Nemko Test Report: 6823RUS1

Applicant: Sensonix
15755 32nd Avenue North
Plymouth, MN 55447
USA

Equipment Under Test: (E.U.T.) RM1809

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:** **17 August 2007**
David Light, Senior Wireless Engineer

APPROVED BY: _____ **DATE:** **18 September 2007**
Mike Cantwell, Verifier

Total Number of Pages: 1

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Section 1. Summary of Test Results

Manufacturer: Sensonix

Model No.: RM1809

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. NONE

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Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
Powerline Conducted Emissions	15.207(a)	Complies
Channel Separation	15.247(a)(1)	Complies
Time of Occupancy	15.247(a)(1)	Complies
20 dB Occupied Bandwidth	15.247(a)(1)	Complies
Peak Power Output	15.247(b)	Complies
Spurious Emissions (Antenna Conducted)	15.247(d)	Complies
Spurious Emissions (Radiated)	15.247(d)	Complies

Footnotes:

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

General Equipment Information

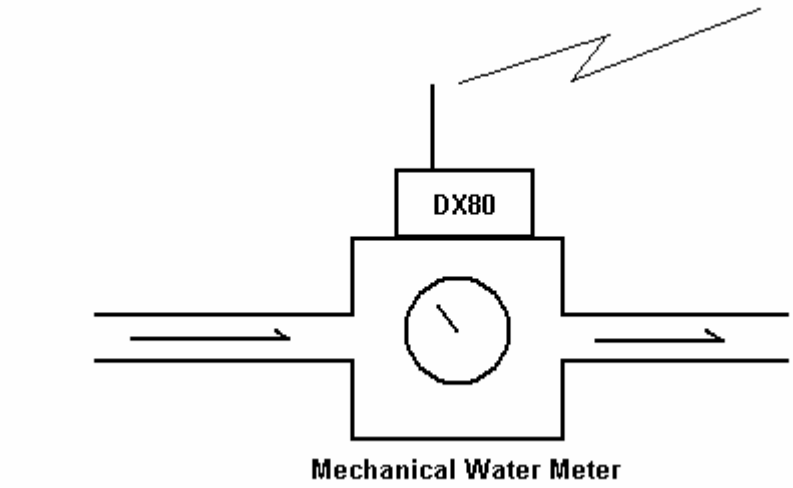
Frequency Band:	☒ 902 – 928 MHz ☐ 2400 – 2483.5 MHz ☐ 5725 – 5850 MHz
Operating Frequency Range:	902.4 to 927.6 MHz
Number of Channels:	26 to 64
Channel Spacing:	400 kHz
Power Output:	0.25 to 1 Watt (24-30 dBm)
User Power Adjustment:	None. Factory set
User Frequency Adjustment:	None. Factory set

Description of EUT

The RM1809 is a 900 MHz frequency hopping transmitter used for data collection. It employs TDMA modulation and is equipped with a reverse polarity SMA antenna connector. Power and is set at the factory from 24 to 30 dBm as predetermined by the antenna used. Pulse width is set determined by the number of frequencies used in hop table to meet the 0.4 second ON time per 10 mS per 15.247(a)(1)(i).
Antennas:

1) 2 dBi dipole
2) 7.2 dBi helical loaded omni with ground plane
3) 8dBi dipole omni
4) 10 dBi Yagi
5) 1 dBi ¼ wave monopole

System Diagram



Section 3. Powerline Conducted Emissions

NAME OF TEST: Powerline Conducted Emissions	PARA. NO.: 15.207(a)
TESTED BY: Scott Oats	DATE: 20 August 2007

Test Results: Complies.

Test Data: Refer to attached plots

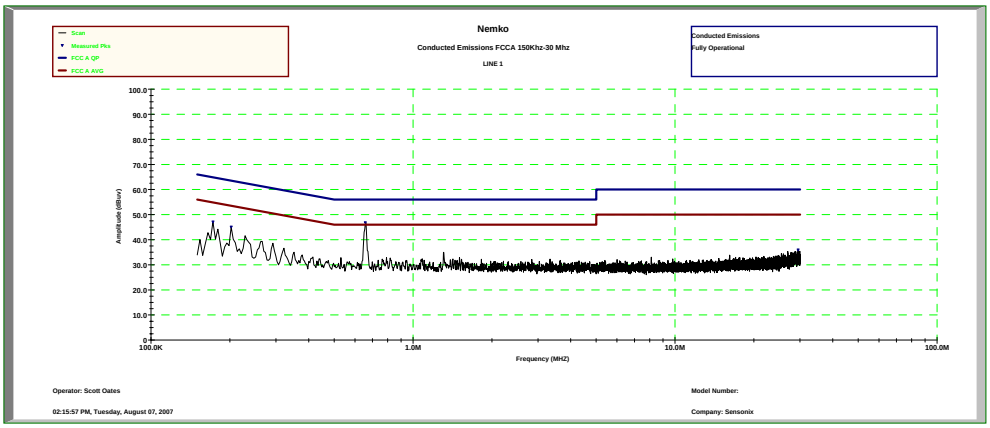
Equipment Used: 1183-1053-1484

Measurement Uncertainty: +/- 1.7 dB

Temperature: 22 °C

Relative Humidity: 40 %

Test Data – Powerline Conducted Emissions



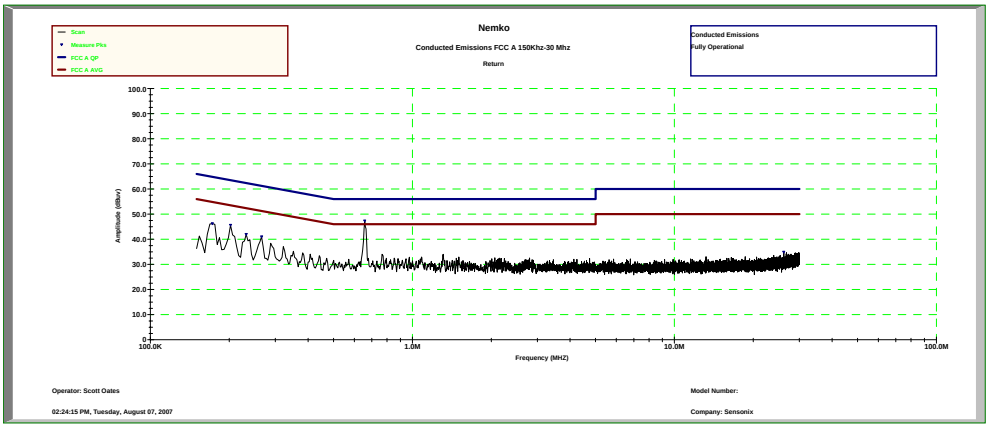
EN55022 B Conducted Emissions

Line 1 Peaks
Operator: Scott Oates Model Number:
Company: Sensonix

09:26:46 AM, Monday, August 20, 2007					
Frequency	Peaks	FCC A	FCC A	Avg	QP
MHz		Avg Limit	QP Limit	Margin	Margin
.172388	47.121	55.360	65.360	-8.239	-18.239
.202238	45.090	54.508	64.507	-9.418	-19.418
.657450	46.836	46.000	56.000	0.836	-9.164
2.9	35.956	50.000	60.000	-14.044	-24.044

657 kHz = ambient

Test Data – Powerline Conducted Emissions



EN55022 B Conducted Emissions

Line 2 Peaks
Operator: Scott Oates Model Number:
Company: Sensonix

09:26:46 AM, Monday, August 20, 2007

Frequency MHz	Peaks	FCC A Avg Limit	FCC A QP Limit	Avg Margin	QP Margin
.172388	46.221	55.360	65.360	-9.139	-19.139
.202238	45.590	54.508	64.507	-8.918	-18.918
.232088	41.956	53.655	63.655	-11.699	-21.699
.265669	41.004	52.695	62.695	-11.691	-21.691
.657450	47.336	46.000	56.000	1.336	-8.664
2.611	34.889	50.000	60.000	-15.111	-25.111

657 kHz = ambient

RBW = VBW = 10 kHz

Section 4. Channel Separation

NAME OF TEST: Channel Separation	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 16 August 2007

Test Results: Complies.

Measurement Data: See 20 dB BW plot

Measured 20 dB bandwidth: 320 kHz Max
Channel Separation: 400 kHz

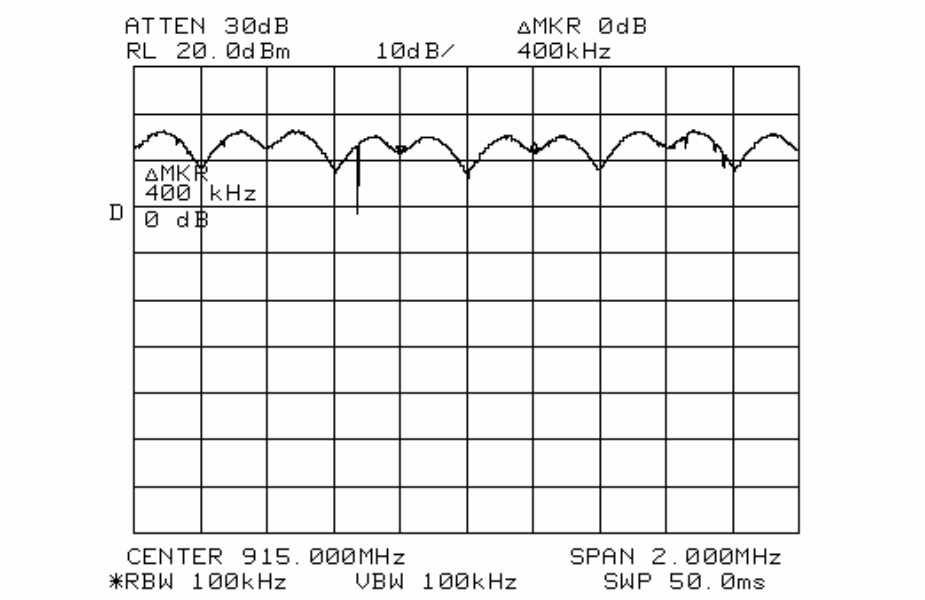
Equipment Used: 1464-1082-802

Measurement Uncertainty: $1X10^{-7}$ppm

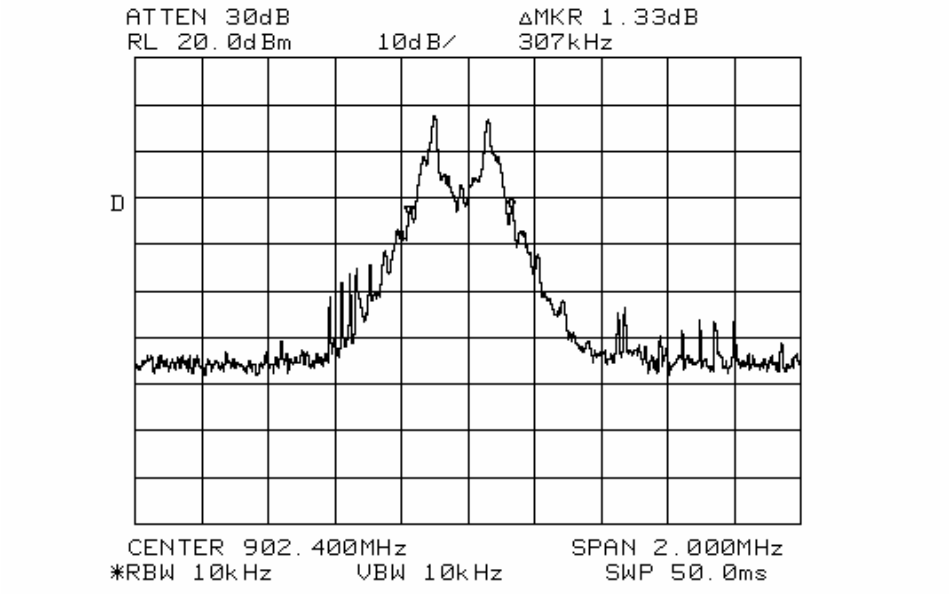
Temperature: 22 °C

Relative Humidity: 40 %

Test Data – Channel Separation

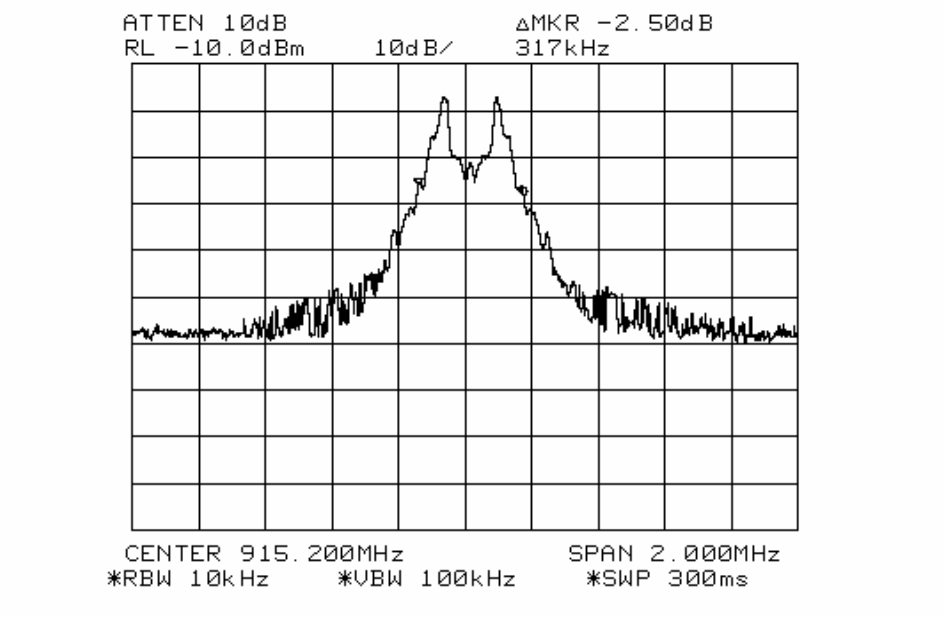


20 dB Bandwidth – Low Channel

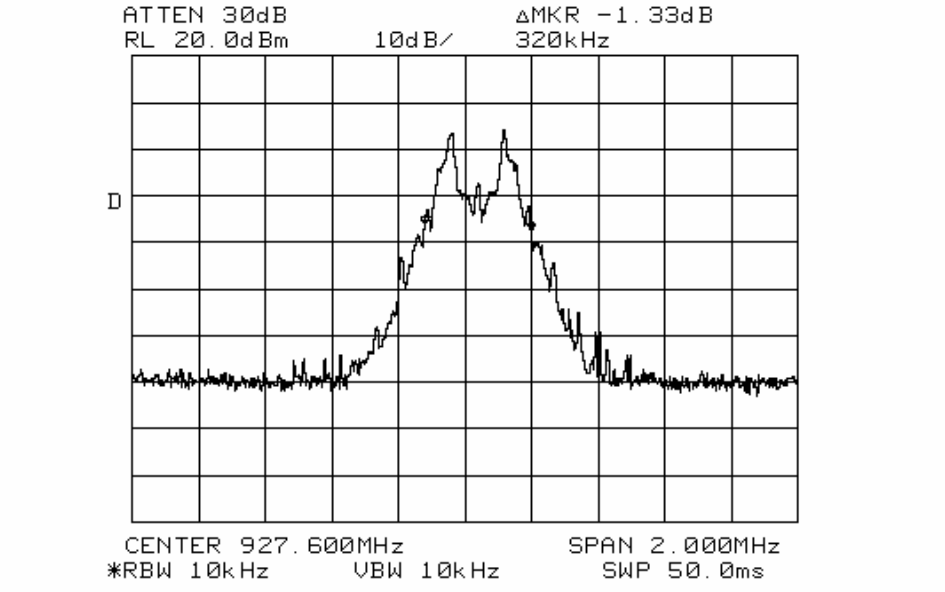


Test Data – 20 dB Bandwidth

Mid Channel



High Channel



Section 5. Time of Occupancy

NAME OF TEST: Time of Occupancy	PARA. NO.: 15.247(a)(1)
TESTED BY: David Light	DATE: 16 August 2007

Test Results: Complies.

Measurement Data:

Maximum Dwell Time On Any Channel: 382.2 mS in 10 seconds

Equipment Used: 1464-1082-802

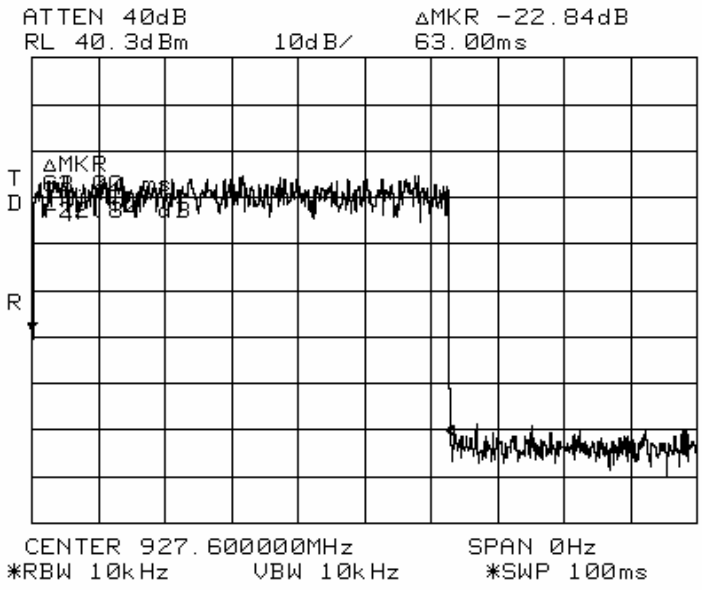
Measurement Uncertainty: $1X10^{-7}$ppm

Temperature: 22 °C

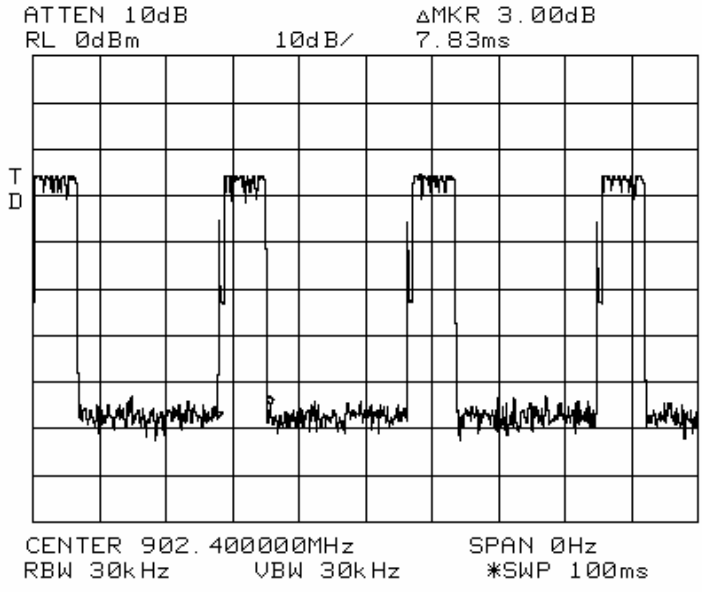
Relative Humidity: 40 %

Test Data – Time of Occupancy

Duty cycle @ highest pulse width
Duty cycle correction = 20 log (63/100) = -4 dB
(Worst case used for radiated measurements)

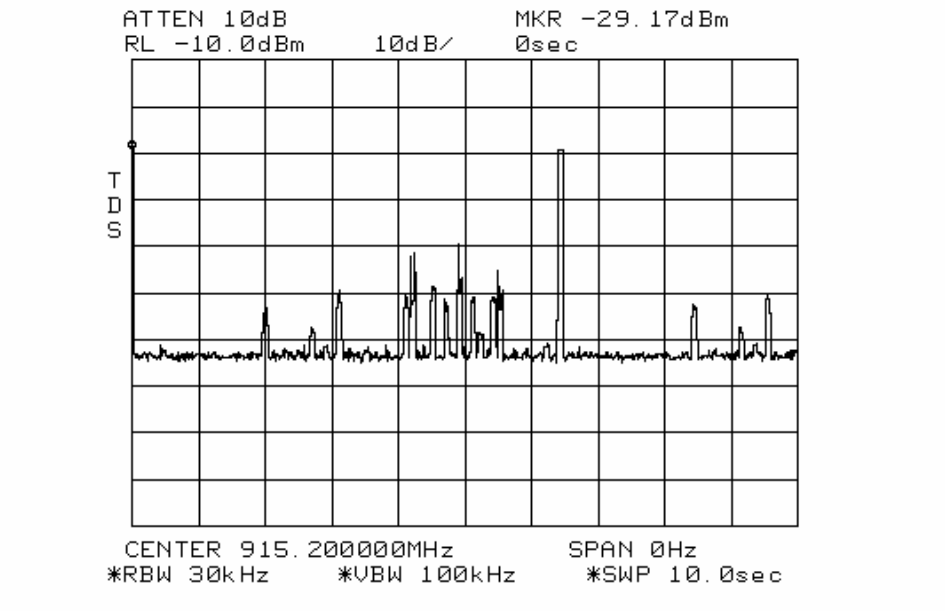


Duty cycle @ lowest pulse width
Duty cycle correction = 20 log (31.2/100) = -10 dB



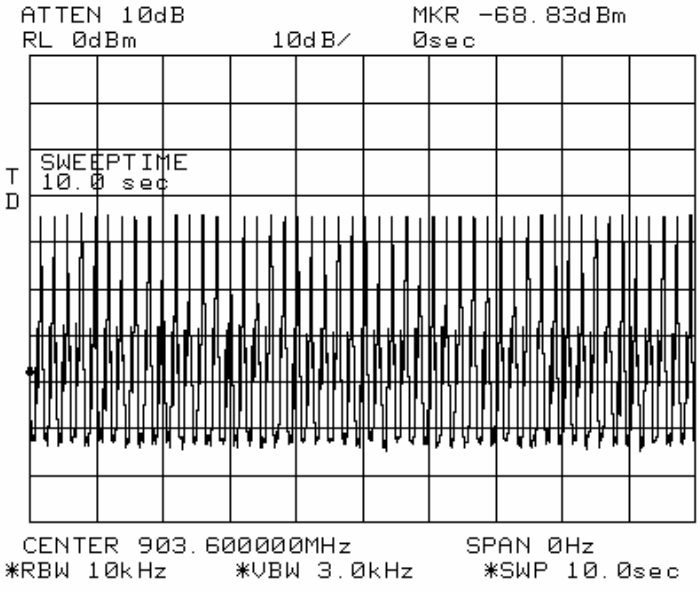
Test Data – Time of Occupancy

10 second sweep at 63 mS pulse width and 64 channels



126 mS in 10 seconds
Limit = 400 mS in 10 seconds

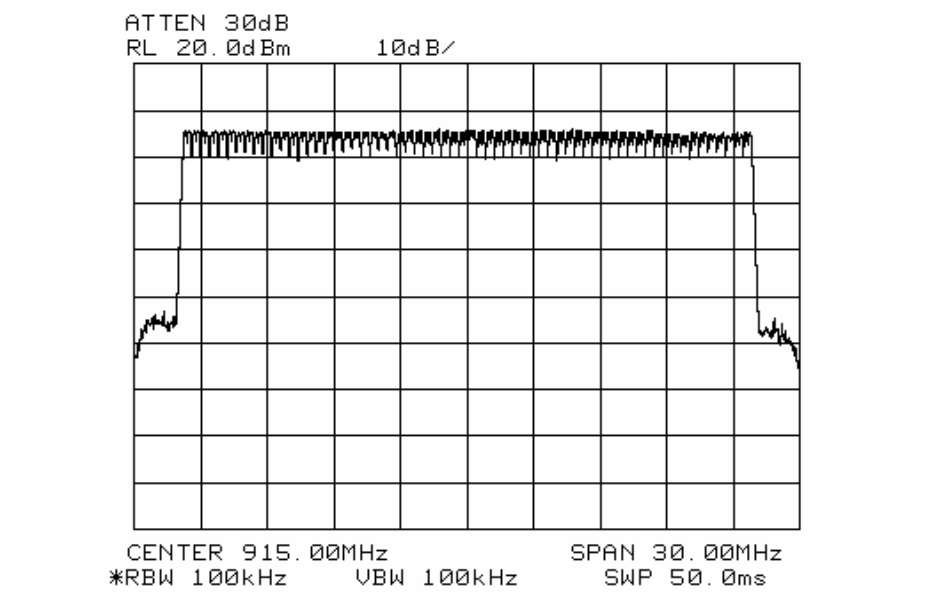
10 second sweep at 7.8 mS pulse width and 26 channels
49 hops in 10 seconds
382.2 mS



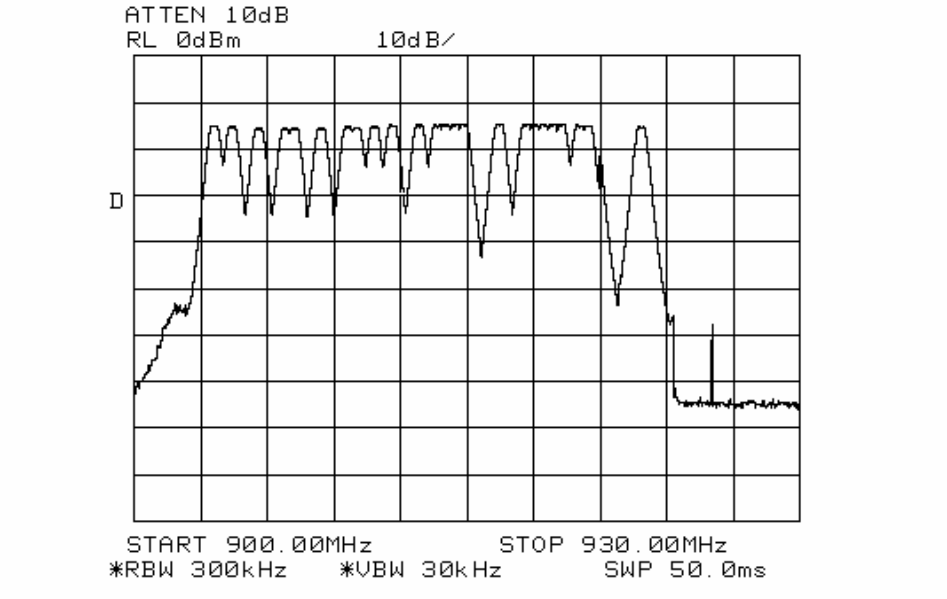
Test Data – Time of Occupancy

Number of hopping channels

64 Channels



26 Channels



Section 6. Peak Power Output

NAME OF TEST: Peak Power Output	PARA. NO.: 15.247 (b)
TESTED BY: David Light	DATE: 16 August 2007

Test Results: Complies.

Measurement Data: See attached plots.

Detachable antenna? ☒ Yes ☐ No
If yes, state the type of non-standard connector used:
Reverse gender SMA or MMCX (Professionally installed.)

Frequency (MHz)	Peak Power (dBm)	Peak Power **(W)**
Highest Power Setting		
902.4	29.63	0.918
915.2	29.63	0.918
927.6	29.80	0.955
Lowest Power Setting		
902.4	23.77	0.238
915.2	23.77	0.238
927.6	23.93	0.247

Antennas:

1. 2 dBi dipole
2. 7.2 dBi helical loaded omni with ground plane
3. 8dBi dipole omni
4. 10 dBi Yagi
5. 1 dBi ¼ wave monopole

Power will need to be attenuated either internally or externally to comply with EIRP limit of 36 dBm (4 Watts) when using antennas with gain higher than 6 dBi. The device is professionally installed.

☒ 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: 1464-1082-1472

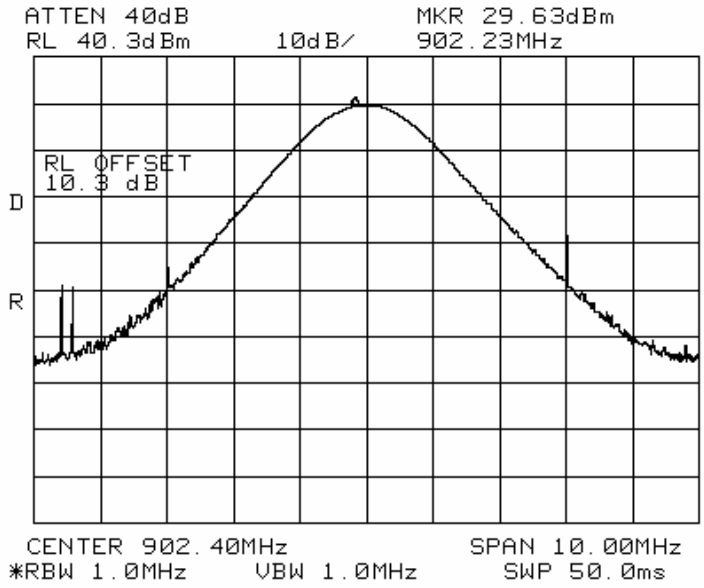
Measurement Uncertainty: 1.7 dB

Temperature: 22 °C

Relative Humidity: 41 %

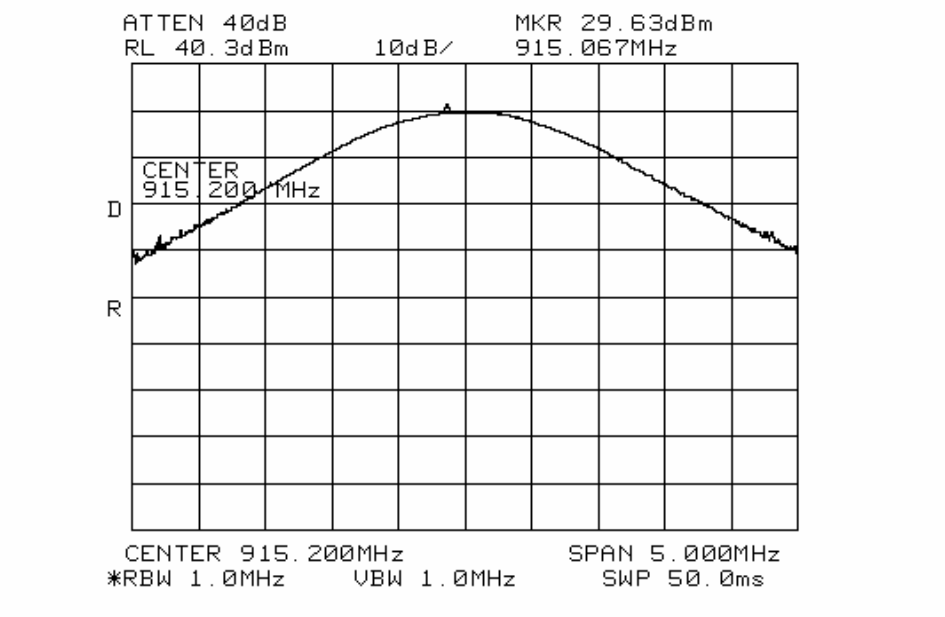
Test Data – Peak Power

Low channel / High power

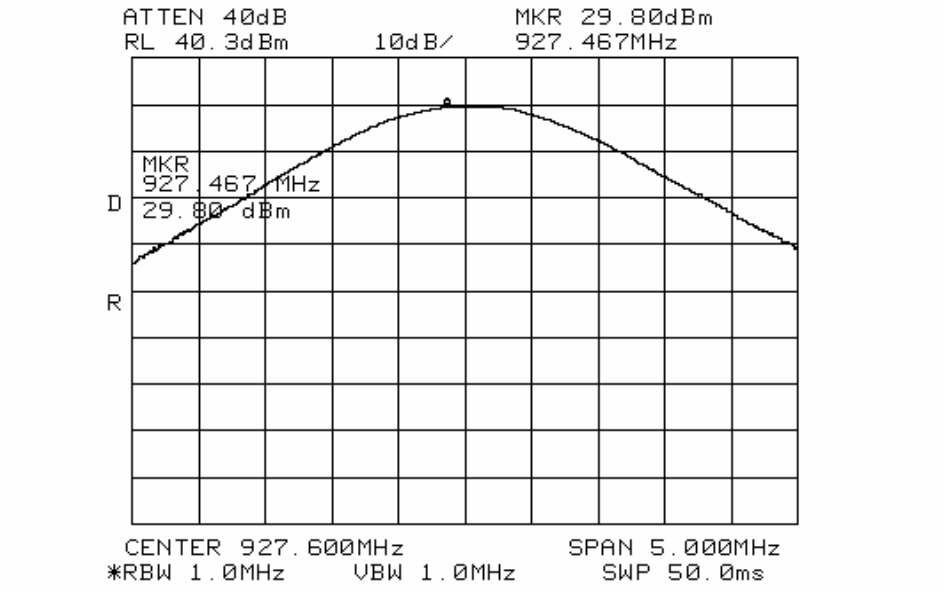


Test Data – Peak Power

Mid channel – High Power

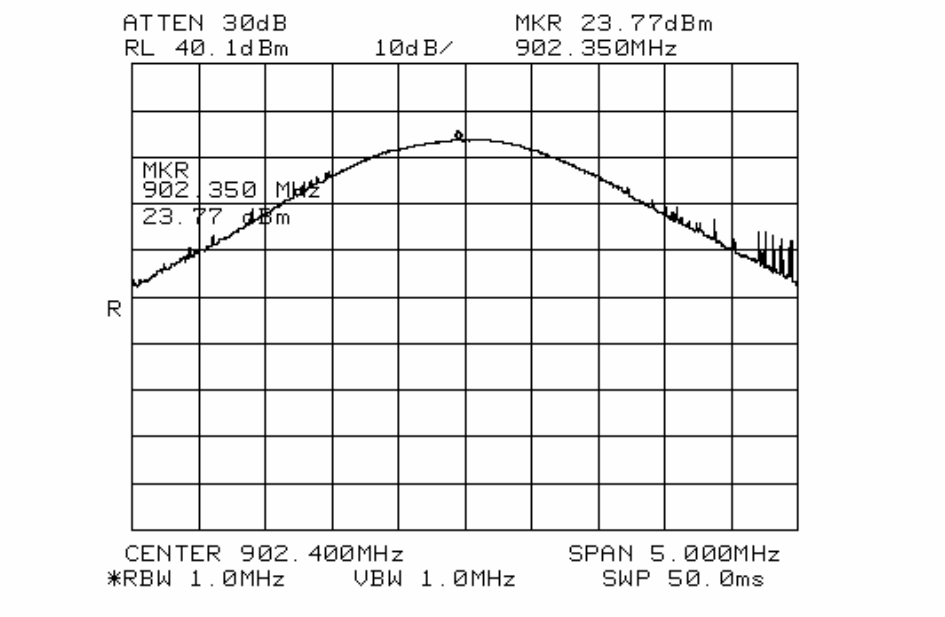


High channel – High Power

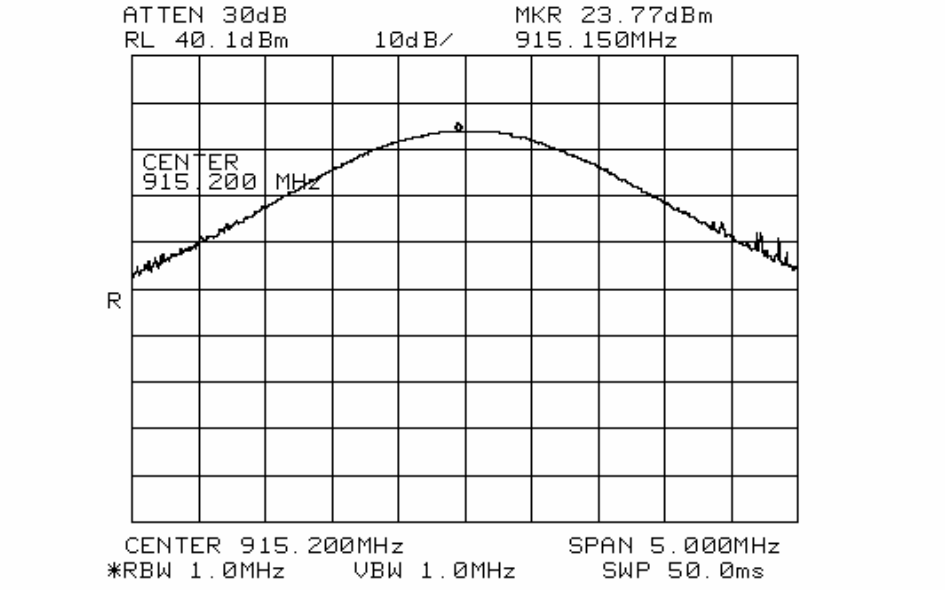


Test Data – Peak Power

Low Channel – Low power

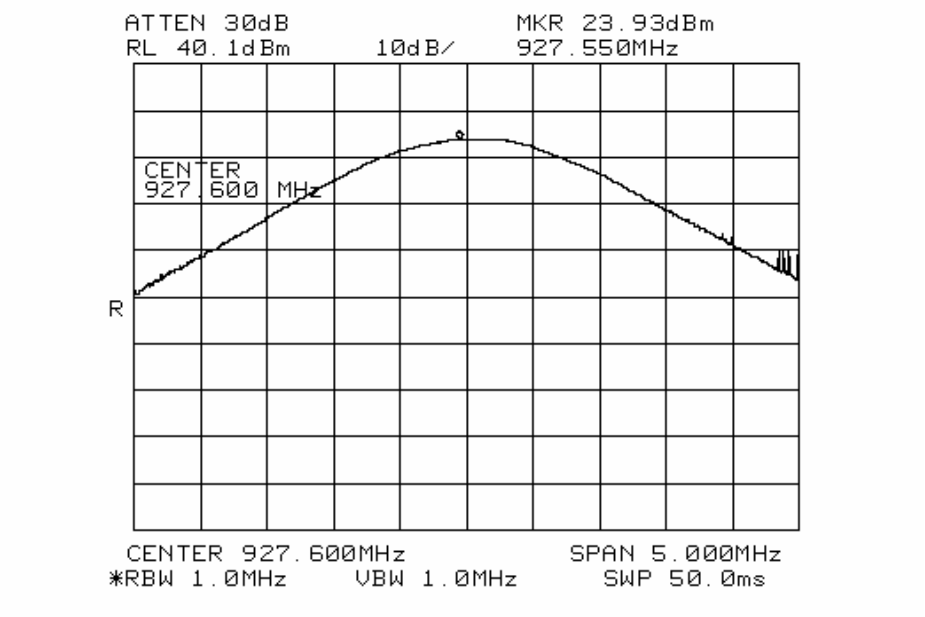


Mid Channel – Low Power



Test Data – Peak Power

High Channel – Low Power



Section 7. Spurious Emissions (Antenna Conducted)

NAME OF TEST: Spurious Emissions (Antenna Conducted)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 16 August 2007

Test Results: Complies.

Measurement Data: See attached plots.

Equipment Used: 146-1082-1472

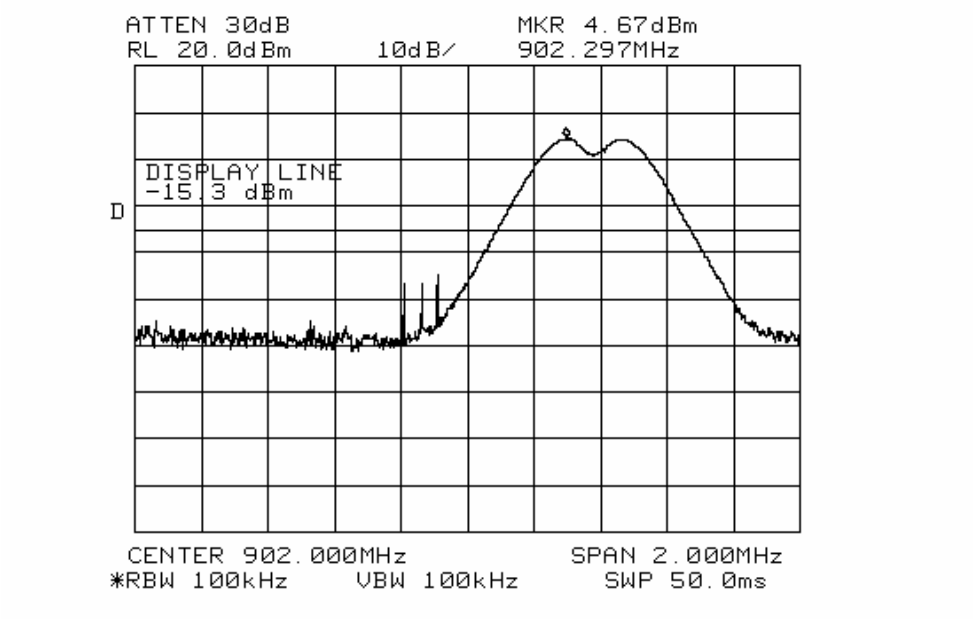
Measurement Uncertainty: $1X10^{-7}$ppm

Temperature: 22 °C

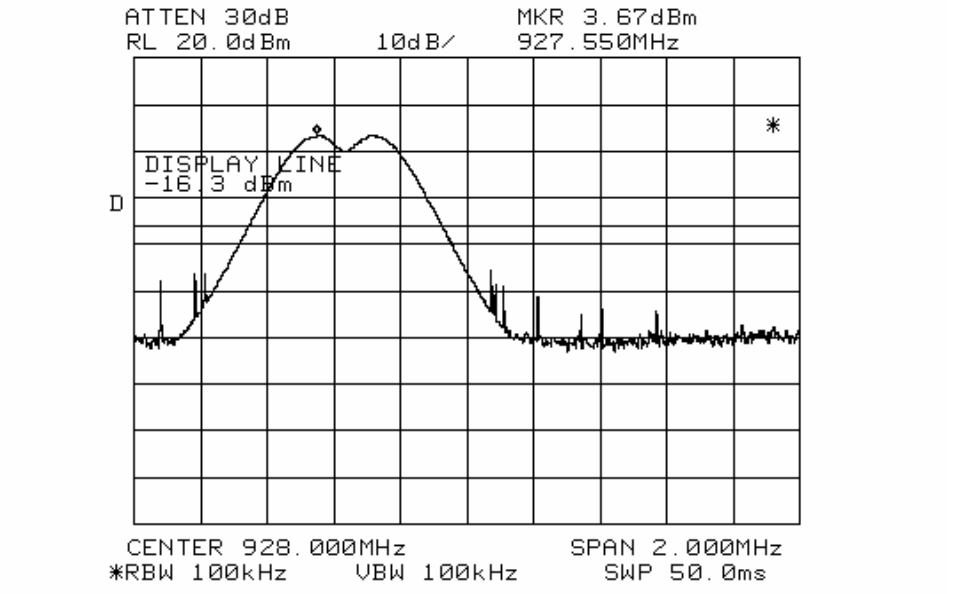
Relative Humidity: 41 %

Test Data – Spurious Emissions at Antenna Terminals

Lower Band Edge

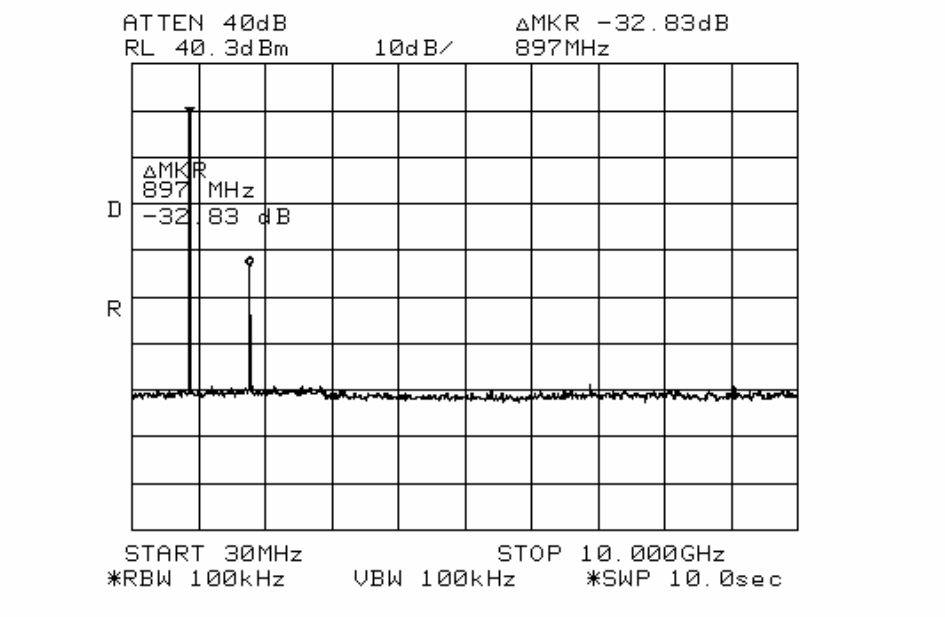


Upper Band Edge

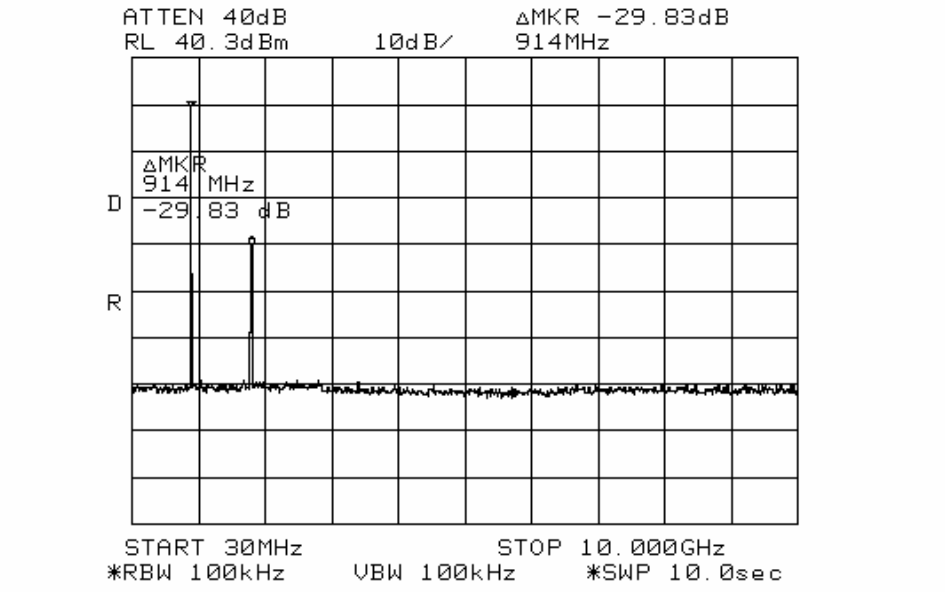


Test Data – Spurious Emissions at Antenna Terminals

Spurs – Low Channel

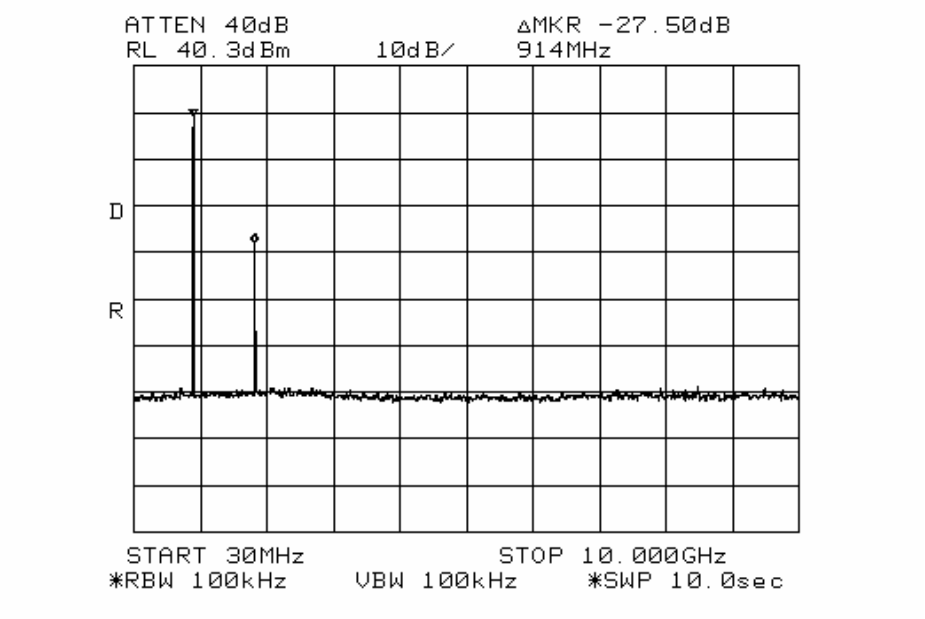


Spurs – Mid Channel



Test Data – Spurious Emissions at Antenna Terminals

Spurs – High Channel



Section 8. Spurious Emissions (Radiated)

NAME OF TEST: Spurious Emissions (Radiated)	PARA. NO.: 15.247(d)
TESTED BY: David Light	DATE: 17 August 2007

Test Results: Complies. The worst case emission was 52.9 dBµV/m at 2707.2 MHz. This is 1.1 dB below the specification limit of 54.0 dBµV/m.

Measurement Data: See attached table.

Duty Cycle Calculation:

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

Notes:

☐ For handheld devices, the EUT was tested on three orthogonal axis'

☒ 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: 759-760-1464-1484-1485-791-1016-1033

Measurement Uncertainty: +/-3.6 dB

Temperature: 21 °C

Relative Humidity: 40 %

Analyzer Settings:

RBW = VBW = 100 kHz (below 1000 MHz)
RBW = VBW = 1 MHz (above 1000 MHz)

Test Data - Radiated Emissions

2 dBi dipole

Freq MHz	Rdng dBµV	Duty C Horn dB	Cable Pre-A dB	Cable dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
2745.6	55.9		+0.7	+2.0		+0.0	49.0	54.0	-5.0	Vert
		+28.5	-31.8					Mid Channel		
8236.8	43.3		+1.3	+4.3		+0.0	52.9	54.0	-1.1	Vert
		+37.3	-33.3					Mid Channel		
8236.8	42.3		+1.3	+4.3		+0.0	52.9	54.0	-21	Horiz
		+37.3	-33.3					Mid Channel		
2782.8	54.9		+0.7	+2.0		+0.0	48.0	54.0	-6	Vert
		+28.5	-31.8					High channel		
8348.4	45.2		+1.3	+4.3		+0.0	54.3	74.0	-19.7	Horiz
		+37.3	-33.3					High channel		
8348.4	45.2	-4.0	+1.3	+4.3		+0.0	50.3	54.0	-3.7	Horiz
Average		37.3	-33.3					High channel		

Please refer to page 14 for duty cycle correction.

All readings are peak unless otherwise indicated. If the peak reading met the average limit, then an average reading was not made.

Peak rdg (dBµV/m) = Meter reading (dBµV)+AF (dB)+Cables (dB)-Gain (dB)

Average rdg (dBµV/m) = MR (dBµV)+AF (dB)+Cables (dB)-Gain (dB)-Duty cycle(dB)

RBW = VBW = 100 kHz (below 1000 MHz)
RBW = VBW = 1 MHz (above 1000 MHz)

Test Data - Radiated Emissions

7.2 dBi helical loaded omni with ground plane

Freq MHz	Rdng dBµV	Duty C Horn dB	Cable Pre-A dB	Cable dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
2707.2	52.7		+0.8	+2.8		+0.0	52.9	54.0	-1.1	Vert
		+29.3	-32.7					Low Channel		
7219.2	43.8	-4.0	+1.4	+4.2		+0.0	53.5	74.0	-20.5	Horiz
		+36.9	-32.8					Low Channel		
7219.2	43.8		+1.4	+4.2		+0.0	49.5	54.0	-4.5	Horiz
Average		+36.9	-32.8					Low Channel		
8121.6	43.3		+1.4	+4.3		+0.0	53.0	74.0	-21.0	Horiz
		+37.5	-33.5					Low Channel		
8121.6	43.3	-4.0	+1.4	+4.3		+0.0	49.0	54.0	-5.0	Horiz
Average		+37.5	-33.5					Low Channel		
3660.8	51.5		+0.8	+2.8		+0.0	53.3	54.0	-20.7	Vert
		+30.5	-+32.3					Mid Channel		
3660.8	51.5	-4.0	+0.8	+2.8		+0.0	53.3	54.0	-4.7	Vert
Average		+30.5	-32.3					Mid Channel		
3660.8	47.5		+1.3	+4.0		+0.0	49.3	54.0	-4.7	Horiz
		+35.2	+31.1					Mid Channel		
2782.8	51.3		+0.8	+2.9		+0.0	51.7	54.0	-2.3	Vert
		+29.4	+32.7					High Channel		
3710.4	53.3		+0.8	+2.8		+0.0	55.3	74.0	-18.7	Vert
		+30.6	+32.2					High Channel		
3710.4	53.3	-4.0	+0.8	+2.8		+0.0	51.3	54.0	-2.7	Vert
Average		+30.6	+32.2					High Channel		
8348.4	45.0		+1.2	+4.4		+0.0	54.2	74.0	-19.2	Vert
		+37.1	+33.5					High Channel		
8348.4	45.0	-4.0	+1.2	+4.4		+0.0	50.2	54.0	-3.8	Vert
Average		+37.1	+33.5					High Channel		
3710.4	49.5		+0.8	+2.8		+0.0	51.5	54.0	-2.5	Horiz
		+30.6	+32.2					High Channel		
8348.4	46.2		+1.2	+4.4		+0.0	55.3	74.0	-18.7	Horiz
		+37.1	+33.6					High Channel		
8348.4	46.2	-4.0	+1.2	+4.4		+0.0	51.3	54.0	-2.7	Horiz
Average		+37.1	+33.6					High Channel		

Test Data - Radiated Emissions

8 dBi Omni

Freq MHz	Rdng dBµV	Duty C Horn dB	Cable Pre-A dB	Cable dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
2707.2	52.0		+0.8	+2.9		+0.0	52.0	54.0	-2.0	Vert
		+29	-32.7					Low Channel		
3609.6	51.5		+0.8	+2.8		+0.0	53.0	74.0	-21.0	Vert
		+30.3	-32.4					Low Channel		
3609.6	51.5	-4.0	+0.8	+2.8		+0.0	53.0	54.0	-5.0	Vert
Average		+30.3	-32.4					Low Channel		
2707.2	51.0		+0.8	+2.9		+0.0	51.0	54.0	-3.0	Vert
		+29	-32.7					Low Channel		
3609.6	49.7		+0.8	+2.8		+0.0	51.2	54.0	-2.8	Horiz
		+30.3	-32.4					Low Channel		
2745.6	48.0		+0.8	+2.9		+0.0	48.0	54.0	-6.0	Vert
		+29	-32.7					Mid Channel		
8236.8	45.8		+1.3	+4.3		+0.0	55.4	57.0	-18.6	Vert
		+37.3	+33.3					Mid Channel		
8236.8	45.8	-4.0	+1.3	+4.3		+0.0	51.4	54.0	-2.6	Vert
Average		+37.3	+33.3					Mid Channel		
3660.8	49.8		+0.8	+2.8		+0.0	51.6	54.0	-2.4	Horiz
		+30.5	+32.3					Mid Channel		
8236.8	45.2		+1.3	+4.3		+0.0	54.8	74.0	-19.2	Horiz
		+37.3	+33.3					Mid Channel		
8236.8	45.2	-4.0	+1.3	+4.3		+0.0	50.8	54.0	-3.2	Horiz
Average		+37.3	+33.3					Mid Channel		
8348.4	43.7		+1.3	+4.3		+0.0	53.4	74.0	-20.6	Vert
		+37.3	+33.2					High Channel		
8348.4	43.7	-4.0	+1.3	+4.3		+0.0	49.4	54.0	-4.6	Vert
Average		+37.3	+33.2					High Channel		
3710.4	50.0		+0.8	+2.8		+0.0	52.0	54.0	-2.0	Horiz
		+30.6	+32.2					High Channel		
8348.4	46.5		+1.2	+4.4		+0.0	55.7	74.0	-18.3	Horiz
		+37.1	+33.5					High Channel		
8348.4	46.5		+1.2	+4.4		+0.0	51.7	54.0	-2.3	Horiz
Average		+37.1	+33.5					High Channel		

Test Data - Radiated Emissions

10 dBi Yagi

Freq MHz	Rdng dBµV	Duty C Horn dB	Cable Pre-A dB	Cable dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
2707.2	51.0		+0.8	+2.9		+0.0	51.0	54.0	-3.0	Vert
		+29	-32.7					Low Channel		
3609.6	48.5		+0.8	+2.8		+0.0	50.0	54.0	-4.0	Vert
		+30.3	-32.4					Low Channel		
4512.0	-46.4		+1.0	+3.1		+0.0	51.0	54.0	-3.0	Vert
		+32.0	-31.5					Low Channel		
2707.2	48.0		+0.8	+2.9		+0.0	48.0	54.0	-6.0	Horiz
		+29	-32.7					Low Channel		
3609.6	47.5		+0.8	+2.8		+0.0	49.0	54.0	-5.0	Horiz
		+30.3	-32.4					Low Channel		
2745.6	47.0		+0.8	+2.9		+0.0	47.0	54.0	-7.0	Vert
		+29	-32.7					Mid Channel		
3660.8	46.5		+0.8	+2.8		+0.0	48.0	54.0	-6.0	Vert
		+30.3	-32.4					Mid Channel		
3660.8	46.5		+0.8	+2.8		+0.0	48.0	54.0	-6.0	Horiz
		+30.3	-32.4					Mid Channel		
8236.8	44.3		+1.3	+4.3		+0.0	53.9	74.0	-20.1	Horiz
		+37.3	+33.3							
8236.8	44.3	-4.0	+1.3	+4.3		+0.0	49.9	54.0	-4.1	Horiz
Average		+37.3	+33.3							

Test Data - Radiated Emissions

1 dBi monopole

Freq MHz	Rdng dBµV	Duty C Horn dB	Cable Pre-A dB	Cable dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
2707.2	53.0		+0.8	+2.8		+0.0	53.2	74.0	-20.8	Vert
		+29.3	-32.7					Low Channel		
2707.2	53.0	-4.0	+0.8	+2.8		+0.0	49.2	54.0	-4.8	Vert
Average		+29.3	-32.7					Low Channel		
3609.6	48.5		+0.8	+2.8		+0.0	50.0	54.0	-4.0	Vert
		+30.3	-32.4					Low Channel		
2707.2	50.0		+0.8	+2.9		+0.0	50.0	54.0	-4.0	Horiz
		+29	-32.7					Low Channel		
3609.6	47.5		+0.8	+2.8		+0.0	49.0	54.0	-5.0	Horiz
		+30.3	-32.4					Low Channel		
2745.6	47.0		+0.8	+2.9		+0.0	47.0	54.0	-7.0	Vert
		+29	-32.7					Mid Channel		
3660.8	46.5		+0.8	+2.8		+0.0	48.0	54.0	-6.0	Vert
		+30.3	-32.4					Mid Channel		
2745.6	47.0		+0.8	+2.9		+0.0	47.0	54.0	-7.0	Horiz
		+29	-32.7					Mid Channel		
2782.8	54.9		+0.7	+2.0		+0.0	48.0	54.0	-6.0	Vert
		+28.5	-31.8					High channel		
7420.8	44.3		+1.3	+4.1		+0.0	53.6	74.0	-20.4	Vert
		+36.7	-32.8					High channel		
7420.8	44.3	-4.0	+1.3	+4.1		+0.0	49.6	54.0	-4.4	Vert
Average		+36.7	-32.8							
8348.4	43.7		+1.3	+4.3		+0.0	53.4	74.0	-20.6	Vert
		+37.4	-33.3					High channel		
8348.4	43.7	-4.0	+1.3	+4.3		+0.0	53.4	54.0	-4.6	Vert
Average		+37.4	-33.3					High channel		
3710.4	48.0		+0.8	+2.8		+0.0	50.0	54.0	-2.5	Horiz
		+30.6	-32.2					High Channel		

All measurements are PEAK unless otherwise stated.

Section 9. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1183	Receiver HF/VHF	Scwarzbeck VUME1520A	0	04/12/00	N/A
1053	VECTOR SIGNAL GENERATOR 300 KHz	ROHDE & SCHWARZ SMIQ 03	DE22081	09/29/05	09/30/08
759	ANTENNA, LOG PERIODIC	A.H. SYSTEMS SAS-200/510	556	03/30/07	03/29/08
760	Antenna biconical	Electro Metrics MFC-25	477	01/19/07	01/19/08
1033	Horn antenna	EMCO 3115	8812-3035	07/28/06	07/28/08
802	Near Field Probe Set	EMCO 7405	103	N/A	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/24/07	01/24/09
1484	Cable	Storm PR90-010-072	N/A	05/02/07	05/01/08
1485	Cable	Storm PR90-010-216	N/A	05/02/07	05/01/08
791	PREAMP, 25dB	Nemko USA, Inc. LNA25	398	05/01/07	04/30/08
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	05/01/07	04/30/08
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE	CBU	N/A
1082	CABLE 2m	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A

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. 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.: 15.247(a)(1)

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 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)(1)

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.: 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(d)

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(d)

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

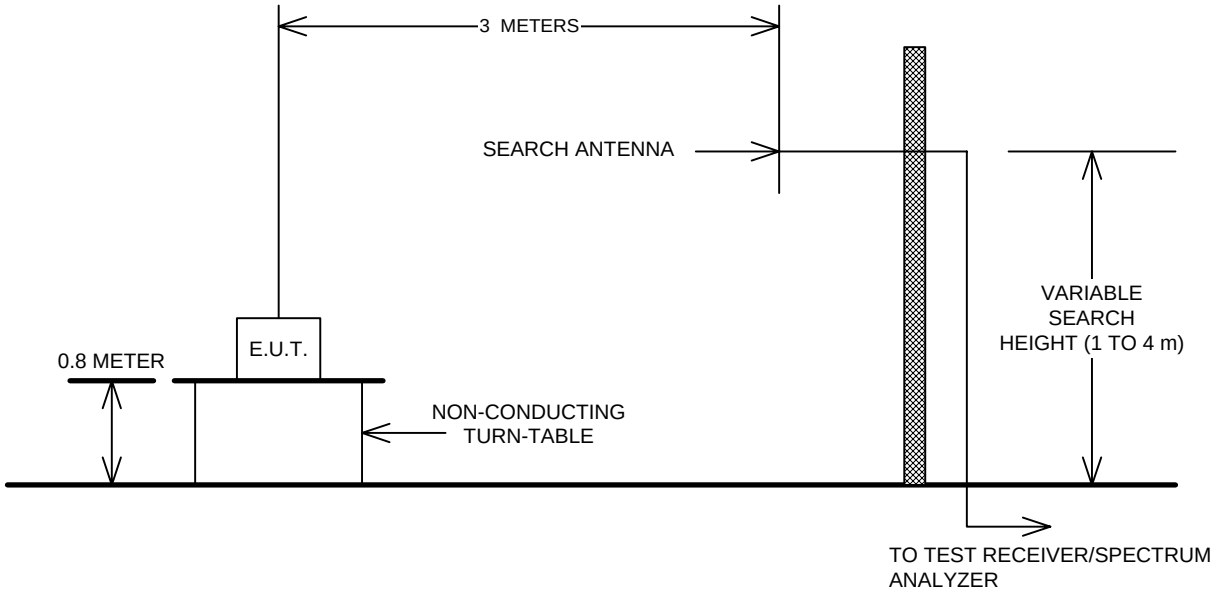
MHz	MHz	MHz	GHz
0.09-0.11	16.42-16.423	399.9-410	4.5-5.25
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.125-6.218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

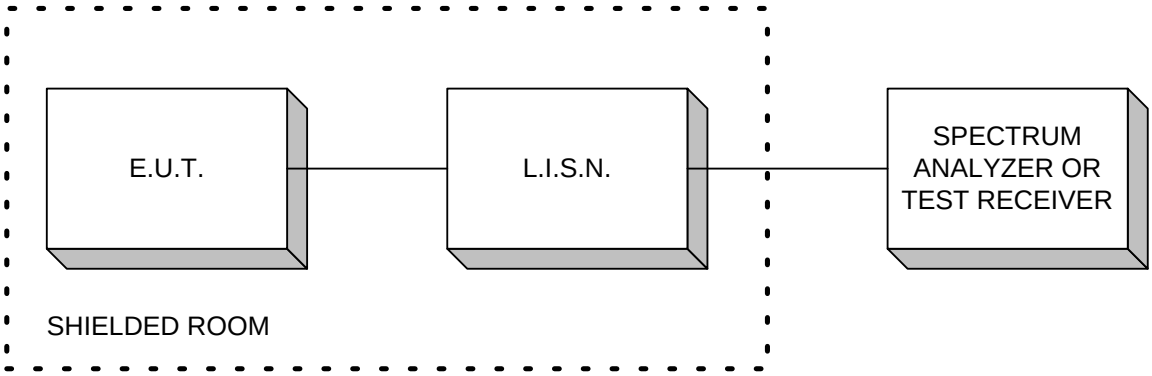
Tuning range	Number of channels tested	Channel location in band
1 MHz or less	1	middle
1 to 10 MHz	2	top and bottom
more than 10 MHz	3	top, middle, bottom

ANNEX B - TEST DIAGRAMS

Test Site For Radiated Emissions



Conducted Emissions



Peak Power at Antenna Terminals