Nemko Test Report: 6L0367RUS1rev1

Applicant: Banner Engineering Corp.
9714 10th Avenue North
Minneapolis, MN 55441
USA

Equipment Under Test: (E.U.T.) DX80 2.4GHz

In Accordance With: **FCC Part 15, Subpart C, 15.247**
Frequency Hopping Transmitters

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

TESTED BY: **DATE:** **August 15, 2006**

David Light
Wireless Engineer

APPROVED BY: **DATE:** **September 1, 2006**

Abe Cox
Key Account Manager

Total Number of Pages: 45

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Section 1. Summary of Test Results

Manufacturer: Banner Engineering Corp.

Model No.: DX80 2.4GHz

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 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted is 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.

☒ New Submission ☐ Production Unit

☐ Class II Permissive Change ☒ 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. All tests were performed radiated
See " Summary of Test Data".

NVLAP®
LAB CODE: 100426-0

Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
Powerline Conducted Emissions	15.207(a)	48 dBμV	Complies
Channel Separation	15.247(a)(1)	Greater of 25 kHz or 20 dB Bandwidth	Complies
Time of Occupancy	15.247(a)(1)(ii)	≤ 0.4 sec in 20 sec	Complies
20 dB Occupied Bandwidth	15.247(a)(1)	≤ 1 MHz	Complies
Peak Power Output	15.247(b)	1 Watt	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	-20 dBc	NA
Spurious Emissions (Radiated)	15.247(c)	Table 15.209(a)	Complies

Footnotes:

All tests were performed radiated. Conducted peak power was determined by subtracting the antenna gain from the radiated EIRP measurement.

Measurements were made with both the battery pack as well as the AC adapter. There were no differences in performance.

This device was tested with a fresh battery.

This device was tested on three orthogonal axis'.

This device was tested at +/- 15% input power with no variation in output power.

This device was tested from 30 MHz to the tenth harmonic of the carrier.

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

General Equipment Information

Frequency Band:

☐ 902 – 928 MHz
☒ 2400 – 2483.5 MHz

Frequency Range of Sample: 2401 to 2482 MHz

Number of Channels: 27

Channel Spacing: 2 MHz

User Frequency Adjustment: Software controlled

Description of EUT

Frequency hopping spread spectrum transceiver used to monitor industrial sensors and controls.

System Diagram

Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: David Light	DATE: 8/14/2006

Test Results: Complies. The worst case emission is 52.57 dBµV at 329.1 kHz. This is 5.4 dB below the specification limit.

Measurement Data: See attached plots.

Equipment Used: 1663-674-1082-1188-704-1977

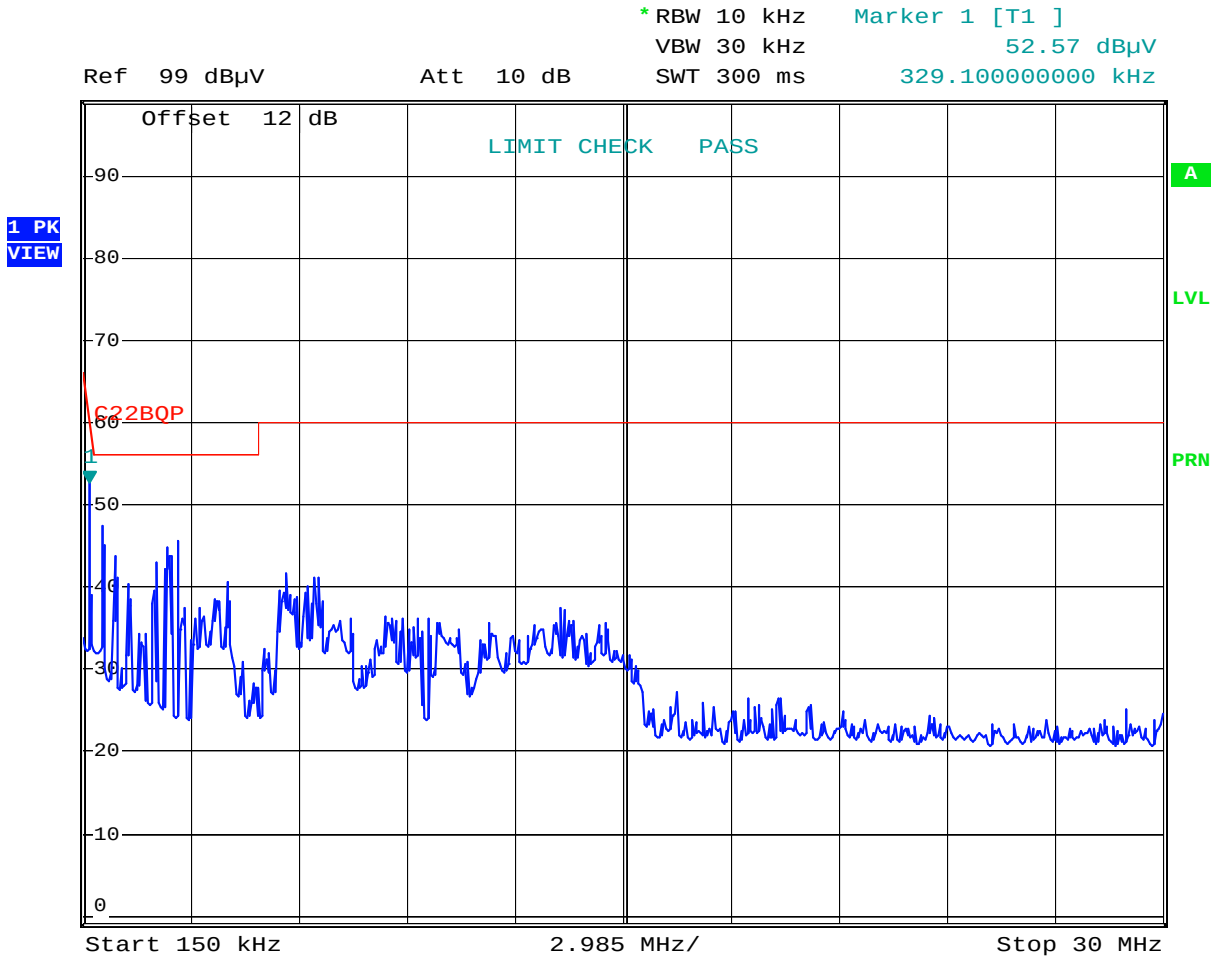
Measurement Uncertainty: +/- 1.7 dB

Temperature: 24°C

Relative Humidity: 30%

Test Data – Powerline Conducted Emissions

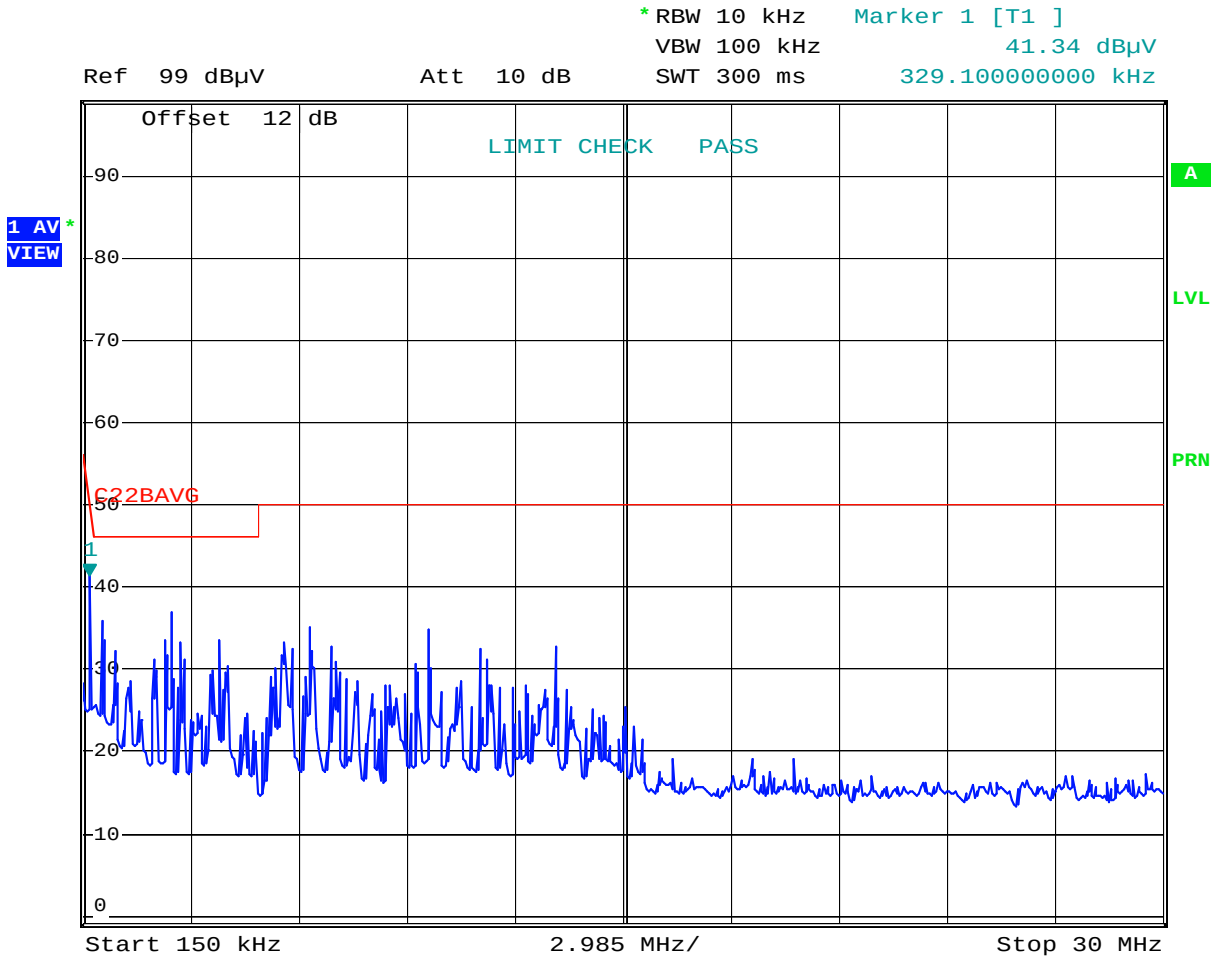
Line - Peak



Date: 14.AUG.2006 10:30:56

Test Data – Powerline Conducted Emissions

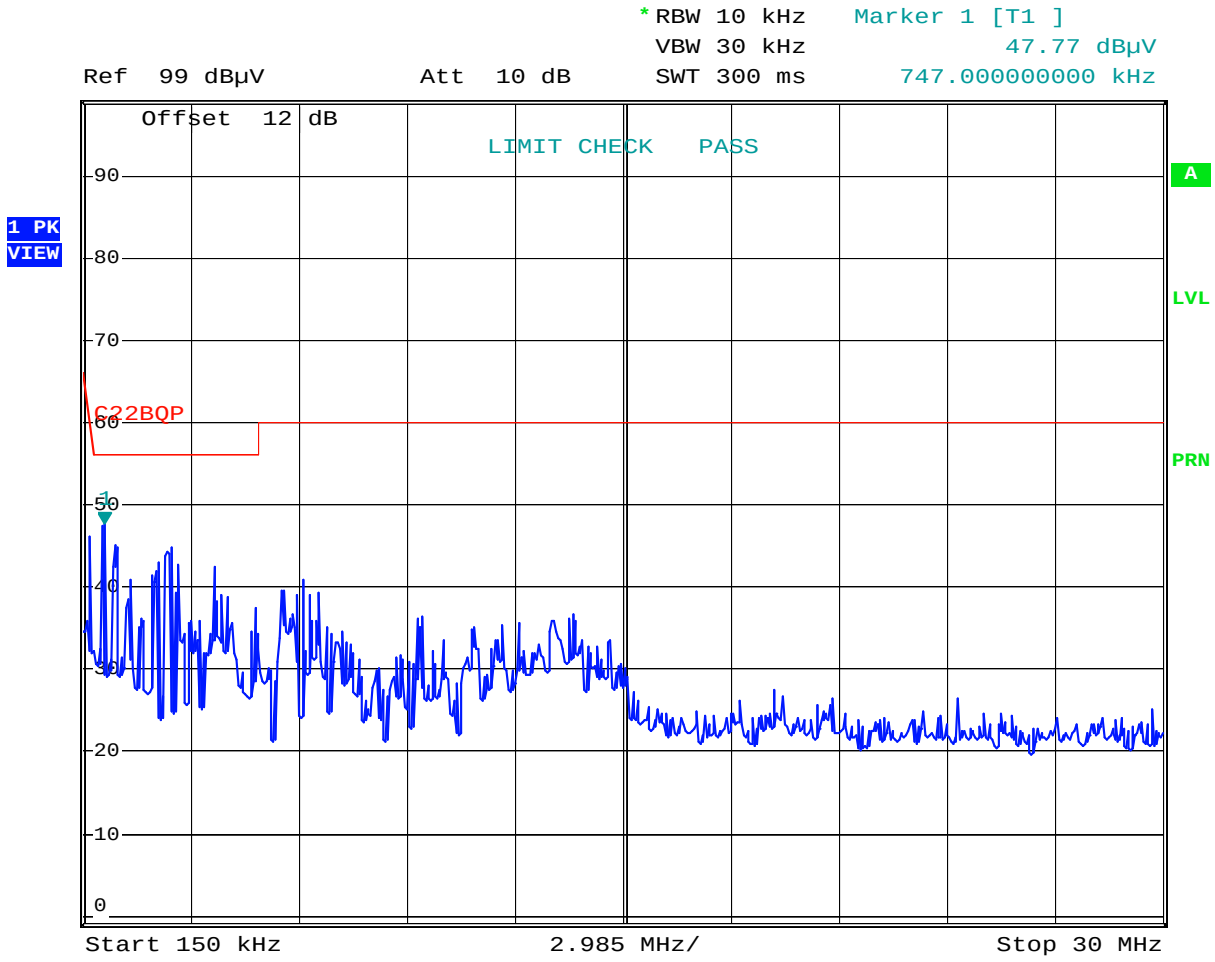
Line - Average



Date: 14.AUG.2006 10:32:11

Test Data – Powerline Conducted Emissions

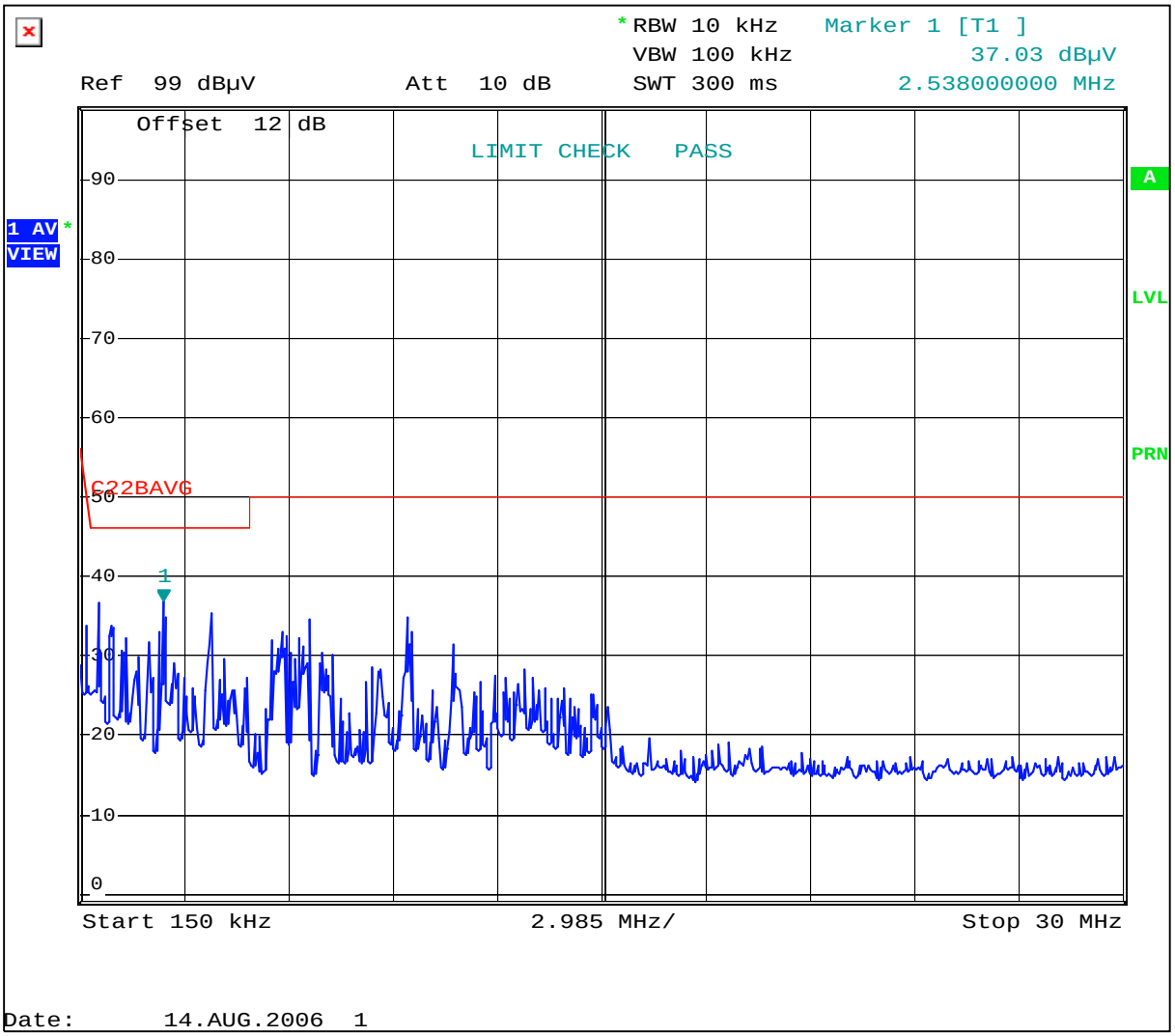
Neutral - Peak



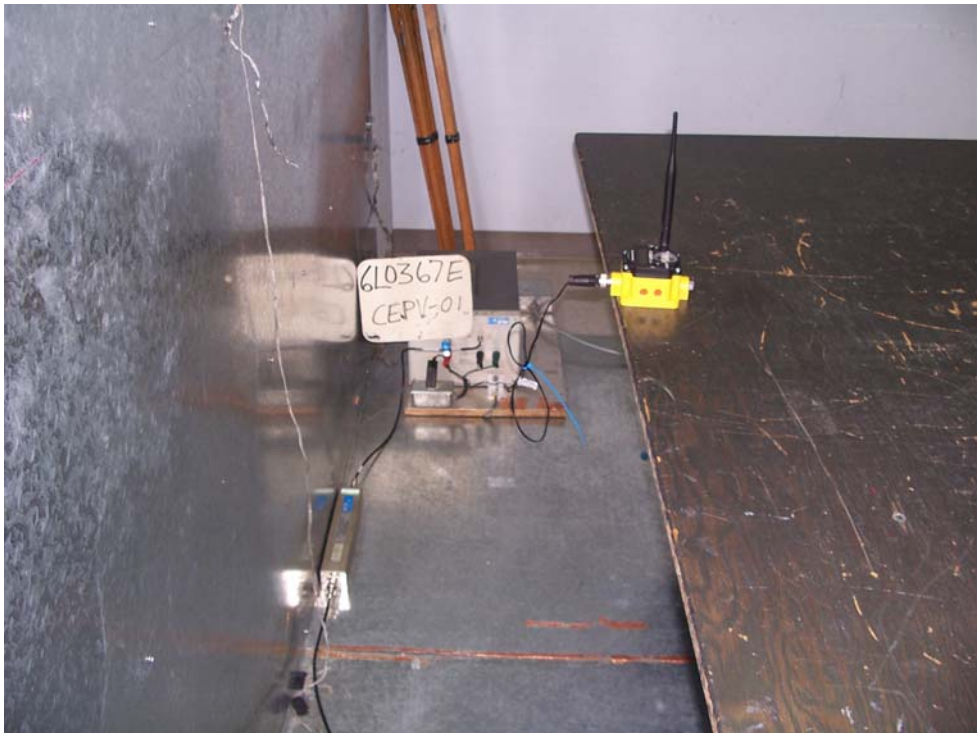
Date: 14.AUG.2006 10:34:14

Test Data – Powerline Conducted Emissions

Neutral - Average



Test Setup



Section 4. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(1)(i)
TESTED BY: David Light	DATE:8/11/2006

Test Results: Complies.

Measurement Data: See attached plots.

Equipment Used: 1036-802

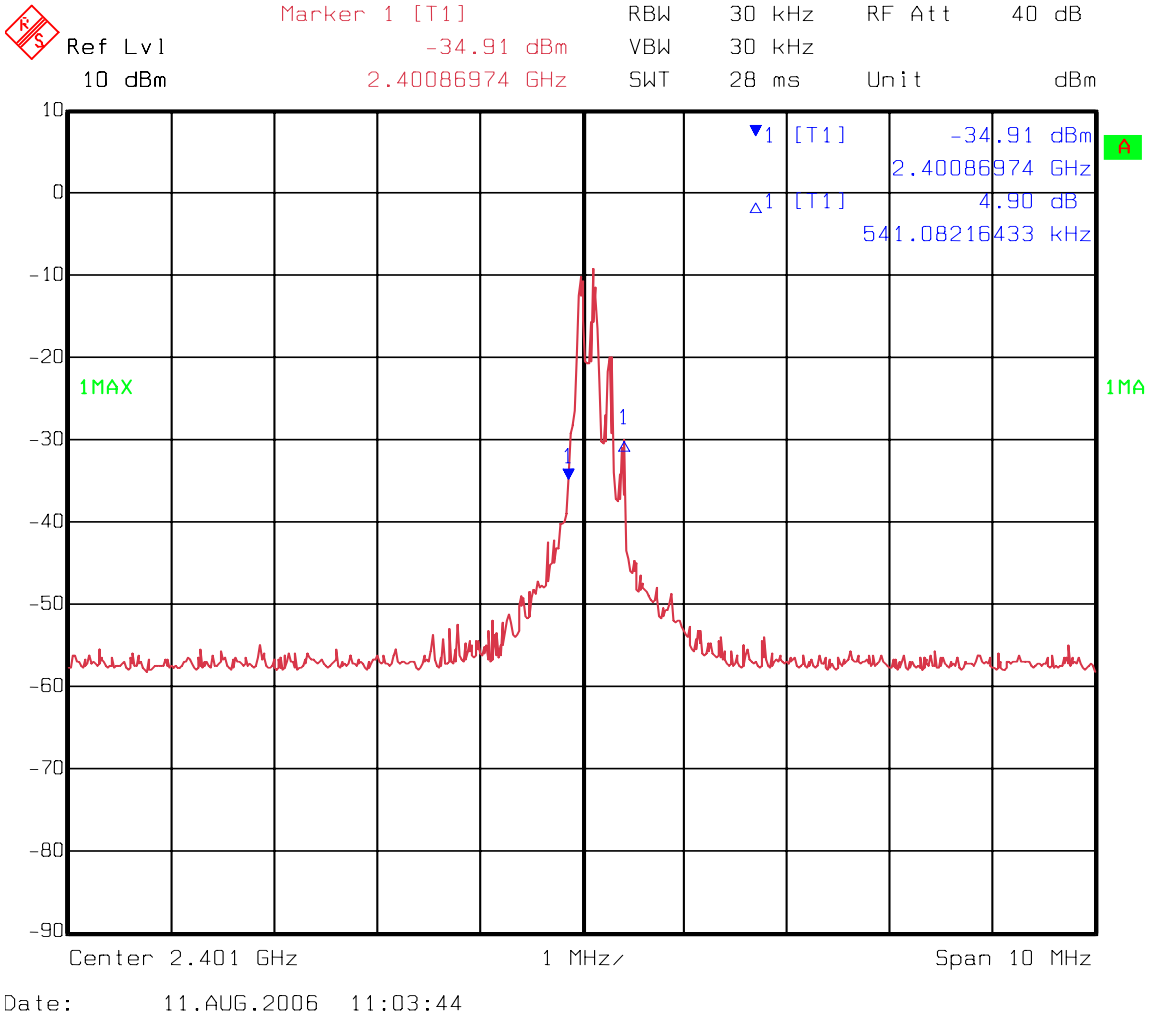
Measurement Uncertainty: +/- $1*10^{-7}$ ppm

Temperature: 22 °C

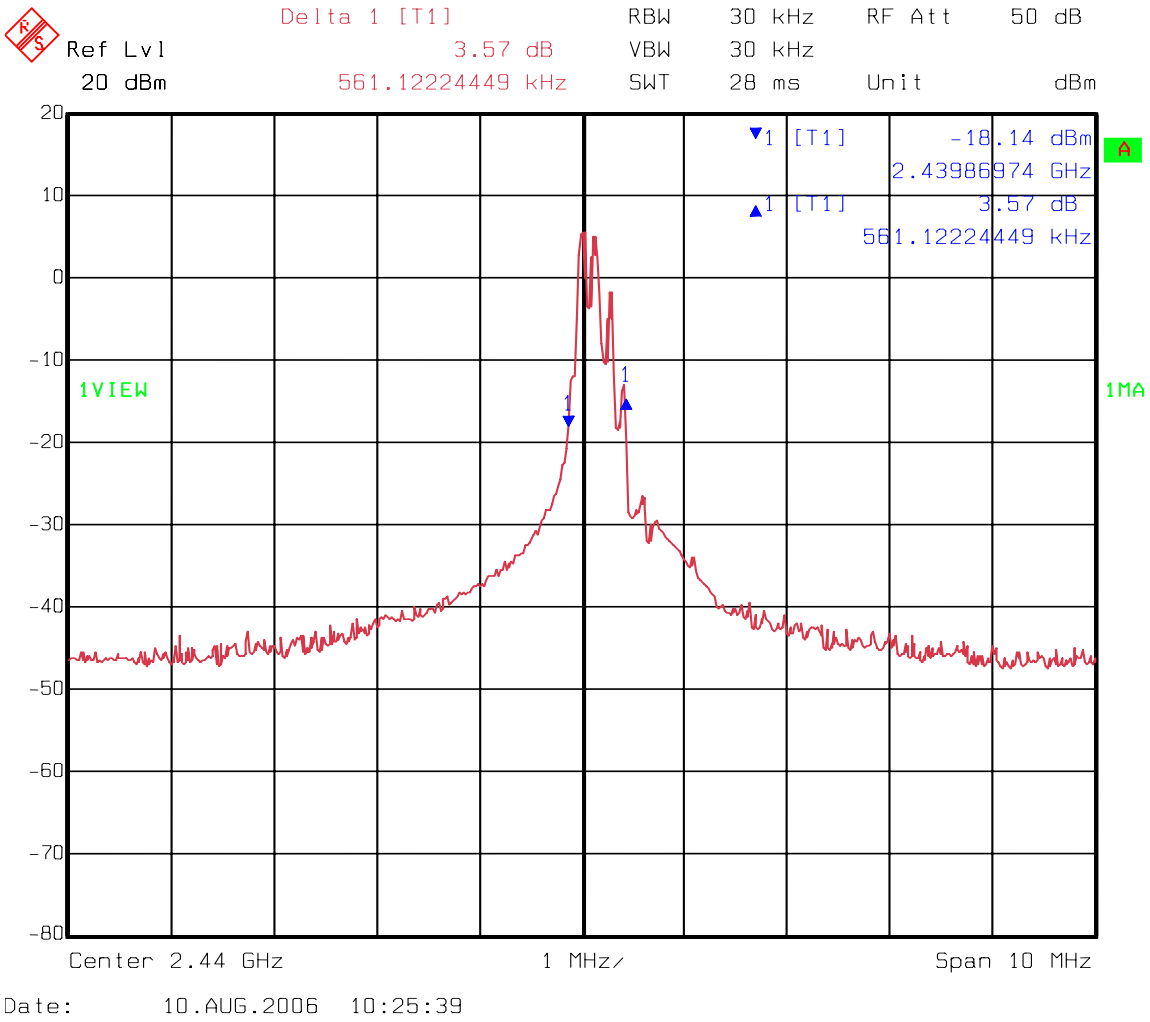
Relative Humidity: 45 %

Test Data – Occupied Bandwidth

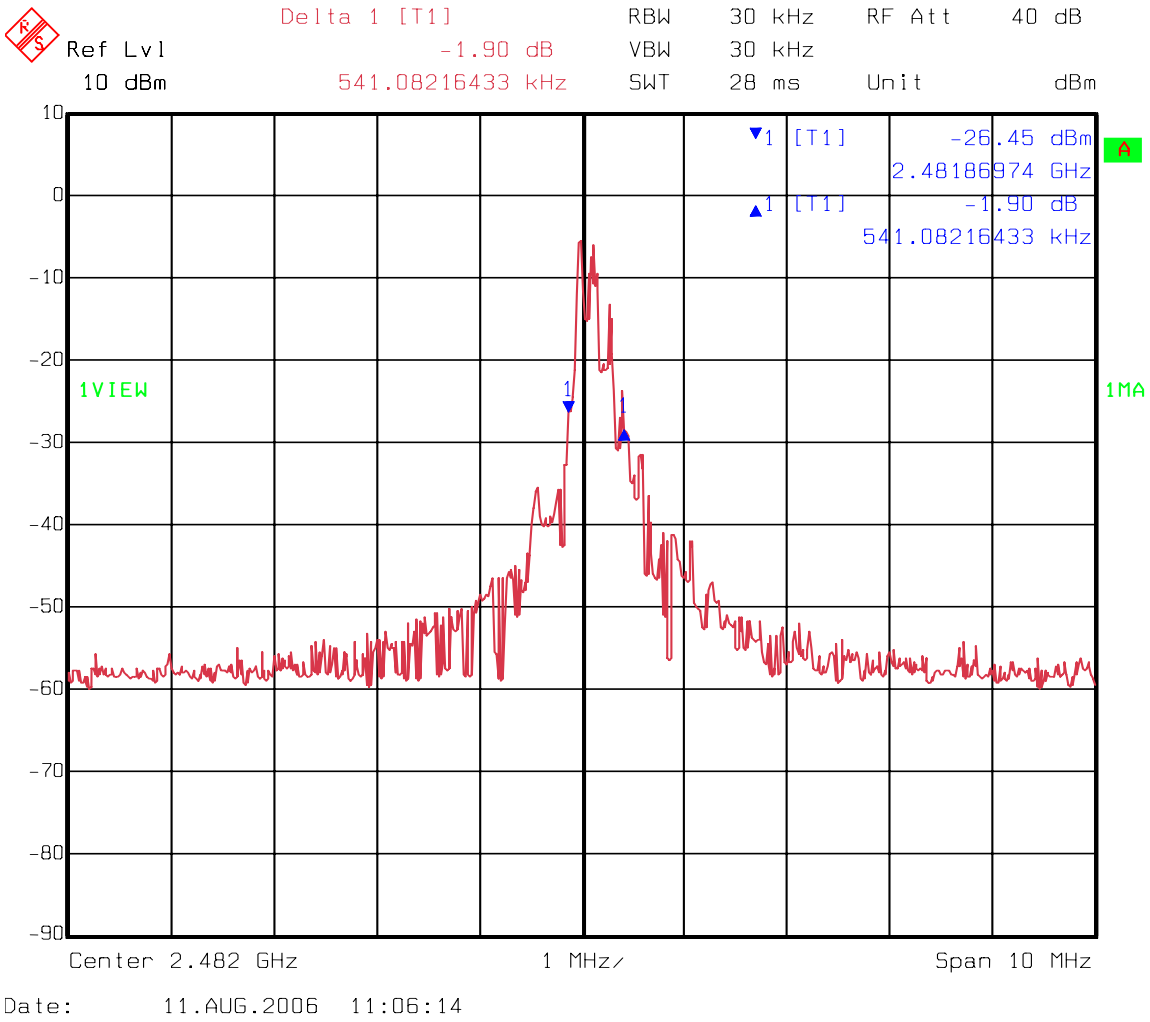
Low Channel



Test Data – Occupied Bandwidth



Test Data – Occupied Bandwidth



Section 5. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 8/10/2006

Test Results: Complies.

Measurement Data: See 20 dB BW plot

Measured 20 dB bandwidth:	5.61 kHz max
Channel Separation:	2 MHz

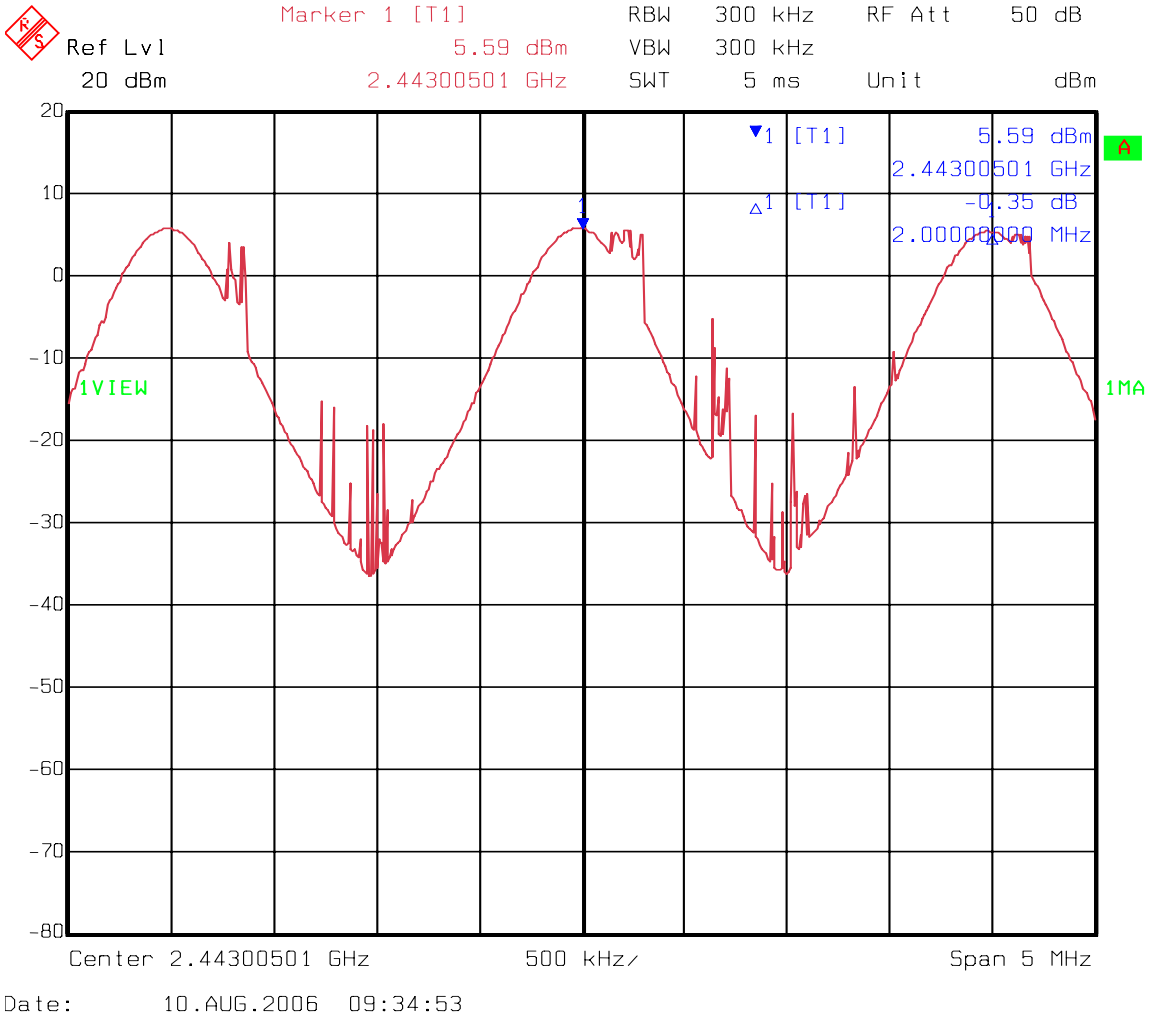
Equipment Used: 1036-802

Measurement Uncertainty: +/- $1x10^{-7}$ ppm

Temperature: 22°C

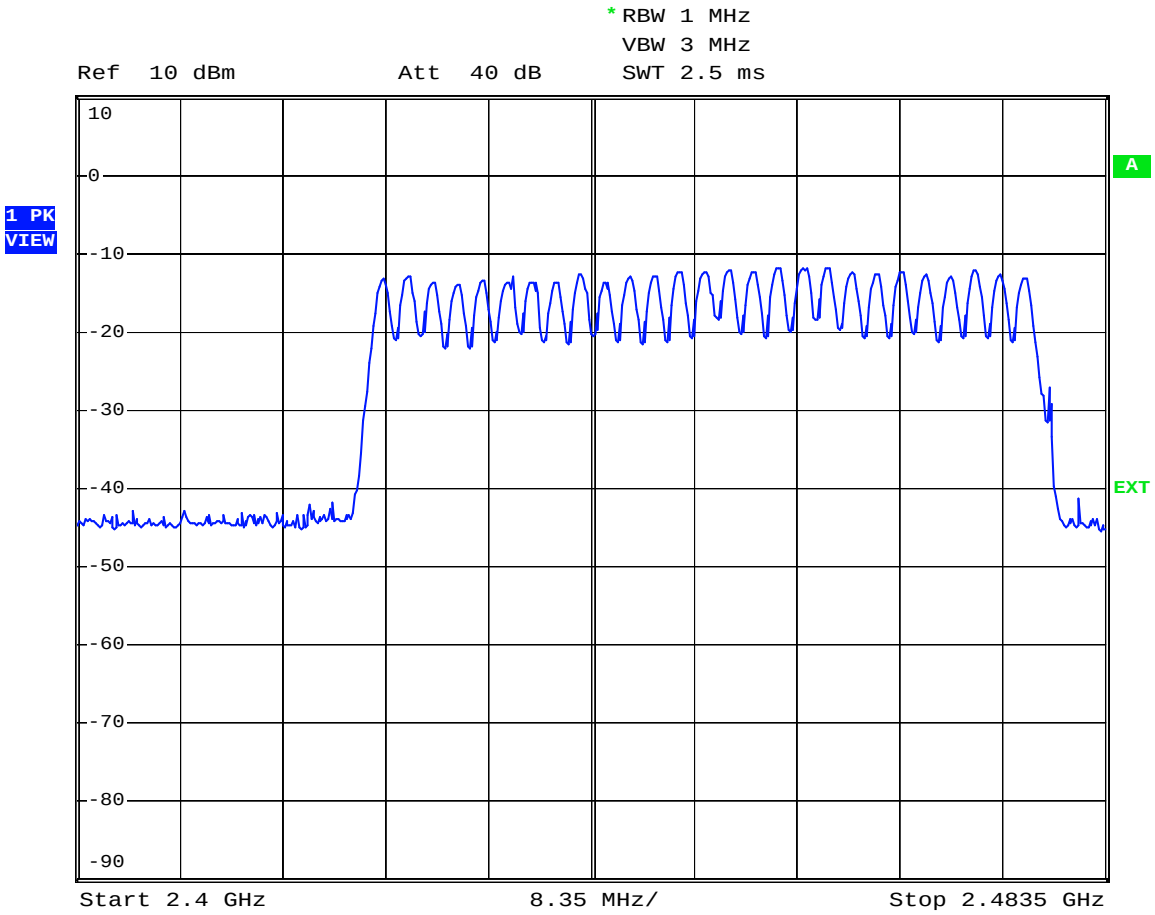
Relative Humidity: 45%

Test Data – Channel Separation



Test Data – Number of Hopping Channels

27 Channels



Date: 31.AUG.2006 09:53:37

Section 6. Time of Occupancy

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 8/10/2006

Test Results: Complies.

Measurement Data:

Maximum Dwell Time On Any Channel: 62.4 mS in 10.8 seconds

Equipment Used: 1036-802

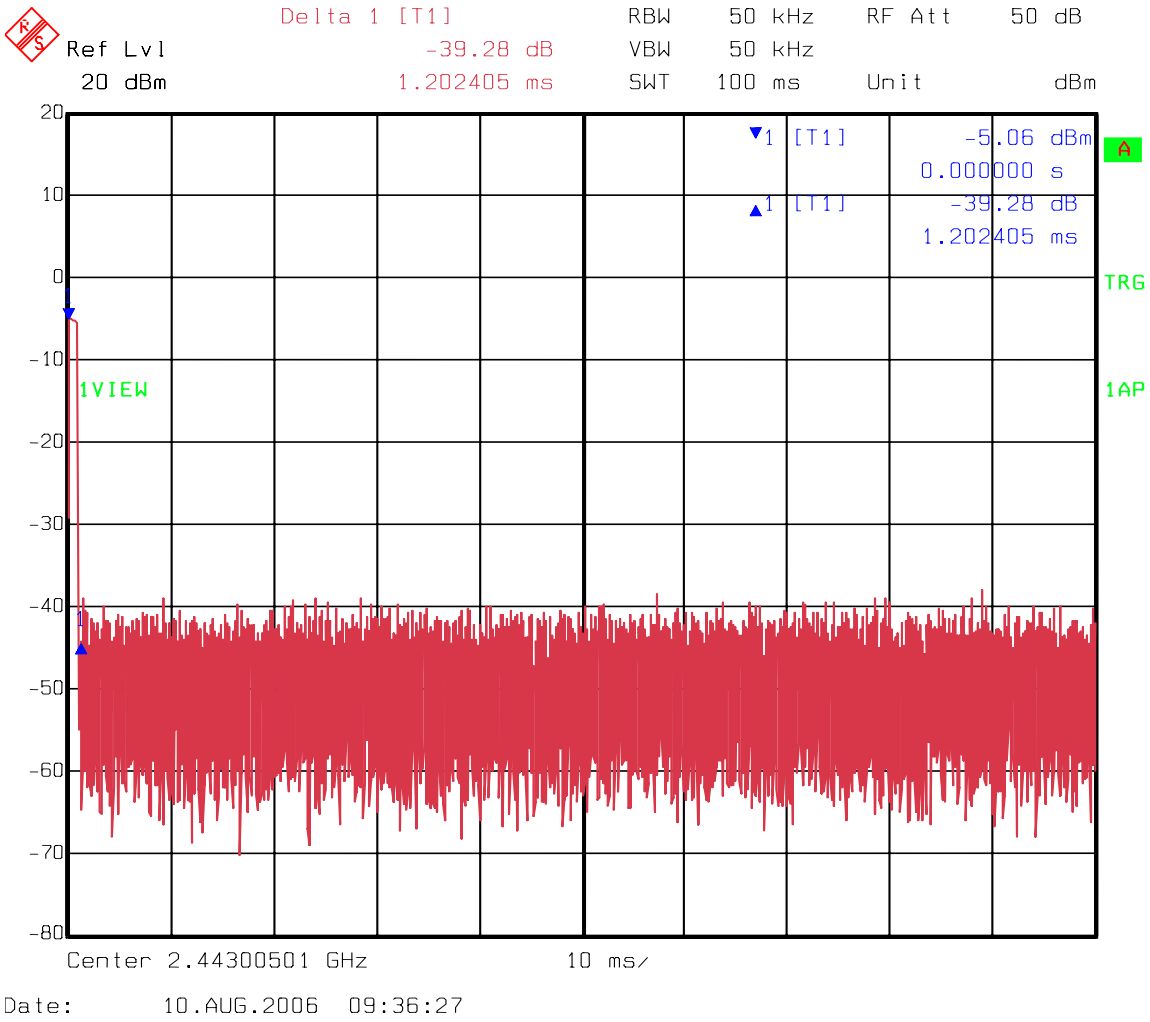
Measurement Uncertainty: +/- $1x10^{-7}$ ppm

Temperature: 22°C

Relative Humidity: 45%

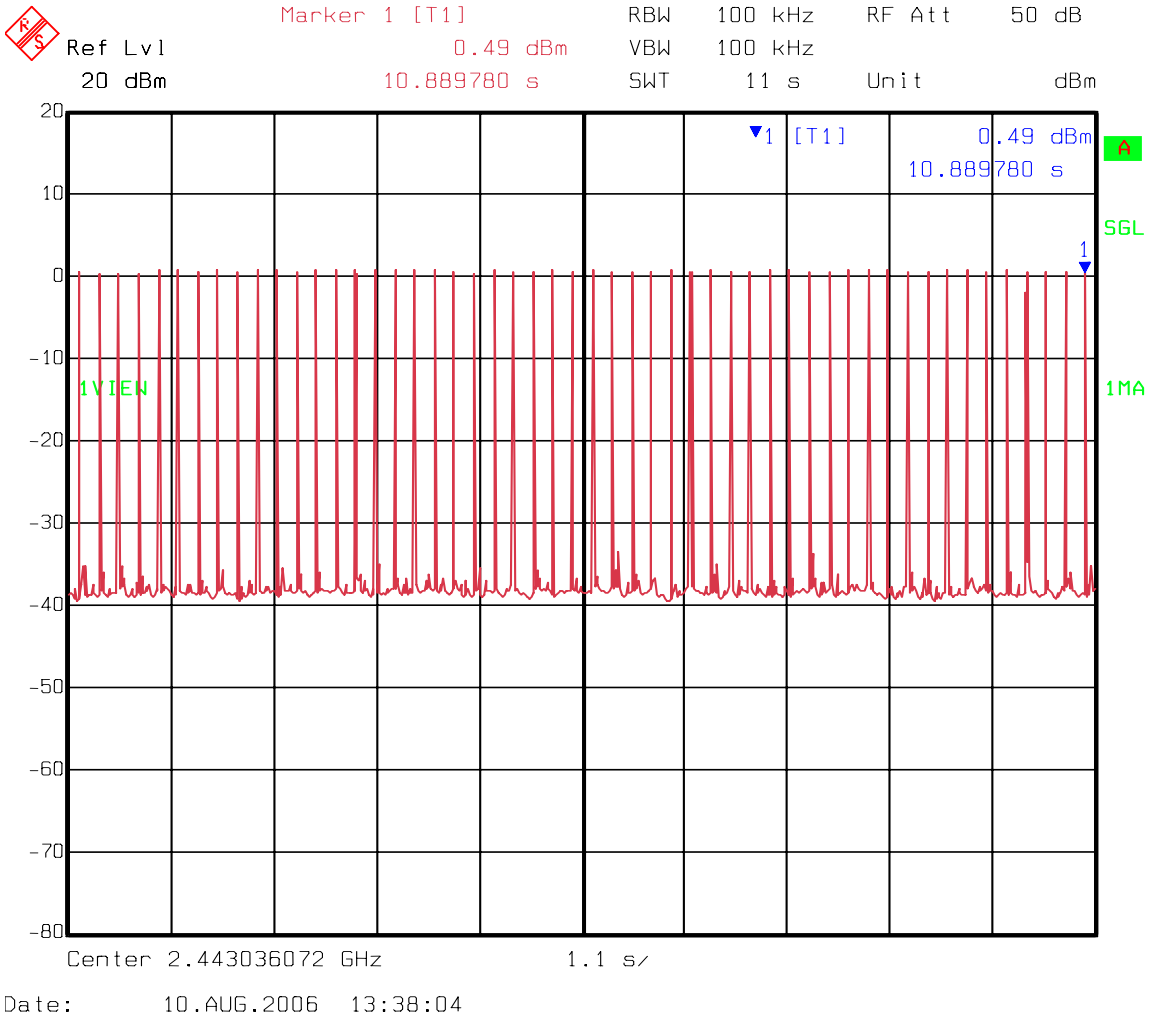
Test Data – Dwell Time

Duty Cycle Correction
20 log (1.20245/100) = -38.4 dB



Test Data – Dwell Time

0.4 * 27 Channels = 10.8 Seconds
52 hops at 1.2 mS each = 62.4 mS within 10.8 seconds
Limit: 400 mS in 10.8 seconds



Section 7. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: Kevin Rose	DATE: 8/10/2006

Test Results: Complies.

Measurement Data:

Detachable antenna? ☒ Yes ☐ No
If yes, state the type of non-standard connector used: Reverse SMA
This device uses a monopole antenna with 2, 5 or 7 dB gain or an integral antenna

Frequency (MHz)	Peak Power (dBm/mW)	Antenna Type	Gain (dBi)	E.I.R.P. (dBm)
2401	16.6/45.7	Monopole	7	23.6
2440	15.7/37.2	Monopole	7	22.7
2482	16.2/41.7	Monopole	7	23.2
2401	17.2/52.48	Integral	0	17.2
2440	16.9/48.98	Integral	0	16.9
2482	17.6/57.54	Integral	0	17.6

All tests were performed radiated. Conducted peak power was determined by subtracting the antenna gain from the radiated EIRP measurement.

The radio was tested with the highest gain antenna designed for this device and option for integral antenna.

The radio was tested with AC Adapter and battery pack. No differences were detected.

The radio was tested with a fresh battery.

Power was varied +/- 15% with no change in output power.

Equipment Used: 1464-1484-1485-1016-993

Measurement Uncertainty: +/- 1.7 dB

Temperature: 22°C

Relative Humidity: 45%

Section 8. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(c)
TESTED BY: Kevin Rose	DATE: August 11, 2006

Test Results: Complies.

Measurement Data: See attached table.

Duty Cycle Calculation:

Duty Cycle correction factor(dB) = 20 log (rf_{ON} in ms/100ms)

Duty Cycle Correction
20 log (1.20245/100) = -38.4 dB
(Refer to plot on page 18)

Equipment Used: 1464-1485-1484-791-1016-993-759-1195

Measurement Uncertainty: +/- 3.6 dB

Temperature: 22 °C

Relative Humidity: 45 %

Test Data - Radiated Emissions – Monopole Antenna

Highest Channel

Measurement Data: Reading listed by frequency. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	2483.500	41.3	+0.8	+2.3			+0.0	73.4	74.0	-0.6	Vert
			+0.0	+29.0	+0.0						
2	2483.500	-5.8	+0.8	+2.3			+0.0	26.3	54.0	-27.7	Vert
	Ave		+0.0	+29.0	+0.0						
3	2483.500	28.8	+0.8	+2.3			+0.0	60.9	74.0	-13.1	Horiz
			+0.0	+29.0	+0.0						
4	2483.500	-6.8	+0.8	+2.3			+0.0	25.3	54.0	-28.7	Horiz
	Ave		+0.0	+29.0	+0.0						
5	4963.750	61.5	+1.0	+3.3			+0.0	66.9	74.0	-7.1	Horiz
			+32.6	+33.7	+0.0						
6	4963.750	23.1	+1.0	+3.3			+0.0	28.5	54.0	-25.5	Horiz
	Ave		+32.6	+33.7	+0.0						
7	4965.883	10.6	+1.0	+3.3			+0.0	16.0	54.0	-38.0	Vert
	Ave		+32.6	+33.7	+0.0						
8	4965.883	49.0	+1.0	+3.3			+0.0	54.4	74.0	-19.6	Vert
			+32.6	+33.7	+38.4						
9	7445.667	49.7	+1.2	+4.1			+0.0	58.4	74.0	-15.6	Horiz
			+32.5	+35.9	+0.0						
10	7445.667	11.3	+1.2	+4.1			+0.0	20.0	54.0	-34.0	Horiz
			+32.5	+35.9	+0.0						
11	7449.000	50.7	+1.2	+4.1			+0.0	59.4	74.0	-14.6	Vert
			+32.5	+35.9	+0.0						
12	7449.000	12.3	+1.2	+4.1			+0.0	21.0	54.0	-33.0	Vert
	Ave		+32.5	+35.9	+0.0						
13	9927.667	44.2	+1.1	+5.0			+0.0	51.8	74.0	-22.2	Horiz
			+35.7	+37.2	+0.0						
14	9932.000	44.8	+1.1	+5.0			+0.0	52.4	74.0	-21.6	Vert
			+35.7	+37.2	+0.0						
15	12409.370	50.8	+1.8	+5.5			+0.0	63.8	74.0	-10.2	Horiz
			+34.4	+40.1	+0.0						
16	12409.370	13.4	+1.8	+5.5			+0.0	26.4	54.0	-27.6	Horiz
			+34.4	+40.1	+0.0						
17	12414.970	47.0	+1.8	+5.5			+0.0	60.0	74.0	-14.0	Vert
			+34.4	+40.1	+0.0						
18	12414.970	8.6	+1.8	+5.5			+0.0	21.6	54.0	-32.4	Vert
	Ave		+34.4	+40.1	+0.0						
19	14890.690	44.2	+1.5	+5.8			+0.0	60.1	74.0	-13.9	Horiz
			+32.1	+40.7	+0.0						
20	14890.690	5.7	+1.5	+5.8			+0.0	21.6	54.0	-32.4	Horiz
	Ave		+32.1	+40.7	+0.0						
21	14897.970	40.7	+1.5	+5.8			+0.0	56.6	74.0	-17.4	Vert
			+32.1	+40.7	+0.0						
22	14897.970	2.3	+1.5	+5.8			+0.0	18.2	54.0	-35.8	Vert
	Ave		+32.1	+40.7	+0.0						

Test Data - Radiated Emissions – Monopole Antenna

Low Channel

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	Duty dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	4801.867	54.3	+1.0	+3.2			+0.0	59.1	74.0	-14.9	Horiz
			+32.5	+33.1	+0.0						
2	4801.867	54.3	+1.0	+3.2			+0.0	20.7	54.0	-33.3	Horiz
	Ave		+32.5	+33.1	+38.4						
3	7203.050	51.5	+1.2	+3.9			+0.0	60.3	74.0	-13.7	Horiz
			+32.1	+35.8	+0.0						
4	7203.050	51.5	+1.2	+3.9			+0.0	21.9	54.0	-32.1	Horiz
	Ave		+32.1	+35.8	+38.4						
5	9604.050	43.0	+1.1	+4.7			+0.0	50.1	74.0	-23.9	Horiz
			+35.8	+37.1	+0.0						
6	12005.050	46.8	+1.8	+5.5			+0.0	58.4	74.0	-15.6	Horiz
			+35.3	+39.6	+0.0						
7	12005.050	46.8	+1.8	+5.5			+0.0	20.0	54.0	-34.0	Horiz
	Ave		+35.3	+39.6	+38.4						
8	4802.050	56.2	+1.0	+3.2			+0.0	61.0	74.0	-13.0	Vert
			+32.5	+33.1	+0.0						
9	4802.050	56.2	+1.0	+3.2			+0.0	22.6	54.0	-31.4	Vert
	Ave		+32.5	+33.1	+38.4						
10	7202.950	49.0	+1.2	+3.9			+0.0	57.8	74.0	-16.2	Vert
			+32.1	+35.8	+0.0						
11	7202.950	49.0	+1.2	+3.9			+0.0	19.4	54.0	-34.6	Vert
	Ave		+32.1	+35.8	+38.4						
12	9604.442	44.3	+1.1	+4.7			+0.0	51.4	74.0	-22.6	Vert
			+35.8	+37.1	+0.0						
13	12005.080	48.8	+1.8	+5.5			+0.0	60.4	74.0	-13.6	Vert
			+35.3	+39.6	+0.0						
14	12005.080	48.8	+1.8	+5.5			+0.0	22.0	54.0	-32.0	Vert
	Ave		+35.3	+39.6	+38.4						
15	14406.130	43.5	+1.6	+5.6			+0.0	60.3	74.0	-13.7	Vert
			+31.6	+41.2	+0.0						
16	14406.130	43.5	+1.6	+5.6			+0.0	21.9	54.0	-32.1	Vert
	Ave		+31.6	+41.2	+38.4						

Test Data - Radiated Emissions – Monopole Antenna

Mid Channel

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	Duty dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
17	4880.008	54.0	+1.0	+3.3			+0.0	59.1	74.0	-14.9	Vert
			+32.6	+33.4	+0.0						
18	4880.008	54.0	+1.0	+3.3			+0.0	20.7	54.0	-33.3	Vert
	Ave		+32.6	+33.4	+38.4						
19	7320.008	49.5	+1.2	+4.0			+0.0	58.2	74.0	-15.8	Vert
			+32.3	+35.8	+0.0						
20	7320.008	49.5	+1.2	+4.0			+0.0	19.8	54.0	-34.2	Vert
	Ave		+32.3	+35.8	+38.4						
21	9760.275	45.2	+1.1	+4.9			+0.0	52.3	74.0	-21.7	Vert
			+36.1	+37.2	+0.0						
22	12199.930	48.8	+1.8	+5.5			+0.0	61.1	74.0	-12.9	Vert
			+34.8	+39.8	+0.0						
23	12199.930	48.8	+1.8	+5.5			+0.0	22.7	54.0	-31.3	Vert
	Ave		+34.8	+39.8	+38.4						
24	14639.930	42.2	+1.5	+5.7			+0.0	58.5	74.0	-15.5	Vert
			+31.8	+40.9	+0.0						
25	14639.930	42.2	+1.5	+5.7			+0.0	20.1	54.0	-33.9	Vert
	Ave		+31.8	+40.9	+38.4						
26	4879.934	54.2	+1.0	+3.3			+0.0	59.3	74.0	-14.7	Horiz
			+32.6	+33.4	+0.0						
27	4879.934	54.2	+1.0	+3.3			+0.0	20.9	54.0	-33.1	Horiz
	Ave		+32.6	+33.4	+38.4						
28	7320.158	51.8	+1.2	+4.0			+0.0	60.5	74.0	-13.5	Horiz
			+32.3	+35.8	+0.0						
29	7320.158	51.8	+1.2	+4.0			+0.0	22.1	54.0	-31.9	Horiz
	Ave		+32.3	+35.8	+38.4						
30	9760.159	43.7	+1.1	+4.9			+0.0	50.8	74.0	-23.2	Horiz
			+36.1	+37.2	+0.0						
31	12200.030	47.2	+1.8	+5.5			+0.0	59.5	74.0	-14.5	Horiz
			+34.8	+39.8	+0.0						
32	12200.030	47.2	+1.8	+5.5			+0.0	21.1	54.0	-32.9	Horiz
	Ave		+34.8	+39.8	+38.4						

The spectrum was searched from 30 MHz to the tenth harmonic of the carrier. All emissions are reported.

Test Data - Radiated Emissions – Integral Antenna

Highest Channel

Measurement Data: Reading listed by order taken. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	Duty dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
17	4964.142	51.3	+1.0	+3.3			+0.0	56.7	74.0	-17.3	Horiz
			+32.6	+33.7	+0.0						
18	4964.142	51.3	+1.0	+3.3			+0.0	18.3	54.0	-35.7	Horiz
	Ave		+32.6	+33.7	+38.4						
19	7445.925	48.8	+1.2	+4.1			+0.0	57.5	74.0	-16.5	Horiz
			+32.5	+35.9	+0.0						
20	7445.925	48.8	+1.2	+4.1			+0.0	19.1	54.0	-34.9	Horiz
	Ave		+32.5	+35.9	+38.4						
21	9927.925	44.0	+1.1	+5.0			+0.0	51.6	74.0	-22.4	Horiz
			+35.7	+37.2	+0.0						
22	4963.925	50.5	+1.0	+3.3			+0.0	55.9	74.0	-18.1	Vert
			+32.6	+33.7	+0.0						
23	4963.925	50.5	+1.0	+3.3			+0.0	17.5	54.0	-36.5	Vert
	Ave		+32.6	+33.7	+38.4						
24	7446.059	46.3	+1.2	+4.1			+0.0	55.0	74.0	-19.0	Vert
			+32.5	+35.9	+0.0						
25	7446.059	46.3	+1.2	+4.1			+0.0	16.6	44.0	-27.4	Vert
	Ave		+32.5	+35.9	+38.4						
26	9928.058	43.8	+1.1	+5.0			+0.0	51.4	74.0	-22.6	Vert
			+35.7	+37.2	+0.0						
27	12410.060	47.0	+1.8	+5.5			+0.0	60.0	74.0	-14.0	Vert
			+34.4	+40.1	+0.0						
28	12410.060	47.0	+1.8	+5.5			+0.0	21.6	54.0	-32.4	Vert
	Ave		+34.4	+40.1	+38.4						
29	2483.500	64.8	+0.8	+2.3			+0.0	62.6	74.0	-11.4	Horiz
	Bandedge		+0.0	+29.0	+34.3						
30	2483.500	-16.0	+0.8	+2.3			+0.0	16.1	54.0	-37.9	Horiz
	Ave		+0.0	+29.0	+0.0						
31	2483.500	34.4	+0.8	+2.3			+0.0	66.5	74.0	-7.5	Vert
	Bandedge		+0.0	+29.0	+0.0						
32	2483.500	-15.6	+0.8	+2.3			+0.0	16.5	54.0	-37.5	Vert
	Ave		+0.0	+29.0	+0.0						

Test Data - Radiated Emissions – Integral Antenna

Lowest Channel

Measurement Data: Reading listed by order taken. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	Duty dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	4801.867	54.1	+1.0	+3.2			+0.0	58.9	74.0	-15.1	Horiz
			+32.5	+33.1	+0.0						
2	4801.867	54.1	+1.0	+3.2			+0.0	20.5	54.0	-33.5	Horiz
	Ave		+32.5	+33.1	+38.4						
3	7203.050	51.0	+1.2	+3.9			+0.0	59.8	74.0	-14.2	Horiz
			+32.1	+35.8	+0.0						
4	7203.050	51.0	+1.2	+3.9			+0.0	21.4	54.0	-32.6	Horiz
	Ave		+32.1	+35.8	+38.4						
5	4802.050	56.0	+1.0	+3.2			+0.0	60.8	74.0	-13.2	Vert
			+32.5	+33.1	+0.0						
6	4802.050	56.0	+1.0	+3.2			+0.0	22.4	54.0	-31.6	Vert
	Ave		+32.5	+33.1	+38.4						
7	7202.950	49.3	+1.2	+3.9			+0.0	58.1	74.0	-15.9	Vert
			+32.1	+35.8	+0.0						
8	7202.950	49.3	+1.2	+3.9			+0.0	19.7	54.0	-34.3	Vert
	Ave		+32.1	+35.8	+38.4						

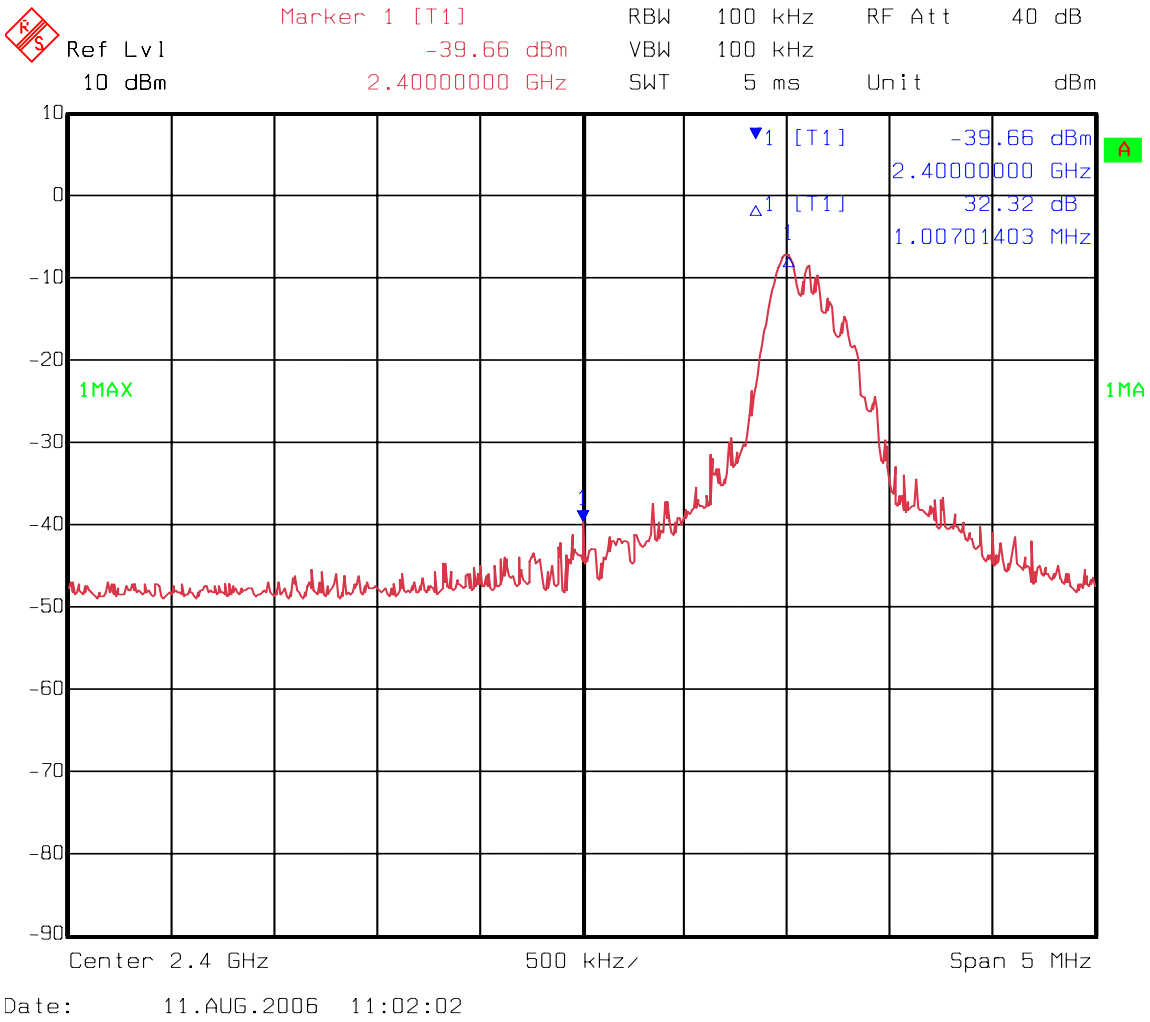
Test Data - Radiated Emissions – Integral Antenna

Mid Channel

Measurement Data: Reading listed by order taken. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	Cable Pre-A dB	Cable Horn dB	Duty dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
9	4880.008	54.3	+1.0 +32.6	+3.3 +33.4	+0.0		+0.0	59.4	74.0	-14.6	Vert
10	4880.008 Ave	54.3	+1.0 +32.6	+3.3 +33.4	+38.4		+0.0	21.0	54.0	-33.0	Vert
11	7320.008	44.8	+1.2 +32.3	+4.0 +35.8	+0.0		+0.0	53.5	74.0	-20.5	Vert
12	7320.008 Ave	44.8	+1.2 +32.3	+4.0 +35.8	+38.4		+0.0	15.1	54.0	-38.9	Vert
13	4879.934	54.3	+1.0 +32.6	+3.3 +33.4	+0.0		+0.0	59.4	74.0	-14.6	Horiz
14	4879.934 Ave	54.3	+1.0 +32.6	+3.3 +33.4	+38.4		+0.0	21.0	54.0	-33.0	Horiz
15	7320.158	51.0	+1.2 +32.3	+4.0 +35.8	+0.0		+0.0	59.7	74.0	-14.3	Horiz
16	7320.158 Ave	51.0	+1.2 +32.3	+4.0 +35.8	+38.4		+0.0	21.3	54.0	-32.7	Horiz

Lower Bandedge



Radiated Photographs

Section 9. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	05/26/06	05/26/08
802	Near Field Probe Set	EMCO 7405	103	N/A	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/14/05	01/15/07
1484	Cable	Storm PR90-010-072	N/A	08/26/05	08/26/06
1485	Cable	Storm PR90-010-216	N/A	08/26/05	08/26/06
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/01/05	08/02/07
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	02/13/06	02/13/07
1195	ANTENNA,BICONICAL	A.H. SYSTEMS SAS-200/542	235	02/10/06	02/10/07
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	04/20/06	04/20/07
791	PREAMP, 25dB	Nemko USA, Inc. LNA25	398	04/20/06	04/20/07
1663	Spectrum Analyzer	Rhode & Schwarz FSP	973351	05/18/06	05/18/07
674	LIMITER	HP 11947A	3107A02200	04/19/06	04/19/07
1082	CABLE	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A
1188	LISN	EMCO 3825/2	1214	04/19/06	04/19/07
704	FILTER, HIGH PASS, 5 KHz	SOLAR 7930-5.0	933126	04/20/06	04/20/07
1977	CABLE, .8m	Nemko USA, Inc. RG223	N/A	03/09/06	03/09/07

ANNEX A - TEST DETAILS

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)

Minimum Standard: §15.207 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.: 15.247(a)(1)

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.

NAME OF TEST: Time of Occupancy PARA. NO.: 15.247(a)(1)(ii)

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	-----	15	=<0.4 sec. in 0.4*#hopping channels (sec).
5725 – 5850	-----	75	=<0.4 sec. in 30 sec.

Method Of Measurement:

The spectrum analyzer is set as follows:

RBW/VBW: 100 kHz
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 (10, 20, or 30 seconds).

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 sec./.001 sec.)/75 chan. = 400 x 1 msec. = 400 msec. or 0.4 sec. in 30 sec.

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 15.247(a)(2)

Minimum Standard:

Frequency Band (MHz)	Maximum 20 dB Bandwidth
902 - 928	500 kHz
2400 – 2483.5	1 MHz
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.: 15.247(b)

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 at Antenna Terminals PARA. NO.: 15.247(c)

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 (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

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 Δ: 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 Δ: 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.: 15.247(c)

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 (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

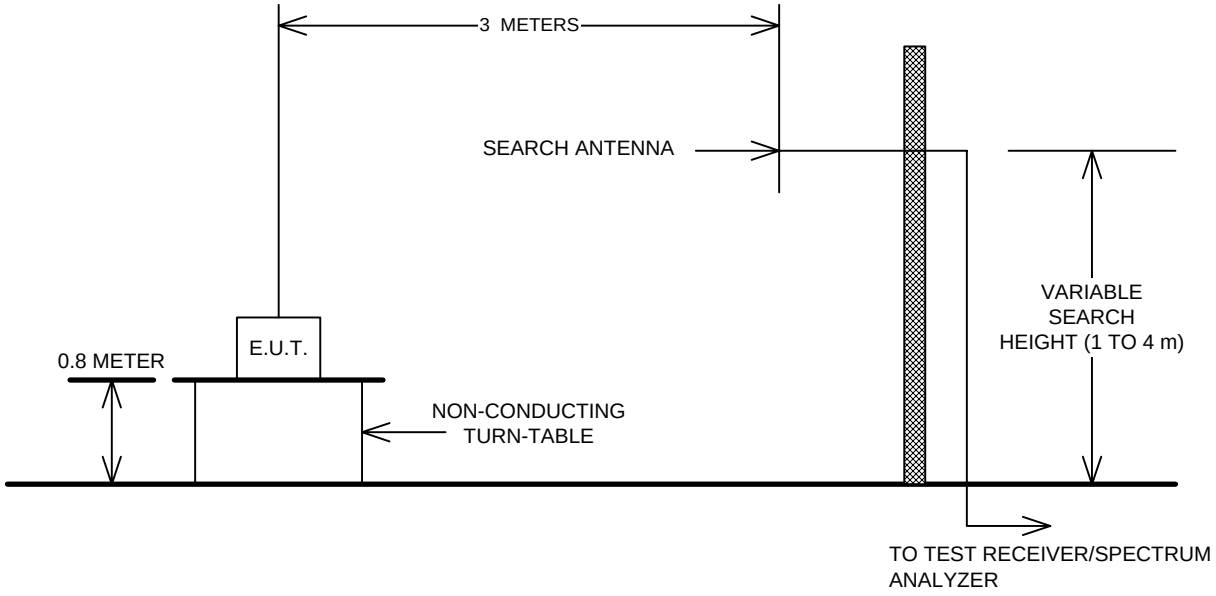
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218	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:

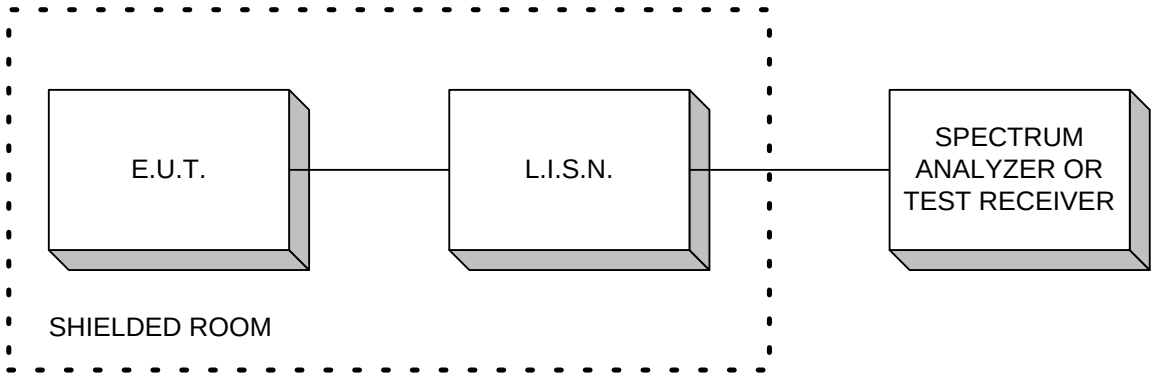
Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted Emissions



Peak Power At Antenna Terminals