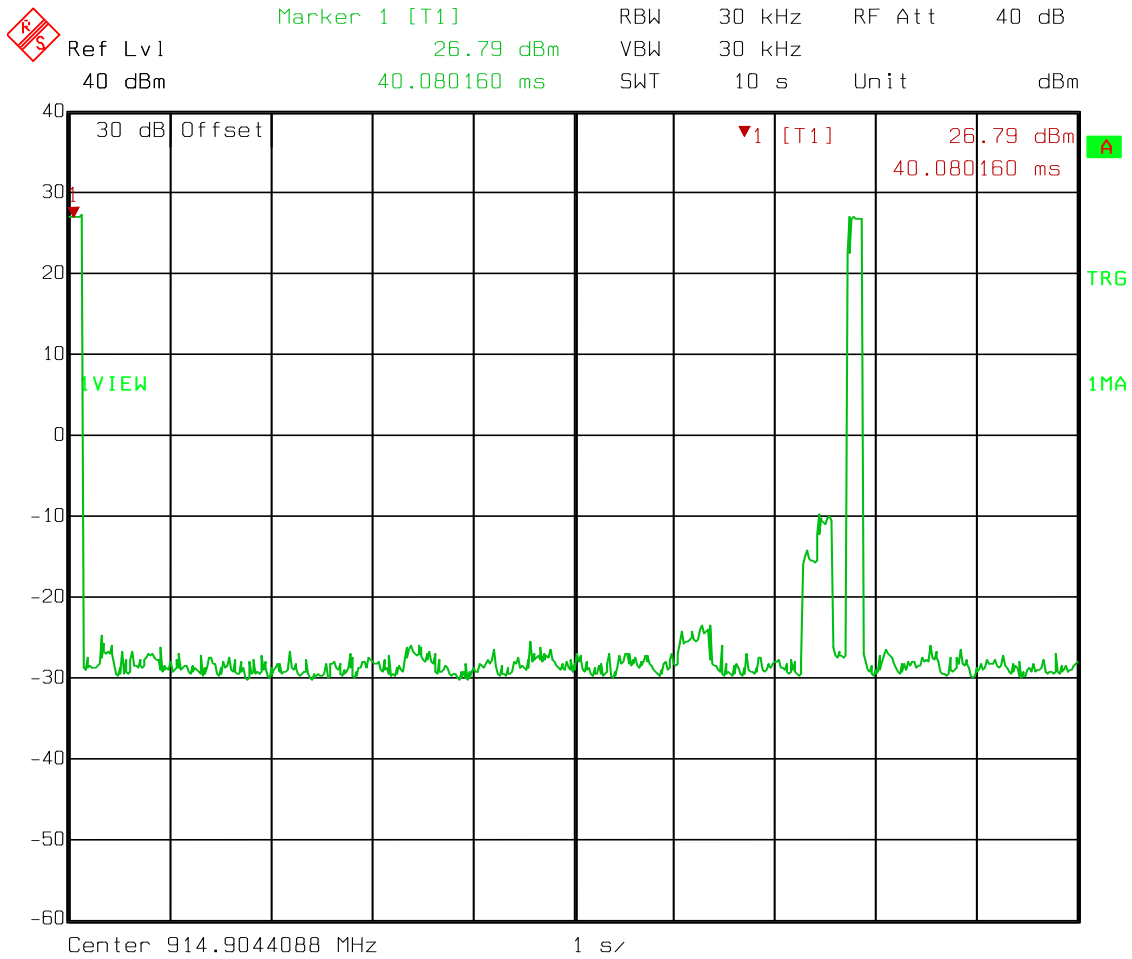


Date: 23.JAN.2012 11:50:00

Hopping on 25 Channels  
Total ON time =174 ms in 10 seconds

Test Data – Time of Occupancy

ON Time in 51 Channel Mode



Date: 23.JAN.2012 11:56:38

Hopping on 51 Channels  
Total ON time =116 ms in 10 seconds

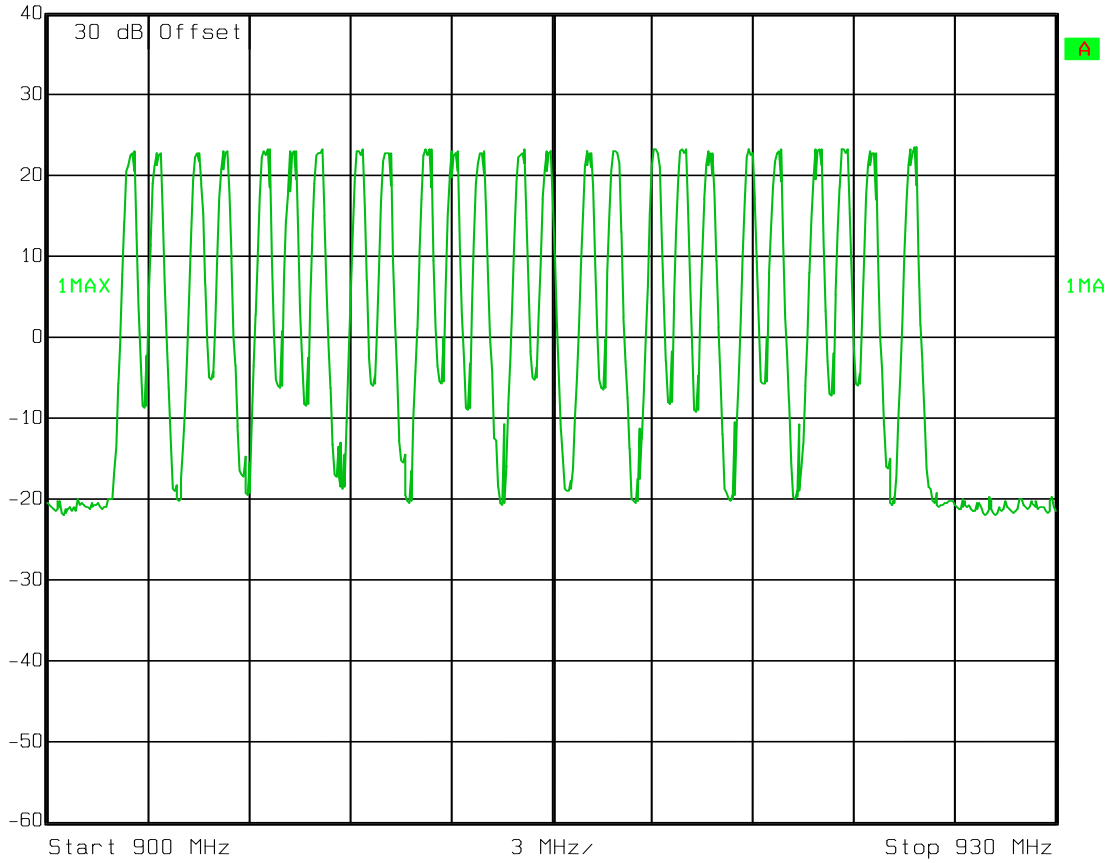


**Test Data – Number of Hopping Channels**  
25 Channels



Ref Lvl  
40 dBm

RBW 100 kHz RF Att 40 dB  
VBW 100 kHz  
SWT 7.5 ms Unit dBm



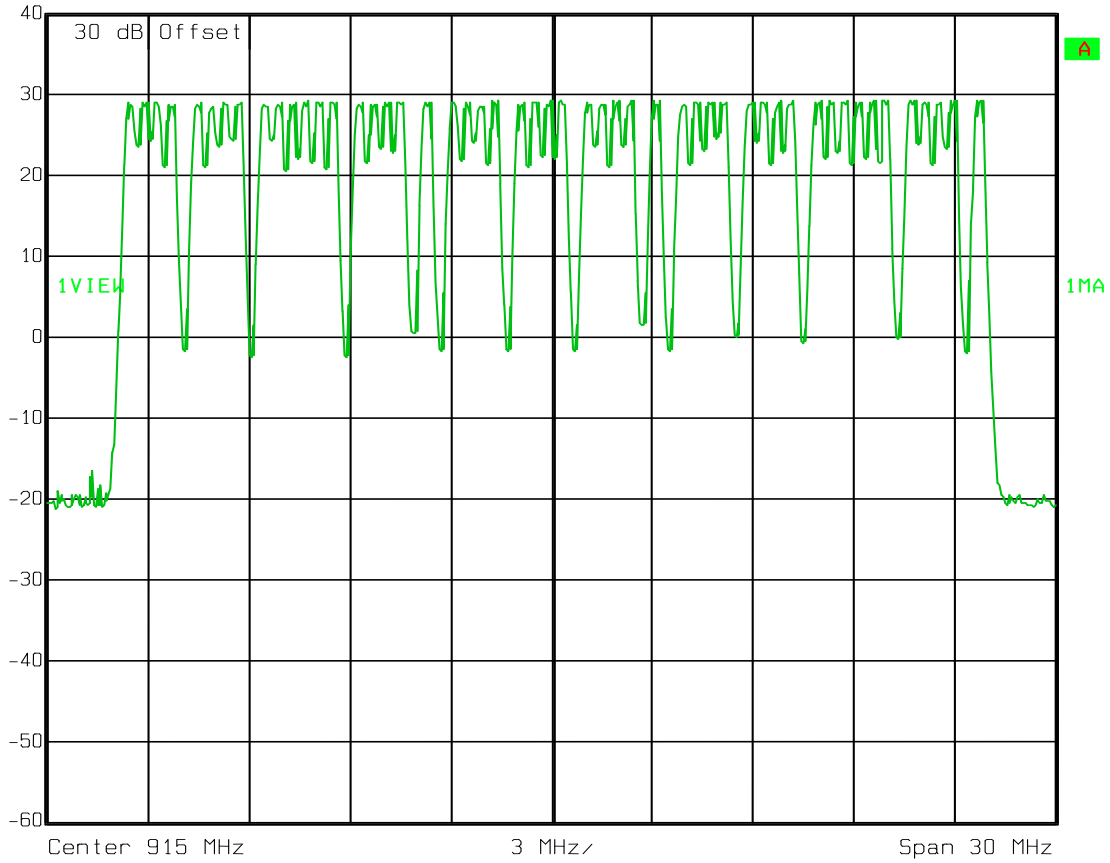
Date: 23.JAN.2012 12:00:08

**Test Data – Number of Hopping Channels**  
51 Channels



Ref Lvl  
40 dBm

RBW 100 kHz RF Att 40 dB  
VBW 100 kHz  
SWT 7.5 ms Unit dBm



Date: 23.JAN.2012 08:06:42

**Section 5. Peak Power Output**

NAME OF TEST: Peak Power Output	PARA. NO.: FCC 15.247 (b) RSS-210 A8.4(1)
TESTED BY: David Light	DATE: 23 January 2012

**Test Results:** Complies.

**Measurement Data:** See attached plots.

Detachable antenna?  Yes  No  
 If yes, state the type of non-standard connector used: R-SMA

**Antenna Types:**

Monopole	7.2 dBi Gain
Dipole	8.2 dBi Gain
Yagi	12.2 dBi Gain

**\*Note:** There is a notation in installation instructions that the output power will require attenuation at radio output to meet the EIRP limit as indicated in FCC 15.247(b)(4) and RSS-210 A8.4(1)

- This device was tested at +/- 15% input power per 15.31(e), with no variation in output power.
- For battery powered equipment, the device was tested with a fresh battery per 15.31(e).
- The device was tested on three channels per 15.31(l).
- This test was performed radiated.

**Equipment Used:** 1036-1082-1472-1469

**Measurement Uncertainty:** 1.7 dB

**Temperature:** 23 °C

**Relative Humidity:** 48 %

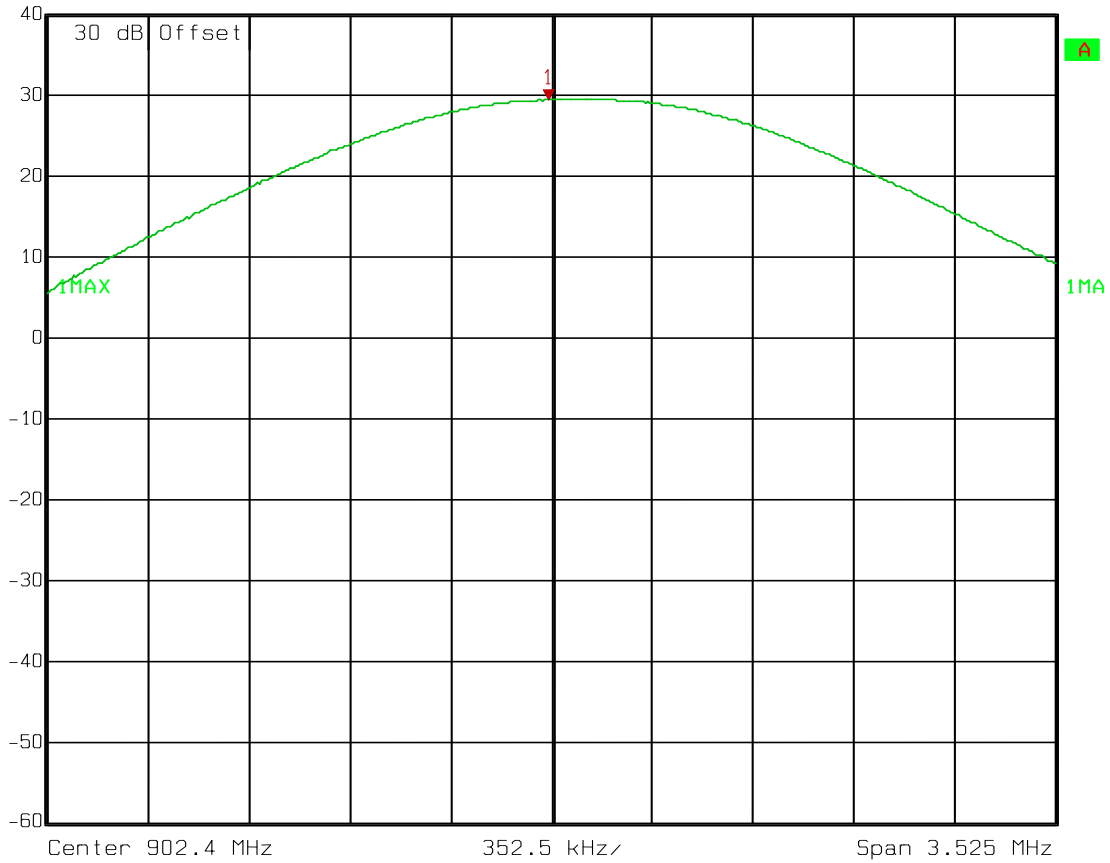
Test Data – Peak Power

High Power

Low Channel (51 hopping channels)



Ref Lvl 40 dBm  
Marker 1 [T1] 29.30 dBm  
902.38940381 MHz  
RBW 1 MHz  
VBW 1 MHz  
RF Att 40 dB  
SWT 5 ms  
Unit dBm



Date: 23.JAN.2012 07:53:16

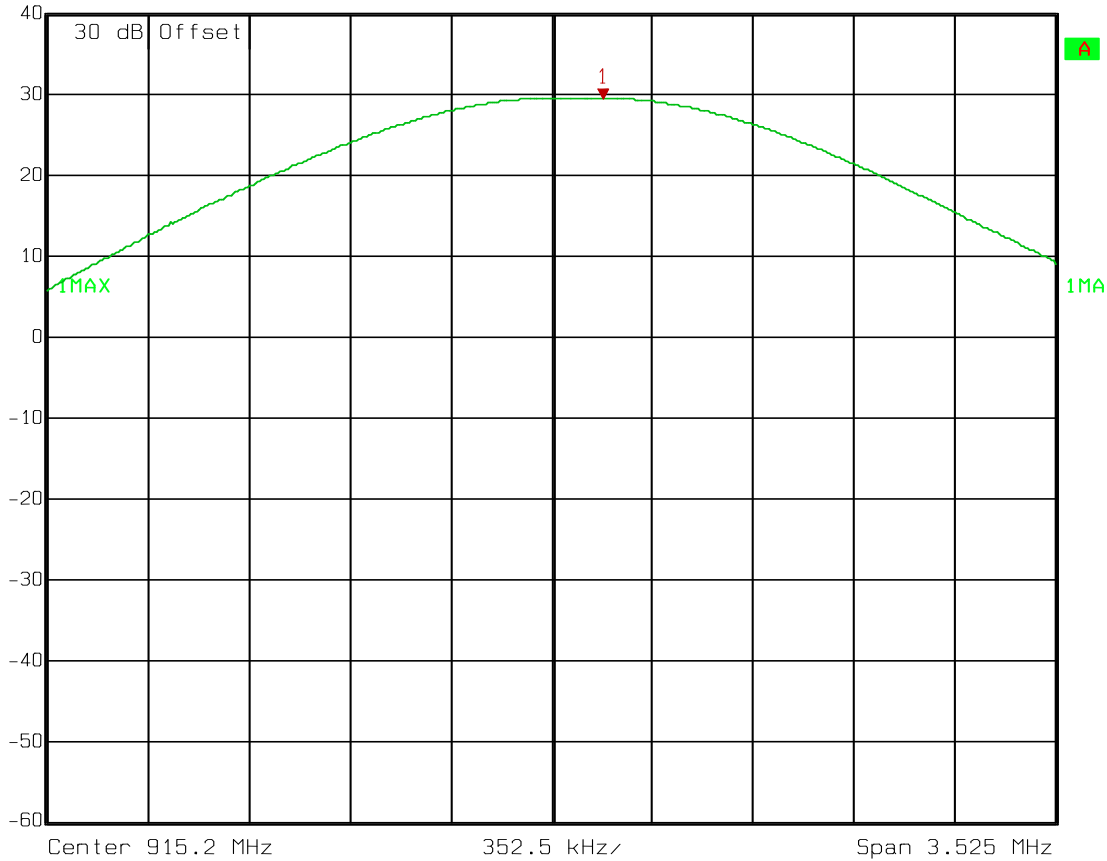
Test Data – Peak Power

High Power

Mid Channel (51 hopping channels)



Ref Lvl 40 dBm  
Marker 1 [T1] 29.45 dBm  
RBW 1 MHz RF Att 40 dB  
VBW 1 MHz  
SWT 5 ms Unit dBm



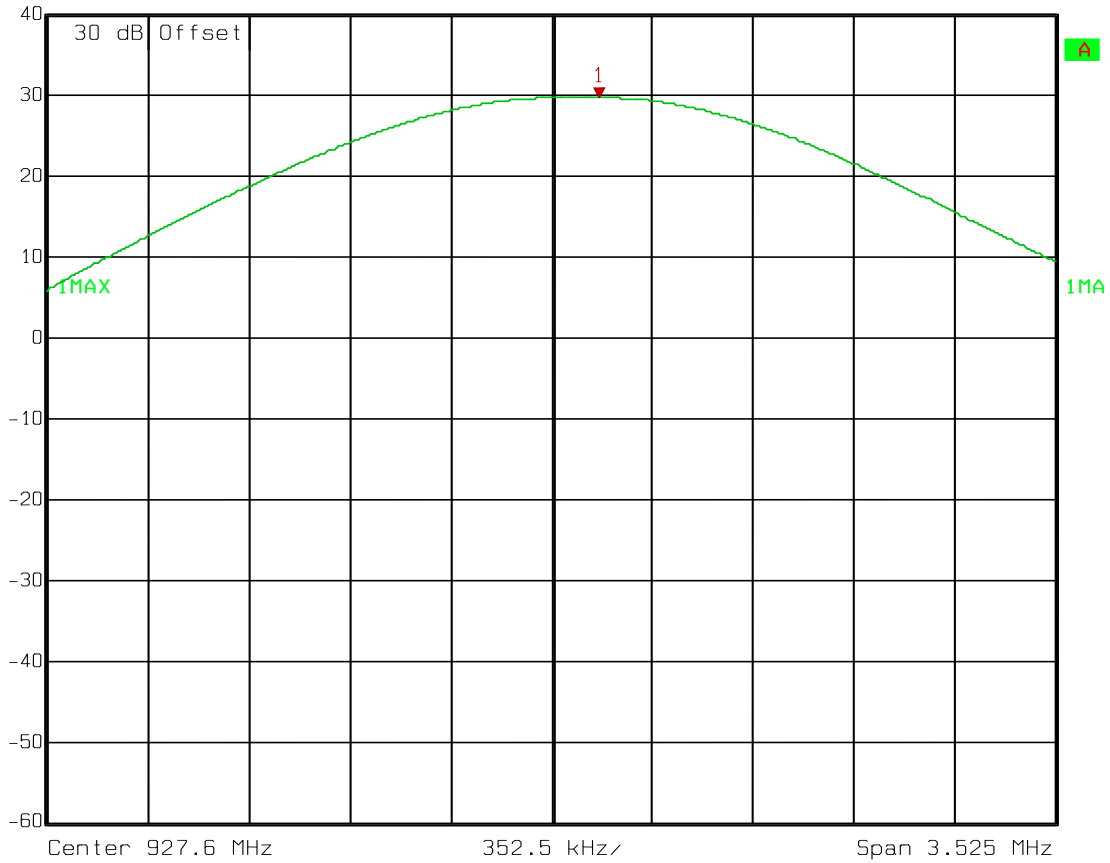
Date: 23.JAN.2012 07:52:51

Test Data – Peak Power

High Power  
High Channel (51 hopping channels)



Marker 1 [T1] RBW 1 MHz RF Att 40 dB  
Ref Lvl 29.57 dBm VBW 1 MHz  
40 dBm 927.76600701 MHz SWT 5 ms Unit dBm



Date: 23.JAN.2012 07:54:21

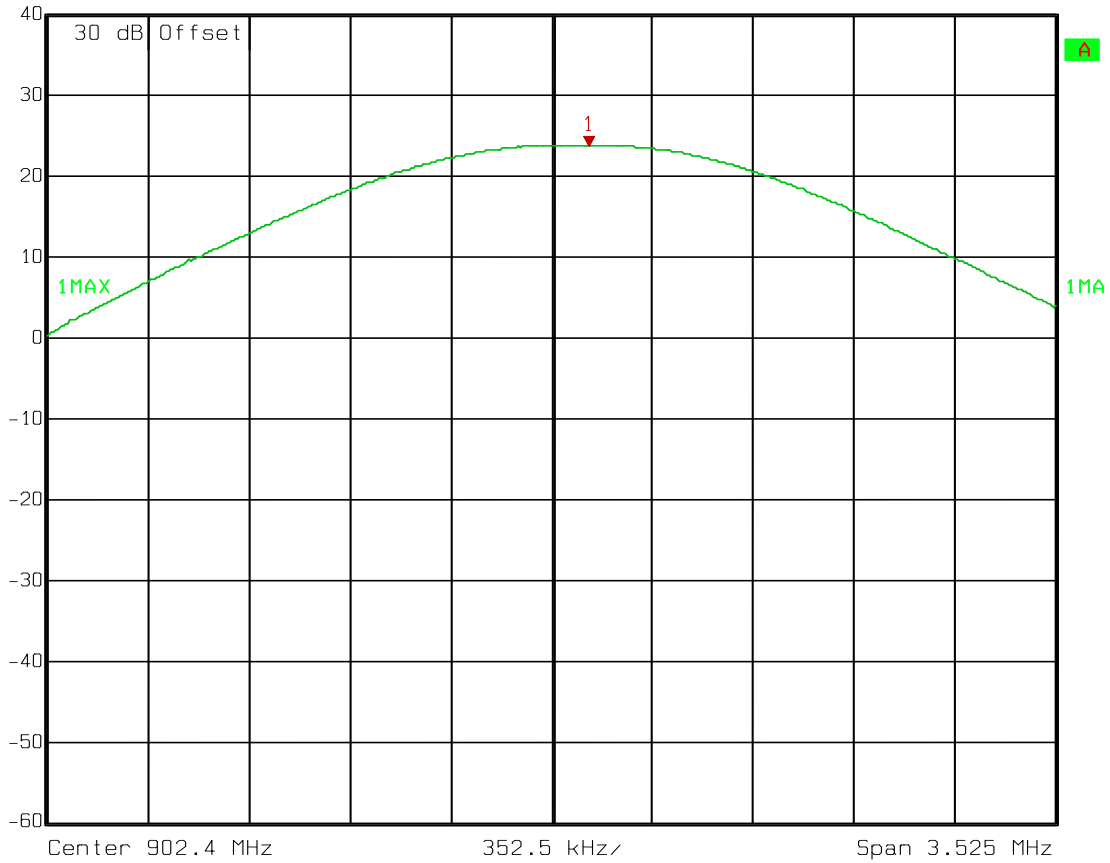
Test Data – Peak Power

Low Power

Low Channel (25 hopping channels)



Ref Lvl 40 dBm  
Marker 1 [T1] 23.69 dBm  
902.53068637 MHz  
RBW 1 MHz  
VBW 1 MHz  
RF Att 40 dB  
SWT 5 ms  
Unit dBm



Date: 23.JAN.2012 07:56:47

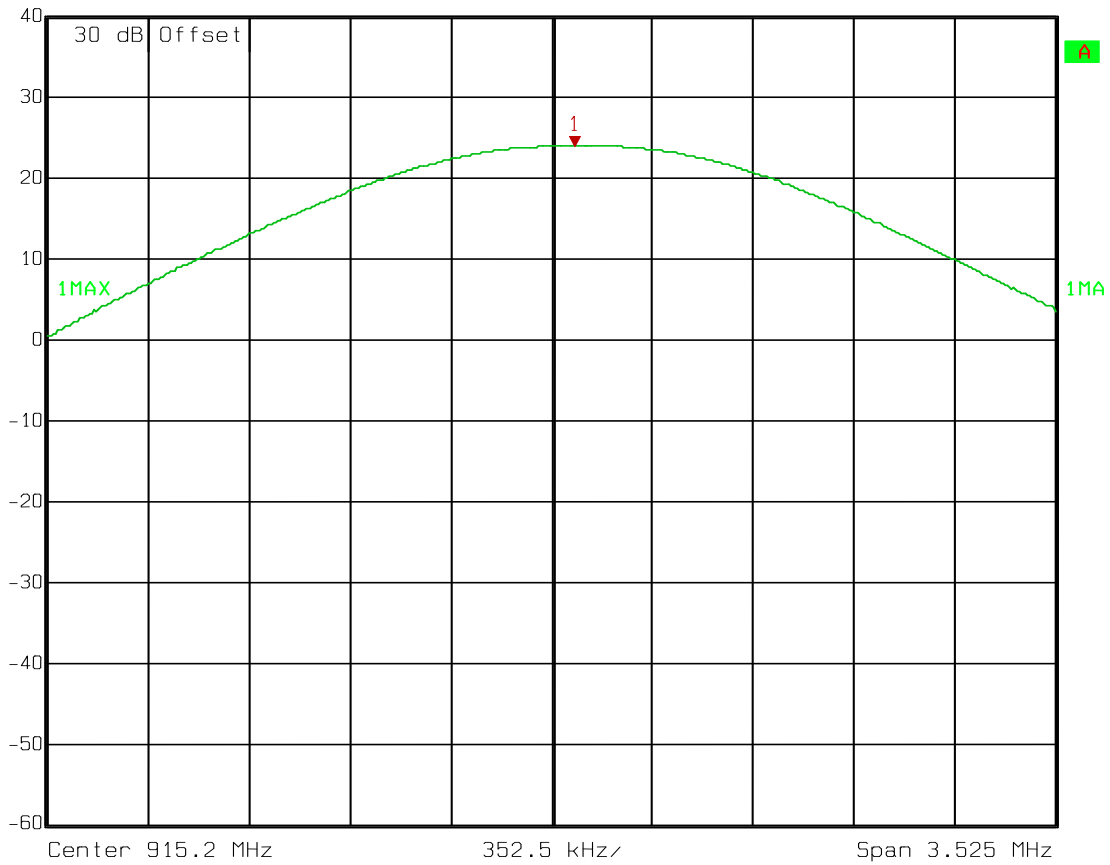
Test Data – Peak Power

Low Power

Mid Channel (25 hopping channels)



Marker 1 [T1] RBW 1 MHz RF Att 40 dB  
Ref Lvl 23.85 dBm VBW 1 MHz  
40 dBm 915.28123747 MHz SWT 5 ms Unit dBm



Date: 23.JAN.2012 07:57:39



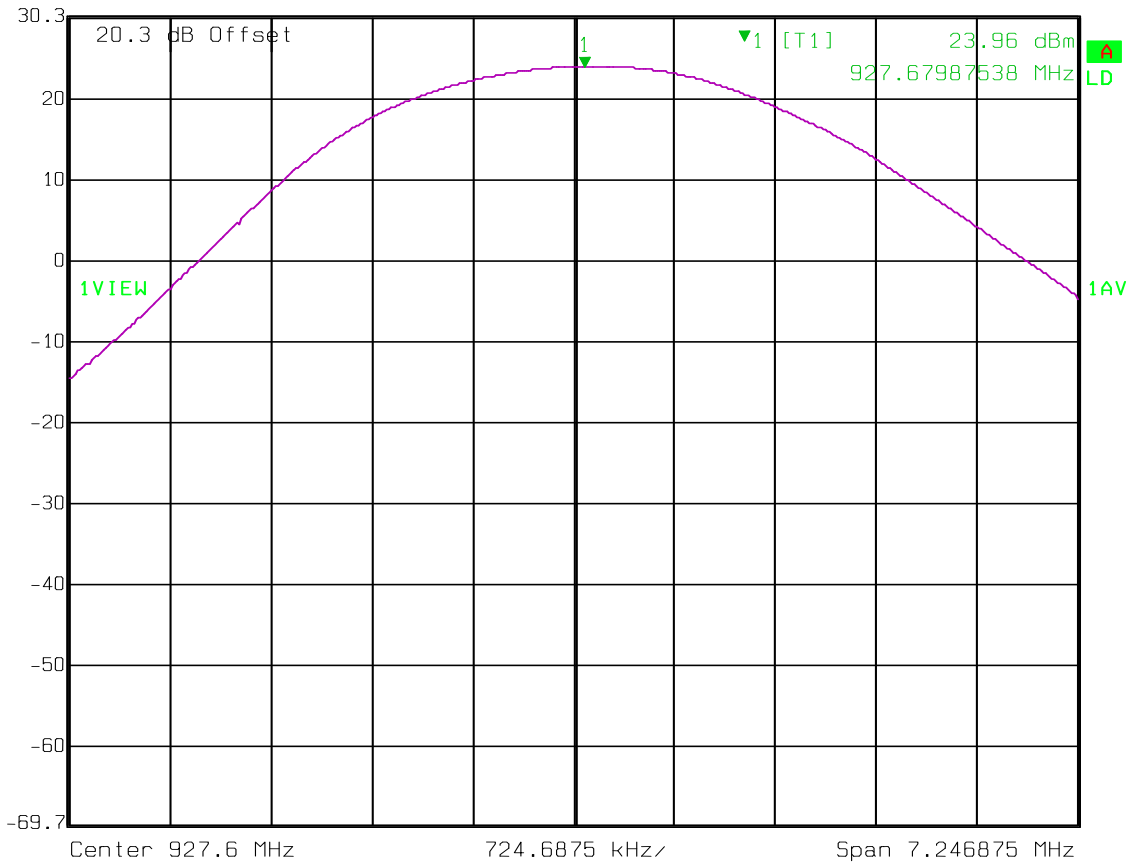
Test Data – Peak Power

Low Power

High Channel (25 hopping channels)



Ref Lvl 30.3 dBm  
Marker 1 [T1] 23.96 dBm  
927.67987538 MHz  
RBW 2 MHz RF Att 50 dB  
VBW 2 MHz Mixer -40 dBm  
SWT 5 ms Unit dBm



Date: 29.FEB.2012 14:20:59

**Section 6. Spurious Emissions (Conducted)**

NAME OF TEST: Spurious Emissions (Conducted)	PARA. NO.: FCC 15.247(d) RSS-210 A8.5
TESTED BY: David Light	DATE: 23 January 2012

**Test Results:** Complies.

**Measurement Data:** See attached plots.

**Equipment Used:** 1036-1082-1472-1469

**Measurement Uncertainty:** 1X10<sup>-7</sup>ppm

**Temperature:** °C

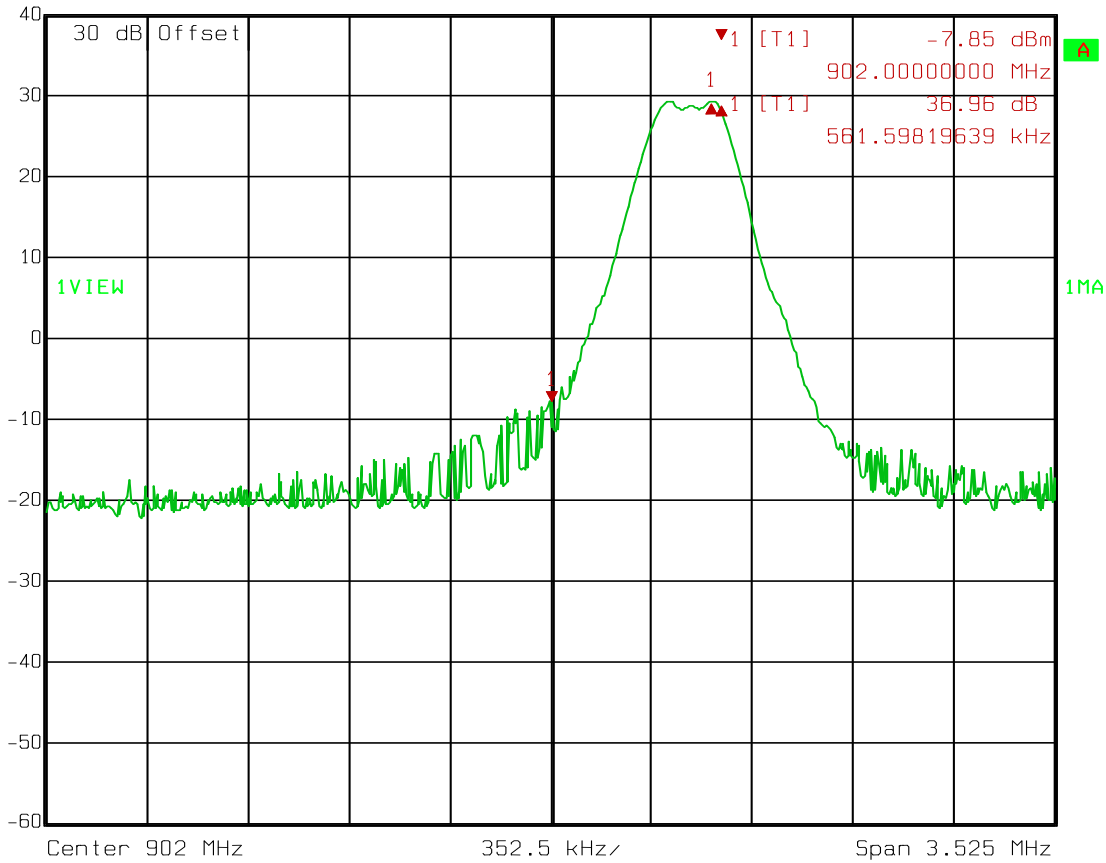
**Relative Humidity:** %

Test Data – Spurious Emissions at Antenna Terminals

Lower Band Edge



Delta 1 [T1] RBW 100 kHz RF Att 40 dB  
Ref Lvl 36.96 dB VBW 100 kHz  
40 dBm 561.59819639 kHz SWT 5 ms Unit dBm



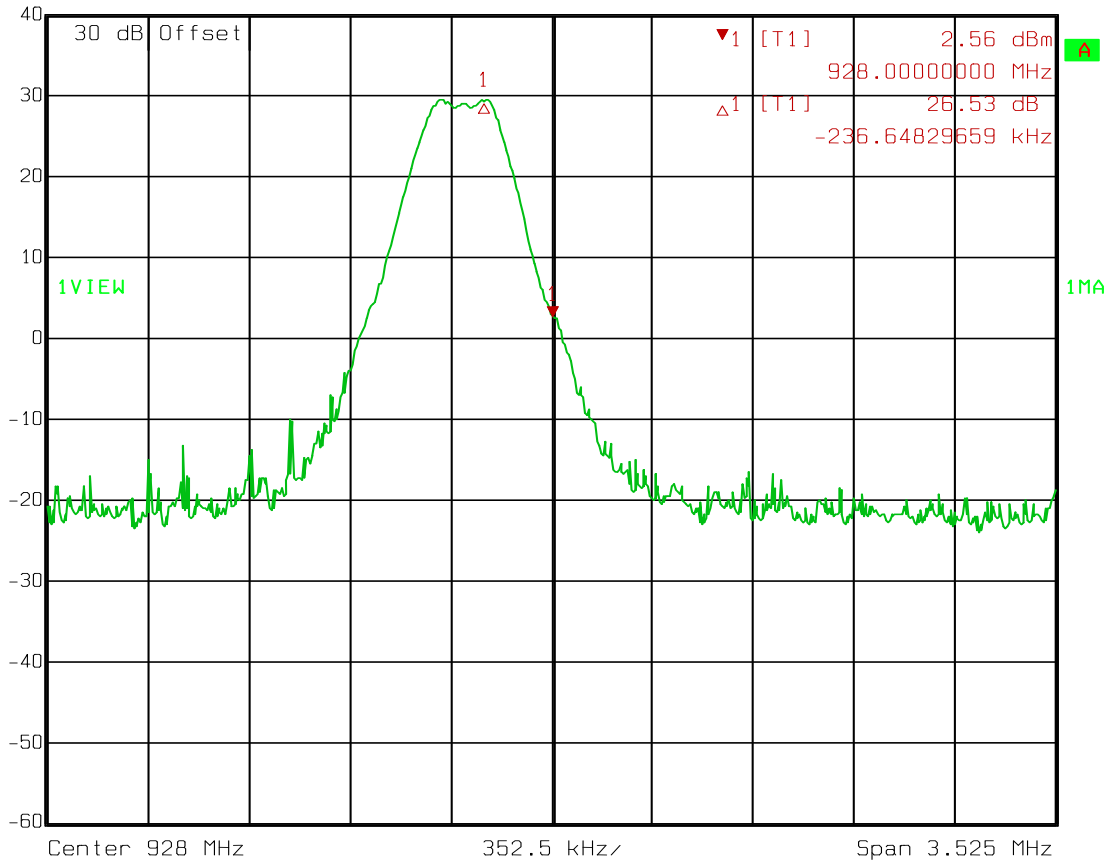
Date: 23.JAN.2012 08:01:06

Test Data – Spurious Emissions at Antenna Terminals

Upper Band Edge



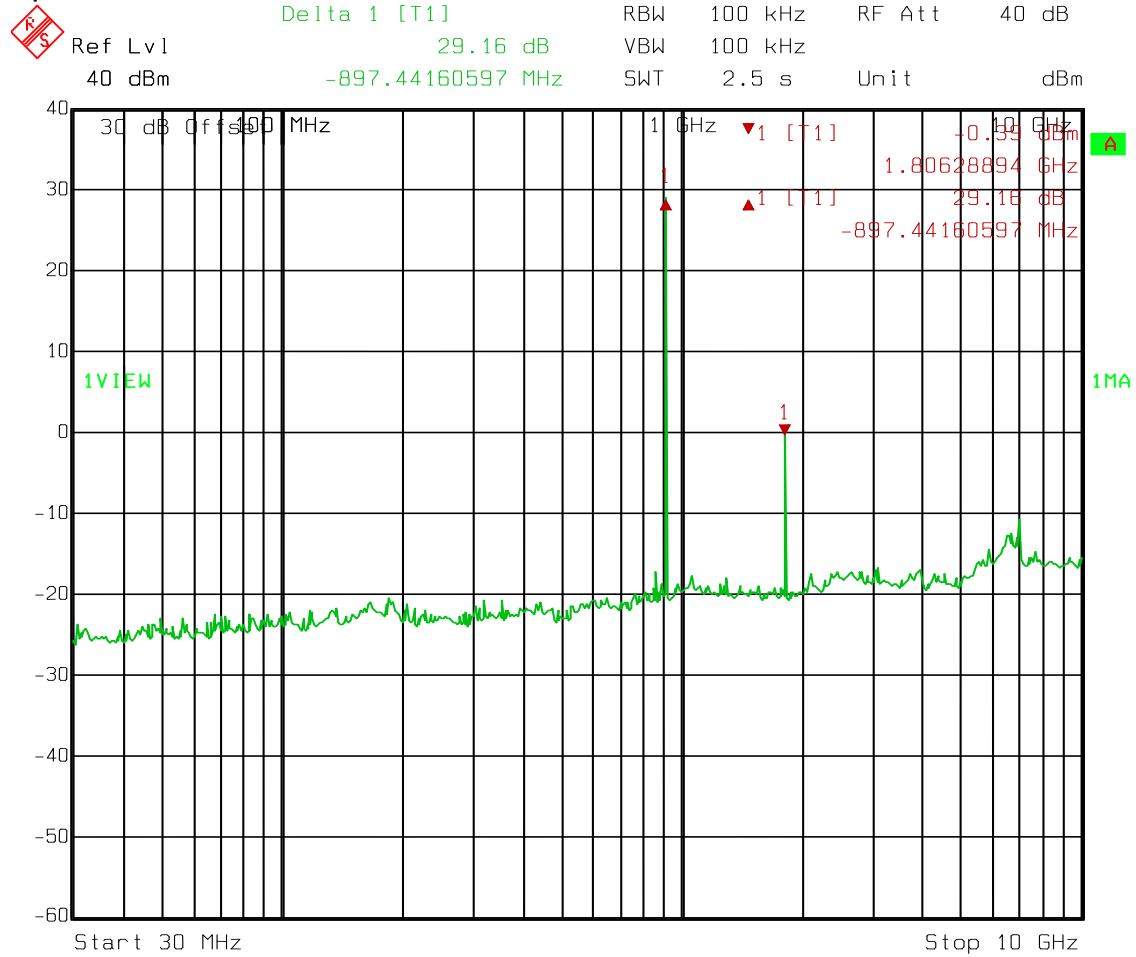
Ref Lvl 40 dBm  
Marker 1 [T1] 2.56 dBm  
928.00000000 MHz  
RBW 100 kHz  
VBW 100 kHz  
RF Att 40 dB  
SWT 5 ms  
Unit dBm



Date: 23.JAN.2012 08:00:22

Test Data – Spurious Emissions at Antenna Terminals

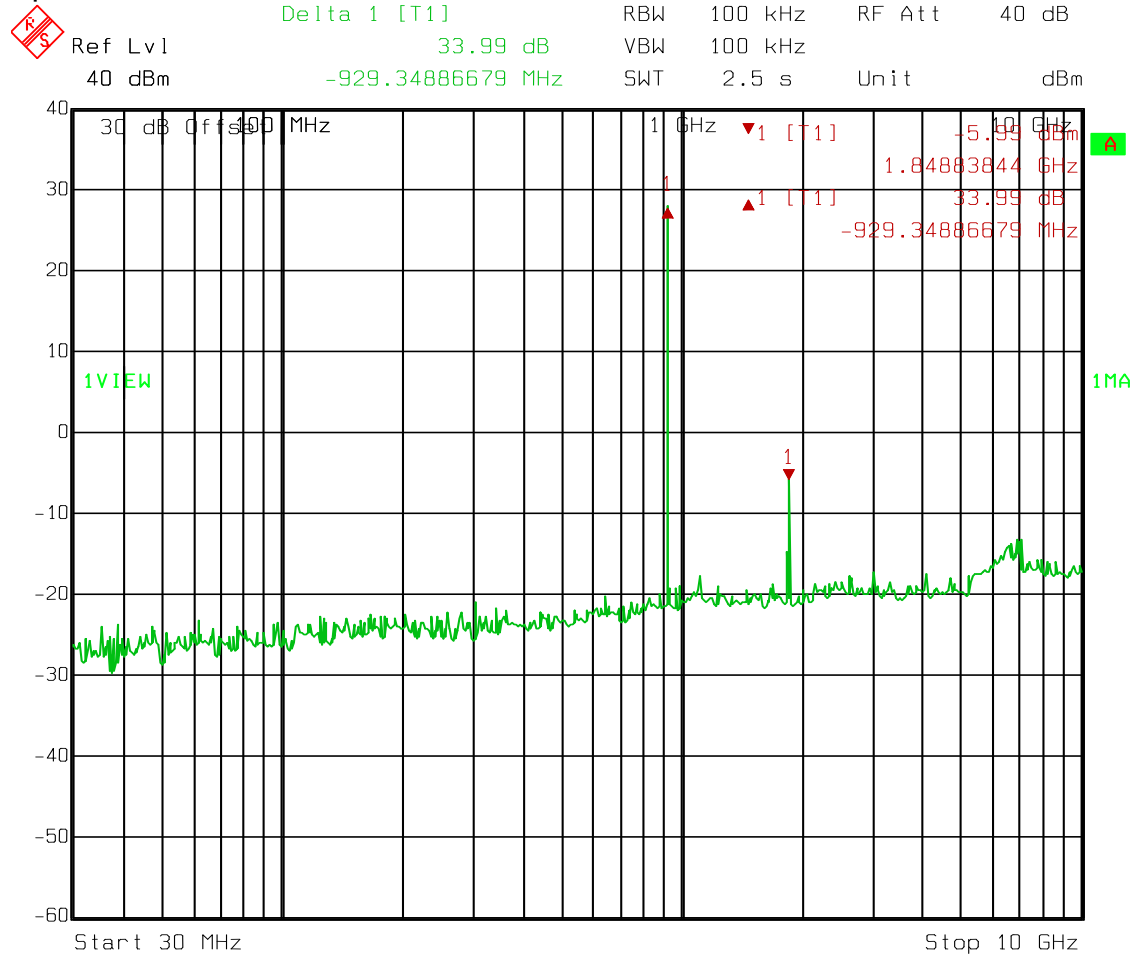
Spurs – Low Channel



Date: 23.JAN.2012 08:03:21

Test Data – Spurious Emissions at Antenna Terminals

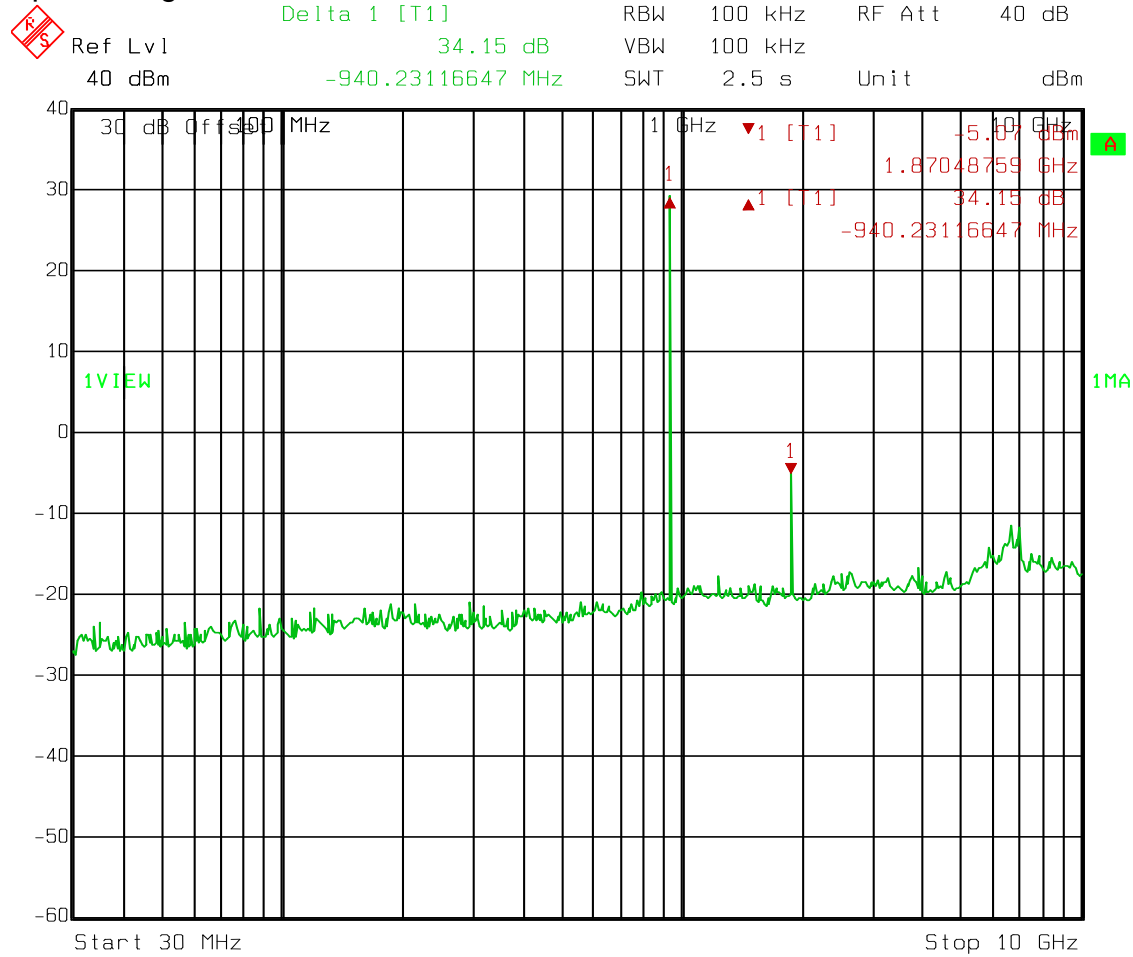
Spurs – Mid Channel



Date: 23.JAN.2012 08:04:01

Test Data – Spurious Emissions at Antenna Terminals

Spurs – High Channel



Date: 23.JAN.2012 08:04:48

### Section 7. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: FCC 15.247(d) RSS-Gen 7.2.2
TESTED BY: David Light	DATE: 20 January 2012

**Test Results:** Complies. The worst case emission was 51.5 dBµV/m at 2782.8 MHz. This is 2.5 dB below the specification limit of 54 dBµV/m.

**Measurement Data:** See attached table.

#### Duty Cycle Calculation:

Duty Cycle correction factor(dB) = 20 log (rf<sub>ON</sub> in ms/100ms)

Notes:

- The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33
- The device was tested on three channels per 15.31(l).
- All emissions within 20 dB of the specification limit are reported per 15.31(o).

**Equipment Used:** 1464-1783-1016-993-1025-1763

**Measurement Uncertainty:** +/-3.6 dB

**Temperature:** 23 °C

**Relative Humidity:** 48 %

#### Analyzer Settings:

Peak Measurements      RBW/VBW = 1 MHz      Peak Detector  
Average Measurements      RBW = 1 MHz      VBW = 1 kHzPeak Detector

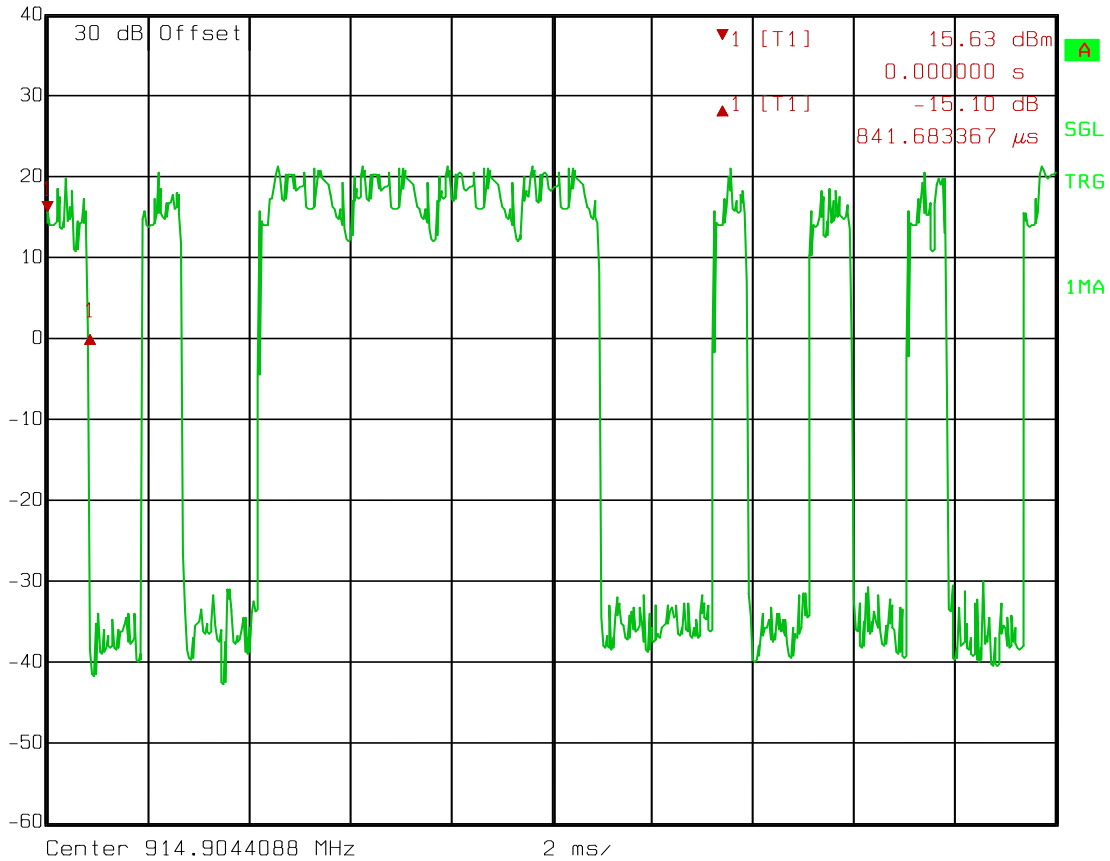


Test Data – Duty Cycle Correction

Narrow Pulses – 841  $\mu$ s



Delta 1 [T1] RBW 30 kHz RF Att 40 dB  
Ref Lvl -15.10 dB VBW 30 kHz  
40 dBm 841.683367  $\mu$ s SWT 20 ms Unit dBm



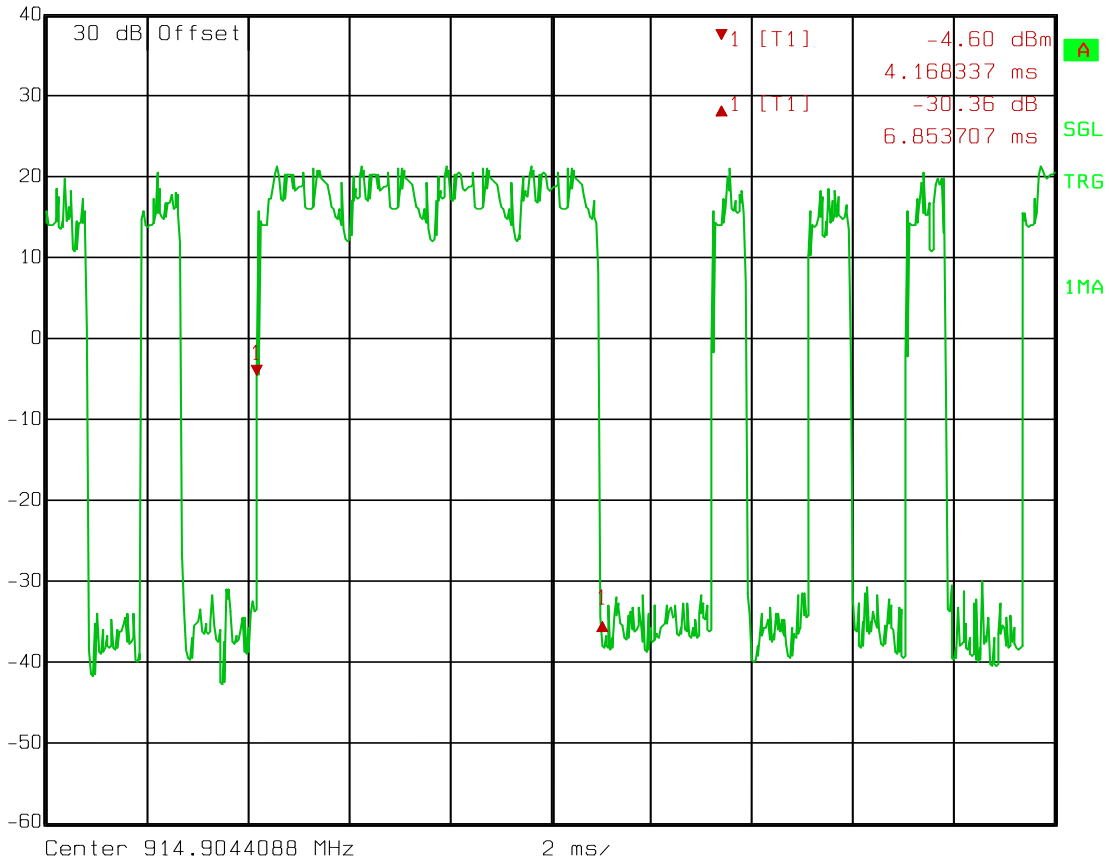
Date: 23.JAN.2012 11:44:05

Test Data – Duty Cycle Correction

Wide pulses = 6.9 ms



Ref Lvl	Delta 1 [T1]	RBW	30 kHz	RF Att	40 dB
40 dBm	-30.36 dB	VBW	30 kHz		
	6.853707 ms	SWT	20 ms	Unit	dBm



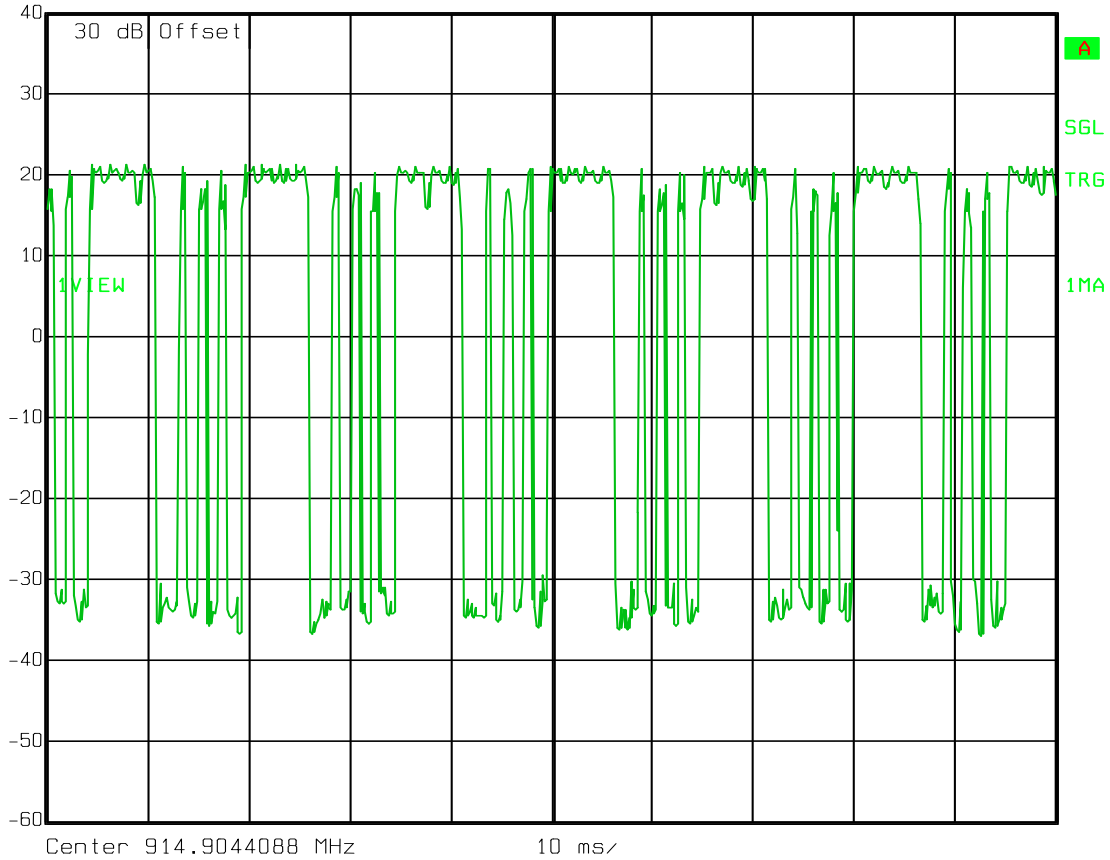
Date: 23.JAN.2012 11:45:01

Test Data – Duty Cycle Correction



Ref Lvl  
40 dBm

RBW 30 kHz RF Att 40 dB  
VBW 30 kHz  
SWT 100 ms Unit dBm



Date: 23.JAN.2012 11:46:45

Duty Cycle Correction

20 pulses @ 0.841

7 pulses @ 6.9

65.1 ms total

$20 \log (65.1/100) = -3.7 \text{ dB Correction}$

**Test Data - Radiated Emissions**

Monopole Antenna

Meas. Freq. (MHz)	Ant. Pol. (H/V)	Duty Cycle (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass/Fail/Unc.	Comment
Tx 902.4 MHz +30 dBm											
2707.2	V	-3.7	47.0	29.0	3.7	30.8	45.2	54.0	-8.8	Pass	Average
3609.6	V	-3.7	46.3	29.9	3.5	31.7	44.3	54.0	-9.7	Pass	Average
4512	V	-3.7	40.8	32.0	4.1	30.7	42.5	54.0	-11.5	Pass	Average
5414.4	V	-3.7	37.1	33.6	4.7	30.3	41.4	54.0	-12.6	Pass	Average
2707.2	H	-3.7	48.0	29.0	3.7	30.8	46.2	54.0	-7.8	Pass	Average
3609.6	H	-3.7	47.0	29.9	3.5	31.7	45.0	54.0	-9.0	Pass	Average
4512	H	-3.7	44.0	32.0	4.1	30.7	45.7	54.0	-8.3	Pass	Average
5414.4	H	-3.7	43.0	33.6	4.7	30.3	47.3	54.0	-6.7	Pass	Average
Tx 915.4 MHz +30 dBm											
2745.6	V	0.0	54.0	29.0	3.7	30.8	55.9	74.0	-18.1	Pass	
2745.6	V	-3.7	48.1	29.0	3.7	30.8	46.3	54.0	-7.7	Pass	Average
3660.8	V	0.0	48.8	29.9	3.5	31.7	50.5	54.0	-3.5	Pass	
4576.0	V	-3.7	41.6	32.0	4.1	30.7	43.3	54.0	-10.7	Pass	Average
5491.2	V	0.0	44.3	33.6	4.7	30.3	52.3	54.0	-1.7	Pass	
2745.6	H	-3.7	49.3	29.0	3.7	30.8	47.5	54.0	-6.5	Pass	Average
3660.8	H	-3.7	47.8	29.9	3.5	31.7	45.8	54.0	-8.2	Pass	Average
4576.0	H	-3.7	45.0	32.0	4.1	30.7	46.7	54.0	-7.3	Pass	Average
5491.2	H	-3.7	43.0	33.6	4.7	30.3	47.3	54.0	-6.7	Pass	Average
Tx 927.6 MHz '+30 dBm											
2782.8	V	0.0	53.3	29.0	3.7	30.8	55.2	74.0	-18.8	Pass	
2782.8	V	-3.7	50.7	29.0	3.7	30.8	48.9	54.0	-5.1	Pass	Average
3710.4	V	0.0	47.8	29.9	3.5	31.7	49.5	54.0	-4.5	Pass	
4638.0	V	-3.7	42.2	32.0	4.1	30.7	43.9	54.0	-10.1	Pass	Average
5565.6	V	-3.7	37.5	33.6	4.7	30.3	41.8	54.0	-12.2	Pass	Average
2782.8	H	-3.7	49.8	29.0	3.7	30.8	48.0	54.0	-6.0	Pass	Average
3710.4	H	-3.7	48.8	29.9	3.5	31.7	46.8	54.0	-7.2	Pass	Average
4638.0	H	-3.7	44.8	32.0	4.1	30.7	46.5	54.0	-7.5	Pass	Average
5565.6	H	-3.7	44.1	33.6	4.7	30.3	48.4	54.0	-5.6	Pass	Average

**Test Data - Radiated Emissions**

Dipole Antenna

Meas. Freq. (MHz)	Ant. Pol. (HV)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
Tx 902.4 MHz +30 dBm											
2707.2	V	0.0	55.2	29.0	3.7	30.8	57.1	74.0	-16.9	Pass	
2707.2	V	-3.7	47.6	29.0	3.7	30.8	45.8	54.0	-8.2	Pass	
3610.6	V	-3.7	47.8	29.9	3.5	31.7	45.8	54.0	-8.2	Pass	
4512.0	V	0.0	49.0	32.0	4.1	30.7	54.4	74.0	-19.6	Pass	
4512.0	V	-3.7	43.6	32.0	4.1	30.7	45.3	54.0	-8.7	Pass	
2707.2	H	-3.7	49.3	29.0	3.7	30.8	47.5	54.0	-6.5	Pass	
3609.6	H	-3.7	50.8	29.9	3.5	31.7	48.8	54.0	-5.2	Pass	
Tx 915.2 MHz +30 dBm											
2745.6	V	0.0	55.0	29.0	3.7	30.8	56.9	74.0	-17.1	Pass	
2745.6	V	-3.7	47.8	29.0	3.7	30.8	46.0	54.0	-8.0	Pass	Average
3660.8	V	-3.7	50.0	29.9	3.5	31.7	48.0	54.0	-6.0	Pass	
4576.0	V	-3.7	43.0	32.0	4.1	30.7	44.7	54.0	-9.3	Pass	
2745.6	H	-3.7	49.0	29.0	3.7	30.8	47.2	54.0	-6.8	Pass	
3660.8	H	-3.7	46.0	29.9	3.5	31.7	44.0	54.0	-10.0	Pass	
Tx 927.6 MHz +30 dBm											
2782.8	V	0.0	55.0	29.0	3.7	30.8	56.9	74.0	-17.1	Pass	
2782.8	V	-3.7	53.2	29.0	3.7	30.8	51.4	54.0	-2.6	Pass	
3710.4	V	-3.7	46.0	29.9	3.5	31.7	44.0	54.0	-10.0	Pass	
4638.0	V	-3.7	44.0	32.0	4.1	30.7	45.7	54.0	-8.3	Pass	
2782.8	H	-3.7	46.8	29.0	3.7	30.8	45.0	54.0	-9.0	Pass	
3710.4	H	-3.7	46.0	29.9	3.5	31.7	44.0	54.0	-10.0	Pass	

**\*Note:** Attenuation was added at radio output to ensure the EIRP was limited to 36 dBm as required by FCC 15.247(b)(4) and RSS-210 A8.4(1)

**Test Data - Radiated Emissions**

Yagi Antenna

Meas. Freq. (MHz)	Ant. Pol. (HV)	Det. Atten. (dB)	Meter Reading (dBuV)	Antenna Factor (dB)	Path Loss (dB)	RF Gain (dB)	Corrected Reading (dBuV/m)	Spec. limit (dBuV/m)	CR/SL Diff. (dB)	Pass Fail Unc.	Comment
Tx 902.4 MHz +30 dBm											
2707.2	V	0.0	53.5	29.0	3.7	30.8	55.4	74.0	-18.6	Pass	
2707.2	V	-3.7	48.7	29.0	3.7	30.8	46.9	54.0	-7.1	Pass	
3609.6	V	-3.7	50.5	29.9	3.5	31.7	48.5	54.0	-5.5	Pass	
4512.0	V	-3.7	43.0	32.0	4.1	30.7	44.7	54.0	-9.3	Pass	
2707.2	H	-3.7	45.6	29.0	3.7	30.8	43.8	54.0	-10.2	Pass	
3609.6	H	-3.7	44.6	29.9	3.5	31.7	42.6	54.0	-11.4	Pass	
4512.0	H	-3.7	43.5	32.0	4.1	30.7	45.2	54.0	-8.8	Pass	
Tx 915.2 MHz +30 dBm											
2745.6	V	0.0	54.5	29.0	3.7	30.8	56.4	74.0	-17.6	Pass	
2745.6	V	-3.7	51.0	29.0	3.7	30.8	49.2	54.0	-4.8	Pass	Average
3660.8	V	-3.7	49.2	29.9	3.5	31.7	47.2	54.0	-6.8	Pass	
4576.0	V	-3.7	47.2	32.0	4.1	30.7	48.9	54.0	-5.1	Pass	
2745.6	H	-3.7	48.5	29.0	3.7	30.8	46.7	54.0	-7.3	Pass	
3660.8	H	-3.7	48.2	29.9	3.5	31.7	46.2	54.0	-7.8	Pass	
4576.0	H	-3.7	45.8	32.0	4.1	30.7	47.5	54.0	-6.5	Pass	
Tx 927.6 MHz +30 dBm											
2782.8	V	0.0	55.6	29.0	3.7	30.8	57.5	74.0	-16.5	Pass	
2782.8	V	-3.7	53.3	29.0	3.7	30.8	51.5	54.0	-2.5	Pass	
3710.4	V	-3.7	50.5	29.9	3.5	31.7	48.5	54.0	-5.5	Pass	
4638.0	V	-3.7	46.6	32.0	4.1	30.7	48.3	54.0	-5.7	Pass	
2782.8	H	0.0	53.3	29.0	3.7	30.8	55.2	74.0	-18.8	Pass	
2782.8	H	-3.7	46.5	29.0	3.7	30.8	44.7	54.0	-9.3	Pass	
3710.4	H	-3.7	47.8	29.9	3.5	31.7	45.8	54.0	-8.2	Pass	
4638.0	H	-3.7	46.2	32.0	4.1	30.7	47.9	54.0	-6.1	Pass	

**\*Note:** Attenuation was added at radio output to ensure the EIRP was limited to 36 dBm as required by FCC 15.247(b)(4) and RSS-210 A8.4(1)

**Section 8. Powerline Conducted Emissions**

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: FCC15.207(a) RSS-Gen 7.2.4
TESTED BY: David Light	DATE: 24 January 2012

**Test Results:** Complies. The worst case emission was 45 dB $\mu$ V at 2.34 MHz. This is 1.0 dB below the average specification limit of 46 dB $\mu$ V. This was a peak measurement.

**Test Data:** Refer to attached plots

**Equipment Used:** 674, 1080, 1188, 1555, 1663

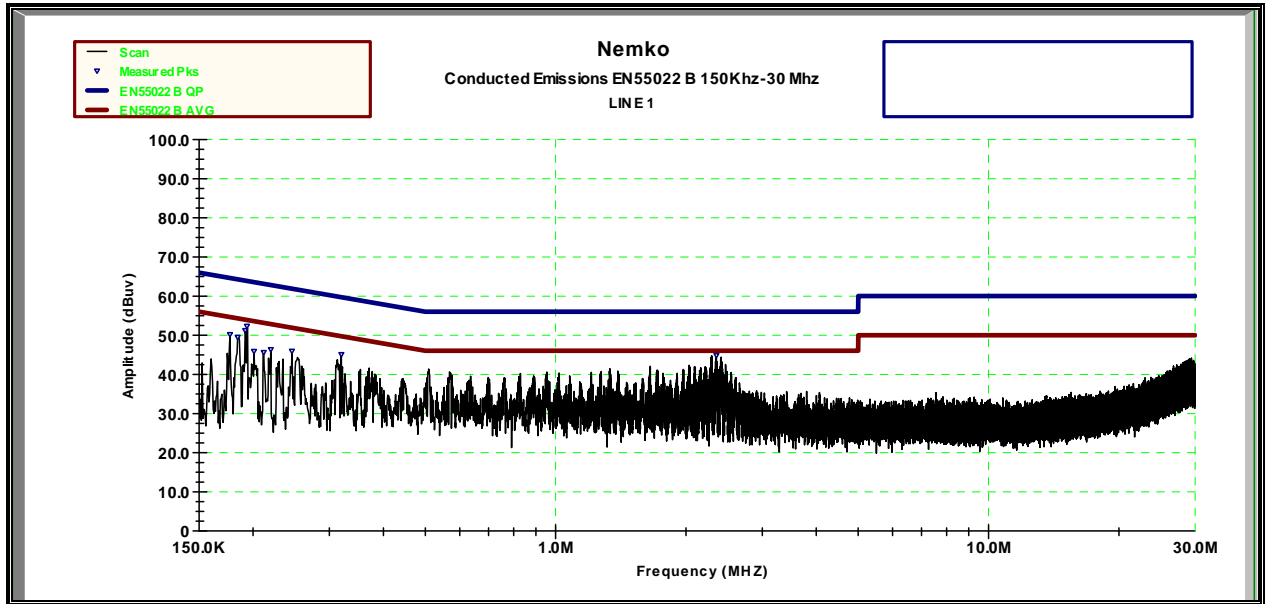
**Measurement Uncertainty:** +/- 1.7 dB

**Temperature:** 23 °C

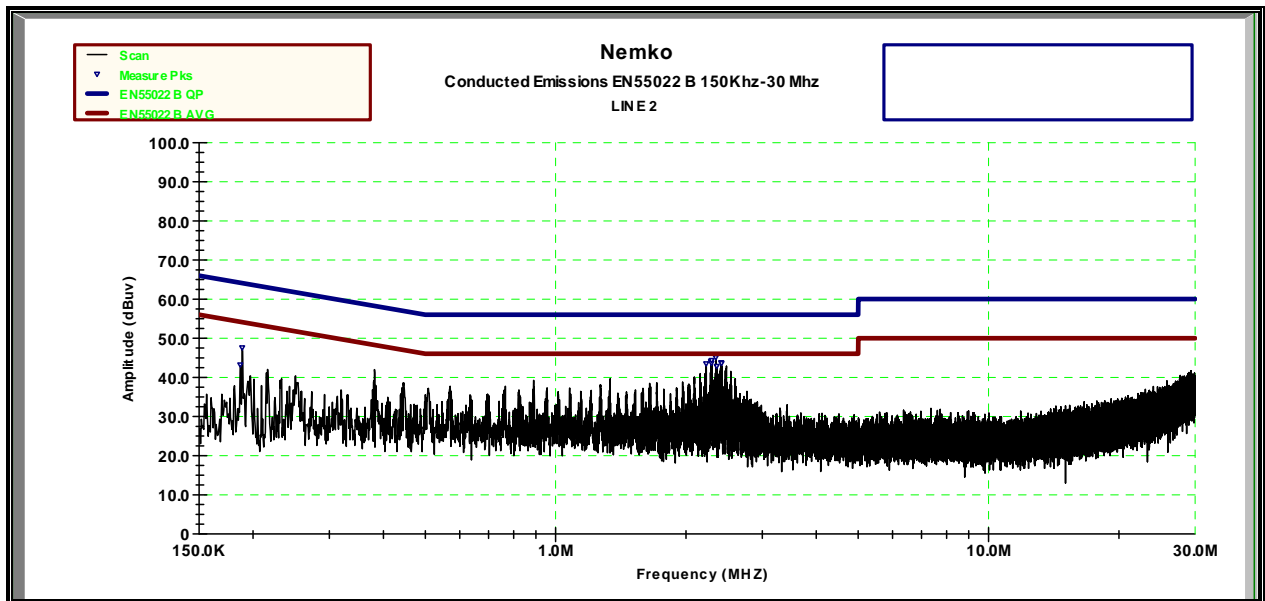
**Relative Humidity:** 45 %

Test Data – Powerline Conducted Emissions

Line 1



Line 2





**Section 9. Receiver Spurious Emissions**

NAME OF TEST: Receiver Spurious Emissions	PARA. NO.: FCC15.207(a) RSS-Gen 7.2.4
TESTED BY: David Light	DATE: 10 February 2012

**Test Results:** Complies. No emissions were detected above the ambient noise floor of the test instrument. The ambient noise floor is – 74.4 dBm (0.036 nW) or less.

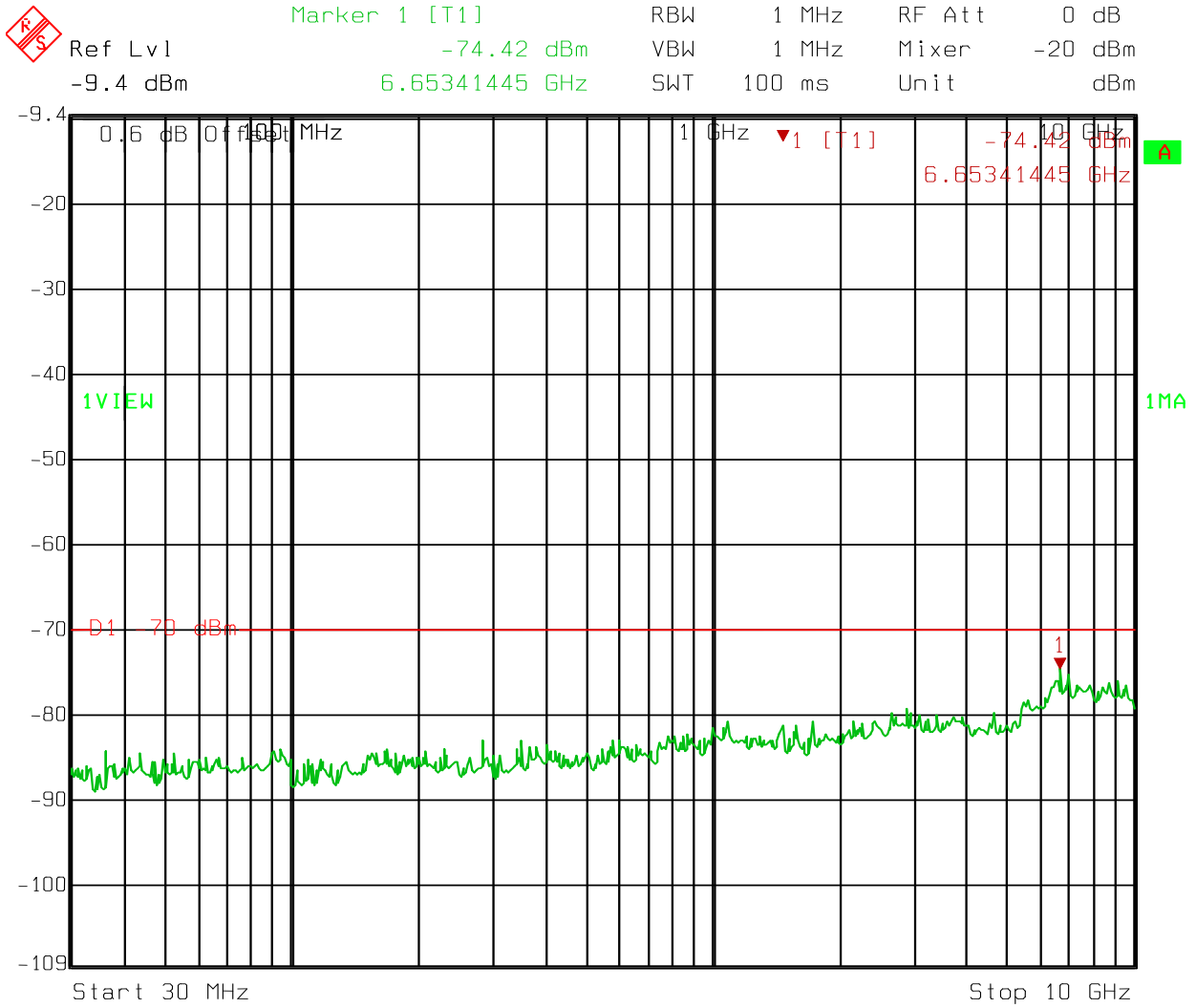
**Test Data:** Refer to attached plot

**Equipment Used:** 1036-1082

**Measurement Uncertainty:** +/- 1.7 dB

**Temperature:** 23 °C

**Relative Humidity:** 45 %



## Section 9. Test Equipment List

Asset Tag	Description	Manufacturer	Model	Serial #	Last Cal	Next Cal
674	Limiter	HP	11947A	3107A02200	01-Nov-2011	01-Nov-2012
993	Antenna	A.H. Systems	SAS-200/571	162	22-Sep-2011	22-Sep-2013
1016	Preamplifier	HP	8449A	2749A00159	20-Jul-2011	20-Jul-2012
1025	Preamplifier,	Nemko USA,	LNA25	399	23-Feb-2011	23-Feb-2012
1036	Spectrum Analyzer	Rohde & Schwartz	FSEK30	830844/006	23-Dec-2011	23-Dec-2013
1080	Cable, 3m	Nemko USA.	RG223		VBU	NA
1082	Cable, 2m	Astrolab	32027-2-29094-72TC		VBU	NA
1188	LISN	EMCO	3825/2	1214	22-Nov-2011	22-Nov-2012
1464	Spectrum Analyzer	Hewlett Packard	8563E	3551A04428	16-May-2011	16-May-2013
1469	Attenuator	MCL Inc.	BW-S10W2 10db-2WDC		VBU	NA
1472	Attenuator	Omni Spectra	20600-20db		VBU	NA
1555	High Pass Filter	Solar Electronics	7930-5.0	933125	19-May-2011	19-May-2012
1663	Spectrum Analyzer	Rohde & Schwartz	FSP3	100073	02-Sep-2011	02-Sep-2013
1763	Antenna	Schaffner	CBL 6111D	22926	11-Feb-2011	11-Feb-2012
1783	Cable Assy	Nemko	Chamber		26-Sep-2011	26-Sep-2012

## **ANNEX A - TEST DETAILS**

NAME OF TEST: Powerline Conducted Emissions

PARA. NO.: FCC 15.207(a)  
RSS-Gen 7.2.4

**Minimum Standard:** Conducted limits.

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 mH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Conducted Emission (MHz)	Limit (dBmV)	
	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.

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

(1) For carrier current systems containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 mV within the frequency band 535-1705 kHz, as measured using a 50 mH/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits as provided in §15.205 and §§15.209, 15.221, 15.223, 15.225 or 15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

NAME OF TEST: Channel Separation

PARA. NO.: FCC 15.247(a)(1)  
RSS-210 A8.1(b)

**Minimum Standard:**

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

NAME OF TEST: Time of Occupancy	PARA. NO.: FCC 15.247(a)(1) RSS-210 A8.1(c)
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**Minimum Standard:**

Frequency Band (MHz)	20 dB Bandwidth	No. of Hopping Channels	Average Time of Occupancy
902 - 928	<250 kHz	50	=<0.4 sec. in 20 sec.
902 - 928	=>250 kHz	25	=<0.4 sec. in 10 sec.
2400 - 2483.5	-----	75	=<0.4 sec. in 0.4 seconds multiplied by the number of hopping channels employed.
5725 - 5850	-----	75	=<0.4 sec. in 30 sec.

**Method Of Measurement:**

The spectrum analyzer is set as follows:

- RBW: 1 MHz
- VBW: = RBW
- Span: 0 Hz
- LOG dB/div.: 10 dB
- Sweep: Sufficient to see one hop time sequence.
- Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

$$(30 \text{ sec.} / .001 \text{ sec.}) / 75 \text{ chan.} = 400 \times 1 \text{ msec.} = 400 \text{ msec. or } 0.4 \text{ sec. in } 30 \text{ sec.}$$

NAME OF TEST: Occupied Bandwidth

PARA. NO.: FCC 15.247(a)(1)  
RSS-210 A8.1(b)

**Minimum Standard:**

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	Not defined
5725 – 5850	1 MHz

**Method Of Measurement:**

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.

VBW: >RBW

Span: Sufficient to display 20 dB bandwidth

LOG dB/div.: 10 dB

Sweep: Auto

**Number of channels tested:**

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom



NAME OF TEST: Peak Power Output

PARA. NO.: FCC 15.247(b)  
RSS-210 A8.4(1)

**Minimum Standard:**

Frequency Band (MHz)	No. of Hopping Channels	Maximum Peak Power Output at Antenna Port
902 - 928	at least 50	1 watt
902 – 928	25 - 49	0.25 watts
2400 – 2483.5	75	1 watt
5725 – 5850	75	1 watt

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operation may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

**Direct Measurement Method For Detachable Antennas:**

If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

**Calculation Of EIRP For Integral Antenna:**

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation  $GP/4\pi R^2 = E^2/120\pi$  and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts

E = the maximum measured field strength in V/m

R = the measurement range (3 meters)

G = the numeric gain of the transmit antenna in relation to an isotropic radiator

The RBW of the spectrum analyzer shall be set to a value greater than the measured 20 dB occupied bandwidth of the E.U.T.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Spurious Emissions (Conducted)

PARA. NO.: FCC 15.247(d)  
RSS-210 A8.5

**Minimum Standard:**

In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength ( $\mu\text{V/m @ 3m}$ )	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

**THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC**

**Method Of Measurement:**

30 MHz - 10th harmonic plot

RBW: 100 kHz

VBW: 300 kHz

Sweep: Auto

Display line: -20 dBc

Lower Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz

Marker: Peak of fundamental emission

Marker  $\Delta$ : Peak of highest spurious level below center frequency.

Upper Band Edge

RBW: At least 1% of span/div.

VBW: >RBW

Span: As necessary to display any spurious at band edge.

Sweep: Auto

Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz

Marker: Peak of fundamental emission

Marker  $\Delta$ : Peak of highest spurious level above center frequency.

Number of channels tested:

Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

NAME OF TEST: Radiated Spurious Emissions

PARA. NO.: FCC 15.247(d)  
RSS-Gen 7.2.2

**Minimum Standard:** Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

Frequency (MHz)	Field Strength (µV/m @ 3m)	Field Strength (dB @ 3m)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above 960	500	54.0

**THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC**

**15.205 Restricted Bands**

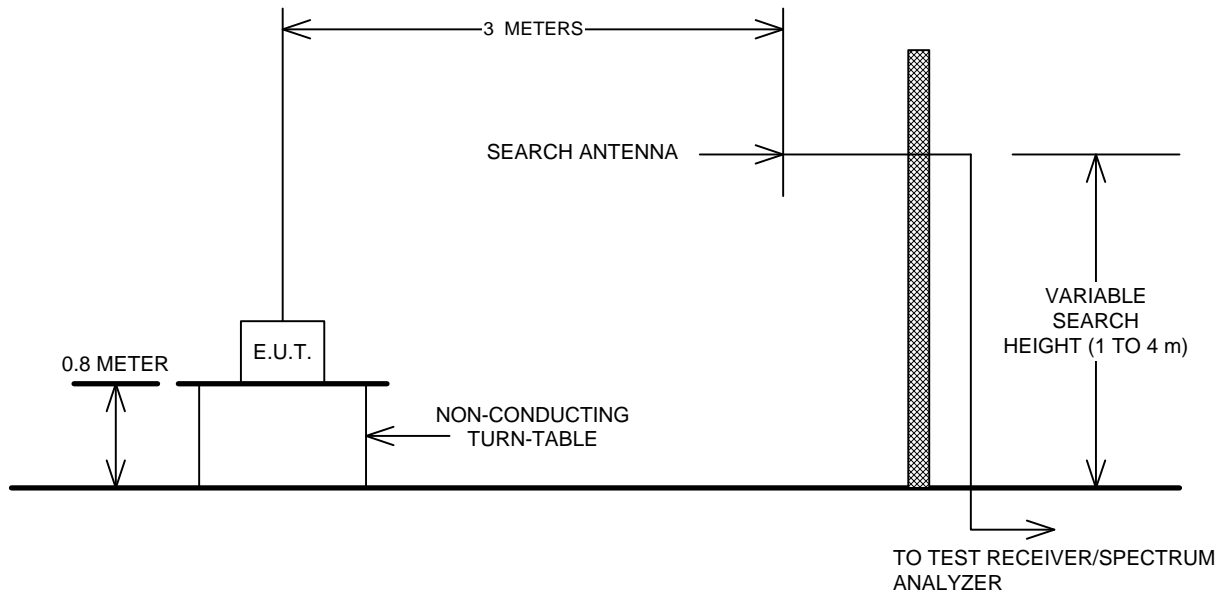
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41	1718		

Number of channels tested:

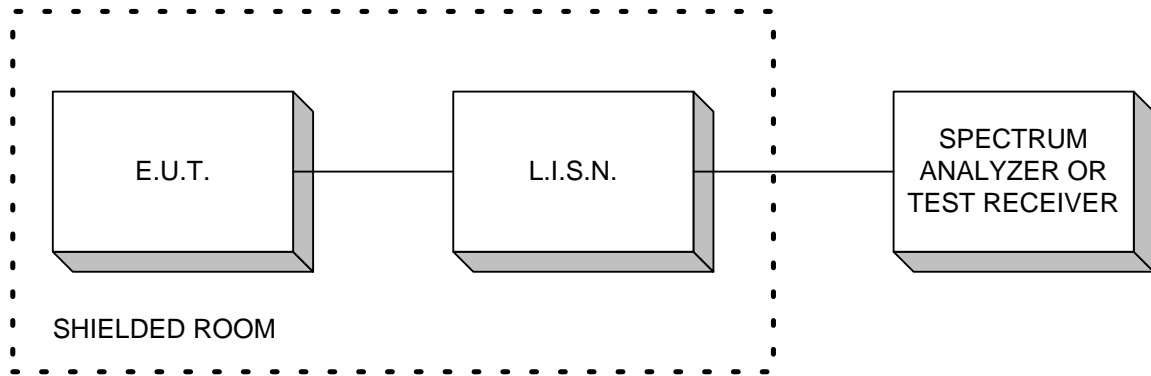
Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

## **ANNEX B - TEST DIAGRAMS**

**Test Site For Radiated Emissions**



**Conducted Emissions**



**Peak Power at Antenna Terminals**

